FACILITATION OF SURGICAL DECISIONS WITHIN A FUNCTIONAL RESTORATION PROGRAM FOR CHRONIC DISABLING OCCUPATIONAL MUSCULOSKELETAL DISORDERS

by

EMILY BREDE

Presented to the Faculty of the Graduate School of

The University of Texas at Arlington in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT ARLINGTON

December 2012

ACKNOWLEDGEMENTS

I would like to thank the members of my committee, Dr. Angela Dougall, Dr. Yuan Peng, and Dr. Robert Gatchel, for their guidance and advice in the writing of this paper. I would also like to thank Dr. Tom Mayer and the staff of the Productive Rehabilitation Institute of Dallas for Ergonomics for allowing me to participate in their research program. Finally, I would like to thank my family for their love and support.

November 9, 2012

ABSTRACT

FACILITATION OF SURGICAL DECISIONS WITHIN A FUNCTIONAL RESTORATION PROGRAM FOR CHRONIC DISABLING OCCUPATIONAL MUSCULOSKELETAL DISORDERS

Emily Brede, PhD

The University of Texas at Arlington, 2012

Supervising Professor: Robert J. Gatchel

Preventing delayed recovery is an important treatment goal in the treatment of chronic disabling occupational musculoskeletal disorders (CDOMDs). However, when CDOMD patients are potentially eligible for elective surgical procedures, decisions about whether or not to pursue surgery can be complicated by surgical uncertainty, which can decrease the likelihood of complete recovery from injury. Resolution of surgical uncertainty allows treatment to proceed, so that patients can reach Maximum Medical Improvement, and ideally return to productivity. The purpose of the current study was to resolve surgical uncertainty while preventing delayed recovery through a surgical option process.

Patients who were undecided about pursuing elective surgical procedures were admitted to an interdisciplinary functional restoration program. After completing half of the treatment (usually 10 full day sessions) the patients re-evaluated whether or not to pursue surgery. Patients were divided into three groups for comparison based on the outcome of the surgical decision meeting: (1) declined surgery (DS, *N* = 164), (2) underwent surgery (US, *N* = 43), and (3)

requested surgery but had the request denied (RSD, *N* = 38). These three groups were compared to a matched comparison group of patients who lacked a surgical option at admission (COMP, *N* = 272). All patients were offered the opportunity to complete the functional restoration program after resolving the surgical option. At one-year after discharge from functional restoration (or discontinuation of treatment), patients were contacted for a structured interview to assess socioeconomic outcomes.

Results of the SOP program were excellent. Although unable to select a treatment option prior to the SOP, 83% of patients were able to make a decision of whether or not to pursue surgery, and 84% of those patients ultimately received the treatment they preferred. Over two-thirds of the patients in the SOP made a personal choice not to pursue surgery, and the majority of patients who chose to pursue surgery went on to receive the requested procedure. The RSD group was less likely than the other groups to complete the full course of functional restoration. A non-significant trend for the RSD group to show less improvement in psychosocial distress measures over the course of functional restoration treatment was identified. RSD patients were less likely to return to work after discharge and were less likely to remain at work compared to the patients in the other three groups. Most patients (99%) adhered to the treatment course they chose during the SOP, and did not have surgery after discharge from functional restoration. Patients who received their desired treatment (DS and US groups) showed significant improvements in pain, disability, depressive symptoms, and health-related quality of life. These patients also had very high rates of return to work and work retention, as well as low levels of excessive healthcare utilization, similar to the COMP group. This suggests that participation in a surgical option process within the context of a functional restoration program can resolve surgical uncertainty for most patients and can help prevent delayed recovery by offering earlier access to high-quality rehabilitation treatment.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

Figure Page

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Decisions about surgical treatment of chronic disabling occupational musculoskeletal disorders (CDOMDs) can be difficult and time consuming. Although in many acute injury conditions and certain chronic conditions, the indications for surgical care well-established, in most cases of chronic pain the indications for surgery are unclear and create a great deal of uncertainty for both providers and patients. Most clinical practice guidelines and workers' compensation systems recommend at least a trial of conservative care before considering surgery, and many guidelines specify that non-operative care should be exhausted prior to surgical treatment (Denniston & Kennedy Jr., 2012). However, there is no objective mechanism for determining when conservative care is exhausted, and perceptions of how long conservative care should be used can vary greatly between providers. In addition, lengthy pre-authorization processes for insurance approval can produce significant delays in obtaining care. This is further complicated by "turf wars" over which insurance carrier is responsible for treatment. Workers' compensation policies are supposed to provide care for work-related injuries but not for other medical conditions, while regular medical insurance is obligated to provide care for most medical conditions, but does not cover work-related injuries. In many CDOMDs the exact etiology of the pain condition is unclear, and disputes over whether an injury is work-related can last for months. Moreover, CDOMD patients often receive mixed messages from providers, family or friends, and self-directed internet "research" which may result in unrealistic patient expectations about the necessity of surgery and the improvement that is likely to result from surgery. Furthermore, when providers and carriers disagree about the most appropriate course of treatment for a patient, even greater delays are introduced into the decision-making process. All of these factors serve to

complicate and prolong the surgical decision-making process for patients with CDOMDs. These delays in treatment may cause delays in recovery, which harms not only the patient, who becomes less likely to recover as treatment delays add up, but also to the insurance carrier, who is responsible for wage replacement and medical care until Maximum Medical Improvement is reached. However, delays in surgical decision-making prevent the progression of medical treatment and prolong the duration of disability, leading to delayed recovery.

Confusion about surgical decisions can come from multiple sources within the healthcare system. In many CDOMDs, the most advanced diagnostic tests are non-specific, resulting in high rates of pathological findings in patients who are asymptomatic. For example, 19% of asymptomatic patients have MRI evidence of bulging or herniated intervertebral discs in the cervical spine, and as many as 70% of asymptomatic patients have herniated lumbar discs identified on MRI (Goldberg, Singh, Van, Garretson, & An, 2002; Lurie et al., 2008). In patients over the age of 60, MRI scans will show evidence of rotator cuff tears in 50% of asymptomatic patients, and 23% of asymptomatic patients will have evidence of rotator cuff tears on ultrasound (Wiesel, Sankar, Delahay, & Wiesel, 2010; Worland, Lee, Orozco, SozaRex, & Keenan, 2003). Similarly, 24% of patients without knee symptoms will have MRI findings indicating a torn meniscus (LaPrade, Burnett, Veenstra, & Hodgman, 1994). On the other hand, about 2% of patients with acute low back pain fail all treatments, and develop severe disability, even though no diagnostic testing can identify a source of the pain (Wiesel et al., 2010). For this reason, clinical practice guidelines always recommend that diagnostic imaging be performed only as a confirmatory test, and that test results that do not correlate with clinical findings and patient history should be interpreted with caution. However, many patients, on hearing that their diagnostic testing was “abnormal” cannot understand why providers will not “just fix it” and resolve their symptoms. Many patients become convinced that surgery will be the solution to all their problems, and are angry and resentful when their requests for surgery are denied as medically unnecessary. However, when symptoms of physical deconditioning and psychosocial

dysfunction are not addressed in these CDOMD patients, even surgical treatment has a high likelihood of unsatisfactory outcomes.

In addition to uncertainty about whether or not surgery is indicated, there is also considerable uncertainty about whether or not surgery will be helpful. Depending of the type of surgery, anywhere from 10-60% of surgical results for CDOMD patients will be unsatisfactory, and many patients report that surgery failed to produce any improvement in their pain intensity, functional abilities, or quality of life (DeBerard, Masters, Colledge, Schleusener, & Schlegel, 2001; Fritzell, Hagg, Wessberg, & Nordwall, 2001; J. N. Katz et al., 2006; Lädermann, Denard, & Burkhart, 2011; V. Wylde, Dieppe, Hewlett, & Learmonth, 2007; Young, Shaffrey, Laws Jr, & Lovell, 1997). Many of the factors that predispose patients to poor surgical outcomes are the same factors that have led them to develop CDOMD in the first place, such as worker's compensation claims and/or litigation, psychological disorders, opioid dependence, and longer duration of symptoms (Aalto et al., 2006; Brede, Mayer, & Gatchel, 2012; Howard, Mayer, Theodore, & Gatchel, 2009; Kidner, Mayer, & Gatchel, 2009; Nguyen, Randolph, Talmage, Succop, & Travis, 2011; Trief, Grant, & Fredrickson, 2000). Therefore, in patients with unclear causes of pain symptoms, significant deconditioning, psychosocial distress, and longer duration of disability, treatment programs such as functional restoration, which are intended to improve all of these symptoms, may improve patient outcomes regardless of whether the patient ultimately undergoes surgery.

To address all these problems, the Productive Rehabilitation Institute of Dallas for Ergonomics (PRIDE) has developed a surgical option process to aid CDOMD patients in making surgical decisions while preventing treatment delays. Under the Surgical Option Process (SOP), patients referred for tertiary rehabilitation for CDOMD, who have an open surgical option (i.e., they have not been conclusively approved or denied for surgery or they are ambivalent about undergoing surgery), entered the functional restoration program at PRIDE. After completing half of the treatment sessions, the patient met with the treatment team to determine if he or she still wishes to pursue surgery. Patients who decided not to pursue surgery were invited to complete

the remaining sessions of functional restoration. Patients who decided that they would prefer to have surgery were referred to the appropriate specialist, with the understanding that the patient would return to PRIDE after the post-operative healing period and complete the remaining functional restoration sessions.

1.2 Pilot Data

A pilot study of the surgical option process (SOP) at PRIDE included a consecutive cohort of 44 patients with an unresolved surgical option (T. G. Mayer, Worzer, Shea, Garcia, & Gatchel, under review). Patients were identified as possible surgical candidates by the at least one treating physician; however, the patient was ambivalent about having surgery, there was a difference of opinion between two or more surgeons, or the request for surgery was denied by the workers' compensation carrier. Patients were compared in groups according to the decision made regarding surgery at the program midpoint. Thirty-two patients declined surgery, four patients elected to undergo surgery and received surgery (which was approved despite a prior dispute), and eight patients elected to undergo surgery, but were denied surgery by a new surgical consultant. Patients who were denied surgery were offered the chance to complete functional restoration treatment. One year after completion of the functional restoration program, patients were contacted for a structured follow-up interview to assess socioeconomic outcomes. The study found that patients who requested surgery but were denied were less likely to complete the treatment program, compared to patients who declined surgery, and those who received surgery. At the one-year follow-up, patients who were denied surgery less frequently return to work or to retain work compared to patients who declined or received surgery, although this difference was not statistically significant. Patients who were denied surgery also had higher rates of healthcare utilization, mostly due to the fact that they continued to pursue surgery after discharge from PRIDE. These patients were 35 times more likely to seek treatment from a new provider and 35 times more likely to claim a subsequent work injury compared to patients who declined surgery. This study suggested that a surgical option process might improve outcomes for patients who are undecided about pursuing surgery at admission to a functional restoration

program. However, the study was extremely small and underpowered. Therefore the primary goal of the present study was to replicate and expand upon the pilot study.

The present study included a larger cohort of surgical option patients, discharged between 2004 a 2011, with an sample size adequate detect small to medium effects and enough participants to detect the non-significant differences in return to work and work retention identified in the pilot study. In addition, with a larger sample, more comparisons were possible, allowing the evaluation of differences in pain, disability, and psychosocial distress among the different SOP decision groups. The pilot study only included a few types of surgery: lumbar spine fusion, rotator cuff repair, and arthroscopic meniscectomy. The present study included a greater variety of types of injury and surgical procedures. The next few chapters will review the current literature regarding common surgeries considered in CDOMD patients, including the indications for surgery, the surgical procedures and recovery regimens, the outcomes associated with the procedures, and the current evidence-based treatment guidelines.

CHAPTER 2

SPINAL DISORDERS.

Spinal pain is highly prevalent among industrialized nations, with as many as 85% of people experiencing significant back pain and 66% of people experiencing significant neck pain at some point during their lives (Cote, Cassidy, & Carroll, 2003; Wiesel et al., 2010). Many cases of back and neck pain will be uncomplicated cases of muscle sprain or strain that resolve in a few weeks, but a small number of people will develop more serious spinal conditions that require surgical intervention (Wiesel et al., 2010).

2.1 Neck Pain

Neck pain related to muscle strain is believed to be generated by the ligaments, facet joints, and surrounding musculature of the cervical spine. The most well-known example of neck pain results from high impact collisions, such as motor vehicle crashes, and is referred to as whiplash. Whiplash is the result of an acceleration-deceleration injury that causes hyper-flexion followed by hyper-extension, resulting in neck sprain. Most neck strains, however, are not traumatic in nature, and have either a gradual onset or no known cause. Neck strains usually resolve spontaneously within one or two weeks, and in the absence of a traumatic event, no diagnostic testing is recommended unless pain persists longer than two weeks (Wiesel et al., 2010). If there are no signs of nerve root compression or other neurological symptoms, there is no evidence that surgery is beneficial for neck pain (Carragee et al., 2009).

Neck pain resulting from structural pathology is more persistent and may require more intensive intervention. Cervical radiculopathy is neck pain resulting from the compression or irritation of a cervical spine nerve root, and usually produces symptoms of pain or paresthesia along the nerve root distribution. Forty-five percent of cervical radiculopathies resolve without

surgical intervention and do not re-occur, making non-operative care the treatment of choice. However, for the 25% of cervical radiculopathy patients who develop persistent and/or recurrent neck pain, surgery may be among the treatment options. In contrast to radiculopathy, cervical myelopathy results from compression of the entire spinal cord rather than an isolated nerve root, and is a more serious condition. Symptoms of cervical myelopathy include numbness and impaired fine motor function of the fingers and hands, weakness of the lower extremities, gait and balance difficulties, and urinary system dysfunction. If evidence of progressive neurological symptoms if found, surgery may be indicated (Wiesel et al., 2010).

Symptoms of cervical radiculopathy or myelopathy may result from several different conditions, such as disc herniation or spondylosis. A cervical spine disc herniation occurs when a portion of the disc protrudes through a tear in the annulus fibrosis into the spinal canal. The herniated disc may compress either a single nerve root or the entire cord; myelopathy is more common with cervical disc herniations than with lumbar disc herniations due to the difference in the diameter of the spinal canal in the cervical and lumbar regions. The most common presentation for cervical disc herniation is the compression of the nerve root, which causes pain in the neck and arm. Diagnostic imaging is recommended only as a confirmatory test (i.e., in addition to history and physical examination), as up to 19% of asymptomatic individuals will show evidence of cervical disc herniations on MRI (Goldberg et al., 2002). Most cervical disc herniations can be treated non-operatively, with anti-inflammatory medications and rest. For persistent pain, physical therapy, selective nerve root blocks, and epidural steroid injections are also possible treatments (Wiesel et al., 2010). Cervical spondylosis, or degenerative disc disease, may also cause symptoms of radiculopathy or myelopathy. Spondylosis is usually the result of age-related deterioration of the intervertebral disc, with a loss of water, proteoglycan, and collagen. This causes a decrease in disc height and a narrowing of the disc space, which may put pressure on the nerve roots or spinal cord. Patients with cervical spondylosis typically present with referred pain patterns or radicular symptoms. If there is no evidence of severe spinal cord involvement, cervical spondylosis may also be treated non-operatively, with anti-

inflammatory medications, trigger point injections (anti-inflammatory or anesthetic injections into small points of painful contracted muscle), selective nerve root blocks, or epidural spinal injections. In cases where there is progressive neurological deterioration or intractable pain, surgery may be considered for cervical disc herniation or spondylosis (Wiesel et al., 2010).

2.1.1 Surgical Procedures for Neck Pain

There are some disorders in which the indications for cervical surgery are clear. These include stabilization of spinal fracture or dislocation, removal of tumors, hemorrhage or infection that threatens the airway, and degenerative or inflammatory conditions that cause increasing spinal cord compression with loss of function (Carragee et al., 2009). However, the indications for cervical surgery for neck pain in the absence of impending spinal cord compromise are often unclear. The Official Disability Guidelines, published by the Work Loss Data Institute, do not recommend surgery unless there is evidence of radicular pain, motor deficit or reflex change, abnormal imaging findings, and the patient has failed to improve after a 6-8 week trial of conservative care (Denniston & Kennedy Jr., 2012). According to the American Board of Orthopedic Surgeons, cervical discectomies and fusions increased by 67% each year from 1999 to 2008. In addition, there were dramatic increases in the use of allograft, interbody fusion devices, and anterior cervical plating (McGuire, Harrast, Herkowitz, & Weinstein, 2012).

The most common surgical treatment for neck pain is anterior cervical discectomy and fusion (ACDF). In this procedure, the incision is made to the anterior neck and dissection proceeds through the sternocleidomastoid muscle, avoiding the carotid sheath on the lateral side and the esophagus and trachea on the medial side. This allows access to the spine from the anterior angle, and the damaged disc is removed in its entirety. To maintain disc height, a bone graft or device is implanted in the disc space, and the spinal levels are usually joined with instrumentation such as pedicle screws or metal plating to stabilize the spine and promote fusion of the adjacent vertebrae (Bono & Garfin, 2004). In certain circumstances, a posterior approach may be used. In the posterior approach, the incision is made to the back of the neck, and the inferior aspect of the facet above the involved disc is resected to allow access to the disc space. For disc

herniations, the protruding portion of the disc is removed, and for stenosis (narrowing of the spinal canal) osteophytes may be removed to decompress the nerve root or the foramen may be enlarged. In general, the posterior approach has fewer complications than the anterior approach, but allows more limited access to the spine (Bono & Garfin, 2004). Other surgical options for neck pain with radiculopathy or myelopathy include decompression without fusion, in which the structure impinging upon the spinal cord (e.g., osteophytes or herniated discs) are removed without fusion of the spine, and fusion without instrumentation, where only bone grafts are used to fuse the spine (Carragee et al., 2009). A few clinical trials have suggested that an artificial disc prosthesis may be used to replace the damaged disc, but so far only short term outcomes are available, and these results are not conclusive as to the safety or efficacy of artificial disc replacement (Carragee et al., 2009; Kishen & Diwan, 2010)

There are many different types of implants that can be used to fuse the cervical spine, such as titanium or carbon fiber cages, rods, plates, and screws. The addition of hardware may increase the rate of bony fusion, but fusion is not necessarily indicative of better functional outcomes (Tribus, Corteen, & Zdeblick, 1999). In addition, there are several options for graft material to insert along with or instead of the implant. The most reliable graft material is autologous bone, harvested from the iliac crest or the facets of the resected vertebrae. Alternatively, an allograft procedure may be used with bone from a tissue donor bank. There are several commercial products available as bone graft substitutes or extenders, such as demineralized bone matrix, calcium based products, and recombinant bone morphogenetic protein; however, synthetic products are associated with higher complication rates than either autograft or allograft bone (Carragee, Hurwitz, & Weiner, 2011).

Most cervical spine surgeries are performed as inpatient procedures, although there have been a few reports of successful outpatient cervical spine surgeries (Villavicencio, Pushchak, Burneikiene, & Thramann, 2007). Depending on surgeon preference, the patients may be instructed to wear a cervical collar for the first few post-operative days. The patient should be mobilized within the first 24 hours of surgery unless there are serious complications (Vokshoor,

2012). Most patients do not require more than a two day hospital stay (Denniston & Kennedy Jr., 2012). Activity is restricted for the first one or two weeks after surgery, and light mobilization (such as walking) may begin after the second week, although lifting is generally restricted. Depending on the extent of the surgery and the number of levels involved, physical therapy and exercise may begin 4-6 weeks post-operatively, with return to vigorous sport activity not anticipated until full healing is reached, at about three months (Vokshoor, 2012).

2.1.2 Outcomes of Surgery and Risk Factors for Poor Outcomes

In general, the results of ACDF procedures are good, with about 80% of patients reporting improvements pain and function at long term follow-up (Carragee et al., 2009; Davis, 1996; Konya, Ozgen, Gercek, & Pamir, 2009; Peolsson, Vavruch, & Öberg, 2002, 2006; Persson, Carlsson, & Carlsson, 1997). Most patients will improve in strength, range of motion, paresthesia, and health-related quality of life, and will have mild or absent residual impairments (Carragee et al., 2009; Konya et al., 2009; Peolsson et al., 2002, 2006; Persson et al., 1997). There is no evidence that any particular fusion technique is superior to the others (Carragee et al., 2009; Rao, Christie, Ghahreman, Cartwright, & Ferch, 2008) and complication rates are generally low. The most frequent complications are failure of the vertebrae to solidly fuse together, difficulty swallowing, respiratory insufficiency, and vocal cord paralysis (Carragee et al., 2009; Y.-C. Chou et al., 2008; Singh et al., 2012). Because the fusion of vertebral segments eliminates motion at that spinal segment, there is greater mechanical strain to the nearby spinal vertebrae, which may result in adjacent segment disease, or the deterioration of adjacent spinal segments. Adjacent segment disease may occur with symptoms of nerve root compression or may be asymptomatic. About 4-5% of ACDF patients undergo additional surgery for adjacent segment disease; this increases with the number of levels fused, and about 25% of 3-level ACDF patients will develop adjacent segment disease in 3.5 years (Kaptain et al., 1999; Singh et al., 2012). The prognosis for additional surgery is generally poorer than for the index procedure, with as many as 30% of patients reporting fair or poor outcomes (Kaptain et al., 1999; Tribus et al., 1999).

Workers' compensation patients and patients involved in litigation proceedings may be at risk delayed recovery after ACDF compared to other patients. Goldberg and colleagues (2002) found that workers' compensation patients had similar outcomes to non-compensated patients in overall outcomes, satisfaction with treatment, physical function, and return to work, although the workers' compensation patients took longer to return to full work duty than non-compensated patients. Most authors found no differences in outcome between compensated and non-compensated ACDF patients (Kaptain et al., 1999; Rao et al., 2008). For patients receiving ACDF under workers' compensation, half of patients return to work within 100 days and over 90% return to work by 12 months post-operatively (Denniston & Kennedy Jr., 2012).

2.2 Low Back Pain

Low back pain is a common condition, with a lifetime prevalence of over 80% and a one month prevalence of 23% (Hoy et al., 2012). Most back pain is the result of strain, sprain, or overexertion, and patients present with limitations in range of motion, localized tenderness, and spasm along the paravertebral muscles (Wiesel et al., 2010). For non-specific low back pain, 80-90% of cases will resolve within 6 months, although patients who have worse general health, psychiatric comorbidities, prior episodes of back pain are at higher risk of developing chronic low back pain (R. Chou & Shekelle, 2010).

Uncomplicated, acute low back pain without signs of nerve root or spinal cord compression should be treated conservatively. Clinical practice guidelines recommend non-steroidal anti-inflammatory drugs (NSAIDs) or acetaminophen as the first line of pharmacological treatment, along with instructions to remain active, and reassurance that the prognosis for acute low back pain is favorable. In addition, bed rest should be avoided, and a supervised exercise program or physical therapy is usually not necessary for acute and subacute pain (Koes et al., 2010). According to the Official Disability Guidelines, 75% of patients with acute low back pain without radiculopathy can safely return to work within 1-2 weeks (Denniston & Kennedy Jr., 2012). However, if low back pain persists longer than three to six months, or signs of neurological deterioration are noted, more intensive interventions may be necessary.

Life-threatening conditions arising from injury to the low back are extremely rare, but should be evaluated carefully. Cauda Equina syndrome results from the compression of the nerves exiting the spinal canal below the level of the first lumbar vertebrae. Presenting symptoms are extreme bilateral back pain with bilateral radiculopathy, severe or progressive weakness of the lower extremities, paresthesia of the groin or lower extremities, reduced or absent lower extremity reflexes, and urinary retention followed by incontinence. Surgery to decompress the nerves of the cauda equina should occur within the first 48 hours after the onset of symptoms (Wiesel et al., 2010). Cauda Equina syndrome is extremely rare and accounts for no more than 3% of spine surgeries (Qureshi, 2011).

Non-emergency low-back conditions for which surgery is a possible treatment option include lumbar disc herniation, spinal stenosis, and spondylolisthesis. Surgery for clearly defined pathological conditions is often successful at relieving back and leg pain, however, surgery for non-specific low back pain is less effective. A small number of people with low back pain will fail to improve with treatment despite no identifiable pathology causing back pain (Wiesel et al., 2010). These patients are over-represented in chronic pain populations, accounting for up to 41% of unsuccessful back surgeries (Long, Filtzer, BenDebba, & Hendler, 1988; Wiesel et al., 2010).

Lumbar disc herniation typically presents with back pain and radiculopathy, often described as a sharp stabbing pain sensation radiating down the leg to a point below the knee. Radicular symptoms are caused by impingement on the nerve root by a portion of the intervertebral disc extending through a cartilage tear. Protruded discs (or “bulging” discs) extend into the spinal canal, but the annulus fibrosis remains intact. An extruded disc crosses the annulus but remains attached to the intervertebral disc; a sequestered disc crosses the annulus and is separated from the nucleus of the intervertebral disc. An uncontained disc herniation crosses both the annulus and the posterior longitudinal ligament (Bono & Garfin, 2004). Disc herniations are most common at the L4-L5 and L5-S1 disc levels, accounting for 95% of all lumbar disc herniations. Disc herniations can often be successfully treated with non-surgical options, such as NSAIDs or other

anti-inflammatory medications, physical therapy, or injections; as many as 80% of patients with herniated lumbar discs respond well to conservative treatment (Wiesel et al., 2010).

Low back pain and radiculopathy can also be caused by stenosis (narrowing of the spinal canal), spondylosis (degenerative changes), or spondylolisthesis (instability between vertebral segments). Stenosis and spondylosis are most often the result of age-related changes in the spine, although both can occur prematurely as a result of prior spine surgery. Spondylolisthesis can be either traumatic in nature, the result of a fracture of the pars interarticularis or the pedicles, or it may be degenerative (Vokshoor, 2012). Most cases of back pain and radiculopathy due to stenosis, spondylosis, and spondylolisthesis can be successfully treated without surgery, but in cases of intractable pain or progressive neurological deterioration, surgery may be considered as a treatment option.

2.2.1 Lumbar Decompression: Discectomy and Laminectomy

The goal of lumbar decompression procedures is to relieve the pressure on the nerve root which is causing the radiculopathy symptoms. The procedure involves removal of a portion of the lamina and spinous process, and an excision of the herniated portion of the disc. In addition, any loose fragments of disc should be removed from the disc space (Bono & Garfin, 2004). For spinal stenosis, laminectomy may be performed without discectomy, and the osteophyte overgrowth that is compressing the nerve root is removed along with any hypertrophied ligaments that impinge on the nerve root (Bono & Garfin, 2004). Patients may ambulate within 4-6 hours after surgery, and may remain in the hospital overnight according to the preference of the surgeon. Most patients should be able to return to work with 6-10 weeks (Sahrakar, 2011). Patients with predominant leg pain (as opposed to predominant back pain) usually have better surgical outcomes, including greater improvements in pain and functional ability (Wiesel et al., 2010).

Patients with relatively short periods of disability prior to surgery may be able to return to normal activity after surgery without physical therapy. However, patients with extensive deconditioning may require additional post-operative interventions to resume normal function.

Many researchers have examined the effects of rehabilitation after lumbar decompression surgery, and most have found that physical therapy or exercise treatments allow patients to resume activity sooner than usual care (Danielsen, Johnsen, Kibsgaard, & Hellevik, 2000; Erdogmus et al., 2007; Tom Mayer et al., 1998). Systematic reviews of rehabilitation after lumbar decompression found strong evidence that intensive exercise and rehabilitation programs beginning 4-6 weeks post-operatively are superior in returning patients to work and improving functional outcomes at short term follow-up, although fewer differences are found at long term follow-up (McFeely & Gracey, 2006; Ostelo et al., 2003). The indirect cost-savings (absenteeism and lost productivity) associated with earlier return to work are quite substantial (Fayssoux, Goldfarb, Vaccaro, & Harrop, 2010), suggesting that providing post-operative rehabilitation to lumbar decompression patients is beneficial to society as well as to the patient.

2.2.2 Outcomes of Spinal Decompression and Risk Factors for Poor Outcomes

Outcomes after discectomy are generally good, although in many cases not significantly different from non-operative care. The Spine Patient Outcomes Research Trial (SPORT) compared surgical treatments against non-operative care for patients with lumbar disc herniation, spinal stenosis, and degenerative spondylolisthesis, at two and four years after treatment (Birkmeyer et al., 2002). According to the intent-to-treat analysis, surgery for disc herniation was found to result in no greater improvement in pain and physical function (as measured by the SF-36), disability (as measured by the Oswestry Disability Index), or treatment satisfaction; but the surgery group did have greater reductions in sciatica bothersomeness that persisted through the four-year follow-up period. However, there were many crossover patients who did not follow their assigned treatment recommendations. When the patients were analyzed as treated, the surgery patients showed greater improvement in pain, physical function, disability, and treatment satisfaction than patients treated non-operatively. There were no differences in return to work between the surgical and non-operative groups in either the intent-to-treat or the as-treated analysis (Weinstein et al., 2008). The cost of treating patients with surgery was over twice as high as the cost of non-operative treatment (Tosteson et al., 2008). In patients with spinal

stenosis, there were greater improvements in pain for the surgery patients than for the non-operative patients at the two-year follow-up, however, at three and four years there were no significant differences between groups, according to the intent-to-treat analysis. In the as-treated analysis, significantly greater improvements were seen in pain, physical function, and perceived disability for the surgically treated patients, who also reported higher treatment satisfaction and rated themselves as more improved than the patients treated non-operatively (Weinstein et al., 2010). Finally, the Maine Lumbar Spine Study followed patients treated surgically and non-surgically for lumbar stenosis over a ten-year period. Patients treated surgically showed greater improvement in leg pain and perceived disability, but no greater improvement in back pain, treatment satisfaction, or general heath compared to patients treated non-operatively (Atlas, Keller, Wu, Deyo, & Singer, 2005). Overall, the state of the current scientific evidence does not provide conclusive evidence favoring either surgical or non-surgical treatment for lumbar disc herniations or spinal stenosis, leading to greater uncertainty for patients and providers trying to make informed decisions regarding medical treatment.

Other studies have examined risk factors for poorer outcomes after lumbar decompression surgery. Patients treated with lumbar decompression for disc herniations at the L2-L3 and L3-L4 levels had significantly better outcomes compared to surgery at the L5-S1 level, which had the worst outcomes (Lurie et al., 2008). In the Maine Lumbar Spine Study, patients with better baseline social function and general health and patients with higher levels of education were more satisfied with treatment, while patients who smoked tobacco had lower levels of satisfaction. In addition, patients who were younger and male, with fewer comorbidities and greater pain intensity at baseline were more likely to undergo a second surgery for back pain (Atlas et al., 2005). In the SPORT trial, patients receiving workers' compensation showed greater improvements than the non-operative patients for the first few months after surgery, but after three months the workers' compensation surgery patients declined significantly. By two years after surgery, there were no differences in outcomes between the surgery and non-surgery groups. However, for patients not receiving workers' compensation, the surgically treated groups

maintained their greater levels of improvement over the non-operative patients throughout the two year follow-up (Atlas et al., 2010). One study followed patients for ten years after decompression surgery for spinal stenosis and then performed a follow-up MRI examination. Although 73% of the patients demonstrated post-operative spinal stenosis on MRI, there was no correlation between radiographic evidence of stenosis and perceived improvement, disability on the ODI, walking performance, or pain intensity (Herno et al., 1999). In spinal stenosis, better surgical outcomes are associated with less depression, lower comorbidity, better pre-operative physical function, and higher incomes (Aalto et al., 2006). For herniated disc surgery, less favorable outcomes are associated with less education, high baseline pain intensity, low work satisfaction, longer duration of sick leave, more psychological symptoms, and maladaptive coping strategies (den Boer et al., 2006).

2.2.3 Lumbar Spinal Fusion

For patients with spinal instability, there is a risk of motion between spinal segments causing damage to the spinal cord. In these cases, the spine may be fused at the unstable levels to permanently prevent motion between the unstable segments. There are a variety of surgical techniques, implants, and graft materials that may be used for spinal fusion, although there is not any conclusive evidence to favor one method over the others. Spinal fusion is a very controversial procedure, and after increasing by 220% from 1990-2001, its use has declined slightly from 2002-2007 (Richard A. Deyo et al., 2010; Martin et al., 2007a).

2.2.3.1 Posterolateral Lumbar Fusion (PLF)

In this procedure, the fusion occurs between the pedicle bones. After exposing the spine via a posterior midline incision, decompression of the nerve root or central cord may be performed if necessary. Holes are drilled through the pedicles and into the vertebral bodies of the spine segments above and below the affected disc level and screws are inserted. The screws are joined by rods or plates to reduce the motion of the spinal segment, and bone grafts may be inserted over the lateral portion of the facet joint and transverse process (Pakzaban, 2012b).

2.2.3.2 Posterior Lumbar Interbody Fusion (PLIF)

Posterior lumbar interbody fusion (PLIF) is similar to PLF in approach, using a midline posterior incision to access the spine. Instead of decompression the nerve root, the abnormal disc is completely excised, and a graft is placed in the space formerly occupied by the intervertebral disc. The graft may consist entirely of harvested bone, or be supplemented with instrumentation such as titanium cages or PEEK polymer implants which are packed with autograft, allograft, or synthetic material. The pedicles above and below the graft are joined with screws and rods or plates. The screws are typically tightened around the graft, which promotes the fusion of the bone segments (Pakzaban, 2012b).

2.2.3.3 Transforaminal Lumbar Interbody Fusion (TLIF)

TLIF is usually performed on one side of the spine only, and there are options for either traditional open or minimally invasive techniques. The facet joint is excised from a medial approach, allowing access to the disc space. The disc material is resected, and an implant is inserted into the disc space. The implant may be packed with autograft, allograft, or synthetic material, and additional graft material is placed around the implant to fill in the disc space. Bilateral pedicle screws are inserted, and the implant is compressed to promote fusion (Madhu, 2008; Pakzaban, 2012b).

2.2.3.4 Anterior Lumbar Interbody Fusion (ALIF)

The anterior approach allows better access to the disc space, with less risk to the spinal nerves and ligaments. However, ALIF usually requires a general surgeon to bypass the peritoneum and abdominal organs without damaging the iliac veins or the aorta. Once the spine is exposed by retracting the abdominal organs, the intervertebral disc is excised and an implant is inserted into the disc space. Screws and plates or rods may be inserted into the anterior aspect of the vertebral body to stabilize the spinal segment. Alternatively, the anterior implant may be stabilized with posterior instrumentation, in a circumferential or 360° fusion (Bono & Garfin, 2004; Madhu, 2008; Pakzaban, 2012b).

2.2.4 Rehabilitation after Lumbar Fusion

Spinal fusion usually requires a 1-3 day hospital stay, depending on the extent of the surgery and the development of complications. Early ambulation is recommended, although exercise therapy is often delayed until more than three months post-operatively, and complete healing of the fused spinal segments is not expected until 12 months (Pakzaban, 2012a). Structured rehabilitation programs, beginning three months after surgery have been shown to be more effective than home exercise programs in improving pain, disability, and work status (Tom Mayer et al., 1998; Søgaard, Bünger, Laurberg, & Christensen, 2008). Abbott and colleagues (2010) found that beginning structured rehabilitation as early as three weeks post-operatively was safe, and produced greater improvements on disability, pain, quality of life, fear-avoidance, work status, sick leave, and subsequent healthcare utilization compared to a traditional home exercise program.

2.2.5 Outcomes of Lumbar Fusion

Comparisons of lumbar fusion procedures with intensive rehabilitation programs show that in many cases, outcomes are no better after surgery than after non-operative care. At two year follow up, exercise programs combined with cognitive behavioral therapy are equivalent to lumbar fusion for improvements in walking ability, health-related quality of life, psychological distress, and work status, although the surgery group did have slightly more improvement in perceived disability (Jens Ivar Brox et al., 2006; Jens I. Brox et al., 2003; J. Fairbank et al., 2005). Keller et al. (2004) found that while both fusion and rehabilitation patients improved in measures of perceived disability, the patients treated with exercise and CBT showed increases in muscular strength and muscle fiber density, while the fusion patients decreased in strength and showed no change in muscle fiber density. A study comparing unstructured non-surgical care with lumbar fusion found that, while all patients improved significantly in all outcomes, surgical patients improved more than non-surgical patients in measures of pain, disability, self-assessed improvement, and work status (Fritzell et al., 2001).

There have been a great many studies comparing the effectiveness of different surgical methods for lumbar fusion. No differences in outcomes were found between instrumented and non-instrumented fusions (Fischgrund et al., 1997), circumferential fusion and posterolateral fusion (Xiuxin, Yue, Cui, & Yajun, 2009), TLIF and PLIF (Whitecloud, Roesch, & Ricciardi, 2001), or PLIF and PLF (Zhou, Zhao, Fang, Zhao, & Fan, 2011). There is some evidence that minimally invasive TLIF procedures have fewer complications and shorter recovery times than open procedures (Parker, Adogwa, Bydon, Cheng, & McGirt, 2011; Sharma et al., 2011; Wu, Fraser, & Hartl, 2010). In addition, recent evidence suggests that decompression without fusion may be more cost-effective than fusion, but with similar clinical outcomes (S. Kim, Mortaz Hedjri, Coyte, & Rampersaud, 2012).

2.2.6 Predictors of Successful Outcome after Lumbar Fusion

One of the most frequently studied risk factors for outcomes after lumbar fusion is the receipt of workers' compensation benefits. Studies of workers' compensation patients receiving lumbar fusion in the state of Washington found that 64% of fusion patients were still disabled two years after surgery. Twenty-two percent of patients received a second fusion procedure, and, of these, 83% remained disabled at follow-up (Juratli, Franklin, Mirza, Wickizer, & Fulton-Kehoe, 2006). Studies of military personnel show that women and those with lower base pay are less likely to return to full duty after lumbar fusion (Kaptain et al., 1999; Young et al., 1997). Studies of workers' compensation patients in Utah have found that, after lumbar fusion, 25% remained permanently disabled, 43% had poor outcomes in disability, and 41% reported that their quality of life had not improved. Poor outcomes were more likely in patients who were older, had longer lengths of disability, were involved in ongoing litigation, had more psychological symptoms, and a lower weekly wage (DeBerard et al., 2001; Wheeler, Gundy, & DeBerard, 2012). In workers' compensation patients in Ohio, less than half as many fusion patients returned to work compared with non-operative patients, and surgery patients who did return to work remained off work three times as long as non-surgery patients. Eighty-five percent of fusion patients were using opiate pain medications prior to surgery (compared to 49% of non-operative patients), and fusion

patients increased their dosage of opioids by 41% after surgery. At three months after surgery, 76% of the fusion patients were still using high doses of opioids. Patients with longer length of disability, more time between injury and surgery, lower wages, attorney representation, and those who smoked were least likely to return to work (Nguyen et al., 2011). Reoperation rates in workers' compensation patients with lumbar fusions are generally higher than in other fusion patients. About 14% of non-compensated fusion patients require a subsequent surgery (Martin et al., 2007a), compared to 20-30% of post-fusion workers' compensation patients (DeBerard et al., 2001; Juratli et al., 2006; Nguyen et al., 2011).

Predictors of outcome in patients not receiving workers' compensation include psychological, social, and physical factors. Pre-operative employment status, psychological distress, and surgical invasiveness are predictive of post-operative return to work (Parker et al., 2011; Trief et al., 2000). Longer duration of symptoms and the presence of psychological disorders are predictive of lesser reductions in pain and disability (Radcliff et al., 2011; Trief et al., 2000). Surgical complications are more likely in patients with prior spine surgeries, more extensive surgical procedures, and anterior surgical approaches (M. J. M. D. Lee et al., 2011; Madhu, 2008; Martin et al., 2007a; Whitecloud et al., 2001; Wu et al., 2010; Xiuxin et al., 2009).

Two of the most common complications of lumbar fusion surgery are failure of the spinal segments to fuse (pseudarthrosis) and adjacent segment disease (degeneration of the spinal segments above or below the fused levels). Pseudarthrosis is more common with non-instrumented fusions and posterolateral fusions (Fischgrund et al., 1997; Xiuxin et al., 2009; Zhou et al., 2011). However, radiographic evidence of fusion is not necessarily indicative of good outcomes in other areas, such as pain, disability, and function (DeBerard et al., 2001; Fischgrund et al., 1997; Fritzell et al., 2001; Rollinghoff et al., 2010). Likewise, adjacent segment disease identified by imaging is not always predictive of poor outcomes and, if the patient is asymptomatic, surgery is not required (Park, Garton, Gala, Hoff, & McGillicuddy, 2004; Rollinghoff et al., 2010; Videbaek, Egund, Christensen, Grethe Jurik, & Bunger, 2010).

2.3 Palliative Medical Devices for Spine Pain

In cases of failed surgery and intractable pain, the use of implanted medical devices may be considered. The two most common such implants for spine pain are spinal cord stimulators and intrathecal drug infusion pumps. The use of both devices remains controversial, and the evidence supporting the use of these devices is extremely limited (Mailis-Gagnon, Furlan, Sandoval, & Taylor, 2009; Noble et al., 2010).

2.3.1 Spinal Cord Stimulators

In spinal cord stimulation, electrodes are implanted percutaneously into the epidural space of the spinal column, under fluoroscopic guidance. The electrodes are then connected to an external generator for a trial period. The generator provides a pulsed electrical stimulation, which produces paresthesia and pain reduction over the stimulated dermatome. If the patient experiences greater than 50% pain relief, paresthesia over at least 80% of the painful region, gains in function, and reduction in opioid use, a permanent generator is implanted into the subcutaneous tissue of the torso (T. Cameron, 2004; Chaudhari & Mackenzie, 2008; Lanner & Spendel, 2007).

Evidence for the efficacy of spinal cord stimulators is mixed. Although some studies show greater pain reductions and opioid discontinuation with spinal cord stimulators compared with repeat spinal surgery (North, Kidd, Farrokhi, & Piantadosi, 2005), studies comparing spinal cord stimulators to conservative care have found that pain relief is achieved in only a minority of patients and that serious functional limitations remain (Eldabe, Kumar, Buchser, & Taylor, 2010; Kumar, Buchser, Linderoth, Meglio, & Buyten, 2007). A meta-analysis of patients with spinal cord stimulators found that measures of pain and opioid use were improved at 12 months follow-up, but less than 35% of patients successfully return to work (Frey et al., 2009). In Washington state workers' compensation patients, no differences between spinal cord stimulators, multidisciplinary rehabilitation, and usual care were found at 12 and 24 months follow-up, in disability, pain, or reductions of opioid use (Judith A. Turner, Hollingworth, Comstock, & Deyo, 2010).

Clinical practice guidelines recommend spinal cord stimulators for only a few indications: failed back surgery syndrome with primary neuropathic leg pain, complex regional pain syndrome, post-amputation pain, and spinal cord injury (Denniston & Kennedy Jr., 2012). The American Pain Society only found evidence supporting the use of spinal cord stimulators for failed back surgery syndrome with persistent radiculopathy, and noted that there were frequent device-related complications in patients with spinal cord stimulators (R. Chou, Atlas, Stanos, & Rosenquist, 2009). Complications include lead migration, pain at the device insertion site, generator malfunction, and failure to relieve pain. Patients need to be carefully screened for psychological disorders, realistic expectations, substance abuse problems, and psychosocial stressors prior to becoming a candidate for spinal cord stimulator implantation (Heckle et al., 2007; Prager & Jacobs, 2001; Whitworth, Schaufele, & Gatchel, 2001).

2.3.2 Intrathecal Drug Infusion Devices

A last resort option for patients who have failed every other method of treatment for low back pain is the implantation of a drug infusion device to deliver medications directly into the intrathecal space. Medications that can be administered intrathecally include opioid analgesics, local anesthetics, muscle relaxants, calcium channel blockers, and α2-adrenergic receptor agonists (Patel et al., 2009; Rainov, Heidecke, & Burkert, 2001). The intrathecal delivery route allows for greater pain relief with smaller doses of medications compared to the oral and transdermal routes.

Prior to surgery, patients usually receive a trial of intrathecal drug administration, and implantation of the device is only considered if significant relief is experienced after single injection. Next, a drug delivery catheter is inserted percutaneously into the intrathecal space, and attached to a subcutaneous reservoir. The reservoir requires refilling by injection every few weeks (Chaudhari & Mackenzie, 2008; Slavin, Hsu, & Fessler, 2002). Complication rates are high, and up to 20% of patients experience complications, with a few fatalities (V. C. Anderson & Burchiel, 1999; Noble et al., 2010). The most common complications are infection, catheter

migrations, catheter occlusion, device malfunction, pain at the device implantation site, and cerebrospinal fluid leak (Follett & Naumann, 2000).

Improvement in pain after intrathecal pump implantation is not necessarily accompanied by improvement in function, work status, or quality of life (Noble et al., 2010). Up to 10% of patients discontinue treatment due to adverse events or insufficient pain relief (Deer et al., 2004; Demartini, Stocco, & Bonezzi, 2010; Noble et al., 2010). Studies of cost-effectiveness of intrathecal drug infusion devices show little to no advantage in costs over interdisciplinary rehabilitation, in addition little advantage in improving outcomes (de Lissovoy, Brown, Halpern, Hassenbusch, & Ross, 1997; Doleys, Brown, & Ness, 2006). As in spinal cord stimulator implantation, patients need to be carefully screened for psychosocial dysfunction prior to being considered for intrathecal drug infusion devices.

2.4 Spine Surgery Recommendations

The general consensus among physicians and researchers is that spine surgery is effective in "carefully selected patients," although there is considerable disagreement on what constitutes "careful selection" (Resnick et al., 2005; Wiesel et al., 2010). There is evidence that patients who are older, have a longer duration of symptoms, have had prior surgeries, have significant psychological distress, are dependent on opioids, are receiving workers' compensation, and are involved in litigation make poorer surgical candidates (Aalto et al., 2006; Atlas et al., 2010; DeBerard et al., 2001; den Boer et al., 2006; Nguyen et al., 2011; Parker et al., 2011; Radcliff et al., 2011; Trief et al., 2000; Wheeler et al., 2012). However, similar risk factors are associated with poorer outcomes after tertiary rehabilitation treatment; including opioid dependence, longer duration of symptoms, psychological disorders, high pain ratings, prior surgery, unresolved litigation, and older age (Brede et al., 2012; Howard et al., 2009; Kidner et al., 2009; T. G. Mayer, Gatchel, & Evans, 2001; McGeary, Mayer, & Gatchel, 2006; Proctor, Mayer, Gatchel, & McGeary, 2004). The Official Disability Guidelines recommend surgery only in cases with clearly defined pathology and a failure of all non-operative treatments (Denniston & Kennedy Jr., 2012). The American Pain Society clinical practice guidelines recommend surgery for the following conditions

only: radiculopathy due to herniated disc and symptomatic spinal stenosis (R. Chou, Baisden, et al., 2009). The North American Spine Society recommends surgery for symptomatic spinal stenosis with predominant leg pain and no instability (North American Spine Society, 2011).

However, despite the relative consistency of guidelines for spine surgery selection, significant differences in actual clinical practice have been observed. Rates of spine surgery vary by geographical regions in patterns not explained by demographic differences between populations (Angevine, Arons, & McCormick, 2003; Richard A Deyo & Mirza, 2006; Keskimäki, Seitsalo, Österman, & Rissanen, 2000; Weinstein, Bronner, Morgan, & Wennberg, 2004). This creates even more confusion for patients attempting to make informed treatment decisions about surgery and creates a situation where patients determined to obtain surgery are able to "doctor shop" until they find a provider willing to perform surgery that was denied by another provider.

CHAPTER 3

SHOULDER DISORDERS

The shoulder has the widest range of motion of any joint in the body, but that mobility comes at the expense of stability. There are many ways in which the shoulder can be injured, but two of the most common shoulder conditions that may be treated surgically are shoulder impingement syndrome and rotator cuff pathology (Wiesel et al., 2010).

3.1 Shoulder Impingement Syndrome (SIS)

Shoulder impingement syndrome occurs when the supraspinatus tendon is compressed against the acromial process, as a result of bony overgrowth, calcification of surrounding ligaments, humeral instability, or inflammation of the subacromial bursa (DeBerardino, 2012). SIS is more common in occupations requiring repetitive overhead motions, and typically presents with pain over the lateral, superior, and anterior regions of the shoulder. In some cases, pain is referred to the deltoid. Range of motion may be limited, particularly when elevating the arm behind the back, and there may also be limitations of strength (Wiesel et al., 2010).

Initial treatment of SIS should be non-operative, and include anti-inflammatory medications as well as range-of-motion exercises. If pain does not improve within the first 4-6 weeks, a subacromial injection may be considered. In this procedure, a combination of local anesthetic and corticosteroid are injected into the subacromial space, producing a decrease in pain and inflammation, and allowing the patient to better tolerate physical therapy (DeBerardino, 2012). Although 60-90% patients with SIS can be treated non-surgically, anatomical variations of the acromial process can affect the outcomes (DeBerardino, 2012). Patients with a type II or type III acromion (curved or hooked) are less likely to benefit from non-operative treatment than patients with a type I (flat) acromion (Galatz, 2008). If there is not substantial improvement after

6 months of non-operative therapy, surgical treatment with arthroscopic or open subacromial decompression may be considered (DeBerardino, 2012; Galatz, 2008).

Arthroscopic shoulder decompression surgery begins with an arthroscopic examination of the subacromial space. Next, the posterior rim of the acromion and any bony overgrowth (osteophyte) is removed. Ideally, the integrity of the coracoacromial arch should be preserved (DeBerardino, 2012; Galatz, 2008). After surgery, a sling is used, along with gentle range-of-motion exercises for about 72 hours. Progressive mobilization is begun 3-4 weeks post-operatively, along with progressive resistance exercises; normal activity can be resumed 6-8 weeks after surgery (Galatz, 2008). Patients may resume heavy work and sport activities after full healing of the shoulder, about 3-4 months after surgery (DeBerardino, 2012).

Outcomes after shoulder decompression surgery are generally good, with 77-90% successful outcomes (Dopirak & Ryu, 2010; Ellman, 2010; Ogilvie-Harris & Choi, 2008). Surgery has been found to associated with improvement in pain, function, sick leave, quality of life, and pain intensity (Bengtsson, Lunsjö, Hermodsson, Nordqvist, & Abu-Zidan, 2006; Järvelä, Järvelä, Aho, & Kiviranta, 2010; Odenbring, Wagner, & Atroshi, 2008) Studies have found no significant differences between open and arthroscopic decompression procedures (Barfield & Kuhn, 2007; Faber, Kuiper, Burdorf, Miedema, & Verhaar, 2006; Gebremariam, Hay, Koes, & Huisstede, 2011; Odenbring et al., 2008; Spangehl, Hawkins, McCormack, & Loomer, 2002), and treatment gains have been maintained over long-term follow-up intervals of 5-12 years (Dom, Van Glabbeek, Van Rie, Verborgt, & Wuyts, 2003; Odenbring et al., 2008). Only about 11% of patients require additional surgery (Pillai, Eranki, Malal, & Nimon, 2012).

The addition of physical therapy after shoulder decompression is associated with improvements in strength and range of motion (Holmgren, Öberg, Sjöberg, & Johansson, 2012) as well as improvements in functional ability and work status (Faber et al., 2006). Aggressive, active physical therapy is associated with particularly good outcomes; the majority of patients were pain-free by three months after surgery, and these outcomes were maintained at the one year follow up (Klintberg, Gunnarsson, Svantesson, Styf, & Karlsson, 2008). Receipt of workers'

compensation benefits was found to be significant risk factor for poorer outcomes, with longer time to return to work and lesser improvements in disability (Frieman & Fenlin Jr, 1995; Koljonen, Chong, & Yip, 2009; Nicholson, 2003).

3.2 Rotator Cuff Damage

The rotator cuff is a set of four muscles that contribute to the rotation and elevation of the shoulder while providing stability to the humerus. Damage to the rotator cuff may be the result of a traumatic injury, or it may be due to cumulative trauma from overuse. A common presentation of rotator cuff pathology is a tear in one of the tendons connecting the rotator cuff muscles to the bone. Partial thickness tears may vary from tears of less than 3 mm (less than 25% of the tendon diameter) up to tears greater than 6 mm, which is more than 50% of the tendon diameter. A full-thickness rotator cuff tear involves the entire diameter on the tendon, and the tendon may remain attached to the bone at one or more points, or it may be completely detached from the humerus (Bilal, 2011; Galatz, 2008; Wiesel et al., 2010). Patients with damage to the rotator cuff usually report pain over the anterior lateral shoulder; pain may wake the patient from sleep and be exacerbated by overhead activities. If the pain is long-standing, patients may have atrophy and weakness of the shoulder muscles. Signs of tendon retraction or atrophy and fatty infiltration of the muscle on MRI are associated with impaired healing after surgery (Wiesel et al., 2010).

Initial treatment of mild to moderate rotator cuff tears is non-operative, and may involve NSAIDs, physical therapy, or intra-articular steroid injection. If there is no improvement after 3-6 months of conservative care, surgery may be considered as a treatment option (Denniston & Kennedy Jr., 2012; Keener, 2008). In acute full-thickness (100% of diameter) or massive (> 5 cm tear or involvement of more than one tendon) rotator cuff tears, surgery should be done within three months of injury, because longer lengths of disability in these cases are associated with degeneration of the tendons and muscles which can prevent future successful repair (Galatz, 2008; Galatz et al., 2005; Wiesel et al., 2010). Chronic or degenerative full thickness tears may be treated non-operatively, however, non-operative treatment may produce improvements in pain intensity but leave significant impairment in strength and range of motion (Wiesel et al., 2010).

Surgical interventions for rotator cuff tears may range from simple debridement for small partial tears to tendon transfer for massive tears, where a tendon from the latissimus dorsi or pectoralis major is used as a substitute for the damaged tendon (Lin, Krishnan, & Burkhead, 2008). In addition, surgery may be performed with either an open or arthroscopic approach. Low grade partial-thickness rotator cuff tears may be treated with debridement to remove the damaged tendon material. The remaining tendon can be sutured to the bone for stability. Debridement may be combined with acromioplasty to reduce compression from the acromion. Outcomes are similar with and without acromioplasty, and 75-88% of debridement procedures for small partial thickness tears are successful, with somewhat better outcomes for tears to the articular side of the tendon rather than the bursal side (Keener, 2008). For tears involving 50-90% of the tendon diameter, subacromial decompression with or without acromioplasty may produce better results. Alternatively, larger partial thickness tears may be repaired with sutures and anchored to the humerus for stability (Keener, 2008).

Full-thickness rotator cuff tears are usually repaired, using either an arthroplastic or open technique. First, the undersurface of the acromion process is smoothed, and may be revised if a curved or hooked anatomy is impinging on shoulder movement. Next, the tendons are stitched back together and anchored to the humerus. There are various techniques for placing the sutures, but there is no conclusive evidence favoring one technique over another (Mahar, Tamborlane, Oka, Esch, & Pedowitz, 2007; Mahar, Tucker, Upasani, Oka, & Pedowitz, 2005; Mazzocca, Millett, Guanche, Santangelo, & Arciero, 2005). For massive tears that cannot be repaired, a tendon transfer may be performed. In this procedure, the latissimus dorsi tendon is used to replace the damaged rotator cuff tendon. The results of this procedure are generally better than conservative treatment, but not as favorable as tendon repair procedures, suggesting that massive tears should be repaired earlier in the treatment process, before tendon retraction and fatty infiltration of the muscle occurs (Gerber, Maquieira, & Espinosa, 2006; Goutallier, Postel, Gleyze, Leguilloux, & Van Driessche, 2003; Lin et al., 2008; Warner & Parsons, 2001). After surgery, the arm is immobilized in a sling for 3-6 weeks to promote tendon healing, although

gentle passive range of motion exercises can be performed. The next six weeks are spent on passive range of motion, and strength training does not being until 12 weeks post-operatively. Full healing is not expected until 6-9 months after surgery (Conti et al., 2009; Galatz, 2008).

Most patients demonstrate significant improvement in function, strength, range of motion, and pain (Lähteenmäki, Hiltunen, Virolainen, & Nelimarkka, 2007; B. G. Lee, Cho, & Rhee, 2012; Piasecki et al., 2010; Shin, Oh, Chung, & Song, 2012; Sugaya, Maeda, Matsuki, & Moriishi, 2005). The outcomes of open and arthroscopic surgeries for rotator cuff repair are similar for patient satisfaction, function, range of motion, and pain (Coghlan, Buchbinder, Green, Johnston, & Bell, 2009; Lädermann et al., 2011; Oh, Yoon, Kim, & Kim, 2012; Youm, Murray, Kubiak, Rokito, & Zuckerman, 2005). There is also some evidence that rotator cuff repairs with and without acromioplasty are equally effective (Chahal et al., 2012; Shin et al., 2012). Repeat tears are uncommon, but may occur more often for medium to large tears treated arthroscopically, and are not necessarily related to differences in pain or function (Bishop et al., 2006; Verma et al., 2006). Patients receiving workers' compensation and patients with prior rotator cuff procedures are more likely to need revision surgery (Piasecki et al., 2010), and are less likely to return to work or show improvement in self-reported disability, pain intensity, and strength (Holtby & Razmjou, 2010). Worse functional outcomes were seen in smokers receiving workers' compensation, even after controlling for pre-operative differences in function (Balyk, Luciak-Corea, Otto, Baysal, & Beaupre, 2008). Patients who are older and have larger tears are less likely to have successful tendon healing and functional improvement (Cofield et al., 2001; Nho et al., 2009; Watson & Sonnabend, 2002).

3.3 Shoulder Surgery Recommendations

The treatment of shoulder injuries is complicated by the fact that delays in care have a direct influence on the outcomes of some surgical procedures (Galatz, 2008). While surgery remains a favorable option for young patients with large, acute, traumatic injuries to the shoulder, the indications for surgery in chronic and degenerative tears are less clear. The American Academy of Orthopaedic Surgeons recommends against surgery for asymptomatic tears, and

evidence for the recommendation of surgery for full-thickness chronic tears is rated as weak (American Academy of Orthopaedic Surgeons, 2010). The Official Disability Guidelines recommend decompression with acromioplasty for shoulder impingement patients who have not improved after 3-6 months of conservative care, but only for those with pain during range of motion and during the night, weak or absent abduction, tenderness to palpation, positive impingement tests, temporary relief from injection, and radiographic evidence consistent with clinical findings. Surgery for rotator cuff repair is recommended for full-thickness rotator cuff tear only when there is also severe pain, limited range of motion, weakness on abduction testing, and radiographic evidence of the tear. In partial thickness tears, surgery is recommended if there is no improvement after 3-6 months of conservative care, but only when there is also pain during motion and during the night, weakness during abduction and/or muscle atrophy, tenderness to palpation, positive impingement testing, temporary relief of pain with intra-articular injection, and radiographic evidence of rotator cuff deficit (Denniston & Kennedy Jr., 2012). However, there is significant variation in providers' knowledge of and adherence to these guidelines (Dunn et al., 2005), contributing to difficulty in surgical decision making regarding shoulder surgery.

CHAPTER 4

WRIST DISORDERS

The most common cause of occupational wrist pain is cumulative trauma or overuse injury, with carpal tunnel syndrome (CTS) being the most frequently diagnosed disorder. Incidence of carpal tunnel syndrome diagnosis and surgery have been increasing over the past decade, both in the United States and in other industrialized nations (Atroshi, Englund, Turkiewicz, Tägil, & Petersson, 2011). CTS occurs when the transverse carpal ligament compresses the median nerve as it passes through the wrist. Symptoms of CTS usually include decreased sensation and paresthesia to the radial three fingers. As symptoms progress, atrophy of the thenar muscles of the thumb may develop (Gong et al., 2008; Wiesel et al., 2010). Clinical tests for CTS include the Phalen test, the Tinel sign and the Durkan sign. In the Phalen test, the patient holds the forearms upright while resting the elbows on a table, and lets the wrists flex passively, by gravity. A positive test is indicated by increase in numbness or paresthesia within one minute. Tinel's sign is found when tapping along the wrist crease elicits numbness or paresthesia, and Durkan's test is positive when pressure over the carpal tunnel reproduces the patient's symptoms of pain or paresthesia (Wiesel et al., 2010). A diagnosis of carpal tunnel can be confirmed and graded using electromyography (EMG). In Grade 1, there are minimal symptoms and no evidence on nerve damage on EMG. Grade 2, mild CTS, there is evidence of slowed sensory nerve conduction, but motor nerve conduction is normal. Grade 3 CTS exhibits slowed motor nerve conduction but normal sensory conduction. Severe CTS is characterized by absent sensory nerve conduction and either slow (Grade 4) or very slow (Grade 5) motor nerve conduction. The most severe cases of CTS (Grade 6) demonstrate absent motor and sensory nerve conduction (Gong et al., 2008).

Initial treatment of CTS is non-operative, and includes splinting to keep the hand in a neutral position, mild analgesics, occupational or physical therapy, and anti-inflammatory injections (Huisstede et al., 2010). Approximately 75% of CTS patients can be successfully treated with stretches and splinting (N. A. Baker et al., 2012). If the symptoms do not improve within six weeks, the patient is referred for diagnostic testing with EMG. Mild cases will usually improve with conservative treatment, but for moderate and severe CTS confirmed with EMG testing, surgery is a treatment option.

CTS surgery may be open or endoscopic. In open carpal tunnel release, an incision is made from the middle to the base of the palm to expose the transverse carpal ligament. The transverse carpal ligament is divided along the ulnar side to enlarge the carpal tunnel and decrease pressure on the median nerve. In the endoscopic version of the procedure, a smaller transverse incision is made at the center of the palm, and an endoscope in inserted into the carpal tunnel to visualize the ligaments. A cutting blade is inserted into the same incision after withdrawal of the scope and the distal half of the ligament is cut (Fuller, 2010). After surgery, immobilization and/or splinting are generally not required. Most patients are not referred for rehabilitation, but are instructed in a home exercise regimen (Fuller, 2010). In cases with significant muscle weakness or atrophy, rehabilitation may be indicated. A study comparing rehabilitation against a home exercise program found that the rehabilitation program produced earlier increases in motor dexterity and return to work, but by 3 months after surgery there were no differences in outcome between the rehabilitation and home exercise groups (Provinciali, Giattini, Splendiani, & Logullo, 2000).

Outcomes after carpal tunnel release surgery are generally good, with as many as 99% of patients reporting improvements in pain, paresthesia, pinch and grip strength, and the majority are satisfied with treatment (Aslani et al., 2012; W. P. A. Lee, Schipper, & Goitz, 2008; D. Nagle, Harris, & Foley, 1994; D. J. Nagle et al., 1996; Straub, 1999). Surgery has shown better long term outcomes in functional ability and symptom relief, although there were more complications relative to non-operative treatment (Shi & MacDermid, 2011). Endoscopic and open carpal tunnel

surgeries have similar outcomes in function, strength, symptom improvement, and treatment satisfaction, but patients undergoing endoscopic procedures return to work sooner than patients treated with open surgeries (Aslani et al., 2012; W. P. A. Lee et al., 2008; D. J. Nagle et al., 1996; Saw et al., 2003). Predictors of poorer outcomes after surgery for carpal tunnel syndrome included type of occupation, patient expectations about surgery, pre-operative function, anxiety or depression symptoms, workers' compensation or litigation, duration of symptoms, and comorbid upper extremity disorders (Amick et al., 2004; Cowan, Makanji, Mudgal, Jupiter, & Ring, 2012; Daniell, Fulton-Kehoe, & Franklin, 2009; J. K. Kim & Kim, 2011; Lozano Calderón, Paiva, & Ring, 2008; D. J. Nagle et al., 1996; Parot-Schinkel et al., 2011; Sanati et al., 2011; Straub, 1999). Rates of revision procedures are generally low, but revisions are more common in patients receiving workers' compensation (Concannon, Brownfield, & Puckett, 2000). Studies of CTS revision procedures found that the most common cause of inadequate symptom relief was incomplete transection of the transverse carpal ligament, followed by constriction of the median nerve by scar tissue, and nerve damage. Although the transverse carpal ligament has been found to heal or reform after surgery; the authors estimated that as many 83% of the cases of recurrent symptoms could have been prevented with proper surgical technique in the index procedure (J. D. Beck et al., 2012; Stütz, Gohritz, van Schoonhoven, & Lanz, 2006).

Most clinical guidelines agree that surgery is the best treatment for CTS when there is evidence of moderate to severe nerve damage, but non-operative treatment (splinting and steroid injection) is recommended when there is only mild nerve damage. The American Academy of Orthopaedic Surgeons recommends a trial of non-operative treatment for up to 7 weeks, but makes no recommendation for endoscopic as opposed to open procedures. Immobilization after surgery is not recommended (American Academy of Orthopaedic Surgeons, 2008). The Official Disability Guidelines recommend carpal tunnel release surgery for severe CTS confirmed by EMG with muscle atrophy or significant weakness and for mild to moderate CTS only when there are symptoms of pain, paresthesia, and impaired dexterity, positive physical tests, failure of conservative therapies, and positive EMG testing (Denniston & Kennedy Jr., 2012).

CHAPTER 5

KNEE DISORDERS

Knee disorders are highly prevalent in adults, accounting for up to 3 million healthcare visits per year. Knee trauma is the second most common occupational injury (low back strain is the most common). Acute knee injury may include damage to the ligaments, particularly the anterior collateral ligament (ACL), or damage to the cartilage, particularly the meniscus. Ligament or cartilage damage may contribute to early joint degeneration, necessitating joint replacement surgery. Rates of knee surgery have increased dramatically over the past few decades especially in younger patients, and now make up some of the most frequently performed orthopedic procedures (J. N. Katz et al., 2006; Khatod et al., 2008; Wiesel et al., 2010). Two common knee surgeries are meniscectomy and total knee arthroplasty (TKA).

5.1 Meniscus Surgery

The meniscus is a fibro-cartilage cushion that permits smooth motion between the tibia and the femur. The meniscus has several functions including load distribution, joint stabilization, and shock absorption. The medial meniscus is less mobile than the lateral meniscus, and accounts for a larger proportion of meniscus injuries (Levy, 2011; Wiesel et al., 2010). The meniscus has three zones that vary in blood supply, with the greater vascularity on the outer third; the central third of the meniscus is essentially avascular. Repairs to the more vascular regions of the meniscus are more likely to be successful (Frank R Noyes & Barber-Westin, 2010). Meniscus tears are classified based on the extent and direction of the tear. Single tears may occur in the longitudinal, horizontal, or radial directions, while complex tears occur in more than one direction. Small tears (less than 10 mm in length) usually do not require surgery, while longer tears extending into the vascularized region of the cartilage may be candidates for surgical intervention (Frank R Noyes & Barber-Westin, 2010).

Patients usually present with symptoms of pain, swelling, limited motion, difficulty with ambulation, “locking”, or a sensation of “giving way” (Bhagia, 2012; Wiesel et al., 2010). The McMurray test indicates a torn meniscus: when the knee is internally and externally rotated from full flexion to 90° flexion, a click is palpable, as the meniscus fragment is intermittently trapped and freed (Wiesel et al., 2010). Many patients will experience improvement in symptoms with non-operative care that includes anti-inflammatory medications, temporary activity modifications, and physical therapy that strengthens the quadriceps muscles (Lim, Bae, Wang, Seok, & Kim, 2010). However, in cases where non-operative care is ineffective or if the meniscus fragment is mechanically blocking the motion of the knee, surgery may be indicated (Wiesel et al., 2010).

Historically, a damaged meniscus was removed entirely; however, complete meniscectomy was found to lead to early and severe osteoarthritis of the knee (Bhagia, 2012; Frank R Noyes & Barber-Westin, 2010). More current surgical techniques for meniscus injury include meniscal repair and partial meniscectomy. Repair of the meniscus is the ideal treatment, as it preserves the cartilage and has less risk of developing arthritis, but is only possible in a small number of meniscus injuries. Meniscus repair is usually arthroscopic, and involves suturing of the torn fibers, with anchoring to the knee capsule (Frank R Noyes & Barber-Westin, 2010). For the 95% of meniscal tears that are not repairable, partial removal of the meniscus is an option. The goal of surgery is to retain as much of the cartilage as possible to prevent the development of arthritis, and so only the damaged cartilage is removed using arthroscopic techniques (S.-J. Kim et al., 2007; Wiesel et al., 2010).

After meniscus repair, weight bearing is restricted until 4-6 weeks post-operatively to allow healing of the cartilage, and only cautious stretching is recommended during this period. For meniscectomy, weight-bearing may begin 4-7 days after surgery. During the initial post-operative period, cryotherapy and NSAIDs may be used to reduce pain and swelling of the knee. When weight bearing is permitted, the patient progresses to exercise designed to improve knee range of motion and strength of the entire lower extremity. In addition, stationary bicycles may be used to increase range of motion of the knee. When full range of motion is regained, the intensity

of the exercises may be increased, and endurance training can be implemented, along with balance and proprioceptive training (Frank R Noyes & Barber-Westin, 2010). The final phase of rehabilitation includes return to work and sport activities, including running, and begins 20 weeks after surgery (B. S. Baker, 2011; Bhagia, 2012; Frank R Noyes & Barber-Westin, 2010). Most patients can return to modified activity within 2-3 months after surgery (Denniston & Kennedy Jr., 2012).

The outcomes of arthroscopic meniscus repair or partial meniscectomy are generally favorable, with maximum improvement occurring from 4 months to 2 years after surgery, in 80-90% of patients (Matsusue & Thomson, 1996; Meredith, Losina, Mahomed, Wright, & Katz, 2005; Pujol & Beaufils, 2009; Scheller, Sobau, & Bülow, 2001). However, older patients and patients with damage to the lateral meniscus (rather than the medial meniscus) have poorer surgical results. A study of patients over age 45 undergoing arthroscopic partial medial meniscectomy found that 29% still had pain, 17% still used a cane for ambulation, and 25% were dissatisfied with treatment at 18 months after surgery (J. N. Katz et al., 2006). Studies comparing lateral and medial meniscus procedures found more evidence of degenerative changes and incomplete healing in lateral meniscus procedures, although functional and subjective outcomes measures were similar for both types of procedures (Chatain, Adeleine, Chambat, & Neyret, 2003; Meredith et al., 2005; Pujol & Beaufils, 2009).

The most important risk factors for poorer outcomes after meniscus procedures are related to the location and severity of the tear. Greater degenerative changes; complex, horizontal, and degenerative tears; work-related injuries; prior surgery; poorer pre-operative function; greater amounts of resected tissue have been found to be risk factors for poorer surgical outcomes (Akkaya, Akkaya, Kıter, Kılıç, & Ardıç, 2012; Ferkel et al., 1985; J. N. Katz et al., 2006; Matsusue & Thomson, 1996; Meredith et al., 2005; Steenbrugge, Verdonk, Hürel, & Verstraete, 2004). However, other studies have found no effects of extent of tear and amount of tissue removed for up to six months after surgery (Fabricant, Rosenberger, Jokl, & Ickovics, 2008; Meredith et al., 2005). There are several suture methods and commercial devices that may be

used for repairing the meniscus, but the in no conclusive evidence to favor one technique over the others (Koukoulias, Papastergiou, Kazakos, Poulios, & Parisis, 2007; Frank R Noyes & Barber-Westin, 2010; Steenbrugge et al., 2004).

Although the importance of post-operative exercise after meniscus surgery is well-established, there is still some disagreement over the best methods providing exercise and rehabilitation. Rehabilitation programs should include strength and range of motion exercise for best results, and the use of passive physical therapy is associated with longer disability duration (B. S. Baker, 2011; Bhagia, 2012; Frank R Noyes & Barber-Westin, 2010; B. S. Webster, Verma, Willetts, Hopcia, & Wasiak, 2011). However, studies comparing home exercise programs with structured supervised rehabilitation programs have found similar improvements in pain, range of motion, self-reported function, swelling, and gait (Goodwin et al., 2003; Kelln, Ingersoll, Saliba, Miller, & Hertel, 2009; Reid, Rydwanski, Hing, & White, 2012).

Meniscus surgery is recommended in only certain circumstances, and trials of non-operative therapy are indicated except in mechanical obstruction by cartilage fragments (Frank R Noyes & Barber-Westin, 2010). Clinical practice guidelines from France recommend meniscus repair only for healthy tissue in vascular cartilage areas and support trials of non-operative care for traumatic meniscal lesions (Beaufils et al., 2009). Noyes (2010) recommends meniscus repair only for vascular regions without significant degenerative changes in patients under age 60 who are willing to comply with the post-operative rehabilitation protocol. The Official Disability Guidelines recommend meniscectomy only after failure of conservative care (physical therapy, medications, and activity modifications); with clinical findings of pain, swelling, giving way, locking, popping, or clicking; signs of meniscus tear on physical examination, and MRI evidence on meniscus tear (Denniston & Kennedy Jr., 2012).

5.2 Total Knee Arthroplasty

With severe degenerative changes to the knee, the surgical option of last resort is knee replacement, or total knee arthroplasty. TKA is indicated for severe, disabling pain caused by arthritis, and over 200,000 TKAs are performed annually in the US (Wiesel et al., 2010). Patients

with degeneration warranting TKA usually report severe pain, pain that wakes them during the night, deformity of the knee joint in either the varus or valgus direction (bow-legged or knock-kneed), effusion or swelling of the knee, limited range of motion, and patellofemoral crepitus. Diagnostic imaging shows narrowing of the joint space, osteophyte formation, cartilage deterioration, and poor alignment when standing (Wiesel et al., 2010). Degeneration of the knee joint may be due to osteoarthritis and age related change, inflammatory conditions such as rheumatoid arthritis, post-surgical changes (e.g. after total meniscectomy), or post-traumatic changes (Glassman, Lachiewicz, & Tanzer, 2011).

Non-surgical options should be exhausted prior to considering a TKA. First lines of therapy include mild analgesics (acetaminophen) or NSAIDs; if this is ineffective, intra-articular corticosteroids may be used to reduce joint pain and inflammation, although not more than three times per year. Physical therapy may be used to improve knee range of motion and strengthen the hamstring and quadriceps muscles. Arthroscopic lavage and debridement has not been shown to be effective in moderate to severe cases of osteoarthritis (Glassman et al., 2011; Wiesel et al., 2010). Pre-operative exercise may be recommended in cases of severe deconditioning, although studies have not found a difference in long term post-operative outcomes between patients who received pre-operative strength or aerobic exercise and those who did not (Beaupre, Lier, Davies, & Johnston, 2004; D'Lima, Colwell, Morris, Hardwick, & Kozin, 1996; Rooks et al., 2006).

In total knee replacement, the damaged joint is removed by cuts at the femur and tibia. The posterior cruciate ligament may be excised or retained depending on the type of prosthesis. In most cases, the patella is resurfaced and re-used in the reconstructed joint. The hardware is fixed to the bone using cement, and a spacer is placed between the ends of the prosthesis to reduce friction between components (Glassman et al., 2011). After surgery, the patient begins passive range of motion exercises. A continuous passive motion machine, which flexes and extends the knee, may be used in the immediate post-operative period. Ambulation is allowed on the second post-operative day, and patients are typically hospitalized for 3-5 days after the

procedure (Denniston & Kennedy Jr., 2012; Palmer & Cross, 2012). It is critical for knee motion to be restored within 3-6 weeks after surgery to prevent the formation of scar tissue which can permanently restrict range of motion and may require additional surgery (Wiesel et al., 2010).

Many patients experience significant improvements in pain and function following TKA (Campbell et al., 2009; Heck, Robinson, Partridge, Lubitz, & Freund, 1998; Mizner et al., 2011). Modern prosthetic devices have good survival: 95% of prostheses are still in place at 10 years, 90% remain functional at 15 years, and 80% of devices are still functional at 20 years after initial placement (Wiesel et al., 2010). However, there are significant numbers of patients whose outcomes are less than successful. Studies of long-term follow-up after TKA have found that 20-50% have residual pain, 30-60% have functional limitations, 40% still need assistive devices for ambulation, and 25% report no improvement in quality of life (Vikki Wylde et al., 2009; V. Wylde et al., 2007). Risk factors for poorer outcomes after TKA include psychological distress, depression, catastrophizing, older age, and greater pre-operative pain intensity (Edwards, Haythornthwaite, Smith, Klick, & Katz, 2009; Heck et al., 1998; Lingard & Riddle, 2007; Nilsdotter, Toksvig-Larsen, & Roos, 2009; Riddle, Wade, Jiranek, & Kong, 2010; Vissers et al., 2012). Studies of patients under age 65 receiving TKA with the goal of returning to work found that 72% of patients were able to reach this goal by three months after surgery. Patients who were self-employed, reported a sense of urgency about returning to work, or worked in a handicapped accessible workplace returned to work sooner, and patients with more demanding jobs, less pre-operative pain, and poorer emotional health took longer to return to work (Styron, Barsoum, Smyth, & Singer, 2011).

Studies of workers' compensation patients undergoing TKA have had mixed results. Subjective outcomes measures, such as self-reported function and overall improvement, are generally worse in workers' compensation patients. However, there are usually no differences in objective outcome measures, such as need for revision surgery, radiographic alignment, medication use, range of motion, stair climbing, and prosthesis stability (de Beer, Petruccelli,

Gandhi, & Winemaker, 2005; Masri, Bourque, & Patil, 2009; Mont, Mayerson, Krackow, & Hungerford, 1998; Saleh, Nelson, Kassim, Yoon, & Haas, 2004).

All clinical guidelines agree that non-operative treatments should be the first line of treatment for degenerative knee disorders. The European standing committee for clinical trials recommends joint replacement for refractory pain associated with disability and radiological deterioration (Pendleton et al., 2000). The Official Disability Guidelines recommend TKA if the following conditions are met: failure of 2-3 months conservative care; clinical findings of limited range of motion, nighttime pain, functional limitations; patient is older than 50 and not obese, and there is evidence of osteoarthritis on standing x-ray or arthroscopy (Denniston & Kennedy Jr., 2012).

CHAPTER 6

EFFECTS OF DELAYED TREATMENT AND EARLY INTERVENTIONS

Because up to 85% of acute pain patients will not develop chronic pain, it is difficult to determine which patients are most likely to benefit from early interventions. In addition, conservative care is recommended for most musculoskeletal conditions for the first two to three months. This makes it extremely difficult to determine the most appropriate surgical timing: enough time must be allowed to ensure that the patient will not improve with conservative care alone, but surgery should not be delayed too long or deconditioning will develop.

There have been many studies about the effect of wait times on surgical outcomes, particularly in countries where single-payer healthcare systems have produced long treatment delays, and in workers' compensation systems where complicated authorization procedures often lead to delays in treatment. A Canadian study examined deterioration in pain and functional measures during the time spent waiting for surgery in chronic pain patients. For wait time of less than 10 weeks, only 36% of patients showed significant declines in pain and function. However, for wait times of greater than 12 weeks, 75% experienced functional deterioration. For extremely long wait times (4 years), there was less likelihood of returning to work after surgery. Specifically for joint replacement procedures, waiting times of less than 12 months produced declines in function but no differences in post-operative outcomes, but wait times of more than 12 months were associated with worse post-operative outcomes (Lynch et al., 2008). A study of knee replacement in Canada found that the wait time for surgery averaged from 112-291 days. Not only did pain and function get worse in the knee awaiting replacement, but deterioration of pain and function was also found in the contralateral knee. The researchers concluded that significant declines in function and quality of life occurred with wait times longer than 3 months and significant increases in pain occurred wait times over 9 months (Desmeules, Dionne, Belzile,

Bourbonnais, & Frémont, 2010). National policy in Norway specifies that subacute pain patients with a high risk of developing chronicity wait no more than two weeks for treatment at a pain clinic, and other pain patients should wait no more than 16 weeks for admission (Hara & Borchgrevink, 2010).

