RESEARCH ARTICLE

Application of Oscillating Saw for Lumbar en Bloc Laminectomy: A Case Series

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Received: 06 November 2018 *Accepted: 05 October 2019*

Abstract

Background: An oscillating bone saw is rarely used to perform laminectomy. The purpose of this study was to describe a relatively quick and harmless technique for multilevel laminectomy in patients with lumbar spinal stenosis (LSS) using an oscillating bone saw to find out how this instrument affects the time of surgery and rate of complications.

Methods: This prospective study was conducted on 45 patients with LSS who required multilevel laminectomy. The bones were cut using an oscillating sagittal saw equipped with a fine 1-cm blade. Posterolateral fusion was performed if any evidence of spinal instability occurred, or the correction of deformity was addressed. The time spent for laminectomy from initial cutting to the whole bone removal (T1) and the duration of laminectomy (i.e., from initiation to the end of decompression; T2) were recorded for the corresponding level. The volume of harvested autograft was also measured, and any dural injuries were reported.

Results: Posterolateral fusion was performed on 32 (71.1%) patients. The mean T1 and T2 per level were estimated at 70.5±5.4 and 157.5±12.1 sec, respectively. In addition, the mean volume of harvested autograft per level was obtained as 3.5±1.2 cc. No durotomy was observed during laminectomy using an oscillating bone saw. However, a dural tear occurred in one patient when a Kerisson punch was utilized for ligamentum flavum removal and foraminotomy.

Conclusion: Based on the findings, it can be concluded that laminectomy by means of the oscillating bone saw is a safe procedure that provides a sufficient volume of harvested autograft for fusion. This technique could also induce a remarkable reduction in the time of surgery.

Level of evidence: IV

Keywords: Decompression, Laminectomy, Lumbar spine, Oscillating saw, Stenosis

Introduction

Lumbar spinal stenosis (LSS) is the most common surgical indication in the elderly population among the spinal pathologies, with a prevalence of nearly 47% in people older than 60 years (1, 2). A number of degenerative changes, such as ligamentum flavum hypertrophy, bulging of the intervertebral disc, and facet arthropathy, usually lead to neural tissue compression (3). Although several techniques have been introduced for the decompression of neural elements, the results have been more or less similar (4). Yet, the total laminectomy is still served as the standard surgical approach for severe degenerative canal stenosis (5, 6).

To date, several instruments have been used for lumbar canal decompression. Some of these devices include high-speed burr, Kerrison punches, double-action rongeur, curved chisel, and sharp osteotomes (6-9). In spite of

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recent advances in applied instruments and surgical techniques, the incidence of inadvertent dural injuries caused by conventional laminectomy techniques is still considerable (10-12). An iatrogenic durotomy might happen during bone removal by the different types of rongeurs. Moreover, the dural tear might occur following the slippage of a cutting burr (12, 13).

Considering the significant morbidity of dural injuries, the optimization of the available instrumentations is of critical importance (12). In the present study, it was hypothesized that the use of an oscillating bone saw in multilevel laminectomy could provide several advantages (e.g., lowering the rate of dural injuries and reducing the time of surgery) over the conventional laminectomy devices.

Regarding this, the present study was conducted to test a multilevel laminectomy technique using the oscillating bone saw in a cohort of LSS patients to find out how this instrument affects the time of surgery and rate of complications. Moreover, this study was targeted toward examining if this technique provides a sufficient volume of harvested autograft in patients who need a spinal fusion following decompression.

Materials and Methods

This study was approved by the review board of Bone and Joint Reconstruction Research Center, Iran University of Medical Sciences, Tehran, Iran. Written informed consent was obtained from the patients before their participation in the study. Between April 2017 and March 2018, a total of 45 LSS patients who needed a lumbar decompression underwent laminectomy by means of an oscillating bone saw. Conservative management was failed in all the patients. None of the patients was a candidate for reoperation or three-column spinal osteotomy to correct the sagittal imbalance.

