

# Combined Laminoplasty With Posterior Lateral Mass Plate for Unstable Spondylotic Cervical Canal Stenosis

## —Technical Note—

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### Abstract

**A technique of combined expanding laminoplasty using longitudinal interspinous iliac bone graft with posterior lateral mass plate is described for the treatment of cervical canal stenosis associated with spinal instability. A 52-year-old male and a 76-year-old female presented with cervical myelopathy. Imaging studies demonstrated spondylotic cervical canal stenosis associated with spinal instability. Posterior stabilization with lateral mass plate by the Axis Fixation System was performed after expanding laminoplasty using interspinous iliac bone graft. The symptoms improved and instability and malalignment (in the female patient) also improved after surgery. This combined surgical technique allows decompression of the spinal cord, immediate internal fixation by plate fixation, and subsequent long-term stabilization by interspinous bony fusion. This technique is indicated in selected patients with multiple segment spondylotic cervical canal stenosis associated with instability and/or malalignment of the spinal column for which simultaneous decompression and stabilization are required.**

Key words: cervical spine, instrumentation, laminoplasty, lateral mass plate, bone graft

### Introduction

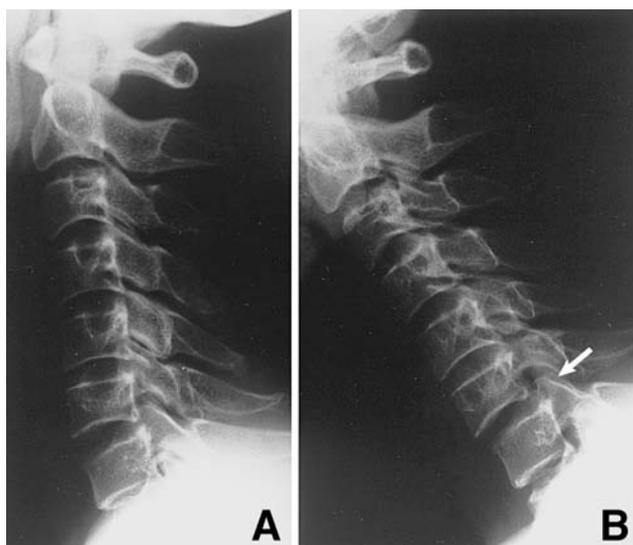
Long segment cervical spondylosis with myelopathy is usually treated by posterior approaches including laminectomy<sup>6)</sup> and laminoplasty.<sup>7,9,10,12,14)</sup> However, laminectomy may result in postoperative instability with associated deformities and delayed neurological deterioration.<sup>6,8,13)</sup> Laminoplasty is widely used for achieving spinal canal expansion but also prevents posterior scar formation and postoperative kyphosis or straightening.<sup>7,9,10,12,14)</sup> We have been employing the modified Kurokawa's method of laminoplasty<sup>9)</sup> in patients with long segment cervical spondylotic myelopathy. However, laminoplasty does not improve spinal alignment, so may not be indicated for the treatment of patients with spinal instability.

Here, we present a technique of combined expanding laminoplasty using interspinous iliac bone graft with posterior lateral mass plating.

### Materials and Methods

**Case 1:** A 52-year-old male was transferred to a community hospital emergency room immediately after fall from a 5 m high construction scaffold. The patient complained of neck pain and dysesthesia in the bilateral fingers. The patient also showed complete paresis in the lower extremities and moderate paresis in the upper extremities. Dynamic cervical radiography revealed cervical canal stenosis with instability between C-6 and C-7 (Fig. 1). Computed tomography (CT) showed a fracture of the C-6 facet joint to the lamina. T<sub>2</sub>-weighted magnetic resonance (MR) imaging demonstrated cord compression and intraspinal high intensity areas at the C3-4 and C6-7 intervertebral levels (Fig. 2). Initially, the patient was managed conservatively with intravenous administration of methylprednisolone and neck collar fixation. His neurological symptoms gradually improved, and his motor weakness became moderate at 1 week after injury.

