



Research Paper

Use of Miniplates and Local Bone Grafts to Prevent Spring Back in Laminoplasty for Cervical Spondylotic Myelopathy

用金屬小綱板和骨移植來防止椎板回彈的技術在椎板成形術中的應用



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ABSTRACT

Background/Purpose: Cervical spondylotic myelopathy/ossification of posterior longitudinal ligament can be treated by anterior or posterior decompression. For multiple levels, it is common to perform posterior decompression by laminoplasty. Hirabayashi described his open-door expansive laminoplasty in 1977, which soon became popular. Spring back of the lamina has always been a problem. Many methods including suturing to soft tissue, suture anchors, bone grafts, hydroxyapatite blocks, and ceramic spacers were used to prevent this problem, but with considerable failure. Recently, miniplates were used to prevent spring back.

Methods: Twenty-nine consecutive patients who had underwent Hirabayashi open-door expansive laminoplasty in a single centre were recruited in this retrospective study. Miniplates were used to keep the laminae open. In addition, the spinous processes of lower cervical vertebrae were excised and used as local bone grafts to fill the gap between the cut laminae. Computerized tomography scans were performed postoperatively for all patients to assess bone union and spring back.

Results: A total of 126 levels of laminoplasty and 51 local bone grafts were studied. The minimal follow-up period was 12 months. Signs of bone union were demonstrated in 123 hinges (97.6%) and 51 bone grafts (100%). No spring back was detected. The clinical outcome in terms of Hirabayashi recovery rate was 47.2%.

Conclusion: Miniplates and local bone grafts are promising and effective tools for preventing spring back in cervical laminoplasty.

中文摘要

引言：後縱韌帶脊髓型頸椎病(CSM)/後縱韌帶骨化(OPLL)可以通過前路或後路減壓治療。在多節的病例,椎板成形術是常見的後路減壓方法。Hirabayashi在1980年代描述了他的單門椎管成形術,並很快廣為採用。椎板回彈一直是椎板成形術的問題。許多方法包括縫合軟組織,錨縫合線,骨移植,人工骨塊hydroxyapatite等,但具有一定的失敗比率。最近,金屬小綱板開始被用來防止椎板回彈。

方法：在單一醫院的回顧性研究。病者都接受了Hirabayashi式的單門椎管成形術,並使用金屬小綱板來防止椎板回彈。此外,手術中將棘突切除並用作本地骨移植植物,放在椎板的開口。術後病者會接受電腦掃描來評估骨癒合和椎板回彈。

結果：29病例,共有126節椎板進行的椎板成形術,51節進行骨移植。隨訪時間最少12個月。骨癒合出現在123節椎板鉸鏈(97.6%)和51骨移植植物(100%)。沒有椎板回彈。病者在JOA恢復方面的臨床結果良好。

Introduction

Cervical laminoplasty has been a means of posterior decompression for numerous cervical conditions, such as congenital cervical canal stenosis, ossification of posterior longitudinal ligament, cervical spondylotic myelopathy, posterior compression

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from ligament hypertrophy, etc. In cervical laminoplasty, a greater dimension of the spinal canal is created without disrupting the dorsal elements and, thus, maintaining posterior stability.^{1,15} Hirabayashi first introduced the method of unilateral open-door laminoplasty in 1977,² and it soon became popular. Traditionally, Hirabayashi used stay sutures over the spinous processes and paraspinal muscles to keep the laminae open. The problem of spring back causing reclosure of laminae was soon encountered, reporting in up to 34% of cases^{3,4} or up to 10% at 6 months.⁵ Thereafter, a variety of methods were introduced to prevent spring back of the opened door. These included the use of titanium plates, suture anchors, hydroxyapatite blocks, ceramic spacers, and bone grafts, with variable outcomes.^{1,6–11} The aim of our study is to look into the clinical and radiological outcomes of the use of miniplates (ARCH plates; Synthes, PA, USA) and local bone grafts in cervical laminoplasty, as well as to find out whether they are effective in preventing spring back.

