

Early results of modified C4-C7 laminoplasty with C3 laminectomy for cervical spondylotic myelopathy in Indian population: An institutional experience

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Abstract

Introduction: Laminoplasty is indicated in patients with cervical spondylotic myelopathy (CSM) who have multilevel cervical spinal cord compression and a neutral or lordotic cervical spine alignment. However, axial neck pain is a common complication post-surgery, which may be caused by surgical damage to the semispinalis cervicis (SSC) muscle attachment on the C2 spinous process. Modified C4-C7 laminoplasty with C3 laminectomy completely preserves the SSC insertion on C2 and reduces the incidence of axial neck pain at subsequent follow-ups.

Aim: Our study aims to evaluate the clinical and radiological outcome of C4-C7 laminoplasty with C3 laminectomy for CSM in the Indian population.

Materials and Methods: We performed a retrospective analysis of 21 patients who underwent the surgery for CSM with a minimum one-year follow-up. Clinical improvement is measured using the modified Japanese Orthopedic Association (MJOA) score and visual analogue scale (VAS). Radiographic parameters evaluated were the C2-C7 lordosis angle and the cervical range of motion (ROM).

Results: In our study, the mean age of the patients was 54 ± 7.7 years, and follow-up period was 20.5 ± 4.6 months. At a one-year follow-up, the mean pre-operative MJOA score improved from 9.5 ± 1.9 to 14.9 ± 1.1 ($p<0.001$). Pre-operative axial neck pain was present in nine patients with a mean VAS score of 4.9 ± 0.8 , which improved to 3.7 ± 0.7 ($p<0.001$) at three-month follow-up. At the final follow-up, only four patients had axial neck pain with a mean VAS score of 1.1 ± 1.4 .

Conclusion: C3 laminectomy with C4-C7 laminoplasty is a safe, effective technique, which achieves good neurological improvement and reduces the incidence and severity of post-operative axial neck pain in the Indian population.

Keywords: Laminoplasty, neck pain, complications, outcomes.

Introduction

Cervical spondylotic myelopathy (CSM) is a chronic degenerative clinical syndrome in which the cervical spinal cord's compression leads to neurological DY functions ^[1, 2]. Classic presentations include subtle loss of balance and coordination, decreased hand dexterity, weakness, numbness, and potential paralysis ^[3]. If left untreated, the condition deteriorates in a stepwise fashion in 75% of patients, slowly and steadily in 20% of patients, and 5% have a rapid onset of symptoms with a stable plateau of dysfunction ^[4]. CSM is the leading cause of spinal cord dysfunction in elderly patients worldwide ^[5]. Surgical intervention is required to prevent further deterioration of the symptoms and aid in the recovery of neurological dysfunction.

Cervical laminoplasty, first described by Oyama ^[6], is a posterior, lamina-preserving spinal cord decompression technique that preserves the dorsal elements. The advantage of preserving dorsal elements is to prevent post-operative kyphosis and iatrogenic instability. Laminoplasty is the treatment of choice in patients with cervical myelopathy who have multilevel cervical spinal cord compression and a neutral or lordotic cervical spine alignment. However, a higher incidence of post-operative axial neck pain has been reported after laminoplasty compared to anterior decompression, resulting in low quality of life in these patients ^[7-9]. Preservation of semispinalis cervicis (SSC) muscle attachment on the C2 spinous process has been emphasized to prevent post-operative neck pain ^[10]. Takeuchi described a modified C4-C7 laminoplasty with C3 laminectomy to completely preserve the SSC insertion on C2 ^[11]. The modification substantially improved axial neck pain at subsequent follow-ups ^[11, 12]. Our study aims to evaluate the clinical and radiological outcome of C4-C7 laminoplasty with C3 laminectomy for CSM in the Indian population.

Methods and Materials

A retrospective study was conducted at a tertiary care institute after obtaining clearance from the institutional ethics committee. A total of 28 patients underwent C4-C7 laminoplasty with C3 laminectomy for CSM between 2015 till 2019. The surgery was advised to clinically and radiologically diagnose CSM patients with multilevel cervical spinal cord compression and a neutral or lordosis cervical alignment.

Inclusion criteria were

- a) Patients who underwent C4-C7 laminoplasty with C3 laminectomy for CSM.
- b) Patients with at least one year of post-operative follow-up.

Exclusion criteria were

- a) Patients with prior cervical spine surgery.
- b) Patients with incomplete or lost medical records.

A total of 21 patients met the criteria and were included in the study.