Other studies have examined the role of duration of pain and disability in determining outcomes of rehabilitation treatments. A studies of United States workers' compensation patients found that greater delays between occurrence and report of injury and well as greater numbers of days off work were associated with less likelihood of returning to work (Shaw, Pransky, Patterson, & Winters, 2005). In fact, of patients who remain out of work at 1 month, 52% were still out of work at 6 months (Hashemi, Webster, Clancy, & Volinn, 1997). Stover et al. (2007) found that U.S. workers' compensation patients who had more than 20 days between the date of injury and the date of the first physician visit were more likely to develop long term disability. Compared to patients treated within the first 10 days after injury, patients who waited more than 20 days for treatment had 172 additional days of disability. A study of patients with acute, uncomplicated back pain found that those who received opioid medications for more than seven days and early imaging procedures had an average of 35 days more disability that patients who did not receive extended opioids or early imaging (Mahmud et al., 2000). A study of administrative and treatment delays in acute non-specific low back pain found an average delay of 33 days due to administrative factors, and an average of 38 days elapsed between injury and the first physician visit. An increase in administrative delay from two weeks to four weeks was associated with a 50% greater likelihood of developing chronic disability (Sinnott, 2009).

Furthermore, delays in accessing treatment or longer duration of symptoms prior to surgery have been found by some researchers to adversely affect the outcome of surgical procedures. In patients undergoing lumbar fusion, longer duration of symptoms is associated with lower rates of return to work and greater likelihood of permanent disability (Agazzi, Reverdin, & May, 1999; Franklin, Haug, Heyer, McKeefrey, & Picciano, 1994; Jordan, Mayer, & Gatchel, 1998; Juratli et al., 2006; Nguyen et al., 2011; Trief et al., 2000), although one study of Utah

workers' compensation patients found no association between length of disability and poorer outcomes (DeBerard et al., 2001). Studies of other types of procedures have been less consistent. For carpal tunnel release procedures, a few studies have found longer durations of symptoms to be related to greater long term disability and less symptom reductions (DeStefano, Nordstrom, & Vierkant, 1997; Spector, Turner, Fulton-Kehoe, & Franklin, 2012), but other studies have found no relationship between duration of symptoms and surgical outcome (Adams, Franklin, & Barnhart, 1994; Burke, Wilgis, Dubin, Bradley, & Sinha, 2006; J. N. Katz et al., 2001). Most studies of rotator cuff repair procedures have found no difference in outcome associated with longer duration of symptoms (Henn, Kang, Tashjian, & Green, 2008; McKee & Yoo, 2000; Murray Jr, Lajtai, Mileski, & Snyder, 2002; Romeo, Hang, Bach, & Shott, 1999). However, Savoie and colleagues (1995) found that delays in surgical referral for workers' compensation patients undergoing rotator cuff repair were associated with higher costs and lower rates of return to work, and Walch, et al. (2005) found that longer duration of symptoms prior to biceps tendon repair was associated with poorer post-operative shoulder function. In addition, one study of knee ligament repair found that delayed surgery was associated with poorer outcomes, while another found no differences in outcome related to duration of symptoms (Akkaya et al., 2012; Liow, McNicholas, Keating, & Nutton, 2003). In general, based on the above studies, it appears that duration of symptoms is a stronger predictor of poor outcome after spinal surgery compared to extremity surgeries.

The effect of early intervention programs has also been extensively studied. An early intervention program in Sweden reduced the time to the first doctor visit by a factor of 3, compared to usual care. For first episodes of musculoskeletal pain, the early intervention was associated with more improvement in activity, less sick leave, and earlier returns to work. It was estimated that the early intervention saved over 1,000 sickness absence days (Linton, Hellsing, & Andersson, 1993). An early intervention program in Norway allowed patients to be referred to a spine clinic within 12 weeks of sickness absence onset. Over the next three years, the early intervention group averaged 126 sick leave days, and 60% reported improvement in pain, while

the usual care group averaged 170 sick leave days and only 50% reported improvements in pain. The researchers estimated that early intervention saved $3,500 per person (Molde Hagen, Grasdal, & Eriksen, 2003). In Great Britain, and early intervention group that received physical therapy for acute low back pain was compared to a group that received physical therapy after a six week delay. At the six month follow up, the early intervention group had less psychological distress (depression, anxiety, somatization, mental health) and better quality of life than the delayed treatment group (Wand et al., 2004). In the U.S., earlier interventions with physical therapy, nurse case managers, occupational therapists, and employers are associated with fewer sick days, greater return to work, less healthcare utilization, and less chronic disability (Arnetz, Sjögren, Rydéhn, & Meisel, 2003; Ehrmann-Feldman, Rossignol, Abenhaim, & Gobeille, 1996; Zigenfus, Yin, Giang, & Fogarty, 2000). Cost savings are estimated at $1,200 per person (Arnetz et al., 2003). Early interdisciplinary rehabilitation treatment in patients with high risk of developing chronic disability was found to be effective and cost-effective in improving work status, healthcare utilization, medication use, and chronic disability (R. Gatchel et al., 2003). In addition, functional restoration for workers' compensation patients within the first eight months of disability was associated with significantly better outcomes and lower costs compared to treatment delayed for more than 18 months. It was estimated that earlier intervention could save $170,000 per case (Theodore, Mayer, & Gatchel, under review). Finally, a meta-analysis of treatment initiation times found that the most appropriate time window for structured rehabilitation interventions was from 8-12 weeks after injury. The researchers concluded that rehabilitation treatment prior to 8 weeks was not cost-effective, while delaying treatment longer than 12 weeks allowed the development of physical deconditioning and psychosocial problems that required more intensive treatments (van Duijn et al., 2010).

All of this evidence suggests that delays in treatment are detrimental to the health and well-being of the patient, in addition to producing poorer outcomes and greater costs. Therefore, any program that can reduce treatment delays will likely produce better patient outcomes. For

patients with chronic pain, delays of no more than 4-8 months before entering an interdisciplinary functional restoration program would be ideal.

CHAPTER 7

WORKERS' COMPENSATION SYSTEMS

7.1 Texas Workers' Compensation System

Workers' compensation programs are one of the oldest social insurance programs in the United States. Prior to the implementation of workers' compensation programs, which began in 1910, workers who were injured on the job could sue their employers for negligence in the court system (Sengupta & Reno, 2007). Managing work injuries through the tort system produced undesirable outcomes for both workers and employers. Injured workers could potentially recover damages related to medical costs, lost wages, pain, and suffering, but only after a lengthy judicial process. The employees also had to prove that their injury was a direct result of the employer's negligence, and not related to the expected hazards of the job (assumed risks), the negligence of a fellow employee, or the injured worker's own individual negligence (Ohana, 2011). In addition to paying legal fees and court costs, workers had to pay out-of-pocket for medical care and had no means of replacing lost wages, until after the case was decided. For employers, each case had the potential to result in a financially devastating verdict in favor of the employee (Sengupta & Reno, 2007).

Thus, the workers' compensation system was a benefit to both parties. Intended to be the "exclusive remedy" for workplace injuries, the new system was a no-fault system. Every employee was entitled to necessary medical care and some level of wage replacement following a workplace injury, regardless of the cause of the injury. In exchange, the employees relinquished the right to sue their employers for negligence in the court system, and gave up their right to recover non-economic damages, such as pain and suffering. For the employers, the costs of the workers' compensation program were fixed, predictable, and often less than the costs of losing a negligence suit (Ohana, 2011; Sengupta & Reno, 2007).

Currently, 49 states mandate that employers provide workers' compensation coverage, except in a few specific circumstances. Independent contractors, domestic service workers, and agricultural workers are commonly excluded from mandatory workers' compensation coverage, and employers with fewer than 3-5 employees (minimum size varies by state) are usually not required to carry workers' compensation insurance (Spieler & Burton, 2012). In Texas, the only state where workers' compensation insurance is not mandatory, there are two additional options. First, employers may self-insure following verification by the Texas Workers' Compensation Commission (TWCC) that the employer has adequate financial resources to pay for injuries to its workforce. Companies that self-insure for work-related injuries must provide a security deposit to the Department of Workers' Compensation and are subject to on-site safety inspections as well as additional fees and taxes (Texas Workers' Compensation Commission, 2012b). Second, employers may opt-out of the workers' compensation system; these employers are referred to as non-subscribers. Non-subscribers are subject to injured employee lawsuits for negligence, and are barred from using the common law defenses of assumption of risk (i.e., the employee agreed to undertake the risk by accepting the job) and contributory negligence (i.e., the accident was a result of the employee's own negligence or the negligence of another employee). In addition, non-subscribers may be sued for non-economic damages (i.e., pain and suffering) in addition to medical costs and wage replacement, and the amount of employee damages is not limited by state law (Ohana, 2011; Texas Workers' Compensation Commission, 2012a). In 2010, 32% of Texas employers opted out of the workers' compensation system, and 17% of the Texas workforce was employed by non-subscribing companies (Texas Department of Insurance, 2010a).

Many non-subscribers offer benefits to their employees following a work-related injury, even though they are not required by law to do so. These "alternative benefit plans" may be administered by the company or contracted out to a third party administrator. In 2008, just over half of non-subscribers offered occupational injury benefits, and of these, 70% covered medical expenses and 68% provided wage replacement. However, the amount and duration of these

benefits were often less than that provided by workers' compensation insurance programs (Morantz, 2011; Ohana, 2011). More non-subscribing companies are satisfied with their occupational benefit programs than workers' compensation subscribers. Non-subscribers also more frequently report that the benefits to injured workers were fair and adequate, that the benefit plan was a good value, and that they were able to effectively manage costs (Texas Department of Insurance, 2010a). However, there is no current data available documenting the satisfaction of employees receiving work-injury benefits from non-subscribing employers; the most recent survey was conducted in 1997 (Morantz, 2011).

7.2 Benefits Mandated by Texas Workers' Compensation Law

Injured workers covered by workers' compensation programs in Texas are entitled to "all healthcare reasonably required by the nature of injury as and when needed." Healthcare includes physician visits, diagnostic testing, rehabilitation services, and medications. More specifically, workers are entitled to care that cures or relieves the symptoms resulting from the injury, care that promotes recovery, and care that increases the employee's ability to return to work. Medical benefits are paid from the date of injury (Texas Department of Insurance, 2010d). Medical benefits are intended to be applied according to the best-practice evidence-based treatment as specified in the Official Disability Guidelines, which are published by the Work Loss Data Institute (Denniston & Kennedy Jr., 2012). Medical care for the work-related injury may not be terminated by claim settlement, and there is no specific timeline as to when medical benefits are no longer payable (Texas Department of Insurance, 2010d).

Workers whose injuries prevent them from continuing to work are eligible for wage replacement benefits after a seven-day waiting period. There are four levels of wage replacement benefits. Temporary Impairment Benefits are provided to employees who are expected to improve in health status and/or functional ability; these benefits are payable at 70-75% of the employee's pre-injury wages up to the maximum of 100% of the state average weekly wage. Temporary Impairment Benefit payments are terminated when the employee reaches Maximum Medical Improvement (MMI), the point at which there is no longer any reasonable

expectation of further improvement, or at 104 weeks of benefit receipt (Texas Department of Insurance, 2011a). MMI is established by a physician who provides an impairment rating in accordance with the American Medical Association Guides to the Evaluation of Permanent Impairment (4th edition) to determine the percentage of work capacity that has been lost due to the injury. The outcome of the impairment rating determines the level of Impairment Income Benefits, which are payable at 70% of the employee's pre-injury wage for three weeks per percentage point of impairment (Texas Department of Insurance, 2010d). When Impairment Income Benefits expire, the injured worker will be eligible for Supplemental Income Benefits if he or she has an impairment rating of 15% or more, is unable to work as a result of the injury, or is working at a reduced wage of 80% or less than former wages. These benefits are payable at 80% of the difference between 80% of the pre-injury weekly wage and the current weekly wage. Workers not currently employed must be actively involved in a vocational rehabilitation program or actively searching for work to be eligible for Supplemental Income Benefits (Texas Department of Insurance, 2010d). In certain situations, the injured worker may be entitled to Lifetime Income Benefits. These benefits are reserved for severely disabling injuries, including total and permanent blindness, multiple extremity amputations, permanent paralysis, severe traumatic brain injury, and widespread third degree burns. Lifetime benefits are payable at 75% of the pre-injury weekly wage, with an annual 3% cost-of-living increase, but not exceeding the state average weekly wage (Texas Department of Insurance, 2010d).

An injured worker may also receive vocational rehabilitation through the Department of Assistive and Rehabilitative Services (DARS) if he or she needs additional help regaining work capacity or if re-training for a new job is necessitated by the nature of the injury (Texas Department of Insurance, 2010d). Vocational rehabilitation services may include counseling, guidance, and referrals, as well as physical restoration treatment. In addition, DARS may pay for job training through colleges and universities or through technical or vocational schools. If the injured worker is unable to pay for basic living expenses, DARS may provide financial assistance with those costs (Texas Department of Assistive and Rehabiitative Services, 2010).

7.3 Resolution of Disputes

Decisions within the workers' compensation system may be disputed is one or more parties are dissatisfied with the outcome. There are several reasons for disputes: indemnity, liability, medical necessity, income benefit disputes, and fee disputes (Texas Department of Insurance, 2011b). Indemnity, or compensability, is a question of whether the injury sustained by the worker was related to the employee's job. Questions of compensability are more frequently encountered in poorly defined injuries such as muscle strain or back pain, in cases of cumulative trauma, such as carpal tunnel syndrome, where a specific date of injury is difficult to establish, and when the injury may have been due in part or whole to activities outside the workplace. Liability disputes involve an injury that was work-related but may or may not have fallen into the categories of injuries excluded from workers' compensation coverage. For example, if the employee was intoxicated at the time of the injury, if the injury was a result of the employee attempting to injure his or herself or another employee, if the injury was intentionally caused by a person other than a co-worker, or if the injury occurred in an off-duty activity (such as athletic or recreational activity) unless such activities were required as a part of the job. Questions of income benefits arise when the insurance carrier disputes the employee's reported wage or the employee disputes the determination of the average weekly wage. Such disputes are more common in occupations with irregular income, such as employees who receive a portion of their salary based on commission or variable amounts of overtime work. Disagreements over medical necessity involve disagreements between parties over whether a particular healthcare service is indicated or if it will substantially improve the employee's condition. Finally, disputes over medical fees involve denial or reduction of reimbursement for compensable medically necessary services (Texas Department of Insurance, 2010d).

The first step in any dispute is a request for reconsideration, which may be submitted either by the employee, the healthcare provider, or the employer. The dissatisfied party can submit a request in writing and may also provide additional information to inform the new decision. If the dispute is not resolved after request for reconsideration, a benefit review

conference may be requested. Benefit review conferences are non-adversarial meetings intended for the parties to explain their positions, discuss the facts and documentation of the claim, and mediate and resolve disputes (Texas Department of Insurance, 2010d). Disputes that are resolved in benefit review conferences are documents with a signed agreement which is legally binding to both the insurance carrier and the claimant.

If the dispute cannot be resolved in the Benefit Review Conference, the dispute may proceed to arbitration or a contested case hearing, which are typically used for disputes over compensability, liability, and income benefits. Arbitration is intended to establish formal, binding resolution of issues and render a final award. All involved parties must present evidence for their claim as required by the arbitrator. Decisions made by the arbitrator are final and cannot be appealed. The contested case hearing is an alternative to arbitration, and follows standard administrative procedure determined by state law. In the contested case hearing, all parties must exchange medical reports and records, witness statements, and other relevant documents. The hearing officer receives testimony, hears examination and cross-examination of witnesses, and accepts documents and other evidence. Decisions are made by the hearing officer in accordance with state law. The outcome of a contested case hearing may be appealed under the judicial system (Texas Department of Insurance, 2010d).

Appeals to contested case hearing decisions are overseen by a three-member panel of judges. The appeals panel may reverse the decision of the hearing officer and issue a new ruling or send the case back to the hearing officer for further consideration. Alternatively, the appeals panel may uphold the hearing officer's decision. Decisions of the appeals panel that are unsatisfactory to one or more parties may be evaluated under the judicial review process. Judicial review proceeds according to the standard procedure for other civil trials, and the party appealing the decision must prove their case by the standard of preponderance of evidence (Texas Department of Insurance, 2010d).

Disputes over medical necessity and medical fees are evaluated by independent review organizations, which are certified under the direction of a physician to review medical decisions in

both workers' compensation and medical insurance cases. The independent review organizations are required to use medically acceptable review criteria that are based on medical and scientific evidence and generally accepted standards of medical practice. The review criteria are intended to be objective and clinically valid, but flexible enough to allow exceptions in appropriate situations. For workers' compensation cases, the decisions of the independent review organization are guided by the Official Disability Guidelines (Denniston & Kennedy Jr., 2012; Texas Department of Insurance, 2010c). Decisions rendered by an independent review organization may be appealed through a contested case hearing, as described above.

7.4 Delays in the Workers' Compensation System

In general, injured workers within the workers' compensation system receive timely care. In the year 2012, about 82% of Texas workers' compensation patients received medical care within seven days of their injury, with an average of five days between injury and initial physical contact (Texas Department of Insurance, 2012). Delays in obtaining care adversely affect treatment outcomes. Workers with delays in obtaining medical care greater than seven days had 41% greater total medical costs in the first six months of treatment (Texas Department of Insurance, 2012). Workers whose claims are denied or disputed for reasons of compensability or extent of injury take three times as long to receive initial treatment than are workers without disputed claims. Disputes over preauthorization account for 24% of medical disputes, and take an average of 20 workdays to resolve (Texas Department of Insurance, 2010b).

In addition to delays in receiving delays in initial treatment, claim disputes may interrupt the sequence of treatment or delay access to secondary or tertiary care. For example, an initial request for authorization of medical services may take up to 15 days to obtain the carrier's response. A reconsideration request must be filed with 15 days of receiving the response. If the reconsideration is also denied, a benefit review conference may be requested within 30-45 days after the second denial. The benefit review conference must be scheduled within 20 days of the request. If the decision of the benefit review conference is appealed through arbitration, the request must be made within 20 days after the benefit review. The arbitrator must be assigned

within 30 days of the benefit review, and must begin within 30 days after the arbitrator is assigned. Once the arbitration hearing is complete, the arbitrator has seven days to render a final ruling. If a worker goes through the entire appeals process, accessing treatment may take as long as 32 months, by which point, significant additional physical deconditioning and psychological issues may develop, hindering the ability of the patient to successfully return to full employment and productivity (Hashemi et al., 1997; Jordan et al., 1998; Mahmud et al., 2000). Therefore, eliminating unnecessary delays in treatment are in the best interest of the employer, the employee, and society.

7.5 Surgical Outcomes in Worker's Compensation Patients

Workers' compensation claims, with or without attorney involvement, have been found to be associated with a variety of undesirable outcomes over a wide range of surgical procedures. Most studies comparing workers' compensation and non-workers' compensation patients undergoing lumbar spine surgery found poorer outcomes for workers' compensation patients in outcomes such as patient satisfaction, pain intensity, functional ability, reoperation rates, and daily activity (Agazzi et al., 1999; Asch et al., 2002; Atlas et al., 2010; Davis, 1994; Fritzell et al., 2001; Hulen, 2008; Klekamp, McCarty, & Spengler, 1998; Martin et al., 2007b; Taylor et al., 2000; Trief et al., 2000; Voorhies, Jiang, & Thomas, 2007). Only two studies found no association between receipt of workers' compensation and outcomes after lumbar fusion (P. A. Anderson, Schwaegler, Cizek, & Leverson, 2006; Deguchi, Rapoff, & Zdeblick, 1998). For cervical spine surgery, most studies found that workers' compensation patients had poorer function, lower satisfaction with surgery, lower rates of return to work, and longer time to return to work (Cauthen et al., 1998; Davis, 1996; Goldberg et al., 2002; Tomaras, Blacklock, Parker, & Harper, 1997; Tribus et al., 1999), however, workers' compensation patients did not have higher levels of post-operative pain than non-workers' compensation patients (Bohlman, Emery, Goodfellow, & Jones, 1993; Rao et al., 2008). Workers' compensation was strongly related to outcomes in carpal tunnel release, with benefits predicting longer time to return to work, lower rates of return to work, poorer work function, more residual symptoms, and lower satisfaction with surgery (Amick et al.,

2004; Carmona, Faucett, Blanc, & Yelin, 1998; Feuerstein et al., 1999; Higgs, Edwards, Martin, & Weeks, 1995; Jeffrey N. Katz et al., 2005; J. N. Katz et al., 2001; D. J. Nagle et al., 1996; Roth, Richards, & MacLeod, 1994; Straub, 1999). In shoulder surgery, the relationship of workers' compensation to outcome was less consistent. Several studies found no differences between workers' compensation and non-workers' compensation patients undergoing shoulder surgery for pain intensity, function, satisfaction with surgery, quality of life, radiographic findings, or return to work (Cole et al., 2007; Iannotti, Bernot, Kuhlman, Kelley, & Williams, 1996; Nicholson, 2003; Piasecki et al., 2010; Walch et al., 2005). However, other studies have found that receipt of workers' compensation was associated with poorer function, less range of motion, poorer health-related quality of life, lower treatment satisfaction, higher pain levels, and lower rates of return to work after shoulder surgery (Balyk et al., 2008; B. D. Cameron, Galatz, Ramsey, Williams, & Iannotti, 2002; Cuff & Pupello, 2012; Frieman & Fenlin Jr, 1995; Henn et al., 2008; Holtby & Razmjou, 2010; Koljonen et al., 2009; McKee & Yoo, 2000; Misamore, Ziegler, & Rushton II, 1995; Nové-Josserand et al., 2011; Paulos & Kody, 1994; Watson & Sonnabend, 2002). Knee replacement patients receiving workers' compensation had higher levels of pain, poorer function, lower range of motion, greater rates of narcotic use, more reoperations, and took longer to return to work than patients not receiving workers' compensation (de Beer et al., 2005; Masri et al., 2009; Mont et al., 1998; Styron et al., 2011). Workers' compensation patients also took longer to return to work after anterior cruciate ligament repair, had poorer function after arthroscopic partial meniscectomy, were less satisfied with treatment after open reduction and internal fixation for heel fractures, and had more pain, swelling, and impairment in daily activity after ankle arthroscopy compared to non-workers' compensation patients (Amendola, Petrik, & Webster-Bogaert, 1996; Geel & Flemister, 2001; J. N. Katz et al., 1992; Frank R. Noyes & Barber-Westin, 1997). In all, the evidence strongly supports the proposition that receiving workers' compensation is a risk factor for poorer outcomes after surgery.

CHAPTER 8

METHODS

8.1 Surgical Option Process

An unresolved surgical option was defined in four different ways: (1) surgery was presented to the patient as a possible option, but no formal request for surgical authorization was made to the insurance carrier, (2) surgery was requested by the surgeon but denied by the insurance carrier, (3) surgery was presented to the patient as a treatment option, but the patient declined surgery, and (4) surgery was requested by one surgeon, but the physician consulted for a second opinion disagreed with the surgical recommendation, and the request for authorization was withdrawn. Patients with an unresolved surgical option were admitted to a functional restoration program. After undergoing a comprehensive evaluation including a complete medical examination, a functional capacity evaluation, and a psychosocial assessment, SOP patients began functional restoration. At the midpoint of treatment, usually after 10 full day sessions, the patient met with the attending physician to decide whether or not they wished to pursue surgery. If the patient declined surgery at this point, he or she completed functional restoraton as usual, generally within 4-6 weeks. If the patient decided to pursue surgery, he or she was referred to an appropriate surgical provider for evaluation. If the surgeon recommended surgery, a formal authorization request for surgery was made to the insurance carrier. The patient awaiting surgery continued with periodic physician visits during the surgical preparation stage and during the post-operative recovery period. When it was thought safe for the patient to resume intensive physical training after surgery, he or she returned to functional restoration and completed the remainder of the treatment sessions (usually 10 additional full treatment days). If the surgeon did not recommend surgery, the patient was offered the opportunity to complete the remainder of the functional restoration treatment sessions. Figure 8.1 shows the design of the SOP program.

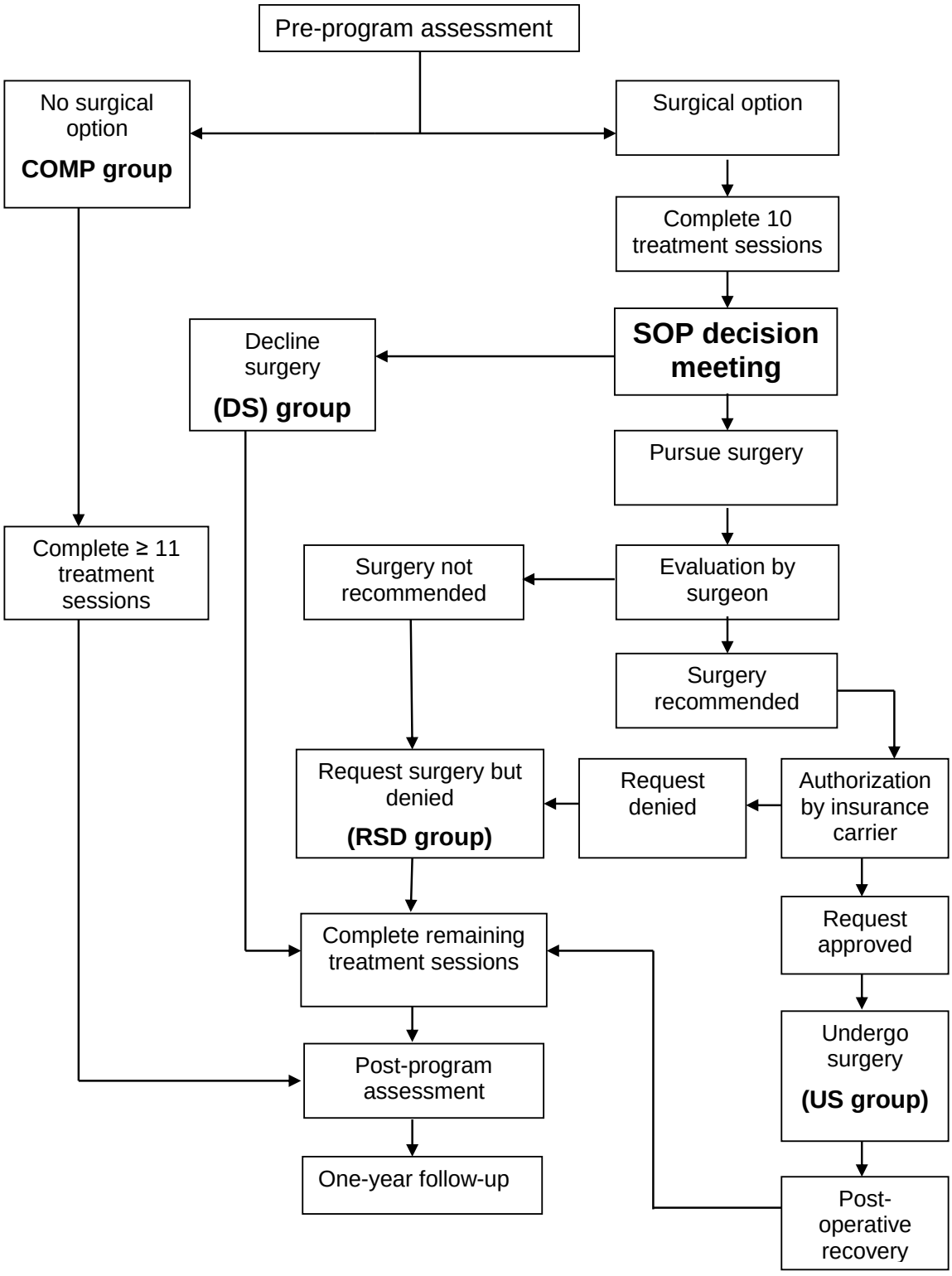


Figure 8.1 Design of the SOP program

8.2 Functional Restoration

Functional restoration rehabilitation for CDOMDs is based on the biopsychosocial model of pain. Treatment was supervised by a physician and guided by serial physical and psychological evaluation. The initial functional capacity evaluation included measures of strength, range of motion, lifting ability, aerobic capacity, and work ability. Throughout the treatment program, serial measurements of strength and range of motion were obtained; these measurements were used to create individualized treatment plans. Physical treatments in functional restoration included exercises intended to increase strength, range of motion, and cardiovascular fitness. Occupational therapy was also based on serial measurements of function, with activities intended to simulate job related tasks, including both whole body activities like walking, carrying, lifting, and stair climbing; and job-specific tasks like manual dexterity training, climbing, and crawling. Job-related activities were matched to the job the patient intended to return to after rehabilitation (T Mayer & Gatchel, 1988).

Psychological therapy began with a comprehensive evaluation that included validated measures of depressive symptoms, perceived disability, and pain intensity. Secondary measures of fear-avoidance, pain anxiety, and insomnia symptoms were also collected. In addition, a licensed psychologist conducted a diagnostic session to evaluate the presence of DSM-IV psychological disorders. Based on the results of the evaluation, the patient may have participated in individual or group counseling sessions, which were based on cognitive-behavioral principles. Patients may also have participated in biofeedback for relaxation and stress management or surface-EMG assisted stretching training to reduce fear avoidance and improve lumbar spine range of motion, if these interventions were judged necessary by the treatment team. If needed, patients were referred to a psychiatrist (on site) for psychotropic medication management or detoxification from opioid pain medications (T Mayer & Gatchel, 1988).

Patients participated in daily educational sessions, where they learned about health behaviors such as diet, exercise, and stress management. They also participated in didactic sessions about musculoskeletal functioning, and training in life skills such as assertiveness, pain

control, coping strategies, and communication skills. The idea that pain does not necessarily signal physical harm, and that some amount of pain must be tolerated to achieve recovery was emphasized throughout the program. Finally, case managers worked with patients to manage the complexities of the workers' compensation system, and helped the patient plan for a successful return to employment and productivity. If the patient's original job was no longer available, or the patient was no longer able to perform his or her previous job, case managers worked with the Texas Department of Assistive and Rehabilitative Services (DARS) to arrange for job placement and/or retraining (T Mayer & Gatchel, 1988).

8.3 Participants

Participants for the current study were 295 consecutive patients who were admitted to PRIDE under the surgical option process and discharged between January 2004 and May 2011. Patients were referred by primary and secondary care providers for treatment of CDOMDs under workers' compensation insurance. Inclusion criteria were as follows: (1) total or partial disability of at least four months prior to program entry, (2) failure of primary and secondary care, including medications, physical therapy, and injections, (3) persistent severe pain with functional limitations, (4) unresolved surgical option, and (5) were able to communicate in English or Spanish. There were 50 patients who did not complete the SOP decision meeting, and were excluded from the analysis: 25 patients were evaluated for the SOP but never enrolled in the functional restoration program and 25 patients began the SOP but dropped out of the program prior to the surgical decision meeting, leaving a total SOP cohort of 245 patients.

During the period from January 2004 and May 2011, there were 1758 additional patients admitted to PRIDE, for a total seven-year cohort of 2053 consecutive patients. A comparison group of patients who were not part of the SOP process was selected out of the remaining patients. The comparison group included only patients without an unresolved surgical option; these patients may have had a prior surgery or not, but additional surgery was not a treatment option at the time of admission to functional restoration. The comparison group was matched to the SOP group for year of discharge to avoid cohort effects, as there were significant economic

changes at both the local and national level that may have changed the overall likelihood of socioeconomic outcomes such as return to work. The initial size of the comparison group was set at 300, to be roughly equivalent to the total size of the SOP cohort. For each discharge year, a comparable percentage of non-SOP patients were randomly selected from the full non-SOP cohort. After the comparison group was selected, non-workers' compensation patients were eliminated from the comparison group, resulting in a total group size of 272 patients. This method of matching eliminated almost all significant differences between the total SOP cohort and the comparison group.

The SOP group and the comparison group completed the program at similar rates [70.6% and 65.8% respectively, χ^2 (1, N = 517) = 1.37, p = .242]. This is comparable to the completion rates found in other studies of functional restoration (Howard et al., 2009; Proctor, Mayer, Theodore, & Gatchel, 2006). Tables 8.1-8.4 show the evaluation of differences between the matched comparison group and the SOP group on demographics, occupational factors, psychosocial test scores, and one-year socioeconomic outcomes. This analysis is also shown in graphical form in Appendix A.

There were only a few measures that differed significantly between the total SOP group and the matched comparison group. First, the SOP group was more likely to be male than the matched comparison group, χ^2 (1, N = 517) = 4.60, p = .032, OR = 1.49, 95% CI [1.0, 2.1]. Second, the SOP group had a higher pre-injury weekly wage than the matched comparison group, t(466) = -3.08, p = .002, d = -0.28. Finally, the SOP group had lower (worse) scores on the SF-36 physical health component summary scale at admission, t(471) = 2.09, p = .0381, d = 0.18. These differences were not corrected with any further matching because the SOP group was actually at lower risk of poor outcomes in terms of gender and pre-injury wage, and the effect sizes for all three differences were small.

Table 8.1. Demographics and Occupational Measures for SOP and COMP Groups (N = 517)

Measure	Matched comparison group (*N* = 272)	All SOP participants (*N* = 245)	Test statistic	*p*	Effect size
Discharge year, *n* (%)			χ^2 =7.59	.370	
2004	1 (0.4%)	1 (0.4%)			
2005	8 (2.9%)	5 (2%)			
2006	18 (6.6%)	15 (6.1%)			
2007	32 (11.8%)	30 (12.3%)			
2008	54 (19.9%)	47 (19.2%)			
2009	63 (23.2%)	57 (23.4%)			
2010	84 (30.9%)	64 (26.2%)			
2011[a]	12 (4.4%)	25 (10.2%)			
Age (years) mean (*SD*)	45.6 (9.6)	47.0 (9.7)	*t* = -1.54	.124	
Gender, *n* (% male)	163 (59.9%)	169 (69.0%)	χ^2 = 4.60	.032	*OR* = 1.49 95% *CI* [1.0, 2.1]
Race, *n* (%)			χ^2 = 5.76	.218	
White, non-Hispanic	136 (50.45)	128 (52.7%)			
Black or African-American	59 (21.9%)	48 (19.8%)			
Hispanic	63 (23.35)	64 (26.3%)			
Asian	5 (1.9%)	2 (0.8%)			
Other	7 (2.6%)	1 (0.4%)			
Type of injury, *n* (%)			χ^2 = 10.78	.056	
cervical spine	8 (3%)	7 (2.9%)			
thoracic/lumbar spine	82 (30.6%)	84 (34.3%)			
extremity only	61 (22.8%)	74 (30.2%)			
multiple spinal	30 (11.2%)	14 (5.7%)			
multiple musculoskeletal	82 (30.6%)	66 (26.5%)			
other	5 (1.9%)	1 (0.4%)			
Number of compensable injuries mean (*SD*)	2.0 (1.5)	1.9 (1.3)	*t* = 1.41	.158	
Months of disability mean (*SD*)	27.7 (33.4)	23.0 (28.8)	*t* = 1.69	.091	
Pre-treatment surgery *n* (%)	125 (48.3%)	122 (50.2%)	χ^2 = 0.19	.663	
Number of pre-treatment surgeries mean (*SD*)	0.82 (1.1)	0.86 (1.1)	*t* = -0.36	.717	

Table 8.1 *Continued.*

Measure	Matched comparison group (*N* = 272)	All SOP participants (*N* = 245)	Test statistic	*p*	Effect size
Number of pre-treatment surgeries, *n* (%)			$\chi^2 = 2.10$	.717	
0	133 (51.8%)	121 (49.8%)			
1	67 (26.1%)	710 (28.8%)			
2	35 (13.6%)	26 (10.7%)			
3	13 (5.1%)	17 (7%)			
≥ 4	9 (3.5%)	9 (3.7%)			
Working at admission *n* (%)	44 (16.9%)	35 (14.8%)	$\chi^2 = 0.38$	.537	
Pre-injury weekly wage mean (*SD*)	$623 (328)	$722 (367)	*t* = -3.08	.002	*d* = -0.28 [b]
Job demand, *n* (%)			$\chi^2 = 3.71$	.295	
sedentary/light	27 (10.4%)	22 (9.4%)			
light/medium	67 (25.9%)	45 (19.1%)			
medium/heavy	93 (35.9%)	94 (40.0%)			
heavy/very heavy	72 (27.8%)	74 (31.5%)			
Job class (*n*, % blue collar)	202 (80.8%)	196 (84.1%)	$\chi^2 = 0.92$	.338	
Disability benefits (SSI or SSDI) *n* (%)	26 (10%)	18 (7.7%)	$\chi^2 = 0.81$	.369	

[a] data collection ended with discharge date of May 31, 2011; [b] medium effect

Table 8.2. DSM-IV Psychiatric Disorders for SOP and COMP Groups (*N* = 517)

Variable	Matched comparison group (*N* = 272)	All SOP participants (*N* = 245)	Test statistic	*p*
Major depressive disorder *n* (%)	183 (68.8%)	161 (67.9%)	$\chi^2 = 0.04$	.835
Any anxiety disorder *n* (%)	92 (34.6%)	79 (33.2%)	$\chi^2 = 0.09$	.767
Bipolar disorder *n* (%)	10 (3.8%)	6 (2.5%)	$\chi^2 = 0.61$	.433
Alcohol abuse or dependence *n* (%)	5 (1.9%)	6 (2.5%)	$\chi^2 = 0.25$	.618
Opioid dependence *n* (%)	27 (10.2%)	13 (5.5%)	$\chi^2 = 3.73$	.054
Any substance abuse *n* (%)	34 (12.8%)	19 (8.0%)	$\chi^2 = 3.02$	.082
Adjustment disorder *n* (%)	48 (18.0%)	43 (18.1%)	$\chi^2 = .001$	.977
Cluster A personality disorder *n* (%)	2 (0.8%)	1 (0.5%)	$\chi^2 = 0.23$	.631
Cluster B personality disorder *n* (%)	24 (9.7%)	14 (6.3%)	$\chi^2 = 1.75$	.185
Cluster C personality disorder *n* (%)	11 (4.4%)	14 (6.3%)	$\chi^2 = 0.84$	.361
Other personality disorder *n* (%)	17 (6.9%)	14 (6.3%)	$\chi^2 = 0.05$	.821
Any Axis II diagnosis *n* (%)	46 (18.5%)	40 (18.1%)	$\chi^2 = 0.02$	.900

Table 8.3. Psychosocial Testing for SOP and COMP Groups (N = 517)

Interval	Test	Matched comparison group (N = 272)	All SOP participants (N = 245)	Test Statistic	*p*	Effect size
Admission						
	Pain intensity VAS	7.58 (1.8)	7.28 (1.7)	*t* = 1.73	.085	
	Beck depression inventory	19.9 (10.2)	19.2 (10.7)	*t* = 0.74	.458	
	Pain disability questionnaire	102.1 (25.3)	102.3 (22.5)	*t* = -0.09	.931	
	Oswestry disability index	45.8 (16.3)	46.3 (15.4)	*t* = -0.31	.757	
	SF-36 mental health component	38.2 (10.3)	39.8 (10.9)	*t* = -1.71	.088	
	SF-36 physical health component	29.5 (6.4)	28.4 (5.5)	*t* = 2.09	.038	*d* = 0.18 [a]
Discharge						
	Pain intensity VAS	5.47 (2.5)	5.21 (2.3)	*t* = 0.96	.340	
	Beck depression inventory	13.2 (9.8)	12.1 (9.0)	*t* = 1.05	.294	
	Pain disability questionnaire	75.4 (33.2)	74.5 (32.1)	*t* = 0.30	.768	
	Oswestry disability index	31.8 (17.4)	31.5 (18.7)	*t* = 0.19	.851	
	SF-36 mental health component	42.9 (12.5)	45.0 (12.6)	*t* = -1.60	.111	
	SF-36 physical health component	34.9 (9.2)	35.3 (10.1)	*t* = -0.41	.682	

Note: All scores are presented as mean (standard deviation). [a] small effect

Table 8.4. One-year Socioeconomic Outcomes for SOP and COMP Groups (*N*=460)

Outcome		Matched comparison group (*N* = 217)	All SOP participants (*N* = 243)	Test value	*p*
Return to work *n* (%)		163 (71.8%)	157 (76.6%)	$\chi^2 = 1.28$	.258
Work retention *n* (%)		124 (61.1%)	116 (65.2%)	$\chi^2 = 0.68$	.410
Treatment seeking *n* (%)		28 (12.9%)	26 (10.7%)	$\chi^2 = 0.54$	.464
Number of visits *n* (%)				$\chi^2 = 1.55$	.460
	none	189 (81.7%)	216 (90%)		
	1 to 5	17 (7.8%)	12 (5%)		
	> 6	11 (5.1%)	12 (5%)		
New injury *n* (%)		7 (3.5%)	10 (5.6%)	$\chi^2 = 0.98$	.323

Note: 57 patients had missing data at follow-up

8.4 Measures

8.4.1 Demographic, Medical History, and Program-Specific Measures

Most demographic information was obtained during the initial evaluation. Relevant data included age, gender, and race. In addition to this, occupational data was collected that included type of job, work status after injury, job demand, pre-injury wage, and receipt of government disability benefits such as Supplemental Security Income (SSI) and Social Security Disability Insurance (SSDI). Medical history measures included type of injury (i.e. body part that was injured), number of injuries compensable under the workers' compensation claim, duration of disability post-injury, and information about pre-admission surgical procedures.

The major program-specific measure was completion status. Program completion was categorized in three ways: completers, who completed the physical, psychological, and vocational parts of the FR program with the intention of returning to work after discharge; drop-outs, who abandoned the program before completing any of the program components; and quality-of-life discharges, who completed the physical and psychological portions of the program but not the vocational reintegration portion of the FR program. Although all patients were employed at the time of injury (a prerequisite for entry into the workers' compensation system), the quality-of-life patients chose not to pursue employment after discharge for reasons such as retirement, becoming a stay-at-home parent, or award of permanent disability benefits.

Additional measures specific to the SOP program included reason for entering the SOP program, type of surgery requested at admission to the SOP, and type of surgery received during the SOP. At the one-year follow-up, the surgery requested at admission to the SOP was compared to any surgical procedures received after discharge from functional restoration. A patient was considered to have reversed their SOP decision if: (1) they declined a surgery during the SOP program and then received that same surgery after discharge (or termination) from the functional restoration program or (2) if their surgery was denied by the surgeon or insurance carrier during the SOP and the patient was able to find a different provider willing to perform the same surgical procedure after discharge/termination from functional restoration. Receiving

surgery to a different compensable body part, or receiving a different surgical procedure than was considered during the SOP (for example, lumbar fusion rather than spinal cord stimulator) was not considered a reversal of the SOP decision.

8.4.2 Measures of Pain and Disability

Pain was measured using a visual analog scale, a 10 cm line with the endpoints of 0 (no pain) and 10 (worst possible pain). Patients indicated their current level of pain by placing a mark along the line. In addition, patients were presented with a line drawing of a person, and they indicated on the drawing all their areas of pain. Both the pain visual analog scale and the quantified pain drawing have been found to be reliable, valid, and responsive measures of pain intensity (Jensen, Chen, & Brugger, 2003; Jensen, Karoly, & Braver, 1986; Margolis, Tait, & Krause, 1986; Ohnmeiss, 2000; Rainville, Ahern, Phalen, Childs, & Sutherland, 1992; Von Korff, Jensen, & Karoly, 2000).

Perceived disability was measured using the Oswestry Disability Index and the Pain Disability Questionnaire (PDQ). The ODI measures pain-related disability. Originally designed for use with low back pain patients, the scale has been adapted for use with a variety of different pain conditions. The scale ranges from 0-100, with higher scores indicating more severe disability. Reliability, validity, and responsiveness of the ODI have been widely established (J. C. T. Fairbank & Pynsent, 2000; Grönblad et al., 1993; Pratt, Fairbank, & Virr, 2002; Roland & Fairbank, 2000; Wittink, Turk, Carr, Sukiennik, & Rogers, 2004). The PDQ is a comprehensive measure of self-reported disability that is relevant to all musculoskeletal disorders, including back pain, upper extremity pain, and lower extremity pain. The PDQ ranges from 1-150, with higher scores indicating more disability, and has been shown to be reliable, valid, and responsive to change (Anagnostis, Gatchel, & Mayer, 2004; R. J. Gatchel, Mayer, & Theodore, 2006).

8.4.3 Measures of Psychological Symptoms

Depressive symptoms were measured using the Beck Depression Inventory (BDI), one of the most widely used depression-related scales. Scores on the BDI can range from 0-63, with higher scores indicating more severe symptoms. The BDI has been shown to be reliable, valid,

and responsive in chronic pain populations (A. Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; A. T. Beck & Steer, 1984; Aaron T. Beck, Steer, & Carbin, 1988; J. D. Beck et al., 2012; Geisser, Roth, & Robinson, 1997; Kendall, Hollon, Beck, Hammen, & Ingram, 1987; J. A. Turner & Romano, 1984).

A clinical interview was performed by qualified clinical staff to evaluate for the presence of psychological disorders according to the DSM-IV diagnostic criteria (American Psychiatric Association, 2000). Both Axis I mood disorders and Axis II personality disorders were evaluated. Additionally, the psychologist screened for family issues, secondary gain motivation, and malingering (R. J. Gatchel & Mayer, 2008).

8.4.4 Measures of Health-Related Quality of Life

Health-related quality of life was measured at admission to and discharge from the functional restoration program using the Medical Outcomes Study 36-item short-form health survey (SF-36). The SF-36 includes subscales that measures a variety of health constructs including physical functioning, social function, mental health, bodily pain, vitality, and perception of overall health ((McHorney, Ware, Rachel Lu, & Sherbourne, 1994; McHorney, Ware, & Raczek, 1993; Ware & Sherbourne, 1992). The SF-36 has excellent reliability and validity for measuring health status at the group level, although its predictive utility at the individual level has been called into question (R. J. Gatchel, Polatin, Mayer, Robinson, & Dersh, 1998). There is some evidence that the SF-36 may be related to socioeconomic outcomes in chronic pain patients, and therefore it was included as part of the comprehensive psychosocial evaluation (R. J. Gatchel, Mayer, Dersh, Robinson, & Polatin, 1999). Two summary scales were used: the physical health component scale, which includes the physical function, physical roles, bodily pain and general health subscales; and the mental health component scale, which includes the mental health, emotional role, social function, and vitality subscales (Ware et al., 1995). Higher scores on the SF-36 indicate higher levels of health-related quality of life.

8.4.5 Measures of Socioeconomic Factors

At one-year after discharge from PRIDE (or discontinuation of treatment), socioeconomic outcomes were evaluated using a structured interview format, either by telephone or in person. Information about work status was obtained, including both return to work (if the patient returned to work at any point during the post-discharge year) and work retention (if the patient was still employed at the one-year follow-up). Healthcare utilization was assessed by collecting the number of visits to new healthcare providers in excess of routine follow-up care and/or visits to new medical providers ("doctor shopping"). In addition, any additional surgical procedures performed after discharge from PRIDE were recorded. In addition, it was noted if the patient has filed a subsequent workers' compensation claim either for a new injury or a recurrent injury to the same body part. If necessary, the follow-up interview was supplemented by contact with the workers' compensation insurance carrier (T Mayer & Gatchel, 1988).

8.5 Hypotheses

The first hypothesis of the current study was that the findings of the pilot study would be replicated. Patients who request surgery but are denied were believed to be less likely to complete the treatment program and to demonstrate poorer socioeconomic outcomes, with lower rates of return to work and work retention; as well as higher rates of healthcare utilization, new injury claims, and additional surgeries. Outcomes and completion status were expected to be similar between patients who decline surgery and patients who receive surgery; in addition, these patients were not expected to be significantly different from the non-SOP comparison group. Furthermore, I did not expect to find significant demographic differences among SOP groups.

The second hypothesis was that there would be differences among the SOP groups in psychosocial distress and disorders. Patients who requested surgery but were denied were hypothesized to have higher levels of depressive symptoms, perceived disability, pain intensity, and psychiatric disorders. Psychological symptoms and disorders were expected to be similar between patients who declined surgery and patients who received surgery; in addition, these patients were not predicted to be significantly different from the non-SOP comparison group. In

particular, patients who continued to pursue surgery after it had been denied were expected to show more treatment-resistant personality characteristics, including opioid dependence and cluster B personality disorders (Howard et al., 2009). Moreover, patients who requested surgery but were denied were hypothesized to show less improvement in psychosocial measures from pre-treatment to post-treatment, but similar improvements were anticipated among the other two SOP groups and the non-SOP comparison group.

The final hypothesis was that no differences in outcomes would be identified between SOP patients being treated for different types of injuries. That is, I expected similar socioeconomic and psychosocial outcomes for lumbar spine, cervical spine, upper extremity, and lower extremity SOP patients.

8.6 Statistical Analysis

The SOP patients were categorized into four groups based on the end result of the SOP program: (1) declined surgery (N = 164), (2) underwent surgery (N = 43), (3) requested surgery but request was denied by the evaluating surgeon (N = 33), and (4) requested surgery but request was denied by the insurance carrier (N = 5). Because the number of patients in the group that was denied surgery by the insurance carrier was so small, this group was combined with the group that was denied surgery by the surgeon to form a group of patients who requested surgery but were denied by the surgeon or the insurance carrier (N = 38). The final three patient groups [declined surgery (DS), underwent surgery (US), requested surgery but denied by surgeon or carrier (RSD)] were compared to the non-SOP comparison group (COMP) in all subsequent analyses. Figure 8.2 shows the progression of participants through the study.

Differences between SOP groups and the non-SOP comparison group were evaluated at program admission, program discharge, and one year after discharge. Categorical variables were evaluated using chi-square tests, with Cohen's *w* as a measure of effect size (Cohen, 1988). Chi-square tests found to be statistically significant ($p < .05$) were further tested with post-hoc pairwise comparisons, using the Holm-Bonferroni step-down procedure to control for Type I error due to multiple comparisons (Holm, 1979). Continuous variables were evaluated using

univariate ANOVA tests, with partial eta-squared as the effect size measure. Pre-treatment to post-treatment change was evaluated using a repeated-measures ANOVA test, with time and SOP group as the independent variables, and partial eta-squared as the effect size measure. Post-hoc testing for ANOVA procedures used the Bonferroni correction for multiple comparisons.

The relationship of the SOP group to one-year socioeconomic outcomes was evaluated using sequential logistic regression. Variables found in prior research to be significantly related to one year outcomes were entered in the first step of the analysis. These variables included age and work status at admission to treatment (Brede et al., 2012), perceived disability as measured by the Pain Disability Questionnaire at program discharge (R. J. Gatchel et al., 2006), pain intensity as measured by the visual analog scale (McGeary et al., 2006), depressive symptoms at program discharge as measured by the Beck Depression Inventory (Brede et al., 2012), and completion of the treatment program (Howard et al., 2009; Proctor et al., 2006). Pre-treatment surgery was also included at this step as it was particularly relevant to the current study, although prior research has not found consistent relationships between pre-treatment surgery and one-year socioeconomic outcomes (Tom Mayer et al., 1998; Wright, Mayer, & Gatchel, 1999). The first step of the model also included significant differences among the SOP subgroups in demographic and occupational measures identified in the univariate analysis. The SOP group (non-SOP comparison, declined surgery, surgery, and denied by surgeon or carrier) was added to the second step of the analysis to evaluate the contribution of the SOP program over and above the effect of other relevant variables.

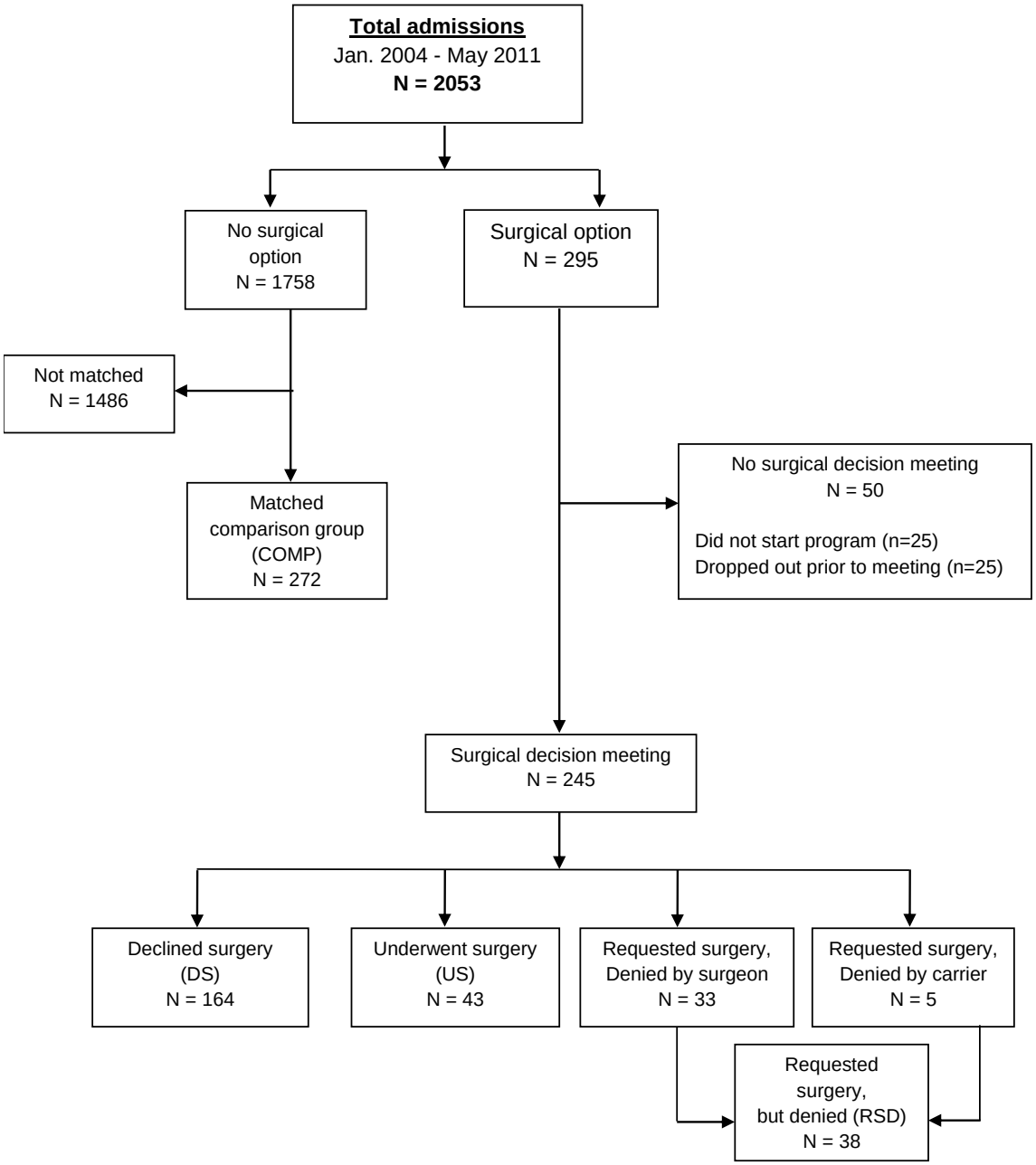


Figure 8.2 Progression of Patients Through the Study

The effect of SOP group on the number of healthcare visits during the post-discharge year was evaluated using a multinomial logistic regression analysis. Although the original plan had been to evaluate this relationship using linear regression, during the data screening process it was determined that the distribution of the number of visits in the post-discharge year did not have the properties of a continuous measure, but instead clustered around discrete values. A three-level categorical variable was created, with values of (1) no additional visits beyond the standard re-check visits, (2) between one and five additional visits, and (3) six or more additional visits. Variables that have previously been found to be related to the prediction of healthcare utilization {Proctor, 2004 #392} were added in the first step of the analysis and SOP group was added in the second step.

CHAPTER 9

RESULTS

9.1 Evaluation of Assumptions

Prior to beginning analysis, the dataset was screened for missing data, outliers, and statistical assumptions. Most of the variables had at least some missing data, but there were no significant differences in the rates of missing data among the SOP patient groups or the non-SOP comparison group. Missing data were treated with pairwise deletion. Data were considered outliers if they exceeded the possible values of the variable. These values were recoded to the maximum possible score for the scale. The distributions of the variables were examined for normality of distributions. Although few of the variables were completely normally distributed (with $p > .05$) according to the Lilliefors test and the Shapiro-Wilk test, most of the distributions were not skewed enough to warrant transformation, given the adequate sample size. The P-P and Q-Q plots were also examined and provided further evidence that transformation was not necessary. The only variable that was determined to not meet the distributional assumptions was the number of healthcare visits at one year. Transformations did not improve the distribution, so the variable was recoded into categories.

For the continuous variables, homogeneity of variance was evaluated with the Levene test, and homogeneity of the variance-covariance matrix was evaluated with Box's M test. The assumption of homogeneity of variance and covariance was met for all variables except for the SF-36 physical health component scale in the repeated measures analysis. To correct for the violation of homogeneity of the variance-covariance matrix in this one analysis, Pillai's criterion was used instead of Wilk's lambda. For the logistic regression analysis, the predictor variables were examined for multicollinearity using the tolerance, variance inflation factor, and condition index. By all of these tests, there were no problems with multicollinearity among the predictor

variables. Multicollinearity was noted in a few instances between specific categories of the SOP group variable and specific categories of the predictor variables. This will be discussed in detail in the results of the regression analysis. In these cases, the category with multicollinearity was removed from the analysis.

A power analysis was conducted to determine if the sample size was adequate. For chi-square tests, in order to detect small effect sizes (w = 0.10) with power β = 0.80, and significance α = .05, a sample of 1091 participants would be required. The sample required to detect medium effect sizes (w = 0.3) is 122, which was exceeded by the present sample size of 517 participants. The smallest effect size detectable in a chi-square analysis, given the present sample size, was w = 0.15, indicating a small effect. For ANOVA tests, a sample of 1096 participants would be necessary to detect small effects (η_p^2 = 0.01) and a sample of 180 participants would be required to detect medium-sized effects (η_p^2 = 0.06). The smallest detectable effect size, using the current sample, in a one-way ANOVA analysis was η_p^2 = 0.022, indicating small to medium effects could be identified.

9.2 Description of the SOP Patient Groups

Of the patients offered participation in the SOP program, 92% began the SOP program, and 83% were able to decide on a preferred course of treatment (surgical or non-surgical) at the SOP decision meeting (see Figure 8.2). The majority of the SOP patients entered the program because surgery had been presented as a treatment option, but no formal request for surgical authorization was made to the insurance carrier (76.7%). Table 9.1 shows the comparison of reasons for entry into the SOP program among the SOP subgroups. No significant differences were found among groups in reasons for entry into the SOP program, χ^2 (6, N = 245) = 7.20, p = .303.

Table 9.2 displays the surgeries requested by the SOP subgroups. The most frequently requested surgery was lumbar fusion (28.6%), followed by cervical fusion and/or decompression (11.4%), and lumbar decompression (11.4%). There were no significant differences in the type of surgery requested among the SOP groups, χ^2 (28, N = 245) = 37.2, p = .115. Among the 43 SOP

patients who received surgery, the most common procedure received was lumbar fusion (18.6%), followed by meniscectomy (11.6%). Table 9.3 displays the types of surgeries received as a part of the SOP program.

Table 9.1. Reason for Entering the SOP Program (N = 245)

Variable	SOP subgroup		
	Declined surgery (DS) N = 164 (67%)	Underwent Surgery (US) N = 43 (18%)	Requested surgery but denied (RSD) N = 38 (15%)
Surgery was presented as a treatment option but no formal request was made to the insurance carrier	128 (78.0%)	35 (81.4%)	25 (65.8%)
Second surgical opinion differed from the first opinion and the surgical request was withdrawn	2 (1.2%)	0 (0%)	2 (5.3%)
Surgery was requested by the surgeon but denied by the insurance carrier	29 (17.7%)	8 (18.6%)	10 (26.3%)
Patient declined surgery	5 (3.0%)	0 (0%)	1 (2.6%)

Table 9.2. Types of Surgery Requested by SOP Patients (N = 245)

	SOP subgroup		
		Underwent	
Surgery requested	Declined surgery (DS) N = 164 (67%)	Surgery (US) N = 43 (18%)	Requested surgery but denied (RSD) N = 38 (15%)
Cervical fusion or decompression	22 (13.4%)	4 (9.3%)	2 (5.3%)
Lumbar fusion	49 (29.9%)	8 (18.6%)	13 (34.2%)
Lumbar decompression	19 (11.6%)	3 (7.0%)	6 (15.8%)
Lumbar hardware removal	4 (2.4%)	4 (9.3%)	0 (0%)
Other lumbar surgery	3 (1.8%)	0 (0%)	1 (2.6%)
Spinal cord stimulator	7 (4.3%)	1 (2.3%)	2 (5.3%)
Meniscectomy	5 (3.0%)	5 (11.6%)	2 (5.3%)
Total knee replacement	9 (5.5%)	2 (4.7%)	2 (5.3%)
Other knee surgery	6 (3.7%)	2 (4.7%)	6 (15.8%)
Ankle, heel, or foot surgery	6 (3.7%)	3 (7.0%)	0 (0%)
Shoulder decompression with or without acromioplasty	9 (5.5%)	1 (2.3%)	1 (2.63%)
Rotator cuff or labrum repair	9 (5.5%)	3 (7.0%)	1 (2.6%)
Other shoulder surgery	5 (3.0%)	2 (4.7%)	1 (2.6%)
Hand, wrist, or elbow surgery including carpal tunnel release	10 (6.1%)	3 (7.0%)	1 (2.6%)
Surgery to other body parts	1 (0.6%)	2 (4.7%)	0 (0%)

Table 9.3. Surgeries Received by Patients Undergoing Surgery (N = 43)

Surgery received	N (%)
Cervical fusion	4 (9.3%)
Lumbar fusion	8 (18.6%)
Lumbar decompression	3 (7.0%)
Lumbar hardware removal	4 (9.3%)
Spinal cord stimulator	1 (2.3%)
Meniscectomy	5 (11.6%)
Total knee replacement	2 (4.7%)
Other knee surgery	2 (4.7%)
Ankle, foot, or heel surgery	3 (7.0%)
Shoulder decompression	1 (2.3%)
Rotator cuff or labrum repair	2 (4.7%)
Other shoulder surgery	2 (4.7%)
Hand, wrist, or elbow surgery including carpal tunnel release	4 (9.3%)
Surgery to other body parts	2 (4.7%)

9.3 Univariate Test Results for the SOP Subgroups and the Non-SOP Comparison Group

The overall functional restoration completion rate was 68.1%, similar to that found in previous studies (Howard et al., 2009; Proctor et al., 2006). There were statistically significant differences among the SOP subgroups, χ^2 (6, N = 517) = 25.7, p < .001, w = 0.22. In post-hoc pairwise comparisons, it was found that, compared to the RSD group, the DS (p < .001, *OR* = 4.24, 95% *CI* [2.03, 8.86]) and COMP groups (p = .012, *OR* = 2.38, 95% *CI* [1.20, 4.73]) were more likely to complete the functional restoration program. In addition, the DS group was more likely to complete the treatment program than the COMP group (p = .010, *OR* = 1.78, 95% *CI* [1.14, 2.78]). Similarly, the RSD group was more likely to drop out of treatment compared to the DS (p < .001, *OR* = 7.00, 95% *CI* [3.11, 15.78]) and COMP groups (p = .001, *OR* = 3.12, 95% *CI* [1.55, 6.31]), and the COMP group was more likely to drop out than the DS group (p = .006, *OR* = 2.24, 95% *CI* [1.25, 4.01]). Non-significant (after Holm step-down correction for multiple comparisons) trends were identified for the US group to be more likely to complete the program than the RSD group (p =.040, *OR* = 2.56, 95% *CI* [1.04, 6.31]) and for the RSD group to be more likely to drop out of the program than the US group (p =.022, *OR* = 3.06, 95% *CI* [1.16, 8.10]). There were no significant differences between any pairs of subgroups in the number of quality of life discharges.

There were few significant differences among the SOP subgroups and the non-SOP comparison group in other demographic characteristics (see Table 9.4). Of particular note is the fact that the non-SOP comparison group was no less likely to have had surgery prior to admission to PRIDE, χ^2 (3, N = 502) = 2.782, p = .426, w = 0.07. There were also no significant differences in the number of pre-treatment surgeries received F(3, 499) = 1.31, p = .271, η_p^2 = 0.01. Significant differences were identified among the groups in age, F(3, 512) = 3.32, p = .020, η_p^2 = 0.02, and pre-injury wage, F(3, 464) = 3.82, p = .010, η_p^2 = 0.03. Post-hoc testing showed that the US group was significantly older than the RSD group (p = .037) and that the DS group has a significantly higher pre-injury wage than the COMP group (p = .012). In addition, there were significant differences in job demand from the job of injury among the groups, χ^2 (9, N = 494) =

22.17, p = .008, w = 0.21. Post-hoc testing revealed that US patients were more likely to have had a sedentary to light job demand pre-injury compared to DS patients (p = .001, OR = 6.05, 95% CI [2.21, 16.56]) and to COMP patients (p = .012, OR = 2.77, 95% CI [1.23, 6.27]), and that DS patients were more likely to have a heavy to very heavy job demand than the US patients (p = .013, OR = 3.12, 95% CI [1.22, 7.86]). A non-significant trend (after correction for multiple comparisons) was identified suggesting that the RSD group was more likely to have a heavy to very heavy job demand compared to the US group, p = .029, OR = 3.30, 95% CI = 1.1, 9.9].

Tables 9.5 and 9.6 show the DSM-IV psychiatric diagnoses for the four groups. There were no significant differences among the subgroups in prevalence of Axis I mood disorders. Because of the low prevalence of personality disorders in the sample, the disorders were combined according to clusters (American Psychiatric Association, 2000). Cluster A (odd or eccentric) includes paranoid, schizoid, and schizotypal personality disorders; Cluster B (dramatic, emotional, or erratic) includes antisocial, borderline, histrionic, and narcissistic personality disorders; and Cluster C (anxious or fearful) includes avoidant, dependent, and obsessive-compulsive personality disorders. There were no significant differences in the prevalence of Axis II personality disorders among the four groups.

Table 9.4. Demographics for SOP Subgroups (N = 517)

	SOP subgroup						
Variable	Non-SOP comparison (COMP) N = 272	Declined surgery (DS) N = 164	Underwent Surgery (US) N = 43	Requested Surgery but Denied (RSD) N = 38	Test statistic	p	Effect size
Program completion, *n* (%)					$\chi^2 = 25.7$	<.001	$w = 0.22$ [d]
Completed program	179 (65.8%)[ab]	127 (77.4%)[a]	29 (67.4%)	17 (44.7%)			
Abandoned treatment	56 (20.6%)[ab]	17 (10.4%)[a]	9 (20.9%)	17 (44.7%)			
Quality-of-life discharge	37 (13.6%)	20 (12.2%)	5 (11.6%)	4 (10.5%)			
Age (years) mean (*SD*)	45.6 (9.6) [c]	47.0 (9.6)	49.7 (9.0) [a]	43.7 (10.2)	*F* =3.32	.020	$\eta_p^2 = 0.02$ [d]
Gender, *n* (% male)	163 (59.9%)	115 (70.1%)	28 (65.1%)	26 (68.4%)	$\chi^2 = 4.98$	.174	
Race, *n* (%)					$\chi^2 = 11.3$	.503	
White, non-Hispanic	136 (50.4%)	83 (50.6%)	27 (65.9%)	18 (47.4%)			
Black or African-American	59 (21.9%)	35 (21.3%)	4 (9.8%)	9 (23.7%)			
Hispanic or Latino	63 (23.3%)	44 (26.8%)	10 (24.4%)	10 (26.3%)			
Asian	5 (1.9%)	1 (0.6%)	0 (0%)	1 (2.6%)			
Other	7 (2.6%)	1 (0.6%)	0 (0%)	0 (0%)			
Type of injury, *n* (%)					$\chi^2 = 17.1$	.313	
cervical spine	8 (3%)	5 (3%)	1 (2.3%)	1 (2.6%)			
thoracic/lumbar spine	82 (30.6%)	58 (35.4%)	11 (25.6%)	15 (39.5%)			
extremity only	61 (22.8%)	47 (28.7%)	16 (37.2%)	11 (28.97%)			
multiple spinal	30 (11.2%)	8 (4.9%)	2 (4.7%)	4 (10.5%)			
multiple musculoskeletal	82 (30.6%)	47 (28.0%)	12 (27.9%)	7 (18.4%)			
other	5 (1.9%)	0 (0%)	1 (2.3%)	0 (0%)			
Number of compensable injuries, mean (*SD*)	2.04 (1.5)	1.84 (1.4)	2.05 (1.3)	1.76 (1.2)	*F* = 0.98	.402	

[a] Different from RSD group, [b] Different from COMP group, [c] Different from US group, [d] small effect

Table 9.4 *Continued*

	Non-SOP comparison (COMP) N = 272	Declined surgery (DS) N = 164	Underwent Surgery (US) N = 43	Requested Surgery but Denied (RSD) N = 38			
Months of disability mean (*SD*)	27.7 (33.8)	23.4 (27.1)	25.9 (40.7)	18.0 (17.2)	$F = 1.41$	.239	
Pre-treatment surgery *n* (%)	125 (48.3%)	83 (50.9%)	24 (57.1%)	15 (39.5%)	$\chi^2 = 2.78$	.426	
No. of pre-treatment surgeries mean (*SD*)	0.82 (1.1)	0.84 (1.1)	1.12 (1.3)	0.66 (1.0)	$F = 1.31$	.271	
No. of pre-treatment surgeries *n* (%)					$\chi^2 = 10.1$	.608	
0	133 (51.8%)	80 (49.1%)	18 (42.9%)	23 (60.5%)			
1	67 (26.1%)	50 (30.7%)	11 (26.2%)	9 (23.7%)			
2	35 (13.6%)	18 (11%)	6 (14.3%)	2 (5.3%)			
3	13 (5.1%)	9 (5.5%)	4 (9.5%)	4 (10.5%)			
≥ 4	9 (3.5%)	6 (3.7%)	0 (0%)	0 (0%)			
Working at admission *n* (%)	44 (16.9%)	26 (16.5%)	6 (14.6%)	3 (8.1%)	$\chi^2 = 1.95$	.584	
Pre-injury weekly wage mean (*SD*)	$623 (328)	$734 (371) [b]	$742 (348)	$647 (373)	$F = 3.82$	.010	$\eta_p^2 = 0.02$ [d]
Job demand *n* (%)					$\chi^2 = 22.2$	.008	$w = 0.21$ [d]
sedentary/light	27 (10.4%) [c]	8 (5.1%) [c]	10 (24.4%)	4 (11.1%)			
light/medium	67 (25.9%)	33 (20.9%)	6 (14.6%)	6 (16.7%)			
medium/heavy	93 (35.9%)	62 (39.2%)	190 (47.3%)	13 (36.1%)			
heavy/very heavy	72 (27.8%)	55 (34.8%) [c]	6 (14.6%)	13 (36.1%)			

[a] Different from RSD group, [b] Different from COMP group, [c] Different from US group, [d] small effect

Table 9.4 *Continued*

Variable	SOP subgroup				Test statistic	p	Effect size
	Non-SOP comparison (COMP) N = 272	Declined surgery (DS) N = 164	Underwent Surgery (US) N = 43	Requested Surgery but Denied (RSD) N = 38			
Job class *n*, % blue collar	202 (80.8%)	135 (87.1%)	30 (73.2%)	31 (83.8%)	$\chi^2 = 5.26$	.154	
Disability benefits (SSI or SSDI) *n* (%)	26 (10%)	12 (7.7%)	4 (9.8%)	2 (5.4%)	$\chi^2 = 1.26$	.739	

[a] Different from RSD group, [b] Different from COMP group, [c] Different from US group, [d] small effect

Table 9.5. Axis I Psychological Disorder Diagnoses for SOP Subgroups (N = 503).*

	SOP subgroup					
Variable	Non-SOP comparison (COMP) N = 266	Declined surgery (DS) N = 160	Underwent Surgery (US) N = 41	Requested Surgery but Denied (RSD) N = 36	Test statistic	p
Major depressive disorder *n* (%)	183 (68.8%)	110 (68.8%)	29 (70.7%)	22 (61.1%)	$\chi^2 = 1.02$	.797
Any anxiety disorder *n* (%)	92 (34.6%)	58 (36.3%)	10 (24.4%)	11 (30.6%)	$\chi^2 = 2.28$	.516
Generalized anxiety disorder *n* (%)	63 (23.7%)	44 (27.5%)	7 (17.1%)	7 (19.4%)	$\chi^2 = 2.57$	.462
Bipolar disorder *n* (%)	10 (3.8%)	5 (3.1%)	0 (0%)	1 (2.8%)	$\chi^2 = 1.66$	.647
Adjustment disorder *n* (%)	48 (18%)	25 (15.6%)	7 (17.1%)	11 (30.6%)	$\chi^2 = 4.46$	.216
Alcohol abuse/dependence *n* (%)	5 (1.9%)	3 (1.9%)	2 (4.9%)	1 (2.8%)	$\chi^2 = 1.64$	.651
Opioid dependence *n* (%)	27 (10.2%)	10 (6.3%)	2 (4.9%)	1 (2.8%)	$\chi^2 = 4.24$	.237
Any substance abuse disorder *n* (%)	34 (12.8%)	14 (8.8%)	3 (7.3%)	2 (5.6%)	$\chi^2 = 3.36$	.339

*Note: 14 patients were not evaluated for Axis I disorders.

Table 9.6. Axis II Psychological Disorder Diagnoses for SOP Subgroups (N = 469).*

	SOP subgroup					
Variable	Non-SOP comparison (COMP) N = 248	Declined surgery (DS) N = 147	Underwent Surgery (US) N = 40	Requested Surgery but Denied (RSD) N = 34	Test statistic	p
Cluster A personality disorder n (%)	2 (0.8%)	1 (0.7%)	0 (0%)	0 (0%)	$\chi^2 = 0.59$	.899
Cluster B personality disorder n (%)	24 (9.7%)	6 (4.1%)	6 (15.0%)	2 (5.9%)	$\chi^2 = 6.80$	.079
Cluster C personality disorder n (%)	11 (4.4%)	9 (6.1%)	3 (7.5%)	2 (5.9%)	$\chi^2 = 0.97$	.809
Other personality disorder n (%)	17 (6.9%)	10 (6.8%)	3 (7.5%)	1 (2.9%)	$\chi^2 = 0.83$	.843
Any Axis II diagnosis n (%)	46 (18.5%)	23 (15.6%)	12 (30.0%)	5 (14.7%)	$\chi^2 = 4.65$	.199

*Note: 49 patients were not evaluated for Axis II disorders.

Table 9.7 shows the results of the psychosocial testing at admission to the treatment program. There were no significant differences in pain intensity, depressive symptoms, perceived disability, health related quality of life, or coping ability among the four groups at admission to the treatment program. Table 9.8 contains the results of the psychosocial testing at discharge from functional restoration. There were also no significant differences in pain intensity, depressive symptoms, perceived disability, health related quality of life, or coping ability among the four groups at discharge from the treatment program.

Table 9.7. Psychosocial Testing at Admission for SOP Subgroups (*N* = 498)*

	SOP subgroup					
Variable	Non-SOP comparison (COMP) *n* = 263	Declined surgery (DS) *n* = 159	Underwent Surgery (US) *n* = 41	Requested Surgery but Denied (RSD) *n* = 35	Test statistic	*p*
Pain intensity mean (*SD*)	7.58 (1.8)	7.26 (1.6)	7.47 (1.7)	7.17 (2.1)	*F* = 1.16	.326
Pain disability questionnaire mean (*SD*)	102.1 (25.3)	101.4 (22.3)	102.7 (23.6)	105.9 (22.3)	*F* = 0.34	.794
Oswestry disability index mean (*SD*)	45.84 (16.3)	45.46 (14.8)	46.3 (14.9)	49.94 (18.2)	*F* = 0.77	.512
SF-36 component scales						
mental health	38.16 (10.3)	39.00 (10.5)	41.00 (11.2)	42.33 (12.2)	*F* = 2.07	.103
physical health mean (*SD*)	29.51 (6.4)	28.59 (5.6)	27.69 (6.1)	28.12 (3.8)	*F* = 1.70	.166

*Note: 19 patients failed to complete psychosocial testing at program admission.

Table 9.8. Psychosocial Testing at Discharge for SOP Subgroups (*N* = 382).*

	SOP subgroup					
Variable	Non-SOP comparison (COMP) *n* = 199	Declined surgery (DS) *n* = 132	Underwent Surgery (US) *n* = 31	Requested Surgery but Denied (RSD) *n* = 20	Test statistic	*p*
Pain intensity mean (*SD*)	5.47 (2.5)	4.97 (2.4)	5.60 (2.0)	6.16 (2.2)	*F* = 1.82	.143
Beck depression inventory mean (*SD*)	13.24 (9.8)	11.71 (8.6)	11.85 (11.0)	14.68 (9.3)	*F* = 0.91	.437
Pain disability questionnaire mean (*SD*)	75.44 (33.2)	71.96 (32.1)	79.71 (33.39)	82.75 (30.3)	*F* = 0.98	.401
Oswestry disability index mean (*SD*)	31.83 (17.4)	30.01 (18.8)	34.10 (19.2)	37.05 (16.5)	*F* = 1.16	.325
SF-36 component scales						
mental health	42.93 (12.5)	45.35 (12.2)	45.03 (15.3)	43.02 (11.3)	*F* = 1.03	.381
physical health mean (*SD*)	34.91 (9.2)	35.88 (8.8)	34.74 (15.1)	32.43 (8.8)	*F* = 0.77	.513

*Note: 135 patients failed to complete psychosocial testing at discharge.

The evaluation of one-year healthcare utilization outcomes is shown in Table 9.9. After discharge, most patients adhered to their SOP decision: only 0.8% of patients (both DS) underwent the surgery that was previously declined during the SOP. One patient had a knee replacement and one had a lumbar fusion, which they had previously declined during the SOP. There were 9 additional patients who received surgery in the year after discharge, but did not receive the same surgery considered as part of the SOP. There were no differences in the rates of different surgeries to the SOP body part among the SOP subgroups. Patients in the RSD group were more likely to had additional surgery to another compensable body part during the post-discharge year than were DS patients (p= .005, *OR* = 14.6, 95% *CI* [1.30, 168.2]), however, this result should be interpreted cautiously as the prevalence of additional surgery was too low to meet the recommended sample size for chi-square testing (i.e., more than 5 cases per cell). When all non-SOP surgeries were considered together (different surgery to same body part and different surgery to different body part), significant differences were identified among the subgroups, χ^2 (3, N = 440) = 13.57, p = .004, w = 0.18. Post-hoc pairwise comparisons found that the RSD patients were more likely to have additional surgery compared to the DS group (p = .006, *OR* = 7.57, 95% *CI* [1.43, 39.97]) and compared to the COMP group (p = .001, *OR* = 9.95, 95% *CI* [1.90, 52.45]). There was a non-significant trend (after correction for multiple comparisons) for the US group to be more likely to have additional surgery than the COMP group (p = .026, *OR* = 5.36, 95% *CI* [1.04, 27.59]. There were no differences in seeking treatment from new providers or the number of healthcare visit utilized) among the SOP subgroups. Table 9.10 lists the specific surgical procedures received by patients during the post-discharge year. As can be seen, patients who underwent additional surgery after discharge from functional restoration rarely retained work and had high rates of treatment-seeking behavior.

