Comparative outcome analysis of lateral mass fixation and trans-facet fixation with posterior decompression in the management of cervical spondylotic myelopathy: An institutional experience

ABSTRACT
Aims and Objectives: Posterior subaxial cervical fusion with lateral mass screw and rod instrumentation is a well-established fixation technique. Subaxial transarticular facet fixation is a lesser known fusion technique that has been shown to be biomechanically equivalent to lateral mass screws. The aim of this study was to evaluate the outcome of cervical decompressive laminectomy with lateral mass fixation compared with decompressive laminectomy with trans-facet fixation.

Materials and Methods: The study was conducted with 20 patients operated for cervical decompressive laminectomy with lateral mass fixation compared with 20 patients operated with trans-facet fixation. The modified Japanese orthopedic association score (mJOA) scale, Nurick’s functional grading and neurological recovery rate (NRR) was used as the functional outcome measurement. The clinical follow-up period was 6 months.

Results: In Group I, the mean preoperative and postoperative mJOA scores in Group I and II were 8.2 ± 2.1 and 12.7 ± 2.8 and 9.3 ± 1.9 and 13.5 ± 1.88, respectively, were statistically significant (P < 0.05). Postoperative NRR at the end of the follow-up period was satisfactory (excellent and good) 55% in Group I and 60% in Group II. Fusion was documented in all 40 patients. No patients experienced neural or vascular injury as a result of screw position.

Conclusions: Both trans-facet and lateral mass fixation techniques are simple, safe, and effective procedures in achieving relief and improvement in patients with multilevel cervical spondylotic myelopathy. Trans-facetal fixation can provide a reasonable alternative to lateral mass fixation.

Keywords: Cervical fixation, cervical spondylotic myelopathy, lateral mass, trans-facet

INTRODUCTION
Cervical spondylotic myelopathy (CSM) is a degenerative disorder of the cervical spine that can potentially cause devastating and irreversible impairment of neurological function.[1-3] Among the adult population, CSM is a major source of disability and is the leading cause of acquired spinal cord dysfunction.[4,5] Given the progressive nature of CSM, many authors advocate surgical treatment of patients diagnosed with this condition.[5,6]

The most optimal surgical technique for CSM is frequently debated among surgeons and is a source of controversy in our
field. Surgical treatment options for CSM include: Anterior cervical discectomy or corpectomy and fusion, laminoplasty, laminectomy, and cervical laminectomy with fusion. All four methods have been shown to be efficacious in the treatment of CSM, and each have their merits, indications, and relative contraindications. Interest in posterior cervical decompression for the treatment of CSM and ossified posterior longitudinal ligament (OPLL) has been renewed since the publication of good results with laminoplasty. Laminoplasty, however, affords little immediate stability and may permit the development of progressive kyphosis. Laminectomy with posterior fusion, however, produces immediate stability of the decompressed levels, thus preventing the development of kyphosis and making further growth of compressing osteophytes unlikely to occur.

Among the various surgical fixation methods employed for CSM, posterior cervical fixation with lateral mass screws, first described by Roy-Camille et al. in 1979, is regarded as gold standard especially for the management of multilevel CSM. Majority of the literature mentions that fusion rate after lateral mass screw and rod fixation were almost 99%–100%. Trans-facet fixation in the cervical spine, first described by Roy-Camille et al. in 1972, affords an alternative to standard screw placement for plate fixation and cervical stabilization.

In this study, the authors detail their clinical results with cervical laminectomy and fusion in the surgical management of CSM patients. The aim of the present study was to compare the two methods of posterior cervical fusion: Lateral mass fixation versus trans-facet fixation and clinical, radiological, and functional outcome in patients of CSM.

MATERIALS AND METHODS

We retrospectively reviewed the records of all patients treated for myelopathy caused by cervical spondylosis or OPLL with multilevel cervical laminectomy and immediate stabilization with either lateral mass screws and rod fixation or trans-facet screws fixation, between January 2019 and December 2020. Forty consecutive patients diagnosed of CSM who underwent cervical laminectomy between January 2019 and December 2020, formed the study population. The study was done at a tertiary referral center in North India. The study was approved by institutional ethics committee and an informed consent was obtained from all the patients. The inclusion criteria were – CSM with multilevel pathology (more than two levels), lordotic and straight spinal alignment, with definitive radiological features of cervical cord compression, as diagnosed by a radiologist. The exclusion criteria included patients with kyphotic cervical curvature and failure to obtain informed consent. Patients who underwent simultaneous anterior and posterior cervical decompression and those who experienced neurological deterioration after trauma were also excluded.

The study was conducted on two groups. Twenty patients operated for cervical decompressive laminectomy with lateral mass fixation using the Magerl technique at various levels from C3 to C7 according to the patient’s requirements formed Group I, were compared with another 20 patients operated for cervical decompressive laminectomy with trans-facet fixation using Takayasu et al. technique named Group II.

