Temporomandibular joint imaging using CBCT: Technology now captures reality!

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_Over many years, dentists and dental specialists have moved from transcranial plain film images through tomography and conventional computed tomography (CT) as well as specialized panoramic imaging of the temporomandibular joint complex to arrive at cone beam CT (CBCT).

This latest imaging modality is making life easy for those clinicians who must evaluate the heart tissues of the temporomandibular joint complex in patients with orofacial pain.

Now, for the first time, we can actually visualize both pathology and anatomy in high-resolution, thin-slice, grayscale views; 3-D color-reconstructed views; and even more-detailed views using virtual endoscopy and robust third-party software.

No longer are we confined to "scout" film panoramics, linear or complex tomography or even high-dose, less-resolute conventional CT for visualizing the condylar head.

Radiographic interpretation of the temporomandibular joint complex, including the condyle, using CBCT imaging enables clinicians to find more subtle osteoarthritic changes, such as subchondral cysts, subchondral sclerosis, osteophyte formation, surface erosion and bony remodeling, consistently and with more certainty – to make their clinical decision-making simpler.

Let's now examine some of these osteoarthritic changes for which CBCT imaging makes their characterization easy.

_c.e. credit part X

This article qualifies for C.E. credit. To take the C.E. quiz, log on to *www.dtstudyclub.com*. The quiz will be available on XXXX.


Fig. 1a


Fig. 1b

Fig. 1a_Small circular radiolucency seen on the left condyle in the sagittal plane just inferior to the cortical margin. (Photos/ Provided by Dr. Dale Miles)

Fig. 1b_The same lesion seen in the coronal plane of section. In this view it is more ovoid and appears to have a septation.

Fig. 1c_The same lesion seen reformatted in the OnDemand3D software for a bilateral TMJ comparison. The right condylar head appears normal; the left reveals the same lesion seen in Figures 1a and 1b.

Fig. 1d_Subchondral cyst formation visualization in thin slice (10 mm), 3-D reconstructed view.

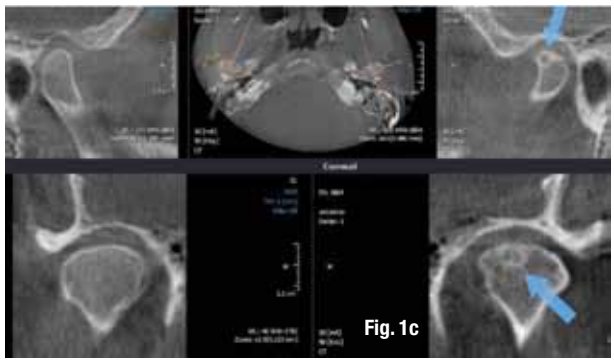
Fig. 1c

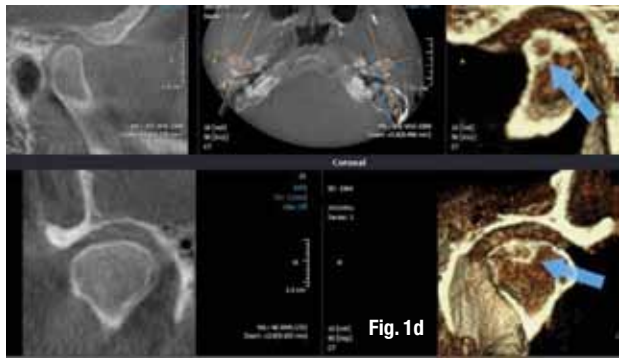
Fig. 1d

Fig. 3a_A thin-slice (0.1 mm) sagittal view through the patient's left condyle showing a projection on the anterior surface of the condylar head. In the past this would have been called a "bird beak." This appearance along with the loss of joint space would seduce the clinician into calling this osteoarthritis.

Fig. 3b_Using a "cube tool" in a third-party software called OnDemand3D (CyberMed, Irvine, Calif.), a 3-D color reconstruction confirms that there is a deep pterygoid fovea and significant "lipping" on the anterior aspect of the condyle. There is no bird beak.