One-year socioeconomic outcomes are shown separately for program completers (Table 9.11) and for all patients (Table 9.12). Of program completers, 85.6% successfully returned to work and 75.3% retained work throughout to follow-up period and significant differences were found among the SOP subgroups in measures of return to work, χ^2 (3, N = 340) = 20.14, p < .001,

w = 0.24, and work retention, χ^2 (3, *N* = 295) = 7.89, *p* = .048, *w* = 0.16. Program completers from the RSD group were more likely to fail to return to work than completers from the US group (*p* = .011, *OR* = 6.52, 95% *CI* [1.40, 30.31]), the DS group (*p* < .001, *OR* = 11.06, 95% *CI* [3.43, 35.63]), and the COMP group (*p* = .002, *OR* = 4.54, 95% *CI* [1.62, 12.74]). Completers from the RSD group were more likely to fail to retain work than completers from the DS group (*p* = .005, *OR* = 4.95, 95% *CI* [1.50, 16.37]). There were non-significant trends suggesting that completers from the DS group were more likely to return to work than the COMP group (*p* = .023, *OR* = 2.44, 95% *CI* [1.11, 5.36]) and that RSD completers were less likely to retain work than the COMP group (*p* = .032, *OR* = 3.339, 95% *CI* [1.06, 10.48]). There were no differences in receipt of SSI or SSDI or prevalence of new compensable injury among completers in any of the subgroups.

When all patients were considered (completers, drop-outs, and quality of life discharges), 74.1% returned to work in the year after discharge and 63.0% retained work throughout the follow up period. Significant differences were identified among the subgroups for return to work, χ^2 (3, *N* = 432) = 25.06, *p* < .001, *w* = 0.24; work retention, χ^2 (3, *N* = 381) = 15.70, *p* = .001, *w* = 0.20; and disability benefits, χ^2 (3, *N* = 369) = 8.28, *p* = .041, *w* = 0.15. The RSD group was more likely to fail to return to work compared to the US group (*p* = .013, *OR* = 3.78, 95% *CI* [1.30, 10.95]), the DS group (*p* < .001, *OR* = 7.79, 95% *CI* [3.85, 23.73.27, 18.55]), and the COMP group (*p* = .001, *OR* = 3.61, 95% *CI* [1.63, 7.98]). The RSD group was also more likely to fail to retain work compared to the DS group (*p* < .001, *OR* = 6.05, 95% *CI* [2.29, 16.00]), and the COMP group (*p* = .005, *OR* = 3.59, 95% *CI* [1.41, 9.11]). In addition, compared to the COMP group, the DS group was more likely to return to work (*p* = .005, *OR* = 2.16, 95% *CI* [1.26, 3.70]). Furthermore, the US group was more likely to be receiving disability benefits compared to the DS group (*p* = .008, *OR* = 3.13, 95% *CI* [1.32, 8.34]), and there was a non-significant trends (after correction for multiple comparisons) suggesting that the US group was more likely to be receiving disability benefits than the COMP group (*p* = .048, *OR* = 2.30, 95% *CI* [0.99, 5.34]) and less likely to retain work than the RSD group (*p* = .025, *OR* = 3.62, 95% *CI* [1.15, 11.4]. There were no differences among the subgroups in rates of new compensable injuries in the year after discharge.

Patients who dropped out of the functional restoration program had poorer socioeconomic outcomes than those who completed the program, as has been shown in other studies (Howard et al., 2009; Proctor et al., 2006). Of the program drop-outs, only 48% returned to work and 28% retained employment throughout the follow-up period. In addition, 31% of the drop-outs were receiving SSI or SSDI at the one-year follow-up. There were no differences in socioeconomic outcomes among the SOP subgroups when considering only program drop-outs. Some patients who received quality of life discharges did return to work at a reduced level (i.e. part time), although at lower rates than the program completers and drop-outs: 18% returned to work and 16% retained work, and 69% of quality of life discharges were receiving SSI or SSDI benefits at the one-year follow-up. There were no differences in the rates of return to work or work retention among the SOP subgroups who received quality of life discharges, but the DS patients receiving quality of life discharges were less likely to be receiving SSI or SSDI than those from the other subgroups. This analysis is also shown in graphical form in Appendix B.

Table 9.9. One Year Healthcare Utilization Outcomes (N = 460)*

	SOP subgroup						
Variable	Non-SOP comparison N = 217	Declined surgery N = 164	Underwent Surgery N = 42	Requested Surgery but Denied N = 37	Test statistic	*p*	Effect size
Treatment seeking *n* (%)	28 (12.9%)	17 (10.4%)	4 (9.5%)	5 (13.5%)	$\chi^2 = 0.89$		
Number of additional healthcare visits, *n* (%)					$\chi^2 = 3.00$		
0	189 (87.1%)	147 (90.2%)	38 (92.7%)	31 (86.1%)			
1 to 5	17 (7.8%)	8 (4.9%)	2 (4.9%)	2 (5.6%)			
> 6	11 (5.1%)	8 (4.9%)	1 (2.4%)	3 (8.3%)			
Reversed SOP decision *n* (%)	N/A	2 (1.2%)	0 (0%)	0 (0%)	N/A		
Post-discharge surgery to other compensable body part *n* (%)	N/A	1 (0.6%)[a]	1 (2.4%)	2 (8.3%)	$\chi^2 = 7.34$	.026	$w = 0.18$[b]
Different post-discharge surgery to same compensable body part *n* (%)	N/A	2 (1.2%)	2 (4.8%)	1 (4.2%)	$\chi^2 = 2.42$	.298	
Non-SOP post-discharge surgery n (%)	3 (1.4%)	3 (1.9%) [a]	3 (7.1%)	3 (12.5%)	$\chi^2 = 13.57$	.004	$w = 0.18$[b]

*Note: 57 patients were lost to follow-up. [a] different from RSD group, [b] small effect

Table 9.10 Surgeries Received after Discharge from Functional Restoration

Patient number	SOP subgroup	Surgery requested at SOP admission	Surgery received during SOP	Surgery received after discharge from functional restoration
1	DS	Lumbar fusion	N/A	Lumbar fusion [a, c, d, e]
2	DS	Knee replacement	N/A	Knee replacement [a, d]
3	DS	Spinal cord stimulator	N/A	Lumbar fusion [a, d]
4	DS	Knee replacement	N/A	Other knee surgery [a]
5	DS	Spinal cord stimulator	N/A	Foot/ankle surgery [b, c, d]
6	US	Lumbar fusion	Lumbar fusion	Lumbar hardware removal [a]
7	US	Biceps tendon repair	Biceps tendon repair	Rotator cuff repair [b, d]
8	US	Wrist hardware removal	Wrist hardware removal	Other shoulder surgery [a, c, d, e]
9	RSD	Knee cartilage allograft	N/A	Knee replacement [a, c, d]
10	RSD	Cervical spine fusion	N/A	Carpal tunnel release [b, c, d]
11	RSD	Lumbar discectomy	N/A	Other knee surgery [a, c, d]

[a] Completed functional restoration, [b] Abandoned treatment, [c] Not working at one year, [d] Treatment seeking at one year, [e] Receiving SSI or SSDI at one year

Table 9.11. One Year Socioeconomic Outcomes for SOP Subgroups, Program Completers Only (N = 340)

	SOP subgroup						
Variable	Non-SOP comparison N = 177	Declined surgery N = 121	Underwent Surgery N = 25	Requested Surgery but Denied N = 17	Test statistic	*p*	Effect size
Return to work, *n* (%)	148 (83.6%) [ab]	112 (92.6%) [a]	22 (88.0%) [a]	9 (52.9%)	$\chi^2 = 20.14$	<.001	*w* = 0.24 [c]
Work retention *n* (%)	114 (74.0%) [a]	85 (81.0%) [a]	17 (73.9%)	6 (46.2%)	$\chi^2 = 7.89$	.048	*w* = 0.16 [d]
New compensable injury, *n* (%)	4 (2.6%)	4 (3.8%)	2 (8.7%)	1 (6.7%)	$\chi^2 = 2.54$	.469	
Receiving SSI or SSDI *n* (%)	11 (7.2%)	9 (8.7%)	4 (18.2%)	1 (7.7%)	$\chi^2 = 2.98$	.394	*w* = 0.15 [d]

[a] different from RSD group, [b] different from DS group, [c] medium effect, [d] small effect

Table 9.12. One Year Socioeconomic Outcomes, All Patients (N = 432)

	SOP subgroup						
Variable	Non-SOP comparison N = 227	Declined surgery N = 143	Underwent Surgery N = 33	Requested Surgery but Denied N = 29	Test statistic	*p*	Effect size
Return to work, *n* (%)	163 (71.8%) [ab]	121 (84.6%) [a]	254 (72.7%) [a]	12 (41.4%)	$\chi^2 = 25.1$	<.001	$w = 0.24$ [c]
Work retention *n* (%)	124 (61.1%) [ab]	90 (72.6%) [a]	19 (61.3%) [a]	7 (30.4%)	$\chi^2 = 15.7$	.001	$w = 0.20$ [d]
New compensable injury, *n* (%)	7 (3.5%)	5 (4.0%)	3 (10.0%)	2 (7.7%)	$\chi^2 = 3.33$	.344	
Receiving SSI or SSDI *n* (%)	35 (17.9%)	16 (13.1%)	10 (32.3%)[b]	5 (28.6%)	$\chi^2 = 8.28$	.041	$w = 0.15$ [d]

[a] different from RSD group, [b]different from DS group, [c] medium effect, [d]small effect

9.4 Repeated Measures Analysis

A repeated measures ANOVA procedure was used to evaluate the rates of changes in psychosocial measures from admission to discharge, both with and between the SOP subgroups. The results of this testing can be found in Table 9.11. There was a significant decrease in pain intensity from admission to discharge, Wilks' $\lambda = 0.81$, $F(1, 311) = 72.0$, $p < .001$, $\eta_p^2 = 0.19$. However, the group X time interaction was not significant, Wilks' $\lambda = 0.99$, $F(1, 311) = 1.63$, $p = .182$, $\eta_p^2 = 0.02$. Examination of the simple effects of time within each of the SOP groups revealed significant improvements in pain intensity from admission to discharge for the COMP group (Wilks' $\lambda = 0.74$, $F(1, 311) = 109.1$, $p < .001$, $\eta_p^2 = 0.26$), the DS group (Wilks' $\lambda = 0.78$, $F(1, 311) = 90.0$, $p < .001$, $\eta_p^2 = 0.23$), and the US group (Wilks' $\lambda = 0.96$, $F(1, 311) = 13.3$, $p = .001$, $\eta_p^2 = 0.04$). The improvement from admission to discharge for the RSD group was not statistically significant, (Wilks' $\lambda = 0.99$, $F(1, 312) = 2.69$, $p = .102$, $\eta_p^2 = 0.01$).

There was a significant decrease in BDI score from admission to discharge, Wilks' $\lambda = 0.88$, $F(1, 307) = 20.22$, $p < .001$, $\eta_p^2 = 0.12$. The group X time interaction was not significant, Wilks' $\lambda = 0.99$, $F(1, 307) = 1.49$, $p = .217$, $\eta_p^2 = 0.01$. Significant improvements in depressive symptoms as measured by the BDI from admission to discharge were identified for the COMP group (Wilks' $\lambda = 0.82$, $F(1, 307) = 68.9$, $p < .001$, $\eta_p^2 = 0.18$), the DS group (Wilks' $\lambda = 0.87$, $F(1, 307) = 47.7$, $p < .001$, $\eta_p^2 = 0.13$), and the US group (Wilks' $\lambda = 0.97$, $F(1, 307) = 10.59$, $p = .001$, $\eta_p^2 = 0.03$). The improvement from admission to discharge for the RSD group was not statistically significant, (Wilks' $\lambda = 1.00$, $F(1, 307) = 0.54$, $p = .465$, $\eta_p^2 = 0.02$).

A significant decrease in perceived disability as measured by the Pain Disability Questionnaire was found from admission to discharge, Wilks' $\lambda = 0.76$, $F(1, 375) = 118.7$, $p < .001$, $\eta_p^2 = 0.24$. The group X time interaction was not significant, Wilks' $\lambda = 1.00$, $F(1, 375) = 0.65$, $p = .586$, $\eta_p^2 < 0.01$. There were significant improvements in PDQ score from admission to discharge for the COMP group (Wilks' $\lambda = 0.71$, $F(1, 375) = 150.6$, $p < .001$, $\eta_p^2 = 0.29$), the DS group (Wilks' $\lambda = 0.75$, $F(1, 375) = 127.3$, $p < .001$, $\eta_p^2 = 0.25$), the US group (Wilks' $\lambda = 0.95$,

$F(1, 375) = 21.65$, $p < .001$, $\eta_p^2 = 0.06$) and RSD group (Wilks' $\lambda = 0.98$, $F(1, 375) = 9.56$, $p = .002$, $\eta_p^2 = 0.03$).

Perceived disability as measured by the Oswestry Disability Index showed significant improvement from admission to discharge, Wilks' $\lambda = 0.80$, $F(1, 361) = 91.58$, $p < .001$, $\eta_p^2 = 0.20$; with a non-significant group X time interaction, Wilks' $\lambda = 1.00$, $F(1, 361) = 0.45$, $p = .721$, $\eta_p^2 < 0.01$. Significant improvements in ODI score from admission to discharge were found for the non-SOP comparison group (Wilks' $\lambda = 0.76$, $F(1, 361) = 112.0$, $p < .001$, $\eta_p^2 = 0.24$), the declined surgery group (Wilks' $\lambda = 0.80$, $F(1, 361) = 88.71$, $p < .001$, $\eta_p^2 = 0.20$), and the underwent surgery group (Wilks' $\lambda = 0.95$, $F(1, 361) = 20.5$, $p < .001$, $\eta_p^2 = 0.05$), and for the requested surgery but denied group (Wilks' $\lambda = 0.98$, $F(1, 361) = 6.38$, $p = .012$, $\eta_p^2 = 0.02$).

The analysis of changes in health-related quality of life identified significant improvements in the mental health summary score, Wilks' $\lambda = 0.97$, $F(1, 349) = 10.24$, $p = .002$, $\eta_p^2 = 0.03$; with a non-significant group X time interaction, Wilks' $\lambda = 0.99$, $F(1, 349) = 1.21$, $p = .307$, $\eta_p^2 = 0.01$. There were significant improvements in the mental health component score from admission to discharge for the non-SOP comparison group (Wilks' $\lambda = 0.96$, $F(1, 349) = 14.70$, $p < .001$, $\eta_p^2 = 0.04$), and the declined surgery group (Wilks' $\lambda = 0.94$, $F(1, 349) = 23.8$, $p < .001$, $\eta_p^2 = 0.07$), but not for the underwent surgery group (Wilks' $\lambda = 0.99$, $F(1, 349) = 2.04$, $p = .147$, $\eta_p^2 = 0.01$) or the requested surgery but denied group (Wilks' $\lambda = 1.00$, $F(1, 349) = 0.05$, $p = .829$, $\eta_p^2 < 0.01$).

For the physical health component score, the assumption of homogeneity of variance-covariance matrices was not met, as indicated by Box's $M = 36.4$, $F(9, 2204) = 3.94$, $p < .001$. As recommended by Tabachnick and Fidell (2007), Pillai's criterion was used to evaluate multivariate effects instead of Wilks' Lambda. There significant improvements in the physical health component from admission to discharge, Pillai's trace = 0.13, $F(1, 349) = 52.70$, $p < .001$, $\eta_p^2 = .13$. The group X time interaction was not significant, Pillai's trace = 0.006, $F(1, 349) = 0.71$, $p = .546$, $\eta_p^2 = 0.01$. All four groups improved significantly in physical health component scores: non-SOP comparison (Pillai's trace = 0.12, $F(1, 349) = 49.1$, $p < .001$, $\eta_p^2 = .12$), declined surgery

(Pillai's trace = 0.13, $F(1, 349) = 51.7$, $p < .001$, $\eta_p^2 = .13$), underwent surgery (Pillai's trace = 0.04, $F(1, 349) = 12.7$, $p < .001$, $\eta_p^2 = 0.04$), and requested surgery but denied (Pillai's trace = 0.02, $F(1, 349) = 5.20$, $p = .023$, $\eta_p^2 = .02$).

Table 9.13. Psychosocial Testing, Admission to Discharge Changes for SOP Subgroups (N = 381)

Measure	SOP subgroups	Mean change (admission to discharge)	Significance of change	Effect size of change	Significance of difference in change between groups
Pain intensity					.182
	Non-SOP comparison	-2.02	< .001	η_p^2 = .260 [c]	
	Declined surgery	-2.32	< .001	η_p^2 = .225 [c]	
	Underwent surgery	-2.05	<.001	η_p^2 = .041 [a]	
	Requested surgery but denied	-0.95	.102	η_p^2 = .009 [a]	
Beck depression inventory					.217
	Non-SOP comparison	-6.05	< .001	η_p^2 = 0.183 [c]	
	Declined surgery	-6.34	< .001	η_p^2 = 0.134 [c]	
	Underwent surgery	-6.85	.001	η_p^2 = 0.033 [a]	
	Requested surgery but denied	-1.58	.465	η_p^2 = 0.002 [a]	
Pain disability questionnaire					.586
	Non-SOP comparison	-25.88	< .001	η_p^2 = 0.286 [c]	
	Declined surgery	-29.26	< .001	η_p^2 = 0.253 [c]	
	Underwent surgery	-24.81	< .001	η_p^2 = 0.055 [b]	
	Requested surgery but denied	-21.05	.002	η_p^2 = 0.025 [a]	
Oswestry disability index					.721
	Non-SOP comparison	-13.15	< .001	η_p^2 = 0.237 [c]	
	Declined surgery	-14.46	< .001	η_p^2 = 0.197 [c]	
	Underwent surgery	-14.20	< .001	η_p^2 = 0.054 [b]	
	Requested surgery but denied	-9.95	.012	η_p^2 = 0.017 [a]	

Note: Negative values for mean change represent decreases in score from admission to discharge, positive values indicate increases in score from admission to discharge. [a] small effect, [b] medium effect, [c] large effect

Table 9.13 *Continued*

Measure	SOP subgroups	Mean change (admission to discharge)	Significance of change	Effect size of change	Significance of difference in change between groups
SF-36 mental health component					.307
	Non-SOP comparison	3.89	<.001	$\eta_p^2 = 0.040$ [a]	
	Declined surgery	6.33	< .001	$\eta_p^2 = 0.065$ [b]	
	Underwent surgery	4.00	.147	$\eta_p^2 = 0.006$ [a]	
	Requested surgery but denied	0.74	.829	$\eta_p^2 = < .001$ [a]	
SF-36 physical health component					.529
	Non-SOP comparison	5.26	< .001	$\eta_p^2 = 0.123$ [c]	
	Declined surgery	6.83	< .001	$\eta_p^2 = 0.129$ [c]	
	Underwent surgery	7.25	< .001	$\eta_p^2 = 0.035$ [a]	
	Requested surgery but denied	5.74	.023	$\eta_p^2 = 0.015$ [a]	

Note: Negative values for mean change represent decreases in score from admission to discharge, positive values indicate increases in score from admission to discharge. [a] small effect, [b] medium effect, [c] large effect

9.5 Regression Analysis of One-Year Socioeconomic Outcomes

Sequential logistic regression was used to evaluate the relationship of the SOP groups (COMP, DS, US, and RSD) to the one-year socioeconomic outcomes. Other pertinent variables were entered in the first step, and SOP group was entered in the second step. Although it would have been preferable to separate non-completers into two groups: quality-of-life discharges and patients who abandoned the treatment program, only about 15% of program drop-outs completed any post-treatment psychosocial testing, and only three drop-outs completed all three post-program psychosocial assessments included in the regression analysis (pain intensity VAS, PDQ, and BDI). Therefore, drop-outs and quality of life discharges were combined into one category: program non-completers.

The regression analysis of return to work at any point during the post-discharge year is shown in Table 9.14. The first step of the analysis included completion status, work status at program admission, age, pre-treatment surgery, pre-injury weekly wage, pre-injury job demand (dichotomized into sedentary/light demand vs. all other demand levels) and levels of perceived disability, depressive symptoms, and pain intensity at program discharge. The first step of the analysis was statistically significant, χ^2 (9, N = 248) = 82.12, p < .001, Nagelkerke R^2 = .427. In the second step of the analysis, SOP groups were added, with the requested but denied surgery group as the reference group. The influence of the SOP groups was statistically significant over and above the variables included in the first step, χ^2 (3, N = 248) = 16.36, p = .001. The total model was also statistically significant, χ^2 (12, N = 248) = 98.49, p < .001, Nagelkerke R^2 = .497, and correctly classified 85.5% of cases (compared to 77% correct classification in the null model). Individually significant predictors were completion status, age, pain intensity, depressive symptoms and SOP group. Compared to the RSD group, the COMP group was 7.48 times more likely to return to work, the DS group was 20.8 times more likely to return to work, and the US group was 14.4 times more likely to return to work after controlling for the effects of the other pertinent variables.

Table 9.14. Regression Model to Predict Return to Work at One-Year after Program Discharge.

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
1								
	Program completer	2.48	0.49	25.22	.000	11.89	4.52	31.23
	Working at admission	0.89	0.69	1.66	.197	2.44	0.63	9.44
	Age	-0.04	0.02	3.02	.082	0.96	0.92	1.01
	Pre-treatment surgery	0.47	0.39	1.46	.228	1.59	0.75	3.39
	Pre-injury weekly wage	0.00	0.00	0.03	.873	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	0.42	0.62	0.47	.495	1.52	0.45	5.11
	Disability (PDQ) at discharge	0.01	0.01	1.25	.264	1.01	0.99	1.03
	Pain intensity (VAS) at discharge	-0.25	0.12	4.78	.029	0.78	0.62	0.97
	Depressive symptoms (BDI) at discharge	-0.07	0.03	6.60	.010	0.94	0.89	0.98
	Constant	2.07	1.51	1.87	.171	7.91		

[a] reference category, [b] compared to program completers, [c] compared to patients who requested but were denied surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.14 *Continued*

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
2								
	Program Completer	2.66	0.52	26.33	.000	14.34	5.19	39.64
	Working at admission	0.74	0.72	1.07	.302	2.10	0.51	8.57
	Age	-0.06	0.03	5.45	.020	0.94	0.90	0.99
	Pre-treatment surgery	0.31	0.41	0.58	.445	1.37	0.62	3.03
	Pre-injury weekly wage	0.00	0.00	0.02	.886	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	0.15	0.67	0.05	.830	1.16	0.31	4.31
	Disability (PDQ) at discharge	0.01	0.01	0.63	.429	1.01	0.99	1.03
	Pain intensity (VAS) at discharge	-0.23	0.13	3.48	.062	0.79	0.62	1.01
	Depressive symptoms (BDI) at discharge	-0.06	0.03	5.32	.021	0.94	0.89	0.99
	Non-SOP comparison group [b]	2.01	0.69	8.41	.004	7.48	1.92	29.15
	Declined surgery [b]	3.04	0.79	14.80	.000	20.82	4.43	97.75
	Underwent surgery [b]	2.67	1.18	5.14	.023	14.38	1.43	144.19
	Requested surgery but denied [a]			15.15	.002			
	Constant	0.90	1.64	0.30	.585	2.45		

[a] reference category, [b] compared to program completers, [c] compared to patients who requested but were denied surgery
Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.15 contains the analysis of work retention, or whether patient was still working at the one-year follow up interview. As in the return to work analysis, the first step included completion status, work status at program admission, age, pre-treatment surgery, pre-injury weekly wage, pre-injury job demand, and levels of perceived disability, depressive symptoms, and pain intensity at program discharge, and was statistically significant, χ^2 (7, N = 224) = 80.1, p < .001, Nagelkerke R^2 = .416. The SOP groups were added in the second step and contributed significantly over and above the first step, χ^2 (3, N = 224) = 9.01, p =.029. The full model was also significant with χ^2 (12, N = 224) = 89.1, p < .001, Nagelkerke R^2 = .454, and it correctly classified 78.6% of cases (compared to 66.2% correct classification in the null model). Individually significant predictors of work retention included completion status, age, and SOP subgroup. Compared to the RSD group, the COMP group was 3.9 times more likely to retain work, the DS group was 8.8 times more likely to retain work, and the US group was 2.6 times more likely to retain work after controlling for the effects of the other variables in the model.

In the analysis of treatment-seeking behavior (healthcare utilization in excess of the standard recheck visits or visits to a new healthcare provider), the group that received surgery demonstrated multicollinearity between treatment-seeking and completion status, as only one patient who received surgery both completed the program and sought treatment from a new provider. The surgery group was therefore removed from the regression analysis. The first step of the analysis included completion status, work status at program admission, age, pre-treatment surgery, pre-injury wage, pre-injury job demand and levels of perceived disability, depressive symptoms, and pain intensity at program discharge (Table 9.16). The first step of the analysis was not statistically significant, χ^2 (9, N = 236) = 15.94, p = .068, Nagelkerke R^2 = .133. In addition, neither the second step (SOP groups), χ^2 (2, N = 236) = 0.04, p = .982, nor the overall model was statistically significant, χ^2 (11, N = 236) = 15.98, p = .142, Nagelkerke R^2 =.133. The only statistically significant individual predictor was perceived disability.

Table 9.15. Regression Model to Predict Work Retention at One-Year after Program Discharge.

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
1								
	Program completer	2.31	0.54	18.38	.000	10.09	3.51	29.03
	Working at admission	0.49	0.54	0.81	.368	1.63	0.57	4.67
	Age	-0.08	0.02	12.90	.000	0.93	0.89	0.97
	Pre-treatment surgery	-0.56	0.36	2.44	.118	0.57	0.29	1.15
	Pre-injury weekly wage	0.00	0.00	0.61	.436	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	-0.14	0.59	0.05	.818	0.87	0.28	2.76
	Disability (PDQ) at discharge	0.00	0.01	0.04	.837	1.00	0.98	1.02
	Pain intensity (VAS) at discharge	-0.12	0.10	1.54	.215	0.89	0.73	1.07
	Depressive symptoms (BDI) at discharge	-0.04	0.03	2.24	.135	0.96	0.92	1.01
	Constant	4.38	1.48	8.74	.003	79.52		

[a] reference category, [b] compared to patients who requested but were denied surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.15 *Continued*

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval LL	95% Confidence Interval UL
2								
	Program Completer	2.43	0.56	18.91	.000	11.31	3.79	33.75
	Working at admission	0.41	0.55	0.57	.451	1.51	0.52	4.41
	Age	-0.09	0.02	15.38	.000	0.91	0.88	0.96
	Pre-treatment surgery	-0.71	0.37	3.60	.058	0.49	0.24	1.02
	Pre-injury weekly wage	0.00	0.00	0.67	.413	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	-0.44	0.63	0.50	.481	0.64	0.19	2.19
	Disability (PDQ) at discharge	0.00	0.01	0.21	.648	1.00	0.98	1.01
	Pain intensity (VAS) at discharge	-0.10	0.10	0.99	.321	0.90	0.74	1.10
	Depressive symptoms (BDI) at discharge	-0.03	0.03	1.58	.210	0.97	0.92	1.02
	Non-SOP comparison group [b]	1.36	0.79	2.95	.086	3.90	0.82	18.49
	Declined surgery [b]	2.17	0.84	6.66	.010	8.78	1.69	45.78
	Underwent surgery [b]	0.97	1.05	0.86	.354	2.63	0.34	20.41
	Requested surgery but denied [a]			8.44	.038			
	Constant	3.73	1.63	5.21	.022	41.60		

[a] reference category, [b] compared to patients who requested but were denied surgery
Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.16. Regression Model to Predict Treatment Seeking at One-Year after Program Discharge.

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
1								
	Program completer	1.45	0.83	3.03	.082	4.25	0.83	21.63
	Working at admission	-1.53	1.06	2.08	.149	0.22	0.03	1.73
	Age	-0.03	0.03	1.85	.174	0.97	0.92	1.02
	Pre-treatment surgery	0.38	0.46	0.69	.408	1.46	0.60	3.56
	Pre-injury weekly wage	0.00	0.00	0.13	.724	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	0.83	1.09	0.58	.448	2.29	0.27	19.37
	Disability (PDQ) at discharge	0.02	0.01	4.21	.040	1.02	1.00	1.05
	Pain intensity (VAS) at discharge	-0.15	0.13	1.29	.257	0.86	0.66	1.12
	Depressive symptoms (BDI) at discharge	0.02	0.03	0.40	.526	1.02	0.96	1.08
	Constant	-4.17	1.94	4.61	.032	0.02		
		1.45	0.83	3.03	.082	4.25	0.83	21.63

[a] reference category, [b] compared to patients who requested but were denied surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.16 *Continued*

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
2								
	Program Completer	1.44	0.83	2.97	.085	4.20	0.82	21.47
	Working at admission	-1.53	1.06	2.07	.150	0.22	0.03	1.74
	Age	-0.03	0.03	1.75	.186	0.97	0.92	1.02
	Pre-treatment surgery	0.38	0.46	0.70	.404	1.47	0.60	3.60
	Pre-injury weekly wage	0.00	0.00	0.09	.761	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	0.81	1.10	0.55	.458	2.26	0.26	19.37
	Disability (PDQ) at discharge	0.02	0.01	4.20	.040	1.02	1.00	1.05
	Pain intensity (VAS) at discharge	-0.15	0.14	1.30	.255	0.86	0.66	1.12
	Depressive symptoms (BDI) at discharge	0.02	0.03	0.39	.530	1.02	0.96	1.08
	Non-SOP comparison group [b]	-0.16	0.88	0.03	.853	0.85	0.15	4.79
	Declined surgery [b]	-0.12	0.90	0.02	.895	0.89	0.15	5.15
	Requested surgery but denied [a]			0.04	.982			
	Constant	-4.03	2.10	3.69	.055	0.02		

[a] reference category, [b] compared to patients who requested but were denied surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

The analysis of disability benefits (SSI or SSDI) received during the post-treatment year is shown in Table 9.17. The first step included completion status, work status at program admission, age, pre-treatment surgery, pre-injury weekly wage, pre-injury job demand, and levels of perceived disability, depressive symptoms, and pain intensity at program discharge, and was statistically significant, χ^2 (9, N = 220) = 79.97, p < .001, Nagelkerke R^2 = .489. The SOP groups were added in the second step and contributed significantly over and above the first step, χ^2 (3, N = 220) = 9.59, p =.022. The full model was also significant with χ^2 (12, N = 220) = 89.6, p < .001, Nagelkerke R^2 = .537, and it correctly classified 84.1% of cases (compared to 19.1% correct classification in the null model). Individually significant predictors of disability benefits included completion status, age, perceived disability, and SOP subgroup. Compared to the DS group, the COMP group was 2.8 times more likely to receive SSI or SSDI, the US group was 12.7 times more likely to receive disability benefits, and the RSD group was 11.5 times more likely to be receiving disability benefits after controlling for the effects of the other variables in the model.

Although it was originally planned to evaluate risk factors for new compensable injuries and additional surgery during the post-discharge year, the prevalence of these outcomes was too low to allow meaningful analysis. Only 11 patients received additional surgery (2.5%) and 17 reported new compensable injuries (4.5%) after discharge from functional restoration.

Table 9.17. Regression Model to Predict Disability Benefits at One-Year after Program Discharge.

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
1								
	Program completer	-2.79	0.55	25.54	.000	0.06	0.02	0.18
	Working at admission	-1.01	0.85	1.40	.238	0.37	0.07	1.94
	Age	0.10	0.03	9.93	.002	1.10	1.04	1.17
	Pre-treatment surgery	0.43	0.46	0.89	.346	1.54	0.63	3.76
	Pre-injury weekly wage	0.00	0.00	0.44	.508	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	-0.80	0.65	1.52	.218	0.45	0.13	1.60
	Disability (PDQ) at discharge	0.02	0.01	3.59	.058	1.02	1.00	1.05
	Pain intensity (VAS) at discharge	-0.17	0.15	1.31	.253	0.85	0.64	1.13
	Depressive symptoms (BDI) at discharge	0.00	0.03	0.01	.917	1.00	0.94	1.06
	Constant	-4.24	1.94	4.80	.028	0.01		

[a] reference category, [b] compared to patients who requested but were denied surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

Table 9.17 *Continued*

Step	Predictor	*B*	Standard Error	Wald χ^2	*p*	Odds ratio	95% Confidence Interval	
							LL	UL
2								
	Program Completer	-3.00	0.59	26.26	.000	0.05	0.02	0.16
	Working at admission	-0.99	0.87	1.28	.258	0.37	0.07	2.06
	Age	0.12	0.03	12.25	.000	1.13	1.05	1.20
	Pre-treatment surgery	0.41	0.47	0.76	.385	1.51	0.60	3.79
	Pre-injury weekly wage	0.00	0.00	1.16	.282	1.00	1.00	1.00
	Pre-injury sedentary/light job demand	-0.31	0.69	0.19	.660	0.74	0.19	2.87
	Disability (PDQ) at discharge	0.03	0.01	4.99	.026	1.03	1.00	1.05
	Pain intensity (VAS) at discharge	-0.21	0.15	2.01	.156	0.81	0.61	1.08
	Depressive symptoms (BDI) at discharge	-0.01	0.03	0.03	.868	1.00	0.93	1.06
	Non-SOP comparison group [b]	1.04	0.58	3.22	.073	2.84	0.91	8.88
	Underwent surgery [b]	2.54	1.00	6.43	.011	12.72	1.78	90.85
	Requested surgery but denied [b]	2.45	1.06	5.34	.021	11.53	1.45	91.71
	Declined surgery [a]			8.85	.031			
	Constant	-6.38	2.24	8.14	.004	0.00		

[a] reference category, [c] compared to patients who declined surgery

Note: PDQ = Pain disability questionnaire, VAS = visual analog scale, BDI = Beck depression inventory

A multinomial logistic regression analysis was used to assess the contribution of SOP subgroups to the number of additional healthcare visits in the post-treatment year (see Table 9.18). The number of visits in the post-discharge year was divided into three categories: (1) no visits in excess of standard rechecks, (2) 1-5 additional healthcare visits, and (3) six or more additional visits. The third group (six or more visits) was used as the reference category. Only the COMP group and the DS group had enough patients in each category to permit analysis, therefore the US and RSD patients were excluded from the analysis. In addition, multicollinearity was identified between the outcome, completion status, job demand, and work status at admission. Therefore, completion status, job demand, and work status at admission were removed from the analysis. All variables were entered in a single step. The model was not statistically significant, χ^2 (14, N = 223) = 16.21, p = .301, Nagelkerke R^2 = .125, and there were no statistically significant individual predictor variables.

Table 9.18. Regression Model to Predict Number of Visits at One-Year after Program Discharge for the Declined Surgery Group

Comparison category	Predictor	*B*	*SE*	Wald χ^2	*p*	*OR*	95% Confidence Interval	
							LL	*UL*
No additional visits [a]								
	Age	0.07	0.04	2.86	.091	1.07	0.99	1.17
	Pre-treatment surgery	-1.13	0.89	1.61	.205	0.32	0.06	1.85
	Pre-injury wage	0.00	0.00	0.18	.670	1.00	1.00	1.00
	Disability (PDQ) at discharge	-0.01	0.02	0.48	.487	0.99	0.95	1.03
	Pain intensity (VAS) at discharge	0.31	0.24	1.75	.185	1.37	0.86	2.18
	Depressive symptoms (BDI) at discharge	-0.06	0.04	2.29	.131	0.94	0.87	1.02
	Declined surgery (DS group) [b]	0.52	0.80	0.42	.515	1.68	0.35	8.01
	Constant	1.25	2.15	0.34	.562			

[a] compared to patients with 6 or more visits; [b] compared to COMP group

Table 9.18 *Continued*

Comparison category	Predictor	*B*	*SE*	Wald χ^2	*p*	*OR*	95% Confidence Interval	
							LL	*UL*
1-5 additional visits [a]								
	Age	0.05	0.05	0.82	.364	1.05	0.95	1.15
	Pre-treatment surgery	-0.78	1.02	0.58	.445	0.46	0.06	3.39
	Pre-injury wage	0.00	0.00	0.21	.646	1.00	1.00	1.00
	Disability (PDQ) at discharge	0.01	0.02	0.28	.596	1.01	0.97	1.06
	Pain intensity (VAS) at discharge	0.25	0.28	0.82	.365	1.28	0.75	2.20
	Depressive symptoms (BDI) at discharge	-0.09	0.06	2.96	.085	0.91	0.82	1.01
	Declined surgery (DS group) [b]	0.39	0.94	0.17	.677	1.48	0.24	9.31
	Constant	-1.38	2.62	0.28	.600			

[a] compared to patients with 6 or more visits; [b] compared to COMP group

9.6 Comparison of Surgical Areas

It was hypothesized that no significant differences would be identified among the different types of surgeries. To evaluate this hypothesis, the SOP patients were divided into groups based on the area involved in the requested surgery: cervical spine (N = 28), lumbar spine (N = 120), upper extremity (N = 46), and lower extremity (N = 48). Patients seeking surgery to other body parts (face or abdomen) were not included in this analysis. Differences in demographics, psychosocial testing, and one-year socioeconomic outcomes were evaluated.

Table 9.19 shows the demographic characteristics of the SOP patients divided into groups according to type of surgery requested at admission to the SOP program. Patients requesting surgery to the lumbar spine were older, had fewer compensable injuries, were less likely to have had surgery prior to admission to the functional restoration program, and were more likely to have jobs with medium or greater demand levels. In addition, patients requesting lumbar spine surgery had higher levels of perceived disability (ODI) at admission compared to patients requesting upper extremity surgery and higher levels of depressive symptoms (BDI) at discharge compared to patients requesting lower extremity surgery (see Tables 9.20 and 9.21). However, despite these differences, patients requesting lumbar spine surgery had similar improvements in psychosocial self-report measures from admission to discharge (Table 9.22). Furthermore, there were no differences among patients requesting different types of surgery in healthcare utilization or socioeconomic outcomes at one year after discharge from the functional restoration program (Tables 9.23 and 9.24). This analysis is also shown in graphical form in Appendix C.

Table 9.19. Demographics by Surgery Requested at SOP Admission (N = 242)

	Surgery requested at admission						
Variable	Cervical spine (N = 28)	Lumbar spine (N = 120)	Upper extremity (N = 46)	Lower extremity (N = 48)	Test statistic	p	Effect size
Program completion, *n* (%)					$\chi^2 = 10.6$	.101	
Completed program	16 (64.3%)	24 (20%)	29 (63%)	41 (85.4%)			
Abandoned treatment	4 (14.3%)	82 (68.3%)	9 (19.6%)	6 (12.5%)			
Quality-of-life discharge	6 (21.4%)	14 (11.7%)	8 (17.4%)	1 (2.1%)			
SOP subgroup, *n* (%)					$\chi^2 = 9.06$	.171	
Declined surgery (DS)	22 (78.6%)	82 (68.3%)	33 (71.7%)	26 (54.2%)			
Underwent surgery (US)	4 (14.3%)	16 (13.3%)	9 (19.6%)	12 (25%)			
Requested surgery denied (RSD)	2 (7.1%)	22 (18.3%)	4 (8.7%)	10 (20.8%)			
Age (years) mean (*SD*)	47.9 (8.8)	45.6 (9.8)	50.7 (9.1) [a]	46.9 (9.6)	*F* =3.21	.024	$\eta_p^2 = 0.04$ [b]
Gender, *n* (% male)	20 (71.4%)	89 (74.2%)	28 (60.9%)	30 (62.5%)	$\chi^2 = 3.95$	.267	
Race, *n* (%)					$\chi^2 = 20.55$	.057	
White, non-Hispanic	12 (42.9%)	73 (60.8%)	22 (50%)	20 (41.7%)			
Black or African-American	12 (42.9%)	15 (12.5%)	10 (22.7%)	11 (22.9%)			
Hispanic or Latino	4 (14.3%)	29 (24.2%)	12 (27.3%)	17 (35.4%)			
Asian	0 (0%)	2 (1.47%)	0 (0%)	0 (0%)			
Other	0 (0%)	0 (0.8%)	0 (0%)	0 (0%)			
Number of compensable injuries, mean (*SD*)	2.4 (1.4) [a]	1.5 (1.1)	2.2 (1.7) [a]	2.0 (1.2)	*F* = 5.20	.002	$\eta_p^2 = 0.06$ [b]
Months of disability mean (*SD*)	30.6 (45.2)	25.2 (29.1)	17.5 (16.8)	19.3 (24.6)	*F* = 1.70	.168	

[a] Different from lumbar spine group, [b] medium effect

Table 9.19 *Continued*

Variable	Surgery requested at admission: Cervical spine (N = 28)	Lumbar spine (N = 120)	Upper extremity (N = 46)	Lower extremity (N = 48)	Test statistic	p	Effect size
Pre-treatment surgery *n* (%)	14 (50%)	47 (39.5%)	27 (58.7%) [a]	33 (70.2%) [a]	$\chi^2 = 14.3$	.003	$w = 0.24$ [b]
Working at admission *n* (%)	3 (10.7%)	18 (15.8%)	9 (19.6%)	5 (11.1%)	$\chi^2 = 1.74$	.627	
Pre-injury weekly wage, mean (*SD*)	$757 (419)	$733 (397)	$680 (301)	$704 (305)	$F = 0.35$	.791	
Job demand, *n* (%)					$\chi^2 = 19.13$	.024	$w = 0.29$ [b]
sedentary/light	3 (10.7%)	6 (5.3%)	6 (13%)	6 (13.3%)			
light/medium	8 (28.6%) [a]	14 (12.4%)	12 (26.1%) [a]	11 (24.4%)			
medium/heavy	10 (35.7%)	45 (39.8%)	21 (45.7%)	17 (37.8%)			
heavy/very heavy	7 (25%)	48 (42.5%)	7 (15.2%) [a]	11 (24.4%) [a]			
Job class (*n*, % blue collar)	22 (78.6%)	96 (86.5%)	37 (80.4%)	38 (84.4%)	$\chi^2 = 1.56$	.669	
Disability benefits (SSI or SSDI), *n* (%)	3 (10.7%)	12 (10.7%)	1 (2.3%)	2 (4.3%)	$\chi^2 = 4.27$	.234	

[a] Different from lumbar spine group, [b] medium effect

Table 9.20. Psychosocial Testing at Admission by Surgery Requested at SOP Admission (N = 232)

	Surgery requested at admission						
Variable	Cervical spine (N = 28)	Lumbar spine (N = 114)	Upper extremity (N = 46)	Lower extremity (N = 44)	Test statistic	*p*	Effect size
Pain intensity mean (*SD*)	7.54 (1.7)	7.39 (1.7)	6.74 (1.8)	7.26 (1.4)	$F = 1.52$	.210	
Beck depression inventory mean (*SD*)	18.0 (12.7)	20.1 (9.9)	19.9 (9.9)	16.4 (11.8)	$F = 1.17$	.324	
Pain disability questionnaire mean (*SD*)	102.4 (18.8)	104.4 (22.5)	95.8 (24.0)	103.0 (23.1)	$F = 1.62$	.187	
Oswestry disability index mean (*SD*)	46.0 (13.7)	50.3 (13.6)	38.3 (15.3) [a]	45.4 (17.2)	$F = 7.03$	<.001	$\eta_p^2 = 0.09$ [b]
SF-36 component scales							
mental health	39.4 (12.6)	40.4 (9.8)	36.4 (12.2)	42.1 (11.3)	$F = 2.04$	.109	
physical health mean (*SD*)	28.6 (5.4)	27.7 (4.9)	29.9 (6.9)	28.0 (4.3)	$F = 1.70$	.167	

[a] Different from lumbar spine group, [b] medium effect

Table 9.21. Psychosocial Testing at Discharge by Surgery Requested at SOP Admission (N = 382)

	Surgery requested at admission						
Variable	Cervical spine (N = 28)	Lumbar spine (N = 120)	Upper extremity (N = 46)	Lower extremity (N = 48)	Test statistic	*p*	Effect size
Pain intensity mean (*SD*)	5.52 (1.7)	5.3 (2.6)	5.0 (2.3)	5.2 (2.0)	$F = 0.18$	.908	
Beck depression inventory mean (*SD*)	11.7 (10.4)	13.6 (9.6)	12.4 (7.6)	7.7 (6.7) [a]	$F = 2.83$	.041	$\eta_p^2 = 0.06$ [b]
Pain disability questionnaire mean (*SD*)	73.2 (31.2)	77.3 (31.7)	71.5 (34.1)	71.2 (32.8)	$F = .453$	.716	
Oswestry disability index mean (*SD*)	31.4 (15.6)	35.1 (19.2)	26.5 (19.8)	28.0 (16.6)	$F = 2.38$	.071	
SF-36 component scales							
mental health	47.4 (9.3)	44.7 (14.2)	44.8 (9.8)	44.9 (12.9)	$F = 0.24$	.869	
physical health mean (*SD*)	35.0 (8.7)	36.0 (11.2)	36.2 (8.1)	32.4 (8.7)	$F = 1.22$	.303	

[a] Different from lumbar spine group, [b] medium effect

Table 9.22. Psychosocial Testing, Admission to Discharge Changes, by Surgery Requested at SOP Admission (N = 178)

		Within-group change				Group X time interaction		
Measure	Surgery requested	Mean change	*F*	*p*	η_p^2	*F*	*p*	η_p^2
Pain intensity						0.19	.902	.004 [a]
	Cervical spine	-1.83	9.9	.002	.067 [b]			
	Lumbar spine	-2.18	52.7	<.001	.276 [c]			
	Upper extremity	-2.10	21.0	<.001	.132 [c]			
	Lower extremity	-1.82	14.6	<.001	.095 [b]			
Beck depression						0.49	.689	.010 [a]
inventory	Cervical spine	-3.28	2.15	.145	.015 [a]			
	Lumbar spine	-5.90	25.8	<.001	.159 [c]			
	Upper extremity	-6.66	14.2	<.001	.094 [b]			
	Lower extremity	-6.30	11.9	.001	.080 [b]			
Pain disability						0.18	.914	.003 [a]
questionnaire	Cervical spine	-27.2	18.4	<.001	.096 [b]			
	Lumbar spine	-26.7	65.6	<.001	.274 [c]			
	Upper extremity	-26.3	25.4	<.001	.127 [c]			
	Lower extremity	-30.7	36.8	<.001	.175 [c]			
Oswestry						0.57	.663	.010 [a]
disability index	Cervical spine	-11.8	11.0	.001	.062 [b]			
	Lumbar spine	-13.6	54.6	<.001	.245 [c]			
	Upper extremity	-12.7	19.1	<.001	.102 [b]			
	Lower extremity	-17.0	36.2	<.001	.177 [c]			

Note: Negative values for mean change represent decreases in score from admission to discharge, positive values indicate increases in score from admission to discharge; [a] small effect, [b] medium effect, [c] large effect

Table 9.22 *Continued*

		Within-group change				Group X time interaction		
Measure	Surgery requested	Mean change	*F*	*p*	η_p^2	*F*	*p*	η_p^2
SF-36 mental health component scale						0.45	.715	.009 [a]
	Cervical spine	7.60	5.72	.018	.035 [a]			
	Lumbar spine	4.67	9.46	.002	.057 [b]			
	Upper extremity	7.30	7.23	.008	.044 [a]			
	Lower extremity	4.21	3.37	.068	.021 [a]			
SF-36 physical health component scale						0.95	.420	.018 [a]
	Cervical spine	5.75	6.05	.015	.037 [a]			
	Lumbar spine	7.95	50.5	< .001	.243 [c]			
	Upper extremity	5.39	7.25	.008	.044 [a]			
	Lower extremity	4.93	7.71	.006	.047 [b]			

Note: Negative values for mean change represent decreases in score from admission to discharge, positive values indicate increases in score from admission to discharge.

Table 9.23. One Year Healthcare Utilization Outcomes by Surgery Requested at SOP Admission (N = 240)*

	Surgery requested at admission					
Variable	Cervical spine (N = 28)	Lumbar spine (N = 119)	Upper extremity (N = 45)	Lower extremity (N = 48)	Test statistic	*p*
Treatment seeking *n* (%)	2 (7.1%)	14 (11.8%)	4 (8.9%)	6 (12.5%)	$\chi^2 = 0.82$	.846
Number of additional healthcare visits, *n* (%)					$\chi^2 = 4.36$	.628
0	26 (92.9%)	105 (89%)	40 (93%)	42 (87.5%)		
1 to 5	0 (0%)	8 (6.8%)	2 (4.7%)	2 (4.2%)		
> 6	2 (7.1%)	5 (4.2%)	1 (2.3%)	4 (8.3%)		
Reversed SOP decision *n* (%)	0 (0%)	1 (0.9%)	0 (0%)	1 (2.2%)	$\chi^2 = 1.58$	.664
Post-discharge surgery to other compensable body part *n* (%)	0 (0%)	2 (1.8%)	2 (4.5%)	0 (0%)	$\chi^2 = 3.20$	.362
Different post-discharge surgery to same compensable body part *n* (%)	0 (0%)	2 (1.8%)	1 (2.3%)	2 (4.7%)	$\chi^2 = 1.87$	.599

Table 9.24. One Year Socioeconomic Outcomes by Surgery Requested at SOP Admission (N = 204)

	Surgery requested at admission					
Variable	Cervical spine (N = 24)	Lumbar spine (N = 102)	Upper extremity (N = 35)	Lower extremity (N = 43)	Test statistic	*p*
Return to work *n* (%)	20 (83.3%)	76 (74.5%)	26 (74.3%)	34 (79.1%)	$\chi^2 = 1.10$	.777
Work retention *n* (%)	15 (75%)	61 (66.3%)	19 (59.4%)	21 (61.8%)	$\chi^2 = 1.55$	.671
New compensable injury *n* (%)	0 (0%)	5 (5.5%)	3 (9.1%)	2 (6.1%)	$\chi^2 = 2.09$	.555
Receiving SSI or SSDI *n* (%)	3 (14.3%)	19 (21.8%)	6 (20%)	4 (11.4%)	$\chi^2 = 2.98$	.394

CHAPTER 10

DISCUSSION

The goal of this study was to evaluate the use of a formal surgical option process within an interdisciplinary functional restoration program. It was believed that introducing this process would enable patients to make more informed decisions about whether or not to undergo surgery while simultaneously preventing delayed recovery by promoting active rehabilitation during the decision-making process. Patients who were admitted to functional restoration under the SOP program attended half of the treatment sessions (usually 10 full days) and then re-evaluated their desire to pursue surgery. Even though all patients admitted to the SOP program had been unable to choose a course of treatment, either surgical or non-surgical, prior to entering the SOP, 83% were able to come to a decision at the midpoint of functional restoration treatment. This suggests that the exposure to high-quality rehabilitation care provided in functional restoration combined with the collaborative decision-making process of the SOP successfully resolved surgical uncertainty for most patients participating in the program. Furthermore, 84% of the patients who reached the surgical decision point received the treatment they desired (DS and US groups). The decision reached during the SOP remained unchanged after discharge for the vast majority of patients, with only two patients (0.8%) who reversed their SOP decision and underwent surgery during the post-discharge year. In addition, the SOP patients did not have significantly different levels of healthcare utilization or rates of government disability benefits than the non-SOP comparison patients. The SOP program allowed patients to make an informed and decisive choice about pursuing surgery, and resulted in outcomes similar to those of patients lacking a surgical option.

The majority of patients who reached the surgical decision meeting (67%, N = 164) decided not to pursue surgery at the treatment midpoint. Of the remaining patients (N = 81) who

decided to pursue surgery, 57% underwent surgery, and the remaining 43% had their surgery denied by either the surgeon or the insurance carrier. Notably, of the 38 patients whose surgical requests were denied, 87% were denied by the surgeon (rather than by the insurance carrier) suggesting that their requested surgery was not medically necessary. For patients who completed both the SOP program and the prescribed course of functional restoration, the results were even better, with 73% electing not to pursue surgery. Of the 46 patients who decided to pursue surgery and also completed the functional restoration program, 63% underwent surgery, and the rest of the patients were denied surgery by the evaluating surgeon. The fact that most patients entering the SOP program made a personal decision not to pursue surgery is evidence suggesting this program is a beneficial addition to functional restoration. Furthermore, the fact that most patients who requested surgery received that surgery suggests that the program may also prevent delays in treatment by identifying patients who were most likely to benefit from surgery.

Patients from the RSD group were significantly less likely to complete the functional restoration program, compared to DS patients and COMP patients. In fact, of the 38 patients whose surgical requests were denied, only 45% ultimately completed the functional restoration program. It may be that patients whose surgical requests are denied are disgruntled with this outcome, and therefore they are more likely to abandon rehabilitation treatment. No differences were found in the length of disability (time between injury and admission to functional restoration) or pre-treatment surgery among the groups, indicating that these factors were unlikely to have been important in determining the outcome of the SOP decision-making process. In addition, there were few differences identified in enrollment in government disability programs, such as SSI and SSDI, at admission or discharge, implying that the decision to pursue surgery was not motivated solely by the desire to obtain these types of benefits as secondary gain.

10.1 Evaluation of Hypotheses

10.1.1 Hypothesis 1: Replication of the Pilot Study

The first hypothesis was that the results of the present study would be similar to those of the original pilot study; this hypothesis was partially supported. RSD patients were found to be significantly less likely to complete the treatment program than the other patient groups. This group was also less likely to return to work after discharge from the program and was less likely to retain work throughout the follow-up period, compared to the DS, US, and COMP groups. These results were similar to those found in the pilot study. However, contrary to the previous study, there were no significant differences found among the groups in treatment seeking behavior or in the number of additional healthcare visits in excess of normal follow-up visits. There were also no differences in the rates of new work-related injury claims at the one year follow-up. The differences between the RSD group and the other two SOP groups not identified in the present study were the outcomes with the lowest prevalence. In fact, in the pilot study, there were no US patients who were treatment-seeking, had new injuries, or received additional surgery after discharge. The number of RSD patients with these outcomes in the pilot study was also small. However, even with the larger sample size of the present study, these outcomes were also rarely found in any of the patients.

Part of the reason that the present study failed to replicate the pilot study in outcomes of healthcare utilization and additional injury may be the low frequencies found for some of these variables. For example, only one patient in the requested surgery but denied group reported a new injury during the post-discharge year and only two patients reversed their SOP decision and underwent surgery after discharge. These outcomes are very desirable from a treatment standpoint, (i.e. these are the outcomes the SOP program is intended to reduce) and are similar to the outcomes found in other studies of functional restoration (Evans, Mayer, & Gatchel, 2001; Garcy, Mayer, & Gatchel, 1996; Proctor et al., 2004). However, the statistical power of these particular analyses may have been reduced, even though the overall power was sufficient. Ideally in a chi-square analysis, each cell of the analysis should have more than 5 participants.

But to meet that requirement, given the prevalence of new injury after discharge (maximum of 8%) and the distribution of patients into the SOP groups (smallest group was 15% of the sample), there would need to be more than 100 participants per group, or over 5 times the current sample size. As the SOP program continues to be utilized to prevent delayed recovery in the PRIDE program, future studies may be able to shed further light on these more infrequent outcomes in studies with a larger sample size.

The second part of Hypothesis 1 was that the three other subgroups (COMP, DS, and US) would not differ in completion rates or one-year outcomes. For all outcome measures, the US and COMP group were found to be equivalent, with nearly identical rates of program completion, return to work, work retention, and healthcare utilization. However, patients in the US group were more likely to be receiving disability benefits such as SSI or SSDI at the one-year follow-up interview than the COMP group. There was also a non-significant trend for US patients to have smaller improvements in psychosocial self-report measures, although both groups did improve significantly from admission to discharge. This may reflect differences in disease process or disease severity, particularly as the US group was significantly older than the COMP group. Even though the COMP and US groups did not differ in type of injury, length of disability, or prior surgical history, the fact that the US group did have an open surgical optional and that surgery was subsequently deemed medically necessary suggests that unmeasured differences in disease severity or medical comorbidity may have existed between the US and COMP groups.

An unexpected finding was that the DS group actually did better than the COMP group on many of the outcome measures. The DS group was more likely to complete the program, more likely to return to work, and more likely to retain work than the non-SOP comparison group. The reasons for the better outcomes in the DS group are unclear, as there were no differences in demographic, occupational, or psychosocial characteristics between the DS and COMP groups. Perhaps participating in collaborative decision-making about treatment options during the SOP increased motivation, self-efficacy, or commitment to treatment in the DS patients. The knowledge that it was their own personal decision to complete functional restoration rather than

undergo surgery may have conferred an additional psychological benefit on the DS patients that was not available to the COMP patients. This could be an example of patients attributing higher value to the option they chose, i.e., the non-operative course of treatment (Gawronski, Bodenhausen, & Becker, 2007).

Almost all patients adhered to the course of treatment determined during the SOP, both surgical and non-surgical. Although 11 patients in the present study received some type of surgery during the post-discharge year, only two of these surgeries were actually reversals of the SOP decision. The rest of the surgeries were either different procedures to the same body part (for example, a spinal fusion rather than a spinal cord stimulator or a knee replacement rather than a knee cartilage graft) or surgical procedures to different, compensable body parts (for example, one patient who received wrist surgery as a part of the SOP program later had an additional shoulder surgery). The patients in the requested surgery but denied group were more likely to have additional surgery after discharge, but only to a different compensable body part. It may be that additional surgery after program discharge reflects a general dissatisfaction with treatment rather than a specific issue related to the SOP program.

The effect of the SOP program on one-year socioeconomic outcomes was further explored using a logistic regression analysis. Even after controlling for other variables known to be predictive of one-year outcomes, the SOP program accounted for additional variance in one-year work-related outcomes over and above that explained by program completion, work status at program admission, age, pre-treatment surgery, pre-injury wage, job demand, and persistent psychosocial distress. Compared to the RSD group, the COMP, DS, and US groups were significantly more likely to return to work and the DS group was more likely to retain work. Furthermore, the regression models that included SOP group produced better classification results for return to work and work retention than the null models. This is unusual for studies of functional restoration, because the high success levels (> 80%) typically leave little room for improvement in prediction over simply predicting all cases will succeed (Brede et al., 2012). The SOP group was also predictive of receipt of disability benefits at the one year follow-up.

Compared to the DS group, the US and RSD groups were more likely to be receiving SSI or SSDI. All these findings suggest that patients whose treatment preferences are accommodated through an SOP process have better socioeconomic outcomes after program discharge.

SOP group did not predict additional variance in treatment seeking-behavior or number of visits over and above the variance explained by the other relevant variables. In fact, none of the individual predictor variables included in the analyses significantly predicted treatment-seeking behavior or number of healthcare visits, and the full regression models were not statistically significant. The results of the multivariate analyses were similar to those of the univariate analyses, in that significant differences among SOP groups were identified for return to work, work retention, and disability benefits, but not for treatment-seeking behavior, new injuries, or number of healthcare visits.

10.1.2 Hypothesis 2: Patients Denied Surgery Will Show Poorer Outcomes

The second hypothesis was that the RSD patients would have a higher prevalence of DSM-IV psychiatric disorders and greater levels of self-reported psychosocial distress. This hypothesis was not supported. No differences in the prevalence of any Axis I or Axis II disorders were identified among the subgroups. It was further hypothesized that the patients in the requested surgery but denied group would share psychosocial characteristics with the treatment resistant personalities identified by Howard, et al. (2009). Despite a significantly greater rate of treatment non-completion, the requested surgery but denied group was no more likely to be diagnosed with opiate dependence or Cluster B personality disorders. Finally, there were no significant differences in self-reported pain intensity, depressive symptoms, perceived disability, or health-related quality of life among the subgroups either at admission or at discharge. One possible reason for failure to identify treatment-resistant personality characteristics may be in the diagnostic criteria for DSM-IV disorders. To be diagnosed with a personality disorder, the person's traits and behaviors must cause significant personal distress that is not better accounted for by another condition. The problems resulting from chronic pain (i.e., pain disorder or somatoform disorder) may have overshadowed personal difficulties caused by personality

characteristics and coping styles. Future research could involve the use of personality inventories to identify traits that do not meet the criteria for an actual personality disorder diagnosis, to better understand how personality relates to surgical decision making and pain rehabilitation outcomes.

The repeated measures analysis of psychosocial testing identified non-significant trends which supported the hypothesis that RSD patients would show less improvement in psychosocial measures from program admission to discharge. Although the interactions between time point and SOP group were not significant, the analysis of the simple effects of time within each individual SOP group found less improvement in the RSD patients for all of the psychosocial measures. Whereas the COMP group, the DS group, and the US group showed statistically significant improvements in pain intensity and depressive symptoms, the RSD group that did not improve significantly on any of these measures. The requested surgery but denied group did show significant improvement in perceived disability and the SF-36 physical health component, however, these improvements consistently had smaller effect sizes than those of the other three groups.

An additional finding in the repeated measures analysis was a non-significant trend for the group that underwent surgery to show lesser improvements in psychosocial testing compared to the COMP group and the DS group. The COMP group and the DS group showed large improvements ($\eta_p^2 > 0.14$) in pain intensity, depressive symptoms, perceived disability (on both the ODI and the PDQ), and the physical health component of the SF-36. In contrast, the US group showed only small improvements ($\eta_p^2 < 0.05$) in pain intensity, depressive symptoms, and the physical health component of the SF-36 and medium improvements (η_p^2 0.06-0.13) in perceived disability. Furthermore, the US group did not improve significantly on the mental health component of the SF-36, while the COMP and DS groups showed small to medium improvements. This suggests that the patients choosing to pursue surgery show somewhat less improvement in psychosocial distress, whether they receive that surgery or not, relative to patients who do not choose to pursue surgery, although the improvement is more significantly

impaired when the requested surgery is denied. A similar non-significant trend can be seen in the admission and discharge psychosocial testing, where the COMP group and the DS group are nearly indistinguishable, while the US group and the RSD group show somewhat higher levels of pain intensity and perceived disability.

It is possible that these trends are non-significant due to sample size limitations. Multivariate analyses require more power than simple univariate tests, and the smaller numbers of patients in the US and RSD groups may have lacked the power necessary to identify these differences in multivariate analyses. However, while these lower group sizes are potentially detrimental to the statistical analysis, it should be reiterated that smaller numbers of patients deciding to pursue surgery is very desirable from a clinical standpoint, and is, in fact, the objective of the SOP program.

10.1.3 Hypothesis 3: The SOP Program Will Be Equally Effective for Different Types of Surgeries

The third hypothesis was that no significant differences in psychosocial or socioeconomic outcomes would be identified among patients requesting surgery to different body parts, which was generally supported. Although a few differences were found in the demographics and psychosocial testing, these differences did not persist through the one-year follow-up period. No differences in one-year socioeconomic outcomes were found among the groups requesting different surgical procedures, and all groups showed similar improvements in psychosocial self-report measures. It would have been interesting to compare the different types of surgical requests within each SOP subgroup, but unfortunately, the sample size was not large enough to accommodate this type of analysis. Future studies may examine the question of whether being denied surgery is more detrimental for patient with one type of injury than those with another type of injury.

10.2 Limitations

The greatest limitation to the current study was the relatively small sample size. Although the SOP program has been operating at PRIDE for seven years, early recruitment into the

program was less inclusive and systematic than in the later years of the program. If the early years of the program had included similar numbers as the more recent years (30-50 patients per year), this could have resulted in nearly twice the current sample size, which would have provided greater statistical power to the analysis. In addition, there were some problems with early attrition. Although enrollment in the SOP was offered to 295 patients, this number was reduced to 245 patients who reached the surgical decision meeting at the program midpoint. The current sample size was not sufficient to support the number of analyses conducted in the present study. Therefore, the end results of this project may be better characterized as exploratory, rather than definitive, and results with marginal significance and/or small effect sizes should be interpreted with caution.

Another sample size limitation was the uneven distribution of participants into groups, where more than two-thirds of the patients declined to pursue surgery and less than 10% of the patients had their request for surgery denied. Therefore, although the sample size as a whole was adequate to detect small-to-medium effects, particular groups or analyses may have been underpowered. The sample size of RSD group was very likely inadequate for many of the analyses, and the US group may also have lacked power to detect small effects, particularly in the multivariate analyses. However, as one of the objectives of the SOP program was to help patients realize that they could achieve their functional and occupational goals through a high-quality functional restoration program, without surgical intervention, it is reasonable that the majority of the patients declined to pursue surgery.

Finally, the current study design did not include an untreated control group. In order to isolate the effects of the SOP from the effect of functional restoration, a group of patients with an unresolved surgical option who did not participate in either the SOP or the functional restoration program would be necessary. However, this type of study design was not feasible for the current project. Most importantly, withholding a treatment that had a well-established success record from patients suffering from chronic pain simply for the purposes of this study is ethically questionable, particularly given the 12-month follow-up time. The literature suggests that patients

prevented from participating in rehabilitation for this length of time will suffer significant additional physical deterioration and psychological distress. While the information gained from this research is clinically important, it does not justify withholding treatment from patients. Therefore, the next best option for the comparison group was employed: a group of patients who participated in functional restoration but not the SOP. Therefore, although this design does not permit the establishment of cause-and-effect relationships between the SOP program and one-year healthcare utilization and socioeconomic outcomes, it is the more ethically acceptable alternative.

10.3 Future Directions

Despite the limitations of the present study, there is fairly good evidence that the SOP program is beneficial in combination with functional restoration. The evidence is certainly sufficient to warrant continuation of the program. As more patients enroll in the SOP program and complete functional restoration, the sample size available for analysis will continue to expand. In the future, it would be beneficial to confirm the results of the present study with a larger sample size.

Another possible consideration might be the applications of an SOP program outside the workers' compensation system. Although delayed recovery is a particularly significant problem within the workers' compensation system in the United States, both administrative and treatment delays are commonly seen in countries with nationalized healthcare systems. As the United States moves closer to a national healthcare system, similar treatment delays may begin to be a problem in other healthcare settings. Programs designed to prevent delays in recovery, such as the SOP program, may be beneficial in a wider context than solely in workers' compensation.

An additional area for future consideration is the role of diagnostic testing in the SOP process. Although most of the patients who enter the SOP program have previously had extensive diagnostic testing, in many cases additional tests were ordered as a part of the surgical decision making process. The most common such test was electromyography and nerve conduction studies, but patients in the current sample also received MRI scans, x-rays, and bone scans. However, some of these procedures may have been ordered to appease anxious patients

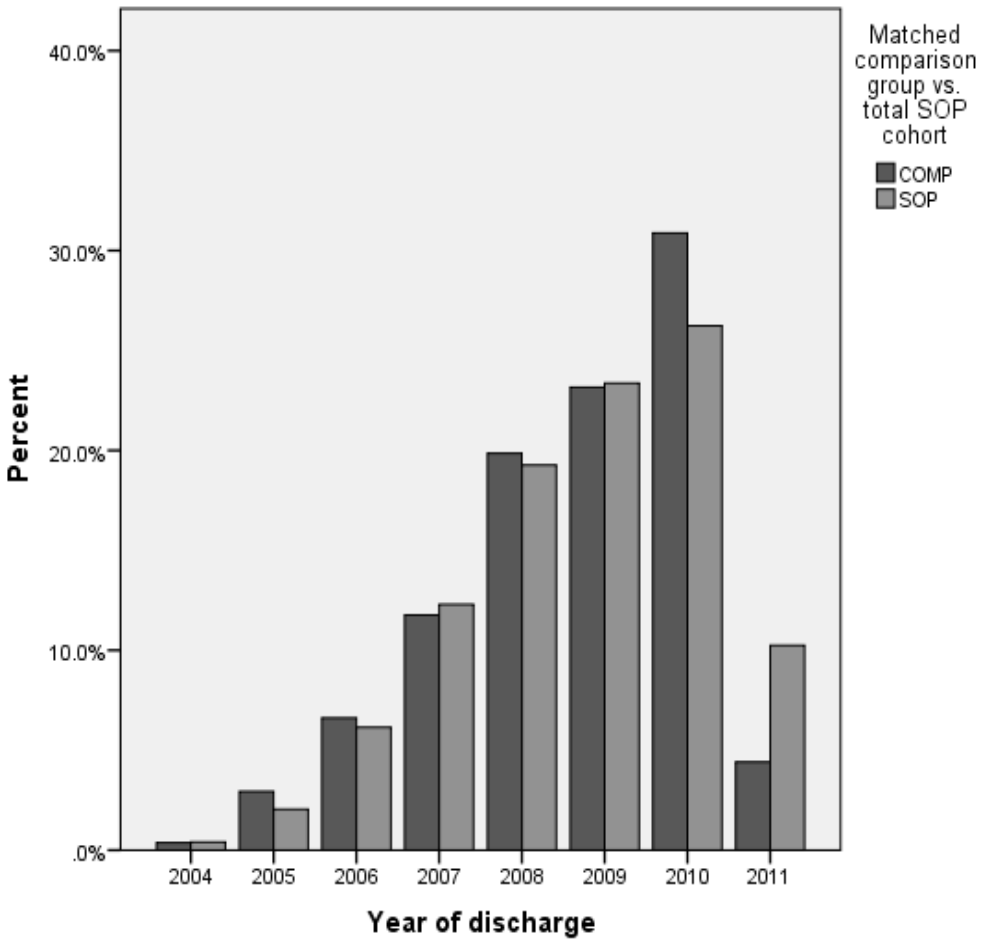
or reluctant insurance carriers. Some evidence suggests that improper use of diagnostic imaging may lead to poorer outcomes (B. B. Webster & Cifuentes, 2010), Therefore, it would be interesting to evaluate whether diagnostic testing as a part of the SOP program results in differences in outcomes.

10.4. Conclusions

In conclusion, the additional of a formal surgical option process to a functional restoration program was found to be beneficial in facilitating the surgical decision-making process. The majority of the patients who completed the SOP program and functional restoration made a personal decision not to pursue additional surgery; these patients demonstrated high levels of improvement in psychosocial distress measures and successful socioeconomic outcomes. The majority of the patients who decided to pursue surgery subsequently underwent surgery, and had similar levels of improvement in psychosocial measures and similar rates of socioeconomic success compared to those who declined surgery. The remaining patients who chose to pursue surgery but had their requests denied showed less improvement in psychosocial distress and poorer socioeconomic outcomes than the patients who declined surgery and the patients who underwent surgery.

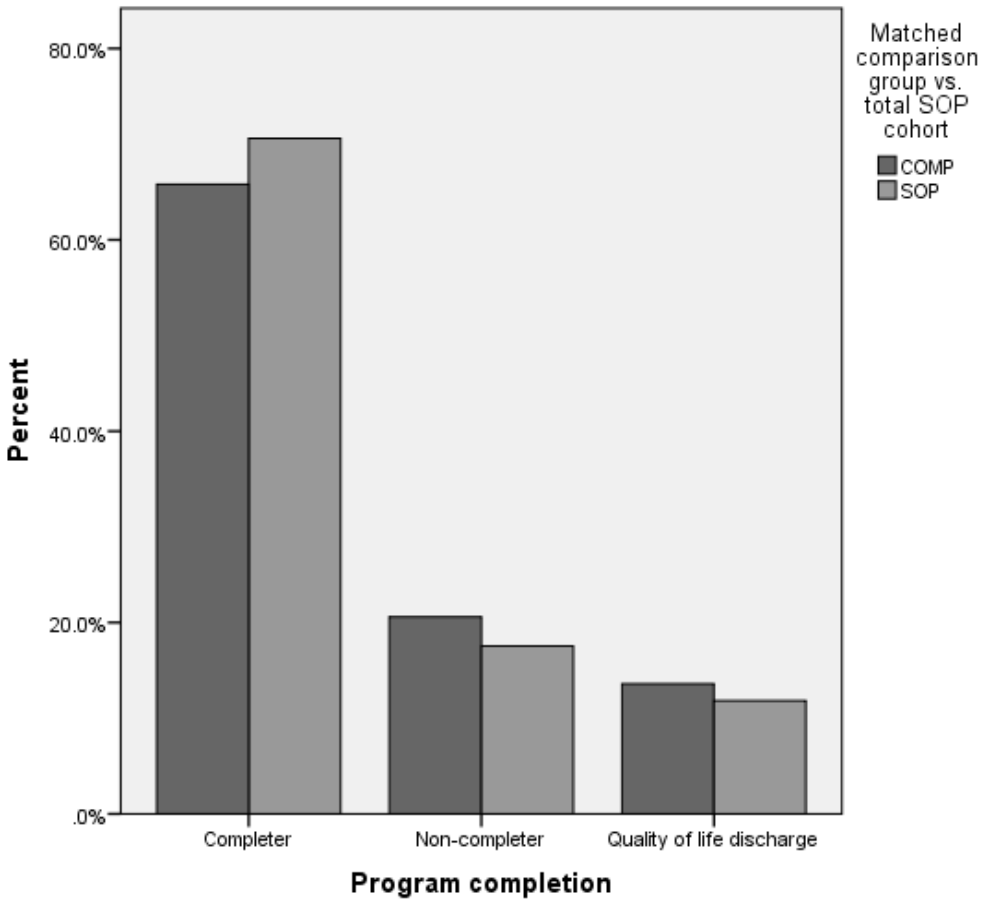
APPENDIX A

MATCHED COMPARISON GROUP VERSUS TOTAL SOP COHORT COMPARISON FIGURES



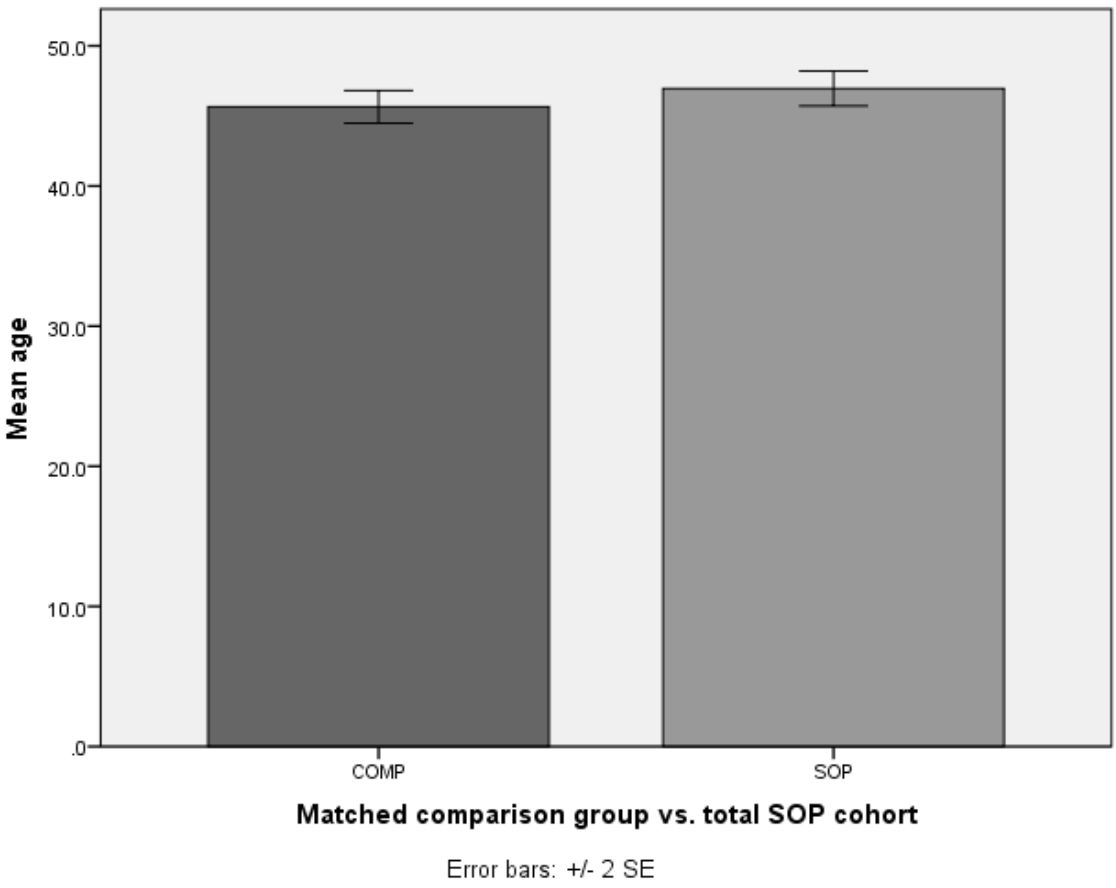
Note: No significant differences between groups.

Figure A1. Discharge year by matched comparison group vs. total SOP cohort



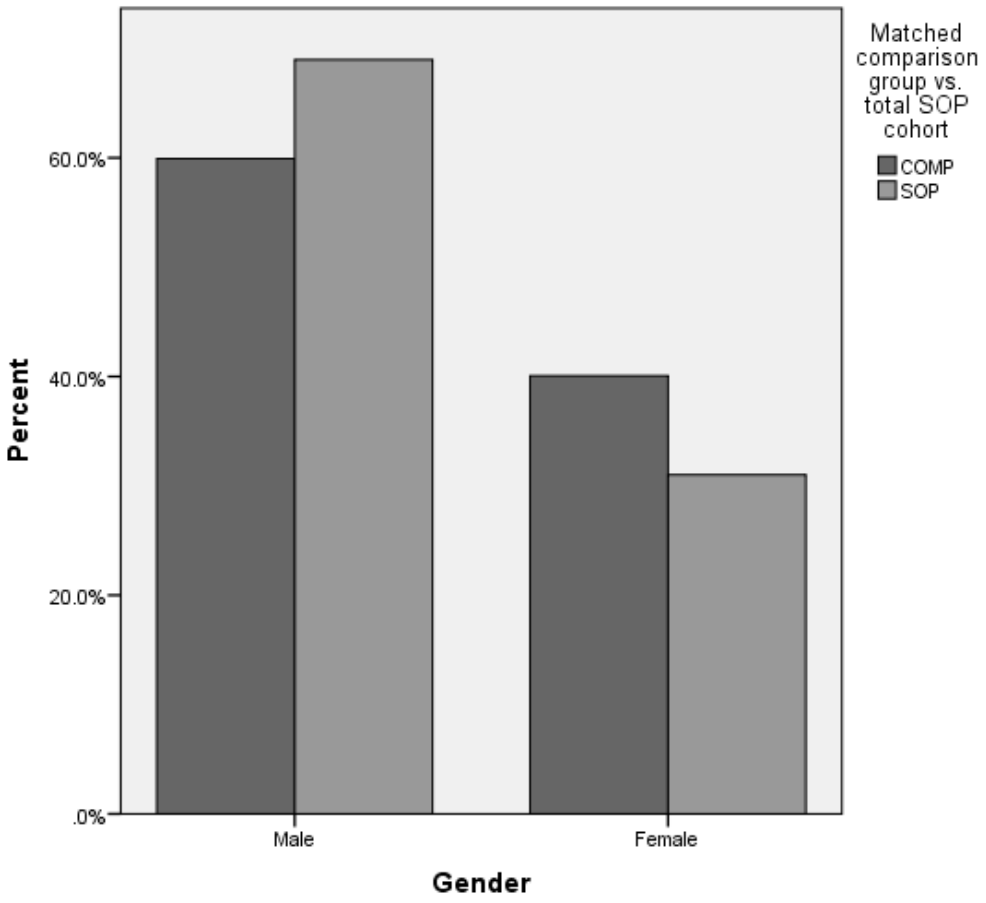
Note: No significant differences between groups.

