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Original Research Article

Cervical ossification of the posterior longitudinal ligament and its post surgical outcome analysis

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ABSTRACT

Background: Ossification of the posterior longitudinal ligament (OPLL) is a complex multi-factorial disease process having both metabolic and biomechanical factors. The objective of this study was to assess the surgical out come and post operative functional improvement in patients with cervical OPLL at a tertiary care centre.
Methods: This prospective observational study included 35 patients undergoing surgery for cervical OPLL in the department of neurosurgery, Care hospitals Hyderabad from October 2015 to October 2016 with follow up at 3months and 6 months.
Results: Total 35 patients who underwent surgery, majority (77.15%) were males and (22.85%) were female. The age of the patients was between 30 to 70 years. The most common type of OPLL was found to be segmental and mixed type. Nurick grade improved by 1.12 in anterior approach vs 0.66 in posterior approach. Recovery rates observed in anterior approach is 57.72% while in posterior surgical approach it is 48.87%. No complication was observed in this study.
Conclusions: OPLL is more common in males as compared to females. The average age of presentation is sixth decade. Younger patients have better outcomes. The most common variant of OPLL is segmental. The recovery rate achieved from anterior approach are better than those from the posterior approach. Improvement in NURICKS score is more in anterior surgical group than in posterior surgical group. No complications seen in this study. No mortality seen in this study.

Keywords: Modified Japanese orthopaedics score, Nuricks grade, Ossified posterior longitudinal ligament

INTRODUCTION

Ossification of the posterior longitudinal ligament causing myeloradiculopathy as a result of chronic pressure on the spinal cord and nerve roots.[1]

First described by CA Key in 1838 in England.[2] The causes of OPLL has been debated since Tsukimoto's autopsy.[3] Various studies conducted over the world have subsequently added significantly to our understanding of the etiology, natural history, and treatment.[4,5] Cervical canal stenosis secondary to OPLL can lead to symptoms in patients.[6,7] OPLL mostly is most common in japan but it can occur in non Japanese Asians also.[8,9]

In India, many centers have substantial experience and management of OPLL.[10-12]

OPLL typically is seen in the mid cervical spine and results in central canal stenosis, predisposing the patient to cord injury longitudinal ligament (OPLL) is characterized by the heterotrophic bone formation.

Cervical OPLL may compress the spinal cord and nerve roots, leading to sensory and motor dysfunction.

Fluoride intoxication, diabetes mellitus, growth-hormone imbalance, disc protrusion, recurrent minor trauma, abnormal calcium metabolism, and infection have all been suggested. A high association has been noted with various hyperostotic spinal changes such as diffuse idiopathic skeletal hyperostosis (DISH), ligamentum flavum ossification, and ankylosing spondylitis.

The process of OPLL is similar to heterotopic bone formation in response to mechanical stress in other tissues. Cartilage cells proliferate first in the periosteum of the vertebral body and then in the annulus fibrosus, longitudinal ligament and dura. The ligament becomes calcified by endochondral ossification. Limited oblique corpectomy also can be done sometimes.[13] Functional outcome and various complication can occur in patients operated for OPLL.[14] Mature lamellar bone is eventually formed. OPLL growth and outcome can be evaluated by mri imaging.[15,16]

Association of DISH and calcification and ossification of posterior longitudinal ligament is there. Immunohistochemical localization of type of collagen is seen in OPLL. The rate of growth varies. OPLL it can occur at any level cervical (75%) thoracic (15%) and lumbar (10%). OPLL occurs in association with degenerative disc disease or spondylosis causing radiculopathy, myelopathy and myeloradiculopathy. Only a minority of patients with OPLL are symptomatic. Therefore, patients may be able to compensate for deep indentations in the ventral spinal cord. Patients with congenital spinal stenosis may be predisposed to earlier symptoms if OPLL present.

The asymptomatic patients can be managed with conservative methods. Once the symptoms of myelopathy develop, appropriate recovery is not expected with conservative treatments. Symptoms may vary from neck pain to sensory or/ and motor deficit of extremities and also, autonomic dysfunction (bladder, bowel disturbances).

The patho-mechanism of myelopathy in OPLL involves both static and dynamic factors. Static factors include- spinal cord stenosis and PLL hypertrophy; and dynamic factors include- instability and associated with protruded disc.