Methods

Patient population

Thirty-two consecutive patients who underwent unilateral open-door laminoplasty in United Christian Hospital, between June 2011 and July 2012, were reviewed retrospectively (Table 1). The diagnosis of cervical spondylotic myelopathy/ossification of posterior longitudinal ligament was made clinically and radiologically. All patients underwent magnetic resonance imaging preoperatively (Figure 1A and B).

Patients with infection, tumours, trauma with fractures, and rheumatoid disorders were excluded. Cases with cervical spine X-rays demonstrating kyphosis were not excluded.

Table 1
Patients' characteristics and operative details

Age	
Range	42–81
Mean	66.6
SD	10.35
Sex	
Female	8
Male	21
Disease	
Cervical spondylotic myelopathy	20
Ossification of posterior longitudinal ligament	9
Levels of laminoplasty	126
Bone grafts	51
Operative time (min)	
Range	110–235
Mean	174.93
SD	33.3
Levels of decompression	
4	19
5	10
Preoperative JOA score	
Range	3–14
Mean	8.62
SD	3.05
Postoperative JOA score	
Range	0–17
Mean	12.3
SD	3.63
Hirabayashi recovery rate (%)	
Range	0–100
Mean	47.23
SD	23.8

* Data are presented as *n* unless otherwise indicated.
JOA = Japanese Orthopaedic Association.

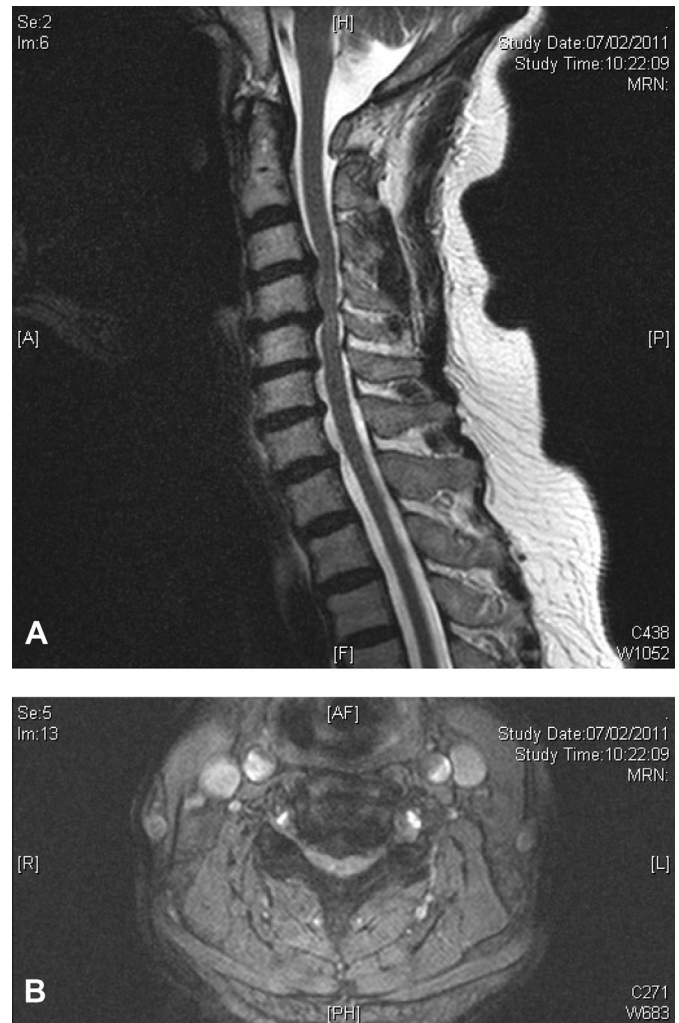


Figure 1. Preoperative magnetic resonance imaging of a patient with cervical spondylotic myelopathy: (A) sagittal image; (B) axial image.

