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Clinical Presentation and Surgical Outcome of Patients with Thoracic Ligamentum Flavum Hypertrophy; an Institutional Experience

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Abstract

Ossification of ligamentumflavum (OLF), though rare, is being increasingly recognized as a cause of thoracic myelopathy. Earlier, OLF has been reported almost exclusively in East Asian countries, particularly in Japan and Korea. Studies of OLF from other regions, such as India, Middle East &Caribbean are increasingly being reported. In view of the low incidence of this disorder and rarity of large clinical reports, the treatment guidelines and surgical prognosis in patients with this disease remain unclear. Hence, the study was conducted.

Objectives: We retrospectively& prospectively studied the risk factors, clinical manifestations, radiological aspects, surgical treatment, and prognostic factors in 31 patients ofthoracic ossification of ligamentumflavum (OLF).

Methods and results: A total of 31 patients who underwent surgical treatment for thoracicmyelopathy secondary to OLF between 2014 and 2018 were studied retrospectively&prospectively.Preoperative and postoperative neurological data were reviewed and the correlationbetween the variables of patient characteristics, preoperative duration of symptoms,preoperative neurological status, and the functional outcome were analyzed. The maleto female ratio was 1.9:1. In total, 23 patients (74.2%) were in the 5th & 6th decadeof life. The lower thoracicregion (D9–D11) was most commonly affected (48.4%).All patientsunderwent wide decompressive laminectomy with medial one-third facetectomyandOLF was resected. The average follow-up was 2 years.

Conclusion: In all, 21 patients (67.7%) had good outcome, 6 patients (19.4%) had fair outcome, 2 patients(6.5%) improved but still required help for their routine work &2 patients (6.5%)were bed-ridden at last follow-up.Mostcommoncomplications observed were dural tear &csf leak (6.4%).

Keywords: Ligamentumflavum; Thoracicspine; Ossification; Laminectomy.

Introduction

The ligamentumflavum is a yellowish elastic ligament extending from second cervical vertebra to the first piece of sacrum. The ligament extends all along the dorsal portion of the spinal canal, attaching the laminae and extending up to the capsules of facet joints and the posterior aspects of the neural foramina[1].

Ligamentumflavum hypertrophy (LFH) is a pathological condition that causes neurological symptom (radiculopathy and or myelopathy). It usually occurs in the thoracic spine and less frequently in the cervical spine[2,3].

Ossification of ligamentumflavum (OLF), though rare, is being increasingly recognized as a cause of thoracic myelopathy. Earlier, OLF has been reported almost exclusively in East Asian countries, particularly in Japan and Korea. Studies of OLF from other regions, such as India, Middle East, and West including Caribbean, are increasingly being reported[4,5]. Adults in the age group of 30 to 60 years are affected most frequently, and the disease has a strong predilection for the lower thoracic spine (T9–T12)[4, 6].

In view of the low incidence of this disorder and rarity of large clinical reports, the treatment guidelines and surgical prognosis in patients with this disease remain unclear. In the present study, we retrospectively and prospectively analyze the clinical features and surgical outcome of patients with symptomatic thoracic LFH treated surgically at our institute.

Aims & Objectives

1. To describe clinical presentation of patients with thoracic ligamentum flavumhypertrophy.
2. To determine the surgical outcomes in patients with thoracic ligamentum flavum hypertrophy.

Anatomy &Pathophysiology

The ligamentumflavum (LF) connects the laminae of adjacent vertebrae, all the way from the second vertebra, axis, to the first segment of the sacrum. They are best seen from the interior of the vertebral canal; when looked at from the outer surface they appear short, being overlapped by the lamina of the vertebral arch.

