Original Article

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Anatomy Section

Incidence and Clinical Implications of Cervical Rib: A Retrospective Study

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ABSTRACT

Introduction: Cervical ribs are an additional rib, which arise from the costal element of the seventh cervical vertebra. Incidence varies from 0.58-6.2%, incidentally detected on radiographs, but when enlarged can lead to various vascular and neurological symptoms. When it is of sufficient length it can compress the neurovascular bundle leading to Thoracic Outlet Syndrome (TOS) causing vascular and neurological symptoms.

Aim: To determine the incidence and morphology of cervical rib in a convenient sample.

Materials and Methods: A retrospective observational study was done in 650 radiographs (356 males and 294 females) from January 2016 to January 2019 and the study was conducted at ESIC Medical College and PGIMSR, Chennai, Tamil Nadu, India, and the data was analysed for the incidence and morphology of cervical ribs.

Results: Incidence of cervical ribs in females (1.7%) was higher than males (1.12%). In the present study, incidence of cervical ribs was 1.38%, we observed there were seven cases of bilateral cervical ribs and two cases of unilateral cervical rib. Morphologically, cervical ribs had head, neck and tubercle and articulated posteriorly with transverse process and no other significant morphological variations were seen.

Conclusion: Knowledge regarding incidence of cervical ribs and other rib anamolies assists the radiologist and surgeons in early diagnosis and management of symptomatic patients in order to avoid neurovascular complications.

Keywords: Chest x-ray, Neurovascular compression, Seventh cervical vertebra, Thoracic outlet syndrome

INTRODUCTION

Cervical ribs are anomalous, supernumerary ribs that arise from the seventh cervical vertebra. Cervical ribs can also originate from the sixth or fifth cervical vertebra [1]. Incidence of the cervical ribs varies from 0.58-6.2% [2-4]. Cervical ribs can be unilateral or bilateral, complete or incomplete. These are detected incidentally on routine radiographs. Cervical ribs are more common in women as compared to men, and are asymptomatic in 90% of cases, however, 10% of patients are symptomatic producing either neurologic or vascular symptoms due to compression caused by the rib over the neurovascular bundle while entering the arm from neck leading to development of TOS [1-4]. Complete cervical ribs, if symptomatic, may produce both vascular and neurological symptoms, while incomplete ones produce only neurological problems [5].

The TOS occurs due to narrowing of interscalene triangle due to presence of symptomatic cervical rib. Common clinical presentations include pain and weakness of hand, tingling and numbness of the forearm and hand, feeble or absent radial pulse, fullness or mass in supraclavicular fossa [5,6]. Hence, identifying and ruling out the presence of cervical rib is mandatory in a patient with upper limb neurovascular abnormality. Radiographic examination of chest is the primary mode of detection. Computed tomography, however remains gold standard in identifying its compressive effects on adjacent structures [7]. Magnetic Resonance Imaging (MRI) is also helpful in visualising the fibrous component of cervical rib and for better soft tissue characterisation, as it allows the detection of the fibrous band which may connect the distal end of cervical rib with the first thoracic rib [8].

Knowledge regarding the incidence and morphology of cervical ribs in a given community assists in the early detection and management of various cases presenting with neurovascular complications of neck, which assists and aids in early detection and management of TOS and supraclavicular neck swellings. With this in mind, the present study was conducted with an aim to determine the incidence and morphology of cervical rib.

MATERIALS AND METHODS

A retrospective observational study was conducted using chest radiographs between January 2016 to January 2019 at ESIC Medical College and PGIMSR, Chennai, Tamil Nadu, India, by using convenient sampling method to study the incidence and morphology of cervical ribs after obtaining permission from Institutional Ethics Committee (35/2018). Consecutive 650 chest radiographs were used which included both sexes, and from all age groups between 12 and 80 years were studied.

Inclusion criteria: Radiographs belonging to both the sexes from age groups between 12-80 years were included in the study.

Exclusion criteria: Radiographs with incorrect patient positioning and fracture of rib, any other associated rib anamolies were excluded from the study.