Operative procedure

In both group, the dissection was extended laterally till full exposure of the lateral mass and facets. The lateral border of each lateral mass was dissected which is a very important step for the placement of the screws. The screws were placed into lateral mass of the affected levels of the subaxial cervical spine before laminectomies so that the bony landmarks can be used for better orientation.

In Group 1, patients were operated with Magerl technique for lateral mass fixation: The entry point of the screw was identified 2 mm inferior and 2 mm medial to the center of the lateral mass using a high speed drill with a trajectory superiorly and laterally 25° in the axial plane, more or less parallel to the inferior spinous process. Fluoroscopy was not necessary during the placement of the screws, but required whenever we felt not confident enough or after the screws were inserted. The patient then underwent laminectomy for decompression, then the rod was inserted and the screw nuts were tightened.

In Group 2, patients were operated with Takayasu et al. technique for trans-facet fixation: The entry point used is 2 mm above the middle of the lateral mass without any lateral angulation. Under fluoroscopic guidance the facet is drilled until all the four cortical surfaces are purchased. Then, the depth is measured to assess the length of the screw required. This is followed by tapping and screw insertion both of which are done under fluoroscopic control. All screws are placed prior to laminectomy to decompress the cervical cord. Finally, the posterior lateral aspects of the lateral mass and the facet joint underwent decortication for bony fusion using bone grafts. Drainage catheters were placed before the closure of the wound.

The presenting clinical symptoms and the outcome are enumerated in Tables 1 and 2. Modified Japanese Orthopedic
Association (mJOA) score, Nurick’s functional grading, and neurological recovery rate (NRR) criteria were used to evaluate the patients before and after surgery and at a follow-up. All patients were investigated with dynamic (flexion and extension views) plain radiography and computerized tomography scan and magnetic resonance imaging before and after surgery. All radiographic measurements were taken with the neck in the neutral position. The radiographic analyses that were performed included the assessment of bone fusion.

The patients were followed up for at least 6 months. Plain X-ray cervical spine was done in AP and lateral study before discharge from the hospital and at 3 months interval later on. The patients were recommended to wear hard cervical collar for at least 6 weeks postoperative, bony fusion recorded within this period of follow-up.

**Statistical analysis**

Data analysis was performed using the Statistical Package for the Social Sciences for Windows version 20 (SPSS Inc., Chicago, Illinois, USA). Data were statistically described in terms of mean ± standard deviation, range, frequencies (number of cases), and percentages when appropriate. Subgroups were compared by Chi-square test, when appropriate. A twosample t-test was used to test the mean differences between the independent samples. Presurgical and postsurgical management were assessed using a paired t-test. The results were considered statistically significant at \( P < 0.05 \).

**RESULTS**

The study included 40 patients. The mean age of Group 1 and Group 2 was 50.9 ± 7.3 years and 53.7 ± 6.5 years, respectively. Male sex was predominant in both groups. Male: Female ratio was 3:1. The mean duration of symptoms was 12 ± 3.6 in Group 1 and 11.5 ± 3.7 months in Group 2 [Table 1]. The mean preoperative mJOA score was 8.2 ± 2.1 in Group 1 and 9.3 ± 2.7 in Group 2, while the mean postoperative mJOA scores score was 12.7 ± 2.8 in group 1 and 13.15 ± 1.88 in group 2 [Table 2]. The mean preoperative Nurick’s functional grading was 4.2 ± 0.7 in Group 1 and 3.95 ± 0.8 in Group 2, while the mean postoperative Nurick’s grading was 3 ± 1.1 in Group 1 and 2.85 ± 0.7 in Group 2 [Table 3]. In Group 1, the operative time ranged from 90 to 140 min with a mean of 110 ± 14.16 min, the hospital stay ranged from 4 to 7 days with a mean of 5 ± 1.76 days and the blood loss ranged from 250 to 800 ml with a mean of 380 ± 193.04 ml. In Group II, the operative time ranged from 80 to 120 min with a mean of 90 ± 24.38 min, the hospital stay ranged from 3 to 6 days with a mean of 4 ± 1.57 days and the blood loss ranged from 100 to 450 ml with a mean of 300 ± 111.22 ml [Table 4].

As regards the complications, we found no recorded cases of spinal cord injury or spinal nerve root injury or screw pullout in both groups. Dural tear was present in two patients in Group I and one patient in Group II. Postoperative neurological deficit occurred in two patients in Group I and one patient in Group II, on comparison with the preoperative condition of the patients. No wrong level was detected in postoperative radiography. In Group I, we recorded three patients complained of superficial wound infection that was treated medically in comparison with two patients in Group II. No recorded cases of vertebral artery injury were found [Table 5].

