3-D imaging: the light in the attic

By Juan-Carlos Quintero, DMD, MS

Orthodontists have always needed to predict the unpredictable, to see the crowns of the teeth in relationship to each other and to visualize the roots and how they influence tooth movement and adjacent teeth. Without enough detailed data, it feels like trying to maneuver through a dark attic filled with objects. If you don't know what is up there, you will surely bump into something.

For an orthodontist, visualization is everything — to see is to know, and to know is to avoid problems. Among my many tools for orthodontic treatment, my CBCT scanner (i-CAT®) provides that precise information that has improved my diagnostic and treatment capability.

In the following case, having three-dimensional scans averted a very serious outcome. The patient was referred by her dentist who noted two impacted canines on his 2-D panoramic X-ray (Fig. 1).

Usually, the orthodontic assumption on 95 percent of cases of bilaterally impacted maxillary canines is that both are located on the lingual or palatal, or on the facial or buccal, or on the front or behind the incisors. Of course, knowing the buccal-lingual position of the tooth is critical, both from a surgical-planning perspective and an orthodontic planning perspective.

At the diagnostic session, we captured an i-CAT scan and sent it to Anatomage for production of an "Anatomodel" that highlights the teeth, produces a digital model from the scan and segments the teeth and the roots (Fig. 2). This interactive model improves visualization.

When the teeth are segmented digitally, I can move them around for virtual treatment planning purposes. This is why we no longer take impressions for study models on any of the cases in our practice.

To my surprise, this case defied the 95 percent rule of both canines being impacted on the same side. In this case, tooth #6, the upper right canine, was actually positioned facial-buccally on top of the upper, the maxillary left lateral incisor.

Armed with the 3-D information, I was able to treatment plan this case for clear, predictable, concise movements. I simulated extractions of the premolars using the Anatomodel and was able to simulate placements of a temporary anchorage device (TAD), a microscrew that was placed in the upper right quadrant of the patient, to perform a virtual movement of the tooth.

Precise tooth movement is critical because with the teeth in this position, using traditional mechanics to force-erupt the tooth would have caused significant problems.
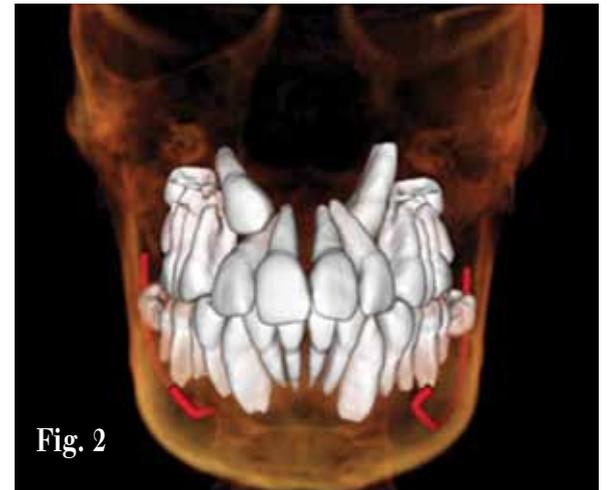
Fig. 1

Fig. 2

Fig. 1: Impacted canines as seen on panoramic X-ray. Fig. 2: The Anatomodel produces a digital model from the scan. (Photos/Provided by Dr. Juan-Carlos Quintero)

I would have exposed the tooth and put a chain on it to bring it down against the archwire. However, with this treatment, the tooth would have moved slightly to the lingual on its way down and collided against the root of the lateral incisor, potentially resulting in root resorption on the lateral incisor and basically leading to the loss of this tooth later.

On a 3-D scan, it was easy to diagnose that a different plan of action was appropriate. I placed a TAD between the upper right first molar and upper right second premolar.

Understanding 3-D geometry and spatial relationships of teeth, the movements had to be instituted in two phases: the crown of the tooth had to be tipped distally away from the roots of the lateral incisor first, to allow the tooth to straighten, and after that, I would force-erupt the tooth and bring it down (Fig. 3). Moving the teeth in this manner avoided iatrogenics, collisions and damage to adjacent teeth.

Six months into treatment, we took a mini 4.8-second progress scan to evaluate root and tooth position to determine if the tooth had cleared the root of the lateral incisor, making it safe to force-erupt it into position. The tooth had moved perfectly, just as we had predicted, and it was now safe to change the vector of force and redirect the retraction of the canine. A potentially disastrous scenario was averted, and the patient achieved a safe and happy ending to orthodontic treatment (Fig. 4).

This is what makes orthodontists lose sleep at night. If I only had traditional 2-D imaging during treatment planning, I would have made an erroneous assumption in this case and probably established my mechanics thinking that the teeth were symmetrical. As a result, I would have been 100 percent wrong at least on one side, leading to incorrect diagnosis and treatment planning and probably to iatrogenic side effects.

With impacted canines, it is imperative to find out the position of the teeth in 3-D. CBCT also allows visualization of space considerations to determine whether there is enough room and, if not, how to create the space.

A panoramic radiograph, ceph or photos are not accurate ways to measure spaces or crowding, and with models, we can see only clinical crowns, not root information. That is critical in simple or complicated cases.

