Original Article

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

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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,[2,3,5] 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.[7] Laminoplasty, however, affords little immediate stability and may permit the development of progressive kyphosis.[8,9] 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[10] 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%.[10-12] 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.[8,13]

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[9] 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[14] 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,[6] 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 I, 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.

Table 1: Demographic data

Variables	Subdivisons	Group I, *n* (%)	Group II, *n* (%)	*P*
n	40	20	20	
Age	Mean±SD	50.9±7.3	53.7±6.5	0.483
Sex				
Male		15 (75)	16 (80)	0.106
Female		5 (25)	4 (20)	
Onset of presentation (months/years)		12±3.6	11.5±3.7	0.543

SD - Standard deviation

Table 2: Comparison of preoperative Modified Japanese Orthopedic Association score and postoperative score in the follow-up period at 6 months

Groups	Variables	Preoperative mJOA score	Postoperative mOJA 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

Table 3: Comparison of preoperative and postoperative Nurick's functional grades in both groups

Nurick's functional grade	Group I		Group II	
	Preoperative	Postoperative	Preoperative	Postoperative
Grade 0	0	0	0	0
Grade 1	0	0	0	0
Grade 2	0	9	0	11
Grade 3	3	5	7	3
Grade 4	11	3	7	3
Grade 5	6	3	6	3
Mean±SD	4.15±0.65	3±1.10	3.95±0.81	2.85±0.74
P of preoperative		0.086 (NS)		
P of postoperative		0.062		

NS - Not significant; SD - Standard deviation

Table 4: Operative data of two groups

Operative data	Group I	Group II	*P*
Operative time			
Range	90.0-140	75.0-120.0	
Mean±SD	110.0±14.16	90±24.38	0.045
Hospital stay			
Range	4.0-7.0	3.0-6.0	
Mean±SD	5.0±1.76	4.0±1.57	0.406
Blood loss			
Range	250.0-800.0	200.0-450.0	
Mean±SD	380.0±193.04	300.0±111.22	0.032

P - *P* value for Student's *t*-test; SD - Standard deviation

Table 5: Operative complications

Operative complications	Group I (%)	Group II (%)
Superficial wound infection	3	2
C_5 root pain	3	1
Instability	0	0
Facet crack	-	5
Kyphosis	0	0
Dural tear	2	1
Postoperative neurological deficit	2	1
Vertebral artery Injury	0	0

Table 6: Neurological recovery rate at the end of follow-up period

Neurological recovery rate	Group I, *n* (%)	Group II, *n* (%)
Excellent ≥75%	1 (5)	3 (15)
Good (50%74%)	10 (50)	9 (55)
Fair (25%49%)	6 (30)	5 (25)
Poor <25%	3 (15)	1 (5)
Mean±SD	46.8±22.41	55.4±17.25
P	0.0945	