Figure A2. Completion status by matched comparison group vs. total SOP cohort



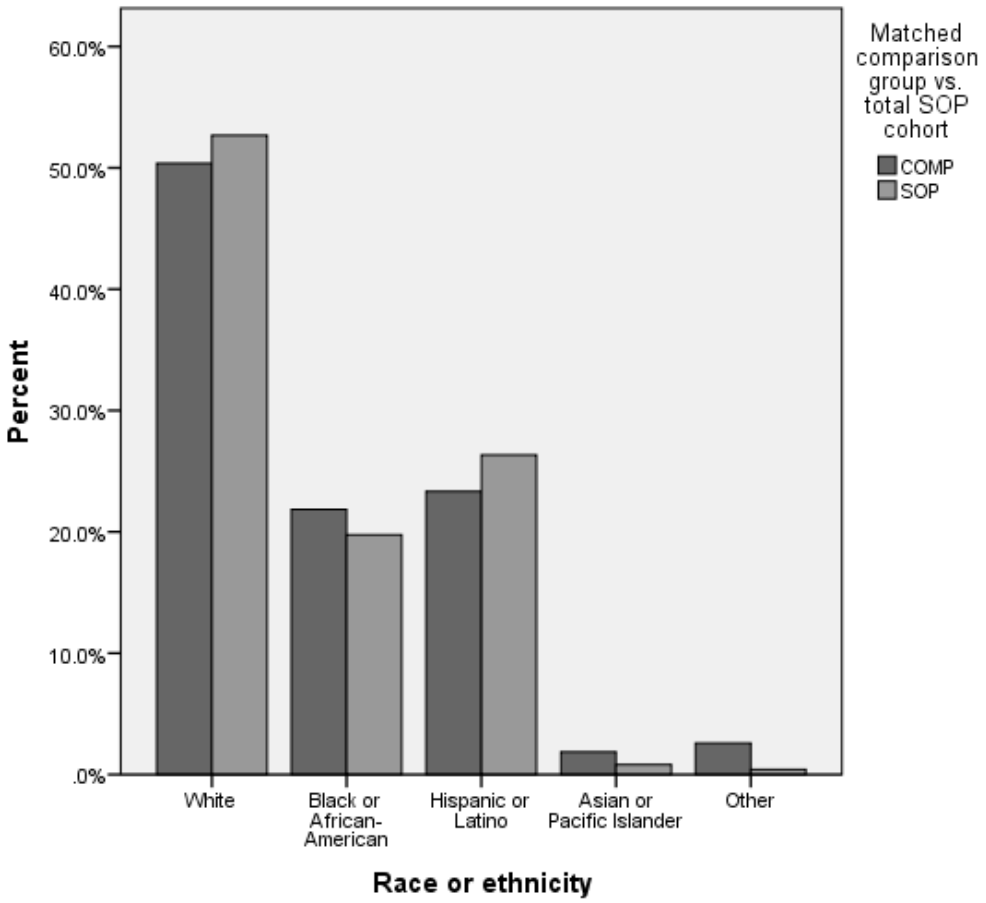
Note: No significant differences between groups.

Figure A3. Mean age by matched comparison group vs. total SOP cohort



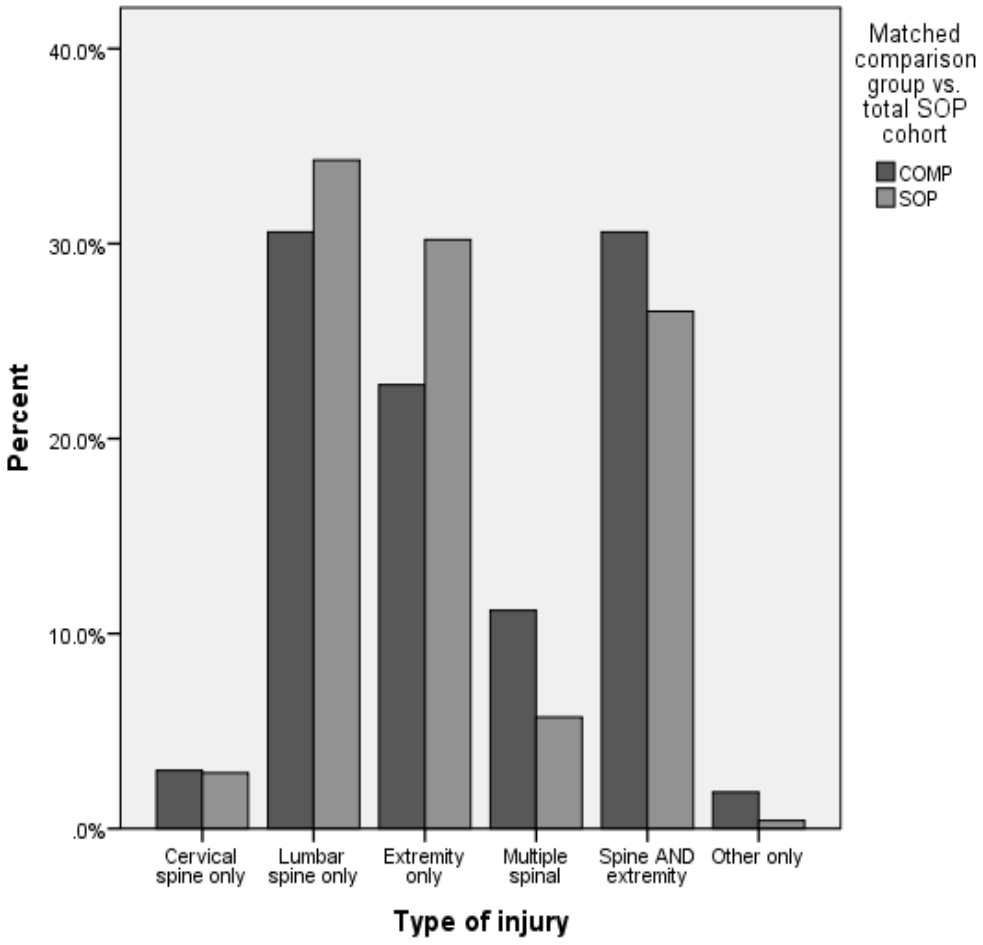
Note: p = .032

Figure A4. Gender by matched comparison group vs. total SOP cohort



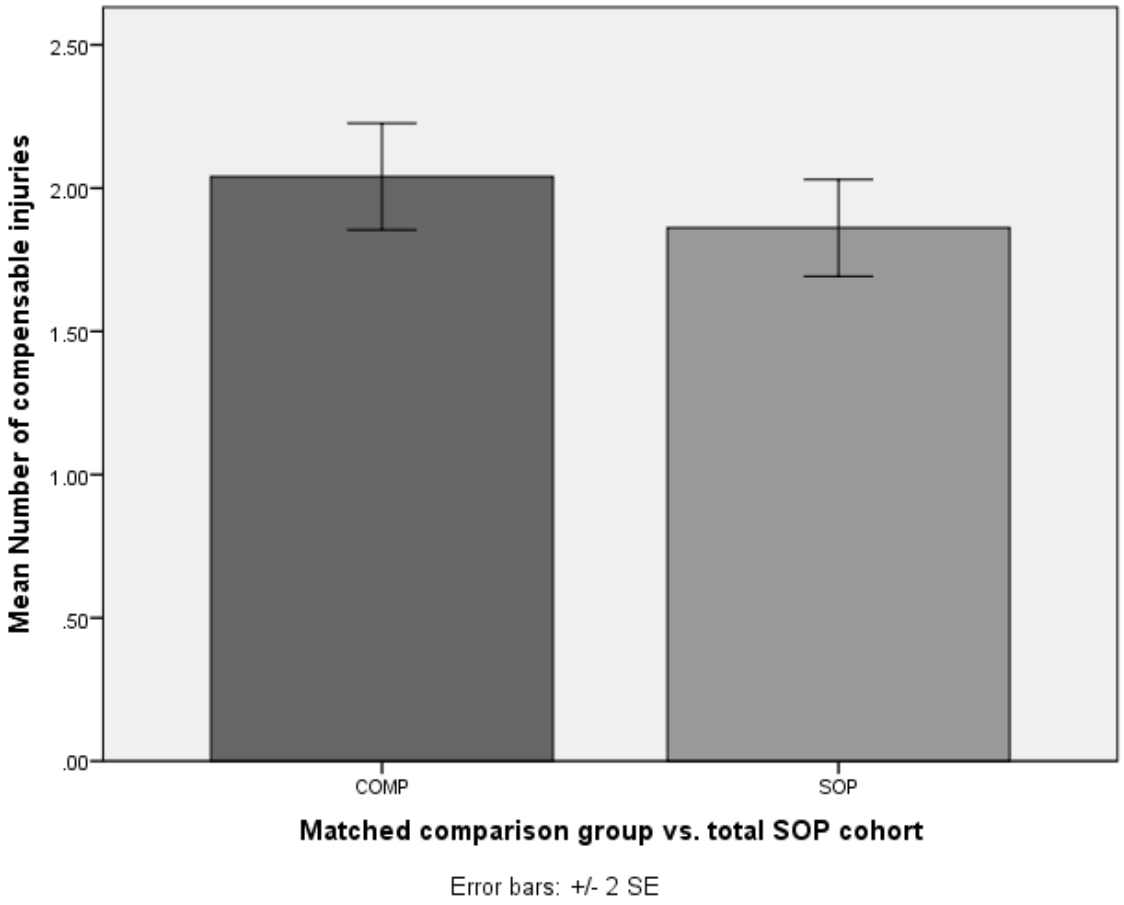
Note: No significant differences between groups.

Figure A5. Race by matched comparison group vs. total SOP cohort



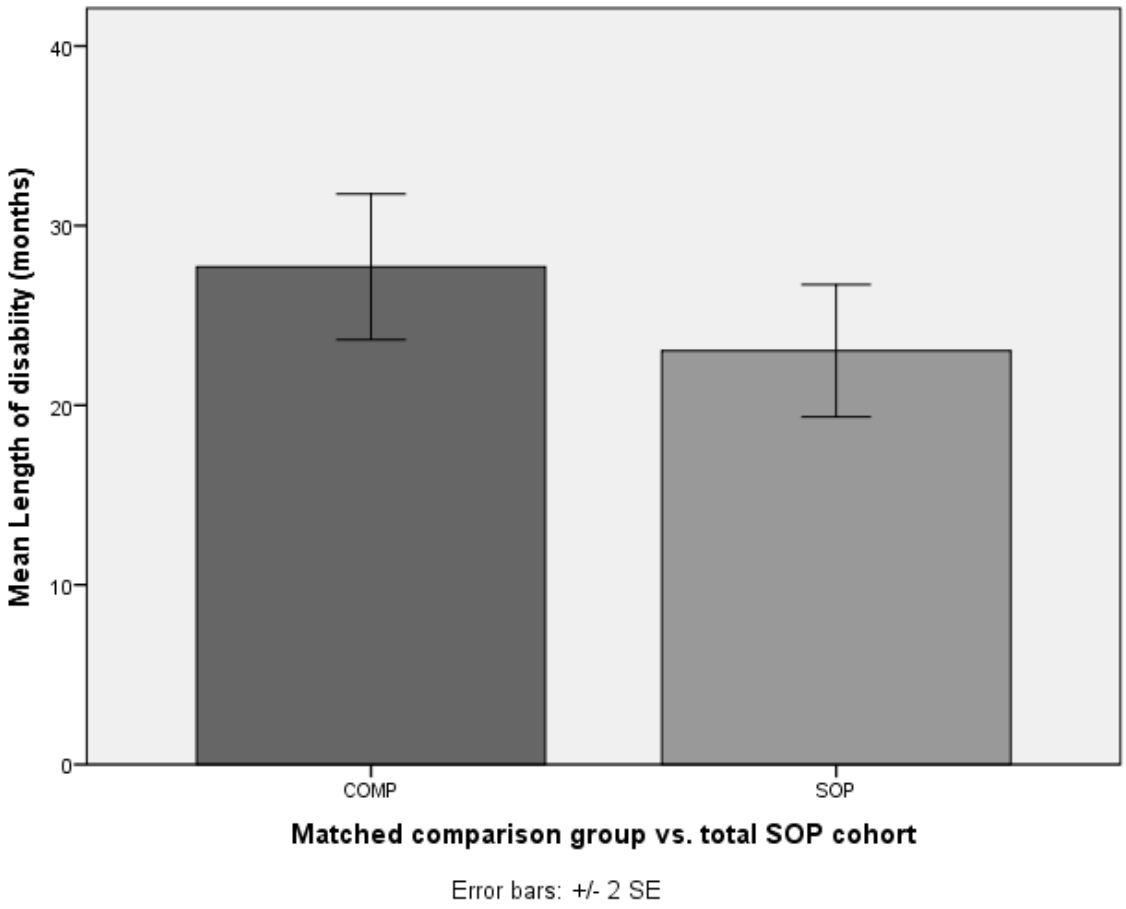
Note: No significant differences between groups.

Figure A6. Type of injury by matched comparison group vs. total SOP cohort



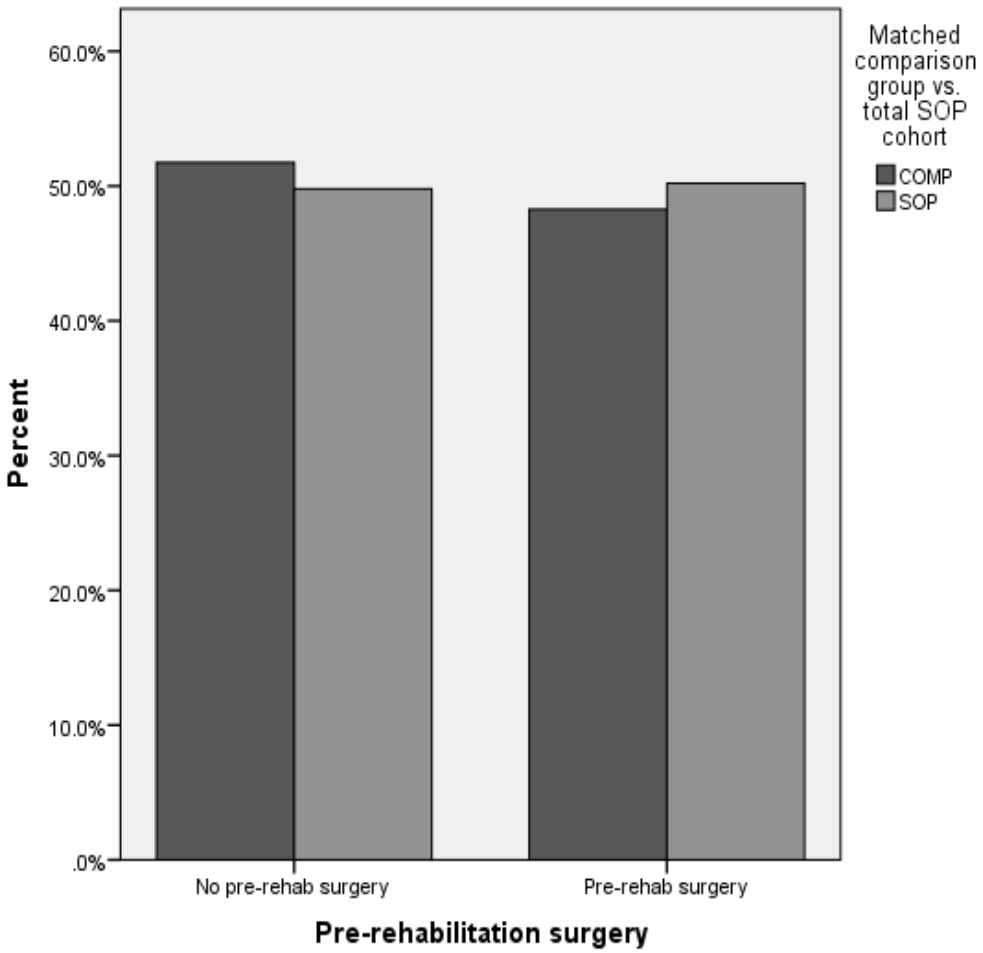
Note: No significant differences between groups.

Figure A7. Mean number of compensable injuries by matched comparison group vs. total SOP cohort



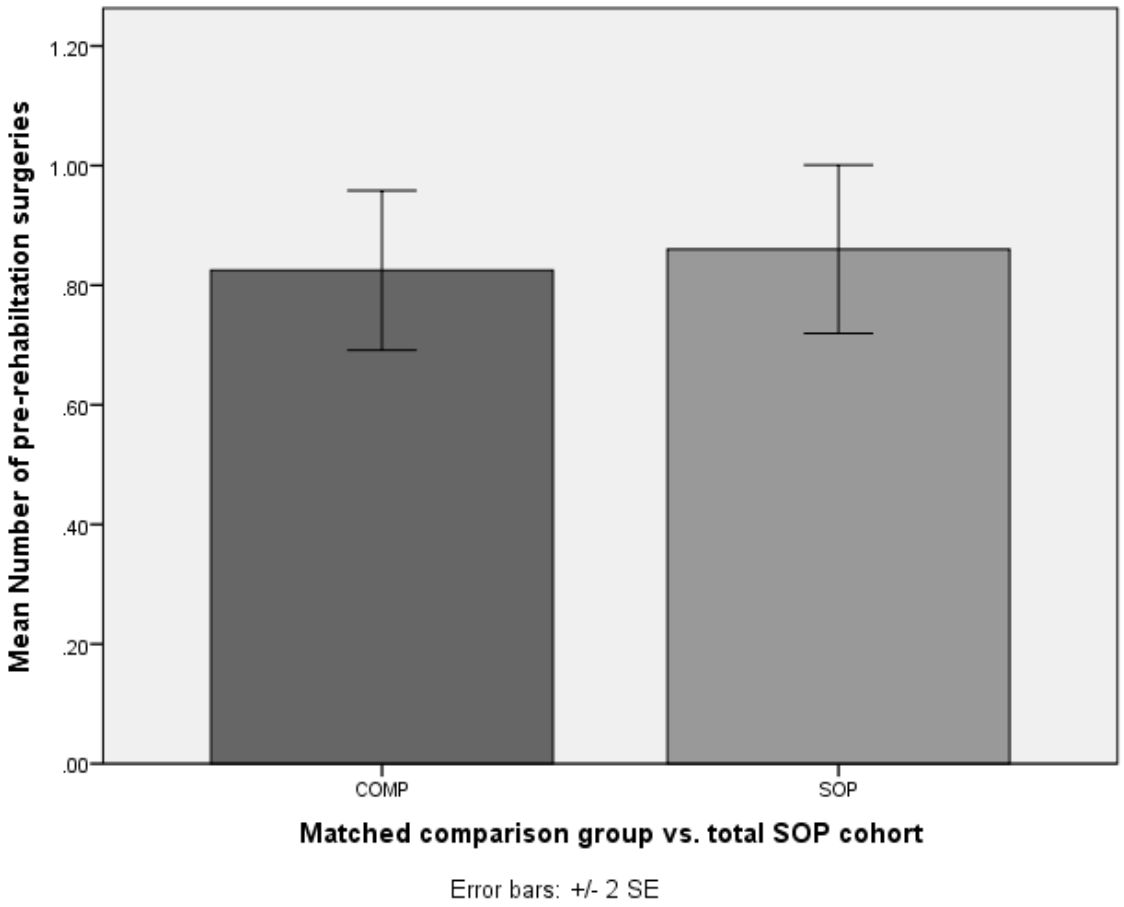
Note: No significant differences between groups.

Figure A8. Mean months of disability by matched comparison group vs. total SOP cohort



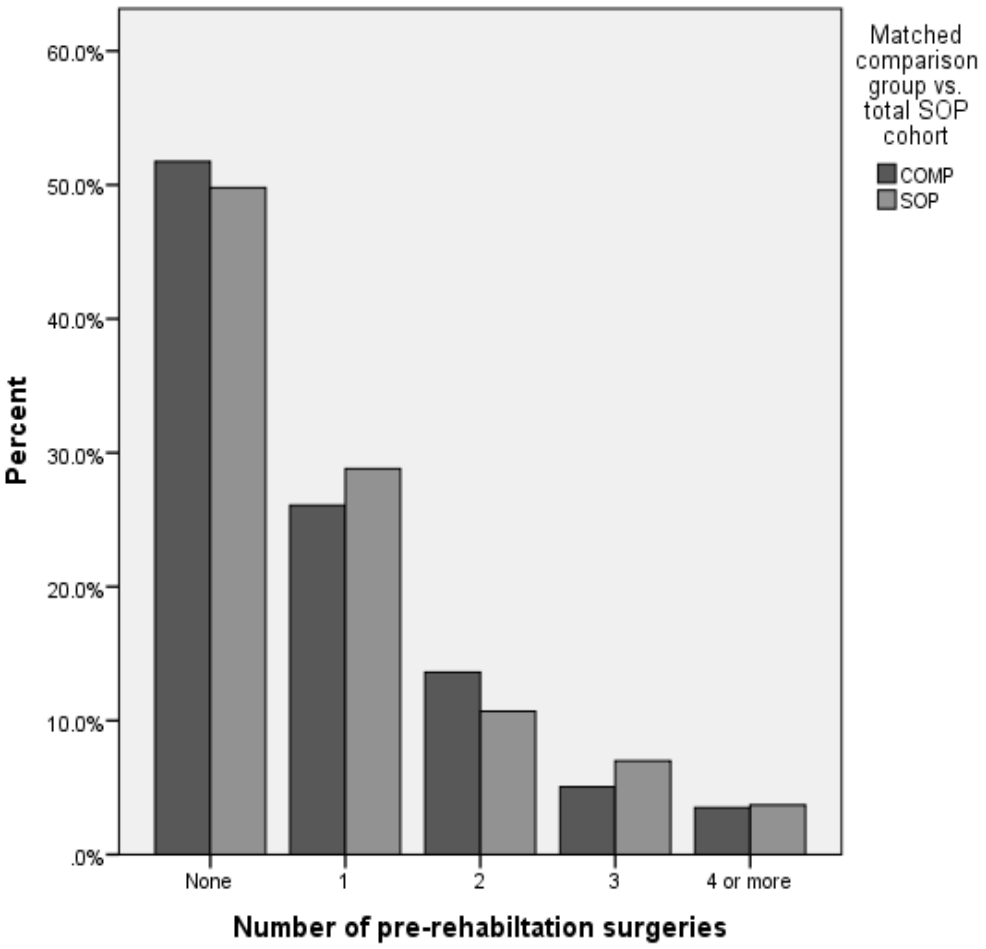
Note: No significant differences between groups.

Figure A9. Pre-rehabilitation surgery by matched comparison group vs. total SOP cohort



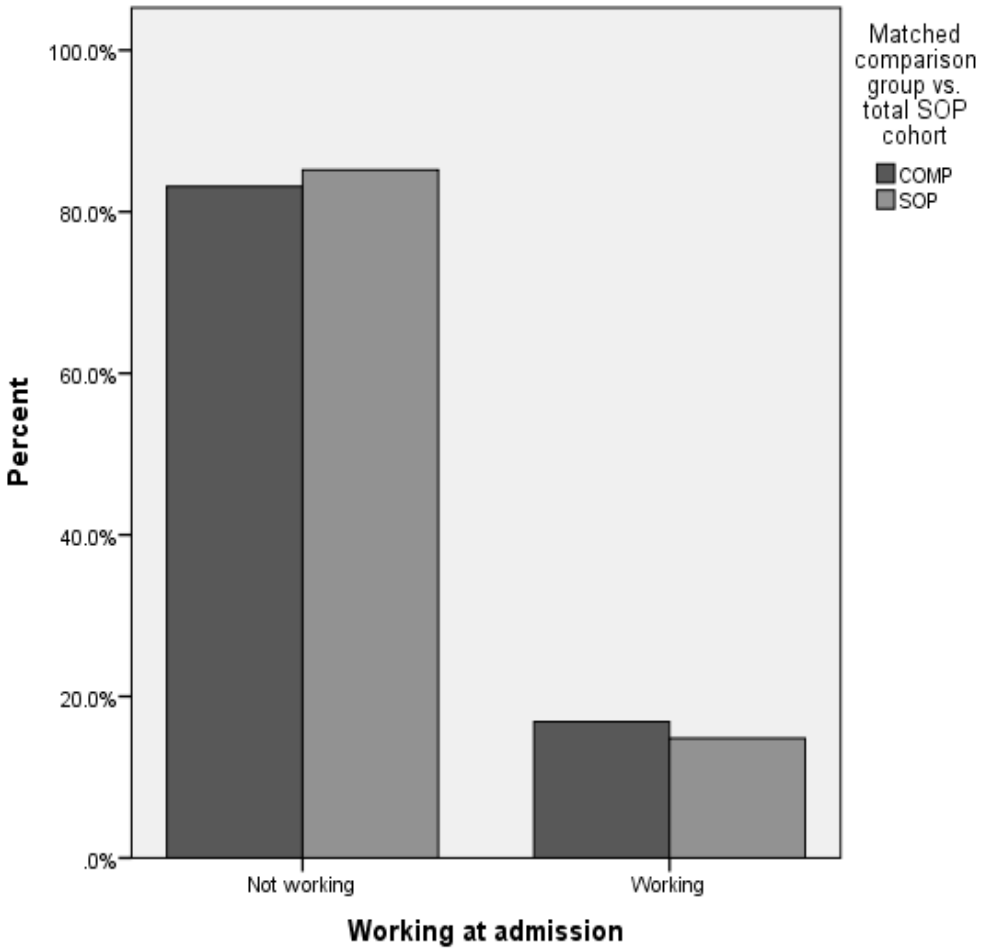
Note: No significant differences between groups.

Figure A10. Mean number of pre-rehabilitation surgeries by matched comparison group vs. total SOP cohort



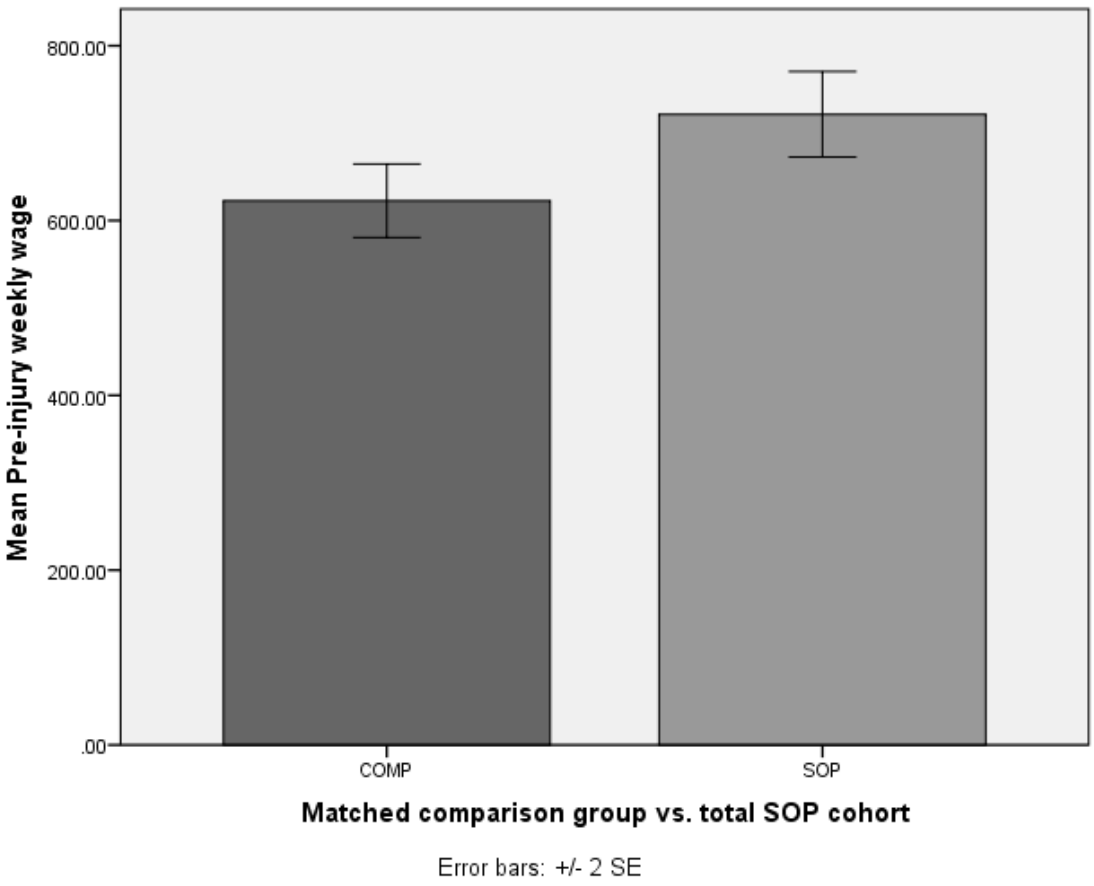
Note: No significant differences between groups.

Figure A11. Number of pre-rehabilitation surgeries by matched comparison group vs. total SOP cohort



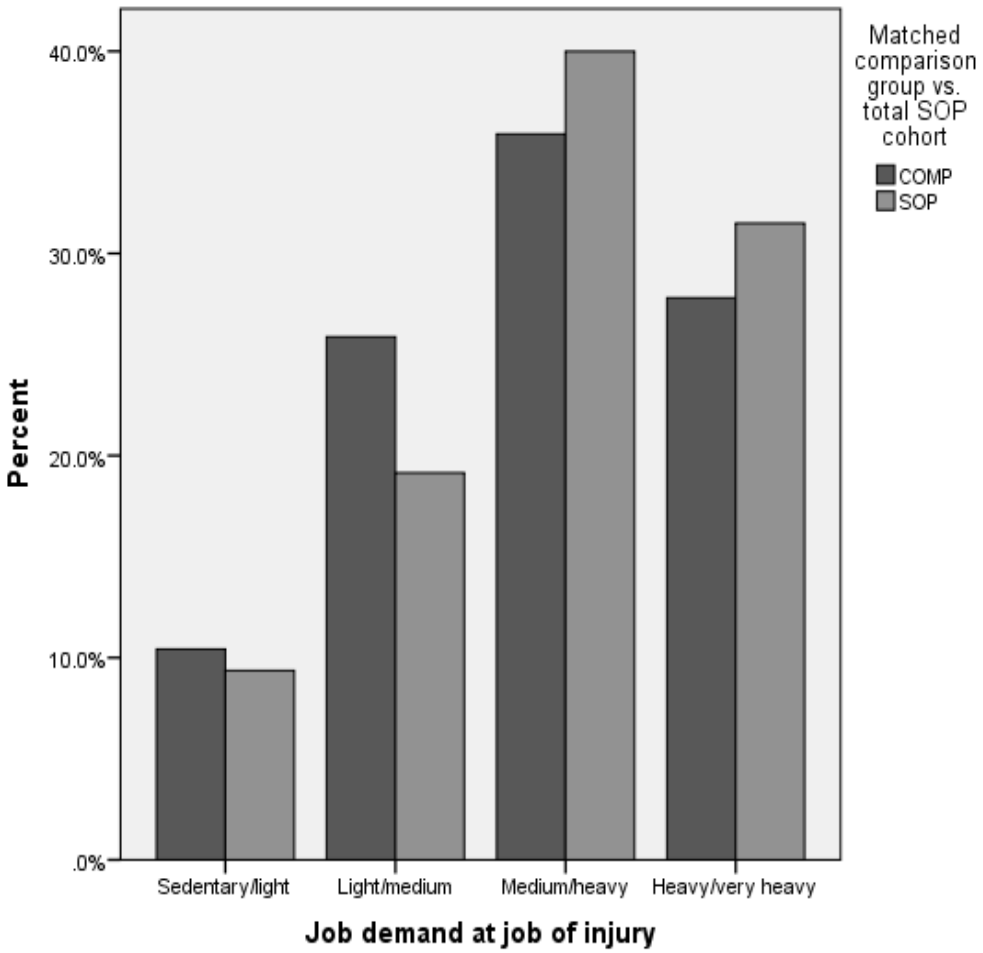
Note: No significant differences between groups.

Figure A12. Work status at admission by matched comparison group vs. total SOP cohort



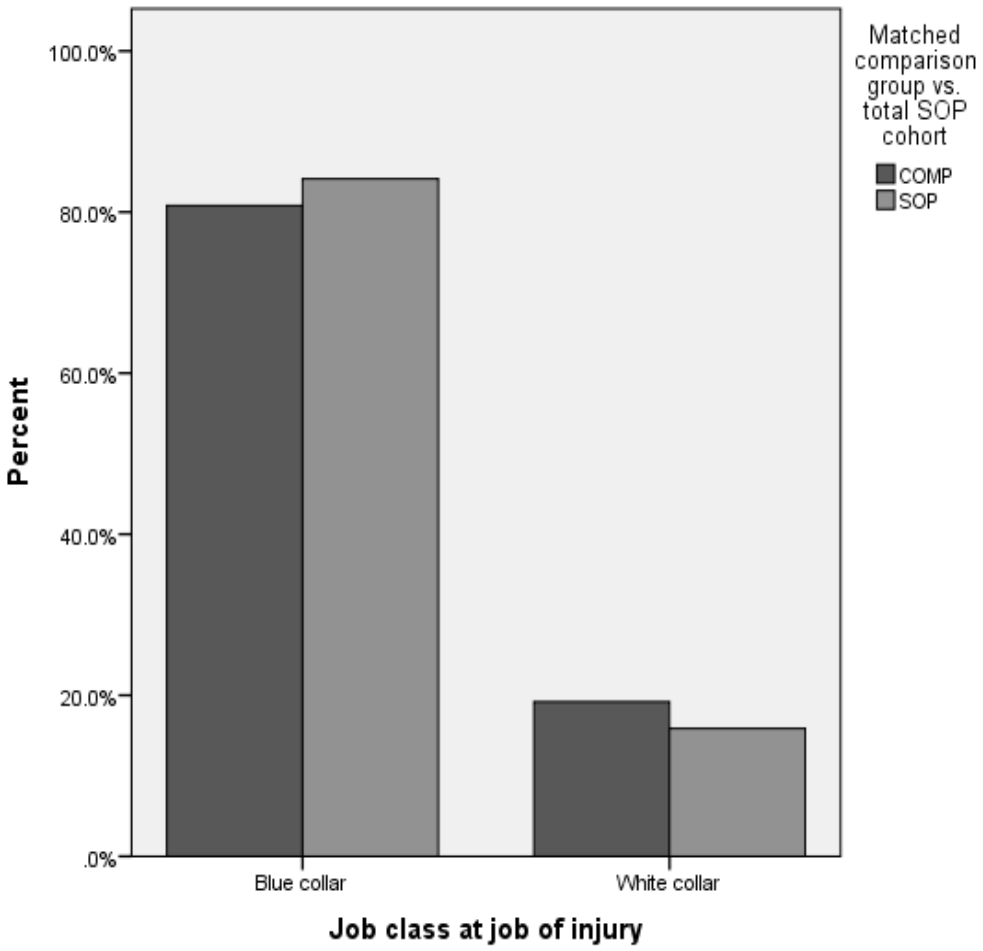
Note: p = .002.

Figure A13. Mean weekly pre-injury wage by matched comparison group vs. total SOP cohort



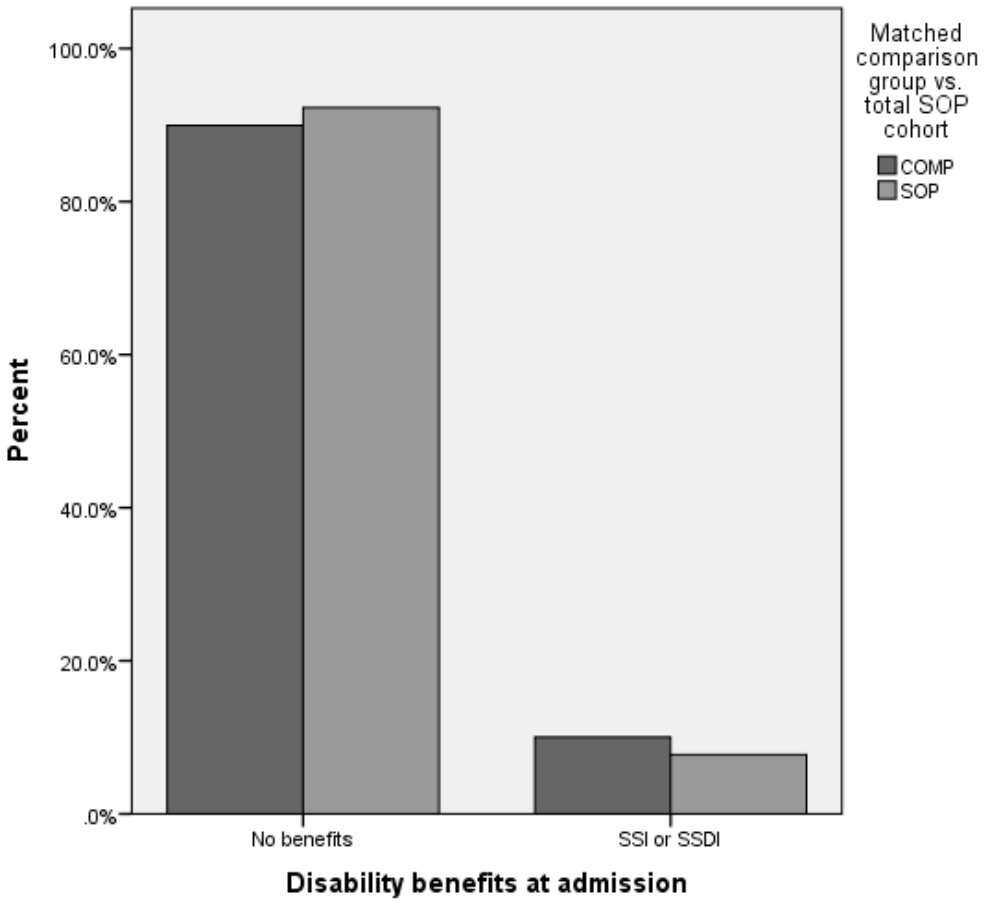
Note: No significant differences between groups.

Figure A14. Job demand at job of injury by matched comparison group vs. total SOP cohort



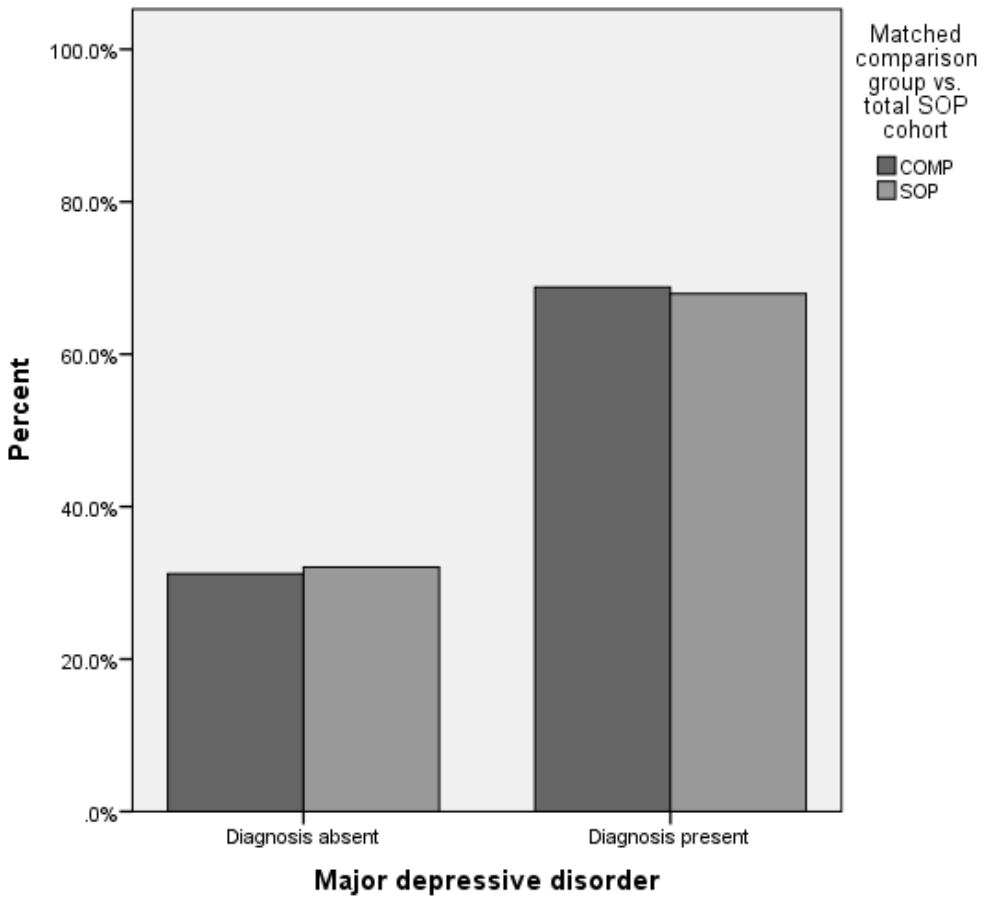
Note: No significant differences between groups.

Figure A15. Job class at job of injury by matched comparison group vs. total SOP cohort



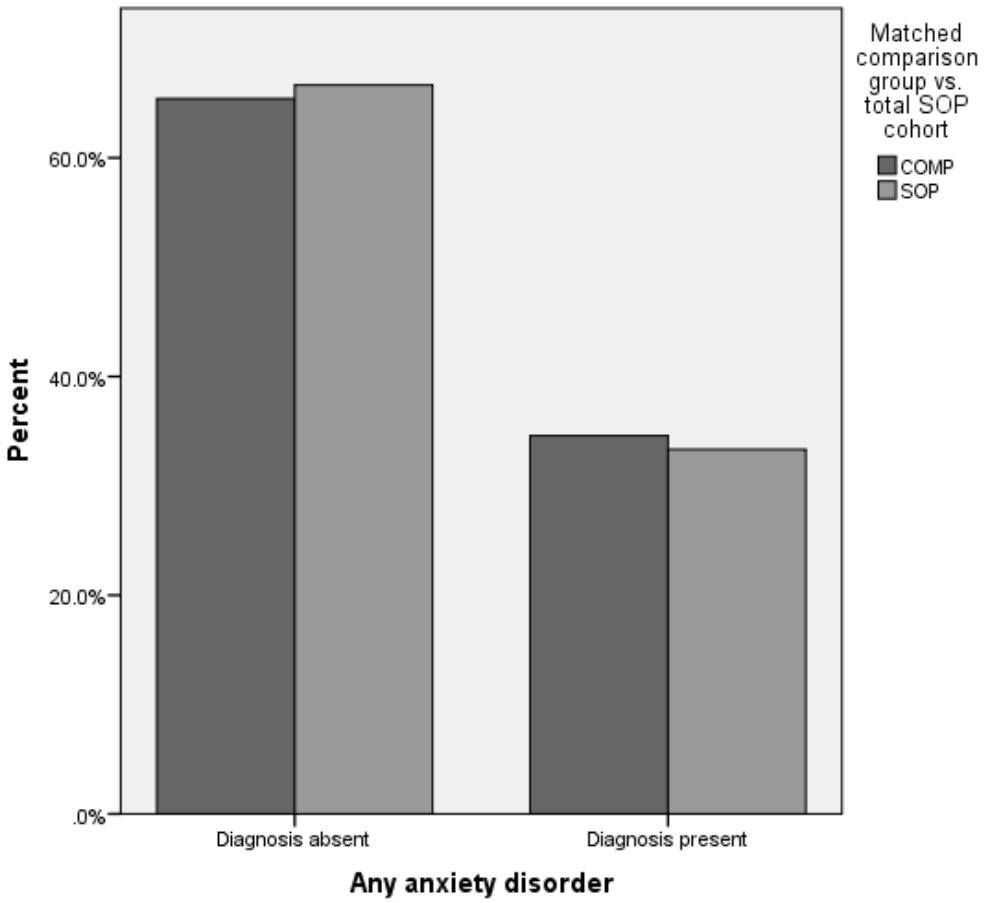
Note: No significant differences between groups.

Figure A16. Disability benefits at admission by matched comparison group vs. total SOP cohort



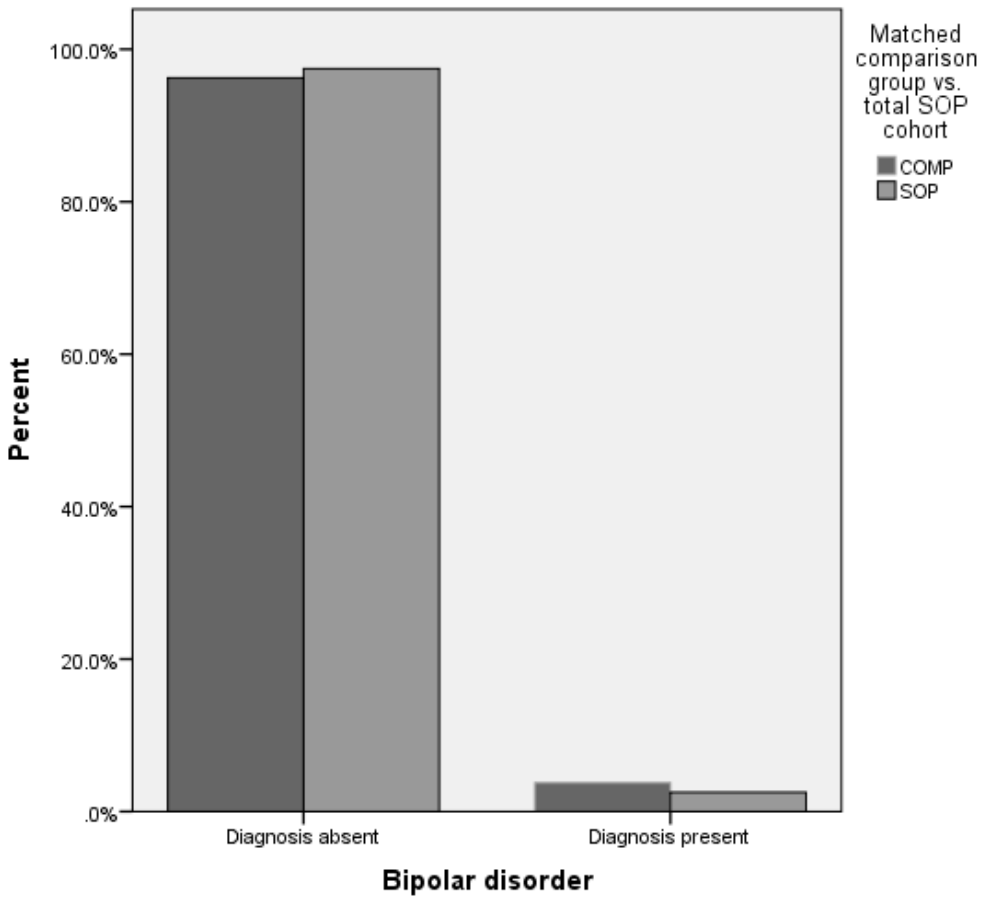
Note: No significant differences between groups.

Figure A17. Major depressive disorder by matched comparison group vs. total SOP cohort



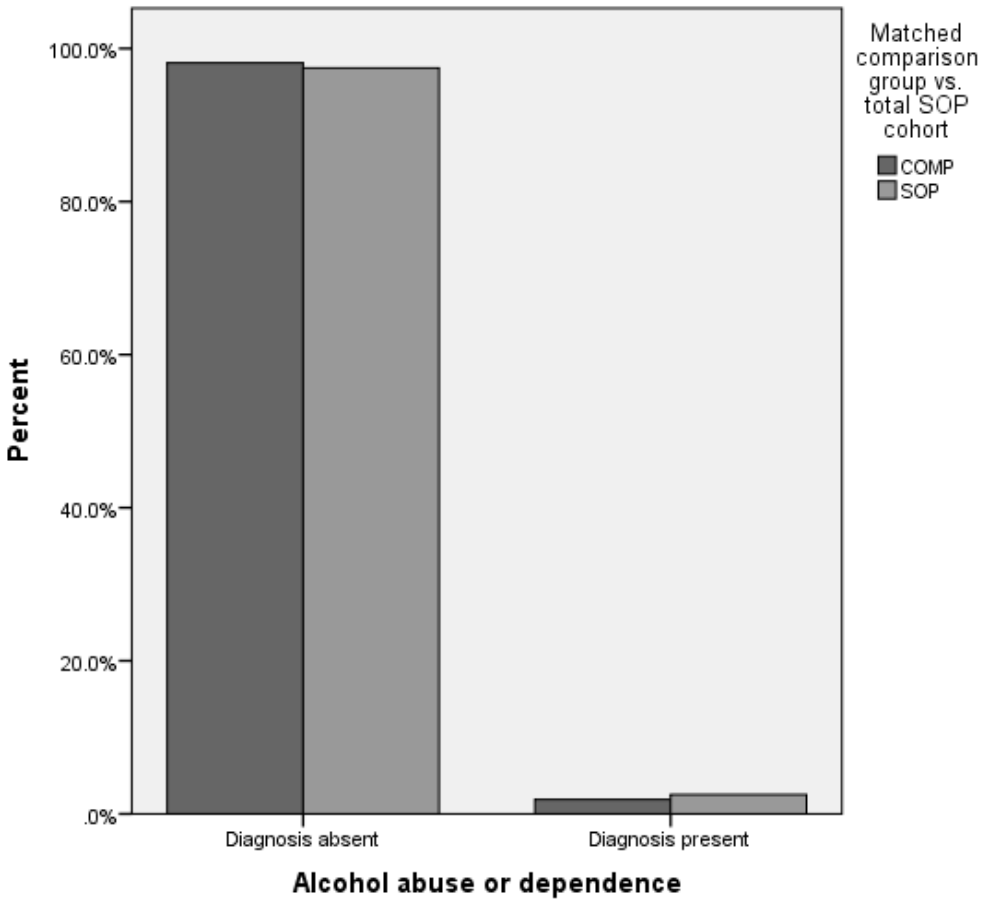
Note: No significant differences between groups.

Figure A18. Major depressive disorder by matched comparison group vs. total SOP cohort



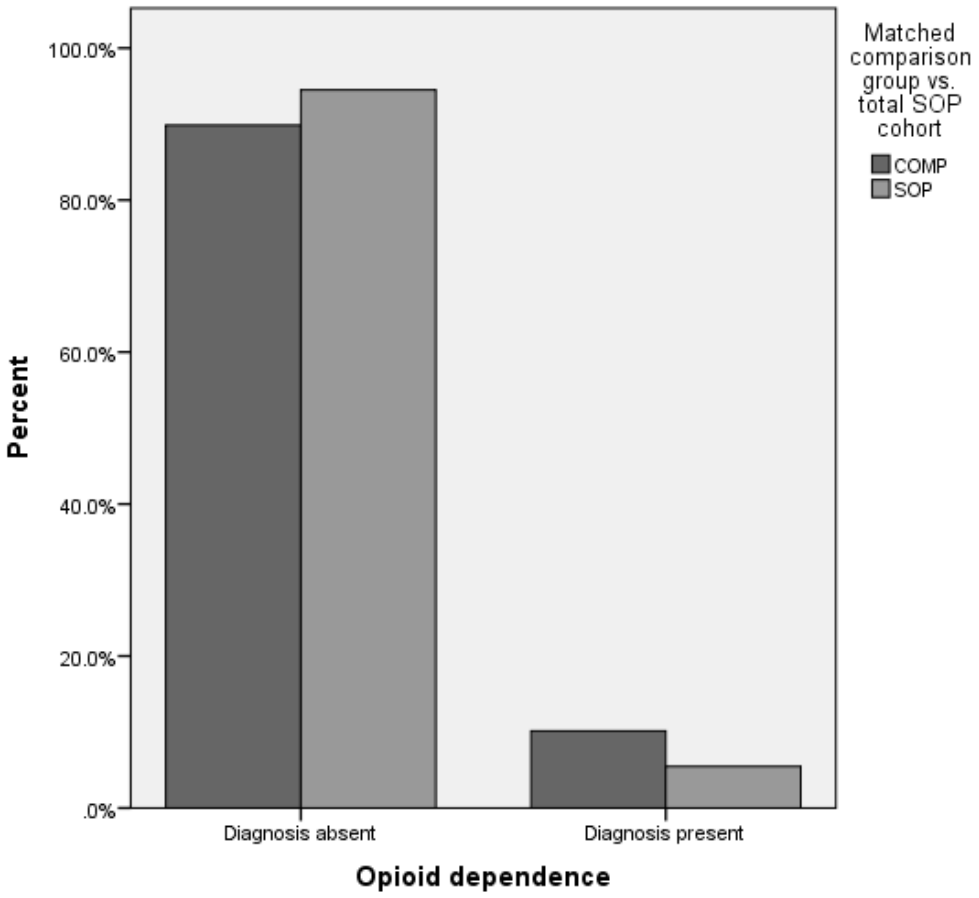
Note: No significant differences between groups.

Figure A19. Major depressive disorder by matched comparison group vs. total SOP cohort



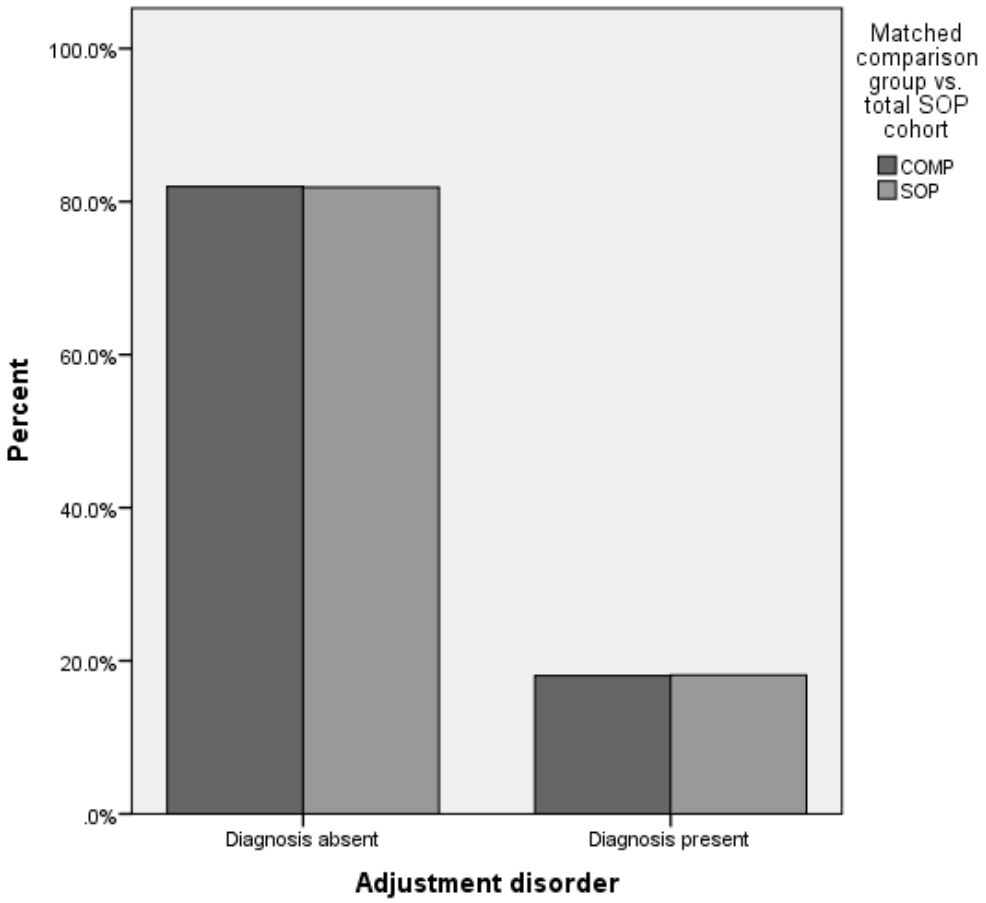
Note: No significant differences between groups.

Figure A20. Major depressive disorder by matched comparison group vs. total SOP cohort



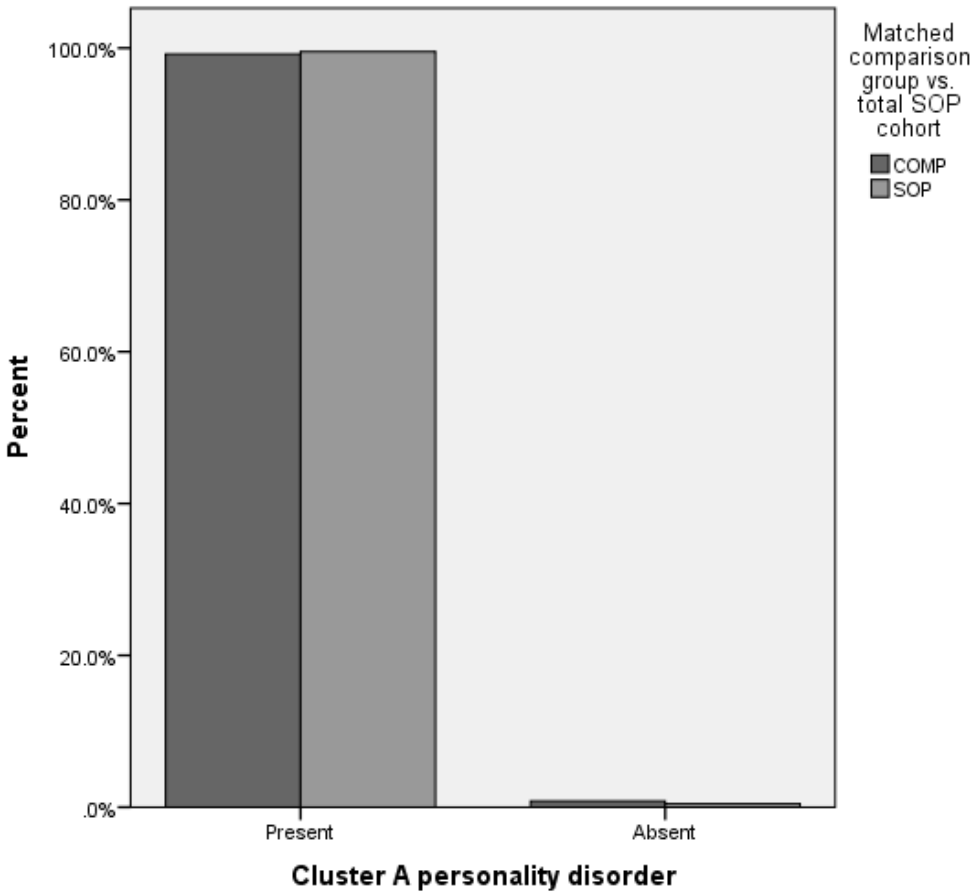
Note: No significant differences between groups.

Figure A21. Major depressive disorder by matched comparison group vs. total SOP cohort



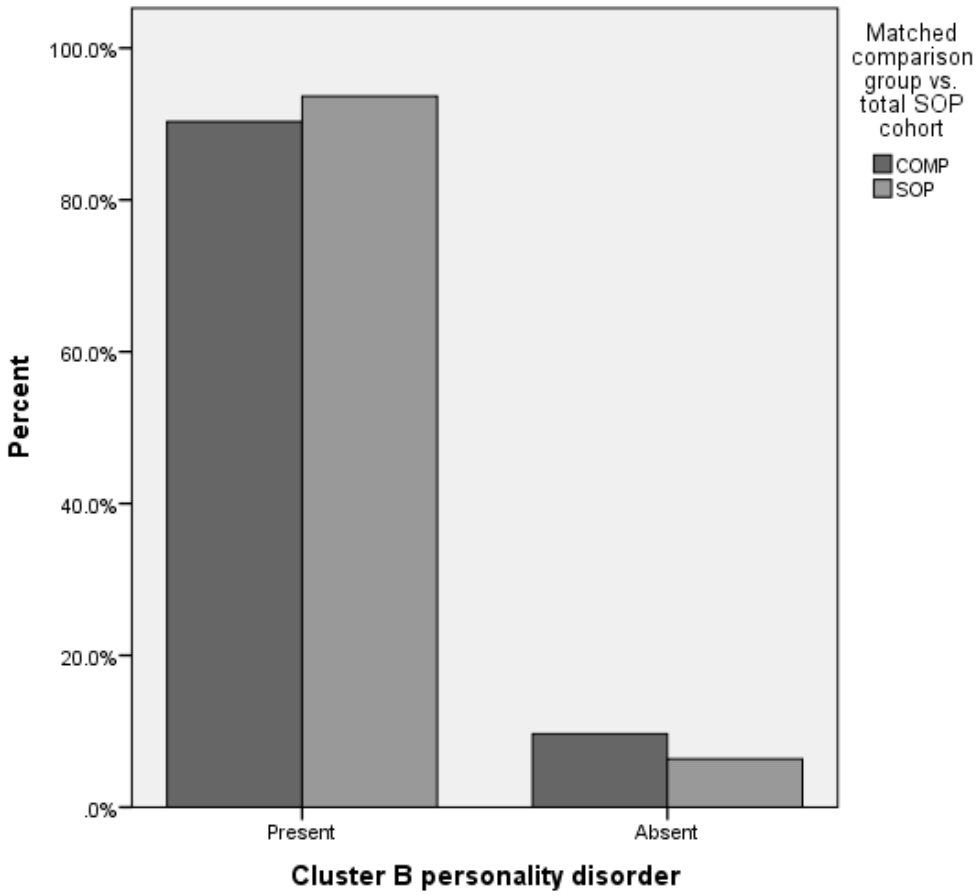
Note: No significant differences between groups.

Figure A22. Major depressive disorder by matched comparison group vs. total SOP cohort



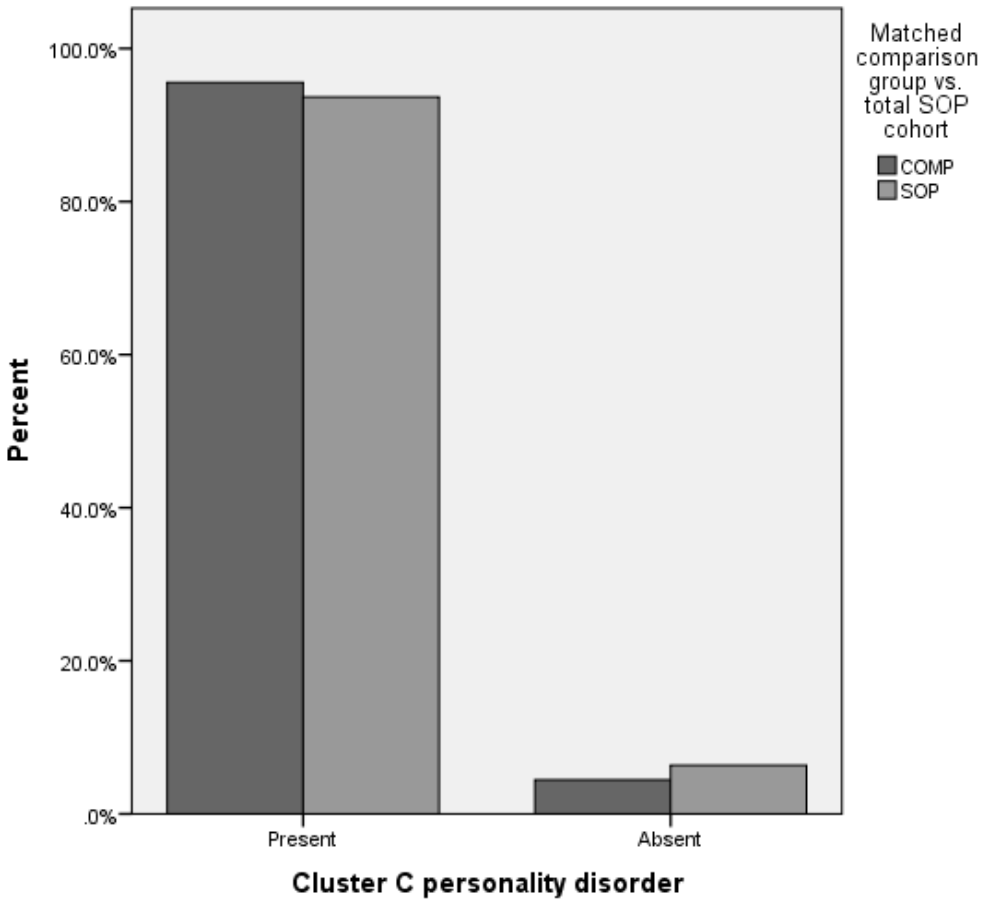
Note: No significant differences between groups.

Figure A23. Cluster A personality disorders by matched comparison group vs. total SOP cohort



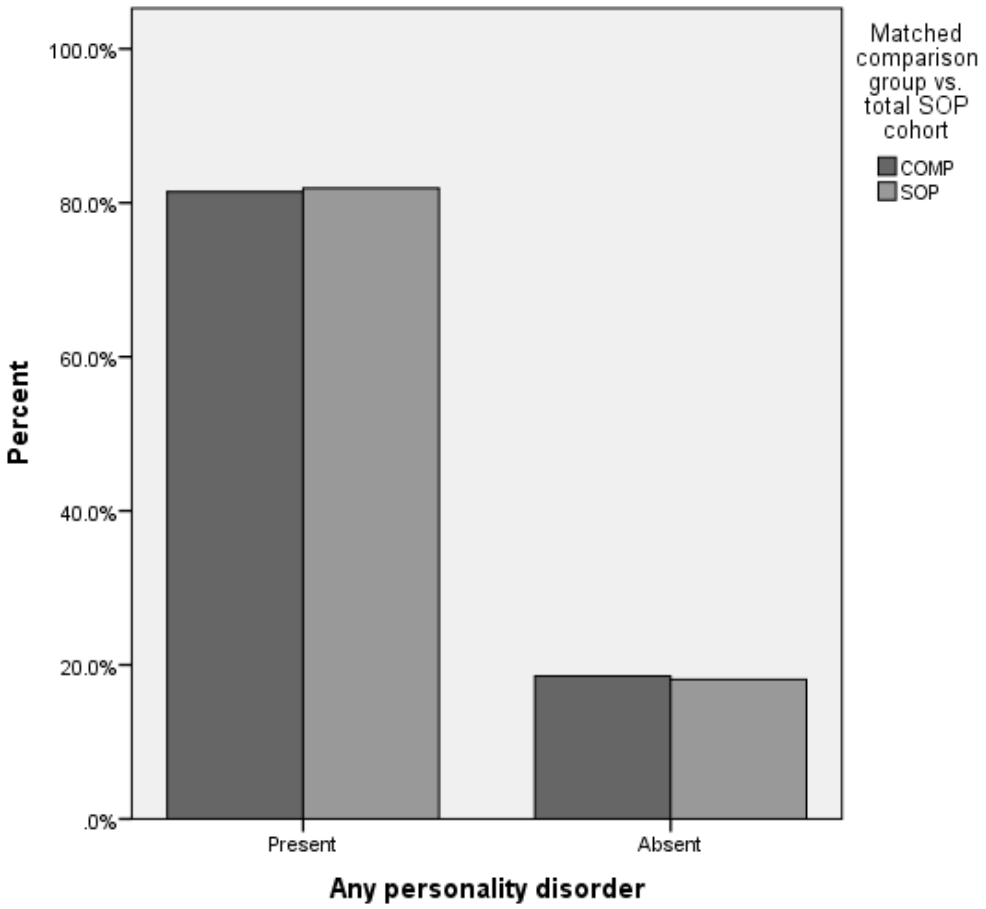
Note: No significant differences between groups.

Figure A24. Cluster B personality disorders by matched comparison group vs. total SOP cohort



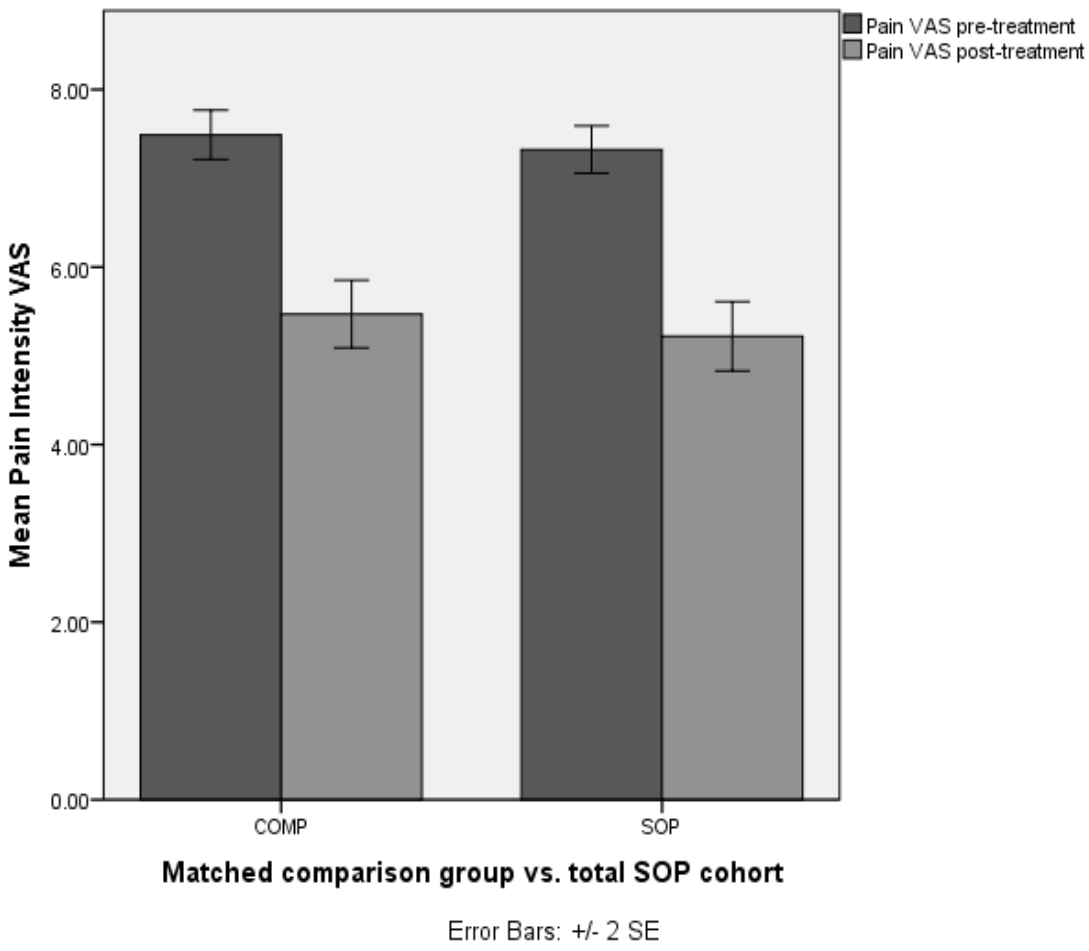
Note: No significant differences between groups.

Figure A25. Cluster C personality disorders by matched comparison group vs. total SOP cohort



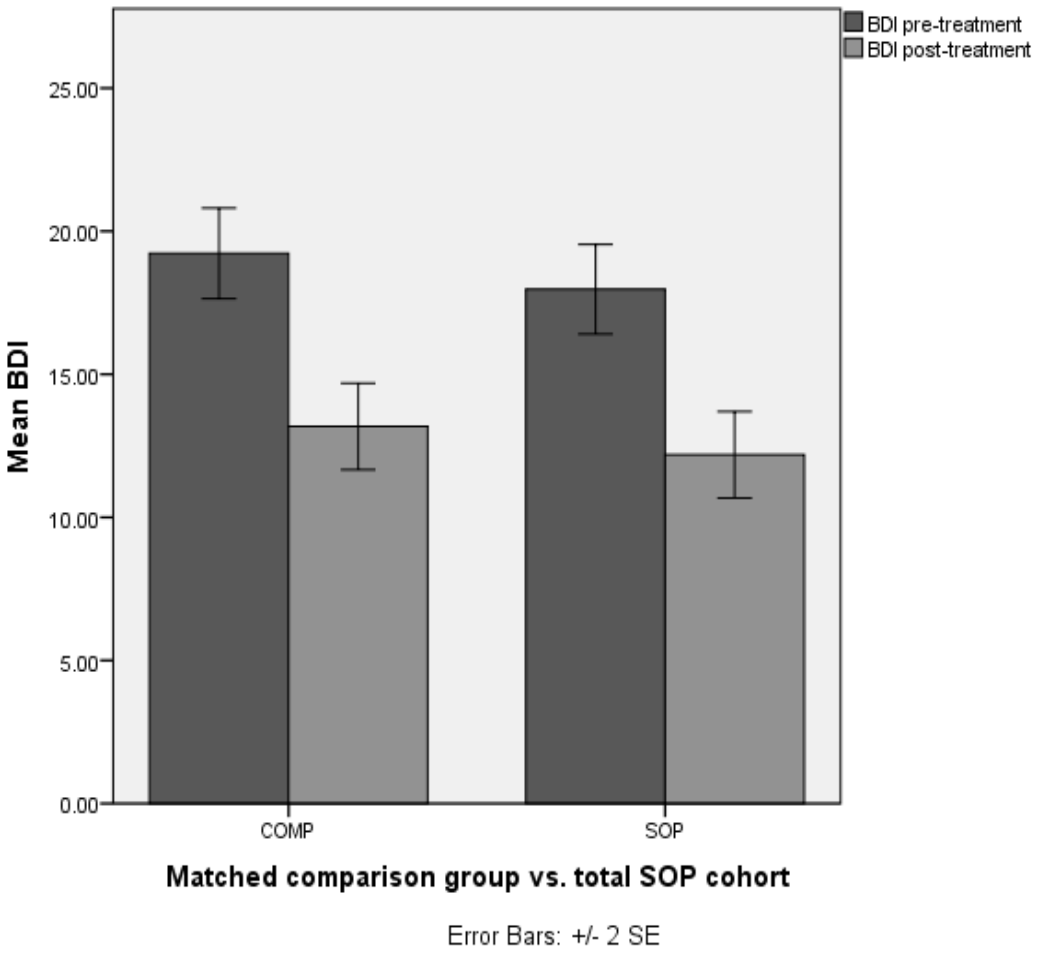
Note: No significant differences between groups.

Figure A26. Any Axis II personality disorder by matched comparison group vs. total SOP cohort



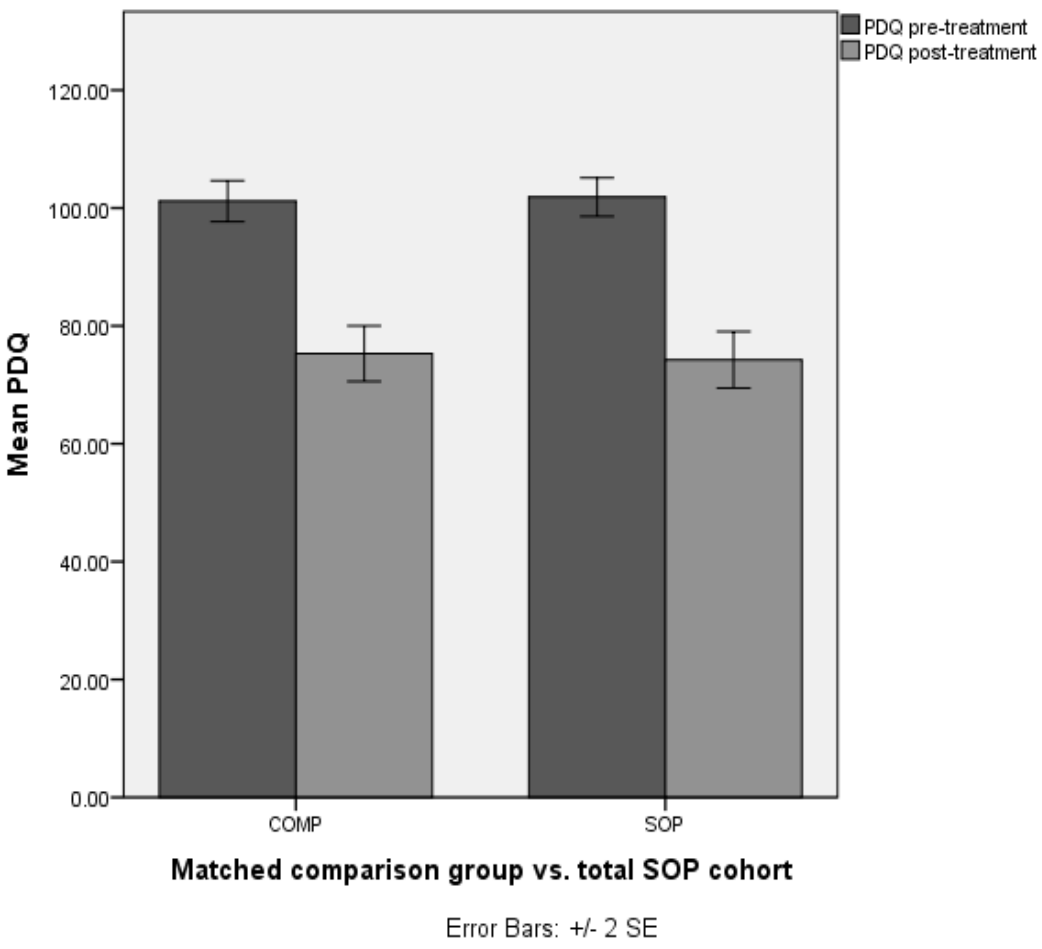
Note: No significant differences between groups.

Figure A27. Mean pain intensity (VAS) by matched comparison group vs. total SOP cohort



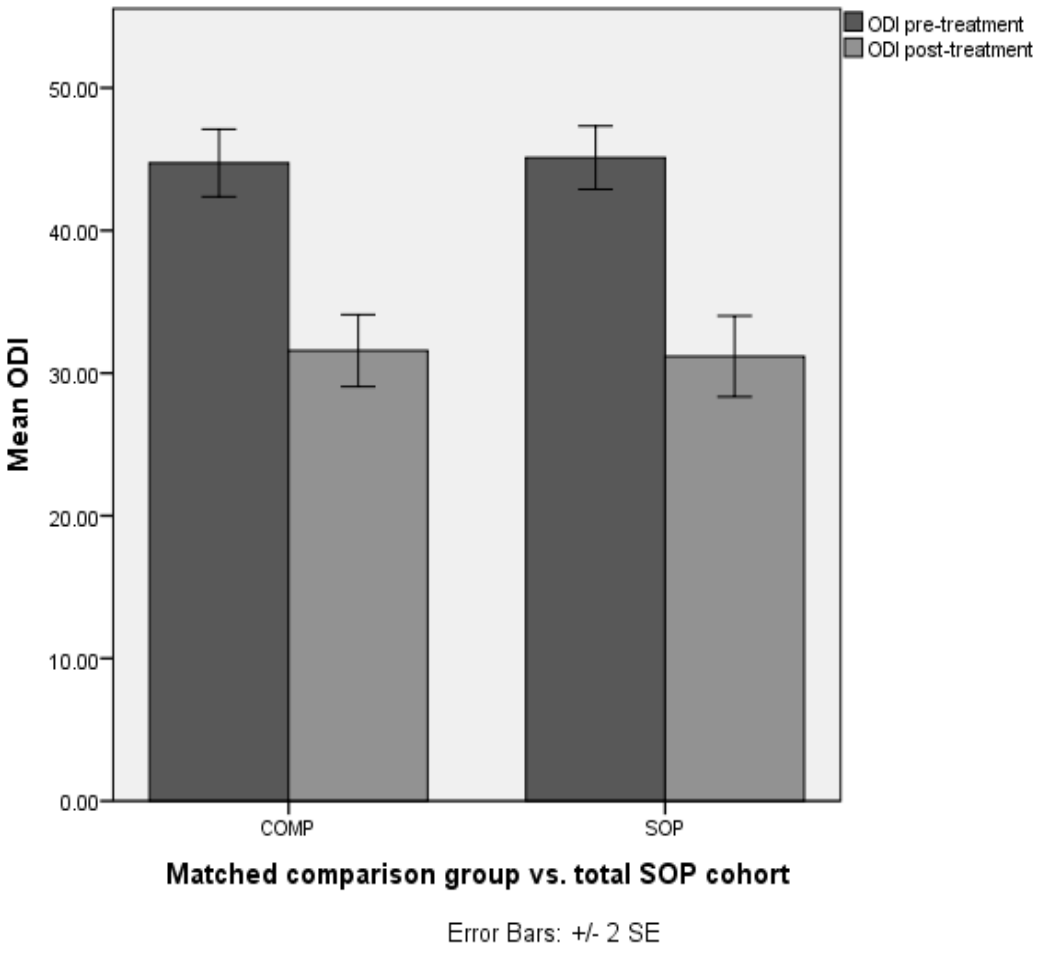
Note: No significant differences between groups.

