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The Influence of Patient Perceptions on the Decision to Undergo Surgery for Lumbar Spinal Stenosis

Alaa El Chamaa, *The University of Western Ontario*

Supervisor: Battié, Michele C., *The University of Western Ontario*
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Abstract

Introduction: Lumbar spinal stenosis (LSS) is a degenerative condition among older adults associated with narrowing of the spinal canal. Spine surgery is considered an elective procedure.

Study Aim: The aim of this study was to examine patient-related factors that may affect surgical treatment decision-making for LSS.

Methods: Data from the Alberta Lumbar Spinal Stenosis Study were used to investigate the association between baseline factors and spine surgery within two years. Possible predictors were examined in crude and multivariable analyses

Results: In univariate analyses the Oswestry Disability Index, Health Utilities Index, Swiss Spinal Stenosis physical function and symptom severity subscales, and patients' beliefs and perceptions were associated with the decision to undergo surgery. In multivariable analysis only beliefs about benefits of spine surgery and dissatisfaction living with symptoms were significant.

Conclusion: Patients' beliefs and perceptions are more important in their surgical decision-making than other factors like disability, sex and age.

Keywords

Lumbar spinal stenosis, Decision to undergo surgery, Patient perceptions, Spine surgery, clinical decision-making.

Summary for Lay Audience

Lumbar spinal stenosis (LSS) is a common condition in older adults associated with a narrowing of the spinal canal in the lower back. This narrowing can cause pressure on the spinal cord, blood vessels and nerves that exit the spinal canal to go to the rest of the body (muscles, organs, etc.). LSS can be treated conservatively (without surgical intervention) or with surgery. We were interested in finding out what factors influence patients' decision to undergo surgery. We were particularly interested in patients' beliefs about the benefits and risks of having back surgery, their satisfaction with prior care, and their level of satisfaction with continuing life with current symptoms. We found that patients that have high levels of disability, more severe symptoms, lower health related quality of life, less satisfaction with symptoms, less satisfaction with the care they previously received, and higher expectations for surgical benefits tend to choose surgery more than the others. But the most important factors among these were patients' perceived benefits of surgery and their level of dissatisfaction with continuing life with current symptoms.

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Chapter 1

1 Background

Lumbar spinal stenosis (LSS) is primarily a degenerative condition among older adults associated with narrowing of the spinal canal or neural foramina and reduced space available for the neurovascular tissues passing through [1]. The main symptoms of LSS are back and leg pain, and numbness and tingling in the legs associated with walking or standing, which leads to reduced overall physical function, mobility, and health-related quality of life [2]. Neurogenic intermittent claudication, leg pain exacerbated by upright standing and walking, is a hallmark of the condition [3]. LSS is a common spinal condition in older adults and the most frequent indication for spine surgery in patients older than 65 years of age [4].

1.1 LSS diagnosis

In the clinical guideline of the North American Spine Society (NASS), imaging is considered the main test to diagnose LSS, primarily using magnetic resonance imaging (MRI) [5]. However multiple studies question a diagnosis made on imaging alone as the correlation between radiologic findings, clinical presentation and symptom severity is unclear [6]. In one study, MRI findings could not differentiate between patients with LSS, patients with back pain, and asymptomatic patients [7]. Electrodiagnostic tests are another tool that specialists can use to help diagnose LSS, mainly because they can detect other disorders that can mimic spinal stenosis (nerve compression, polyneuropathy, etc.). But these tests are considered to be not completely accurate and can sometimes be painful to patients. Electromyography (EMG), especially quantitative paraspinal mapping, was shown to differentiate between patients with LSS, back pain and asymptomatic patients [7, 8]. Furthermore, Yagci et al. (2009) found that 15 out of the 16 asymptomatic patients with stenosis identified on MRI had normal paraspinal mapping and 26 out of 28 patients with LSS symptoms and MRI finding of stenosis had abnormal paraspinal mapping. [9] However, NASS guidelines for LSS diagnosis do not support its use [5].

The diagnosis of LSS remains controversial. While a stenotic canal revealed on imaging is a prerequisite for the clinical syndrome of LSS, many people have stenotic canals without chronic back pain or neurogenic intermittent claudication. Clinicians rely on a combination of physical examination, patient history and imaging findings [10]

1.2 Natural History of LSS

When a patient is diagnosed with a condition that may require surgical intervention, a frequent question from patients is “What can I expect if I don’t do anything” [11]. This refers to the natural history of a condition or disease, defined as its progression in an individual without treatment, or how it progresses without intervention from the time of onset until an outcome occurs which may be healing, experiencing chronic symptoms, or death. [12]

Medical practitioners are interested in knowing the natural history of a condition so they can understand the different stages of its pathological progression and possibly intervene to alter the course of the condition and minimize the possibility of health deterioration [12]. They also need to inform their patients of the natural history, explaining possible outcomes and how different treatments or other factors can affect the natural progression, to assist them in deciding how to deal with their condition. This includes considerations of the benefits of surgery [13] and whether the benefits outweigh the potential risks, [11] so patients can make an informed decision on whether to opt for a surgical treatment, another intervention, or to allow the condition to take its natural course.

The first recorded research of which I am aware that aimed to study the natural history of lumbar spinal stenosis (LSS) was reported by Porter et al in 1984 [14]. In their study they had 2360 patients that were referred to a back pain clinic, including 249 (54% male, mean age 51 years) with severe symptoms from “entrapment of the lumbar root within the root canal”, distinct from a disc lesion or prolapse. The majority of the patients (81%) received “no active treatment” other than their clinic consultation, while others received steroid epidural injections (14%) related to severe symptoms. Surgical root canal decompression was performed in 24 patients, as deemed necessary when epidural injections did not improve patients' symptoms and they experienced disabling pain that was interfering with their work, activities of daily living and recreational activities. Three years later the patients that received no surgical treatment were contacted and 78% of the responders said that they still experienced some degree of leg pain, but they did not feel that it was bothering them enough to seek surgical treatment.