Fig. 3c_A close-up of the 3-D color reconstruction, slightly rotated, to help the clinician visualize the true morphology of the condylar head.

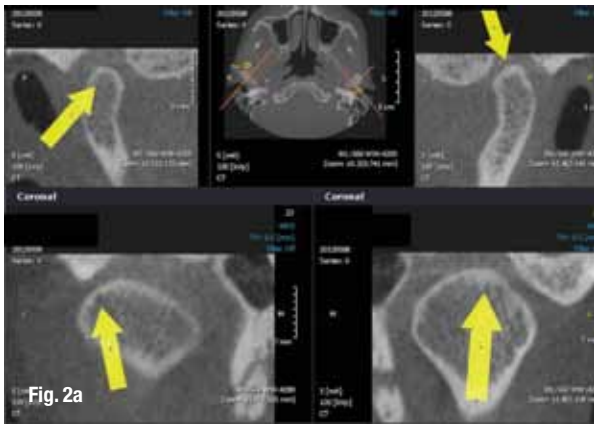

Fig. 2a

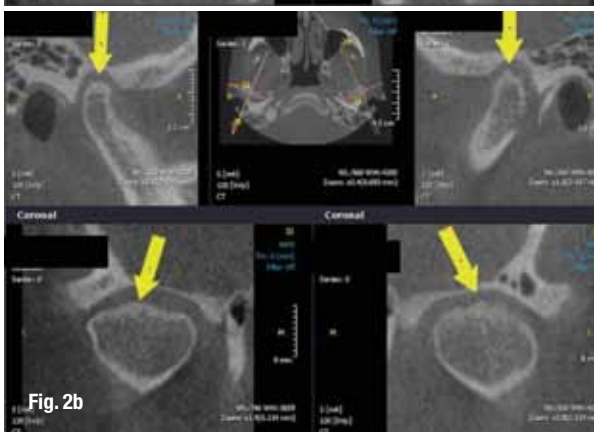

Fig. 2b

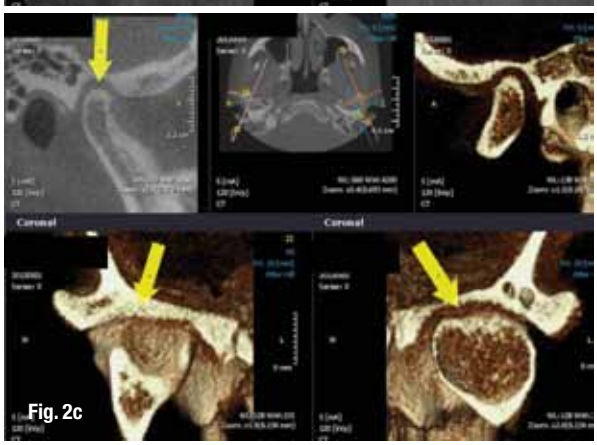

Fig. 2c


Fig. 3a

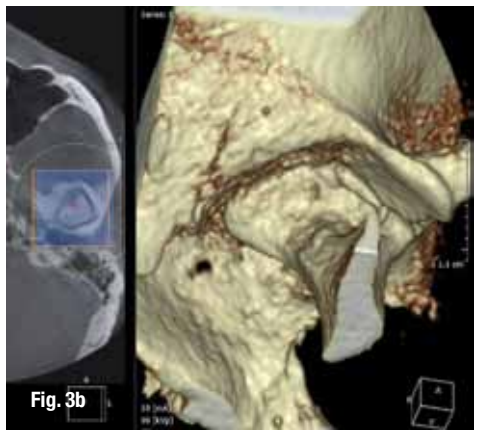
Fig. 3b

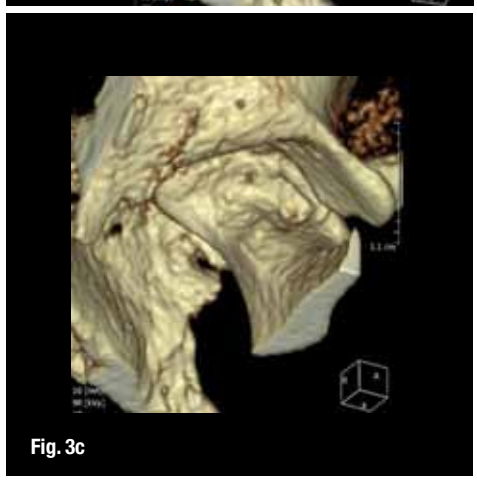
Fig. 3c

Dr. Miles: Image 3c cannot be made any larger

_Subchondral cyst formation

Subchondral cyst formation is an early indicator of osteoarthritic changes in the joint surface. I cannot honestly say that I have a good example of a subchondral cyst, even after 35 years of looking at panoramic and other TMJ images using tomography or other plain-film techniques.

However, having looked at more than 12,000 CBCT scans, I can easily identify such cysts and embed images of them into reports that I produce for my clients. Figure 1 demonstrates examples of subchondral cyst formation.

_Subchondral sclerosis

Subchondral sclerosis is an increased intensity or thickening of the cortex below a cartilaginous surface. It can occur on the condylar head or on the opposing surface of the glenoid fossa. It is often seen in conjunction with subchondral cyst formation.

Loss of joint space, subchondral sclerosis and subchondral cyst formation are considered the radiographic hallmarks of osteoarthritis.

In long-standing rheumatoid arthritis there is also a tendency for the joint surface, especially in the TMJ complex, to exhibit sclerotic change. This cortical alteration has been identified in the past on conventional panoramic images, either on film-based

images or with newer digital, solid-state detectors.

_Lipping

The formation of a liplike structure, as at the articular end of a bone in osteoarthritis (source, *www.biology-online.org/dictionary/lipping*).

