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Outcomes and Predictive Correlates of Injured Workers Who Have Undergone Percutaneous Facet Radiofrequency Neurotomy of the Spine

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OUTCOMES AND PREDICTIVE CORRELATES OF INJURED WORKERS WHO HAVE UNDERGONE PERCUTANEOUS FACET RADIOFREQUENCY NEUROTOMY OF THE SPINE

by

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ABSTRACT

Analysis of Outcomes and Predictive Correlates of

Percutaneous Facet Radiofrequency

Neurotomy of the Spine

by

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Radiofrequency neurotomy is a pain intervention procedure designed to coagulate nerves that innervate a specific area of spinal vertebrae known as the facet joint. Despite moderate to strong research support for the efficacy of radiofrequency neurotomy to improve short-term subjective pain levels, much of the literature to date has used strict selection criteria and has not focused on functional and quality of life outcomes. Moreover, few studies have examined outcomes in worker's compensation patients or considered biopsychosocial predictive variables for the procedure. The current study aimed to characterize injured workers who have undergone radiofrequency neurotomy across a number of pre and post-procedural variables, evaluate multidimensional functional and quality of life outcomes, and examine biopsychosocial variables predictive of success and failure in this sample.

The current study comprised 101 injured workers who had undergone at least one radiofrequency neurotomy of the spine (cervical, thoracic, or lumbar) in the past 11 years. Participants were solicited through the Worker's Compensation Fund of Utah computerized database. By employing a retrospective cohort design, patients' medical charts were reviewed and various preprocedural variables were coded for analysis including age at the time of the first neurotomy, history of depression, lawyer involvement in the claim, prior back and neck surgical history, and quantity of other compensation claims. Of the total sample, 56 patients (55.4%) were contacted and completed outcome surveys that assessed patient satisfaction, functional impairment, disability status, pain catastrophization, and general physical and mental health functioning.

Findings revealed a moderate proportion of patients with total disability (40%), poor back/neck specific functioning (63%), and dissatisfaction with their current back/neck condition (75%). A multivariate regression model was consistently predictive of patient outcomes. Specifically, litigation status was a robust predictor of multidimensional outcomes, while depression and age retained slightly less predictive power. Results of descriptive, correlational, and regression analyses are compared to existing data for radiofrequency neurotomy and other spine procedures with similar populations. Limitations of the study are discussed, such as the retrospective design, lack of matched controls, and small sample size.

(198 pages)

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Tyler J. Christensen

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CHAPTER 1

INTRODUCTION

The societal, economic, and occupational costs of back pain in industrialized countries have been well-documented throughout the spine literature. In a recent review, Hurwitz and Shekelle (2006) reported that 50 - 85% of community-based populations are affected by low back pain (LBP) at some point in their lives. United States national surveys from 2002 indicate that LBP remains the most common type of pain reported by U.S. adults (Deyo, Mirza, & Martin, 2006). It is estimated that at any point in time, 2-5% of the U.S. population has a disabling low back condition (Andersson, 1991). Though the prevalence of LBP does not appear to have increased significantly over the past few decades, the overall costs and medical utilization relative to treating back pain in industrialized countries have grown dramatically (Leboeuf-Yde & Lauritsen, 1995; Maniadakis & Gray, 2000).

Medical expenses and worker compensation claims for spinal pain account for substantial economic costs in the United States. On average, individuals with back pain incur health expenditures 60% higher than individuals without back pain (Luo, Pietrobon, Sun, Liu, & Hey, 2004) with an estimated $20-$50 billion spent annually in direct health care costs (Frymoyer & Durett, 1997; Smith & McGhan; 1998). In terms of work-related back-pain, 5.6 million cases were documented in 1995, resulting in nearly $9 billion in worker's compensation claim costs alone (Murphy & Volinn, 1999). When this figure includes worker's lost production time, estimates indicate that back pain costs employers nearly $20 billion annually, while the total impact as a nation is estimate to be nearly $171 billion (Leigh, Markowitz, Fahs, Shin, & Landrigan, 1997; Stewart, Ricci, Chee, Morganstein, & Lipton, 2003). Worldwide, 37% of LBP has been attributed to occupational risk factors with more than 800,000 disability-adjusted life years lost annually (i.e., both time lost due to premature death and time spent disabled by back pain; Punnett et al., 2005).

Increasing costs have contributed to a growing body of literature focused on the prevention and treatment of spinal pain. Notably, the U.S. Department of Health and Human Services has developed evidence-based clinical practice guidelines updated annually to provide physicians with information regarding efficacious assessment and treatment of lumbar and thoracic pain (Work Loss Data Institute, 2007). Although the guidelines emphasize conservative nonoperative treatments (physical therapy, chiropractic, patient education, and anti-inflammatory medications), as many as 70% of patients do not respond to such treatments and experience chronic persistent or recurring pain symptoms that last one year or longer after the initial episode (Cassidy, Côté, Carroll, & Kristman, 2005; Garofalo & Polatin, 1999; Hestbaek, Leboeuf-Yde, & Manniche, 2003). A large number of these individuals, particularly injured workers, turn to surgical interventions as a next possible solution.

Despite the increasing prevalence of back operations (e.g., fusion, discectomy) in the United States (DeFrances & Hall, 2007; Deyo & Mirza, 2006), rates of successful outcomes are quite variable with often a significant proportion of patients not appearing to do well after back surgery (Carragee, Han, Suen, & Kim, 2003; Hoffman, Wheeler, & Deyo, 1993; Nachemson, Zdeblick, & O'Brien, 1996). Predicting who will experience positive surgical outcomes and who will not has proven to be quite difficult and a large body of research focuses on this question. Some attribute mixed surgery outcomes to biopsychosocial variables (Epker & Block, 2006; LaCaille, DeBerard, Masters, Colledge, & Bacon, 2005; Linton, 2000), while others have pointed to the shortcomings in radiographic imaging as a rather unreliable tool for diagnosing pain sources and providing grounds for surgery (DeBerard, Masters, Colledge, Schleusener, & Schlegel, 2001; Jarvik & Deyo, 2002; Jensen et al., 1994).

One common cause of spinal pain that cannot be identified through radiological evaluation or physical examination is the facet or zygapophysial joint. The spinal facet joints are diarthrodial (freely moving) articulations between posterior elements of adjacent vertebrae that are innervated by the medial branches of pain transmitting nerves (Bogduk, 2005; Bogduk & Long, 1979). According to criteria established by the International Association for the Study of Pain (Merskey & Bogduk, 1994), facet joint pain has been implicated as responsible for chronic pain in 15-45% of patients with low back pain, 36-67% of patients with neck pain, and 34-48% of patients with thoracic pain (Manchikanti et al., 2004; Manchukonda, Manchikanti, Cash, Pampati, & Manchikanti, 2007). Biomechanical and neuroanatomical studies show that facet joints undergo high strains during spine-loading and contain nerve endings along with mechanically sensitive nociceptors (Cavanaugh, Lu, Chen, & Kallakuri, 2006). In order to identify the facet joint as a source of spinal pain, diagnostic blocks of the facet joint must be performed by administering a local anesthetic intrarticularly or on the medial branches of the dorsal rami that innervate the joint (Bogduk, 1997). If neural blockades reliably reduce or eliminate pain, then treatment can be accomplished by performing percutaneous radiofrequency (RF) neurotomy of the facet joint.

RF neurotomy is a minimally invasive procedure designed to denervate the zygapophysial joint. An electrode is inserted parallel to medial branches that innervate the pain-inducing joint and is heated to coagulate the nerves thereby relieving pain. However, these nerves may eventually regenerate in 6-12 months, which may or may not coincide with a reoccurrence of pain (Smith, McWhorter, & Challa, 1981). Recent literature aimed at describing evidence-based guidelines for RF neurotomy has concluded that there is “moderate” to “strong” support for its efficacy when proper patient selection and anatomically correct techniques are used (Bogduk, 2008; Boswell, Colson, Sehgal, Dunbar, & Epter, 2007). This evidence is based on checklists of accepted criteria for evaluating the quality of clinical trials in multiple systematic reviews (Boswell et al., 2007; Boswell, Colson, & Spillane, 2005; Manchikanti et al., 2002). Using strict selection criteria, one study showed that 87% of patients obtained at least a 60% reduction in pain at 12-month follow-up (Dreyfuss et al., 2000). However, in the past nine years, controversy regarding the procedure has been perpetuated by two double-blind, placebo-controlled studies showing no or minimal benefit for RF neurotomy compared to sham lesioning (Leclaire, Fortin, Lambert, Bergeron, & Rossignol, 2001; van Wijk et al., 2005). It appears that mixed results in these procedures are due to a number of possible factors including, false-positive diagnostic blocks, placebo effects, co-occurring sources of pain, and improper placement of electrodes (Bogduk, 2008; Bogduk & Aprill, 1993; Manchukonda et al., 2007). Retrospective effectiveness studies using less stringent patient selection criteria show more modest success rates with 40-45% of patients experiencing more than 50% pain reduction (North, Han, Zahurak, & Kidd, 1994; Tzaan & Tasker, 2000). Additionally, outcome measures have primarily consisted of subjective pain relief, with little consideration for the functional status of the patients.

Given that a number of clinical and psychosocial factors have been associated with patient functioning and disability status following other back procedures (DeBerard et al., 2001; Gatchel & Gardea, 1999; LaCaille et al., 2005), it is surprising that similar correlates have not been more closely investigated for RF neurotomy. Two fairly recent studies have attempted to determine clinical factors associated with the success and failure of RF neurotomy of the lumbar and cervical facet joints (Cohen, Bajwa et al., 2007; Cohen, Hurley, et al., 2007). In both cases, “paraspinal tenderness” was the only factor associated with a successful outcome.

Facet joint interventions rank second only to epidural steroid injections as the most commonly used pain management procedure in the United States and there has been more than a 200% increase in utilization in the Medicare population within the last decade (Manchikanti, 2004). Despite its growing popularity, it appears that evidence for the long-term effectiveness and clear benefit for the use of RF neurotomy is only modestly established.

While the importance of patient selection has been stressed (Bogduk, 2008), there are few reports of studies with the intent of determining psychosocial predictive variables for RF neurotomy and only some studies measuring multidimensional outcomes. The paucity of literature is especially apparent in the case of worker’s compensation patients who have received virtually no empirical attention addressing predictors and outcomes relevant to this unique population. Thus, when considering the economic costs involved, increasing utilization of facet joint interventions, and few studies examining variables predictive of success and failure, it is critical that steps be taken to identify patients at risk for poor outcomes. The current study has three primary purposes: (a) to characterize the patient variables in a population of worker's compensation patients who have undergone percutaneous RF neurotomy, (b) to evaluate RF neurotomy outcomes in this sample, and (c) to examine biopsychosocial variables predictive of success and failure from the procedure.

CHAPTER II

REVIEW OF LITERATURE

This review of the literature examines specific indications for RF neurotomy, a description of the procedure itself, as well as relevant outcome studies. Predictive correlates for the treatment of spinal pain will be reviewed for both surgical and non-surgical interventions in order to provide a general picture of possible contributing variables. Studies and review articles were primarily extracted from a search of the Medline database using keywords associated with RF neurotomy.

The impact of spinal pain on industrialized countries would be difficult to overestimate. About two thirds of adults report LBP at some point in their lives and about one-half experience LBP in any given year (Hurwitz & Shekelle, 2006; Lawrence et al., 1998). Among individuals who report one episode of back pain, as many as 75% will have recurring episodes and develop persistent pain lasting for more than 1 year (Cassidy et al., 2005; Thomas et al., 1999). Overall, back pain patients incur 60% more health care costs than those without back pain, with direct expenditures exceeding $90 billion annually (Luo et al., 2004). Workplace injuries and disability claims are largely responsible for these costs and approximately 16% of all compensation claims are the result of LBP (Hadler, Carey, & Garrett, 1995; Waddell, 1996). Additional factors contributing to the collective effects among United States workers include, activity limitations, functional impairment, reduced quality of life, underemployment, and reduced work productivity (Stewart et al., 2003). Many injured workers turn to surgical treatments in an effort to find pain relief and improve functioning.

The utilization of invasive surgical treatments for low back pain (e.g., discectomy, spinal fusion, laminectomy) has been on the incline, yet outcome research continues to produce inconsistent results (Carragee et al., 2003; Hoffman et al., 1993; Nachemson et al., 1996; Turner et al., 1992). Some of this variation may be due to psychosocial variables, which have been linked to mixed surgery outcomes in spine patients (DeBerard, Masters, Colledge, & Holmes, 2003; Gatchel & Gardea, 1999). Worker's compensation status is one variable that has been associated with poor outcomes and is linked to a number of confounding factors (Atlas et al., 2007). The effectiveness of back pain interventions is also complicated by multiple origins of back pain, which include intervertebral discs, facet joints, sacroiliac joints, ligaments, muscles and nerve root dura (Cavanaugh, 1995; Kuslich, Ulstrom, & Michael, 1991).

While some anatomical sources of chronic pain (i.e., vertebral instability) may call for diagnostic imaging procedures and open operations (i.e., fusion), others, such as facet arthropathy, are best diagnosed and treated through interventional pain management techniques that tend to be less invasive than conventional surgery (Boswell, Trescot, et al., 2007; Hancock et al., 2007). Interventional techniques for chronic spinal pain are performed by physicians from multiple specialties (e.g., rheumatologists, orthopedic surgeons, anesthesiologists, neurologists, etc.) and in various settings (e.g., hospital outpatient departments, ambulatory surgical centers, and physician offices). In the past decade, the American Society of Interventional Pain Physicians has developed and regularly updated evidenced-based practice guidelines for interventional techniques to improve the quality of patient care and treatment outcomes, while promoting efficacious and cost effective interventions (Boswell, Trescot, et al., 2007). Evidenced-informed treatment is vital given that the utilization of pain management procedures of this type are growing at a considerable rate with a 95% increase from 1998 to 2003 in the Medicare population and approximately 15 million procedures performed annually in the United States (Manchikanti, 2004).

RF neurotomy has emerged as one of the most widely utilized nonsurgical procedures for persistent spinal pain. In fact, facet joint interventions rank just behind epidural steroid injections, as the second most commonly used interventional pain management procedures (Manchikanti, 2004). While RF neurotomy for cervical, thoracic, and lumbar facet pain has been the subject of many outcomes studies since its first use over 30 years ago, there continue to be questions about its efficacy due to conflicting results in select studies (Geurts et al., 2003; Leclaire et al., 2001; van Wijk et al., 2005). Nonetheless, most studies concur that appropriate patient selection is a key ingredient to successful outcomes.

Indications for RF Neurotomy

The first mention of the facet joint as a source of pain was by Goldthwait in 1911 and more than 20 years later a "facet syndrome" was described by Ghormley (1933). Following these initial descriptions, the intervertbral discs became a primary focus of researchers and physicians, drawing attention away from the facet joint until the early 1970s. Modern evidence has shown that spinal facet joints are well innervated by pain transmitting nerves, undergo high strains during lifting, and are often a source of pain in the upper, mid-, and lower back as well as referred pain in the head and the upper and lower extremities (Cavanaugh et al., 2006; Cavanaugh, Ozaktay, Yamashita, & King, 1996; Dreyfuss, Tibiletti, & Dreyer, 1994; Mooney & Robertson, 1976). Though the spinal facet joint is a common source of chronic pain in the cervical, thoracic, and lumbar regions (Manchukonda et al., 2007), there is much overlap in pain patterns with other back conditions (e.g., disc degeneration and herniation, stenosis, spondolysthesis, etc.). Thus, differentiating facet pain from other sources of pain can be a difficult task, which is made more difficult by the fact that pain may be stemming from more than one anatomical structure at the same time (Bogduk & April, 1993).

Several studies have attempted to predict which chronic pain patients have the facet joint as their principal source of pain. Some have claimed that a combination of clinical features, such as old age and exacerbation of pain by coughing, can predict the presence of facet syndrome (Helbig & Lee, 1988; Laslett, McDonald, Aprill, Tropp, & Oberg, 2006; Revel et al., 1998). However, based on today's practice, the preponderance of evidence indicates that clinical characteristics are not reliable predictors on their own, such that the rate of false-positives (i.e., those selected based on clinical features who do not respond to subsequent nerve blocks) is too great (Jackson, Jacobs, & Montesano, 1988; Manchikanti, Pampati, Fellows, & Bakhit, 2000; Schwarzer et al., 1994). Another proposed diagnostic method is the use of radiographic imaging for the identification of facet joint arthropathy. Though a few recent studies have demonstrated the potential of medical imaging (Houseni, Chamroonrat, Zhuang, & Alavi, 2006; Pneumaticos, Chatziioannou, Hipp, Moore, & Esses, 2006), others have contrasted such findings, criticizing the methodology used in these studies and conclude that imaging is not a reliable diagnostic tool for predicting pain elimination following facet injections (Stojanovic, Sethee, Mohiuddin, Cheng, Barker, Wang, et al., 2010; Schwarzer et al., 1995; Sehgal, Dunbar, Shah, & Colson, 2007). Given the lack of evidence to show sufficient specificity for diagnosing facet pain, the strongest indicator currently for RF neurotomy is positive response (significant reduction of pain) following diagnostic nerve blocks of the facet joints (Sehgal et al., 2007).

Diagnostic blocks are accomplished by injecting a small volume of local anesthetic onto the nerves that innervate the facet joints, which are suspected of causing pain. If pain is relieved following the injection, then this is thought to confirm the hypothesis that pain is originating from the selected facet joints (Bogduk, 2002). This type of injection is termed a medial branch block (MBB) as its purpose is to anesthetize the medial branches of the pain inducing nerves that innervate the joint. According to guidelines developed by the International Spine Intervention Society (ISIS), MBBs should be performed under controlled conditions where the needle is guided using fluoroscopically guided techniques (ISIS, 2004). The guidelines also emphasize the importance of conducting a second comparative block to confirm the diagnosis, as single MBBs may not reliably identify facet syndrome (Manchikanti, Pampati, Fellows, & Bakhit, 2000). The two blocks are administered on different occasions using a short- and long-acting anesthetic. The short-acting anesthetic should result in short-lived pain relief, while the long-acting anesthetic should result in long-term pain relief (ISIS, 2004). Optimally, the patient will report complete pain relief on the visual analog scale (VAS); however, in practice this rarely happens and 80% relief is generally deemed sufficient to proceed with RF neurotomy. A pain reduction of 50% following MBB has been a source of debate in the literature with many researchers arguing that this does not represent a positive response to nerve blocks and may simply represent a placebo response (Bogduk, 2008).

Among various groups, comparative diagnostic MBBs have provided highly variable prevalence estimates. It is estimated that 15-45% of chronic low back pain patients have pain originating from the facet joints, while this is the case in 36-67% of chronic neck pain patients (Manchikanti et al., 2004; Manchukonda et al., 2007). Among injured workers with back pain the prevalence has ranged from 5-15% (Jackson et al., 1988; Laslett et al., 2006; Schwarzer et al., 1994). ISIS guidelines report that younger patients are less likely to respond to MBBs and physicians should first consider discogenic pain (ISIS, 2004). The prevalence of facet pain in failed back surgery patients is estimated to be approximately 16% (Manchikanti, Manchukonda, Pampati, Damron, & McManus, 2007).

As it currently stands, MBBs are the only validated method for the diagnosis of facet joint involvement in chronic spinal pain. However, some have attempted to identify variables that may influence the predictive accuracy of MBBs. For example, Manchikanti, Cash, Pampati, and Fellows (2008) recently investigated the effects of psychological variables (i.e., depression, anxiety, and somatization) on the diagnosis of facet syndrome. Results demonstrated no differences in false-positive rates between those with and without psychopathology in the lumbar and thoracic regions. In the case of chronic neck pain, however, those with major depression showed a higher incidence of facet pain and lower false-positive rates compared to patients without major depression. The authors did not provide an explanation for why this was the case.

In general, the evidence supports the diagnostic utility of MBBs in most chronic spinal pain patients. In a recent systematic review, Boswell and his colleagues (2007) concluded that there is strong evidence for the accuracy of diagnostic facet joint injections in the lumbar and cervical regions and moderate evidence for the thoracic region. In a similar review, Sehgal and colleagues (2007) report that controlled comparative MBBs are "safe, valid, and reliable" and can accurately distinguish painful facet joints from those that are not. However, despite the diagnostic utility of MBBs, a considerable number of patients do not respond to RF neurotomy or have a very short duration of pain relief, evidencing the difficulty in accurately selecting individuals to undergo the procedure. In addition to problems with patient selection, failure to achieve long-term pain relief may be the result of dual sources of pain (i.e., the facet joint and intervertebral discs) or a poor RF neurotomy procedure in general (Bogduk, 1997).

RF Neurotomy Apparatus and Procedure

While the injection of an anesthetic, such as in MBB, is thought to temporarily reduce pain in the facet joint by acting on the sodium channels of the target nerve, RF neurotomy acts on the nerve by physically altering its structure through thermal coagulation, leading to a much longer effect (Bogduk, 2008). Shealy (1974) was the first to attempt a fluoroscopically guided radiofrequency technique he termed "percutaneous spinal facet rhizotomy" and later "facet denervation" (Shealy, 1975). The terminology was changed to "medial branch neurotomy" when it was discovered that the articular branches targeted in Shealy's technique were too small to be accurately denervated (Bogduk & Long, 1980). Rather, neurotomy requires precise anatomical evidence so that medial branches of the dorsal rami can be properly targeted and coagulated (Lau, Mercer, Govind, & Bogduk, 2004). Because a variety of techniques have been used with varying efficacy, Gofeld and Faclier (2008) recently analyzed these methods and proposed step-by-step guidelines for maximizing anatomic and technical accuracy of the procedure.

RF neurotomy is generally performed as an ambulatory procedure using a local or general anesthetic based on the patients needs. The patient lies prone on the operating table and a RFcannula is inserted parallel to the target nerve. Correct placement of the electrode is critical and should be verified through electrostimulation and through the use of fluoroscopic projections. Once the cannula is accurately placed a small volume of local anesthetic (e.g., .5mL of lidocaine 1%) is usually administered to numb the patient to the thermal action. The RF probe is inserted into the cannula and a RF generator produces a lesion on the nerves that innervate the facet joint at a temperature of 60-80° C for a period of 60-90 seconds. A modification to Shealy's technique that has received considerable attention has to do with the direction of electrode placement in relation to the target nerve. RF electrodes have been shown to coagulate tissues most effectively when they are placed parallel to the target nerve (Bogduk, Macintosh, & Marsland, 1987). However, numerous studies, including many randomized control trials have placed the electrode perpendicular to the nerve. This can result in an inadequate coagulation of nerve tissue and shortened duration of pain relief (Lau et al., 2004). Essentially, RF neurotomy denatures the nerve so that pain signals are impeded from reaching the brain. Longer segments of thermal coagulation lead to longer durations of pain relief (Bogduk, 2008). If performed properly, regeneration of the nerves may take several months or longer. Serious complications and side effects for RF neurotomy are extremely rare. Incidentally, using a blade to completely sever the nerves is not an option due to undesirable complications such as large hematomas (Shealy, 1975).

RF Neurotomy Outcome Studies

In response to increased utilization of RF neurotomy in the routine care of chronic spinal pain patients, there has been a growing body of research examining the efficacy, effectiveness, and general outcomes of the procedure. Consequently, multiple systematic reviews (Boswell et al., 2005; Boswell, Colson, et al., 2007; Geurts, van Wijk, Stolker, & Groen, 2001; Manchikanti et al., 2002; Niemisto, Kalso, Malmivaara, Seitsalo, & Hurri, 2003) and practice guidelines (Boswell, Trescot, et al., 2007; Manchikanti, Singh, Bakhit, & Fellows, 2000) have been published in recent years in an effort provide evidence-based recommendations to practitioners. Three of the reviews utilized criteria from the Agency for Healthcare Research and Quality (AHRQ; West et al., 2002) to evaluate individual randomized and observational trials (Boswell, Colson, et al., 2007; Boswell et al., 2005; Manchikanti et al., 2002). These criteria outline important elements for rating the strength of scientific evidence along a number of domains. An examination of several systematic reviews, randomized control trials, and observational studies can be found below.

In their review, Manchikanti and colleagues (2002) evaluated four randomized trials of RF neurotomy, four prospective studies, and three retrospective studies. Inclusion in the review was based on stringent AHRQ checklists regarding the quality the trials. Studies were rated along five levels of effectiveness, namely: “conclusive, strong, moderate, limited, and indeterminate.” Based on their evaluation, the authors reported that there is "strong" evidence for RF neurotomy in offering short-term (3 to 6 months) relief and "moderate" long-term (> 6 months) relief in patients with facet joint pain originating in the cervical, thoracic, and lumbar regions. In this case, "strong" is defined as empirical evidence from at least one well-designed randomized control trial (RCT), from several smaller RCT's, or from at least one RCT along with positive findings from prospective and retrospective studies. On the other hand, "moderate" evidence involves support from one properly designed small RCT, well-designed pseudorandomized comparative studies (i.e., with concurrent controls), or positive findings from at least one meta-analysis.

A more recent systematic review by Boswell and colleagues (2007) evaluated two randomized trials and 15 observational studies. Similar to the previous review, studies were required to meet a minimum level of AHRQ standards to be included in the evaluation. The authors concluded that evidence was "strong" for short-term (< 3 months) and "moderate" for long-term (> 3 months) relief of lumbar and cervical facet joint pain. The definitions for "strong" and "moderate" are essentially the same as those provided by Manchikanti et al. (2002). For RF neurotomy of the thoracic region the evidence was indeterminate.

Two additional reviews (Geurts et al., 2001; Niemisto et al., 2003) evaluated only randomized control trials for RF neurotomy and arrived at less promising and more conflicting results. In their review of six randomized control trials, Geurts and colleagues (2001) rated the evidence as "limited" for RF neurotomy in the treatment of cervical facet joint pain in whiplash patients and "moderate" for lumbar facet pain compared to placebo. In this review "limited" was defined as "one relevant high-quality RCT or more than one relevant, low-quality RCT with generally consistent outcomes," while "moderate" was defined as "one relevant high-quality RCT and one (or more) low quality RCTs with generally consistent outcomes (Geurts et al., 2001, p. 397). Niemisto and colleagues (2003) included seven randomized control trials in their review, several of which were also evaluated by Geurts et al. (2001). These authors concluded that evidence was "limited" for short-term pain relief in the cervical region and "conflicting" for facet pain relief in the lumbar region. Based on these authors' criteria, evidence was positive in only one high or low-quality RCT or findings were not consistent across available RCTs. It should be noted that both of these latter systematic reviews have been criticized for inappropriate methodology (Boswell, Colson, et al., 2007; Hopayian, 2001) and were not included in the creation of evidence-based guidelines for RF neurotomy "due to several deficiencies" (Boswell, Trescot, et al., 2007, p. 37). Synthesizing the evidence from all the above reviews there remains some question regarding the effectiveness of RF neurotomy, especially with respect to long-term pain relief.

In the past nine years, two double-blind, placebo-controlled trials have demonstrated no or minimal benefit from RF neurotomy (Leclaire et al., 2001; van Wijk et al., 2005). The first, conducted by Leclaire and colleagues (2001) used a sample of 70 outpatients with LBP of at least three months duration and no previous history of low back surgery. Patients were selected for the study if they experienced significant relief of their LBP for a 24-hour period in the 7 days following intraarticular facet injections. These patients then underwent either RF neurotomy of the lumbar facet joints or a sham therapy involving the same procedure without raising the temperature of the electrode. After 12 weeks, no differences were found between the two groups in levels of pain as assessed by the VAS, nor functional disability, as assessed by the Roland-Morris scale (Roland & Morris, 1983a, 1983b) and the Oswestry questionnaire (Fairbank, Couper, Davies, & O'Brien, 1980). In a similar sham lesion-controlled trial, vanWijk and colleagues (2005) attempted to reflect common clinical practice by including LBP patients who had a positive response ($\geq$ 50% pain relief) to a single diagnostic intrarticular block. Success of the treatment was determined *a priori* using a combined outcome measure that took into account changes in VAS, changes in daily activities, and the use of analgesic medications. On this combined measure no differences were found between the neurotomy group and the sham group; however, both groups experienced significant pain relief according to the VAS. Notably, the neurotomy group reported significantly more pain relief than the sham group as measured by global perceived effect. The primary criticisms of these two studies has been the high likelihood of false-positives due to single rather than comparative diagnostic blocks and placement of the needle perpendicular to the nerve rather than parallel (Bogduk, 2006; Boswell, Trescot, et al., 2007; Cohen & Raja, 2007). In contrast to the above studies, several randomized control trials have found significant benefit for RF neurotomy.

In a smaller randomized trial of neck pain patients, Lord, Barnsley, Wallis, McDonald, and Bogduk (1996) treated 24 patients with chronic cervical facet joint pain following an automobile accident. Patients were properly selected based on placebo-controlled diagnostic MBBs and had no signs or symptoms of radiculopathy. Using the VAS and the McGill Pain Questionnaire (Melzack, 1975) as outcome measures the median time to the return of at least 50% of preoperative pain levels was 263 days for the treatment group and 8 days for the sham lesion group. The authors concluded that RF neurotomy of the cervical spine with multiple lesions (i.e., two to three RF lesions on the same nerve to maximize coagulation) can lead to long-term pain relief. Additionally, several patients underwent repeat RF neurotomy after the recurrence of pain and experienced a comparable duration of pain relief.