In 1991, Johnsson et al published a study comparing the course of central lumbar spinal stenosis between a surgical group (N=44) and a nonsurgical group (N=19). After a three-year follow-up, the groups had similar improvements in pain, working capacity and neurophysiologic changes, but better improvement was found in walking capacity in patients treated surgically. No serious deterioration was observed in the nonsurgical group [15]

The same group of investigators reported a prospective cohort study in 1992 of the natural course of LSS in 32 patients that were not treated surgically (24 men and 8 women with a mean age of 60 years (range 42-80 years)). They had symptoms, such as radicular pain and claudication, for a mean duration of 22 months (range 4-96 months). Thirty patients did not receive surgical treatment because they refused it, and two patients had advanced cardiovascular disease and the anesthesiologist refused to administer anesthesia. The patients were observed over a mean of 49 months. After 4 years, 15% of the participants reported worse symptoms, 70% remained unchanged, and 15% improved. They also found that all the patients who experienced worsening of symptoms had the narrowest AP (anterior-posterior) diameters of the dural sac (mean 4.7mm). [16]

In the 1996 annual meeting of the International Society for the Study of the Lumbar Spine, Herno et al reported on the natural course of LSS in 91 patients that had a complete block, moderate stenosis(AP diameter <10 mm), mild stenosis (AP 10 mm< diameter <12 mm) and lateral stenosis . After a mean follow-up of 8 years (± 3 years), 27 remained unchanged, 41 experienced improvements and 23 had somewhat worse outcomes, leading them to conclude that the natural course of LSS was benign, with remarkable stability in the physical and subjective manifestations. [17]

In 1998, Hurri et al. reported on a follow-up of 75 patients with LSS after approximately 12 years. They found that in nonsurgically treated patients 11% worsened, 45% remained unchanged and 44% improved, while in surgically treated patients 18% worsened, 19% remained unchanged and 63% improved. [18]

Wessberg & Frennered (2017), in a study of 146 patients with LSS, found that some patients with moderate symptoms of lumbar spinal stenosis, and without an extremely narrow dural sac area (identified by diagnostic imaging as $<0.5\ cm^2$), experienced spontaneous improvements in symptoms related to pain and health related quality of life over a median of 3.3 years, but with no improvement in walking ability over the same period of time [19].

According to Kreiner et al. (2013), there are some limitations in the available literature about the natural history of LSS, but they concluded that "in patients with mild or moderately symptomatic degenerative lumbar stenosis, rapid or catastrophic neurologic decline is rare" [20]. Throughout the studies reviewed, it appears that a substantial proportion of nonsurgical patients remain unchanged or improve while only a small proportion deteriorate and get worse with time, and only patients with more severe symptoms at baseline may require surgical intervention. Thus, surgical indications should not be based on solely on pathoanatomical stenosis severity, but also largely on persistent pain and disability [21]. Furthermore, patients should be well informed of their condition, prognosis, treatment options and the effectiveness and potential risks of these treatments.

1.3 LSS Treatments

Treatment of LSS can be conservative or surgical. Usually, the first choice is a non-surgical treatment, such as physical therapy treatments, bracing, manipulation, exercise, mobilization, acupuncture, education, drugs and cognitive behavioral treatments. [6] If unsuccessful, a surgical option might be chosen. Surgical interventions for lumbar spinal stenosis can include fusion, laminectomy, prostheses, and minimally invasive implants. [22] The comparative effectiveness of these treatments is still debatable after many years of studies, and there is still a lack of agreement on which treatment approach has better outcomes or the optimal time for surgery. [23]

In 2021, a systematic review by Bussières et al covered randomized controlled trials up until October 2020 and aimed to develop a guideline for non-surgical treatment for LSS. Their first recommendation was that initial treatment be nonpharmacological, with education focusing on advice and behavioral changes, home exercises, manual therapy and acupuncture. The second recommendation considered pharmacological treatment with tricyclic antidepressants or serotonin-norepinephrine reuptake inhibitors to improve pain, return to function and quality of life. The third and final recommendation was against the use of NSAIDS (nonsteroidal anti-inflammatory drugs), opioids, muscle relaxants, methylcobalamin, gabapentin, paracetamol, calcitonin, muscle relaxants, pregabalin and epidural steroid injection due to their lack of short and long-term efficacy, and the complications that can be caused by them [24].

Anderson et al, in 2021, aimed to critically appraise the available clinical guidelines for LSS treatments. They included 10 guidelines with 76 total recommendations. Only 4 of the guidelines were considered to be of good methodological quality and most of the recommendations had poor supportive evidence (72.4%), with the rest based on fair evidence (27.6%). None had good evidence. They also found that recommendations in the guidelines were more positive for surgery and injections than for medications and other non-surgical treatments [25].

Wei et al. (2021) conducted a review of 34 randomised controlled trials (up to October 2019) to evaluate the efficacy of various LSS interventions mainly on level of pain and disability. They found no significant difference between various surgical and non-surgical interventions in patient functional improvement. They also found that surgical interventions (laminotomy, decompression, inter-spinous process spacer implantation, etc.) had better results in pain relief, but they were associated with more complications [26].

There is general agreement in the literature that in the long-term both surgical and nonsurgical treatments have positive and often similar outcomes. In the short-term (1-4 years), better outcomes and symptom improvements were reported with surgical treatments, [27, 28] but in the long-term (after 8 to 10 years) both treatment options led to similar outcomes and improvements in symptoms related to low back pain, leg pain, and satisfaction with outcome status[28].

1.4 LSS Treatment Risks and Side Effects

The spine is a delicate region to operate in and surgeries for LSS conditions have variable outcomes, with high costs and considerable risks of postsurgical complications.

Zaina et al. (2016) reported a high rate of side effects (10-24%) in three of five surgical groups of LSS patients, compared to no notable side effects with conservative treatment in their systematic review, “Surgical versus non-surgical treatment for lumbar spinal stenosis”. Among the three studies, Malmivaara et al. (2007) studied 94 participants (50 surgical treatment and 44 conservative). In the surgical group, 24% of the patients experienced complications, including a misplaced transpedicular screw, lesions to the dural sac and peridural haematoma that led to neural dysfunction and reoperation. Weinstein et al. (2008) studied 289 patients who underwent surgery for LSS and reported 10% intraoperative complications, such as dural tear and spinal fluid leak, 10% postoperative complications, such as wound haematoma and infection, and a 13% reoperation rate within 4 years. The third study reporting complications was by Zucherman et al. (2005) and included 191 patients with LSS who were treated conservatively or with interspinous spacer implants. They found that 11% of the surgical group experienced side effects, such as coronary ischaemia, haematoma, spinous process fracture and death caused by pulmonary oedema [2, 29-31].

Of the two additional studies included in the review, Deyo et al. (2010) investigated medical complications associated with lumbar spinal stenosis surgery using data from Medicare claims in US hospitals between 2002 and 2007. They divided complications into 3 categories, including 1) major medical complications (cardiorespiratory arrest, acute myocardial infarction, pulmonary embolism, bacterial pneumonia, stroke, respiratory failure, aspiration and pneumonia with unknown organism), 2) wound complications (hematoma or seroma, non-healing surgical wound, infection, etc.), and 3) mortality within 30 days of hospital discharge. Their data was for 32,152 patients with LSS who received surgical interventions (54% women, mean age 75 years). Major complications were recorded by 3.1%, wound complications by 1.2% and mortality in 0.4%. [32] In another study by Deyo et al. (2011), they used the same data and included 4 years of follow-up to investigate the rate of reoperation. They found that the reoperation rate was 11% within 4 years (3461). The probability of reoperation decreased with greater age and comorbidity, but increased in cases of prior lumbar surgery [33].

