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Detection of an Early Ossification of Thyroid Cartilage in an Adolescent on a Lateral Cephalometric Radiograph

Muralidhar Mupparapu, DMD;[a] Anitha Vuppalapati, MD[b]

ABSTRACT

We report ossification of the thyroid cartilage detected on a routine lateral cephalometric film and discuss the clinical implications of this finding. The thyroid cartilage is a part of the laryngeal cartilaginous complex and may undergo calcification or endochondral ossification (or both), thereby becoming visible radiographically. Usually, ossification is visible only in individuals over the age of 20 years. It is unusual to see ossification in children or adolescents. We report here a case of thyroid ossification in a 14-year-old patient that is visible on a routine lateral cephalometric radiograph. An incidental limbus vertebra is also noticed situated anteroinferior to the fourth cervical vertebra.

KEY WORDS: Metastatic calcification, Laryngeal cartilages, Superior cornu, Limbus vertebra.

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INTRODUCTION Return to TOC

Mineralization of the human thyroid cartilage is a normal physiologic process in adults, and it increases with age. The thyroid and cricoid 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.[1] Early ossification of the thyroid lamina or the cornu is unusual in children or adolescents.[1] The mechanisms involved in mineralization and ossification of human thyroid cartilage are not well understood.[2] Although the likelihood of metastatic calcification (MC) is low in the present case because of the absence of symptoms and the lack of calcification in structures other than the laryngeal cartilages, concomitant presence of a calcified limbus vertebra increases the suspicion of a generalized state of hypermineralization. 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 MC processes in the body.[3] In the absence of hyperphosphatemia, hypercalcemia, or increased serum PTH, the early ossification of the cartilage could just be an anatomical variation.[4]

CASE REPORT Return to TOC

A 14-year-old male patient was referred for a routine preorthodontic lateral cephalometric film. The radiograph was obtained using a

Kodak T-Mat G/RA film (Eastman Kodak, Rochester, NY) with a standard 8 × 10 cassette containing a Dupont Cronex Quanta III GB intensifying screen (DuPont Nemours and Co., Wilmington, DE). A Quint Sectographic machine (Quint Sectograph, Los Angeles, Calif) with a source-to-image distance of 170 cm and an object-to-film distance of 13 cm was used to obtain the lateral cephalogram. An Ultralum X-ray grid (Liebel-Flarsheim USA, Cincinnati, Ohio) with a grid ratio of 10:1 was used. The radiograph showed two interesting anomalies. First, the superior cornu of the thyroid cartilage, which is normally not radiographically apparent unless ossified, was clearly noticed (Figure 1). An incidental limbus vertebra was also found at the level of the fourth cervical vertebra (C4).[5] The limbus is a developmental variant of the annulus fibrosus of the cervical vertebrae and is seen because of herniation and ossification of the nucleus pulposus. It is often mistaken for a fracture if not identified accurately.[6] The patient had no history of significant medical problems, and the systems review was within normal limits. He was referred back to his orthodontist and his primary care physician with the documentation of the ossification. The patient was then scheduled for a follow-up visit in 3 months to review the reports from his physician. The consult from the primary care physician indicated that there were no clinical signs of hypercalcemia at the time of the examination to warrant any further imaging studies; serum calcium and phosphorus were found to be within normal limits and serum PTH was intact. The thyroid ossification was hence considered a physiologic variation, and no treatment was suggested.

DISCUSSION Return to TOC

Terminal differentiation and mineralization of human thyroid cartilage usually occurs after the end of adolescence.[2] By that time, most of the previously cartilaginous human skeletal elements have become ossified, and the epiphyseal disks are in the process of closing.[2] 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.[7] Other permanent cartilages, including first rib cartilage and bronchial cartilage also start to mineralize and ossify after the end of adolescence.[2] 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 patient.

