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Ossification of Posterior Longitudinal Ligament of Cervical Spine Among Omani Patients Referred for CT Scan at a Tertiary Care Hospital in Oman

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ABSTRACT

Objectives: We sought to evaluate the proportion of ossification of the posterior longitudinal ligament (OPLL) of the cervical spine and associated factors among Omani patients. ***Methods:*** We reviewed the cervical spine computed tomography (CT) scans of all patients referred to the Radiology Department, Sultan Qaboos University Hospital, from 2011 to 2017. Descriptive statistics were employed to determine the proportion of OPLL. We used the chi-square test to determine the association of age, gender, and diabetes mellitus with OPLL. ***Results:*** A total of 843 patients aged ≥ 20 years were included in the study. The proportion of OPLL was 2.7% and was more frequent in men (3.2%) than women (1.9%). The male to female ratio of OPLL was 1.7:1.0. OPLL occurrence was significantly more in non-diabetic patients ($p < 0.001$). No significant association was found between OPLL with gender ($p = 0.281$) and age ($p = 0.878$). ***Conclusions:*** The observed proportion of OPLL in this single-center study is relatively low, but the finding is important as the condition can eventually lead to debilitating neurologic outcomes affecting the patient's quality of life. OPLL occurrence was significantly more in non-diabetic patients, which necessitate further research on OPLL in a larger sample across Oman.

Ossification of the posterior longitudinal ligament (OPLL) is a hyperostotic condition characterized by hyperplasia of cartilage cells with eventual endochondral ossification, resulting in ectopic calcification of the posterior longitudinal ligament (PLL). The PLL is located within the vertebral canal and runs on the dorsal aspect of vertebral bodies and intervertebral discs of the vertebral column. It extends from the body of axis (C2) at the upper cervical spine down to the sacrum; above the level of the body of axis, it continues with the tectorial membrane. The ligament is broader at the cranial end than the caudal end and thicker in the thoracic region than the cervical and lumbar regions. It is wider at the level of intervertebral disc space and narrower at the level of vertebral bodies.[1]

OPLL was first recognized in the early 18th century. Initially, it was considered to occur only in Japan.[2] Later, more OPLL related studies emanated from East Asia with comparatively fewer studies from other parts of the globe. OPLL is classified into four subtypes: continuous, segmental, localized, and mixed. In the continuous-type, ossification occurs over multiple segments continuously; in the segmental type, ossification occurs over the body of the vertebra; in the local type, ossification is observed only at the level of the intervertebral disc; and the mixed-type is a combination of the previous three types.[3] OPLL appears in the form of a linear band of ossified tissue over the dorsal surface of the vertebral

