An Overview of the Risks & Benefits of Cone Beam Computed Tomography

by Dr. Ed Lin

As an orthodontist and health-care provider, I want to clearly state that my first and foremost priority for my patients is with my patients' welfare and to provide them with the highest quality of care and service while utilizing the most clinically accepted and advanced technologies available. There have been several different technologies that have made major impacts in my private practice over the past 12 years. However, I consider the integration of a cone beam computed tomography machine (CBCT), more specifically the i-CAT, to have made one of the biggest positive impacts in my practice.

Whenever a new technology is introduced to our profession, there is a process that must take place prior to consideration of the technology becoming a "standard of care." Four key stages that make up this process: First, clinical research must substantiate the efficacy and safety of the technology for our patients and clinicians. Second, the technology must be taught properly to the qualified providers who will be utilizing the technology to ensure safety. Third, systems must be created to allow for effective implementation of the technology in the clinical private practice environment. And fourth, the costs associated with investment of this technology must demonstrate a positive return on investment both financially for the practice and clinically for the doctor and the patient. CBCT is the middle of this process of consideration for being the "standard of care" for our profession.

In this article, I would like to first discuss the risks and benefits associated with CBCT. I would then like to review the guidelines we have set up in our practice to minimize the risk and maximize the incredible benefits. Finally, I will share some clinical examples to demonstrate the benefits of CBCT.

As we all know, whenever we utilize any X-ray imaging for our patients, there is an increased lifetime risk of cancer for our patients. This is the one increased risk associated with CBCT when compared to conventional 2D imaging. However, the incredible benefits associated with CBCT have been clearly substantiated with independent clinical research over the past decade.[1,2]

The invention of CT was a Nobel-prize winning discovery and today is still considered to be the greatest innovation in radiology since the discovery of X-rays. The reason they were awarded with one of the most prestigious honors in society is because CT is considered to be one of the most important methods of radiological diagnosis with far superior imaging in comparison to 2D radiography with clearer, non-superimposed images and more accurate images.

So how does a medical CT scanner work? I have attached a diagram (Fig. 1) from the Food and Drug Administration (FDA) to explain the mechanism with a medical CT scan.

There are two major differences between CBCT and medical CT. First, CBCT uses a low-energy fixed-anode tube, similar to that used in dental panoramic machines. Second and most important, the mechanism capturing the data with CBCT is different than the mechanism with medical CT. These differences are illustrated in the diagram (Fig. 1). With the medical CT, the head anatomy is exposed in small fan-shaped or flat slices as the X-ray source and detector make multiple revolutions around the patient's head while moving up or down the head anatomy. While collecting this information with a medical CT, there is overlapping of radiation.

With CBCT, the head anatomy is captured during the scan with only one revolution around the head with a cone-shaped beam. In contrast to the medical CT, the X-ray source and detector of the CBCT rotate only one time around the head anatomy and remain in the same vertical plane during the entire scan. With CBCT, the X-ray source and detector never move up or down during the single rotation.[3]

As a result, the same volumes of data with the head anatomy can be captured with both CBCT and medical CT. However, there is significantly decreased radiation exposure to the patient with CBCT in comparison to medical CT, due to the single cone-beam revolution around the patient's head. In fact in the *New York Times* an article published the statistics of CT medical scans versus those taken by an iCAT. The article stated a standard medical CT scan of the head exposes a patient to approximately 2,000 microsieverts of radiation and a standard i-CAT scan exposes a patient to approximately 74 microsieverts of radiation.

Radiation dosages to a patient from any CT scan are dependent on two factors: 1) the type of CT scanner used and 2) the patient. Each CT scanner has its own unique settings and mechanism. As a result, the radiation dosages for each CT scanner will be different. The age and size of the patient and tissue type to be scanned are also important factors that determine the amount of radiation exposure to the patient. Young patients are more sensitive to radiation than a mature adult. Patients who are smaller in size are also more sensitive to radiation than larger patients. Finally, tissues such as the lung, breast and colon are much more sensitive to radiation than the brain, skin and thyroid.[4,5]

