Turkish Neurosurgery 2009, Vol: 19, No: 2, 121-126

Clinical Outcomes Following Cervical Laminoplasty for 19 Patients with Cervical Spondylotic Myelopathy

Servikal Spondilotik Miyelopati Nedeniyle Servikal Laminoplasti Yapılan 19 Olguda Klinik Sonuçlarımız

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Received : 17.12.2008
Accepted : 16.02.2009

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ABSTRACT

OBJECTIVE: Cervical laminoplasty is an effective procedure. We describe the technique of open-door and french-door cervical laminoplasty and present our clinical results.

METHODS: All patients undergoing laminoplasty at our clinic during the 1997-2008 period were included in the study. All patients had myeloradiculopathy. Neurological functions and recovery in myelopathy in patients were evaluated using the Nurick score. Pre- and postoperative kyphotic evaluation was measured using the sagittal tangent method. Peri- and postoperative complications were recorded.

RESULTS: Clinical evaluation showed that all patients had reduced postoperative complaints compared to their complaints before the procedure. Average time of surgery was 180 min. Average blood loss in surgeries was 300 cc. According to the Nurick classification, no improvement was observed in seven patients; nine patients showed improvement of one grade; and three patients showed an improvement of two grades. Temporary C5 nerve root paralysis was observed in two patients as a postoperative complication. Complete recovery was observed in both patients within 2 months.

CONCLUSIONS: Laminoplasty is a safe and effective alternative procedure to treat cervical spondylotic myelopathy.

KEYWORDS: Laminoplasty, Cervical spine, Laminectomy, Posterior approach, Myelopathy, Cervical stenosis

ÖZ

Servikal laminoplasti etkili bir dekompresyon yöntemidir. Servikal laminaların açılma şekline göre open door ve French door olmak üzere iki ana teknik ile yapılmaktadır. Bu çalışmada, 1997-2008 yıllarında bu teknikler kullanılarak ameliyat edilen spinal kord kompresyonu basısı olan hastaların sonuçları sunulmuştur. Çalışma sonucunda uygun vakalarda etkin dekompresyon sağlandığını, Nurick klasifikasyonuna göre hastalarda belirgin iyileşme sağlandığı, iki hastada geçici C5 kök lezyonu tespit edildiği ve başka bir komplikasyonun olmadığı tespit edilmiştir. Spinal kord basısı bulgularında kötüleşme hiç saptanmamıştır. Sonuç olarak laminoplasti indikasyonu olan olgularda etkin bir dekompresyon yöntemidir.

ANAHTAR SÖZCÜKLER: Laminoplasti, Servikal omurga, Laminektomi, Posterior yaklaşım, Miyelopati, Servikal stenoz

INTRODUCTION

Posterior approaches to decompress multilevel cervical spinal cord compression include laminectomy, laminectomy with fusion, and laminoplasty (18). For a long time, cervical laminectomy has been widely used to treat multilevel cervical spondylosis (2,3,14,17,18,19, 20,21). In fact, this procedure can easily and safely bring adequate decompression of the cervical spinal cord; nevertheless, it can have the adverse outcomes of epidural scar formation (postlaminectomy membrane) after cervical laminectomy and of postlaminectomy kyphosis secondary to iatrogenic destabilization of the cervical spine (10,17,19,20). Concern about instability after laminectomy has led many surgeons to perform an instrumental posterior fusion operation with laminectomy. However, this procedure has been associated with factors that can increase morbidity, such as failure of fusion, longer surgical time, complications, adjacent segment degeneration, and reduced motion in the cervical spine (3,9,17).

The search for new surgical approaches to avoid the delayed sequelae of cervical laminectomy finally led to the development in Japan of laminoplasty, which widens the dimensions of the spinal canal without permanently removing the dorsal elements of the cervical spine. Oyama et al. introduced and described a Z laminoplasty of the cervical spine for the first time in the literature and reported that this procedure allowed wide canal decompression, while preserving cervical stability and alignment (17). Hirabayashi et al. (7) reported open-door laminoplasty in 1981, and various modifications were subsequently made that are reported to improve safety and effectiveness (3,16,17,20).

In this study, we reviewed results from our clinic for patients with cervical spondylotic myelopathy who underwent laminoplasty.

