# **Original Research Article**

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# Retrospective and prospective analysis of clinical, radiological and prognostic factors affecting surgical denouement in ossified posterior longitudinal ligament: an institutional experience

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#### **ABSTRACT**

**Background:** The most common cause of radiculopathy or myelopathy is "ossification of the posterior longitudinal ligament (OPLL)". Surgical management consists of various anterior and posterior procedures. Anterior procedures done are corpectomy and fusion. Posterior procedures include laminectomy and laminectomy with fusion that include the use of lateral mass or pedicle screws with rods. Objective was to study the clinical course and to delineate clinicoradiological prognostic factors with regard to surgical outcome.

**Methods:** Patients operated for cervical OPLL were included. Detailed clinical history and radiological findings were retrospectively taken from the case records of the patients and prospectively recorded in the cases operated till May 2018. A minimum follow-up of 6 months was done for improvement. Preoperative clinical evaluation was done. Surgical options were individualized for each patient. Detailed clinical evaluation was done at discharge and at follow-up.

**Results:** It has been found that those patients who were admitted with Nurick's myelopathy grade IV and V at admission, those with higher number of levels involved like 5, 6 and 7, those with duration of symptoms of more than one year were more likely to have same or deteriorated outcome compared to their counterparts. Other parameters were not found to be significantly associated with outcome.

**Conclusions:** Duration of symptoms >12 months, Sphincter disturbances were significant poor clinical prognostic markers. Significant poor radiological prognostic markers were segmental stenotic index <0.4, MRI T2-Weighted hyper intense signal change.

Keywords: OPLL, Prognostic factors, Retrospective study, Surgical outcome

### INTRODUCTION

The most common cause of radiculopathy or myelopathy is "ossification of the posterior longitudinal ligament (OPLL)". This was mentioned by Byung-Wan Choi et al<sup>1</sup>. The disorder is usually seen in the fifth to seventh decades of life. 1,2 It is more common in males compared to females. This was mentioned by Bin Zhu et al in their study in 2013. 2 It has been found that the areas where

fluorosis is endemic, the prevalence of OPLL is more. The outcome of cervical OPLL in operated cases is difficult to predict.<sup>2</sup>

The definition of the "Ossification of the posterior longitudinal ligament" is "True ossification with Haversian canals present in the slab of bone that replaces the posterior longitudinal ligament." There is not only the fibrosis but also the hypertrophy of the "posterior"

longitudinal ligament" and this is followed by "cartilaginous proliferation, lamellar bone formation, and Haversian canal production." OPLL occurs mainly in the cervical region. Neurologically it is an important disorder. It can cause radiculopathy or myelopathy or both. Its outcome is difficult to predict. The precise of epidemiologic aspects, clinical contributions parameters and radiological factors to disease progression remain controversial, thus making it difficult to prognosticate.<sup>3-5</sup> The sensory clinical factors are radicular pain and numbness. The motor clinical factors are weakness, stiffness, wasting and Nurick's myelopathy grading. The various radiological prognostic factors include OPLL type, OPLL extent, number of levels involved, effective canal diameter, and segmental stenotic index and cord signal changes in MRI.5

Surgical management consists of various anterior and posterior procedures. Anterior procedures done are corpectomy and fusion. Posterior procedures include laminectomy and laminectomy with fusion that include the use of lateral mass or pedicle screws with rods. Wu JC et al, observed that anterior resection procedure gives better results in terms of outcome compared to that of the posterior decompression of OPLL.<sup>6</sup>

With this background, present study was carried out to study the clinical course and to delineate clinicoradiological prognostic factors with regard to surgical outcome.

#### **METHODS**

Patients operated for cervical OPLL in the Department of Neurosurgery at Vydehi Institute of Medical Sciences and Research Centre by Posterior fusion and anterior fusion from January 2010 to May 2018. Patients who met the inclusion and exclusion criteria were recruited.

#### Inclusion criteria

All cervical OPLL cases undergoing surgery including single and multiple levels.

#### Exclusion criteria

- Individuals with abnormal bone-density due to other causes.
- Cases of canal stenosis due to OLF and severe cervical spondylosis,
- All cervical PIVD cases.

Detailed clinical history and radiological findings were retrospectively taken from the case records of the patients and prospectively recorded in the cases operated till May 2018. A minimum follow-up of 6 months was done for improvement.