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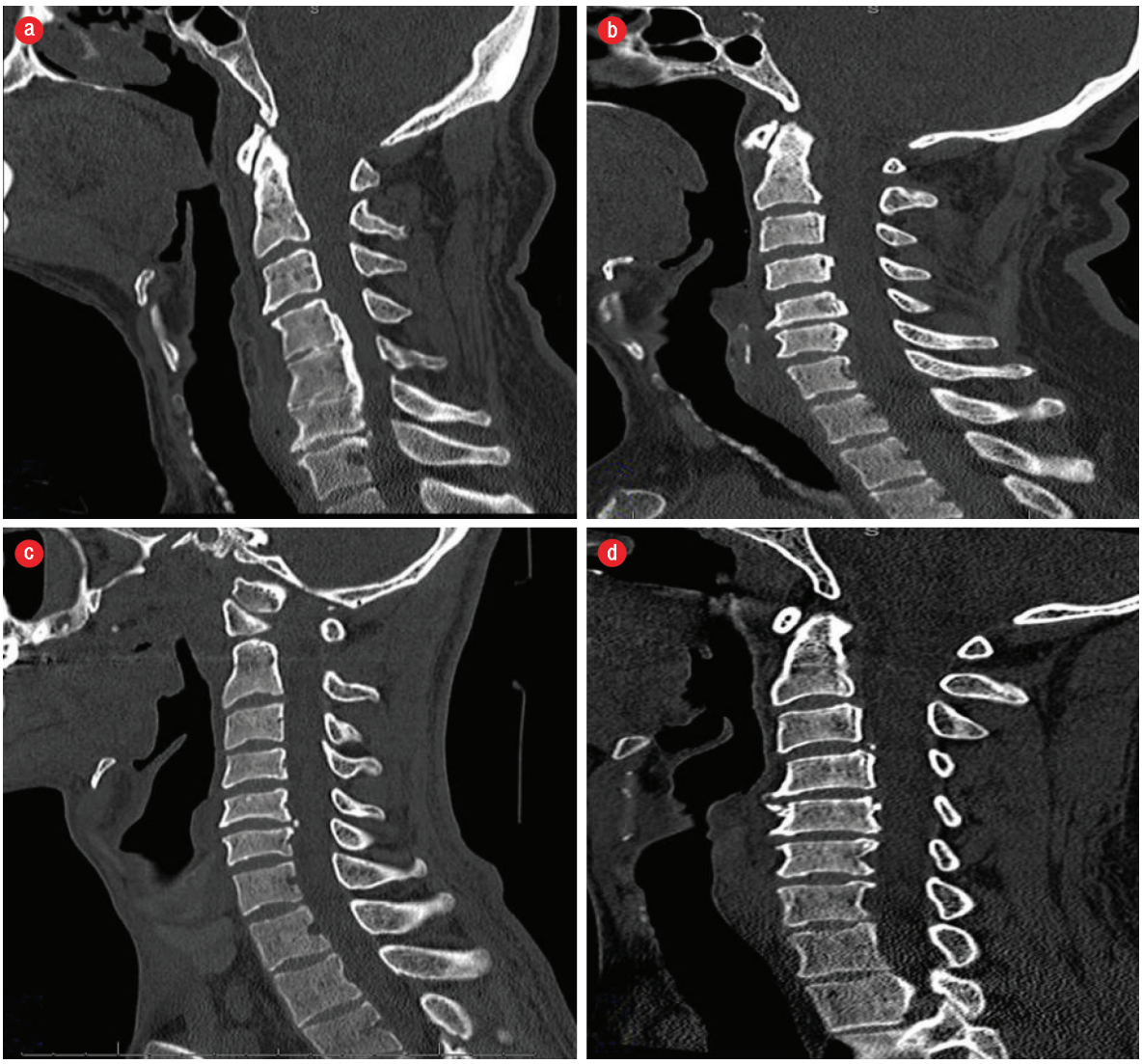

Figure 1: CT scans of different ossification of the posterior longitudinal ligament types: **(a)** continuous, **(b)** segmental, **(c)** localized, and **(d)** mixed.

body and intervertebral discs.[4] OPLL is commonly observed in the cervical spine, especially at the C2-C4 vertebral level.[5] However, the occurrence of OPLL is also reported in the thoracic and lumbar regions.[6] In clinical practice, computed tomography (CT) and magnetic resonance imaging (MRI) scans are frequently used to diagnose various spine-related conditions.[7,8] Most recent studies have used CT or MRI for diagnosis.[9–12] However, OPLL of cervical spine diagnosis using lateral X-rays can lead to underestimation of the condition, whereas MRI is prone to overestimation. This is because of the difficulty in distinguishing between hypertrophy and ossification. Therefore, CT has been demonstrated to be the best tool for diagnosis.[13]

