Original Article

Cervical rotation before and after hinge-door cervical laminoplasty for cervical spondylotic myelopathy

ABSTRACT

Background: Hinge-Door Cervical laminoplasty is commonly performed procedure in patients with cervical spondylotic myelopathy. Most available studies have established restriction of flexion and extension motion post laminoplasty but the literature on post-laminoplasty axial rotation is sparse.

Objective: To study the axial neck rotation on either side following hinge door cervical laminoplasty.

Materials and Methods: Twenty consecutive patients of cervical spondylotic myelopathy planned for cervical laminoplasty were included in the study. Preoperative and postoperative radiological data was recorded for each patient and analysed by an experienced neuroradiologist. The clinical and radiological follow-up was recorded at 6 months post surgery. All patients underwent standard hinge door C3-C6 laminoplasty preserving the muscle attachments to C2 and C7 vertebra.

Results: There were 13 men and 7 women with a mean age of 60.5 years, age range 58-70 years. The mean preop C1 C2 rotation was 46.5 degrees and mean post-operative C1-C2 rotation was 44.3 degrees. The average subaxial cervical spine rotation was 11.66 degrees preoperatively and 12.47 degrees postoperatively. The global cervical spine rotation was 80.95 degrees preoperatively and 76.82 degrees postoperatively. There is no significant change in segmental, subaxial and global cervical spine rotation following hinge door C3-C6 laminoplasty preserving the muscle attachments to C2 and C7 vertebra.

Conclusion: Cervical laminoplasty preserves cervical ROM and is a motion-preserving surgery as far as axial rotation is concerned.

Keywords: Cervical spondylotic myelopathy, hinge-door laminoplasty, range of motion, rotation

INTRODUCTION

Hinge-door cervical laminoplasty is commonly performed procedure in patients with cervical spondylotic myelopathy with good postoperative neurological recovery. However, the procedure has been reported to be associated with postoperative restriction of neck mobility and axial neck pain. Most available studies have established the restriction of flexion and extension motion postlaminoplasty, but the literature on postlaminoplasty axial rotation is sparse.[1-3] This study was carried out to study the axial neck rotation on either side after hinge-door cervical laminoplasty.

MATERIALS AND METHODS

The study was carried out in the Department of Neurosurgery, All India Institute of Medical Sciences, New Delhi; a tertiary care apex referral center. Twenty consecutive patients of cervical spondylotic myelopathy planned for cervical laminoplasty were included in the study. Patients with cervical myelopathy due to other causes such as ossified posterior longitudinal ligament, ankylosing spondylitis,

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diffuse idiopathic skeletal hyperostosis, rheumatoid arthritis, cervical trauma, and infection were not included in the study. Preoperative and postoperative radiological data were recorded for each patient and analyzed by an experienced neuroradiologist. Senior neuroradiologists then confirmed these measurements. The clinical and radiological follow-up was recorded at 6-month postsurgery. All patients underwent standard hinge-door C3–C6 laminoplasty preserving the muscle attachments to C2 and C7 vertebra. The study protocol was approved by the Institute Ethics Committee.

Computed tomography scan imaging protocol

The scans were performed preoperatively and at 6-month postsurgery on the same computed tomography (CT) scan machine in the neurosciences center on a 128-slice CT scanner, (Somatom Definition Edge, Siemens Healthcare, Germany) at a tube voltage of 140 kV and tube current of 200 mA. The acquisition was done using spiral CT scan with a slice thickness of 0.6 mm and reconstructed at 1 mm in axial, coronal, and sagittal planes in both soft tissue and bone windows. Data were uploaded in Syngo.via workstation (Siemens Healthcare), and measurements were done after fusion with neutral and rotational datasets.

All patients underwent preoperative magnetic resonance imaging cervical spine as per protocol [Figure 1]. For evaluating the axial rotation on the CT scan, all patients were first placed in the supine position. After the initial scan in a neutral position, the patients were instructed to actively rotate their neck on either side as far as possible while keeping their shoulders horizontal [Figure 2]. The preoperative and postoperative C1–T1 rotation angles were measured in both the directions [Figures 3-5].