Traditionally in orthodontics in the United States, prior to initiating treatment for a patient, diagnostic records must be taken. This typically requires obtaining photographs of the patient, models of their bite and radiographs (typically a panoramic X-ray and lateral cephalogram X-ray). However, sometimes there might be other types of radiographs that will be requested such as a posterior-anterior cephalometric X-ray, submental vertex X-ray, occlusal X-ray and TMJ tomograms. Some of the various types of radiographs utilized in orthodon-

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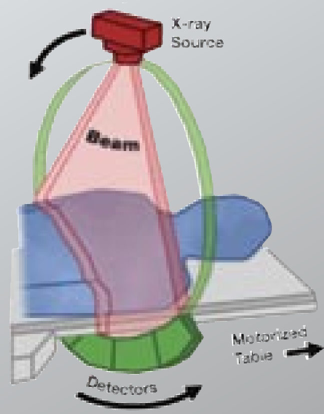
Fig. 1: How a CT system works

Description: Computed tomography (CT) scanning, also called computerized axial tomography (CAT) scanning, is a medical imaging procedure that uses X-rays to show cross-sectional images of the body.

A CT imaging system produces cross-sectional images or "slices" of areas of the body, like the slices in a loaf of bread. These cross-sectional images are used for a variety of diagnostic and therapeutic purposes.

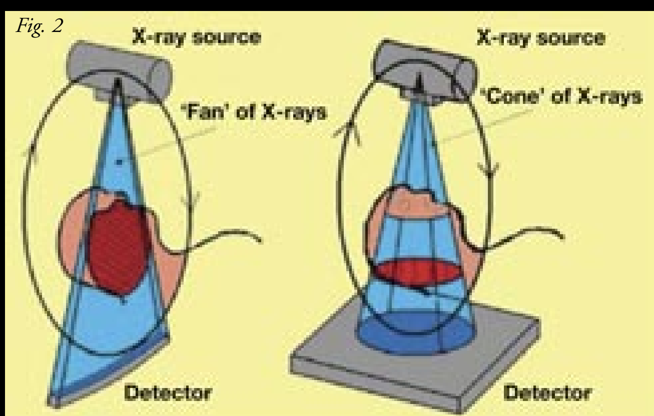


How a CT system works:

1. A motorized table moves the patient through a circular opening in the CT imaging system.
2. While the patient is inside the opening of the CT imaging system, an X-ray source and detector within the housing rotate around the patient. A single rotation takes about 1 second. the X-ray source produces a narrow, fan-shaped beam of X-rays that passes through a section of the patient's body.
3. A detector opposite from the X-ray source records the x-rays passing through the patient's body as a "snapshot" image. Many different "snapshots" (at many angles through the patient) are collected during one complete rotation.
4. For each rotation of the X-ray source and detector, the image data are sent to a computer to reconstruct all of the individual "snapshots" into one or multiple cross-sectional images (slices) of the internal organs and tissues.

Source: U.S. Food and Drug Administration

Fig. 2



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tics are listed with the amount of radiation exposure in microsieverts in the graph (Fig. 3) from a study by Dr. John Ludlow in September 2008, published in *Journal of the American Dental Association.*

A standard set of radiographs in orthodontics consists of a 2D digital panoramic X-ray (24.3 microsieverts) and a 2D digital lateral cephalometric X-ray (5.6 microsieverts). The total radiation exposure to the patient is approximately 30 microsieverts with these two X-rays. With a "single i-CAT scan," all of this diagnostic information can be captured at a very low radiation exposure range of 30 to 160 microsieverts, which is the equivalent of or only slightly higher radiation exposure to the patient with far superior imaging and detail when compared to 2D radiographs.

The reason there is such a range for a single i-CAT scan is due to three factors which determine the amount of radiation exposure to the patient: 1) field of view (FOV), 2) resolution or voxel size and 3) scan time.

FOV in radiology is defined as the maximum diameter of the area of the scanned object from the detector that is represented in the reconstructed image. With the i-CAT, the FOV of the rectangular detector has a maximum scanned area of 23cm x 17cm. However, the FOV can be adjusted with i-CAT's software application to be reduced to a FOV of 4cm x 16cm. In our practice, we typically use a FOV between 8cm x 16cm to 13cm x 16cm. We keep a CBCT log of every scan taken. Our i-CAT logbook indicates that we typically use this range for approximately 95 percent of our i-CAT scans. We only use the maximum FOV of 23cm x 17cm less than five percent of the time and this is only utilized for very large individuals. As a result, the smaller the FOV, the less radiation exposure there is to a patient.