When thyroid ossification is noticed on a lateral cephalometric film at an early age, further imaging using studies like ultrasound, computerized tomography, or magnetic resonance imaging[8] may be helpful to rule out parathyroid adenomas. Radiographic cephalometry was begun by Pacini[9] in 1922 for anthropometric purposes and was refined for use in dentistry by the introduction of a patient cephalostat in 1931 by Hofrath[10] in Germany and in 1937 by Broadbent[11] in the United States. The cephalostat had a fixed subject-target distance; hence, it was possible to obtain standardized and accurate measurements from the radiographs obtained from this device. The cephalometric radiograph is a specialized lateral skull view, which allows clinicians to investigate not only facial types, growth patterns, and relationship of jaws and teeth but also the anatomical positioning of cervical vertebrae, the hyoid bone, and on occasion, laryngeal cartilages. A number of well-known normal variants of branchigenic structures are often discovered on this lateral film of the head and neck. Included are long styloid processes, calcified stylohyoid ligaments, and enlarged superior cornu of the thyroid cartilages. Many of these anomalies as well as the unusually ossified laryngeal cartilages have been previously confused with ingested foreign bodies.[1]

The three major cartilages of the larynx—the thyroid, cricoid, and arytenoids are all hyaline cartilage and may undergo calcification or endochondral ossification (or both) and become visible radiographically.[12] The other cartilages consist of elastic cartilage (as do the apices and vocal processes of the arytenoids). The degree and frequency of ossification of the thyroid cartilage is less in females than in males, especially in its anterior aspect.[12] The degree and frequency of ossification of the cricoid is also less in females than in males.[12] In both sexes, the degree of ossification of thyroid and cricoid cartilage increases with age.[12] Ossification is first seen in the thyroid, followed by the cricoid and the arytenoids. In both males and females, the ossification begins at the age of 18 years to 20 years in the posterior part of the thyroid cartilage. Ossification of laryngeal cartilages is usually symmetrical.[2,12]

On occasion, fracture of the superior cornu has been documented on a lateral skull radiograph after a blunt trauma from a blow to the larynx.[13] The radiograph showed fragmentation of the ossified thyroid cartilage with displacement of the superior cornu. Redman et al[14] reported a case of osteoma of the thyroid cartilage that was responsible for difficulty in intubation before coronary bypass surgery.

MC, also termed metastatic calcinosis, usually results from the deposition of calcified product in otherwise normal tissues as a result of hyperphosphatemia with or without concurrent hypercalcemia.[15] Hypercalcemia in the absence of hyperphosphatemia does not appear to be sufficient to stimulate this form of calcification.[16] MC may be associated with a variety of disorders, including end-stage renal disease and hyperparathyroidism, and may affect the visceral organs such as kidneys, lungs, gastric mucosa, joints, as well as eyes and skin.[16] These calcifications are often fine and diffuse throughout the soft tissues. The other systemic conditions that may induce hyperphosphatemia and hypercalcemia are sarcoidosis and disseminated malignancy, which includes lymphoma, multiple myeloma, and metastatic carcinoma.[3] Hyperparathyroidism is classified into three categories on the basis of the cause of excessive PTH secretion. Primary hyperparathyroidism, thought to be an irreversible condition, results from autonomous growth of the parathyroid glands.[4] Secondary and tertiary hyperparathyroidism are both known to occur in patients with chronic renal failure. Secondary hyperparathyroidism is considered a reversible condition, with phosphate retention believed to be the inciting factor. As a result, the total body calcium decreases because of the increase in serum phosphate levels. In response, the parathyroid glands stimulate PTH production, which in turn increases serum calcium levels. Prolonged parathyroid gland stimulation causes glandular hyperplasia with increased serum PTH levels.[4] Calcium metabolism and homeostasis thus represent a complex process, which if disrupted can result in either increased or decreased

serum calcium levels. This altered balance is also frequently identified in asymptomatic patients during routine laboratory screening for other causes.[17]

Clinicians should be vigilant for the various kinds of radiographic and clinical signs indicative of MC when performing skeletal growth and development analysis in patients before orthodontic treatment.

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FIGURES Return to TOC

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FIGURE 1. Cropped view of the lateral cephalometric radiograph showing the calcified superior cornu of the thyroid cartilage seen extending superiorly just anterior to the fourth cervical vertebra (arrow). Also notice the limbus vertebra present anteroinferior to C4

[a]Assistant Professor of Radiology, Department of Oral Medicine, School of Dental Medicine, University of Pennsylvania, Philadelphia, Pa

[b]Clinician, Ambulatory Care Services, City of Philadelphia Health Department, Philadelphia, Pa

Corresponding author: Muralidhar Mupparapu, Radiology, Suite F-11, School of Dental Medicine, University of Pennsylvania, 4001 Spruce Street, Philadelphia, PA 19104 (E-mail: murali96@pobox.upenn.edu)