The patient then underwent surgical intervention. The patient was placed in a prone position with his neck in the neutral position, and his head secured in



**Fig. 1** Case 1. Preoperative dynamic cervical radiographs (A: neutral, B: flexion) showing instability at the C6-7 intervertebral level (arrow).

a 3-pin Mayfield skull clamp. The muscles were carefully dissected via a midline skin incision, and the spinous processes and laminae from C-3 to C-7 were exposed. Each spinous process was removed, and grooves were made with a high-speed drill in the dorsal aspect of the laminae just medial to the bilateral articular facets. Then, posterior fixation using lateral mass plate (Axis Fixation System; Sofamor Danek, Memphis, Tenn., U.S.A.)<sup>2)</sup> was performed. For screw insertion, a point 1 mm medial to the exact center of lateral mass was drilled to a depth of 10–11 mm. The drill was aimed directly anterior and at 10 degrees in the lateral direction. Each self-tapping screw was then positioned and connected to the plate. Screws were positioned in the bilateral C-5, C-6, and C-7 lateral masses, except for the left C-6 lateral mass because of a bony fracture (Fig. 3A, B). Prior to plate fixation, the facet joint was decorticated and the cancellous bone was placed into the facet joint to obtain arthrodesis. As the final step, the laminae were split in the midline with Kurokawa's method. A 4 cm long iliac bone was harvested, and this iliac bone graft was securely tightened with titanium wires (Atlas Cable System; Sofamor Danek)<sup>2)</sup> between C-5 and C-7 (Fig. 3C, D). The iliac bone was decorticated at the attachment to the laminae. Hydroxyapatite spacers (Bonaceram-P; Sumitomo Pharmaceutical Co., Ltd., Osaka) were inserted between the two halves of the split laminae of C-3, and C-4. The operation time was 3 hours 45 minutes and loss of blood was 762 ml.

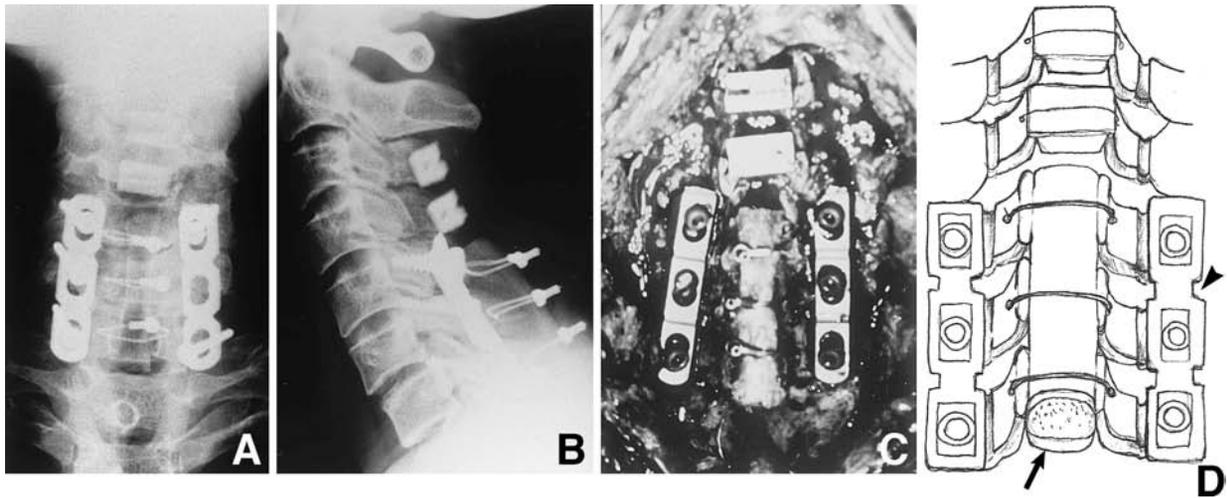


**Fig. 2** Case 1. Sagittal T<sub>2</sub>-weighted magnetic resonance image showing cord compression from C3-4 to C6-7 intervertebral levels and intraspinal high intensity areas at the C3-4 and C6-7 intervertebral levels.