OPLL pathogenesis and natural history are still unclear. Various factors (including genetic, environmental, lifestyle, and hormonal) are involved in the pathogenesis of OPLL.[14–18] However, there is an ongoing debate on this issue. OPLL is usually associated with neurological defects and is also seen along with other diseases such as schizophrenia, ankylosing spondylitis, and diffuse idiopathic skeletal hyperostosis (DISH).[19] In patients with schizophrenia, the incidence of OPLL is about 20%.[20] Recently, an association between diabetes mellitus (DM) and OPLL has been demonstrated.[21,22] An in vitro study has shown that hyperglycemia induces the synthesis of collagen from the cultured cells of cervical PLL through transforming growth factor-β1 and promotes hypertrophy of the ligament.[23]

The government of Oman provides free health services to all citizens. In Oman, as of now, there is no information on OPLL. In view of the various factors/

conditions associated with OPLL, some of which are a burden in Oman, our study was undertaken to help generate baseline data on the proportion of OPLL of the cervical spine among patients referred for CT scan in a tertiary care referral hospital in Oman, and to study its association with age, gender, and DM.

METHODS

Our study included both admitted patients and outpatients aged ≥ 20 years who had visited the Sultan Qaboos University Hospital (SQUH) and were referred to the Radiology Department for CT scans of the cervical region between May 2011 and August 2017. All patients with a history of spinal fracture, previous spinal surgery, and non-Omani nationals were excluded from the study. The patients' data were collected from the database of the Radiology Information System and Hospital Information System of SQUH, which was the sole source of the study. Patient demographics such as age, gender, nationality, and diabetic status were documented. The diagnosis of OPLL was made based on the findings of CT scans, covering the region from the clivus to vertebra prominence (C7) using PACS® software (version 4.4.516.21, Philips, Intellispace, USA). After diagnosis, patterns and the vertebral levels of ossification were noted manually from each scanned image [Figure 1].[3] Reviews of all CT images were done by the same radiologist. The study was reviewed and approved by the Medical Research Ethics Committee, College of Medicine, SQUH (Ref. no. SQU-EC/154/17).

SPSS Statistics (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IB) was used to analyze the data. Descriptive statistics were used to present the data. The association of OPLL with age, gender, and the presence of DM was determined using the chi-square test. A *p*-value of less than 0.050 was considered to be statistically significant.

RESULTS

A total of 843 patients were included in the study. Among these patients, 533 were men and 310 were women. The proportion of OPLL was 2.7% (n = 23) and was more frequent in men (3.2%, n = 17) than women (1.9%, n = 6). The male to female ratio of OPLL was 1.7:1.0. Among the different types of OPLL, the segmental and the localized were the most commonly observed types (10 each). The continuous and the mixed types were observed only in two and one cases, respectively. The most frequent type of OPLL was localized among men (n = 8) and segmental among women (n = 4)

Table 1: Proportion of patients with ossification of the posterior longitudinal ligament (OPLL) by gender and age.

Gender	Age, years	Patients, n					Total
		No OPLL	OPLL				
			Continuous	Segmental	Localized	Mixed	
Males	21–30	148	0	2	1	0	151
	31–40	128	1	0	4	0	133
	41–50	79	0	1	1	0	81
	51–60	121	1	3	1	0	126
	61–70	38	0	0	1	1	40
	> 70	2	0	0	0	0	2
	Total	516	2	6	8	1	533
Females	21–30	62	0	1	0	0	63
	31–40	84	0	1	0	0	85
	41–50	64	0	2	1	0	67
	51–60	61	0	0	0	0	61
	61–70	27	0	0	1	0	28
	> 70	6	0	0	0	0	6
	Total	304	0	4	2	0	310

Table 2: Association between ossification of the posterior longitudinal ligament (OPLL) with gender, age, and diabetes status.

Variable	No OPLL	OPLL	Chi-square test *p*-value
Gender			
Males	516	17	NS
Females	304	6	
Age, years			
21–30	210	4	
31–40	212	6	
41–50	143	5	
51–60	182	5	NS
61–70	65	3	
> 70	8	0	
DM			
No	254	16	< 0.001
Yes	566	7	

NS: not significant; DM: diabetes mellitus.

