

To Study the Age of Fusion of the Costal Cartilage of the First Rib with Manubrium in North Indian Population Radiologically

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ABSTRACT

Introduction: Despite being scanned in many routine radiologic tests, the costal margin has been overlooked in the radiology literature. Costal cartilage calcification radiographically until after the puberty; thus, the present study has been done to find out the age of fusion in sternal end of the costal cartilage of the first rib with manubrium radiologically as there is not much literature to prove it.

Material and Methods: The present study has been conducted in the Department of Anatomy in collaboration with the Department of Forensic Medicine and Radiology, PGIMS, Rohtak, whereby specimen comprised of 50 pairs of first rib along with manubrium in both sexes in the age ranging from 15-30 years and were collected from the cases of medico-legal autopsies done in Department of Forensic Medicine after taking proper consent from the legal heir of the deceased and were then radiographed in the Department of Radiology.

Results: In the present study, out of the total 50 pairs of specimens obtained, 13 pairs were categorized into Grade 0 calcification (mean age being 15.25 years in males and 16 years in females), 12 pairs were categorized into Grade 1 calcification (mean age being 17.1 years in males and 17 years in females), 8 pairs into Grade 2 calcification (mean age of 18.8 years in males and 19 years in females), 5 pairs into Grade 4 calcification (mean age being 24 years in males and 23 years in females), 9 pairs into grade 6 calcification (mean age of 26.33 years in females and 27 years in males) and 3 pairs into grade 7 calcification (mean age of 29 years in males). No cases of grade 3 and grade 5 were observed.

Conclusion: Incidence of calcification is more in males than in females

Keywords: Age, Calcification, Fusion, Males, Radiograph

INTRODUCTION

The sternum, 12 thoracic vertebrae, and 12 pairs of ribs with their costal cartilages make up the skeleton of the thoracic wall. True ribs are those in which the costal cartilages of the upper seven pairs of ribs join directly to the sternum. The remaining five pairs of ribs are referred to be "false" ribs because they do not directly attach to the sternum but are attached to the 7th rib by cartilage¹. This is a primary cartilaginous junction that connects the anterior end of the ribs to the cartilages. The primary centre for the shaft of the first rib appears about the second month of intrauterine life. Around puberty, secondary centres for the head and tubercle emerge. By 20 years, fusion is complete. Only when there is calcification within the first costal cartilages, they become

more apparent on radiography²⁻⁴. Radiographic examination of costal cartilages is useful and convenient for estimating age and sex of an individual. The study will also be useful to see any deviation or change in the age and pattern of ossification if observed, as there is insufficient literature to prove it.

MATERIAL AND METHODS

The present study was done in the Department of Anatomy in collaboration with the Department of Forensic Medicine and Radiology, PGIMS, Rohtak. The specimen consisted of 50 pairs of first rib along with manubrium in the age group of 15-30 years collected from the cases of medico-legal autopsies done in Department of Forensic Medicine after taking proper consent from the legal heir of the deceased. Specimens whose autopsies had been performed within 24 hours of death were analyzed to see the results after obtaining their radiographs.

Exclusion criteria

- Accident/Trauma cases where first rib had been fractured.
- Cases in which first rib was distorted during autopsy.
- Cases showing any fracture or malunion.

Method of extraction

Manubrium along with 2-3 cm of sternal ends of first rib with costal cartilage were taken for study. The specimens were collected after giving midline incision in thorax and reflecting the skin and the muscles laterally in upper part of thorax. After elevating the clavicle, manubrium along with the first rib 2-3 cm lateral to the costochondral junction were cleaned on both the sides and the above part was dissected and removed from the dead body. The specimens were retrieved from the cadaver and were tagged and numbered. The specimens were left in the glass container filled with saturated solution of sodium chloride for 6-8 weeks to macerate the soft tissue. They were cleaned and dried to see for the fusion of the first costal cartilage with manubrium

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radiologically.

The radiological grading was done as described by Pushpa et al⁵.

- Grade 0- No calcification in costal cartilage (Figure 1).
- Grade 1- Traces of calcification in first costal cartilage (Figure 2).
- Grade 2- Calcification along the single margin of the first costal cartilage (Figure 3).
- Grade 3- Calcification along both the margins of the costal cartilage (No case).
- Grade 4- Prominent central or bifid calcification of the first costal cartilage (Figure 4).
- Grade 5- Mixed-marginal and central calcification which is <50% calcification in costal cartilage (No case)
- Grade 6- Mixed 50-74% of calcification in first costal cartilage (Figure 5).
- Grade 7- Calcification around 75% and above in first costal cartilage (Figure 6).