Each ligament consists of two lateral portions which commence one on either side of the roots of the articular processes, and extend backward to the point where the laminae meet to form the spinous process; the posterior margins of the two portions are in contact and to a certain extent united, slight intervals being left for the passage of small vessels. Each consists of yellow elastic tissue, the fibers of which, almost perpendicular in direction, are attached to the anterior surface of the lamina above, some distance from its inferior margin, and to the posterior surface and upper margin of the lamina below&both side flaps are separated at the midline. It extends laterally to the anterior side of the facet joint and is separated from the dura mater by epidural fat. In the neck region the ligaments are thin, but broad and long; they are thicker in the thoracicregion and thickest in the lumbar region.

For convenience of theexplanation of the pathologic progression, LF is dividedinto two parts: as a capsular portion and an inter-laminar portion.

Pathophysiology

There are two putative theories for the development of OLF: intrinsic causes such as genetic and dietary factors[7], and extrinsic causes which includesbio mechanical alterations[5,8]. In the past, intrinsic factors were re¬garded as being more important because the disorder was considered to develop only in limited areas of the world.But extrinsic factors are presumed to be more important nowadays after its occurrence has been seen throughout the world[9-11]. A biomechanical mechanism as a cause of this disorder would be different in nature from the usual degenerative processes that occur due to hyper¬mobility because the movement of the thoracic spine is limited compared to the cervical and lumbar spines. The putative mechanism is as follows. When the tensile force increases, BMP-2, TGF-beta, and SOX are elevated in the ligamentumflavum. Then, the fibroblasts become dif¬ferentiated into chondroblasts and osteoblasts and finally ossification of the ligament develops[12]. One of the reasons why it develops more frequently in East Asia is considered to be due to the more frequent squatting posi¬tion adopted by members of those populations[13,14]. In cases with diffuse idiopathic skeletal hyperostosis, Paget’s disease, fluorosis, adenocarcinomatous metastasis, hypo-phosphatemic vitamin D resistant rickets, hydroxiapetite and disorders of calcium metabolism may result in OLF[15,16]. However, the exact pathophysiology has not been fully elucidated yet. It progresses byendochondralossifi¬cation.

The predilection sites are the lower thoracic, high thoracic and mid thoracic areas, in order of frequency. The most frequent site is between T10 and T11, and it is presumed that this is because these segments receive the maximum tensile force[11].

Ossification begins from the capsular portion and progresses to the interlaminar portion of the LF. In the transverse plane, ossification begins from the posterior side and progresses to the dural side[17,18]. On both sides, the paramedian cords meet at the midline and form a nodular mass and this usually progresses in a cranial direction[19,20].

Etiopathogenesis

It has been documented that the incidence of thoracic OLF is higher in the patients with diffuse idiopathic skeletal hyperostosis, fluorosis, diabetes mellitus, and ankylosing spondylitis. Moreover, this disorder may occurincombination with ossification of the posterior longitudinal ligament[12].

Demographic Features

Ossification of the ligamentumflavum is a relatively rare disease, and there are insufficient controlled epidemiological data in the literature. Ossification of theligamentumflavum is reported to affect 20% of Asians older than 65 years of age[4]. Although OLF has been reported as endemic to Japan, reports from outside ofthis endemic area—North Africa,[23,24,25] the Middle East, India,[26,27] Caribbean, Europe,[4,] and North America[28,29] have been increasingly reported inthe literature. However, the Japanese population remains the largest population affected, with 88.8% of the reports of OLF in the literature based on Japanese patients, and Caucasians are the second-most common, comprising8.2% of the reports[30].

Clinical Presentation

Clinical manifestations and imaging tests are the two mainstays in the diagnosis. Local thoracic pain, stiffness and slowly progressive myelopathy are the distinctive features. In the early stage, posterior cord syndrome, i.e., loss of vibration and proprioception, develops because compression of the spinal cord usually begins from the posterior side. As the ossification progresses, the lateral corticospinaltracts are compressed and then spastic paraparesis develops. And as the area of ossification enlarges, compression of the lateral spinothalamic tracts causes loss of sensation. The most common clinical manifestation at the time of the diagnosis is loss of functional gait. Radicular pain and loss of pain and temperature sensation are rare[31,32].