Surgical technique

The operation was performed by spine specialists. Patients were laid prone, with head slightly flexed with a horse-shoe support. A longitudinal midline incision was made. Paraspinal muscles were retracted off the laminae and spinous processes of C3–6 (or C7 if necessary) subperiosteally. Spinous processes of C5 and C6 (C7 as well if it was included in the laminoplasty) were identified and split in the middle by a mini-saw down to the base and then osteotomized. C5 spinous processes were sometimes too small in the Chinese population and were not suitable for use as bone grafts in this operation. The bone grafts were saved to be used at a later stage. Gutters were created in the usual manner using a high-speed burr and Kerrison rongeurs. A hinge is made on the less symptomatic side, by creating a greenstick crack leaving only the ventral cortex intact, while the lamina door is opened on the more symptomatic side by drilling through both the ventral and the dorsal cortices. The gaps of the lamina opening were measured, and the bone grafts were fashioned to fit the gap size. The bone grafts were fixed to the centre of the miniplates by screws and nonabsorbable sutures. Patients with small spinous processes, which could not be used, would have only alternate levels of the laminoplasty gaps filled with bone grafts. The miniplates with or

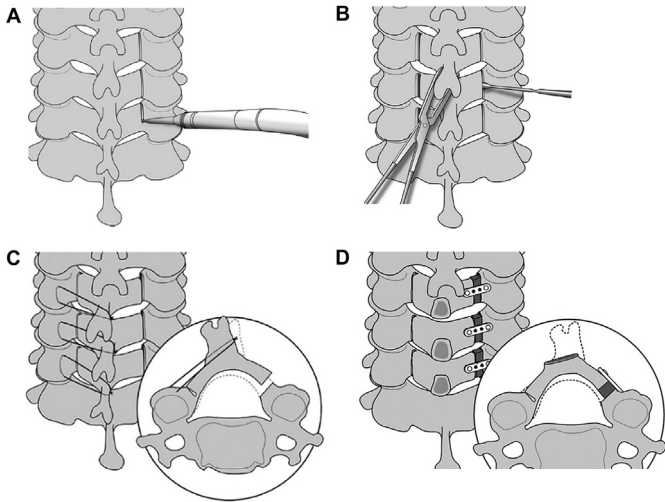


Figure 2. A simplified illustration of the operation. (A) A gutter is created at the junction between each lamina and the medial aspect of the lateral mass. (B) At the hinge side, the gutter is not burred through completely, leaving the ventral cortex intact, while at the other side, the dorsal and ventral cortices are destroyed to create an open door. (C) Decompression is achieved by lifting the door. (D) The spinous process is removed and used as a local bone graft, bridging the gap and keeping the door open by fixing it to the miniplate. Ref. [1].

without bone grafts were fixed to the spine by mini screws, two on the lateral masses and two at the bases of the spinous processes, to keep the door open (Figures 2–7).

Postoperatively, the patients were put on a soft neck collar for 8–16 weeks. Regular follow-ups were arranged for them at the outpatient spine clinic. At each follow-up, patients were assessed clinically for any upper limb symptoms, axial neck pain, C5 palsy, and recurrence of symptoms. Japanese Orthopaedic Association (JOA) scores were used for the evaluation of progress. The JOA score was used to reflect the degree of postoperative recovery of normal function.^{1,12,13} Plain radiographs were taken to check the overall alignment at every follow-up, at 2 weeks, 1 month, and every 3 months thereafter. Computed tomography scanning of the cervical spine was arranged at 6 months or 1 year after the operation. Hinge healing was defined as the evidence of bridging bone in both the ventral and the dorsal cortices. Bone graft healing was defined as cross trabeculation seen between the bone ends. All X-rays and computed tomography scans were read by a single spinal surgery consultant (Figures 8 and 9). Hirabayashi recovery rate was obtained using the following equation:

$$\text{Hirabayashi recovery rate} = \frac{(\text{postoperative JOA score} - \text{preoperative JOA score})}{(17 - \text{preoperative JOA score})} \times 100\%$$