According to the surgery-related complications in this study, there were no serious complications such as neurovascular injuries, CSF leak, or deep infection necessitating screw removal [Table 5]. The postoperative NRR at the end of the follow-up period was satisfactory (excellent and good) in 55% in Group I and 60% in Group II [Table 6]. There were statistically nonsignificant differences regarding the postoperative clinical results in both groups. Group 2 had better “improved” and less “worsened” postoperative clinical results [Table 6].

In both group, plain X-ray was done in A–P and lateral positions for all the patients immediately postoperative and after 3 month interval till bony fusion was detected.

| Variables | Subdivisions | Group I, n (% | Group II, n (%) | \( P \)
|-----------|--------------|---------------|----------------|----------------|
| \( n \)    | 40           | 20            | 20             | 0.483          |
| Age       | Mean±SD      | 50.9±7.3      | 53.7±6.5       | 0.106          |
| Sex       | Male         | 15 (75)       | 16 (80)        | 0.543          |
|           | Female       | 5 (25)        | 4 (20)         |                |
| Onset of presentation (months/years) | | 12±3.8 | 11.5±3.7 | 0.095 |
| SD - Standard deviation |

| Groups   | Variables | Preoperative mJOA score | Postoperative mJOA score |
|----------|-----------|-------------------------|--------------------------|
| Group I  | Mean±SD   | 8.2±2.1                 | 12.7±2.8                 |
| Group II | Mean±SD   | 9.3±1.9                 | 13.15±1.88               |
| \( P \)  | 0.089     | 0.078                   |                          |

*Significant. MJOA - Modified Japanese Orthopedic Association; SD - Standard deviation
Bony fusion was achieved in all the patients after 3 months follow-up. Stability of the fixation was confirmed in postoperative X-ray in flexion and extension films in all the patients [Figure 1].

DISCUSSION

CSM is a condition of chronic spinal cord dysfunction in the cervical region with insidious onset and slowly progressive course as it is compromised by cervical spondylosis which is believed to be an age-related degenerative disorder of the cervical spine components with highly variable presenting symptoms and signs in the adult population over 50 years.[15] Brain et al.[16] defined it for the first time in 1952. CSM is caused by both dynamic and static factors. All efforts have been directed toward the elimination of the static factors such as cervical intervertebral disks and disk-osteophyte complexes, hypertrophied ligaments, and/or OPLL.[17-21] Even the added fixation and eventually fusion is just complementary to the resection procedures to prevent the expected postoperative instability.[22-25] The oldest technique for posterior decompression of CSM is laminectomy without fusion. The major postoperative complication of such an approach is postlaminectomy instability.

This was a comparative retrospective study that involved 40 patients with CSM, who were admitted and managed in the neurosurgery department of our institute, from January 2019 to December 2020. Group I included 20 patients who underwent posterior cervical laminectomy with lateral mass fixation. Group II included 20 patients who underwent facet fixation with laminectomy. The patients were followed up for 6 months in the outpatient clinic of neurosurgery. There was no significant association between age, sex, or duration of symptoms and NRR in both groups. Many studies in the literature concluded similar results in their studies that age, sex, or duration of symptoms of the patients at presentation was not important variables or prognostic factors influencing the surgical outcome.[25,26]

In this study, Group I comprised 20 patients (100%) with 15 males (75%) and 5 females (25%). Group II comprised
20 patients with 16 males (80%) and 4 females (20%). In both groups, we found that males are more affected than females as they were more exposed to trauma, but there were no significant statistical differences between both groups as regards the sex. This was matched with other studies by Watter and Levinthal\textsuperscript{[27]} who showed that males were more affected than females (61% males and 39% females) in a similar study and also O’Laoire and Thomas\textsuperscript{[28]} who found that males are commonly affected than females (65 males to 35 females) in another study.

In Group I, the age ranged from 44 to 65 years with a mean of 50.9 ± 7.3, and in Group II, the age ranged from 40 to 66 years with a mean of 53 ± 6.5. Watter and Levinthal\textsuperscript{[27]} study showed that the average age was 46 years and O’Laoire and Thomas\textsuperscript{[28]} showed that the average age was 47 years, and finally, Jankowitz and Gerszten\textsuperscript{[29]} showed that the average age was 50–60 years in a large series.