Myelopathy Scales

For assessing functional status of the patient in thoracic OLF, various myelopathy grading scales are used; which are: the Nurick'sGrading of Myelopathy, 42 the Japanese Orthopedic Association (JOA) Scale[34,35,] the Harsh's Spine Function ScoreandRanavat Neurological Classes & Grades. Of these, the Nurick's grading is more widely accepted.

The Nurick's Myelopathy Grading:

Grade 0	Signs or symptoms of root involvement but without evidence of spinal cord disease
Grade I	Signs of spinal cord disease but no difficulty in walking
Grade II	Slight difficulty in walking which did not prevent full-time employment
Grade III	Difficulty in walking which prevented full-time employment or the ability to do all housework, but which was not so severe as to require someone else's help to walk
Grade IV	Able to walk only with someone else's help or with the aid of a frame
Grade V	Chair bound or bedridden

Although easy to use, this grading system does not incorporate the sensory and sphincter dysfunctions.

Radiological Parameters

Plain X-Ray Films & Myelogram

Ossification of the ligamentumflavum (OLF) was discovered by Polgar through a lateral X-ray film.

Radiographic examination plays an important role in the diagnosis & evaluation of OLF. On lateral conventional radiography and/or conventional X-ray tomography, OLF appears beak like or nodular bony densities projecting into the posterior aspect of the central spinal canal. On conventional water- soluble contrast myelography, a complete block or partial obstruction of flow may be demonstrated at the most severely affected levels.

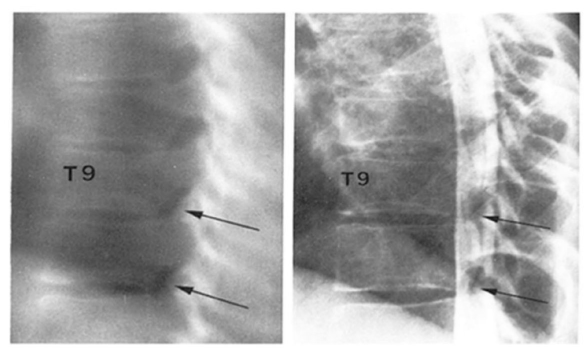


Fig 2: Lateral dorsal x-ray showing beak like appearance.

However, the investigation of the disease began in earnest after the development of the computed tomography (CT) and magnetic resonance imaging (MRI).

Both CT & MR can accurately demonstrate the shape, location, distribution & levels of the OLF as well as relative degree of associated central spinal canal stenosis.

