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Clinical and radiological outcome of wide enbloc laminectomy with subaxial lateral mass screw fixation in patients of cervical spondylotic myelopathy with ossification of posterior longitudinal ligament: a prospective observational study

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ABSTRACT

Background: Data evaluating the clinical and radiological outcome of wide enbloc laminectomy with sub-axial lateral mass screw fixation in patients of cervical spondylotic myelopathy with ossification of posterior longitudinal ligament (OPLL) is scanty in the literature.

Methods: This is a prospective observational study aimed to know the clinical and radiological outcome of wide enbloc cervical laminectomy with sub-axial lateral mass screw fixation in patients of cervical spondylotic myelopathy associated with OPLL. A total of sixty patients were included in our study who underwent wide enbloc cervical laminectomy and sub axial lateral mass screw fixation and were followed up to 1 year postoperatively. Modified Japanese orthopedic association (MJOA) score was used for functional outcome calculation, which was done at 1 month, 3 months, 6 months and 1 year postoperatively. We used C2-C7 Cobb's angle as parameter of cervical alignment on lateral radiograph of cervical spine, modified Singh's grading was used to asses cord compression on cervical spine MRI.

Results: There was significant improvement in MJOA score from preoperative (12.2) to one year postoperative (15.7). The mean improvement in MJOA was 3.5 points. The average neurological recovery rate was 60.34%. Overall, 90% patients showed improvement in MJOA score. Cervical alignment is maintained from preoperative 15 degree to postoperative 14.3 degree. The average decrease in cobb's angle was 0.7 degree and cord compression value improved from preoperative 2.7 to postoperative 0.4 according to modified Singh's grade.

Conclusions: Wide enbloc cervical laminectomy with sub-axial lateral mass screw fixation is a safe and effective treatment of multilevel cervical spondylotic myelopathy associated with OPLL providing a good functional outcome, maintaining adequate cervical alignment postoperatively.

Keywords: Spine, Vertebra, Laminectomy, Myelopathy, Ossification of posterior longitudinal ligament

INTRODUCTION

Cervical spondylotic myelopathy (CSM) is a neurologic disorder which slowly worsens over time as degenerative abnormalities in the spine compress the spinal cord and surrounding structures.[1] It is the most common cause of spinal cord dysfunction in patients who are older than fifty-five. The pathogenesis begins with degenerative changes in the disc and this causes changes in the osseous and soft tissue structures.[2] The most frequent causes of CSM are degeneration of facet joints and intervertebral disc, ligamentum flavum and ossification of posterior longitudinal ligament (OPLL).[3-5]

OPLL is a complex disease that arises from calcification of the PLL and ectopic osteophytes.[6] This leads to the formation of a bony mass that deteriorates neurological function and compresses spinal cord to varying degrees. Ossification in bodily tissues, including interosseous membranes, ligaments, and tendons, is known to be caused by fluorosis. When this ossification happens in duramater, ligamentum flavum (yellow ligament)/ PLL, compressive myelopathy develops, resulting in a neurological impairment and ultimately resulting in debilitating disability.[7] Western Rajasthan of India is prevalent belt for OPLL which is attributed to high prevalence of fluorosis. On basis of standard lateral radiographs OPLL is classified as mixed, continuous, segmental, and isolated type.

Cervical myelopathy can be treated surgically by anterior, posterior and combined approach. Anterior approach is best suited when disease is confined to one or two level with neutral or kyphotic alignment of neck. Anterior decompression removes the direct compression over cord. When disease is of multiple level, use of anterior approach is controversial as it is associated with complications like pseudoarthrosis, graft displacement, implant failure and adjacent segment degeneration.[8]

Posterior approach consists of cervical laminoplasty, cervical laminectomy alone and laminectomy with fusion and fixation with lateral mass screws. Posterior approach is best suited for multiple level disease (more than two level) with lordotic alignment of the neck. OPLL is associated with micro instability, hence posterior cervical decompression alone without instrumentation is associated with complications like iatrogenic cervical kyphosis, instability, postoperative neurological deterioration and perineural adhesion while fixation provides immediate stability and prevent adjacent segment degeneration.[9,10] However, it cannot directly remove the OPLL.