Preoperative clinical evaluation included history taking (duration of symptoms, incidence of neck pain, radicular

weakness, stiffness, numbness, sphincter involvement, co-morbid factors, history of acute deficit/trauma) and detailed neurological examination (restriction of neck movements, wasting, spasticity, muscle power, sensory system, sphincter involvement, Nurick's myelopathy grading). Preoperative radiological evaluation included X-ray cervical spine (AP view, Lateral view: flexion, neutral, extension-active) and CTcervical spine (sagittal, coronal and axial sections); the features studied were OPLL type; no. of levels involved; segmental stenotic index. MRI-cervical spine T1weighted, T2-weighted, images were acquired, and the features studied included: OPLL type; number of levels involved: effective canal diameter (ECD); at the level of maximum compression were calculated; T2-weighted cord signal changes, other changes (including other ligaments ossification). The MRI measurements were made in T1-weighted images.

Surgical options were individualized for each patient; in general, up to two vertebral body levels involvement was approached anteriorly and more than that approached posteriorly in the absence of preoperative cervical spine kyphosis (instability). Anterior approaches included anterior cervical central corpectomy with discectomy with fusion and instrumentation. Posterior approaches included laminectomy and laminectomy with fusion. Post-operative cervical spine immobilization for 12 weeks was followed.

Detailed clinical evaluation was done at discharge and at follow-up (minimum 6-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).

# Statistical analysis

The data was entered in the Microsoft excel worksheet and analyzed using proportions. The results were analyzed with respect to overall functional improvement and were analyzed for 40 patients with follow-up; as discussed below. Nuricks myelopathy grading was selected for the analysis of results at follow-up. Open epi info software and socscistatistic was used to calculate the chi square and p value. These are free-wares available on the internet.

# **RESULTS**

In our study (n=41) were male and (n=6) female patients. Age ranged from 27 years to 70 years. Majority of the patients were more than 45 years (n=39) of age and 45-55 (n=26) age group. The duration of symptoms ranged from 1 month to 200 months. Observing the clinical presentation, localized neck pain was seen in (n=31) patients (65.95%) and radicular pain was seen in (n=12) patients (25.5%). Observing the pattern of weakness (n=17) patients (36.2%) had present with

myeloradiculopathy and (n=23) patients (48.9%) had presented with myelopathy alone, while (n=1) did not have any weakness. On analyzing the Nuricks myelopathy grading at admission majority of the patients were in Nuricks grade 3 and 4 (n=40) (81%). Bladder involvement was observed in (n=15) patients (31.9%) (Table 1).

Table 1: Distribution of study subjects as per clinical parameters.

Clinical parameters		Number	%
Sex	Male	41	87.2
	Female	06	12.8
Age (years)	< 45	08	17.0
	45-55	26	55.3
	> 55	13	27.7
Neck pain	Yes	31	65.9
	No	16	34.1
Radicular pain	Yes	12	25.5
	No	35	74.5
Nurick's Myelopathy grading at admission	I	1	2.1
	II	0	0
	III	23	48.9
	IV	17	36.2
	V	6	12.8
Bladder involvement	Yes	15	31.9
	No	32	68.1

All the patients (47) underwent pre-operative x-ray of the cervical spine (AP and lateral view dynamic). All patients underwent CT- cervical spine (sagittal and coronal) and MRI-cervical spine (T1 and T2). As expected in OPLL patients all spines were stable spines. In our study mixed type of OPLL (n=19) (40.5%) emerged as the commonest type. Around 57.4% patients had more than three vertebral segment involvements. 14 (29.8%) patients in our series showed hyperintense MRI spinal cord signal intensity changes (Table 2).

Table 2: Distribution of study subjects as per radiological parameters.

Radiological parameters		Number	%
Type of OPLL	Focal	4	8.5
	Segmental	16	34.0
	Continuous	8	17.0
	Mixed	19	40.5
Number of levels involved	1	4	8.5
	2	0	0
	3	16	34.0
	4	13	27.7
	5	11	23.4
	6	2	4.3
	7	1	2.1
T2W Hyper	Yes	14	29.8
intense signal	No	33	70.2

Table 3: Distribution of study subjects as per surgical parameters.