Surgical procedure

All patients underwent hinge-door laminoplasty by the Hirabayashi technique. In almost all patients, the decompression was done from C3 to C6. A full-thickness trough was drilled using a high-speed nitrogen drill (Drill size AM8, MIDAS REX, Medtronics) on the lamina on the more symptomatic side, and a partial-thickness trough was drilled on the contralateral side. The ligamentum flavum was removed from the trough. The laminoplasty was secured with miniplates and miniscrews fixed to the lamina and the lateral masses to keep the "door open." After achieving complete hemostasis, the paraspinal muscles were meticulously repositioned, and the closure was done eliminating any possible dead space. The patients were provided Philadelphia collar for 4–6 weeks in the postoperative period.

Statistical analysis

The data were analyzed using SPSS version 24 (IBM SPSS Statistics version 24 IBM, New York, USA). Paired *t*-test was used to test the significance of observations obtained. $P < 0.05$ was considered statistically significant.

RESULTS

There were 13 men and 7 women with a mean age of 60.5 years, age range 58–70 years. The mean preoperative modified Japanese Orthopedic Association score was 10.0 (range: 8–14). The mean postoperative modified Japanese Orthopedic Association score was 14.0 (range: 12–18). There was a mean improvement in

Table 1: Mean preoperative and postoperative cervical spine rotation

	Preoperative rotation	Postoperative rotation	*P*
C1-C2	46.5°	44.3	0.1722
C2-C3	22.8	20.05	0.0813
C3-C4	18.15	19.65	0.0654
C4-5	13.23	14.95	0.0777
C5-C6	11.00	11.75	0.4341
C6-C7	9.6	10.00	0.6751
C7-T1	6.3	6.00	0.7064
Average subaxial cervical spine rotation	11.66	12.47	0.6719
Global cervical spine rotation	80.95	76.82	0.1864

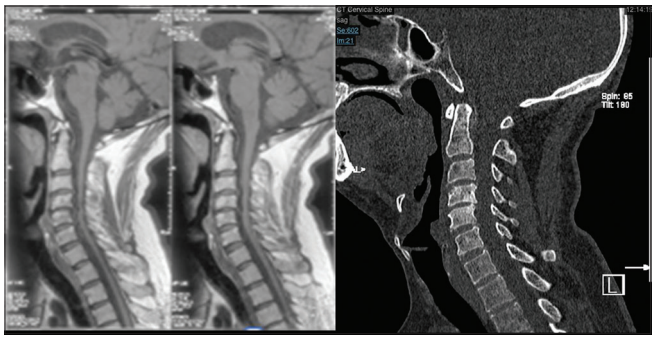

Figure 1: An illustrative magnetic resonance imaging and computed tomography sagittal section showing cervical spondylotic myelopathy

