



## Interpreting the **CBCT** Data Volume in Orthodontic Cases **Part 1**

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# Part 1: Interpreting the CBCT Data Volume in Orthodontic Cases: *You Should See What You May Be Missing!*

by Dale A. Miles, DDS, MS, FRCD(C)

This is a two-part article designed to help clinicians understand the more common findings they will encounter in the anatomic regions they capture in larger field-of-view (FOV) CBCT machines. Many of these findings will also be seen in smaller FOV machines when the volume capture is moved around to view things like the temporomandibular joint or third molar regions. So this article will be of interest to all clinicians, not just orthodontists. Part I will address the skull, oropharynx, cervical soft tissues and cervical spine. Part II will cover the paranasal sinus regions, nasal cavity, sella tursica region and TMJ. Anyone who owns or uses the data from a CBCT machine will see these pathologic findings and need to recognize them. Some findings are incidental but reportable/recordable. Many cited in this article can significantly impact the patient's health and after finding them, the patient must be referred to a medical specialist for further evaluation and management. Some might even save your patient's life. Missing the most important findings could lead to harm to the patient and result in litigation. All of this information will benefit both you and your patients.

## Introduction

It should be intuitively apparent to the orthodontist that there are important structures to examine beyond the dentoskeletal bases in any cone beam data volume that require interpretation. Typical anatomic structures that need to be examined in each volume include the:

1. skull and its contents
2. oropharyngeal tissues
3. cervical soft tissues
4. cervical spine
5. paranasal sinuses
6. nasal cavity
7. sella tursica and parasellar regions
8. temporomandibular joint complexes

This article will instruct the orthodontist on the methodology of examining these important anatomic regions and illustrate some of the more frequent findings in each of these areas. Some of the findings might simply be noteworthy and some will inevitably lead to referral either to another dental specialist or a medical provider. All of the figures seen in this article come from the author's radiology practice; that is, CBCT volumes referred by dentists and dental specialists using CBCT.

## The Skull and Its Contents

Most commonly there are physiologic calcifications seen within the skull on large field-of-view CBCT machines. These include the more common calcifications of the pineal gland, choroid plexuses and falx cerebri. Although calcification of the falx cerebri is seen in the nevroid basal cell carcinoma syndrome (Gorlin-Goltz) it is, nevertheless, a common finding, about 10 percent of the general population,<sup>1</sup> unassociated with a syndrome. Figure 1 is an example of such a normal falx finding.

Pineal gland calcification is usually physiologic in nature, occurring in about 40 percent of the general population by age 20.<sup>2</sup> Pineal calcifications less than 1cm in diameter are considered to be normal. Calcifications greater than 1cm could indicate a lesion in the pineal gland.<sup>2</sup> Figure 2 shows normal, physiologic calcification of the pineal gland

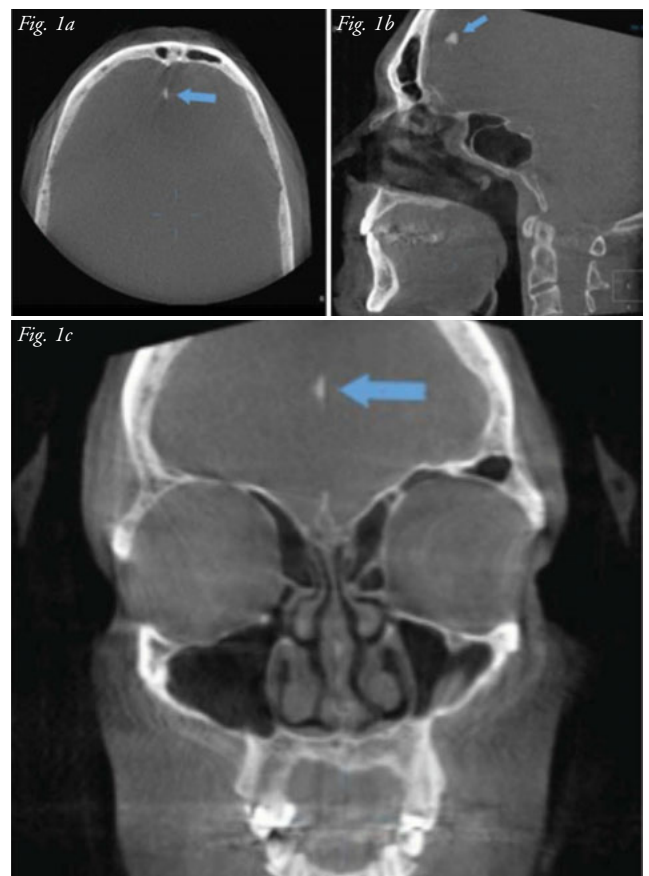


Fig. 1: (a.) Calcification of the falx in an axial view. (b.) In a sagittal view. (c.) In a coronal view. All slices are at 0.1mm thickness.