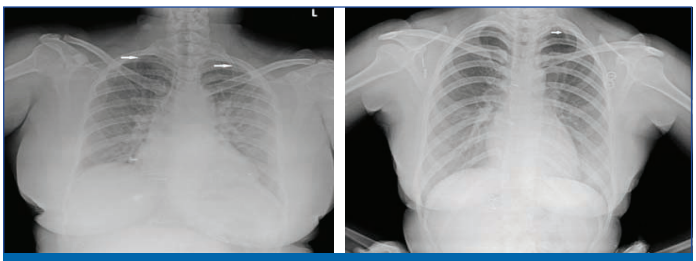
Cervical ribs were identified based on the articulation with transverse process of the vertebra. They were termed as complete cervical rib, when it's posterior end articulates with transverse process of C7 and anterior end articulates with first rib or its cartilage; and was termed as incomplete when the anterior end was free [1,4,6,9].

STATISTICAL ANALYSIS

Data was subjected to descriptive analysis and the categorical data was expressed in the form of percentage and presented in the form of tables.

RESULTS

Out of 650 radiographs studied, we observed seven cases of bilateral cervical ribs (1.07%) with four males (out of 356) and three females (out of 294). In males, there were two bilateral complete cervical ribs and two bilateral incomplete ribs, while in females only one side had incomplete cervical rib among the two bilateral cases [Table/Fig-1]. We also observed two cases of unilateral cervical ribs [Table/Fig-2] in females with one on each side however there were no unilateral cervical ribs observed in the males. Incidence of cervical rib in the present study was 1.38%. Incidence of cervical



[Table/Fig-1]: Bilateral cervical ribs in a female aged 48 years. Arrow depicting bilateral cervical ribs. **[Table/Fig-2]:** Left side unilateral cervical rib in a female aged 34 years. Arrow depicting left side cervical rib. (Images from left to right)

rib in females (1.7% i.e., five out of 294) was higher compared to males (1.12% i.e., four out of 356) [Table/Fig-3]. Morphologically, all cervical ribs consisted of a head, neck, and tubercle, with the shaft it was attached posteriorly to transverse process but anteriorly in case of incomplete cervical rib it was ending freely, but in complete rib it was attached to first rib or its cartilage. No other significant variations were noted with respect to morphology of cervical ribs.

Sex incidence of cervical rib n (%)	Absent n (%)	Right side	Left side	Bilateral	Total
Male 4 (1.12%)	352 (98.88)	Nil	Nil	2 (Complete) 2 (Incomplete)	356
Female 5 (1.7%)	289 (98.3)	1	1	2 (Complete) 1 (Incomplete only left side)	294
Total 9 (1.38%)	641 (98.61)	1	1	7(1.07)	650

[Table/Fig-3]: Incidence of cervical ribs with respect to gender and laterality.

DISCUSSION

Incidence of cervical rib in the present study was 1.38% however the incidence of cervical rib in females (1.7%) was higher compared to males (1.12%) which correlates with earlier studies of Brewin J et al., who reported an overall incidence of 0.74% in London population, Ebite LE et al., reported an overall incidence of 0.58%, Aziz MA et al., reported an overall prevalence of 0.7%, Lukasz S and Cecot T reported an incidence of 0.58% in Malawian population [1,2,7,10]. Comparison of incidence of cervical rib with other studies have been shown in [Table/Fig-4] [4,10-15].

Study	Year of study	Study population	Overall incidence	Incidence in males	Incidence in females
Present study	2021	Indian	1.38	1.12	1.7
Abimbola EO and Willido AA [4]	2014	Nigerian	0.6	0.4	0.78
Aziz MA et al., [10]	2016	Sudanese	2	1.1	2.5
Sharma DK et al., [11]	2014	Indian	1.2	0.68	0.54
Agarwal S et al., [12]	2018	Indian	0.79	2.5	1
SN Ezeofor SN et al., [13]	2016	Nigerian	0.7	0.2	1.1
Viertal VG et al., [14]	2012	American	2	1.4	2.8
Bajpe R and Ashwin NS [15]	2019	Indian	2	1.4	2.8

[Table/Fig-4]: Comparison of incidence with relation to earlier studies among males and females [4,10-15].