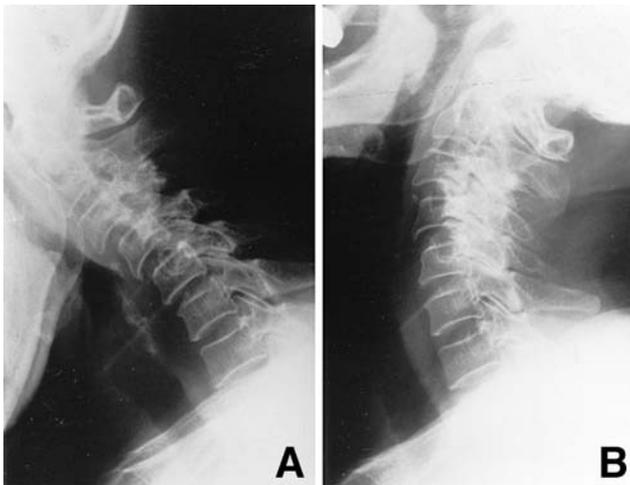
The patient was managed with a Philadelphia collar, and started rehabilitation 1 week after surgery. He was able to walk with a stick and returned to his normal daily life without support 1 month after discharge. The instability improved after surgery and bony fusion was also achieved 15 months after operation.

**Case 2:** A 76-year-old female presented with progressive motor weakness and sensory disturbances including dysesthesia and paresthesia in the bilateral upper and lower extremities. Cervical radiography demonstrated cervical canal stenosis with spinal instability between C-3 and C-5 (Fig. 4), and MR imaging revealed cord compression (Fig. 5A).

Combined expanding laminoplasty using an interspinous iliac bone graft with posterior lateral mass plating was performed to achieve spinal cord decompression, spinal stabilization, and correction of the kyphotic deformity. First, the lateral gutter just medial to the facet joint was drilled minimally to provide stable expanded laminae for the fixation. Posterior fixation using lateral mass plate (Axis Fixation System) was performed at the C-3, C-4, and C-5 facets using 10 to 14 mm screws under x-ray fluoroscopy control. The plate was bent to obtain the normal lordotic curvature of the spine. The facets of C3-4 and C4-5 intervertebral levels were partially decorticated and cancellous bone was inserted into

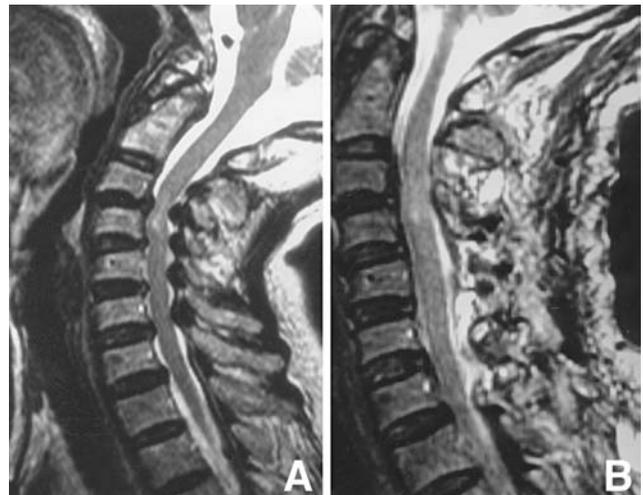


**Fig. 3** Case 1. A, B: Postoperative radiographs (A: anteroposterior view, B: lateral view) showing the plate fixation and the wiring. C, D: Intraoperative photograph (C) and illustration (D) showing hydroxyapatite spacers at the C-3 and C-4 laminae, the iliac bone graft (arrow) between C-5 and C-7, and the lateral mass plates (arrowhead).



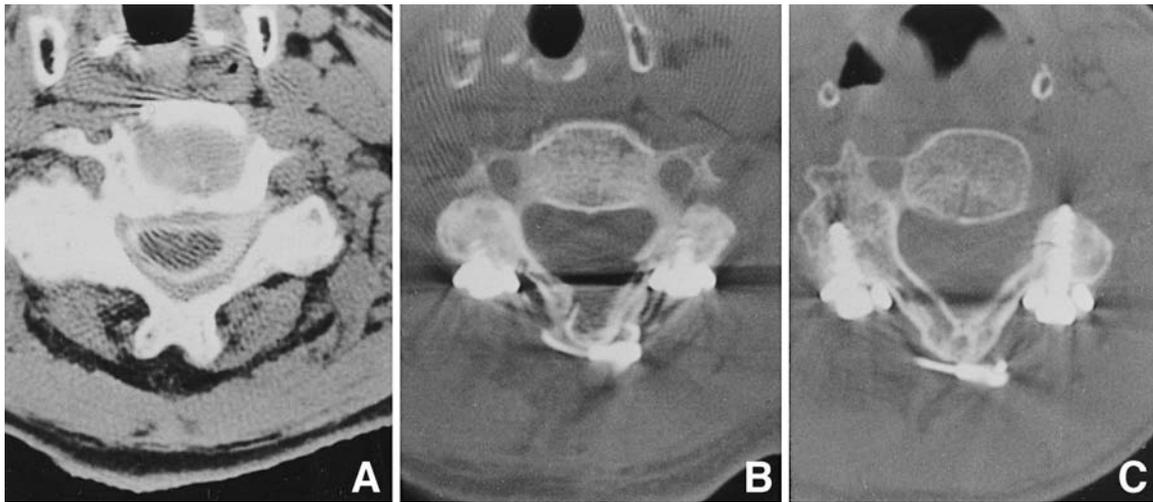
**Fig. 4** Case 2. Preoperative dynamic cervical radiographs (A: flexion, B: extension) showing instability at C3-4 and C4-5 intervertebral levels.