Calcification of the choroid plexuses is usually bilateral and is only worrisome if “exuberant” calcification is seen in young children.<sup>1</sup> Figure 2 and 3 below show physiologic choroid plexus calcifications.

### Oropharyngeal Tissues

Tonsilloliths are common findings either unilaterally or bilaterally in the pharyngeal tissues. These calcifications can

occur singly or in clusters. Although all are noteworthy, multiple calcifications can be a source of malodor for the patient,<sup>3</sup> often undiagnosed in the dental office. They can cause repeated inflammatory problems and even ulcerate to the surface of the tonsillar crypt tissues.<sup>3</sup> Figure 4 illustrates more florid examples of tonsilloliths.

Although not specifically in the oropharyngeal airway space, the components of the stylohyoid ligament chain are

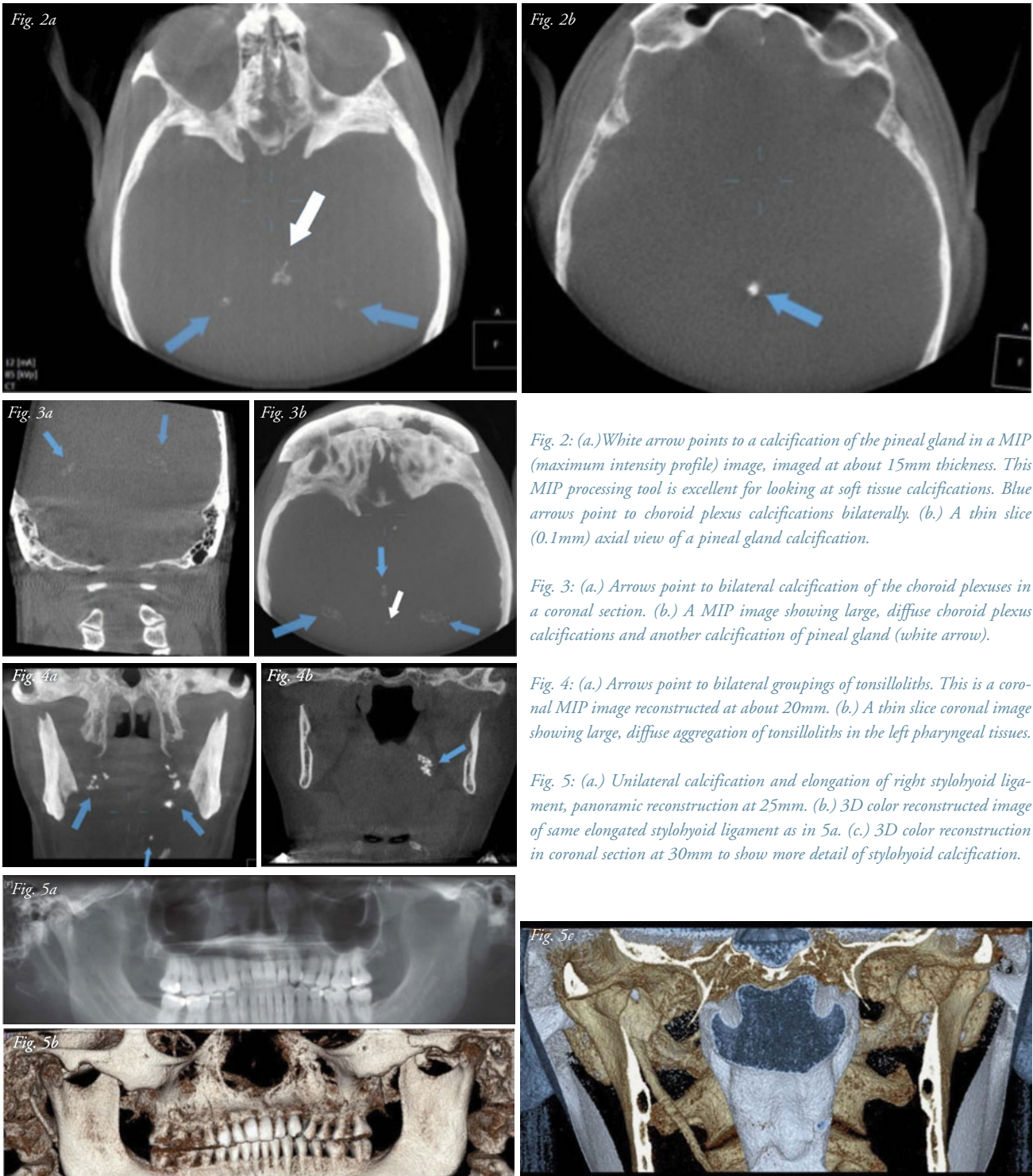


Fig. 2: (a.) White arrow points to a calcification of the pineal gland in a MIP (maximum intensity profile) image, imaged at about 15mm thickness. This MIP processing tool is excellent for looking at soft tissue calcifications. Blue arrows point to choroid plexus calcifications bilaterally. (b.) A thin slice (0.1mm) axial view of a pineal gland calcification.

Fig. 3: (a.) Arrows point to bilateral calcification of the choroid plexuses in a coronal section. (b.) A MIP image showing large, diffuse choroid plexus calcifications and another calcification of pineal gland (white arrow).

Fig. 4: (a.) Arrows point to bilateral groupings of tonsilloliths. This is a coronal MIP image reconstructed at about 20mm. (b.) A thin slice coronal image showing large, diffuse aggregation of tonsilloliths in the left pharyngeal tissues.

Fig. 5: (a.) Unilateral calcification and elongation of right stylohyoid ligament, panoramic reconstruction at 25mm. (b.) 3D color reconstructed image of same elongated stylohyoid ligament as in 5a. (c.) 3D color reconstruction in coronal section at 30mm to show more detail of stylohyoid calcification.