The Japanese Orthopaedic Association has established criteria for grading of myelopathy that include an assessment of activities of daily living (upper and lower extremity function), sensory exam, and bladder function.

Various radiological tests have been used to establish the level and severity of this condition including plain X-rays, Computed Tomography (CT) scan and magnetic resonance imaging (MRI). OPLL is radiographically classified into four types based on the sagittal plane appearance: 1) segmental (37%), 2) continuous (27%), 3) mixed (29%), and 4) circumscribed (8%). CT has allowed further classification based on the transverse plane appearance of OPLL into three major groups: 1) mushroom (62%), 2) square (19%), and 3) hill (19%).

The surgical strategies used for treatment of cervical OPLL are anterior decompression with fusion and posterior decompression via techniques such as laminectomy, laminectomy and fusion and laminoplasty.

Anterior decompression and fusion is done in patients with OPLL involving more than 50% of canal occupancy and when less than 3 segments are involved. The posterior indirect decompression and fixation has now been adopted as the primary treatment for cervical OPLL involving multiple levels with canal occupancy by OPLL less than 50%. Laminectomy effectively decompress the spinal cord in patients with multilevel cervical OPLL, it may result in instability, progressive kyphosis and late neurological deterioration. The aim of this study is to evaluate the outcomes of surgery for cervical ossification of posterior longitudinal ligament.

Author aimed to study the surgical outcomes of different surgical approaches for ossification of the posterior longitudinal ligament in cervical spine.

Objectives of the study was to evaluate the patients of cervical OPLL by X-ray, MRI and CT-scan of cervical spine, to select surgical technique to be executed in patients of cervical OPLL depending on the number of levels of involvement by OPLL and occupancy ratio and to assess the surgical outcome in patients with cervical OPLL by different functional parameters.

METHODS

This is a Prospective, cross- sectional, observational study included 35 patients with cervical ossified posterior longitudinal ligament (OPLL), between November 2015 to October 2016 admitted in the department of neurosurgery, Care Hospital, Hyderabad. Patients follow up was done at 3 and 6 months. Till April 2017 the study with follow up was completed of the last patient.

Inclusion criteria

- Patients with cervical ossification of posterior longitudinal ligament with neurological impairment.
- Patients in age group 18-80 years.

Exclusion criteria

- Patients with ossification in another spinal region (thoracic ossification of posterior longitudinal ligament) and ossification of ligamentum flavum.
- Patients with serious comorbid condition unfit for general anesthesia.

Preoperative procedure for all the patients with cervical ossified posterior longitudinal ligament were enrolled in the study after informed consent. Apart from age, gender, occupation, sensory symptoms, motor symptoms and their duration along with autonomous dysfunction was noted in all patients. The patients were evaluated both clinically and radiologically.

Radiological assessment includes;

- X-ray: antero-posterior, lateral- flexion and extension cervical radiographs.
- MRI of the cervical spine
- CT scan of cervical spine was conducted for grading of OPLL.

Neurological examination of the patient was conducted in detail including tone and power.

Recovery rate as described by Hirabayashi et al, indicating the degree of normalization post surgery was calculated as follows-

Recovery rate (%) =

(postoperative mJOA score - preoperative mJOA score) × 100
(17- preoperative mJOA score)

Functional disability was graded according to the Nurick's scale.

The classification of the Investigative Committee on the Ossificatiion of the Spinal Ligaments of the Japanese Ministry of Public Health and welfare was used to determine the type of OPLL continuous, segmental, mixed and localized

Sample size

$$n = \frac{2\left\{\frac{Z\alpha}{2} + Z\beta\right\}^2 \times \sigma^2}{d^2}$$

α= 0.05, β= 0.2(power 80%), two sided effect size = 0.7

The sample size is calculated as per above formula is 32. The final sample size is being taken as 35.

Statistical analysis

Data will be entered in excel software (Microsoft). IBM SPSS version 19.0 will be used for data analysis. A p-value <0.05 will be considered statistically significant.