Surgical parameters		Number	%
Type of surgery	Corpectomy	8	17.1
	Laminectomy	33	70.1
	Laminectomy with fusion	6	12.8
Nurick's	Improved	26	55.3
Myelopathy grading at discharge	Same	18	38.3
	Deteriorated	3	6.4

Patients (n=8) underwent anterior corpectomy and fusion with titanium expandable cage and anterior plate in which (n=5) patients had one level cervical OPLL and (n=3) had three level OPLL. (n=33) patients underwent decompressive laminectomy without fusion. (n=6) patients underwent decompressive laminectomy and lateral mass fusion with titanium screws. One of our patients who underwent corpectomy had post-operative radiculopathy. One patient had CSF leak which was managed with lumbar drainage. In all patients with dural adherence the portion of the OPLL adherent to the dura was left in-situ to prevent dural tear. The functional statuses of patients were noted at discharge. According to Nurick's myelopathy grading, only 3 patients had deteriorated as compared to preoperative status (Table 3).

Table 4 shows association between parameters and outcome. It has been found that those patients who were admitted with Nurick's myelopathy grade IV and V at admission were more likely to have same or deteriorated outcome compared to those who were admitted with grade I to III (58.8% vs. 7.1%). This was found to be statistically significant. It was also noted that those with higher number of levels involved like 5, 6 and 7 were more likely to have worst or same outcome compared to those with lower grades of 1-4 (70% vs. 18.8% and 25%). This was also found to be statistically significant. Those with duration of symptoms of more than one year were more likely to have same or deteriorated outcome compared to those with duration of symptoms of less than one year (83.3% vs. 5.3%). This difference was found to be statistically significant (p<0.05). T2W hyper intense signals and sphincter involvement was also significantly associated. Other parameters were not found to be significantly associated with outcome.

#### DISCUSSION

The most common cause of cervical myelopathy is OPLL. But the cause is still not clear. But it has been found that areas with water having high fluoride levels have been associated with the OPLL as the common cause of cervical myelopathy.

Cervical OPLL appears more commonly in males than in females usually twice as common; the results, however, are reflective of a predominantly Japanese Mongoloid and North-American Caucasoid ethnicity. 6-8 In our study, the male: female ratio is higher (about 7:1); whether it reflects an ethnic difference (the population under study

being Asian Indians) is to be seen. In a previous study based on Asian Indians however, no gender significant differences were apparent.<sup>9</sup>

Table 4: Association between parameters and outcome.

Clinical parameters		Outcome Same or deteriorated	Improved	Chi square	P value
Age (years)	> 55	4 (25%)	12 (75%)	0.2327	0.3148
	< 55	9 (37.5%)	15 (62.5%)		
Duration of symptoms	> 12 months	12 (75%)	4 (25%)	13.44	0.0001
	< 12 months	3 (12.5%)	21 (87.5%)		
	Myelopathy	10 (38.5%)	16 (61.5%)		
Clinical syndrome	Myeloradiculopathy	5 (41.7%)	7 (58.3%)	0.1229	0.940
	Radiculopathy	1 (50%)	1 (50%)		
Cubinatan invalvament	Yes	10 (66.7%)	5 (33.3%)	5 444	0.009
Sphincter involvement	No	6 (24%)	19 (76%)	5.444	
	Continuous	3 (50%)	3 (50%)		0.302
True of ODL I	Segmental	6 (50%)	6 (50%)	3.644	
Type of OPLL	Mixed	3 (18.8%)	13 (81.2%)		
	Focal	2 (33.3%)	4 (66.7%)		
NI1	1 and 2	1 (16.7%)	5 (83.3%)		0.006
Number of levels involved	3 and 4	3 (13.1%)	20 (86.9%)	9.9687	
	5, 6 and 7	7 (63.6%)	4 (36.4%)		
Segmental stenotic index	> 0.4	6 (25%)	18 (75%)	1.653	0.099
	< 0.4	8 (50%)	8 (50%)		
T2W hyper intense signals	Hyperintense	11 (100%)	0	35.14	< 0.0001
	Not hyperintense	0	29 (100%)		
Nature of surgery	Corpectomy	1 (14.3%)	6 (85.7%)	1.6289	0.442
	Laminectomy	8 (27.6%)	21 (72.4%)		
	Laminectomy with fusion	2 (50%)	2 (50%)		
Nurick's myelopathy	I to III	1 (5%)	19 (95%)	8.025	0.002
grading at admission	IV and V	10 (50%)	10 (50%)		

Patients with this disorder usually present in their fifth to seventh decade of life.<sup>9,10</sup> In our series, the mean age of presentation was 49.62 years, thus reflecting the occurrence of disease in early part of age of presentation.