A "voxel" can be defined as the smallest distinguishable box-shaped part of a 3D image. Think of a voxel as a 3D pixel from 2D digital photography. With the i-CAT, the voxel setting can be adjusted using the iCAT's software application from a range of 0.125 voxel to 0.4 voxel. The smaller the voxel, the higher the resolution. As a result, 0.125 voxel offers the highest resolution and 0.4 voxel offers the lowest resolution. As can be evidenced by our i-CAT scanning protocol, approximately two-thirds of our i-CAT scans are taken at 0.4 voxel or 0.3 voxel. We only utilize the 0.2 voxel setting approximately one-third of the time for SureSmile scans and for larger individuals. We never utilize the highest resolution setting of 0.125 in our practice. As a result, the lower the resolution, the less radiation exposure there is to the patient. Conversely, the higher the resolution, the higher the radiation exposure to the patient. Simply stated, there is a direct correlation between the quality of the image and the amount of radiation exposure to the patient.

"Scan time" is the setting for the amount of time it takes for the X-ray source and detector to make a "single" 360-degree rotation around the patient's head. The scan time setting range varies from: 4.8 seconds to 26.9 seconds. We typically utilize a scan time setting of 4.8 seconds, 8.9 seconds and 14.7 seconds. In our orthodontic practices, rarely do we

Fig. 3: Effective dose for commonly used dental radiographic examinations

Comparison of Internation Commission on Radiological Protection (ICRP) methods from 1990* and 2007. †

Type of Examination	Effective Dose (Microsieverts) ICRP 1990 Tissue Weights	ICRP 2007 Tissue Weights	Change in Effective Dose 1990-2007 (%)
FMX‡ with PSP§ or F-Sped Film and Rectangular Collimation	12.2	34.9	186
BW¶ with PSP or F-Speed Film and Rectangular Collimation	1.0	5.0	422
FMX with PSP or F-Speed Film and Round Cone	58.4	170.7	192
FMX with D-Speed Film and Round Cone#	133	388	192
Panoramic Orthophos XG** (CCD††)	4.3	14.2	231
Panoramic ProMax‡‡ (CCD)	7.1	24.3	241
Posteroanterior Cephalometric (PSP)	3.9	5.1	32
Lateral Cephalometric (PSP)	3.7	5.6	51

• Source: International Commission on Radiological Protection.[1]
† Source: Valentin.[3]
‡ FMX: Full-mouth radiographs.
§ PSP: Photo-stimulable phosphor.
¶ BW: Bitewing
# Calculated as F-speed film value x 2.3 (See Ludlow and colleagues[5]).
** Orthophos XG is manufactured by Sirona Group, Bensheim, Germany.
†† OCD: Charge-coupled device
‡‡ ProMax is manufactured by Planmeca, Helsinki, Finland.

utilize the highest scan time setting of 26.9 seconds. This scan time setting is really only utilized for very large individuals. As a result, the shorter the scan time, the less radiation exposure there is to the patient.

iCAT Settings for Next Generation Machine (Dr. Lin)

Panorex only (ck 8s or eruption):
Diameter - 16cm, Height - 8cm, .4 voxel, 4.8 or 8.9 seconds.
Panorex/lateral ceph (all records):
Diameter - 16cm, Height - 13cm, .3 voxel, 4.8 or 8.9 seconds.
or for a larger FOV:
Diameter - 23cm, Height - 17, .3 voxel, 4.8 or 8.9 seconds.
For patients age 10 or under, use 4.8 seconds unless the patient is a larger individual.
SureSmile scan that needs a panorex only:
Diameter - 16cm, Height - 8cm, .2 voxel, 14.7 seconds.
SureSmile scan that needs both panorex and lateral ceph X-rays:
Diameter - 16cm, Height - 13cm, .25 voxel, 14.7 seconds.