With older imaging modalities, we often spoke of a "bird beak" appearance, which was indicative of an osteophyte and/or osteoarthritic change. With 3-D color CBCT imaging we now see that there are very few "bird beaks."

Tomography, transcranial and panoramic views used in the past underestimated some of the changes and gave a false appearance depending on the slice thickness or lack of view of the condyle from a truly lateral perspective. Figures 3a through 3c demonstrate the past problem in the future solution.

_Surface erosions

Surface erosions are also common features in osteoarthritis. Until now these changes have been more difficult to demonstrate on the TMJ condyles. However CBCT imaging, especially 3-D color reconstructions, enables the clinician to visualize these smaller surface changes like never before.

_Condylar comparison

When a patient presents with orofacial pain, which the clinician suspects to be related to the temporomandibular joint condyles, it is imperative to compare both sides. This is slightly more cumbersome with smaller field-of-view (FOV) machines because two views of the condyles are necessary and must be acquired separately.

If evaluation of patients with orofacial pain is a large part of the dental practice, a larger FOV CBCT machine may be indicated. A single image acquisition allowing comparison of both sides while evaluating a single volume is probably a more preferable arrangement for this patient population.

It is much easier to compare the condyles in a single multiplanar view or in specialized CBCT temporomandibular joint views as seen in the images presented here.

_Conclusion

As you can see from the examples shown, conditions such as osteoarthritis can be easily evaluated and visualized completely with thin, grayscale multiplanar images, thickened-slice data and 3-D color reconstruction.

Almost all pathology can be evaluated or visualized as it truly exists within the patient. This visualization was unachievable with all of the previous imag-