Figure A28. Mean Beck Depression Inventory (BDI) by matched comparison group vs. total SOP cohort



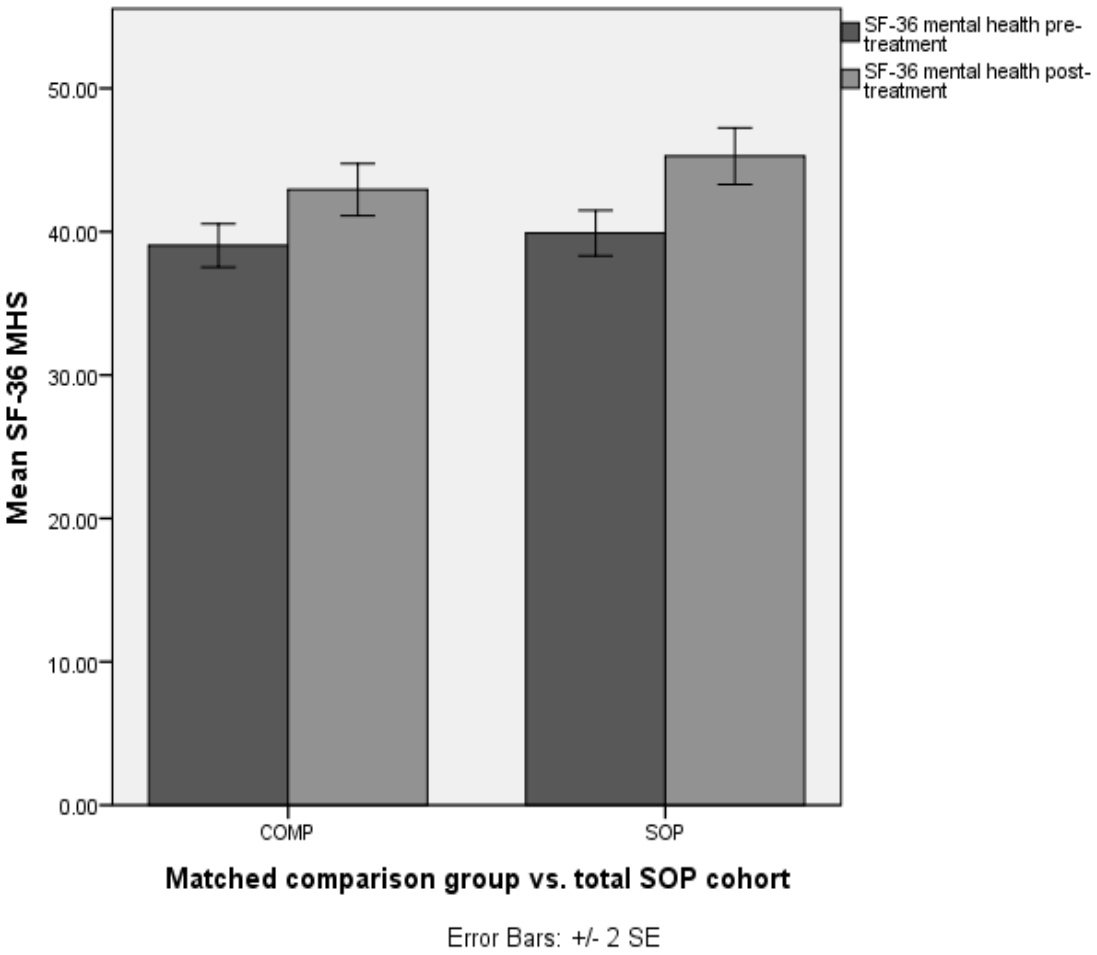
Note: No significant differences between groups.

Figure A29. Mean Pain Disability Questionnaire (PDQ) by matched comparison group vs. total SOP cohort



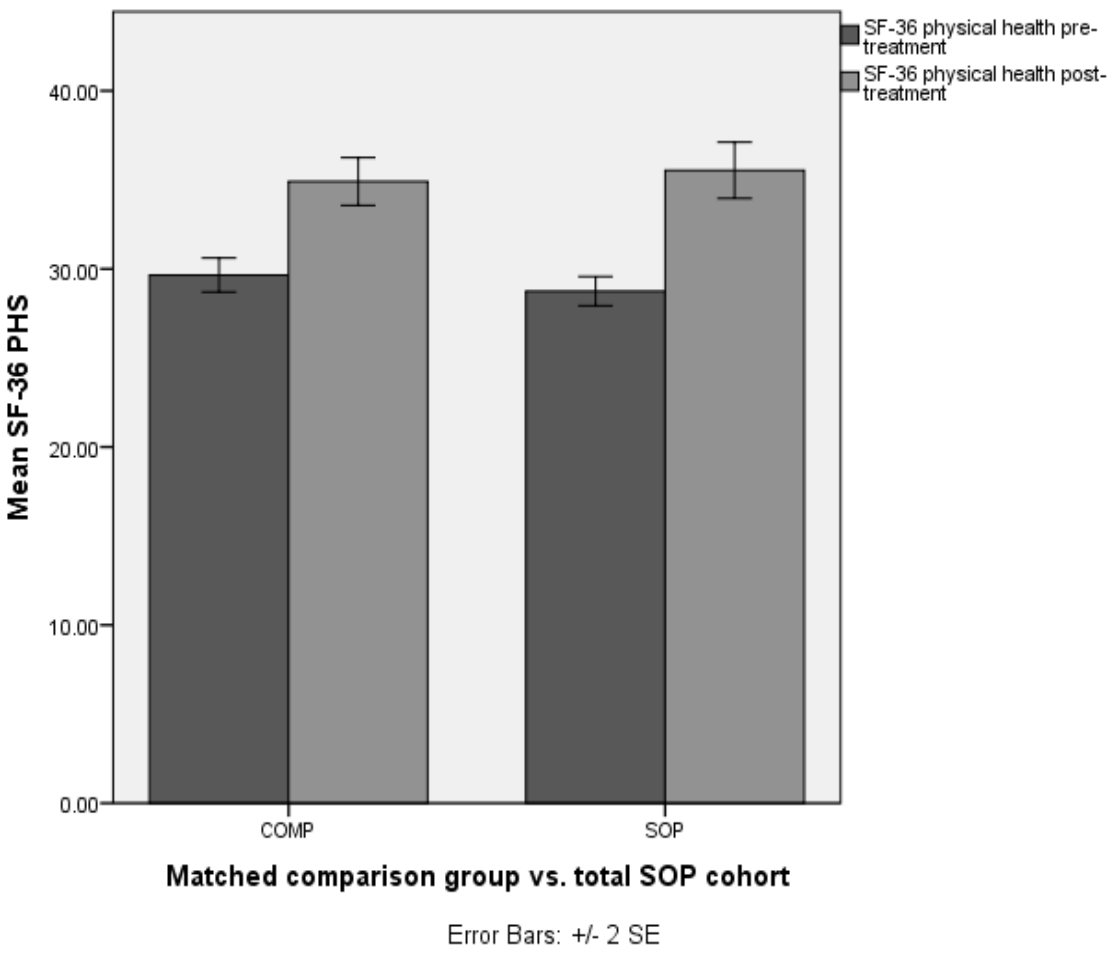
Note: No significant differences between groups.

Figure A30. Mean Oswestry Disabiility Index (ODI) at admission by matched comparison group vs. total SOP cohort



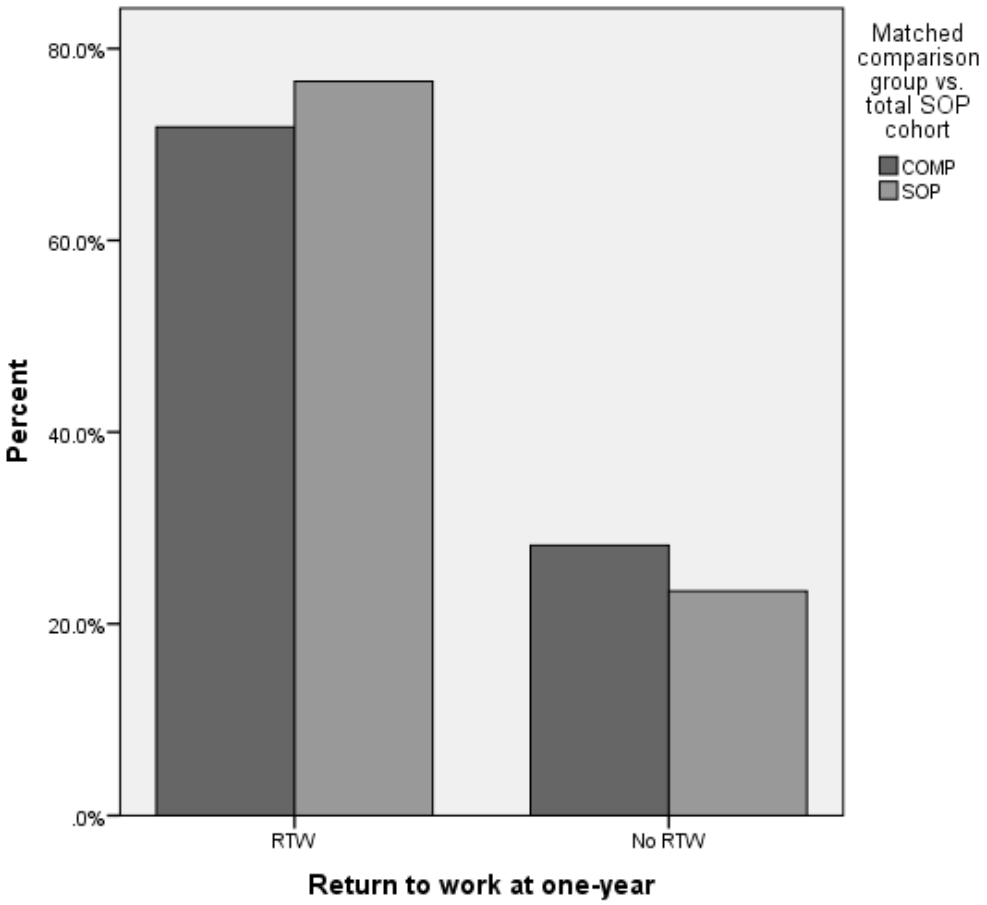
Note: No significant differences between groups.

Figure A31. Mean SF-36 mental health component by matched comparison group vs. total SOP cohort



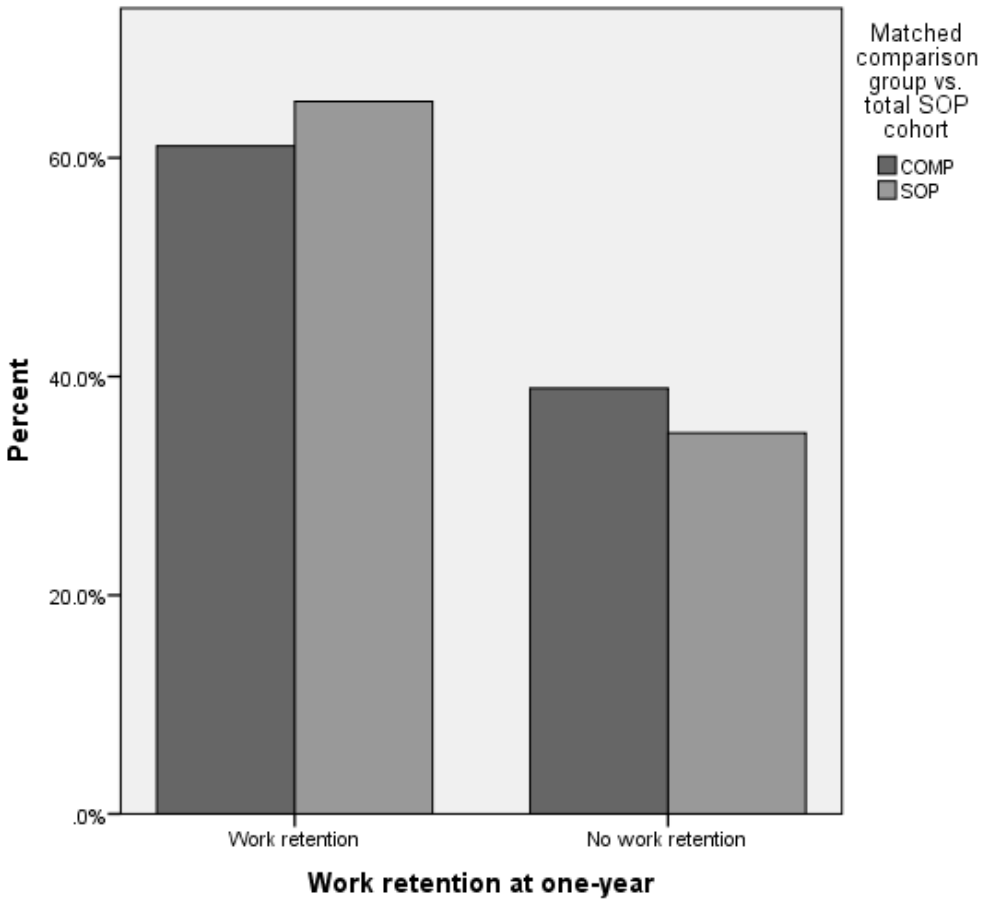
Note: p = .038 at pre-treatment, No significant differences between groups at post-treatment.

Figure A32. Mean SF-36 physical health component by matched comparison group vs. total SOP cohort



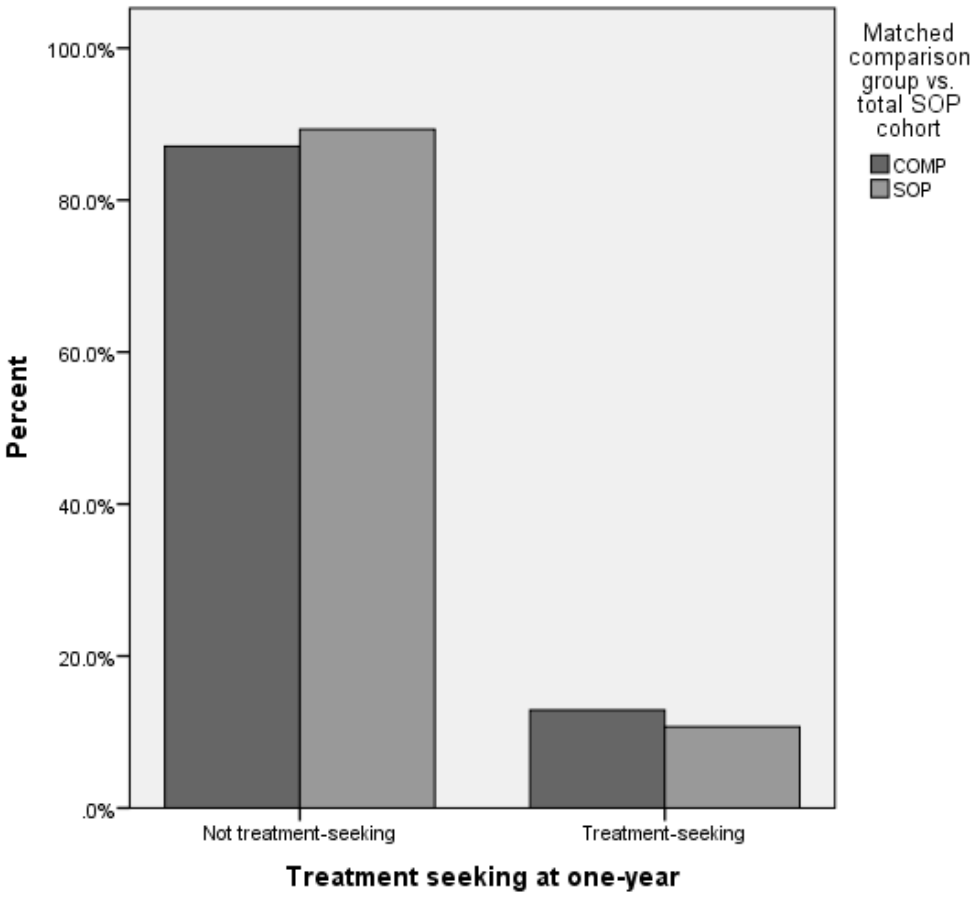
Note: No significant differences between groups.

Figure A33. Return to work at one-year by matched comparison group vs. total SOP cohort



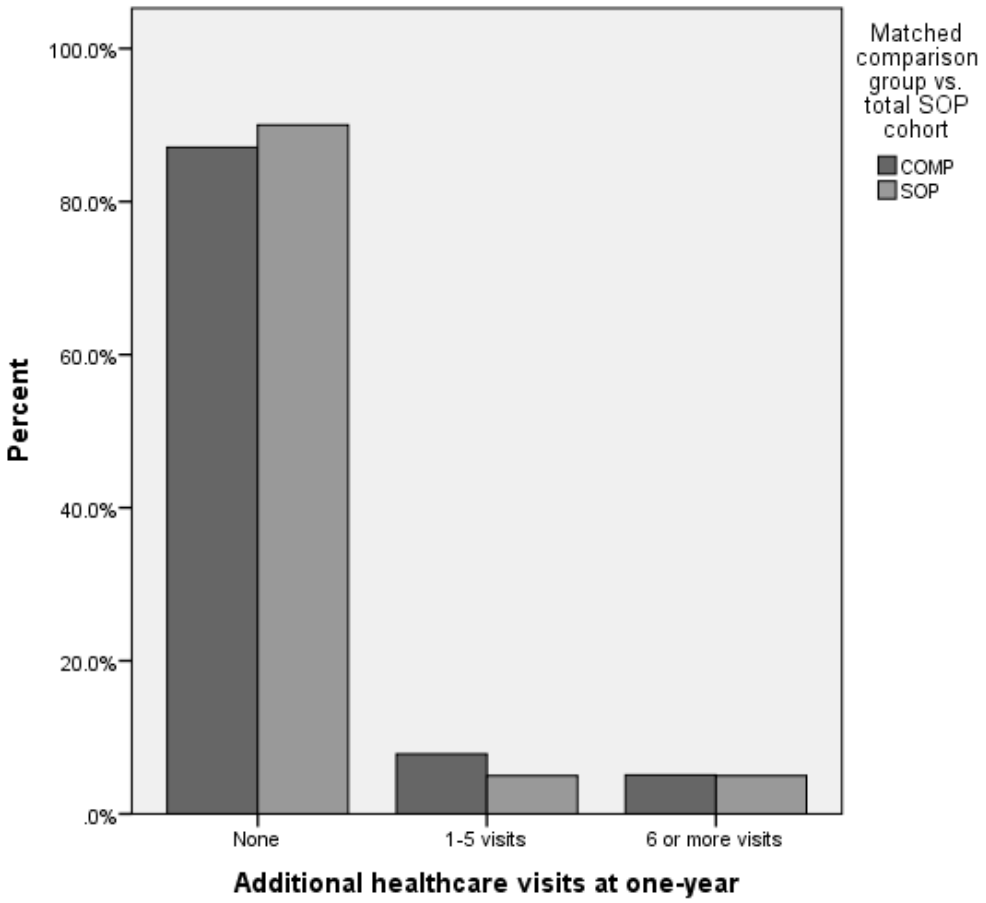
Note: No significant differences between groups.

Figure A34. Work retention at one-year by matched comparison group vs. total SOP cohort



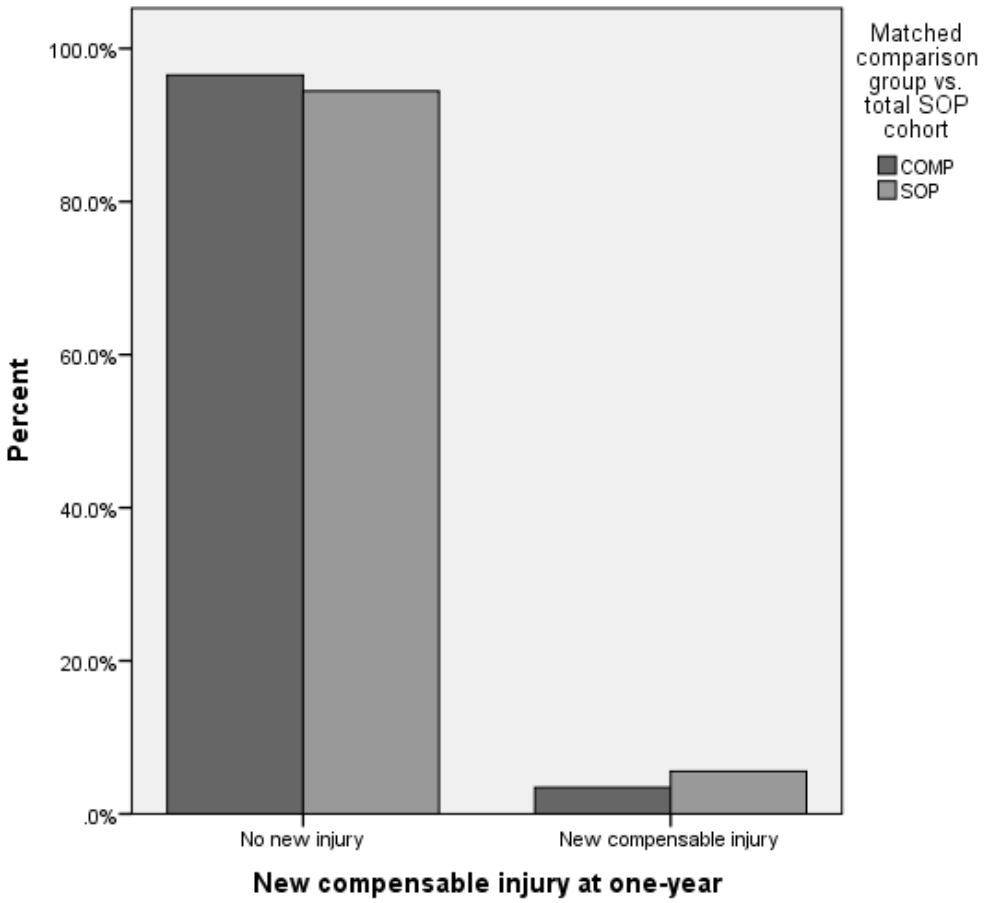
Note: No significant differences between groups.

Figure A35. Treatment-seeking at one-year by matched comparison group vs. total SOP cohort



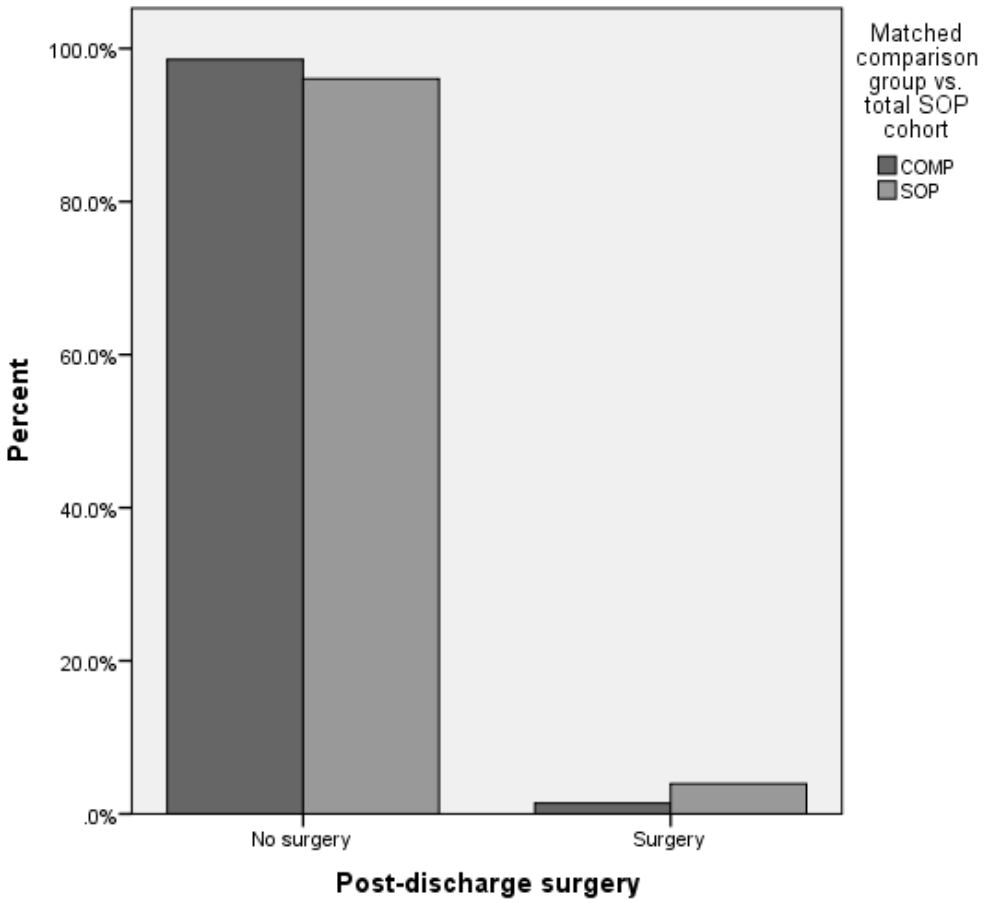
Note: No significant differences between groups.

Figure A36. Number of visits at one-year by matched comparison group vs. total SOP cohort



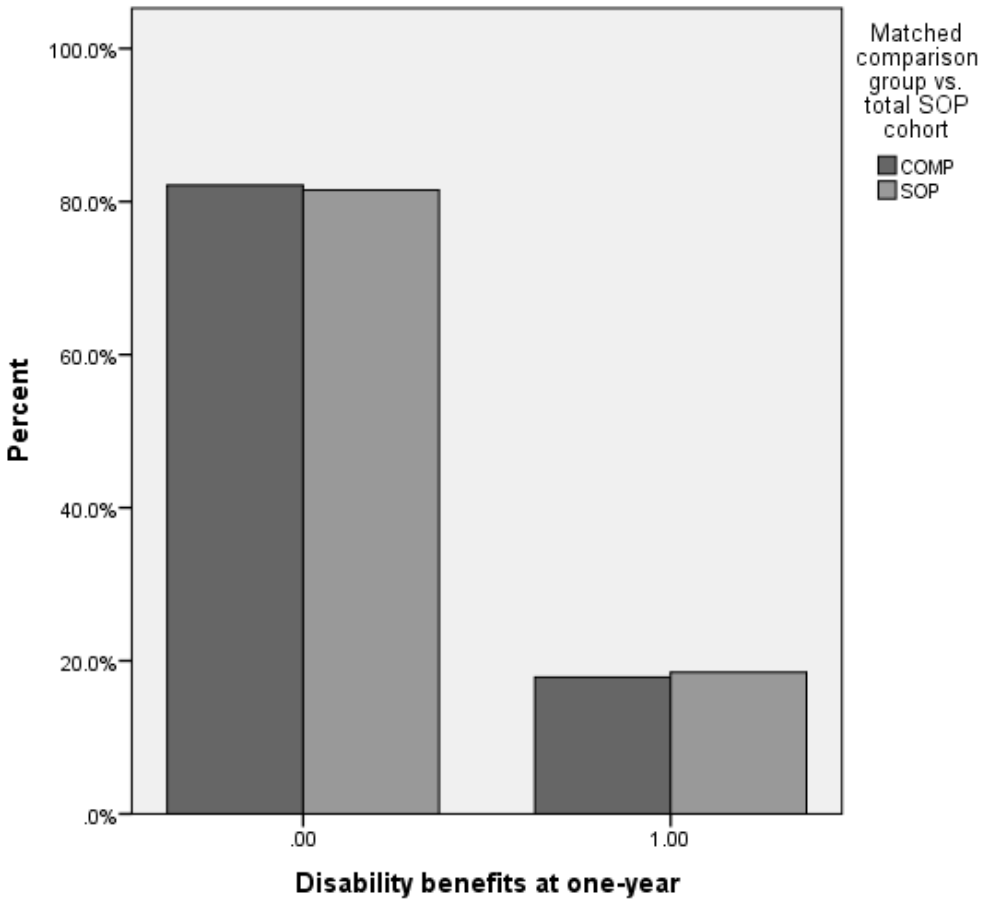
Note: No significant differences between groups.

Figure A37. New compensable injury at one-year by matched comparison group vs. total SOP cohort



Note: No significant differences between groups.

Figure A38. Additional non-SOP surgery at one-year by matched comparison group vs. total SOP cohort

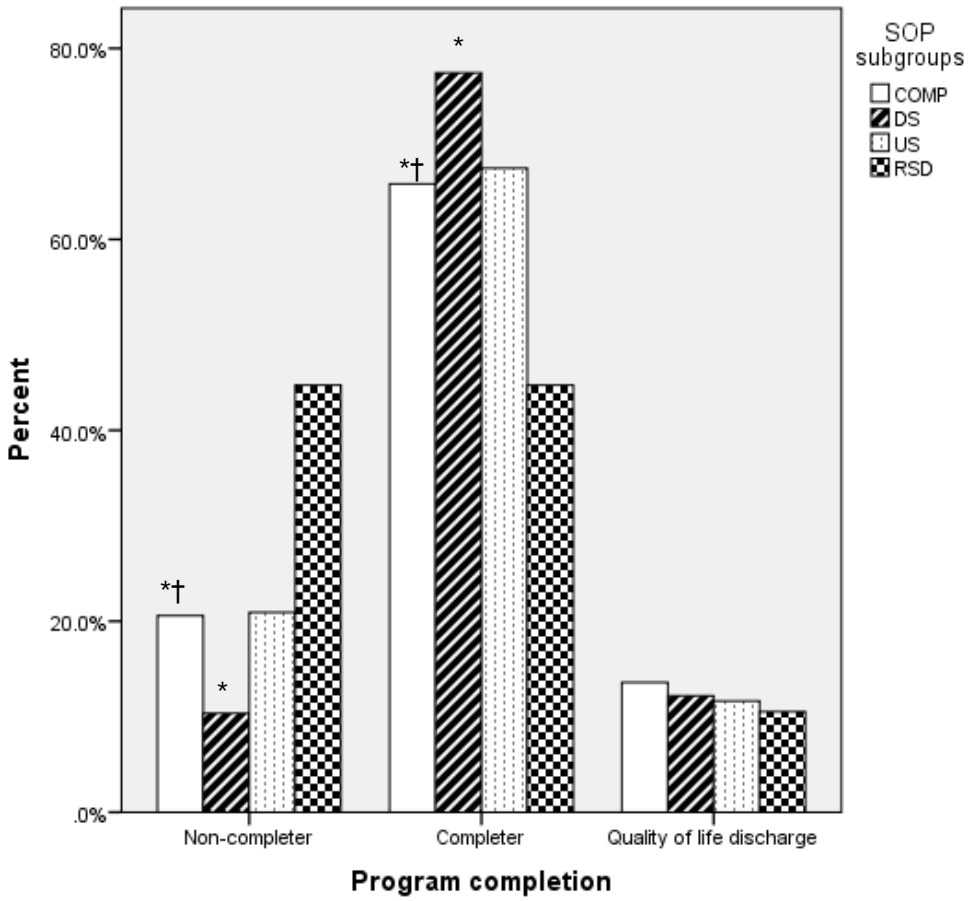


Note: No significant differences between groups.

Figure A39. Disability benefits at one-year by matched comparison group vs. total SOP cohort

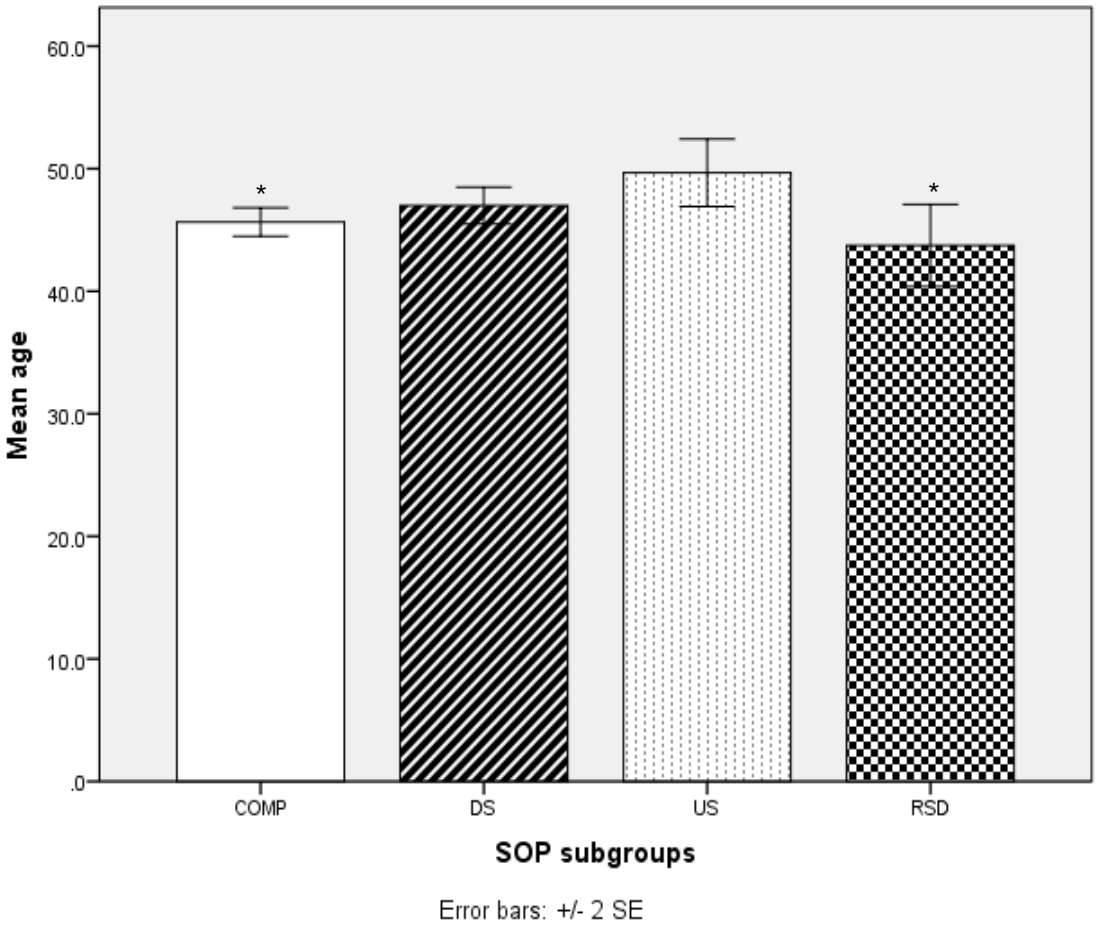
APPENDIX B

SOP SUBGROUP COMPARISON FIGURES



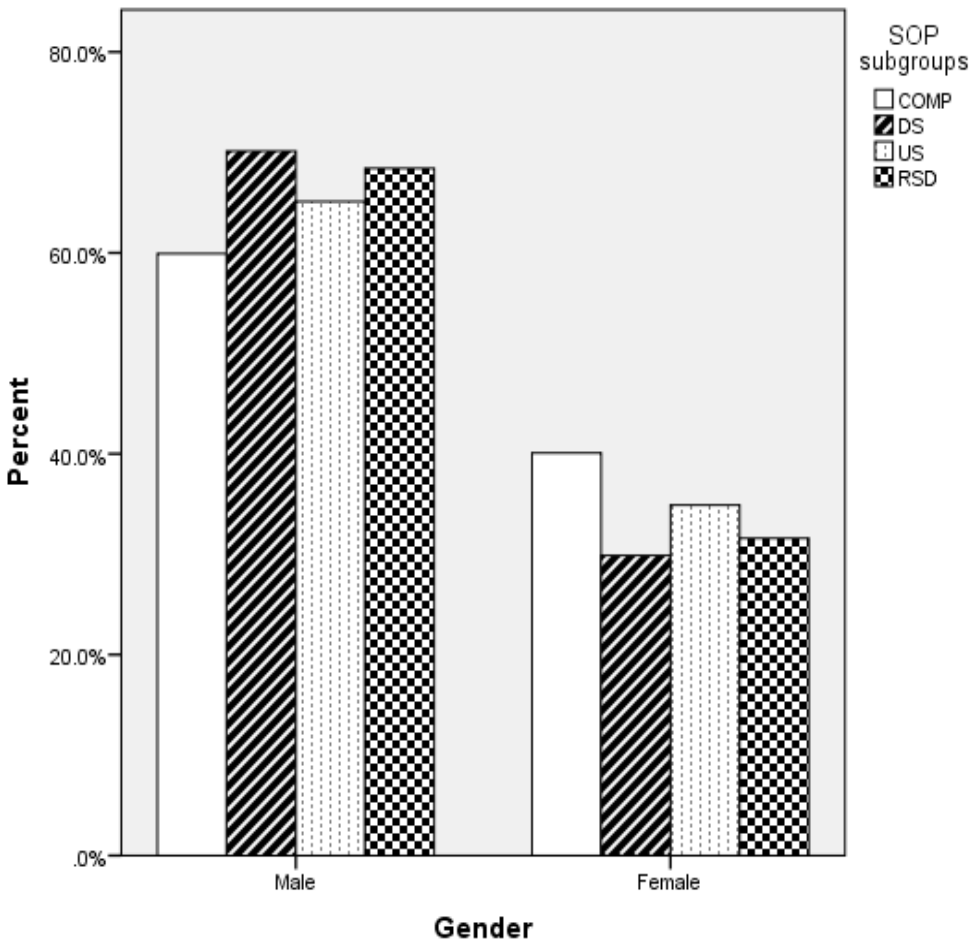
Note: p <.001. * Different from RSD group, †different from DS group.

Figure B1. Completion status by SOP subgroup



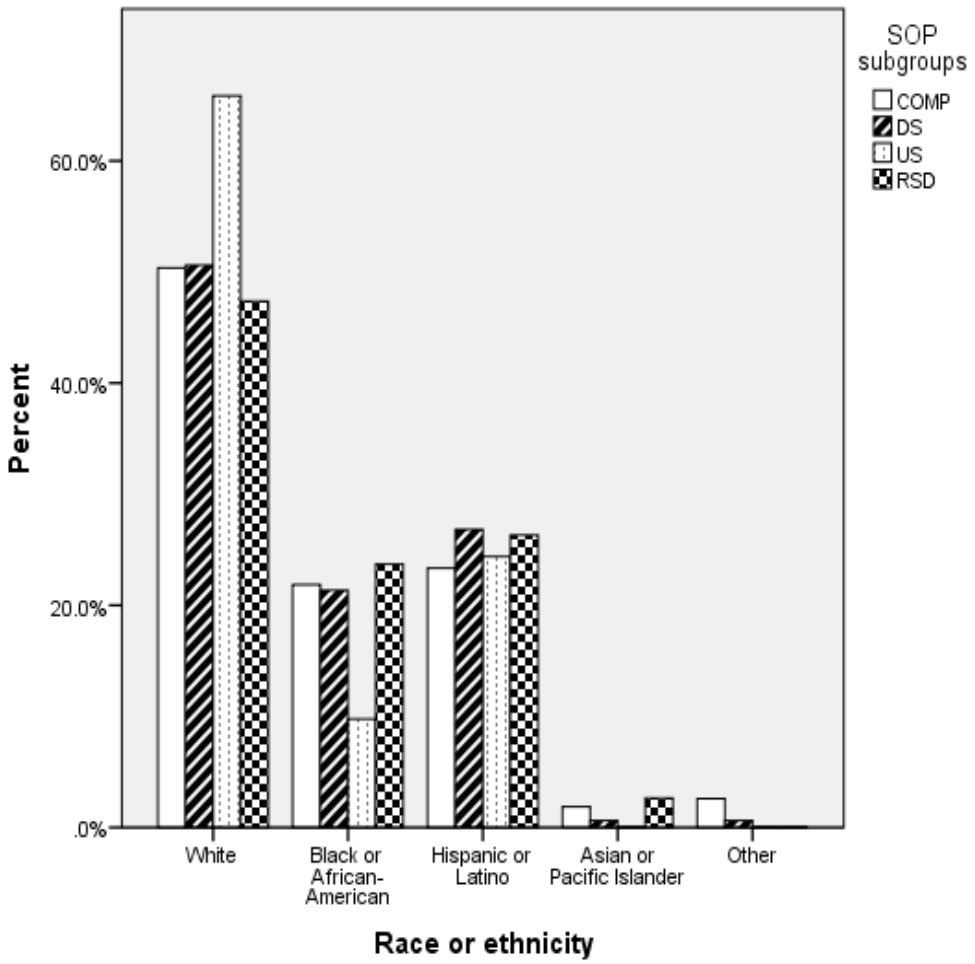
Note: p =.020. * Different from from US group.

Figure B2. Mean age by SOP subgroup



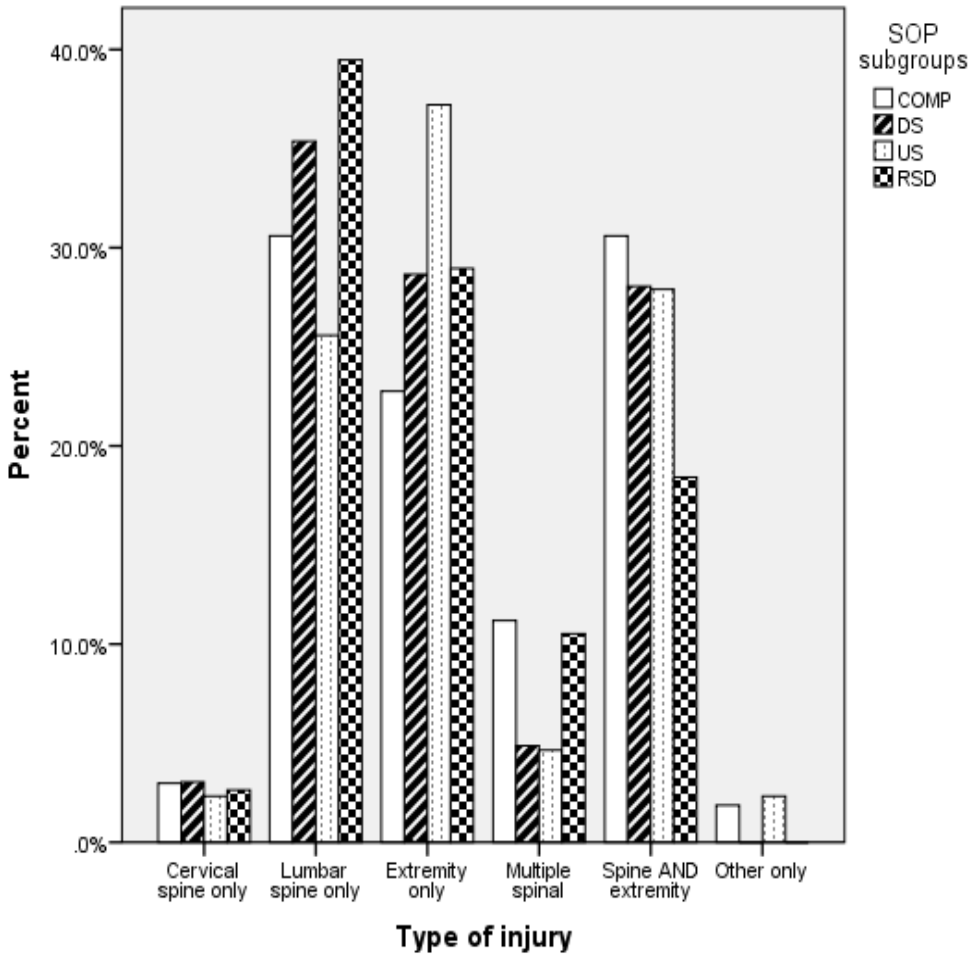
Note: No significant differences among subgroups.

Figure B3. Gender by SOP subgroup



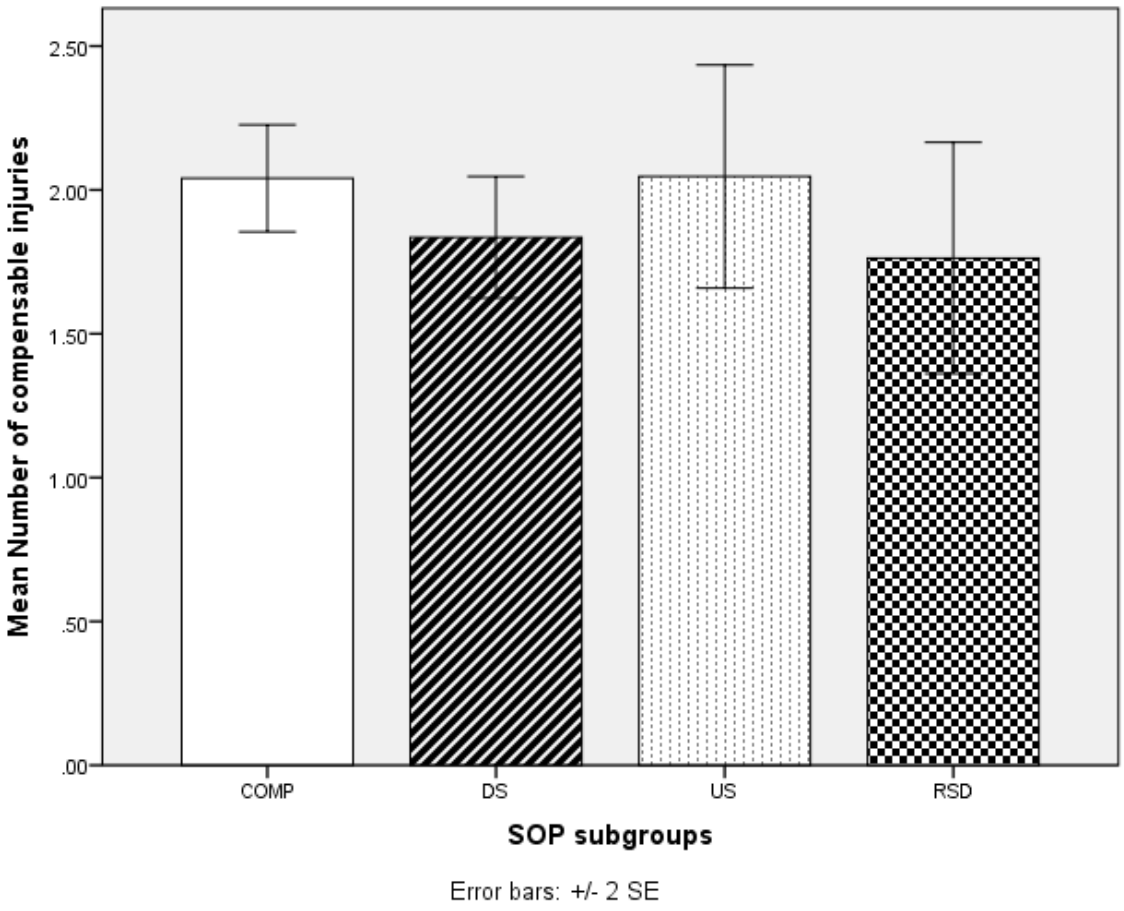
Note: No significant differences among subgroups.

Figure B4. Race by SOP subgroup



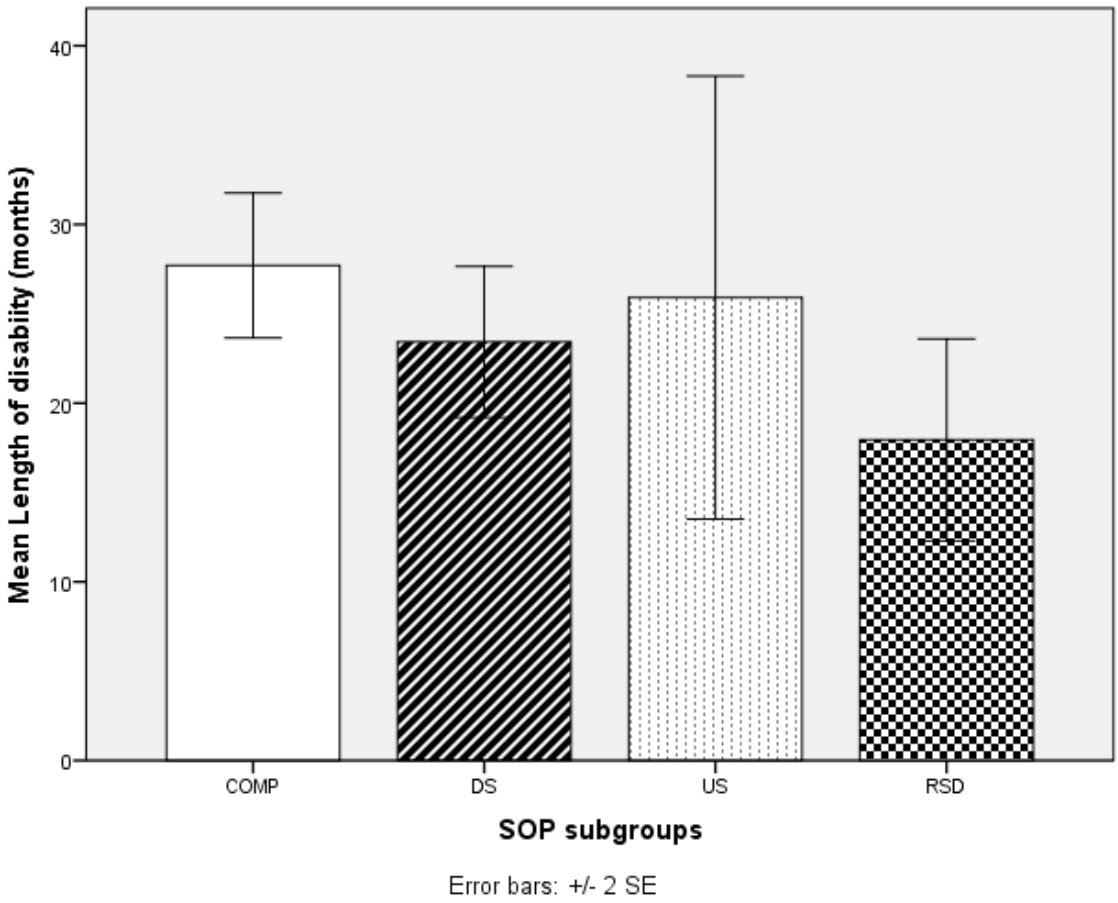
Note: No significant differences among subgroups.

Figure B5. Type of injury by SOP subgroup



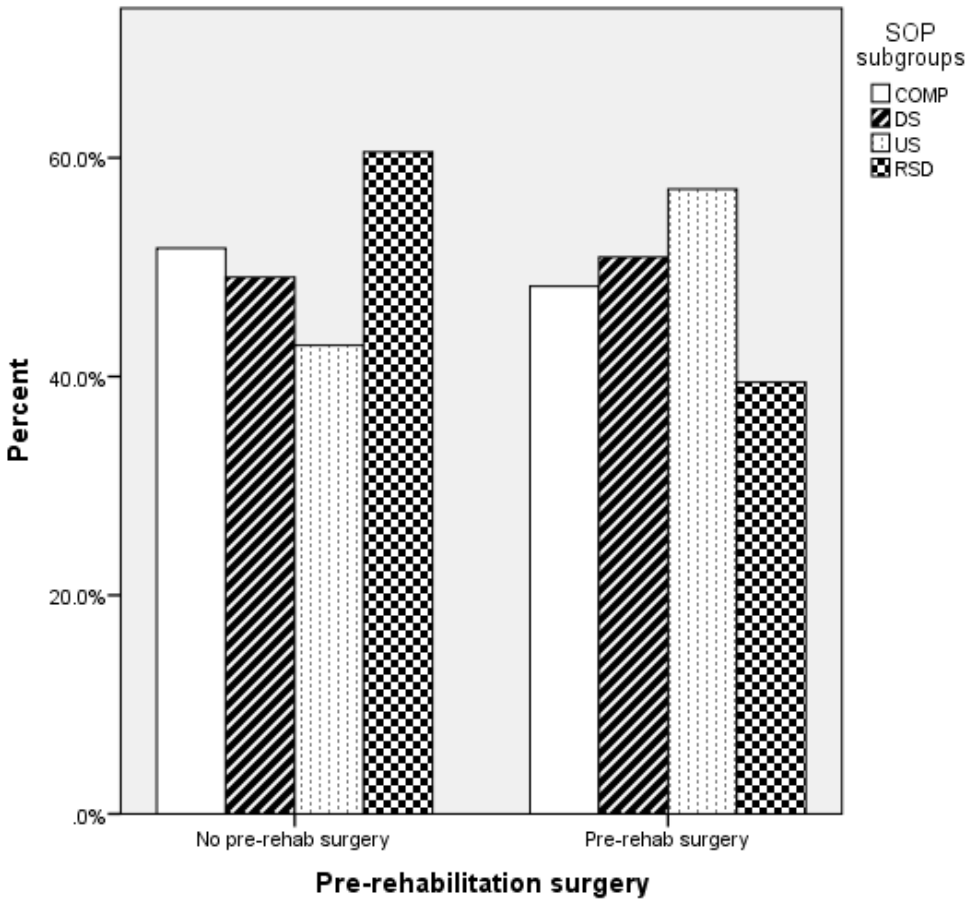
Note: No significant differences among subgroups.

Figure B6. Mean number of compensable injuries by SOP subgroup



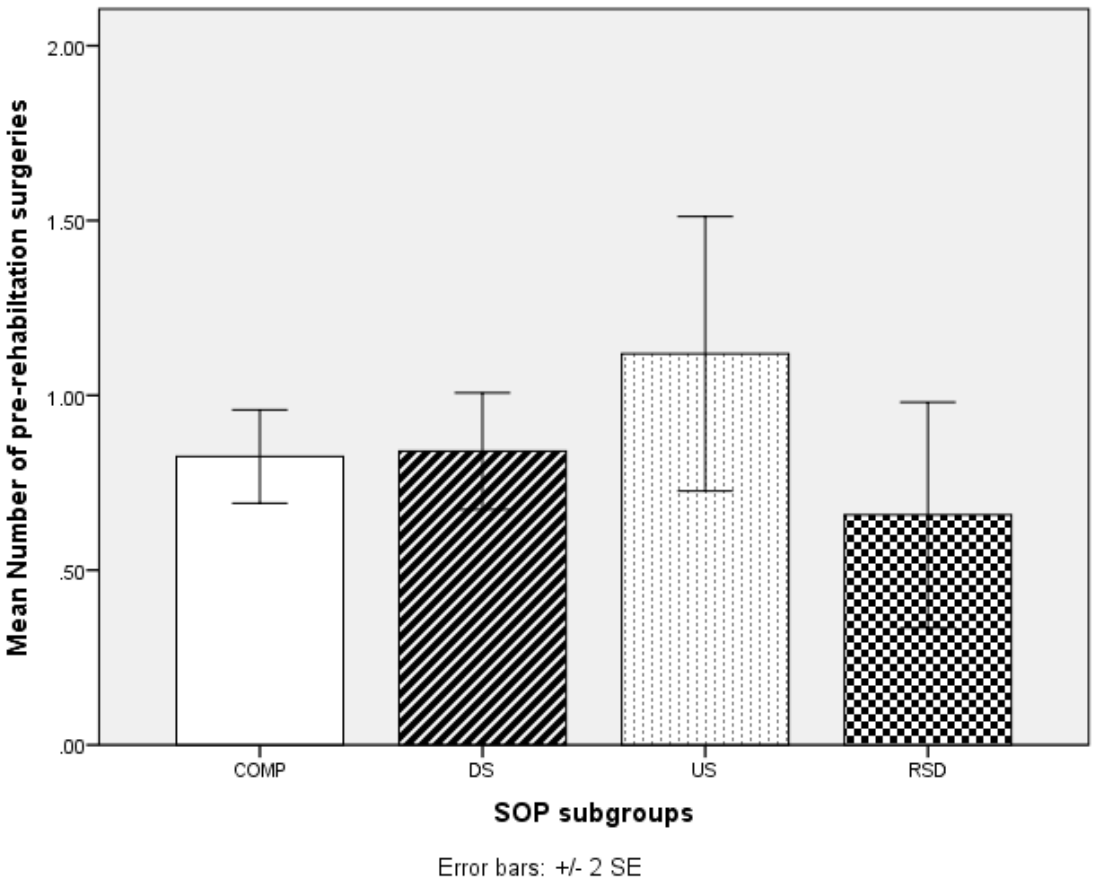
Note: No significant differences among subgroups.

Figure B7. Mean months of disability by SOP subgroup



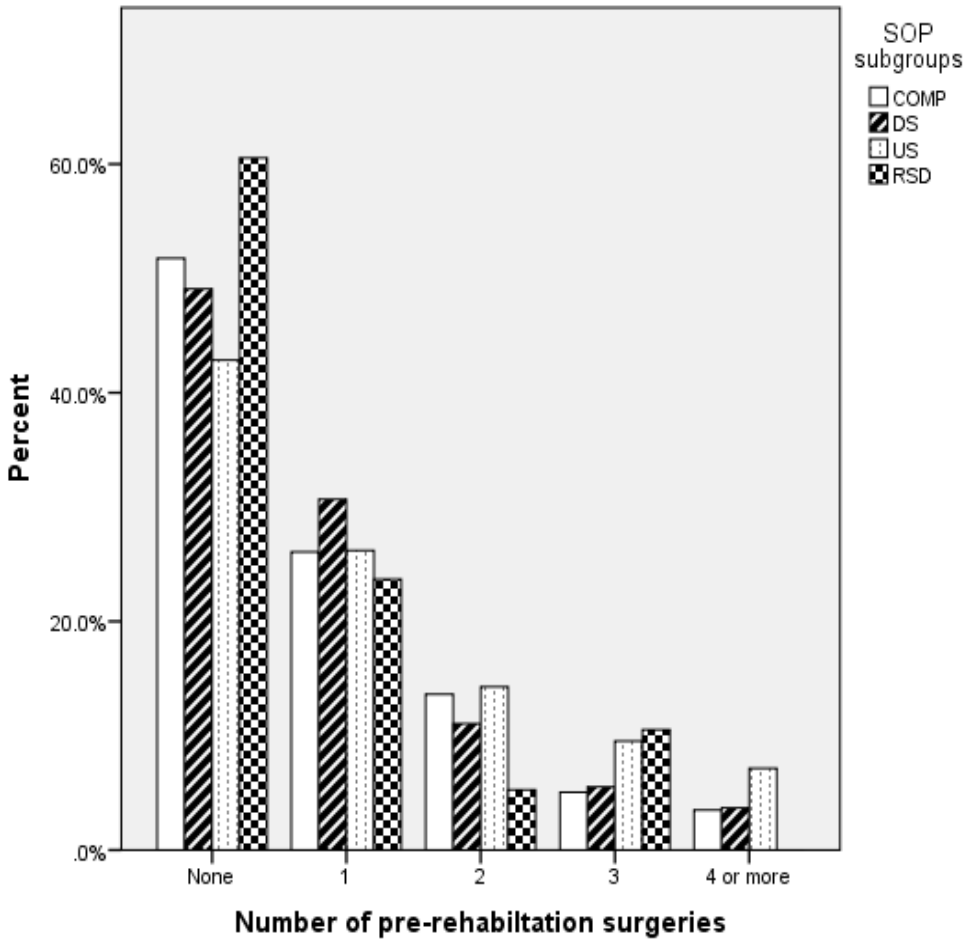
Note: No significant differences among subgroups.

Figure B8. Pre-rehabilitation surgery by SOP subgroup



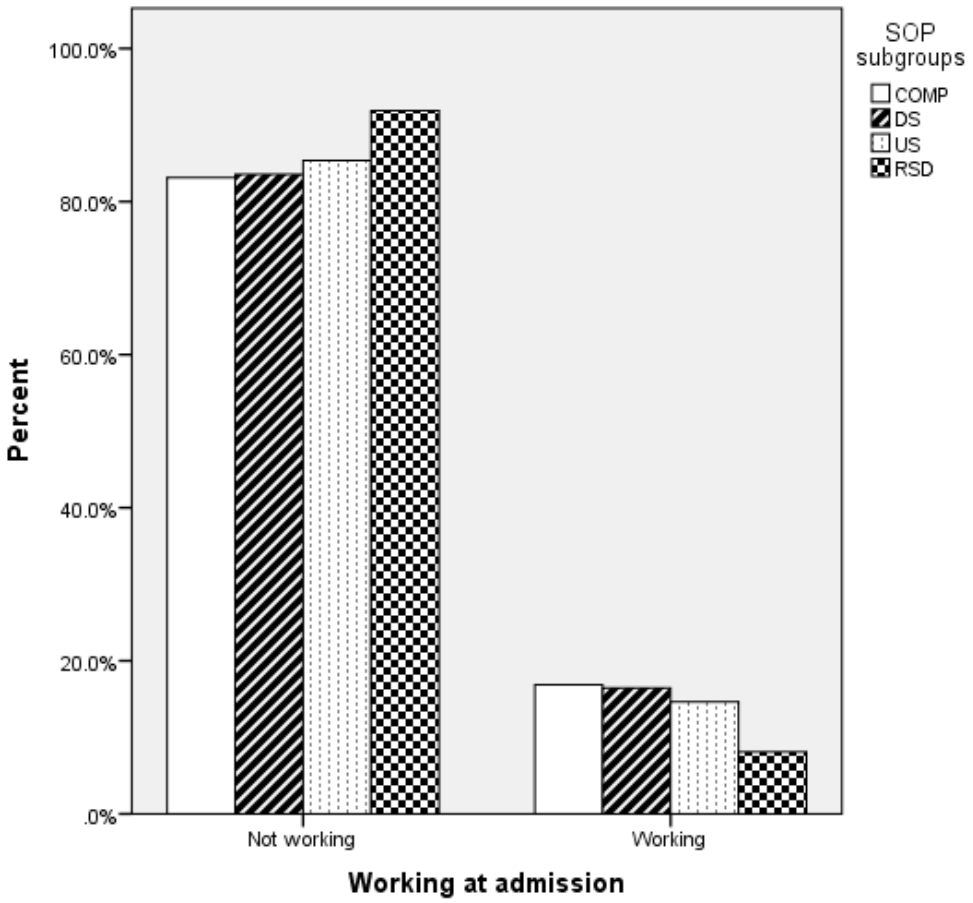
Note: No significant differences among subgroups.

Figure B9. Mean number of pre-rehabilitation surgeries by SOP subgroup



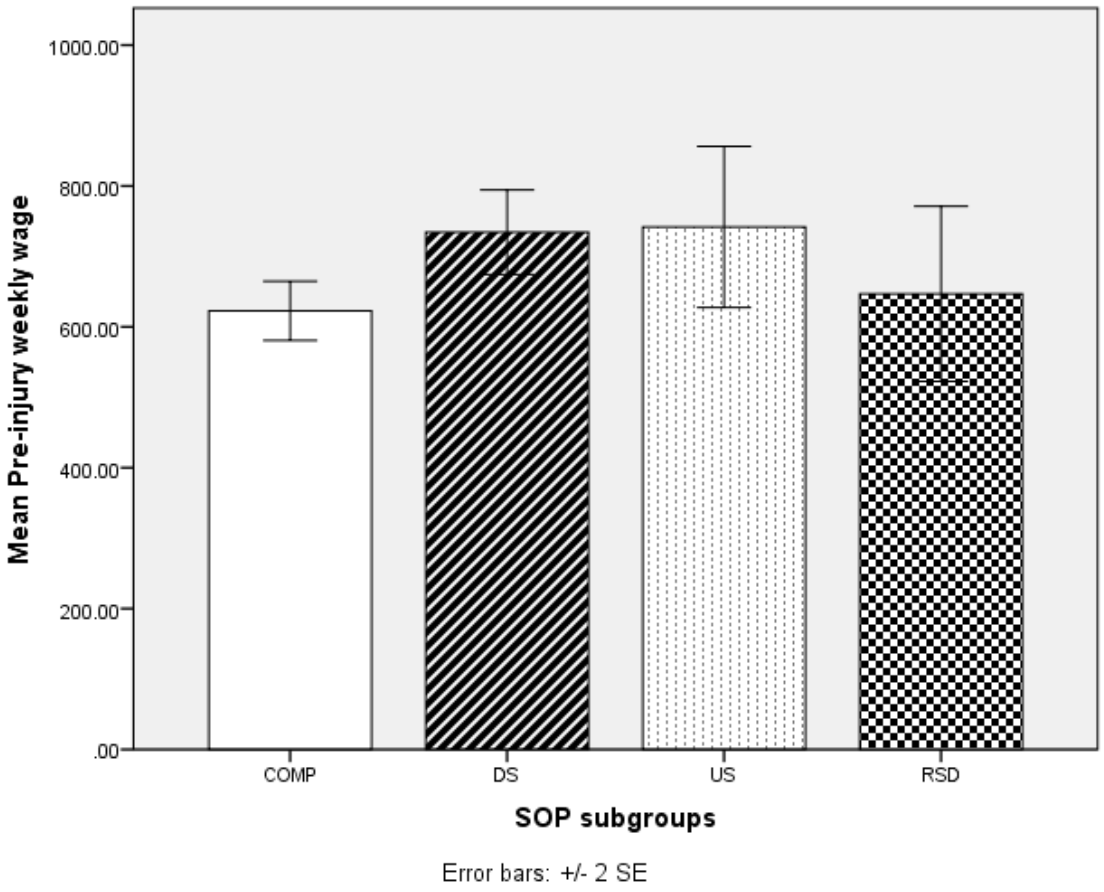
Note: No significant differences among subgroups.

Figure B10. Number of pre-rehabilitation surgeries by SOP subgroup



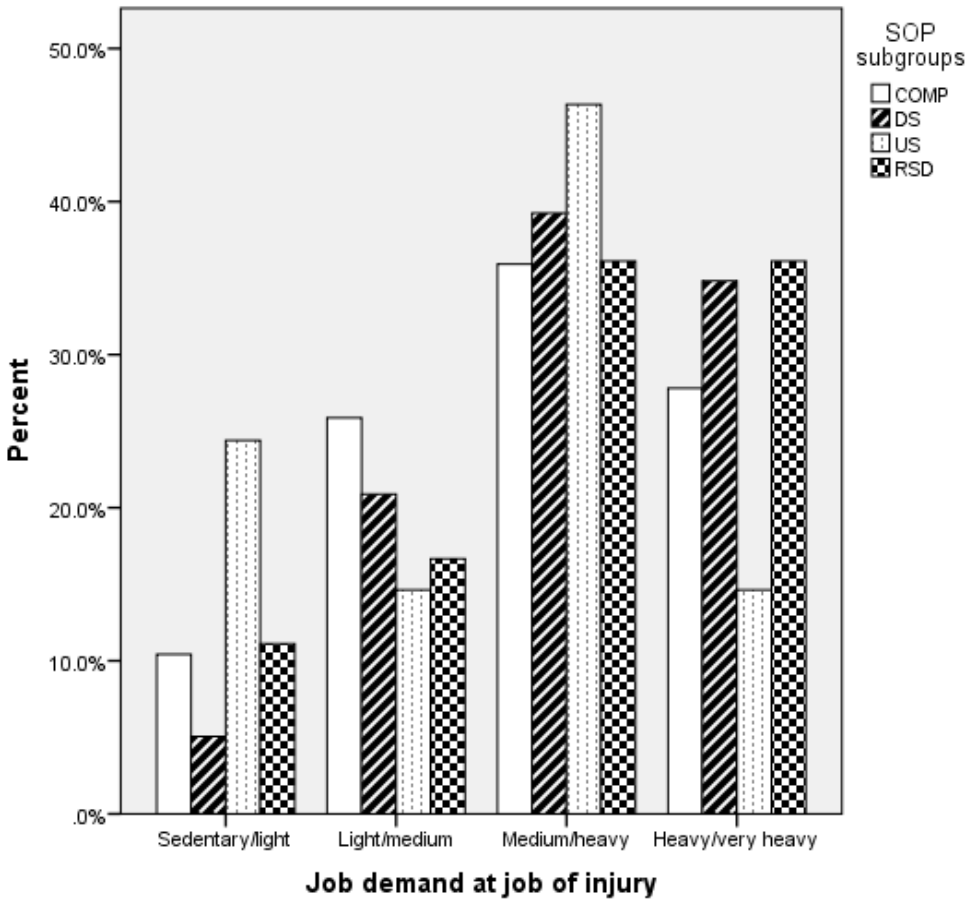
Note: No significant differences among subgroups.

Figure B11. Work status at admission by SOP subgroup



Note: p = .010, *Different from COMP group.

Figure B12. Mean weekly pre-injury wage by SOP subgroup

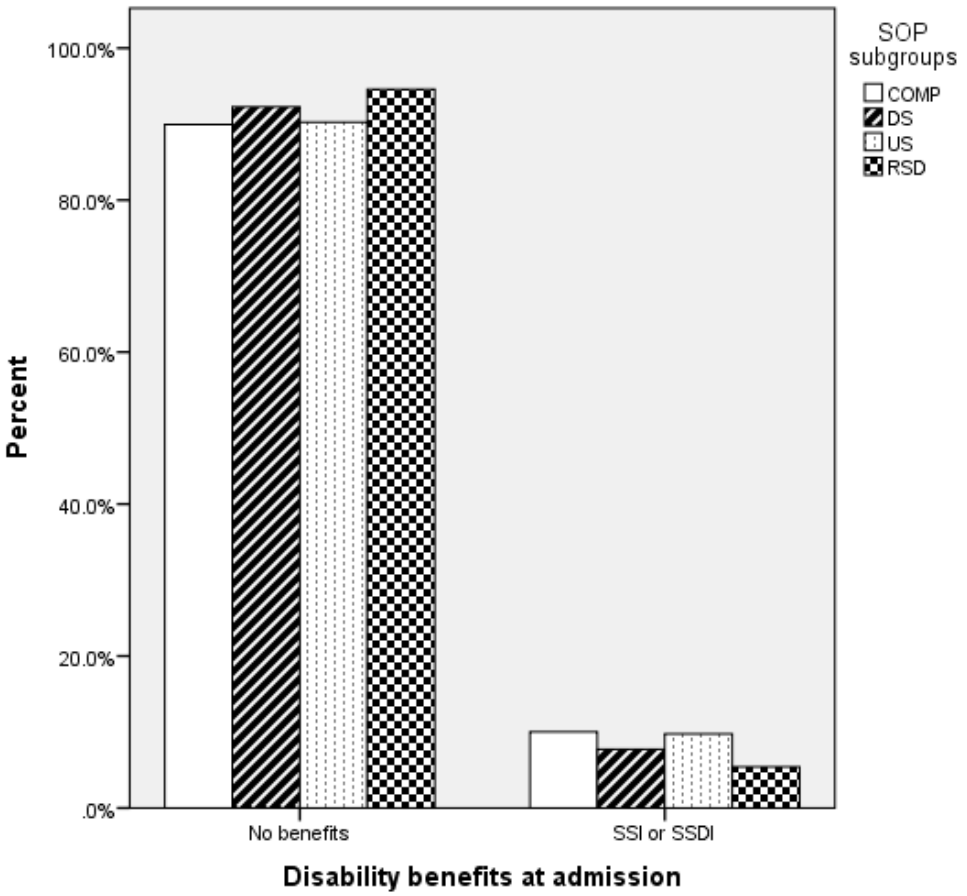


Note: p = .008, *Different from US group, †Non-significant trend, different from US group

Figure B13. Job demand at job of injury by SOP subgroup

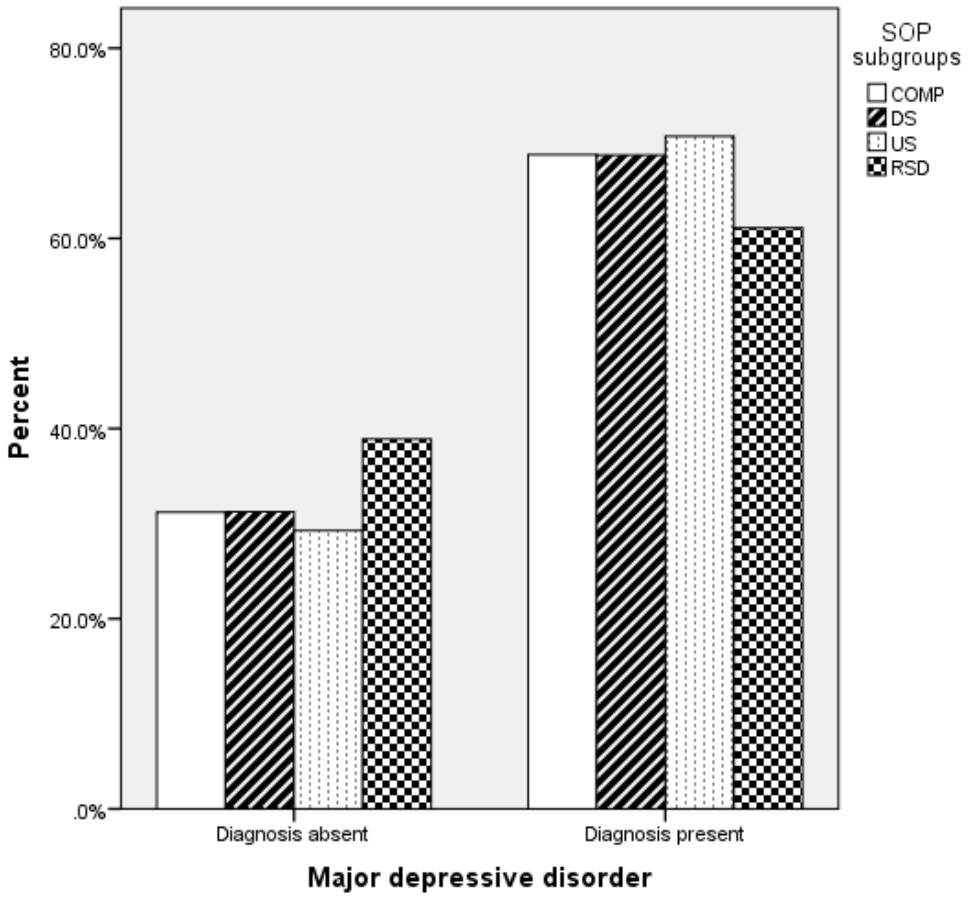
Note: No significant differences among subgroups.

Figure B14. Job class at job of injury by SOP subgroup



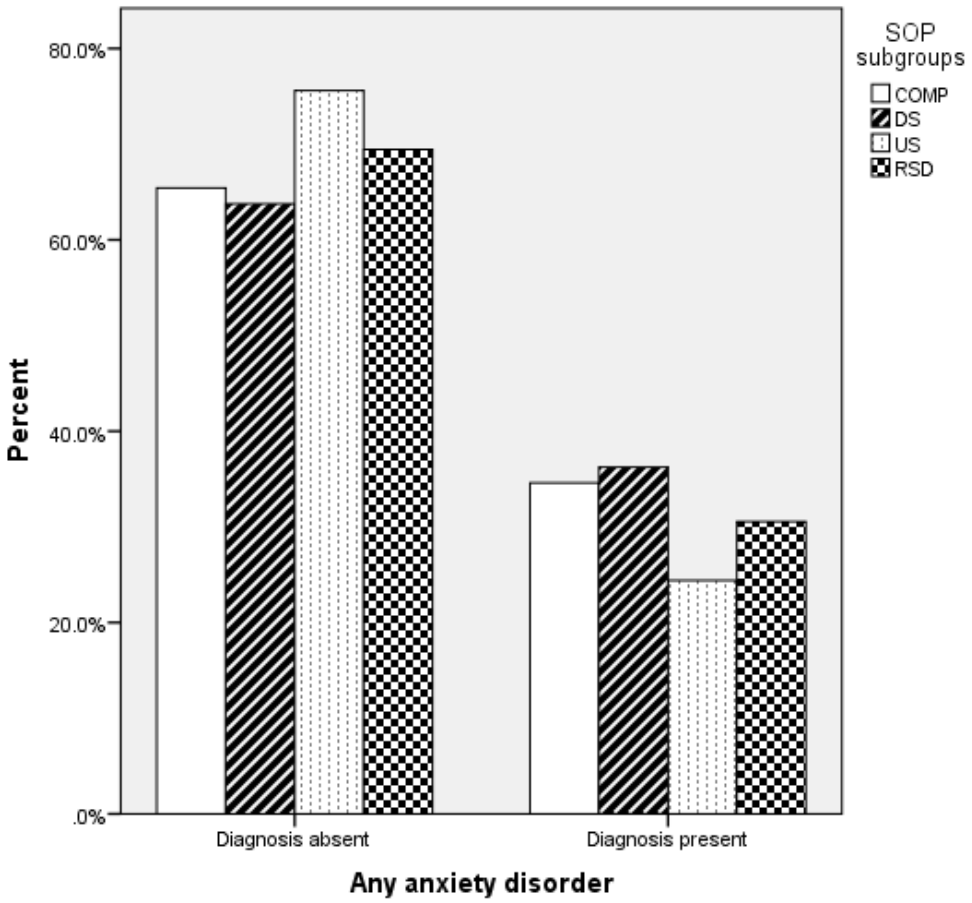
Note: No significant differences among subgroups.