Nerland et al. (2015) found that 8.7% of their participants experienced clinically significant deterioration 12 months after their surgery. The factors related to this deterioration included younger age, previous surgery at the same or a different lumbar level, low preoperative ODI (Oswestry Disability Index) scores, tobacco smoking and the American Society of Anesthesiologists classification system used to predict perioperative risks of grade ≥3 [34].

Again, clinicians should make sure that their patients are well informed about treatment options and their possible side effects, to come to a well-informed decision [2].

1.5 Clinical Reasoning/Decision-making

Clinical decision-making can be divided into 3 phases starting with the diagnosis of the condition, then a severity assessment, and finally a management decision [35] . Usually, surgeons refer to guidelines and Class 1 evidence (low risk of bias, randomized controlled trials of good quality) [36] to make most of their clinical decisions [37] . Other factors can be influential, especially if no guidelines or evidence are available. Gunaratnam & Bernstein, published a qualitative study in 2018, in which they interviewed 32 clinical surgical decision makers and found that a clinical decision is usually based on 5 groups of factors that include the condition itself as to its diagnosis, severity (stage of disease) and the presence of comorbidities. Another group is patient related factors, such as age. Surgeons said that they are more likely to give less aggressive procedures to elderly patients. Sex is an additional patient factor that affected surgical decision making, especially if the procedure can affect fertility. Patient preferences (e.g., not wanting to undergo surgical procedures) were also considered important. The other groups of factors included information available on the condition (specific condition guidelines, class 1 evidence), surgeons' factors (their religious beliefs, years of experience, their comfort with the procedure and their personal views), and institutional factors (resource availability, socioeconomics and geography) [37].

In the case of lumbar spinal stenosis, the consulting physician or spine surgeon can choose to recommend surgery to a patient based on their guidelines or preferences, and they usually offer this option to patients with worse symptoms and lower physical function [19], and to patients who have been unresponsive to conservative treatments [38] . Conversely, a nonsurgical option is often chosen for patients with less severe symptoms or those thought to be susceptible to clinical deterioration post-surgery [34].

The dural sac cross-sectional area and the stenosis morphology grade were also found to be useful in helping clinicians decide on the best management for patients with LSS. [39] Spine surgery for LSS, however, is considered an elective surgery and has a variable outcome, so the final decision is left to the patient, who is increasingly encouraged to take the primary role in clinical decision-making [40].

1.6 Patient Decision-making Regarding Surgery

Very few studies have focused on patients' perspectives in the decision-making process. A systematic review by Lam and Loke was published in 2017 to identify relevant literature that addressed patient related factors that might influence the decision to undergo spine surgery. They were only able to find seven relevant studies [41], demonstrating how scarce the literature is around the subject of factors influencing patients' decision to opt for spinal surgery.

Of the three studies identified in the systematic review of patients specifically with LSS, the Michigan Spinal Stenosis Study II recruited subjects from neurosurgeon and orthopedic clinics. In the data analysis for this study of 39 patients who were offered surgery for lumbar spinal stenosis, only pain (VAS) and health-related quality of life (SF-36) were measured and found to be related to the decision to undergo surgery [42]. Another study analyzed data from the hospital medical records of 555 patients who were diagnosed with lumbar spinal stenosis and received conservative or surgical treatment. Patient data included measures of Health-Related Quality of life (SF-36), disability (ODI) and pain (VAS), as well as motor weakness. Males and patients with greater leg pain (VAS), disability (ODI), lower health-related quality of life as indicated through multiple subscales of the Short Form 36 (Physical Function: PF, Role of Physical: RP, Social Function: SF, and Role of Emotion: RE), and motor weakness were more likely to have surgical treatment [43]. Another study included in the review analyzed baseline data of 356 patients diagnosed with lumbar spinal stenosis who were considered surgical candidates in the Spine Patient Outcomes Research Trial (SPORT) Study. Younger patients, those who reported dissatisfaction with their symptoms, had worse disability on the ODI scale and the SF-36, and worse pain were more likely to have surgery [44]. The results of these studies support the contention that patients with LSS who have more severe symptoms and pain-related disability are more likely to have spine surgery for LSS.

Another paper from the SPORT study that focused on lumbar intervertebral disc herniation also found that younger patients and those with higher levels of pain and disability on the ODI and SF-36 were more likely to have surgery [45]. Two other studies dealt with factors associated with electing surgery for “degenerative disease of the lumbar spine (DDLS)” and low back pain without specifying a disease. The study of DDLS included 164 patients referred by family physicians to spine surgeons for a history of back/leg pain with “degenerative disease” of the lumbar spine and included measures of pain duration, severity, and location, as well as neurological symptoms and walking intolerance. Patients who were older, had pain of greater severity and duration, and walking intolerance were found to be more likely to have spine surgery [46]. In another study, patients referred to a spine center with low back pain were surveyed on their first visit prior to diagnosis and treatment planning. They were asked about their level of pain, the existence of problems with activities of daily living, and how long they were willing to wait for treatment to take effect. Females and patients with persistent and severe pain were more likely to choose surgery [47]. An additional study included in the systematic review looked at patient preferences regarding the decision-making process itself using the Ideal Patient Autonomy Scale, which is a scale that assesses patients’ and physicians’ views on clinical decision-making. Specifically, preferences for patients to be autonomous and decide everything for themselves, involve the physicians in the decision, or let the physicians be completely in charge of the clinical decision were examined. In contrast to the current practice to shift clinical decision-making to the patient, the study found that most patients preferred to leave the decision of whether or not to elect surgery to the surgeon, rather than making the decision themselves [40].

Overall, there is agreement in the literature that some factors, including higher levels of pain and pain-related disability (e.g., as measured with the ODI), and lower levels of health-related quality of life, are related to the decision to have spine surgery. However, associations with age and sex are conflicting, which may be related to differences in study populations as Kløjgaard et al. (2014) targeted patients with low back pain and found that females chose surgery more [47], while Kim et al. (2015) specifically targeted patients with lumbar spinal stenosis and found that males chose surgery more often [43]. The same goes for age, as Bederman et al. (2010) studied the decision to undergo lumbar spine surgery without specifying the condition and found that older patients were more likely to have surgery [46], while Kurd et al. (2012) specifically targeted subjects with lumbar spinal stenosis and found younger patients were more likely to choose surgery [44]. The association with other factors, such as motor weakness[43], walking intolerance and pain duration [46], and dissatisfaction with symptoms [44], are reported in only one study and remains uncertain.