In the most recent randomized control trial to date, Nath, Nath, and Pettersson (2008) compared outcomes of RF neurotomy of the lumbar spine to sham surgery. Forty patients with a mean duration of LBP of 11-12 years were diagnosed with facet joint pain by way of at least 80% pain relief (recorded each hour for 6 hrs) following controlled MBBs. This stands in contrast to the diagnostic procedures of Leclaire et al. (2001) and van Wijk et al. (2005) who relied on single nerve blocks and more leniencies in the degree and duration of pain relief. Outcomes were assessed at 6 months post-procedure by patient's subjective perception of global improvement, pain relief based on the VAS, quality of life variables (i.e., walking, sleeping, social life, etc.), analgesic intake, and range of movement based on physical examination. Results were overwhelmingly in favor of the RF treatment group. At follow-up, patients who underwent RF neurotomy reported significantly greater overall improvements, more pain reduction, better quality of life, fewer pain medications, and a greater capacity for movement than the placebo group. The authors stress that positive outcomes will depend on careful selection of patients (in this study 40 patients were identified from an original pool of 376) as well as the ability of the operator to accurately place the RF electrode.

In a frequently-cited and well-designed prospective non-randomized trial, Dreyfuss and colleagues (2000) used stringent selection criteria, similar to that of Nath and colleagues (2008), to evaluate the efficacy of RF neurotomy for lumbar facet pain.

Exclusion criteria included prior low back surgery, compensation, work injury, ongoing litigation, and verified discogenic pain. Of the 460 individuals who responded to invitations, only 15 were included in the study based on positive response to controlled MBBs. An extra step was taken to verify that the targeted nerves had been coagulated by submitting the participants to an electromyogram. At 12-month follow-up, 60% of patients had at least a 90% reduction in pain and 87% obtained at least a 60% reduction leading the authors to conclude that long-term pain relief is possible following RF neurotomy. These findings are comparable to those of other prospective studies that have evaluated RF neurotomy for cervical facet joint pain. For example, Barnsley (2005) examined results from RF neurotomy in routine clinical practice and reported a mean duration of complete pain relief of 35 weeks in 74% of neck pain patients. McDonald, Lord, and Bogduk (1999) obtained equivalent results for patients with neck pain stemming from a motor vehicle accident. The median duration of complete pain relief was 219 days for 71% of the sample; however, this duration nearly doubled to 422 days when only the successes were considered. While this is encouraging, the rigorous exclusion criteria are indicative of a best-case scenario limiting the external validity of these findings. Overall, the outcomes from prospective studies have primarily been in favor of RF neurotomy, this has not been the case with retrospective designs.

In one of the original RF neurotomy studies, Schaerer (1978) utilized a retrospective design to evaluate outcomes in 50 patients with facet pain originating in the cervical region and 71 patients in the lumbar region. A “pain evaluation profile” was obtained from each patient before and after the procedure that consisted of items pertaining to severity and duration of pain, activity level, analgesic intake, and mood. Pre to post change scores on this measure were categorized as excellent, good, fair or poor. At an average follow-up of 15.4 months 50% of the cervical group demonstrated good or excellent outcomes, while 35% of the lumbar group obtained this result at 13.7 months follow-up. It is notable that this study used Shealy's (1975) outdated RF technique and inadequate single diagnostic nerve blocks.

In a more recent retrospective study, Tzaan and Tasker (2000) obtained results similar to Schaerer (1978) for patients suffering from cervical, thoracic, and lumbar facet pain. In this study, 41% of patients experienced at least a 50% reduction in pain at an average follow-up of 5.6 months (range: 1 to 33 months). The authors admit that these unimpressive findings may be the result of inaccurate placement of the electrode or high numbers of false-positives due to single rather than double MBBs.

In contrast, Schofferman and Kine (2004) selected patients who underwent successful RF neurtomy of the lumbar facets in order to evaluate the effectiveness of repeat procedures. Data were gathered through medical chart reviews at a single spine center for patients who had undergone at least two RF neurotomies. Successful outcomes were defined as greater than 50% pain relief in the target area. The duration of pain relief was 10.5 months following the initial RF neurotomy. Of the 20 patients who underwent repeat procedures 17 (85%) had successful outcomes and a duration of pain relief equivalent to the initial procedure. The authors concluded that RF neurotomy is a useful tool that can be used repeatedly for palliative care when there has been an initial beneficial effect.

Synthesizing evidence from over 30 years of research, there is tentative support for the use of RF neurotomy in the management of chronic spinal pain. Though the procedure itself has some evidence for its efficacy, this evidence has been obtained using highly selected patients and techniques that may not be reflective of routine clinical practice. This is manifest by a host of retrospective studies that have found poor outcomes in the evaluation of RF patients undergoing routine care. One randomized trial (van Wijk et al., 2005) that has received intense criticism actually used a diagnostic technique (i.e., single MBB) that reflects general clinical practice. The literature contains several inconsistencies with regard to the definition and duration of pain relief as well as variability in diagnosis and technique. However, there is a consensus that patient selection is of primary importance if one wishes to maximize benefits from RF neurotomy. Thus, it is surprising that more work has not been done to identify factors predictive of success and failure. Finally, multidimensional functional outcomes have not been closely investigated for RF neurotomy; rather, pain reduction has been the major focus. Though RF neurotomy is considered a "minimally invasive procedure" there is always the potential for complications, not to mention significant financial costs involved. Therefore, characterizing patients who are most likely to respond to RF neurotomy becomes a considerable interest for patients and physicians alike.

RF Neurotomy Outcomes in Compensation Patients

Compensation status is often associated with poor outcome after therapeutic spine intervention (Agazzi, Reverdin, & May, 1999; Harris, Mulford, Solomon, van Gelder, & Young, 2005; Walsh & Dumitru, 1987). However, the basis for this difference is unclear and has been hypothesized to be related to baseline differences in clinical and non-clinical factors (Atlas et al., 2007; Hadler et al., 1995). Harris and colleagues (2005) conducted an extensive meta-analysis of 129 studies involving surgical outcomes for more than 20,000 compensation and non-compensation patients including various forms of spine interventions. They found significant and consistent differences in outcome between the two groups with compensation patients showing inferior outcomes. Atlas and colleagues (2007) examined sociodemographic variables that may explain these outcome differences in a large sample of compensated and non-compensated patients. Notable baseline differences were found between the two groups such that workers' compensation patients tended to be younger, nonwhite, less educated, and smokers. Additionally, patients receiving workers' compensation reported more physically demanding activities and lower annual income; they were less likely to work as a manager or professional and were less likely to expect to return to their usual job after surgery. The authors concluded that disparities in clinical outcomes for compensated patients are at least partially mediated by these significant differences in socioeconomic factors.

While there is a fairly broad literature base that has investigated invasive spine surgery outcomes in worker's compensation patients, considerably less attention has been given to minimally invasive procedures such as RF neurotomy. Preliminary evidence suggests that compensation patients may differ in their response to treatment based on the type of spine intervention. For example, one study found that patients undergoing microdiskectomy (a less-invasive procedure) had better outcomes than fusion patients in a population of injured workers (Hodges, Humphreys, Eck, Covington, & Harrom, 2001). RF outcomes in compensation patients were examined in only two studies extracted from the Medline database search for the current literature review. The first study by Silvers

(1990) examined success rates in a sample of 223 chronic LBP patients who underwent RF neurotomy of the lumbar spine. Results showed no significant differences in the degree of pain relief for those with a pending compensation claim (*n* = 82, success rate = 67%) compared to those without a claim (*n* = 141, success rate = 70%). The second study, by Leclaire and colleagues (2001), investigated outcomes in LBP patients undergoing RF treatment using a double-blind RCT. Surprisingly, in the group who received RF neurotomy, compensation status was associated with better therapeutic outcomes (i.e., improved functional status & increased pain relief). The authors noted that this is a difficult finding to interpret, given typically poorer outcomes in compensation populations (Atlas et al., 2007; Harris et al., 2005). The paucity of literature related to RF neurotomy outcomes in compensation patients along with conflicting results in available studies suggest a need for more research in this area, especially as it relates to predictive variables.

Variables Predictive of RF Neurotomy Outcomes

An extensive literature has been dedicated to identifying prognostic and risk factors for spinal pain, disability, and response to various treatments (Block & Callewart, 1999; Hurwitz & Shekelle, 2006; LaCaille et al., 2005; McCracken & Turk, 2002). In the case of back surgery, patient selection is complicated by symptoms that often do not correlate with radiographic images (Jarvik & Deyo, 2002; Jensen et al., 1994) and pre-surgical diagnoses that often fail to predict outcomes (DeBerard et al., 2001; Franklin, Haugh, Heyer, McKeefrey, & Picciano, 1994; LaCaille et al., 2005; Turner et al., 1992). In fact, a body of research suggests that psychosocial variables may be just as or more effective as physical indicators in predicting surgical outcomes (Gatchel & Gardea, 1999). For example, older age, presence of litigation, lower income at time of injury, alcohol use, number of prior low back operations, and presence of depression have been found to be predictive of lumbar fusion outcomes in injured workers (DeBerard et al., 2001; LaCaille et al., 2005). Relatively few studies have attempted to identify such predictive variables for minimally invasive procedures. In the case of RF neurotomy, most evaluations of prognostic and risk factors are based on limited descriptive statistics obtained from outcome studies where results have been mixed. Nevertheless, three published reports have emerged in the past three years that have specifically targeted the identification of predictive correlates for the RF technique (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007; van Wijk et al., 2008). It is important to note that none of these studies have investigated predictive variables specific to worker's compensation patients, which may be particularly informative given the unique characteristics of this population (Block & Callewart, 1999). It would be important to determine if injured workers are at greater risk for poor outcomes when undergoing RF neurotomy, commensurate with that which has been demonstrated in more invasive spine surgeries. Findings from the above studies and others reporting data on demographic, clinical, and psychosocial predictors of outcomes for RF neurotomy will be described below.

Demographic Variables

Older age has been associated with a higher incidence of back pain and poorer outcomes following spine operations (Chen, Baba, Kamitani, Furusawa, & Imura, 1994; Deyo & Tsui-Wu, 1987). This finding can be generalized to outcomes for some minimally invasive techniques, such as spinal cord stimulation, where younger aged patients have been shown to obtain greater levels of pain relief following the procedure than their older counterparts (Burchiel et al., 1995; Kim, Chin, Yoon, Jin, & Cho, 2002; North, Kidd, Wimberly, & Edwin, 1996). In contrast, there are no clear indications in the literature that suggest older age is predictive of treatment failure following RF neurotomy. In fact, at least two outcome studies have shown the reverse: greater benefit for older patients following RF neurotomy than for younger patients. In their randomized trial, Leclaire and colleagues (2001) found no differences between RF neurotomy and placebo; however, logistic regression and interaction analyses revealed a better overall therapeutic response for patients older than age 46 years. Similarly, van Wijk and colleagues (2005) found that patient's self-reported improvement based on the GPE following RF treatment was superior to sham treatment if the patient was over the age of 40 years. On the other hand, Cohen, Hurley, and colleagues (2007) found no association between age and patient-reported outcome in their evaluation of clinical predictors for both cervical and lumbar RF neurotomy.

The predictive effectiveness of gender, ethnicity, level of education, and marital status has primarily received attention from studies examining the risks and protective factors associated with developing chronic back pain (Epker & Block, 2006; Gatchel & Gardea, 1999; Hurwitz & Shekelle, 2006). In a cross-sectional study of Americans, Hurwitz and Morgenstern (1997) found that males were more likely than females to have disabling episodes of back pain, while non-Caucasians were less likely to have back problems than Caucasians. In the same study, disabling back problems were more prevalent among those with at least some college education. In relation to injured workers, married men have been shown to return to work sooner than unmarried men

(Volinn, Koevering, & Loeser, 1991); while a study of utility workers found being married to be a risk factor for chronic back pain (Lee, Helewa, Goldsmith, Smythe, & Stitt, 2001). However, investigation of these factors has been limited in terms of their prognostic value for RF neurotomy outcomes. In fact, based on the review of literature by the current author, gender is the only variable that has been critically examined in this context with females reporting more benefit from the procedure in one study (van Wijk et al., 2005) and no predictive power for this variable in two other studies (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007).

Job-related variables have been another point of interest in several studies investigating predictors of back pain and surgical outcomes. Using National Health Interview Survey data, Guo and colleagues (1995) compared males in specific occupations to all U.S. workers and found those at highest risk for back pain were construction laborers, carpenters, and industrial truck and tractor equipment operators. In a later study by the same first author, results showed that female industries at highest risk for back pain were nursing and personal care facilities, beauty shops, and motor vehicle equipment manufacturing (Guo, Tanaka, Halperin, & Cameron, 1999). In relation to response to surgery, Junge, Dvorak, and Aherns (1995) found occupation status and education level were inversely correlated with poor surgery outcomes 1 year after spinal diskectomy. An outcome study for lumbar nerve root decompression found that the type of work (i.e., sedentary, moderate, heavy) did not influence surgery outcomes; however, sedentary workers were more likely to return to their previous work (Jönsson & Strömqvist, 1994). The related variable of household income has also received some limited attention in the outcome literature. For example, Katz and colleagues (1999) noted that higher income for patients undergoing laminectomy was linked to better walking capacity, less severe symptoms, and better satisfaction 2-years post surgery. Similarly, in a study of presurgical correlates for lumbar fusion, DeBerard and colleagues (2001) found that income at time of surgery predicted surgical outcomes. Though trends have been identified for work-related predictors in the case of back surgery, these types of occupational variables have not been widely studied for non-surgical techniques such as RF neurotomy. In a randomized trial described earlier, Van Wijk and colleagues (2005) gave one of the only reports for job status, noting that patients with employment had more self-reported benefit from RF treatment than their unemployed counterparts.

In sum, research on demographic variables in back pain has provided adequate evidence for predicting back pain and disability as well as outcomes following surgical treatment. However, relatively limited attention has been given to the predictive efficacy of these variables for interventional pain management techniques. As for RF neurotomy, few studies have investigated demographic factors and consequently no trends or reliable predictors of clinical outcomes have been identified in the literature. Slightly more attention has been given to compensation and litigation variables.

Compensation and Litigation Variable*s*

A large body of research has investigated compensation and litigation variables as predictors of spinal pain and disability. Some have hypothesized that a unique set of characteristics accompanies patients receiving compensation for spinal problems, and have coined the term "compensation neurosis" (Block & Callewart, 1999). Providing support for this notion, Hee and colleagues (2001) found significant differences in self-perceived health status between patients receiving workers compensation and those who were not. In this broad cross-sectional study of over 18,000 spinal disorder patients, workers compensation status was associated with poorer physical and mental health even though this group was younger, had a shorter duration of symptoms, and fewer comorbid medical problems. The authors concluded that these differences must be due to psychological factors rather than actual organic/medical problems. However, others have shown compensation to be associated with a number of confounding variables such as injury severity, heavy physical work load, income, and education (Burns, Sherman, Devine, Mahoney, & Pawl, 1995; Sanderson, Todd, Holt, Getty, 1995). Though compensation/litigation variables have been linked to increased disability and poorer outcomes in many studies, in a narrative review, Hurwitz and Shekelle (2006) noted that interpreting results from these studies is problematic due to potential confounding variables (e.g., injury severity, income, and education).

In relation to predicting surgical outcomes, the influence of compensation and litigation variables has received increased attention. In studies of spinal fusion, Vacarro, Ring, Scuderi, Cohen, & Garfin (1997) found that active management of a compensation case and related litigation was the single most powerful predictor of poor outcomes. Likewise, DeBerard et al. (2001) noted an astounding 376% increase in the probability that patients would remain disabled 2 years following surgery if the claim involved litigation. Conversely, Vamvanij, Fredrickson, Thorpe, and Stadnick (1998) found that compensation status had no influence on outcomes across several types of spinal fusions. Predictors of this type have also been seen in the use of minimally invasive procedures. For example, presence of compensation issues at the time of chemonucleolysis treatment was significantly related to outcomes (Herron, Turner, & Weiner, 1988), while compensation patients treated with intradiscal thermal annuloplasty (IDTA) had higher VAS scores, but similar improvements in activities of daily living compared to the non-compensation group.

Unlike surgical interventions, little support has been found for the predictiveness of compensation and litigation variables in RF neurotomy. Silvers (1990) reported that patients with a pending compensation claim or other litigation did not have better or worse results from RF treatment than patients without a claim. Similarly, Sapir and Gorup (2001) found no significant differences in VAS, self-reported improvement, and medication usage for litigants and nonlitigants who underwent RF neurotomy of the cervical spine. Three other studies lend support to these results showing no effect of litigation status on patient outcomes (Barnsley, 2005; Lord et al., 1996; McDonald et al., 1999). Contrary to expectations, one outcome study reported a greater probability of improvement in patients compensated for a work injury following RF neurotomy (Leclaire et al., 2001). Thus, the limited evidence available does not provide a clear picture for the use of compensation and litigation variables as prognostic tools in RF treatment.

Health and Behavioral Variables

Obesity has been linked to numerous medical illnesses and chronic health conditions and is widely viewed as an epidemic in the United States. However, its function, as a predictor for back problems has not been well established. Reflecting this ambiguity, a recent systematic review of body weight and LBP concluded that the relationship between obesity and spinal pain and disability is unclear and at best obesity can be seen as a weak risk factor for LBP (Leboeuf-Yde, 2000). Obesity is likely to have an indirect influence on spine surgery outcomes through lowered physical mobility and activity (Frymoyer, 1992; Junge et al., 1995), though a moderator relationship has been reported (e.g., Epker & Block, 2001). With respect to RF neurotomy, two recent studies evaluating predictive variables found no influence of obesity (defined as body mass index >30) on clinical outcomes (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007). As these were the first two studies to examine this variable, more work is needed to clarify its impact or lack thereof.

Though not frequently reported as a predictive variable in spine patients, the same two studies by Cohen just cited, also included opioid usage in their predictive model for cervical and lumbar neurotomies. Results from both studies showed that opioid usage at the time of the RF procedure predicted outcome using univariate analyses; however, when confounding factors were controlled for in multivariate analyses opioid usage was no longer a predictor. More often changes in opioid usage are used to measure outcomes. In this case, at least three outcome studies for RF neurotomy have found significant reductions in opioid usage following treatment (Gofeld, Jitendra, & Faclier, 2007; Nath, et al., 2008; van Kleef et al., 1999).

While obesity and opioid usage have modest support as predictive variables, habitual cigarette smoking has received considerably more support as a risk factor for developing back pain and predicting poor surgical outcomes (e.g., Andersen et al., 2001; Boshuizen, Verbeek, Broersen, & Weel, 1993; Goldberg, Scott, & Mayo, 2000; Rossignol, Lortie, & Ledoux, 1993). In a retrospective cohort study that examined several presurgical correlates of interbody cage lumbar fusion outcomes, smoking at the time of surgery was the only variable that predicted multidimensional health outcomes (i.e., both physical & mental health indices) at an average of 2 years follow-up (LaCaille et al., 2005). On the other hand, smoking history has not been implicated as a risk factor for poor outcomes following RF neurotomy. In fact, in a randomized trial described previously, smokers showed greater benefit from the intervention than nonsmokers (Leclaire et al., 2001). The authors admitted this finding is difficult to interpret given the inverse relationship that typically exists between smoking and back pain. Additionally, the recent investigation of predictive factors for RF treatment by Cohen, Bajwa, et al. (2007) showed that smoking was not associated with patient outcomes. While smoking, obesity, and analgesic intake have received limited attention in the RF neurotomy literature, mental health variables have been given relatively more consideration.

Psychological Disturbance Variables

Given the almost indistinguishable relationship between the experience of chronic pain and affective states (Gaskin, Greene, Robinson, & Geisser, 1992), it is not surprising that psychological variables can predict spine-related disability as well as outcomes following treatment (Epker & Block, 2006; Garofalo & Polatin, 1999; McCracken & Turk, 2002). Supporting this view, Lindsay and Wyckoff (1981) reported that 85% of chronic pain patients meet the diagnostic criteria for depression. Following the biopsychosocial model, it is possible that this negative emotional disturbance can lead to a hypersensitivity to pain resulting in social isolation, sedentary lifestyle and other pain behaviors, which only serve to exacerbate pain and adversely impact treatment outcomes (Epker & Block, 2006; Turk & Okifuji, 2002). The clinical importance of psychological variables has been recognized by several authors who have advocated for presurgical psychological screenings for chronic back pain patients (Block, Ohnmeiss, Guyer, Rashbaum, & Hochschuler, 2001; DeBerard et al., 2001).

In terms of minimally invasive procedures, several studies have attempted to identify psychological predictors relevant to patient outcomes. In a recent retrospective trial for RF neurotomy, van Wijk and colleagues (2008) utilized pre-interventional self-report questionnaires to construct five patient psychological profiles hypothesized to predict RF outcomes, namely: “psychologically negative,” “adaptive manager,” “inflexible qualities,” “presence of a supporting partner,” and “strong ego.” At 12 months follow-up, the “psychologically negative” profile (i.e., disturbed mood, negative self-efficacy, catastrophizing, high state and trait anxiety) predicted poorer outcomes, while the “adaptive manager” (i.e., low pain intensity, positive expectations reasonable activity level and social functioning) predicted more positive outcomes. These findings are similar to those found in a study of prognostic factors for spinal cord stimulation. Patients who endorsed low levels of “anxiety” and high levels of “joy” were more likely (in univariate analyses & not multivariate analyses) to achieve successful outcomes (North et al., 1996). The above authors have recommended psychosocial evaluation of patients prior to minimally invasive procedures.

A related study by Samwel, Slappendel, Crul, and Voerman (2000) examined predictors of change in pain intensity following RF lesioning of the cervical facets for patients suffering from chronic cervicobrachialgia. Results indicated that catastrophizing was the only statistically significant predictor of change in VAS scores, while negative self-efficacy, physical dysfunction, psychosocial dysfunction, and overall distress were not associated with outcomes. Thus, decreases in VAS scores did not translate into overall improvements in functioning (in terms of less physical and psychosocial dysfunction and overall distress). Psychological distress variables have also been found to be resolved following RF treatment in a randomized trial of whiplash patients. This suggests distress may be consequent to somatic pain, rather than underlying psychosocial problems per se (Wallis, Lord, & Bogduk, 1997).

Surgical History and Procedural Variables

Researchers suggest that patients who undergo reoperation following a previous back surgery are more likely to experience poor outcomes and surgical complications (DeBerard et al., 2001; Hu, Jaglal, Axcell, & Anderson, 1997; Jönsson & Strömqvist, 1993). Some patients who experience persistent and recurrent pain that is refractory to conservative treatments and repeated surgery are said to have failed back surgery syndrome (FBSS). In these patients, interventional pain management procedures may be the therapies of choice. For example, in a recent systematic review of clinical outcomes for spinal cord stimulation Taylor, Van Buyten, and Buchser (2005) reported that 62% of FBSS patients achieved 50% pain relief or more and 53% no longer required anelgisics. With respect to RF neurotomy, the effect of prior back surgery on outcomes is not clear. Previously operated patients did not respond as well as unoperated patients to RF treatment in several studies (Babur, 1994; Cohen, Hurley, et al., 2007; Shealy, 1975; Silvers, 1990; van Wijk, et al., 2005), while no association between the two groups was found in others (Cohen, Bajwa, et al., 2007; North et al., 1994; Tzaan & Tasker, 2000). These conflicted results speak to the need for further inquiry into the influence of previous back surgery on RF outcomes.

Other studies have examined the relationship between the number of vertebral levels denervated by the RF procedure and treatment outcomes. Based on the patient's response to MBBs, the physician can coagulate the nerves innervating one facet joint or in several facets of adjacent vertebrae. Additionally, the procedure can be performed unilaterally (i.e., the facet joints are targeted on only one side of the vertebrae) or bilaterally (i.e., the facet joints are targeted on both sides of the vertebrae). No relation was found between procedure outcome and the number of levels treated in 3 studies (Cohen, Bajwa, et al., 2007; North et al., 1994; Tzaan & Tasker, 2000); however, Cho, Park, and Chung (1997) found that three levels of coagulation had superior results to two levels in RF treatment of the lumbar facets. Cohen, Hurley, and colleagues (2007) reported that patients who had more levels treated had higher levels of global satisfaction, but this was not true of VAS scores. No statistical differences have been detected in bilateral versus unilateral neurotomy in three relevant studies (North et al., 1994; Silvers, 1990; Tzaan & Tasker, 2000).

Three other patient selection variables have received at least some attention in the outcome literature, namely: number of diagnostic MBBs, facet pathology seen on an MRI, and duration of pain symptoms. The value of conducting comparative rather than single MBBs in the selection of patients for RF neurotomy has been described in an earlier section of this report. Diagnosis using two nerve blocks results in fewer false-positives and better outcomes (Boswell, Trescot, et al., 2007; Manchukonda et al., 2007). MRI findings indicative of facet joint degeneration in both the lumbar and cervical spine has no statistically significant relationship to treatment success (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007). While a negative correlation exists between length of symptoms and treatment success for lumbar disc surgery (Quigley, Bost, Maroon, Elrifai, & Panahandeh, 1998) and epidural steroid injections (Benzon, 1986), the evidence is lacking for this relationship in RF neurotomy. Silvers (1990) found no effect for symptom duration on treatment success, whereas Cohen, Hurley, and colleagues (2007) found a negative correlation and van Wijk (2005) found a positive correlation.

Conclusions from the Literature Review

Despite over 30 years of research on facet RF neurotomy, there continue to be questions as to its effectiveness in many contexts. In particular, research examining long-term outcomes for RF interventions in routine clinical practice and with large samples of worker's compensation patients has been lacking. Positive findings for the procedure have been reported in a number of randomized and observational studies, yet these outcomes are generally defined by self-reported pain reduction (e.g., VAS) rather than potentially more meaningful variables such as functional status, quality of life, analgesic intake, and additional treatments required. Furthermore, a majority of retrospective studies report negative results for RF neurotomy with authors stressing the importance of proper patient selection.

A number of demographic, occupational, health, psychological, and clinical variables have been linked to RF neurotomy outcomes. However, the available literature provides limited and conflicting evidence regarding the predictive efficacy of these factors, especially in the analysis of multiple variables simultaneously. The current study replicates the methods of DeBerard (19988) and DeBerard and colleagues (2001) who examined predictors of lumbar fusion surgery outcomes. The methodology is well suited for an evaluation of RF neurotomy outcomes in that it addresses limitations in the literature by employing a multivariate predictive model and a multidimensional outcome approach. The factors to be used in the model were identified from among the classes of variables reviewed here and include the following: age at the time of the procedure, obesity, litigation status, previous history of depression, smoking history, prior history of back surgery, compensation claim history, case manager assigned to compensation claim, and number of diagnostic nerve blocks prior to RF neurotomy. Some of these variables were selected because of their strong association with outcomes in the invasive surgical literature (i.e., fusion and discectomy), while others were chosen based on the conflicting or nonexistent relationship with outcomes in RF neurotomy studies. In effect, it was hypothesized that preprocedural predictors with empirical support in other widely investigated spine surgeries should be extended to RF neurotomy, keeping in mind that biopsychosocial variables have received very limited attention in the neurotomy literature to date. For instance, lawyer involvement has a fairly strong and consistent history of predicting fusion and discectomy outcomes, yet litigation status and compensation variables have obtained contradictory results in the few available RF neurotomy studies to date. Similarly, the presence of depression has been linked to back surgery outcomes elsewhere, but in the case of RF neurotomy, there are virtually no studies that have considered this relationship.

Purpose and Research Questions

The three main objectives of the current study were (a) to characterize patient variables, (b) to assess multidimensional outcome variables and (c) to test a predictive model in a sample of injured Utah workers who have undergone percutaneous facet RF neurotomy. To satisfy the first objective, RF neurotomy patients were characterized (e.g., via descriptive statistics) across seven outcome domains, that include (a) basic clinical outcomes (pain relief, analgesic intake, return to work, functional ability, and additional back procedures performed); (b) patient satisfaction; (c) current work/disability status; (d) back pain disability score; (e) general physical health rating; (f) general mental health rating; and (g) pain catastrophizing score. To satisfy the third objective, it was necessary to determine if a set of patient variables would be significantly predictive of a set of RF neurotomy outcome variables in several domains. Multiple patient variables were considered for the predictive model, including age at time of injury, level of education, obesity, tobacco use, history of depression, presence of a case manager, litigation status, number of prior back/neck operations, history of prior claims, and number of diagnostic nerve blocks performed. Figure 1 depicts a summary table of both patient variables and outcome variables that were utilized in this project. Study objectives were addressed through retrospective review of patient medical records and through a telephone outcome survey at least 3 months following RF treatment. The following research questions were addressed in the current study:

1. What is the nature of the sample with regard to patient and procedural variables?
2. What are the intercorrelations among patient variables?
3. What are the rates of satisfaction for the sample?
4. What are the rates of good, fair, and poor outcomes for the sample based on the Stauffer-Coventry Index?
5. What are the rates of pain intensity and subjective levels of improvement?