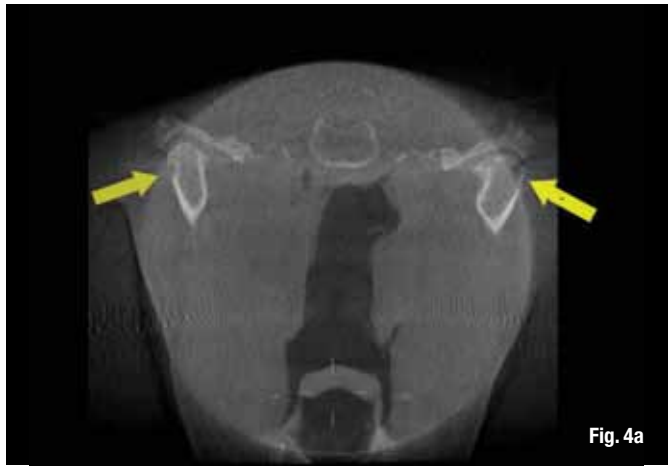

Fig. 4a

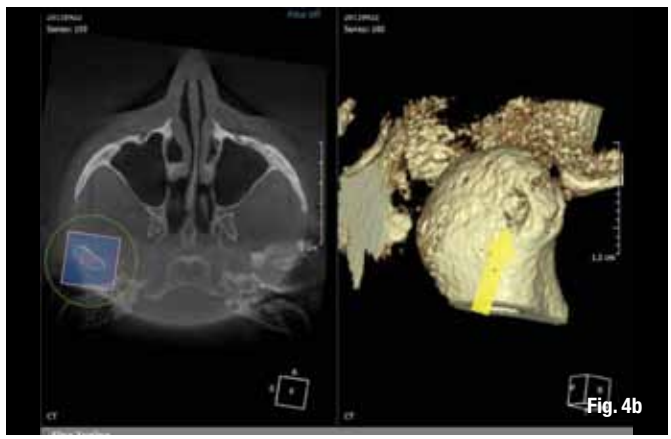

Fig. 4b

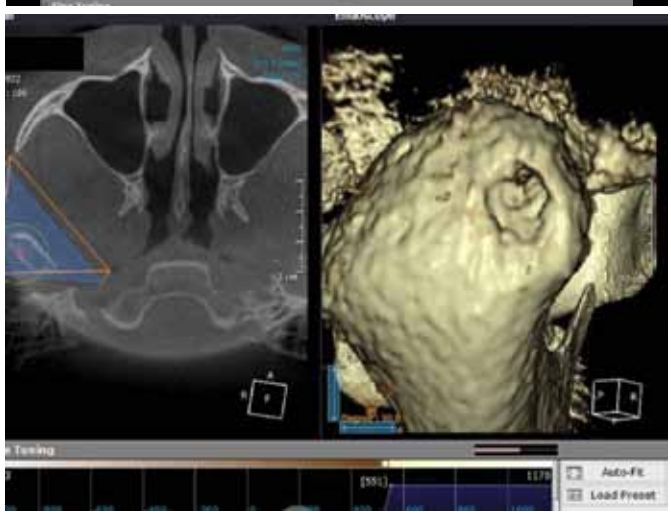

Fig. 4c

Fig. 4a_Radiolucencies on each condyle near the lateral pole suggestive of erosions.

Fig. 4b_3-D color reconstruction using the "cube tool" confirms presence of a surface erosion on the condyle just posterior to the lateral pole.

Fig. 4c_This 3-D color reconstruction also employs a "virtual endoscopy tool," which allows an even more detailed visualization of this erosion and subcortical defect.

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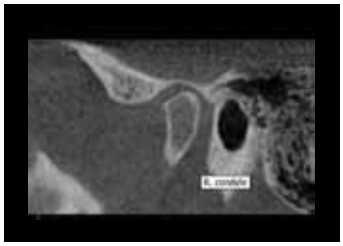