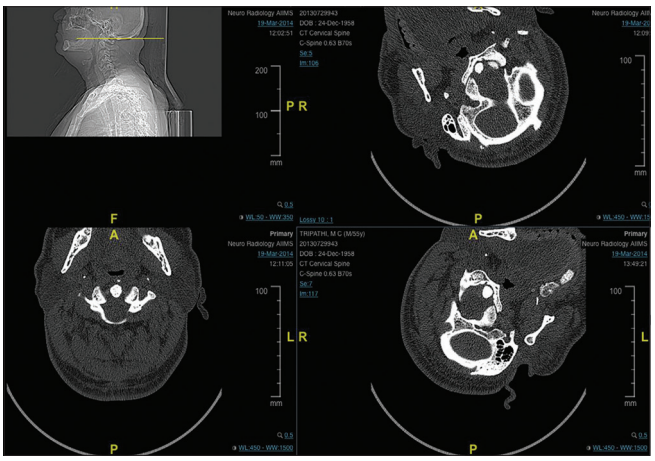

Figure 2: Assessment of axial rotation at C1–C2 level

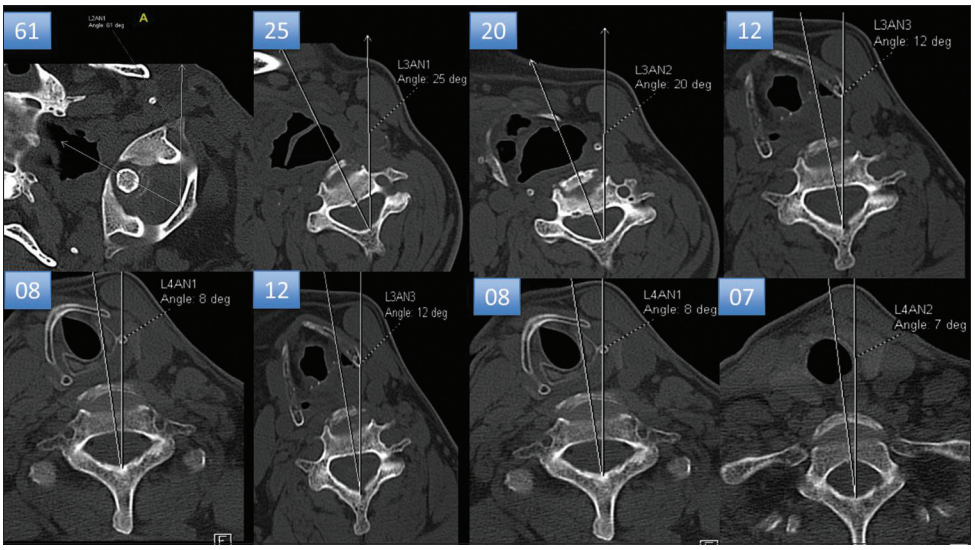

Figure 3: Preoperative axial computed tomography sections showing axial range of motion to the right

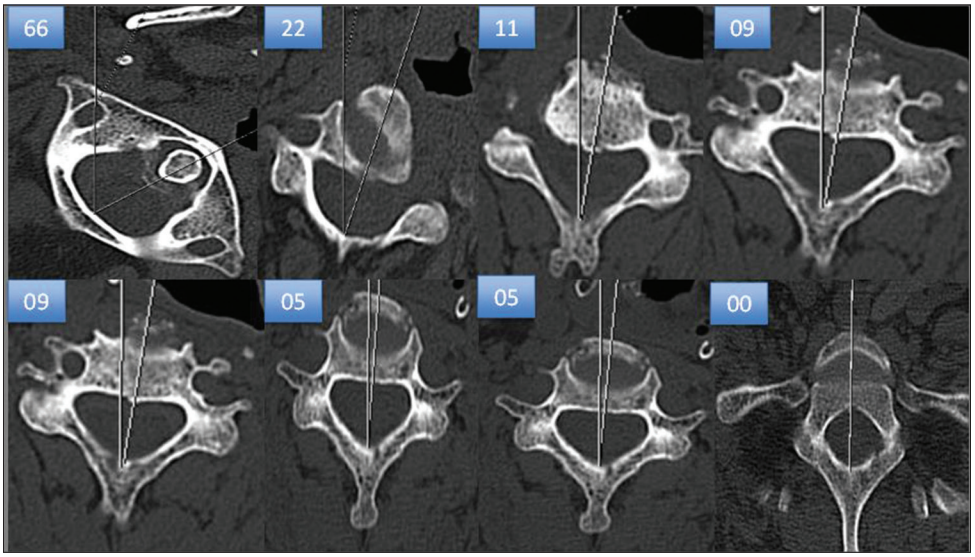

Figure 4: Preoperative axial computed tomography sections showing axial range of motion to the left