PREDICTIVE VARIABLES	PATIENT OUTCOME VARIABLES
DEMOGRAPHIC VARIABLES	**STAUFFER-COVENTRY INDEX**
*Age at injury	Good, Fair, and Poor Outcome Categories
Income Level	**PATIENT SATISFACITON**
Education Level	Global Perceived Effect
Gender	Current Pain Level on 11-Point Scale (VAS)
Ethnicity	Back/Neck Pain Following Surgery
Marital Status	Quality of Life Following Neurotomy
Child Care Responsibility	Have Neurotomy Again
PHYSIOLOGICAL VARIABLES	Pain Better or Worse than Expected
*Obesity Status	How Satisfied if Back Condition Continued
Diagnosis	How Satisfied with WCFU
Physical Exam Data	**WORK VARIABLES**
TREATMENT VARIABLES	Current Work/Disability Status
Number of Levels Treated	If Not Employed, Why Not
*Number of Diagnostic MBBs	Number of Days Worked Past 4 Weeks
*Number of Prior Back/Neck Operations	Number of Hours a Week Spent Working
Degree of Heat for Thermal Action	**HEALTH**
Duration of Heat for Thermal Action	Analgesic Use (from med chart and survey)
HEALTH VARIABLES	Back or Neck Procedures 2 years post-RF (from med chart and survey)
*Smoking at Time of Neurotomy	Smoking History
General Health Problems	**ROLAND-MORRIS DISABILITY QUESTIONNAIRE**
Alcohol Use	Level of Dysfunction Score
Amount of Pain Before Neurotomy	**SHORT-FORM 36 VERSION 2**
Use of Pain Meds Prior to Neurotomy	Physical Health Component Summary Score
WORK/COMPENSATION VARIABLES	Mental Health Component Summary Score
*Lawyer Involvement	Physical Functioning
*History of Prior Claims	Role Functioning
*Case Manager Assigned	Social Functioning
Total Compensation Costs	General Mental Health
Time Between Date of Injury and Neurotomy	Current Health Perceptions
Employed at Time of Neurotomy	Pain
Occupation Title	
PSYCHOLOGICAL VARIABLES	
*History of Depression	
Pain Catastrophizing Total Score (obtained during the telephone survey)	
Rumination	
Magnification	
Helplessness	

Note. *=Identifies variables that were considered for use in the prediction analyses.

Figure 1. A summary of patient and outcome variables.

6, What are the pain attitudes among patients in the sample?

7. What is the frequency of analgesic intake and additional back/neck procedures performed after RF neurotomy?

8. What is the rate of continued work disability for the sample following treatment?

9. What is the level of post-treatment back-specific functioning for the sample?

10. What are the levels of post-treatment functioning across a multidimensional health-index for the sample, and how do these compare with existing norms?

11. What are the interrelationships among the outcome variables for the sample?

12. Is a multivariate biopsychosocial pre-neurotomy model predictive of disability status?

13. To what degree is a multivariate model predictive of multidimensional outcome variables for the sample.

CHAPTER III

PROCEDURES

Population and Sample

The current study examined adults who underwent at least one percutaneous RF neurotomy of the spine (cervical, thoracic, or lumbar) at least 3 months prior to the time of follow-up. Three months was determined to be an acceptable time delay due to its broad use as a marker of short-term improvement in neurotomy systematic reviews and interventional pain guidelines (Boswell, Trescott, et al., 2007; Boswell, Colson, et al., 2007). Participants consisted of injured workers solicited through the Worker's Compensation Fund of Utah (WCFU). The WCFU computer database was used to identify all patients who underwent the RF procedure since 1998. Based on preliminary predictions, it was estimated that 130 individuals would make up the study sample. However, after access to the WCFU database was granted and chart review commenced, it was apparent that a sample of this size was not available. This was due to several patients who were flagged by the database multiple times for the same procedure and others being flagged for RF neurotomies that were done as part of a surgical procedure (e.g., fusion). It is expected that results of this study could be generalized to United States worker's compensation patients who have undergone RF neurotomy.

A total of 101 patients met the study's inclusion criteria and were available for medical chart review. Of these patients, 75 were male (74.3%) and 26 female (25.7%), and they ranged in age from 18 to 82 years (M = 46.15, SD = 11.74). In terms of ethnicity, 92 were Caucasian (91.1%), 8 were Hispanic (7.9%), and 1 was Asian (1.0%).

In general, participants had experienced chronic back or neck pain and had previously been prescribed conservative treatments, such as light exercise, anti-inflammatory medications, and/or physical therapy, prior to undergoing RF neurotomy. An array of physicians, physiatrists, and anesthesiologists specializing in spine care and pain management performed the RF procedures. Accordingly, the diagnostic and procedural practices of these diverse physicians differed somewhat for individual patients. For example, some relied on one nerve block to diagnose facet arthropathy, while others required at least two. Similarly, the exact placement and angle approach of the electrode during the procedure varied depending on the physicians' preferences. Selected procedural differences were coded in order to assess their impact on outcomes.

Study Design

This is an observational study that used a retrospective cohort design involving two separate phases of data collection. During the first phase, information was garnered from a review of participants' medical files and compensation claim records contained within the WCFU computerized database. These data comprise patient variables that were present prior to follow-up and included both pre and post-neurotomy information. The second phase commenced with the mailing of letters to participants regarding the nature of the study and to request their participation in a brief telephone interview. Following these mailings, participants were contacted by telephone to complete the interview with the purpose of gathering RF neurotomy outcome data. This phase provided information about the current status of the patient and, in some cases, long-term follow-up.

Phase 1

This author obtained medical record and compensation claim data onsite from the WCFU database using a Medical Chart Review Form (see Appendix A). This comprised information that included the following variable categories: demographics, general health, surgical history, psychosocial status, litigation status, compensation costs, diagnosis and procedure, medication usage, and additionally required pain interventions. Data was coded using a modified medical chart review instrument designed by DeBerard (1998) to study lumbar fusion outcomes in a similar worker's compensation sample. The coding instrument was adapted to fit the specific purposes of examining correlates and outcomes in RF neurotomy. For example, it was important to code the number of diagnostic nerve blocks administered as well as the number and location of coagulated nerves.

Phase 2

Following WCFU database reviews, an initial contact letter (see Appendix B) was sent to RF neurotomy patients to introduce them to the study and inform them of the forthcoming telephone interview. Letters contained information about the study's purpose and methods, a request for their voluntary participation, and a confidentiality statement. Additionally, participants were notified that they would receive $10 by mail if they chose to participate in the telephone survey. A self-addressed stamped postcard was included to obtain any changes in telephone numbers or addresses. For those participants who did not return the postcard, an attempt was made to contact them by telephone and the contents of the letter were summarized verbally.

Consent for participation in the outcome survey was obtained verbally at the time of the telephone contact. An introduction to the study was explained by way of a written script (see Appendix C) adapted from DeBerard (1998). Previous information from the letters regarding confidentiality and monetary incentives were repeated and highlighted for the patients. The rest of the script contained rating scales and satisfaction questionnaires described in detail below. When participants could not be reached by the address or telephone number listed in the WCFU database, other methods of obtaining contact information were used, such as internet searches and directory assistance.

Data and Instrumentation

Medical Record Review Form

The Medical Chart Review Instrument as depicted in Appendix A is an adapted version of a data coding form used in previous research (e.g., DeBerard, 1998; LaCaille et al., 2005) with worker's compensation patients treated for spine injuries. Items in the chart review code a number of variables linked to spine intervention outcomes that were previously discussed in the literature review. Two important modifications to the instrument were made to fit the purposes of the current study. First, analgesic usage was added as an outcome measure at 3, 6, 12, and 18 months as well as the tracking of any additional back procedures performed for 24 months following the RF neurotomy. The strength and quantity of analgesics prior to the RF procedure will be recorded and compared to the patient's medication status at intervals listed above. Second, radiological findings will not be taken into account for individual patients, since previous studies (Schwarzer et al., 1995; Sehgal et al., 2007) have shown little to no association with symptoms or outcomes. Additionally, the diagnosis of facet syndrome in nearly all available clinical studies is based on the patients' response to nerve blocks and not radiological tests.

Telephone Survey Instruments

In the follow-up portion of this study, each participant was contacted by telephone and asked to answer a series of questions. Interview questions were composed of various instruments and scales as identified in Appendices D through H. Among other topics, patients were asked about the quality of claim management by WCFU, level of satisfaction with the RF neurotomy procedure, functional status, pain intensity, quality of life, disability status, and pain attitudes. It was necessary in some cases to ask patients for information missing from the WCFU database, such as ethnicity and marital status. The phone contact began with a script read by the interviewer (see Appendix C), which made reference to the contact letter sent previously, introduced the study, provided a confidentiality statement, and reminded the participants that they receive $10 for their participation.

Patient satisfaction. Despite the importance of patient satisfaction with treatment outcomes, it has not been the focus of published studies on RF neurotomy. Some questionnaires have been developed to measure patient satisfaction with regard to overall hospital and surgical care (Hudak & Wright, 2000), but do not generally distinguish satisfaction with treatment as an outcome measure per se. In this sense, patient satisfaction entails quality of life and patient expectation variables. Five close-ended questions used in previous research on spinal surgery outcomes (DeBerard, 1998; DeBerard et al., 2001; Franklin et al., 1994; LaCaille, 2003) will be used to gauge patient satisfaction specific to their RF neurotomy procedure (see Appendix E, items 5, 6, 7, 17, and 19). These items are both positively and negatively worded and use a response format ranging from a 3- to a 7-point scale. Patients were asked whether they would consider having the procedure again, if their back problem is better or worse than expected, and how they would feel if they were to live the rest of their life with their back in its current condition.

Stauffer-Coventry Index. The Stauffer-Coventry Index (SCI; Stauffer & Coventry, 1972) is a 4-item self-report measure that has been widely used with back pain patients to quickly gauge good, fair, or poor outcomes following surgery. Items are highly face valid and ask the patient to rate their level of pain relief, work status, restriction of physical activities, and pain medication usage (see Appendix E, items 1-4). While the SCI has been utilized as a clinical outcome measure in numerous back surgery studies (e.g., DeBerard et al., 2001; LaCaille et al., 2005; Schade, Semmer, Main, Hora, & Boos, 1999; Turner et al., 1992), it has not been previously used as a tool for assessing RF neurotomy outcomes. However, the items appear to be practical, highly face valid, relevant to RF outcomes, and easily adapted to a telephone interview format.

Global perceived effect. A simple one-item outcome measure, the Global Perceived Effect (GPE), has been used to approximate response to treatment in the RF neurotomy and interventional pain management literature. The GPE provides a subjective report of the patient's level of improvement and can be found in Appendix E, item 22. The patient is asked: "Compared to when this episode first started, how would you describe you back these days?" A wide variety of response formats and rating scales have been used with the GPE, including a 4-point scale (van Wijk et al., 2005), a 6-point scale (Nath et al., 2008), a 7-point scale (van Kleef et al., 1999), and an 11-point scale (Stewart, Maher, Refshauge, Bogduk, & Nicholas, 2007). A 4-point Likert scale (complete relief of pain, more than 50% relief, no change, increase of pain) was chosen for the current study due to its ease of use in a phone interview format. The use of the GPE allowed for comparisons among previous studies of RF neurotomy outcomes.

Verbal Numeric Rating Scale. The Verbal Numeric Rating Scale (VNRS) is a generic self-report measure that will be used to assess the patient's perceived level of pain at the time of the telephone interview as well as an averaged rating of their pain over the past week as depicted in Appendix E, items 20 and 21. On this scale the patient is asked to verbally rate their pain from 0 to 10 (an 11-point scale), where 0 represents "no pain" and 10 represents "the worst pain imaginable." The validity of VNRSs has been well documented and this type of scale has demonstrated sensitivity to treatments expected to relieve pain (Jensen, Karoly, O'Riordan, Bland, & Burns, 1989; Kaplan, Metzger, & Jablecki, 1983). It should be noted that the acronym "VAS" is often used interchangeably with VNRS; however, a true VAS consists of a visually presented 10cm line whose ends are labeled as the extremes of pain. The patient is asked to make a mark along the line to best represent their pain intensity. A majority of RF neurotomy outcome studies utilize the VAS as a primary outcome measure, yet it is not always readily apparent whether the visual or the verbal rating scale was used. For the purposes of the current study, the patient's subjective level of pain was coded from their medical chart and is most often a VNRS garnered from physician notes. Thus, the patient's VNRS was coded prior to the RF procedure, at 3, 6, 12, and 18 months (when available in the medical chart), and during the telephone survey. Test-retest reliability for the VNRS has been found to have a Pearson coefficient as high as .99, which is superior to several other one-item pain scales (Gallasch & Alexandre, 2007). Though VNRSs and true VASs are highly correlated (95%), overall patients tend to rate their pain slightly higher when doing so verbally (Holdgate, Asha, Craig, & Thompson, 2003).

Disability status. A number of researchers have stressed the importance of assessing disability status following back interventions (Amick, Lerner, Rogers, Rooney, & Katz, 2000; Deyo et al., 1998; Mannion & Elfering, 2006). This is especially true of worker's compensation patients for whom returning to work is a significant outcome variable. Improvements in disability status were correlated with reductions in pain in at least one outcome study for RF neurotomy (van Kleef et al., 1999). Waddell and Turk (2001) have previously described the complexity of disability status, yet the current study has simplified this construct into a dichotomous variable (i.e., disabled or not disabled). This is because data pertaining to other aspects of disability will be gathered through the use of other measures. Disability status was achieved in the telephone survey phase by asking participants whether or not they currently receive total disability for their back condition (see Appendix E, item 10), which was also verified by the medical chart review. Other scales, including physical functioning and daily activities, will capture additional aspects of disability.

Roland-Morris Disability Questionnaire. The Roland-Morris Disability Questionnaire (RDQ; Roland & Morris, 1983a, 1983b) is a 24-item self-report instrument designed to measure level of dysfunction in back pain patients and can be found in Appendix F. The patient is asked to respond "yes" or "no" to sentences describing activities that require some level of physical functioning (i.e., housework, dressing, mobility, etc.) with a few items dealing with appetite changes, pain severity, and irritability. The content of each item makes clear that restrictions or limitations in daily activities are the direct result of the individual's back pain (i.e., "because of my back pain…"). The RDQ is well suited for telephone administration and has been broadly used in back pain research. Internal consistency as measured by Cronbach's alpha has been estimated at .95 in a sample of worker's compensation patients (Turner, Fulton-Kehoe, Franklin, Wickizer, & Wu, 2003). Additionally, scores on this instrument correlate highly with other subjective measures of pain and functional status as well as objective measures of spinal mobility (Kopec, 2000; Mannion, Dvorak, Müntener, & Grob, 2005). For the current study, the RDQ will be modified for a select group of patients who underwent RF neurotomy of the cervical spine. For these individuals, the word "back" was replaced with the word "neck" in the instructions and item content. This modified version has been used elsewhere with neck pain patients to measure changes in functional status following cervical interventions (Garvey, Transfeldt, Malcolm, & Kos, 2002).

Short Form Health Survey-36, Version 2. A widely used measure of general health, the Short Form Health Survey (SF-36v2; Ware, Kosinski, & Dewey, 2000), assesses eight dimensions of health-related quality of life namely: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health. The SF-36 has been used to study a wide variety of chronic pain patients, including back pain (Deyo et al., 1998; Keeley et al, 2008; Maurer, Block, & Squillante, 2008) and neck pain (Klaber Moffet et al., 2005; Schwerla et al., 2008). With respect to research on RF neurotomy, the SF-36 was recently used to study psychological predictors of pain reduction (van Wijk et al., 2008) and to measure outcomes in both a randomized trial (van Wijk et al., 2005) and a high quality prospective trial (Dreyfuss et al., 2000).

Aggregating the eight subscales of the SF-36 into Physical Health (PCS) and Mental Health (MCS) Component Summary scales facilitates statistical analyses of these two higher order health indices, without a substantial loss of information (Ware, 2000; Ware, Snow, Kosinski, & Gandek, 2000). The authors of the SF-36 indicate that these summary scores (PCS/MCS) may function to enhance the precision of general physical and mental health outcomes. When scoring the PCS and MCS scales, a linear *T*-score transformation is used so that both scales have a mean of 50 and a standard deviation of 10. Internal consistency reliability coefficients for general population samples are satisfactory and range from .83 to .95 for the eight SF-36 subscales (Ware. Snow, et al., 2000). Based on numerous studies with wide ranging populations and in varied research contexts, SF-36 authors conclude that there is sufficient evidence for its content, criterion, construct, concurrent, and predictive validity. For instance, systematic comparisons have found that the SF-36 contains eight of the most frequently assessed health concepts, while clinical studies have generally supported the SF-36 factor structure by measuring health before and after treatments (i.e., physical health scores improved following medical intervention and mental health scores improved following mental health interventions; Ware, Snow, et al., 2000). A script for telephone interview SF-36v.2 administration has been provided by the authors and is fitting for use in the current study (see Appendix G).

Analgesic intake. Ideally, successful back pain interventions should lead to a decreased need for pain medications. Given the growing international concern over opioid addiction in chronic pain patients, there are important reasons to scale back the use of narcotics when possible (Højsted & Sjøgren, 2007). Analgesic use has been measured as an outcome variable in RF neurotomy patients using varied approaches, ranging from a complex 8-point system (van Wijk et al., 2005) to a simple 3-point scale (Gofeld et al., 2007). In the latter study, analgesic consumption was assessed by a determination of "decreased/ no change/ or increased" use following RF treatment. In the current study, analgesic intake will be measured using this 3-point coding scheme due to its simplicity (see Appendix A, items 74 through 86). However, it is important to note that tracking the use of pain medications in this study was exploratory. Due to the nature of the WCFU database and limited availability of physician medical notes and documentation, there were limited data available, especially related to long-term follow-up. Despite these limitations, analgesic use was tracked at 3, 6, 12, and 18 month follow-up appointments as outlined in the Medical Chart Review Instrument. This involved recording the number and names of opioid and muscle relaxant medications. Additionally, patients were asked in the telephone interview to describe their analgesic usage (see Appendix D, item 4).

Pain Catastrophizing Scale. The Pain Catastrophizing Scale (PCS; Sullivan, Bishop, & Pivik, 1995) is a 13-item self-report instrument that asks patients to reflect on a pain experience and then to provide ratings as to how often they dwell on pain-related thoughts and feelings using a 5-point scale (see Appendix H). The PCS comprises one general construct and three empirically derived subscales, namely Magnification, Rumination, and Helplessness. Psychometric studies have shown adequate internal consistency estimates for the PCS, with Cronbach's alpha coefficients that were high for both community samples (.95) and pain outpatient samples (.92; Osman et al., 2000).

With respect to chronic low-back pain patients, pain catastrophizing has been shown to be a good predictor of severity of disability and is associated with lower levels of physical activity (Elfving, Andersson, & Grooten, 2007). In patients who underwent RF lesioning of the cervical spine dorsal ganglion, the level of catastrophizing prior to treatment predicted 10% of the change in pain intensity following treatment (Samwel et al., 2000). More recently, van Wijk and colleagues (2008) found that "psychologically negative" patients characterized by, among others, catastrophizing, disturbed mood, and negative self-efficacy were at greater risk for poor outcomes following RF neurotomy of the lumbar spine than those with a more positive psychological profile.

Analysis

Data were analyzed using the Statistical Packages for Social Sciences (SPSS), Version 17.0. As mentioned in previous sections, this study examined a sample of worker's compensation patients who have undergone RF neurotomy with three primary objectives: (a) to characterize patient variables, (b) to assess multidimensional outcome variables, and (c) to test a 5-variable predictive model. With respect to the first objective, descriptive statistics were employed to characterize the sample in relation to demographic, physiological, treatment, health, work, and psychological variables. Pearson correlation coefficients were used to assess interrelationships among these variables. To address the second objective, outcome variables (e.g., patient satisfaction, global perceived improvement, pain intensity, functional status, physical & mental health-related quality of life, etc.) were characterized using frequency tables, descriptive statistics and intercorrelation matrices. In relation to the third objective, the strength of a multivariate predictive model of patient outcomes was tested using a series of logistic and multiple regression analyses. Specific research questions and their corresponding data analyses are summarized in Figure 2.

OBJECTIVE 1: Research Questions	OBJECTIVE 1: Data Analyses
1. What is the nature of the sample with regard to patient and procedural variables? 2. What are the intercorrelations among patient variables?	1. Descriptive statistics were calculated to characterize the patient sample with respect to multidimensional variables. 2. A correlation matrix of patient variables is presented.
OBJECTIVE 2: Research Questions	**OBJECTIVE 2: Data Analyses**
3. What are the rates of satisfaction for the sample? 4. What are the rates of good, fair, and poor outcomes for the sample (based on the SCI)? 5. What are the rates of pain intensity and subjective levels of improvement? 6. What is the frequency of analgesic intake and additional back/neck procedures performed after RF neurotomy? 7. What are the pain attitudes among patients in the sample? 8. What is the rate of continued work disability for the sample following treatment? 9. What is the level of postreatment back-specific functioning for the sample? 10. What are the levels of postreatment functioning across a multidimensional health-index for the sample, and how do these compare with existing norms? 11. What are the interrelationships among the predictor and outcome variables for the sample?	3. Frequencies for the five patient satisfaction items were calculated? 4. Frequencies and percentages for responses on the SCI are presented. 5. Percentage change on the VAS and perceived improvement on the GPE are reported using descriptive statistics. 6. Percentages and frequencies of analgesic intake data and follow-up back/neck procedures are reported. 7. Scores from the Pain Catastrophizing Scale were calculated and correlated with selected outcome variables. 8. A dichotomous frequency (disabled vs. not disabled) was calculated. 9. A frequency breakdown of total scores on the Roland-Morris Questionnaire was calculated? 10. Physical and mental health composite scores were calculated for the SF-36 and values were compared with existing norms. 11. A correlation matrix of various patient variables and outcome indices is presented.
OBJECTIVE 3: Research Questions	**OBJECTIVE 3: Data Analyses**
12. Is a multivariate biopsychosocial pre-neurotomy model predictive of disability status? 13. To what degree is a multivariate model predictive of multidimensional outcome variables for the sample.	12. Logistic regression was used to measure the predictive efficacy of the model. 13. Multiple regression analyses were used to assess the predictive efficacy of the model. Resulting regression equation statistics were interpreted.

Figure 2. Research questions and associated analyse

CHAPTER IV

RESULTS

The results of this study are organized according to the following sections: (a) descriptive statistics and intercorrelations of patient and procedural variables; (b) response rates and bias checks; (c) patient outcomes; (d) intercorrelations of outcomes (e) intercorrelations between patient characteristics and outcomes; and (f) prediction of outcomes. Throughout the analyses, each of the pertinent research questions in the study will be addressed as outlined in Figure 2 (above).

Descriptive Statistics and Intercorrelations of Patient and Procedural Variables

The first objective of this study was to characterize patient and procedural variables for injured workers who had undergone percutaneous RF neurotomy. To that end, descriptive statistics were performed for the entire sample (N = 101) based on information that was gleaned from the patients' medical record. Patient characteristics were examined with statistics that were executed for the following variables: gender, age, education, average weekly income, claim status (open or closed), body mass index, smoking history, depression, case manager involvement, lawyer involvement, number of prior back and/or neck surgeries, total compensation costs incurred, and number of prior compensation claims (see Table 1).

Approximately 74% of patients were male and 26% female, while the average age of patients at the time of their first neurotomy was 46.15 years (SD = 11.74). In regards

Table 1

Descriptive Statistics of Patient Characteristics

Patient characteristic	Frequency[a] (*N* = 101)	*M*	*SD*	Min - Max
Gender				
Male	75			
Female	26			
Age		46.15	11.74	18 - 82
Education				
Not reported	13			
<12 years	19			
HS degree/GED	36			
Some college	18			
Trade school	9			
College degree	6			
Average weekly income		$518	$232	
Claim status				
Open	59			
Closed	42			
Body Mass Index		27.64	6.03	17 - 47
Smoking at time of neurotomy				
Yes	40			
No	61			
Presence of depression				
Yes	53			
No	48			
Case manager assigned				
Yes	50			
No	51			
LawyeriInvolvement				
Yes	32			
No	69			
Prior back/neck surgery		0.80	1.30	0 - 7
None	62			
One	17			
Two	10			
Three or more	12			
Total WCF costs incurred		$145,505	$183,162	
Prior WCF claims		3.08	3.55	0 - 21
None	31			
One or more	70			

[a] Frequency values are nearly equal to percentages, thus percentages are not listed.

to level of education, roughly 19% of patients had less than 12 years of education, about 36% reported having a high school diploma or general education degree, while about 33% had at least some college or technical training. Thirteen patients did not have education information available in their medical chart. Worker's compensation claims were open or active in 59 patients, while 42 had been closed or settled at the time of follow-up. This likely affected the availability of current and accurate patient contact information as a large number of claims were no longer being updated by WCFU. The average body mass index was 27.64, which places a majority of patients in the overweight category (25.0 - 29.9) but is consistent with adult national norms of 27 - 29 (Ogden, Fryar, Carroll, & Flegal, 2004). Approximately 40% of the patient sample was smoking at the time of their first neurotomy. Depression was documented in nearly 52% of patients. Notably, this is a much greater proportion of depressed patients than is reported in studies of discectomy (13.4%; DeBerard, LaCaille, Spielmans, Colledge, & Parlin, 2009) and fusion (16.4%; LaCaille, 2003) patients drawn from similar WCFU populations. Compensation claim case managers were assigned to about 50% of patients, while 32% had an attorney involved in either mediation for a workers' compensation claim or attempts to obtain disability. Slightly more than 37% of patients had undergone at least one back or neck operation (e.g., fusion, discectomy, laminectomy) prior to their first neurotomy. About 70% had a history of one or more previous claims filed with the WCFU for various injuries, including both spinal and non-spinal related injuries.

In order to fully address research question 1, a second set of variables related to the neurotomy procedure itself was similarly examined using descriptive statistics as found in Table 2. The average time delay from the date of injury to the patients' first

Table 2

Descriptive Statistics of Procedural Variables

Procedural variables	Frequency[a]	*N*	*M*	*SD*	Min - Max
Time delay from injury to first neurotomy (months)		101	45.86	57.22	1 - 308
Time delay from 1st neurotomy to date of follow-up (months)		56	56.16	29.88	10 - 132
Diagnostic nerve blocks		101			
One	79				
Two	22				
Spinal region of neurotomy		101			
Lumbar	70				
Cervical	24				
Thoracic	1				
Combination	6				
Number of levels treated on first neurotomy		101	2.48	1.03	1 - 8
One	13				
Two	43				
Three	34				
Four or more	11				
Number of neurotomies[b]		101	1.68	1.15	1 - 8
One	60				
Two	27				
Three	7				
Four or more	7				

[a] Frequency values are nearly equal to percentages, thus percentages are not listed.
[b] Two neurotomies performed on separate sides within a three month period were coded as a single bilateral RF neurotomy.

neurotomy was 45.86 months (*SD* = 57.22). The average time from the patients' first neurotomy to follow-up (i.e., date of their telephone interview) was 56.16 months (*SD* = 29.88). Roughly 78% of patients received one diagnostic nerve block (medial branch block or facet joint injection), whereas 22% received the recommended two nerve blocks before their first neurotomy. In terms of patient spinal regions treated with RF neurotomy, 70 were performed on the lumbar spine, 24 were cervical, 1 was thoracic, and 6 underwent procedures involving multiple spine regions. In a vast majority of patients, neurotomy procedures targeted more than one vertebral level, with close to 43% treated at 2 levels and 45% treated at three or more levels. This was the first and only neurotomy documented in the WCFU database for 59.4% of patients, while 27.7% had two neurotomies, 6.9% had three, and another 6.9% underwent more than four RF procedures. It is important to note that patients commonly underwent neurotomies to ablate the nerves innervating the facet joint on one side of the vertebrae and soon after had an identical procedure perfomed on the other side. If patients had two procedures performed on opposite sides within a three-month period, this was coded as a single bilateral neurotomy.

To address research question 2, intercorrelations among a set of patient variables were calculated and are presented in a correlation matrix (see Table 3). The nine variables in the matrix are part of the original set of predictors that were being considered for regression analyses and include age, body mass index, smoking history, depression case manager involvement, lawyer involvement, history of prior back and neck surgeries, history of prior WCF claims, and number of diagnostic nerve blocks received. Correlation coefficients ranged from -.20 to .40 and four were statistically significant at

Table 3

Pearson Correlations Between Patient and Procedural Variables

Variable	1	2	3	4	5	6	7	8	9
1. Age at time of neurotomy	---								
2. Body Mass Index	.10	---							
3. Smoking at time of neurotomy	-.14	-.13	---						
4. Preneurotomy depression	.10	.07	.12	---					
5. Case manager assigned	.06	-.03	-.11	.15	---				
6. Lawyer involvement	.10	-.10	.10	.27**	.13	---			
7. Number of prior back/ neck operations	.40**	-.04	.03	.34**	.18	.17	---		
8. Number of WCF claims	-.07	.19	.05	-.01	-.01	-.13	-.10	---	
9. Number of diagnostic blocks	-.14	-.20*	.06	-.12	-.09	-.10	-.05	-.06	---

*$p \leq .05$, ** $p \leq .01$, $N = 101$.

an alpha level of .05. Number of prior back and neck surgeries was positively related to age at the time of first neurotomy (r = .40, $p < .01$) as well as the presence of depression (r = .34, $p < .01$). Thus, older patients had a history of more back and neck operations (before their first neurotomy) and had a higher incidence of depression when compared to their younger counterparts. History of depression was also positively correlated with lawyer involvement in patient claims (r = .27, $p < .01$), suggesting that patients with a history of depression tended to have an attorney. There was a negative relationship between body mass index and the number of diagnostic nerve blocks patients received before their first neurotomy (r = -.20, $p < .05$). That is, as body mass index scores increased, the number of nerve blocks decreased (i.e., one as opposed to two blocks). In general, the magnitude of these intercorrelations was fairly modest which minimizes problems due to multicollinearity.

Response Rates and Bias Checks

As noted previously, a total of 101 patients were identified as having had a RF neurotomy and were included in the medical chart review (Phase 1). Of these, 56 were contacted by telephone and agreed to participate in the telephone interview portion of the study (Phase 2), yielding an overall response rate of 55.4%. This author conducted 54 of the interviews, while 2 outcome surveys were completed in Spanish with Hispanic participants by a Spanish-speaking interviewer. Six individuals declined to participate in the interview (5.9%) and three were deceased (3.0%). The remaining 36 (35.6%) nonresponders could not be located, typically due to invalid or outdated contact information. Overall, the average time from the most recent neurotomy to outcome follow-up was 3.87 (*SD* = 2.63) years. RF procedures were completed between August 19, 1998 and February 12, 2009.

