



## Interpreting the **CBCT** Data Volume in Orthodontic Cases **Part 2**

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# Part 2: 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. This article will be of interest to all clinicians, not just orthodontists. Part I addressed the skull, oropharynx, cervical soft tissues and cervical spine and can be found on Orthotown.com or in the July/August 2011 issue of *Orthotown Magazine*. 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.

## Part II: Paranasal Sinuses

The paranasal sinuses include the maxillary, sphenoid and frontal sinuses. Although not strictly sinus spaces, the ethmoid air cells are also included in this category. All of these spaces communicate with one another. Inflammatory changes are seen in all these spaces; however, the maxillary sinuses and ethmoid air cells seem to be involved more commonly. Frontal and sphenoid involvement is less common. Nevertheless if changes are seen in the sphenoid sinus region, because of the important neural, vascular and optic structures which travel in the parasellar region, referral to an otolaryngologist and/or the patient's primary care provider is mandatory. Inflammatory or infectious changes in the sphenoid sinus could disseminate rather rapidly because of the proximity of the neurovascular structures in this region. In addition diffuse headache symptoms are common with

paranasal sinus problems and can be confusing to delineate and diagnose. Most of the changes seen in the paranasal sinus region are from chronic inflammatory complaints. But, things like antroliths, foreign bodies and even osteoma can occur in any of these spaces. Furthermore, dental problem such as apical periodontitis and chronic periodontal conditions can affect the maxillary sinus and caused mucosal alterations. If the field of view (FOV) fails to include all of the paranasal sinus regions and substantial changes are seen in the more inferior spaces such as the maxillary sinus and ethmoids, it might be necessary to reimagine the patient or referred to an ENT specialist for clinical and endoscopic evaluation. The figures demonstrate some of these problems.

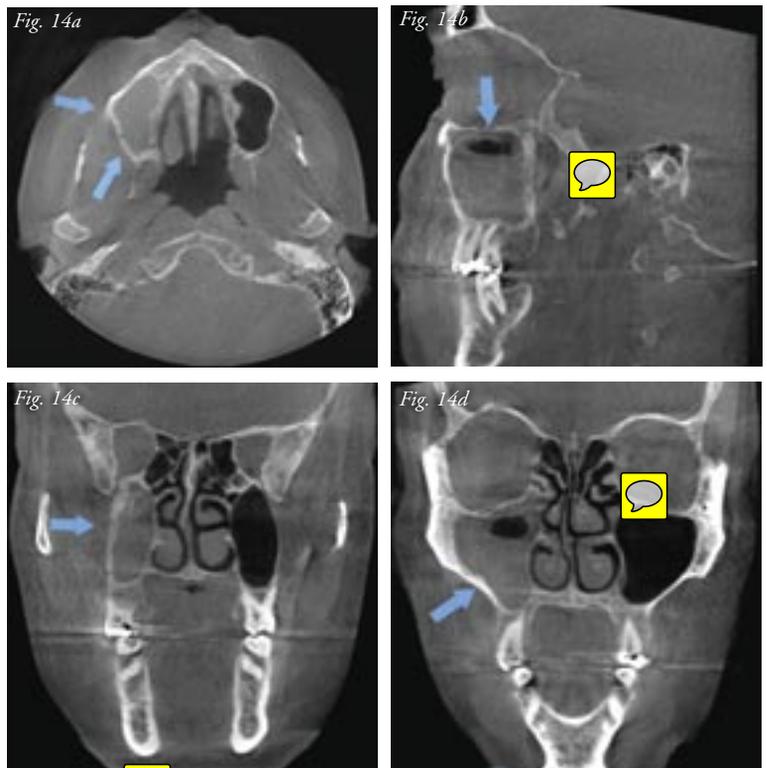


Fig. 14: (a, b) Blue arrows in the axial view and the white arrow in the sagittal view show a thickened lateral wall and a thickened posterior wall of the right maxillary sinus. The term for this is called "hyperostosis" and is indicative of a chronic inflammatory complaints or disease process. (c.) Hyperostosis is also seen in this coronal view of the right antrum. (d.) The white arrow shows to inflammatory change which is probably blocking the ostium (the communication between the maxillary sinus in the middle meatus). Blockages of this sort often lead to retrograde inflammatory change in the ethmoid air cells, frontal sinus and sphenoid sinus.