found adjacent to this region and calcification of some or all of their parts can lead to symptoms 4-6. Calcified elongated stylohyoid ligaments are quite common in any age group. It is only when symptoms arise that treatment is indicated. Figures 5 and 6 illustrate unilateral and bilateral cases. Eagle's syndrome has two presentations: the classic or more common is the feeling of a sharp pain like a fishbone in the throat upon swallowing (dysesthesia), the second presentation is one of a dull pain in the throat with radiating pain to the parietal, supra-orbital or infra-orbital regions.<sup>7</sup>

## Cervical Soft Tissues

In the cervical region in CBCT examinations the most important pathologic finding to recognize are calcifications in the carotid arteries either unilateral or bilateral. Sclerotic plaques associated with hypertension and increased stroke potential have been seen on panoramic images and reported for many years.<sup>8-10</sup> Although some are bilateral most are seen on one side of the image only. Many are probably missed on conventional panoramic because of the positioning of the focal trough in some machines; however, none should be missed on CBCT images. Bilateral, circumferential calcifications of the carotid arteries in the neck region sometimes in conjunction with concomitant parasellar calcifications of the internal carotid will be found within CBCT volumes. A subgroup of the larger numbers of carotid plaques these bilateral circumferential findings might indicate Medial Arterial Calcification (MAC) seen an undiagnosed or uncontrolled type II diabetes mellitus possibly in patients with end stage renal disease (ESRD).<sup>11-13</sup> Figures 7 to 9 illustrate cases with calcifications of the carotid arteries, routinely found in CBCT data volumes.

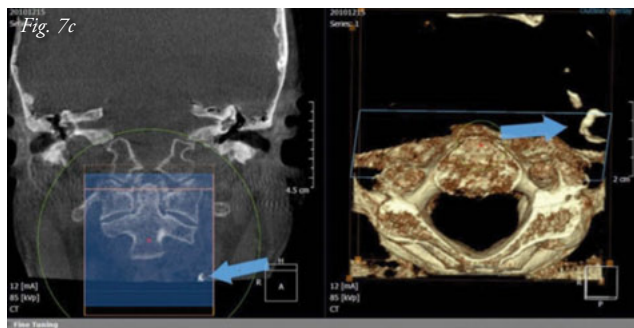


Fig. 7: (a.) Large calcification of the left carotid artery at the level of C3/C4. (b.) 3D color reconstruction of the same calcification seen in 7a. (c.) 3D color reconstruction using the "Cube" image processing tool and OnDemand 3D (CyberMed International, Seoul, Korea and Irvine, California) viewed from the coronal (left side) caudal (right side) positions. (d.,e.) Bilateral circumferential calcifications of the internal carotid artery in the parasellar region seen in a thin slice (1.0mm) coronal section and a thick slice (5.0mm) MIP image.