As mentioned by Lam & Loke in their systematic review, there is a dearth of studies on the decision to undergo spine surgery and, therefore, the reasons behind patients' decisions to have spine surgery are still not well understood [41]. Out of the seven studies included in the review, only three targeted lumbar spinal stenosis specifically. Despite study limitations, there was agreement in their findings that lower health-related quality of life (SF-36) and higher levels of disability (ODI) and pain (using multiple/different measurement methods) were associated with undergoing surgery. Other factors influencing this important decision remain unknown, with few factors studied and no more studies on the topic identified since the time of the review published in 2017. We aim to enhance knowledge of patient-related factors influencing the decision to undergo spine surgery in lumbar spinal stenosis, with a focus on patient perceptions.

1.7 Study Aim

The aim of this study was to examine patient-related factors that may affect treatment decision-making regarding undergoing surgery for lumbar spinal stenosis. Of particular interest were patients' perceptions and beliefs about back surgery, satisfaction with prior care, and level of dissatisfaction with living the rest of their lives with symptoms as experienced over the prior month.

Chapter 2

2 Methods

Secondary analysis of data from the Alberta Lumbar Spinal Stenosis Study, a prospective cohort study on prognostic factors and outcomes in LSS, was used to investigate baseline factors associated with subsequent spine surgery for LSS. In this study we were interested in factors associated with the occurrence of subsequent spine surgery in patients diagnosed with LSS.

2.1 Subjects

Participants for the Alberta Lumbar Spinal Stenosis Study were recruited from patients referred for clinical lumbosacral imaging for back-related symptoms between April 2004 and May 2005, who had findings of some degree of stenosis at one or more lumbar levels as indicated on their clinical radiological report. All patients had attended any of the four adult imaging centers serving a metropolitan area of Alberta, Canada. They were referred by both general practitioners and specialists in a public healthcare system in which all patients were guaranteed universal coverage for physician visits and hospital and medical services. Study participants also had to be English speaking due to the extensive questionnaires and interviews in the original study.

Additional inclusion criteria for identifying the clinical syndrome of LSS were a minimum of 40 years of age and a clinical diagnosis of lumbar spinal stenosis. The latter was determined by 1) referral for lumbar spine imaging specifically due to a suspicion of LSS that was confirmed by imaging findings of stenosis at one or more levels indicated on a clinical radiological report, or 2) the diagnosis of LSS noted on their medical chart by a consulting spine surgeon after imaging. This led to identifying a cohort of 250 participants with the clinical syndrome of LSS, as reported in an earlier study of LSS and associated health-related quality of life and comorbidities. [48] In the present study, the identification of additional LSS cases was also possible through ICD 9 codes indicating spinal stenosis in the administrative health data that was available for two years subsequent to baseline measurements, for those participants who provided consent to access their medical records.

Exclusion criteria included spinal malignancies, fractures, infections, inflammatory conditions, and active cancer suspected of metastases.

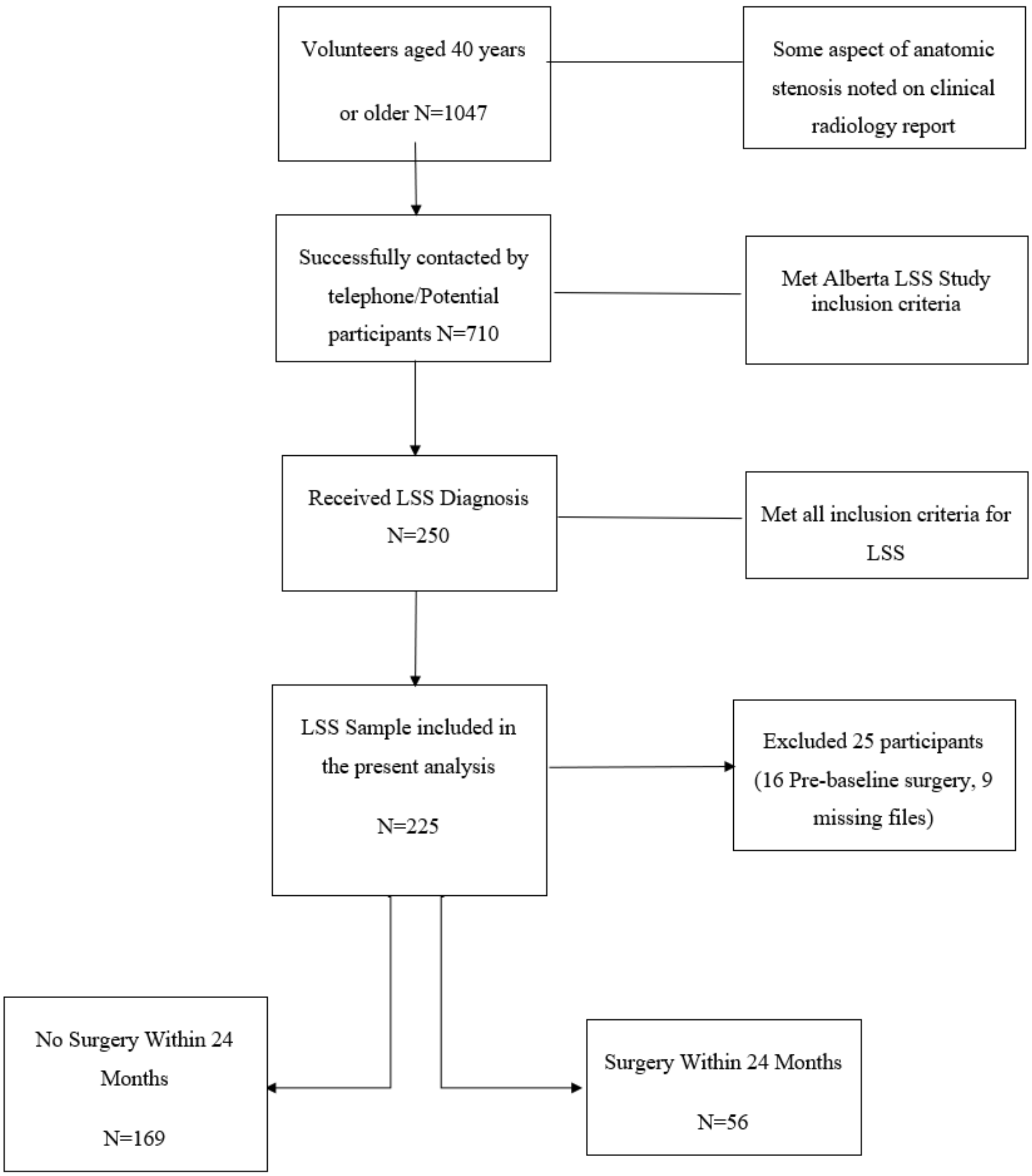

Figure 1. LSS sample Flowchart, study enrollment.

2.2 Data Acquisition

Following recruitment at the time of imaging, the study cohort was contacted to complete an extensive structured interview (baseline). The interview included spinal stenosis specific measures of physical function and symptoms, back pain related disability, health-related quality of life, comorbidities, and a series of questions on participants' beliefs about spine surgery, satisfaction with prior care and current symptoms. Patients were asked whether they had received spine surgery for their condition, and administrative health data for the subsequent two years were also available with details on whether spine surgery had been received.