Preoperatively, a careful physical and radiographic examination was performed to determine the level of stenosis, as well as instability, if present. Radiographic investigation necessitated the implementation of full-length spinal radiography in a standing position, flexion-extension lumbosacral X-rays, and magnetic resonance imaging. Posterolateral instrumented fusion was performed in patients with spinal instability or deformity based on the preoperative flexion/extension X-rays. Furthermore, an autograft harvested from the laminae was applied for fusion.

Surgical Technique

After prepping and draping, a midline skin incision was made according to the required level of decompression while the patient was in the prone position. Subsequently, the bilateral paraspinal muscles were dissected from spinous processes. The muscles were retracted after subperiosteal detachment to expose the laminae. The extension of lateral exposure depended on the scheduled procedure (i.e., decompression with or without posterolateral fusion).

If the predominant symptom in patients was claudication with no or mild low-back pain, and there was no instability/deformity, the facet joints were preserved. The muscles were retracted over the capsule to the lateral margin of the facets. If posterolateral fusion was necessary, implants were placed before laminectomy. The bone cut was performed using an oscillating sagittal saw (Stryker Co, USA) with a fine 1-cm blade [Figure 1]. The most appropriate site to initiate cutting was identified to be the boundary of the lamina and pars, 5 mm medial from the lateral border of the pars interarticularis. The blade was maintained perpendicular to the laminae to avoid durotomy. The cutting line was along the lateral recess. The region of the lamina with minimal thickness was cut.

Since dura is protected naturally by the ligamentum flavum adjacent to the distal two-thirds of the lamina, both laminar cortices can be cut safely by the saw in this region. However, at the proximal third, only one cortex must be cut by the saw to reduce the risk of dural injury. After cutting as many laminae as were needed bilaterally, the second cortex of the lamina was opened with a fine tip osteotome [Figure 2]. The resulted cutting edge was a sharp straight line. The spinous process was pulled up using a towel clip while a Cobbs elevator concurrently levered the lamina [Figure 3]. The dura and ligamentum flavum were released underneath the lamina by a Penfield retractor [Figure 4]. The lamina and spinous process were removed using the en bloc resection [Figures 5A; 5B].

If laminectomy was needed in multiple levels, the laminae were resected from distal to proximal. In case of the observation of considerable overlap of the laminae, the resection was performed from proximal to distal. Following the laminectomy, lateral recess and foramina were decompressed using Kerrison rongeurs, while the dura was protected by ligamentum flavum. Finally, the hypertrophied ligamentum flavum was resected.

Surgery-associated features

The time from the beginning of laminectomy to the end of lamina removal (T1) and from laminectomy to the

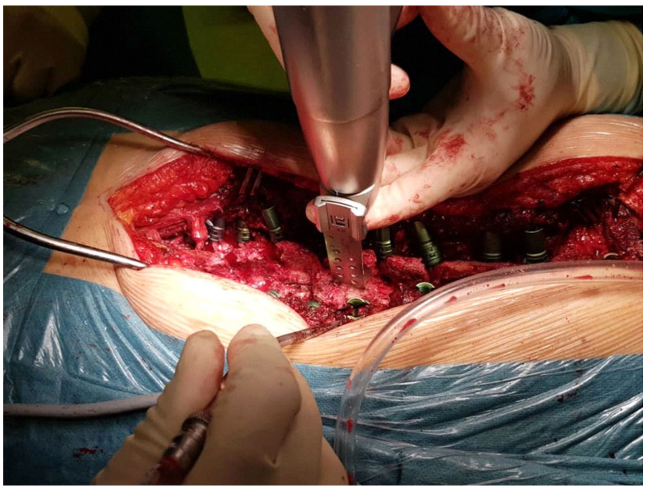

Figure 1. Bone cuts made using the oscillating bone saw.

Figure 2. Use of a fine tip osteotome to open the second cortex of the laminae after cutting the laminae by means of the oscillating saw.

