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Original Article

Minimally invasive surgery through endoscopic laminotomy and foraminotomy for the treatment of lumbar spinal stenosis

John A. Polikandriotis, Elizabeth M. Hudak*, Michael W. Perry

Laser Spine Institute, 3001 North Rocky Point Drive East, Tampa, FL 33607, USA

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ABSTRACT

Background: Lumbar spinal stenosis is a common cause of radicular and generalized back pain among older adults. Endoscopic minimally invasive surgery, in contrast to open decompression, may provide the opportunity for a less invasive surgical intervention. Thus, the purpose of this study is to evaluate the safety (operative complications, estimated blood loss, operative room time) and effectiveness (pre- versus postoperative level of disability and pain severity) of minimally invasive surgery using endoscopic laminotomy and foraminotomy among a large sample of patients with lumbar spinal stenosis.

Methods: This study is composed of 320 consecutive patients with lumbar spinal stenosis who underwent posterior lumbar laminotomy and foraminotomy between 2008 and 2011. Outcome measures consisted of perioperative complications, estimated blood loss, operative room time, level of disability, and pain severity. Pain severity and level of disability were prospectively analyzed to an average of 18 months (12–36 months) post-surgery.

Results: There was an average estimated blood loss of 39.3 cc and a mean operative room time of 74 min. Seven patients experienced minor operative complications. All patients were discharged the same day as surgery and reported a significantly lower level of disability ($p = 0.00$) and pain severity ($p = 0.00$) postoperative compared to preoperative.

Conclusions: Minimally invasive surgery using endoscopy for the treatment of lumbar spinal stenosis has a short operative time, a low operative complication rate, and minimal estimated blood loss. This study also indicates that MIS for the treatment of LSS can significantly reduce pain and disability level. Thus, minimally invasive surgery using endoscopic laminotomy and foraminotomy appears to be a safe and effective alternative surgical treatment for open decompression surgery in adult patients with lumbar spinal stenosis.

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1. Introduction

Lumbar spinal stenosis (LSS) is an age-related progressive condition and the most common reason for back surgery in

patients over the age of 65. LSS refers to the narrowing of the central spinal canal that may cause compression on the nerve root, resulting in intense radiating pain in the buttocks or legs.¹ Patients who do not respond to conventional pain

* Corresponding author. Tel.: +813 289 9613x215; fax: +813 418 4237.

E-mail address: ehudak@laserspineinstitute.com (E.M. Hudak).

URL: <http://www.laserspineinstitute.com>

treatment methods such as medications, steroid injections, chiropractic treatment, or physical therapy typically turn to surgery as their next attempt at pain relief.

While invasive open spine surgeries are an acceptable surgical treatment and reported satisfactory for spinal decompression,² they often result in hospital stays, general anesthesia, large operative blood loss, a long length of recovery and rehabilitation, soft tissue damage, and the risk for operative complications.³ With the goal of reducing the negative components associated with open surgeries of the spine,⁴ minimally invasive surgery (MIS) using endoscopy have become increasingly popular for the treatment of LSS. This is because studies found that MIS may achieve the same objectives as open procedures but with reduced postoperative pain and level of disability,⁵ minimal blood loss,^{6–8} less disruption of surrounding soft tissue structures,^{6–8} and no hospital stay or general anesthesia.^{5–7} However, some of these studies report on a small sample of patients (e.g. Refs. 5, 9, 10). In this study, the safety (perioperative complications, operative blood loss, and operative time), and effectiveness (level of postoperative pain and disability compared to preoperative) of endoscopic MIS using laminotomy and foraminotomy for the treatment of LSS was examined among a large sample of 320 consecutive patients.

2. Materials and methods

2.1. Participants

Patients were deemed candidates for MIS if they had all of the following: 1) LSS documented by magnetic resonance imaging (MRI) or computerized tomography (CT); 2) LSS symptoms noted on physical exams; and 3) at least 3-months of failed conventional pain management such as physical therapy, chiropractic treatment, anti-inflammatory and pain medications, or steroid injections. Patients who underwent the lumbar endoscopic laminotomy and/or foraminotomy regardless of diagnosis that completed both preoperative and minimum 1-year postoperative outcome questionnaire were included in analyses. Patients who underwent previous spinal surgery were excluded from analysis in order to reduce possible variables that may influence the results of this study.

Informed consent was obtained from all patients. Analyses were conducted on 320 patients between 22 and 90 years of age ($M = 60.8$ years, $SD = 13.5$). The sample included mostly men ($n = 192$) and were mostly Caucasian in race ($n = 278$). Body mass index (BMI) for this sample was 28.4 ($SD = 5.16$). Approximately 40 (12.5%) of patients reported being smokers at the time of surgery. Patients reported being in pain for an average of 9.3 years ($SD = 11.04$). Baseline patient characteristics are displayed in Table 1.

2.2. Measures

Patient demographics (age, race, gender, BMI, and smoking status) and information pertaining to the safety of the surgical procedure (EBL, perioperative complications, and length of surgery) were obtained through patient medical records.

Table 1 – Baseline patient characteristics.