2.2.1 Primary predictive Factors of Interest

The following predictive factors (independent variables) were of primary interest:

Level of satisfaction with continuing life with current symptoms was measured through the following question: *"If you had to spend the rest of your life with the symptoms you have had over the PAST MONTH, how would you feel about it?"* A 7-point Likert scale was used for the response, with the following possible answers "1 very dissatisfied, 2 mostly dissatisfied, 3 slightly dissatisfied, 4 neither satisfied nor dissatisfied, 5 somewhat satisfied, 6 mostly satisfied, and 7 very satisfied"

Perceived benefits of having back surgery were measured using the following three items:

"Do you believe that back surgery would help your current condition?"

"Do you believe that back surgery would lead to pain relief?"

"Do you believe that back surgery would help you better perform your *regular activities?"*

These 3 questions were answered using a 5-point Likert scale ranging from "Not at all likely" to "Extremely likely", with an additional option of "Don't Know". The responses were recoded into 4 points “1 - Not Likely” that included the “Not at all likely” answers, 2 – “Don’t Know”, 3 - Likely that included “Slightly likely” and “Somewhat likely,” and 4 - Very likely that included “Very likely” and “Extremely likely”. These questions showed a high level of internal consistency (Chronbach’s alpha = 0.95), so they were combined into one measure: patients’ beliefs about benefits of spine surgery.

Perceived risks of having back surgery were indicated from the question: *“Do you believe that surgery would include significant risks”*. Participants responded using a 5-point Likert scale ranging from “Not at all likely” to “Extremely likely”, with an additional option of “Don’t know”. The responses were recoded into 4 points “1 - Not likely” that included the “Not at all likely” answers, 2 – “Don’t know”, 3 - Likely that included “Slightly likely” and “Somewhat likely” and 4 - Very likely that included “Very likely” and “Extremely likely”.

Satisfaction with prior care was indicated from the response to the following question: “*Over the course of treatment for your low back pain or leg pain, how satisfied were you with your overall care?”* A 5-point Likert scale was used, with the following possible answers “-2 Very dissatisfied, -1 slightly dissatisfied, 0 neither satisfied nor dissatisfied, 1 somewhat satisfied, and 2 very satisfied”.

2.2.2 Other Measures

Other patient characteristics and possible predictors of the decision to undergo surgery were also available from the baseline survey, including:

Age was recorded in years at the time of the baseline or pre-surgical interview.

Sex as a dichotomous measure (male or female).

Symptom Severity was measured using a subscale of the Swiss Spinal Stenosis Questionnaire (SSSQ), which is a disease-specific outcome measure for LSS. The SSSQ has demonstrated reliability, internal consistency, and the ability to detect change, which have been rated as excellent, and there is evidence supporting its validity. [49] The Questionnaire consists of three subscales, two of which were used in the Alberta Lumbar

Spinal Stenosis Study baseline questionnaire. The symptom severity subscale consists of 7 questions, the first 6 use a 5-point ordinal scale and corresponding scores ranging from 1 to 5, the seventh question has 3 possible choices scored as 1, 3 and 5.

Physical Function is measured with another subscale of the Swiss Spinal Stenosis Questionnaire that quantifies physical function characteristics of patients with LSS by asking questions about their walking capacity and ambulation in the past month (distance, walking outdoors, indoors, etc.) The Physical function subscale contains 5 questions that use a 4-point ordinal scale scored from 1 to 4.

A continuous overall score can be calculated for each of the Swiss Spinal Stenosis Questionnaire subscales (see Appendix A and B), expressed as the percentage of the maximum score possible, with higher scores representing higher levels of disability [50].

Back-related disability was measured with the Oswestry Disability Index (ODI), which is a commonly used disability index for painful spinal conditions in general, unlike the Swiss Spinal Stenosis questionnaire that specifically measures disability related to the condition of spinal stenosis. The ODI is considered the “gold standard for outcome measures in painful spinal disorders” [51] and has demonstrated good construct validity, acceptable internal consistency, and high responsiveness and stat-retest reliability [52]. It is a continuous measure expressed as a percentage, with higher score indicating worse disability.

General health/health-related quality of life was measured with the Health Utilities Index (HUI) Mark 3. This index’s validity and reliability are rated as good. [53] The HUI Mark 3 includes 8 attributes measuring “vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain/discomfort”. The overall score is a continuous measure that ranges from -0.36 (worst possible health) to 1.0 (perfect health) with 0 representing deceased. [54]

Comorbidity count:

The comorbid conditions in the questionnaire included: asthma, chronic bronchitis or emphysema, arthritis or rheumatism, back problems, excluding arthritis (this item was not included in the comorbidity count for this study), high blood pressure, heart disease, diabetes, cancer, effects of a stroke, migraine headaches, Alzheimer's disease or any other dementia, urinary incontinence, a bowel disorder such as Crohn's disease or colitis, a thyroid condition, and any other long-term condition that has been diagnosed by a health professional.

These conditions were selected from the Charlson Comorbidity Index [55] and the Canadian National Population Health Survey for inclusion in the Alberta Lumbar Spinal Stenosis Study questionnaire. Any remaining comorbidities noted were collapsed into the category "other long-term conditions" for analysis.

The variable representing comorbidities in this study is the count of comorbidities reported by participants, with a possible range of 0-14.

2.2.3 Outcome of Interest – Spinal Surgery

Our outcome of interest was whether spine surgery was performed over the two years subsequent to baseline data collection. Spine surgery was identified through self-report at the time of the follow-up study interview, *"If surgery was already performed since your spine imaging on …, note date of surgery: _____(month), _____(year),"* or from the administrative provincial health data covering the two years subsequent to diagnostic imaging and study recruitment, for those who gave permission to access their related medical records data. ICD 9 codes were used to identify participants diagnosed with Lumbar Spinal Stenosis (LSS), with follow-up medical chart review in some cases. The codes identified were:

-724 (Other and unspecified disorders of back)

-724.0 (Spinal Stenosis other than cervical)

-724.00 (Spinal Stenosis, unspecified region)

-724.02 (Spinal Stenosis, Lumbar region, without neurogenic claudication)

-724.03 (Spinal Stenosis, lumbar region, with neurogenic claudication)

-724.09 (Spinal Stenosis, other region)

2.3 Statistical Analysis

Missing values were imputed with sequential imputations using chained equations (Linear regression equations for continuous variables and ordered logistic regression for ordinal variables) and all our univariate and multivariable analyses included the complete set of 225 subjects.

Means and standard deviations were computed for continuous variables, and percentages for categorical variables.

The overall sample was divided into two groups consisting of participants who chose the surgical treatment option within two years of the baseline interview date and those that continued with nonsurgical management during the same timeline. Baseline characteristics of these groups were described and compared using Welch t test for continuous variables and the chi-squared test for categorical variables.