the facet joint space. The spinous process was split according to Kurokawa's method to obtain a wide attachment area of the spinous process and the iliac bone. The iliac bone was decorticated partially at the attachment to the spinous process. A 4 cm long iliac bone graft was placed between C-3 and C-5 and was securely tightened with titanium wires (Atlas Cable System). The autologous spinous processes were inserted and fixed at the C-6 and C-7 levels in the remaining stable portion. The operation time was 5 hours 59 minutes and loss of blood was 750 ml.



**Fig. 5** Case 2. A: Preoperative T<sub>2</sub>-weighted magnetic resonance (MR) image showing degenerative spinal canal stenosis, spinal cord compression, and high intensity change at C3-4 intervertebral level. B: Postoperative T<sub>2</sub>-weighted MR image showing expansion of the spinal canal and preserved alignment.

Her motor weakness and sensory disturbance were improved but not completely resolved after surgery. The patient was discharged 3 weeks after surgery and could enjoy daily life without support. MR imaging (Fig. 5B) and CT (Fig. 6B) showed expansion of the cervical canal compared to the preoperative CT (Fig. 6A). Radiography showed the alignment was lordotic without instability immedi-



**Fig. 6 Case 2. Computed tomography scans at the C4-5 intervertebral level before surgery (A), 3 months after surgery (B) showing the spinal canal is expanded, and 15 months after the operation (C) showing bony fusion.**

ately after the operation. CT revealed partial bony fusion of the iliac bone and lamina after 3 months, and complete bony fusion at 15 months after operation (Fig. 6C). Three and half years after the operation, the patient is independent in daily life and enjoys gardening. Radiography showed no instability or re-stenosis.

### Discussion

The modified Kurokawa's lamina splitting method inserts removed spinous process or ceramic bone between the split laminae as a roof at each cervical level, and provides a good decompression of the spinal cord.<sup>9)</sup> However, laminoplasty with insertion of either hydroxyapatite or autologous spinous process in each level may not improve spinal stability, and malalignment and slight kyphotic changes are sometimes observed after operation. Thus, this procedure may be insufficient to treat patients with spinal instability or to correct the malalignment. The original Kurokawa's method also includes the possibility of use a long iliac bone graft.<sup>9)</sup>

In the present cases, Kurokawa's method was applied with long iliac bone insertion and fusion by new type of titanium wire. The titanium wire system can be tightened with an instrument to provide immediate secure fixation and also compression between the laminae and iliac bone. This compression force is important to obtain long-term bony fusion. However, the kyphotic alignment may not be sufficiently improved using only this technique. We used additional posterior lateral mass plating to

obtain more stable fixation and simultaneously to improve the alignment of the cervical spine. The combination of these methods enables secure stabilization of the unstable cervical spine. Previously, laminoplasty was combined with posterolateral fixation by open laminoplasty without covering the laminae and the bone chips from the resected spinous process were placed in the lateral grooves.<sup>12)</sup> However, no immediate stability could be achieved using this technique. Our current method provides immediate fixation and long-term stabilization, and decompression of the spinal cord. This procedure also maximizes patient participation in the acute stage of rehabilitation.