Classification of OLF based on CT

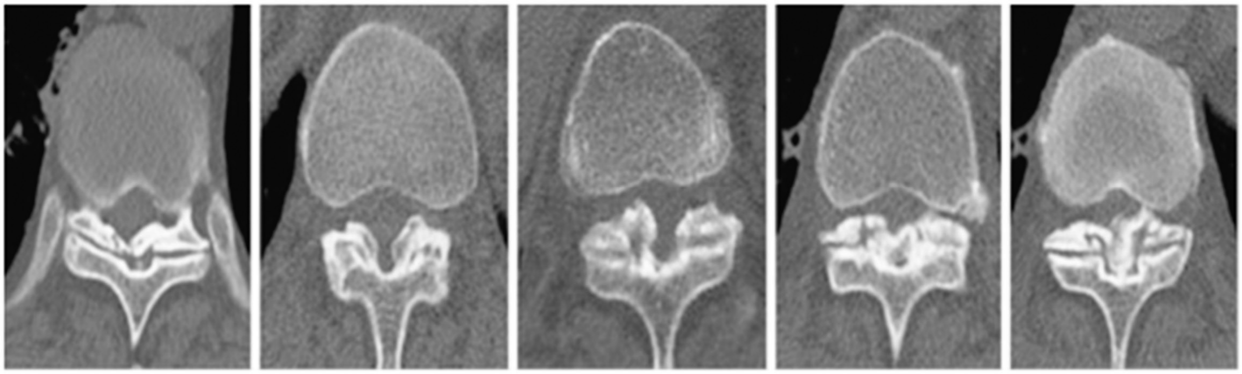


Fig. 5: Sato classification

Sato classification

According to the progression of the ligament ossification. (A) Lateral type which means ossification of only the capsular portion of the ligamentumflavum. (B) Extended type which means extended ossification of the interlaminar portion. (C) Enlarged type which means anteromedial thickening and enlargement of ossification. (D) Fused type which means fusion of the bilateral ossified masses at the midline. (E) Tuberous type which means anterior growth of the fused mass of ossification.

OLF Type based on MRI

FIG. 6. Sagittal MR images documenting the distribution patterns of theossifications: isolated type (left); continuoustype (center); and noncontinuous type (right).

Degree and duration of spinal cord compression are the most important determinants of disease development and outcome. Okada et al. have reported that the cross-sectional area of spinal cord (sagittal cord diameter × transverse cord diameter) evaluated as a static factor yielded a higher correlation with myelopathy than minimal diameter as determined usingplain radiography, and this variable is gaining attention as a important static factor.

Diagnosis of Olf

In imaging investigations, it is not easy to discover this lesion through simple radiography because the lower thoracic spine is overlapped by the liver and the upper thoracic spine is overlapped by the shoulders. An MRI examination is cardinal in the case of myelopathy. T2 sagittal MRI is most instrumental for examining the whole spine and discovering multiple OLFs. Furthermore, it is helpful for determining prognosis through the signal changes of the spinal cord[5, 32, 35]. However, the differential diagnosis of hypertrophy or calcification is difficult even with an MRI. Thus, a CT examination is important for making an exact diagnosis and for setting up a surgical plan[37]. In the case of accompanying lumbar spinal diseases, the clinical symptoms may become vague and confusing, making it easy for clinicians to miss the exact diagnosis. Hence it is important to perform, a whole spine sagittal T2 MRI.

Management Options

Options of surgical decompression

- Laminotomy
- Laminoplasty
- Enblock laminectomy + Duralexcision leaving arachnoid
- En block laminectomy + duralexcision + patch graft
- Laminectomy+floating ossified dura mater

In our study the universal method, bilateral laminectomy and excision of ossified ligament, technique was used. The sequence of decompression is as follows: the medial[1/3rd] ofinferior articular processes and the inferior lamina of the vertebra above are excised; then the ossified ligament is separated from the duramater; next, the ossified ligament and superior articular processes of the inferior vertebra are ground into a paper-thin plate; and finally, the thin bony plate is removed[39]. However, in the case of ossification up to the dura mater, the fourth and fifth methods should be used. Total excision of the ossified dura mater and insertion of a patch graft is usually followed by massive cerebrospinal fluid (CSF) leakage and a pseudomeningocele. The method which floats the ossified dura mater, i.e., floating laminectomy, is feasible; however, dural floating will be insufficient in cases where the dural ossification extends to the vertebral foramen. Fortunately, the floated ossified mass usually atrophies and the intradural space widens gradually as time goes by.

Materials and Methods

Patients operated for Thoracic LFH in the Department of Neurosurgery at Vydehi Institute of Medical Sciences and Research Centre between January 2014 to December 2018.

Patients who met the inclusion and exclusion criteria were recruited.

Detailed clinical history and radiological findings were retrospectively taken from the case records of the patients and prospectively recorded in the cases operated till December 2018.

A minimum follow-up of 3 months was done for improvement.