MATERIALS and METHODS

All patients were diagnosed via magnetic resonance imaging (MRI). All patients had myeloradiculopathy, and their compressions were multifactorial, involving some combination of congenital cervical narrow canal, wide disc herniation, and ligament hypertrophy. In all but one patient, compression was observed in at least three disc spaces. Patients who had kyphotic deformity, radiological instability, or previous spinal surgery were excluded from the study.

Patients' neurological functions and improvement in myelopathy were evaluated pre- and postoperatively using the Nurick score. Preoperative and postoperative kyphotic evaluation was performed using the sagittal tangent method (Table I). Preoperative and postoperative complications were recorded.

Nineteen patients with cervical spondylotic myelopathy (14 male, five female) were treated with open-door (18 patients) and french-door laminoplasty (1 patient) between 1997-2008. The average age of the patients was 57 years (range, 29 to 84). Average follow up was 48 months (range, 19 to 126). We used allograft and mini-plates on 15 of 18 open-door laminoplasty patients, with two patients receiving only mini-plates and one receiving Hirabayashi-type suture fixation. Allograft and fusion were performed in french-door laminoplasty.

Surgical Procedure:

Hirabayashi and colleagues were the first to describe the expansive open-door laminoplasty (7). In this technique, the spinous processes and laminae are exposed from C2 to C7. The decompression extends from the laminar level of one above to one below the stenotic site, as diagnosed by preoperative imaging. Using a high-speed drill, a bony trough is created at the junction of the laminae and facets, on the side showing the most symptoms. The depth of the trough stops just below the anterior cortex of the laminae. This extends in the cephalad to caudad direction from one level above to one level below the stenotic levels involved. This thin rim and interconnecting ligamentum are then removed with a 2-mm or 3-mm kerrison rongeur. In the opposite or 'closed' side, a second trough is then created using a high-speed drill. The anterior aspect of the laminae on the closed side is not removed and must remain intact. The opening on the open side is then gently expanded, thus lifting the lamina off the spinal cord and expanding the canal. The open door may be kept open by placing sutures through the facet capsule and the spinous processes on the closed side. This is the most traditional way of maintaining door patency. Many variations to maintain the open hinge have been described. Variations to the basic procedure include bone graft (allograft and autograft), the use of titanium mini-plates, and ceramic spacers (11,16) (Figure 1A,B,C,D).

Table I: Patient demographic data, and clinical and sagittal alignment outcomes

Patient No.	Age (y)	Gender	Level No.	Nurick Grade Pre-op	Nurick Grade Post-op	Complications	Follow-Up (mo.)	Sagittal Alignment, Pre-op	*Sagittal Alignment, Post-op
1	54	M	4	1	1		28	6	10
2	71	M	4	2	1		55	7	11
3	65	F	4	2	1		28	9	14
4	58	M	5	2	1		41	6	11
5	69	M	3	2	1	transient C5 palsy	19	4	8
6	42	F	4	1	1		24	5	8
7	51	F	4	3	2		67	5	14
8	45	M	3	2	1		16	5	7
9	50	M	4	1	1		61	5	9
10	29	F	2	1	1		23	3	6
11	63	M	5	5	3	transient C5 palsy	19	5	8
12	43	M	4	1	1		22	6	10
13	69	M	4	1	1		49	9	12
14	45	M	3	1	1		45	7	9
15	55	F	3	2	1		57	4	7
16	84	M	4	3	1		84	8	12
17	72	M	3	4	2		126	8	10
18	60	M	4	2	1		96	6	9
19	55	M	4	2	1		56	17	22

*These radiological results are evaluated according to the last follow-up radiological examination. The time of the follow-up examination for every patient is given in table 1.