Combination of laminectomy with posterior fusion is useful for the treatment of patients with cervical spondylotic myelopathy with straight or lordotic spines and multilevel compression, but not for patients with kyphosis (and probably patients with instability).<sup>8)</sup> In fact, postoperative MR imaging of this technique demonstrated kyphotic change. Therefore, simple laminectomy and posterior fusion is not indicated in cases like ours. Since the laminoplasty method is popular in Japan,<sup>7,9,10,12,14)</sup> we think that there is no reason not to combine plate fixation and laminoplasty with multilevel iliac bone graft rather than laminectomy and plate fixation.<sup>1,8)</sup> This combined technique may save an additional anterior approach operation for stabilization or correction of the kyphosis.

Posterior stabilization of the cervical spine may use plating methods and wire techniques. Wire techniques are effective for resisting flexion forces,<sup>15)</sup> but

are less suitable to prevent rotational or extension forces than plating methods.<sup>1-5,8,11)</sup> We employed the posterior lateral mass plate, which allows immediate and excellent fixation at the facet joint. In addition, the plates are secured bilaterally at the locus of movement, and the rotational stability after plating seems superior to that of interspinous wiring techniques. Although posterior plate fixation without bone grafting has achieved high stabilization rates,<sup>2,5)</sup> the series included several cases of screw loosening and increased kyphosis which required anterior fusion or posterior wiring.<sup>5)</sup> Therefore, plate fixation with bone grafting seems to be ideal to achieve immediate and long-term stabilization. In our cases, an interspinous longitudinal iliac bone graft was used in combination with plate fixation, which was expected to provide both immediate fixation and long-term stabilization. Furthermore, the longitudinal multilevel iliac bone graft could also improve the malalignment.

Our bone graft method is somewhat similar to the Bohlman triple wire technique<sup>15)</sup> in using wires and an iliac bone graft to the laminae. However, this technique is not intended to decompress of the spinal canal.<sup>15)</sup> In our technique, the bone graft is placed between the split halves of the expanded lamina in longitudinal fashion. The longitudinally placed bone graft allows fixations throughout the unstable levels. In addition, the cancellous portion of the iliac bone graft faces the split halves of the lamina, which facilitates early bony fusion. The new titanium wire system is also ideal in applying compression force to the transplanted bone.

During the operation, the lateral gutter must not be made too loose because of the possibility of fracture of the lamina at the gutter due to the mechanical stress from the multilevel stabilization. The operation time and blood loss are slightly greater than the usual laminoplasty method or lateral mass plating. However, we think these increases are acceptable because both procedure are performed in one stage and no serious postoperative complication was related to the operation time and bleeding volume. This method may also save an additional operation from the anterior approach.

Combined expanding laminoplasty using iliac bone graft with posterior lateral mass plating can achieve a favorable result after a one stage operation and may be considered in selected patients with spondylotic canal stenosis associated with instability or malalignment.

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### Commentary

The authors reported a technique of combined expanding laminoplasty using iliac bone graft with posterior lateral mass plating for the treatment of spondylotic canal stenosis associated with instability or malalignment. Many surgical procedures have been suggested for the treatment of patients with cervical narrow canal associated with kyphosis and/or instability, including multilevel anterior cervical discectomy and fusion, anterior and posterior combined surgery, and posterior decompression with a long bone graft. The present procedure seemed to be a useful surgical technique which was practically well documented. Many spine and spinal surgeons may be able to adapt this technique in addition to combined anterior discectomy and fusion with simultaneous posterior decompression. Further clinical experiences and long-term follow up will be preferable for observing postoperative cervical alignment and range of motion.

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Matsumura et al. have presented two patients treated with combined laminoplasty and posterior lateral mass fixation. Both patients had cervical spondylosis with spinal stenosis and segmental instability. One patient sustained a cervical spinal cord injury after trauma, and the second patient presented with a slowly progressive cervical myelopathy. The internal fixation and fusion stabilized the cervical spine, and the laminoplasty decompressed the central cervical canal. The advantage of performing laminoplasty rather than laminectomy in these patients remains unclear. With the currently described technique, laminoplasty may offer the advantages of preventing epidural scar formation and increasing fusion rates. However, epidural scar formation is often not a problem in the lordotic cervical spine and fusion rates are high with simple posterior lateral mass fixation and fusion. In a recent critical review of cervical laminoplasty, Ratliff and Cooper concluded that "the literature has yet to support the purported benefits of laminoplasty."<sup>1)</sup> The advantage of laminoplasty versus laminectomy in combination with lateral mass fixation and fusion will need to be proven in larger controlled studies.

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