DOI: 10.21608/pajn.2024.281875.1124

Original Article

Outcome of Using the Oscillating Saw in Lumbar Laminectomy

Mohammud Ahmud Salim,[1] Hossam Elnoamany,[1] Mohammed Adel Dorrah,[1] Zahraa M Mahdy,[2] Mazen Lotfy Agour,[1] Ahmed Said Mansour[1]

[1]Department of Neurosurgery, Menoufia University, Shibin Elkom, EGYPT

[2]Ministry of Health, Menoufia, EGYPT

Received: 6 April 2024 / **Accepted:** 14 August 2024 / **Published online:** 15 December 2024

BACKGROUND: A study focused on lumbar spinal stenosis (LSS), a common condition affecting nearly 47% of elderly individuals. LSS results from various degenerative changes causing neural tissue compression.

OBJECTIVE: We investigated a multilevel laminectomy procedure utilizing an oscillating bone saw, aiming to assess its impact on surgery duration and complication frequency, particularly dural injuries. The study emphasizes the need to optimize surgical tools to mitigate associated morbidity.

PATIENTS AND METHODS: All patients had their full medical histories evaluated and underwent general physical and neurological examinations. Both magnetic resonance imaging (MRI) and lumbosacral x-rays were performed on all cases. We analyzed the extent of stenosis and instability across all levels using physical and radiographic methods. We conducted posterolateral fusion with instrumentation in those who have spinal instability or deformityaccording to the preoperative flexion/extension X-rays. Moreover, we fused the tissue using an autograft made from the removed laminae.

RESULTS: Results showed that laminectomies were performed at varying levels; one level in 39% of patients, two levels in 36.8%, three levels in 18.4% and four levels in 5.2%. The mean time for laminectomy at each level was 3.3 minutes, ranging from 1.5 to 6 minutes per level, with blood loss averaging 6.4 ml per level. Notably, no dural tears occurred during laminectomy, and only 7.9% of cases experienced incidental durotomy during decompression with Kerrison, not during laminectomy itself.

CONCLUSION: According to our study, laminectomy using an oscillating bone saw was a safe, efficient method of treating lumbar canal stenosis.

KEYWORDS: Laminectomy, Lumbar stenosis, Oscillating bone saw.

INTRODUCTION

Neurogenic claudication is a serious symptom that refers to spinal canal stenosis.[1] A complete neurological examination is essential to confirm pain, muscle weakness, sensory deficits and painful limitations.[2] Since these symptoms are present and deemed severe enough to require a surgical treatment, a confirmatory MRI is indicated which is the most sensitive and precise radiological examination to detect the level and type of narrowing.[3] Spinal stenosis is the final consequence of narrowing of the canal of the spine and increasing the compression on the neural elements such as: spinal cord, thecal sac, and nerve roots. It could be classified into anatomical and etiological causes (congenital or acquired), such as disc degeneration, facet osteoarthritis with hypertrophy, hypertrophy of the ligamentum flavum, scoliosis and ligament ossification.[1] The main purpose of surgical treatment is to decrease the pressure on the neural elements to allow the reversal of neurological deficit and prevent the progression of the pathology. Decompression has been achieved by various methods relying on the degree of the severity and type of stenosis such as laminectomy, discectomy, foraminotomy and corpectomy.[1] With a 47% prevalence in individuals over 60, total laminectomy remains the primary surgical technique for severe canal stenosis.[4-7] However, with various instruments such as highspeed burrs, double-action rongeur, Kerrison punches, curved chisel, and osteotomies that are sharp,[7,8] spinal stability and sagittal balance could be at risk. Despite the improvement in surgical tools and methods, traditional laminectomy can cause unintentional dural tears. These tears are caused by the laminectomy.[9] To prevent the complications of dural tears, it is essential to optimize the instruments utilized for laminectomy.

Correspondence:
Mohammed Dorrah
Neurosurgery Department of Menoufia University, Menoufia, EGYPT
Email: mohammeddorrah@med.menofia.edu.eg

We aimed in this study to use a harmless and effective technique for laminectomy in lumbar stenosis patients. An oscillating bone saw is designed to cut bone quicker and easier in total knee arthroplasty.[10] We asserted that an oscillating bone saw could be used to decrease the duration of the surgery and complications. This study examined the effects and advantages of lumbar laminectomy with an oscillating bone saw, as well as the surgical problems that may arise, such as incidental durotomies and hemorrhage.