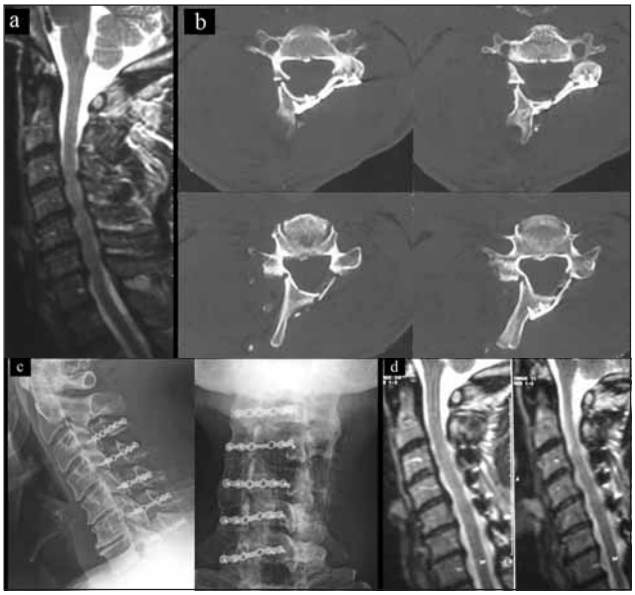

Figure 1: *(**A**) Preoperative MRI of a 58-year-old man, demonstrating five-level servical stenosis with C5-6 and C6-7 right foraminal stenosis. (**B**) Sagittal CT (computed tomography) after open-door laminoplasty using allograft and mini-plates. (**C**) Postoperative radiography of the cervical vertebral column, carried out antero-posteriorly and laterally, shows allografts and mini-plateswith good alignment. (**D**) Postoperative MRI shows an enlarged cervical spinal canal.*

In French door laminoplasty, the door is opened along the midline and thus creates a symmetric opening of the canal. Bilateral troughs are created similarly to the open door technique. This procedure is applied with a high-speed drill, and care is taken not to drill completely through the laminae. The midline opening is created using a fine kerrison rongeur and high-speed drill. The split laminae are opened in sequence, similar to French doors, to create an opening approximately 15-20 mm wide, using a modified laminar spreader. In the original French door technique, the canal is left open and bilateral sutures are used. Variations have been described. For example, various materials have been used to maintain patency of the decompression in the French door technique. These include ceramic spacers, iliac crest bone graft, autologous ribs, and allografts (Figure 2A,B). Pieces of the resected spinous processes may be secured with wire between the lamina (4,14,17).

RESULTS

Postoperative follow-ups were performed at six months after the procedure and annually thereafter. The mean preoperative Nurick grade was 2 (range, 1

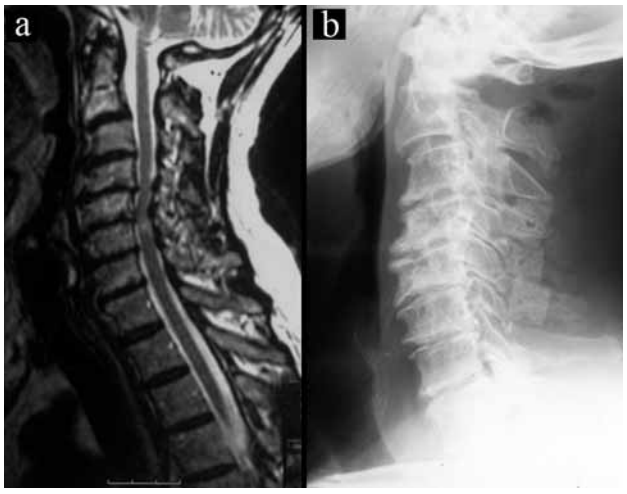

Figure 2: *(**A**) Preoperative MRI of a 60-year-old man with cervical spondylotic myelopathy. (**B**) Postoperative radiography after French-door laminoplasty. In this case of three-level stenosis, allografts for median reconstruction at C4,C5, and C6 levels were used.*

to 5). Pre- and last postoperative kyphotic evaluation was measured using the sagittal tangent method (Table I). Pre- and postoperative results were compared statistically with the t–test ($P<0.005$). About four degrees of anterior angulation was found after the operation at the long-term radiological investigation but there was no clinical problem. Patients presented with decompression of two to five levels (average, four levels). One patient underwent decompression and laminoplasty at two levels, five at three levels, 11 at four levels, and two at five levels. The mean operating time was 180 minutes, and mean blood loss was 300 cc. Mortality did not occur during or after surgery. Clinical evaluation showed that all patients (19 of 19, 100%) had reduced postoperative complaints compared to their complaints before the procedure. According to the Nurick classification, nine patients demonstrated improvement of one grade, three patients improved by two grades, and seven patients were unchanged. Postoperative complications were observed in two patients who developed temporary C5 nerve root paralysis. Both patients experienced complete recovery within two months.

DISCUSSION

Surgeries have been shown to cause neurological improvements in the short term, but they have been linked to long-term complications in some cases. One of the most troubling sequelae following posterior decompression is neck pain or postlaminectomy kyphosis manifested as a subacute spinal cord wound (18,20,21). Other reported sequelae are delayed neurological deterioration; tethering of the dorsal dura to the posterior neck muscles, resulting in postlaminectomy membrane; and scar formation (12,13,20).