Preoperative clinical evaluation included history taking (duration of symptoms, incidence of back pain, radicular pain, weakness, stiffness, numbness, sphincter involvement, co-morbid factors, history of acute deficit/trauma) and detailed neurological examination (weakness of limbs, spasticity, muscle power, sensory system, sphincter involvement, Nurick's myelopathy grading). Preoperative radiological evaluation included X-ray thoracicspine (AP view, Lateral view) and CT-thoracic spine (sagittal, coronal and axial sections); the features studied were OLF type, no. of levels involved. MRI- Thoracic spine T1-weighted, T2-weighted, images were acquired and the features studied included: OLF type; number of levels involved; T2-weighted cord signal changes, other changes (including other ligaments ossification). The MRI measurements were made in T1-weighted images. Surgery:Decompressive bilateral laminectomy with excision of hypertrophied / ossified ligamentumflavum.

Detailed clinical evaluation was done at discharge and at follow-up (minimum 3-months follow-up was required) using similar parameters as in pre-operative evaluation and functional grading scales of Nurick's myelopathy grading {improvement/ deterioration in percentages for the same were calculated.

Results

Study design: An observational study.

Clinical Parameters

Table 1: Age distribution of patients studied.

		Count	%
Age	<40 years	6	19.4%
	41 to 50 years	12	38.7%
	51 to 60 years	11	35.5%
	>60 years	2	6.5%
	Total	31	100.0%

Mean age was 47.97 ± 9.738 years.

Majority of patients where in 5th & 6th decade.

Table 2: Sex distribution of patients studied.

		Count	%
Sex	Female	11	35.5%
	Male	20	64.5%

This study shows incidence of OLF is more common in males than in females.

Table 3: Duration of symptom distribution of patients studied.

		Count	%
Duration	<6 months	6	19.4%
	6 months to 1 year	13	41.9%
	>1 year	12	38.7%

19.4% had symptoms for <6 months, 41.9% for 6 months to 1 year and 38.7% had symptoms for >1 year.

Table 4: Symptoms in the patients studied.

	Present		Absent	
	Count	%	Count	%
Back Ache	23	74.2%	8	25.8%
Difficulty walking	18	58.1%	13	41.9%
Numbness of LL	12	38.7%	19	61.3%
Sphincter disturbance	4	12.9%	27	87.1%

Majority of patients had back ache (74%) & Difficulty walking (58%).

Table 5: Bladder Involvement of patients studied.

Bladder Involvement	No. of Cases	(%)
No	27	87%
Yesw	4	13%

Majority of patients has no bladder involvement (87%).

Table 6: Comorbidities distribution of patients studied.

Co-morbidities	Count	%
No	20	64.5%
DM	5	16.13%
Hypothyroid	2	6.45%
HTN	5	16.13%
Obese	1	3.22%
IHD	1	3.22%

16.13% had DM or HTN, 6.4% had Hypothyroidism, and 3.2% had IHD or Obesity.

Table 7: Nuricks Grade at Admission of patients studied.

Nuricks Grade at Admission	No. of Cases	%
1	2	6.5%
2	4	12.9%
3	11	35.5%
4	6	19.4%
5	8	25.8%

Majority of patients were in Nurick's grade 3 (35.5%).

Radiological parameters

Table 8: OLF Type distribution among patients studied

		Count	%
OLF Type	A	4	12.9%
	B	9	29.0%
	C	7	22.6%
	D	3	9.7%
	E	8	25.8%

12.9% had OLF Type A, 29% had OLF Type B, 22.6% had Type C respectively, 9.7% had OLF type D and 25.8% had OLF type E.