In order to check for differential bias between responders and nonresponders, the nine patient sociodemographic and medical characteristics were compared using univariate t-tests and chi-square tests along with a logistic regression analysis to measure prediction of group membership (see Table 4). Alpha values for univariate mean comparisons ranged from .09 to .71 with effect sizes ranging from -.17 to .33. The overall logistic model was not statistically significant (chi square = 10.87, p = .29), indicating that the nine-variable model did not result in better prediction of group membership than expected with observed base-rates alone. Thus, because none of the above comparisons reached statistical significance, we can assume that responders and nonresponders are statistically equivalent on a number of important patient characteristics. This is of importance because there is reduced concern for systematic bias in the sample and results can be considered generalizable to those patients who were not included in follow-up surveys (Phase 2).

Patient Outcomes

As a means of achieving the second objective of this study, RF neurotomy descriptive outcomes have been calculated and are presented in grouped-format in the following sequence: (a) patient satisfaction, (b) categorization of outcome, (c) subjective pain levels and methods of management, (d) disability status and functional impairment, and (e) general physical and mental health functioning. The results of these analyses will

Table 4

Comparisons of Select Patient Variables for Respondents Versus Non-Respondents[a]

Patient variables	Respodents (*n* = 56) Means or Proportion (%)	Nonrespondents (*n* = 45) Means or Proportion (%)	t or Chi-Square *P*-value	Effect size[b] (SMD/Phi)
Age	46.95	45.16	.45	.14
Body Mass Index	27.44	27.91	.71	.07
Smoking at time of neurotomy	32.14	48.88	.09	-.17
Presence of nepression	50.00	55.56	.58	-.06
Case manager assigned	51.79	46.67	.61	.05
Lawyer involvement	28.57	35.56	.45	-.08
Prior back/neck surgery			.53	-.12
None	60.71	62.22		
One	14.29	20.00		
Two	12.50	6.67		
Three or more	12.50	11.11		
Prior WCF claims			.35	-.09
None	26.79	35.56		
One or more	73.21	64.44		
Diagnostic nerve blocks			.56	-.06
One	80.36	75.56		
Two	19.64	24.44		

[a] Omnibus chi-square = 10.87 (df = 9), $p = .29$
[b] Effect sizes based upon univariate analyses

address research questions 3 through 10, with specific questions highlighted in the appropriate sections.

Patient Satisfaction with Outcome

Research question 3 inquired about levels of patient satisfaction with respect to RF neurotomy. In order to address this question, descriptive analyses were computed for the five patient satisfaction variables collected during the telephone survey, as follows: expected pain reduction after the procedure, improved quality of life, expected current pain level, satisfaction with back/neck condition, and whether they would repeat the RF neurotomy. Frequencies and percentages for these variables are summarized in Table 5. Patients were asked in the first satisfaction item if their pain following neurotomy was worse than expected, no worse or better than expected, or better than expected, which yielded rates of 30.4%, 39.2%, and 30.4%, respectively. In a similar item, patients were again asked to rate their expectations in regards to pain; however, in this case, they were asked to rate their overall back or neck pain *currently* on a 6-point scale. According to this item, fewer patients had met expectations as it related to current pain (versus pain following their neurotomy) with 55.4% indicating that their pain was somewhat worse or much worse than expected.

Patient perceptions of changes in their quality of life resulting from their neurotomy were examined using a 7-point scale as depicted in Table 5. At least some level of improvement was noted in 37.5% of individuals, while the remaining individuals reported either no change (42.9%) or worsened quality of life (19.7%) due to the procedure. When asked how satisfied patients would be if they had to spend the rest of their life with their back condition in its current state, a large majority (76.8%) felt they

Table 5

Patient Satisfaction with Outcomes of Radiofrequency Neurotomy

Outcome category	Frequency (n = 56)	Percentage
Back/neck/ leg pain after neurotomy		
Worse than expected	17	30.4
No worse or better	22	39.2
Better than expected	17	30.4
Quality of life		
Great improvement	7	12.5
Moderate improvement	5	8.9
Little improvement	9	16.1
No change	24	42.9
A little worse	3	5.4
Moderately worse	6	10.7
Much worse	2	3.6
Back/neck/leg pain now		
Much better	5	8.9
Somewhat better	7	12.5
What I expected	8	14.3
Somewhat worse	14	25.0
Much worse	17	30.4
No expectation	5	8.9
Satisfaction with back/neck condition		
Extremely dissatisfied	19	33.9
Very dissatisfied	16	28.6
Somewhat dissatisfied	8	14.3
Neutral	5	8.9
Somewhat satisfied	6	10.7
Very satisfied	1	1.8
Extremely satisfied	1	1.8
Retrospectively, would choose to have neurotomy done again		
Yes	30	53.6
No	25	44.6
Undecided	1	1.8

would be at least somewhat dissatisfied. Conversely, 14.3% felt they would be at least mildly satisfied, while roughly 9% were neutral. Finally, when asked if patients would, retrospectively, go back in time and choose to have the RF procedure performed again, 53.6% believed that they would, whereas 44.6% would not.

Outcome Categorization

This section addresses research question 4, which pertains to characterizing the rates of good, fair, and poor outcomes from the RF neurotomy procedure. To this end, the SCI self-report instrument was used to gain information about patient outcomes along four subscales, namely, pain relief, return to work, physical activity, and analgesic utilization. Both the patient ratings and outcome categories can be found in Table 6. Approximately, 71% reported a poor level of pain relief since their neurotomy, whereas the remainder (28.5%) obtained better more than 25% relief in their back or neck pain. This classification was based on participant rating of their pain relief on a 0 to 100 scale, which when calculated, yields an average of 18.77% pain relief (SD = 29.53). Though this level of pain improvement is not impressive, it is notable that many patients stated informally that initial relief from the procedure had dissipated prior to follow-up. Recall that average time to follow-up of nearly four years.

In relation to employment following their most recent neurotomy, about half of patients (48.2%) were able to return to their previous job or work status, while nearly 18% required a lightened work load, and 34% were unable to return to work. When surveyed, neurotomy patients differed in terms of restrictions on their physical activities following RF treatment, in the range of minimal (37.5%), moderate (39.3%), and severe (23.2%) restrictions. Concerning medication usage, a majority of patients (69.6%)

Table 6

The Stauffer-Coventry Index Outcomes

	Pain relief			Employment status			Physical limitations			Medication usage		
Category	Rating	Freq.	%	Rating	Freq.	%	Rating	Freq.	%	Rating	Freq.	%
Good	76-100% improvement	5	8.9	Return to previous work status	27	48.2	Minimal or no restrictions	21	37.5	Occasional or no use of mild analgesics	9	16.1
Fair	26-75% Improvement	11	19.6	Return to lighter work	10	17.9	Moderate restrictions	22	39.3	Regular use of non-narcotic analgesics	8	14.3
Poor	0-25% Improvement	40	71.4	No return to work	19	33.9	Severe restrictions	13	23.2	Occasional or regular use of narcotic analgesics	39	69.6

Note. Ratings and percentages based on follow-up *n* of 56 patients.

reported occasional or regular use of narcotic analgesics. Conversely, 30.4% reported taking non-narcotic analgesic medications on a regular or infrequent basis.

Subject Levels of Pain and Methods of Pain Management

This section incorporates research questions 5 through 7 and outlines descriptive outcomes for pain intensity ratings, documented narcotic use, frequency of additional post-neurotomy pain intervention procedures, and pain attitudes (see Table 7). To supplement SCI outcome categories, two common instruments for measuring pain intensity and levels of improvement from the RF neurotomy literature were utilized. The first measure is the Global Perceived Effect (GPE) scale, which asks patients to rate their pain as follows: "Compared to when this episode first started, how would you describe your back or neck pain these days?" According to this scale, 30.4% of patients reported more than 50% pain relief, no change in 32.1% of patients, and increased pain in 37.5% of the sample. No participants in the survey endorsed complete relief of pain on the GPE.

A second common subjective pain measure used in the study, the VNRS, simply asks patients to rate their pain (on average over the past week) on a scale from 0 to 10, where 10 represents the most severe pain. This provides a current pain level that can be used to measure change over time. At the time of the survey, patients rated their pain in the 8-10 range at a rate of 26.8%, in the 4-7 range at a rate of 58.9%, and in the 0-3 range at a rate of 14.3%. In addition to current pain ratings, a percent change in VNRS scores was calculated for the sample based on pre-neurotomy ratings that patients had reported to their physician and was included in their medical chart. Change scores revealed that a large number of patients had worsened pain at follow-up (40.8%) or had mild improvement of 0-25% change in pain ratings (44.9%). Alternately, a less substantial proportion of patients (14.3%) had more than 25% pain relief based on these self-reported ratings.

In order to address research question 6, an exploratory part of this study tracked pain medication prescriptions that were coded from the medical chart for the entire sample. Specifically, narcotic and muscle relaxant medications were included in the data collection procedures at various time intervals pre and post-neurotomy. For the purposes of the current study, changes in analgesic use were examined at a point before, and three months after, the initial neurotomy. Data was unavailable in the chart for 33 patients; therefore results are reported for the remaining 68 individuals. A simple coding approach involved calculating a decrease, no change, or increase in quantity of medications, which yielded rates in the patient sample of 30.9%, 45.6%, and 23.5%, respectively.

A second method for investigating outcomes via medical record review entailed tracking back/neck interventional pain procedures and surgeries that patients underwent in the 24 months following their first neurotomy. The rationale for this research method involves the assumption that patients who had additional pain interventions likely had poor neurotomy outcomes. As seen in Table 7, more than half of the sample (54.5%) had no additional procedures during the two-year interval, while 23.8% had one, and 21.7% had two or more documented pain interventions. The types of medical procedures performed included, among others, discectomy, fusion, epidural steroid injection, trigger point injection, selective nerve root block, and spinal cord stimulator implant.

Table 7

Global Perceived Effect, Verbal Numeric Rating Scale, Analgesic Medication Use, and Additional Pain Procedure Outcomes

Outcome measure	Frequency	Percentage
Global perceived effect[a]		
Complete relief of pain	0	0
More than 50% pain relief	17	30.4
No change in the level of pain	18	32.1
The pain has increased	21	37.5
Verbal Numeric Rating Scale (VNRS)[b]		
Mild pain (0-3.5)	8	14.3
Moderate pain (4-7.5)	33	58.9
Severe pain (8-10)	15	26.8
Percent change in VNRS rating[c]		
76-80% improvement	0	0
51-75% improvement	2	4.1
26-50% improvement	5	10.2
0-25% improvement	22	44.9
Pain worse at follow-up	20	40.8
Change in analgesic prescriptions[d]		
Decreased	21	30.9
No change	31	45.6
Increased	16	23.5
Number of additional pain procedures[e]		
None	55	54.5
One	24	23.8
Two	12	11.9
Three	2	1.9
Four or more	8	7.9

[a] Survey item: "Compared to when this episode first started, how would you describe your back/neck pain these days?"; *n* of 56 at follow-up.
[b] Self-report pain rating on a 0-10 scale for *n* of 56 patients at the time of follow-up.
[c] Change on VNRS in *n* of 49 respondents at follow-up when compared to pre-neurotomy rating; 7 missing values due to unavailability of data from medical chart review.
[d] Change in number of prescribed opioid and muscle relaxant medications from before the first neurotomy to 3 month follow-up for *n* of 68 patients; 33 missing values due to unavailability of data from medical chart review.
[e] Number of subsequent pain intervention procedures received within 2 years of initial neurotomy by *N* of 101 patients based on medical chart review.

In addition to the evaluation of other pain elements, the current study examined pain attitudes of neurotomy patients as highlighted in research question 7. To this end, the Pain Catastrophizing Scale was administered during the course of the telephone survey, providing a total scale score along with subscale scores for Rumination, Magnification, and Helplessness. Scale means and standard deviations are summarized for the neurotomy sample and are compared to norms from a pain clinic population as summarized in Table 8. The average total score for the sample was 16.9 (*SD* = 11.9), which lies well below the cut-off score of 38 that has been suggested for this measure (Sullivan et al., 1998). That is, neurotomy patients showed lower levels of pain catastophization than is typical for other chronic pain patients.

Disability Status and Functional Impairment

Rates of patient work-disability and back-specific functional impairment following RF neurotomy were investigated in conjunction with research questions 8 and 9. Approximately 39% of patients at the time of the telephone survey were considered totally disabled and unable to work as a consequence of their back or neck condition (see Table 9). According to the Roland-Morris Disability Questionnaire (RDQ), which measures levels of back and neck specific functional impairment, 64.3% of the patient sample scored at or above the recommended cut-off score of 14 points (Roland & Morris, 1983a, 1983b). Scores ranged broadly from 2 to 22 with a mean RDQ score of 14.39 (*SD*= 5.66) that lies slightly above the cut-off, a median of 16 and a mode of 19. A visual representation of the RDQ data (see Figure 3) reveals skewed frequencies in the direction of more severe functional impairment.

Table 8

Pain Catastrophizing Scale (PCS) Scores and Comparisons

	Neurotomy patients		Pain clinic patients[a]		Effect size
Catastrophizing scale	*M*	*SD*	*M*	*SD*	*SMD*[b]
Total score[c]	16.9	11.9	28.2	12.3	-0.9
Rumination	7.2	4.9	10.1	4.3	-0.7
Magnification	2.1	2.3	4.8	2.8	-1.0
Helplessness	7.6	5.7	13.3	6.1	-0.9

Note. Based on *n* of 54 at follow-up. Two patients did not complete the PCS.
[a] Patients undergoing evaluation and treatment at a multidisciplinary pain clinic (Sullivan et al., 1998).
[b] Standardized mean difference effect size = difference between means divided by the normative sample standard deviation.
[c] Suggested cut-off score is 38 (80th percentile). Two neurotomy patients exceeded this cut-score.

Table 9

Disability Status and Roland-Morris Disability Questionnaire Outcomes

Outcome	Frequency	Percentage
Total disability		
Yes	22	39.3
No	34	60.7
RDQ—Poor outcome[ab]		
Yes	36	64.3
No	20	35.7

Note. Based on *n* of 56 at follow-up.
[a] Poor outcome is defined as a score of 14 or greater.
[b] Overall *M*(*SD*) for patients = 14.39 (5.66).

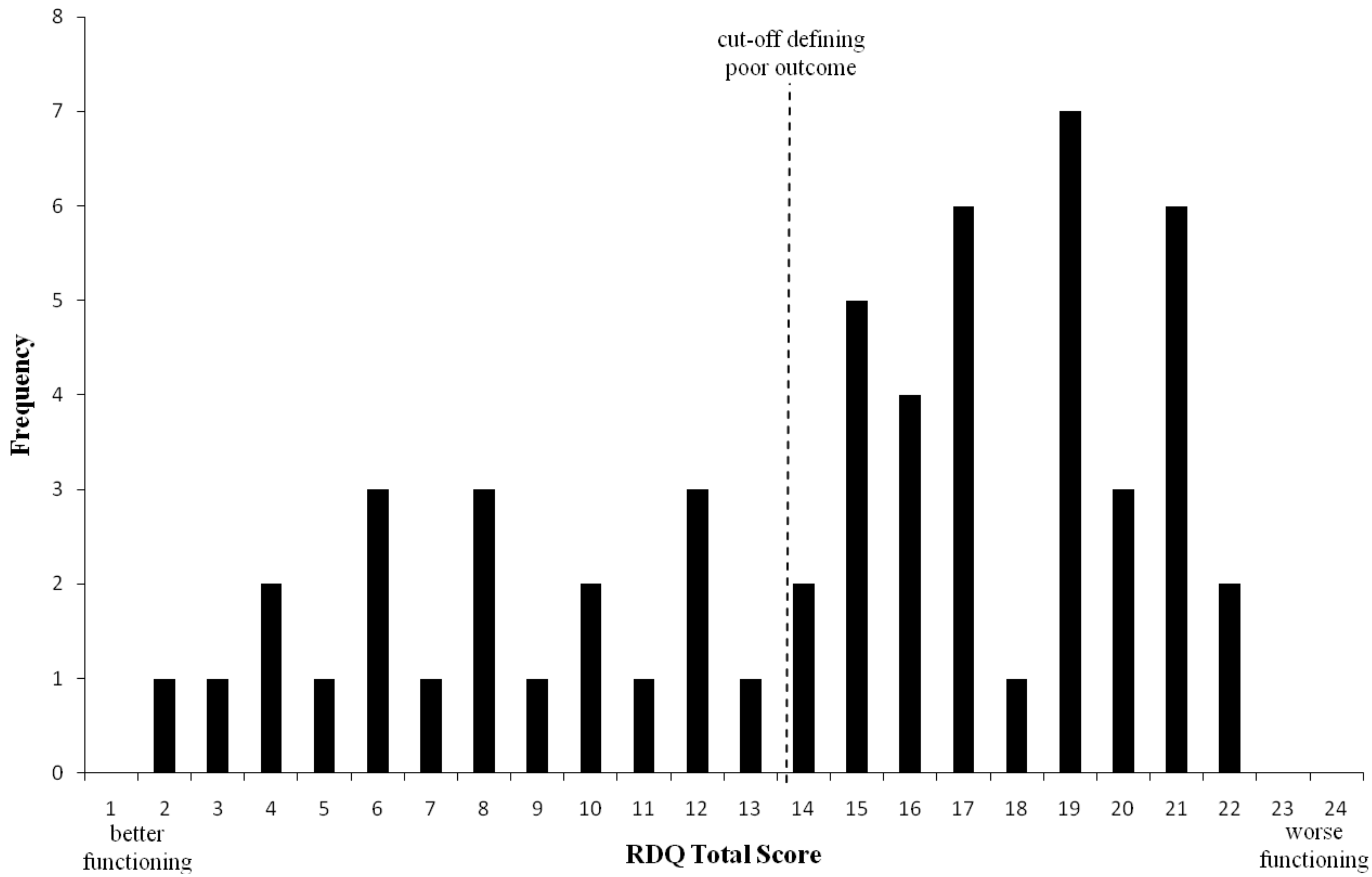

Figure 3. Frequency distribution of Roland-Morris Disability Questionnaire total scores.

General Physical and Mental
Health Functioning

To address research question 10, general physical and mental health functioning, were examined via the widely used SF-36v.2 (Ware, Kosinski, et al., 2000) health survey. As depicted in Table 10, mean values for the eight subscales [physical functioning (PF), role-physical functioning (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional functioning (RE), and mental health (MH)] as well as two summary scales [physical component summary (PCS) and mental component summary (MCS)] were computed and compared with existing norms provided by Ware and colleagues (Ware, 2000; Ware, Koainaki, et al., 2000). Normative data were drawn from the general U.S. adult population (*N* = 6742) and from a smaller sample of patients with a history of back pain or sciatica within the last six months and comorbid hypertension (*N* = 481). Based on recommendations from SF-36v.2 developers, norm-based scoring was used with the neurotomy sample, which has a general population mean of 50 and standard deviation of 10. As expected, the RF neurotomy sample (*N* = 56) subscale scores were considerably lower than the general population norms. In fact, when comparing the two groups, the standard mean difference effect sizes were quite large and ranged in magnititude from -0.3 to -1.8. Of note, scales that involved physical health variables, such as general physical health, self-care, functional limitations, and pain intensity had the largest effect sizes. Thus, neurotomy patients reported significantly poorer health than the general population, especially as it pertained to physical realms of functioning. In a similar fashion, neurotomy patients scored consistently lower than the back pain/sciatica norm reference group demonstrating poorer health. Here the effect sizes were more modest, ranging from -0.1 to -1.2; however, the same trend was observed

Table 10

SF-36(v.2) Multidimensional Health Outcomes and Comparisons

SF-36 subscale	Neurotomy sample *M* (*SD*)	General population[a] *M* (*SD*)	General population effect size[b]	Back pain/ sciatica *M* (*SD*)[c]	Back pain/ sciatica effect size[b]
Physical functioning	33.9 (12.3)	50.0 (10.0)	-1.6	46.6 (11.3)	-1.1
Role functioning	34.6 (11.8)	50.0 (10.0)	-1.5	46.4 (11.4)	-1.0
Pain severity	34.1 (9.5)	50.0 (10.0)	-1.6	44.6 (9.3)	-1.1
General health	39.1 (10.1)	50.0 (10.0)	-1.1	46.5 (10.6)	-0.7
Vitality	39.9 (11.1)	50.0 (10.0)	-1.0	46.5 (10.2)	-0.6
Social functioning	40.8 (13.6)	50.0 (10.0)	-0.9	46.9 (11.2)	-0.5
Role-emotional functioning	44.4 (11.4)	50.0 (10.0)	-0.6	47.6 (11.3)	-0.3
Mental health functioning	43.9 (12.4)	50.0 (10.0)	-0.6	47.6 (10.9)	-0.3
Physical component summary	32.2 (10.6)	50.0 (10.0)	-1.8	45.6 (10.8)	-1.2
Mental component summary	47.1 (11.7)	50.0 (10.0)	-0.3	47.9 (11.0)	-0.1

Note. Scores range from 0-100. A high score indicates better health status.
[a] General U.S. adult population; *N* = 6742 (Ware, Snow, et al., 2000).
[b] Standardized mean difference effect size = difference between means divided by normative sample *SD*.
[c] Norms for sample comorbid condition: back pain/sciatica (in last 6 months) with hypertension; *N* = 481.

with the largest effect sizes seen on scales related to physical health variables. A direct comparison of RF neurotomy patients with both the general normative sample and the back/pain co-morbid sample is conveniently presented in graphic form in Figure 4.

As discussed previously, the primary eight subscales of the SF-36 can be aggregated into PCS and MCS summary scores, which operate as indicators of physical and psychosocial aspects of general health, respectively. Examination of values for the PCS (32.2) and MCS (47.1) scales in the current RF neurotomy sample revealed scores substantially lower than the general adult population on physical components, but only modestly lower on mental components. This pattern was also found when comparing the neurotomy group to the back pain/sciatica normative group. As such, the PCS scores differed from the general and back pain reference groups by 1.8 and 1.2 standard deviation units, respectively, while the MCS differed by 0.3 and 0.1 standard deviations (see Table 10). That is, injured workers who have undergone at least one RF neurotomy, reported poorer physical health outcomes than might be expected for an adult sample of pain patients. The greatest perceived impairments were found in the areas of physical functioning (PF), work/daily activity limitations (RF), and intensity of bodily pain (BP).

Intercorrelations of Outcomes

With regard to research question 11, interrelationships among outcome variables were investigated by calculating Pearson product-moment correlations on 22 different indices. These correlations were organized into a matrix in Table 11 and include the following outcome variables: quality of life and satisfaction with outcome (four items), Stauffer-Coventry Index (four scales), total disability status (yes/no), Roland-Morris

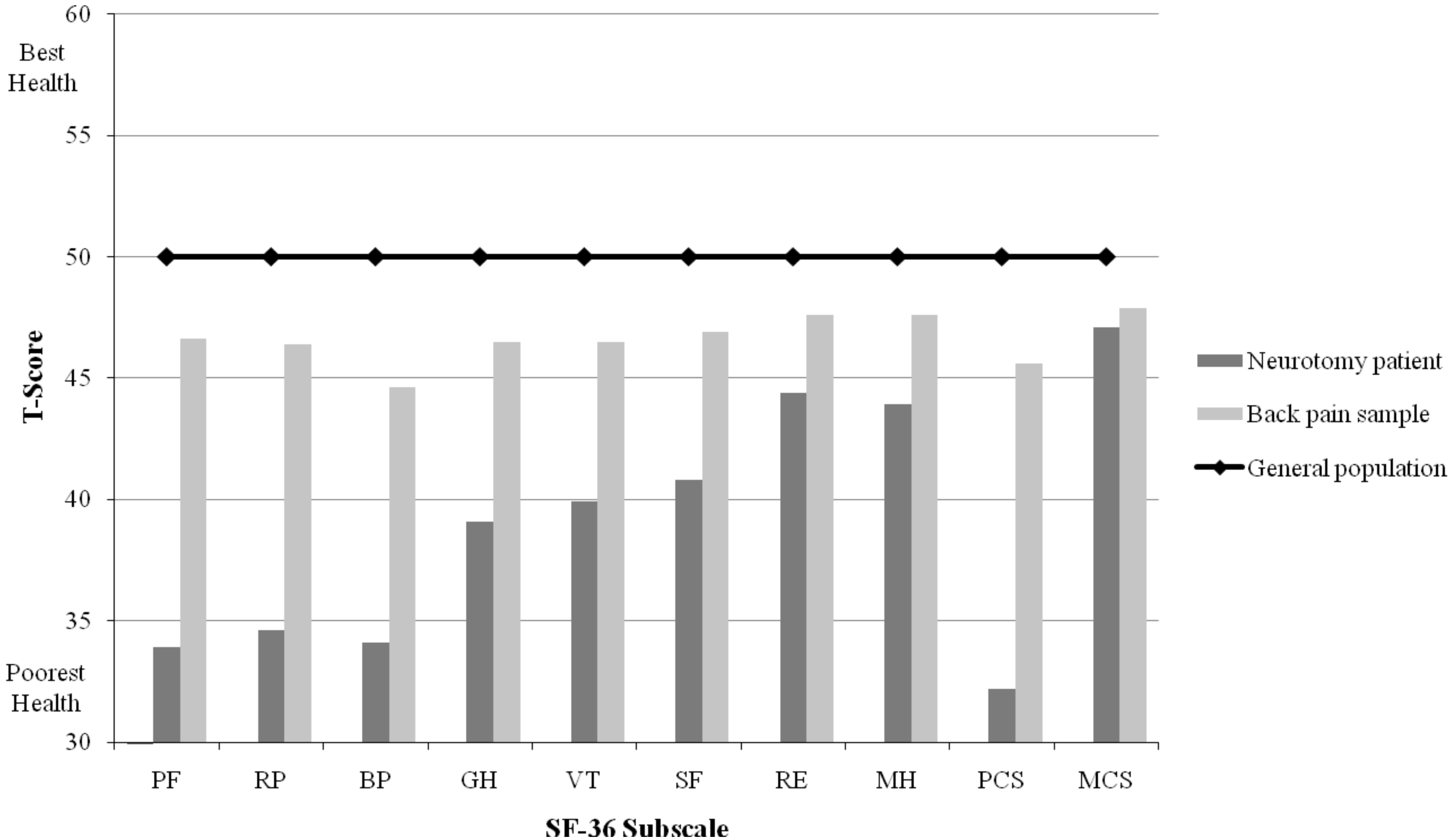

Figure 4. Short Form-36 subscale and summary scores for neurotomy patients, back pain/sciatica sample, and general population.

Table 11

Pearson Correlations Between Outcome Variables

	Variable																					
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	---																					
2	.60*	---																				
3	.19	.14	---																			
4	.44*	.39*	.20	---																		
5	.49*	.48*	.15	.35*	---																	
6	.04	-.01	.08	.26	.16	---																
7	.36*	.34*	.14	.27*	.22	.49*	---															
8	.05	.20	.19	.06	.08	.06	.13	---														
9	.15	.10	.08	.20	.01	.50*	.58*	.16	---													
10	.18	.09	.31*	.27*	.08	.42*	.43*	.43*	.54*	---												
11	.49*	.25	.30	.48*	.36*	.14	.24	.20	.15	.28*	---											
12	.05	.07	-.04	-.12	.19	-.23	.03	.16	-.12	-.13	-.12	---										
13	.25	.05	.24	.24	.07	.53*	.65*	.23	.65*	.82*	.24	-.13	---									
14	.12	.03	.25	.12	-.06	.45*	.50*	.37*	.69*	.80*	.24	-.17	.80*	---								
15	.15	.04	.46*	.24	.03	.42*	.39*	.34*	.50*	.68*	.34*	-.15	.68*	.75*	---							
16	.07	-.14	.11	.10	-.04	.41*	.21	.28*	.34*	.37*	.24	-.17	.43*	.46*	.17	---						
17	-.02	.10	.20	.22	.03	.18	.16	.43*	.41*	.63*	.13	-.12	.47*	.56*	.43*	.33*	---					
18	.09	.05	.16	.12	-.17	.25	.31*	.35*	.37*	.63*	.24	-.02	.61*	.73*	.55*	.36*	.36*	---				
19	.06	.08	.24	.20	.00	.24	.34*	.39*	.40*	.50*	.28*	-.10	.46*	.62*	.48*	.22	.44*	.70*	---			
20	.10	.09	.25	.05	.01	.17	.13	.51*	.33*	.63*	.29*	-.04	.43*	.57*	.48*	.32*	.57*	.70*	.61*	---		
21	.19	-.02	.26	.21	.01	.56*	.58*	.22	.65*	.75*	.23	-.19	.91*	.85*	.74*	.56*	.44*	.51*	.30*	.28*	---	
22	.01	.10	.20	.10	.05	.08	.09	.50*	.26	.51*	.25	-.02	.31*	.53*	.38*	.25	.59*	.76*	.82*	.90*	.14	---

Note. 1=quality of life change[a]; 2=retrospectively, would repeat neurotomy; 3=satisfaction with current back condition; 4=back/neck/leg pain change[a]; 5=SCI: pain relief (%)[a]; 6=SCI: employment status[a]; 7=SCI: physical limitations[a]; 8=SCI: medication usage[a]; 9=disability status (yes/no)[a]; 10=RDQ total score[a]; 11=global perceived effect[a]; 12=number pain procedures two years post-first neurotomy[a]; 13=SF-36: Physical Functioning; 14= SF-36: Role Physical Functioning; 15= SF-36: Bodily Pain; 16= SF-36: General Health; 17= SF-36: Vitality; 18= SF-36: Social Functioning; 19= SF-36: Role Emotional; 20= SF-36: Mental Health; 21= SF-36: Physical Component Summary; 22= SF-36: Mental Component Summary.