Figure B15. Disability benefits at admission by SOP subgroup



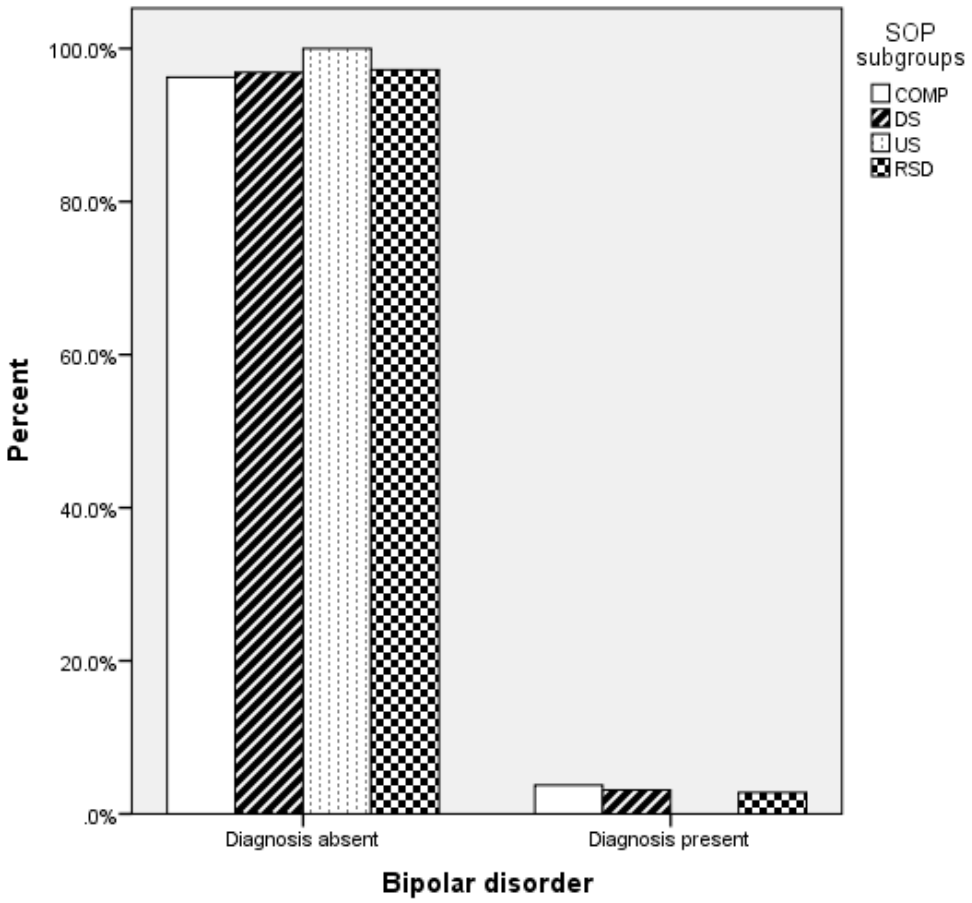
Note: No significant differences among subgroups.

Figure B16. Major depressive disorder by SOP subgroup



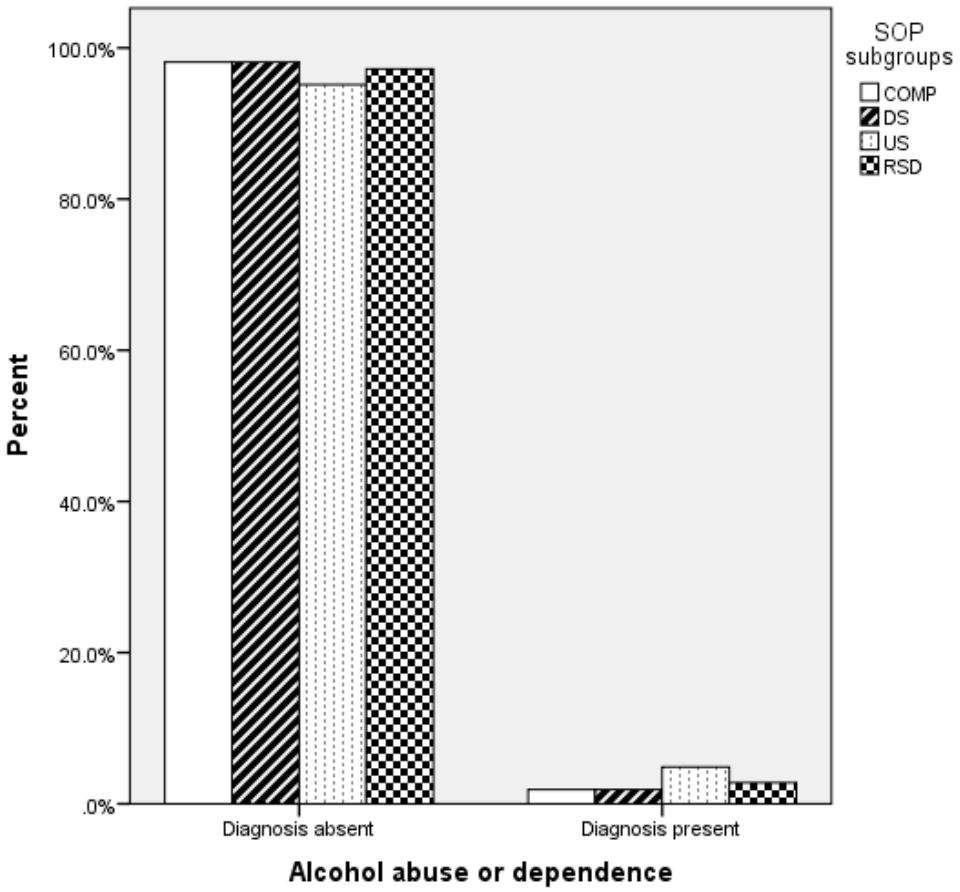
Note: No significant differences among subgroups.

Figure B17. Anxiety disorders by SOP subgroup



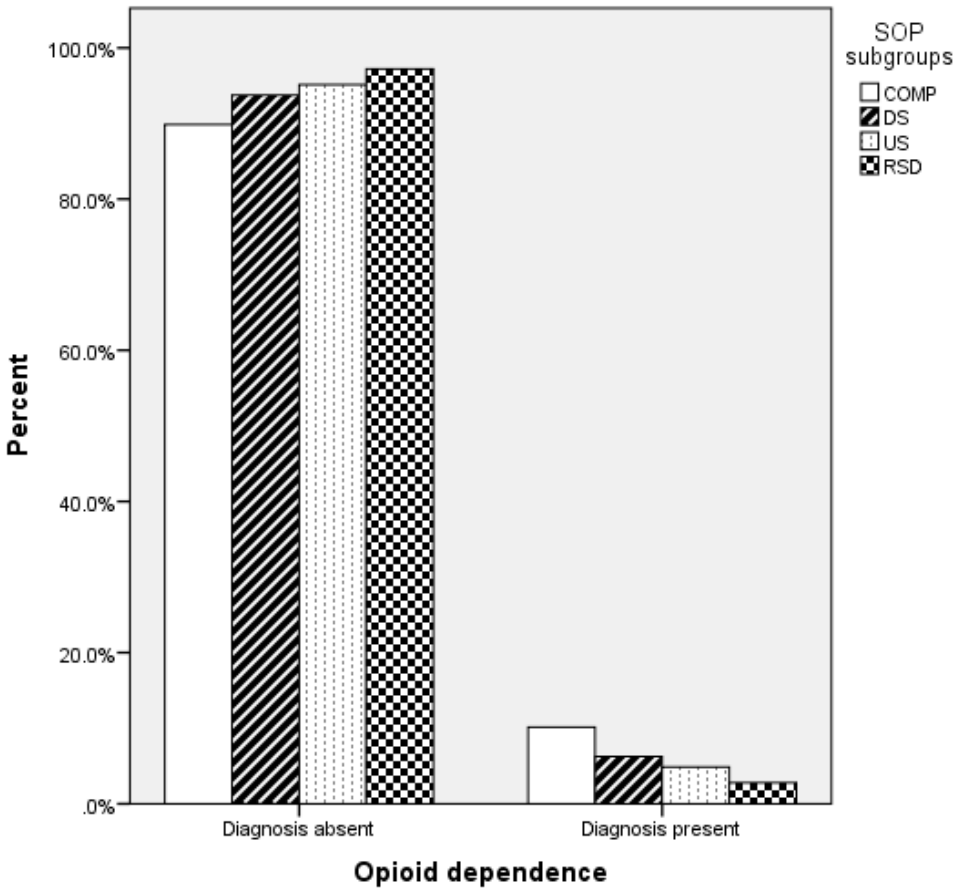
Note: No significant differences among subgroups.

Figure B18. Bipolar disorder by SOP subgroup



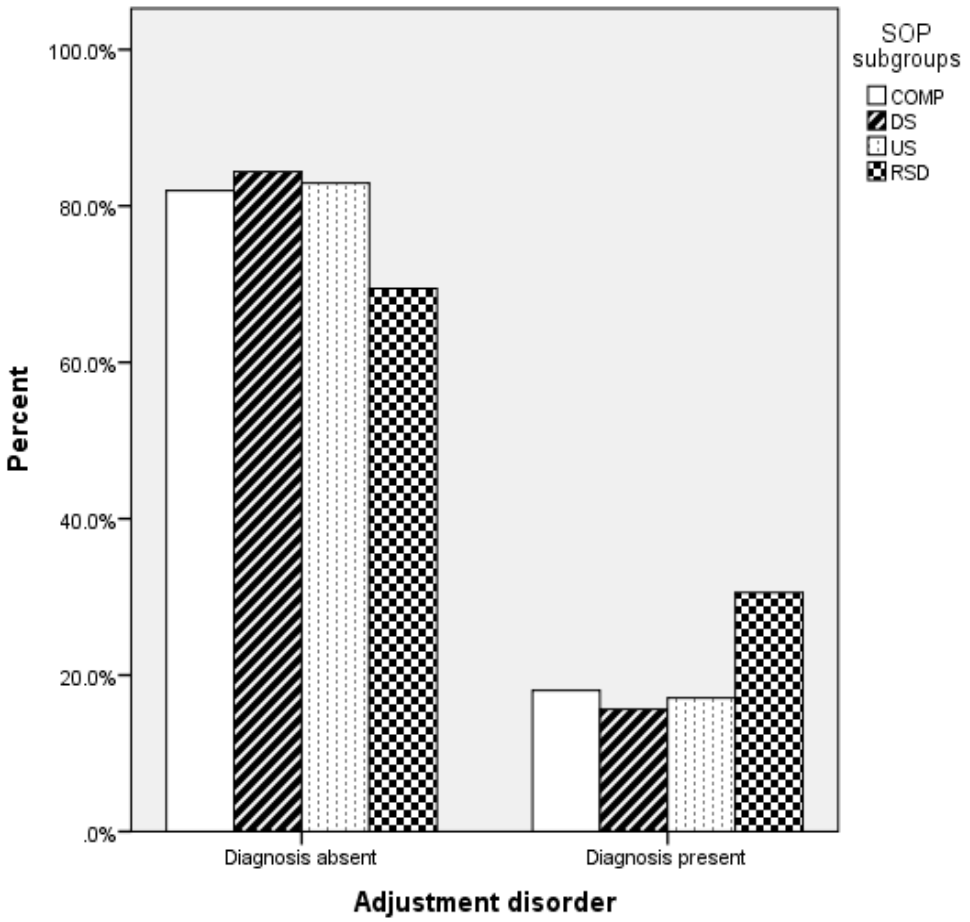
Note: No significant differences among subgroups.

Figure B19. Alcohol use disorders by SOP subgroup



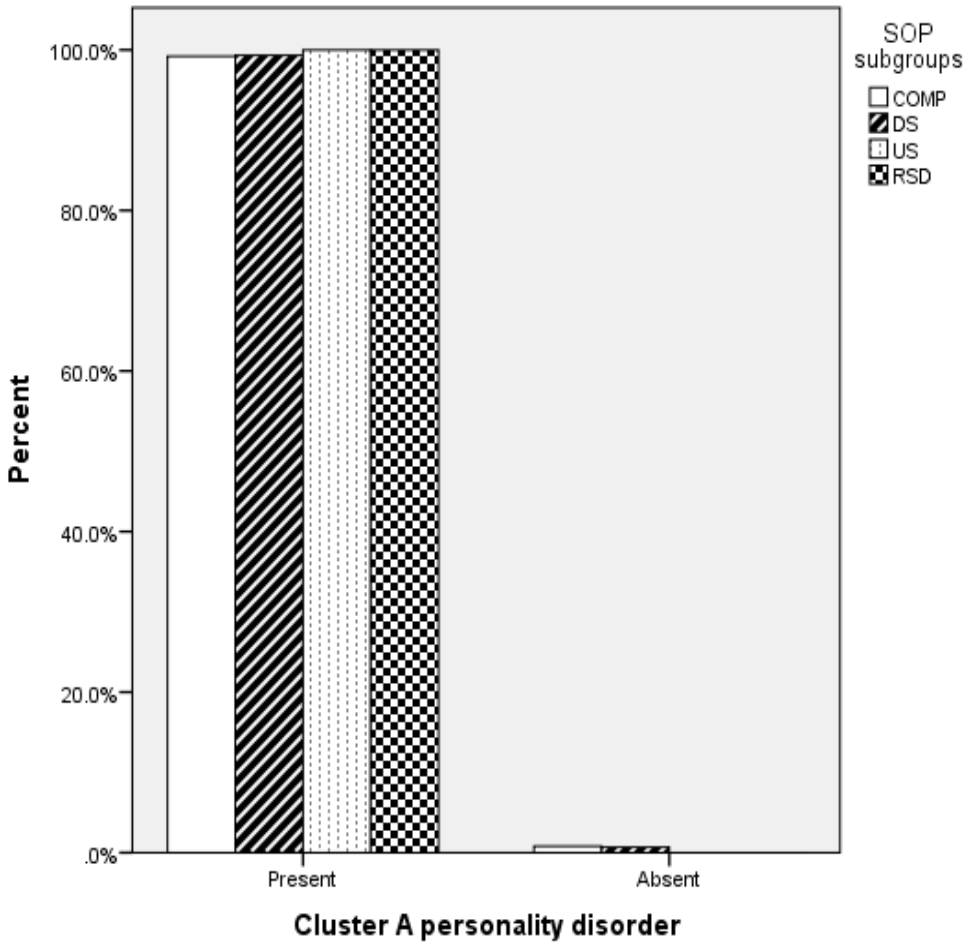
Note: No significant differences among subgroups.

Figure B20. Opioid dependence disorder by SOP subgroup



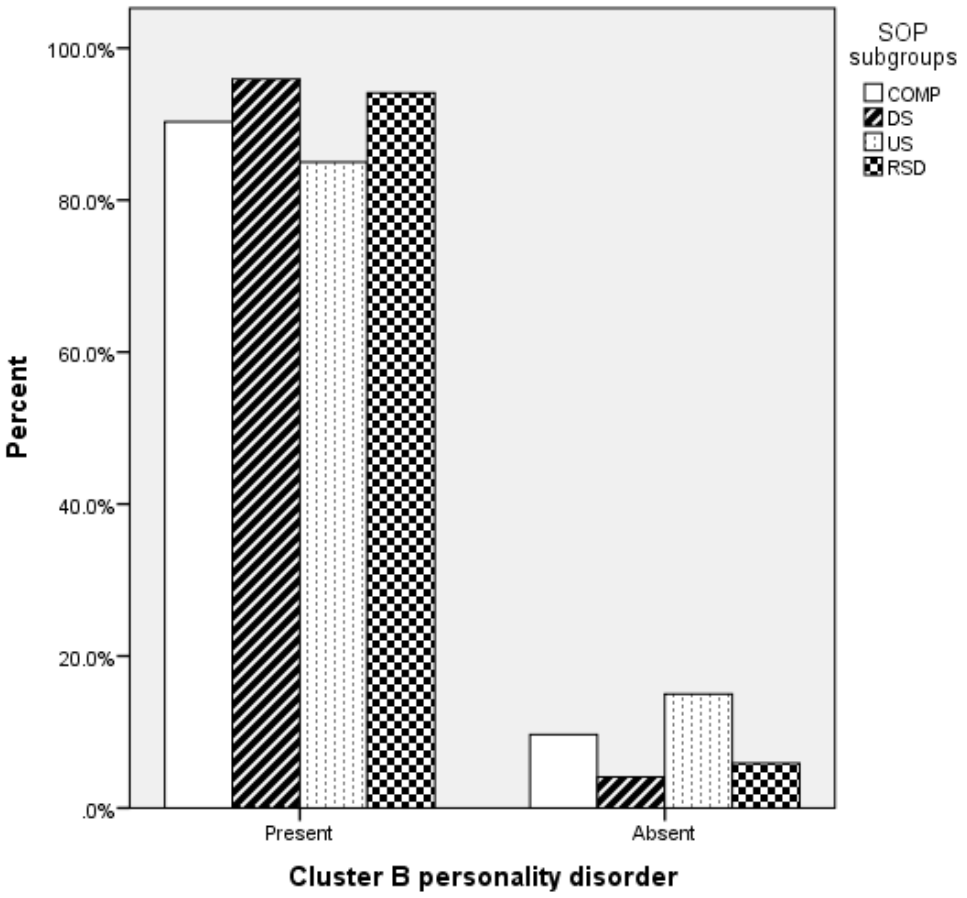
Note: No significant differences among subgroups.

Figure B21. Adjustment disorder by SOP subgroup



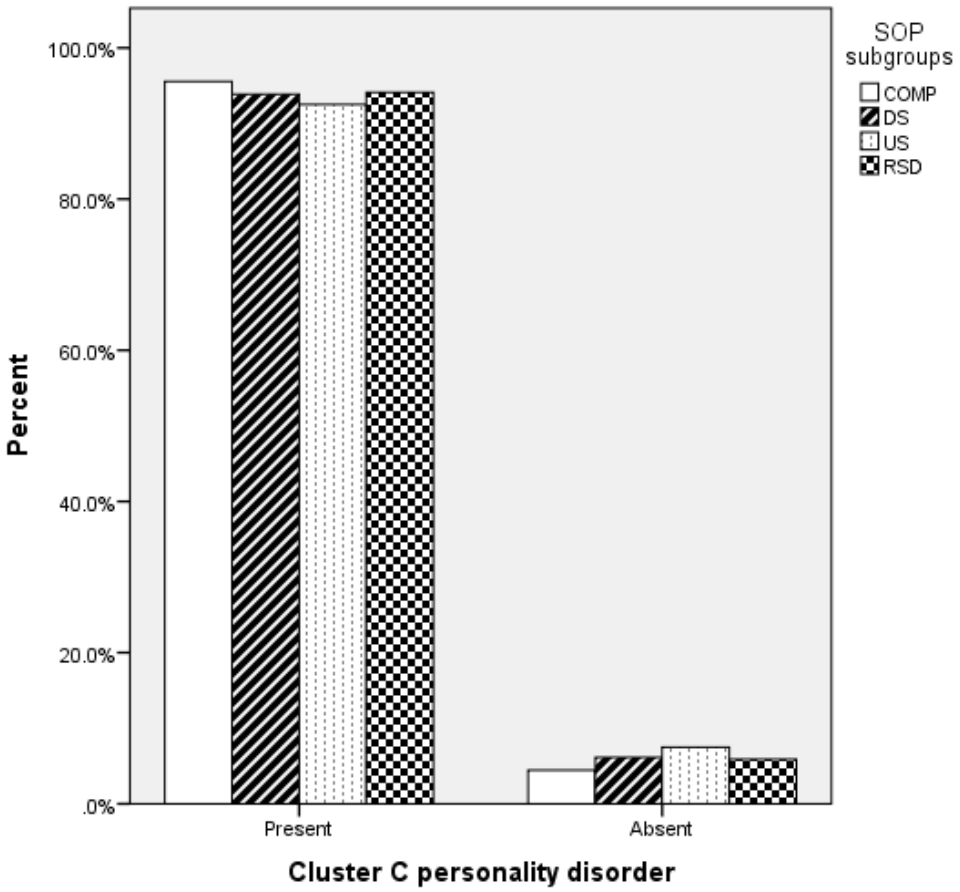
Note: No significant differences among subgroups.

Figure B22. Cluster A personality disorders by SOP subgroup



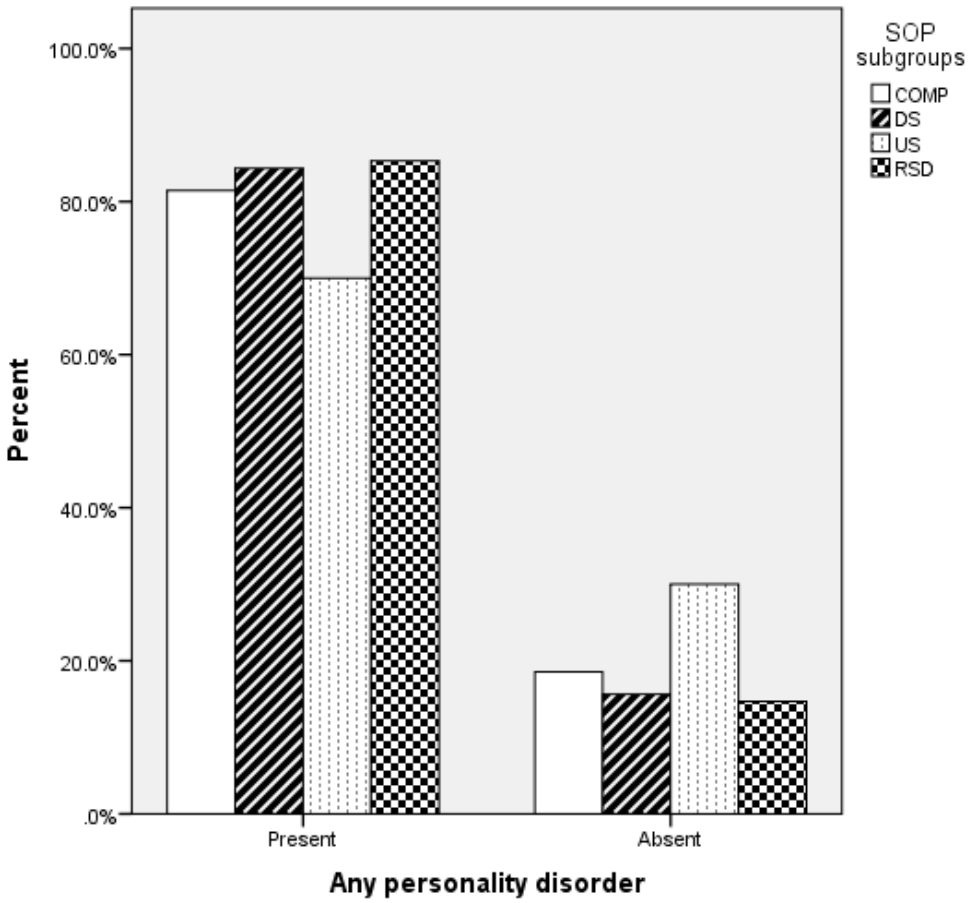
Note: No significant differences among subgroups.

Figure B23. Cluster B personality disorders by SOP subgroup



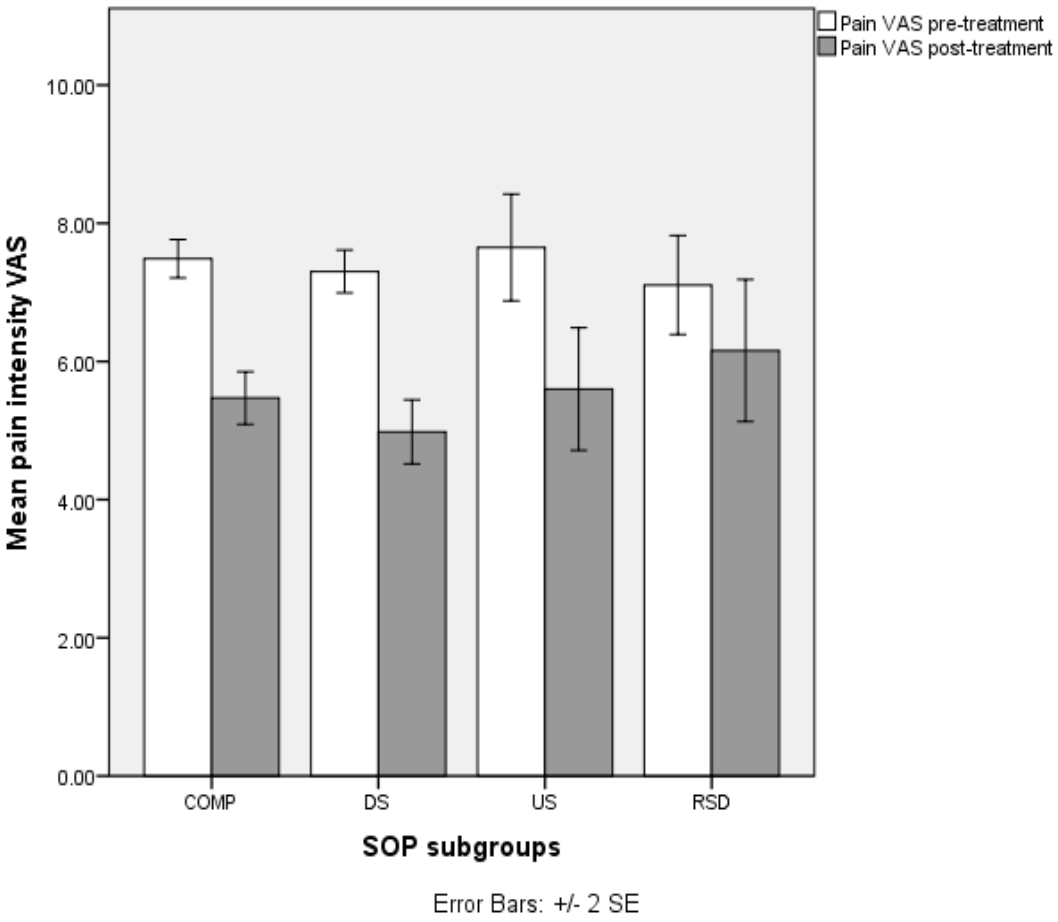
Note: No significant differences among subgroups.

Figure B24. Cluster C disorders by SOP subgroup



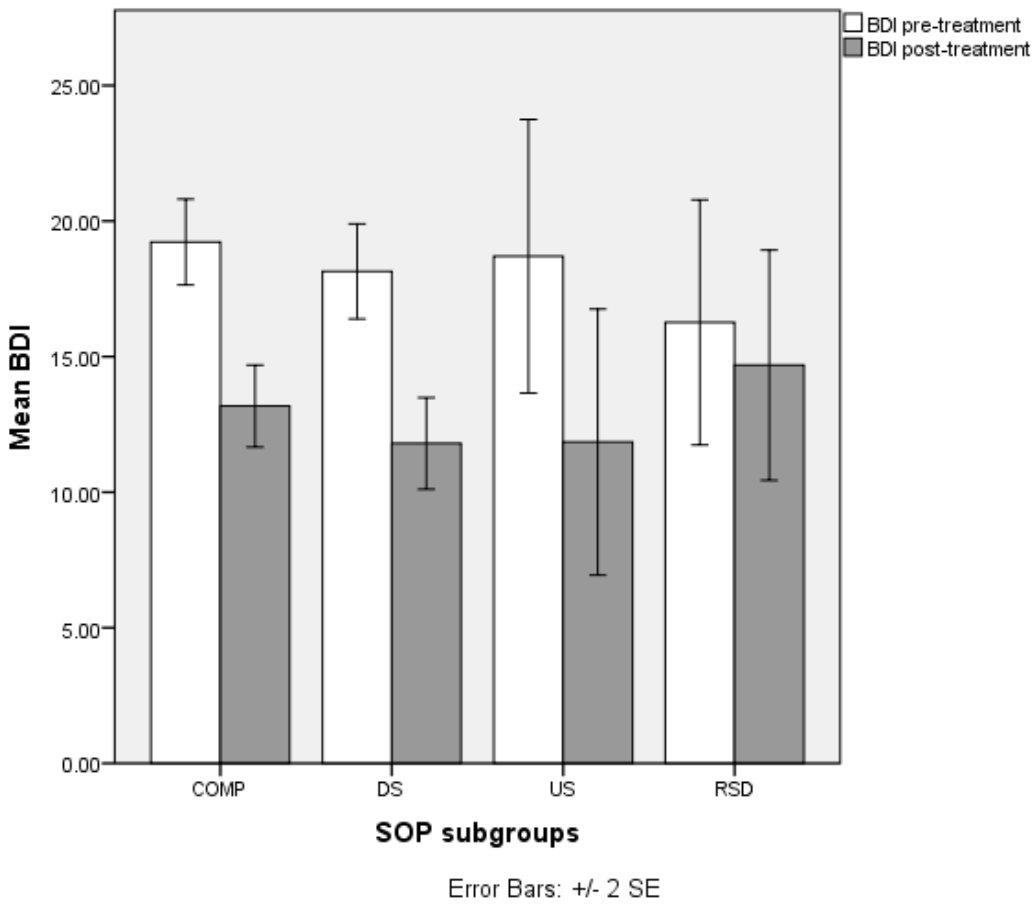
Note: No significant differences among subgroups.

Figure B25. Any personality disorder by SOP subgroup



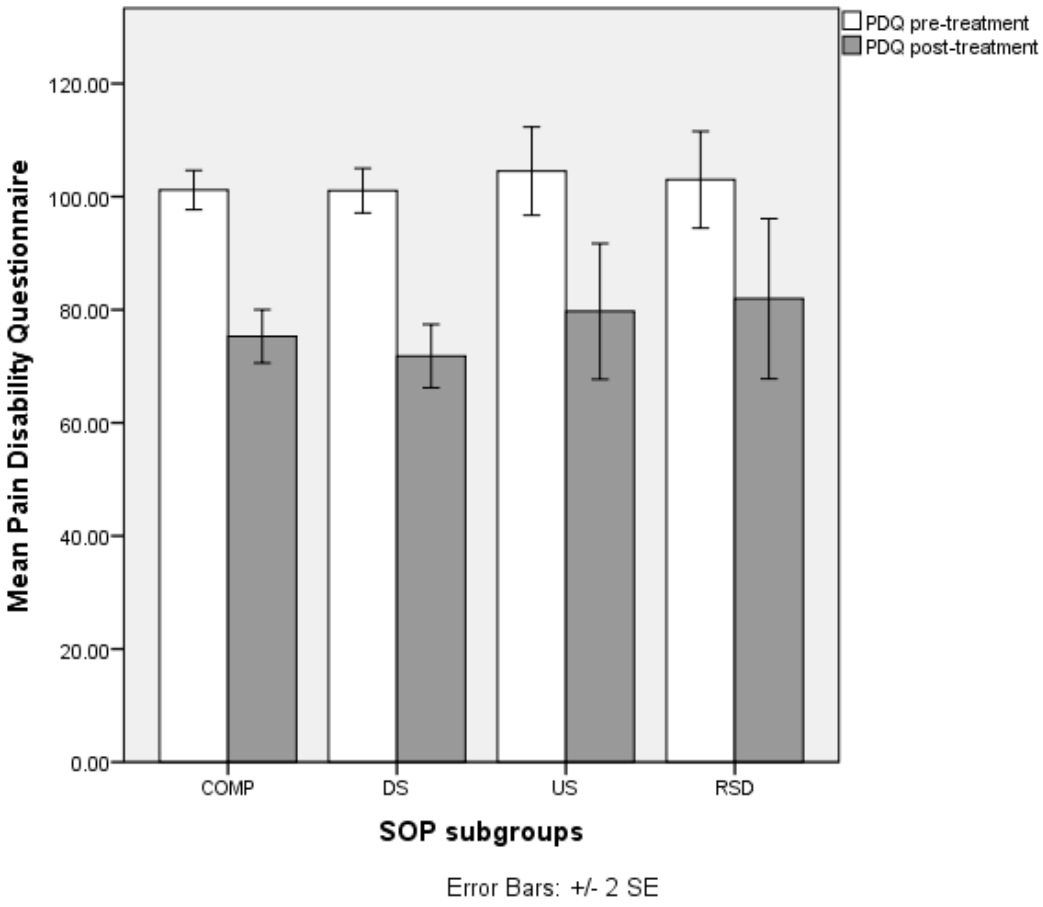
Note: No significant differences among subgroups.

Figure B26 Mean pain intensity (VAS) by SOP subgroup



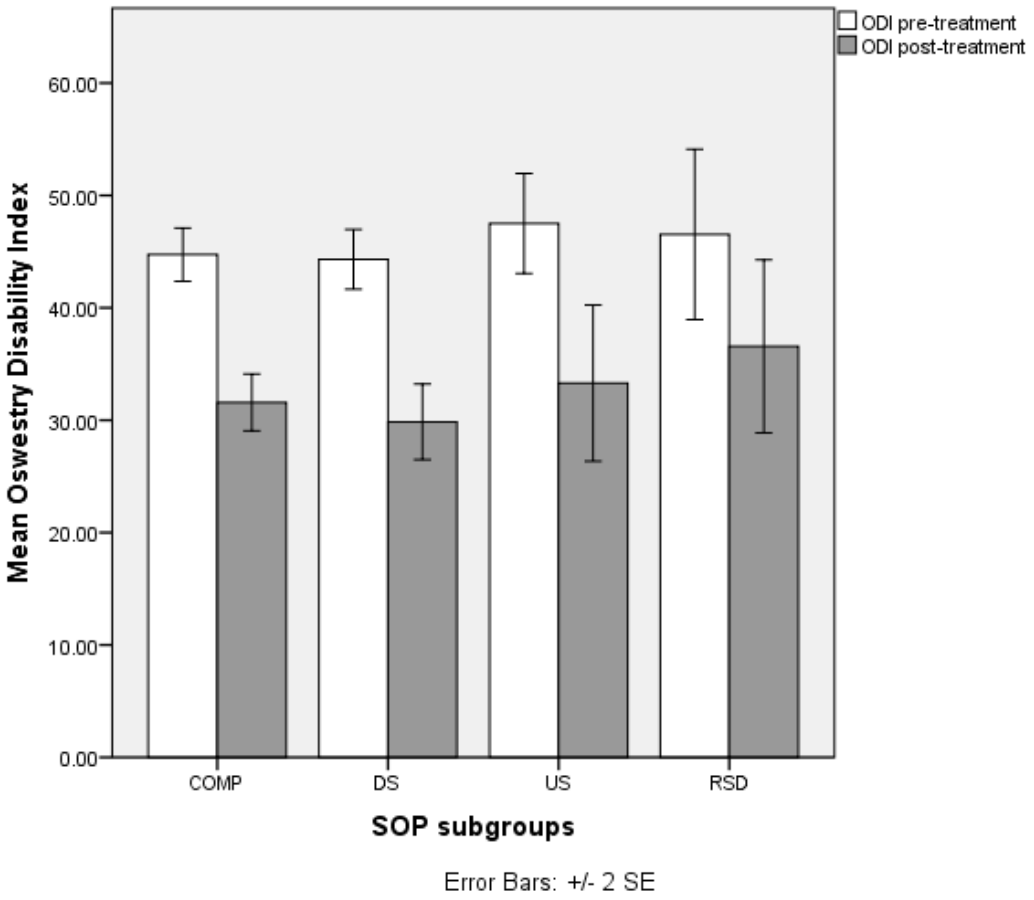
Note: No significant differences among subgroups.

Figure B27. Mean Beck Depression Inventory (BDI) by SOP subgroup



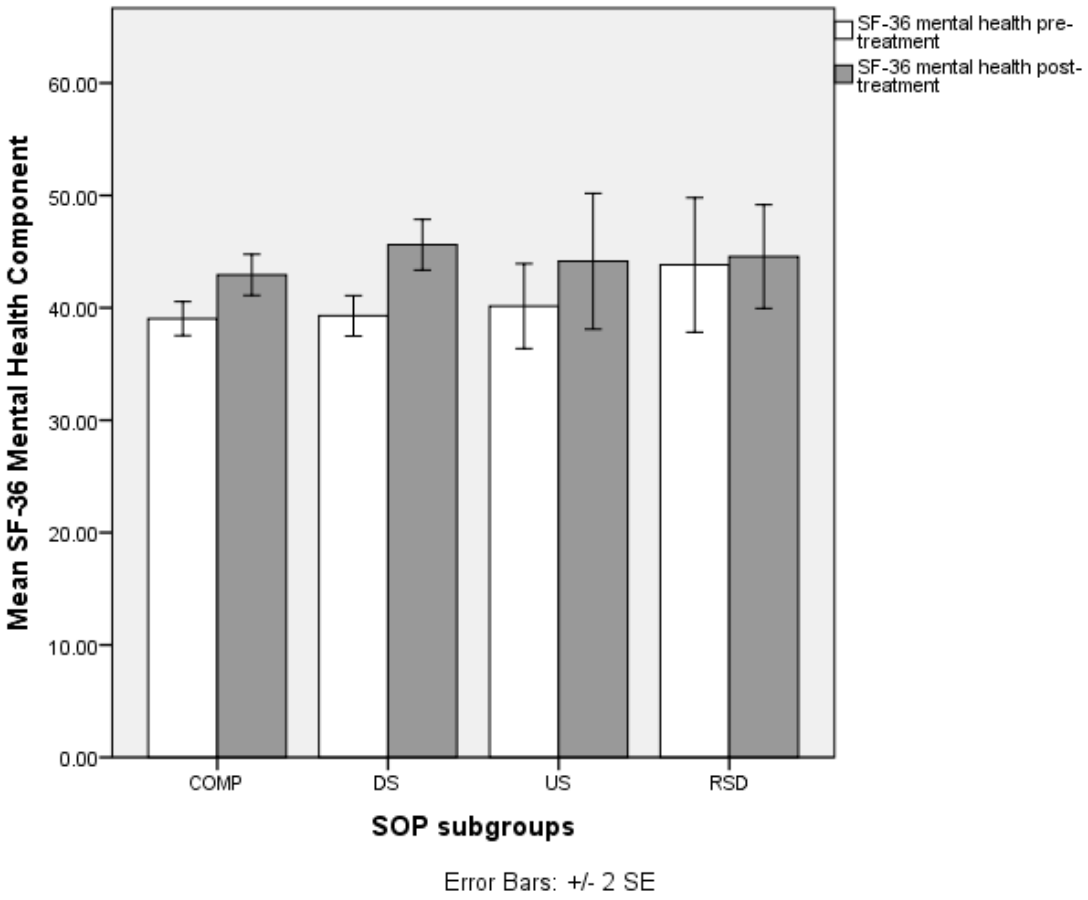
Note: No significant differences among subgroups.

Figure B28. Mean Pain Disability Questionnaire (PDQ) by SOP subgroup



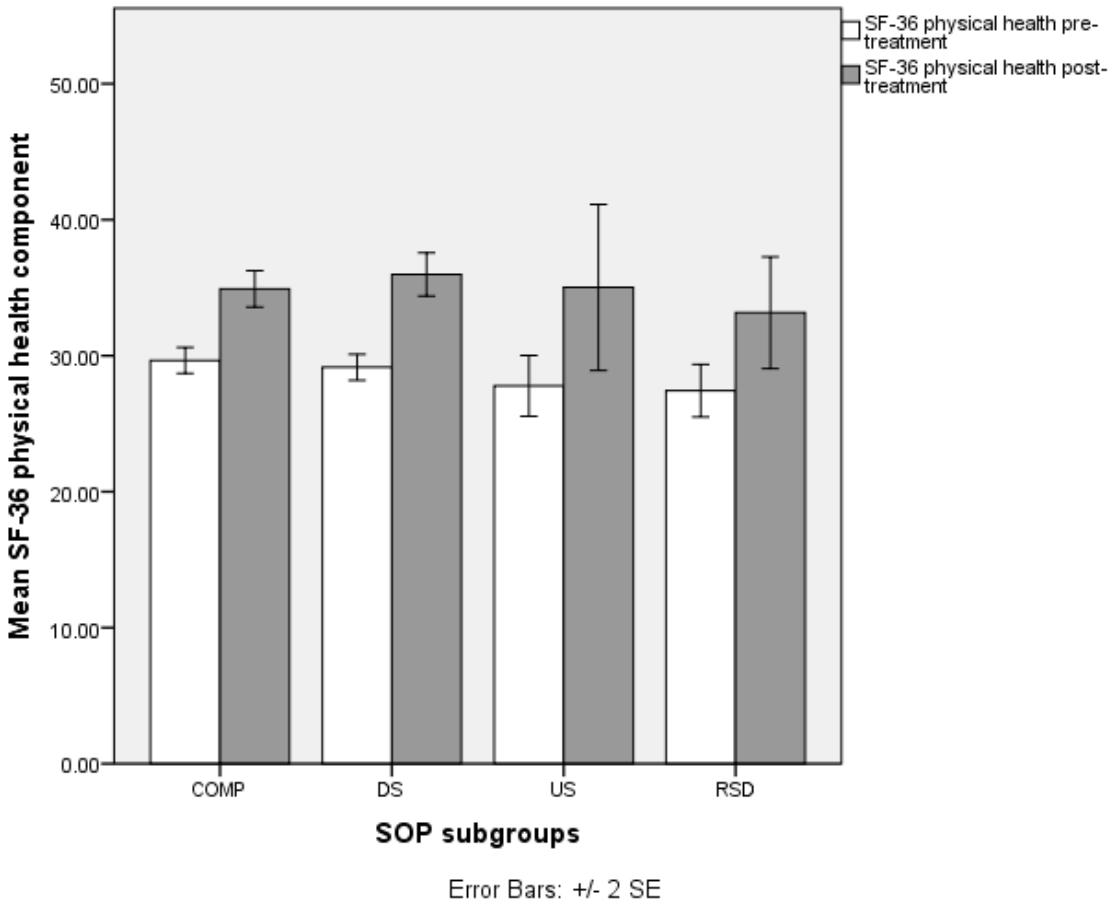
Note: No significant differences among subgroups.

Figure B29. Mean Oswestry Disabiility Index (ODI) at admission by SOP subgroup



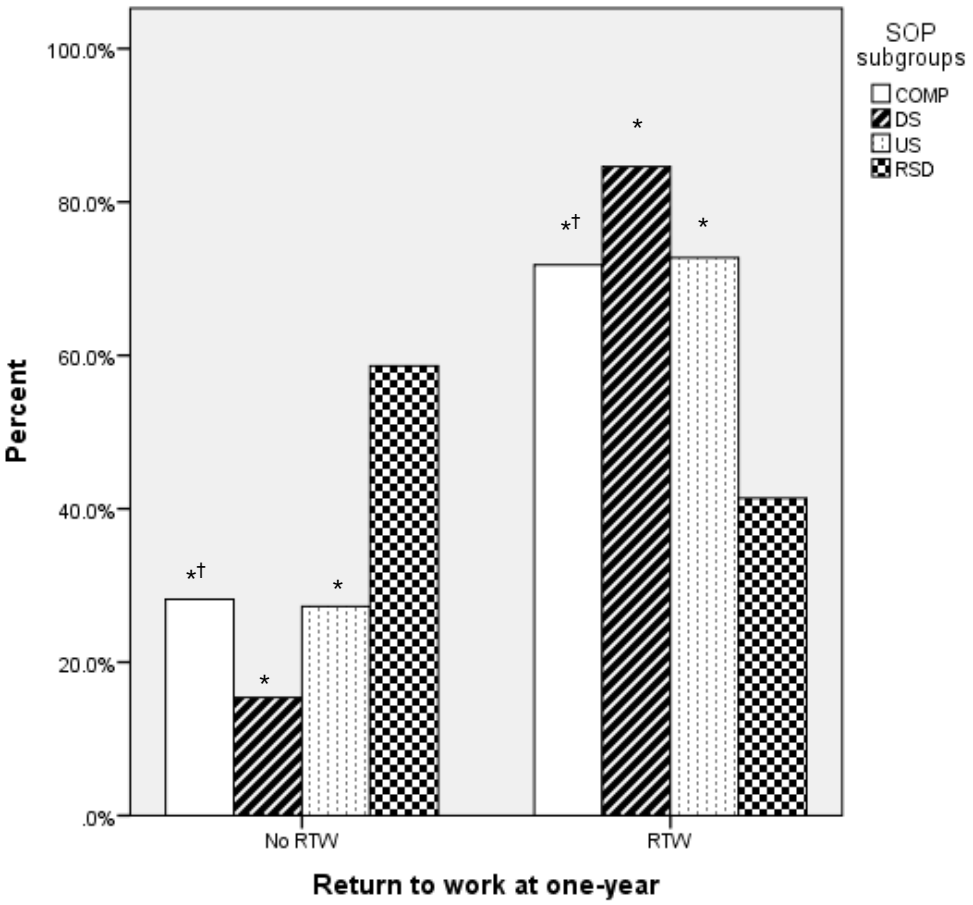
Note: No significant differences among subgroups.

Figure B30. Mean SF-36 mental health component by SOP subgroup



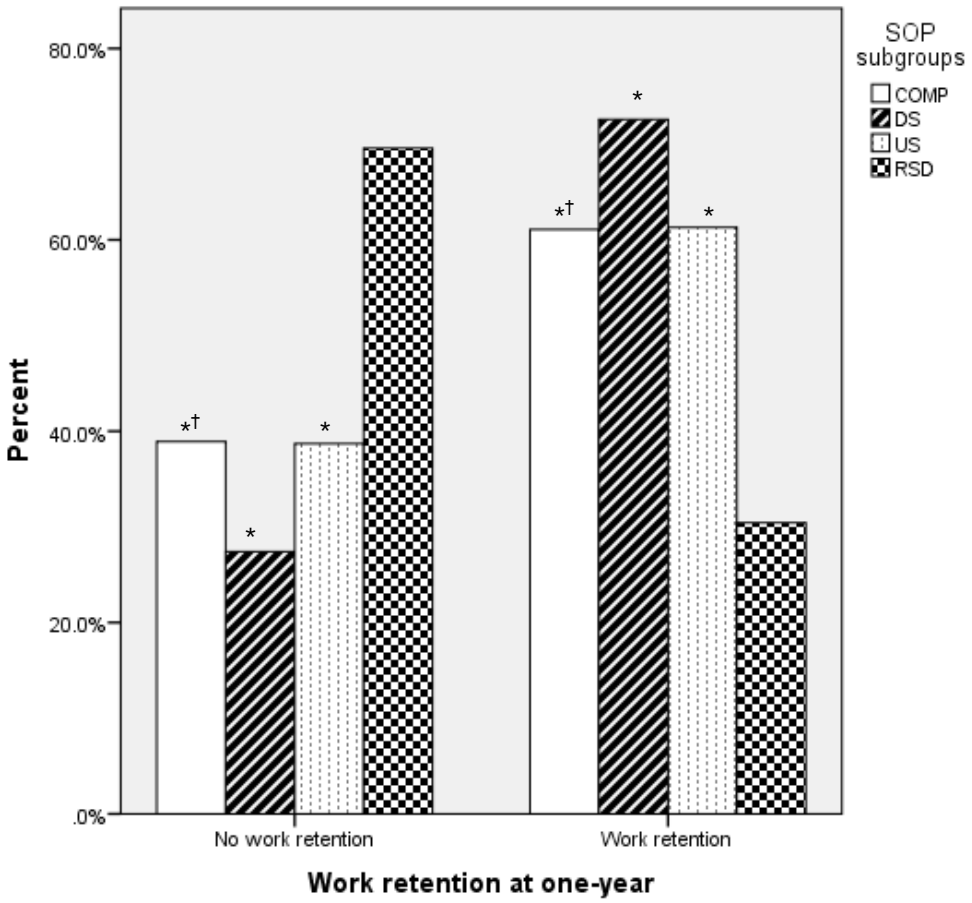
Note: No significant differences among subgroups.

Figure B31. Mean SF-36 physical health component by SOP subgroup



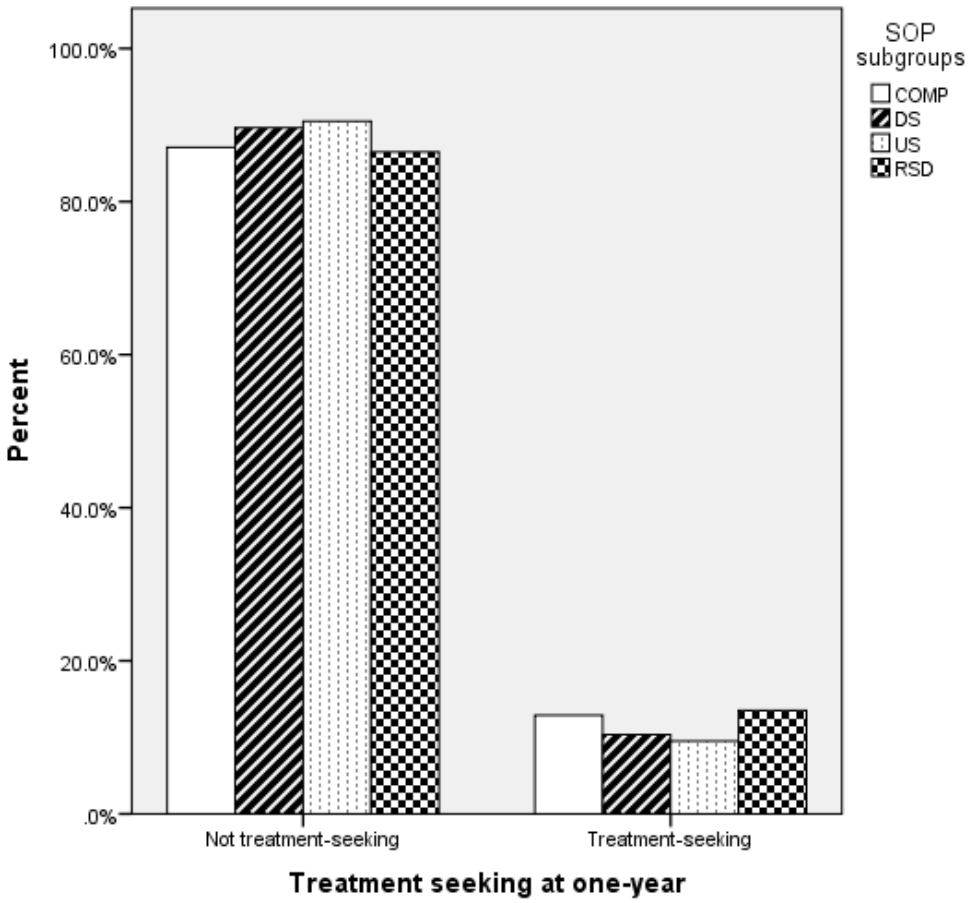
Note: p <.001, *Different from RSD group, †Different from DS group

Figure B32. Return to work at one-year by SOP subgroup



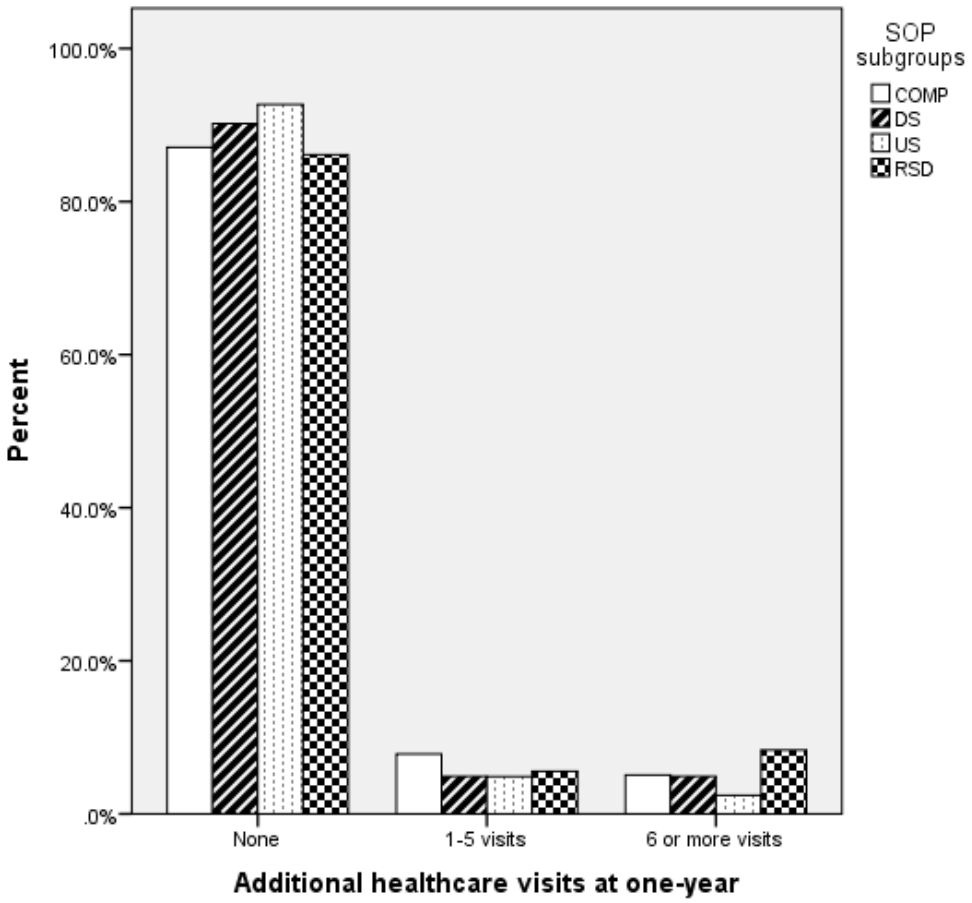
Note: p =.001, *Different from RSD group, †Different from DS group

Figure B33. Work retention at one-year by SOP subgroup



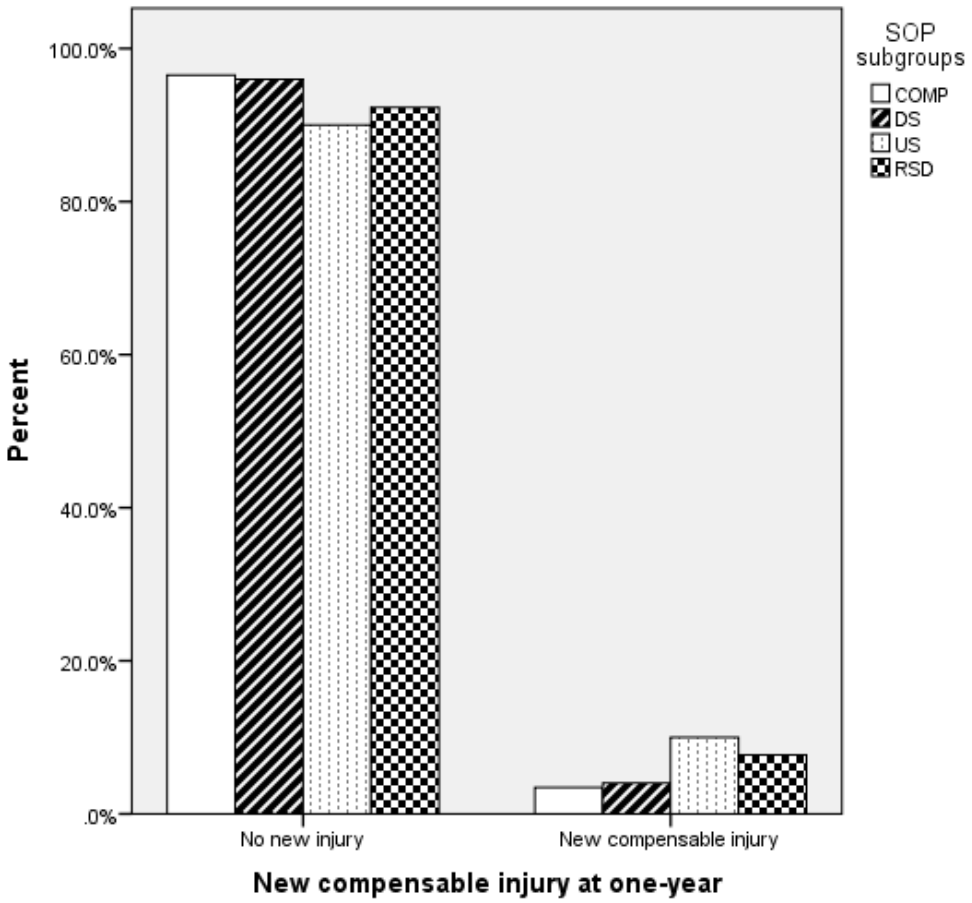
Note: No significant differences among subgroups.

Figure B34. Treatment-seeking at one-year by SOP subgroup



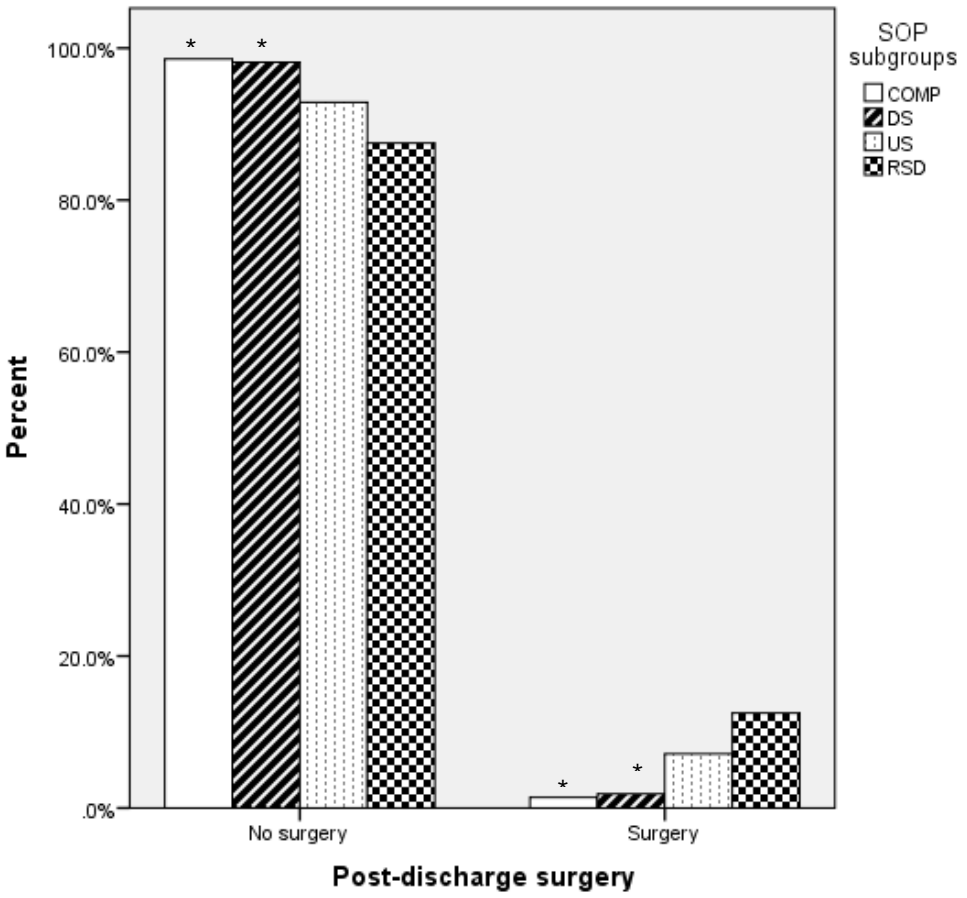
Note: No significant differences among subgroups.

Figure B35. Number of visits at one-year by SOP subgroup



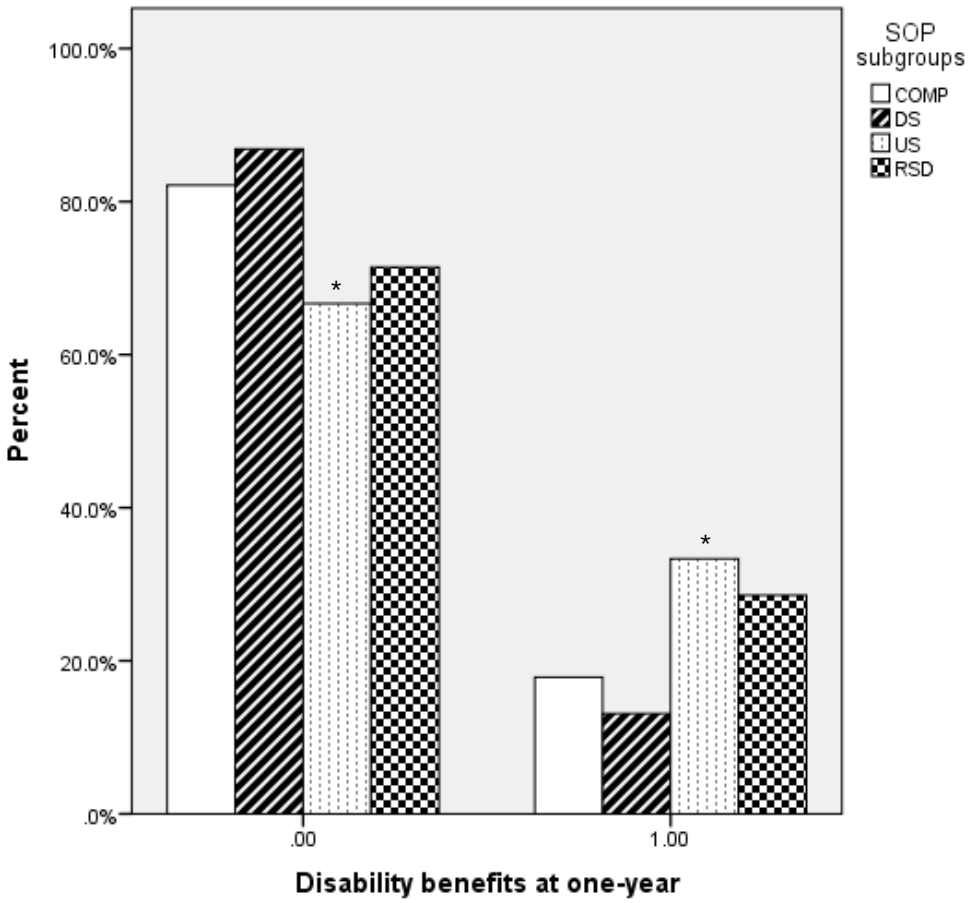
Note: No significant differences among subgroups.

Figure B36. New compensable injury at one-year by SOP subgroup



Note: p = .004, *Different from RSD group

Figure B37. Additional non-SOP surgery at one-year by SOP subgroup

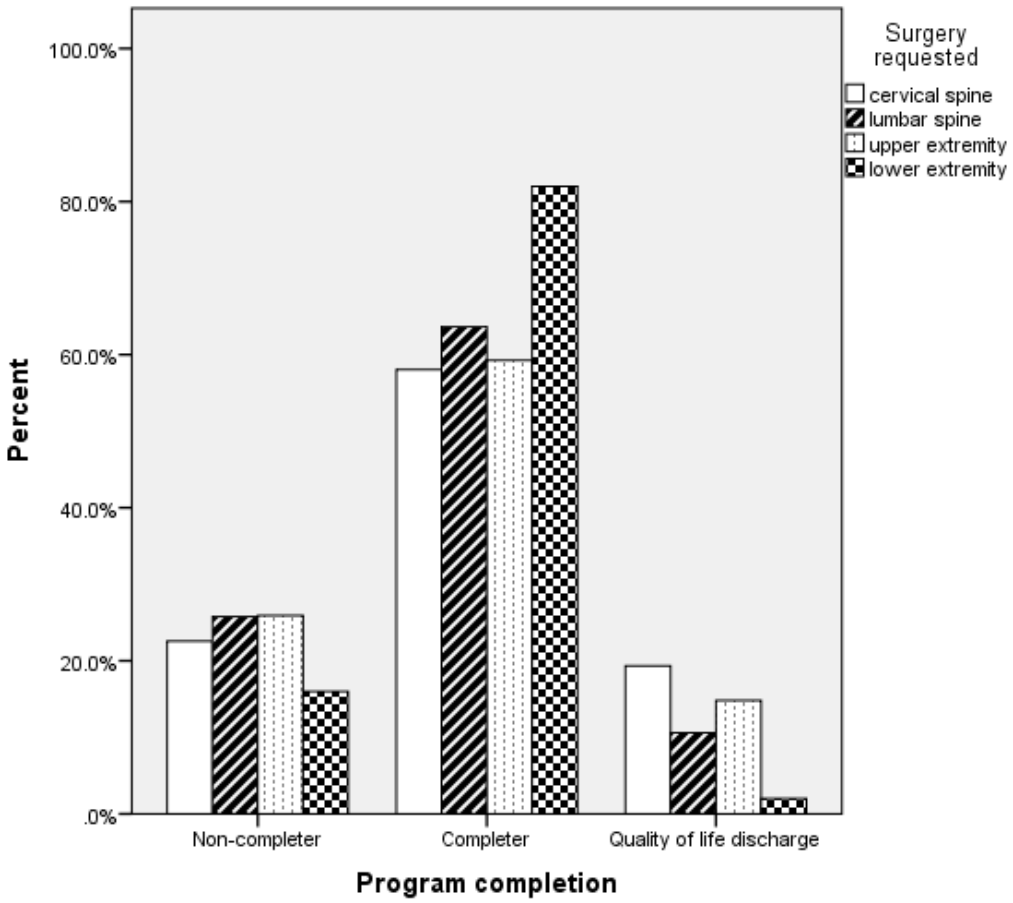


Note: p = .041, *Different from DS group

Figure B38. Disability benefits at one-year by SOP subgroup

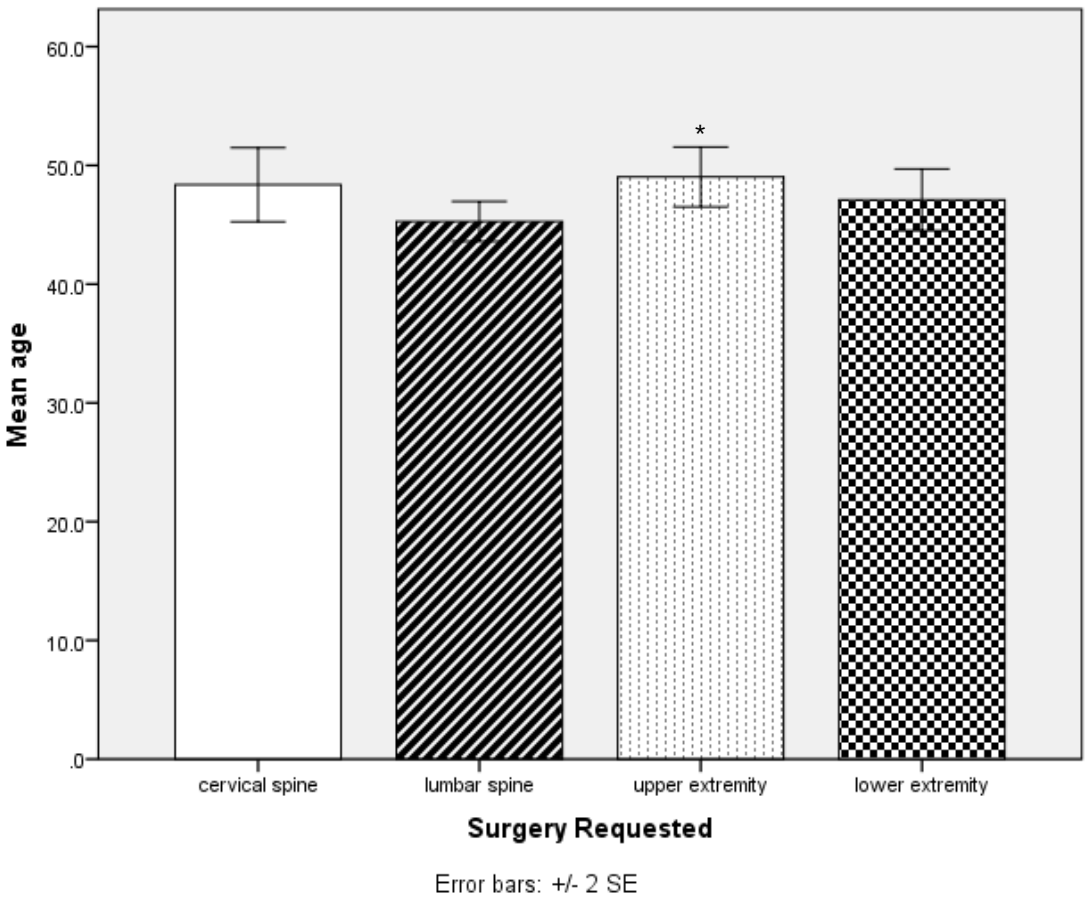
APPENDIX C

SURGERY REQUESTED COMPARISON FIGURES



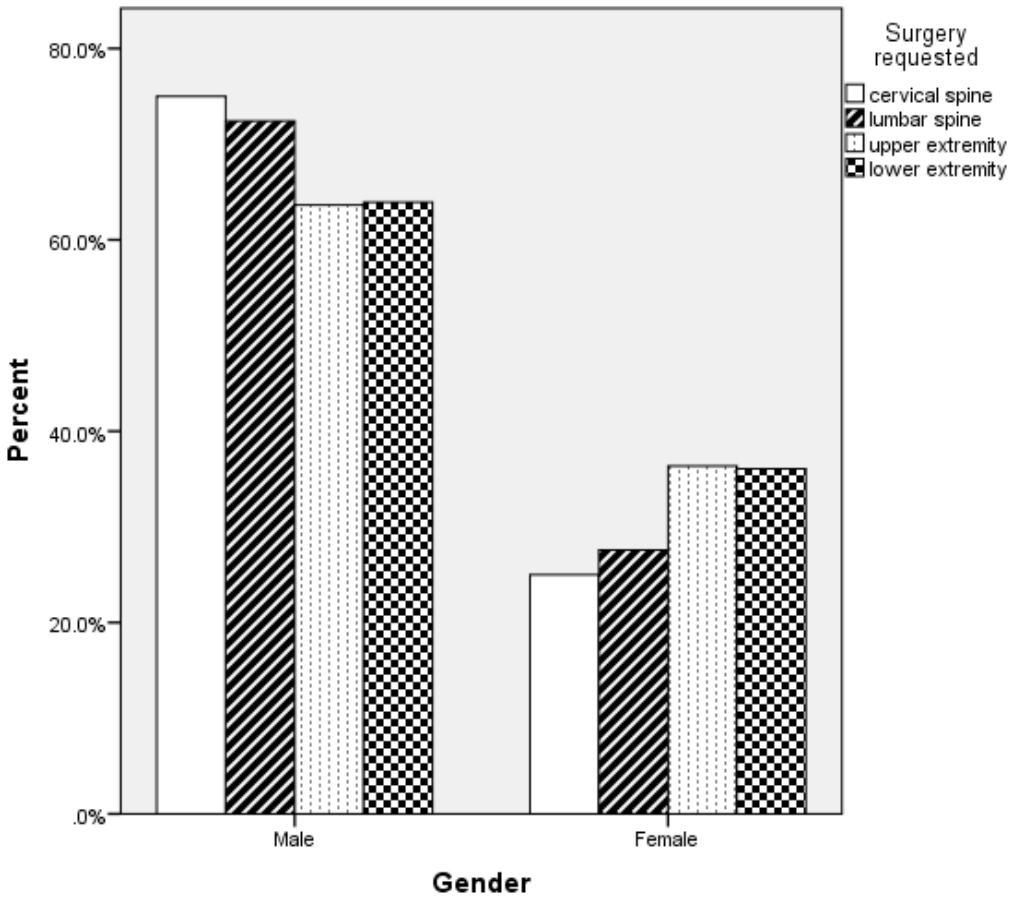
Note: No significant differences among surgery groups.

Figure C1. Completion status by Surgery type



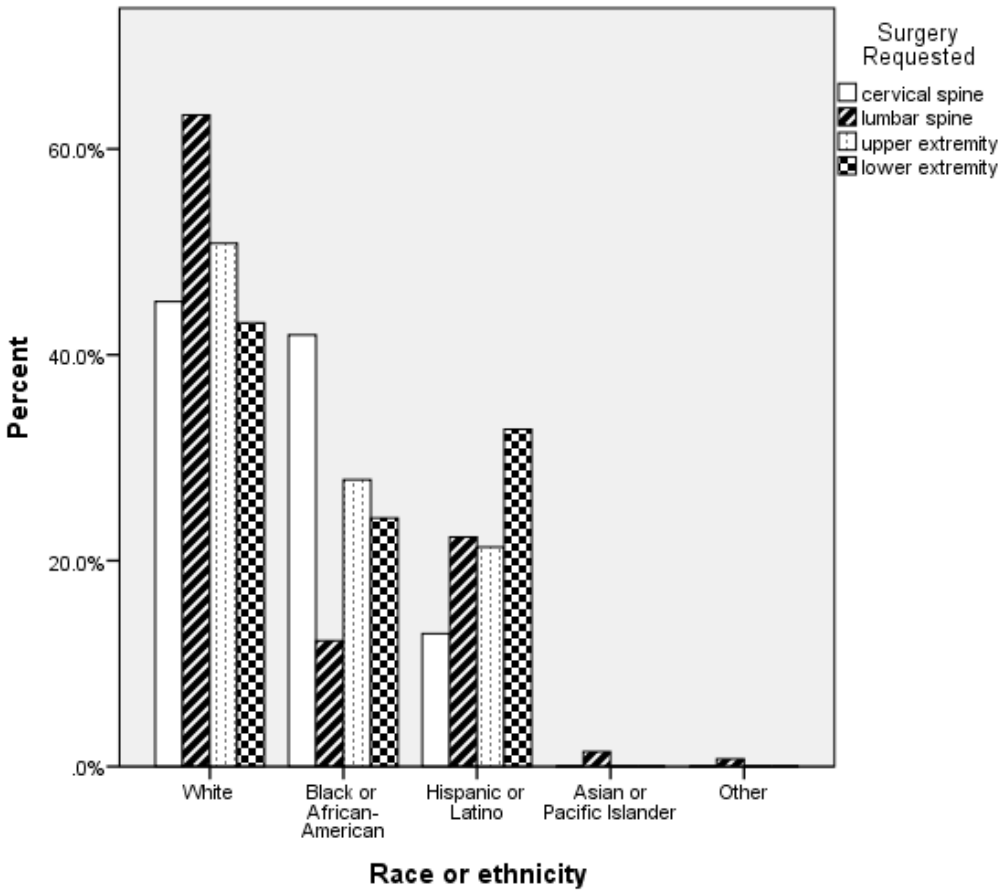
Note: p = .024, *Different from lumbar spine group.

Figure C2. Mean age by Surgery type



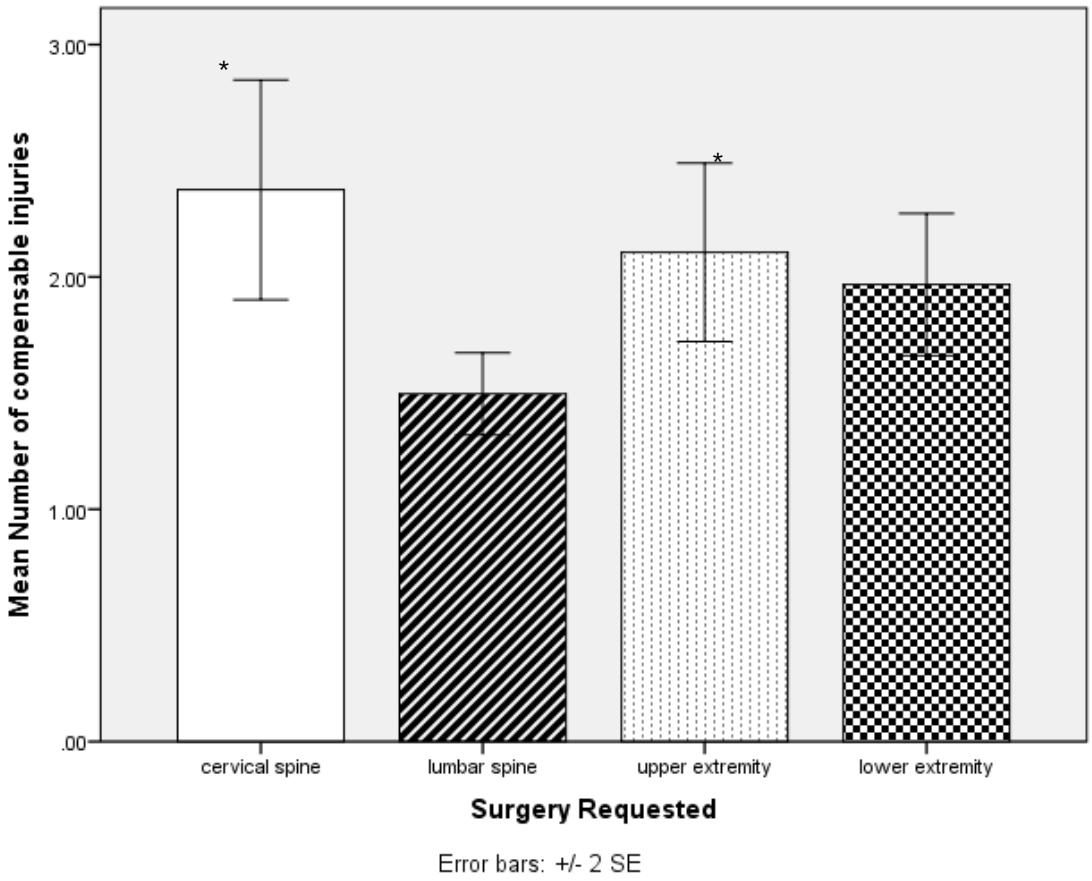
Note: No significant differences among surgery groups.

Figure C3. Gender by Surgery type



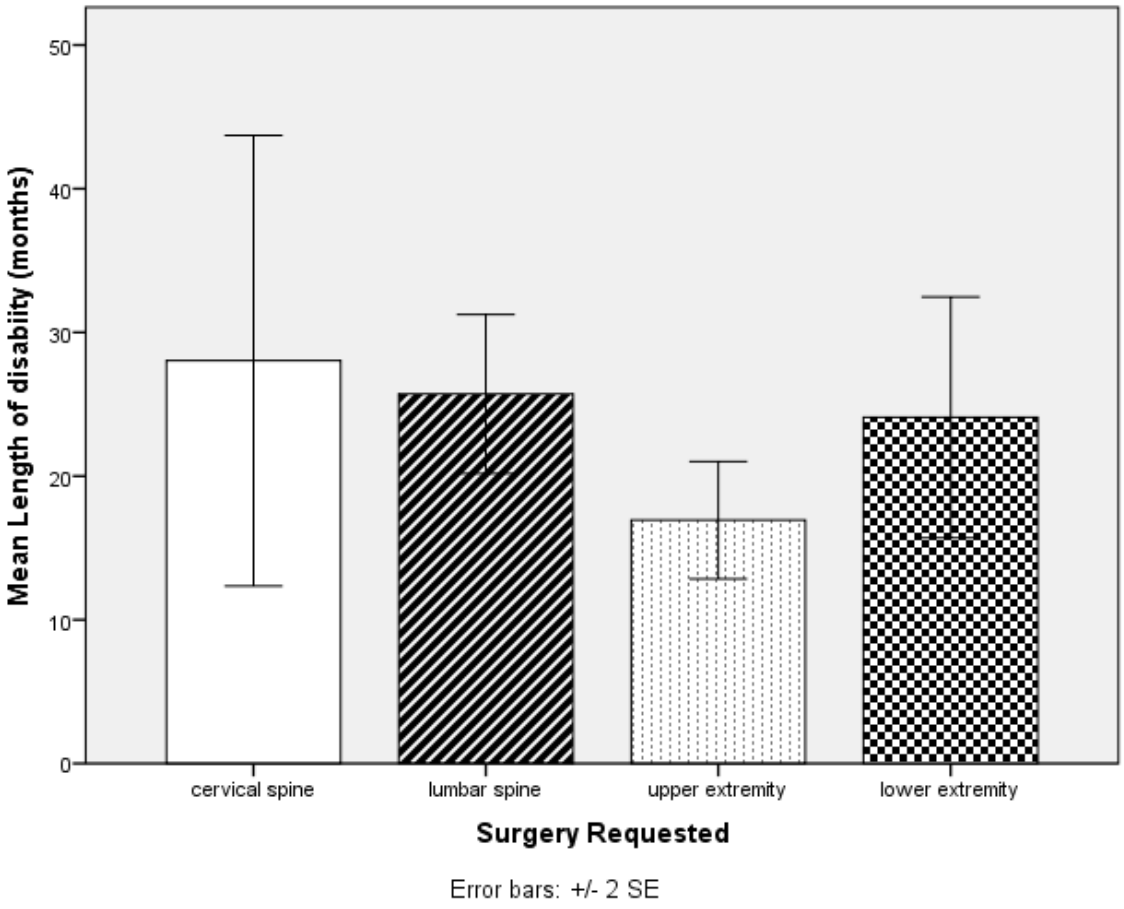
Note: No significant differences among surgery groups.