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

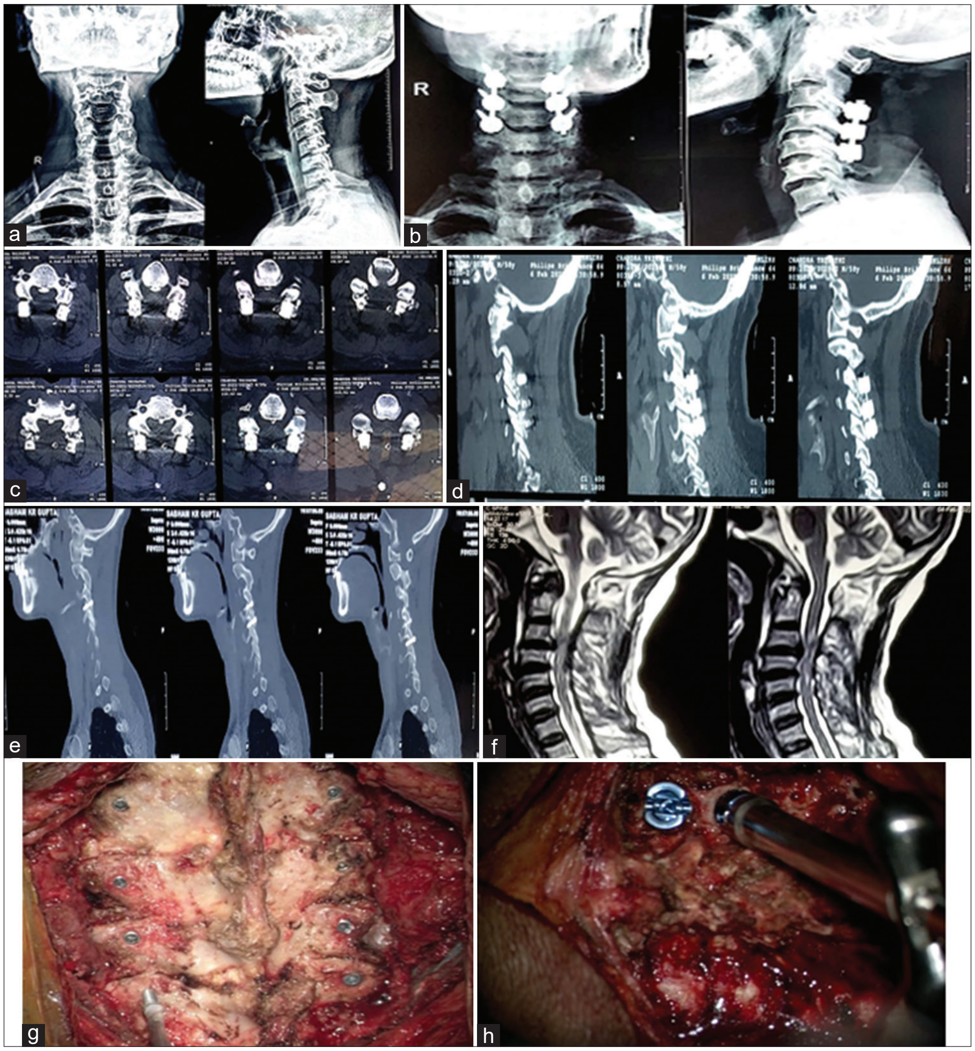

Figure 1: Postoperative photo of the cervical spine after the insertion of the trans-facet screws. (a) and lateral mass screws and rods. (b) fixation in Anterior-Posterior and Lateral view. Postoperative multislice CT cervical spine- axial and sagittal view showing lateral mass and rod fixation. (c and 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

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[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[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[27] study showed that the average age was 46 years and O'Laoire and Thomas[28] showed that the average age was 47 years, and finally, Jankowitz and Gerszten[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 *et al*.[30] recorded 85% improvement after cervical laminectomy with fixation in comparison with other posterior laminectomy. Symon and Lavender[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 patients showed no improvement but no deterioration. These groups belonged to grade 4 and 5 myleopathy. This was mostly due to the severe decompression of the cord with cord changes like myelomalacia. Kumar *et al*.[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 ± 14.16 min but in Group II, was 90 ± 24.38 min, and $P = 0.045$. The mean hospital stay in Group I was 5 ± 1.76 days and in Group II, was 4 ± 1.57 days with $P = 0.46$. Finally, the mean blood loss in Group I was 380 ± 193.04 ml and in Group II, was 300 ± 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 paraveretebral 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*.[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*.[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[35] found that decompressive laminectomy with lateral mass fixation results in successful arthrodesis in 98% of patients and < 1% neurovascular injury. Swank *et al*.[36] found that the incidence of fusion with lateral mass fixation was 98% and Takayasu *et al*.[14] and Goel[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.