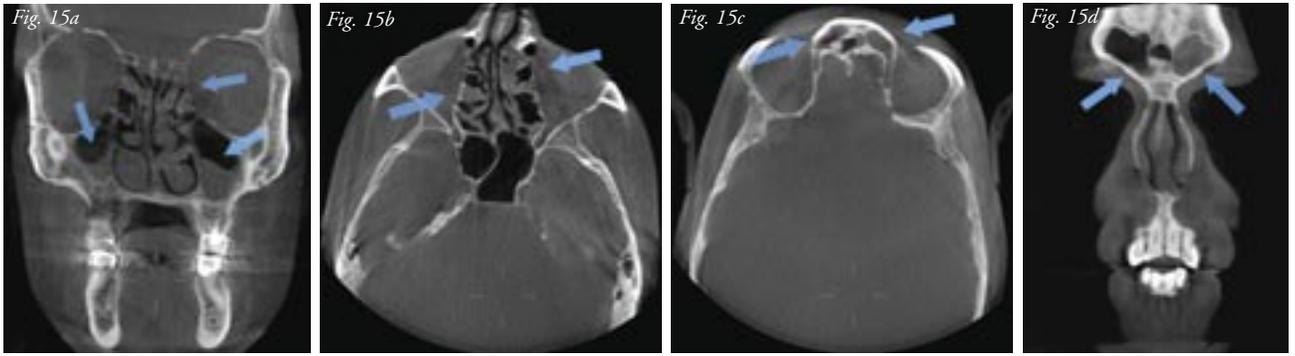


Fig. 15: (a.) A thin slice coronal view of maxillary antra and ethmoid air cell involvement. (b.) Axial view showing ethmoid air cell opacification seen in a. (c.&d.) Axial and coronal views of the frontal sinus involvement in the same case. Note the more florid involvement of the left frontal sinus.

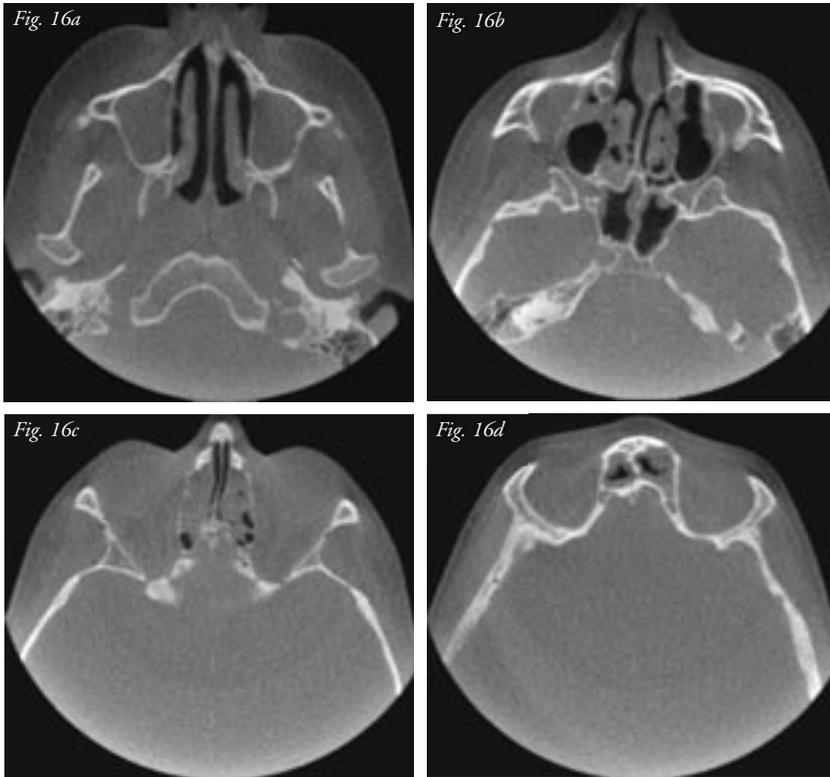
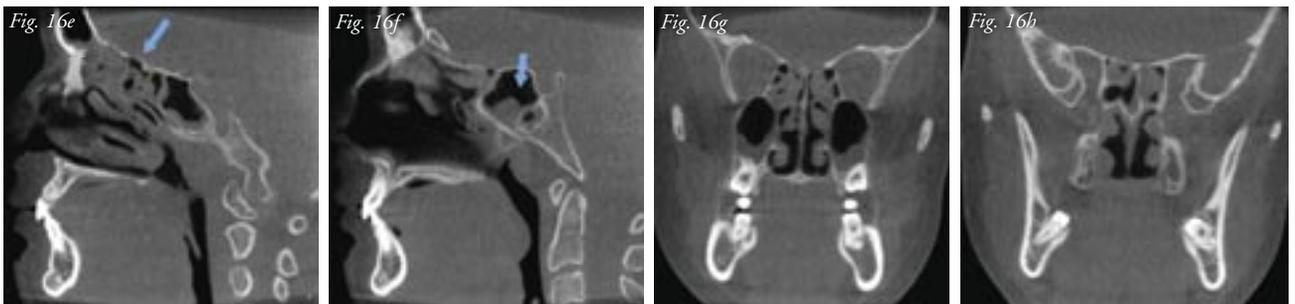