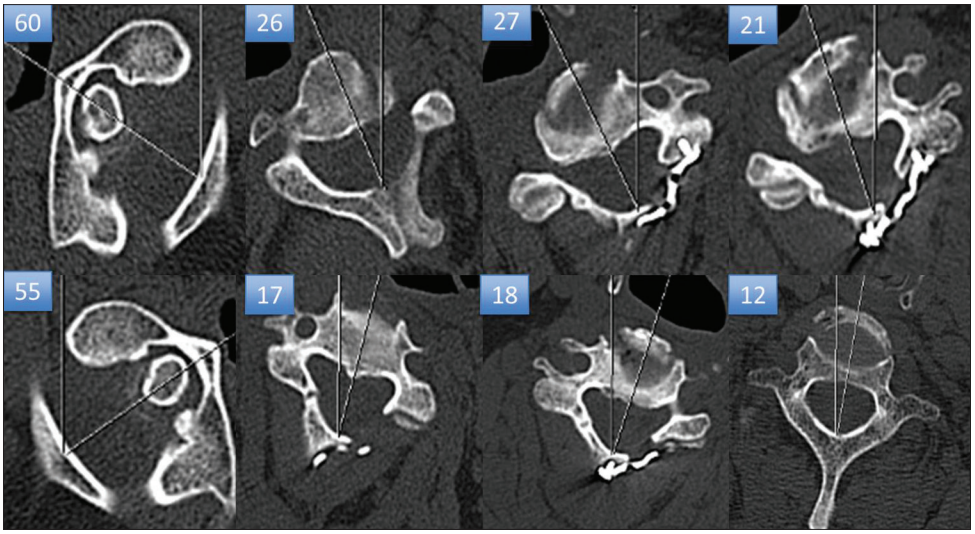

Figure 5: Postoperative axial computed tomography sections showing axial range of motion to the right and the left

postoperative modified Japanese Orthopaedic Association scores by 4 points at 6-month follow-up.

The mean preoperative C1–C2 rotation was 46.5°. The mean preoperativeC2–C3 rotation was 22.8°. Similarly, the preoperative C3–C4 rotation was 18.15°, C4–C5 rotation was 13.23°, C5–C6 rotation was 11.00°, C6–C7 rotation was 9.6°, and C7–T1 rotation was 6.3° [Table 1 and Figure 6].

The mean postoperative C1–C2 rotation was 44.3°, C2–C3 rotation was 20.05°, C3–C4 rotation was 19.65°, C4–C5 rotation was 14.95°, C5–C6 rotation was 11.75°, C6–C7 rotation was 10.00°, and C7–T1 rotation was 6.00° [Table 1 and Figure 6]. The average subaxial cervical spine rotation was 11.66° preoperatively and 12.47° postoperatively [Figure 7].

The global cervical spine rotation was 80.95º preoperatively and 76.82° postoperatively [Figure 7]. There was an insignificant decrease in C1–C2 rotation postoperatively by 2.3°. There was an insignificant decrease in C2–C3 rotation postoperatively by 2.75°. There was an insignificant increase in subaxial cervical spine rotation overall by 0.81° with an insignificant decrease in C7–T1 rotation by 0.3°. This was reflected as a decrease in the global cervical spine rotation by 4.13° [Figure 7].

DISCUSSION

The cervical spine is the most mobile segment of the vertebral column. The assessment of the mobility of cervical spine was a challenge before the advent of functional CT owing to its complex anatomy. Functional CT scan is a useful method to evaluate axial rotation at the atlantoaxial level and the subaxial level.[2] The majority of studies that have studied cervical motion have primarily dealt with the sagittal planar movements of flexion and extension.[4] Hyun *et al*.[5] reported a decrease in cervical spine range of motion (ROM) by as much as 20% at 6 months following expansive laminoplasty, but they primarily measured flexion and extension by C2–C7 angles on lateral radiographs. The CT scan is vastly superior, as it allows for the visualization of the C7–T1 region that is masked by the shoulders in the lateral radiographs.

Most of the previous studies have reported that cervical ROM decreases significantly following laminoplasty.[1,3,5-19] However, there are only a few studies that have studied cervical rotation on CT scan while evaluating cervical ROM [Table 2].[14,20,21]

Baba *et al*.[1] were one of the first investigators to evaluate segmental cervical ROM using lateral radiographs and they found a significant decrease in cervical ROM at all levels, except C2–C3 and C7–T1 at an average of 5.8-year follow-up. It is difficult to accurately assess segmental ROM on functional radiographs, as the increments are often too small. However, even they did not assess cervical rotation.

Takeuchi *et al*.[21] reported that rotation is much preserved if the semispinalis cervicis insertion is preserved as compared to where it is not. Sugimoto *et al*.[20] reported in their study that there was a decrease in the rotation angle 2 weeks postlaminoplasty, which recovered to over the next 6 months.