Individuals with cervical OPLL have various neurological manifestations. The commonest type of presentation in our series was myelopathy (61.5%), in concordance with literature. In the series by Ono and coworkers, the incidence of myelopathy was 56%. Sphincter dysfunction was found in 15 patients (31.9%) in our study, which is higher as compared to literature; a 16% incidence of sphincter dysfunction was reported by Houten et al. In

The functional outcome of patients following surgery has been assessed by various scales by different authors. Among the various qualitative scales Nurick's grading is in trend in literature, most widely used and suitable to Indian lifestyle.12

Segmental form (39%) is usually the commonest type encountered, then the mixed form (29%), continuous form (27%) and the focal form (5%).<sup>13</sup> In our series, however, the 'mixed' form has been the commonest (40.1%) and segmental form second commonest (34.1%), a marginal difference was noted in the two forms. Further studies may be required to prove the role of ethnic differences.<sup>9</sup>

The overall improvement of 64.55% noted in our study is comparable to similar results published in literature. Most of our patients who improved were in preoperative Nurick's grades 3 and 4, similar to the results of Matsunaga et al. 12

The optimal approach, however, remains controversial.<sup>13</sup> Direct anterior resections of OPLL have been shown to

result in improved postoperative outcome and are usually preferred when the extent of OPLL is restricted to three vertebral motion segments and do not extend above C3 vertebral level.<sup>14</sup> More typically, OPLL involves several segments (three or more vertebral segments), with a need for multilevel decompression; even in these cases, (especially three vertebral motion segments involvement) ventral approaches to OPLL resulting in direct resection have been correlated with better long-term outcomes, although immediate perioperative morbidity may prove higher.<sup>14</sup> If laminectomy is done in elderly patients having cervical lordosis then the success rate is doubtful.<sup>15</sup> Other options available for multi-segmental involvement are the anterior floatation method of corpectomy and circumferential surgeries comparable results.16

In our study, anterior surgery was performed when compression was less than three segments and posterior surgery in rest of the cases. Meaningful comparison of results between anterior and posterior decompressive procedures could not be made in our study, as it is a retrospective and prospective non- randomized study, the choice of surgical procedure being determined on the basis of clinical localization and surgeon's preference; the number of patients in each group was not comparable.

Eight patients underwent anterior corpectomy and fusion with titanium expandable cage. 33 patients underwent decompressive laminectomy without fusion with success rate of 65%. Six patients underwent decompressive laminectomy and lateral mass fusion with titanium screws. No statistically significant difference was noted as regards the grades of improvement, among the three surgical groups.

Complications of surgery for cervical OPLL, as reported in literature, differs widely with different approaches. Various predictors of surgical outcome have been analyzed in the literature.

It is of paramount importance to ascertain the duration of clinical symptomatology, as this has significant implication on prognosis. Clinical improvement is noted to be rare in patients with longer duration of symptoms; symptom duration of less than 6 months to one year is considered critical for good outcome. Harbayashi et al, reported that myelopathy of more than 2 years duration was associated with a poor outcome. To patients in our study who did not improve had presented with myelopathic symptoms more than 12 months, thus reflecting the importance of duration of symptoms with respect to outcome.

Pre-operative bladder dysfunction was found to be associated with poorer outcome in the series by Lee et al.<sup>19</sup> Similarly, in our series, 66.7% of the patients who did not improve had preoperative sphincter dysfunction where as seventy six percent patients without sphincter involvement showed improvement.

Most of our patients who improved were in preoperative Nurick's grades 3 and 4, similar to the results of Matsunaga et al.<sup>12</sup>

However, no significant difference in outcome was noted between those with multiple ligamentous ossifications and those with isolated OPLL. Probably, longer followup analysis is required.

Greater detail of intrinsic changes in the cord may be seen on T2-weighted MR studies; hyper intense foci reflecting edema, myelomalacia, or gliosis may also be seen. "These factors have been found to constitute poor prognostic indicators for patients with spondylotic myelopathy compared with OPLL-related myelopathy".<sup>20</sup>

# **CONCLUSION**

Symptomatic cervical OPLL benefits from surgery, especially in patients with pre-operative Nurick grades 3 and 4. Mixed type of OPLL has been the commonest in our study. Myelopathy is commonest type of presentation. Significant poor clinical prognostic markers in our study are: Duration of symptoms >12 months, Sphincter disturbances. Significant poor radiological prognostic markers in our study are segmental stenotic index <0.4, MRI T2-Weighted hyper intense signal changes.

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