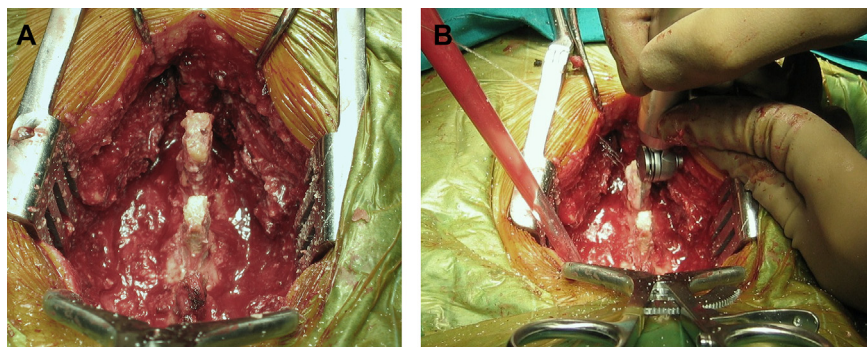


Figure 3. Spinous processes were (A) exposed and (B) split to use as bone grafts.

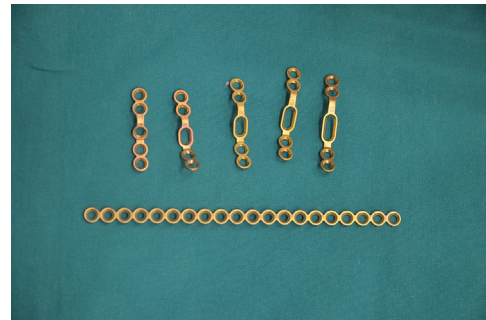


Figure 4. Titanium miniplates.



Figure 5. Bone grafts from spinous process screwed and sutured to the miniplate.

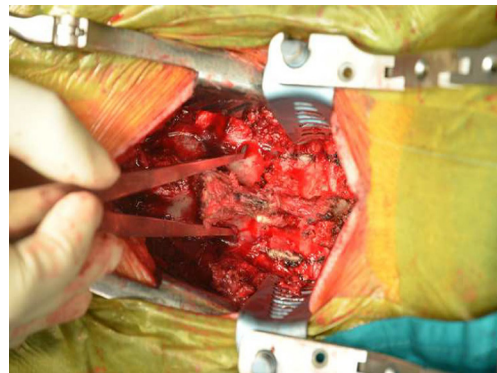


Figure 6. Measuring the dimensions of the opened door with a caliper.

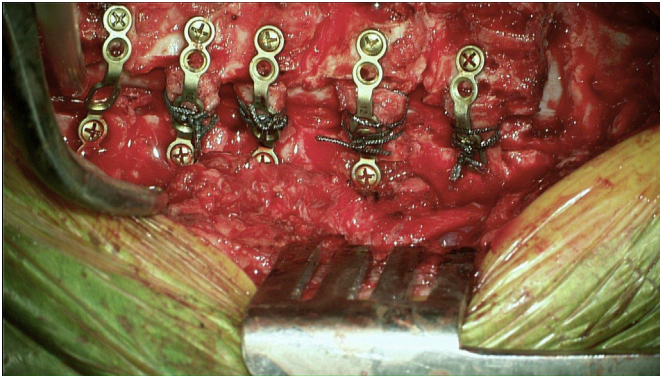


Figure 7. The finished configuration with miniplates and bone grafts incorporated.

All data were collected and coded on a spreadsheet. SPSS statistical software was used to perform statistical analyses. Wilcoxon signed rank test was employed to compare the JOA scores before and 1 year after the operation. A p value of <0.05 is statistically significant. The study was approved by the local ethics committee.

Results

Twenty-nine patients were available for analysis because two died of unrelated causes and one was a revision case. No patients were lost to follow-up.

The female-to-male ratio was of 8:21. The mean age was 66.6 years (range 42–81 years) and the minimum follow-up time was 12 months.