Logistic regression was used to evaluate predictors of patients choosing to undergo surgery. We first conducted univariate logistic regression with each independent variable (age, sex, ODI, HUI, comorbidities count, Physical Function and Symptom Severity subscales of the Swiss Lumbar Spinal Stenosis Questionnaire). Variables that were statistically significant (p value < 0.1) were considered for inclusion in the multivariable logistic regression model alongside the main predictive factors of interest (level of dissatisfaction living life with current symptoms, patients' beliefs about benefits of spine surgery, belief that surgery would include significant risk, and satisfaction with prior care).

To avoid overfitting our multivariable logistic regression model we followed the guideline of having at least 10 events per variable in the model (Babyak, 2004) [56]. Correlations between variables were investigated, if two were found to be highly correlated only one was included in the regression model. Coefficients and 95% confidence intervals were computed and reported. All assumptions of logistic regression were tested and found to be tenable in the analysis (independence of observations, absence multicollinearity, linear relationship between continuous independent variables and the logit transformation of the dependent variable, and no significant outliers).

All statistical analyses were performed using STATA by StataCorp LLC, version 16.0, with p values <0.05 considered statistically significant.dd

Chapter 3

3 Results

3.1 Sample characteristics

For the purpose of this study, 16 cases were excluded from the analysis for having had surgery prior to the baseline survey date, and 9 cases that self-reported their surgeries were excluded as their physical files were missing at the time of the present analysis, hence the occurrence of the surgery could not be verified. Therefore, the overall LSS cases included were reduced to 225 patients (Mean Age 65.6/SD 11.7), including 56 who underwent spine surgery within two years of baseline interviews (mean age 63.9/SD 10.8) and 169 who did not (mean age 66.2/SD 11.9).

The total number of incomplete observations (missing data) among the 225 cases for each of the six independent variables examined ranged from 20 for satisfaction with prior care to 1 for level of dissatisfaction with continuing life with current symptoms **(Table 1).**

Table 1. Missing observations per variable

	Missing observations/225	Percentage
HUI mark 3	5	2.2
ODI	6	2.6
Physical function	2	0.8
Symptom severity	9	4
Satisfaction with prior care	20	8.8
Level of dissatisfaction with continuing life with current symptoms	1	0.4

Missing data were unrelated to the other measures as no specific group (related to one of the other measures) had more missing data, so they were deemed to be missing at random. As well, Little's MCAR test supported that they were missing completely at random [57, 58]. A total of 20 imputations were run using Stata 16.0.

Baseline characteristics of the 225 patients with LSS are shown in **Table 2**.

The level of dissatisfaction with continuing life with current symptoms item had a mean score of 2.58, between "2-mostly dissatisfied and 3-slightly dissatisfied". Concerning satisfaction with prior care, 19.1% of the study sample were very dissatisfied and 20.8% said that they were very satisfied. 4.9% thought that surgery was not likely to include significant risk and 63.1% believed that it was very likely to include significant risk. 28.4% said that it was not likely that surgery would help their current condition and 27.6% thought that it was very likely to help (Table 2).

Table 2. Study baseline characteristics (means and standard deviations or percentage, when noted)

	Total sample N= 225	Surgery N= 56	No-Surgery N= 169	Significance p*
Age in years	65.7 (11.72)	63.9 (10.86)	66.3 (11.97)	
Sex (Female)	58.2%	57.1%	58.6%	
ODI	34.4 (16.37)	**42.91** **(14.43)**	**31.63** **(16.04)**	***
HUI Mark 3	0.6 (0.26)	**0.44** **(0.27)**	**0.65** **(0.24)**	***

Comorbidities count	2.3 (1.59)	2.4 (1.56)	2.3 (1.6)	
Swiss Spinal Stenosis Questionnaire:				
Physical Function	53.9 (18.54)	**64.1 (15.49)**	**50.6 (18.25)**	***
Symptom Severity	57.3 (15.95)	**66.3 (13.61)**	**54.4 (15.58)**	***
Level of satisfaction with continuing life with current symptoms	**2.6 (1.74)**	**1.5 (0.87)**	**2.9 (1.81)**	***
Belief that surgery would help their current condition				***
Not likely	28.4%	1.8%	37.2%	
Don’t know	16.4%	8.9%	18.9%	
Likely	27.6%	25%	28.4%	
Very likely	27.6%	64.3%	15.4%	
Belief that surgery would include significant risk				
Not likely	4.9%	1.8%	5.9%	

Don’t know	6.7%	3.6%	7.7%	
Likely	25.3%	32.1%	23.1%	
Very likely	63.1%	62.5%	63.3%	
Satisfaction with prior care				**
Very dissatisfied	19.1%	35.5%	13.6%	
Slightly dissatisfied	15.3%	13.8%	15.8%	
Neither satisfied nor dissatisfied	15%	10.4%	16.6%	
Somewhat satisfied	29.8%	24.5%	31.5%	
Very satisfied	20.8%	15.8%	22.4%	

Notes: ODI: Oswestry disability index; HUI: Health utilities index;

P<0.05 * p<0.01 ** p<0.001 ***

Of those 225 patients, 56 had LSS surgery within two years of study recruitment and baseline survey completion. Baseline characteristics of the two groups are shown and compared in **Table 2.** There was no statistically significant difference between the two groups in age, sex, or comorbidities count. Patients in the no surgery group had a significantly lower mean ODI score (31.6) signifying less pain-related disability compared to patients in the surgery group (42.9, p<0.001), they also had a higher (better) mean HUI score of 0.7 compared to 0.4, p<0.001). Patients in the no surgery group also had significantly lower (better) mean Physical Function (50.6) and Symptom Severity (54.3) scores on the Swiss Spinal Stenosis questionnaire compared to those in the surgery group (64.1 and 66.3 respectively, p<0.001). Patients in the surgical group had greater dissatisfaction with continuing life with current symptoms than those in the no surgery group (1.5 and 2.9, p<0.001).

Of those that ended up having surgery, 64.3 thought that surgery was very likely to help them with their current condition, as compared to 15.4% of patients that did not undergo surgery. ($p<0.001$).

Concerning their satisfaction with prior care, 35.5% of those in the surgery group were very dissatisfied, as compared to 13.6% that were very dissatisfied in the no surgery group ($p<0.05$).

There was no statistically significant difference between the two groups in beliefs about the risks of having back surgery.

3.2 Crude associations

In the univariate logistic regression analyses the ODI, HUI, physical function and symptom severity subscales of the Swiss Spinal Stenosis Questionnaire, level of dissatisfaction with continuing life with current symptoms, belief that surgery would help their current condition, and satisfaction with prior care (negatively correlated) were all significantly associated with the subsequent decision to undergo spine surgery within two years (Table 3).

