



OSSIFIED CARTILAGO THYREOIDEA AND ITS CLINICAL INSIGHT: A CADAVERIC STUDY

Kosuri Kalyan Chakravarthi^{1*}, Nelluri Venumadhav¹ and Huban Thomas²

^{1*}Department of Anatomy, Santhiram Medical College, NH-18, Nandyal-518501, Kurnool Dt., A.P, India

¹Department of Anatomy, Melaka Manipal Medical College (MMMM), Manipal University, Manipal, Karnataka, India

²Department of Anatomy, Kasturba Medical College (KMC), Manipal University, Manipal Karnataka, India

Received for publication: April 22, 2013; Revised: May 07, 2013; Accepted: June 27, 2013

Abstract: The three major cartilages of the larynx - thyroid, cricoid, and arytenoids are all hyaline cartilage. They may undergo calcification or endochondral ossification (or both), such calcified or ossified cartilage may compress the neuro vascular structures around it. Accordingly the present study was undertaken to observe the incidence of the ossified thyroid cartilages (Cartilago Thyreoidea) in the human cadavers, discuss its clinical implications and to review the literature regarding these anatomical variations. This study was carried out on 54 human cadavers at Department of Anatomy-Santhiram Medical College Nandyal, Department of Anatomy- Melaka Manipal Medical College (MMMM)-Manipal and Department of Anatomy, Kasturba Medical College (KMC), Manipal Karnataka. Early ossified thyroid cartilages were detected in 4 female cadavers out of 54 human [27 male and 27 female] cadavers. To the best of our knowledge, early calcified thyroid cartilages observed in this study have not been cited in modern literature. Frequently, the partly ossified cartilages create a diagnostic problem for the radiologist examining for foreign bodies. Proper knowledge and diagnosis of such calcified or ossified thyroid cartilages assists the clinician in the appropriate management of the patient.

Keywords: Calcification, Ossification, Thyroid Cartilages, Windows.

INTRODUCTION

The larynx is made up of nine cartilages that are lined by mucous membrane, connected by membranes and ligaments, and moved by muscles. [1] The cartilago thyreoidea (thyroid cartilage) is the largest of the nine cartilages that acts as a shield of protection of larynx from the front. It is composed of two plate-like laminae that fuse in front of the cartilage to form a peak, called the laryngeal prominence. Such laryngeal prominence is often referred to as the "pomus Adamus" or "Adam's apple". The prominence is more prominent in adult male than female because of the difference in the size of the angle: 90° in male and 120° in female.

Ossification and calcification of the laryngeal cartilages have been investigated since the original study by Chievitz. [2] The thyroid, cricoid, and greater part of the arytenoid cartilages consist of hyaline cartilage that undergoes calcification and ossification as part of the aging process. The terms "calcified" and "ossified" are often used synonymously but calcification always precedes ossification when cartilage becomes transformed into bone. [3] Premature calcification of cartilage in both the larynx and trachea is a rarity. [4] The thyroid and cricoid cartilages have been found to undergo a greater frequency of ossification in female population, but a higher degree of ossification has been noted in male subjects. [5] Early ossification of the thyroid lamina or the cornu is

unusual in children or adolescents. [5] The mechanisms involved in mineralization and ossification of human thyroid cartilage are not well understood. [6] A thorough medical history, physical examination of the patient including systems review, estimation of serum calcium and phosphorus, and parathyroid hormone (PTH) assay are normally needed to rule out any metastatic calcification processes in the body. [7] In the absence of hyperphosphatemia, hypercalcemia, or increased serum PTH, the early ossification of the cartilage could just be an anatomical variation. [8] Calcified thyroid cartilages have a tendency to fracture on impact. But the uncalcified or unossified thyroid cartilage elasticity helps it to spring back into its original position after the impact. Hence damage to uncalcified or unossified cartilages is minimal than the calcified or ossified cartilages. The knowledge of this kind of variations is of great importance in radiodiagnostic procedures and surgery. Therefore, the aim of this study was investigate the incidence of the ossified thyroid cartilages in the human cadavers and discuss its clinical implications.