Fig. 8: (a.) Bilateral circumferential calcifications of the left and right carotid arteries. (b.) MIP reconstruction demonstrating the same calcifications at the level of C3/C4.

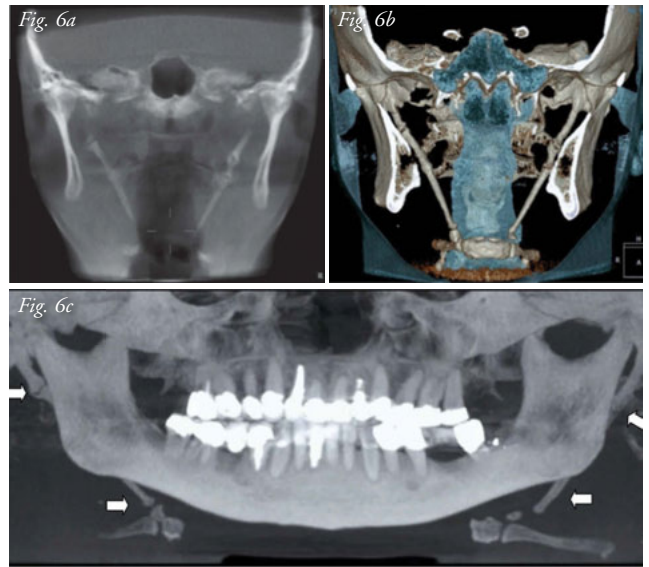
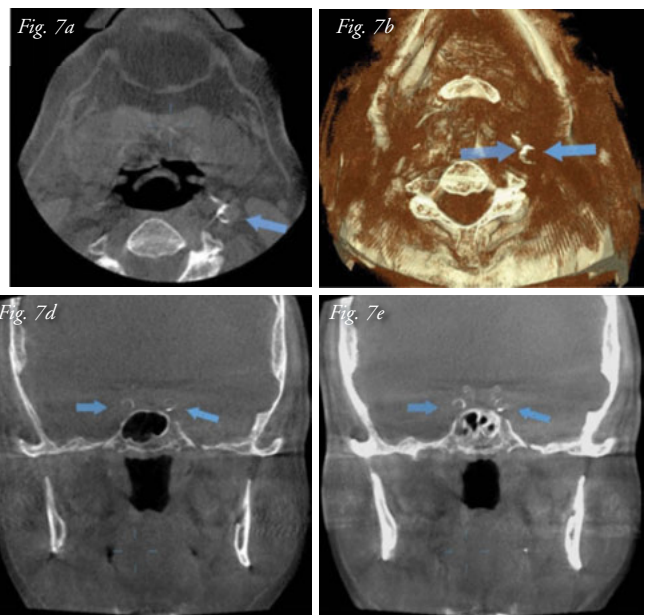


Fig. 6: (a.) Bilateral calcification and elongation of the stylohyoid ligaments. A coronal section reconstructed at about 10.0mm. (b.) 3D color reconstruction at 3mm details perfectly this rare total calcification of all elements of the stylohyoid ligament chain. (c.) A MIP image of the bilateral calcifications (white arrows).