Fig. 16: (a.) Bilateral maxillary sinus involvement (axial view). (b.) Axial view showing ethmoid air cell involvement in uniform thickening in sphenoid sinuses, both left and right. (c.) ethmoid air cell involvement more superiorly. (d.) Bilateral involvement of the frontal sinuses in an axial view. (e.) Inflammatory changes in the frontal sinus, ethmoid air cell region and sphenoid sinus. Note how these spaces communicate one with the other. (f.) Sagittal view of sphenoid sinus involvement in the same case. (g.&h.) Thin slice coronal sections showing bilateral maxillary sinus involvement and involvement of the superior ethmoid air cell complex as well as sphenoid sinuses again bilaterally.



## Nasal cavity

Anatomy of the nasal cavity is quite complicated. Besides typical structures like the turbinates and meatal shadows and nasal spine, there are additional anatomic structures like the uncinata process, the ostium, the ethmoid air cells, nasolacrimal ducts, sphenoid recess and frontal sinus ostium. Luckily, as in the paranasal sinuses, most abnormal things will be radiopaque. Below is

a state  occurs commonly in the nasal cavity called “concha bullosa.” This is an aeration or pneumatization of the middle turbinate structure. It can be uni- or bilateral. When inflammatory change occurs in the nasal cavity, either originating there or spread from other paranasal sinus spaces, this can also have inflammatory problems. There are examples of both normally appearing concha bullosa and some with inflammatory change.

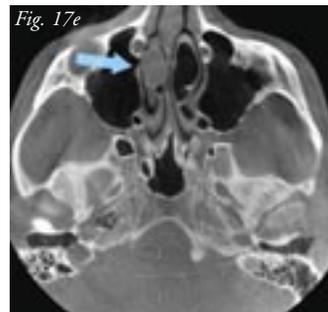
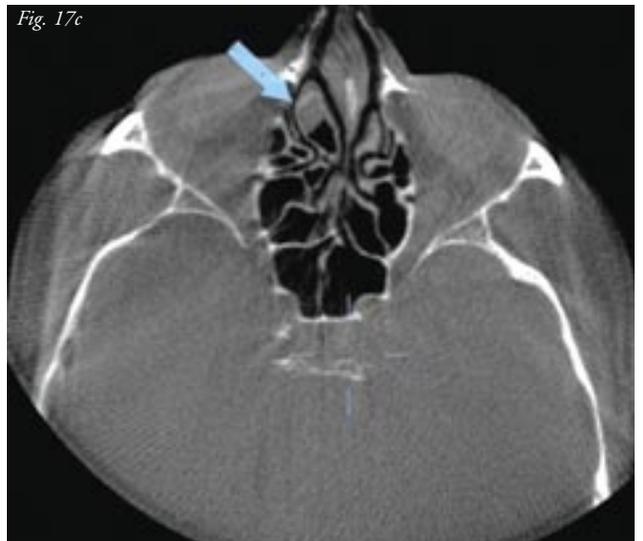
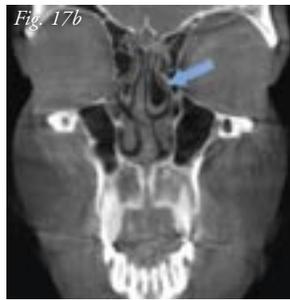


