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Technical Note

Recapping hemilaminoplasty for spinal surgical disorders using ultrasonic bone curette

Hidenori Matsuoka, Yasunobu Itoh, Shinichi Numazawa, Masato Tomii, Kazuo Watanabe, Yoshitaka Hirano[1], Hiroshi Nakagawa[2]

Department of Neurosurgery, Southern TOHOKU General Hospital Southern TOHOKU Research Institute for Neuroscience, [1]Center for Spine and Spinal Cord Disorders, Southern TOHOKU General Hospital, [2]Global Spine, 7-115 Yatsuyamada Koriyama, Fukushima 963-8563, Japan

E-mail: *Hidenori Matsuoka - matsuoka119@yahoo.co.jp; Yasunobu Itoh - yasuitoh@mt.strins.or.jp; Shinichi Numazawa - shin.numazawa@gmail.com; Masato Tomii - masatotomii@ybb.ne.jp; Kazuo Watanabe - dr-kazu@mt.strins.or.jp; Yoshitaka Hirano - mth10yhirano@flute.ocn.ne.jp; Hiroshi Nakagawa - h.nakagawa1485@gmail.com
*Corresponding author

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Abstract

Objective: The authors present a novel method of the recapping hemilaminoplasty in a retrospective study of patients with spinal surgical disorders. This report describes the surgical technique and the results of hemilaminoplasty using an ultrasonic bone curette. The aim of this study was to examine the safety and effectiveness of the hemilaminoplasty technique with ultrasonic bone curette.

Methods: Between April 2003 and July 2011, 33 patients with various spinal diseases (17 spinal tumors, 5 dural arteriovenous fistulas, 3 syringomyelia, 2 sacral perineural cysts, and 2 arachnoid cysts) were treated microsurgically by using an ultrasonic bone curette with scalpel blade and lightweight handpiece. The ultrasonic bone curette was used for division of lamina. After resection of the lesion, the excised lamina was replaced exactly in situ to its original anatomic position with a titanium plate and screw. Additional fusion technique was not required and the device was easy to handle. All patients were observed both neurologically and radiologically by dynamic plain radiographs and computed tomography (CT) scan.

Results: The operation was performed successfully and there were no instrument-related complications such as dural laceration, nerve root injury, and vessels injury. The mean number of resected and restored lamina was 1.7. CT confirmed primary bone fusion in all patients by 12 months after surgery.

Conclusion: The ultrasonic bone curette is a useful instrument for recapping hemilaminoplasty in various spinal surgeries. This method allows anatomical reconstruction of the excised bone to preserve the posterior surrounding tissues.

Key Words: Recapping hemilaminoplasty, spinal surgery, ultrasonic bone curette

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INTRODUCTION

The laminoplasty technique is the most widely used procedure in cervical spinal surgery. Hemilaminoplasty with ultrasonic bone curette SONOPET® (Striker Co. Ltd., Tokyo, Japan) was reported as a bone-cutting device.[3] Since April 2003, we have used an ultrasonic surgical aspirator system, SONOPET® as a novel method of the

recapping hemilaminoplasty that can expose the spinal canal, lateral recess, and foramen. The preservation of the spinous process, lamina, and facet allows the spinal canal to be reconstructed. Here, we discuss the safety and efficacy of ultrasonic bone curette with utilized in spinal surgery.

MATERIALS AND METHODS

Between April 2003 and July 2011, 33 patients with various spinal diseases (17 spinal tumors, 5 dural arteriovenous fistulas, 3 syringomyelia, 2 sacral perineural cysts, and 2 arachnoid cysts) underwent surgeries by the combined use of the ultrasonic bone curette SONOPET® and scalpel blade [Table 1]. They did not need spinal canal enlargement after the intradural procedure was completed. There were 18 men and 15 women with a mean age of 47.1 years (range 4–74 years). The mean follow-up period was 41.0 months (range 7–98 months). Ultrasonic bone curette was used to cut the lamina off for the exposure of the spinal dural sac via a posterior approach. The mean number of resected and restored lamina was 1.7. One-level hemilaminoplasty was performed in 13 patients. Two-level hemilaminoplasty was performed in 17 patients, and three-level hemilaminoplasty was performed in 3 patients. The underlying abnormality was schwannoma in 12 patients, dural arteriovenous fistula in 5 patients, syringomyelia in 3 patients, and intramedullary ependymoma, meningioma, sacral perineural cyst, and arachnoid cyst in 2 patients. We usually selected bilateral recapping laminoplasty for intramedullary tumors to obtain a wider