Posterior cervical spine fixation can be done by using posterior wiring, Haliflex clamp, posterior plate and screw or poly-axial screw with rod. It is well known that posterior fixation with lateral mass screw fixation is an easy, secure, and high-fusion rate technique. Owing to its user-friendliness and reliability, Cobb's angle method continues to be clinical standard for determining cervical lordosis.[11] Roy-Camille introduced lateral mass fixation in 1979, since when this has been widely used after posterior cervical decompression to fix cervical spine.[12]

We aimed in this study to evaluate clinical and radiological outcome of wide enbloc cervical laminectomy with sub axial lateral mass screw fixation in patients of multilevel cervical spondylotic myelopathy associated with OPLLs.

METHODS

Study design

This prospective observational study was performed after the approval of institutional research committee in Sampurnanand medical college Jodhpur, Rajasthan. A total of 60 patients of cervical spondylotic myelopathy with OPLL were treated with enbloc wide cervical laminectomy with lateral mass screw fixation from July 2021 to July 2024. The inclusion criteria for our study were patients having cervical myelopathy of multiple level (more than 3) associated with OPLL and having lordotic alignment of neck, under 80 years age and exclusion criteria was age above 80 years age and cervical myelopathy caused by other than OPLL (disc induced, trauma) or less than 3 level involvement, tandem spinal stenosis, patients having previous cervical spine surgery and patients having kyphotic alignment of neck. SPSS statistics software was used for statistical analysis.

Clinical evaluation

Myelopathy signs assessed included hand grip, hyperreflexia, gait, Hoffman sign, Babinski sign, patella and ankle clonus. Myelopathy symptoms were assessed by scoring was done by MJOA score. Clinical evaluation was done by using MJOA score for myelopathic symptoms.[13] Neurological recovery rate was calculated utilizing the Hirabayashi et al method, where:[14]

Recovery rate (%)=(postop MJOA score-preop MJOA score)/(18-preop MJOA score)×100

Radiological evalution

It was done preoperatively for every patient by doing anteroposterior AP and lateral dynamic (flexion and extension) radiographs of the cervical spine, CT scan and MRI of cervical spine. The C2-C7 Cobb's angle is calculated as the angle of intersection between the lines parallel to superior end plate of C2 and inferior endplate of C7.[15] Cervical spine is considered to be in lordosis if Cobb's angle is more than 100, straight when angle is between 50 to 100, and kyphotic if angle is <50 (Figure 1).

Cord compression is assessed using the Modified Singh's grading system on axial T2 weighted MRI. The axial cut section showing maximum compression of the spinal cord is used to assign the grading as per Singh et al grading system (Figure 2).[16]

Operative procedure

All the patients were operated under general anesthesia, patients placed in prone position with neck fixed in neutral position by elastic adhesive bandage and both the upper limb placed by the side of body with finger traction applied for proper visualization for cervical spine under c-arm. Following this operative site was scrubbed, painting and draping was done. Posterior midline skin incision given and dissection done along ligamentum nuche to minimize intraoperative bleeding and exposure of spinous process lateral mass facet joints done for desired level. First, we make the entry for lateral mass screw by using Ann's free hand technique. High speed drill was used to make entry hole. Then tapping was done directed toward the so-called "safe quadrant" for each lateral mass. Then two lateral gutters at spinolateral mass junction were made from C2 to C6 by using 2 mm metal tip high speed burr system then diamond tip burr is used to make it paper thin. Kerrison Rounger was used to remove final bony attachment. Caudal ligamentum flavum was separated by using Kerrison Rounger and enbloc removal of lamina was done.