Fig. 17: (a.) Axial view of bilateral pneumatization states called concha bullosa (blue arrows). (b.) Unilateral concha bullosa state of left middle turbinate in coronal slice (blue arrow). (c.&d.) Inflammatory change filling one half of the concha bullosa anomaly in the right middle turbinate. (c.) Axial view (blue arrow); (d.) coronal view (blue arrow). (e.) Inflammatory material filling the right middle turbinate completely in an axial view. (f.) The same patient showing this change in a coronal slice. The left middle turbinate is patent. There is some mucosal thickening in the right antrum identified by the lowest blue arrow. (g.) A possible mucocele or pyocele in the superior ethmoid air cell complex. The round nature of the lesion suggests a fluid.

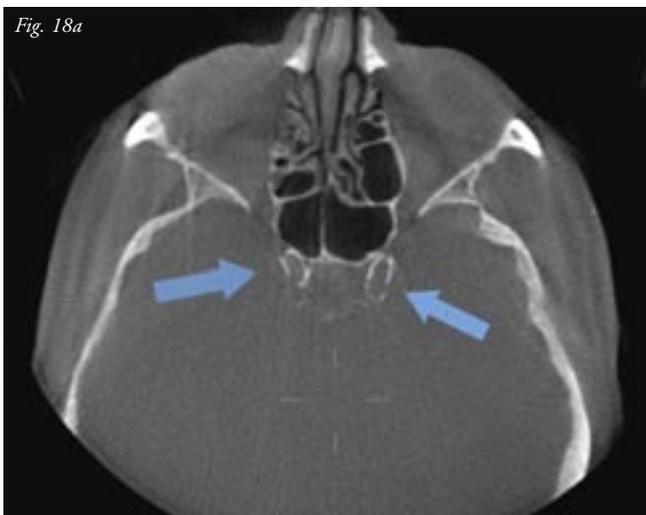
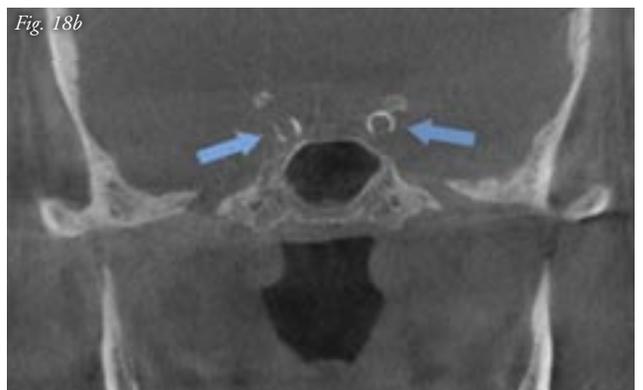


Fig. 18: (a.) Bilateral calcification of the internal carotid arteries on each side of the sella just posterior to the sphenoid sinus. (b.) The same calcifications as they loop anteriorly seen just superior to the sphenoid sinus and below the anterior clinoid processes.



### Sella Tursica and Parasellar Regions

Adenomas, craniopharyngiomas and disorders such as acromegaly can affect the size of the sella tursica.<sup>1</sup> However, to date, in more than 9,000 CBCT scans I have seen only one enlarged sella tursica but many parasellar changes as were described in the section on carotid calcifications; namely, calcification of the internal carotid artery. Since the contents of the pituitary fossa (sella tursica) can only be seen by magnetic res-

onance imaging, the clinician is more likely to see the parasellar changes. Figure 18 again illustrates the calcification seen in the internal carotid arteries. Since uncontrolled type II diabetes mellitus (NIDDM – Non Insulin Dependent Diabetes Mellitus), especially when the renal involvement is severe (as in ESRD – end stage renal disease), is so prevalent in the North American population, the clinician is more likely to discover calcified arteries rather than altered size of the sella tursica.

## Temporomandibular Joint Complexes

Of course the most common changes affecting the condylar head and sometimes the adjacent bone in the glenoid fossa are the same as those that affect the cervical spine and other weight-bearing joints.

These include:

1. osteophyte formation
2. subchondral cyst formation
3. subchondral sclerosis
4. surface erosion
5. lipping
6. loss of joint space

In addition to these changes of osteoarthritic, the clinician might also see hyper- or hypoplasia of one condylar head relative to the other, osteochondritis dissecans, avascular necrosis (AVN), loose body formation and occasionally synovial chondromatosis. In conventional 2D radiographic views such as panoramic or tomographic views loose bodies and even subchondral cyst formation can be misinterpreted. The focal trough layer or tomographic slice might not depict the true situation as can be seen in color 3D reconstructed views or even multi-planar views of the same joint. Figure 19 shows a number of these temporomandibular joint changes and disorders.