The bottom line is that we always try to keep the amount of radiation exposure to our patients as low as possible, typically in the range of 30 to 75 microsieverts. We do follow the International Commission on Radiological Protection's (ICRP) ALARA principle to keep radiation exposure "as low as reasonably achievable." With our i-CAT, we now have a technology in our orthodontic practice that allows us to significantly reduce the radiation exposure to our patients in comparison to a medical CT, and still allows us the incredible benefits of 3D imaging so that we can make the best decisions for treating our patients! I would also like to point out that in our practice, we do not charge a fee for the i-CAT scans for our patients. As a result, there is no financial incentive for us to take extra scans of our patients. A scan is only recommended if the doctor feels that it is clinically necessary for the patient.

I will now illustrate how 3D CBCT imaging is superior to conventional 2D radiography leading to improved diagnosis and treatment planning for our patients.[6,7,8] For example, let us look at the 2D panoramic X-ray (Fig. 4a) that was created from a single, low-radiation i-CAT CBCT scan.

With a single i-CAT scan, we can view 2D cross sections as in the panorex above, but can also view things in 3D. Let us take a look at the same patient in the 3D mode (Fig. 4b).

The red arrow above points to a supernumerary tooth positioned behind the patient's permanent upper left central incisor. Any orthodontist will understand the significance of not knowing that an extra tooth is present under the bone and tissue can put the patient at risk for damaging the roots of the adjacent permanent teeth, especially if we begin moving teeth with orthodontic appliances. The reason that you cannot see the extra tooth in the 2D panoramic X-ray is because the extra tooth is superimposed behind the root of the patient's upper left central incisor. Because of the i-CAT, I was able to diagnose the extra tooth, which has since been extracted, and the patient is currently in orthodontic treatment with me without any risk to the roots of the adjacent permanent teeth while in treatment. This patient entered into my practice for a second opinion. The original orthodontist never diagnosed the extra tooth because the orthodontist did not see the extra tooth on the 2D panoramic X-ray and lateral cephalometric X-ray, and a CBCT scan was never taken.

Another example of the incredible benefits of CBCT for our patients is illustrated with figure 5. Let us first take a look at the

Fig. 4a

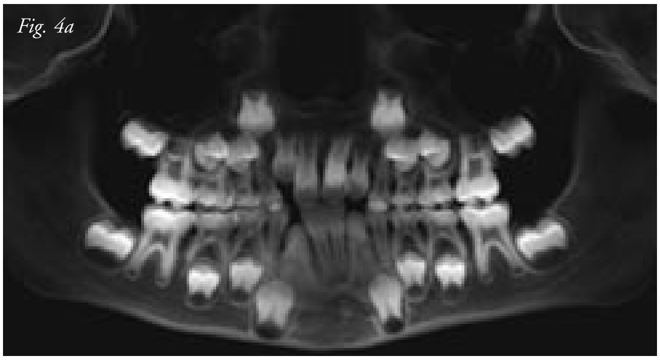

Fig. 4b

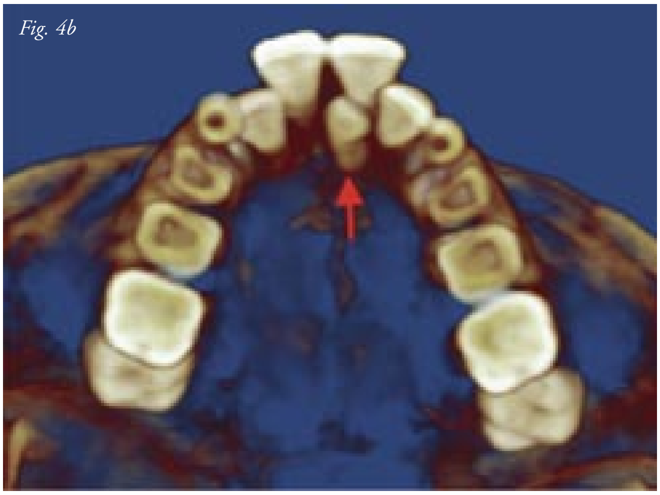

Fig. 5a

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2D digital panoramic X-ray that was provided to us by the pediatric dentist of our patient (Fig. 5a).

Compare this 2D digital panoramic X-ray to a 3D view that was created from an iCAT scan of the same patient 12 months later (Fig. 5b).

The red arrow points to a "blue circular area" in the patient's right lower jaw that is clearly abnormal and looks very suspicious for pathology. In comparison, in the original 2D digital panoramic X-ray taken before the start of treatment, the lesion is not apparent and looks very similar in appearance to the same area on the patient's left side as is illustrated by the red arrows in Fig 5c.