Table 1: Summary of cases of hemilaminoplasty with an ultrasonic bone curette

Patient No.	Age (years)/ sex	Disease	Laminotomy level	No. of laminotomy	Operation Total	Time (min) per lamina
1	60/M	Syringomyelia	T12	1	341	341
2	39/M	Dural AVF	T7	1	262	262
3	62/F	Syringomyelia	C7, T1	2	202	101
4	74/F	Schwannoma	T1, T2	2	272	136
5	66/F	Dural AVF	S1	1	166	166
6	66/M	Intramedullary ependymoma	L1,L2	2	314	157
7	42/M	Schwannoma	L2,L3	2	405	203
8	4/F	Meningeal cyst	C3, C4	2	254	127
9	32/F	Thoracic disc hernia	T12	1	232	232
10	25/M	Schwannoma	C5, C6	2	211	106
11	32/M	Arachnoid cyst	T10–T12	3	227	76
12	67/F	Schwannoma	C7, T1	2	201	101
13	30/M	Intramedullary ependymoma	T12, L1	2	300	150
14	43/M	Schwannoma	T5	1	187	187
15	55/F	Arachnoid cyst	L1	1	178	178
16	49/M	Schwannoma	T12	1	284	284
17	48/M	Dural AVF	T12	1	196	196
18	57/M	Intradural lipoma	L1–L3	3	344	115
19	37/M	Schwannoma	L3, L4	2	317	159
20	15/M	Schwannoma	C1	1	335	335
21	71/F	Intradural meningioma	C3–C5	3	298	100
22	42/M	Neurofibroma	L2, L3	2	339	170
23	62/M	Dural AVF	T6	1	161	161
24	66/F	Syringomyelia	T1, T2	2	170	85
25	62/M	Schwannoma	C2	1	199	199
26	56/F	Sacral perineural cyst	S1, S2	2	172	86
27	38/F	Schwannoma	C2, C3	2	246	123
28	4/M	Spinal epidural hematoma	C5, C6	2	105	53
29	73/F	Intradural meningioma	T10	1	228	228
30	74/F	Schwannoma	T4, T5	2	135	68
31	29/F	Sacral perineural cyst	S2	1	213	213
32	29/M	Schwannoma	L2, L3	2	291	97
33	48/F	Dural AVF	T12, L1	2	244	122
Average				1.7	243	162

view compared with extramedullay lesions except in the above two patients. In this study, patients requiring bilateral laminoplasty were excluded. Bony fusion was evaluated by dynamic plane radiographs based on Ray's criteria and by computed tomography (CT) at 3, 6, and 12 months, and then every 12 months to determine the state of the union of the restored lamina.

Surgical technique of recapping hemilaminoplasty

Laminotomy is carefully performed using the ultrasonic bone curette with scalpel blade protecting dura mater with a cottonoid in the epidural space [Figure 1]. On the open side, the bone curette divides the lamina at its lateral margin, just medial to the facet joints and pedicle [Figure 1a]. On the opposite side, lamina is cut obliquely on the central side toward the opposite site preserving the supraspinal ligaments and interspinal ligaments [Figure 1b]. The same procedure is performed at each level on the affected side. Unilateral osteotomy of the posterior arch in this procedure provides an exposure of the posterior elements of the spinal canal and the foramen. The intradural procedure can be done as usual [Figure 1c], and then each lamina restored to the original site is affixed on the open side utilizing a titanium miniplate with screws (Striker Leibinger Co., Tokyo, Japan) extending from the spinous process to each respective lateral mass [Figure 1d]. In children, the replaced lamina was fixed with 1-0 nylon sutures, resulting in a complete reconstruction of the posterior elements of the spinal column.

RESULTS

Recapping hemilaminoplasty was done safely to obtain an enough wider laminotomy space in 33 patients. The average of the operation time and the operation time per lamina were 243 ± 70.1 and 162 ± 72.5 min, respectively. There were no major complications such as cord injury, root injury, and CSF fistula. Dural laceration did not occur during the manipulation with the ultrasonic bone curette.

Bone CT scans and dynamic X-rays confirmed primary bone fusion in all patients within 12 months after surgery. No signs of spinal column deformity such as kyphosis or sinking of the replaced lamina were noted in any patient during the follow-up period.