Figure C4. Race by Surgery type



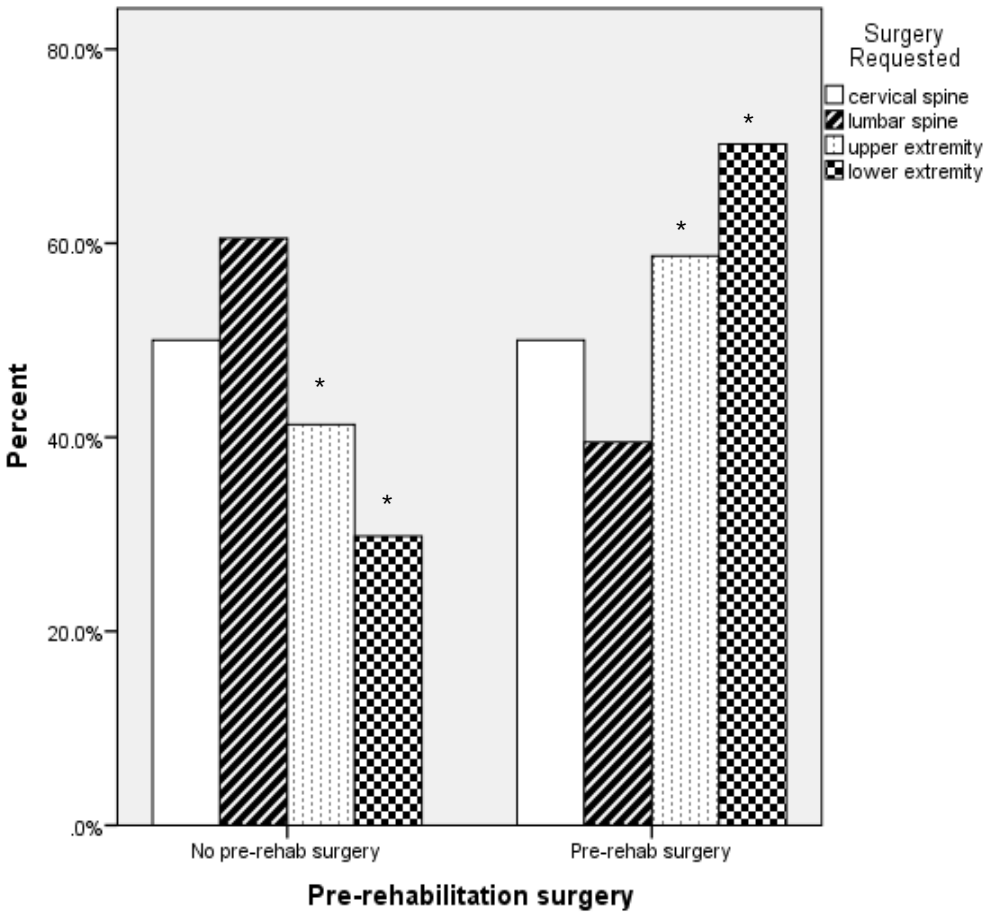
Note: p = .002, *Different from lumbar spine group.

Figure C5. Mean number of compensable injuries by Surgery type



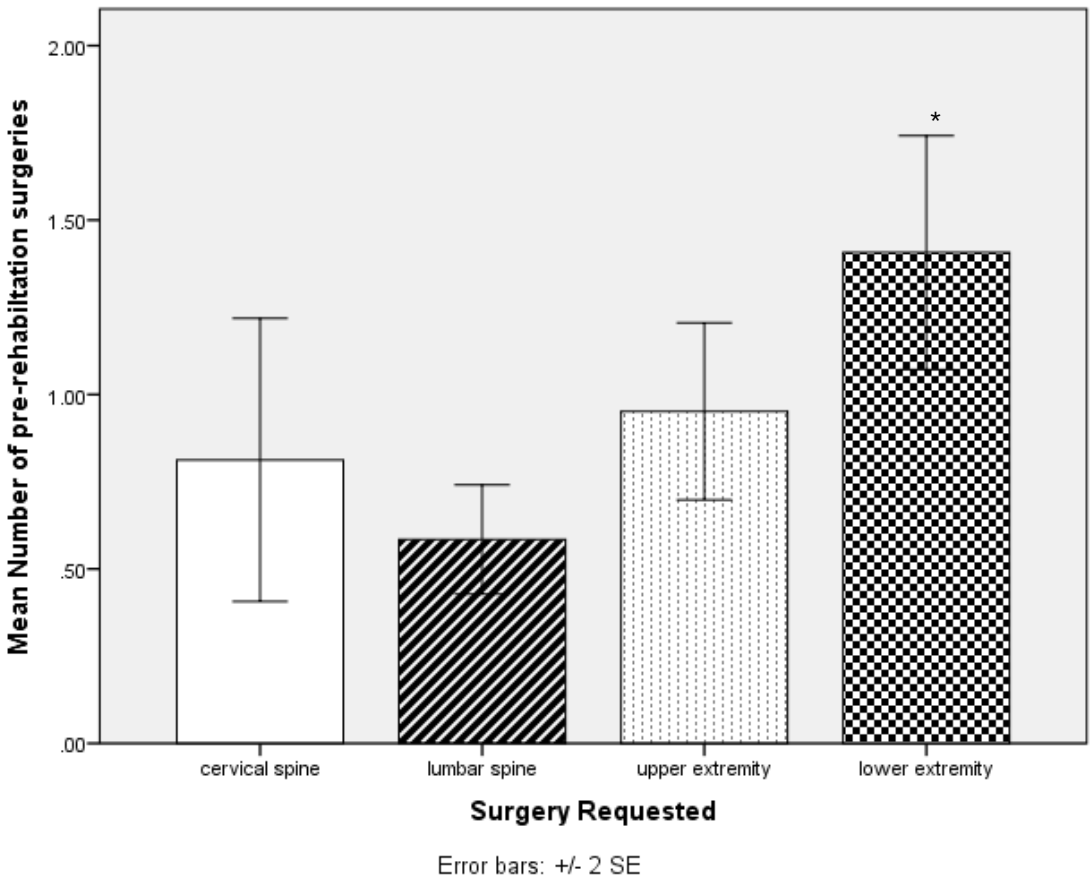
Note: No significant differences among surgery groups.

Figure C6. Mean months of disability by Surgery type



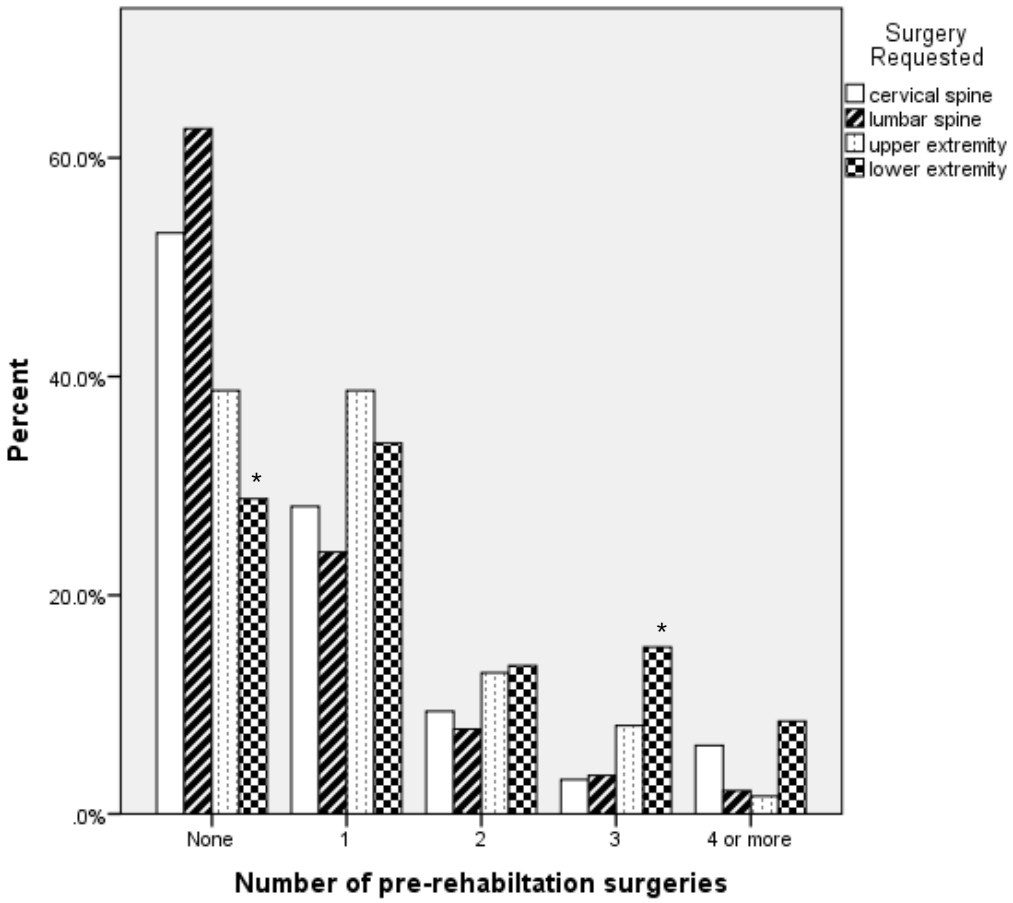
Note: p = .003, *Different from lumbar spine group.

Figure C7. Pre-rehabilitation surgery by Surgery type



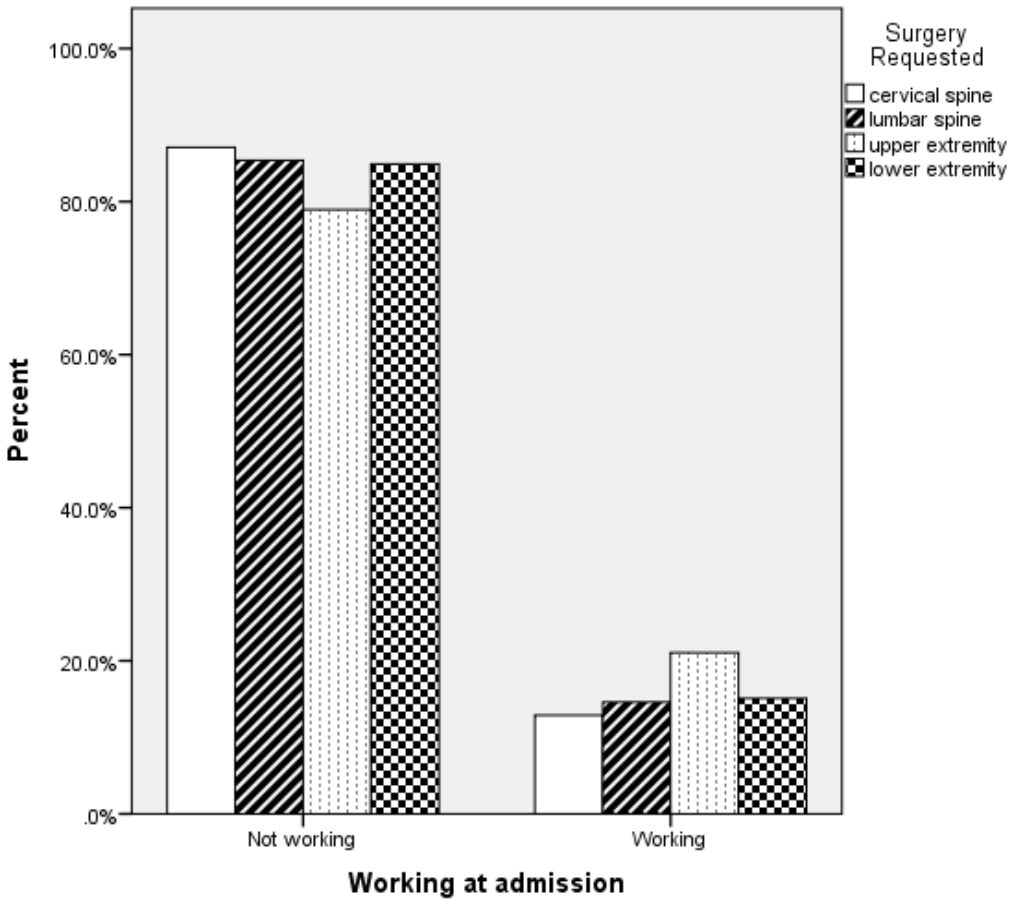
Note: p < .001, *Different from lumbar spine group.

Figure C8. Mean number of pre-rehabilitation surgeries by Surgery type



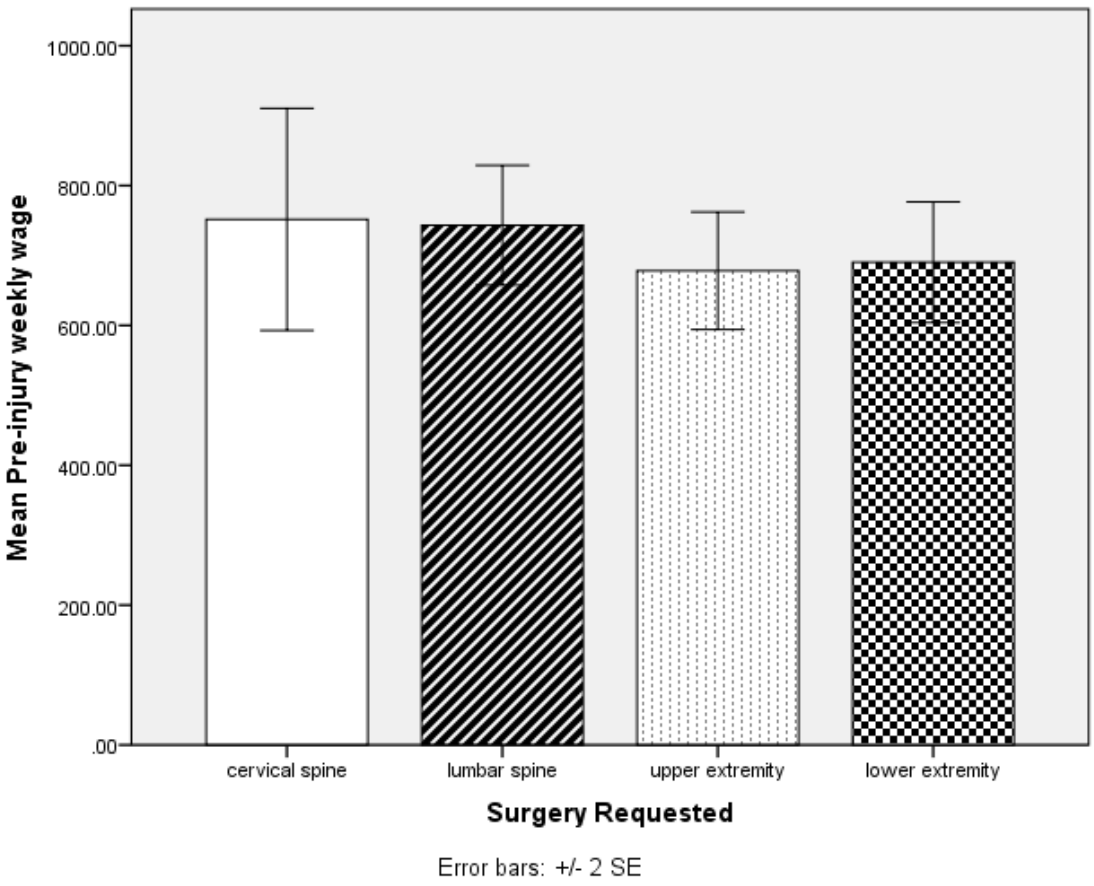
Note: p = .026, *Different from lumbar spine group.

Figure C9. Number of pre-rehabilitation surgeries by Surgery type



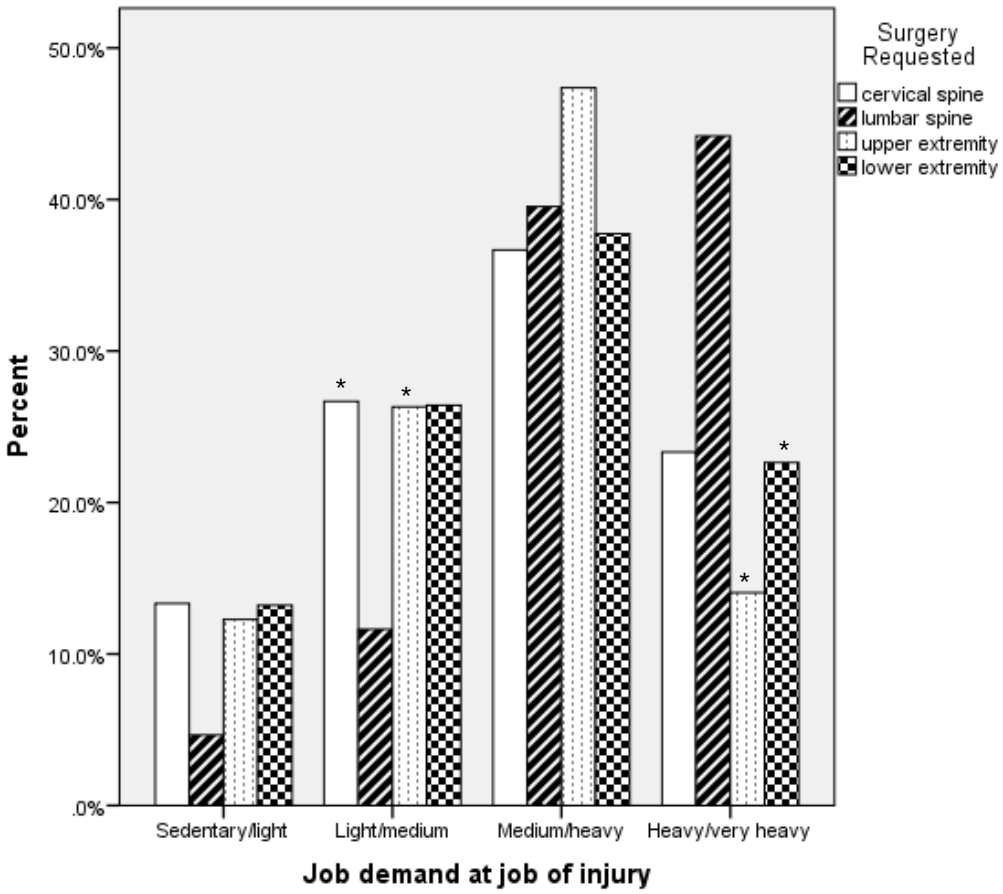
Note: No significant differences among surgery groups.

Figure C10. Work status at admission by Surgery type



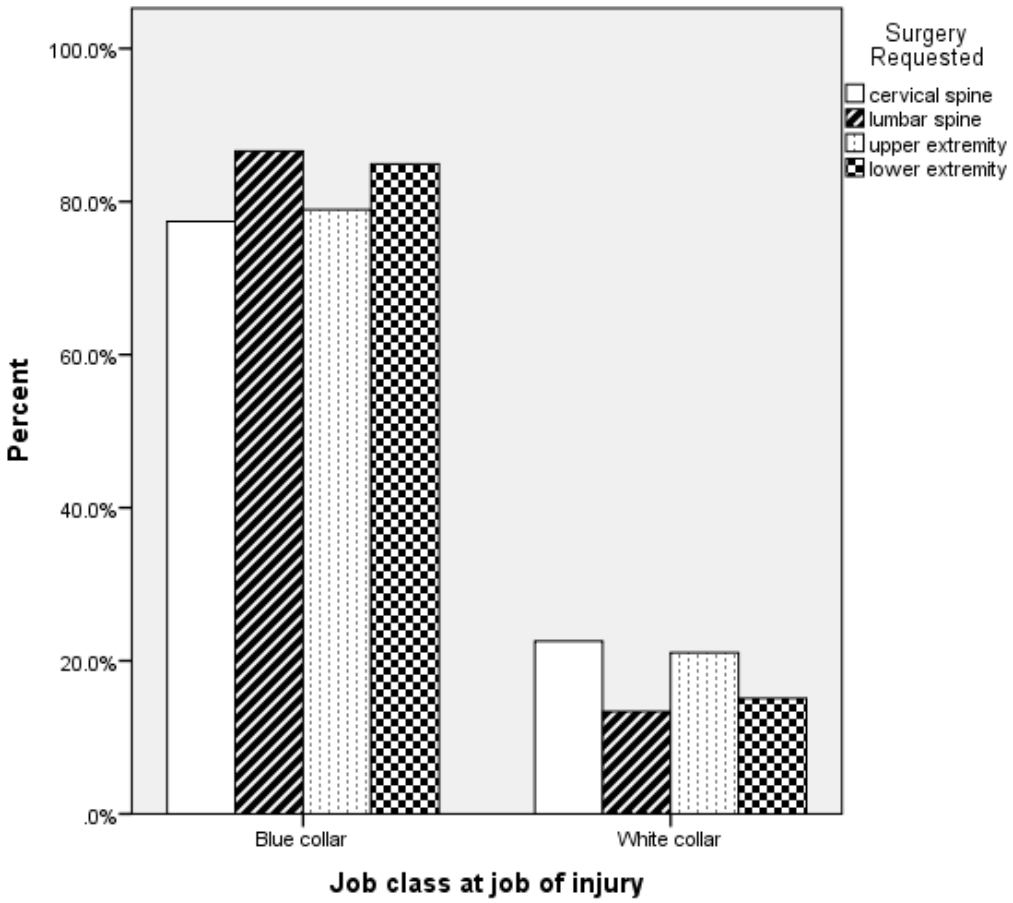
Note: No significant differences among surgery groups.

Figure C11. Mean weekly pre-injury wage by Surgery type



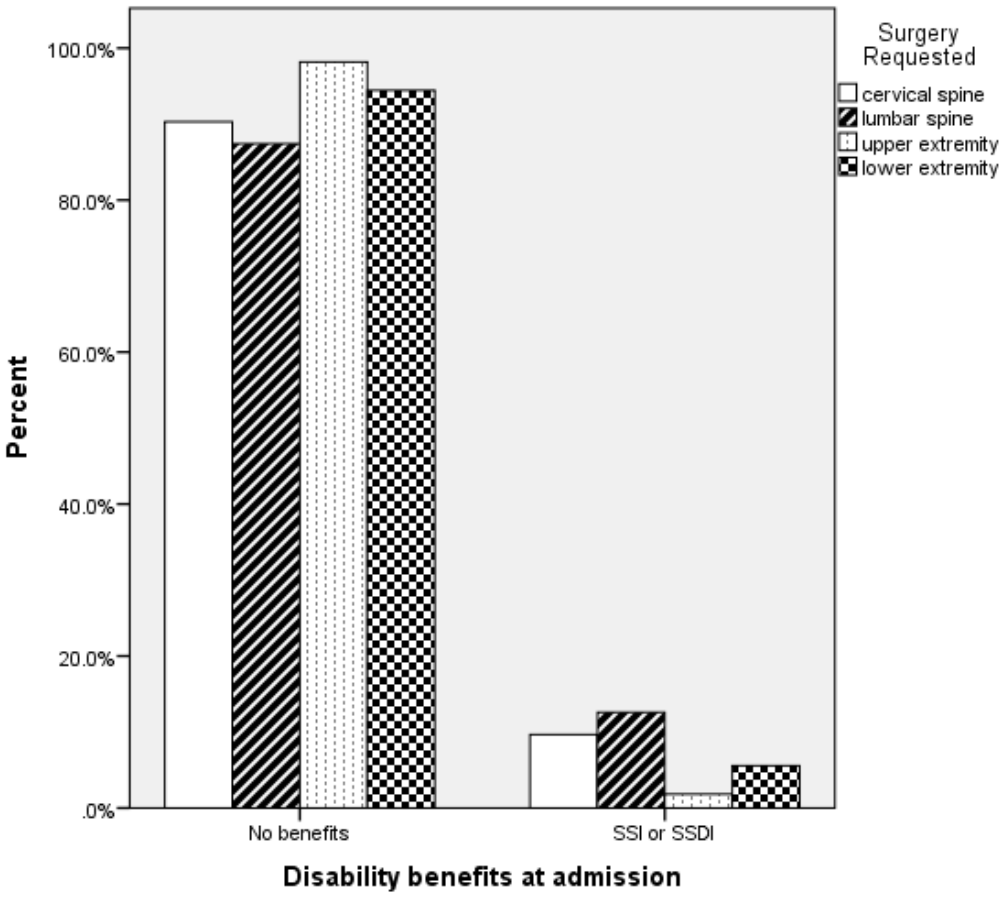
Note: p = .024, *Different from lumbar spine group.

Figure C12. Job demand at job of injury by Surgery type



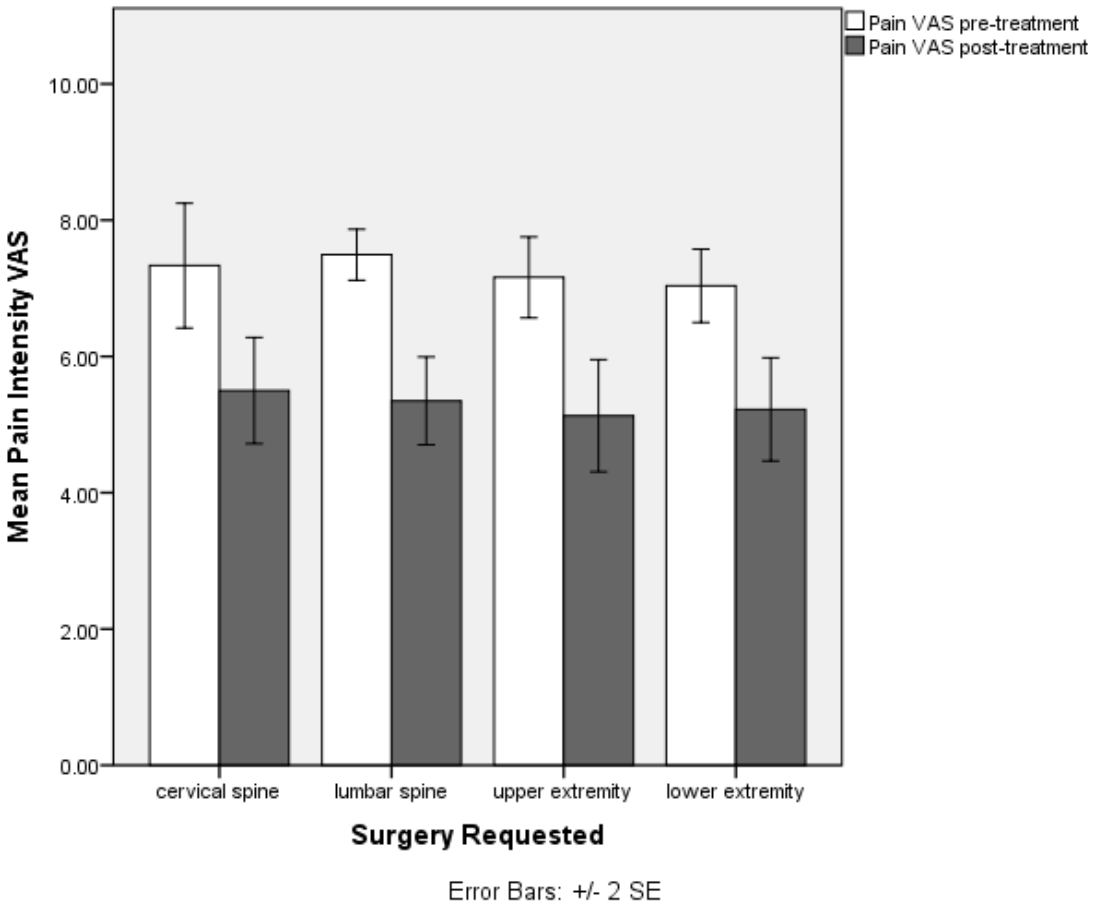
Note: No significant difference among surgery groups.

Figure C13. Job class at job of injury by Surgery type



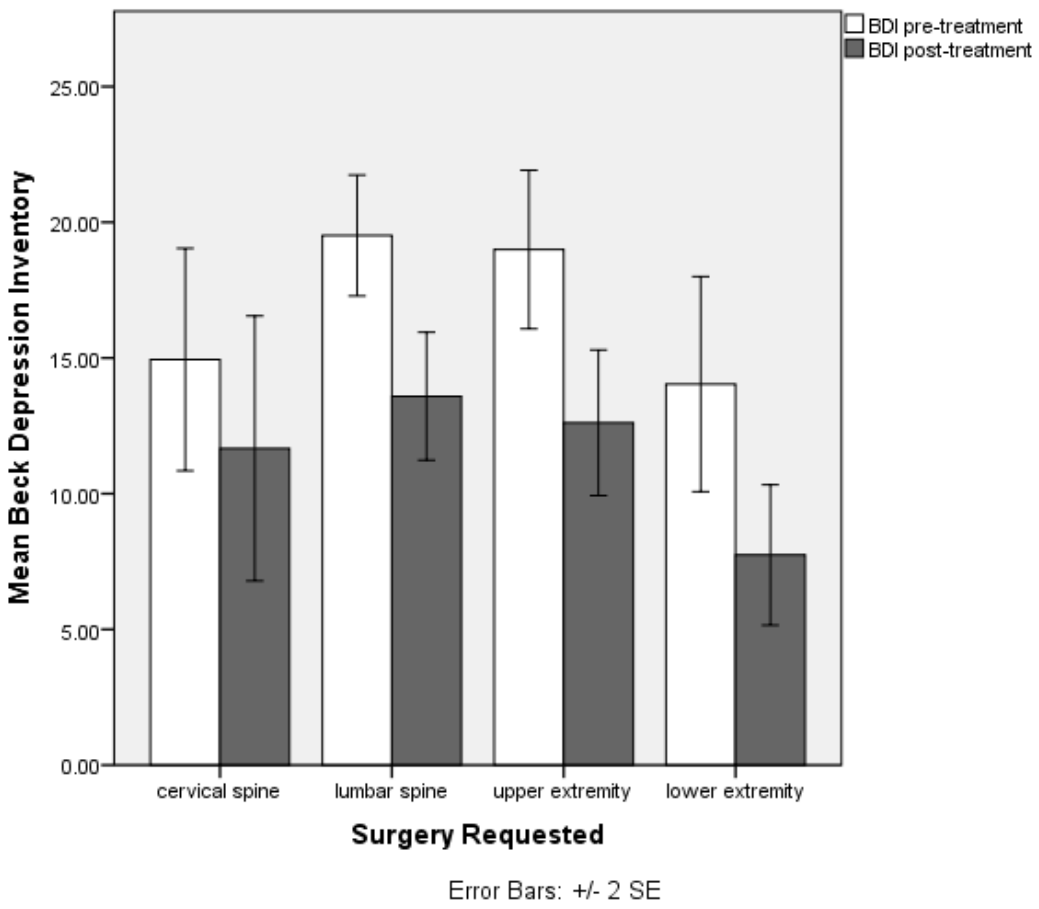
Note: No significant difference among surgery groups.

Figure C14. Disability benefits at admission by Surgery type



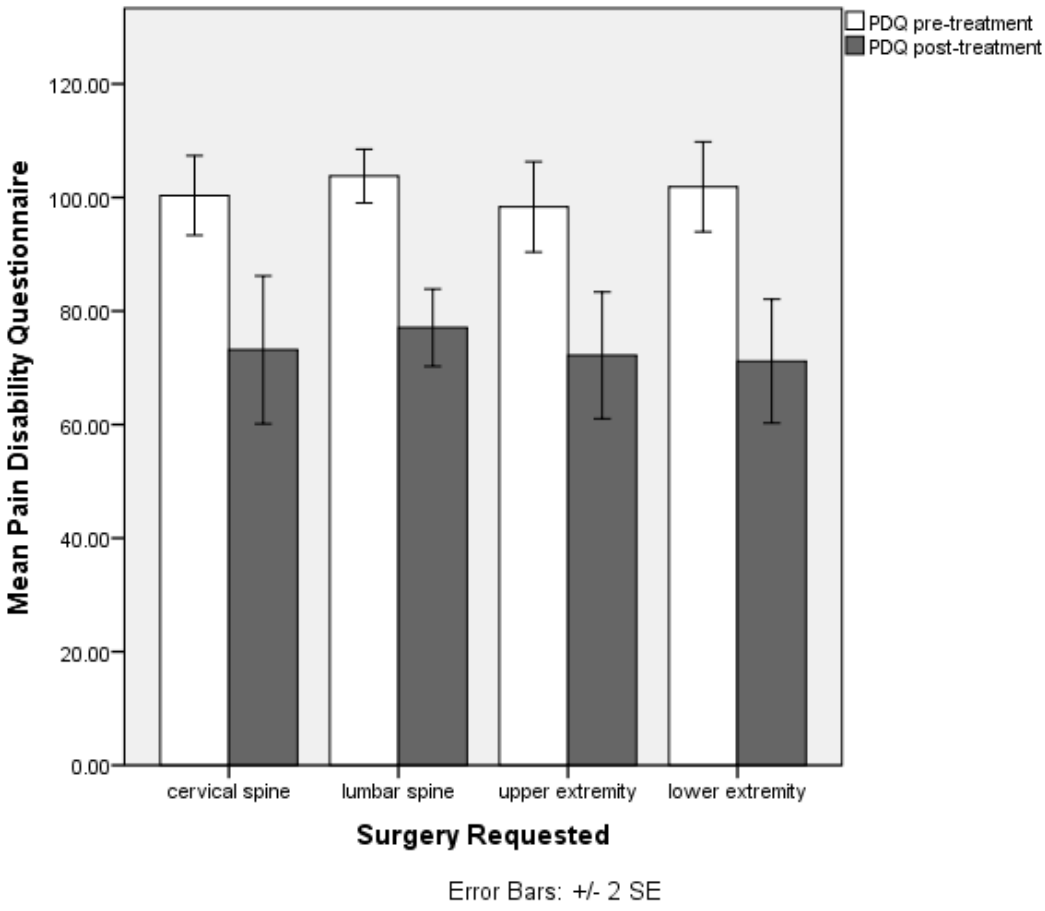
Note: No significant difference among surgery groups.

Figure C15. Mean pain intensity (VAS) by Surgery type



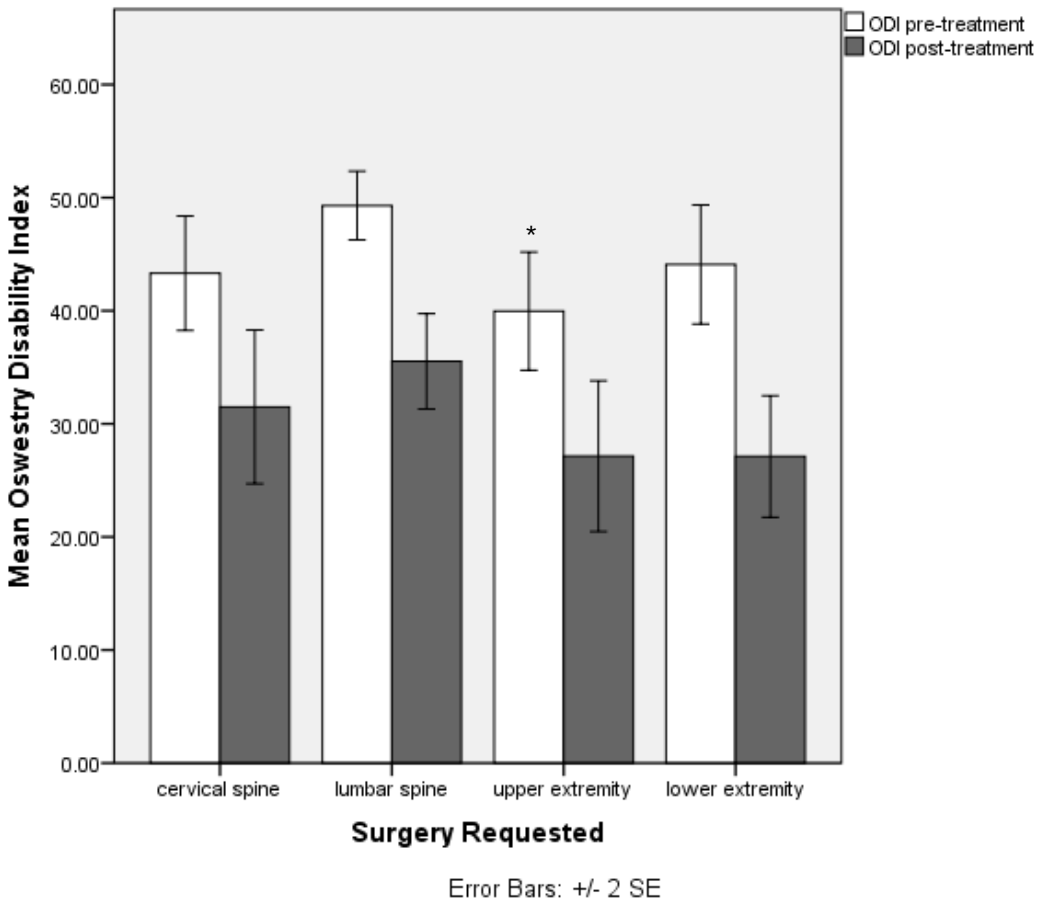
Note: No significant difference among surgery groups at pre-treatment, $p = .041$ at post-treatment, *Different from lumbar spine group.

Figure C16. Mean Beck Depression Inventory (BDI) by Surgery type



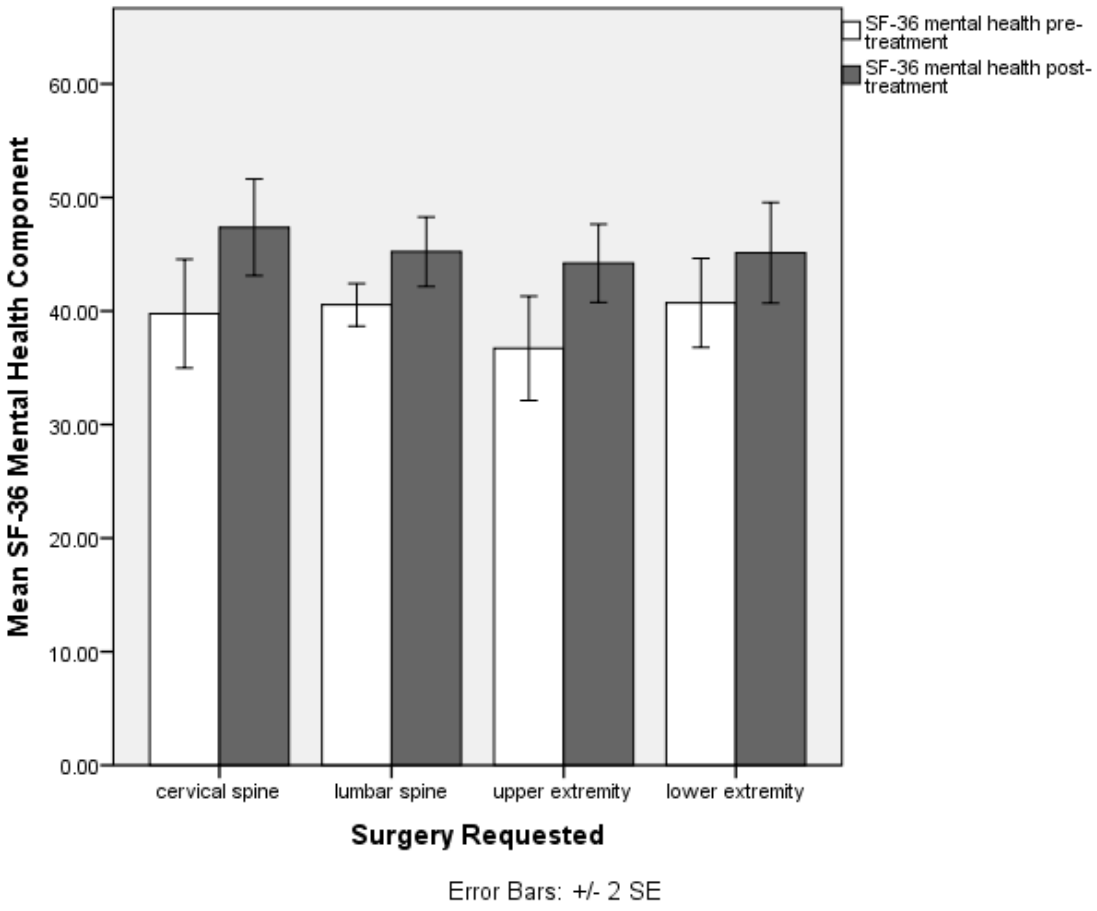
Note: No significant difference among surgery groups.

Figure C17. Mean Pain Disability Questionnaire (PDQ) by Surgery type



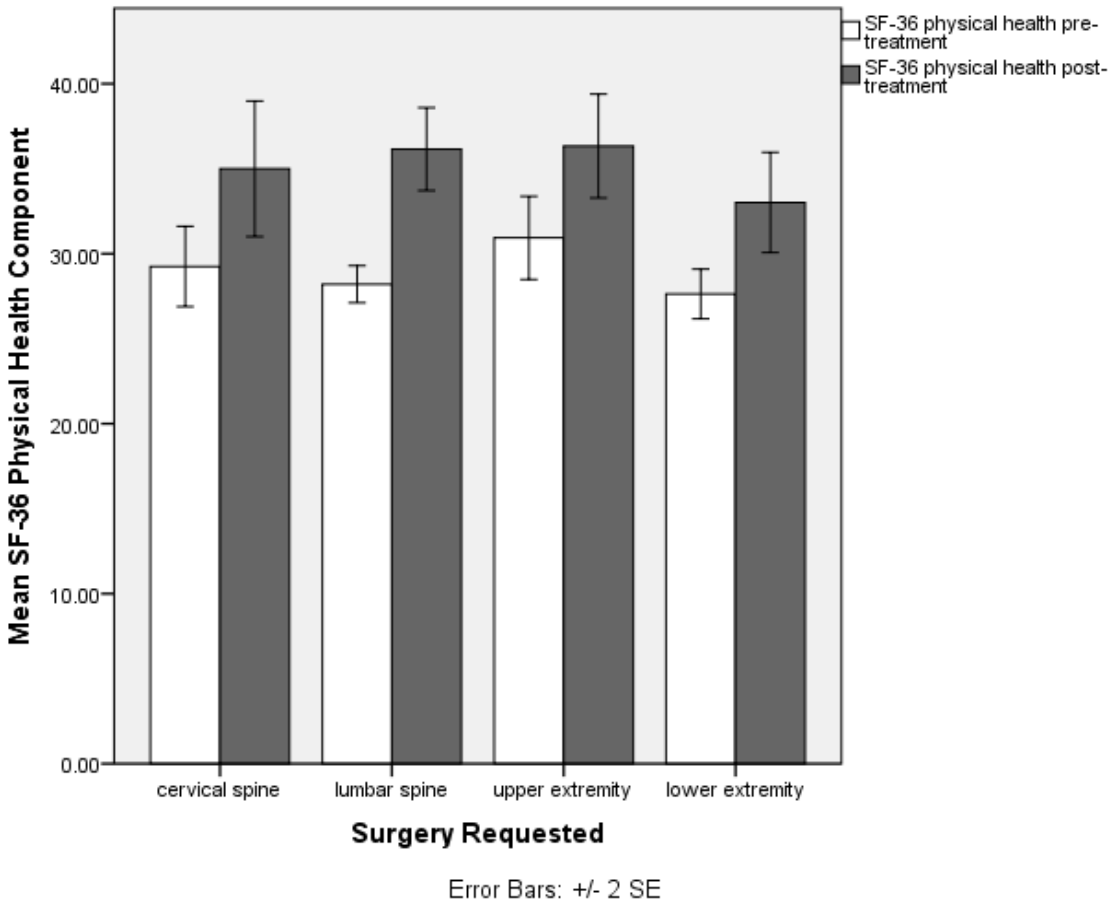
Note: $p < .001$ at pre-treatment, no significant differences at post-treatment, *Different from lumbar spine group.

Figure C18. Mean Oswestry Disabiility Index (ODI) at admission by Surgery type



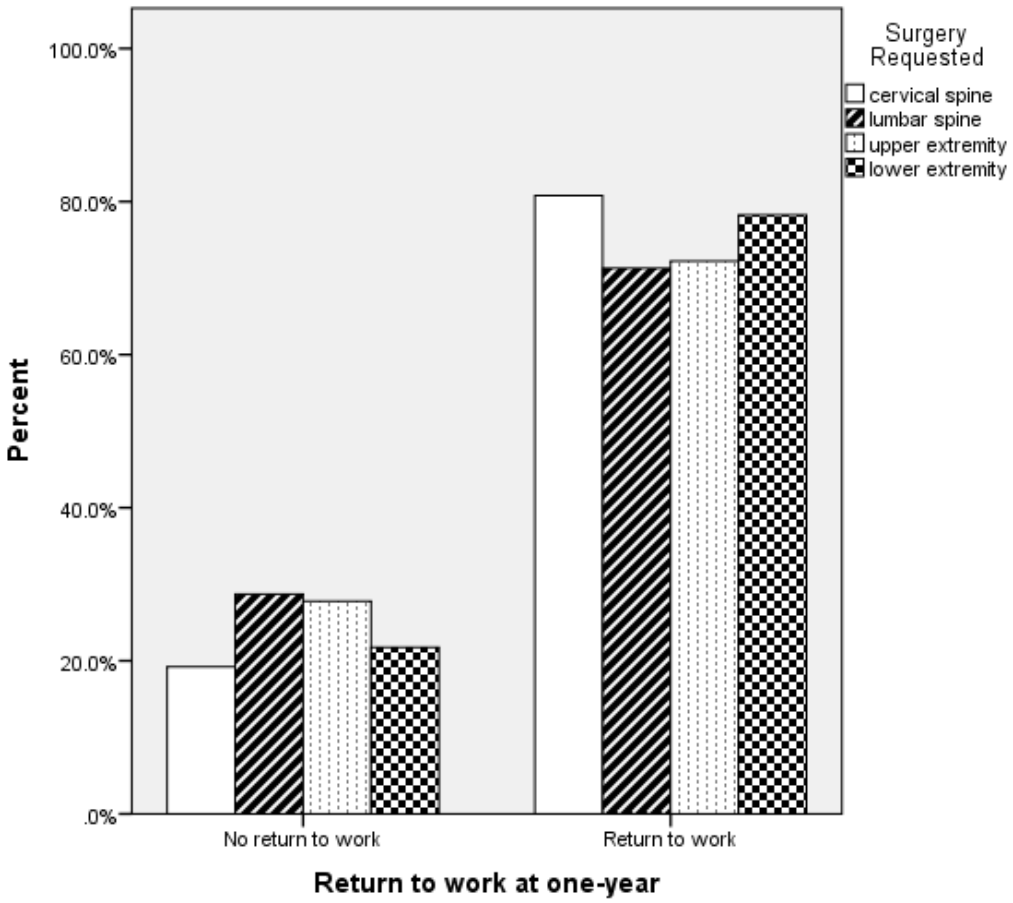
Note: No significant difference among surgery groups.

Figure C19. Mean SF-36 mental health component by Surgery type



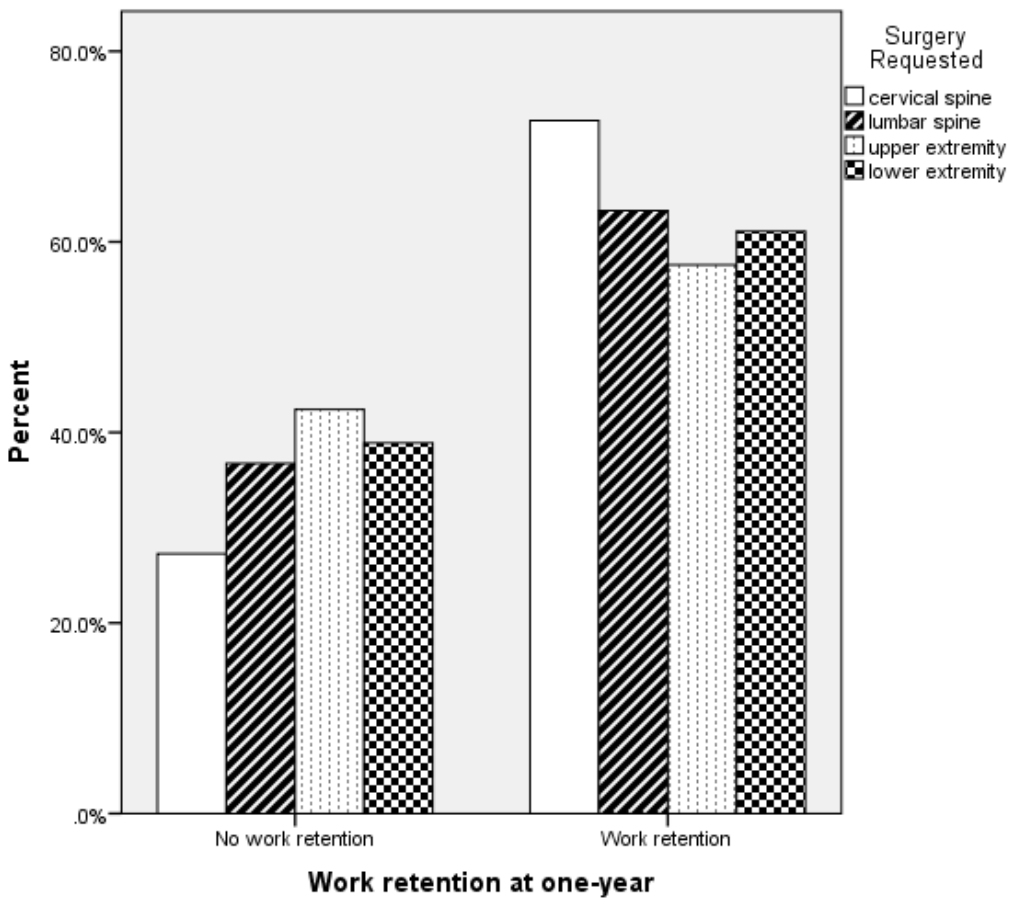
Note: No significant difference among surgery groups.

Figure C20. Mean SF-36 physical health component by Surgery type



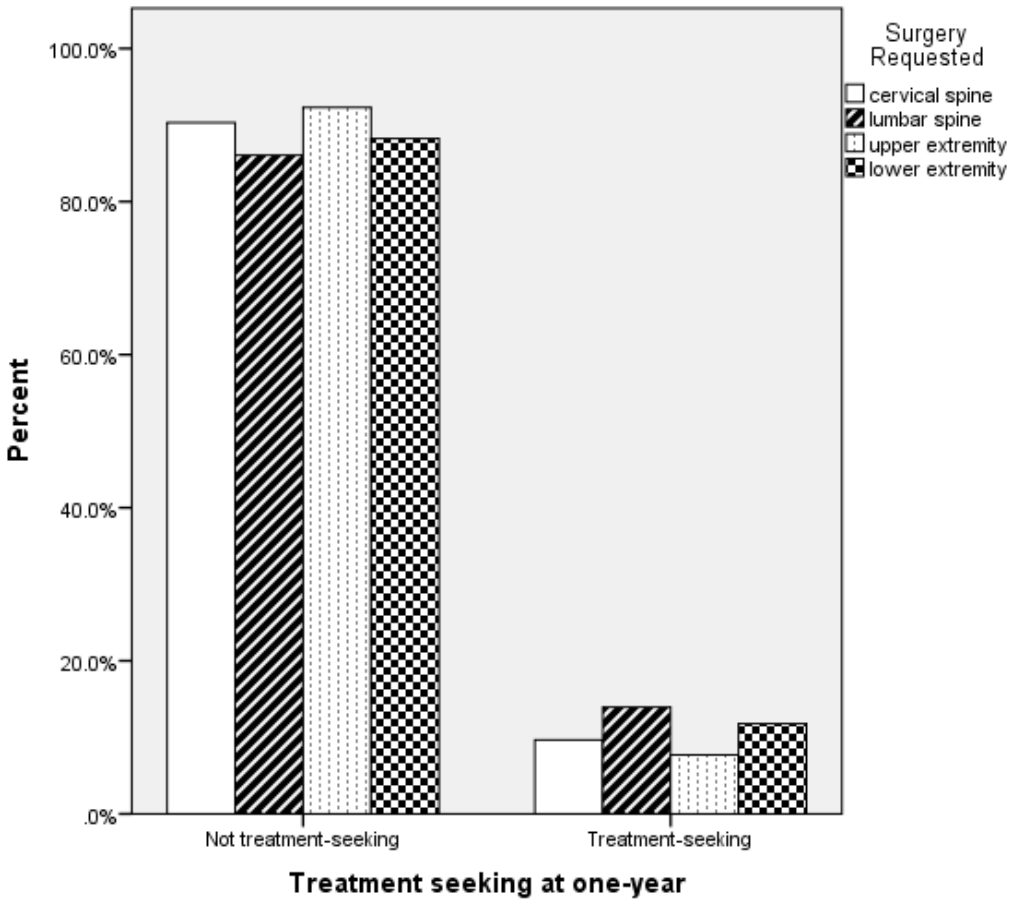
Note: No significant differences among surgery groups.

Figure C21. Return to work at one-year by Surgery type



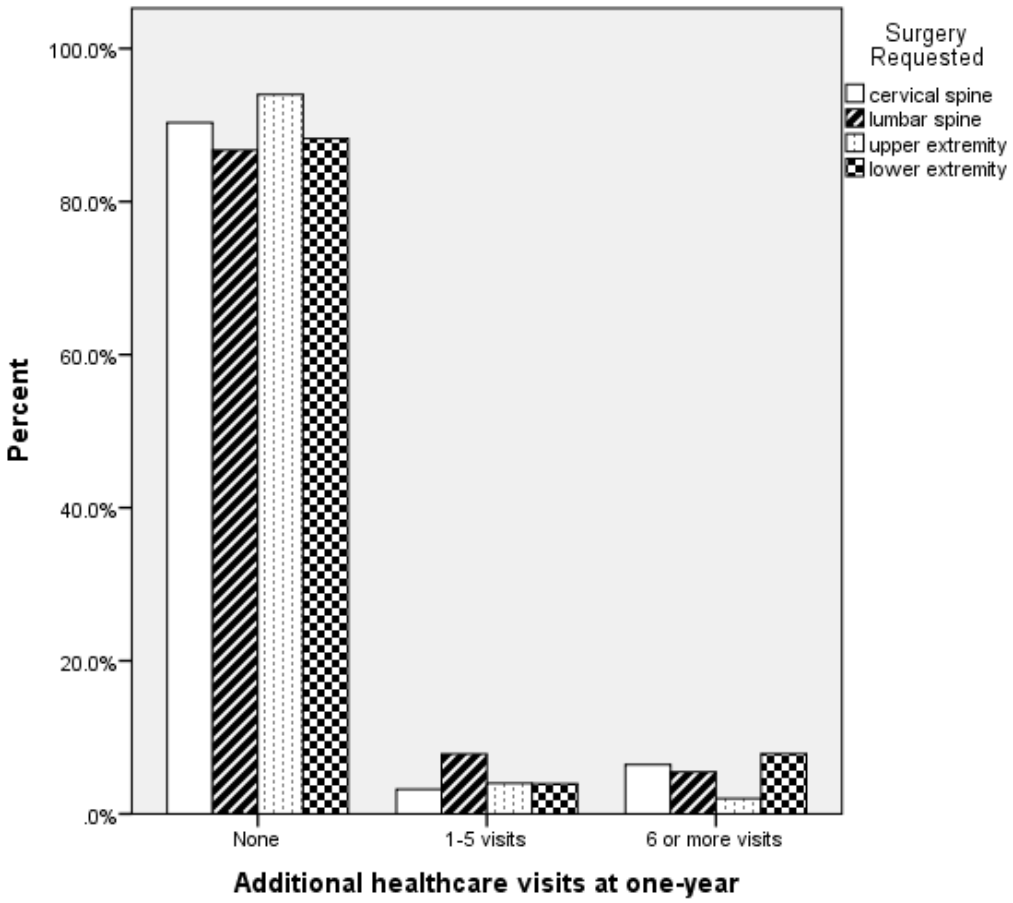
Note: No significant differences among surgery groups.

Figure C22 Work retention at one-year by Surgery type



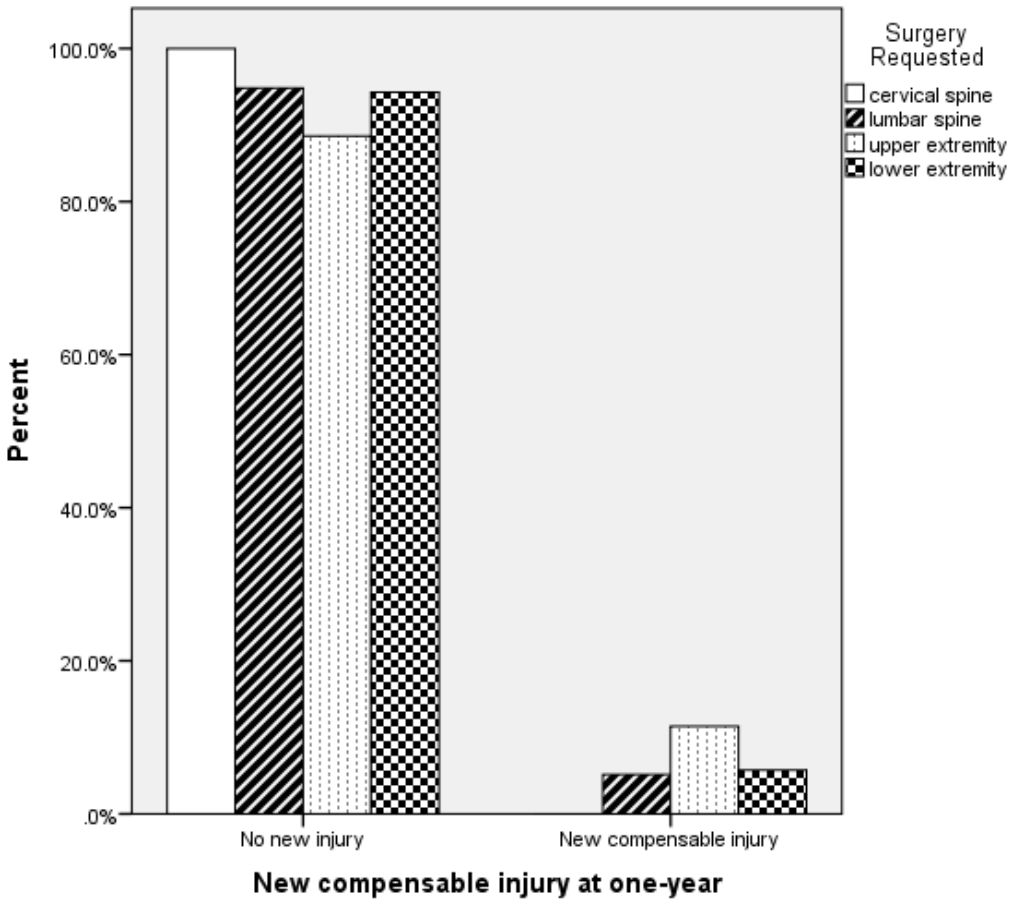
Note: No significant differences among surgery groups.

Figure C23. Treatment-seeking at one-year by Surgery type



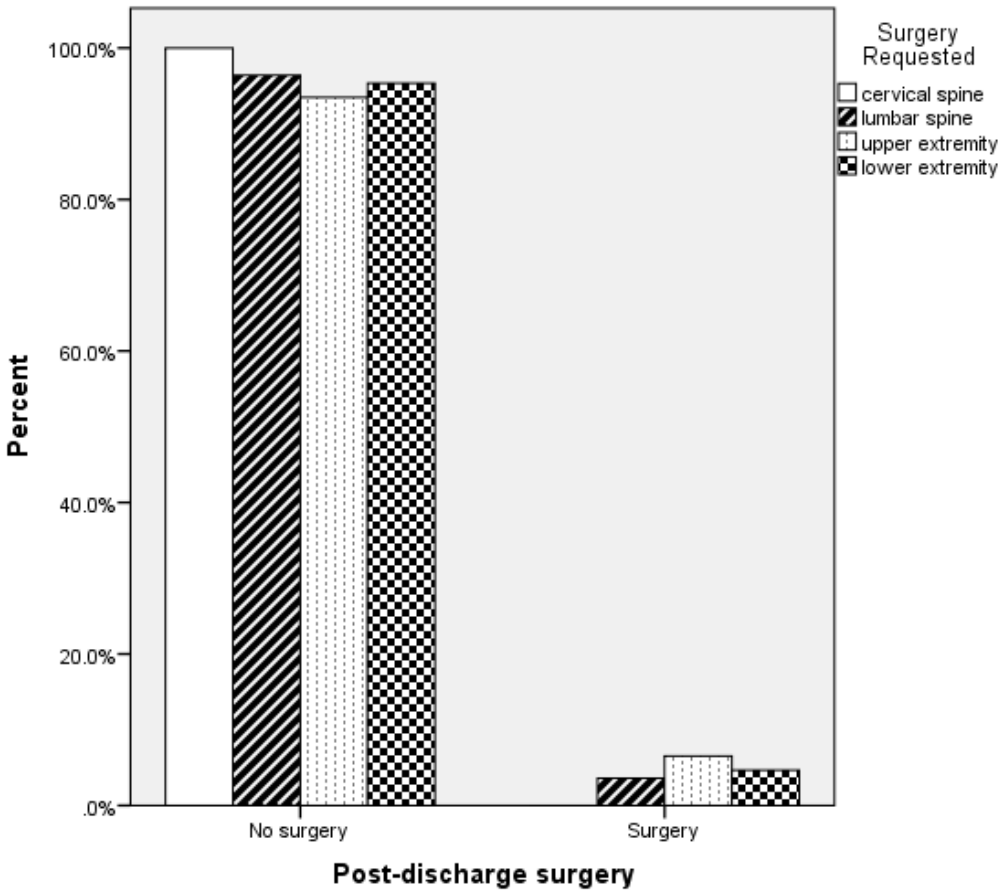
Note: No significant differences among surgery groups.

Figure C24. Number of visits at one-year by Surgery type



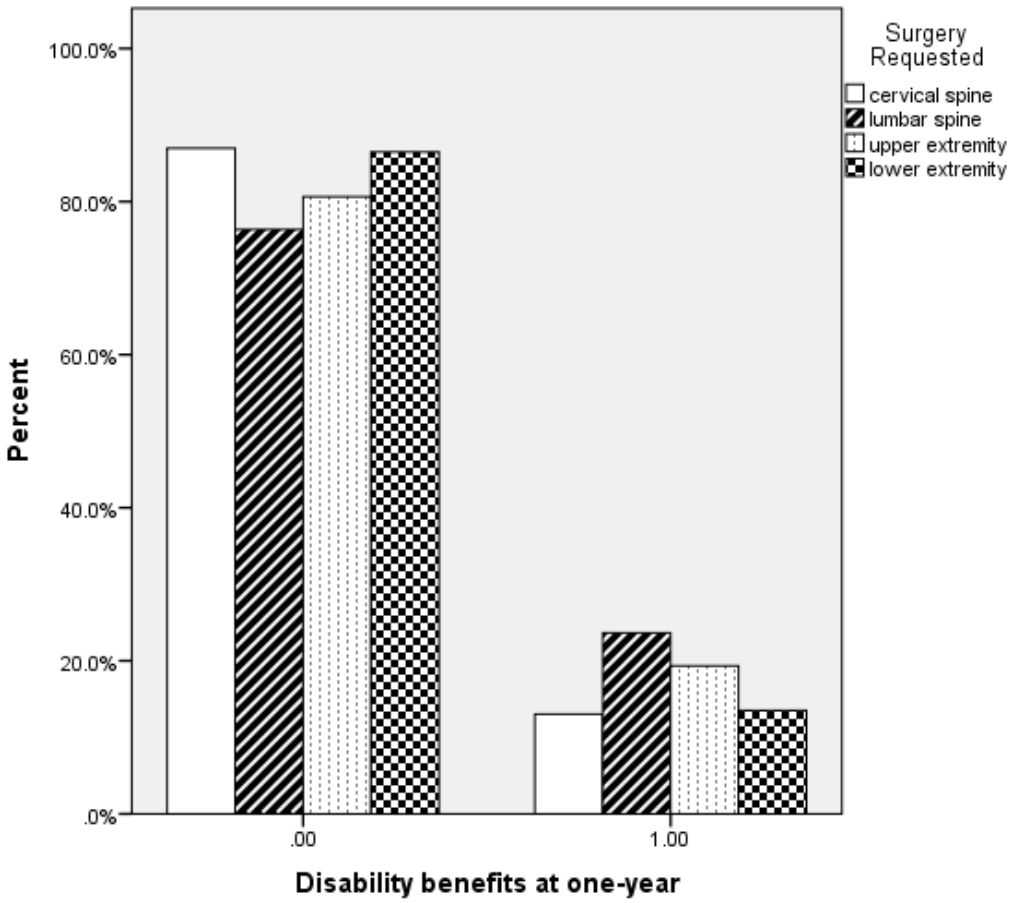
Note: No significant differences among surgery groups.

Figure C25. New compensable injury at one-year by Surgery type



Note: No significant differences among surgery groups.

Figure C26. Additional non-SOP surgery at one-year by Surgery type



Note: No significant differences among surgery groups.

Figure C27. Disability benefits at one-year by Surgery type

REFERENCES

Aalto, T.J., Malmivaara, A., Kovacs, F., Herno, A., Alen, M., Salmi, L., . . . Airaksinen, O. (2006). Preoperative predictors for postoperative clinical outcome in lumbar spinal stenosis: Systematic review. *Spine, 31*(18), E648-E663 610.1097/1001.brs.0000231727.0000288477.da.

Abbott, A., Tyni-Lenne, R., & Hedlund, R. (2010). Early rehabilitation targeting cognition, behavior, and motor function after lumbar fusion: A randomized controlled trial. *Spine, 35*(8), 848-857.

Adams, M.L., Franklin, G.M., & Barnhart, S. (1994). Outcome of carpal tunnel surgery in washington state workers' compensation. *American Journal of Industrial Medicine, 25*(4), 527-536. doi: 10.1002/ajim.4700250407

Agazzi, S., Reverdin, A., & May, D. (1999). Posterior lumbar interbody fusion with cages: An independent review of 71 cases. *Journal of Neurosurgery: Spine, 91*(2), 186-192. doi: doi:10.3171/spi.1999.91.2.0186

Akkaya, S., Akkaya, N., Kıter, E., Kılıç, A., & Ardıç, F. (2012). [functional status, patient satisfaction and quality of life in patients with arthroscopic partial meniscectomy]. *Eklem Hastalik Cerrahisi, 23*(1), 9-14.

Amendola, A., Petrik, J., & Webster-Bogaert, S. (1996). Ankle arthroscopy: Outcome in 79 consecutive patients. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 12*(5), 565-573. doi: 10.1016/s0749-8063(96)90196-6

American Academy of Orthopaedic Surgeons. (2008). Clinical guidelines on the treatment of carpal tunnel syndrome. Rosemont, IL: American Academy of Orthopaedic Surgeons.

American Academy of Orthopaedic Surgeons. (2010). Optimizing the management of rotator cuff problems: Guideline and evidence report. In R. A. Pedowitz (Ed.), *AAOS Clinical Practice Guidelines*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders, fourth edition: Dsm-iv-tr*® (4 ed.). Arlington, VA: American Psychiatric Association.

Amick, B.C.I., Habeck, R.V., Ossmann, J., Fossel, A.H., Keller, R., & Katz, J.N. (2004). Predictors of successful work role functioning after carpal tunnel release surgery. *Journal of Occupational and Environmental Medicine, 46*(5), 490-500.

Anagnostis, C., Gatchel, R.J., & Mayer, T.G. (2004). The pain disability questionnaire: A new psychometrically sound measure for chronic musculo-skeletal disorders. *Spine (Phila Pa 1976), 29*, 2290-2302

Anderson, P.A., Schwaegler, P.E., Cizek, D., & Leverson, G. (2006). Work status as a predictor of surgical outcome of discogenic low back pain. *Spine, 31*(21), 2510-2515.

Anderson, V.C., & Burchiel, K.J. (1999). A prospective study of long-term intrathecal morphine in the management of chronic nonmalignant pain. *Neurosurgery, 44*(2), 289-300.

Angevine, P.D., Arons, R.R., & McCormick, P.C. (2003). National and regional rates and variation of cervical discectomy with and without anterior fusion, 1990–1999. *Spine, 28*(9), 931-939.

Arnetz, B.B., Sjögren, B., Rydéhn, B., & Meisel, R. (2003). Early workplace intervention for employees with musculoskeletal-related absenteeism: A prospective controlled intervention study. *Journal of Occupational and Environmental Medicine, 45*(5), 499-506.

Asch, H.L., Lewis, P.J., Moreland, D.B., Egnatchik, J.G., Yu, Y.J., Clabeaux, D.E., & Hyland, A.H. (2002). Prospective multiple outcomes study of outpatient lumbar microdiscectomy: Should 75 to 80% success rates be the norm? *Journal of Neurosurgery: Spine, 96*(1), 34-44. doi: doi:10.3171/spi.2002.96.1.0034

Aslani, H.R., Alizadeh, K., Eajazi, A., Karimi, A., Karimi, M.H., Zaferani, Z., & Hosseini Khameneh, S.M. (2012). Comparison of carpal tunnel release with three different techniques. *Clinical Neurology and Neurosurgery*(0). doi: 10.1016/j.clineuro.2012.02.017

Atlas, S.J., Keller, R.B., Wu, Y.A., Deyo, R.A., & Singer, D.E. (2005). Long-term outcomes of surgical and nonsurgical management of lumbar spinal stenosis: 8 to 10 year results from the maine lumbar spine study. *Spine, 30*(8), 936-943.

Atlas, S.J., Tosteson, T.D., Blood, E.A., Skinner, J.S., Pransky, G.S., & Weinstein, J.N. (2010). The impact of workers' compensation on outcomes of surgical and nonoperative therapy for patients with a lumbar disc herniation: Sport. *Spine, 35*(1), 89-97.

Atroshi, I., Englund, M., Turkiewicz, A., Tägil, M., & Petersson, I.F. (2011). Incidence of physician-diagnosed carpal tunnel syndrome in the general population. *Archives of Internal Medicine, 171*(10), 941-954. doi: 10.1001/archinternmed.2011.203

Baker, B.S. (2011). Meniscus injuries Retrieved 5/9/2012, from http://emedicine.medscape.com/article/90661-overview

Baker, N.A., Moehling, K.K., Rubinstein, E.N., Wollstein, R., Gustafson, N.P., & Baratz, M. (2012). The comparative effectiveness of combined lumbrical muscle splints and stretches on symptoms and function in carpal tunnel syndrome. *Archives of Physical Medicine and Rehabilitation, 93*(1), 1-10. doi: 10.1016/j.apmr.2011.08.013

Balyk, R., Luciak-Corea, C., Otto, D., Baysal, D., & Beaupre, L. (2008). Do outcomes differ after rotator cuff repair for patients receiving workers' compensation? *Clinical Orthopaedics and Related Research®, 466*(12), 3025-3033. doi: 10.1007/s11999-008-0475-1

Barfield, L.C., & Kuhn, J.E. (2007). Arthroscopic versus open acromioplasty: A systematic review. *Clinical Orthopaedics and Related Research, 455*, 64-71 10.1097/BLO.1090b1013e31802f35436.

Beaufils, P., Hulet, C., Dhénain, M., Nizard, R., Nourissat, G., & Pujol, N. (2009). Clinical practice guidelines for the management of meniscal lesions and isolated lesions of the anterior cruciate ligament of the knee in adults. *Orthopaedics & Traumatology: Surgery & Research, 95*(6), 437-442. doi: 10.1016/j.otsr.2009.06.002

Beaupre, L.A., Lier, D., Davies, D.M., & Johnston, D.B.C. (2004). The effect of a preoperative exercise and education program on functional recovery, health related quality of life, and

health service utilization following primary total knee arthroplasty. *The Journal of Rheumatology, 31*(6), 1166-1173.

Beck, A., Ward, C., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 561-571.

Beck, A.T., & Steer, R.A. (1984). Internal consistencies of the original and revised beck depression inventory. *Journal of clinical psychology, 40*(6), 1365-1367.

Beck, A.T., Steer, R.A., & Carbin, M.G. (1988). Psychometric properties of the beck depression inventory: Twenty-five years of evaluation. *Clinical Psychology Review, 8*(1), 77-100. doi: 10.1016/0272-7358(88)90050-5

Beck, J.D., Brothers, J.G., Maloney, P.J., Deegan, J.H., Tang, X., & Klena, J.C. (2012). Predicting the outcome of revision carpal tunnel release. *The Journal of Hand Surgery, 37*(2), 282-287. doi: 10.1016/j.jhsa.2011.10.040

Bengtsson, M., Lunsjö, K., Hermodsson, Y., Nordqvist, A., & Abu-Zidan, F.M. (2006). High patient satisfaction after arthroscopic subacromial decompression for shoulder impingement: A prospective study of 50 patients. *Acta Orthopaedica, 77*(1), 138-142.

Bhagia, S.M. (2012). Meniscal injury *Physical Medicine & Rehabilitation Articles: Lower Limb Musculoskeletal Conditions.* Retrieved 5/9/2012, from http://emedicine.medscape.com/article/308054-overview

Bilal, R.H. (2011). Rotator cuff pathology *Orthopedic Surgery Articles: Knee.* Retrieved 5/9/2012, from http://emedicine.medscape.com/article/1262849-overview

Birkmeyer, N.J.O., Weinstein, J.N., Tosteson, A.N.A., Tosteson, T.D., Skinner, J.S., Lurie, J.D., . . . Wennberg, J.E. (2002). Design of the spine patient outcomes research trial (sport). *Spine, 27*(12), 1361-1372.

Bishop, J., Klepps, S., Lo, I.K., Bird, J., Gladstone, J.N., & Flatow, E.L. (2006). Cuff integrity after arthroscopic versus open rotator cuff repair: A prospective study. *Journal of Shoulder and Elbow Surgery, 15*(3), 290-299. doi: 10.1016/j.jse.2005.09.017

Bohlman, H.H., Emery, S.E., Goodfellow, D.B., & Jones, P.K. (1993). Robinson anterior cervical discectomy and arthrodesis for cervical radiculopathy. Long-term follow-up of one hundred and twenty-two patients. *The Journal of bone and joint surgery. American volume, 75*(9), 1298-1307.

Bono, C.M., & Garfin, S.R. (2004). *Spine*: Lippincott Williams & Wilkins.

Brede, E., Mayer, T.G., & Gatchel, R.J. (2012). Prediction of failure to retain work 1 year after interdisciplinary functional restoration in occupational injuries. *Archives of Physical Medicine and Rehabilitation, 93*(2), 268-274. doi: 10.1016/j.apmr.2011.08.029

Brox, J.I., Reikerås, O., Nygaard, Ø., Sørensen, R., Indahl, A., Holm, I., . . . Friis, A. (2006). Lumbar instrumented fusion compared with cognitive intervention and exercises in patients with chronic back pain after previous surgery for disc herniation: A prospective randomized controlled study. *Pain, 122*(1–2), 145-155. doi: 10.1016/j.pain.2006.01.027

Brox, J.I., Sorensen, R., Friis, A., Nygaard, O., Indahl, A., Keller, A., . . . Reikeras, O. (2003). Randomized clinical trial of lumbar instrumented fusion and cognitive intervention and exercises in patients with chronic low back pain and disc degeneration. *Spine, 28*(17), 1913-1921.

Burke, F.D., Wilgis, E.F.S., Dubin, N.H., Bradley, M.J., & Sinha, S. (2006). Relationship between the duration and severity of symptoms and the outcome of carpal tunnel surgery. *The Journal of Hand Surgery, 31*(9), 1478-1482. doi: 10.1016/j.jhsa.2006.08.017

Cameron, B.D., Galatz, L.M., Ramsey, M.L., Williams, G.R., & Iannotti, J.P. (2002). Non-prosthetic management of grade iv osteochondral lesions of the glenohumeral joint. *Journal of Shoulder and Elbow Surgery, 11*(1), 25-32. doi: 10.1067/mse.2002.120143

Cameron, T. (2004). Safety and efficacy of spinal cord stimulation for the treatment of chronic pain: A 20-year literature review. *Journal of Neurosurgery: Spine, 100*(3), 254-267. doi: doi:10.3171/spi.2004.100.3.0254

Campbell, M.K., Fiddian, N., Fitzpatrick, R., Grant, A.M., Gray, A., Morris, R., . . . Walker, A. (2009). The knee arthroplasty trial (kat) : Design features, baseline characteristics and

two-year functional outcomes after alternative approaches to knee replacement. *Journal of Bone and Joint Surgery, 91*(1), 134-141. doi: 10.2106/JBJS.G.01074

Carmona, L., Faucett, J., Blanc, P.D., & Yelin, E. (1998). Predictors of rate of return to work after surgery for carpal tunnel syndrome. *Arthritis & Rheumatism, 11*(4), 298-305. doi: 10.1002/art.1790110411

Carragee, E.J., Hurwitz, E.L., Cheng, I., Carroll, L.J., Nordin, M., Guzman, J., . . . Haldeman, S. (2009). Treatment of neck pain: Injections and surgical interventions: Results of the bone and joint decade 2000–2010 task force on neck pain and its associated disorders. *Journal of Manipulative and Physiological Therapeutics, 32*(2), S176-S193.

Carragee, E.J., Hurwitz, E.L., & Weiner, B.K. (2011). A critical review of recombinant human bone morphogenetic protein-2 trials in spinal surgery: Emerging safety concerns and lessons learned. *The Spine Journal, 11*(6), 471-491. doi: 10.1016/j.spinee.2011.04.023

Cauthen, J.C., Kinard, R.E., Vogler, J.B., Jackson, D.E., DePaz, O.B., Hunter, O.L., . . . Williams, V.M. (1998). Outcome analysis of noninstrumented anterior cervical discectomy and interbody fusion in 348 patients. *Spine, 23*(2), 188-192.

Chahal, J., Mall, N., MacDonald, P.B., Van Thiel, G., Cole, B.J., Romeo, A.A., & Verma, N.N. (2012). The role of subacromial decompression in patients undergoing arthroscopic repair of full-thickness tears of the rotator cuff: A systematic review and meta-analysis. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 28*(5), 720-727. doi: 10.1016/j.arthro.2011.11.022

Chatain, F., Adeleine, P., Chambat, P., & Neyret, P. (2003). A comparative study of medial versus lateral arthroscopic partial meniscectomy on stable knees: 10-year minimum follow-up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 19*(8), 842-849. doi: 10.1016/s0749-8063(03)00735-7

Chaudhari, M., & Mackenzie, P. (2008). Implantable technology for pain management. *Anaesthesia & Intensive Care Medicine, 9*(2), 69-74. doi: 10.1016/j.mpaic.2007.11.003

Chou, R., Atlas, S.J., Stanos, S.P., & Rosenquist, R.W. (2009). Nonsurgical interventional therapies for low back pain: A review of the evidence for an american pain society clinical practice guideline. *Spine, 34*(10), 1078-1093 1010.1097/BRS.1070b1013e3181a1103b1071.