A total of 126 levels of laminoplasty were performed and 51 bone grafts were incorporated. The number of bone grafts used depended on their availability in the spinous processes of lower cervical spine. The mean operation time was 174.9 minutes (range 110–235 minutes).

Satisfactory decompression was achieved in all 29 cases. The mean intraoperative blood loss was 503 mL (range 50–2850 mL, standard deviation 611.5). Clinically, improvement was demonstrated in almost all patients. The mean preoperative JOA score was 8.6 and the mean postoperative JOA score was 12.7 (Figure 10). The mean

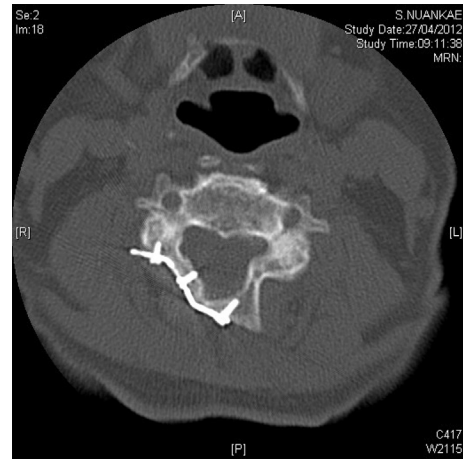


Figure 9. Postoperative CT showing the miniplate in-situ and bone graft incorporating well.

Hirabayashi recovery rate was found to be 47.2% (Figure 11). This is compatible with the results of most reports in the literature.^{1,4,14}

By Wilcoxon signed rank test, a statistically significant difference was noted between the JOA scores before and that 1 year after operation ($p < 0.001$).

No miniplate breakage or screw loosening was found at 1-year follow-up in all patients.

Upon radiological examination at 1 year after operation, healing at the hinges was demonstrated in 123 out of 126 levels (97.6%), while all bone grafts were incorporated (100%). Three hinges, each on a different patient, showed healing of one cortex only. No spring back was found.

Three patients had axial neck pain that resolved with conservative management. Activities of daily living were not affected. Two patients developed C5 palsy during their follow-up.

Discussion

The use of miniplates and local bone grafts is a fairly new method used for keeping the laminae door open in cervical laminoplasty. There are very few reports indicating the success rate of

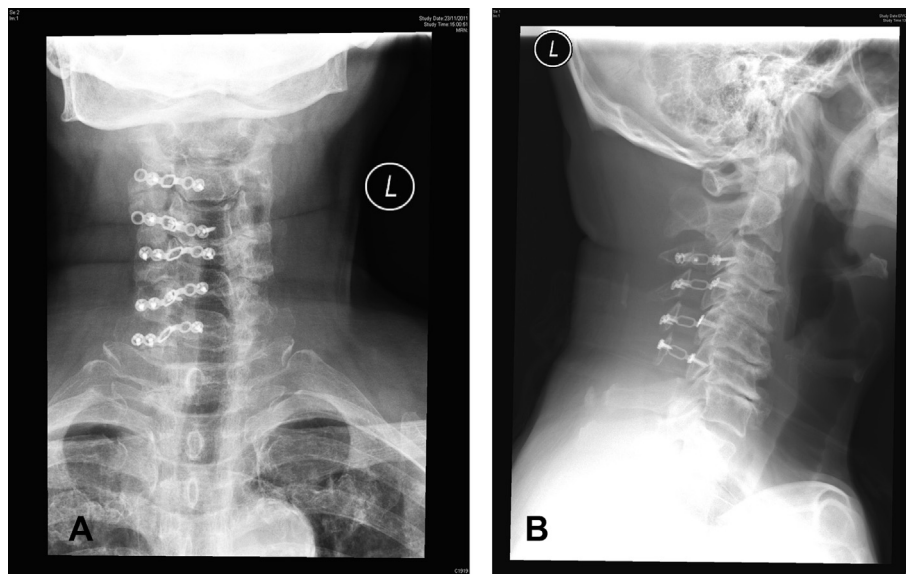


Figure 8. Postoperative radiography: (A) anteroposterior view; (B) lateral view.