PATIENTS AND METHODS

The aim of our study was to evaluate the outcome, including time of procedure, complications, and loss of blood with the oscillating saw in lumbar laminectomy. Our study was performed at neurosurgery department of Menoufia University Hospitals and neurosurgery private clinics. Sample size was dependent on all patients with spinal canal stenosis grade 2 or higher who were surgically treated in the neurosurgery department of Menoufia University Hospitals between 2020 and 2022. Prior to their involvement in the research, patients at Menoufia University Hospitals and private practices between 2020 and 2022 gave their signed consent with full knowledge to participate in the research. The study was approved by the institutional review board (IRB) of the Faculty of Medicine, Menoufia University (number NEUS 9/3 at 1/2024). We included thirty-eight patients with lumbar spinal stenosis requiring lumbar decompression. All patients with lumbar stenosis grade 2 or higher had laminectomy using the oscillating bone saw.The data collection was obtained through a self-designed questionnaire approved by specialists in the neurosurgery department of Menoufia University.An informed consent was taken in which each participant has been informed of all aspects of the study and had the right to give up as they wanted. We collected data from participants, who fulfill our eligibility criteria just after admission of the patient to neurosurgery department of Menoufia University Hospitals or neurosurgery private clinics.

All the patients who did not respond to conservative treatment were not eligible for another surgery or a complex spinal procedure to fix the sagittal misalignment. Before the operation, we assessed the extent of stenosis and instability at every level using physical and radiographic methods. The radiographic examinations included standing full-spine X-rays, lumbosacral X-rays in flexion and extension, and magnetic resonance imaging (MRI).

We performed posterolateral fusion with instrumentation among patients who had instability on dynamic images prior to surgery deformity. We also employed an autograft from the removed laminae for fusion. Statistical analysis was performed with the statistical package for social sciences (SPSS) version 11.0

Surgical technique

The position of surgery was prone, and the skin incision was made along the midline based on the level of decompression needed. The spinous processes were exposed by separating the paraspinal muscles on both sides. The muscles were pulled back after removing the periosteum to reveal the laminae. The lateral extent of exposure was determined by whether posterolateral fusion was performed or not. If the patients had claudication with little or no low-back pain, and there was no instability deformity, the facet joints were left intact. We implanted screws first before laminectomy if we had to do posterolateral fusion. A sharp 2-cm blade of an oscillating sagittal saw was employed to divide the bone **(Fig. 1).** We began the cutting at the union of the pars and lamina, away from the lateral edge of the pars interarticularis 5mm medially **(Figs. 2-4)**. To prevent durotomy, we kept the blade vertical to the laminae. We utilized the lateral recess as a guide for cutting. We cut the thinnest part of the lamina. We were not afraid of damaging the dura while doing laminotomy by the saw at the lower two-thirds, since the ligamentum flavum naturally safeguards the dura in this area. At the upper third, we were very cautious about cutting the dura, so we cut only one cortex by the saw to decrease any risk of incidental durotomy. We exposed the second cortex of the lamina with a fine-tip osteotome after completing bilateral cuts as necessary. The cut surface was a straight line. A towel clip lifted the spinous process, and a Cobbs elevator pushed the lamina simultaneously. A McDonald's dissector removed the dura and ligamentum flavum under the lamina. The posterior ligamentous complex was removed **(Fig. 3)**. We removed the laminae from lower end to upper one for multiple-level laminectomy. If the laminae overlapped significantly, the cut was from proximal to distal. Kerrison rongeurs decomposed lateral recess and foramina with ligamentum flavum protecting the dura. Finally, the enlarged ligamentum flavum was removed.

Fig 1: Oscillating drill saw with 2 cm blade.

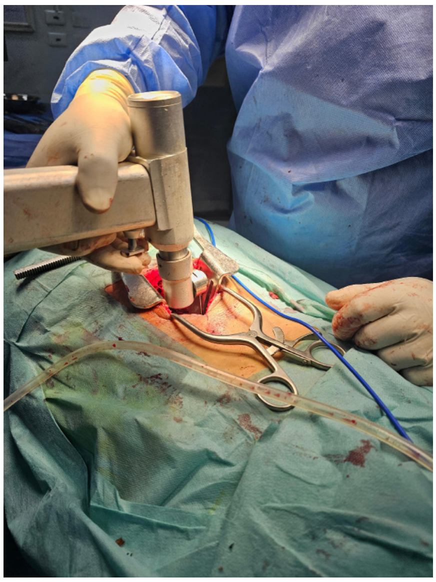

Fig 2: Using of oscillating saw in lumbar laminectomy.