[a] Reverse coded so higher scores reflect better functioning/outcome.

[*] $p \leq .05$; $N = 56$.

Disability Questionnaire total score, Global Perceived Effect (pain relief; one item), number of additional pain procedures performed two years post-first neurotomy (via medical chart tracking), and the Short Form-36 v.2 Health Survey (subscales and summary scores). In order to facilitate interpretation of the interrelationships, 10 of the outcome indices were reverse coded so that higher correlations would reflect better functioning/outcome. On the whole, correlations coefficients ranged from -0.19 to 0.90 with 105/231 falling within the range of statistical significance.

Intercorrelations among the four patient satisfaction items revealed three statistically significant relationships (r = .60, .44, and .39), while there were 11 significant correlations with other outcome indices, ranging from .27 to .49 ($p \leq .05$). For example, satisfaction with quality of life was significantly related to pain relief based on the GPE (r = .49) and retrospectively choosing neurotomy was linked to pain relief based on the SCI (r = .48). Various SCI scales correlated, as expected, with several other outcome variables related to physical health (SF-36 scales), disability status, and functional impairment (RDQ), and coefficients ranged in magnitude from -.17 to .65. Similarly, disability status was significantly correlated with physical status and functional limitation measures, though it was not linked to patient satisfaction items. Compared to other indices, the RDQ total score had the largest number of interrelationships at 17 that reached significance, ranging from .08 (SCI: pain relief) to .82 (PF subscale; $p \leq .05$). In contrast, the number of pain intervention procedures coded in the patients' medical chart had no statistically significant relationships with any other outcome measures (-.23 to .19) and in fact many were slightly negative in direction. Interrelationships between the SF-36 scales and other outcome variables ranged from -.19 to .82 and, of these, 42 were significant correlations. Taking into account the entire correlation matrix, there do not appear to be large inconsistencies in what would be conceptually anticipated from the interrelationships. In other words, a vast majority of correlations were in the direction that would be expected given outcome categories and corresponding operational definitions.

Correlations Between Patient Characteristics and Outcomes

To fully address research question 11, interrelationships between patient variables and outcome indices were calculated in the same manner as above using Pearson product-moment correlations. As seen in Tables 12 and 13, a correlation matrix was generated from 10 patient variables (age, body mass index, smoking history, depression history, assignment of a case manager, lawyer involvement, number of prior back or neck surgeries, number of prior WCFU claims, number of diagnostic nerve blocks, and score on the Pain Catastrophizing Scale) and 4 outcome variables (SCI subscales, RDQ total score, disability status, and SF-36v.2 subscale and summary scores).

First, patient characteristics were compared to the four SCI subscales, the RDQ, and disability status, yielding 18/60 significant correlations ranging in value from -.32 to .59 (see Table 12). The SCI pain relief subscale did not correlate significantly with any patient variables, whereas the SCI return to work status, physical restrictions, and pain medication subscales resulted in 10 significant correlations that ranged from -.32 to .45 ($p \leq .05$). Back/neck specific functional impairment, as measured by the RDQ, was strongly related to a history of depression ($r = .38$), lawyer involvement ($r = .54$) and pain

Table 12

Correlations of Pre-Neurotomy Variables with Outcome Variables

Patient variable	SCI: Pain relief	SCI: Return to work status	SCI: Physical restrictions	SCI: Pain medications	Outcome variables[a]	Disability status
Age	.12	.24	.40*	-.13	.22	.36*
Body Mass Index	-.25	.14	.10	-.16	.10	.08
Smoking	-.02	.02	-.02	.12	.22	.15
History of depression	-.14	.20	.28*	.38*	.38*	.29*
Case manager assigned	-.06	.09	.01	.12	.09	.04
Lawyer involvement	-.06	.45*	.32*	.28*	.54*	.46*
Prior back/neck surgery	.13	-.01	.26*	.13	.13	.33*
Prior WCF claims	-.04	-.01	-.06	.04	.04	.06
Diagnostic nerve blocks	.01	.03	-.32*	-.29*	-.19	-.21
Catastrophizing scale	.08	.15	.25	.47*	.59*	.29*

[a] Higher scores equate to worse outcomes/functioning.
* $p \leq .05$.

Table 13

Correlations of Pre-Neurotomy Variables with Short-Form 36 Subscales and Composite Scales

	SF-36 subscale[a]									
Patient variable	PF	RP	BP	GH	VT	SF	RE	MH	PCS	MCS
Age	-.34*	-.27	-.11	-.09	-.16	-.14	-.03	.02	-.33*	.04
Body Mass Index	-.24	-.05	-.10	-.13	-.09	-.14	.03	-.13	-.17	-.05
Smoking	-.13	-.26	-.12	.09	.07	-.23	-.19	-.26	-.07	-.20
History of depression	-.39*	-.47*	-.48*	-.09	-.37*	-.43*	-.59*	-.32*	-.33*	-.44*
Case manager assigned	-.12	.00	-.14	-.03	-.13	.05	-.10	-.05	-.08	-.04
Lawyer involvement	-.48*	-.47*	-.48*	-.26	-.41*	-.41*	-.44*	-.38*	-.44*	-.39*
Prior back/neck surgery	-.17	-.13	-.05	-.01	-.34*	.16	.04	.01	-.18	.06
Prior WCF claims	-.09	-.15	-.22	.04	-.06	-.06	.00	-.14	-.12	-.05
Diagnostic nerve blocks	.21	.17	.12	.10	.20	.19	.21	.29*	.11	.26
Catastrophizing scale	-.50*	-.56*	-.40*	-.34*	-.41*	-.63*	-.55*	-.73*	-.37*	-.65*

Note. PF = Physical Functioning; RP = Role-Physical; BP = Bodily Pain; GH = General Health; VT = Vitality; SF = Social Functioning; RE = Role-Emotional; MH = Mental Health; PCS = Physical Component Summary; MCS = Mental Component Summary

[a] Higher scores equate to better outcomes/functioning.

* $p \leq .05$.

catastrophization (r = .59). Thus, patients who were depressed, had hired attorneys, or had distressing pain attitudes tended to report more functional impairement. Similarly, disability status was positively related to patients' age, history of depression, lawyer involvement, number of prior back surgeries, and pain catastrophization.

Next, interrelationships were examined among patient variables and SF-36v.2 outcomes, yielding a total of 32/100 significant correlations ranging from -.73 to .29. Similar to previously observed trends, there were strong relationships between the SF-36 and patient variables that included depression, lawyer involvement, and pain catastrophizing (see Table 13 above). Correlations among these variables were consistently negative, indicating that patients who had more negative perceptions of their physical and mental health tended to be depressed, have used an attorney in handling their claim, and reported higher levels of catastrophizing in response to their pain.

Multivariate Prediction of Outcomes

Forming a basis for the final objective of the current study is an examination of the predictive efficacy of RF neurotomy outcomes from a set of pre-neurotomy variables. This will incorporate research questions12 and 13, which will be presented in two segments. The first involves examining the prediction of disability status utilizing a logistic regression model of biopsychosocial pre-neurotomy variables. The second, and more extensive section, evaluates simultaneous entry multiple regression models for predicting RDQ total score and the various SF-36v.2 component summary scores and subscales.

Logistic and multiple regression analyses will employ a five-variable model for predicting outcome from RF neurotomy. It was originally anticipated to make use of a larger number of predictors in the forthcoming regressions; however, fewer participants were recruited for telephone interviews (Phase 2) than initially estimated due to inaccurate or outdated patient contact information. Consequently, the number of predictors was reduced to five based on the conventional standard of approximately one predictor per 10 subjects (Kleinbaum, Kupper, & Muller, 1998; Stevens, 1996). These variables were previously described in the literature review and include: age at the time of the first neurotomy, depression history, lawyer involvement, number of prior back or neck surgeries, and number of prior WCF claims. Predictors were selected for inclusion in the following analyses based on research with similar worker's compensation populations and suggestions from the neurotomy outcome literature.

Prediction of Disability Status

Disability status is a dichotomous variable (yes/no) and therefore logistic regression analysis was most fitting for evaluating outcome predictability. Unlike linear regression which is best suited for normal distributions, logistic regression is called for when the dependent variable (i.e., disability status) has a binomial distribution of scores allowing for clinically meaningful interpretations. Logistic regression is widely used as a preferred method for computing the odds (or risk) of developing a specified disease as a function of certain risk factors (Hosmer & Lemeshow, 2000).

The five-variable logistic model was statistically significant (chi-square = 22.79, $p \leq .001$), indicating that, taken together, these patient variables led to better prediction of disability status than would be expected given observed base-rates alone. As shown in

Table 14, the overall hit rate for the model was 80.4%, with specific hit rates of 85.3% for predicting nondisabled patients and 72.7% for predicting disabled patients at follow-up. Considering the base-rate of 60.7% (34/56) for nondisabled patients, the regression model improved upon the hit rate by 24.6%. Likewise for disabled patients, the model improved the hit rate 33.4% from the base-rate of 39.3% (22/56). Because the overall logistic model was statistically significant, the individual contribution of each variable deserves examination.

As depicted in Table 15, the Wald values were statistically significant ($p \leq .05$) for the two patient variables of patient age at the time of the first neurotomy and lawyer involvement. Alternately, depression, number of prior back/neck surgeries, and number of WCF claims did not predict a statistically significant amount of variance in disability status. Of more clinical utility are the logistic coefficients, which provide the log odds and the odds that the patient will be disabled given individual predictor variables. In a basic sense, the logistic coefficient is a measure of association that indicates how much more likely (or unlikely) it is for a patient to be disabled per one unit of change in the predictor variable. The logistic coefficient (β) and the estimated logistic coefficient (Exp β) allow for the interpretation of log odds and odds, respectively. Estimated logistic coefficients are easier to interpret, such that values greater than 1 indicate that the odds a patient is disabled are increased, where values less than 1 mean the odds are decreased. Therefore, when the estimated logistic coefficient is equal to 1, this means the pre-neurotomy variable does not increase or decrease the likelihood that a patient will be

Table 14

Logistic Regression Model: Disability Classification[a]

Observed	Predicted: Not disabled	Predicted: Disabled	% Correct
Not disabled	29	5	85.3
Disabled	6	16	72.7
Overall correctly predicted			80.4

[a] The cut-value for group membership is .50.

Table 15

Logistic Regression Equation Predicting Disability Status with Five Preneurotomy Variables as Predictors[a]

Variable	B	Wald	*P*	Exp (B)	95% CI
Age	.07	4.44	.04	1.08	1.01 – 1.15
Depression	.61	.53	.47	1.84	.36 – 9.43
Lawyer involvement	2.09	5.80	.02	8.05	1.47 – 43.90
Prior back/neck surgery	.25	.77	.38	1.29	.73 – 2.25
Prior WCF claims	.13	2.61	.11	1.14	.97 – 1.35
Constant	-7.77	11.45		.01	

[a] Omnibus chi-square = 22.79, df = 5, p = $\leq$ .001.

disabled (i.e., there is essentially no relationship between the two variables). The greatest value for the estimated logistic coefficient was for lawyer involvement (8.05), whereas the other four variables had substantially lower values, ranging from 1.08 to 1.84. Thus, patients retaining attorneys were approximately 8 times more likely to be disabled than those without an attorney, assuming all the other variables in the model remain constant. Although the other four variables also contributed to the predictive efficacy of the model, it was to a much lesser degree.

The second regression analysis examined the ability of the same five-variable model to predict back/neck-specific functioning based on the RDQ at the time of follow-up. Unlike disability status, the RDQ total score was a continuous variable making it more suitable for classic linear regression. The simultaneous-entry multiple regression analysis was employed and resulted in a statistically significant model, $F = 5.52$, $p \leq .001$, with an R^2 of .356 (see Table 16). In other words, 36% of the total variance of the RDQ total score was accounted for by the set of predictors. Beta weights, in multiple linear regression, indicate the expected change in the dependent variable (e.g., RDQ total score) associated with a unit change in the predictor variable, while partialing out the

Table 16

Simultaneous-Entry Multiple Regression Model Predicting the RDQ Total Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	0.087	3.108	0.198	0.127
Depression	2.069	0.056	0.184	0.186
Lawyer involvement	5.711	1.543	0.460	0.001
Prior back/neck aurgery	-0.338	1.669	-0.085	0.522
Prior WCF xlaims	0.165	0.524	.120	0.314
Constant	1.616	.162		

[a] Model summary: $p \leq .001$, $R = .596$, $R^2 = .356$, adjusted $R^2 = .291$.

other predictor variables (Stevens, 1996). These beta weights, however, cannot be directly compared with one another; therefore it is helpful to examine the standardized beta weights to address the relative contribution of respective predictor variables. In terms of predictive importance relative to the RDQ, lawyer involvement ($\beta = .460$) was by far the most influential followed by age ($\beta = .198$), but only lawyer involvement was statistically significant ($p = .001$). Thus, retaining an attorney predicted poorer back-specific functioning for patients who have undergone neurotomy at the time of follow-up, while the other variables in the model were less important.

The remaining analyses in the current study used simultaneous-entry multiple regression and the five-variable model mentioned above to predict multidimensional physical and mental health outcomes via the summary and subscale scores of the SF-36v.2. As with with RDQ, the SF-36 is a continuous variable and therefore linear regression is the preferred form of data analysis. Beginning with the component summary scores, the regression model summary for the SF-36 PCS score was statistically significant, $F = 4.85$, $p \leq .001$, and resulted in an R^2 of .327. That is, nearly 33% of the total variance of the PCS score was accounted for by the set of predictors. As denoted in Table 17, the beta weights associated with lawyer involvement ($\beta = -.340$, $p = .017$) and age ($\beta = -.315$, $p = .019$) were the most influential and the only predictors that reached statistical significance. These results indicate that having an attorney involved in the case as well as older age predicted poorer self-perceptions of physical functioning (i.e., lower PCS scores) post-neurotmy.

As seen in Table 18, the next multiple regression analysis that was conducted involved prediction of the mental component summary score (MCS) of the SF-36v.2.

Table 17

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Physical Component Summary Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	B	*P*
Age	-0.258	0.107	-0.315	0.019
Depression	-3.958	2.944	-0.189	0.185
Lawyer involvement	-7.855	3.183	-0.340	0.017
Prior back/neck surgery	0.398	1.000	0.054	0.693
Prior WCF claims	-0.485	.309	-0.189	0.123
Constant	57.899	7.610		

[a] Model summary: $p \leq .001$, $R = .572$, $R^2 = .327$, adjusted $R^2 = .259$.

Table 18

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Mental Component Summary Score[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	B	*P*
Age	-0.020	.122	-0.022	0.869
Depression	-8.898	3.379	-0.383	0.011
Lawyer involvement	-6.642	3.653	-0.258	0.075
Prior back/neck surgery	1.859	1.148	0.226	0.112
Prior WCF claims	-0.135	.355	-0.047	0.705
Constant	59.882	6.805		

[a] Model summary: $p \leq .01$, $R = .531$, $R^2 = .282$, adjusted $R^2 = .210$.

This analysis also resulted in a statistically significant model, $F = 3.92$, $p, \leq, .01$, with an R^2 of .282. Thus, the set of predictors accounted for 28% of the total variance in the MCS score. In this case, history of depression (β = -.383) was the only significant predictor at an alpha level of less than .05, while lawyer involvement (β = -.258) had a trend toward significance ($p = .075$). As expected for this model, the presence of depression was the largest predictor of poorer mental health functioning (i.e., lower MCS scores) and, to a lesser degree, retaining an attorney.

Due to significant findings from predictive analyses for the PCS and MCS scales, it was determined to move forward with an examination of the eight SF-36 subscale scores to obtain more detailed information about patient functioning. Therefore, the remainder of this chapter will comprise regression analyses for these subscales insuccession as depicted in Tables 19 through 26. The Physical Functioning subscale (PF) was the first to be examined. Items from the PF require respondents to rate the extent to which their physical health impedes them accomplishing various activities, such as climbing stairs, walking, bathing, and dressing. With PF as the dependent variable, the simultaneous-entry regression analysis was found to be statistically significant, $F = 6.05$, $p \leq .001$. This resulted in an R^2 value of .377, indicating that the five-variable model accounted for nearly 38% of the total variance of the PF score. As seen in Table 19, age at time of the first neurotomy (β = -.343) and lawyer involvement (β = -.350) were statistically significant predictors, whereas depression (β = -.253) only approached significance ($p = .067$). Thus, older age, attorney involvement in the case, and history of depression were predictive of perceptions of physical functioning at follow-up.

Table 19

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Physical Functioning Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	B	*SE*	β	*P*
Age	-0.777	0.285	-0.343	0.009
Depression	-14.684	7.854	-0.253	0.067
Lawyer involvement	-22.495	8.492	-0.350	0.011
Prior back/neck surgery	2.018	2.669	0.098	0.453
Prior WCF claims	-1.083	.825	-0.152	0.195
Constant	120.168	15.818		

[a] Model summary: $p \leq .001$, $R = .614$, $R^2 = .377$, adjusted $R^2 = .315$.

The next analysis predicted Role-Physical (RP), a subscale containing items related to the frequency with which a person's health restricts them from performing work or other kinds of daily activities. The simultaneous-entry regression was statistically significant, $F = 6.80$, $p \leq .001$, with an R^2 value of .405. That is, 40.5% of the total variance in the RP subscale can be explained by the set of predictors. When considering individual beta weights, as depicted in Table 20, it is evident that depression (β = -.363), lawyer involvement (β = -.308), and age (β = -.304) were all significant at an alpha level of .05, while the number of prior WCF claims (β = -.192) had a trend toward significance ($p = .096$). Thus, depression history, presence of an attorney, older age, and to a lesser extent, higher number of WCF claims predicted lower levels of RP at follow-up.

Table 20

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Role-Physical Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	-0.712	0.287	-0.304	0.016
Depression	-21.711	7.916	-0.363	0.008
Lawyer involvement	-20.395	8.560	-0.308	0.021
Prior back/neck surgery	2.881	2.690	0.136	0.289
Prior WCF claims	-1.411	0.831	-0.192	0.096
Constant	116.509	15.943		

[a] Model summary: $p \leq .001$, $R = .636$, $R^2 = .405$, adjusted $R^2 = .345$

Table 21 presents results of the multiple regression analysis predicting the SF-36 Bodily Pain (BP) subscale. This subscale entails patient evaluation of pain levels (over the past four weeks) and to what extent pain has interfered with work inside and outside their home. In this case the five-variable model successfully predicted BP score, $F = 6.745$, $p \leq .001$, and resulted in an R^2 of .403, indicating that 40% of the total amount of variance in BP can be explained by the set of predictors. Here, the beta weights were significant for lawyer involvement (β = -.370), history of depression (β = -.337), and number of prior WCF claims (β = -.265). That is, retaining an attorney, identifying depression in the patient's medical chart, and increasing number of prior compensation claims predicted lower scores on BP (i.e., higher levels of pain and pain interference).

The next SF-36 subscale, General Health (GH), comprises an evaluation of personal health and expectation of future health combined with a perception of one's

Table 21

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Bodily Pain Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	-0.242	0.213	-0.139	0.262
Depression	-14.975	5.887	-0.337	0.014
Lawyer involvement	-18.203	6.365	-0.370	0.006
Prior back/neck surgery	2.292	2.000	0.146	0.257
Prior WCF claims	-1.449	0.618	-0.265	0.023
Constant	79.353	11.856		

[a] Model summary: $p \leq .001$, $R = .635$, $R^2 = .403$, adjusted $R^2 = .34$.

health in relation to others. Unlike previous analyses of the SF-36, the simultaneous-entry multiple regression for GH was not statistically significant, $F = .817$, $p = .543$, with a small R^2 of .076, indicating that a trivial amount of total variance in GH was explained by the set of predictors. Accordingly, none of the individual predictors in the model reached statistical significance at an alpha level of .05 (see Table 22). It can be interpreted from this finding that the set of predictors were not adequate for predicting general health perceptions following neurotomy.

Table 23 summarizes the simultaneous-entry multiple regression analysis for the Vitality (VT) subscale of the SF-36. The VT score pertains to an assessment of the extent to which the individual feels full of energy and life versus feeling worn out and tired. The five-variable model was statistically significant, $F = 3.80$, $p = \leq .01$, with an R^2 of .276, denoting that the set of predictors explained approximately 28% of the total variance in the VT subscale. Lawyer involvement (β = -.302) had the only statistically

Table 22

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 General Health Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	-0.108	.250	-0.066	0.668
Depression	0.863	6.894	0.021	0.901
Lawyer involvement	-12.829	7.455	-0.277	0.091
Prior back/neck surgery	1.005	2.343	0.068	0.670
Prior WCF claims	-0.005	0.724	-0.001	0.995
Constant	68.258	13.885		

[a] Model summary: $p = .543$, $R = .275$, $R^2 = .076$, adjusted $R^2 = -.017$.

Table 23

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Vitality Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	-0.049	.233	-0.028	0.835
Depression	-6.660	6.440	-0.151	0.306
Lawyer Involvement	-14.734	6.964	-0.302	0.039
Prior Back/Neck Surgery	-3.789	2.189	-0.243	0.090
Prior WCF Claims	-0.784	.676	-0.145	0.252
Constant	68.900	12.971		

[a] Model summary: $p \leq .01$, $R = .525$, $R^2 = .276$, adjusted $R^2 = .203$.

significant beta weight at an alpha level of .05, while number of prior back/neck operations approached significance (p = .090). Thus, retaining an attorney successfully predicted poorer perceptions of vital living (i.e., lower VT scores) with a more marginal contribution from quantity of previous spinal surgeries.

The next subscale examined was Social Functioning (SF), which is an index of the extent to which physical health and emotional difficulties have impeded the individual from engaging in various social activities. As shown in Table 24, the model summary from the simultaneous-entry multiple regression analysis was also statistically significant, $F = 7.06, p \leq .001$. The five-variable model resulted in an R^2 of .414, indicating that 41% of the total variance in the SF subscale was explained by the set of predictors. Specifically, number of prior spine operations (β = .458), history of depression (β = -.441), age (β= -.295), and lawyer involvement (β = -.265) were statistically significant ($p \leq .05$). Thus, fewer previous spine surgeries, older age at the time of the first neurotomy, depression, and attorney involvement successfully predicted poorer social functioning as per lower scores on the SF subscale.

Table 25 presents results for the simultaneous-entry multiple regression analysis predicting the Role-Emotional (RE) subscale of the SF-36v.2. This subscale assesses the difficulties in performing work and other daily activities cause by emotional factors. The model summary was again statistically significant, $F = 8.44, p \leq .001$, with an R^2 of .458, meaning that nearly 46% of the total variance in RE can be explained by the set of predictors. Individual variables reaching the level of statistical significance, included depression history (β = -.589) and number of prior back/neck surgeries (β = .320) with lawyer involvement (β = -.209) only approaching significance (p = .096). In sum,

Table 24

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Social Functioning Subscale[a]

Variable	Coefficients: Unstandardized β	Unstandardized *SE*	Standardized β	*P*
Age	-0.713	0.294	-0.295	0.019
Depression	-27.302	8.118	-0.441	0.001
Lawyer involvement	-18.167	8.778	-0.265	0.044
Prior back/neck surgery	10.008	2.759	0.458	0.001
Prior WCF claims	-0.338	0.853	-0.044	0.693
Constant	126.171	16.349		

[a] Model summary: $p \leq .001$, $R = .643$, $R^2 = .414$, adjusted $R^2 = .355$.

Table 25

Simultaneous-Entry Multiple Regression Model Predicting the SF-36 Role-Emotional Subscale[a]

Variable	Coefficients: Unstandardized β	Unstandardized *SE*	Standardized β	*P*
Age	-0.266	0.222	-0.140	0.236
Depression	-28.540	6.120	-0.589	0.000
Lawyer involvement	-11.219	6.618	-0.209	0.096
Prior back/neck surgery	5.486	2.080	0.320	0.011
Prior WCF claims	0.103	0.643	0.017	0.873
Constant	111.301	12.326		

[a] Model summary: $p \leq .001$, $R = .676$, $R^2 = .458$, adjusted $R^2 = .403$.

presence of depression in the medical chart, fewer previous spine surgeries, and to a lesser extent, attorney involvement predicted more difficulty as a result of emotional problems at follow-up.

The final regression analysis in this study investigated the SF-36 Mental Health (MH) subscale, which is a measure of current levels of depression and anxiety. The five-variable model was statistically significant (F = 2.74, $p \leq .05$) and predicted 21.5% of the total variance (R^2 = .215) in the MH subscale score. As depicted in Table 26, lawyer involvement (β = -.343) was the only statistically significant (p = .025) predictor in the set. That is, retaining an attorney predicted higher levels of depression and anxiety for post-neurotomy patients at the time of follow-up.

Table 26

SimultaneousEntry Multiple Regression Model Predicting the SF-36 Mental Health Subscale[a]

	Coefficients			
	Unstandardized		Standardized	
Variable	β	*SE*	β	*P*
Age	0.009	0.239	0.005	0.970
Depression	-8.094	6.606	-0.186	0.226
Lawyer involvement	-16.505	7.143	-0.343	0.025
Prior back/neck surgery	1.668	2.245	0.109	0.461
Prior WCF claims	-0.938	0.694	-0.175	0.182
Constant	91.109	13.304		

[a] Model summary: $p \leq .05$, R = .464, R^2 = .215, adjusted R^2 = .136.

Summary of Predicting Outcomes

In summarizing the prediction data, it is evident that older age and attorney involvement were both related to high rates of disability, whereas only attorney involvement maintained its contribution to the prediction of increased physical impairment per the RDQ total score. With the exception of the GH subscale, all the five-variable multiple regression analyses were significant in this study. That is, a significant amount of variance in RDQ and SF-36v.2 component summary and subscale scores could be accounted for by the set of predictors. Among these predictors, lawyer involvement was notable for consistently accounting for a significant amount of variance, whereas age and depression history were statistically significant or approached significance ($p \leq .15$) in half of the regression analyses. The other two variables (prior claims and spine surgeries) had less of an impact on the analyses. A summary of the predictors and frequency of statistical significance are as follows: age at the time of the first neurotomy (5/12), depression history (5/12), lawyer involvement (9/12), number of prior back or neck surgeries (2/12), and number of prior compensation claims (1/12).

CHAPTER V

DISCUSSION

The current study utilized a retrospective cohort design to examine a number of research questions related to the minimally invasive spine procedure, percutaneous radiofrequency neurotomy, in a sample of injured Utah workers. These questions are comprised by the three principal study objectives, which entail: (a) identifying the central characteristics of worker's compensation patients who have undergone the RF neurotomy procedure, (b) evaluating multidimensional outcomes for the sample, and (c) investigating the predictive efficacy of a biopsychosocial multivariable model with regard to outcomes. Results for each of these primary aims will be discussed and interpreted in the intial sections of this chapter followed by implications of the findings, limitations of this study, and suggestions for future research.

Characteristics of the Patient Sample and the RF Procedure

Because there is limited published information describing worker's compensation patients who have undergone neurotomy, one important objective in this study was to present descriptive statistics for this Utah sample. Data revealed a sample that was approximately 74% male with a mean age at the time of their first neurotomy of about 46 years. Compared to two fairly recent neurotomy studies investigating non-compensation patients (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007), the current sample is younger and has a higher proportion of males, whereas this sample is slightly older and more female than a recent discectomy study involving a similar Utah sample from the

WCFU (DeBerard et al., 2009). With respect to ethnicity, the current study was restricted to primarily Caucasian participants (96%), which is consistent with restrictions found in studies with fusion and discectomy patients in Utah (DeBerard et al., 2001, 2009; LaCaille, 2003). The U.S. Census data reveal a near 50% split in gender and greater racial diversity (i.e., 89% and 75% Caucasian in Utah and U.S., respectively), making the generalizability of these results to the general population somewhat limited (U.S. Census Bureau, 2000). Nevertheless, the focus in this study was to document characteristics and outcomes of worker's compensation patients who have undergone RF neurotomy and not the community at large.

Health factors, such as obesity, tobacco use, and depression have received limited attention in the RF neurotomy literature, thus direct comparison with other studies is lacking. The proportion of obese patients in the current study was 35% (BMI > 30), which is commensurate with rates seen in lumbar neurotomy patients (41%; Cohen, Hurley, et al., 2007), but much higher than that seen in cervical neurotomy patients (17%; Cohen, Bajwa, et al., 2007). A nearly identical percentage of participants (39.6%) smoked in this study as compared those in a randomized control trial by LeClaire and colleagues (2001), though this was a higher rate than was observed in the two studies mentioned above by Cohen and colleagues with non-compensation patients (22% and 28%; Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007).

Given the rather conservative approach of diagnosing clinical depression by examining the patient medical chart, it is somewhat surprising to find such a high prevalence (52%) of depression in the current study. Nevertheless, these rates are consistent with the elevated incidence found in general samples of chronic back pain patients, which range from 30 - 57% (Epker & Block, 2001; Rush, Polatin, & Gatchel, 2000). More specific to facet joint pain, one study investigating the role of psychopathology on diagnostic nerve blocks found depression rates of 64% and 57% for cervical and lumbar spine regions, respectively (Manchikanti et al., 2008). Conversely, studies on discectomy and fusion patients at the WCFU, using an identical method for identifying positive cases of depression found much lower rates of 13 - 19% (DeBerard et al., 2009; LaCaille et al., 2005). One way to explain a higher incidence of depression in this RF neurotomy sample versus the above fusion and discectomy samples, is the notion that patients undergoing neurotomy may be more likely to have a more extensive chronic back pain history. Because of the somewhat mixed results from neurotomy literature, WCFU may be less likely to approve the procedure in the early stages of back pain. Thus, patients may have undergone more procedures or experienced a longer history of back pain making them more susceptible to developing depressive symptomatology. This postulate is further substantiated by the finding that this neurotomy sample comprised four times the number of patients with a previous history of spine surgery when compared to a similar WCFU discectomy sample cited above (DeBerard et al., 2009).

