

# Prevalence of cervical ribs and elongated transverse processes in Saudi Arabia

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## ABSTRACT

**الأهداف:** وصف معدل حدوث الإصابة الأولى للضلع الرقبى، والنتائج المعترض الطويل لدى المجتمع السعودي.

**الطريقة:** أُجريت هذه الدراسة المقطعية في مستشفى جامعة الملك عبدالعزيز، جدة، المملكة العربية السعودية خلال فترة 3 أشهر من أكتوبر إلى ديسمبر 2010م. وتمت مراجعته 1,000 أشعة سينية رقمية للصدر للكبار، والبحث عن وجود إصابة الضلع الرقبى والنتائج المعترض الطويل للفقرة الرقبية السابعة.

**النتائج:** أثبتت ملاحظتنا وجود الضلع الرقبية في 3.4% من أفراد عينتنا. ولقد زاد وجود الضلع الرقبى في السيدات بنسبة اثنين إلى واحد. وظهر الضلع الرقبى في الجهتين لدى 41% من المصابين، فيما وُجد النتائج المعترض الطويل للفقرة الرقبية السابعة لدى 23% من أفراد العينة.

**خاتمة:** لوحظ ارتفاع معدل وجود الضلع الرقبى والنتائج المعترض الطويل للفقرة الرقبية السابعة في مجتمع الدراسة إذا قورن بالمجتمعات العالميه الأخرى. ونحن ننصح بإجراء دراسات مستقبلية تؤكد هذه النتائج وتوضح أهميتها.

**Objectives:** To describe the prevalence of the full spectrum of transverse process elongation and cervical ribs for the first time in over a decade in a Saudi population, trying to assess any changes in the interim.

**Methods:** A cross-sectional hospital based study was conducted at King Abdulaziz University Hospital, Jeddah, Saudi Arabia in the 3-month period between October and December 2010. The study comprised a radiologic review of 1,000 consecutive chest radiographs of adults from the digital database looking for the presence of cervical ribs and elongated transverse processes.

**Results:** Our study showed that cervical ribs are present in 3.4% of our population; a female to male ratio was 2.01 to 1. They were bilateral in 41% of

those afflicted individuals. Elongated transverse processes were present in 23%.

**Conclusion:** The prevalence of cervical ribs and elongated transverse processes in our population is higher than that reported in other populations. It also shows an interim increase in prevalence when compared with a previous study on our population more than a decade back.

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Previously considered an anomaly of no clinical significance, cervical ribs are now believed by the medical community to be both a cause for disease and a possible marker of an underlying diseased genotype. The significance of the cervical rib arose once the anatomy of the thoracic outlet was described and understood. It was then realized that its presence in this anatomically crowded region is not without morbidity. Observations by Cooper in 1818<sup>1</sup> showed that it might lead to compression of adjacent neural structures, specifically the lower trunk of the brachial plexus, or vascular structures, mainly the subclavian vessels. The full spectrum of disorders caused by its presence continues to grow this day, with reports of new associations with

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diseases affecting the upper limb; anterior and possibly even posterior circulations of the brain.<sup>2-7</sup> Its presence has also been linked to subclinical nerve damage even in the asymptomatic.<sup>3</sup> The next chapter in the medical community's realization of this anomaly's significance would be revealed in the laboratory. Genetic studies showed that the Homeobox gene plays an integral role in the development of the axial skeleton in mammals.<sup>8</sup> Mutations of this gene leads to a wide variety of anomalies, cervical ribs being fairly common in this group. Only after an increased incidence of malignancy was associated with Homeobox gene mutations in transgenic mice had scientists become able to explain why this anomaly is so rare in mammals.<sup>9</sup> The cervical rib was consequently regarded as a marker for a diseased genotype. Skeletal surveys of humans with embryonal cancers would confirm this association in man, with cervical ribs having a noted prevalence of 17.1-33% in this population compared to a baseline of 0.05-0.7%.<sup>10-14</sup> These studies were to also lay down the foundation for further investigations of the role of the Homeobox gene in oncogenesis. The purpose of this study was to describe the current prevalence of transverse process elongation and cervical ribs in the Saudi population. The aim is to provide baseline prevalence for future studies to use when attempting to associate these anomalies with patient complaints or with effects possibly explained by their presence. We also aim to raise awareness of the Saudi medical community regarding this often-unnoticed anomaly with possibly significant morbidity.