Chou, R., Baisden, J., Carragee, E.J., Resnick, D.K., Shaffer, W.O., & Loeser, J.D. (2009). Surgery for low back pain: A review of the evidence for an american pain society clinical practice guideline. *Spine, 34*(10), 1094-1109 1010.1097/BRS.1090b1013e3181a1105fc.

Chou, R., & Shekelle, P. (2010). Will this patient develop persistent disabling low back pain? *Journal of the American Medical Association, 303*(13), 1295-1302.

Chou, Y.-C., Chen, D.-C., Hsieh, W.A., Chen, W.-F., Yen, P.-S., Harnod, T., . . . Chen, S.-Y. (2008). Efficacy of anterior cervical fusion: Comparison of titanium cages, polyetheretherketone (peek) cages and autogenous bone grafts. *Journal of Clinical Neuroscience, 15*(11), 1240-1245. doi: 10.1016/j.jocn.2007.05.016

Cofield, R.H., Parvizi, J., Hoffmeyer, P.J., Lanzer, W.L., Ilstrup, D.M., & Rowland, C.M. (2001). Surgical repair of chronic rotator cuff tears : A prospective long-term study. *The Journal of Bone & Joint Surgery, 83*, 71-77.

Coghlan, J.A., Buchbinder, R., Green, S., Johnston, R.V., & Bell, S.N. (2009). Surgery for rotator cuff disease. *Cochrane Database of Systematic Reviews, 1*(Art. No.: CD005619). doi: 10.1002/14651858.CD005619.pub2

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2 ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cole, B.J., McCarty Iii, L.P., Kang, R.W., Alford, W., Lewis, P.B., & Hayden, J.K. (2007). Arthroscopic rotator cuff repair: Prospective functional outcome and repair integrity at minimum 2-year follow-up. *Journal of Shoulder and Elbow Surgery, 16*(5), 579-585. doi: 10.1016/j.jse.2006.12.011

Concannon, M.J., Brownfield, M.L., & Puckett, C.L. (2000). The incidence of recurrence after endoscopic carpal tunnel release. *Plastic and Reconstructive Surgery, 105*(5), 1662-1665.

Conti, M., Garofalo, R., Delle Rose, G., Massazza, G., Vinci, E., Randelli, M., & Castagna, A. (2009). Post-operative rehabilitation after surgical repair of the rotator cuff. *Musculoskeletal Surgery, 93*(0), 55-63. doi: 10.1007/s12306-009-0003-9

Cote, P., Cassidy, J.D., & Carroll, L. (2003). The epidemiology of neck pain: What we have learned from our population-based studies. *JCCA. Journal of the Canadian Chiropractic Association. Journal de l'Association chiropratique canadienne, 47*(4), 284-290.

Cowan, J., Makanji, H., Mudgal, C., Jupiter, J., & Ring, D. (2012). Determinants of return to work after carpal tunnel release. *The Journal of Hand Surgery, 37*(1), 18-27. doi: 10.1016/j.jhsa.2011.10.033

Cuff, D.J., & Pupello, D.R. (2012). Prospective evaluation of postoperative compliance and outcomes after rotator cuff repair in patients with and without workers' compensation claims. *Journal of Shoulder and Elbow Surgery*(0). doi: 10.1016/j.jse.2012.03.002

D'Lima, D.D., Colwell, C.W.J., Morris, B.A., Hardwick, M.E., & Kozin, F. (1996). The effect of preoperative exercise on total knee replacement outcomes. *Clinical Orthopaedics and Related Research, 326*, 174-182.

Daniell, W.E., Fulton-Kehoe, D., & Franklin, G.M. (2009). Work-related carpal tunnel syndrome in washington state workers' compensation: Utilization of surgery and the duration of lost work. *American Journal of Industrial Medicine, 52*(12), 931-942.

Danielsen, J.M., Johnsen, R., Kibsgaard, S.K., & Hellevik, E. (2000). Early aggressive exercise for postoperative rehabilitation after discectomy. *Spine, 25*(8), 1015-1020.

Davis, R.A. (1994). A long-term outcome analysis of 984 surgically treated herniated lumbar discs. *Journal of Neurosurgery, 80*(3), 415-421. doi: doi:10.3171/jns.1994.80.3.0415

Davis, R.A. (1996). A long-term outcome study of 170 surgically treated patients with compressive cervical radiculopathy. *Surgical Neurology, 46*(6), 523-533. doi: 10.1016/s0090-3019(96)00278-9

de Beer, J., Petruccelli, D., Gandhi, R., & Winemaker, M. (2005). Primary total knee arthroplasty in patients receiving workers' compensation benefits. *Canadian Journal of Surgery, 48*(2), 100-105.

de Lissovoy, G., Brown, R.E., Halpern, M., Hassenbusch, S.J., & Ross, E. (1997). Cost-effectiveness of long-term intrathecal morphine therapy for pain associated with failed back surgery syndrome. *Clinical Therapeutics, 19*(1), 96-112. doi: 10.1016/s0149-2918(97)80077-x

DeBerard, S., Masters, K.S., Colledge, A.L., Schleusener, R.L., & Schlegel, J., D. (2001). Outcomes of posterolateral lumbar fusion in utah patients receiving workers' compensation: A retrospective cohort study. *Spine, 26*(7), 738-746.

DeBerardino, T.M. (2012). Shoulder impingement syndrome *Sports Medicine Articles: Shoulder.* Retrieved 5-9-2012, from http://emedicine.medscape.com/article/92974-overview

Deer, T., Chapple, I., Classen, A., Javery, K., Stoker, V., Tonder, L., & Burchiel, K. (2004). Intrathecal drug delivery for treatment of chronic low back pain: Report from the national outcomes registry for low back pain. *Pain medicine (Malden, Mass.), 5*(1), 6-13.

Deguchi, M., Rapoff, A.J., & Zdeblick, T.A. (1998). Posterolateral fusion for isthmic spondylolisthesis in adults: Analysis of fusion rate and clinical results. *Journal of Spinal Disorders, 11*(6), 459-464.

Demartini, L., Stocco, E., & Bonezzi, C. (2010). Failed back surgery syndrome and intrathecal drugs infusion. *European Journal of Pain Supplements, 4*(4), 299-301. doi: 10.1016/j.eujps.2010.09.015

den Boer, J., Oostendorp, R., Beems, T., Munneke, M., Oerlemans, M., & Evers, A. (2006). A systematic review of bio-psychosocial risk factors for an unfavourable outcome after

lumbar disc surgery. *European Spine Journal, 15*(5), 527-536. doi: 10.1007/s00586-005-0910-x

Denniston, P.J., & Kennedy Jr., C.W. (2012). *2012 official disability guidelines* (Vol. 17). San Diego, CA: Work-Loss Data Institute.

Desmeules, F., Dionne, C.E., Belzile, É., Bourbonnais, R., & Frémont, P. (2010). The burden of wait for knee replacement surgery: Effects on pain, function and health-related quality of life at the time of surgery. *Rheumatology, 49*(5), 945-954. doi: 10.1093/rheumatology/kep469

DeStefano, F., Nordstrom, D.L., & Vierkant, R.A. (1997). Long-term symptom outcomes of carpal tunnel syndrome and its treatment. *The Journal of Hand Surgery, 22*(2), 200-210. doi: 10.1016/s0363-5023(97)80152-9

Deyo, R.A., & Mirza, S.K. (2006). Trends and variations in the use of spine surgery. *Clinical Orthopaedics and Related Research, 443*, 139-146 110.1097/1001.blo.0000198726.0000162514.0000198775.

Deyo, R.A., Mirza, S.K., Martin, B.I., Kreuter, W., Goodman, D.C., & Jarvik, J.G. (2010). Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *Journal of the American Medical Association, 303*(13), 1259-1265. doi: 10.1001/jama.2010.338

Doleys, D.M., Brown, J.L., & Ness, T. (2006). Multidimensional outcomes analysis of intrathecal, oral opioid, and behavioral–functional restoration therapy for failed back surgery syndrome: A retrospective study with 4 years' follow-up. *Neuromodulation: Technology at the Neural Interface, 9*(4), 270-283. doi: 10.1111/j.1525-1403.2006.00069.x

Dom, K., Van Glabbeek, F., Van Rie, R.P., Verborgt, O., & Wuyts, F.L. (2003). Arthroscopic subacromial decompression for advanced (stage ii) impingement syndrome: A study of 52 patients with five years follow-up. *Acta Orthopaedica Belgica 69*(1), 13-17.

Dopirak, R., & Ryu, R.K.N. (2010). Management of the failed arthroscopic subacromial decompression: Causation and treatment. *Sports Medicine and Arthroscopy Review, 18*(3), 207-212 210.1097/JSA.1090b1013e3181eb1096ce1098.

Dunn, W.R., Schackman, B.R., Walsh, C., Lyman, S., Jones, E.C., Warren, R.F., & Marx, R.G. (2005). Variation in orthopaedic surgeons' perceptions about the indications for rotator cuff surgery. *The Journal of Bone & Joint Surgery, 87*, 1978-1984. doi: 10.2106/JBJS.D.02944

Edwards, R.R., Haythornthwaite, J.A., Smith, M.T., Klick, B., & Katz, J.N. (2009). Catastrophizing and depressive symptoms as prospective predictors of outcomes following total knee replacement. *Pain Research and Management, 14*(4), 307-311.

Ehrmann-Feldman, D., Rossignol, M., Abenhaim, L., & Gobeille, D. (1996). Physician referral to physical therapy in a cohort of workers compensated for low back pain. *Physical Therapy, 76*(2), 150-156.

Eldabe, S., Kumar, K., Buchser, E., & Taylor, R.S. (2010). An analysis of the components of pain, function, and health-related quality of life in patients with failed back surgery syndrome treated with spinal cord stimulation or conventional medical management. *Neuromodulation: Technology at the Neural Interface, 13*(3), 201-209. doi: 10.1111/j.1525-1403.2009.00271.x

Ellman, H. (2010). Arthroscopic subacromial decompression: Analysis of one- to three-year results. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 26*(1), 104. doi: 10.1016/j.arthro.2009.10.003

Erdogmus, C.B., Resch, K.-L., Sabitzer, R., Muller, H., Nuhr, M., Schoggl, A., . . . Ebenbichler, G.R. (2007). Physiotherapy-based rehabilitation following disc herniation operation: Results of a randomized clinical trial. *Spine, 32*(19), 2041-2049.

Evans, T., Mayer, T.G., & Gatchel, R.J. (2001). Recurrent disabling work-related spinal disorders after prior injury claims in a chronic low back pain population. *The Spine Journal, 1*, 183-189.

Faber, E., Kuiper, J., Burdorf, A., Miedema, H., & Verhaar, J. (2006). Treatment of impingement syndrome: A systematic review of the effects on functional limitations and return to work. *Journal of Occupational Rehabilitation, 16*(1), 6-24. doi: 10.1007/s10926-005-9003-2

Fabricant, P.D., Rosenberger, P.H., Jokl, P., & Ickovics, J.R. (2008). Predictors of short-term recovery differ from those of long-term outcome after arthroscopic partial meniscectomy. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 24*(7), 769-778. doi: 10.1016/j.arthro.2008.02.015

Fairbank, J., Frost, H., Wilson-MacDonald, J., Yu, L.M., Barker, K., Collins, R., & Spine Stabilisation Trial, G. (2005). Randomised controlled trial to compare surgical stabilisation of the lumbar spine with an intensive rehabilitation programme for patients with chronic low back pain: The mrc spine stabilisation trial. *BMJ (Clinical research ed.), 330*(7502), 1233.

Fairbank, J.C.T., & Pynsent, P.B. (2000). The oswestry disability index. *Spine, 25*(22), 2940-2953.

Fayssoux, R., Goldfarb, N.I., Vaccaro, A.R., & Harrop, J. (2010). Indirect costs associated with surgery for low back pain—a secondary analysis of clinical trial data *Population Health Management 13*(1), 9-13. doi: 10.1089/pop.2009.0061

Ferkel, R.D., Randall Davis, J., Friedman, M.J., Fox, J.M., Del Pizzo, W., Snyder, S.J., & Berasi, C.C. (1985). Arthroscopic partial medial meniscectomy: An analysis of unsatisfactory results. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 1*(1), 44-52. doi: 10.1016/s0749-8063(85)80078-5

Feuerstein, M., Burrell, L.M., Miller, V.I., Lincoln, A., Huang, G.D., & Berger, R. (1999). Clinical management of carpal tunnel syndrome: A 12-year review of outcomes. *American Journal of Industrial Medicine, 35*(3), 232-245. doi: 10.1002/(sici)1097-0274(199903)35:3<232::aid-ajim3>3.0.co;2-g

Fischgrund, J.S., Mackay, M., Herkowitz, H.N., Brower, R., Montgomery, D.M., & Kurz, L.T. (1997). 1997 volvo award winner in clinical studies: Degenerative lumbar

spondylolisthesis with spinal stenosis: A prospective, randomized study comparing decompressive laminectomy and arthrodesis with and without spinal instrumentation. *Spine, 22*(24), 2807-2812.

Follett, K.A., & Naumann, C.P. (2000). A prospective study of catheter-related complications of intrathecal drug delivery systems. *Journal of Pain and Symptom Management, 19*(3), 209-215. doi: 10.1016/s0885-3924(99)00153-0

Franklin, G.M., Haug, J., Heyer, N.J., McKeefrey, S.P., & Picciano, J.F. (1994). Outcome of lumbar fusion in washington state workers' compensation. *Spine, 19*(17), 1897-1903.

Frey, M.E., Manchikanti, L., Benyamin, R.M., Schultz, D.M., Smith, H.S., & Cohen, S.P. (2009). Spinal cord stimulation for patients with failed back surgery syndrome: A systematic review. *Pain Physician, 12*(2), 379-397.

Frieman, B.G., & Fenlin Jr, J.M. (1995). Anterior acromioplasty: Effect of litigation and workers' compensation. *Journal of Shoulder and Elbow Surgery, 4*(3), 175-181. doi: 10.1016/s1058-2746(05)80048-5

Fritzell, P., Hagg, O., Wessberg, P., & Nordwall, A. (2001). 2001 volvo award winner in clinical studies: Lumbar fusion versus nonsurgical treatment for chronic low back pain: A multicenter randomized controlled trial from the swedish lumbar spine study group. *Spine, 26*(23), 2521-2532.

Fuller, D.A. (2010). Orthopedic surgery for carpal tunnel syndrome *Orthopedic Surgery Articles: Hand And Upper Extremity.* Retrieved 5/11/2012, from http://emedicine.medscape.com/article/1243192-overview

Galatz, L.M. (2008). *Orthopaedic knowledge update: Shoulder and elbow* (3 ed.). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Galatz, L.M., Rothermich, S.Y., Zaegel, M., Silva, M.J., Havlioglu, N., & Thomopoulos, S. (2005). Delayed repair of tendon to bone injuries leads to decreased biomechanical properties and bone loss. *Journal of Orthopaedic Research, 6*, 1441-1447. doi: 10.1016/j.orthres.2005.05.005.1100230629

Garcy, P., Mayer, T.G., & Gatchel, R.J. (1996). Recurrent or new injury outcomes after return to work in chronic disabling spinal disorders: Tertiary prevention efficacy of functional restoration treatment. *Spine (Phila Pa 1976), 21*, 952-959.

Gatchel, R., Polatin, P.B., Noe, C., Gardea, M., Pulliam, C., & Thompson, J. (2003). Treatment- and cost-effectiveness of early intervention for acute low-back pain patients: A one-year prospective study. *Journal of Occupational Rehabilitation, 13*(1), 1-9. doi: 10.1023/a:1021823505774

Gatchel, R.J., & Mayer, T.G. (2008). Psychological evaluation of the spine patient. *Journal of the American Academy of Orthopaedic Surgeons, 16*, 107-112.

Gatchel, R.J., Mayer, T.G., Dersh, J., Robinson, R., & Polatin, P. (1999). The association of the sf-36 health status survey with one-year socioeconomic outcomes in a chronically disabled spinal disorder population. *Spine (Phila Pa 1976), 24*, 2162-2170.

Gatchel, R.J., Mayer, T.G., & Theodore, B.R. (2006). The pain disability questionnaire: Relationship to one-year functional and psychosocial rehabilitation outcomes. *Journal of Occupational Rehabilitation, 16*, 75-94.

Gatchel, R.J., Polatin, P., Mayer, T.G., Robinson, R., & Dersh, J. (1998). Use of the sf-36 health status survey with a chronically disabled back pain population: Strengths and limitations. *Journal of Occupational Rehabilitation, 8*, 237-245.

Gawronski, B., Bodenhausen, G.V., & Becker, A.P. (2007). I like it, because i like myself: Associative self-anchoring and post-decisional change of implicit evaluations. *Journal of Experimental Social Psychology, 43*(2), 221-232. doi: 10.1016/j.jesp.2006.04.001

Gebremariam, L., Hay, E.M., Koes, B.W., & Huisstede, B.M. (2011). Effectiveness of surgical and postsurgical interventions for the subacromial impingement syndrome: A systematic review. *Archives of Physical Medicine and Rehabilitation, 92*(11), 1900-1913. doi: 10.1016/j.apmr.2011.06.006

Geel, C.W., & Flemister, A.S.J. (2001). Standardized treatment of intra-articular calcaneal fractures using an oblique lateral incision and no bone graft. *The Journal of Trauma and Acute Care Surgery, 50*(6), 1083-1089.

Geisser, M.E., Roth, R.S., & Robinson, M.E. (1997). Assessing depression among persons with chronic pain using the center for epidemiological studies-depression scale and the beck depression inventory: A comparative analysis. *The Clinical Journal of Pain, 13*(2), 163-170.

Gerber, C., Maquieira, G., & Espinosa, N. (2006). Latissimus dorsi transfer for the treatment of irreparable rotator cuff tears. *The Journal of Bone & Joint Surgery, 88*, 113-120. doi: 10.2106/JBJS.E.00282

Glassman, A.H., Lachiewicz, P.F., & Tanzer, M. (2011). *Orthopaedic knowledge update: Hip and knee reconstruction* (4 ed.). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Goldberg, E.J., Singh, K., Van, U., Garretson, R., & An, H.S. (2002). Comparing outcomes of anterior cervical discectomy and fusion in workman's versus non–workman's compensation population. *The Spine Journal, 2*(6), 408-414. doi: 10.1016/s1529-9430(02)00441-2

Gong, H.S., Oh, J.H., Bin, S.W., Kim, W.S., Chung, M.S., & Baek, G.H. (2008). Clinical features influencing the patient-based outcome after carpal tunnel release. *The Journal of Hand Surgery, 33*(9), 1512-1517. doi: 10.1016/j.jhsa.2008.05.020

Goodwin, P.C., Morrissey, M.C., Omar, R.Z., Brown, M., Southall, K., & McAuliffe, T.B. (2003). Effectiveness of supervised physical therapy in the early period after arthroscopic partial meniscectomy. *Physical Therapy, 83*(6), 520-535.

Goutallier, D., Postel, J.-M., Gleyze, P., Leguilloux, P., & Van Driessche, S. (2003). Influence of cuff muscle fatty degeneration on anatomic and functional outcomes after simple suture of full-thickness tears. *Journal of Shoulder and Elbow Surgery, 12*(6), 550-554. doi: 10.1016/s1058-2746(03)00211-8

Grönblad, M., Hupli, M., Wennerstrand, P., Järvinen, E., Lukinmaa, A., Kouri, J.-P., & Karaharju, E.O. (1993). Intel-correlation and test-retest reliability of the pain disability index (pdi) and the oswestry disability questionnaire (odq) and their correlation with pain intensity in low back pain patients. *The Clinical Journal of Pain, 9*(3), 189-195.

Hara, K.W., & Borchgrevink, P. (2010). National guidelines for evaluating pain—patients' legal right to prioritised health care at multidisciplinary pain clinics in norway implemented 2009. *Scandinavian Journal of Pain, 1*(1), 60-63. doi: 10.1016/j.sjpain.2009.10.002

Hashemi, L., Webster, B.S., Clancy, E.A., & Volinn, E. (1997). Length of disability and cost of workers' compensation low back pain claims. *Journal of Occupational and Environmental Medicine, 39*(10), 937-945.

Heck, D.A., Robinson, R.L., Partridge, C.M., Lubitz, R.M., & Freund, D.A. (1998). Patient outcomes after knee replacement. *Clinical Orthopaedics and Related Research, 356*, 93-110.

Heckle, D.R., Gatchel, R.J., Lou, L., Whitworth, T., Bernstein, D., & Stowell, A.W. (2007). Presurgical behavioral medicine evaluation (pbme) for implantable devices for pain management: A 1-year prospective study. *Pain Practice, 7*(2), 110-122. doi: 10.1111/j.1533-2500.2007.00118.x

Henn, R.F., Kang, L., Tashjian, R.Z., & Green, A. (2008). Patients with workers' compensation claims have worse outcomes after rotator cuff repair. *The Journal of Bone & Joint Surgery, 90*(10), 2105-2113. doi: 10.2106/jbjs.f.00260

Herno, A.M.D.P., Partanen, K.M.D.P., Talaslahti, T.M.D., Kaukanen, E.M.D., Turunen, V.M.D., Suomalainen, O.M.D.P., & Airaksinen, O.M.D.P. (1999). Long-term clinical and magnetic resonance imaging follow-up assessment of patients with lumbar spinal stenosis after laminectomy. *Spine, 24*(15), 1533.

Higgs, P.E., Edwards, D., Martin, D.S., & Weeks, P.M. (1995). Carpal tunnel surgery outcomes in workers: Effect of workers' compensation status. *The Journal of Hand Surgery, 20*(3), 354-360. doi: 10.1016/s0363-5023(05)80086-3

Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics, 6*, 65-70.

Holmgren, T., Öberg, B., Sjöberg, I., & Johansson, K. (2012). Supervised strengthening exercises versus home-based movement exercises after arthroscopic acromioplasty: A randomized clinical trial. *Journal of Rehabilitation Medicine, 44*(1), 12-18. doi: 10.2340/16501977-0889

Holtby, R., & Razmjou, H. (2010). Impact of work-related compensation claims on surgical outcome of patients with rotator cuff related pathologies: A matched case-control study. *Journal of Shoulder and Elbow Surgery, 19*(3), 452-460. doi: 10.1016/j.jse.2009.06.011

Howard, K.J., Mayer, T.G., Theodore, B.R., & Gatchel, R.J. (2009). Patients with chronic disabling occupational musculoskeletal disorder failing to complete functional restoration: Analysis of treatment-resistant personality characteristics. *Archives of Physical Medicine and Rehabilitation, 90*(5), 778-785. doi: 10.1016/j.apmr.2008.11.009

Hoy, D.G., Bain, C., Williams, G., March, L., Brooks, P., Blyth, F., . . . Buchbinder, R. (2012). A systematic review of the global prevalence of low back pain. *Arthritis & Rheumatism, Forthcoming*. doi: 10.1002/art.34347

Huisstede, B.M., Hoogvliet, P., Randsdorp, M.S., Glerum, S., van Middelkoop, M., & Koes, B.W. (2010). Carpal tunnel syndrome. Part i: Effectiveness of nonsurgical treatments–a systematic review. *Archives of Physical Medicine and Rehabilitation, 91*(7), 981-1004. doi: 10.1016/j.apmr.2010.03.022

Hulen, C.A. (2008). A review of the significance, indications, techniques, and outcomes of revision lumbar laminectomy surgery. *Seminars in Spine Surgery, 20*(4), 270-276. doi: 10.1053/j.semss.2008.08.005

Iannotti, J.P., Bernot, M.P., Kuhlman, J.R., Kelley, M.J., & Williams, G.R. (1996). Postoperative assessment of shoulder function: A prospective study of full-thickness rotator cuff tears. *Journal of Shoulder and Elbow Surgery, 5*(6), 449-457. doi: 10.1016/s1058-2746(96)80017-6

Järvelä, S., Järvelä, T., Aho, H., & Kiviranta, I. (2010). Arthroscopic subacromial decompression: Outcome comparison between outpatient and hospitalized patients with 2- to 5-year follow-up. *Scandinavian Journal of Surgery, 99*(1), 50-54.

Jensen, M.P., Chen, C., & Brugger, A.M. (2003). Interpretation of visual analog scale ratings and change scores: A reanalysis of two clinical trials of postoperative pain. *The Journal of Pain, 4*(7), 407-414. doi: 10.1016/s1526-5900(03)00716-8

Jensen, M.P., Karoly, P., & Braver, S. (1986). The measurement of clinical pain intensity: A comparison of six methods. *Pain, 27*(1), 117-126. doi: 10.1016/0304-3959(86)90228-9

Jordan, K., Mayer, T.G., & Gatchel, R.J. (1998). Should extended disability be an exclusion criterion for tertiary rehabilitation? Socioeconomic outcomes of early versus late functional restoration compensation spinal disorders. *Spine (Phila Pa 1976), 23*, 2110-2117.

Juratli, S.M.M.D.M.P.H., Franklin, G.M.M.D.M.P.H., Mirza, S.K.M.D.M.P.H., Wickizer, T.M.P.M.P.H., & Fulton-Kehoe, D.P.M.P.H. (2006). Lumbar fusion outcomes in washington state workers' compensation. *Spine, 31*(23), 2715-2723.

Kaptain, G.J., Shaffrey, C.I., Alden, T.D., Young, J.N., Laws Jr, E.R., & Whitehill, R. (1999). Secondary gain influences the outcome of lumbar but not cervical disc surgery. *Surgical Neurology, 52*(3), 217-225. doi: 10.1016/s0090-3019(99)00087-7

Katz, J.N., Amick, B.C., Keller, R., Fossel, A.H., Ossman, J., Soucie, V., & Losina, E. (2005). Determinants of work absence following surgery for carpal tunnel syndrome. *American Journal of Industrial Medicine, 47*(2), 120-130. doi: 10.1002/ajim.20127

Katz, J.N., Harris, T.M., Larson, M.G., Krushell, R.J., Brown, C.H., Fossel, A.H., & Liang, M.H. (1992). Predictors of functional outcomes after arthroscopic partial meniscectomy. *Journal of Rheumatology, 19*(12), 1938-1942.

Katz, J.N., Losina, E., Amick, B.C., Fossel, A.H., Bessette, L., & Keller, R.B. (2001). Predictors of outcomes of carpal tunnel release. *Arthritis and rheumatism, 44*(5), 1184-1193.

Katz, J.N., Meredith, D.S., Lang, P., Creel, A.H., Yoshioka, H., Neumann, G., . . . Losina, E. (2006). Associations among preoperative mri features and functional status following arthroscopic partial meniscectomy. *Osteoarthritis and Cartilage, 14*(5), 418-422. doi: 10.1016/j.joca.2005.11.014

Keener, J.D. (2008). Partial-thickness rotator cuff tears. In L. M. Galatz (Ed.), *Orthopaedic knowledge update: Shoulder and elbow* (3 ed., pp. 161-172). Rosemont, IL: American Academy of Orthopaedic Surgeons.

Keller, A.M.D., Brox, J.I.M.D.P., Gunderson, R.M.D., Holm, I.P.T.P., Friis, A.P.T., & Reikeras, O.M.D.P. (2004). Trunk muscle strength, cross-sectional area, and density in patients with chronic low back pain randomized to lumbar fusion or cognitive intervention and exercises. *Spine, 29*(1), 3-8.

Kelln, B., Ingersoll, C., Saliba, S., Miller, M., & Hertel, J. (2009). Effect of early active range of motion rehabilitation on outcome measures after partial meniscectomy. *Knee Surgery, Sports Traumatology, Arthroscopy, 17*(6), 607-616. doi: 10.1007/s00167-009-0723-2

Kendall, P.C., Hollon, S.D., Beck, A.T., Hammen, C.L., & Ingram, R.E. (1987). Issues and recommendations regarding use of the beck depression inventory. *Cognitive Therapy and Research, 11*(3), 289-299. doi: 10.1007/bf01186280

Keskimäki, I., Seitsalo, S., Österman, H., & Rissanen, P. (2000). Reoperations after lumbar disc surgery: A population-based study of regional and interspecialty variations. *Spine, 25*(12), 1500-1508.

Khatod, M., Inacio, M., Paxton, E.W., Bini, S.A., Namba, R.S., Burchette, R.J., & Fithian, D.C. (2008). Knee replacement: Epidemiology, outcomes, and trends in southern california 17,080 replacements from 1995 through 2004. *Acta Orthopaedica, 79*(6), 812-819. doi: doi:10.1080/17453670810016902

Kidner, C., Mayer, T.G., & Gatchel, R.J. (2009). Higher opioid doses predict poorer functional outcome in chronic disabling occupational musculoskeletal disorders. *Journal of Bone and Joint Surgery, 91*(4), 919-927.

Kim, J.K., & Kim, Y.K. (2011). Predictors of scar pain after open carpal tunnel release. *The Journal of Hand Surgery, 36*(6), 1042-1046. doi: 10.1016/j.jhsa.2011.03.036

Kim, S.-J., Chun, Y.-M., Jeong, J.-H., Ryu, S.-W., Oh, K.-S., & Lubis, A. (2007). Effects of arthroscopic meniscectomy on the long-term prognosis for the discoid lateral meniscus. *Knee Surgery, Sports Traumatology, Arthroscopy, 15*(11), 1315-1320.

Kim, S., Mortaz Hedjri, S., Coyte, P.C., & Rampersaud, Y.R. (2012). Cost-utility of lumbar decompression with or without fusion for patients with symptomatic degenerative lumbar spondylolisthesis. *The Spine Journal, 12*(1), 44-54. doi: 10.1016/j.spinee.2011.10.004

Kishen, T.J., & Diwan, A.D. (2010). Fusion versus disk replacement for degenerative conditions of the lumbar and cervical spine: Quid est testimonium? *The Orthopedic clinics of North America, 41*(2), 167-181.

Klekamp, J., McCarty, E., & Spengler, D.M. (1998). Results of elective lumbar discectomy for patients involved in the workers' compensation system. *Journal of Spinal Disorders, 11*(4), 277-282.

Klintberg, I.H., Gunnarsson, A.-C., Svantesson, U., Styf, J., & Karlsson, J. (2008). Early activation or a more protective regime after arthroscopic subacromial decompression -- a description of clinical changes with two different physiotherapy treatment protocols -- a prospective, randomized pilot study with a two-year follow-up. *Clinical Rehabilitation, 22*(10-11), 951-965.

Koes, B., van Tulder, M., Lin, C.-W., Macedo, L., McAuley, J., & Maher, C. (2010). An updated overview of clinical guidelines for the management of non-specific low back pain in primary care. *European Spine Journal, 19*(12), 2075-2094. doi: 10.1007/s00586-010-1502-y

Koljonen, P., Chong, C., & Yip, D. (2009). Difference in outcome of shoulder surgery between workers' compensation and nonworkers' compensation populations. *International Orthopaedics, 33*(2), 315-320. doi: 10.1007/s00264-007-0493-8

Konya, D., Ozgen, S., Gercek, A., & Pamir, M.N. (2009). Outcomes for combined anterior and posterior surgical approaches for patients with multisegmental cervical spondylotic myelopathy. *Journal of Clinical Neuroscience, 16*(3), 404-409. doi: 10.1016/j.jocn.2008.07.070

Koukoulias, N., Papastergiou, S., Kazakos, K., Poulios, G., & Parisis, K. (2007). Clinical results of meniscus repair with the meniscus arrow: A 4- to 8-year follow-up study. *Knee Surgery, Sports Traumatology, Arthroscopy, 15*(2), 133-137.

Kumar, K., Buchser, E., Linderoth, B., Meglio, M., & Buyten, J.-P.V. (2007). Avoiding complications from spinal cord stimulation: Practical recommendations from an international panel of experts. *Neuromodulation: Technology at the Neural Interface, 10*(1), 24-33. doi: 10.1111/j.1525-1403.2007.00084.x

Lädermann, A., Denard, P.J., & Burkhart, S.S. (2011). Midterm outcome of arthroscopic revision repair of massive and nonmassive rotator cuff tears. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 27*(12), 1620-1627. doi: 10.1016/j.arthro.2011.08.290

Lähteenmäki, H.E., Hiltunen, A., Virolainen, P., & Nelimarkka, O. (2007). Repair of full-thickness rotator cuff tears is recommended regardless of tear size and age: A retrospective study of 218 patients. *Journal of Shoulder and Elbow Surgery, 16*(5), 586-590. doi: 10.1016/j.jse.2007.04.001

Lanner, G., & Spendel, M.C. (2007). Spinal cord stimulation for the treatment of chronic non-malignant pain operative neuromodulation. In D. E. Sakas, B. A. Simpson & E. S. Krames (Eds.), (Vol. 97/1, pp. 79-84): Springer Vienna.

LaPrade, R.F., Burnett, Q.M., Veenstra, M.A., & Hodgman, C.G. (1994). The prevalence of abnormal magnetic resonance imaging findings in asymptomatic knees. *The American Journal of Sports Medicine, 22*(6), 739-745. doi: 10.1177/036354659402200603

Lee, B.G., Cho, N.S., & Rhee, Y.G. (2012). Effect of two rehabilitation protocols on range of motion and healing rates after arthroscopic rotator cuff repair: Aggressive versus limited

early passive exercises. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 28*(1), 34-42. doi: 10.1016/j.arthro.2011.07.012

Lee, M.J.M.D., Hacquebord, J.M.D., Varshney, A.M.D., Cizik, A.M.M.P.H., Bransford, R.J.M.D., Bellabarba, C.M.D., . . . Chapman, J.M.D. (2011). Risk factors for medical complication after lumbar spine surgery: A multivariate analysis of 767 patients. *Spine, 36*(21), 1801-1806.

Lee, W.P.A., Schipper, B.M., & Goitz, R.J. (2008). 13-year experience of carpal tunnel release using the indiana tome technique. *The Journal of Hand Surgery, 33*(7), 1052-1056. doi: 10.1016/j.jhsa.2008.03.013

Levy, D.B. (2011). Soft tissue knee injury *Orthopedic Surgery Articles: Knee.* Retrieved 5/9/2012, from http://emedicine.medscape.com/article/826792-overview

Lim, H., Bae, J., Wang, J., Seok, C., & Kim, M. (2010). Non-operative treatment of degenerative posterior root tear of the medial meniscus. *Knee Surgery, Sports Traumatology, Arthroscopy, 18*(4), 535-539. doi: 10.1007/s00167-009-0891-0

Lin, K.C., Krishnan, S.G., & Burkhead, W.Z. (2008). Massive rotator cuff tears. In L. M. Galatz (Ed.), *Orthopaedic knowledge update: Shoulder and elbow* (3 ed., pp. 179-188). Rosemont, IL: American Academoy of Orthopaedic Surgeons.

Lingard, E.A., & Riddle, D.L. (2007). Impact of psychological distress on pain and function following knee arthroplasty. *The Journal of Bone & Joint Surgery, 89*(6), 1161-1169. doi: 10.2106/JBJS.F.00914

Linton, S.J., Hellsing, A.-L., & Andersson, D. (1993). A controlled study of the effects of an early intervention on acute musculoskeletal pain problems. *Pain, 54*(3), 353-359. doi: 10.1016/0304-3959(93)90037-p

Liow, R.Y.L., McNicholas, M.J., Keating, J.F., & Nutton, R.W. (2003). Ligament repair and reconstruction in traumatic dislocation of the knee. *Journal of Bone & Joint Surgery, British Volume, 85-B*(6), 845-851. doi: 10.1302/0301-620x.85b6.13972

Long, D.M., Filtzer, D.L., BenDebba, M., & Hendler, N.H. (1988). Clinical features of the failed-back syndrome. *Journal of Neurosurgery, 69*(1), 61-71. doi: doi:10.3171/jns.1988.69.1.0061

Lozano Calderón, S.A., Paiva, A., & Ring, D. (2008). Patient satisfaction after open carpal tunnel release correlates with depression. *The Journal of Hand Surgery, 33*(3), 303-307. doi: 10.1016/j.jhsa.2007.11.025

Lurie, J.D., Faucett, S.C., Hanscom, B., Tosteson, T.D., Ball, P.A., Abdu, W.A., . . . Weinstein, J.N. (2008). Lumbar discectomy outcomes vary by herniation level in the spine patient outcomes research trial. *The Journal of Bone & Joint Surgery, 90*(9), 1811-1819. doi: 10.2106/JBJS.G.00913

Lynch, M.E., Campbell, F., Clark, A.J., Dunbar, M.J., Goldstein, D., Peng, P., . . . Tupper, H. (2008). A systematic review of the effect of waiting for treatment for chronic pain. *Pain, 136*(1–2), 97-116. doi: 10.1016/j.pain.2007.06.018

Madhu, T.S. (2008). Posterior and anterior lumbar interbody fusion. *Current Orthopaedics, 22*(6), 406-413. doi: 10.1016/j.cuor.2008.07.006

Mahar, A.T., Tamborlane, J., Oka, R., Esch, J., & Pedowitz, R.A. (2007). Single-row suture anchor repair of the rotator cuff is biomechanically equivalent to double-row repair in a bovine model. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 23*(12), 1265-1270. doi: 10.1016/j.arthro.2007.07.010

Mahar, A.T., Tucker, B.S., Upasani, V.V., Oka, R.S., & Pedowitz, R.A. (2005). Increasing the insertion depth of suture anchors for rotator cuff repair does not improve biomechanical stability. *Journal of Shoulder and Elbow Surgery, 14*(6), 626-630. doi: 10.1016/j.jse.2005.03.011

Mahmud, M.A, Webster, B.S., Courtney, T.K., Matz, S., Tacci, J.A., & Christiani, D.C. (2000). Clinical management and the duration of disability for work-related low back pain. *Journal of Occupational & Environmental Medicine, 42*(12), 1178-1187.

Mailis-Gagnon, A., Furlan, A.D., Sandoval, J.A., & Taylor, R.S. (2009). Spinal cord stimulation for chronic pain. *Cochrane Database of Systematic Reviews, 3*(Art. No.: CD003783).

Margolis, R.B., Tait, R.C., & Krause, S.J. (1986). A rating system for use with patient pain drawings. *Pain, 24*(1), 57-65. doi: 10.1016/0304-3959(86)90026-6

Martin, B.I., Mirza, S.K., Comstock, B.A., Gray, D.T., Kreuter, W., & Deyo, R.A. (2007a). Are lumbar spine reoperation rates falling with greater use of fusion surgery and new surgical technology? *Spine, 32*(19), 2119-2126 2110.1097/BRS.2110b2013e318145a318156a.

Martin, B.I., Mirza, S.K., Comstock, B.A., Gray, D.T., Kreuter, W., & Deyo, R.A. (2007b). Reoperation rates following lumbar spine surgery and the influence of spinal fusion procedures. *Spine, 32*(3), 382-387 310.1097/1001.brs.0000254104.0000255716.0000254146.

Masri, B.A., Bourque, J., & Patil, S. (2009). Outcome of unicompartmental knee arthroplasty in patients receiving worker's compensation. *The Journal of Arthroplasty, 24*(3), 444-447. doi: 10.1016/j.arth.2007.11.011

Matsusue, Y., & Thomson, N.L. (1996). Arthroscopic partial medial meniscectomy in patients over 40 years old: A 5- to 11-year follow-up study. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 12*(1), 39-44. doi: 10.1016/s0749-8063(96)90217-0

Mayer, T.G., & Gatchel, R.J,. (1988). *Functional restoration for spinal disorders: The sports medicine approach.* . Philadelphia: Lea & Febiger.

Mayer, T.G., McMahon, M.J., Gatchel, R.J., Sparks, B., Wright, A., & Pegues, P. (1998). Socioeconomic outcomes of combined spine surgery and functional restoration in workers' compensation spinal disorders with matched controls. *Spine, 23*(5), 598-605.

Mayer, T.G., Gatchel, R.J., & Evans, T. (2001). Effect of age on outcomes of tertiary rehabilitation for chronic disabling spinal disorders. *Spine (Phila Pa 1976), 26*, 1378-1384.

Mayer, T.G., Worzer, W.E., Shea, M., Garcia, C., & Gatchel, R.J. (under review). Facilitation of surgical decisions when uncertainty leads to delayed recovery: A surgical option process within an interdisciplinary functional restoration program. *The Spine Journal*.

Mazzocca, A.D., Millett, P.J., Guanche, C.A., Santangelo, S.A., & Arciero, R.A. (2005). Arthroscopic single-row versus double-row suture anchor rotator cuff repair. *The American Journal of Sports Medicine, 33*(12), 1861-1868. doi: 10.1177/0363546505279575

McFeely, J., & Gracey, J. (2006). Postoperative exercise programmes for lumbar spine decompression surgery: A systematic review of the evidence. *Physical Therapy Reviews, 11*(4), 248-262. doi: 10.1179/108331906x144127

McGeary, D.D., Mayer, T.G., & Gatchel, R.J. (2006). High pain ratings predict treatment failure in chronic occupational musculoskeletal disorders. *Journal of Bone and Joint Surgery, 88-A*(317-325).

McGuire, K.J., Harrast, J., Herkowitz, H., & Weinstein, J.N. (2012). Geographic variation in the surgical treatment of degenerative cervical disc disease: American board of orthopedic surgery quality improvement initiative; part ii candidates. *Spine, 37*(1), 57-66 10.1097/BRS.1090b1013e318212bb318261.

McHorney, C.A., Ware, J.E., Rachel Lu, J.F., & Sherbourne, C.D. (1994). The mos 36-ltem short-form health survey (sf-36): Iii. Tests of data quality, scaling assumptions, and reliability across diverse patient groups. *Medical Care, 32*(1), 40-66.

McHorney, C.A., Ware, J.E., & Raczek, A.E. (1993). The mos 36-item short-form health survey (sf-36): Ii. Psychometric and clinical tests of validity in measuring physical and mental health constructs. *Medical Care, 31*(3), 247-263.

McKee, M.D., & Yoo, D.J. (2000). The effect of surgery for rotator cuff disease on general health status results of a prospective trial*. *The Journal of Bone & Joint Surgery, 82*(7), 970-970.

Meredith, D.S., Losina, E., Mahomed, N.N., Wright, J., & Katz, J.N. (2005). Factors predicting functional and radiographic outcomes after arthroscopic partial meniscectomy: A review of the literature. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 21*(2), 211-223. doi: 10.1016/j.arthro.2004.10.003

Misamore, G., Ziegler, D.W., & Rushton II, J.L. (1995). Repair of the rotator cuff. A comparison of results in two populations of patients. *The Journal of Bone & Joint Surgery, 77*(9), 1335-1339.

Mizner, R.L., Petterson, S.C., Clements, K.E., Zeni Jr, J.A., Irrgang, J.J., & Snyder-Mackler, L. (2011). Measuring functional improvement after total knee arthroplasty requires both performance-based and patient-report assessments: A longitudinal analysis of outcomes. *The Journal of Arthroplasty, 26*(5), 728-737. doi: 10.1016/j.arth.2010.06.004

Molde Hagen, E.M.D., Grasdal, A.P., & Eriksen, H.R.P. (2003). Does early intervention with a light mobilization program reduce long-term sick leave for low back pain: A 3-year follow-up study. *Spine, 28*(20), 2309-2315.

Mont, M.A., Mayerson, J.A., Krackow, K.E., & Hungerford, D.S. (1998). Total knee arthroplasty in patients receiving workers' compensation. *The Journal of Bone & Joint Surgery, 80*(9), 1285-1290.

Morantz, A. (2011). Opting out of workers' compensation in texas: A survey of large multistate nonsubscribers. In D. P. Kessler (Ed.), *Regulation versus litigation: Perspectives from economics and law* (pp. 197-238). Chicago, IL: University of Chicago Press.

Murray Jr, T.F., Lajtai, G., Mileski, R.M., & Snyder, S.J. (2002). Arthroscopic repair of medium to large full-thickness rotator cuff tears: Outcome at 2- to 6-year follow-up. *Journal of Shoulder and Elbow Surgery, 11*(1), 19-24. doi: 10.1067/mse.2002.120142

Nagle, D., Harris, G., & Foley, M. (1994). Prospective review of 278 endoscopic carpal tunnel releases using the modified chow technique. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 10*(3), 259-265. doi: 10.1016/s0749-8063(05)80108-2

Nagle, D.J., Fischer, T.J., Harris, G.D., Hasting Ii, H., Lee Osterman, A., Palmer, A.K., . . . Foley, M. (1996). A multicenter prospective review of 640 endoscopic carpal tunnel releases using the transbursal and extrabursal chow techniques. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 12*(2), 139-143. doi: 10.1016/s0749-8063(96)90001-8

Nguyen, T.H. Randolph, D.C., Talmage, J., Succop, P.P., & Travis, R. (2011). Long-term outcomes of lumbar fusion among workers' compensation subjects: A historical cohort study. *Spine, 36*(4), 320-331.

Nho, S.J., Brown, B.S., Lyman, S., Adler, R.S., Altchek, D.W., & MacGillivray, J.D. (2009). Prospective analysis of arthroscopic rotator cuff repair: Prognostic factors affecting clinical and ultrasound outcome. *Journal of Shoulder and Elbow Surgery, 18*(1), 13-20. doi: 10.1016/j.jse.2008.05.045

Nicholson, G.P. (2003). Arthroscopic acromioplasty: A comparison between workers' compensation and non-workers' compensation populations. *The Journal of Bone & Joint Surgery, 85*, 682-689.

Nilsdotter, A.K., Toksvig-Larsen, S., & Roos, E.M. (2009). A 5 year prospective study of patient-relevant outcomes after total knee replacement. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society, 17*(5), 601-606.

Noble, M., Treadwell, J.R., Tregear, S.J., Coates, V.H., Philip J Wiffen, Akafomo, C., & Schoelles, K.M. (2010). Long-term opioid management for chronic noncancer pain. *Cochrane Database of Systematic Reviews, 1*(Art. No.: CD006605). doi: 10.1002/14651858.CD006605.pub2

North American Spine Society. (2011). Diagnosis and treatment of degenerative lumbar spinal stenosis. In D. S. Kreiner, W. O. Shaffer, J. Baisden, T. Gilbert, J. Summers, J. Toton, S. Hwang, R. Mendel & C. Reitman (Eds.), *Evidence-Based Clinical Guuidelines for Multidisciplinary Spine Care*. Burr Ridge, IL: North American Spine Society.

North, R.B., Kidd, D.H., Farrokhi, F., & Piantadosi, S.A. (2005). Spinal cord stimulation versus repeated lumbosacral spine surgery for chronic pain: A randomized, controlled trial. *Neurosurgery, 56*(1), 98-107 110.1227/1201.NEU.0000144839.0000165524.E0000144830.

Nové-Josserand, L., Liotard, J.P., Godeneche, A., Neyton, L., Borel, F., Rey, B., . . . Walch, G. (2011). Occupational outcome after surgery in patients with a rotator cuff tear due to a

work-related injury or occupational disease. A series of 262 cases. *Orthopaedics & Traumatology: Surgery & Research, 97*(4), 361-366. doi: 10.1016/j.otsr.2011.01.012

Noyes, F.R., & Barber-Westin, S.D. (1997). A comparison of results of arthroscopic-assisted anterior cruciate ligament reconstruction between workers' compensation and noncompensation patients. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 13*(4), 474-484. doi: 10.1016/s0749-8063(97)90127-4

Noyes, F.R., & Barber-Westin, S.D. (2010). Meniscus tears: Diagnosis, repair techniques, and clinical outcomes. In F. R. Noyes (Ed.), *Noyes' knee disorders: Surgery, rehabilitation, and clinical outcomes* (pp. 733-771). Philadelphia: Saunders.

Odenbring, S., Wagner, P., & Atroshi, I. (2008). Long-term outcomes of arthroscopic acromioplasty for chronic shoulder impingement syndrome: A prospective cohort study with a minimum of 12 years' follow-up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 24*(10), 1092-1098. doi: 10.1016/j.arthro.2008.04.073

Ogilvie-Harris, D., & Choi, C.H. (2008). Arthroscopid subacromial decompression in stage ii impingement - five to twelve year follow-up. *Journal of Bone & Joint Surgery, British Volume, 90-B*(S1), 119.

Oh, J.H., Yoon, J.P., Kim, J.Y., & Kim, S.H. (2012). Effect of expectations and concerns in rotator cuff disorders and correlations with preoperative patient characteristics. *Journal of Shoulder and Elbow Surgery*(0). doi: 10.1016/j.jse.2011.10.017

Ohana, J. (2011). Texas elective workers' compensation: A model of innovation? *William & Mary Business Law Review, 323*. http://scholarship.law.wm.edu/wmblr/vol2/iss2/5

Ohnmeiss, D.D. (2000). Repeatability of pain drawings in a low back pain population. *Spine, 25*(8), 980-988.

Ostelo, R.W., de Vet, H.C., Waddell, G., Kerckhoffs, M.R., Leffers, P., & van Tulder, M. (2003). Rehabilitation following first-time lumbar disc surgery: A systematic review within the framework of the cochrane collaboration. *Spine, 28*(3), 209-218.

Pakzaban, P. (2012a). Spinal instability and spinal fusion surgery. *Neurosurgery Articles: Spine.* Retrieved 5/16/2012, from http://emedicine.medscape.com/article/1343720-overview

Pakzaban, P. (2012b). Spinal instability and spinal fusion surgery treatment & management. *Neurosurgery Articles: Spine.* Retrieved 5/16/2012, from http://emedicine.medscape.com/article/1343720-treatment#a1128

Palmer, S.H., & Cross, M.J. (2012). Total knee arthroplasty *Clinical Procedures Articles: Musculoskeletal.* Retrieved 5/9/2012, from http://emedicine.medscape.com/article/1250275-overview

Park, P.M.D., Garton, H.J.M.D.M., Gala, V.C.M.D., Hoff, J.T.M.D., & McGillicuddy, J.E.M.D. (2004). Adjacent segment disease after lumbar or lumbosacral fusion: Review of the literature. *Spine, 29*(17), 1938-1944.

Parker, S.L., Adogwa, O., Bydon, A., Cheng, J., & McGirt, M.J. (2011). Cost-effectiveness of minimally invasive versus open transforaminal lumbar interbody fusion for degenerative spondylolisthesis associated low-back and leg pain over two years. *World Neurosurgery*(0). doi: 10.1016/j.wneu.2011.09.013

Parot-Schinkel, E., Roquelaure, Y., Ha, C., Leclerc, A., Chastang, J.-F., Raimbeau, G., . . . Descatha, A. (2011). Factors affecting return to work after carpal tunnel syndrome surgery in a large french cohort. *Archives of Physical Medicine and Rehabilitation, 92*(11), 1863-1869. doi: 10.1016/j.apmr.2011.06.001

Patel, V.B., Manchikanti, L., Singh, V., Schultz, D.M., Hayek, S.M., & Smith, H.S. (2009). Systematic review of intrathecal infusion systems for long-term management of chronic non-cancer pain. *Pain Physician, 12*(2), 345-360.

Paulos, L.E., & Kody, M.H. (1994). Arthroscopically enhanced "miniapproach" to rotator cuff repair. *The American Journal of Sports Medicine, 22*(1), 19-25. doi: 10.1177/036354659402200104

Pendleton, A., Arden, N., Dougados, M., Doherty, M., Bannwarth, B., Bijlsma, J.W.J., . . . Zimmermann-Gorska, I. (2000). Eular recommendations for the management of knee

osteoarthritis: Report of a task force of the standing committee for international clinical studies including therapeutic trials (escisit). *Annals of the Rheumatic Diseases, 59*(12), 936-944. doi: 10.1136/ard.59.12.936

Peolsson, A., Vavruch, L., & Öberg, B. (2002). Disability after anterior decompression and fusion for cervical disc disease. *Advances in Physiotherapy, 4*(3), 111-124.

Peolsson, A., Vavruch, L., & Öberg, B. (2006). Can the results 6 months after anterior cervical decompression and fusion identify patients who will have remaining deficit at long-term? *Disability & Rehabilitation, 28*(2), 117-124.

Persson, L.C.G.R.P.T.M., Carlsson, C.-A.M.D.P., & Carlsson, J.Y.P. (1997). Long-lasting cervical radicular pain managed with surgery, physiotherapy, or a cervical collar: A prospective, randomized study. *Spine, 22*(7), 751-758.

Piasecki, D.P., Verma, N.N., Nho, S.J., Bhatia, S., Boniquit, N., Cole, B.J., . . . Romeo, A.A. (2010). Outcomes after arthroscopic revision rotator cuff repair. *The American Journal of Sports Medicine, 38*(1), 40-46. doi: 10.1177/0363546509346401

Pillai, A., Eranki, V., Malal, J., & Nimon, G. (2012). Outcomes of open subacromial decompression after failed arthroscopic acromioplasty. *ISRN Surgery, 2012*(Article ID 806843). doi: 10.5402/2012/806843

Prager, J., & Jacobs, M. (2001). Evaluation of patients for implantable pain modalities: Medical and behavioral assessment. *The Clinical Journal of Pain, 17*(3), 206-214.

Pratt, R.K., Fairbank, J.C.T., & Virr, A. (2002). The reliability of the shuttle walking test, the swiss spinal stenosis questionnaire, the oxford spinal stenosis score, and the oswestry disability index in the assessment of patients with lumbar spinal stenosis. *Spine, 27*(1), 84-91.

Proctor, T., Mayer, T.G., Gatchel, R.J., & McGeary, D.D. (2004). Unremitting health-care-utilization outcomes of tertiary rehabilitation of chronic musculoskeletal disorders. *Journal of Bone and Joint Surgery, 86*, 62-69.

Proctor, T., Mayer, T.G., Theodore, B.R., & Gatchel, R.J. (2006). Failure to complete a functional restoration program for chronic musculoskeletal disorders: A prospective 1-year outcome study *Archives of Physical Medicine and Rehabilitation, 86*, 1509-1515.

Provinciali, L., Giattini, A., Splendiani, G., & Logullo, F. (2000). Usefulness of hand rehabilitation after carpal tunnel surgery. *Muscle & Nerve, 23*(2), 211-216. doi: 10.1002/(SICI)1097-4598(200002)23:2<211::AID-MUS11>3.0.CO;2-J

Pujol, N., & Beaufils, P. (2009). Healing results of meniscal tears left in situ during anterior cruciate ligament reconstruction: A review of clinical studies. *Knee Surgery, Sports Traumatology, Arthroscopy, 17*(4), 396-401.

Qureshi, N.H. (2011). Neurosurgery for cauda equina syndrome *Neurosurgery Articles: Neoplasm.* Retrieved 5/16/2012, from http://emedicine.medscape.com/article/249203-overview

Radcliff, K.E.., Rihn, J.., Hilibrand, A.., Dilorio, T., Tosteson, T., Lurie, J.D.., . . . Weinstein, J.N. (2011). Does the duration of symptoms in patients with spinal stenosis and degenerative spondylolisthesis affect outcomes?: Analysis of the spine outcomes research trial. *Spine, 36*(25), 2197-2210.

Rainov, N.G., Heidecke, V., & Burkert, W. (2001). Long-term intrathecal infusion of drug combinations for chronic back and leg pain. *Journal of Pain and Symptom Management, 22*(4), 862-871. doi: 10.1016/s0885-3924(01)00319-0

Rainville, J., Ahern, D.K., Phalen, L., Childs, L.A., & Sutherland, R. (1992). The association of pain with physical activities in chronic low back pain. *Spine, 17*(9), 1060-1064.

Rao, P.J., Christie, J.G., Ghahreman, A., Cartwright, C.A., & Ferch, R.D. (2008). Clinical and functional outcomes of anterior cervical discectomy without fusion. *Journal of Clinical Neuroscience, 15*(12), 1354-1359. doi: 10.1016/j.jocn.2007.12.009

Reid, D., Rydwanski, J., Hing, W., & White, S. (2012). The effectiveness of post-operative rehabilitation following partial meniscectomy of the knee. *Physical Therapy Reviews, 17*(1), 45-54. doi: 10.1179/1743288x11y.0000000046

Resnick, D.K., Choudhri, T.F., Dailey, A.T., Groff, M.W., Khoo, L., Matz, P.G., . . . American Association of Neurological Surgeons/Congress of Neurological, S. (2005). Guidelines for the performance of fusion procedures for degenerative disease of the lumbar spine. Part 7: Intractable low-back pain without stenosis or spondylolisthesis. *Journal of neurosurgery. Spine, 2*(6), 670-672.

Riddle, D., Wade, J., Jiranek, W., & Kong, X. (2010). Preoperative pain catastrophizing predicts pain outcome after knee arthroplasty. *Clinical Orthopaedics and Related Research®, 468*(3), 798-806. doi: 10.1007/s11999-009-0963-y

Roland, M., & Fairbank, J. (2000). The roland–morris disability questionnaire and the oswestry disability questionnaire. *Spine, 25*(24), 3115-3124.

Rollinghoff, M., Schluter-Brust, K., Groos, D., Sobottke, R., Michael, J.W., Eysel, P., & Delank, K.S. (2010). Mid-range outcomes in 64 consecutive cases of multilevel fusion for degenerative diseases of the lumbar spine. *Orthopedic reviews, 2*(1), e3.

Romeo, A.A., Hang, D.W., Bach, B.R.J., & Shott, S. (1999). Repair of full thickness rotator cuff tears gender, age, and other factors affecting outcome. *Clinical Orthopaedics and Related Research, 367*, 243-255.

Rooks, D.S., Huang, J., Bierbaum, B.E., Bolus, S.A., Rubano, J., Connolly, C.E., . . . Katz, J.N. (2006). Effect of preoperative exercise on measures of functional status in men and women undergoing total hip and knee arthroplasty. *Arthritis Care & Research, 55*(5), 700-708. doi: 10.1002/art.22223

Roth, J.H., Richards, R.S., & MacLeod, M.D. (1994). Endoscopic carpal tunnel release. *Canadian Journal of Surgery, 37*(3), 189-193.

Sahrakar, K. (2011). Lumbar disc disease treatment & management. *Orthopedic Surgery Articles: Spine.* Retrieved 5/16/2012, from http://emedicine.medscape.com/article/249113-treatment

Saleh, K., Nelson, C., Kassim, R., Yoon, P., & Haas, S. (2004). Total knee arthroplasty in patients on workers' compensation: A matched cohort study with an average follow-up of 4.5 years. *The Journal of Arthroplasty, 19*(3), 310-312. doi: 10.1016/s0883-5403(03)00257-2

Sanati, K., Mansouri, M., Macdonald, D., Ghafghazi, S., Macdonald, E., & Yadegarfar, G. (2011). Surgical techniques and return to work following carpal tunnel release: A systematic review and meta-analysis. *Journal of Occupational Rehabilitation, 21*(4), 474-481. doi: 10.1007/s10926-011-9310-8

Savoie, F.H., Field, L.D., & Nan Jenkins, R. (1995). Costs analysis of successful rotator cuff repair surgery: An outcome study. Comparison of gatekeeper system in surgical patients. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 11*(6), 672-676. doi: 10.1016/0749-8063(95)90107-8

Saw, N.L.B., Jones, S., Shepstone, L., Meyer, M., Chapman, P.G., & Logan, A.M. (2003). Early outcome and cost-effectiveness of endoscopic versus open carpal tunnel release: A randomized prospective trial. *The Journal of Hand Surgery: British & European Volume, 28*(5), 444-449. doi: 10.1016/s0266-7681(03)00097-4

Scheller, G., Sobau, C., & Bülow, J.U. (2001). Arthroscopic partial lateral meniscectomy in an otherwise normal knee: Clinical, functional, and radiographic results of a long-term follow-up study. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 17*(9), 946-952. doi: 10.1053/jars.2001.28952

Sengupta, I., & Reno, V. (2007). Recent trends in workers' compensation. *Social Security Bulletin, 67*(1), 17-26.

Sharma, A.K., Kepler, C.K., Girardi, F.P., Cammisa, F.P., Huang, R.C., & Sama, A.A. (2011). Lateral lumbar interbody fusion: Clinical and radiographic outcomes at 1 year: A preliminary report. *Journal of Spinal Disorders & Techniques, 24*(4), 242-250 210.1097/BSD.1090b1013e3181ecf1995.

Shaw, W.S.P., Pransky, G.M.D.M., Patterson, W.M.D.M.P.H., & Winters, T.M.D.M.P.H. (2005). Early disability risk factors for low back pain assessed at outpatient occupational health clinics. *Spine, 30*(5), 572-580.

Shi, Q., & MacDermid, J.C. (2011). Is surgical intervention more effective than non-surgical treatment for carpal tunnel syndrome? A systematic review. *Journal of Orthopaedic Surgery and Research 6*, 17. doi: 10.1186/1749-799X-6-17

Shin, S.-J., Oh, J.H., Chung, S.W., & Song, M.H. (2012). The efficacy of acromioplasty in the arthroscopic repair of small- to medium-sized rotator cuff tears without acromial spur: Prospective comparative study. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 28*(5), 628-635. doi: 10.1016/j.arthro.2011.10.016

Singh, K., Phillips, F.M., Park, D.K., Pelton, M.A., An, H.S., & Goldberg, E.J. (2012). Factors affecting reoperations after anterior cervical discectomy and fusion within and outside of a federal drug administration investigational device exemption cervical disc replacement trial. *The Spine Journal*(0). doi: 10.1016/j.spinee.2012.02.005

Sinnott, P. (2009). Administrative delays and chronic disability in patients with acute occupational low back injury. *Journal of Occupational & Environmental Medicine, 51*(6), 690-699.

Slavin, K.V., Hsu, F.P., & Fessler, R.G. (2002). Intrathecal opioids: Intrathecal drug delievery systems. . In K. Burchiel (Ed.), *Surgical management of pain*. New York: Thieme Medical Publishers, Inc.

Søgaard, R., Bünger, C., Laurberg, I., & Christensen, F. (2008). Cost-effectiveness evaluation of an rct in rehabilitation after lumbar spinal fusion: A low-cost, behavioural approach is cost-effective over individual exercise therapy. *European Spine Journal, 17*(2), 262-271. doi: 10.1007/s00586-007-0479-7

Spangehl, M.J., Hawkins, R.H., McCormack, R.G., & Loomer, R.L. (2002). Arthroscopic versus open acromioplasty: A prospective, randomized, blinded study. *Journal of Shoulder and Elbow Surgery, 11*(2), 101-107. doi: 10.1067/mse.2002.120915

Spector, J.T., Turner, J.A., Fulton-Kehoe, D., & Franklin, G. (2012). Pre-surgery disability compensation predicts long-term disability among workers with carpal tunnel syndrome. *American Journal of Industrial Medicine, 55*(9), 816-832. doi: 10.1002/ajim.22029

Spieler, E.A., & Burton, J.F. (2012). The lack of correspondence between work-related disability and receipt of workers' compensation benefits. *American Journal of Industrial Medicine, 55*, 487-505. doi: 10.1002/ajim.21034

Steenbrugge, F., Verdonk, R., Hürel, C., & Verstraete, K. (2004). Arthroscopic meniscus repair: Inside-out technique vs. Biofix meniscus arrow. *Knee Surgery, Sports Traumatology, Arthroscopy, 12*(1), 43-49.

Stover, B.P., Wickizer, T.M.P.M.P.H., Zimmerman, F.P.M.S., Fulton-Kehoe, D.P.M.P.H., & Franklin, G.M.D.M.P.H. (2007). Prognostic factors of long-term disability in a workers' compensation system. *Journal of Occupational & Environmental Medicine, 49*(1), 31-40.

Straub, T.A. (1999). Endoscopic carpal tunnel release: A prospective analysis of factors associated with unsatisfactory results. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 15*(3), 269-274. doi: 10.1016/s0749-8063(99)70033-2

Stütz, N., Gohritz, A., van Schoonhoven, J., & Lanz, U. (2006). Revision surgery after carpal tunnel release – analysis of the pathology in 200 cases during a 2 year period. *The Journal of Hand Surgery: British & European Volume, 31*(1), 68-71. doi: 10.1016/j.jhsb.2005.09.022

Styron, J.F., Barsoum, W.K., Smyth, K.A., & Singer, M.E. (2011). Preoperative predictors of returning to work following primary total knee arthroplasty. *The Journal of Bone & Joint Surgery, 93*(1), 2-10. doi: 10.2106/JBJS.I.01317

Sugaya, H., Maeda, K., Matsuki, K., & Moriishi, J. (2005). Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: Single-row versus dual-row fixation. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 21*(11), 1307-1316. doi: 10.1016/j.arthro.2005.08.011

Tabachnick, B., & Fidell, L. (2007). *Using multivariate statistics* (5th ed.). Boston: Pearson Education, Inc.

Taylor, V.M., Deyo, R.A., Ciol, M., Farrar, E.L., Lawrence, M.S., Shonnard, N.H., . . . Goldberg, H.I. (2000). Patient-oriented outcomes from low back surgery: A community-based study. *Spine, 25*(19), 2445-2452.

Texas Department of Assistive and Rehabiitative Services. (2010). Texas administrative code: Social services and assistance. Retrieved 6/23/2012, from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=40&pt=2&ch=107

Texas Department of Insurance. (2010a). Employer participation in the texas workers' compensation system: 2010 estimates. Retrieved 6/23/2012, from http://www.tdi.texas.gov/reports/wcreg/documents/Non-sub%202010.pdf

Texas Department of Insurance. (2010b). Setting the standard: An analysis of the impact of the 2005 legislative reforms on the texas workers' compensation system, 2010 results. Retrieved 6/23/2012, from http://www.tdi.texas.gov/reports/wcreg/documents/Setting_the_Standard.pdf

Texas Department of Insurance. (2010c). Texas administrative code: Independent review organizations. Retrieved 6/23/2012, from http://info.sos.state.tx.us/pls/pub/readtac$ext.ViewTAC?tac_view=4&ti=28&pt=1&ch=12

Texas Department of Insurance. (2010d). Texas workers' compensation act. from http://www.tdi.texas.gov/wc/act/index.html#pdf

Texas Department of Insurance. (2011a). About workers' compensation. Retrieved 10-29-2011, 2011, from http://www.tdi.texas.gov/wc/dwc/index.html#whatiswc

Texas Department of Insurance. (2011b). Dispute resolution for injured employees. Retrieved 6/23/2011, from http://www.tdi.texas.gov/wc/employee/dispute.html

Texas Department of Insurance. (2012). Access to medical care in the texas workers' compensation system, 1998-2010. Retrieved 6/23/2012, from http://www.tdi.texas.gov/reports/wcreg/documents/Access_to_care_2012.pdf

Texas Workers' Compensation Commission. (2012a). Information for workers' compensation nonsubscribers. Retrieved 6/23/2012, from http://www.tdi.texas.gov/pubs/consumer/cb007.html

Texas Workers' Compensation Commission. (2012b). Workers' compensation: Certified self-insurance. Retrieved 6/23/2012, from http://www.tdi.texas.gov/wc/si/index.html

Theodore, B., Mayer, T., & Gatchel, R. (under review). Cost-effectiveness of early versus delayed functional restoration for chronic disabling occupational musculoskeletal disorders. *The Spine Journal*.

Tomaras, C.R., Blacklock, J.B., Parker, W.D., & Harper, R.L. (1997). Outpatient surgical treatment of cervical radiculopathy. *Journal of Neurosurgery, 87*(1), 41-43. doi: doi:10.3171/jns.1997.87.1.0041

Tosteson, A.N.A., Skinner, J.S., Tosteson, T.D., Lurie, J.D., Andersson, G.B., Berven, S., . . . Weinstein, J.N. (2008). The cost effectiveness of surgical versus nonoperative treatment for lumbar disc herniation over two years: Evidence from the spine patient outcomes research trial (sport). *Spine, 33*(19), 2108-2115 2110.1097/BRS.2100b2013e318182e318390.

Tribus, C.B.M.D., Corteen, D.P.B.S., & Zdeblick, T.A.M.D. (1999). The efficacy of anterior cervical plating in the management of symptomatic pseudoarthrosis of the cervical spine. *Spine, 24*(9), 860.

Trief, P.M.P., Grant, W.E., & Fredrickson, B.M.D. (2000). A prospective study of psychological predictors of lumbar surgery outcome. *Spine, 25*(20), 2616-2621.

Turner, J.A., Hollingworth, W., Comstock, B.A., & Deyo, R.A. (2010). Spinal cord stimulation for failed back surgery syndrome: Outcomes in a workers' compensation setting. *Pain, 148*(1), 14-25. doi: 10.1016/j.pain.2009.08.014

Turner, J.A., & Romano, J.M. (1984). Self-report screening measures for depression in chronic pain patients. *Journal of clinical psychology, 40*(4), 909-913.

van Duijn, M., Eijkemans, M.J., Koes, B.W., Koopmanschap, M.A., Burton, K.A., & Burdorf, A. (2010). The effects of timing on the cost-effectiveness of interventions for workers on sick leave due to low back pain. *Occupational and Environmental Medicine, 67*(11), 744-750. doi: 10.1136/oem.2009.049874

Verma, N.N., Dunn, W., Adler, R.S., Cordasco, F.A., Allen, A., MacGillivray, J., . . . Altchek, D.W. (2006). All-arthroscopic versus mini-open rotator cuff repair: A retrospective review with minimum 2-year follow-up. *Arthroscopy: The Journal of Arthroscopic & Related Surgery, 22*(6), 587-594. doi: 10.1016/j.arthro.2006.01.019

Videbaek, T.S., Egund, N.M., Christensen, F.B., Grethe Jurik, A.M., & Bunger, C.E. (2010). Adjacent segment degeneration after lumbar spinal fusion: The impact of anterior column support: A randomized clinical trial with an eight- to thirteen-year magnetic resonance imaging follow-up. *Spine, 35*(22), 1955-1964.

Villavicencio, A.T., Pushchak, E., Burneikiene, S., & Thramann, J.J. (2007). The safety of instrumented outpatient anterior cervical discectomy and fusion. *The Spine Journal, 7*(2), 148-153. doi: 10.1016/j.spinee.2006.04.009

Vissers, M.M., Bussmann, J.B., Verhaar, J.A.N., Busschbach, J.J.V., Bierma-Zeinstra, S.M.A., & Reijman, M. (2012). Psychological factors affecting the outcome of total hip and knee arthroplasty: A systematic review. *Seminars in Arthritis and Rheumatism, 41*(4), 576-588. doi: 10.1016/j.semarthrit.2011.07.003

Vokshoor, A. (2012). Spondylolisthesis, spondylolysis, and spondylosis treatment & management. *Orthopedic Surgery Articles: Spine.* Retrieved 5/9/2012, from http://emedicine.medscape.com/article/1266860-treatment

Von Korff, M., Jensen, M.P., & Karoly, P. (2000). Assessing global pain severity by self-report in clinical and health services research. *Spine, 25*(24), 3140-3151.

Voorhies, R.M., Jiang, X., & Thomas, N. (2007). Predicting outcome in the surgical treatment of lumbar radiculopathy using the pain drawing score, mcgill short form pain questionnaire,

and risk factors including psychosocial issues and axial joint pain. *The spine journal : official journal of the North American Spine Society, 7*(5), 516-524.

Walch, G., Edwards, T.B., Boulahia, A., Nové-Josserand, L., Neyton, L., & Szabo, I. (2005). Arthroscopic tenotomy of the long head of the biceps in the treatment of rotator cuff tears: Clinical and radiographic results of 307 cases. *Journal of Shoulder and Elbow Surgery, 14*(3), 238-246. doi: 10.1016/j.jse.2004.07.008

Wand, B.M., Bird, C.M., McAuley, J.H., Dore, C.J.B., MacDowell, M.M., & De Souza, L.H. (2004). Early intervention for the management of acute low back pain: A single-blind randomized controlled trial of biopsychosocial education, manual therapy, and exercise. *Spine, 29*(21), 2350-2356.

Ware, J.E., Kosinski, M., Bayliss, M.S., McHorney, C.A., Rogers, W.H., & Raczek, A.E. (1995). Comparison of methods for the scoring and statistical analysis of sf-36 health profile and summary measures: Summary of results from the medical outcomes study. *Medical Care, 33*(4), AS264-AS279.

Ware, J.E., & Sherbourne, C.D. (1992). The mos 36-ltem short-form health survey (sf-36): I. Conceptual framework and item selection. *Medical Care, 30*(6), 473-483.

Warner, J.J.P., & Parsons, I.M. (2001). Latissimus dorsi tendon transfer: A comparative analysis of primary and salvage reconstruction of massive, irreparable rotator cuff tears. *Journal of Shoulder and Elbow Surgery, 10*(6), 514-521. doi: 10.1067/mse.2001.118629

Watson, E.M., & Sonnabend, D.H. (2002). Outcome of rotator cuff repair. *Journal of Shoulder and Elbow Surgery, 11*(3), 201-211. doi: 10.1067/mse.2002.122271

Webster, B.B., & Cifuentes, M. (2010). Relationship of early magnetic resonance imaging for work-related acute low back pain with disability and medical utilization outcomes. *Journal of Occupational & Environmental Medicine, 52*(9), 900-907.

Webster, B.S., Verma, S., Willetts, J., Hopcia, K., & Wasiak, R. (2011). Association of disability duration with physical therapy services provided after meniscal surgery in a workers'

compensation population. *Archives of Physical Medicine and Rehabilitation, 92*(10), 1542-1551. doi: 10.1016/j.apmr.2011.04.023

Weinstein, J.N., Bronner, K.K., Morgan, T.S., & Wennberg, J.E. (2004). Trends: Trends and geographic variations in major surgery for degenerative diseases of the hip, knee, and spine. *Health Affairs*. doi: 10.1377/hlthaff.var.81

Weinstein, J.N., Lurie, J.D., Tosteson, T.D., Tosteson, A.N., Blood, E.A., Abdu, W.A., . . . Fischgrund, J. (2008). Surgical versus nonoperative treatment for lumbar disc herniation: Four-year results for the spine patient outcomes research trial (sport). *Spine, 33*(25), 2789-2800.

Weinstein, J.N., Tosteson, T.D., Lurie, J.D., Tosteson, A., Blood, E., Herkowitz, H., . . . An, H. (2010). Surgical versus nonoperative treatment for lumbar spinal stenosis four-year results of the spine patient outcomes research trial. *Spine, 35*(14), 1329-1338 1310.1097/BRS.1320b1013e3181e1320f1304d.

Wheeler, A.J., Gundy, J.M., & DeBerard, M.S.P. (2012). Predicting compensation and medical costs of lumbar fusion patients receiving workers' compensation in utah using presurgical biopsychosocial variables. *Spine, 37*(7), 605-611.

Whitecloud, T.S.I., Roesch, W.W., & Ricciardi, J.E. (2001). Transforaminal interbody fusion versus anterior–posterior interbody fusion of the lumbar spine: A financial analysis. *Journal of Spinal Disorders & Techniques, 14*(2), 100-103.

Whitworth, T., Schaufele, M., & Gatchel, R.J. (2001). Spinal cord stimulation vs. Intrathecal opioid pump options for failed back surgery syndrome. *SpineLine, 5*(1), 18-24.

Wiesel, B.B., Sankar, W.N., Delahay, J.N., & Wiesel, S.W. (2010). *Orthopaedic surgery: Principles of diagnosis and treatment*. Philadelphia: Lippincott Williams & Wilkins.

Wittink, H., Turk, D.C., Carr, D.B., Sukiennik, A., & Rogers, W. (2004). Comparison of the redundancy, reliability, and responsiveness to change among sf-36, oswestry disability index, and multidimensional pain inventory. *The Clinical Journal of Pain, 20*(3), 133-142.

Worland, R.L., Lee, D., Orozco, C.G., SozaRex, F., & Keenan, J. (2003). Correlation of age, acromial morphology, and rotator cuff tear pathology diagnosed by ultrasound in asymptomatic patients. *Journal of the Southern Orthopaedic Association, 12*(1), 23-26.

Wright, A., Mayer, T.G., & Gatchel, R.J. (1999). Outcomes of disabling cervical spine disorders in compensation injuries: A prospective comparison to tertiary rehabilitation response for chronic lumbar spinal disorders. *Spine (Phila Pa 1976), 24*, 178-183.

Wu, R.H., Fraser, J.F, & Hartl, R. (2010). Minimal access versus open transforaminal lumbar interbody fusion: Meta-analysis of fusion rates. *Spine, 35*(26), 2273-2281.

Wylde, V., Blom, A.W., Whitehouse, S.L., Taylor, A.H., Pattison, G.T., & Bannister, G.C. (2009). Patient-reported outcomes after total hip and knee arthroplasty: Comparison of midterm results. *The Journal of Arthroplasty, 24*(2), 210-216. doi: 10.1016/j.arth.2007.12.001

Wylde, V., Dieppe, P., Hewlett, S., & Learmonth, I.D. (2007). Total knee replacement: Is it really an effective procedure for all? *The Knee, 14*(6), 417-423. doi: 10.1016/j.knee.2007.06.001

Xiuxin, H., Yue, Z., Cui, C., & Yajun, W. (2009). A meta-analysis of circumferential fusion versus instrumented posterolateral fusion in the lumbar spine. *Spine, 34*(17), E618-E625 610.1097/BRS.1090b1013e3181a1099beab.

Youm, T., Murray, D.H., Kubiak, E.N., Rokito, A.S., & Zuckerman, J.D. (2005). Arthroscopic versus mini-open rotator cuff repair: A comparison of clinical outcomes and patient satisfaction. *Journal of Shoulder and Elbow Surgery, 14*(5), 455-459. doi: 10.1016/j.jse.2005.02.002

Young, J.N., Shaffrey, C.I., Laws Jr, E.R., & Lovell, L.R. (1997). Lumbar disc surgery in a fixed compensation population: A model for influence of secondary gain on surgical outcome. *Surgical Neurology, 48*(6), 552-559. doi: 10.1016/s0090-3019(97)00393-5

Zhou, Z.-J., Zhao, F.-D., Fang, X.-Q., Zhao, X., & Fan, S.-W. (2011). Meta-analysis of instrumented posterior interbody fusion versus instrumented posterolateral fusion in the

lumbar spine. *Journal of Neurosurgery: Spine, 15*(3), 295-310. doi: doi:10.3171/2011.4.SPINE10330

Zigenfus, G.C.M., Yin, J.B.S.P., Giang, G.M.M.B.A., & Fogarty, W.T.M.D. (2000). Effectiveness of early physical therapy in the treatment of acute low back musculoskeletal disorders. *Journal of Occupational & Environmental Medicine, 42*(1), 35.

BIOGRAPHICAL INFORMATION

Emily Brede received a B.A. in Psychology from the University of Oklahoma in 2001, a B.S. in Nursing from Texas Woman's University in 2005, and a M.S. in Experimental Psychology from the University of Texas at Arlington in 2011. She has worked as a critical care nurse for seven years and holds advanced certification as a CCRN. Dr. Brede's research interests have included clinical outcomes after interdisciplinary rehabilitation for chronic pain, the use of surface electromyography biofeedback in the treatment of occupational low back pain, surgical outcomes after interdisciplinary rehabilitation, fear avoidance in chronic pain patients, and assessment of insomnia and fibromyalgia in occupational injury patients. Dr. Brede is currently working at the Uniformed Services University of the Health Sciences in Bethesda, MD, where her research involves the implicit cognitive process underlying psychological disorders. Dr. Brede received the Verne Cox Outstanding Graduate Research Award in 2012. Her work has been presented to the American Association of Neuroscience Nurses, the North American Spine Society, and the Biofeedback Society of Texas.