RESULTS

From November 2015 to October 2016, 35 patients were enrolled in this study. Out of 35 patients, 27(77.15%) patients were male and 8(22.85%) patients were female, with a gender ratio of 3.3:1 (male: female). OPLL is more common in males as per authors study and as per the references cited in text (Table 1).

Table 1: Gender distribution.

Gender	No.	%
Males	27	77.15
Females	8	22.85
Total	35	100

The average age of presentation is found to be 53.37 years with maximum number of patients i.e., 22 (62.85%) in the sixth decade. Hence it can be concluded that OPLL is a disease of elderly age group (Table 2).

Table 2: Age distribution.

Age group (in years)	No. of patients	%
30-35	2	5.8
36-40	1	2.8
41-45	3	8.5
46-50	2	5.8
51-55	14	40
56-60	8	22.8
61-65	3	8.5
66-70	2	5.8
Total	35	100

The common type of OPLL was found to be segmental and mixed type, with segmental type of OPLL seen in 51.4% patients. Hence segmental type of OPLL is most common which is in accordance to other studies (Table 3).

Table 3: Types of OPLL.

Types	No. of pts	%
Localised	0	0
Continuous	5	14.3
Mixed	12	34.3
Segmental	18	51.4
Total	35	100

Table 4: Postoperative Nurick's grade.

Nurick's grade	No. of patients	
	Anterior approach	Posterior approach
0	12	5
1	3	7
2	2	4
3	0	1
4	0	1
5	0	0
Total	17	18

The post-operative Nurick's score in this study is found to be 0.8. Nurick's grade improved by 1.12 in anterior

approach and by 0.66 in cases operated by posterior approach postoperatively. Hence, it can be concluded that anterior approach is more suitable for good post op recovery (Table 4).

In this study 17 patients (48.6%) underwent surgery through anterior approach out of which ACDF and corpectomy was done in 8 patients, in the remaining 18 patients (51.4%) posterior approach was used i.e., laminectomy and fusion (Table 5).

Table 5: Different surgical approaches used for OPLL.

Type of surgical approaches		No. of patients	%
Anterior approach	ACDF	9	25.8
	ACDF + CORP	8	22.8
Posterior approach	Laminectomy + fusion	18	51.4
Total		35	100

Table 6: Recovery rates in different surgical approaches.

Recovery rate (%)	Surgical approaches	
	Anterior	Posterior
0-10	0	0
11-20	0	0
21-30	1	2
31-40	6	6
41-50	3	7
51-60	0	0
61-70	3	1
71-80	0	0
81-90	0	0
91-100	4	2
Total	17	18

Table 7: Improvement in mJOA score in presence and absence of cord changes in different surgical approaches.

Improvement in mJOA score	Cord change in anterior approach		Cord change in posterior approach	
	Present	Absent	Present	Absent
Improvement by 1	2	5	3	10
Improvement by 2	4	5	3	1
Improvement by 3	0	1	0	0
Improvement by 4	0	0	1	0

Recovery rate observed in anterior surgical approach is 57.72% while in posterior surgical approach it is 48.87% with an overall recovery rate of 53.17%. Nurick score was better in post op period in case of anterior approach as compared to posterior approach (Table 6).

Improvement was observed in more number of cases without cord changes. Hence, if cord changes like myelomalacia is seen in preop scan the recovery is less as compared to others without cord changes (Table 7).

DISCUSSION

Ossification of the posterior longitudinal ligament (OPLL) has been known to be an important cause of cervical myelopathy in both Asian and Western countries. Although many clinical features of cervical OPLL are similar to those of cervical spondylotic myelopathy or cervical disc herniation, it also has several unique characteristics.

According to Tsuyama till 1978 it was postulated that OPLL is endemic to Japan to such an extent that it is called 'Japanese Disease'. Later various epidemiological studies helped in establishing the prevalence in other countries.

Trojan DA et al, in their study found some similarities among non-Japanese and Japanese cases including- male predominance. peak age at onset of symptoms at sixth decade; clinical presentation ranging from asymptomatic to quadriplegia; with progressive or acute onset of neurological deterioration; greater than 95% cases localized to cervical spine; association with several conditions including diffuse idiopathic skeletal hyperostosis; spondylosis; and ankylosing spondylosis. Differences between the 2 groups were minimal including greater proportion of patients with DISH and with continuous type of OPLL in Non-Japanese group.