MATERIALS AND METHODS

This study was carried out on 54 human cadavers of known age and sex at Department of Anatomy-Santhiram Medical College-Nandyal, Department of Anatomy- Melaka Manipal Medical College (MMMM) -

*Corresponding Author:

Kosuri Kalyan Chakravarthi

Department of Anatomy,

Santhiram Medical College, NH-18,

Nandyal-518501, Kurnool Dt., A.P, India



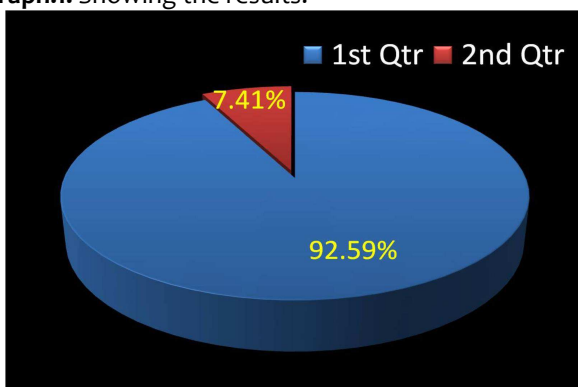
Manipal and Department of Anatomy-Kasturba Medical College (KMC) – Manipal, Karnataka. During the routine cadaveric dissection of the neck region for the undergraduate students ossified thyroid cartilages were carefully observed and isolated from the cadavers and appropriate photographs were taken for the proper documentation.

RESULTS

For the present study, 54 human cadavers [27 male and 27 female] were observed. Fifty (92.59%) of the human cadavers had neither complete nor incomplete ossified thyroid cartilage [Graph.1]. Four female cadavers (7.41%) (Aged 24 yrs, 26yrs, 26yrs and 30 yrs old) had unusual ossified thyroid cartilages (Fig-1, 2, 3, and 4). It was observed that the parts of thyroid cartilage i.e. Laryngeal prominence, Inferior horns, Superior horns and Laminae except a small central part were ossified.

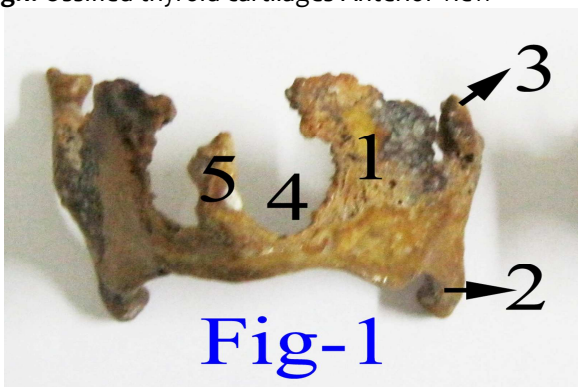
The results of the present study was compared with that of previous studies from medical literature shows that the occurrence of such ossified thyroid cartilages were relatively very rare.

Graph.1: Showing the results.



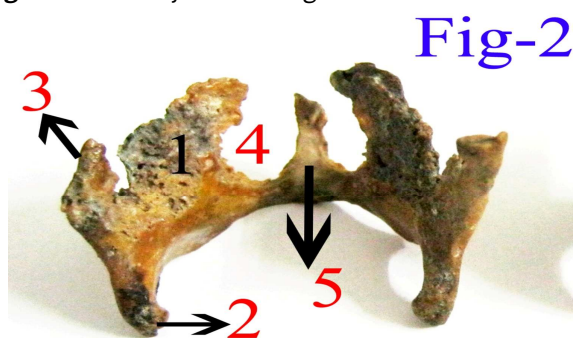
1st Qtr: Incidence of neither complete nor incomplete ossified or calcified thyroid cartilage [92.59%]; 2nd Qtr: Incidence of ossified thyroid cartilage [7.41%].

Fig.1: Ossified thyroid cartilages-Anterior view



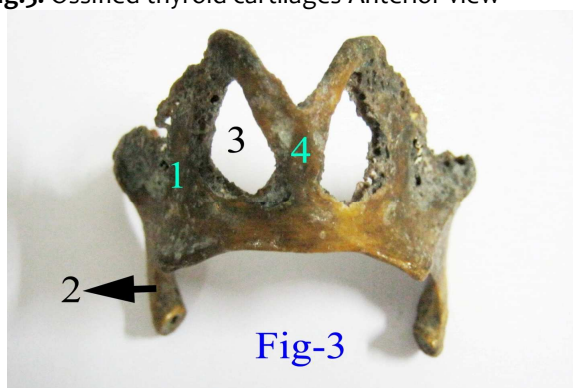
1. Lamina. 2. Inferior horn. 3. Superior horn. 4. Windows (unossified portions of the laminae). 5. Laryngeal Prominence.