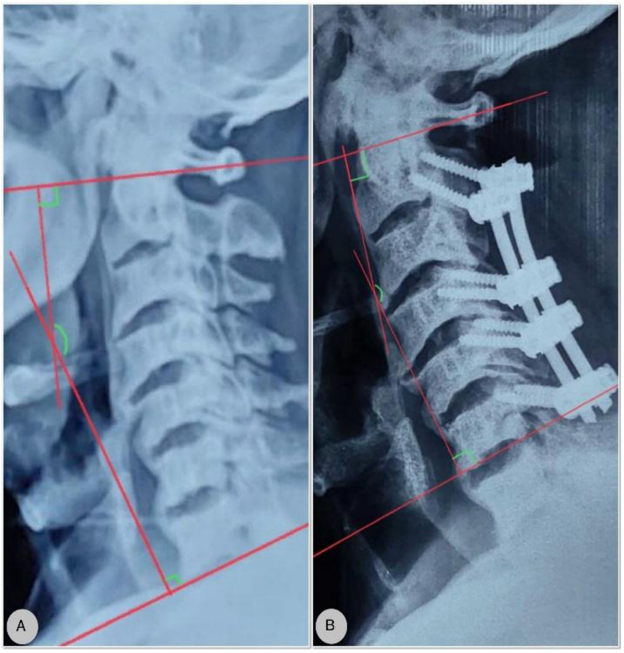

Figure 1 (A and B): Cobb's angle calculation in preoperative and postoperative lateral cervical radiograph: Horizontal line is drawn along superior end plate of C2 and inferior end plate of C7 vertebrae and then angle made between perpendicular lines to the above two horizontal lines is calculated to be as Cobb's angle.

Highlighted area inside red circle shows the relation between CSF and spinal cord.

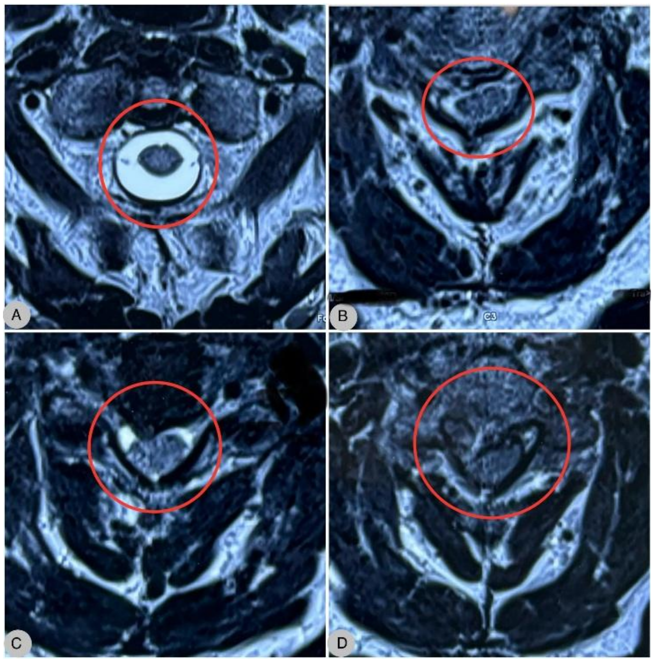

Figure 2 (A-D): Grade 0-no compression of spinal cord, CSF visible surrounding the cord in all directions. Grade 1-CSF minimally visible all around the spinal cord, but the cord is not compressed. Grade 2-mild compression of spinal cord. Grade 3-severe compression of spinal cord, no CSF visible.

Figure 3: Highlighted area within red circle shows the underside of the lamina of the cervical spine which is removed in the process of decompression by enbloc laminectomy.

Enbloc removal of lamina was done because it is a time saving procedure having low chance of iatrogenic cord injury (Figure 3).

Figure 4: The highlights area under yellow circle shows the lateral mass screws in position and decompressed spinal cord in the centre.

Laminectomy was done at levels with greater than level 1 compression according to the Singh's grading. The lateral mass screw fixation done at each level after checking appropriate length (Figure 4).

Rods of adequate size were inserted. High speed burr was used for decortication of bone and facet joints and local bone graft was placed lateral to screw which was followed by wash and wound closure in layers after placing a negative suction drain. Postoperatively, cervical collar was used for 6 weeks so that immobilization is maintained till the fusion is induced.

Postoperative imaging and follow up

Radiographic evaluation done on postoperative day two by radiograph, CT and MRI to check screw position and cord decompression. Follow up is taken by serial x-rays taken at 1 month, 3 month, 6 month and 12 months postoperatively.

RESULTS

Total 60 patients of cervical spondylotic myelopathy with OPLL were treated with wide enbloc cervical laminectomy with fixation by lateral mass screws and connecting rods. Positive signs of myelopathy seen were bilateral weak hand grip in 44 (74%) patients, hyperreflexia in 37 (62%) patients, gait imbalance in 32 (54%) patients, Hoffman sign in 23 (38%) patients, positive Babinski sign in 19 (32%) patients, ankle clonus in 7 (11%) and patellar clonus in 30 (5%) patients (Table 1).