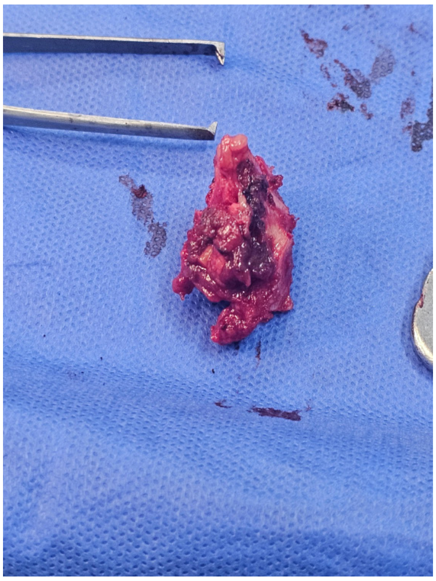

Fig 3: Lamina after removal by oscillating saw.

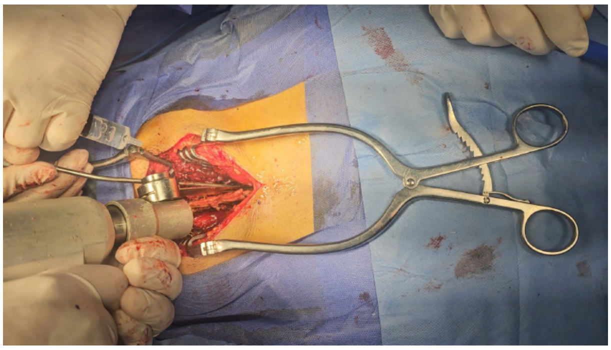

Fig 4: Using oscillating saw in laminectomy.

RESULTS

We have operated on thirty-eight patients, with the age range from 20 years to 65 years. The mean age was 42.8 ±12.4 years. Nineteen (50%) patients were males, and 19 (50 %) patients were females. Fourteen(36.5%) patients were diagnosed with lumbar spondylolisthesis, 14 (36.5%) were diagnosed with lumbar disc prolapse and the other 10 (27%) patients were diagnosed with lumbar canal stenosis. The number of laminectomies was one level in 15 (39%) patients, 2 levels in 14 (36.8%) patients ,3 levels in 7 (18.4%) patients and 4 levels in 2 (5.2%) patients. The mean time of laminectomy per one level was 3.3 ± 1.7 minutes and ranged from 1.5 and 6 minutes per level. Blood loss ranged from 3 ml to 10 ml per level with an average of 6.4 ml. No dural tears occurred during laminectomy. There were only 3 (7.9%) cases with incidental durotomy that occurred during decompression with Kerrison not during laminectomy.

DISCUSSION

Traditional laminectomy can cause unintentional dural tears, despite the improvement in surgical tools and methods.[9] Add to this a common complication of spine operations is blood loss which may require transfusions.[12] Removing bone is a crucial part of many spine surgeries.[13] An oscillating bone saw is designed to cut bone quicker and more easily in total knee arthroplasty.[10] However, spine surgeons rarely use the oscillating bone saw, a common tool for bone piercing in other orthopedic operations, due to the potential risk of damaging the neural elements around the vertebrae. However, this is not the only study to propose a bone saw for laminectomy. In 1982, Ray performed laminectomy by cutting the posterior spinal element with the oscillating saw and then reattaching them with monofilament nylon after decomposing the neural structures.[8] In this study, we used the oscillating bone saw for laminectomy in thirty-eight patients with lumbar spine disorders and did not encounter any accidental durotomy during this technique in our series. However, 3 patients (7.9%) had a dural tear when we removed the lateral recesses with the Kerrison rongeur. We observed that the laminectomy and decompression time was significantly shorter than the double-action rongeur and Kerrison rongeurs. This could also reduce the blood loss and infection risk substantially.

We use Erthropoietin, iron loading, and transfusions to treat preoperative anemia and to reduce blood loss and the need for transfusions. During the operation, antifibrinolytics are used to reduce bleeding.[12] In previous studies, the mean blood loss for decompression of one level was 29.5 ml in conventional laminectomy,[14] and the mean blood loss in microscopic laminectomy was 30 ml and the mean blood loss in open laminectomy was 144 ml. However, in our study, blood loss decreased from 3 ml to 10 ml per level, with an average of 6.4 ml and this shows significant decrease in blood loss using the oscillating saw.