In regards to litigation status, the rates vary considerably among the minority of neurotomy studies where this characteristic is reported. When examining RF procedures for cervical whiplash patients, Sapir and Gorup (2001) reported that 32 out of 50 patients (64%) were retaining the services of an attorney, while Silvers (1990) described a smaller rate of 82 out of 223 (37%) from a lumbar RF neurotomy group. The proportion of patients with a history of lawyer involvement in the current study (32%) is more commensurate with the latter, whereas the former may be explained to have elevated litigation numbers due to the complicating factor of motor vehicle insurance in whiplash claims. Further, the incidence of litigation in the current sample is unremarkable relative to rates reported for invasive spine surgery patients (12 - 33%) drawn from the same Utah worker's compensation company (DeBerard et al., 2009; LaCaille et al., 2005). As it pertains to reporting the history of prior compensation claims for RF neurotomy patients, there does not appear to be a precedent in the literature based on this author's search of the Medline database.

Much has been made in the research literature about the diagnosis of facet joint pain and the technical aspects of the RF neurotomy procedure itself. A majority of randomized controlled trials and systematic reviews have concluded that double comparative (versus single) diagnostic nerve blocks are key to improving success rates (e.g., Boswell, Trescot, et al., 2007; Manchukonda et al., 2007). Alternately, some (LeClaire et al., 2001; van Wijk et al., 2005) have posited that double blocks are cost-prohibitive and single blocks are more reflective of common clinical practice, despite reported false positive rates of 38% (Schwarzer et al., 1994). Such was the case with the current neurotomy sample, where a vast majority (78%) of patients underwent single rather than double blocks. Additionally, the mean number of facet joint levels (2.48) that were treated in this study was slightly lower than those observed (3.0 - 3.7) in multi-center studies of cervical and lumbar neurotomies (Cohen, Bajwa, et al., 2007; Cohen, Hurley, et al., 2007). Another study looking specifically at the effectiveness of repeat RF neurotomies (Schofferman & Kine, 2004), reported a high rate of patients with a history of two or more procedures (69%) in noncompensation patients at a single spine center, while a smaller proportion (40%) was found in the current sample. Although speculative, compensation status may account for fewer repeat RF procedures in this sample due to the complicating factor of obtaining third-party medical approval.

One unique feature of the current study is the extended duration of time delay from the initial neurotomy to follow-up. While it is useful and necessary to measure short-term outcomes, longer-term observations may help to provide an understanding of alternative contributors to treatment success and failure. The mean duration of 4.68 years (maximum of 11 years) from the first neurotomy to follow-up in this study stands in contrast to the bulk of studies that follow patients for no more than 3 years. Though, an exception to the trend toward short-term follow-up can be found in Silvers' (1990) study of 223 patients who underwent chemoneurolysis (injection of a neurolytic agent) by the author to ablate the offending nerve, as opposed to radiofrequency (heat activated) neurolysis. These patients were followed for an average of 6.2 years and a maximum of 10 years. Interestingly, Silvers (1990) found a 69% rate (>50% self-reported pain relief) during the follow up period, with no differences observed in worker's compensation versus non-worker's compensation patients. In contrast, the current study found that only 29% achieved greater than 25% pain relief at follow-up (based on SCI pain relief scale). This is somewhat perplexing, but may be explained by more stringent criteria diagnosing facet pain and identifying appropriate candidates for the procedure in the Silvers' study.

Multidimensional Outcomes of RF Neurotomy

Based on a search of the WCFU database, 101 individuals were identified as having undergone at least one RF neurotomy, and of these, 56 participated in all or part of the follow-up telephone survey. One plausible explanation for this moderate response rate is the observation that nearly half of the compensation claims had been closed/settled at the time of the medical chart review, perhaps due to extended follow-up times. Once closed, patient contact information was not being updated, and thus, the primary reason for not completing the outcome measures was an inability to locate patients following a change of address or phone number (despite multiple attempts at searching public databases). To be confident that responders did not differ substantially from nonresponders (i.e., bias check), mean comparisons were carried out for the two groups, finding them to be statistically indistinguishable on a number of important patient and procedural characteristics. Smoking at the time of the first neurotomy was the one variable with an alpha level that approached significance ($p = .09$), therefore it was not included in later regression analyses.

The following section will summarize multidimensional outcomes in a format similar to the previous chapter. This will comprise findings associated with patient satisfaction, categorization of outcome, subjective pain levels and methods of management, disability status and functional impairment, and general physical/mental health functioning.

Patient Satisfaction Outcomes

Positive outcomes in the spine literature are typically measured in terms of pain reduction and functional improvements with less emphasis placed on the patients' subjective perception of surgical satisfaction. Although some have argued the importance of administering satisfaction measures to evaluate pain interventions (Hudak & Wright, 2000), there are few neurotomy outcomes studies to date that have made patient satisfaction a part of outcome assessment. In the current sample, rates of satisfaction covaried according to the time frame of the question. For example, following the RF neurotomy procedure, pain expectations were met or exceeded in nearly 70% of patients, while quality of life was unchanged or improved in 80% of the sample as a result of the procedure. In contrast, when asked about satisfaction with their current condition, markedly fewer patients (23%) endorsed neutral to positive perceptions. A relatively balanced rate was seen among those who, given what they know now, would choose to have the neurotomy done again (54%) versus those who would decline the intervention or were undecided (46%).

Thus, it appears that a considerable portion of the sample was not initially disappointed by the procedure and held fairly reasonable expectations for improvement. Given the long duration of time to follow-up and literature documenting pain relief that typically lasts 6-18 months from neurotomy, it is not surprising that an average of four to five years later patients would be experiencing less satisfaction with their back/neck condition. Given that RF neurotomy is a rather minimally invasive pain intervention when compared to open surgeries, these patients are perhaps more willing to choose the procedure again even when positive outcomes are not long-lasting. This was the qualitative experience of this author during phone interviews, in the sense that patients frequently expressed their willingness to go to great lengths in order to obtain even minor levels of pain relief.

Categorization of Outcome

Recall that the SCI has been used in a number of back surgery outcome studies as a means of categorizing changes following a spine operation into good, fair, or poor outcomes. A brief comparison of the current neurotomy data with those of discectomy and fusion surgery patients (DeBerard et al., 2009; LaCaille et al., 2005), shows considerably less pain improvement (43% poorer) and much higher rates of opioid usage (42% greater) among neurotomy patients. However, differences were more marginal as it pertained to rates of work-related disability, with 7% more disability observed in neurotomy patients. Meanwhile, 1.8% fewer patients in the neurotomy sample had severe restrictions on their physical activities following their neurotomy.

The noticeably poorer pain ratings and higher prevalence of narcotic use can tentatively be understood from the framework of diminished benefit from RF neurotomy due to nerve regeneration after a 12 - 18 month period. Generally, discectomy and fusion surgeries are thought to have a longer-term impact and more permanent effect from the standpoint of structural repair, as compared to RF neurotomy. The more invasive nature of these surgeries would also help explain the slightly higher rates of severe physical restrictions (in fusion patients) due to extended recovery times and the potential for more serious stenosis or segmental instability in the spine.

Subjective Pain Levels and Methods of Management

In order to supplement the set of outcome measures and survey instruments first established for studying surgical patients by DeBerard (1998), additional information was gathered through survey questions and coding of medical chart data. The first is the Global Perceived Effect (GPE), a non-standardized one-item question used in other studies of neurotomy that requires the subject to provide a rating of pain relief in comparison to when the pain first started. Based on responses to this question, 38% of the current sample endorsed increased pain at follow-up, 32% reported no change in the level of pain, 30% had more than 50% pain relief, while no participants endorsed complete pain relief. In comparison, a randomized, double-blind study of 40 lumbar RF neurotomy patients found higher rates of improvement using the same scale (62% ≥ 50% pain relief; 38% <50% pain relief) at 3 months follow-up (van Wijk et al., 2005). This is not surprising, considering the more rigorous selection criteria and short-term follow-up that were not present in the current study. Additionally, the current rate of increased pain (38%) is approaching the rate of patients who, retrospectively, would not choose RF neurotomy again (45%).

A large number of back pain studies use the VAS or VNRS (0-10 pain rating scale) as a principal outcome measure. Thus, this study attempted to collect available VNRS data from the patient medical chart and then calculated percentage change in these ratings at follow-up. Overall, 41% had higher VNRS scores (worse pain) at follow-up, 45% reported slight improvement (0-25%) improvement and just 14% were found to have more than 25% pain improvement on the scale. These rates of improvement are much lower than most studies of neurotomy outcomes and should be interpreted with caution given the method of data collection. That is, initial VNRS scores were gathered from physician notes on the day of a medical visit and reflect a brief glimpse of a patient's pain level at a given time. It is conceivable that a substantial number of patients report momentarily elevated pain at the doctor's office due to the stress and pain involved with long travel times for many patients.

Tracking pain analgesic intake has been argued in at least one systematic review of the neurotomy outcome literature to be an important aspect of measuring outcome

(Niemisto et al., 2003). Some have reported large decreases in rates of individuals who decreased pain medication consumption (83%) for one to two years following an RF neurotomy (Gofeld et al., 2007). Others have found little to no change in analgesic use following the procedure (van Wijk et al., 2005) and still others have found opioid use to be associated with treatment failure (Cohen, Bajwa, et al., 2007). The current study coded the type and number of opioid and muscle relaxant medication prescriptions from the medical chart before the first neurotomy and at intervals of 3, 6, 12, and 18 months postneurotomy. Sixty-eight of the 101 patients who qualified for medical chart reviews had medication information available pre- and three months postneurotomy. Of these, about 31% decreased medication usage (i.e., lower number of prescriptions), while nearly 46% had no changes, and 23% increased their usage. It is important to note that controlled randomized trials (e.g., van Wijk et al., 2005) were able to monitor actual consumption of analgesics (i.e., quantity of pills), whereas this study simply tracked available information retrospectively based on physician prescriptions. Due to missing data and difficulties associated with copy-and-pasted physician notes, the tracking of analgesic intake was an exploratory part of this study.

Another method devised for tracking outcomes in this study involved the coding of additional pain intervention procedures (e.g., epidural steroid injections, trigger point injections, discectomies, fusion surgeries) that the patient received in the two years following their RF neurotomy. Although this method of evaluation has not been reported in other neurotomy studies, it was hypothesized that patients who received additional procedures during this time frame were likely to have experienced a poor outcome (i.e., less than two years pain reduction) from the neurotomy. Additionally, patients needing supplemental pain intervention are likely to be incurring greater costs and may be refractory to treatment. Overall, 45.5% of patients in this study underwent at least one interventional pain procedure or surgery in the 24 months following their first neurotomy. Once again, this rate is nearly identical to the proportion of patients (44.6%) who would retrospectively decline their initial neurotomy.

Finally, in another exploratory aspect of this study, pain catastrophization was measured using the Pain Catastrophization Scale. Generally, pain catastrophizing is thought of as a predictor variable that has been shown in RF neurotomy studies to be associated with increased psychosocial dysfunction, negative self-efficacy, and poorer outcomes (Samwell et al., 2000; van Wijk et al., 2008). In the current study, catastrophization was measured at follow-up, therefore it cannot technically be classified as a predictor variable. Of note, the current sample endorsed a level of catastrophizing (M = 16.2) that was nearly one standard deviation below the mean of a sample of pain clinic patients (M = 28.2; Sullivan et al., 1998) and far below the suggested cut-off of 38. Although speculative, this finding may suggest that compensation patients with chronic back pain who have tried multiple pain procedures, such as neurotomy, do not tend to overestimate or inflate their pain levels and may actually be experiencing intractable or untreatable pain.

Disability Status and Functional Impairment

Total disability status following RF neurotomy occurred in 39% of patients at follow-up. This rate is nearly identical to a sample of Utah compensation patients who underwent interbody cage fusion (38%; LaCaille et al., 2005), while it is considerably higher than that found in a similar sample of discectomy patients (13%; DeBerard et al., 2009). This is an interesting finding, given that one would expect work-related disability rates for neurotomy patients to be more similar to the less invasive discectomy surgery (open and percutaneous) as opposed to the more invasive fusion surgery. In fact, neurotomy patients tend to have rates of disability that are more like those with severe and chronic back conditions, such as in failed back surgery syndrome.

Functional impairment due to back or neck pain, as gauged by the RDQ recommended cut-off of 14, occurred in 64% of neurotomy patients at follow-up. Consistent with previous findings, the mean rating of 14.4 (*SD* = 5.7) showed considerably more severe impairment than discectomy patients (*M* = 8.3; DeBerard et al., 2009), while ratings more similar to those of fusion patients (*M* = 12.5). Comparison with other neurotomy studies on the RDQ was not available due to alternative versions and scoring transformations in these few studies that differed from the current format and procedure.

General Physical and Mental Health Functioning

Scores on the SF-36v.2 revealed much poorer functioning than the general population. Additionally, when compared to the back pain/sciatica sample, means for the neurotomy sample remained approximately one standard deviation below the means for physical/role impairment and pain subscales. Patients who underwent RF neurotomy reported more limitations in physical (e.g., self-care) and general health, social and role activities (e.g., work and family functions), vitality, more severe bodily pain, and greater psychological distress than the normative group. As expected, the greatest areas of impairment were in physical/role functioning and bodily pain.

Direct comparison with neurotomy samples on the SF-36v.2 is not possible due to the use of a previous version of the questionnaire in the few studies found in the research literature. However, DeBerard and colleagues (2009) administered the appropriate version to discectomy patient at the WCFU, with a similar pattern of findings. That is, the physical/role functioning and bodily pain subscales of the discectomy sample were nearly one standard deviation above the neurotomy sample. Similar inferior outcomes were seen when neurotomy patients were compared to fusion patients at the WCFU. That is, neurotomy patients generally had lower scores on the SF-36, reflecting poorer ratings of general health functioning (DeBerard et al., 2001; LaCaille et al., 2005).

The finding that the current sample of workers' compensation patients had much poorer perceptions of their physical health and reported significantly worse pain ratings than their discectomy and fusion counterparts at the WCFU is a notable discovery that deserves further discussion here. Combined with inferior back and neck-specific functioning that was found on the RDQ, these results provide a rather striking picture of poor overall outcomes for neurotomy patients in this sample. Based on a review of the RF neurotomy outcome literature and anatomical studies of the spine, there does not appear to be empirical evidence to suggest that structural pathology in the facet joints causes more severe or more chronic pain than pathology in the intervertebral discs, for example, or vertebral instability. Therefore, it is difficult to explain this finding and any hypothesis is only speculative at this point.

One possible explanation for comparatively worse outcomes in the current neurotomy sample, involves the long-term nature of follow-up in the current study. Because outcome data were gathered up to 11 years after the initial RF neurotomy, it would be expected that patients are not maintaining benefit from the procedure. There is fairly strong consensus in the literature that positive outcomes are typically restricted to 6-18 months following RF neurotomy due to regeneration of the coagulated nerves that innervate the facet joint. In the case of fusion and discectomy patients there is an expectation on the part of the surgeon and patient to maintain some long-term level of pain relief and improved functioning based on the nature of the surgical procedure itself, whereas this expectation does not necessarily exist for RF neurotomy patients.

Another plausible explanation for poor outcomes found in the current sample is the insufficient diagnostic procedures that were used to qualify patients for RF neurotomy. Though it is strongly recommended in the research literature that patients undergo dual comparative nerve blocks for the purpose of proper patient selection, in this study nearly 80% of participants had only one block. Thus, it is conceivable that a number of patients were not good candidates for the procedure due to placebo response from the diagnostic nerve blockade.

Intercorrelations Among Variables

Results of correlational analyses were intended to provide information concerning the nature of relationships between and among variables in this study. Given the large quantity of variables involved in these analyses, only a brief account of the most noteworthy relationships will be discussed here. In regards to intercorrelations among outcome variables, the findings are generally consistent with expectations. For example, patients who reported greater improvement in their quality of life following RF neurotomy were also more likely, in retrospect, to choose to have the procedure done again (r = .60). Also, as expected, healthier physical functioning as measured by the SF-36 physical component summary was strongly correlated with fewer physical restriction based on the SCI (r = .58), employment at the time of follow-up (r = .65), and improved back/neck specific functioning per the RDQ total score (r = .75).

One unanticipated finding from this correlation matrix was the slightly negative relationship between the number of additional pain intervention procedures/surgeries performed two years post-first neurotomy and various other outcome measures. It was originally thought that the need for additional interventions would be associated with worse outcomes, such as poorer physical functioning and greater disability. In fact, contrary to expectations, many of these correlations were slightly negative in direction, indicating that more pain procedures in the months following neurotomy was associated with somewhat less disability and fewer physical limitations. Although this relationship is difficult to interpret, it may indicate that patients in this sample who found limited pain relief from their initial neurotomy were able to achieve more benefit from alternative methods (e.g., epidural steroid injection, trigger point injection, spinal cord stimulator implant, fusion surgery).

Second and third correlation matrixes were calculated to further investigate the relationship between various patient characteristics and selected outcome variables (i.e., SCI, RDQ, disability status, & SF-36). Most notably, these calculations revealed a fairly consistent pattern of strong and significant correlations for two pre-neurotomy variables, namely: depression history and lawyer involvement. That is, those patients who had been diagnosed with depression in their medical chart and those who retained an attorney reported more physical restrictions, a higher use of pain medications, greater functional impairment, and higher rates of work-related disability. Similarly, the presence of depression and litigation were associated with lower scores on the SF-36, such that these patients consistently endorsed more pain and poorer physical and mental health. Pain catastrophization was another strong correlate in the current study with relationship to outcome in the expected direction. In other words, neurotomy patients who had higher levels of catastrophizing at follow-up also had poorer multidimensional outcomes from the procedure. While there is little precedent in the literature for depression in RF neurotomy patients, litigation status has received some attention, with findings contrasting those of the current study, showing little no link with outcome (Barnsley, 2005; Sapir & Gorup, 2001; Silvers, 1990). In contrast, pain catastrophization has been shown previously in neurotomy patients to be associated with poorer outcomes as observed in the current study (Samwell et al., 2000).

Prediction of RF NeurotomyOutcomes

Many have posited that mixed results from RF neurotomy are due to technical flaws, such as improperly diagnosing facet pain or incorrectly performing the procedure itself. Considering that RF neurotomy is the second most commonly performed pain management procedure in the United States (Manchikanti, 2004), it is surprising that little attention has been paid to biopsychosocial factors predictive of outcome from the procedure. The current study aimed to identify an empirically informed five-variable biopsychosocial model capable of predicting multidimensional outcomes following RF neurotomy with compensation patients.

Five-Variable Model as a Predictor of Outcomes

Taken together, the five variables employed in the multiple regression model consistently predicted patient outcomes in the form of disability status, back-specific functional impairment (RDQ total score), and general physical and mental health factors (SF-36 subscale scores). With respect to predicting work-related disability, the multivariate model achieved an overall hit rate of more than 80%, improving the identification of disabled and nondisabled patients by approximately 33% and 25%, respectively. Further, the model accounted for a significant amount of variance (22-46%) across multidimensional outcomes, with one exception (8%) on the general health subscale of the SF-36. Individual variables differentially contributed to the predictive efficacy of the model with the most consistent contribution coming from lawyer involvement (75%), history of depression (42%), and age at the time of the first neurotomy (42%). Each of the five patient variables in the model will now be discussed in more detail.

Lawyer involvement as a predictor. In concurrence with much of the back pain literature, litigation was determined to be a robust predictor of poorer multidimensional outcomes in this study. In fact, retaining an attorney increased the odds of being disabled at follow-up by an astounding 701%, while successfully predicting greater functional impairment, more physical disability, increased bodily pain, and less vitality. Litigious patients have been found to experience delays in returning to work, incur higher compensation costs, have increased rates of disability, and greater levels of pain (DeBerard et al. 2009; Kaptain et al., 1999; LaCaille et al., 2007; Vacarro et al., 1997).

In contrast, the RF neurotomy literature to date has found minimal influence of litigation status on outcome. For example, two separate studies with whiplash patients found no effect for litigation on outcome following cervical RF neurotomy (Lord et al., 1996; Sapir & Gorup, 2001). Similarly, LBP patients with a pending compensation claim or other litigation did not have better or worse results from lumbar RF treatment than patients without the presence of secondary gain (Silvers, 1990). The paucity of research with pure samples of worker's compensation patients may explain the contrary findings in the current study. That is, the additive effect of compensation on litigation may provide conditions more replete with complicating factors and a greater susceptibility to poor outcomes. Prediction models with the current sample are commensurate with the concept of "compensation neurosis" coined by Epker and Block (2001), suggesting that financial incentives and social contextual variables associated with litigious patients may cause an increased sensitivity to pain. From a biopsychosocial perspective, hypersensitivity to pain is thought to lead to activity restrictions and physical deconditioning that eventually results in poorer response to pain treatments, increased functional impairment, and exacerbation of pain (McCraken & Turk, 2002; Turk & Okifuji, 2002). It is also conceivable that the exceptionally long time delay to follow-up in this study further compounds these effects, supplementing the overall impact of compensation and litigation variables on poor outcome.

Depression as a predictor. In multivariate analyses, a history of depression in RF neurotomy patients as coded from their medical chart was strongly predictive of several subscales from the SF-36 including, MCS, RP, BP, SF, and RE. Three of these scales (MCS, SF, and RE) are psychosocial in nature, thus depression history as a predictor is theoretically consistent with observed associations. It is noteworthy, that depression was also predictive of perceptions of work/daily activity impairment (RP) and ratings of bodily pain (BP) in this study.

Depression and chronic back pain/impairment commonly co-occur in the pain literature, which has led to frequent debate over the causal nature of this relationship (Epker & Block, 2001; Rush et al., 2000). That is, does depression lead to a hypersensitivity to pain and increased disability or does protracted pain cause greater psychological distress? While there is some evidence that the relationship between chronic pain and depression is reciprocal in nature (Polatin, Kinney, Gatchel, Lillo, & Mayor, 1993), more recent evidence suggests that depression is a central mechanism in the onset and maintenance of back pain. For example, an experimental study found that induced negative mood increased self-reported pain and decreased tolerance for a pain-relevant task, while induced positive states had the opposite effect (Tang et al., 2008). Additionally, Glombiewski, Hartwich-Tersek, and Rief (2010) have recently demonstrated that successfully treating depression results in reduced pain intensity and pain disability. While it is impossible in the current retrospective study of RF neurotomy patients to differentiate the etiology of pain and depression, it is clear that there is both a predictive and correlational association.

It should be noted that depression was not a significant predictor of disability status or back/neck specific functional impairment (RDQ) in the current study. A similar lack of predictability was seen in LaCaille and colleagues' (2009) investigation of compensation patients following discectomy surgery, which may be explained by the relatively imprecise method of measuring depression in both studies. That is, identifying depression from physician documentation of a diagnosis of depression in the patient's medical chart may be an insensitive measure and decrease the likelihood of significant findings from regression analyses. Despite these limitations, Pearson correlational analyses that were outlined in a previous section of this report did reveal a statistically significant relationship between depression and rates of disability ($r = .29$, $p \leq .05$) as well as depression and RDQ total score ($r = .38$, $p \leq .05$).

Age as a predictor. Similar to depression, age proved to be a moderately effective predictor of neurotomy outcomes at more than 4.5 years follow up, as evidenced by significant findings in 5 out of 12 multiple regressions analyses. Successful prediction was observed for disability status and four SF-36 subscales including, Physical Component Summary, Physical Functioning, Role-Physical, and Social Functioning. The finding that older aged patients tend to have poorer physical disability and functional impairment outcomes is not surprising in this sample of chronic back and neck pain patients. In the United States, self-reported disability rates have been found to double from ages 18 - 44 years to 45 - 64 years and double again for those 65 and older (Center for Disease Control, 2009). Natural degenerative physical changes in spinal structures are thought to lower normal baseline levels of strength, flexibility, endurance, and rates of healing in older aged patients (Boos et al., 2002; Chen et al., 1994). More specifically, the pain generator targeted in RF neurotomy, the facet joint, has recently been found to show age-related increases in the surface area of the joint, especially in patients with chronic low back pain (Otsuka et al., 2010).

Despite the predictive effectiveness of age in the current study, there are no clear indications in existing literature that suggest older age is predictive of treatment failure following RF neurotomy. In fact, in randomized trials LeClaire et al. (2001) and van Wijk et al. (2005) found enhanced outcomes for older aged patients following the RF procedure than their younger aged counterparts. While this finding is difficult to interpret, one possible explanation is that nerve regeneration, thought to cause the re-onset of pain following RF lesioning, may be slowed in older aged persons and thereby extend the duration of pain relief. In this case it would be conceivable that short-term follow up, as in the above two studies, would lead to improved outcomes for older aged patients, whereas long-term follow-up found in the current study would lead to worse outcomes. This supposition is further supported by research on other minimally invasive techniques that do not involve nerve cauterization, such as spinal cord stimulation, where younger aged patients have been shown to have greater benefit from these procedures than their older aged counterparts (Burchiel et al., 1995; Kim et al., 2002; North et al., 1996).

Surgical history and prior compensation claims as predictors. Although less impactful than the above preprocedural variables, both a previous history of spine surgery and number of WCF claims were predictive of selected outcome variables. Number of prior back or neck operations was significantly predictive of social and role-related emotional functioning from the SF-36 health survey. This finding substantiates the previously discussed contribution of psychosocial health variables to chronic pain and extends this association to sequelae from failed spine surgeries. However, it is noteworthy that surgical history failed to predict a number of relevant physical impairment variables, in spite of its relatively strong correlation with disability status

($r = .33$, $p \leq .05$). An inspection of neurotomy outcome studies provides inconsistent information regarding the effect of prior back surgery on outcomes. For example, previously operated patients did not respond as well as unoperated patients to RF treatment in several studies (Babur, 1994; Cohen, Hurley, et al., 2007; Shealy, 1975; Silvers, 1990; van Wijk et al., 2005), while no association between the two groups was found in others (Cohen, Bajwa, et al., 2007; North et al., 1994; Tzaan & Tasker, 2000). In relation to physical variables, the long-term outcome variables in post-neurotomy Utah workers appear to be more commensurate with the latter.

With respect to compensation variables, the number of additional WCF claims in the current study was a significant predictor for a single outcome measure, namely bodily pain ratings (BP) from the SF-36. There are at least two explanatory frameworks for this finding: (a) a patient who has filed more compensation disability claims is likely to have been exposed to more accident-prone environments, leading to an increased number of physical injuries and greater levels of pain from these injuries, or (b) a "compensation neurosis" occurs where increased financial rewards for illness act as a nonspecific force that exacerbates pain and compels the patient to guard against getting well (Bellamy, 1997; Block & Callewart, 1999). Perhaps the most intuitive approach would be to assume that a combination of these factors is at play, particularly in relation to self-reported pain and determination of financial compensation for work-related injuries. A number of potential confounding variables have been identified to account for increased disability and poorer outcomes in compensation/litigation patients, especially following surgical intervention (Burns et al., 1995; Hurwitz & Shekelle, 2006; Sanderson et al., 1995). With respect to available RF neurotomy literature, compensation status has proven to have little impact in terms of predicting outcomes. Although the current study is missing a non-WCF comparison group, the association of additional compensation claims with self-reported bodily pain does speak somewhat to the longer-term course of chronic pain in those patients who are subject to multiple injuries in the workplace.

Implications

Based on findings from this study, there are several noteworthy implications for RF neurotomy, particularly in regards to worker's compensation patients. First, there is scant literature to date that describes characteristics and predictive correlates of RF neurotomy patients from the standpoint of biopsychosocial markers. Due to fairly recent double-blind placebo-controlled trials that have found no or minimal benefit for neurotomy (LeClaire et al., 2001; van Wijk et al., 2005), it is surprising that more has not been done to determine specific patient variables that could predict treatment success or failure. Moreover, psychosocial factors have received little to no attention in neurotomy patients, despite their association with patient functioning and disability in many other invasive and non-invasive pain procedures (DeBerard et al., 2001; Gatchel & Gardes, 1999; LaCaille et al., 2005). The current study demonstrated that psychological factors (i.e., depression), social factors (i.e., lawyer involvement), and biological factors (i.e., age) were all quite efficacious in terms of predicting long-term outcomes for the RF procedure providing further support for the usefulness of a biopsychosocial model in understanding these patients. It also points to the potential utility of preprocedural variables in assisting with identification of patients likely to have a poor response to RF treatment. Additionally, an array of patient characteristics gathered in this study further elucidates the complexity of chronicity of this compensation sample. For example, more than 50% had a history of depression, more than a third had a history of failed spine surgeries, 70% had more than one compensation claim, 40% smoked, nearly a third retained an attorney, their average income was about $500 per week, and they averaged nearly $150,000 in incurred compensation costs. These findings can better inform pain intervention specialists and physicans regarding the possible complicating factors and non-specific forces acting on compensation patients who undergo this procedure.