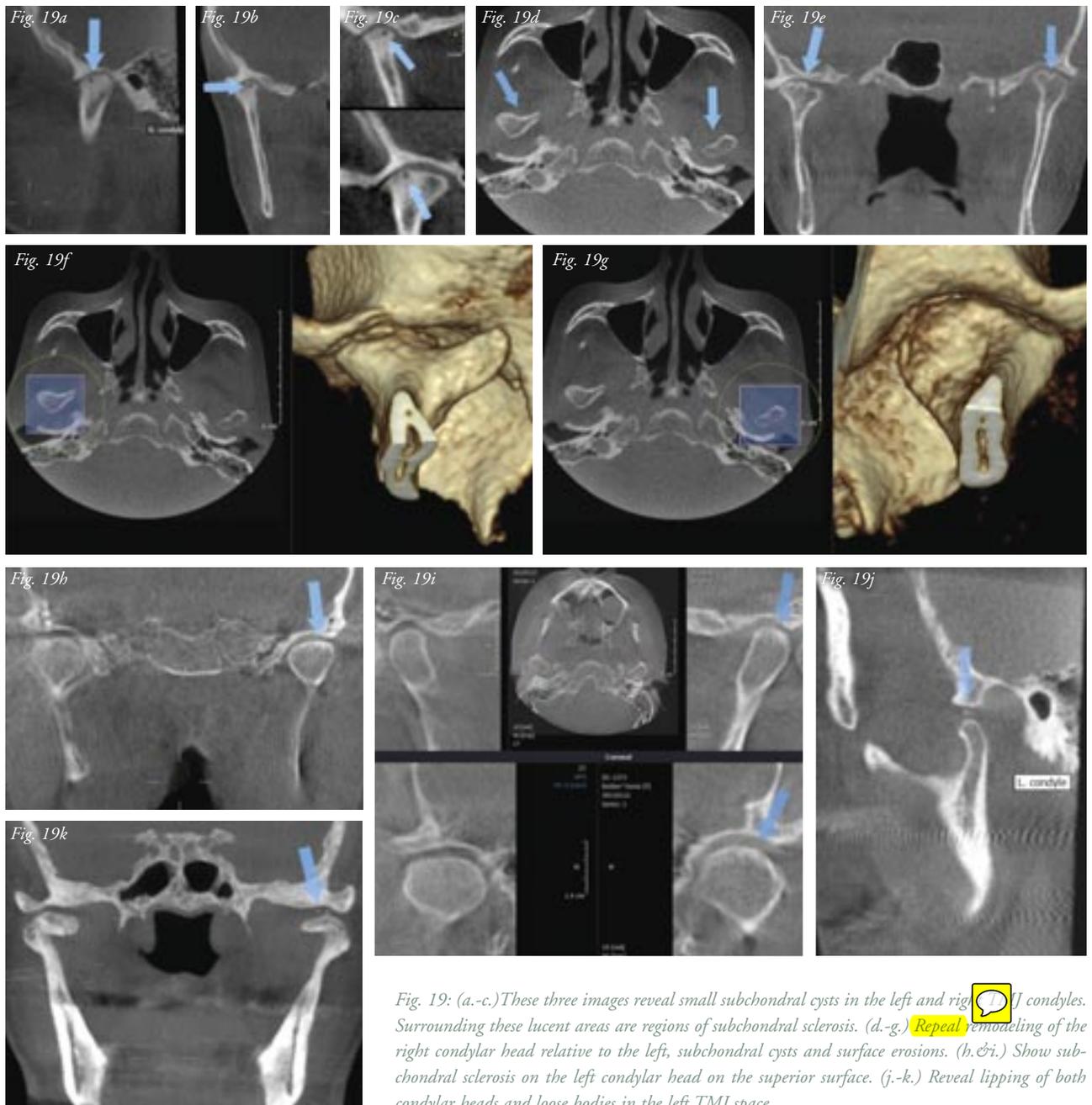
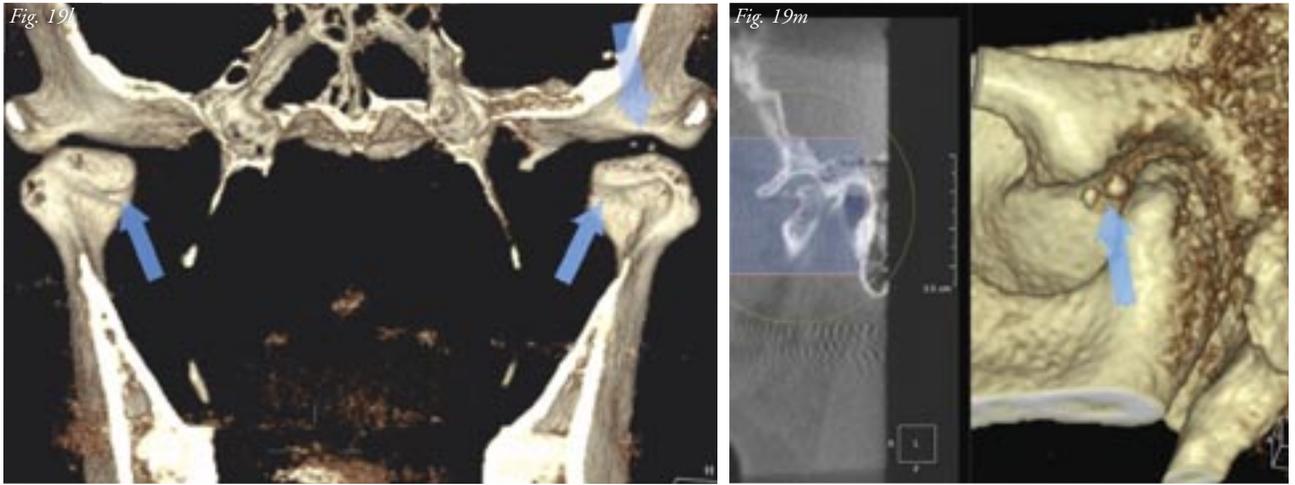