The average surgical duration for single- level decompression was 22.7 minutes in conventional laminectomy in one study,[14] while the average operative time in single level laminectomy was 76.8 minutes in microscopic discectomy and 100.9 minutes in open laminectomy.15 In our study, the average time of laminectomy per level was 3.3 +/- 1.7 minutes, with a range of 1.5 to 6 minutes per level, which was even shorter in duration than microscopic discectomy.

We did not experience any severe tears throughout the laminectomy in our study. Only 3 (7.9%) patients had accidental durotomy throughout the decompression stage with Kerrison, not during the laminectomy. None of them had any issues with cerebrospinal fluid (CSF) leakage. In contrast to previous studies, CSF leakage has been reported as a common complication after lumbar spine surgery.[16,17] In 1990, Rama et al. study was conducted on thirty-two patients, including adults and children, using an oscillating bone saw to conduct laminoplasty and laminectomy. Three months following the spinal cord transection, they documented one case of infection-related complications.[18] In contrast, Padanyi et al. the oscillating bone saw was utilized to carry out laminotomy on five patients with intra-axial lesions and did not report any cases of dural tears.[19] For the spinal surgeon, CSF leak can be challenging because it can result in chronic headaches and increase the risk of meningitis.[16,20,21] The literature identifies various rates of CSF leaks, from 5.5% to 9% in primary lumbar spine surgeries and from 13.2% to 21% in revision surgeries on the lumbar spine.[16,22] Some durotomies may happen unintentionally during surgery, with a rate of 6.8%, but they may not always cause clinical symptoms of CSF leak.[16,23]

Our patients experienced a low rate of dural injury (7.9%), which suggests that the oscillating bone saw is a secure alternative to other instruments. High-power drills are often used for laminectomy, as they are fast and efficient.[24] However, the heat made by the burr tip against the cortical bone of the lamina may cause thermal necrosis of the soft tissues and bone.[25] Additionally, unlike an oscillating bone saw, this instrument's rotational force may limit the surgeon's control over the tool.[13] The strength of this study is that there were no recent publications that discuss outcomes, including time of procedure, complications, and blood loss using the oscillating saw in lumbar laminectomy, particularly in developing countries such as Egypt. It is essential to mention the study constraints. First, the utilization of oscillating bone saw in relieving lumbar canal stenosis requires technical skill and adequate knowledge and experience of spinal anatomy. Second, the follow up period was short, therefore a longer follow up period is recommended in future studies. Another limitation is that we could not use a microscope because of financial issues and its limited availability in our workplace.

CONCLUSION

Our study found out that using the oscillating bone saw for laminectomy could reduce the time of the operation and blood loss. Furthermore, this method was safe, and effective for relieving the narrowing of the lumbar region. However, this method requires technical skill and adequate knowledge and experience of spinal anatomy. Therefore, one should be aware of the challenges and limitations of this technique.

List of Abbreviations

CSF: Cerebrospinal fluid.
IRB :Institutional Review Boards.
LSS: Lumbar spinal stenosis.
SPSS: statistical package for social sciences.
MRI: Magnetic resonance imaging.

Disclosure

The authors report no conflict of interest in the materials or methods used in this study or the findings specified in this manuscript.

Funding

The authors received no financial support for the research, authorship, and/or publication of this paper.