Once thought to occur mainly in Japan OPLL is frequently seen in countries like India. Various studies have been published. The clinical, radiological, and pathological manifestations of OPLL have been reported to be similar as in Japanese population.

Most patients with cervical myelopathy have pre-existing cervical spinal stenosis and then are affected by progressive cervical spondylosis or ossification of the posterior longitudinal ligament which compress the spinal cord anteriorly. When the cervical spinal canal diameter is reduced, the amount of room available for the spinal cord decreased. Then, when the cervical spine is in hyperextension, the result is buckling of the ligamentum flavum posteriorly, and the cord may become compressed against an anterior osteophyte or ossification lesion.

In OPLL, limitations in the movement of the cervical spine develop with ligament ossification, resulting in uneven strain distribution in the disc. Dynamic stress is also concentrated in discs showing abnormal strain distribution, causing high stress in the posterior

longitudinal ligaments adjacent to such discs. As PLL restrains and reverses flexion of the vertebral column it is subjected to frequent dynamic stress in activities of work.

Interpretation of results

In the present study gender ratio is found to be 3.3:1 (male: female), which is in accordance with the study of Nakamura et al, where it was observed to be 3.5:1.

The average age of presentation is found to be 53.37 years in our study. The incidence of trauma in this study is observed to be 8.5%. The pre-operative and post-operative JOA scores and recovery rate for the trauma group were lower than those for the non-trauma group

The common type of OPLL was found to be mixed and segmental type C. In this study segmental type of OPLL is seen in 51.4% patients.

The mJOA questionnaire is often used to grade the severity of cervical myelopathy.

The anterior surgery was significantly better than posterior in the final recovery rate, i.e., 57.72% and 48.87% respectively.[17]

The overall recovery rate in our study is found to be 53.17%. The pre-operative Nurick's grade improved by 1.22 in anterior approach and by 0.66 in cases operated by posterior approach. The Nurick scale focuses on ambulation ability.

The advantage for anterior surgery is that it is more radical than posterior surgery in decompressing the nerve tissue by directly removing all of the anterior pathogenic structures such as protruded discs, osteophyte or ossification lesion.[18] With grafting, immediate stability of cervical spine can be achieved. The advantages of posterior decompression is that the operation is relatively straight forward. However, the possibility of progression of OPLL, post laminectomy membrane formation, kyphotic deformity, and instability of the cervical spine remains which can be diagnose via post op mri.[19]

The progression of OPLL, especially the transverse spread in the residual ossification foci, would recompress the spinal cord.[20] DISH is associated with more risk of OPLL.[21] Despite the high progression rate after posterior surgery few patients experienced worsening myelopathy during the follow-up period.

OPLL is also common in DISH patients.[21,22] Different types of collagen in found in OPLL patients.[23,24]

OPLL has familial aasociation.[25] OPLL can occur in thoracic spine also but most common is cervical spine.[26] Pathogenesis in involvement of OPLL is varied.[27]

Cervical myelopathy secondary to multiple spondylotic protrusions are very common and risk factor.[28,29]

Bladder and bowel involvement can occur in patients of long standing OPLL.[30,31]

CT and MRI can be used for diagnosing the type of OPLL.[32,33]

In this study no patient required reoperation for reconstruction failure, nor any other major complications were seen. Also, there was no mortality observed in this study.

Hirabayashi et al, analyzed the results of laminectomy in patients with OPLL and reported that the most common cause of deterioration was the progression of the OPLL.[34,35] However the follow-up period in our study is relatively short and the progression of OPLL and kyphotic deformity could not be evaluated.

CONCLUSION

Incidence of OPLL is more common in males as compared to females. The average age of presentation is sixth decade of life. Younger patients have better neurological and functional outcomes. The most common variant of OPLL is segmental followed by mixed. Two-level disc involvement is the common presentation. The recovery rate in traumatic patients is less than the non-traumatic group of patients. A higher JOA score indicates fewer neurological deficits with better neurological outcomes. The recovery rate achieved from anterior approach are better than those from the posterior approach.

Improvement in Nurick's score is more in anterior surgical group than in posterior surgical group. No complications seen in this study. No mortality seen in this study.

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