Patients underwent surgery using the standard posterior approach. The SSC insertion on the C2 spinous process was preserved, and laminectomy was performed at C3. The open door laminoplasty was performed at C4-C7, and a holed lateral mass screw with wire was used to prevent door enclosure. Anatomical closure of muscles and fascia was performed in layers and is critical to prevent post-operative axial neck pain. Post-operatively, a rigid cervical collar was advised for two weeks, followed by gradual neck mobilization exercise as tolerated. Patients were allowed to sit and walk with support on the second post-operative day. Patients were evaluated clinically and radiologically during the follow-up visits at one month, three months, six months, one year, and yearly after that.

Clinical outcome was measured using modified Japanese Orthopedic Associate (MJOA) ^[13]

score preoperatively and at yearly follow-up visits. The recovery rate was measured using the formula: recovery rate = (post-operative MJOA score – pre-operative MJOA score) / (18 – pre-operative MJOA score) × 100 (%) [14]. If present, post-operative complications such as C5 palsy and axial neck pain were evaluated at each post-operative visit. Visual Analogue Scale (VAS) was used to measure the severity of axial neck pain. Radiological evaluation was done using MRI, cervical spine anteroposterior, lateral, and flexion-extension views. Cervical C2-C7 lordosis was measured using Cobb's method [15] preoperatively and yearly follow-up visits. The value is positive for cervical lordosis and negative for kyphosis. Cervical range of motion (ROM) was measured using the formula: C2-C7 angle in extension- C2-C7 angle in flexion. Radiographs were accessed for signs of cervical instability post-operatively.

Continuous variables were summarized using mean and standard deviation, and categorical values were summarized using frequencies and percentages. The changes in average MJOA score, C2-C7 angle, and cervical ROM were estimated by a two-sided student t-test. Pearson's correlation coefficient was used to evaluate linearity between duration of symptoms and preoperatively and post-operative MJOA scores. All tests were performed at a 5% level significance using SPSS (Statistical Package for Social Studies) version 25 for windows (IBM corp., Armonk, NY, USA).

Results

The mean age of the patients in our study was 54±7.7 years, and the mean duration of symptoms before surgery was 10±3.5 months. The demographic data of our study are highlighted in table 1. The mean blood loss during the surgery was 315±61.5ml. At a one-year follow-up, the mean pre-operative MJOA score improved from 9.5±1.9 to 14.9±1.1 ($p<0.001$). Pre-operative axial neck pain was present in nine patients with a mean VAS score of 4.9±0.8, which improved to 3.7±0.7 ($p<0.001$) at three-month follow-up. Only four patients had axial pain at one-year follow-up with a mean VAS score of 1.1±1.4 ($p<0.001$). The mean pre-operative C2-C7 lordosis and the cervical ROM decreased at one-year follow-up, as outlined in table 2. The mean cervical ROM preserved was 62.2±11.5%. There were no radiological signs of cervical spine instability at the final follow-up.

Duration of symptoms before the surgery negatively correlated with the pre-operative and post-operative MJOA scores, as outlined in table 3. One patient developed a post-operative left C5 root paresis that recovered completely at a three-month follow-up. One patient had a superficial stitch infection managed with local debridement and dressings. Apart from the above, no significant complications were observed in the study.

Table 1: Demographic data.

Total number of patients	N=21
Age (years)	54.0±7.7
Duration of symptoms(months)	10.0±3.5
Male: Female ratio	17:4
Diagnosis	
Cervical spondylosis	18
Ossified posterior longitudinal ligament	3
Surgical duration (minutes)	151±23.2
Blood Loss	315±61.5
Duration at final follow-up (months)	20.5±4.6

Table 2: Clinical and radiological parameters.

Parameters	Mean \pm SD	p-value
MJOA Score		
Pre-operative	9.5 \pm 1.9	p<0.001
Post-operative - 1year	14.9 \pm 1.1	
C2-C7 lordosis		
Pre-operative (degree)	18.6 \pm 7.1	P<0.001
Post-operative - 1year (degree)	16.7 \pm 7.1	
Cervical ROM		
Pre-operative (degree)	26.9 \pm 10.1	P<0.001
Post-operative - 1year (degree)	17.2 \pm 8.2	
VAS score		
Pre-operative	4.9 \pm 0.8	p<0.001
Post-operative - 3 months	3.7 \pm 0.7	
Post-operative - 1year	1.1 \pm 1.4	p<0.001

MJOA= modified Japanese Orthopedic Association. ROM= range of motion. VAS= visual analogue scale

Table 3: Duration of duration of symptoms and MJOA scores.