Table 1: Demographic details of patients.

Variables	Percentages (%)
Mean age (in years)	65.6
Sex	
Male	85
Female	15
Occupation	
Manual laborers	60
Drivers	20
Others	20
OPLL type	
Mixed	53.3
Segmental	26.7
Continuous	13.3
Focal	6.66
Mean symptom duration	10.6 months

Majority of patients were in age group of 60-80 year. Youngest person was 45 years age and oldest person was 80 years age. The mean age was 65.6 years. Out of 60 patients 51 (85%) were male and 9 (15%) were female in present study. The male to female ratio is 5.66:1. Most of patients, 36 (60%) were manual laborers by occupation and motor vehicle drivers constituted 12 (20%). In our study, 32 (53.3%) patients had mixed type of OPLL, 16 (26.7%) had segmental type, 8 (13.3%) had continuous and 40 (6.66%) had focal type of OPLL. The mean duration of symptom was 10.6 month, with maximum duration of 24 months and minimum of 3 months.

The mean MJOA score was 12.20±1.85 preoperative and 14.8±1.94 at 1 month postoperative, 15.3±1.95 at 3 month postoperative, 15.60±1.94 at 6 months, and 15.70±1.96 at 1 year postoperative as shown in Table 2. The improvement in MJOA scores at 1-year postoperative compared to preoperative was statistically significant ($p<0.05$) The average neurological recovery rate was 60.34% (range 0-100%,). Overall, 54 patients (90%) of patients improved at least one point in the MJOA score after surgery and 6 (10%) of our patients had no improvement in MJOA.

Radiological outcome measured by immediate post op x-ray of cervical spine to check out the implant positioning,

Cobb's angle. In our study preoperatively the mean cobb's angle was 15±1.2 degrees and ranged from 12-18 degrees. The immediate postoperatively mean Cobbs's angle was 14.3±1.14 degrees and ranged from 10-18 degrees. Postop MRI was done in all patients that show adequate decompression of spinal cord. The mean compression of cord was 2.7 (ratio) preoperatively that was reduced to 00.40 (ratio) postoperatively (Table 2).

Table 2: Preoperative and postoperative MJOA, Cobb's angle and modified Singh's index comparison.

Measure	Pre-operative	Post-operative	P value
MJOA score	12.20±1.85	15.70±1.96 (1 year)	Significant
Cobbs's angle	15^0±1.20^0	14.3^0±1.14^0 (immediate post operative)	Significant
Singh index	2.7	0.04	Significant

MJOA and Cobb's angle values are mentioned in terms of mean±SD. Singh index mentioned in terms of ratio. $P<0.05$ was considered significant.

Complication

In our study one patient had wound infection which was treated by open debridement and vacuum assisted closure (VAC). One patient had immediate postoperative worsening of neurological function whose MJOA score reduced from preoperative 15 to 7 and 14 to 8 on postoperative day 2, which gradually improved over time. We did not observe any postoperative epidural hematoma and C5 palsy.

DISCUSSION

In the Asian population, one of the most frequent causes of cervical cord compressive myelopathy is OPLL.[17] The goal of surgical treatment is to perform adequate decompression of the cord, nerve root and to maintain stability of the vertebrae body alignment. Enblock cervical laminectomy provides indirect decompression by shifting the cord posteriorly. Fixation and fusion are done by lateral mass screw and local bone graft to prevent post operative cervical kyphosis and neurological worsening. In our present study, 60 patients of cervical spondylotic myelopathy associated with OPLL were treated by enbloc cervical laminectomy and fixation with lateral mass screws, out of these, 51 were male and 9 were female. The male to female ratio was 5.66:1 in our study which is in accordance with study by Choi et al indicating the incidence to be higher in males.[18] We divided the age of patients in age group of <60 years age and >60 years age. The mean neurological recovery rate was 62.5% in age group of <60 year and 36% in age group of >60 years age ($p=0.003$). We found that neurological recovery is better in younger age group compared to the older one possibly due to presence of comorbidities like diabetes, obesity, hypertension. We agreed to study by Nakashima et al who concluded that younger patients who undergo surgical decompression have better functional status than senior patients because older patients are less successful in converting neurological recovery into functional gains.[19] In our study, most of the patients were manual labours (60%) pointing towards the reason that could be because of continuous extension stress on neck. We agreed to study done by Takamiya et al which concluded that extension strain of the cervical spine is a risk factor for degenerative cervical spine disorders.[20]