When treating cervical spondylotic myelopathy, most surgeons prefer ventral decompressive procedures when compressive cervical spinal cord is limited to one or two levels, given the high rate of neurological improvement and predictable solid fusion (19). If three or more levels of decompression are required, anterior decompression and fusion may cause several complications. Long-term effects of this procedure include arthrodesis insufficiency, with frequencies up to 45% reported in the literature (1,5,21). Additional complications of such wide anterior cervical surgery include dysphagia, recurrent laryngeal nerve paralysis, esophageal and vertebral artery injuries, graft fracture, and dislodgement (10,19,20,21). Studies that have examined the long-term results of anterior fusion surgery report a risk of adjacent level disease as high as 25% (6,19). Currently, posterior approaches to the cervical spine are limited to laminectomy with fusion or laminoplasty. Instrumental posterior cervical fusion is a surgical option to avoid postlaminectomy kyphotic deformation. It has been linked to the following postoperative complications: failure of fusion, loss of fixation, and adjacent segment degeneration (3,9).

The delayed neurological deficits after cervical laminectomy and the high rate of complications in multilevel anterior cervical approaches necessitated a new surgical approach. Laminoplasty was developed in Japan in the 1970s to treat multilevel cervical stenosis, and it was reported to allow maintaining cervical alignment and stability during wide canal decompression (3,17,20,21). Advantages of laminoplasty include providing a widened spinal canal, avoiding postoperative instability of the cervical spine, and protecting the spinal cord. The incidence of postprocedural kyphosis has been found to be lower in laminoplasty in both animal models and clinical studies (2,20). In their prospective study of 85 cases, Suk (18) et al. reported that kyphosis developed in 10.6% of the patients after laminoplasty. Postlaminectomy membrane has not been reported to occur as a complication following laminoplasty, because of the preservation

of the dorsal bony arch (20).

The mean operative time and blood loss are low in laminoplasty. In their laminoplasty series of 204 cases, Wang et al. (21) reported a mean operative time of 210 minutes and a mean blood loss of 350 cc. In our study, the corresponding values were 180 minutes and 300 cc. As in the present study, Wang et al. used the Nurick Score to assess improvement in myelopathy. They found their Nurick scores to improve by one point in 78 patients (38%), two points in 37 patients (18%), three points in 7 patients (4%), and four points in 5 patients (3%). In their series, 74 patients (36%) experienced no improvement, and three patients (1%) deteriorated by one point. In our series of 19 patients, seven patients (37%) experienced no improvement, nine patients (47%) improved by one point, and three patients (16%) improved by two points.

Previous large-series studies have shown that the Nurick scores of patients with cervical spondylotic myelopathy who were treated with laminoplasty improved by 60% (10,21). Consistent with these findings, our study found 63% of patients to show postoperative neurological improvement based on the Nurick score.

Neurological complications after laminoplasty are uncommon. Fifth cervical root motor palsies occur after posterior decompressive procedures with an incidence of 5-14% (3,10,15,21). This complication is a result of the short course of the C5 root, which becomes stretched as the thecal sac migrates dorsally after decompression (12,13,20). In our series, temporary C5 palsy developed in two patients (11%) and complete recovery was observed in both cases in two months.

One of the most troubling sequelae of laminoplasty is axial neck pain. Significant shoulder and neck pain lasting for months to years after surgery is frequently observed. Hosono et al. (8) reported a frequency of 60% for postoperative axial symptoms after laminoplasty. In our study, seven patients (37%) complained of axial symptoms, and all complaints were reduced after the first postoperative year. The cause of axial symptoms remains unclear. It may be related to surgical manipulation and nearby dissection of the facet joints (17,20).

CONCLUSION

Laminoplasty, popularized in the 1980s, is a safe and effective alternative to both anterior surgery and laminectomy with fusion for treating multilevel cervical spinal pathologies, cervical spondylotic myelopathy, and posterior longitudinal ligament calcification. The advantages of laminoplasty are that it widens the spinal canal while preventing postoperative instability and it protects the spinal cord. Postoperative complications of laminoplasty include stubborn axial symptoms and segmental motor paralysis. The laminoplasty procedure is technically straightforward and can be performed quickly with minimal risk to the patient. The advantages of this procedure over other approaches may be particularly significant when treating elderly patients.