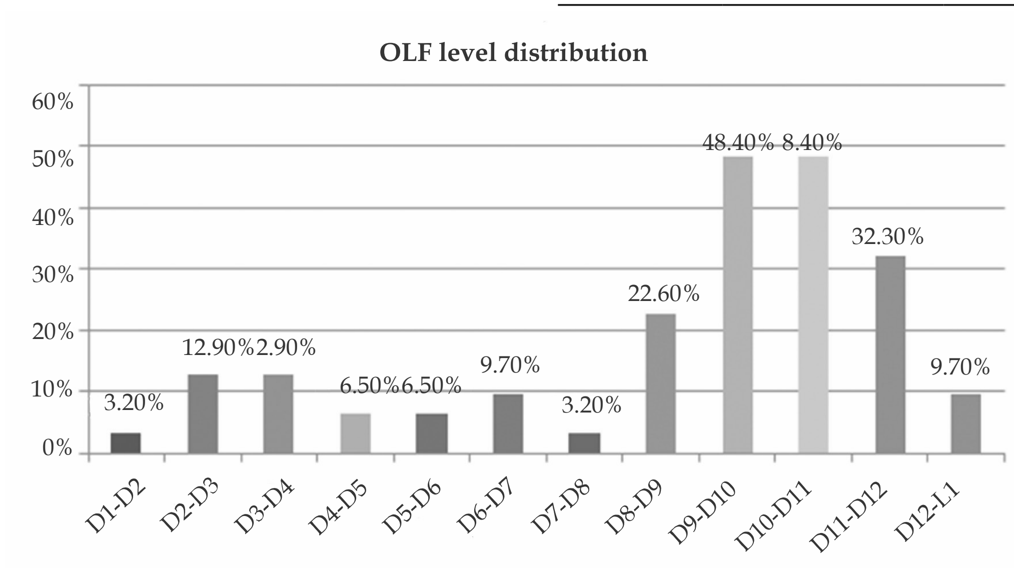
Table 9: T2W Hyper intense signal on MRI of patients studied.

Hyper intense signals	No of Patients	Percent
Yes	12	38.7%
No	19	61.3%

38.7% patients had hyper intense signals on MRI.

Table 10: OLF level distribution of the patients studied.

Level	No. of Cases	Percentage
D1-D2	1	3.2%
D2-D3	4	12.9%
D3-D4	4	12.9%
D4-D5	2	6.5%
D5-D6	2	6.5%
D6-D7	3	9.7%
D7-D8	1	3.2%
D8-D9	7	22.6%
D9-D10	15	48.4%
D10-D11	15	48.4%
D11-D12	10	32.3%
D12-L1	3	9.7%



Majority of patients had D9-D11 (48.8%) involvement.

Table 11: Associated Lesions of patients studied.

Associated lesions	No. of Cases	Percentage (%)
None	17	57
Concomitant Cervical + Dorsal Involvement	7	23
Concomitant Lumbar + Dorsal Involvement	6	20

43% of patients had associated lesions along with dorasal OLF.

Surgical Parameters

Table 12: Out Come at immediate postop of patients studied

Change	No. of Cases
Same	22
Improved	7
Worsened	2

23% of patients improved neurologically in the immediate post period.

Table 13: Complications distribution of patients.

		Count	%
Complications	Dural Tear, CSF Leak	2	6.4%
	Wound Infection	1	3.2%
	No	29	93.5%

Table 14: Follow up distribution of patients studied.

Follow up at	Count	Percentage
3 months	2	6.5%
6 months	1	3.2%
1 year	8	25.8%
2 year	20	64.5%

Mean duration of followup was 22.74 months.

Table 15: neurologicalOutcome distribution of patients studied.

Outcome	Count	%
Good Improvement by ≥3 grades Nurick's grade at last follow-up 0-2	21	67.7%
Fair Improvement by 2 grades Nurick's grade at last follow-up 3	6	19.4%
Improved Improvement by 1 grade Nurick's grade at last follow-up 4	2	6.5%
Poor No Improvement/neurological deterioration Nurick's grade at last follow-up 5	2	6.5%

Majority of patients had good outcome (67.7%).

TABLE 16: Maximum Improvement in Outcome at different follow-up periods.

Maximum Improvement in Outcome	No. of cases	%
<6m	20	65%
6m-1yr	5	16%
2yr	4	23%
Same/ Worsened	2	6%

Majority of patients (65%) improved within 6 months of follow up.

Table 18: geographical distribution of patients studied with respect to fluorosis prevalent states.

Fluorotic Belt	No. of Cases	%
No	8	26%
Yes	23	74%

Table 17: Nurick'sGrade comparison between Pre op and post op grades at different periods of follow up.

