New Titanium Spacer for Cervical Laminoplasty: Initial Clinical Experience
—Technical Note—

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Abstract

Many commercially available hydroxyapatite (HA) spacers for cervical laminoplasty have been introduced but have disadvantages such as lack of plasticity, easy cracking, and occasional difficulty in fixation by sutures. Here we present the short-term results of a newly designed titanium spacer (Laminoplasty Basket) in open-door cervical laminoplasty, and evaluated clinically and radiologically. The titanium box-shaped spacer with two arms for fixation was easily inserted and fixed into the laminoplasty space with 4-mm or 5-mm length screws after the posterior cervical arch was repositioned for the canal expansion. Twenty-one patients with cervical myelopathy due to spondylosis or ossification of the longitudinal ligament or developmental narrow canal observed for more than 6 months postoperatively were enrolled in this study. The neurological condition of these patients improved from 9.4 points on the Japanese Orthopaedic Association scale preoperatively to 13.5 points at 6 months after surgery. Postoperative radiological evaluation showed no laminar closure or implant failure and cervical spine curvature was maintained. These results seemed to have no significant difference compared with those using HA spacers. This titanium spacer is a potential substitute for conventional HA or other similar devices in cervical laminoplasty.

Key words: cervical myelopathy, hydroxyapatite, laminoplasty, spacer, titanium

Introduction

Cervical posterior decompressive procedures such as laminectomy and laminoplasty are usually indicated for myelopathy associated with cervical spondylosis and/or ossification of the longitudinal ligament (OPLL) and/or cervical disk herniation. Cervical laminoplasty has gradually become established as an intervention since first introduction in 1983,10 despite some doubts about the efficacy for a long time.4,9,26 Artificial spacers seem to be essential elements to support the elevated laminae, so many types of hydroxyapatite (HA) spacers are made commercially to provide stabilization of the expanded laminar arch.8,11,16,17,19,21,29–31 However, HA spacers have the disadvantages of lower plasticity and implant-related complications, such as breakage or occasional difficulty in tightening by sutures, that can result in loosening of the spacers.13–15,23 Novel techniques in laminoplasty with titanium miniplates have been used in cranial surgery.3,6,12,22,27,28 Several types of titanium spacers are designed for laminoplasty,1,5,7,24,25 but no titanium spacers legally approved for spine surgery have been available in Japan.

We recently adopted a titanium spacer for laminoplasty and present the results of cervical unilateral open-door laminoplasty using this device.

Methods

The titanium spacer (Laminoplasty Basket: L-Basket; Ammtec, Tokyo) has been applied in 46 patients since January 2008, 12 cases of bilateral open-door...
laminoplasty and 34 cases of unilateral open-door laminoplasty. Twenty-one of 34 patients with unilateral open-door laminoplasty aged from 26 to 83 years (mean 60.4 years) who could be observed for more than 6 months were enrolled in this study. Main indications for surgery were cervical spondylotic myelopathy in 14 patients, OPLL in 4, and developmentally narrow canal in 3. All patients consented to undergo laminoplasty with the newly designed titanium spacer.

All patients were evaluated preoperatively and at 6 months after surgery. The evaluations included Japanese Orthopaedic Association (JOA) score for the neurological condition, C2–C7 angle and range of motion on plain radiography, and implant condition on computed tomography (CT). Statistical analysis used the Wilcoxon signed-rank test for JOA score and the parametric test (paired t test) for radiological evaluations.

The spacer, made of titanium-6 aluminum-4 vanadium extra low interstitial alloy, consists of a box-shaped cage (10 mm width, 4 mm height, and 8, 10, 12, or 14 mm length) with 15 mm long arms on both sides for fixation (Fig. 1). Bending both arms allows modification of the spacer to fit into the surrounding bony structures followed by fixation with screws (4 or 5 mm length, and 2.0 or 2.4 mm outer diameter). The cage has many small apertures to allow insertion of local bone chips or beta-tricalcium phosphate granules to facilitate bone growth conduction.

The surgical procedure consisted of unilateral open-door laminoplasty from C3 to C6 as follows. After full-length unilateral laminar exposure from the lower part of C2 to the upper part of C7 (Fig. 2A), horizontal amputation of the spinous processes of C3 to C6 was performed with a bone saw. After bilateral laminar exposure was carried out (Fig. 2B), the lower part of the C2 and the upper part of the C7 laminae were partially removed. Following the ipsilateral laminotomy, the outer cortical bone of the contralateral side of each lamina was also drilled out to facilitate elevation (Fig. 2C). After elevation of the laminae, cage templates (8, 10, 12, and 14 mm length) were applied to the space between the elevated lamina and the corresponding lateral mass to choose the appropriate cage size. Both arms were trimmed to the required length. The selected spacer with both arms bent into an “open Z” configuration was fitted into the space between the elevated lamina and the corresponding lateral mass. After fixing all spacers to the elevated lamina with 4-mm or 5-mm length screws, the contralateral sides of the spacers were also fixed to the corresponding lateral masses with the same screws (Fig. 2D). One screw for each arm was used for fixation to the bone structures. After release of the self-retaining retractor, a thicker suture was passed through a hole made in the spinous process and two other holes were made on both sides of the elevated lamina. All spinous processes were re-approximated in the midline (Fig. 2E). All patients wore a cervical soft collar during the first few weeks after surgery.