Fig.2: Ossified thyroid cartilages- Posterior view



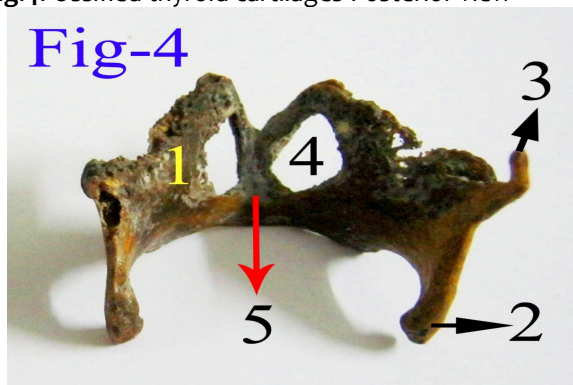
1. Lamina. 2. Inferior horn. 3. Superior horn. 4. Windows (unossified portions of the laminae). 5. Laryngeal Prominence.

Fig.3: Ossified thyroid cartilages-Anterior view



1. Lamina. 2. Inferior horn. 3. Superior horn. 4. Windows (unossified portions of the laminae). 5. Laryngeal Prominence.

Fig.4: Ossified thyroid cartilages-Posterior view



1. Lamina. 2. Inferior horn. 3. Superior horn. 4. Windows (unossified portions of the laminae). 5. Laryngeal Prominence.

DISCUSSION

Disordered ossification or calcification of ligaments or cartilages may compress neurovascular structures and can cause serious implications in any surgical intervention in the region, and may lead to false neurological differential diagnosis. [9, 10] There is a general trend of increase in the ossification of laryngeal

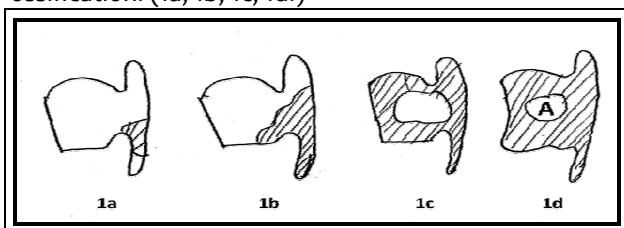
cartilages as the age advanced. ^[11] Terminal differentiation and mineralization of human thyroid cartilage usually occurs after the end of adolescence. By that time, most of the previously cartilaginous human skeletal elements have become ossified, and the epiphyseal disks are in the process of closing. Ossification normally starts in both sexes at the posterior border, the lower margin, and the inferior horn of the thyroid cartilage. The male thyroid cartilage is ossified in most of its parts around the age of 70 years, but the female cartilage never ossifies completely, leaving the ventral half cartilaginous. ^[12] It is unusual to find the ossification of the superior margin of the lamina or the superior horn of the thyroid cartilage at an early age as seen in this study (Fig.1, 2, 3 and 4). The degree and frequency of ossification of the thyroid cartilage is less in females than in males, especially in its anterior aspect. ^[13]

Ossified thyroid cartilages may compress the neuro vascular structures around it. Internal and external laryngeal nerves are the branches of superior laryngeal nerve, which are closely related to the thyroid cartilage. Ossified thyroid cartilages found in this study may leads to the Internal or external laryngeal palsy or compression. External laryngeal palsy or compression will result in voice changes ranging from slight huskiness and inability to reach a high pitch. Internal laryngeal palsy or compression will result in loss of laryngeal cough reflex, and, in turn, the risk of aspiration pneumonia.

Pattern of Thyroid Cartilage Ossification:

Ossification begins in the inferior portion of the posterior third of the lamina and in the inferior horn. It then extends to the upper portion of the posterior third of the lamina and also forwards along the inferior margin of the anterior two thirds of the lamina (Fig.5: 1a, 1b, 1c and 1d). Separate centers often occur in the superior margin of the lamina and at the junction of the two laminae anteriorly. The superior horn usually ossifies at a much later stage. The unossified portions of the laminae persist as radiolucent "windows", often to a late age.

Fig.5: Showing the pattern of thyroid cartilage ossification: (1a, 1b, 1c, 1d.)



A- Window (unossified portions of the thyroid cartilage laminae).