REFERENCES

1. Rahman A. "Only fixation:" Simple act, but mammoth stride toward great aspiration in managing cervical spondylotic myelopathy. J Craniovertebr Junction Spine 2015;6:137-9.
2. Adams CB, Logue V. Studies in cervical spondylotic myelopathy. 3. Some functional effects of operations for cervical spondylotic myelopathy. Brain 1971;94:587-94.

3. Anderson PA, Matz PG, Groff MW, Heary RF, Holly LT, Kaiser MG, *et al*. Laminectomy and fusion for the treatment of cervical degenerative myelopathy. J Neurosurg Spine 2009;11:150-6.
4. Ebersold MJ, Pare MC, Quast LM. Surgical treatment for cervical spondylitic myelopathy. J Neurosurg 1995;82:745-51.
5. Herkowitz HN. A comparison of anterior cervical fusion, cervical laminectomy, and cervical laminoplasty for the surgical management of multiple level spondylotic radiculopathy. Spine (Phila Pa 1976) 1988;13:774-80.
6. Nurick S. The pathogenesis of the spinal cord disorder associated with cervical spondylosis. Brain 1972;95:87-100.
7. Roy-Camille R, Gaillant G, Bertreaux D. Early management of spinal injuries. In: McKibben B, editor. Recent Advances in Orthopedics. Edinburgh: Churchill-Livingstone; 1979. p. 57-87.
8. Roy-Camille R, Saillant G. Surgery of the cervical spine. 2. Dislocation. Fracture of the articular processes. Nouv Presse Med 1972;1:2484-5.
9. Magerl FG, Seemann D. Stable dorsal fusion of the cervical spine [C2-TH1] using hook plates. In: Andreas W, Kehr P, editors. Cervical Spine I Strasborg. New York: Springer-Verlag; 1987. p. 217-21.
10. Roy-Camille R, Saillant G, Mazel C. Internal fixation of the unstable cervical spine by a posterior osteosynthesis with plates and screws. In: Sherk HH, Dunn HJ, Eismont FJ, editors. The Cervical Spine. 2nd ed. Philadelphia, PA: J.B. Lippincott Company; 1989. p. 390-4.
11. DalCanto RA, Lieberman I, Inceoglu S, Kayanja M, Ferrara L. Biomechanical comparison of transarticular facet screws to lateral mass plates in two-level instrumentations of the cervical spine. Spine (Phila Pa 1976) 2005;30:897-2.
12. Cheung WY, Arvinte D, Wong YW, Luk KD, Cheung KM. Neurological recovery after surgical decompression in patients with cervical spondylotic myelopathy – A prospective study. Int Orthop 2008;32:273-8.
13. Benzel EC, Lancon J, Kesterson L, Hadden T. Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. J Spinal Disord 1991;4:286-95.
14. Takayasu M, Hara M, Yamauchi K, Yoshida M, Yoshida J. Transarticular screw fixation in the middle and lower cervical spine. Technical note. J Neurosurg 2003;99:132-6.
15. Mattei TA, Goulart CR, Milano JB, Dutra LP, Fasset DR. Cervical spondylotic myelopathy: Pathophysiology, diagnosis, and surgical techniques. ISRN Neurol 2011;2011:463729.
16. Brain WR, Northfield D, Wilkinson M. The neurological manifestations of cervical spondylosis. Brain 1952;75:187-225.
17. Shamji MF, Ames CP, Smith JS, Rhee JM, Chapman JR, Fehlings MG. Myelopathy and spinal deformity: Relevance of spinal alignment in planning surgical intervention for degenerative cervical myelopathy. Spine (Phila Pa 1976) 2013;38:S147-8.
18. Kire N, Jain S, Merchant ZA, Kundnani V. The efficacy of posterior cervical laminectomy for multilevel degenerative cervical spondylotic myelopathy in long term period. Asian J Neurosurg 2019;14:848-52.
19. Woernle K, Marbacher S, Khamis A, Landolt H, Fandino J. Clinical outcome after laminectomy without fusion for cervical spondylotic myelopathy. Open J Mod Neurosurg 2015;5:41-8.