Unilateral cervical ribs were reported more on the left side than on the right side by Bots J et al., however, in the present study we had only two cases with unilateral cervical ribs in females with one on each side [16]. Cervical ribs can become symptomatic due to their close anatomical relation to the interscalene triangle where they can compress the neurovascular structures such as the brachial plexus or subclavian artery by narrowing the boundaries of the triangle, while entering the limb and lead to either neurological or vascular symptoms [17]. In some, even mild narrowing itself can produce severe symptoms, whereas, in majority of individuals it remains asymptomatic. Incomplete cervical ribs more commonly produce neurological manifestation by compressing the brachial plexus and its branches, which include intermittent migrating pain in the neck, affected upper limb, chest, shoulder, paraesthesia and numbness in the affected forearm and fingers, weakened grip, motor strength of forearm and hand muscles may be effected due to compression. Clawing of the little, ring, and middle fingers may also be noted [1,6,8-10,14,18-20]. Severity of the clinical signs and symptoms depends on whether it is a complete or incomplete cervical rib, however, such observations could not be made in the present study as the study design was retrospective in nature.

Complete cervical ribs cause both neurological and vascular manifestations simultaneously, which includes pain in the upper limb during abduction and overhead elevation, weakness and wasting of the muscles of hand and forearm, discolouration of the skin of the hand, claudication, dizziness, diminished distal pulses at wrist, prolongation of capillary refill, and sometimes even gangrenous changes in the finger tips. Systolic blood pressure can be decreased and bruits may be heard and patient may present with subclavian artery thrombosis as a presenting feature. Distal embolisation of the thrombus can occur and may require immediate intervention to prevent complications. The subclavian vein compression could lead to subclavian venous thrombosis or more dangerous life-threatening pulmonary embolism [1,6,8,11,14,16-20].

Symptomatic cervical rib can be treated conservatively by using physical therapy such as neck stretching exercises, abdominal breathing exercises, posture correction, nerve glides etc. when conservative methods fail, surgical resection of the cervical rib is indicated. If adequate decompression of the subclavian artery and brachial plexus is still not achieved then, resection of first rib is also done along with cervical rib resection [1,8,18-21].

Clinical Implications

Cervical ribs have been involved in various neurovascular disturbances of upper limb due to its close proximity to the neurovascular bundle in the cervical region. Hence, incidence of cervical ribs, whether complete or incomplete can provide an insight to the various neurological and vascular disturbances arising due to it, which aids in initiating an early diagnosis and treatment of patients presenting with neck pain so as to prevent life threatening complications.

Paraxial mesoderm gives rise to somites on either side of the neural tube, which differentiates into a ventral part sclerotome and a dorsal part dermatome. Usually by the end of the fourth week, the cells of the sclerotome convert into mesenchymal cells, which later differentiate into the ribs. Hox genes are responsible for development of the axial skeleton, and mutations in them can lead to the development of cervical ribs from costal or vertebral process of primitive vertebral arches [1,8,18].

Cervical vertebrae present foramen transversarium in lateral masses, which transmits the vertebral artery. This foramen is bounded by anterior root, anterior tubercle, costo transverse bar, posterior tubercle, and posterior root. The posterior root represents the transverse process while remaining parts form costal element. In thoracic region, costal element forms rib, while in other region of vertebral column, it is incorporated to form the costal element [18,22].

Excessive growth of the costal element of the seventh cervical vertebra may lead to the development of cervical ribs. It has been reported that all foetuses have cervical ribs, which disappear before childbirth [18,22]. Higher prevalence of cervical ribs in stillborn foetuses compared with live-born ones who died in the first year has been reported earlier [12]. Cervical ribs can act as a marker of developmental defects in the early stages of development, which have been implicated in both cervical segmentation defects and

foetal mortality [23]. Galis F et al., has reported a higher mortality rate of 78%, in foetuses and neonates with cervical rib before birth [24]. Prospective study in larger samples can be done to access the correlation of clinical features and symptoms in cases of complete and incomplete cervical ribs.

Limitation(s)

The scope of this study is limited by the nature of its population and by the rarity of this condition and CT or MRI can evaluate the morphology of the variants and the sub types of cervical ribs as well as their dynamic compression effects in detail which was not used in present study.

CONCLUSION(S)

Radiologists and surgeons must be aware of congenital anomalies such as cervical ribs, to intervene immediately and assist in the management of symptomatic patients presenting with supraclavicular mass, TOS, brachial plexopathy in order to avoid the neurovascular and life threatening complications.

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