**Ossified portions of
Thyroid cartilage**

Worning differentiated a male from a female type of ossification on the basis of this window formation. ^[14] Von Glass and Pesch described 4 ossification patterns of thyroid cartilage ossification, i.e., horizontal-caudal, vertical-lateral, vertical-median, and oblique. ^[15] However, a qualitative difference in the type of ossification present in the two sexes does emerge in that ossification in the male tends to be homogeneous and hazy, whereas that in the female is more often irregular and dense. Similar qualitative differences have been noted by O'Bannon and Grunow in their study of 47 cases. ^[16] They also quoted Cuirlo and Olivera who described a similar pattern of thyroid ossification. Keen and Wainwright in their study of 133 larynges, regarding the pattern of ossification stated that the front parts of the laminae and the mid-line area remain cartilaginous. ^[17] The lower border, inferior cornu, front parts of the laminae and the mid-line area (laryngeal prominence) are ossified at an early age as seen in this study (Fig.1, 2, 3 and 4). Such abnormal ossified thyroid cartilages may compress the recurrent laryngeal nerve, bilateral nerve damage can result in breathing difficulties and aphonia (the inability to speak). As calcified normal structures, particularly the laryngeal cartilages can mimic abnormal radio-opaque foreign bodies, it is important to be able to recognise the normal calcified structures seen on the neck radiograph.

CONCLUSION

It may be summarized that the presence of the ossified thyroid cartilages noted in this study are very rare findings, which may not be detected unless symptomatic, the cause of which may be very difficult to diagnose. The anatomical knowledge of early ossified thyroid cartilages very important for surgeons and radiologists as it may increase the success of diagnostic evaluation and surgical approaches to the region.

REFERENCES

1. Snell RS. Clinical Anatomy for Medical Students.6th ed. Baltimore Md: Williams and Wilkins 2000, 744-8.
2. Chievitz JH. Untersuchungen über die Verknöcherung der menschlichen kehlknorpel. Arch Anat Physiol Anat Abt 1882, 49,303-49.
3. Strauss S. Sonographic appearance of cricoid cartilage calcification in healthy children. AJR Am J Roentgenol 2000, 174,223-8.
4. Goldbloom RB, Dunbar JS. Calcification of cartilage in the trachea and larynx in infancy associated with congenital stridor. Pediatrics 1960, 26,669-73.

5. Rubin MM, Krost BS. Calcification of the thyroid cartilage mistaken for an aspirated tooth. *J Oral Maxillofacial Surg* 1991, 49,745-6.
6. Kirsch T, Claassen H. Matrix vesicles mediate mineralization of human thyroid cartilage. *Calcif Tissue Int* 2000, 66,292-7.
7. Alawi F, Freedman PD. Metastatic calcification of the nasal septum presenting as an intraoral mass: a case report with a review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2001, 91,693-9.
8. Potts Jr JT. Diseases of the parathyroid gland and other hyper and hypocalcemic disorders. In: Fauci AS, Braunwald E, Isselbacher KJ, et al, eds. *Harrison's Principles of Internal Medicine*. Vol 2. 14th Ed. New York: McGraw Hill 1998, 2227-36.
9. Kosuri Kalyan Chakravarthi, Nelluri Venumadhav, Ravindranath Gandrakota. Abnormal Bone Outgrowths and Osseous Structures around the Foramen Ovale May Leads to Mandibular Compression or Entrapment Neuropathy. *Int J Bioassays*, 2013, 02, 922-925.
10. Kosuri Kalyan Chakravarthi, Sarath Babu K. An anatomical study of the pterygo-alar bar and porus crotaphitico buccinatorius. *Int J Med Health Sci*. 2012; 1: 3-9.
11. Mupparapu M, Vuppapapati A. Ossification of laryngeal cartilages on lateral cephalometric radiographs. *Angle Orthod* 2005, 75,196-201.
12. Tillman B, Wustrow F. *Larynx*. New York, NY: Thieme 1982, 1, 6-1.7.
13. Salman RA, Kinney LA. Calcified thyroid cartilage. *Oral Surg Oral Med Oral Pathol* 1990, 70,806-07.
14. Worning B. *Acta radiol Stockh* 1934, 15, 8.
15. Von Glass W, HJ Pesch. Zum Ossifikationsprinzip des Kehlkopfskelets von Mensch und Saugetieren. *Acta Anat (Basel)* 1983, 116,158-67.
16. Bannon RP and Grunow O H. *Southern Med J* 1954, 47, 310.
17. Keen JA, Wainwright J. Ossification of the thyroid, cricoid and arytenoid cartilages. *S Afr J Lab Clin Med* 1958, 4, 83-108.

Source of support: Nil

Conflict of interest: None Declared