As a result of the diagnosis of this lesion from the iCAT-SureSmile scan, the patient was given a referral to both an oral surgeon and endodontist. The lesion was removed and biopsied and was diagnosed as a traumatic bone cyst. Unfortunately, the pathology had extended to the lower right second premolar and root canal treatment was necessary for that tooth as well. This is illustrated by the red arrow in the 2D digital panoramic X-ray (Fig. 5d) that was provided to us by the patient's pediatric dentist.

Now the question needs to be asked, What if this lesion would have continued to go undiagnosed because it was not evident in the 2D digital panoramic X-ray or other types of 2D dental X-rays. The answer to that question is that 1) the lesion could have continued to grow larger over time, 2) the lesion could have affected other teeth requiring additional root canals or even the loss of teeth and 3) if the lesion continued to grow and destroy the bone in the patient's lower jaw, this would put the patient at greater risk for fracture of his lower jaw.

A 15-yea-old male patient transferred into my practice for a second opinion as the patient had been in orthodontic treatment for approximately 14 months with the previous dentist. As you can tell in the photographs and illustrated by the red arrows, there is a significant problem with the eruption of this young man's teeth in the right quadrant of his lower jaw (Fig. 6a). The previous dentist had recommended extraction of his permanent lower right first and second premolars because the dentist felt that these two teeth were "ankylosed or stuck" under the bone and tissue.

This young man had suffered trauma to the head and jaw in an ATV accident as an 11-year-old. As a result, he had suffered a fracture in his lower right jaw, which had required surgery to repair the fracture with plates and screws. This is illustrated by red arrows in the 2D panoramic X-ray (Fig. 6b) that was created from a single, low-radiation iCAT scan. In looking at a cross section of that same area in the 3D mode (Fig. 6c), it is clearly evident with the red arrows that the screws on the sides of the permanent lower right second premolar are embedded into the roots of that tooth. This young man also was suffering from chronic facial and jaw pain, frequent headaches, difficulty in chewing, and his grades in school had suffered since the accident.

As a result, I recommended removal of the plates and screws with an oral surgeon and have since taken over his case. The follow-up photographs were taken on 11/10/2010 (Fig. 6d). As is clearly evident, the teeth on his right side have come together and I should have his orthodontic treatment completed in the beginning of 2011. More importantly, the patient no longer suffers any side effects from his accident, his grades have improved and he will be graduating from high school and going to college in 2011.