Parameters	Pearson's correlation coefficient	p-value
Duration of symptoms and pre-operative MJOA score	0.86	p<0.001
Duration of symptoms and post-operative MJOA score	0.73	p<0.001

Discussion

In our study, the mean age of the patients was 54 \pm 7.7 years, and the male to female ratio was 17:4. Cervical spondylosis was present in 18 cases and OPLL in 3 cases. The mean duration of symptoms was 10 \pm 3.5 months and the mean follow-up period was 20.5 \pm 4.6 months. The average surgical time was 151 \pm 23.2 minutes, and blood loss was 315 \pm 61.5ml. Our study's demographic and operative data is comparable to the previously published studies for the Indian population [16-18].

Cervical laminoplasty provides satisfactory results over 10 years when performed for cervical myelopathy secondary to cervical spondylosis or OPLL [19, 20]. As measured by MJOA score, neurological impairment improves after laminoplasty and remains consistent at follow-up. Similar clinical improvement is noted after C3 laminectomy and C4-C7 laminoplasty, as per the study by Takeuchi *et al.* [11]. In our study, the mean pre-operative MJOA score improved from 9.5 \pm 1.9 to 14.9 \pm 1.1 (p<0.001) at one-year follow-up with a mean recovery rate of 64.1 \pm 7.5%. Our results are similar to the study by Takeuchi *et al.* and comparable to the results following C3-C7 laminoplasty or laminectomy in the Indian population [11, 17, 18].

Post-operative axial neck pain is a common complication of laminoplasty and can be seen in up to 60% of the patients [7-9, 21, 22]. Some authors have emphasized preserving the attachment of SSC on the C2 spinous process to reduce the incidence of post-operative neck pain while maintaining good cervical ROM [10]. Incidences of repair failure of the SSC have also been observed by Iizuka *et al.* [21]. Hence, to completely preserve the SSC inserted in C2, Takeuchi introduced a modified C4-C7 laminoplasty with C3 laminectomy [11]. In their study, the number of patients with no post-operative symptoms increased from 19% to 52.5%, and the number of patients with neck pain that worsened after surgery decreased from 50% to 17.5% [11]. Mesfin *et al.* reported improvement in Neck Disability Index scores at six weeks and one-year post-surgery using the C4-C7 laminoplasty with C3 laminectomy technique [12]. In our study, pre-operative axial neck pain was present in nine patients with a mean VAS score of

4.9±0.8, which improved to 3.7±0.7 ($p<0.001$) at three-month follow-up. At the final follow-up, only four patients had axial neck pain with a mean VAS score of 1.1±1.4.

Posterior cervical muscles, especially the SSC, act as a dynamic stabilizer of the cervical spine and maintain the sagittal cervical alignment. Takeshita *et al.* reported that the loss of C2-C7 lordosis was 5.2° with a C2 dome laminotomy, and 1.5° when the C2 lamina was left intact during laminectomy [23]. In our study, the mean pre-operative C2-C7 lordosis was 18.6°±7.1° which decreased to 16.7°±7.1°, a difference of 1.9°. The change of cervical lordosis in our study is similar to other studies on cervical laminoplasty [21, 24, 25].

Loss of cervical ROM is common after laminoplasty, which may be due to interlinear bony fusion between adjacent opened lamina and damage to cervical extensor muscles [26]. In our Study, the cervical ROM decreased from 26.9±10.1 to 17.2±8.2 at one-year follow-up, with 62.2±11.5% of cervical motion preserved. Cervical ROM preserved is around 42% to 75%, as observed in various studies on laminoplasty, similar to our study [18, 24, 25].

In our study, patients who presented late had poor pre-operative and post-operative MJOA scores. According to several studies, early surgical treatment in patients with signs of cervical myelopathy leads to a better outcome, similar to our study [18, 27]. C5 nerve palsy is a common post-operative complication of laminoplasty, which is thought to be caused by posterior migration of the spinal cord along with tethering of the ventral nerve root. The reported incidence rate of post-operative C5 nerve palsy is around 5.5%, and around 67% of these palsies recover entirely with conservative treatment at a mean follow-up of 4.1 months [28, 29]. In our study, one patient developed left-sided C5 nerve palsy, which recovered entirely at three-month follow-up.

The limitations to our study include a small number of cases with short-term follow-up, lack of a control group, and the study's retrospective nature. A long-term, multicentric, prospective, controlled, double-blinded study can provide better insight into the surgery outcomes.

Conclusion

C3 laminectomy with C4-C7 laminoplasty achieves good neurological improvement and reduces the incidence and severity of post-operative axial neck pain in the Indian population. The technique is safe, effective, with low rates of complications, and maintains cervical motion. Good clinical outcomes can be achieved by preserving the attachment of semispinalis cervicis at C2 and performing anatomical multi-layered closure of the semispinalis cervicis muscle and fascia.

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