Cone beam helps the orthodontist to consider the biomechanical considerations of the case — the vectors of force needed to successfully retrieve the canines into position, to calculate the directions of movement that we want to produce and determine the anchorage requirements. If we have all this data, even more complicated cases become quite simple.
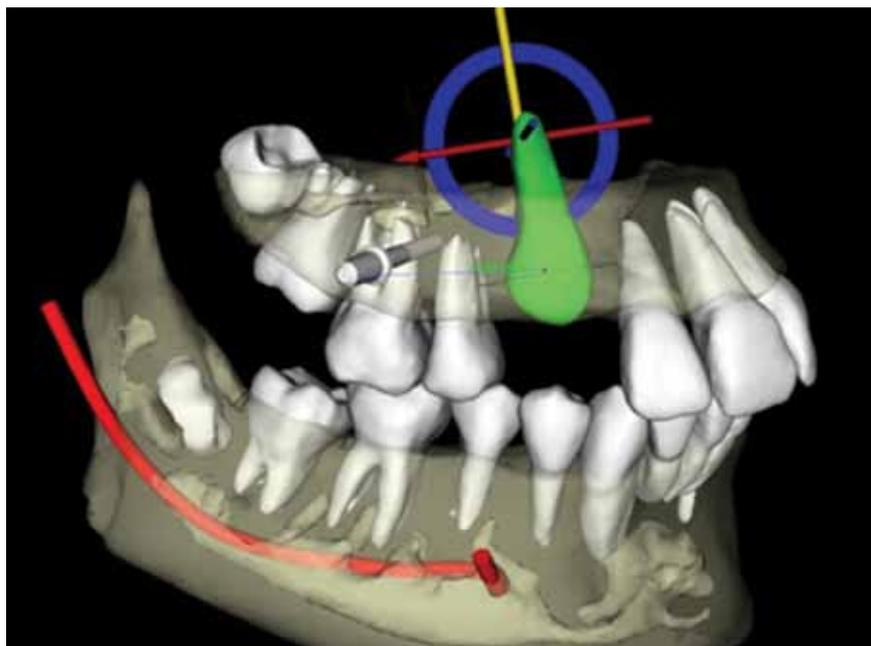

Fig. 3: Planning tooth movements virtually allows for more predictable and positive outcomes.

Fig. 4: A progress scan helps to determine if the teeth have moved into the proper position to safely continue treatment.

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CBCT machines are not all alike. Mine allows me to control all of the variables of the 3-D image, from the field of view to exposure time, pixel size and resolution. My practice is very radiation-exposure conscious. I can capture a limited field of view, a full head or just the maxilla or mandible and control exposure time because parameters for each case differ according to the patient's needs.

It is important to educate patients about our dedication to radiation safety. We explain to them that we are cognizant of dosimetry of radiation levels at all times and for all patients.

In orthodontics, radiation levels with 2-D radiographs can be similar or more to that of a low dose 3-D scan. The difference is that the CBCT data offers a greater wealth of information and more accurate data.

When you compare taking a traditional digital pan, a lateral and frontal ceph, an occlusal radiograph, an FMX or a couple of bitewings and a couple of periapicals, the patient can potentially be exposed to more radiation than taking a low dose CBCT on landscape mode.

The public watchdog for radiation safety, known as the International Commission on Radiological Protection (ICRP), recommends that we should keep diagnostic radiation exposure to less than 1,000 microsieverts per year,[1] and our i-CAT scans measure way below that threshold (only 3 percent to 7 percent of that threshold level).

CBCT has elevated patient care in my practice to previously unattained levels. We have better and more information for diagnostic and treatment-planning sessions, and we make fewer mistakes. Our new model increases patient education.

Prior to implementing our CBCT unit, we followed what most prac-

About the author

Dr. Juan-Carlos Quintero received his dental degree from the University of Pittsburgh in Pennsylvania and his degree in orthodontics from the University of California at San Francisco (UCSF). He also holds a master's of science degree in oral biology. He has served as national president of the American Association for Dental Research Student Research Group, is a faculty member at the L.D. Pankey Institute and is an attending professor at Miami Children's Hospital, Department of Pediatric Dentistry, as well as the immediate past-president of the South Florida Academy of Orthodontists (SFAO). He practices in South Miami, Fla.

At the AAO

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tice management consultants recommend: condensing three appointments into one (exam, records and treatment conference). Before 3-D, we took a pan, ceph and photos at the same visit and made a quick decision. I felt rushed and stressed because there is a lot at stake for orthodontic patients. It felt too "sales-y."

CBCT scans show how teeth are integrated into sinuses, jaw joints and buccal lingual dimensions of bone. I look at airways more and also differently than ever before and actually design most treatments around airway status now. It makes me slow down and treatment plan more clearly, more comprehensively and with greater confidence.

We also educate patients more and build stronger relationships with them than ever before. I no longer feel the anxiety of the dark attic. CBCT sheds light on potential obstacles and makes the orthodontic process more precise. OT

Reference

1. International Commission on Radiological Protection: Radiation protection, ICRP Publication 60, 1990.