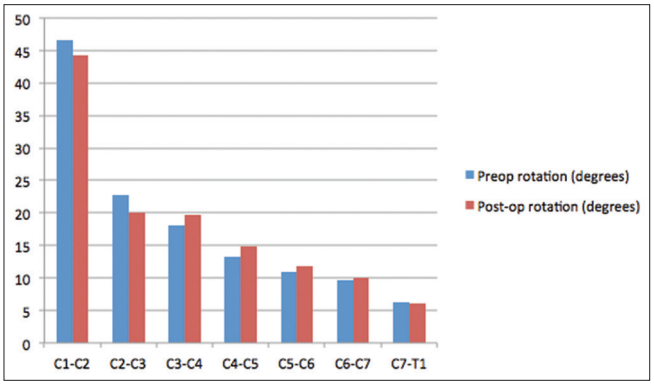

Figure 6: Segmental rotational range of motion of cervical spine before and after laminoplasty

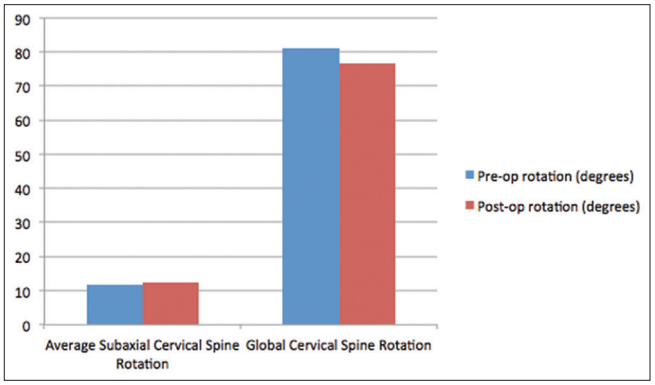

Figure 7: Subaxial and global cervical spine rotational range of motion before and after laminoplasty

Table 2: Previous studies which have reported on axial range of motion following laminoplasty

Investigator	Number of patients at final follow-up	Mean follow-up	Results
Nagamoto[14]	11	6 months	Statistically insignificant 10.2% decrease in segmental cervical rotation
Sugimoto[20]	18	6 months	C1-T1 rotation angle significantly decreased at 2 weeks after surgery, but recovered to almost preoperative levels (11% decreases) by 6 months after surgery with no difference between the right and left motion Subaxial rotation (C2-T1) angles did not significantly decreased after the surgery

Hence, this corroborates with the findings in our study that axial rotation is preserved postlaminoplasty. Nagamoto *et al*.[14] described C0–T1 ROM in flexion-extension as well as rotation using functional CT scan and found that C0–T1 ROM did not change significantly at 6-month follow-up which corroborates with our finding that there is an insignificant change in the global cervical spine ROM.

We also found that the global cervical spinal rotation decreased slightly despite a marginal increase in the average subaxial cervical spinal rotation. This reaffirmed the fact that 60% of the global cervical rotation occurs at the atlantoaxial joint alone[2] and any decrease in the same affects the global cervical rotation.

Our study is a valuable addition to a scarce literature there is relative preservation of axial ROM if hinge-door laminoplasty is done in an appropriate fashion preserving attachments at C2 and C7.

Limitations of the study

This study was done with the precise objective of assessing cervical axial rotation only. As such global cervical spine ROM, which includes flexion-extension and lateral bending also, was not assessed as there are already studies regarding it. The sample size was small. Further studies are needed with a larger sample size. Furthermore, we did not compare the axial rotation following laminectomy and lateral mass fixation with that following laminoplasty which is the limitation of the current study.

CONCLUSION

Cervical laminoplasty preserves cervical ROM and is a motion-preserving surgery as far as axial rotation is concerned. The decrease in global cervical spine rotation angle is insignificant if at all it does occur. Subaxial spine rotation angles also do not decrease after laminoplasty. Functional CT scan is the best modality to assess cervical ROM postsurgery.

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Conflicts of interest

There are no conflicts of interest.

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