Patient demographics	Preoperative (n = 320)
Age, mean (range)	60.8 (22–90)
Race, no. (%)	
Caucasian	278 (86.9%)
White Hispanic	14 (4.4%)
African American	6 (1.9%)
Hispanic	2 (0.6%)
American Indian	1 (0.3%)
Asian	1 (0.3%)
Asian/Pacific Islander	1 (0.3%)
Other	3 (0.9%)
Missing	12 (3.8%)
Refused	2 (0.6%)
Male, no. (%)	192 (60.0%)
Smokers, no. (%)	41 (17.8%)
Non-smokers, no. (%)	264 (82.5%)
Not indicated, no. (%)	15 (4.7%)
Years in pain, no. (range)	9.4 (0.2–60)
BMI, no. (range)	28.4 (16.7–47.5)

To measure pain intensity pre- and postoperatively, the prospective visual analog scale (VAS)¹¹ was used. Administration consists of patients being presented with a 10-cm line anchored with the phrases “no pain” and “worst possible pain”. Patients are instructed to bisect the line at the point matching their current level of pain. The pain score is determined by the length of the segment beginning from “no pain” and terminating at the point indicated by the patient. VAS scores range from 0 to 10 with lower scores indicating less severe symptoms of pain.

The Oswestry disability index (ODI)¹² was used to measure disability level pre- and postoperatively. More specifically, patients were instructed to answer ten multiple choice questions relating to how back pain has affected their ability to manage in everyday life. Scores range from 0 to 100% with lower scores indicating less disability.

2.3. Surgical procedure

In brief, intravenous antibiotics were administered preoperatively. The procedure was performed under Monitored Anesthesia Care sedation. The entry site was determined via fluoroscopy. A scalpel was used to make a stab wound through which a guide-wire was inserted down to the facet region of the vertebral body associated with stenosis. Over this guide-wire, a commercially available dilating system was used to dilate the tissues to approximately 18 mm. A drill bit was used to create a window into the foraminal canal. This was done through fluoroscopy to determine the depth of penetration of the drill unit. Electrocautery and holmium lasers were used for hemocoagulation and soft tissue removal. Once the bone and the newly drilled hole were visualized, a standard mechanical burr system was utilized to grind away the lamina of the vertebral body and widen the opening that was created with the bit. Kerrisons and pituitaries rongeurs were utilized during the entire process to smooth the edges of the bone that had been burred and for general debulking of soft tissues and loose bone fragments. Once the region of the lamina and

foraminal canal was properly opened, the dilation tube was removed and the procedure was completed. All surgeries were performed in an outpatient setting.

3. Statistical analysis

Statistical modeling was performed with use of IBM SPSS Statistics software (version 20.0). Significance was defined as $p < 0.05$ on the basis of a two-sided hypothesis test. A two-sided t-test comparing ODI and VAS was conducted to determine if there were any significant differences before and after surgery in level of pain and disability.

4. Results

4.1. Patient demographics

320 consecutive primary lumbar endoscopic laminotomy/foraminotomy patients that met inclusion and exclusion criteria were evaluated to an average of 18 months (range 12–36 months) postoperative.

4.2. Outcome measures

All 320 patients were discharged from the surgical center the same day as surgery. The average surgery time was 74 min (SD = 28 min) and the average EBL was minimal at 39 cc (SD = 42.3 cc). Surgical complications occurred in seven (2.2%) patients. All of these patients experienced a dural leak, in which all were repaired intraoperatively.

The two-sided t-test indicated a significant difference between preoperative and postoperative level of pain ($p = 0.00$) with significantly better mean VAS scores at postoperative compared to preoperative (6.0–3.40, respectively). Analyses also indicated a significant difference between preoperative and postoperative level of disability ($p = 0.00$) with mean ODI scores being significantly lower postoperatively than preoperatively (40.1–22.6, respectively). Mean preoperative and postoperative ODI and VAS scores are presented in Table 2.

5. Discussion

This paper examined the safety (operative time, perioperative complications, and estimated blood loss) and effectiveness

(pain and disability) of MIS using endoscopic laminotomy and foraminotomy among a large case series for the treatment of LSS.

Results indicate that MIS using endoscopy for the treatment of LSS is associated with short operative times, low complication rates, and minimal average EBL. Results also indicate that patients who underwent MIS also reported less pain and disability postoperatively than preoperatively. These findings support the current literature that MIS using endoscopy may be both a safe and effective treatment for LSS (e.g. Refs. 13–15).

There are a few notable weaknesses to this study. To start, this study suffers from inherent bias by including only patients that completed both preoperative and postoperative ODI and VAS outcome forms. Nevertheless, this study reports on a large cohort of patients treated by multiple surgeons at multiple sites: adding power and applicability to the results. Secondly, postoperative imaging was not performed in these patients to verify decompression. In our experience however, a disconnect may exist between reported symptoms and imaging. Thus, the clinical response demonstrated by the relief of symptoms may be more relevant and provided sufficient evidence to indicate decompression. Another study limitation pertains to the fact that this is a case series so it is unable to directly compare MIS using endoscopy to open decompression. Studies that have made the direct comparison between the two have reported endoscopic techniques to be as successful as open techniques at lumbar decompression with less disruption of surrounding tissue structures, less operative blood loss, and shorter hospitalizations for patients.^{6,8} In fact, this study demonstrates that this type of surgery only requires IV sedation (instead of general anesthesia), and did not require any hospital stays.

Regardless of the few limitations, results from this study indicates that MIS using endoscopy for the treatment of LSS has a short operative time, a low operative complication rate, minimal EBL, and can significantly reduce pain and disability level. Thus, MIS using endoscopic laminotomy and foraminotomy appears to be a safe and effective surgical treatment for adult patients with LSS.

Conflicts of interest

All authors have none to declare.

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Table 2 – Preoperative and postoperative VAS and ODI mean scores.

	Preoperative score mean (SD)	Postoperative score mean (SD)	p-Value
VAS	6.0 (2.0)	3.0 (2.7)	<0.001
ODI	40.1 (17.2)	22.6 (19.8)	<0.001

Abbreviations: VAS, visual analog scale; ODI, Oswestry disability index.

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