**Methods.** We reviewed 1000 chest x rays of adult patients (age above 20 years) at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, taken during the 3-month period between October and December 2010. The biomedical ethics and research committee approved this cross-sectional, hospital-based study. The reviewed x-rays had to meet our eligibility criteria; we only accepted those with clear, complete, and unobstructed visualization of the seventh cervical and first thoracic vertebrae. This resulted in excluding 138 images. Exclusion criteria being technical inadequacy (no inclusion of complete seventh vertebral body, rotation, or inadequate exposure), repeat radiographs of the same patient, and radiographs acquisition prior to 20 years of age. All approved radiographs were posterior-anterior projections and without rotation. Although counterintuitive, we elected not to rely on cervical spine x-rays, since these studies are usually ordered for symptoms of neck pain and neurovascular symptoms of the upper limb, and would thereby be a form of selection bias artificially increasing prevalence. The chest radiographs would also provide us with a larger pool of patients not attainable by relying on cervical spine radiographs that are ordered less frequently.

Our radiographic database is digital, this allows us to zoom in on regions of interest and manipulate contrast and brightness settings to best delineate its anatomy. For the purpose of comparison with the only three other studies<sup>13,15,16</sup> we found that describe the prevalence of the complete spectrum of this anomaly, we depended on their classification criteria. The criteria used to identify the cervical rib are similar to those used in previous reports<sup>10,12,16</sup> as follow: 1) The cervical rib must articulate with the seventh cervical vertebra and project either caudally or laterally, as opposed to the first rib that projects superiorly. 2) The cervical rib must not articulate with the manubrium sterni, but may do so with the first rib. This serves to differentiate it from the rudimentary first rib. 3) To be classified as a rib it must be discrete from the transverse process of C7. The elongated transverse process of C7 is any transverse process that projects beyond the lateral limits of the first thoracic vertebra. These radiographs were initially screened and were subsequently classified as normal, elongated transverse processes, and cervical rib according to the aforementioned criteria (**Figure 1**). Laterality was specified with each abnormality detected, and results were then reviewed.

**Results.** Among our study population of 1000 patients, 490 were male and 510 were female. The study was reported normal in 736 patients (376 males and 360 females). Cervical ribs were found in 34 patients, constituting a prevalence of 3.4% of our study population (**Table 1**). The female to male ratio was 2.1:1, a female predominance consistent with the literature. Cervical ribs were bilateral (**Figure 1**) in 41%, right-sided in 32.3%, and left sided in 26.7%. Of the 20 patients with unilateral cervical ribs, 15 (75%) had associated elongated transverse processes contralateral to the cervical rib. Two hundred and thirty patients had an elongated transverse process, giving an overall prevalence of 23%. The female to male ratio was 1.18:1 showing a female predominance consistent with the literature. Of these 230 patients, 128 patients (55.6%) had bilateral anomalies, while 70 patients (30.4%) have elongated left transverse processes; the remaining 32 patients (14%) have an elongated right-sided elongated transverse process.

**Discussion.** The definition of what constitutes a cervical rib is somewhat controversial, with no consensus reached on what constitutes a well-developed elongated transverse process as opposed to a cervical rib.

The highest prevalence of cervical ribs reported was 3% in a series of 6630 radiographs reviewed in a Turkish population.<sup>18</sup> Erken et al<sup>19</sup> recently reported a prevalence of 6.2% for cervical rib in a population sample from Turkey. Another study conducted in an isolated Italian

community showed the presence of cervical ribs in 2.5% of individuals,<sup>16</sup> but the largest radiographic surveys available, conducted in largely Caucasian populations, produced figures in the range of 0.05-0.54%.<sup>12-14</sup>

On literature review, we found only one previous study by Al Zahrani et al,<sup>20</sup> that described the prevalence of elongated transverse processes and cervical ribs in the Saudi population. It was a prospective study conducted in Makkah, Saudi Arabia more than 14 years ago. Of 1,300 chest radiographs of patients attending the outpatient clinics, cervical ribs were found in 25 (1.9%), 76% were bilateral, and 74% in females. Of these, 9 were symptomatic. Neurogenic compression was demonstrated in 9 and vascular compression in the other 2, and the authors concluded that radiologists and physicians should be cognisant of the higher prevalence of symptomatic cervical rib in the Gulf region. These results are in stark contrast to our results of the presence of elongated transverse processes in a significant portion of patients, with cervical ribs being not infrequent. Given the resurfacing interest of this anomaly, and the absence of any articles describing its prevalence in a neighboring Gulf or Arab country with whom to compare our results, we set to repeat the study to compare our results with Al Zahrani et al's study.<sup>20</sup>