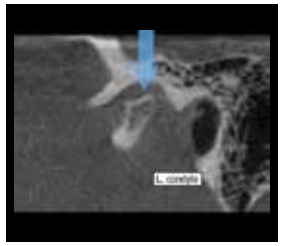

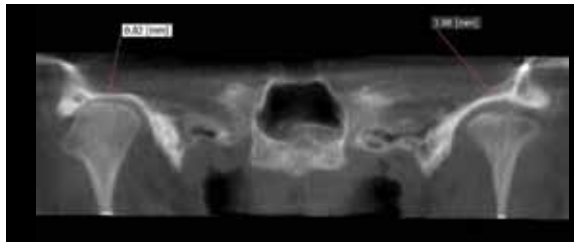

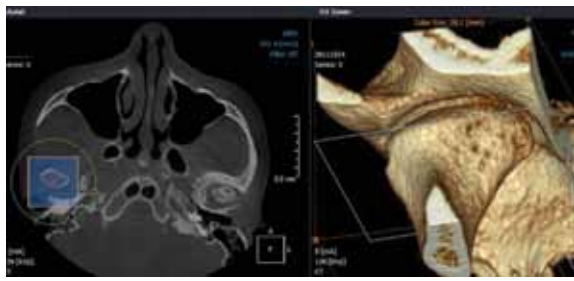

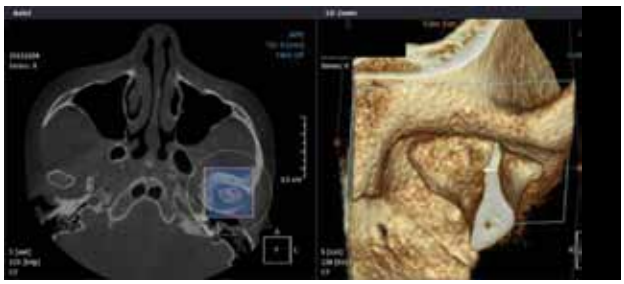

Figs. 5a, 5b_Thin-slice sagittal view showing a hypoplastic left condyle relative to the right.

Fig. 5c_The 8.6-mm-slice thickness showing hypoplastic left condylar head with a possible surface erosion. There also appears to be less joint space on the right.

Fig. 5d_Three-dimensional color reconstructed view comparing the condylar heads. This was done in the slice thickness of about 40 mm. Measurements of the condylar width are within 0.1 millimeter accuracy.

Fig. 5e_Three-dimensional color-reconstructed view of another patient's right condyle. Note the subchondral cyst formation and subchondral sclerosis in the left condylar head in the axial slice on the left.

Fig. 5f_Three-dimensional color-reconstructed view of the left condyle of the patient seen in Figure 5e. This condyle is obviously remodeled and hypoplastic relative to the right.

Fig. 5g_Three-dimensional color-reconstructed panoramic view showing the hypoplastic left condyle. However, this is only part of the patient's hypoplasia problem, because the ramus is smaller in the posterior sending ramus a shorter. These changes would not be as apparent on a conventional panoramic image. Nor would the patient's periodontal bone loss be as easily assessed.

ing modalities used in dentistry. In addition, we can make our terminology more precise when describing these changes because we can see the condyles in color in 3-D.

More complex situations, such as the unilateral condylar hypoplasias shown in Figure 5g can also be easily visualized and compared using the many tools and features in third-party CBCT imaging software.

If the clinical signs and symptoms warrant a CBCT evaluation of the patient, the clinician will be rewarded by easier visualization of the anatomy and pathology as well as more precise clinical decision-making because of the excellent images available with this imaging modality._

_about the author

cone beam

Dale A. Miles BA, DDS, MS, FRCD(C) is a professor of oral and maxillofacial radiology and at the Arizona School of Dentistry & Oral Health and adjunct professor in radiology at the University of Texas Dental School at San Antonio. He has held positions as 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. Miles has been named one of the "Top 100 Clinicians in CE" for the last 10 years by Dentistry Today. He has authored more than 130 peer-reviewed articles and five textbooks, including the best-selling atlas Cone Beam Imaging (second edition release scheduled for September). Miles has been a consultant to the U.S. Navy Postgraduate Dental School in oral diagnosis, oral medicine and oral radiology for more than 17 years. Miles has a website for teaching dentists and auxiliaries about digital and cone-beam imaging at www.learndigital.net. He is in full-time practice of oral and maxillofacial radiology in Fountain Hills, Ariz. To date he has read more than 12,000 cone-beam CT scans for his dental clients. You may contact him at *miles.dale@gmail.com*.