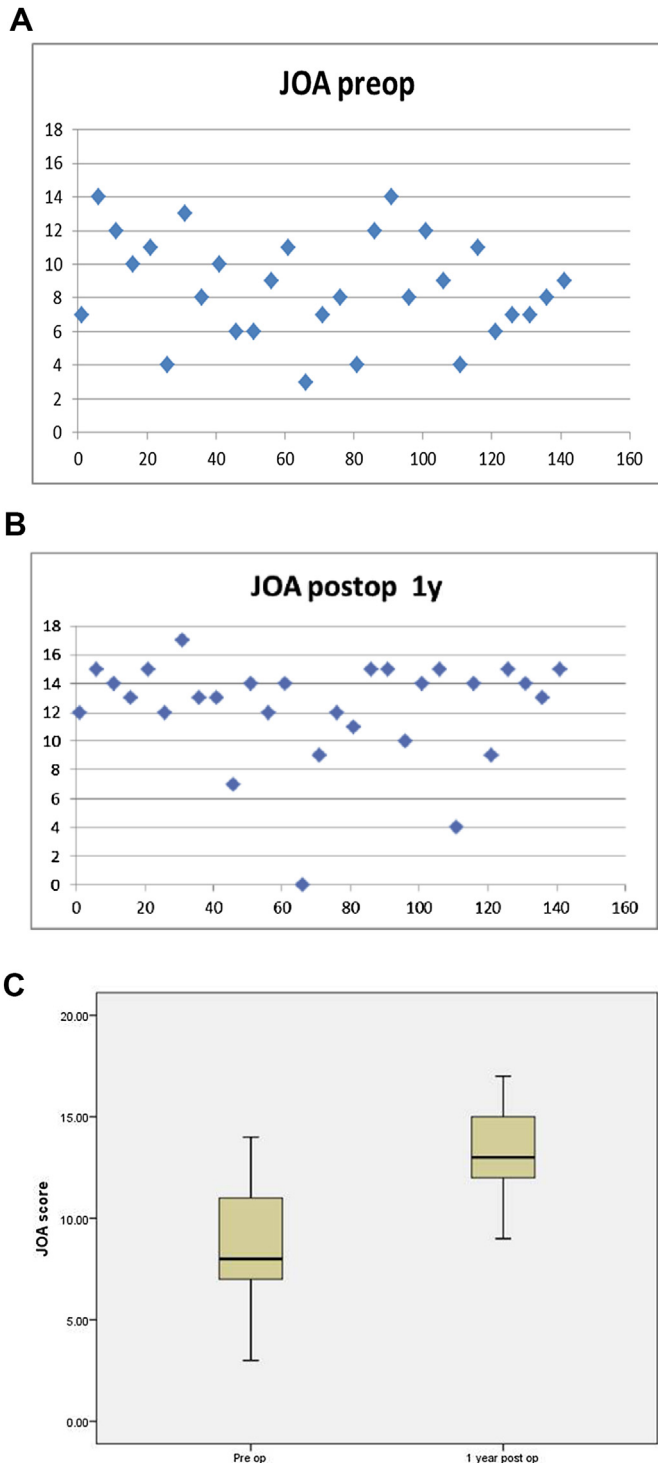


Figure 10. (A) Distribution of preoperative JOA scores. (B) Distribution of 1-year postoperative JOA scores. (C) Comparison of the mean preoperative and postoperative JOA scores. JOA = Japanese Orthopaedic Association.

the use of miniplates plus bone grafts and the stability of the vertebral segments.