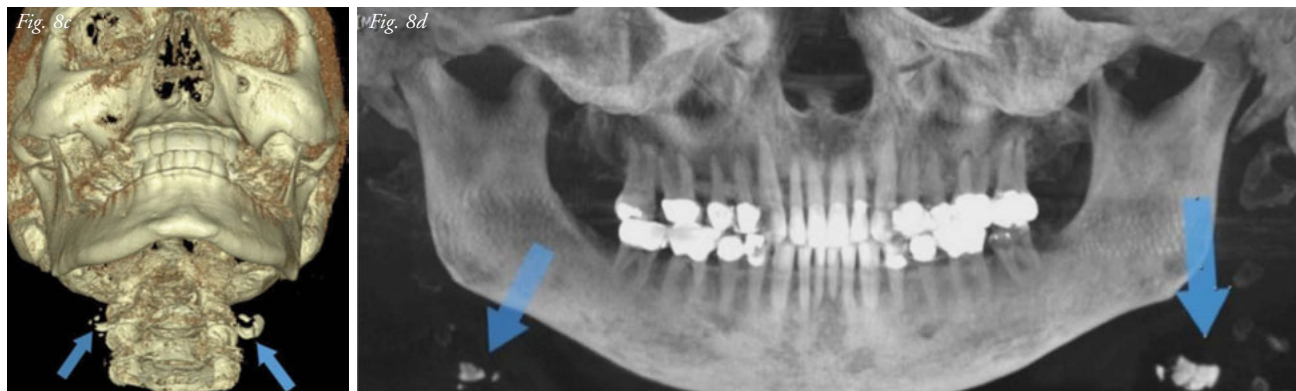


Fig. 8: (c.) 3D full color reconstruction of the patient's skull demonstrating bilateral carotid calcifications. The left appears quite circumferential. (d.) Panoramic MIP image reconstructed at about 35mm showing bilateral calcifications but no indication that they are circumferential as in 8a and 8c.

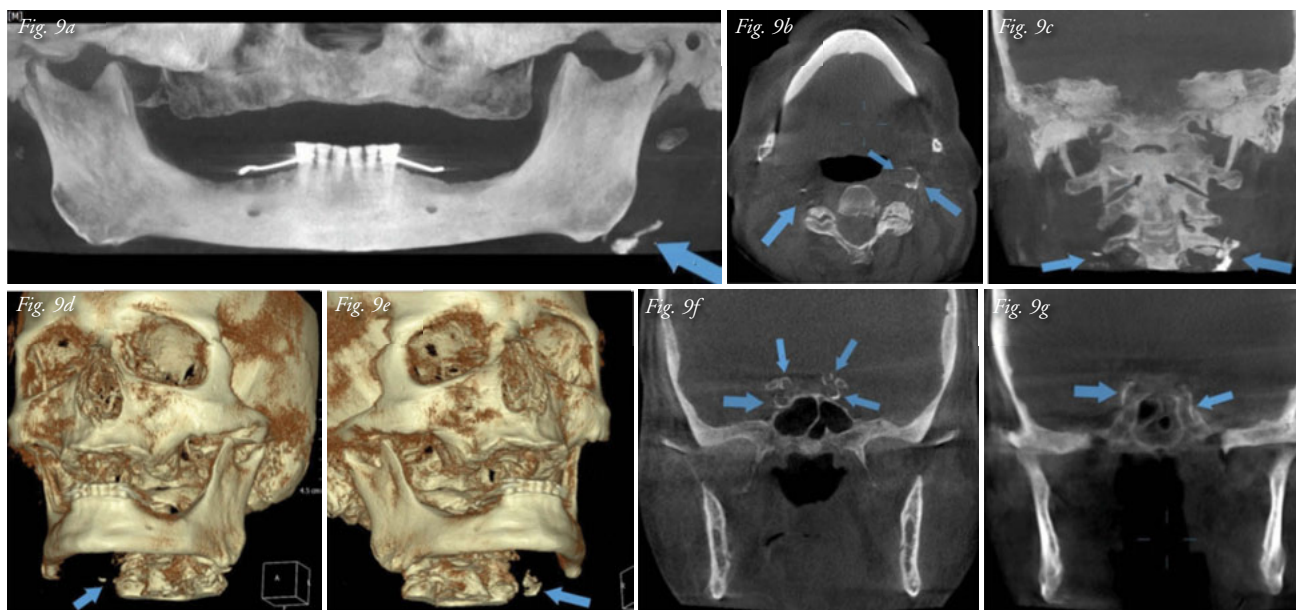


Fig. 9: (a.) Reconstructed Panoramic MIP image (35mm) demonstrating the large calcification on the patient's left side. There is no indication of any involvement of the right carotid artery even at this focal trough thickness. (b.,c.) Axial and coronal images showing calcifications of each side. (d.,e.) 3D color reconstructed views of the left and right side. (f.) Circumferential calcifications around curves segments of internal carotid in the parasellar regions bilaterally. (g.) Calcifications along the length of the internal carotid artery bilaterally has occurs from inferiorly to superiorly.

