Clinical Neurology and Neurosurgery 134 (2015) 17–23

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Postoperative three-dimensional cervical range of motion and neurological outcomes in patients with cervical ossification of the posterior longitudinal ligament: Cervical laminoplasty versus laminectomy with fusion

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ARTICLE INFO

Article history:
Received 29 January 2015
Received in revised form 30 March 2015
Accepted 5 April 2015
Available online 17 April 2015

Keywords:
Cervical range of motion
Ossification of the posterior longitudinal ligament
Laminoplasty
Laminectomy
Fusion

ABSTRACT

Objective: Laminoplasty (LP) and laminectomy with fusion (LCF) are acceptable surgical options for cervical myelopathy caused by ossification of the posterior longitudinal ligament (OPLL). This study focused on evaluating cervical range of motion (ROM) on a three-dimensional basis as well as neurological outcomes after LP and LCF.

Methods: This prospective cohort study consisted of 38 patients undergoing LP ($n=20$) or LCF ($n=18$) from December 2010 to December 2012. Before surgery and at the 3rd, 6th, 12th month follow-up, patients were assessed with three-dimensional cervical ROM, Japanese Orthopaedic Association (JOA) scores, Visual Analogue Scale (VAS) and complications.

Results: The patients in both groups had significant ROM loss after surgery in six directions of motion. At the 12th month follow-up, the LP group preserved more ROM than LCF in all directions except bilateral rotations. Major reduction was observed in extension, as with only 59.8% and 54.3% ROM preserved in LP and LCF groups. However, the most preserved ROM was witnessed in rotation, especially in the LP group (90.8%). For JOA and VAS, both groups showed significant improvements postoperatively, and the difference between the two groups was not statistically significant.

Conclusions: Patients with OPLL had an obvious reduction in active cervical ROM following LP and LCF. Major reduction was observed in extension, and less impact was detected on rotation. Compared with LCF, LP had better ROM preserved. Both LP and LCF provided patients with significant neurological improvement.

1. Introduction

Cervical ossification of the posterior longitudinal ligament (OPLL) is an ectopic ossification, which could exert significant chronic pressure on the spinal cord and lead to myelopathy. Patients with severe progressive myelopathy due to OPLL are generally considered as definitive candidates for surgical treatment [1]. However, with more than three levels involved, increasing complications associated with the anterior surgical approaches, such as fusion failure, adjacent level degeneration, instrumentation failure and dysphagia have been observed [2], yielding the posterior approaches preferable. Posterior approaches, such as laminoplasty (LP) and laminectomy with fusion (LCF), are popular surgical options for cervical OPLL without cervical kyphosis.

Laminectomy featured with extensive decompression was initially regarded as the gold standard in treating multilevel cervical myelopathy. However, loss of cervical stability and cervical lordosis after laminectomy has prompted prophylactic fusion of decompressed cervical levels to gain popularity [3]. LP has been offered as an alternative to these approaches, which could maintain postoperative spine stability by preserving the bony arch and the posterior tension band, hence reducing the incidence of postoperative kyphosis without subjecting the patients to the risks of instrumentation [4]. Satisfactory results from the patients with LP or LCF have been reported throughout the literature [5]. However, the above-mentioned approaches will cause subjective discomfort owing to the limitation of cervical range of motion (ROM) [5,6]. In this case, cervical ROM shall be an important parameter in evaluating the effect of surgical treatment.

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http://dx.doi.org/10.1016/j.clineuro.2015.04.004
0303-8467/

A number of studies have compared the cervical ROM after LP and LCF focusing on two-dimensional motions. However, few studies have analyzed cervical ROM on a three-dimensional basis. In addition, though several studies have demonstrated favorable neurological recoveries after LP and LCF, the superiority of one over the other is still a subject of controversy. The primary purpose of this study was to assess cervical ROM on a three-dimensional basis and to examine the neurological outcomes after LP and LCF.

2. Materials and methods

2.1. Patients

This study was a prospective, cohort study of two surgical procedures (LP, LCF) for treating cervical myelopathy caused by OPLL. Inclusion criteria included the following: (1) symptoms of cervical myelopathy (mainly manifested with cervical discomfort, restricted cervical ROM, various degrees of limb numbness, decreased muscle tone, impaired fine motor function, unsteady gait, etc.); (2) failed conventional treatments; (3) lordotic sagittal alignment; (4) at least three levels of cervical compression caused by OPLL with radiographic confirmation. Patients were excluded with the following conditions: (1) myelopathy caused by cervical disk herniation or spondylosis; (2) history of cervical surgery or injury; (3) cervical kyphosis; (4) C2 vertebrae involved; (5) neurodegenerative diseases like Parkinson's disease; (6) unstable medical conditions. Consecutive patients who met the above criteria and admitted to our hospital between December 2010 and December 2012 were included in this study. Approval has been obtained from the institutional review board of our hospital.