STATISTICAL ANALYSIS-

The result was tabulated and analyzed by entering it in the MS Excel spreadsheet and then coded appropriately in SPSS (Statistical Package for Social Sciences) for windows version 20.0. Unpaired T test was applied to compare two means and *P* value was calculated using the test to know how significant the differences were. The test was performed at 5% level significance; thus, an association was significant if the value was less than 0.05 (p value < 0.05). The data

was then analyzed using statistical software package SPSS program for minimum, maximum values along with mean and standard deviation (S.D.) for age of fusion of sternal end of first rib costal cartilage with manubrium radiographically.

RESULT

The result has been tabulated in table 1 which indicates that the minimum age of grade 0 calcification was 15 years in males and 16 years in females. The maximum age of grade 0 calcification was 16 years in both the sexes on both sides. The minimum age of Grade 1 calcification was 16 years in both the sexes and maximum age was upto the age of 18 years. Grade 2 ossification or calcification along single margin of costal cartilage was seen earlier in males at 16 years of age as compared to females at 19 years of age. Grade 4 ossification or prominent central or bifid calcification was found upto the age of 25 years in males and 24 years in females on both sides. Grade 6 calcification or mixed calcification of 50-74% was found earlier in males at the age of 23 years as compared to females (25 years). Grade 7 calcification or calcification around 75% and above was seen only in males. No such calcification was found in females radiographically. No bilateral asymmetry was noticed in any of the specimens in both the sexes in terms of differences in grading or patterns of calcification on right and left sides. No synovial cavities were seen in the first chondrosternal joint in any of the specimens.