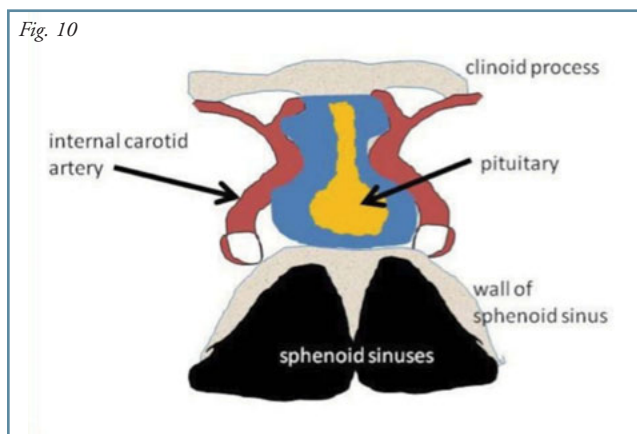


Fig. 10: Drawing of parasellar region showing relationship of internal carotid artery to pituitary fossa (sella tursica). Compare this drawing with figures 9f and g.

## Cervical Spine

Of course the most common changes found in the cervical spine are those that we also see in the TM joint complex. These include subchondral sclerosis, subchondral cyst formation, loss of joint space and osteophyte formation. Occasionally we also see a "loose body," especially at the atlantoaxial junction and less commonly calcification of the paraspinal ligaments especially the anterior. What is probably not appreciated by the orthodontist or dentist are that most of these changes are also seen in the facet joints, and not just the vertebral bodies. The examples in figures 11 to 13 (see next page) show most of these changes. In more than 9,000 CBCT cases that I have reviewed to date there also have been several lesions of the vertebral bodies, including possible metastatic lesions.

This course concludes in *Orthotown Magazine* next month. ■

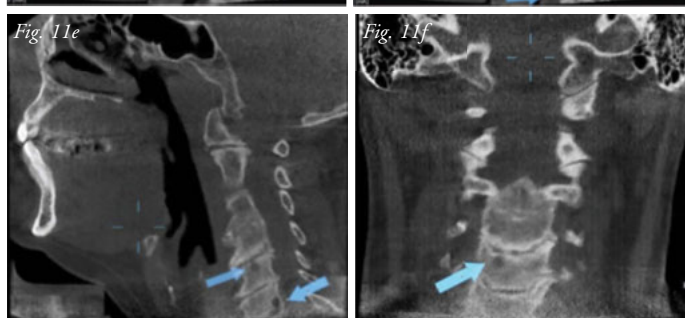
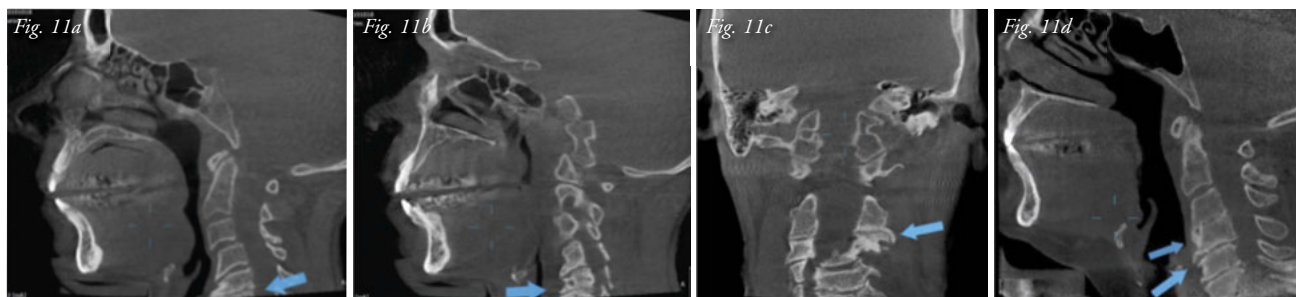


Fig. 11: (a.,b.) Loss of joint space osteophyte and subchondral cyst formation are seen in the vertebral bodies C5 and C6. (c.) Remodeling and loss of joint space seen in the right facet joint between C3 and C4 and the same case. (d.-f.) Similar changes in another case in the vertebral body C3 to C7. The osteophyte formation loss of joint space are consistent with osteoarthritis. The subchondral cyst formation seen in the vertebral bodies C4 and C5 are then most likely consistent with osteoarthritic changes. However, multiple site involvement of these radiolucent areas could also be consistent with metastases.