Spring back

Spring back is one of the most undesirable results in cervical laminoplasty. It is reported in as much as 34% of patients in Hirabayashi's suture-only open-door expansive laminoplasty.^{3,4} With

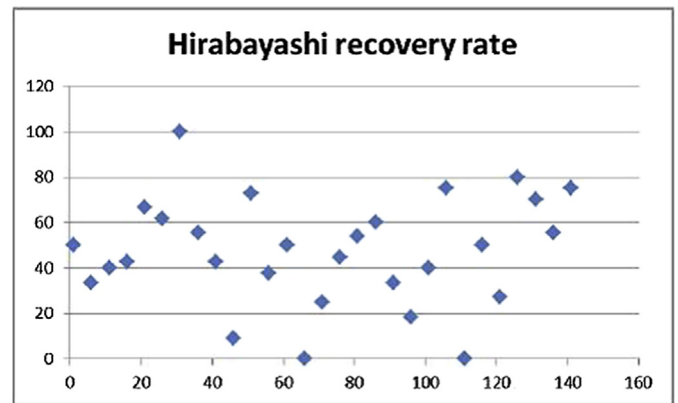


Figure 11. Distribution of Hirabayashi recovery rate.

this conventional method, laminar closure was seen in 10% of patients at 6 months, although a hinge healing rate of 91% was achieved after 6 months.⁵ In a local retrospective series in 2011, spring back was found in 10% of patients at 6 months.²⁵ The rate of spring back varied with subsequent modifications in techniques for holding the laminae door open. Promising results have been reported for plate-only laminoplasty in the literature. In a retrospective study, a hinge healing rate of 93% was achieved at 12 months. No spring back was reported in that series, and those who did not heal, on the basis of computed tomography results, maintained patent expansion of the spinal canal without neurological compromise.¹⁶

Our study has found that miniplates and local bone grafts are promising in preventing spring back. The healing rates at the hinge and bone graft sites were excellent. Even when hinge healing was suboptimal or when the hinge fractured, there was no recurrence of neurological symptoms.

This study demonstrated that levels of laminoplasty with or without bone grafts healed well without spring back. Owing to insufficient samples, we could not conclude whether the use of miniplates alone is sufficient to prevent spring back or both the plates and bone grafts are needed.

Axial neck pain

Three patients (10.3%) suffered from axial neck pain postoperatively. The underlying cause of axial neck pain after laminoplasty has been unclear. It has been reported to have an incidence of up to 60–80%.^{17,18} Muscle dystrophy, after detaching the musculature around C2–7, has been connected to an increased risk of axial neck pain, and muscle-preserving laminoplasty has been reported to reduce the incidence.^{19–22} Some believe in a more crucial role of the spinous process of C7, and that a disturbance in the muscle and ligaments around the C7 spinous process alone can explain the symptoms.²³

The three patients who suffered from axial neck pain in our study underwent C3–6 laminoplasty and C7 was not disturbed. The severity of pain was mild, and they were all treated conservatively. It is, therefore, hard to conclude, in such a small sample of patients, that the preservation of C7 spinous process would lead to a lower incidence of axial neck pain. We postulate with the bone graft, there is less adhesion to the dura by fibrous scar tissue and may have a benefit in lowering axial neck pain. Further study will be needed to confirm this postulation.

C5 palsy

The incidence of C5 palsy was 6.9% (2 out of 29). This is compatible with the modern literature that C5 nerve root paresis

manifesting as deltoid paralysis and biceps weakness is reported to have an incidence of 3–15%.²⁴

Two cases had a Hirabayashi recovery rate of 0/17 at 1 year after operation. One of them is a resident of the elderly home and showed poor rehabilitation potential with general deconditioning after the operation. The other had a score of 4/17 before and 1 year after the operation.

The limitation of our study is the small sample size. The Hirabayashi recovery rate showed a considerably scattered distribution. For long-term results of miniplates in laminoplasty, a larger sample with a longer follow-up is required to find out whether miniplates are effective in preventing spring back and whether they translate into neurological symptoms.

Conclusion

The use of miniplates and local bone grafts produces good results in preventing spring back in cervical laminoplasty in patients with cervical spondylotic myelopathy or ossification of posterior longitudinal ligament.

Conflicts of interest

No conflicts of interest or benefits of any form have been received or will be received that are directly or indirectly related to the subject matter of this article.

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