There was significant improvement of myelopathy in both groups. The improvement was mostly due to the stability of the cervical spine after fixation and widening of the intervertebral foramen to decompress the nerve root in both groups. This was matched with other studies as Epstein and Epstein \textit{et al.}\textsuperscript{[30]} recorded 85% improvement after cervical laminectomy with fixation in comparison with other posterior laminectomy. Symon and Lavender\textsuperscript{[31]} recorded 70% improvement in patients operated with cervical laminectomy only without fixation in comparison with 85% improvement after fixation. As regards the myelopathy, we found that improvement in all grades of myelopathy with both groups showing 70% of patients grading 3 or below and 30% of

Figure 1: Postoperative photo of the cervical spine after the insertion of the trans-facet screws. (a) and lateral mass screws and rods. (b) fixation in Anterior-Posterior and Lateral view. Postoperative multislice CT cervical spine- axial and sagittal view showing lateral mass and rod fixation. (c and d) Postoperative multislice CT cervical spine- sagittal view showing transfacet screws fixation. (e) Sagittal MRI T2-weighted image of the cervical spine before surgery. (f) Intra-operative images showing trans-facet screws. (g) And lateral mass screws. (h) While being inserted in sub-axial cervical spine. CT - Computerized tomography; MRI - Magnetic resonance imaging
patients showed no improvement but no deterioration. These groups belonged to grade 4 and 5 myelopathy. This was mostly due to the severe decompression of the cord with cord changes like myelomalacia. Kumar et al.\textsuperscript{32} recorded 80% improvement with good outcome and 76% improvement in myelopathy score after cervical laminectomy with lateral mass fixation. In this study, majority of patient presented to us in grading 3 or more. This can be explained by delayed presentation to seek treatment and poor reach of primary treatment to the peripheral areas of city, town, and villages in the Indian subcontinent.

There was a significant difference between both groups in regards to the operative time, blood loss, and the hospital stay. We found that in Group I, the mean operative time was $110 \pm 14.16$ min but in Group II, was $90 \pm 24.38$ min, and $P = 0.045$. The mean hospital stay in Group I was $5 \pm 1.76$ days and in Group II, was $4 \pm 1.57$ days with $P = 0.46$. Finally, the mean blood loss in Group I was $380 \pm 193.04$ ml and in Group II, was $300 \pm 111.22$ ml, with $P = 0.032$. The blood loss in Group I is more than that in Group II due to long operative time and lateral dissection during surgery with the injury of the epidural and paravertebral venous plexuses. This significant results show that trans‑facet compare to lateral mass fixation require lesser time to operate, relative ease to surgery, and lesser manipulation of paravertebral muscles due to the absence of space-occupying rods in fixation.

There was no significant difference between both groups in regards to the postoperative complications; there were no cases of spinal cord or nerve root or vertebral artery injury in both groups. Dural tear occurred in two cases in Group I and 1 case in Group II. Dural tear was managed intraoperatively by primary closure of rent using 4-0 prolene suture and application of Fibrin glues. Superficial wound infection occurred in 3 cases in Group I and 2 cases in Group II. No screw loosening and pullout occurred in any case. Heller et al. and Kast et al.\textsuperscript{33,34} found in a series of patients operated for decompressive laminectomy with lateral mass fixation that the incidence of nerve root injury was 0.69%, screw loosening was 1.17%, infection was 1.3%, facet breakout was 0.2%, and 0% vertebral artery injury. Graham et al.\textsuperscript{25} in a series of patients with lateral mass fixation reported 6.1% incidence of screw malposition and 1.8% incidence of radiculopathy per screw with no vertebral artery injury.

Bony fusion was achieved in all the patients after 6-month follow-up. Stability of the fixation was confirmed in the postoperative X-ray in flexion and extension films in all the patients of both groups. Traynelis\textsuperscript{35} found that decompressive laminectomy with lateral mass fixation results in successful arthrodesis in 98% of patients and < 1% neurovascular injury. Swank et al.\textsuperscript{36} found that the incidence of fusion with lateral mass fixation was 98% and Takayasu et al.\textsuperscript{14} and Goel\textsuperscript{37} reported 100% fusion with trans‑facet fusion with no neurovascular injury.

Placement of a transarticular screw into the C2–3 facet is sometimes challenging because the occipital bone protuberance makes it difficult to achieve the proper screw trajectory, but this can be overcome by using curved/angled instruments.

**Limitations**

The drawback of the presented evaluation is the homogeneous nature of patient population and the relatively short follow-up of the patients treated. The current study is a single center, single surgeon experience; although this ensures consistency in surgical techniques, future research could validate our findings in the large population, probably with robust randomization of patients. In addition, a scientific study involving a double‑blinded patient‑based protocol is mandatory. Long‑term evaluation is also mandatory to assess the degree of continued clinical improvement, alignment of spine stability, and curvatures.

**CONCLUSIONS**

Both facet and lateral mass fixation techniques are simple, safe, and effective procedures in achieving fusion for multilevel CSM. Both fixation methods provide better postoperative Nurick’s grades, mJOA scores, and better postoperative NRR without significant complications, while preventing postoperative instability and kyphosis, which remain the main drawback of posterior cervical laminectomy. The transarticular screw can be used as an anchor screw for posterior cervical instrumentation or for facet fixation. The relative ease and safety of this method justify more widespread usage.

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**Conflicts of interest**

There are no conflicts of interest.

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