	Pre Op		Post Op		3 Months		6 Months		1 year		2 years	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
G 0	0	0%	1	3.2%	2	6.5%	4	12.9%	9	29.0%	9	29.0%
G 1	1	3.2%	3	9.7%	6	19.4%	6	19.4%	2	6.5%	2	6.5%
G 2	5	16.1%	2	6.5%	8	25.8%	7	22.6%	2	6.5%	2	6.5%
G 3	11	35.5%	9	29.0%	8	25.8%	8	25.8%	4	12.9%	4	12.9%
G 4	6	19.4%	9	29.0%	6	19.4%	3	9.7%	1	3.2%	1	3.2%
G 5	8	25.8%	7	22.6%	1	3.2%	1	3.2%	0	0%	0	0%
P value			<0.001*	<0.001*	0.001*	0.041*	0.038*					

In the study there was significant improvement inNurick's grade, at 1 month, 3 months, 6 months & 1 year.

Table 19: Association between Duration of symptoms & Outcomeof patients.

		Outcome							
		Good		Fair		Improved		Poor	
		Count	%	Count	%	Count	%	Count	%
Duration	<6 months	6	28.6%	0	0.0%	0	0.0%	0	0.0%
	6 months to 1 year	13	61.9%	0	0.0%	0	0.0%	0	0.0%
	>1 year	2	9.5%	6	100%	2	100.0%	2	100.0%

χ 2 =23.37, df =6, p =0.001*

Majority of patients ((90%) had good outcome whose symptoms was < 1 year,there was significant association between Outcome and duration of symptoms.

Table 20: Association between OLF Type& Outcome of patients.

		Outcome							
		Good		Fair		Improved		Poor	
		Count	%	Count	%	Count	%	Count	%
OLF type	A	4	19.0%	0	0.0%	0	0.0%	0	0.0%
	B	9	42.9%	0	0.0%	0	0.0%	0	0.0%
	C	6	28.6%	1	16.7%	0	0.0%	0	0.0%
	D	1	4.8%	2	33.3%	0	0.0%	0	0.0%
	E	1	4.8%	3	50.0%	2	100.0%	2	100.0%

χ 2 =25.39, df =12, p =0.013*

OLF type B & C had good outcome compared to type D & E

Table 21: Association between bladder involvement & outcome of patients.

		Outcome							
		Good		Fair		Improved		Poor	
		Count	%	Count	%	Count	%	Count	%
Bladder involvement	No	21	100.0%	6	100.0%	0	0.0%	0	0.0%
	Yes	0	0.0%	0	0.0%	2	100.0%	2	100.0%

χ 2 =31, df =3, p <0.001*

Patients who had bladder involvement showed poor outcome. There was significant association between Outcome and bladder involvement

Table 22: Association betweenT2w Hyper intense signal& Outcome of patients.

		Outcome							
		Good		Fair		Improved		Poor	
		Count	%	Count	%	Count	%	Count	%
T2w Hyper intense signal	No	19	90.5%	0	0.0%	0	0.0%	0	0.0%
	Yes	2	9.5%	6	100.0%	2	100.0%	2	100.0%

χ 2 =23.37, df =3, p <0.001*

In the study 90% of patients hadgood outcome thathad noT2w Hyper intense signal on MRI. There was significant association between Outcome and T2w Hyper intense signal.

Discussion

Calcification of ligamentumflavum is usually encountered in East Asian population and exceptionally reported in Caucasian people[38-40]. However the disease is now being increasingly recognized as a cause of thoracic myelopathy in Indian population. Mostcases of OLF occur in the thoracic spine or the thoraco lumbar spine and rarely in the cervical spine[41]. In our study, majority of the patients were males as comparable with other studies. In our study majority of the patients were in 5th & 6th decade that is comparable with other studies[42].