No significant association was found between having spine surgery and age, sex, comorbidities count and belief that surgery would include significant risk.

Table 3. Results of univariate logistic regression analyses

	Coefficient [95% CI]	Significance p*
Age in years	-0.017 [-0.043 0.008]	0.193
Sex: Male	0.058 [-0.552 0.67]	0.850
ODI	**0.046 [0.024 0.067]**	**<0.001**
HUI Mark 3	**-2.92 [-4.133 -1.706]**	**<0.001**
Comorbidities count	0.053 [-0.133 0.241]	0.573
Swiss Spinal Stenosis Questionnaire:		
Physical Function	**0.043 [0.024 0.062]**	**<0.001**
Symptom Severity	**0.052 [0.029 0.075]**	**<0.001**
Level of satisfaction with continuing life with current symptoms	**-0.847 [-1.215 -0.48]**	**<0.001**
Believe that surgery would help their current condition	**1.325 [0.901 1.749]**	**<0.001**
Believe that surgery would include significant risk	0.182 [-0.211 0.577]	0.363
Satisfaction with prior care	**-0.308 [-0.532 -0.084]**	**0.007**

Notes: ODI: Oswestry disability index; HUI: Health utilities index;

3.3 Multivariable logistic regression

The ODI, HUI, and Symptom Severity and Physical Function scales were found to be significant in the univariate logistic regression at $p < 0.1$, but they were found to be highly correlated (ODI/HUI: r= -0.72; ODI/symptom severity: r= 0.73; ODI/ physical function: r= 0.75; HUI/ symptom severity: r= -0.67; HUI/ physical function: r= -0.73). Therefore, only the ODI was chosen to be included in the multivariable model, due to its inclusion in prior related studies, alongside the 4 main independent or predictor factors of interest.

Table 4. Multivariable logistic regression model of predictive factors for undergoing LSS surgery in the subsequent 2 years

Variable	Coefficient [95% CI]	Significance p*
ODI	-0.014 [-0.051 0.022]	0.243
Believe that surgery would help their current condition	**1.157 [0.693 1.621]**	**<0.001**
Level of satisfaction with continuing life with current symptoms	**-0.413 [-0.816 -0.01]**	**0.035**
Belief that surgery would include significant risk	0.268 [-0.25 0.787]	0.31
Satisfaction with prior care	-0.063 [-0.051 0.022]	0.428

Notes: ODI: Oswestry disability index

In the multivariable analysis a higher "level of satisfaction with continuing life with current symptoms" reduced the odds of having spine surgery for LSS (on the satisfaction scale a higher score indicated higher satisfaction levels), and "patients' beliefs that surgery would help their current condition" increased the odds of having spine surgery for LSS (positive coefficient), both were significantly associated with the decision to undergo spine surgery. Those who were dissatisfied living life with their current symptoms and who believed surgery would help were more likely to elect surgery. Once these variables were in the model, the ODI score, satisfaction with prior care and the belief that surgery would include significant risk were not significantly associated with the decision to have surgery (Table 4).

Chapter 4

4 Discussion

In this study, we found that patient related factors and perceptions were more predictive of patients' decision to undergo spine surgery for lumbar spinal stenosis than other factors, such as the level of LSS-related pain and disability, sex and age.

4.1 Crude analysis findings

Crude analysis of findings allowed comparisons with prior studies of factors associated with the decision to undergo spine surgery. Similar to the findings of Kim et al. (2015) and Roszell et al. (2016) from studies of factors influencing the decision to undergo LSS spine surgery, we found no significant difference in age between surgical and non-surgical groups [43,42]. However, in an outcomes study of LSS, Kurd et al. (2012) found age was significantly different between the surgical and non-surgical groups, with younger patients more likely to undergo spine surgery (p=0.022) [44]. Kim et al. thought that their contradicting findings with Kurd et al. might be due to the fact that their study (of Kim et al.) was conducted in a country with universal health coverage, where everyone is covered with insurance for surgery regardless of their age. Our study supports this explanation as it took place under similar conditions with equal access to surgery for older and younger patients.

Similar to the findings of Roszell et al. and Kurd et al. we did not find sex to be a significant predictor of treatment choice [42, 44]. Kim et al., on the other hand, found that females were less likely to choose surgery. They thought that the reason behind this association between sex and treatment decision was that females are less willing to accept the risks of surgery and they prefer to delay surgeries [43, 59, 60]. We think that the difference in findings between our study and those of Kim et al. might be explained by the fact that they had an unbalanced sample with many more females than males (71% females/ 29% males) suggesting a sampling bias, which they mentioned in their limitations and stated that it would affect their findings, while our present study sample was more equally distributed between the two sexes (58.22% females/ 41.78% males).

Comorbidities count was also investigated as a potential predictive factor by Kurd et al. and, similar to our study, was not a significant predictor of treatment decision [44].

The ODI score is the most commonly used measure for low back related disability [51]. In our univariate analysis, the ODI score was found to be significantly different between the surgical and non-surgical groups, patients with higher ODI scores (more disability) were more likely to opt for a spine surgery within two years than those with lower scores ($p<0.001$). This was a consistent finding in previous reports with the ODI being associated with surgical decision making in univariate analysis ($p< 0.001$) [43, 44]. In our current study, the HUI was used to measure health related quality of life (HRQOL), and was found to be significantly different between groups. Patients with lower (worse) HUI scores were more likely to choose surgical treatment within two years ($p<0.001$) than those who continued with non-surgical management. In the previous reports the SF-36 (36-item short form survey) was used to measure HRQOL and was also found to be a predictor of treatment choice [42-44]. We used the Swiss Lumbar Spinal Stenosis Questionnaire to measure patients' symptom severity and physical function. The two subscales were found to be significant predictors of treatment choice in our univariate analyses; patients with higher symptom severity and worse physical function were more likely to choose surgical treatment within the two years ($p<0.001$). These four aspects of patients' conditions and disease severity were all significant predictive factors in previous reports, as well as in our univariate analyses. Intuitively, as found in our study and previous research, patients with a more severe condition, disability and symptoms are more likely to seek surgery to help alleviate them, and patients with a less severe condition are more likely to avoid the surgery and its potential risks. The ODI was chosen to be included in the multivariate model instead of the SSSQ subscales and the HUI, since it is the most common measure used in the literature which allows more direct comparisons. The ODI is also considered the "gold standard for outcome measures in spinal disorders" [51]

There was no significant difference between the groups in perceived risks of having surgery ($p= 0.363$), as most patients thought that there were significant potential risks of having spine surgery. It appears, however, that some are more willing to take such risks if they think that the benefits outweigh them. This was supported by the finding that patients that chose to have surgery within two years had higher expectations of surgical benefits or potential improvement from the intervention ($p < 0.001$). Patients that were more dissatisfied with continuing their life with their current symptoms were also more likely to choose surgery ($p<0.001$), which is supported by the findings of Kurd et al., that used multiple bothersome indexes (Stenosis Bothersome Index, Back Pain Bothersomeness Scale, Leg Pain Bothersomeness Scale) and found that patients that were more bothered (dissatisfied) with their symptoms were more likely to choose surgical treatment ($p < 0.001$) [44]. So, it appears the risk benefit ratio is of utmost importance as both groups perceive risk, but the surgical group had worse symptoms, more dissatisfaction with living life with current symptoms and perceived higher chance of benefit of surgery than those electing non-surgical management. Finally, dissatisfaction with prior care was also significantly associated with the decision to undergo surgery in the present study when investigated in univariate analysis ($p < 0.01$). Patients that are less satisfied with the care that they received previously appear more likely to choose new options, such as surgical treatment, that might help them more than the interventions that they received.