2.2. Surgical intervention

All operations were performed by the same surgical team. Patients were allocated into two groups (LP, LCF) by the same surgeon by experience: relative indications for LCF included transverse CT scan indicating transverse diameter of heterotopic ossification larger than 1/2 transverse diameter of vertebral posterior edge. LP procedure was performed at C3-C7 levels in our institution. After the spinous processes and laminae of C3-C7 were exposed, a trough was drilled at the junction of the lateral mass and the lamina on the less symptomatic side with a high-speed drill. The contralateral lamina-facet junction was drilled from C3 to C7 down to the ligamentum flavum. The left lamina was conventionally opened and fixed to the contralateral articular capsule with a tread. LCF started with the similar procedure to the LP, but drilling at the gutters was performed bilaterally and the bone was removed completely. Lateral mass screws were placed bilaterally to C3, C5, C7, and were fixed with rods. The autograft was placed posterolaterally. The postoperative cervical collar period was 4 weeks for all the patients.

2.3. ROM measurement

The CROM device (Performance Attainment Associates, MN, USA), which has been reported to have good intra-tester and inter-tester reliability, was applied for active cervical ROM measurement [7,8]. It could measure the cervical ROM of flexion, extension, lateral flexion, and rotation with separate inclinometers (Fig. 1).

The measurement protocol was set under the CROM device manual (Performance Attainments Associates TM). Each patient was asked to sit in a neutral pelvic position with knees vertical to the floor, feet flat on the floor, and arms resting in lap. The CROM device was placed on the head. For active movements, the patient was asked to move his head at a steady pace as much as possible, whilst keeping back and shoulder still. Movement degrees were recorded when the ROM was stopped by muscle tightness, pain or any substitution movement. Each measurement was performed three times and the average data was calculated by one single surgeon before surgery as well as at the 3rd, 6th, and 12th month follow-up.

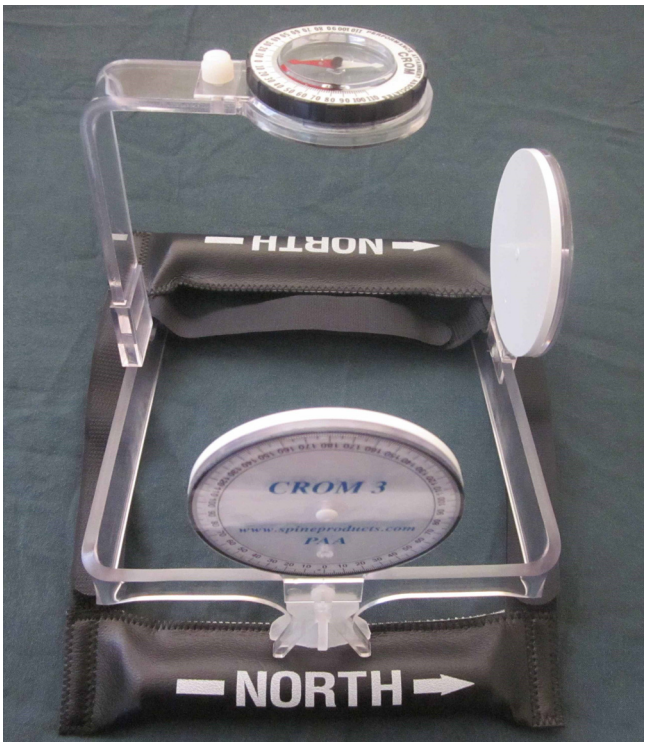

Fig. 1. The CROM device with magnetic yoke.

2.4. Neurological assessment

Patients were evaluated with Visual Analogue Scale score (VAS, score range 0–10, with 10 indicating the worst pain), Japanese Orthopedic Association score (JOA), and complications before surgery and at the 3rd, 6th, 12th month follow-up.

2.5. Statistical methods

SPSS Version 12.0 software (SPSS Inc., Chicago, IL, USA) was applied for statistical analysis. The one-way analysis of variance (ANOVA) was performed to compare ROM, JOA, VAS between LP and LCF group, paired *t*-test was used to compare ROM, JOA, VAS within groups before and after surgery. *P* value <0.05 was considered statistically significant.

3. Results

3.1. General data

A total of 38 patients underwent LP or LCF with an average age of 52, among whom 20 patients had continuous OPLL and 13 patients had mixed OPLL. In LP group, there were 20 patients with 14 males and 6 females, with the mean age of 59 and the mean disease duration of 22 months. In LCF group, there were 11 males and 7 females, with the mean age of 62 and the mean disease duration of 18 months. There was no significant difference between groups. The characteristics of the patients were summarized in Table 1. Until the 12th month follow-up, no cervical kyphosis has been observed. The