Fig. 19: (a.-c.) These three images reveal small subchondral cysts in the left and right TMJ condyles. Surrounding these lucent areas are regions of subchondral sclerosis. (d.-g.) Repeat remodelling of the right condylar head relative to the left, subchondral cysts and surface erosions. (h.&i.) Show subchondral sclerosis on the left condylar head on the superior surface. (j.-k.) Reveal lipping of both condylar heads and loose bodies in the left TMJ space.

Fig. 19: (l-m.) Reveal lipping of both condylar heads and loose bodies in the left TMJ space.



### Osteophyte vs. Lipping

Until clinicians were able to see the changes on the temporomandibular joint condyles in 3D reconstruction, the terms “bird-beak” and osteophyte were often used as synonyms in 2D planar imaging such as panoramic, lateral cephalometric and even tomographic slices. So-called “bird-beak” changes were interpreted as such when indeed many cases might have represented lipping<sup>3</sup> on the anterior aspect of the condyle, simply captured in a relatively thin slice, predominantly sagittal view. Figures 20a-c demonstrate this pitfall.

### Conclusions

Relatively common pathologic findings have been reviewed for the anatomic area seen in large FOV CBCT machines. While all of these findings are certainly reportable, there are only a few which are truly significant and would impact the systemic health of the patient. Significant findings such as calcification of arteries, airway masses, fluid paranasal sinus disease and lucencies in the vertebral column could lead

to a catastrophic health event for the patient. Knowledge of these more common findings and normal anatomy of the region cited will help the clinician avoid a missed diagnosis and possibly a subsequent legal problem. Even though the clinician does not have to make a diagnosis based on the radiographic findings alone, he or she must examine the volume or refer for examination to an oral maxillofacial radiologist or other competent provider so that significant findings are not missed. This practice of referral is not only prudent, but also professionally mandated in the American Dental Association’s Code of Ethics.<sup>4</sup> ■

### References

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All images were created using OnDemand3D software (Irvine, California and Seoul, Korea).