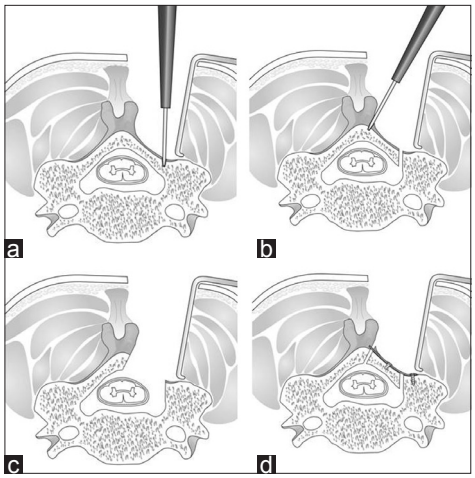

Figure 1: Schematic drawings of recapping hemilaminoplasty using ultrasonic bone curette with scalpel blade (axial views). (a) After unilateral separation of the paravertebral muscles, cutting of the lamina just medial to the facet joints and pedicle. (b) Cutting of the lamina obliquely at the base of the spinous process; (c) the intradural procedure can be done; (d) the lamina restored to the original site was fixed with titanium miniplates and screws

DISCUSSION

Laminoplasty has been developed to prevent postoperative spinal instability or kyphotic deformity. Laminoplasty might be a useful procedure to decrease postlaminectomy membrane. Several kinds of laminoplasties have been reported by spinal surgeons. These are divided into expansive and nonexpansive methods, depending on the enlargement of the spinal canal after laminoplasty was performed.

We describe a simple method for nonexpansive laminoplasty performed with a scalpel blade type ultrasonic bone curette with scalpel blade. The first report about recapping hemilaminoplasty using the scalpel blade type ultrasonic bone curette was published in 2009.[3] The ultrasonic bone curette is a device for cutting bone with oscillation without rolling movement, which can be applied along the whole spinal regions and cranial base.[1,2,5-7] It has a number of advantages as follows. The SONOPET® is able to scrape and cut the bone tissues without the risk of injuring soft tissues such as the dura and nerve roots or becoming entangled in cottonoids. The width of the scalpel blade type ultrasonic bone curette is thin (0.7 mm) and the tip of the blade is small so that it can be safely inserted into narrow epidural space and cut the lamina off safely as wanted. However, it is important to put cottonoid on the dura mater not to lacerate dura mater and other neural tissue. There were previous reports concerning dural tears while using the SONOPET® in spinal surgery.[4] They also recommend that cottonoid be placed between the ultrasonic bone curette and important structures. An advantage is that it requires only one hand for holding, usually the dominant right hand, but it can also be held with the left hand when absolutely necessary.[5] Another advantage of this method is that the posterior supporting elements such as the supraspinous and interspinous ligament and spinous process can be preserved. Paravertebral muscle from only the affected side needs to be dissected, thus making it less invasive to the soft tissue than conventional laminectomy. With the method we describe, the operative field is wide enough to resect most extramedullary tumors, and

the spinal canal can be reconstructed after intracanal procedure without the need for fusion techniques because the spinous process, lamina, and facet joint are preserved. Additionally, bone loss from cutting lamina can be minimized. All the patients achieved physiological and anatomic reconstruction of the vertebral arch after intracanal procedure. This procedure may be useful in maintaining spinal stability without deformity. In our study, nobody required additional fusion techniques after hemilaminoplasty. There were no CSF leakages during the postoperative course. It is certain that replaced lamina with rigid fixation prevents postoperative CSF leakage from the beginning.

The disadvantages of this method include a somewhat longer operation time during laminotomy as compared with conventional laminectomy, although this did not cause significant complications in the patients we treated. Additionally, we guess it will initially be technically difficult for the beginner to do this procedure. This new method, termed recapping laminoplasty, has several advantages during operation compared with conventional laminoplasty. Therefore, it can be applied widely to various spinal surgeries.

CONCLUSION

The ultrasonic bone curette is a useful, safe instrument for recapping hemilaminoplasty while avoiding excessive heat production and mechanical injury. This method provides sufficient exposure for intraspinal canal procedures and allows preservation of posterior spinal elements. This procedure with the ultrasonic bone curette is recommended for various spinal surgeries.

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