The neurotomy outcome literature to date has focused primarily on self-reported pain relief as the primary indicator of success, with limited attention paid to broader outcome categories, such as disability, functional impairment, and analgesic usage. This study conforms to recommendations by some to increase standardized outcome measures (Deyo et al., 1998) and examines multidimensional outcomes from a broad domain of functioning. Additionally, the methodology facilitates comparison with more invasive surgical procedures (e.g., DeBerard et al., 2001, 2009; LaCaille et al., 2005) that have used similar methods. It is somewhat surprising that even when compared to fusion and discectomy patients, the current sample showed much poorer back/neck specific functional impairments, higher levels of pain, and worse perceptions of their physical health. Though unanticipated, this finding combined with other available data, suggests that RF neurotomy may be used with patients as a last resort when all other treatments have not been successful, which can then lead to less than optimal outcomes. Thus, it substantiates the frequently cited position among neurotomy studies that patient selection is a key component to obtaining benefit from this procedure. Inclusion of patients who may not meet the strict criteria found in most randomized trials may also help explain why nearly half of patients would choose, retrospectively, to not repeat the procedure, and about the same proportion went on to have additional pain procedures in the 24 months following their initial neurotomy.

In the same vein of patient selection, this study provides additional insight into the "real world" practice of determining which candidates are most likely to have a positive response to RF neurotomy given various restrictions and financial limitations. While the efficacy literature posits that using two diagnostic nerve blocks results in fewer false-positives and better outcomes (Boswell, Trescot, et al., 2007; Manchukonda et al., 2007), the experience in everyday practice involves less rigorous selection criteria. In the current study this meant that a large majority (79%) of patients received only one diagnostic nerve block before their first neurotomy and identification of a successful nerve block response varied considerably (i.e., percentage self-reported pain relief). Thus these results may be more representative of the effectiveness of the RF procedure from the perspective of routine practice, rather than optimal technical adherence.

A final general implication stems from the extended length of time delay to follow-up that is rather unique to this study, especially with respect to compensation patients. Generally, RF neurotomy has been shown to provide pain relief for an average of 6 - 24 months, therefore the exceptionally high level of functional impairment found on the SF-36, SCI, and RDQ questionnaires can at least partially be attributable to expected regeneration of pain transmitting nerves that innervate the facet joint. In any case, these results provide an indication of the long-term trajectory of patients who undergo RF neurotomy and speak to the chronic aspects of spinal pain in compensation patients. Consequently, it would be advisable for physicians who perform the procedure to discuss with patients the expected short- and long-term outcomes that are specifically applicable to compensation patients.

Limitations and Future Research

There are several limitations to this study that deserve attention here. Firstly, a retrospective cohort design with no matched controls was used to examine RF neurotomy outcomes. With no direct comparison group, this design depended on an existing sample of patients and data that had previously been collected in the medical chart. Thus, there was no opportunity to administer relevant measures prior to neurotomy for the purposes of quantifying change scores. In essence, without a control group it was not possible to make assertions about the clinical efficacy of the RF procedure on injured workers. Positive or negative changes over time could have been due to spine injury natural history and/or regression to the mean. Further, the impact of placebo effects on improvement after spine interventions cannot be overlooked. Similar to medication treatments, pain procedures and surgical treatments are often complicated by high rates of placebo responses that cannot be quantified or fully examined without a randomized control group and, in this case, sham lesioning (Turner, Deyo, Loeser, Von Korff, & Fordyce, 1994).

Despite a thorough and standardized medical chart review, there were unavoidable barriers to gathering comprehensive patient information, including missing data, unclear or nonspecific physician notes, and other inconsistencies in medical documentation. As a result, not all data points could be gathered for all patients, leading to less inclusive results. This was particularly true for coding analgesic use and self-reported pain at consistent intervals because, for instance, the physician notes were not available for review for an extended period following the procedure. Additionally, in some cases, information was contradictory. For example, a physician might discuss patient improvement following an initial RF neurotomy in a request to WCFU to financially compensate a repeat procedure, yet the actual medical visit notes suggest a worsening of symptoms.

Furthermore, a certain amount of subjectivity was inherent in the data collection process and this study did not make use of multiple research assistants for the coding of medical information or conducting phone interviews. A more empirically sound approach would have included multiple reviewers and interviewers to provide a comparison point and estimates of interrater reliability. For instance, this method may have been helpful in classifying patients along the variable of depression history, which requires the chart reviewer to look closely at a range of medical documentation to find mental health diagnoses. Of note, is the finding that depression history was not a significant predictor of the Mental Health subscale of the SF-36 in the multivariable regression model, perhaps calling into question the accuracy of coding for depression from the patient's medical chart. Similarly, audio recordings of phone interviewers may have been useful in allowing for another research assistant to code the interview and compare for reliability purposes.

Restriction of the sample size was another limitation in this study. It was originally anticipated that as many as 130 participants would be able to take part in the study; however, upon further examination of the WCFU database many patients had been listed more than once for the same procedure or had received alternative pain intervention procedures. Of the 101 patients who actually met the criteria and were included in Phase 1 of the study, 56 completed the telephone survey resulting in an overall response rate of 55.4%. It is important to note that 34 participants could not be reached due to outdated contact information, which was likely linked to the fact that a large number of compensation claims were closed (42) at the time of follow-up. Claims that are closed are no longer being tracked by the WCFU and therefore personal contact information is not kept up to date. A reduced sample size led to the inclusion of fewer predictive variables in the multiple regression model and narrowed the scope of statistical analyses.

Taking into account the above noted limitations, there are several recommendations for future research in the area of RF neurotomy. Undoubtedly, a prospective randomized controlled study would be a preferable research design and several already exist in the literature base; however, these studies have focused primarily on self-reported pain relief with limited attention paid to psychosocial aspects of neurotomy outcomes. The benefit of this design is that biopsychosocial measures can be administered pre and post treatment to more explicitly examine treatment specific change. Additionally, a number of preprocedural variables deserve further elucidation, such as litigation status, depression, anxiety, obesity, tobacco consumption, age, socioeconomic status, and surgical history. In particular, the data call for clarification of the underlying mechanisms for lawyer involvement, depression, pain catastrophization, and age as predictors to be employed in a multivariable model. For instance, patients who retained an attorney were consistently found to have poorer outcomes in correlational and predictive analyses. There are a number of explanatory frameworks that might be used to explain this finding, which would require a more in depth analysis of potential interactions and contributing factors.

The current study is the only known investigation of an RF neurotomy sample made up entirely of patients who are being compensated for their injuries. To generalize these findings to other compensation patients there is a need to replicate this study with larger and more diverse sample sizes and to make direct comparisons with a control group of non-compensation patients. Moreover, short-term as well as long-term outcomes should be assessed to provide a clearer picture of the duration of neurotomy benefit. Given the failure of two randomized trials in the past 10 years to show significant benefit, more efficacy and effectiveness studies utilizing standardized multidimensional outcomes are needed to establish RF treatment gains and improve comparison among studies.

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APPENDICES

Appendix A:

Medical Records Review Instrument

DEMOGRAPHIC/COMPENSATION VARIABLES		
1. Patient Name:	**2. Address:**	**3. Phone Number (home):**
4. Claim Number:	**5. Gender** 0=not reported 1= Male 2= Female	**6. Happened on employer premises:** Y N
7. Study Number:	**8. Date of Birth:**	**9. Date of Injury** **9a. Injury type:** **9b. Date first Tx:** **9c. Prior injury same part of body:** Y N **9d. Date employer notified**
9e. Prior Interventions 1 = Physical Therapy 2 = Injections 3 = Acupuncture 4 = Chiropractic 5 = Narcotics 6 = Bed Rest 7 = Heat 8 = TENS unit 9 = Other	**9g. Modified employment available:** Y N **9h. Previous convictions:** Y N	
9f. Initial complaint ________________________ ________________________ ________________________	**9i. Witness to accident/injury:** Y N	**10. Hire date:**
	13. Validity of claim doubted by employer: Y N	**11. Date RTW:** **12. Months worked for employer prior to injury:**
14. Marital status at time of injury: 0=Not reported 1=Married 2=Divorced 3=Separated 4=In a significant relationship (i.e., boyfriend or girlfriend) 5=Single	**16. Safeguards available at work:** Y N **17. Safeguards used during injury:** Y N	**15. Time interval between injury and surgery? (Days):**
18a. Occupation at time of injury: **18b. Change Jobs:** Y N	**19. Average weekly wage:** 0 = not reported	**20. Hourly wage at time of injury:** **0 = not reported**

21. Date WCFU file created:	**22. Child care responsibility:** 1=No 2=Yes **Total # Dependents__________**	**23. Laweyer involvement in compensation case?** 0=not reported 1=no 2=yes

24. Red Flags

A. AGE	**(AG) - Claimant age over 50.................**	**1=yes**	**2=no**
B. ALCOHO	**(AL) - History of Alcoholism................**	**1=yes**	**2=no**
C. CREDIB	**(CR) - Questionable Validity.................**	**1=yes**	**2=no**
D. CUMTRA	**(CT) - Cumulative Trauma..................**	**1=yes**	**2=no**
E. DISVAL	**(DI) - Disputed Validity Settlement....**	**1=yes**	**2=no**
F. DRUG	**(DR) - History of Drug Abuse..............**	**1=yes**	**2=no**
G. EDUCAT	**(ED) - Education Level.........................**	**1=yes**	**2=no**
H. EMPLOY	**(EF) - Employment Factors..................**	**1=yes**	**2=no**
I. FNCOVER	**(FO) - Functional Overlay.....................**	**1=yes**	**2=no**
J. FRAUD	**(FR) - Fraud..**	**1=yes**	**2=no**
K. LEGAL	**(LG) - Claim Involves Litigation...........**	**1=yes**	**2=no**
L. LIEN	**(LI) - Claim Involves Lienholder..........**	**1=yes**	**2=no**
M. NESPEK	**(NE) - Language Barriers.......................**	**1=yes**	**2=no**
N. OBESE	**(OB) - Obesity...**	**1=yes**	**2=no**
O. OFFCR	**(OF) - Claimant Officer/Partner...........**	**1=yes**	**2=no**
P. OTHER	**(OT) - Other Factors..............................**	**1=yes**	**2=no**
Q. OVRPAY	**(OP) - Compensation Overpayments....**	**1=yes**	**2=no**
R. PIREF	**(PR) - Private Investigator Referred...**	**1=yes**	**2=no**
S. PREEXI	**(PR) - Pre-Existing Condition................**	**1=yes**	**2=no**
T. PRIORS	**(PS) - Claiman has prior claims............**	**1=yes**	**2=no**
U. PSYCH	**(PF) - Psychological Factors..................**	**1=yes**	**2=no**
V. PTSD	**(PT) - Post-Traumatic Stress Dis...........**	**1=yes**	**2=no**
W. SOCIAL	**(SF) - Social Factors..............................**	**1=yes**	**2=no**
Y. SUBSYM	**(SS) - CLMT has subjective sympt.......**	**1=yes**	**2=no**
X. SYSDIS	**(SD) - Systemic Diseases........................**	**1=yes**	**2=no**

25. Received full days pay on day of injury:

Y N

26. Salary con't:

Y N

WORK/COMPENSAITON VARIABLES		
27. Date last worked:	**33. Total Paid Comp**	**43. Total paid to date:**
28. History of prior industrial claim? (Generic) 0=not reported 1=no 2=yes **Total Number_________________** **Specific Code #'s_______________** **Type of Injury_______________** __________________________	**34. Total paid temporary comp:**	**44. Expected duration**
	35. Total paid permanent comp:	**45. Medical stability date** **% Impairment**
29. History of prior industrial claim? (Low Back Pain) 0=not reported 1=no 2=yes Total Number__________________ Specific Codes #'s______________	**36. Total paid medical:**	**46. Total weeks impaired**
30. Vocational rehabilitation following surgery? 0=not reported 1=no 2=yes	**37. Total paid rehab**	**47. Time to medical stability from date of surgery (days):**
	38. Total ALAE	
31. Light duty available? 0=not reported 1=no 2=yes	**39. Total Medical:**	**48. RTW date:**
	40. Total Rehab:	
32. Case manager assigned? 0=not reported 1=no 2=yes	**41. Grand total paid out:**	**49. WCFU Adjustor Name:**
	42. Percent physical impairment paid out:	

PHYSICAL/HEALTH/PROCEDURAL VARIABLES

50. Physical exam data

a. Height________
b. Weight________
c. Straight leg raise (30-70 degree raise produces radicular pain below knee)
0=not reported
1=Positive
2=Negative
d. Neck pain with radiation
(circle: Left or Right)
0=not reported
1=Positive
2=Negative
e. Neck pain without radiation
(circle: Left or Right)
0=not reported
1=Positive
2=Negative
f. Back pain with radiation
(circle: Left or Right)
0=not reported
1=Positive
2=Negative
g. Back pain without radiation
(circle: Left or Right)
0=not reported
1=Positive
2=Negative
h. Radicular pain
(circle: Left or Right)
0=Not reported
1= Shoulder
2=arm
3=Face
4=To thigh
5=To knee
6=To foot
7=Groin
i. Motor weakness (asymmetric)
0=Not reported
1= Shoulder
2=arm
3=Face
4=To thigh
5=To knee
6=To foot
7=Groin
j. Any Non-organic signs present?
0=not reported
1=superficial or non-anatomic tenderness
2=Pain with simulated axial loading or rotation
3=Distraction (SLR different sitting v. supine)
4= Regional disturbance (Non-anatomic sensory pr motor deficit)
5=Overreaction

51. Patients primary surgical diagnosis:
0=not reported
1= Disc Herniation
2=Degenerative disc disease (internal disc derangement
3= Degenerative Scoliosis
4= Segmental Instability
5= Pseudoarthrosis
6= Degenerative Spondylolisthesis
7= Spinal Stenosis
8=Failed Back Surgery Syndrome
9=Osteoarthritis
10=Facet Syndrome
11=Other:
____

52. General health problems (list up to 5 conditions)

0=None reported
1=Diabetes
2=Heart Disease
3=Stroke
4=Arthritis
5=Asthma
6=Depression
7=Hypertension
8=Colitis
9=Psoriasis
10=Cancer history
11=Trauma history
12=Infectious history
13=Auto-immune history
14=Steroid usage
15=Other:

53. Imaging studies conducted prior to surgery?

0=none reported
1=X-ray
2=CT
3=MRI
4=CT Myelogram
5=Discography
6=Other:

54. Additional misc. procedures performed?

0=Not reported
1=none

____
____
____
____

55. Number of prior back/neck operations?

0=None
1=One
2=Two
3=Three
4=Four or more

56. Back/Neck surgical history:

Dr:

Procedure:

Dr:

Procedure:

Dr:

Procedure:

Dr:

Procedure:

57. Psychological history additional notes:

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PHYSICAL/HEALTH/PROCEDURAL VARIABLES		
58a. 1ST Nerve Block: 0=Not reported 1= L1 – L2 Left Right Bilateral 2= L2 – L3 Left Right Bilateral 3= L3 – L4 Left Right Bilateral 4= L4 – L5 Left Right Bilateral 5= L5 – S1 Left Right Bilateral 6= C1 – C2 Left Right Bilateral 7= C2 – C3 Left Right Bilateral 8= C3 – C4 Left Right Bilateral 9= C4 – C5 Left Right Bilateral 10= C5 – C6 Left Right Bilateral 11= C6 – C7 Left Right Bilateral 12= C7 – T1 Left Right Bilateral **Date:**______________________ **Physician:**__________________ **Product:**_____________________	**58b. 2nd Nerve Block:** 0=Not reported 1= L1 – L2 Left Right Bilateral 2= L2 – L3 Left Right Bilateral 3= L3 – L4 Left Right Bilateral 4= L4 – L5 Left Right Bilateral 5= L5 – S1 Left Right Bilateral 6= C1 – C2 Left Right Bilateral 7= C2 – C3 Left Right Bilateral 8= C3 – C4 Left Right Bilateral 9= C4 – C5 Left Right Bilateral 10= C5 – C6 Left Right Bilateral 11= C6 – C7 Left Right Bilateral 12= C7 – T1 Left Right Bilateral **Date:**______________________ **Physician:**__________________ **Product:**_____________________	**59a. Levels 1st rhizotomy:** 0=Not reported 1= L1 – L2 Left Right Bilateral 2= L2 – L3 Left Right Bilateral 3= L3 – L4 Left Right Bilateral 4= L4 – L5 Left Right Bilateral 5= L5 – S1 Left Right Bilateral 6= C1 – C2 Left Right Bilateral 7= C2 – C3 Left Right Bilateral 8= C3 – C4 Left Right Bilateral 9= C4 – C5 Left Right Bilateral 10= C5 – C6 Left Right Bilateral 11= C6 – C7 Left Right Bilateral 12= C7 – T1 Left Right Bilateral **Date:**______________________ **Physician:**__________________ **Product:**_____________________
58c. Duration of pain relief following 1st block in hours: ______________________	**58c. Duration of pain relief following 1st block in hours:** ______________________	**59b. Levels 2nd rhizotomy:** 0=Not reported 1= L1 – L2 Left Right Bilateral 2= L2 – L3 Left Right Bilateral 3= L3 – L4 Left Right Bilateral 4= L4 – L5 Left Right Bilateral 5= L5 – S1 Left Right Bilateral 6= C1 – C2 Left Right Bilateral 7= C2 – C3 Left Right Bilateral 8= C3 – C4 Left Right Bilateral 9= C4 – C5 Left Right Bilateral 10= C5 – C6 Left Right Bilateral 11= C6 – C7 Left Right Bilateral 12= C7 – T1 Left Right Bilateral Date:______________________ Physician:__________________ Product:_____________________
60a. Number of levels receiving 1st block: 0=Not reported 1=One level 2=Two levels 3=Three or three plus levels	**60b. Number of levels receiving 2nd block:** 0=Not reported 1=One level 2=Two levels 3=Three or three plus levels	**63a. Degree of heat/duration used on 1st rhizotomy:** 0=Not reported
60c. Number of levels operated on 1st rhizotomy: 0=Not reported 1=One level 2=Two levels 3=Three or three plus levels	**60d. Number of levels operated on 2nd rhizotomy:** 0=Not reported 1=One level 2=Two levels 3=Three or three plus levels	**63b. Degree of heat/duration used on 2nd rhizotomy:** 0=Not reported

61a. Total # blocks:
1=1
2=2
3=3
 	
61b. Total # rhizotomies:
1=1
2=2
3=3
	62. Post-operative treatment?
	0=Not reported
	1=Patient education/counseling
	2=physical therapy
	3=Manipulation
	4=Activity restriction
	5=Devices (corsets/casts)
	6=Injections
	7=Functional restoration/rehab programs
		64. Surgical complications:
		0=Not reported
		1=None
		2=Deep infection
		3=Superficial infection
		4=Motor/sensory loss
		5=Afibrilation
		6=Nerve root injury
		7=Operation at wrong level
		8= Increased pain
		9=Percutaneous burn
		10= Other_________________

PHYSICAL/HEALTH/SURGICAL VARIABLES		
65. Previous Chiropractic Treatment? 0=not reported 1=no 2=yes	**68. Amount of Pain Before Surgery?** 0=No Pain or Minimal Pain 1=Mild 2=Moderate 3=Severe	**71. Use of Pain Meds Prior to Surgery** 0=not reported 1=no 2=yes
66. Significant testing after surgery? 0=None Reported 1=X-ray 2=CT 3=MRI 4=CT Myelogram 5=Discography 6=Other__________	**69. Smoking at time of Surgery?** 0 = Not reported 1 = No 2 = Yes	**72. Alcohol Use at time of Surgery?** 0=Not reported 1=no 2=yes
67. Ethnicity 0=Not reported 1=White 2=Black of African American 3=Hispanic 4=Asian or Pacific Islander 5=Native American Indian 6=Other (Specify___________)	**70. Education Level** 0=Not reported 1=Less than 12 years 2=12 years (HS Degree) 3=Some College 4=Trade School/AA 5=College Degree 6=Advanced Degree	**73. Lifting restrictions in pounds following surgery:**

PRE/POST PROCEDURAL VARIABLES			
74a. Medications before 1^{st} rhizotomy (list):			
74b. VAS score before 1^{st} rhizotomy (0-10):	74c. Total # of meds before 1^{st} rhizotomy:	74d. Morphine equivalence of narcotics before 1^{st} rhizotomy:	
75a. Medications before 2^{nd} rhizotomy (list):			
75b. VAS score before 2^{nd} rhizotomy (0-10):	75c. Total # of meds before 2^{nd} rhizotomy:	75d. Morphine equivalence of narcotics before 2^{nd} rhizotomy:	
76a. Medications 3 months after 1^{st} rhizotomy (list & date):			Date:
76b. VAS score 3 months after 1^{st} rhizotomy (0-10):	76c. Total # of meds 3 months after 1st rhizotomy:	76d. Morphine equivalence of narcotics 3 months after 1st rhizotomy:	
77a. Medications 6 months after 1^{st} rhizotomy (list & date):			Date:
77b. VAS score 6 months after 1^{st} rhizotomy (0-10):	77c. Total # of meds 6 months after 1st rhizotomy:	77d. Morphine equivalence of narcotics 6 months after 1st rhizotomy:	
78a. Medications 12 months after 1^{st} rhizotomy (list & date):			Date:
78b. VAS score 12 months after 1^{st} rhizotomy (0-10):	78c. Total # of meds 12 months after 1st rhizotomy:	78d. Morphine equivalence of narcotics 12 months after 1st rhizotomy:	

79a. Medications 18 months after 1st rhizotomy (list & date):	**Date:**

79b. VAS score 18 months after 1st rhizotomy (0-10):	**79c. Total # of meds 18 months after 1st rhizotomy:**	**79d. Morphine equivalence of narcotics 18 months after 1st rhizotomy:**

80. Additional back/neck procedures within 2 years following 1st rhizotomy (list & date):

1=	Date:
2=	Date:
3=	Date:
4=	Date:

81a. Medications 3 months after 2nd rhizotomy (list & date):			**Date:**
82b. VAS score 3 months after 2nd rhizotomy (0-10):	**82c. Total # of meds 3 months after 2nd rhizotomy:**	**82d. Morphine equivalence of narcotics 3 months after 2nd rhizotomy:**	
83a. Medications 6 months after 2nd rhizotomy (list & date):			**Date:**
83b. VAS score 6 months after 2nd rhizotomy (0-10):	**83c. Total # of meds 6 months after 2nd rhizotomy:**	**83d. Morphine equivalence of narcotics 6 months after 2nd rhizotomy:**	
84a. Medications 12 months after 2nd rhizotomy (list & date):			**Date:**
84b. VAS score 12 months after 2nd rhizotomy (0-10):	**84c. Total # of meds 12 months after 2nd rhizotomy:**	**84d. Morphine equivalence of narcotics 12 months after 2nd rhizotomy:**	
85a. Medications 18 months after 2nd rhizotomy (list & date):			**Date:**

85b. VAS score 18 months after 2nd rhizotomy (0-10):	**85c. Total # of meds 18 months after 2nd rhizotomy:**	**85d. Morphine equivalence of narcotics 18 months after 2nd rhizotomy:**
86. Additional back/neck procedures within 2 years following 2nd rhizotomy (list & date):		
1=		Date:
2=		Date:
3=		Date:
4=		Date:

Appendix B:

Participant Letter of Information

Date
Participant name
Address

Dear Participant:

Professor Scott DeBerard, Ph.D. and graduate student Tyler Christensen, M.S. from the Department of Psychology at Utah State University (USU) are conducting a research study to evaluate outcomes following spinal rhizotomy. USU has established a research partnership with the Workers' Compensation Fund of Utah (WCFU) and with their permission, we obtained your name and address from their database. The research team at USU is very interested in hearing about your results from this spine treatment and sends this letter to inform you in advance of our request for a telephone interview. We hope to have approximately 130 participants in this study.

To select participants for this study, information regarding your prior rhizotomy procedure was collected from the WCFU database. Participants were selected based upon this review and the information is now stored in a confidential manner at USU. There is minimal risk involved in participating in this research study.

During the months of June through October of 2009, one of our interviewers from USU will call you about an outcome survey of patients who have undergone the back/neck pain management procedure called rhizotomy (a.k.a., radiofrequency neurotomy). The interview will be conducted over the telephone, at your convenience, and will take approximately 20 to 30 minutes. The interview will consist of primarily 'yes/no' or rating-type questions and will be conducted from a private office to maintain privacy of the interviews. Your consent to participate in the study will be requested by the interviewer before the interview begins.

Participation in research is voluntary and you may withdraw at anytime without consequence. We want to emphasize this research is being conducted independently from WCFU and that your participation in this research will in no way affect your compensation status or treatment now or at any time in the future. *All patient data will be examined by USU and the WCFU in a combined summarized manner. Individual cases will not be revealed or examined by USU or the WCFU.*

Study records that identify you will be kept confidential as required by law. Federal Privacy Regulations provide safeguards for privacy, security, and authorized access. Except when required by law, you will not be identified by name, social security number, address, telephone number, or any other direct personal identifier in study records disclosed outside of USU. In the unlikely event that we learn that you are having serious thoughts of, or are engaging in behaviors related to harming yourself or others, we may need to report this to the appropriate authorities.

All of your responses will be strictly confidential. To maintain your confidentiality, all information will be kept in a locked file cabinet in a locked room at USU. Only the researchers will have access to this information. To protect your privacy, your name and identifying information will be replaced with a confidential ID number, which will be used in any datasets generated from this project. Your name and identifying information will be stored separately from these datasets in order to maximize your privacy.

We are interested in documenting outcomes following rhizotomy and learning how to better predict rhizotomy outcomes. We are hopeful that the information you provide may help future candidates for this procedure by predicting those patients who are most likely to benefit from this procedure. People who have been treated for back and neck pain often report a mixture of both positive and negative results. Your unique experience, whether positive or negative, is very important to us.

If you have questions or concerns you may contact Dr. DeBerard (telephone contact and email address is below). If you are interested in receiving a summary of our study results, please notify us and we will send you a copy. We will be offering a $10.00 incentive to you that will be sent to you following completion of the telephone survey via check.

The Institutional Review Board for the protection of human participants at USU has approved this research study. If you have any pertinent questions or concerns about your rights or a research-related injury, you may contact the IRB Administrator at (435) 797-0567. If you have a concern or complaint about the research and you would like to contact someone other than the research team, you may contact the IRB Administrator to obtain information or to offer input.

To help us in contacting you, please fill in your name, address, phone number and the best time to contact you on the enclosed postcard and drop it in a mailbox. Returning the postcard does not imply that you are giving your consent to participate; consent will be asked of you at the time of your telephone interview. Your participation will be greatly appreciated since this is a very important study. If you have any questions, please do not hesitate to call me at (435) 797-1462.

Sincerely,

Scott DeBerard, Ph.D., Research Director
Utah Rhizotomy Outcome Study
Telephone: (435) 797-1462
scott.deberard@usu.edu

Tyler J. Christensen, M.S.
Graduate Assistant
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Appendix C:

Telephone Survey Script

UTAH RHIZOTOMY OUTCOME STUDY
TELEPHONE INTERVIEW SCRIPT

Hello. Is this the______________________residence? (If wrong number, then terminate).

This is ________________ calling from Utah State University. We are conducting a study to learn more about people who have undergone spinal rhizotomy, also known as radiofrequency neurotomy, to treat their back or neck pain.

Earlier this month a letter describing the study was sent to you? Did you receive it?

If yes: (Proceed with the rest of the introduction).

If no: I am sorry it did not reach you. The letter was to inform you of this call and the nature of the study. (Proceed to the introduction).

INTRODUCTION

As the letter (or The letter indicated) indicated you were chosen for this study because you underwent a rhizotomy procedure to treat your back or neck pain through the Worker's Compensation Fund of Utah. Your opinion of how you have progressed since this procedure is critical to this study and results of the survey will be used to help others who are considering having a rhizotomy. Your participation is voluntary and your treatment or compensation status will in no way be affected by your participation. For your participation in the survey we will be sending you $10 and if you wish we could also send you a brief report of the study findings. All of your answers will be kept confidential as provided by law and you may skip any questions you prefer not to answer. Okay?

Please feel free to ask questions at any time during the survey. The survey will take about 20 to 30 minutes to complete. Would you be willing to participate?

☐ Yes, *verbal consent obtained*: (Proceed with survey)

☐ No, *verbal consent not obtained*: Would you prefer we call you back at a better time?

Yes: Date:
Day:
Time:

No: Okay, thank you for your time. (Do not proceed with survey)

Appendix D:

WCFU-Employer Satisfaction Questions

Let's begin with a few questions about how you feel your claim was handled by the Workers Compensation Fund and your employer. Okay?

WORKER'S COMPENSATION QUESTIONS

1. Overall, where you satisfied with how the Workers Compensation Fund of Utah handled your back surgery claim?
1=Yes
2=No
3=Undecided
4=Other

2. Overall, did you feel that the Workers Compensation Fund of Utah responded fairly to your health concerns?
1=Yes
2=No
3=Undecided
4=Other

3. Overall, did you feel that your employer responded fairly to your health concerns?
1=Yes
2=No
3=Undecided
4=Other

Appendix E:

Stauffer-Coventry Index, Global Perceived Effect, Verbal Numeric Rating Scale, Patient Satisfaction and Demographic Questions

ah Rhizotomy Outcome Study Telephone Survey - General Questions

The next part of the survey will involve some general questions about how you have done since you had your rhizotomy. Please respond to each question according to how you feel today. Okay?