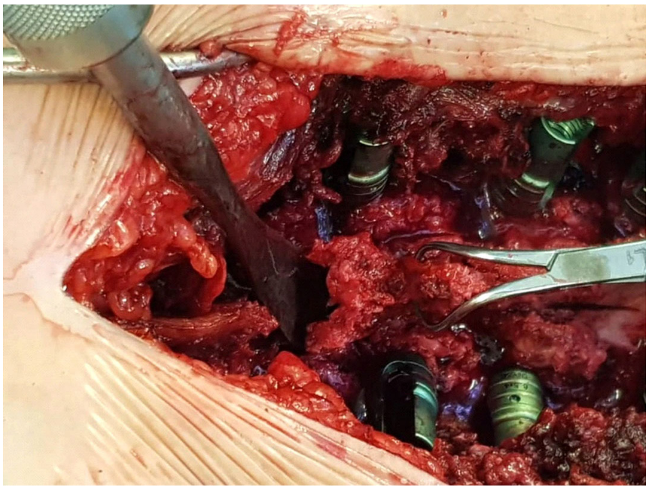

Figure 3. Pulling up of the spinous process by a towel clip and concurrent use of a Cobbs elevator to lever the lamina.

end of the decompression of corresponding levels (T2) were recorded. To measure the volume of the harvested autograft during the laminectomy, the resected bones were morselized to small pieces. Subsequently, the bone pieces were put in a measuring cylindrical bottle filled with saline. The autograft volume was then calculated as bottle volume minus the poured saline volume. Any dural injuries at the time of laminectomy or decompression were recorded.

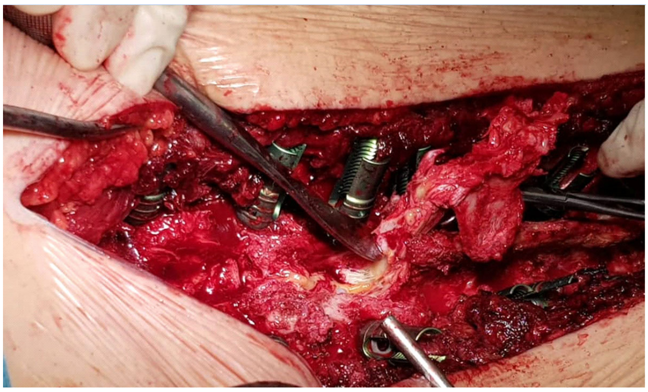

Figure 4. Release of the dura and ligamentum flavum underneath the lamina using a Penfield retractor.

Statistical analysis

Data analysis was performed using SPSS statistical software (version 15). The quantitative data were presented as mean±standard deviation. Furthermore, the ordinal and nominal data were described as number and percentage.

Results

A total of 45 LLS patients were included in the study. The demographic data of the patients are presented in Table 1. Based on the data, the mean number of the involved levels was 2.1±1.1 (range: 1-5). Spinal fusion was performed in 32 (71.1%) patients. Table 2 shows the data related to the time of the surgery. The mean harvested autograft volume per level was obtained as 3.5±1.2 cc (range: 3-24 cc). The harvested autograft was applied for fusion, if necessary, and allograft was not required in any cases. Incidental durotomy did not occur in any of the patients during the laminectomy. Yet, the dura was torn in one patient during decompression using a Kerrison punch. This was repaired with nylon stitches and fibrin glue.