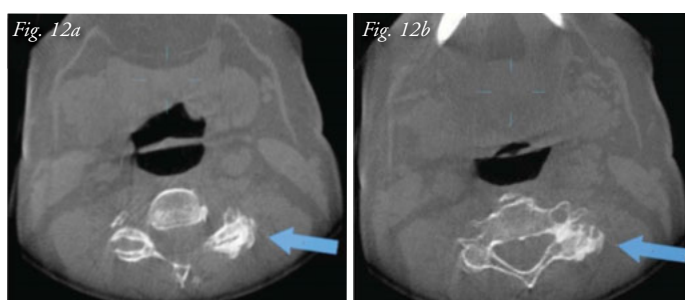


Fig. 12: (a.,b.) Gross remodeling subchondral sclerosis and subchondral cyst formation seen in the left facet joint between C3 and C4. (c.,d.) Loss of joint space, subchondral cyst formation, osteophyte formation and a loose body at the atlanto-axial junction are seen in this case. In addition there is a reverse curvature at the level of vertebral body C3 and C4 consistent with a cervical lordosis. In this case both the vertebral bodies in facet joints show comparable changes. All are consistent with osteoarthritis.

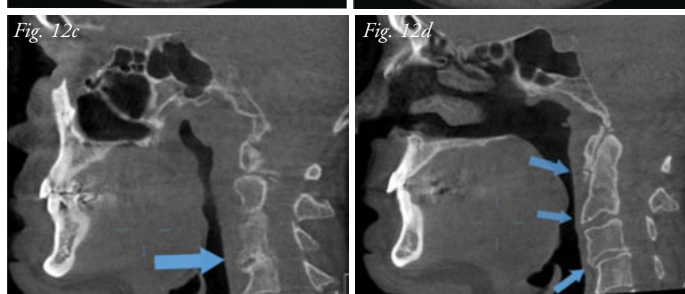
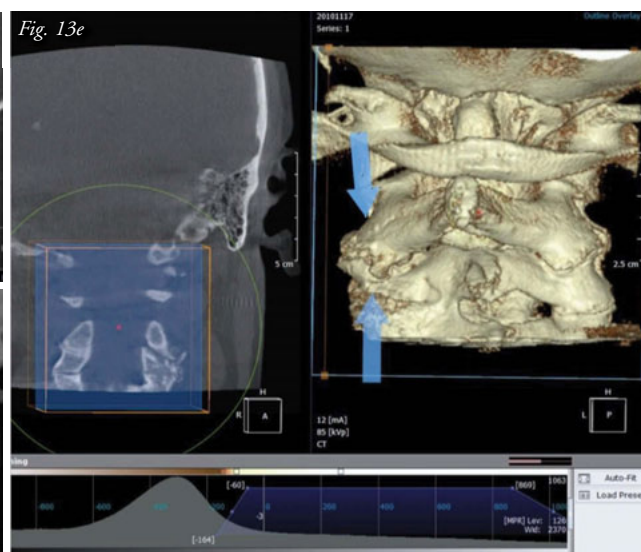
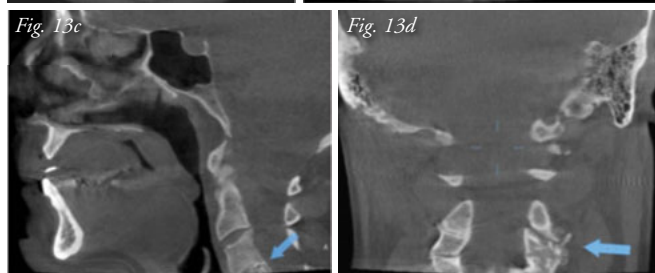
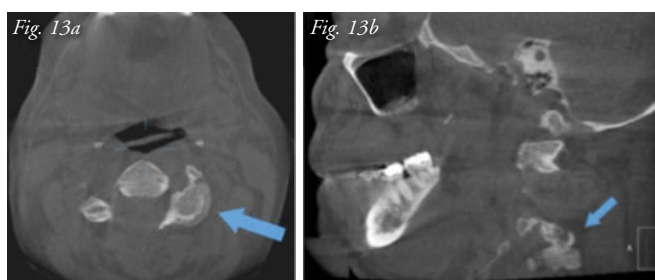


Fig. 13: (a.) An unusual change in the left facet joint between C3 and C4. The enlargement and mixed appearance of the lesion suggest a bony tumor rather than osteoarthritic change. (b.) A thin slice sagittal view through a portion of the lesion almost suggests some multilocularity. (c.) The radiolucency seen in the superior aspect of C4 is suggestive of a simple subchondral cyst. However, the changes seen in figure 13d in the facet joint are not consistent with osteoarthritic change. (e.) A 3D color reconstruction shows a gross remodeling of this left facet joint. The diagnosis of this particular lesion is not known at this time.