REFERENCES

1. Melancia JL, Francisco AF, Antunes JL. Spinal stenosis.Handb Clin Neurol. 2014;119:541-549.
2. Lynch AC. Gait kinematics and spinal loading in patients with lumbar spinal stenosis and healthy older adults. *Boston University.* 2023.
3. Jensen MC, Brant-Zawadzki MN, Obuchowski N,Modic MT,Malkasian D, Ross JS. Magnetic resonance imaging of the lumbar spine in people without back pain. *N Engl J Med.* 1994;331(2):69-73.
4. Postacchini F. Surgical management of lumbar spinal stenosis. *Spine (Phila Pa 1976).* 1999;24(10):1043-1047.
5. Gunzburg R, Szpalski M. The conservative surgical treatment of lumbar spinal stenosis in the elderly.In: Aebi M, Gunzburg R, Szpalski M, eds. The Aging Spine. *Springer.* 2005: 94-98.2005:94-98.
6. Deyo RA, Mirza SK, Martin BI, Kreuter W, Goodman DC, Jarvik JG. Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA.* 2010;303(13):1259-1265.
7. Kalichman L, Cole R, Kim DH, et al. Spinal stenosis prevalence and association with symptoms: The Framingham Study. *Spine J.* 2009;9(7):545-550.
8. Ray CD. New techniques for decompression of lumbar spinal stenosis. *Neurosurgery.* 1982;10(5):587-592.
9. Kalevski SK, Peev NA, Haritonov DG. Incidental dural tears in lumbar decompressive surgery: Incidence, causes, treatment, results. *Asian J Neurosurg.* 2010;5(1):54-59.
10. Plaskos C, Hodgson AJ, Inkpen K, McGraw RW. Bone cutting errors in total knee arthroplasty. *J Arthroplasty.* 2002;17(6):698-705.
11. Lee GY, Lee JW, Choi HS, Oh KJ, Kang HS. A new grading system of lumbar central canal stenosis on MRI: An easy and reliable method. Skeletal Radiol. 2011;40(8):1033-1039.
12. Qureshi R, Puvanesarajah V, Jain A, Hassanzadeh H.Perioperative Management of Blood Loss in Spine Surgery. *Clin Spine Surg.* 2017;30(9):383-388.
13. Hu X, Ohnmeiss DD, Lieberman IH. Use of an ultrasonic osteotome device in spine surgery: experience from the first 128 patients. *Eur Spine J.* 2013;22(12):2845-2849.
14. Kanbara S, Yukawa Y, Ito K, Machino M, Kato F. Surgical outcomes of modified lumbar spinous process-splitting laminectomy for lumbar spinal stenosis. *J Neurosurg Spine.* 2015;22(4):353-7.

15. Ohtomo N, Nakamoto H, Miyahara J, et al. Comparison between microendoscopic laminectomy and open posterior decompression surgery for single-level lumbar spinal stenosis: A multicenter retrospective cohort study. *BMC Musculoskelet Disord.* 2021;22(1):1053.

16. Menon SK, Onyia CU. A short review on a complication of lumbar spine surgery: CSF leak. *Clin Neurol Neurosurg.* 2015;139:248-251.

17. Wong AP, Shih P, Smith TR, et al. Comparison of symptomatic cerebral spinal fluid leak between patients undergoing minimally invasive versus open lumbar foraminotomy, discectomy, or laminectomy. *World Neurosurg.* 2014;81(3-4):634-640.

18. Rama B, Markakis E, Kolenda H, Jansen J.Reconstruction instead of resection: laminotomy and laminoplasty[Article in German]. *Neurochirurgia (Stuttg).* 1990;33 Suppl 1:36-9m.

19. Padanyi C, Vajda J, Banczerowski P. Para-split laminotomy: a rescue technique for split laminotomy approach in exploring intramedullary midline located pathologies. *J Neurol Surg A Cent Eur Neurosurg.* 2014;75(4):310-316.

20. Hughes SA, Ozgur BM, German M, Taylor WR.Prolonged Jackson-Pratt drainage in the management of lumbar cerebrospinal fluid leaks. *Surg Neurol.* 2006;65(4):410-415.

21. Turgut M, Akyüz O. Symptomatic tension pneumocephalus: An unusual post-operative complication of posterior spinal surgery. *J Clin Neurosci.* 2007;14(7):666-8.

22. Chen MN, Kang JD. Cerebrospinal fluid leaks in anterior and posterior cervical spine surgery. *Semin Spine Surg.* 2009;21(3):161-166.

23. Patel MR, Louie W, Rachlin J. Postoperative cerebrospinal fluid leaks of the lumbosacral spine: management with percutaneous fibrin glue. *AJNR Am J Neuroradiol.* 1996;17(3):495-500.

24. Dujovny M, Agner C. The use of high power drills for laminectomy in spinal stenosis: technical report. *Neurol Res.* 1997;19(2):219-21.

25. Matthes M, Pillich DT, El Refaee E, Schroeder HWS, Müller JU. Heat Generation During Bony Decompression of Lumbar Spinal Stenosis Using a High-Speed Diamond Drill with or without Automated Irrigation and an Ultrasonic Bone-Cutting Knife: A Single-Blinded Prospective Randomized Controlled Study. *World Neurosurg.* 2018;111:e72-e81.