REFERENCES

1. Epstain N: Evaluation and management of cervical stability associated with pseudartrosis after anterior cervical surgery for occification of the posterior longütudinal ligament. Surg Neurol 49:246-252, 1998
2. Fields MJ, Hoshijima K, Feng AH, Richardson WJ, Myers BS: A Biomechanical radiologic, and clinical comparison of outcome after multilevel cervical laminectomy or Laminoplasty in the Rabbit. Spine 25(22):2925-2931, 2000
3. Hale JJ, Gruson KI, Spivac JM. Laminoplasty: A review of its role in compressive cervical myelopathy. Spine 6: 289-298, 2006
4. Hase H, Watanabe T, Hirasawa Y: Bilateral open Laminoplasty using ceramic laminas for cervical myelopathy. Spine 16:1269-1276, 1991
5. Herkowitz H: A comparison of anterior cervical fusion, cervical laminectomy, and cervical laminoplasty for the surgical management of multiple level spondylotic radiculopathy. Spine 13: 774-780, 1988
6. Hilibrand AS, Carlson GD, Palumbo MA, Jones PK, Bohlman HH: Radyculopathy and myelopathy at segments adjacent to the site of a previous anterior cervical artrodesis. J Bone Joint Surg Am 81: 519-528, 1999
7. Hirabayashi K, Miyakawa J, Satomi K: Maruyama T, Wakano K. Operative Results and postoperative progression of ossification among patients with ossification of cervical posterior longitudinal ligament. Spine 6: 354-364, 1981
8. Hosono N, Yonenobu K, Ono K. Neck and shoulder pain after laminoplasty. A noticeable complication. Spine 21: 1969-1973, 1996
9. Houten JK, Cooper PR: Laminectomy and posterior cervical plating for multilevel cervical spondylotic myelopathy and ossification of the posterior longitudinal lagament: effects on cervical alignment, spinal cord compression, and neurological outcome. Neurosurgery 52: 1081-1088, 2003
10. Kaplan L, Bronstein Y, Barzilay Y, Hasharoni A, Finkelstein J: Canal expansive laminoplasty in the management of cervical spondylotic myelopathy. Isr Med Assoc Journal 8(8):548-552, 2006
11. Matsuzaki H,Hoshino M, Kiuchi T, Toriyama S: Dome-like expansive laminoplasty for the second cervical vertebrae. Spine 14: 1198-1203, 1989

12. Morimoto T, Ohtsuka H, Sakaki T, Kawaguchi M: Postlaminectomy cervical spinal cord compression demonstrated by dynamic magnetic resonance imaging. J Neurosurg 88:155-157, 1998
13. Oiwa T, Hirabayashi K, Uzawa M, Ohira T: Experimental study on postlaminectomy deterioration of cervical spondylotic myelopathy. Spine 10: 717-721, 1985
14. Patel KP, Cunningham BJ, Herkowitz HN: Techniques in Cervical Laminoplasty. Spine 2(6): 450-455, 2002
15. Sakaura H, Hosono N, Mukai Y, Ishii T, Yoshikawa H: C5 Palsy after Decompression Surgery for Cervical Myelopathy, Review of the Literature. Spine 28(21):2447-2451, 2003
16. Shimamura T, Kato S, Toba T, Yamazaki K, Ehara S: Sagittal splitting laminoplasty for spinal canal enlargement for ossification of the spinal ligaments (OPLL and OLF). Semin Musculoskelet Radiol 5(2): 203-206, 2001
17. Steinmetz MP, Resnick DK: Cervical laminoplasty. Spine 6: 274-281,2006
18. Suk KS, Kim KT, Lee JH, Lee SH, Lim YJ, Kim JS: Sagittal alignment of the cervical spine after the laminoplasty. Spine 32(23):656-660, 2007
19. Vitarbo E, Sheth RN, Levi AD: Open-door expansile cervical laminoplasty. Neurosurgery 60(1):154-159, 2007
20. Wang MY, Green BA: Open-door cervical expansile laminoplasty. Neurosurgery 54(1): 119-123, 2004
21. Wang MY, Shah S, Green BA. Clinical outcomes following cervical laminoplasty for 204 patients with cervical spondylotic myelopathy. Surg Neurol 62:487-493, 2004