Diagnosis of thoracic myelopathy tends to be delayed because of its complex neurological manifestations and rarity[43]. Increased lower extremities muscle tone and deep tendon reflexes, and presence of pathological reflexes indicate myelopathy. However, these are more frequently recognised in, and associated with, cervical myelopathy.

In our study 43% of the patients had associated cervical or lumbar pathology.

Weakness, pain, or sensory deficit in lower extremities and sphincter dysfunction sometimes mimic lumbar disorders. As a result, the neurological manifestations from thoracic myelopathy are sometimes misdiagnosed as cervical or lumbar disorders. Altered sensations of light touch, pain, temperature, vibration, and proprioception correspond to the dysfunction of the spinal cord tracts. Proprioception is one way to examine the deep senses that are carried in the dorsal column in the spinal cord. Thus, inability to detect joint position in space reflects dysfunction of the dorsal column. OLF is in the posterior part of the spinal canal; consequently, it may easily cause dorsal column dysfunction. Proprioception is important as altered joint position sensation causes gait disturbance. It sometimes also gives the wrong impression of subjective weakness in the lower extremities when normal muscle strength is elicited in physical examination. Therefore, impairment of proprioception in the big toe may be an important sign in the diagnosis of thoracic myelopathy. Takenakaet al[8] reported symptoms specific to anatomical pathology or compressed segments in thoracic myelopathy. These may also aid in diagnosis and initial investigations.

CT is an excellent tool in evaluating local extent of OLF & the axial configuration of the central spinal canal but MRI provides overall information concerning levels, presence of associated diseases & the effects on the underlying spinal cord. In our study all patients underwent MRI & CT whole spine.

MRI T2WI Intramedullary high signal intensity has shown significant poor outcome compared to the other patients with no hyper-intensity changes in the cord.

Conservative management has been demonstrated to be ineffective for symptomatic patients[44]. Decompression has proven effective in the treatment of thoracic OLF,[12,43] Patients with a shorter preoperative duration of symptoms experienced significantly better neurological outcomes[40,42]. This emphasises the importance of early diagnosis and prompt surgical decompression in thoracic myelopathy. Similarly all our patients underwent wide bilateral laminectomy procedure & 90% of the patients had good outcome whose duration was less than 1 year and maximum neurological improvement occurred within 6 months of surgery (65% of patients)

In our study, overall improvement in pre-operative neurological status was seen in > 90% of patients. Neurological status remained Unchanged/ worsened in 6.5% of patients another study done at India[42] showed neurological improvement in 84% of patients, unchanged in 12 % and worsened neurological status in 4% of patients who were operated for ossified ligamentumflavum.

The most important factors in most studies are the severity of the preoperative symptoms and the time interval before the decompres¬sion surgery. Therefore, early diagnosis and decom¬pression are the most important factors for obtaining better outcomes.

Similarly in our study Pre-operative duration of symptoms <1 year (19 patients) 90%

improved significantly, indicates the importance of early operative intervention to achieve better result.

The most important and interesting fact of this study in that, the 23 (74%) patients belong to high fluorosis effected districts of India[46, 47]. This needs further studies to correlate the association with the disease.

Conclusions

1. OLF is acommon cause of myelopathy in thoracic spine.
2. OLF is mostly seen in 5th & 6th decade of life.
3. Males are more affected than females.
4. Local back ache & spasticity are the usual type of presentation.

5. Lower thoracic levels aremost frequently affected in OLF.
6. Significant poor clinical prognostic markers in our study are:
   a. Long duration of symptoms before surgery > 12 months.
   b. Sphincter disturbances.
   c. Severe preoperative condition(poor nuricks grade).
   d. Intramedullary high signal intensity
   e. Severity of morphological classification.
7. Conservative treatment has no role in this disorder.
8. A standard decompressive bilateral laminectomy has shown significant

   BenefitinTOLF.
9. Symptomatic thoracic OLF benefits from surgery, especially in patients with Pre-operativeNurick's grades 3 and 4.

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