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## Author's Bio



**Dale A. Miles** is a professor of radiology at the Arizona School of Dentistry & Oral Health and an adjunct professor at University of Texas, San Antonio. He has previously held several prestigious positions, including, associate dean for clinical affairs at Arizona, chair of the Department of Oral Health Sciences at the University of Kentucky and graduate program director of Diagnostic Sciences at Indiana University. He is a diplomate of the American Board of Oral and Maxillofacial Radiology and the American Board of Oral Medicine. Dr. Miles has been named one of the "Top 100 Clinicians in CE" for the last eight years by Dentistry Today. He has authored more than 130 scientific articles and five textbooks, including the latest on Cone Beam Imaging. He has been a consultant to the U.S. Navy Postgraduate Dental School in Oral Diagnosis, Oral Medicine and Oral Radiology for more than 15 years. Dr. Miles has a Web site for teaching dentists and auxiliaries about digital imaging at [www.learn.digital.net](http://www.learn.digital.net). He is in full-time practice of oral and maxillofacial radiology in Fountain Hills, Arizona. To date he has read more than 10,000 cone beam CT scans for dental clients.

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1. All of the following pathoses might be seen in the soft tissues of the neck and pharyngeal regions EXCEPT ONE. Which ONE is the EXCEPTION?
  - a. tonsillolith(s)
  - b. CESLs (calcified elongated stylohyoid ligaments)
  - c. carotid plaques
  - d. sialoliths
2. All of the following physiologic calcifications might be seen in the cranial vault EXCEPT ONE. Which ONE is the EXCEPTION? Calcifications of the:
  - a. pineal gland
  - b. choroid plexus(es)
  - c. internal acoustic meatus
  - d. falx cerebri
3. Intimal calcifications (plaques in the tunica intima of an artery) of the carotid artery seen in the cervical soft tissues at the level of C3/C4 can be associated with all of the following EXCEPT ONE. Which ONE is the EXCEPTION?
  - a. stroke
  - b. hypotension
  - c. renal disease
  - d. Addison's disease
4. In addition to the more common location for carotid artery plaques seen in the cervical soft tissues in a CBCT scan, carotid plaques might also be seen in the following location:
  - a. adjacent to the foramen ovale
  - b. in the common carotid artery
  - c. in the parasellar region
  - d. near the internal acoustic meatus
5. According to some studies, pineal gland calcifications occurred in what percentage of the general population?
  - a. 10%
  - b. 20%
  - c. 30%
  - d. 40%
6. All of the following are clinical features of MAC (medial arterial calcification) EXCEPT ONE. Which ONE is the EXCEPTION?
  - a. most commonly bilateral
  - b. associated with type II diabetes mellitus
  - c. associated with type I diabetes mellitus
  - d. associated with the ESRD (end stage renal disease)
7. Although calcification of the falx cerebri is a common or incidental anomaly, it can be found as part of which genetic syndrome?
  - a. Gorlin-Holtz syndrome
  - b. Nevroid basal cell carcinoma syndrome
  - c. Chediak-Higashi syndrome
  - d. Sjögrens syndrome
8. All the following are sites of osteoarthritic change EXCEPT ONE. Which ONE is the EXCEPTION?
  - a. pedicles
  - b. spinal facet joints
  - c. atlanto-axial junction
  - d. none of the above
9. Calcified, elongated stylohyoid ligaments can be associated with which of the following?
  - a. Eagle's syndrome
  - b. Behcet's syndrome
  - c. Ernest's syndrome
  - d. Auriculo-temporal syndrome
10. William Eagle described two distinct syndromes. The second type was associated with all of the following symptoms EXCEPT ONE. Which ONE was the EXCEPTION?
  - a. dull throat pain
  - b. orbital region
  - c. parietal pain
  - d. dysethesia

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## Interpreting the CBCT Data Volume in Orthodontic Cases Part I

by Dale A. Miles, DDS, MS, FRCD(C)

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