**Table 1** - Frequency distribution of cervical rib and elongated transverse process in 1,000 studied patients.

Variables	Cervical rib	Elongated C7 transverse process n (%)	Normal
Males (n=490)	11 (2.2)	103 (21.0)	376 (76.4)
Females (n=510)	23 (4.5)	127 (24.9)	360 (70.6)
Female:Male ratio	2.0:1	1.18:1	0.96:1
<b>Total</b>	34	230	
Right rib	11	32	
Left rib	9	70	
Bilateral	14	128	



**Figure 1** - Chest radiograph demonstrating elongated C7 transverse processes on the right side (white arrow) and cervical ribs on the left side (black arrow).

The only other studies that looked at the prevalence of elongated transverse cervical processes include a study conducted by Brewin et al,<sup>15</sup> and showed a prevalence of 2.2%. Another conducted study showed a prevalence of 1.89%, with the third study in an isolated Italian community and reported a prevalence of 4.98%.<sup>16</sup> One explanation for our results and the apparent increase in prevalence of this anomaly in the interim may be attributable to our population's gene pool and the high rate of consanguinity. An alternative explanation is the possible confounder of having a higher prevalence of malignancy in our studied population. Both mentioned factors may increase the prevalence of Homeobox gene mutations in our sample. This may imply an important role for the Homeobox gene in our population's malignancies that warrants further assessment.

Limitations of our study are mainly related to the setting. We conducted the study in a tertiary level hospital, although consecutive chest radiographs were utilized in an effort to avoid selecting for patients with a higher chance of having cervical ribs, for example, relying on studies performed for patients attending rheumatology, neurosurgery, or orthopedic clinics. This does not protect against the possible confounder of our patient population having a possibly increased chance of underlying malignancy, as we are one of the few accessible institutions that offer a comprehensive oncologic service in our region. This is, however, unavoidable and a larger radiologic survey at a primary care institution is warranted to better dilute this factor. It would be interesting to ascertain the prevalence of neurovascular symptoms and malignancy among those with and without the vertebral anomaly. It would also be very interesting to know whether characteristics of the elongated process, such as angle of projection or length, may be correlated to the probability of developing clinical symptoms or neurophysiologic changes.

Strengths of our study include it being the first such study to report on this anomaly in more than 14 years, we also followed the definitions proposed by Brewin,<sup>15</sup> and this allows the direct comparison between populations and mitigates the amount of confusion in the literature. The previous study conducted in our population made no mention of the definitions used to classify an anomaly as an elongated transverse process or rib, and thus cannot be used accurately to compare with other populations.

A valid question to ask is whether these incomplete variants are as clinically significant as their more developed counterparts. Anatomic studies have shown that fibrous bands may extend from their tips towards the first rib; these bands are radiolucent and therefore can be present even with an apparently 'benign' looking elongated transverse process on x-ray. Several reports

have linked these bands to clinical neurovascular compression.<sup>21,22</sup> These effects may be clinically silent, as a recent post mortem study reported histopathologic evidence of nerve damage in both patients with incidentally discovered cervical ribs although their records bring no mention of related symptoms. This implies that interpretation of neurophysiologic studies may be confused by their presence, giving false positives that may misguide the treating physician.<sup>5</sup>

In conclusion, it appears that the Saudi population has a higher prevalence of cervical rib (3.4%), and elongated transverse processes (23%) than previously reported in the literature. Our study reiterates the necessity for the practicing physicians to consider this high prevalence in evaluating patients with neurological symptoms of the upper extremities. It also points to a possible target for research in the gene's role in our population's malignancies.

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## Ethical Consent

All manuscripts reporting the results of experimental investigations involving human subjects should include a statement confirming that informed consent was obtained from each subject or subject's guardian, after receiving approval of the experimental protocol by a local human ethics committee, or institutional review board. When reporting experiments on animals, authors should indicate whether the institutional and national guide for the care and use of laboratory animals was followed.