Discussion

Bone removal is the keystone in many spine surgery procedures (14). Although the oscillating bone saw is used for bone cutting during different orthopedic surgeries, such as periacetabular osteotomy and knee and hip arthroplasty, spine surgeons rarely use this instrument to remove vertebral components owing to the probable incidence of harmful consequences during applying this device around the neural tissues. It should be noted that the current study is not the first research suggesting the use of a bone saw for laminectomy. In 1982, Dr. Ray used the oscillating saw in patients with stenosis to remove the lamina and spinous process as a

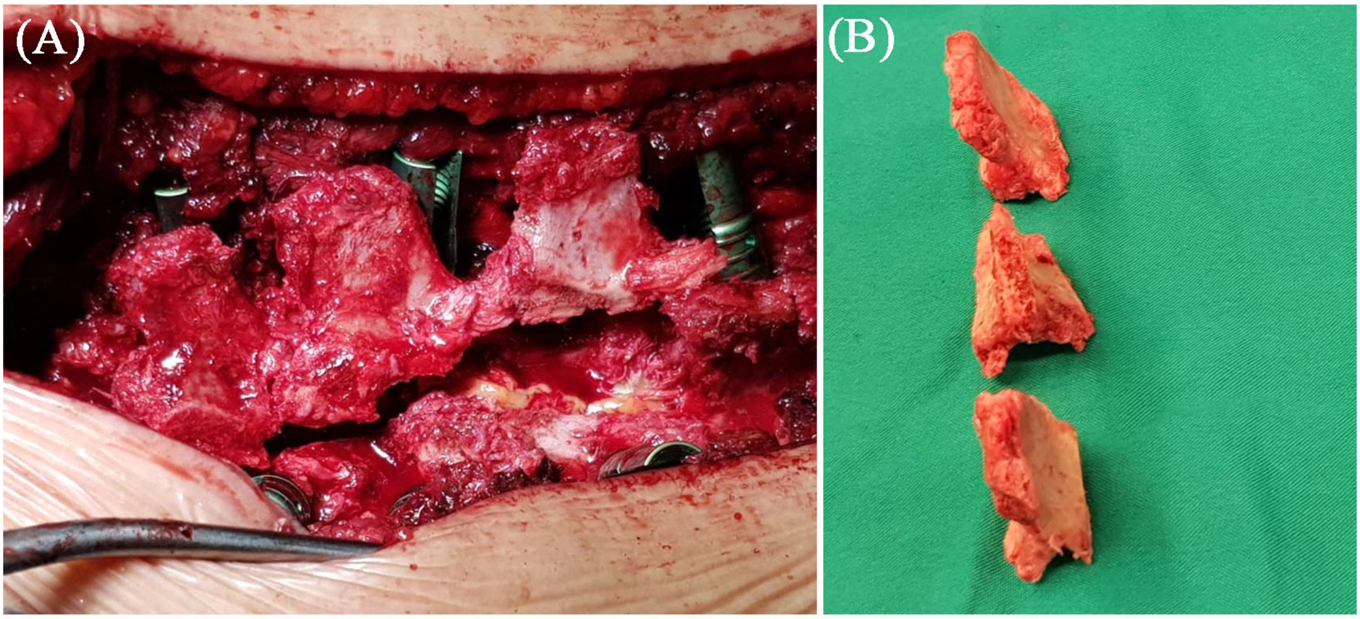

Figure 5. (A) En Bloc resection of the laminae and spinous processes, (b) harvested autograft after en bloc resection.

Table 1. Demographic data of the patients

Age (y)		63.6±8.7 (range: 46-82)
Sex	Male	13 (28.9%)
	Female	32 (71.1%)
Pathology	Isolated canal stenosis	13 (28.9%)
	Canal stenosis with instability	21 (46.7%)
	Canal stenosis with deformity	11 (24.4%)
No. stenosis levels	1	16 (35.6%)
	2	14 (31.1%)
	3	10 (22.2%)
	4	4 (8.9%)
	5	1 (2.2%)

Table 2. The operation time and the operation time per level

T1 (s)	148.7±82.1 (range: 50-465)
T2 (s)	332.5±135 (range: 105-635)
T1 per level (s)	70.5±5.4
T2 per level (s)	157.5±12.1

T1: the time from the beginning of laminectomy to the end of lamina removal
T2: the time from laminectomy to the end of the decompression of corresponding levels

piece. After the decompression of neural elements, the bony piece was tied back using monofilament nylon (8).