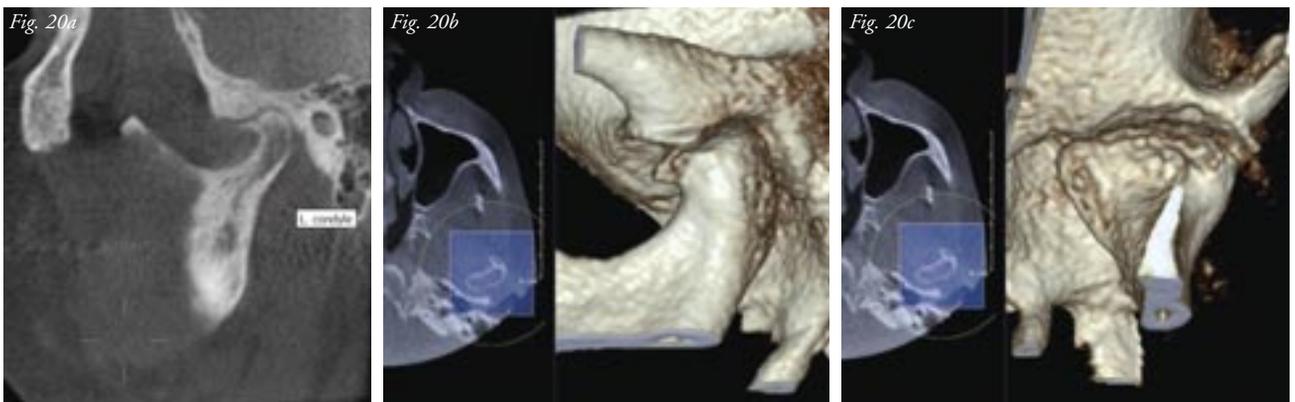


Fig. 20: (a.) This thin slice sagittal view of the left condylar head shows a pointed appearance on the anterior aspect resembling a “birds-beak.” (b.) This 3D reconstruction of the left condyle seems to mirror somewhat figure 19a. There appears to be a projection on the anterior surface which could be mistaken for an osteophyte. (c.) This 3D reconstructed coronal view reveals a deep pterygoid fovea and significant lipping of the anterior surface. There is no birds-beak or osteophyte on this condyle, simply unaltered surface morphology, deep depression and growth of the bone anteriorly.

## 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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- Mucosal change in the maxillary sinuses can be caused by all of the following EXCEPT ONE. Which ONE is the EXCEPTION?
  - apical periodontitis
  - chronic periodontitis
  - allergic sinusitis
  - antrolithiasis
- Most commonly the changes seen in the paranasal sinuses are inflammatory; however, additional lesions can include all the following EXCEPT ONE. Which ONE is the EXCEPTION?
  - cholesteatoma
  - osteoma
  - antrolith
  - none of the above
- Blockage of the ostium most directly causes which of the following?
  - retrograde inflammation in the ethmoid air cells
  - retrograde inflammation in the maxillary sinuses
  - inflammation of the concha bullosa
  - inflammation of the frontal sinuses
- Osteoarthritic changes of the temporomandibular joint condyles include all of the following EXCEPT ONE. Which ONE is the EXCEPTION?
  - lipping
  - subchondral sclerosis
  - subchondral cyst(s)
  - synovial chondromatosis
- Which of the following is the term used for a common state of the nasal cavity found in the middle turbinates?
  - nasal polyp
  - uncinate bulla
  - ivory osteoma
  - concha bullosa
- In which of the paranasal sinus spaces is significant radiographic change, like opacification, a reason for immediate referral to the otolaryngologist?
  - ethmoid air cells
  - sphenoid sinus
  - frontal sinuses
  - none of the above
- All of the following disorders can alter the size of the sella tursica EXCEPT ONE. Which ONE is the EXCEPTION?
  - acromegaly
  - pituitary adenoma
  - craniopharyngioma
  - nasopharyngeal carcinoma
- Radiographic changes of the temporomandibular joint condyles might be seen in all of the following disorders EXCEPT ONE. Which ONE is the EXCEPTION?
  - avascular necrosis
  - synovial chondromatosis
  - anterior disk displacement
  - none of the above
- A "birds-beak" appearance in images of the temporomandibular joint is pathognomonic of osteoarthritic change.
  - True
  - False
- Which of the following anatomic regions, seen in CBCT scans, is important to examine for possible calcification of the internal carotid artery?
  - cervical soft tissues near C5-C6
  - inside the sella tursica
  - the region of the dens
  - parasellar region

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

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