4.1 Multivariable analysis findings

In our multivariable logistic regression model, when the four main predictive factors of interest were included with the ODI, only patients' beliefs about benefits of surgery and their level of satisfaction with continuing life with current symptoms remained significant predictors of treatment choice within two years. In the study by Kim et al., the ODI remained significant in their multivariable logistic regression model ($p= 0.005$) which was not the case with the ODI in our analysis ($p= 0.243$), however they did not have data on beliefs about the benefits of surgery and level of dissatisfaction living with current symptoms. Their model mainly included factors related to patients' symptoms and condition severity (VAS score for leg pain, ODI, motor weakness, role of emotion, radiologic stenotic grade, age, and sex), while our model also considered factors related to patients' beliefs and perceptions, which might be more important in decision making than disease or symptom specific factors. The ODI might be important for treatment decision making from a surgeon's point of view, as they offer treatment options mainly based on patients' symptoms and levels of disability [19]. However, when it comes to a patient's decision of whether to undergo surgical intervention, disability as indicated from an ODI appears not be as important as the patient's beliefs about the benefits of surgery. For example, if a patient had high disability levels but thought that surgery was not likely to improve their condition and that it included substantial risks, they may choose a non-surgical treatment option.

4.2 Strengths and Limitations

The present study had several strengths, including that it is the only study of which we are aware that looked at patients' beliefs and perceptions about spine surgery and their influence on the decision-making process. All other identified studies looked only at factors related to symptoms, demographics and levels of disability, which gave us a new perspective on what is more important in the surgery decision making process. Secondly, our statistical analysis included multivariable logistic regression, while most other studies simply relied on crude analyses, which provide a limited understanding of predictive factors and ignore possible confounding. Constructing a multivariable model allowed us to investigate the relative importance of multiple variables when considered together.

We also must acknowledge several study limitations. First, the sample size and the number of patients that chose surgical treatment limited the number of predictive factors that could be considered in the multivariable analysis, while avoiding overfitting. Second, there are limitations related to measurement issues. Well accepted measures of health-related quality of life and pain and disability were used, the measures of the perceived benefits and risks of spine surgery and dissatisfaction living with symptoms have face validity, but their psychometric properties are unknown. Third, we used multiple imputation to deal with missing values in our dataset, and even with it being the best alternative to missing data and the associated loss of statistical power, it is inferior to having complete data in the analysis. With that being said, our dataset had a small percentage of missing data that were missing at random and unlikely to cause any systematic bias in the results. Fourth, our dependent variable of the decision to undergo surgery had a two-year window and it is possible that the measures may have changed from the baseline values during these two years, affecting their association with the decision to have surgery. We also did not know if the patient was formally offered surgery.

4.3 Conclusion and Implications

Patient perceptions and beliefs about spine surgery appear to be more important predictive factors of treatment choice than patients' demographics, symptoms and levels of disability. The level of satisfaction with continuing life with current symptoms and beliefs about benefits from surgery were particularly important.

Patients are usually more optimistic than surgeons about surgical outcome expectations [61]. Considering that such expectations appear to be more important than symptoms or concerns of surgical risks in patients' decisions to undergo LSS spine surgery, it is particularly important that they are well informed of likely outcomes.

The decision to undergo spine surgery is perhaps the most consequential one that patients with lumbar spinal stenosis will make, particularly as outcomes are quite variable and costs are high. With only three previous studies found related to this topic in patients with LSS, our present study is an important contribution to currently available knowledge of factors associated with this important clinical decision, and should be considered by patients and surgeons alike in the surgical decision-making process, as well as other care providers advising patients with LSS of their treatment options.

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Appendices

Appendix A. Symptom severity subscale of the Swiss Spinal Stenosis Questionnaire

In the past month, how would you describe:

I. **The pain you have had on the average, including pain in your back and buttocks, as well as pain that goes down the legs?**

1. None
2. Mild
3. Moderate
4. Severe
5. Very Severe

II. **How often have you had back, buttock, or leg pain?**

1. Less than once a week
2. At least once a week
3. Every day, for at least a few minutes
4. Every day for most of the day
5. Every minute of the day

III. **The pain in your back or buttocks?**

1. None
2. Mild
3. Moderate
4. Severe
5. Very Severe

IV. **The pain in your legs or feet?**

1. None
2. Mild
3. Moderate
4. Severe
5. Very Severe

V. **Numbness or tingling in your legs or feet?**

1. None
2. Mild
3. Moderate
4. Severe
5. Very Severe

VI. **Weakness in your legs or feet?**

1. None
2. Mild
3. Moderate
4. Severe
5. Very Severe

VII. **Problems with your balance?**

1. No, I've had no problems with balance
3. Yes, sometimes I feel my balance is off, or that I am not surefooted
5. Yes, often I feel my balance is off, or that I am not surefooted

Appendix B. Physical function subscale of the Swiss Spinal Stenosis Questionnaire

In the past month, on a typical day:

VIII. **How far have you been able to walk?**

1. More than 2 miles
2. More than 2 blocks, but less than 2 miles
3. More than 50 feet, but less than 2 miles
4. Less than 50 feet

IX. **Have you taken walks outdoors or around the shops for pleasure?**

1. Yes, comfortably
2. Yes, but sometimes with pain
3. Yes, but always with pain
4. No

X. **Have you been shopping for groceries or other items?**

1. Yes, comfortably
2. Yes, but sometimes with pain
3. Yes, but always with pain
4. No

XI. **Have you walked around the different rooms in your house or apartment?**

1. Yes, comfortably
2. Yes, but sometimes with pain
3. Yes, but always with pain
4. No

XII. **Have you walked from your bedroom to the bathroom?**

1. Yes, comfortably
2. Yes, but sometimes with pain
3. Yes, but always with pain
4. No

Curriculum Vitae

Name:	Alaa El Chamaa
Post-secondary Education and Degree:	Beirut Arab University Beirut, Lebanon B.A. Health Science
Related Work Experience	Teaching Assistant University of Western Ontario