1. Since your rhizotomy, how much pain relief have you experienced in your back and lower extremities? Please provide a percent rating from 0 to 100. _______________

Category Rating:
1=Good (76-100 % improvement)
2= Fair (26-75% improvement)
3= Poor (0-25% improvement)

2. With regard to your employment after rhizotomy, which of the following best describes your status after treatment?
1=Return to previous work status following surgery
2=Return to lighter work following surgery
3=No return to work following surgery

3. With regard to your physical activities after rhizotomy, which of the following best describes your status after treatment?:
1=Minimal or no restrictions of physical activities.
2=Moderate restrictions of physical activities
3=Severe restrictions of physical activities

4. With regard to your use of analgesic medications after rhizotomy, which of the following best describes your usage:
1=Occasional mild analgesics or no analgesics
2=regular use of nonnarcotic analgesics
3=occasional or regular narcotic analgesics

5. With regard to your back/leg pain following rhizotomy, which of the following is true:
1=Back or leg pain is worse than expected
2=Back or leg pain is no worse or better than expected
3=Back or leg pain is better than expected

6. Is your quality of life better or worse as a result of rhizotomy? That is, is it:
1=A great improvement
2=A moderate improvement
3=A little improvement
4=No change
5=A little worse
6=Moderately worse
7=Much worse

7. Given what you know: If you could go back in time, would you choose to have the rhizotomy again?
0=Undecided
1=No
2=Yes

8. What was your principal occupation/job title at the time of your injury?:

9. Are you currently working?
1. No
2. Yes, Full Time
3. Yes, Part Time
4. No answer

10. If not working, which of the following best describes why you are not employed?:
1. I am still disabled
2.I am not disabled & I want to work but cannot find a job.
3. I was laid off.
4. I am a student.
5. I am a homemaker.
6. I am retired
7. Other____________________
8. No answer

11. How many days have you worked in the past 4 weeks?

12. How many hours a week do you usually work at your job?

13. Did you change jobs because of your back problem?
1=no
2=yes
3=not applicable
0=No answer

14. Do you currently retain an attorney because of you back/neck problems?
1=no
2=yes
0=No answer

15. Do smoke now?
1=no
2=yes
0=No answer
15.a. Ever Smoked? 1=yes/2=no

Last Time Smoke_____________

#Cigarettes: day_____years_____

16. Have you had any back operations since your rhizotomy?
1=No
2=No, but I'm scheduled to
3=Yes
Operation Types:

17. Overall, is your back or leg pain problem better than or worse than you expected it to be at this point? That is, is it?
1. Much better
2. Somewhat better
3.What I expected
4. Somewhat worse
5. Much worse
6. No expectations

18. What is the highest year in school you completed?
1. Less than High School
2. Some High School
3. High School Graduate/GED
4. Attended or graduated from technical school
5. Attended college but did not graduate
6. College graduate
7. Graduate Studies

19. If you had to spend the rest of your life with your back condition as it is right now, how would you feel about it?
1. Extremely dissatisfied
2. Very dissatisfied
3. Somewhat dissatisfied
4. Neutral
5. Somewhat satisfied
6. Very satisfied
7. Extremely satisfied

20. On a scale from zero to ten, where zero represents no pain and ten represents the worst pain imaginable, how would you rate your current pain level?

#:_______

21. Now, using the same scale, how would you rate your level of pain on average over the past week?

#:________

22. Compared to when this episode first started, how would you describe your back/neck these days?
1. Complete relief of pain
2. More than 50% pain relief
3. No change in the level of pain
4. The pain has increased

Appendix F:

Roland-Morris Disability Questionnaire

Disability Questionnaire Now we are going to ask you more specific questions about your back.... "When your back hurts, you may find it difficult to do some of the things you normally do. The list I'm going to read you now contains some sentences people have used to describe themselves when they have back pain. As I read the list, think of yourself today. When I read a sentence that describes you today, please indicate so by telling me yes. If the sentence does not describe how you feel today, please indicate so by telling me no. Do you have any questions?"		
Yes	**No**	**Items**
1	2	1. I stay at home most of the time because of my back.
1	2	2. I change positions frequently to try and get my back comfortable.
1	2	3. I walk more slowly than usual because of my back.
1	2	4. Because of my back I am not doing any of the jobs I usually do around the house.
1	2	5. Because of my back, I use a handrail to get upstairs.
1	2	6. Because of my back, I lie down to rest more often.
1	2	7. Because of my back, I have to hold on something to get out of an easy chair.
1	2	8. Because of my back, I try to get other people to do things for me.
1	2	9. I get dressed more slowly than usual because of my back.
1	2	10. I only stand up for short periods of time because of my back.
1	2	11. Because of my back, I try to not bend or kneel down.
1	2	12. I find it difficult to get out of a chair because of my back.
1	2	13. My back is painful almost all of the time.
1	2	14. I find it difficult to turn over in bed because of my back.
1	2	15. My appetite is not very good because of my back pain.
1	2	16. I have trouble putting on my socks (or stockings) because of pain in my back.
1	2	17. I only walk short distances because of my back pain.
1	2	18. I sleep less well because of my back.
1	2	19. Because of my back pain, I get dressed with help from somone else.
1	2	20. I sit down for most of the day because of my back.
1	2	21. I avoid heavy jobs around the house because of my back.
1	2	22. Because of my back pain, I am more irritable and bad tempered with people than usual.
1	2	23. Because of my back, I go upstairs more slowly than usual.
1	2	24. I stay in bed most of the time because of my back.

Note. For cervical patients, the word "back" will be replaced with the word "neck"

Appendix G:

Short-Form Health Survey-36 Version 2

Interview Script, 4-Week Recall

Standard Interview Script for SF-36 Health Survey (4-Week Recall)

Script for Interview Administration

***These first questions are about your health now and your current daily activities. Please try to answer every question as accurately as you can.**

1. **In general, would you say your health is…** (read response choices)
(Circle one number)

Excellent…………………………………………………………………..1
Very good……………………………………………………………………2
Good…………………………………………………………………………3
Fair……………………………………………………………………….....4
Poor…………………………………………………………………………..5

2. **Compared to one year ago, how would you rate your health in general now. Would you say it is…** (read response choices)
(Circle one number)

Much better now than one year ago……………………………………………..1
Somewhat better now than one year ago……………………………………...2
About the same as one year ago…………………………………………………3
Somewhat worse now than one year ago……………………………………….4
Much worse now than one year ago……………………………………………..5

***Now I'm going to read a list of activities that you might do during a typical day. As read each item, please tell me if your health now limits you a lot, limits you a little, or dows not limit you at all in these activities.**

3a. **First, vigorous activities, such as running, lifting heavy objects, participating in strenuous sports. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little………………………………………………………….2
No, not limited at all………………………………………………………...3

3b. **…moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little…………………………………………………………2
No, not limited at all………………………………………………………...3

3c. **…lifting or carrying groceries. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little…………………………………………………………2
No, not limited at all………………………………………………………...3

3d. **…climbing several flights of stairs. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little…………………………………………………………2
No, not limited at all………………………………………………………...3

3e. **…climbing one flight of stairs. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little…………………………………………………………2
No, not limited at all………………………………………………………...3

3f. **…bending, kneeling, or stooping. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot…………………………………………………………1
Yes, limited a little……………………………………………………….2
No, not limited at all……………………………………………………...3

3g. **…walking more than a mile. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot…………………………………………………………1
Yes, limited a little……………………………………………………….2
No, not limited at all……………………………………………………...3

3h. **…walking several hundred yards. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot…………………………………………………………1
Yes, limited a little……………………………………………………….2
No, not limited at all……………………………………………………...3

3i. **…walking one hundred yards. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot…………………………………………………………1
Yes, limited a little……………………………………………………….2
No, not limited at all……………………………………………………...3

3j. **…bathing or dressing yourself. Does your health now limit you a lot, limit you a little, or not limit you at all?** (read response choices)

[If respondent says s/he does not do activity, probe: Is that because of your health?]
(circle one number)

Yes, limited a lot……………………………………………………………1
Yes, limited a little…………………………………………………………2
No, not limited at all………………………………………………………...3

***The following four questions ask you about your physical health and your daily activities.**

4a. **During the past four weeks, how much of the time have you had to cut down on the amount of time you spent on work or other daily activities as a result of your physical health?** (read response choices)
(circle one number)

All of the time………………………………………………………………1
Most of the time……………………………………………………………..2
Some of the time……………………………………………………………3
A little of the time…………………………………………………………...4
Or None of the time…………………………………………………………5

4b. **During the past four weeks, how much of the time have you accomplished less than you would like as a result of your physical health?** (read response choices)
(circle one number)

All of the time………………………………………………………………1
Most of the time……………………………………………………………..2
Some of the time……………………………………………………………3
A little of the time…………………………………………………………...4
Or None of the time…………………………………………………………5

4c. **During the past four weeks, how much of the time wre you limited in the kind of work or other regular daily activities you do as a result of your physical health?** (read response choices)
(circle one number)

All of the time………………………………………………………………1
Most of the time……………………………………………………………..2
Some of the time……………………………………………………………3
A little of the time…………………………………………………………...4
Or None of the time…………………………………………………………5

4d. **During the past four weeks, how much of the time have you had difficulty performing work or other regular daily activities as a result of your physical health, for example, it took extra effort?** (read response choices)
(circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………….2
Some of the time…………………………………………………………3
A little of the time………………………………………………………...4
Or None of the time………………………………………………………5

***The following three questions ask about your emotions and your daily activities.**

5a. **During the past four weeks, how much of the time have you had to cut down the amount of time you spent on work or other regular daily activities as a result of any emotional problems, such as feeling depressed or anxious?**
(read response choices)
(circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………….2
Some of the time…………………………………………………………3
A little of the time………………………………………………………...4
Or None of the time………………………………………………………5

5b. **During the past four weeks, how much of the time have you accomplished less than you would like as a result of any emotional problems, such as feeling depressed or anxious?** (read response choices)
(circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………….2
Some of the time…………………………………………………………3
A little of the time………………………………………………………...4
Or None of the time………………………………………………………5

5c. **During the past four weeks, how much of the time did you do work or other regular daily activities less carefully than usual as a result of any emotional problems, such as feeling depressed or anxious?** (read response choices)
(circle one number)

All of the time……………………………………………………………………1
Most of the time………………………………………………………………….2
Some of the time…………………………………………………………………3
A little of the time……………………………………………………………...4
Or None of the time……………………………………………………………5

6. **During the past four weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors or groups? Has it interfered…** (read response choices) (Circle one number)

Not at all…………………………………………………………………..1
Slightly…………………………………………………………………….2
Moderately………………………………………………………………...3
Quite a bit………………………………………………………………….4
Or Extremely………………………………………………………………5

7. **How much bodily pain have you had during the past four weeks? Have you had…** (read response choices) (Circle one number)

None…...…………………………………………………………………..1
Very mild………………………………………………………………….2
Mild……...………………………………………………………………...3
Moderate…………………………………………………………………..4
Severe……………………………………………………………………...5
Or Very severe …………………………………………………………….6

8. **During the past four weeks, how much did pain interfere with your normal work, including both work outside the home and housework? Did it interfere…** (read response choices) (Circle one number)

Not at all…………………………………………………………………..1
A little bit………………………………………………………………….2
Moderately………………………………………………………………...3
Quite a bit………………………………………………………………….4
Or Extremely………………………………………………………………5

***The next questions are about how you feel and how things have been with you during the past four weeks.**

As I read each statement, please give me the one answer that comes closest to the way you have been feeling; is it all of the time, most of the time, some of the time, a little of the time, or none of the time?

9a. **How much of the time during the past four weeks… did you feel full of life?**
(read response choices)
(Circle one number)

All of the time……………………………………………………………………1
Most of the time…………………………………………………………………..2
Some of the time…………………………………………………………………3
A little of the time………………………………………………………………...4
Or None of the time………………………………………………………………5

9b. **How much of the time during the past four weeks… have you been very nervous?** (read response choices)
(Circle one number)

All of the time……………………………………………………………………1
Most of the time…………………………………………………………………..2
Some of the time…………………………………………………………………3
A little of the time………………………………………………………………...4
Or None of the time………………………………………………………………5

9c. **How much of the time during the past four weeks… have you felt so down in the dumps that nothing could cheer you up?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………………1
Most of the time…………………………………………………………………..2
Some of the time…………………………………………………………………3
A little of the time………………………………………………………………...4
Or None of the time………………………………………………………………5

9d. **How much of the time during the past four weeks… have you felt calm and peacefu?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………………1
Most of the time…………………………………………………………………..2
Some of the time…………………………………………………………………3
A little of the time………………………………………………………………...4
Or None of the time………………………………………………………………5

9e. **How much of the time during the past four weeks… did you have a lot of energy?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………2
Some of the time…………………………………………………………3
A little of the time……………………………………………………...4
Or None of the time……………………………………………………5

9f. **How much of the time during the past four weeks… have you felt downhearted and depressed?** (read response choices only if necessary) (Circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………2
Some of the time…………………………………………………………3
A little of the time……………………………………………………...4
Or None of the time……………………………………………………5

9g. **How much of the time during the past four weeks… did you feel worn out?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………2
Some of the time…………………………………………………………3
A little of the time……………………………………………………...4
Or None of the time……………………………………………………5

9h. **How much of the time during the past four weeks… have you been happy?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………2
Some of the time…………………………………………………………3
A little of the time……………………………………………………...4
Or None of the time……………………………………………………5

9i. **How much of the time during the past four weeks… did you feel tired?** (read response choices only if necessary)
(Circle one number)

All of the time……………………………………………………………1
Most of the time…………………………………………………………2
Some of the time…………………………………………………………3
A little of the time……………………………………………………...4
Or None of the time……………………………………………………5

***These next questions are about your health and health-related matters.**

Now, I'm going to read a list of statements. After each one, please tell me if it is definitely true, mostly true, mostly false, or definitely false. If you don't know, just tell me.

10. **During the past four weeks, how much of the time has your physical health or emotional problems interfered with your social activities like visiting with friends or relatives? Has it interfered…** (read response choices)
(circle one number)

All of the time………………………………………………………………1
Most of the time……………………………………………………………2
Some of the time……………………………………………………………3
A little of the time…………………………………………………………...4
Or None of the time…………………………………………………………5

11a. **I seem to get sick a little easier than other people. Would you say that's…**
(read response choices)
(circle one number)

Definitely true………………………………………………………………1
Mostly true…………………………………………………………………..2
Don't know…………………………………………………………………3
Mostly false…..……………………………………………………………...4
Definitely false………………………………………………………………5

11b. **I am as healthy as anybody I know. Would you say that's…** (read response choices)
(circle one number)

Definitely true………………………………………………………………1
Mostly true…………………………………………………………………..2
Don't know…………………………………………………………………3
Mostly false…..……………………………………………………………...4
Definitely false………………………………………………………………5

11c. **I expect my health to get worse. Would you say that's…** (read response choices)
(circle one number)

Definitely true……………………………………………………………………1
Mostly true……………………………………………………………………….2
Don't know……………………………………………………………………3
Mostly false…….…………………………………………………………….....4
Definitely false……………………………………………………………………5

11d. **My health is excellent. Would you say that's…** (read response choices)
(circle one number)

Definitely true……………………………………………………………………1
Mostly true……………………………………………………………………….2
Don't know……………………………………………………………………3
Mostly false…….…………………………………………………………….....4
Definitely false……………………………………………………………………5

Appendix H:

Pain Catastrophizing Scale

Catastrophizing Questionnaire

Okay, just a few more questions and then we'll be finished. Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint pain, or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures, or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain.

0—not at all 1—to a slight degree 2—to a moderate degree 3—to a great degree 4—all the time

Ask yourself, when I'm in pain…

	I worry all the time about whether the pain will end.
	I feel I can't go on.
	It's terrible and I think it's never going to get any better.
	It's awful and I feel that it overwhelms me.
	I feel I can't stand it any more.
	I become afraid that the pain will get worse.
	I keep thinking of other painful events.
	I anxiously want the pain to go away
	I can't seem to keep it out of my mind.
	I keep thinking about how much it hurts.
	I keep thinking about how badly I want the pain to stop.
	There's nothing I can do to reduce the intensity of the pain.
	I wonder whether something serious may happen.

CURRICULUM VITAE

Tyler J. Christensen

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Education

2010, Ph.D. (anticipated)
Utah State University, Logan, Utah
Combined Clinical/Counseling/School Psychology (APA-accredited)
Emphasis: Health Psychology
Dissertation: Analysis of Outcomes and Predictive Correlates for Facet Radiofrequency Neurotomy of the Spine.
Chair: Scott DeBerard, Ph.D.

2006, M.S.
University of Utah, Salt Lake City, Utah
Educational Psychology (Professional Counseling Program)
Thesis: Assessing Psychosocial Concerns in Primary Care: A New Measure
Chair: Robert Hill, Ph.D.

2001, B.S.
University of Utah, Salt Lake City, Utah
Psychology, Cum Laude
Minor in French

Clinical Experience

2009-Present **Pre-Doctoral Clinical Internship, APA Accredited**
George E. Wahlen Department of Veterans Affairs Medical Center, Salt Lake City, UT

Major Clinical Rotations:
Medical Inpatient Mental Health Consult Liaison Team

Participated on an interdisciplinary team providing mental health services to patients within Acute Medicine, Surgery, Neurology, Cardiology, and Intensive Care Units for medical decision-making capacity, cognitive functioning, adjustment to illness, evaluation/management of psychiatric symptoms, and substance abuse/detoxification. Also conducted organ transplant evaluations for appropriateness of candidates from a psychological standpoint.

Supervisor: Tracy Black, Ph.D.

Primary Care/Behavioral Health

Provided curbside mental health consultation and triage services to physicians in a busy primary care clinic including screening, assessment, diagnosis, and treatment of mental health conditions, as well as referral to specialty mental health when appropriate. Conducted brief outpatient therapy, which included adjustment to chronic illness, chronic pain, current life stressors, sleep disturbance, grief, and mild depression/ anxiety. Assessed and treated patients alongside a behavioral health psychiatrist and worked within a multidisciplinary team.

Supervisor: Renn Sweeney, Ph.D.

Inpatient Psychiatry

Delivered crisis-oriented services to patients including individual and group therapy, comprehensive psychological assessment, psychopharmacology, and process and psychoeducational groups.

Supervisor: Richard Weaver, Ph.D.

Post-Deployment Primary Care and Polytrauma

Participated on two interdisciplinary teams providing mental healthcare services to veterans who have recently returned from deployment including readjustment and family counseling, telemental health, neuropsychological assessment, comprehensive evaluation of traumatic brain injury, PTSD assessment, teaching behavioral medicine topics, and program development.

Supervisor: Ashley Greenwell, Ph.D.

Neuropsychological Assessment

Conducted neuropsychological assessments for referral issues including questions about medical decision-making capacity, dementia vs. depression, cognitive disorders due to traumatic brain injury or other medical conditions (i.e., anoxia, stroke) and differential diagnosis of psychiatric conditions.

Supervisor: Janet Madsen, Ph.D.

Outpatient Mental Health

Provided individual and group psychotherapy in a general outpatient clinic utilizing Evidenced Based Psychotherapies for a wide range of mental disorders. Co-led a social skills training group for individuals with severe and persistent mental illness.

Supervisor: Michael Tragakis, Ph.D.

2007- 2009 **Student Therapist, Graduate Clinical Assistantship**

State of Utah Division of Services for People with Disabilities, Logan, UT

Responsibilities: psychological and diagnostic evaluations with adults and children to determine eligibility for State services, administer measures of intellectual and adaptive functioning, integrative report writing, conduct psychological records reviews, individual and group therapy for individuals with intellectual disabilities and Axis I disorders, consult with parents and case managers regarding behavioral and psychological issues, co-lead parent training groups, present on psychological topics at state employee staff meetings.

Supervisor: David Stein, Ph.D.

2007- 2008 **Student Therapist, Counseling Psychology Practicum**

Utah State University, Student Counseling Center

Responsibilities: intakes, individual and group psychotherapy with college students, report writing, case conceptualization, treatment planning.

Supervisors: Thomas Berry, Ph.D.; David Bush, Ph.D.

2007 **Student Therapist, Health Psychology Practicum, Medical Setting**

Utah State University, Student Health and Wellness Clinic

Responsibilities: collaborate with five referring physicians in a primary care clinic to provide brief psychological assessment and intervention, conduct medical chart reviews and crisis consultation, assist with medication monitoring and management, write assessment reports and treatment notes for inclusion in the patient medical chart.

Supervisor: Scott DeBerard, Ph.D.

2006 - 2007 **Student Therapist, School Psychology Practicum**

Utah State University, Center for Persons with Disabilities

Responsibilities: intakes, evaluation of adult, child, and adolescent clients, administration and interpretation of cognitive and achievement measures, conduct clinical interviews, write integrative reports, work within a multidisciplinary team that included physicians, occupational therapists, speech pathologists, audiologists, and social workers.

Supervisor: Robert Cook, Ph.D.

2006 - 2007 **Student Therapist, Health Psychology Practicum, Medical Setting**

Cardiac Rehabilitation, Brigham City Community Hospital, UT

Responsibilities: psychosocial assessments and psychological interventions with medical patients participating in cardiac rehabilitation, administered and interpreted the DUKE Health

profile, conducted stress management groups, promoted exercise and program adherence as well as smoking cessation work.
Supervisor: Scott DeBerard, Ph.D.

2005 - 2006 **Student Therapist, Clinical Psychology Practicum**
Utah State University, Psychology Community Clinic
Responsibilities: Intakes, report writing, individual psychotherapy with adults and children, couples therapy, treatment planning.
Supervisor: Susan Crowley, Ph.D.

2004 - 2005 **Student Therapist Intern, *Counseling Internship***
Sandy Counseling, Sandy, Utah
Responsibilities: Psychotherapy with individuals, couples, families and child victims of sexual abuse, conduct assessment and intake interviews for perpetrators of domestic violence, co-facilitate dual-focus (domestic violence/substance abuse) groups and groups for children who have witnessed domestic violence, act as on-site therapist for adolescents at the Boys and Girls Club.
Supervisor: Rick Vassar, L.M.F.T.

2004 - 2005 **Student Therapist Intern, Counseling Internship**
Assessment and Referral Services, Salt Lake City, Utah
Responsibilities: Assessments and referral to treatment for persons who have had legal problems related to alcohol and drug use, clinical interviewing, administration of the Addiction Severity Index and SASSI-3, report writing for judges and substance abuse treatment providers.
Supervisor: Kelly Lundberg, Ph.D.

2003 - 2004 **Substance Abuse Group Facilitator and Agency Representative**
Interim Group, Assessment and Referral Services, Salt Lake City, UT
Responsibilities: Co-facilitate support groups for individuals with chemical dependency awaiting county-funded substance abuse treatment and consult with people charged with alcohol or drug related offenses at the Salt Lake City Justice Court to explain assessment and legal process.
Supervisors: Kelly Lundberg, Ph.D.

2003 **Student Therapist, Counseling Psychology Practicum**
University of Utah, Counselor Training Clinic
Responsibilities: Intakes, psychotherapy with university students, develop case conceptualizations, treatment planning.
Supervisor: Robert Finley, Ph.D.

Other Work Experience

2006 - 2007 **Behavior Specialist, Graduate Assistantship**
Cache Employment and Training Center, Logan, UT
Responsibilities: Conduct experimental functional analysis, collect behavioral data, develop and maintain behavior support plans for people with developmental disabilities and mental illness based on a competing model of behavior, conduct in-service trainings with staff in the implementation of behavioral interventions, provide behavior consultation and crisis behavior management.
Supervisor: Matthew Furzland, M.S., B.C.B.A.

1998 - 2004 **Program Director**
TKJ Inc., Sandy, UT
Responsibilities: Manage a residential facility for people with dual-diagnosis (mental illness and mental retardation), employ behavioral interventions and positive behavior supports, collect behavioral data, manage and train group home staff, write monthly progress reports, assist with psychiatric evaluations, and establish an understanding of the symptomatology and psychopharmacological treatment of various anxiety, mood, and psychotic disorders.
Supervisor: Rian Jensen, L.C.S.W.

Research Experience

2007 - present **Dissertation Research**
Utah State University, Combined Psychology Doctoral Program
Responsibilities: Use a retrospective cohort design to examine the predictive efficacy of psychosocial presurgical variables and multidimensional health outcomes for facet radiofrequency neurotomy of the lumbar, thoracic, and cervical vertebrae, conduct detailed medical chart reviews for over 100 patients at the Worker's Compensation Fund. Anticipated completion date: December 2009.
Supervisor: Scott DeBerard, Ph.D.

2005 - 2006 **Field Interviewer, Research Assistantship**
Utah State University, Cache County Study on Memory and Aging
Responsibilities: Administer neuropsychological and health screening interviews for aging individuals as part of the Cache County Study on Memory and Aging, scored cognitive measures, and participated in multidisciplinary research meetings; assessment measures included the Hopkins Verbal Learning Test, the

Modified Mini-Mental State Examination, and the Shipley Vocabulary Test.

Supervisor: JoAnn Tschanz, Ph.D.

2003 - 2006 **Thesis Research**

University of Utah, Department of Educational Psychology

Responsibilities: Designed and conducted a study which developed of a self-report instrument to measure psychological distress and well-being in a primary care setting, collected factor analytic, reliability, and validity evidence, gathered data from primary care physicians and adult outpatients at a local family practice clinic.

Supervisor: Robert Hill, Ph.D.

2003 - 2005 **Psychological Vital Signs Research Group**

University of Utah, Department of Family and Preventative Medicine

Responsibilities: Participate in weekly research meetings with clinical psychologists to develop various research projects related to health psychology and behavioral medicine, collaborate with physicians in the development of research projects.

Supervisors: Robert Hill, Ph.D.; Michael Rigdon, Ph.D.; Norman Anderson, Ph.D.

2000 - 2001 **Research Assistant**

University of Utah, Department of Psychology

Responsibilities: Use the Functional Family Therapy Alliance Rating Scale to rate the level of alliance among patients and therapists in video-taped family therapy sessions and coded transcripts.

Supervisor: Jim Alexander, Ph.D.

2000 **Research Assistant**

University of Utah, Department of Psychology

Responsibilities: Use an infusion pump to administer experimental drugs to rats in order to establish nicotinic receptor involvement in memory and Alzheimer's, run rats in a maze.

Supervisor: Jim Alexander, Ph.D.

Publications

Christensen, T.J., Hill, R.D., Anderson, N.S., III, & Rigdon, M.A. (2008). A brief self-report tool for assessing psychological distress in primary care: The psychological vital sign screening test. Manuscript submitted for publication.

Professional Presentations

Christensen, T. J., Hill, R.D., & Anderson, N.S., III. (March, 2008). Validation of a theoretically grounded screening instrument to measure psychological distress in primary care: the psychological vital sign screening test (PVSST). Poster session presented at the annual meeting of the Society of Behavioral Medicine, San Diego, CA.

Christensen, T. J., Hill, R.D., Rigdon, M.A., & Anderson, N.S., III. (August, 2006). Assessing psychosocial concerns in primary care: A new measure. Poster session presented at the annual convention of the American Psychological Association, New Orleans, LA.

Teaching Experience

2006 **Graduate Teaching Assistant, Utah State University, Logan, UT**
History and Systems of Psychology 6100
Responsibilities: Lecturing, provide professor support and office hours, grading of assignments and exams.
Supervisor: David Bush, Ph.D.

2005 **Graduate Teaching Assistant, Utah State University, Logan, UT**
Psychometrics 6330
Responsibilities: Lecturing, provide professor support and office hours, grading of assignments and exams.
Supervisor: Kerstin Schroder, Ph.D.

2003 **Instructional Assistant**
Jordan School District, Youth In Custody, Salt Lake City, UT
Responsibilities: Teach life skills and science to high school students in the custody of the Division of Child and Family Services or Department of Youth Corrections, provide basic problem-solving support to students, cooperate with provider agencies to facilitate student success, provide instruction to students with learning disabilities, manage behavioral issues.
Supervisor: Susan Chilton, Ph.D.

Outreach Experience

February 2008 **Guest Lecturer** (Stress Management)
Utah State University, Logan, UT
Present on stress management techniques in a graduate-level Health Psychology course.

January 2008	**Screening Interviewer** (Depression) *Utah State University, Logan, UT* Briefly assess college students for depression symptoms in a university-wide depression screening event.
November 2007	**Guest Lecturer** (Law Enforcement Training) *Box Elder Police Force Crisis Intervention Training, Brigham City, UT* Present to a group of police officers on how to effectively intervene when they encounter criminal activity among people with developmental disabilities.
September 2007	**Guest Lecturer** (Introduce Psychological Services) *Utah State University, Logan, UT* Introduce the Counseling Center to a group of multicultural incoming freshman.
September 2007	**Screening Interviewer** (Anxiety) *Utah State University, Logan, UT* Briefly assess college students for anxiety symptoms in a university-wide anxiety screening event.

Clinical Training Experience

April 2009	Two-Day ACT Experiential Training: by Steven Hayes, Ph.D. *Utah State University Psychology Department*
April 2009	An Introduction to ACT: by Steven Hayes, Ph.D. *Utah State University Counseling Center Conference*
October 2008	ACT-based Multicultural Training: by Michael Twohig, Ph.D. *Utah State University Psychology Department*
September 2008	WAIS IV Update Training Workshop: by Patrick Moran, Ph.D. *The Utah Psychological Association*
March 2008	Mindfulness Workshop: by Mark Lau, Ph.D. Utah State University Counseling Center Conference
March 2007	Motivational Interviewing Workshop: by Carolina Yahne, Ph.D. Utah State University Counseling Center Conference

Awards and Honors

Research Travel Award ($600; poster presentation; March, 2008; Utah State University)
Research Travel Award ($600; poster presentation; August, 2006; Utah State University)
Phi Beta Kappa (national honor society in the liberal arts and sciences)
Psi Chi (national honor society in psychology)
Dean's list, University of Utah
Alpha Epsilon Delta (national pre-medical honors society)

Professional Affiliations

Student Affiliate, Society of Behavioral Medicine
Student Affiliate, American Psychological Association
Student Affiliate, Health Psychology, Division 38 of APA
Student Affiliate, Utah Psychological Association
American Association of Mental Retardation, Board Member (2000 - 2002)