20. Goel A, Vutha R, Shah A, Patil A, Dhar A, Prasad A. Cervical spondylosis in patients presenting with "severe" myelopathy: Analysis of treatment by multisegmental spinal fixation – A case series. J Craniovertebr Junction Spine 2019;10:144-51.
21. Goel A, Dharurkar P, Shah A, Gore S, More S, Ranjan S. Only spinal fixation as treatment of prolapsed cervical intervertebral disc in patients presenting with myelopathy. J Craniovertebr Junction Spine 2017;8:305-10.
22. Löfgren H, Osman A, Blomqvist A, Vavruch L. Sagittal alignment after laminectomy without fusion as treatment for cervical spondylotic myelopathy: Follow-up of minimum 4 years postoperatively. Global Spine J 2020;10:425-32.
23. Goel A, Shah A. Facetal distraction as treatment for single- and multilevel cervical spondylotic radiculopathy and myelopathy: A preliminary report. J Neurosurg Spine 2011;14:689-96.
24. Nishizawa K, Mori K, Saruhashi Y, Matsusue Y. Operative outcomes for cervical degenerative disease: A review of the literature. ISRN Orthop 2012;2012:165050.
25. Graham AW, Swank ML, Kinard RE, Lowery GL, Dials BE. Posterior cervical arthrodesis and stabilization with a lateral mass plate. Clinical and computed tomographic evaluation of lateral mass screw placement and associated complications. Spine (Phila Pa 1976) 1996;21:323-8.
26. Kaptain GJ, Simmons NE, Replogle RE, Pobereskin L. Incidence and outcome of kyphotic deformity following laminectomy for cervical spondylotic myelopathy. J Neurosurg 2000;93:199-204.
27. Watters WC 3rd, Levinthal R. Anterior cervical discectomy with and without fusion. Results, complications, and long-term follow-up. Spine (Phila Pa 1976) 1994;19:2343-7.
28. O'Laoire SA, Thomas DG. Spinal cord compression due to prolapse of cervical intervertebral disc (herniation of nucleus pulposus). Treatment in 26 cases by discectomy without interbody bone graft. J Neurosurg 1983;59:847-53.
29. Jankowitz BT, Gerszten PC. Decompression for cervical myelopathy. Spine J 2006;6:317S-322S.
30. Epstein JA, Janin Y, Carras R, Lavine LS. A comparative study of the treatment of cervical spondylotic myeloradiculopathy. Experience with 50 cases treated by means of extensive laminectomy, foraminotomy, and excision of osteophytes during the past 10 years. Acta Neurochir (Wien) 1982;61:89-104.
31. Symon L, Lavender P. The surgical treatment of cervical spondylotic myelopathy. Neurology 1967;17:117-27.
32. Kumar VG, Rea GL, Mervis LJ, McGregor JM. Cervical spondylotic myelopathy: Functional and radiographic long-term outcome after laminectomy and posterior fusion. Neurosurgery 1999;44:771-7.
33. Heller JG, Silcox DH 3rd, Sutterlin CE 3rd. Complications of posterior cervical plating. Spine (Phila Pa 1976) 1995;20:2442-8.
34. Kast E, Mohr K, Richter HP, Börm W. Complications of transpedicular screw fixation in the cervical spine. Eur Spine J 2006;15:327-34.
35. Traynelis VC. Anterior and posterior plate stabilization of the cervical spine. Neurosurg 1992;2:59-76.
36. Swank ML, Sutterlin CE 3rd, Bossons CR, Dials BE. Rigid internal fixation with lateral mass plates in multilevel anterior and posterior reconstruction of the cervical spine. Spine (Phila Pa 1976) 1997;22:274-82.
37. Goel A. Only fixation for cervical spondylosis: Report of early results with a preliminary experience with 6 cases. J Craniovertebr Junction Spine 2013;4:64-8.