In the current study, the oscillating bone saw was used for laminectomy in a cohort of 45 LSS patients, and no incidental durotomy was observed during this procedure in our series. However, a dural tear occurred in one patient (2.2%) during the decompression of lateral recces using the Kerrison rongeur. According to our observation, the time of laminectomy and decompression could be considerably shorter with the oscillating bone saw than piecemeal lamina removal with double-action and Kerrison rongeurs. This, in turn, significantly reduces the risk of infection and blood loss. Moreover, the use of the oscillating bone saw increases the volume of the harvested graft to 3.5 cc per level, thereby eliminating the need for extra allograft or autograft from the iliac crest.

In 1990, Rama et al. used the oscillating bone saw to perform laminoplasty and laminectomy on 32 pediatric and adult patients. They reported one case of spinal cord transection, followed by infection, 3 months later (15). In 2000, Mimatsu et al. reported the results of 154 patients who underwent laminectomy for different pathologies using a micro-bone saw. In the mentioned study, dural laceration occurred in five patients with reoperation; however, there was no report of root or cord injury (16). In another study, Padanyi et al. performed split laminotomy on five patients with intramedullary pathologies using the oscillating bone saw and reported no case of dural tear (17).

Multiple instruments have been developed for the removal of the lamina and decompression of the spinal canal (18-20). However, each instrument has its own limitations, and no ideal instrument has been introduced yet. Inadvertent dural injury is one of the frequent intraoperative complications of spine surgery having an incidence range of 1-17% based on different studies (12). Considering the low rate of dural injury in our patients (2.2%), the oscillating bone saw can be suggested as a safe substitute for other available instruments.

One of the most common instruments for laminectomy is high-power drills. Dujovny and Agner reported a high-speed drill as a safe and quick instrument for laminectomy (21). However, the thermal necrosis of the bone and soft tissues due to the heat produced by the friction of the burr tip with the cortical bone of the lamina remains a concern (22). Moreover, the rotating force of this instrument may decrease the ability of the surgeon to control the device, compared to the oscillating bone saw (14). Furthermore, it is necessary to replace the burrs due to quick wearing, especially when used to cut the thick bone of the lumbar spine (15).

Tomita et al. described another method for spondylectomy in patients who were a candidate for tumor surgery. They passed a thread wire saw with a specific guide into the epidural space and then pulled it out through the intervertebral foramen to perform pediculotomy (23). In this technique, the inferior facet of the rostral vertebra should be removed first since it is not suitable for stenosis decompression induced by instability. Nonetheless, this technique was claimed to be time-consuming by Hara et al., using this technique to perform laminoplasty. They also asserted that the insertion of the guidewire into the narrow canal is technically challenging (19).

Hazer et al. evaluated the safety and efficacy of the ultrasonic bone shaver in a variety of spinal surgeries. They concluded that it is a safe instrument in spine surgery with a very low complication rate. Therefore, they recommended this instrument as an assistant device in various spine surgeries (24). Yet, this instrument is not only expensive but also hardly accessible. Furthermore, in another study, laminectomy by means of an ultrasonic scalpel was reported to be accompanied by dural injury in 8.6% of the cases, two of which directly occurred by the device (14).

The current study entails several limitations. One of the drawbacks of our study is its small sample size. Furthermore, there was no control group to undergo decompression using other techniques for comparative purposes. Finally, there were no data in the literature regarding the time spent for laminectomy and the volume of harvested autograft to compare with our results.

As the findings of the current study demonstrated, the use of the oscillating bone saw for laminectomy reduced the time of operation and could provide sufficient harvested autograft for fusion. Moreover, our results showed this technique is efficient, safe, and effective for decompressing the lumbar canal stenosis. In spite of these advantages, one should note that the described method is technically demanding and requires appropriate knowledge and sufficient experience about spinal anatomy.

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