Figure-1: Grade 0 calcification



Figure-3: Grade 2 Calcification

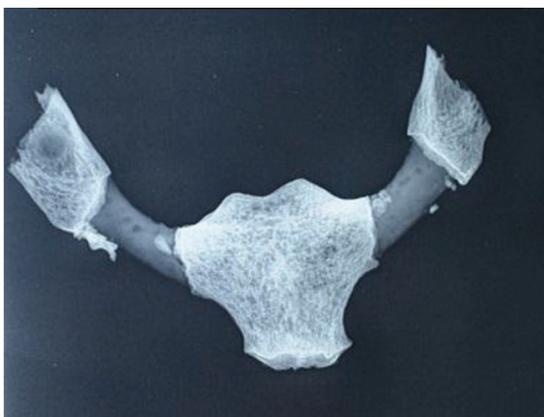


Figure-2: Grade 1 Calcification



Figure-4: Grade 4 Calcification

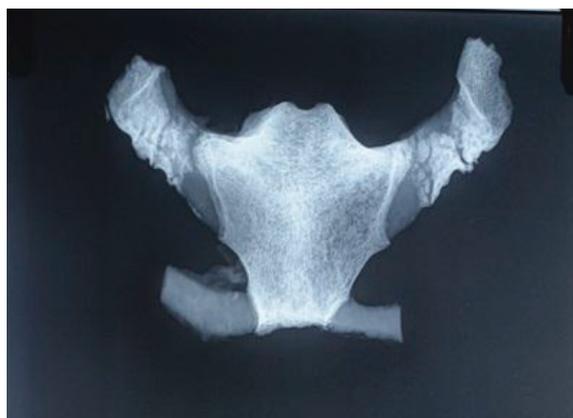


Figure-5: Grade 6 Calcification

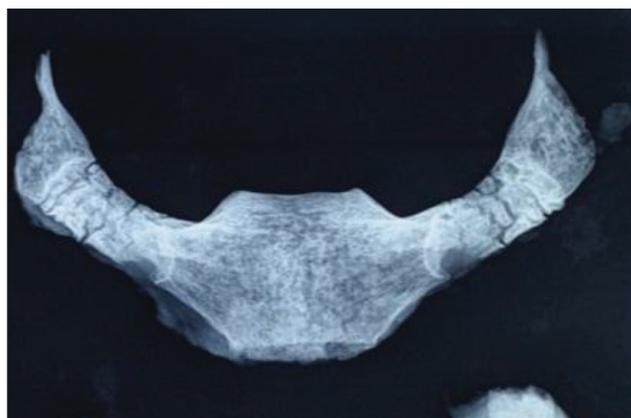


Figure-6: Grade 7 Calcification

Number of cases	Minimum (age in years)		Maximum (age in years)		Mean ± S.D. (age in years)		P value
	Right	Left	Right	Left	Right	Left	
For Grade 0 calcification							
Males (12)	15	15	16	16	15.25±0.45	15.25± 0.45	0.91
Female (1)	16	16	16	16	16	16	
For Grade 1 Calcification							
Males (8)	16	16	18	18	17.1±0.83	17.1±0.83	0.51
Females (4)	16	16	18	18	17±0.82	17±0.82	
For Grade 2 calcification							
Males (7)	16	16	22	22	18.8±2.27	18.8±2.27	0.52
Female (1)	19	19	19	19	19	19	
For Grade 4 calcification							
Males (3)	23	23	25	25	24±1	24±1	0.95
Females (2)	22	22	24	24	23±1.41	23±1.41	
For Grade 6 Calcification							
Males (6)	23	23	30	30	26.33±2.94	26.33±2.94	0.37
Females (3)	25	25	29	29	27±2.31	27±2.31	
For Grade 7 calcification (no Female cases were observed for this grade)							
Males (3)	28	28	30	30	29±1	29±1	-

Table-1: Minimum, maximum and mean age of different grades of calcification of first costal cartilage with manubrium as seen in radiographs in both sexes on both sides.

Author	Calcification absent (age in years)		Calcification present (age in years)	
	Males	Females	Males	Females
Khatri et al ⁶	≤ 15	≤ 17	-	-
Rao and Pai (Karnataka) ⁷	≤16	≤20	>21	
Garamendi et al (Spain) ⁸		≤20		≥25
McCormick (Texas) ⁹		≤15		-
Nishino (Japan) ¹⁰		≤16		≥30
Present study	≤ 16	≤ 16	≥ 17	≥ 17

Table-2: Comparison of age of absence or presence of calcification radiographically in two sexes in different populations by different authors.

DISCUSSION

In the present study no calcification was found upto the age of 16 years in females. This finding of the present study is almost in consistency to the findings of Khatri et al⁶ and differs from the study of Rao and Pai⁷. Khatri et al⁶ studied North Indian Population and in their study no calcification was seen upto the age 17 years in females (Table 2). Rao and Pai⁷ studied South Indian Population and in their study no calcification was seen upto the age of 20 years

in females. This discrepancy may be due to the different eating habits of the South Indian Population who consume comparatively less milk and dairy products as compared to North Indian Population particularly Haryana. The findings of the present study regarding absence of calcification were less than that reported by Garamendi et al⁸ who studied on Spanish population and the findings of the present study is in accordance to McCormick⁹ and Nishino¹⁰ (Table 2) who studied on American and Japanese population respectively.

The radiographic presence of calcification was seen after 17 years of age in both the sexes in the present study. The finding of the present study is less than that reported by Garamendi et al⁸ who mainly studied on Spanish population and observed presence of calcification after 25 years of age. This discrepancy may be attributed to the stature and built of the western population.

Human anatomy research makes a significant contribution to medical science practice. Attempts to link costal cartilage calcification to various diseases have been done in the past¹¹. Various disorders, such as tuberculosis and its effect on costal cartilage calcification, arteriosclerosis and costal cartilage calcification, have been studied in the past¹². Hence, study of costal cartilage calcification is of significant interest in medical field. The disparities in calcification onset age, according to a few authors, could be attributable to endocrine factors^{13,14}. According to King¹⁵, rib cartilage calcification might be linked to habit, and costal cartilage calcification was a physiological response of a connective tissue to the pressures put on it by muscular action in order to react to higher rigidity of the anterior chest wall.

One of the limitations of the present study was that a smaller number of cases were included. The study did not take into account the nutritional status of the deceased. In recent years, Dual-Energy CT (DECT) is playing an important role in the clinical fields' due spectral images. Hence, further study on the specimens can be done by CT scan techniques to obtain more information on pattern of first rib costal cartilage calcification. Studies can also be done in the future regarding costal cartilage calcification and its effect on chest expansion and thoracic wall movements and in turn on respiratory activities.

CONCLUSION

This concludes that calcification of first costal cartilage exhibits a definite pattern in relation to the sex involved. Incidence of calcification is more in males than females. No bilateral asymmetry was noticed in any of the specimens in both the sexes in terms of differences in grading of calcification on both sides. Radiographic examination of costal cartilages is a useful and convenient method for estimating age and sex of an individual. The present study has dealt with age of fusion of first costal cartilage with manubrium along with sex differences which will be useful for Anatomists, Forensic experts in medicolegal cases, Anthropologists and Orthopedicians.

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