**Fig. 1** A: Photograph of the implant (Laminoplasty Basket) demonstrating the cage with small apertures and two arms. **B**: Schemas of the implant with multi-axial views.

**Fig. 2** Schemas of unilateral open-door laminoplasty. Unilateral exposure of lamina (A1, A2), bilateral exposure after horizontal amputation of the spinous process (B1, B2), unilateral laminotomy and contralateral gutter (C1, C2), fixation of the spacer (D1, D2), and re-approximation of the spinous process (E1, E2).
Table 1  Preoperative and postoperative (6 month) surgical outcomes of Japanese Orthopaedic Association (JOA) score, spinal alignment, C2–C7 angle, and range of motion

<table>
<thead>
<tr>
<th></th>
<th>Mean JOA score (point)</th>
<th>Alignment (cases)</th>
<th>Mean C2–C7 angle (degree)</th>
<th>Mean range of motion (degree)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lordotic</td>
<td>Straight</td>
<td>S-shaped</td>
</tr>
<tr>
<td>Preoperation</td>
<td>9.4 (6–14)</td>
<td>13</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Postoperation</td>
<td>13.5 (8–16)</td>
<td>14</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>p Value</td>
<td>0.001</td>
<td></td>
<td></td>
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</tbody>
</table>

Values in parentheses show range.

Results

In the 21 patients undergoing unilateral open-door laminoplasty, 63 laminae were elevated in total. Operation time ranged from 75 to 246 minutes (mean 155.4 min). Blood loss ranged from 5 to 120 ml (mean 55.6 ml). No complications occurred except for one case of transient postoperative left C5 palsy. The mean JOA score of 9.4 points improved to 13.5 points (improvement rate 43.6%) at 6 months after surgery. This postoperative improvement was statistically significant (p = 0.001). Cervical spine curvature did not change, except in one patient with kyphotic curvature converted into straight alignment. Preoperative lordosis in 13 patients, straight spine in 4, S-shaped spine in 2, and kyphosis in 1 remained with only change in the mean C2–C7 angle from 13.7 to 13.2 degrees 6 months after surgery (Table 1). The mean C2–C7 angle did not significantly change (p = 0.87). The preoperative motion range of 28.1 degrees decreased by 4.7 degrees (83.6%) (Table 1). However, this decrease in motion was not statistically significant (p = 0.067). No complications related to the cage such as closure of elevated laminae or implant dislodgement were observed (Table 1). All laminae were stabilized within 6 months after surgery with solid bone union at gutter site.

Discussion

In this preliminary prospective study, neurological and neuroradiological outcomes seemed to be sufficient to decide on the early postoperative safety and no implant-related complications or laminar closure occurred as a complication of laminoplasty.20 Reconstructed laminae were assumed to be stabilized, because laminar stabilization is usually accomplished within 3 months postoperatively with bone union at the gutter site.31 Cervical motion reductions of 4.7 degrees with this procedure showed no significant difference from similar procedures using HA spacers (7.2–15.2 degrees).16,18,31 The achievements of safe laminar elevation and maintained spinal alignment resulted in the expected significant neurological improvement.2,18 This newly designed spacer for laminoplasty had several improvements in characteristics as follows. Universal design for both unilateral and bilateral open-door laminoplasty as indicated in Figs. 3 and
Fig. 5  T₂-weighted magnetic resonance image obtained 3 months after unilateral open-door laminoplasty showing minimum artifacts around the cage.

4. Malleability to fit with elevated laminae. Less chance of implant failure such as crack formation associated with HA spacers. Foraminotomy is possible after implantation, as the arms need minimal interface for fixation with lateral masses. Promotion of bone conduction into the cage filled with local bone chips, as postoperative CT indicated continuous bone density inside the cage (Figs. 3 and 4). Minimum artifacts on postoperative magnetic resonance imaging, as the cage consists of thin titanium alloy (Fig. 5). Some mechanical aspects remain to be investigated, but this implant can be a convenient substitute for HA or other commercially available spacers for laminoplasty.

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