[Table 1 and Figure 1]. The continuous and mixed types were not observed in women. OPLL occurrence was significantly more in non-diabetics (5.9%) than in patients with DM (1.2%, $p < 0.001$). No significant association was found between OPLL with gender ($p = 0.281$) and age ($p = 0.878$) [Table 2]. The majority of localized type cases were noted at the C3/C4 (n = 4) and C5/C6 (n = 5) vertebral levels [Table 3]. The segmental type of OPLL cases was observed at the level of all the cervical vertebrae except the first cervical vertebra.

Table 3: Vertebral levels of ossification of the posterior longitudinal ligament (OPLL).

Type of OPLL	Vertebral levels of OPLL	Cases, n
Continuous	C4-C6	1
	C5-C6	1
Segmental	C5	1
	C3,C4	1
	C5,C6	3
	C2,C3,C4	1
	C3,C4,C5	1
	C4,C5,C6	1
	C4,C5,C6,C7	1
	C2,C3,C4,C5,C6	1
Localized	C3/C4	4
	C5/C6	5
	C6/C7	1
Mixed	C5,C6,C6/C7	1

DISCUSSION

Our study determined the proportion of cases of OPLL among Omani patients as 2.7%. These findings are marginally higher than the findings from other Asian ethnic groups noted in studies from Hong Kong (0.8%),[24] Singapore (0.8%),[25] the Philippines (1.5%),[26] and Korea (0.6–1.9%).[27,28] However, our findings are similar to studies from Japan (1.9–4.3%)[26] and Taiwan (2.6–7.7%).[26,29]

Initially, OPLL was thought to be unique to the Asian population, and due to this there was little research in the US and Europe.[30] Later, OPLL research gained momentum in western populations when studies revealed the incidence of OPLL in Caucasians having DISH.[31] The results of this research emphasized that OPLL is a DISH subtype. In West Germany and the US, the observed prevalence of cervical spine OPLL ranged from 0.01–1.7%.[26] In a study conducted among different ethnic groups, the prevalence of cervical OPLL has been reported as 1.3% in Caucasian Americans and 4.8% in Asian Americans.[32] These results further confirm the previously proposed hypothesis that Asians are more likely to be affected by ectopic OPLL compared to non-Asians.

Different risk factors, such as DM, age, genetic factors, and environmental factors, are associated with OPLL.[14–18] DM was found to be an independent risk factor for the onset of OPLL.[21,22] A high prevalence of DM was noted in patients with cervical myeloradiculopathy due to OPLL.[33] Further, a positive correlation between ossified spinal ligament and glycation end products was observed.[34] Our findings from this limited study are similar to other studies,[35,36] but are in contrast to the established positive association of OPLL and DM.[21,22,33,34]

Age is an independent risk factor for the onset of OPLL.[22,37] In our sample, OPLL was more prevalent in the 31–40 year age group, although this was not statistically significant. Our findings are in line with the majority of studies which report male predominance in OPLL with the male/female ratio varying between 1.1 and 3.0.[29,37] However, one study noted opposite findings of 1:3 ratio, and this discrepancy could be due to sampling bias and the

method of screening.[38] In Japanese[39] and Koreans,[27] the most frequent location of OPLL was the vertebral levels of C4, C5, C6 and C3, C4, C5, respectively. In our study, OPLL was more frequently observed at the vertebral levels of C3, C4, C5, and C6.

We could not investigate the genetic relationship with OPLL even though the prevalence of genetic diseases in Oman is high.[40] There is a possibility of underestimation of the prevalence due to selection bias as we included only those subjects who underwent radiological investigation at this center.

CONCLUSION

The observed proportion of OPLL in this single-center study is relatively low, but the finding is important as the condition can eventually lead to debilitating neurologic outcomes affecting the quality of life of the patient. OPLL occurrence was significantly more in non-diabetic patients, which indicates the need for further research on OPLL in a larger sample across Oman.

Disclosure

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