Out of 60 patients with cervical OPLL, it was observed that 32 patients (53.3%) had mixed OPLL, 16 patients (26.6%) had segmental OPLL, 8 patients (13.3%) had continuous OPLL, and 4 patients (6.66%) had focal OPLL. This is consistent with research by Raykar et al who likewise discovered that segmental, continuous, and focal types of OPLL are the most prevalent, followed by mixed types.[21] In our study, duration of symptoms ranged from 3 months to 24 months with mean duration of 10.6 months. When comparing individuals with symptoms that have lasted less than a year to those who have had symptoms for more than a year, we find that MJOA scores have significantly improved in the former group. This is consistent with research by Baaj et al which studied the poor prognostic variables in OPLL and discovered that the longer the symptoms had been present, the worse the outcome.[22] We measured the outcome of our study both clinically and radiologically. Radiologically we used C2-C7 Cobb's angle as parameter of cervical alignment which was calculated according to a study done by Guo et al on cervical lateral radiograph in neutral position to be 12.7±6.6 in female patients and 16.3±7.3 in male patients in 414 asymptomatic volunteers.[23] Patients in our study who had higher cervical lordosis before surgery had better functional outcomes. We concurred with research by Shamji et al who found that individuals who had preoperative kyphotic alignment did not progress as well as those who had lordotic alignment.[24]

Our study showed favorable neurological and clinical result outcome as measured by MJOA score. The mean preoperative MJOA score was 12.2 which was improved to 14.8 at 1 month postoperatively to 15.70 till last follow up. The mean neurological improvement was 60.34%. The possible reasons for good outcome could be right patient selection, good surgical exposure, adequate decompression and proper placement of implant, using good amount of bone graft for fusion. Similar to a study by Chang et al 90% of patients in our study showed improvement in MJOA score postoperatively, and 10% of patients show no improvement in MJOA score.[25] Of the 58 patients with multilevel cervical myelopathy treated with laminectomy and fusion with lateral mass screws, MJOA improved in 85.5% of cases, while 14.5% of patients showed no improvement in MJOA.

In our study we had one patient with postoperative wound infection with possible cause for that being obese with short neck along with uncontrolled diabetes. We don’t have any postoperative C5 palsy. Multilevel cervical laminectomies are often associated with C5 palsy caused by nerve root traction injury as the spinal cord migrates posteriorly after laminectomy. Nerve root traction injury is more common at C5 level because of the anteriorly located facet joint, shorter nerve root and larger distance of posterior shift of the cord at C5 compared to other cervical levels.[26] We performed C5 foraminotomy in all patients to prevent postoperative C5 palsy, and facet joint undermining was done to create sufficient room for dorsal shift of nerve root. Postoperative epidural hematoma is another complication associated with posterior cervical spine surgery which can occur due to bleeding from bony edge. We don’t have any postoperative epidural hematoma because of adequate hemostasis which was achieved during surgery using bone wax, bipolar electrocautery, surgicell and negative suction drain. If a postoperative hematoma is not drained in a timely manner, it may result in a lifelong neurological deterioration and even death.[27] In our study, complication incidence was low which can be due to appropriate selection of patients, adequate decompression, and proper positioning of implant.

Limitations of our study include, the short term follow up of one year, which cannot give an idea about long term complications of sub-axial cervical fixation like any adjacent segment degenerative changes and the effect on cervical range of motion including its effect on activities of daily living for the patient, which although was not studied in this research, can be a consideration for analysis in the near future.

CONCLUSION

Wide enbloc cervical laminectomy with sub-axial lateral mass screw fixation is safe and effective for treatment of multilevel cervical spondylotic myelopathy associated with OPLL. It gives good functional and radiological outcome along with maintaining cervical alignment provided there is meticulous patient selection, adequate soft tissue and bone handling with watchful hemostatic control and good post operative care.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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