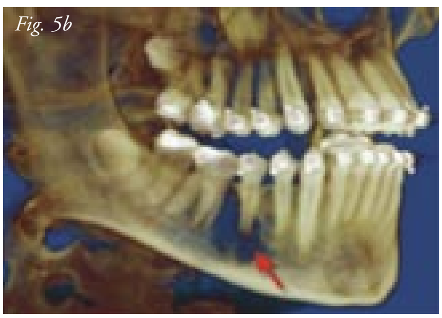
Fig. 5b

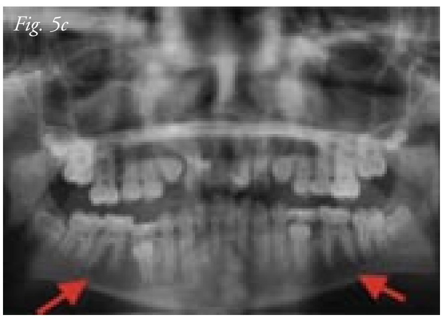
Fig. 5c

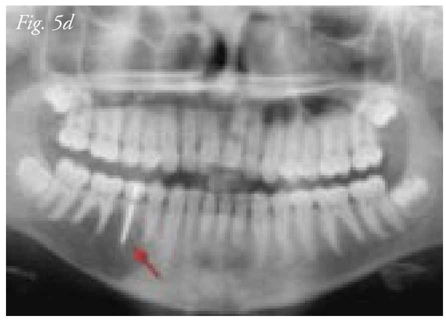
Fig. 5d

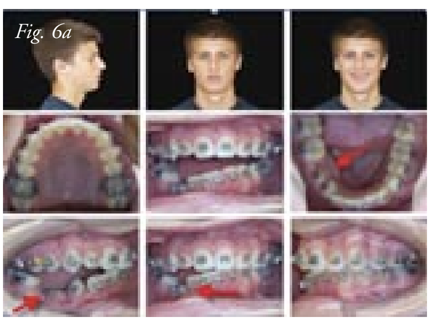
Fig. 6a

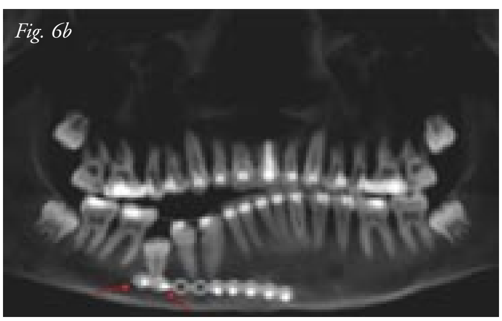
Fig. 6b

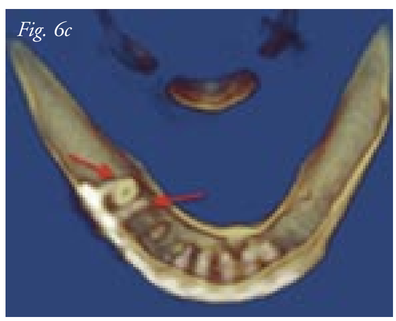
Fig. 6c

Evaluation of the eruption patterns of the permanent teeth is another example of the incredible benefits of CBCT.

Let's look at a patient who entered into my practice in December of 2010. This patient's 2D panoramic X-ray (Fig. 7a) was created from a single, low-radiation i-CAT scan.

Clearly evident and indicated by the red arrow in Fig. 7a, this patient's permanent upper right canine is impacted underneath the gum tissue and bone. However, is the permanent canine in front of or behind the permanent upper right lateral incisor? Also, are there any other areas of concern on this panoramic X-ray?

The upper left red arrow in Fig.7b clearly illustrates that the permanent upper right canine is positioned behind the permanent upper right lateral incisor and is impacted in the roof of the mouth. The second red arrow illustrates that there is also a second impaction that was not evident on the 2D panoramic X-ray with the permanent upper left second premolar lying almost horizontally in the roof of the mouth.

The surgeon will know exactly where to go to surgically uncover these two teeth to allow me to bring them down into their correct positions. This will minimize the amount of trauma to the patient during the surgical procedure. I would also like to point out that if a CBCT scan would have been taken on this patient a couple of years earlier, perhaps both of these impactions could have been avoided with an earlier diagnosis and the recommendation of the extraction of the two primary teeth. The negative consequences of impacted teeth are: 1) surgery and recovery time, 2) additional expense for the surgical procedure, 3) additional time for orthodontic treatment and 4) additional expense for orthodontic treatment due to extra work involved.

One final example of the incredible benefits that CBCT has to offer for our patients with diagnosis and treatment planning is with a comparison of the images of the next two patients. The first patient (Fig 8) entered into my practice in September of 2009. When taking a single, low-radiation iCAT scan for our initial diagnostic records, I discovered the root of his maxillary lateral incisor had been destroyed, which is illustrated in the 2D panoramic X-ray created from the i-CAT scan with the red arrow (Fig. 8).

The mother told me that they have always gone to see their general dentist for their routine dental checkups every six months. Unfortunately, the eruption path of the permanent upper right canine had gone undiagnosed, and as a result, this young man will eventually lose his permanent upper right lateral incisor in the near future.

In comparison to this case above, the following patient's images (Fig. 9) were created from a single, low-radiation i-CAT scan.

The area of concern again is illustrated by the red arrow. However, on this 2D panoramic X-ray created from the iCAT scan, it does not appear as if the root of the permanent upper right lateral incisor has been damaged or is in danger of being damaged. We also cannot tell if the permanent upper right canine is in front of or behind the permanent upper right lateral incisor (Fig. 9b).

As can be evidenced by the red arrow, the eruption path of the permanent upper right canine of this patient is coming directly over the top of the root of the permanent upper right lateral incisor and this patient has a significant risk of damage to the root of the permanent upper right lateral incisor if treatment were not rendered.

The reason I have brought these two patients' cases up for comparison is because they are very similar cases. However,


Fig. 6d

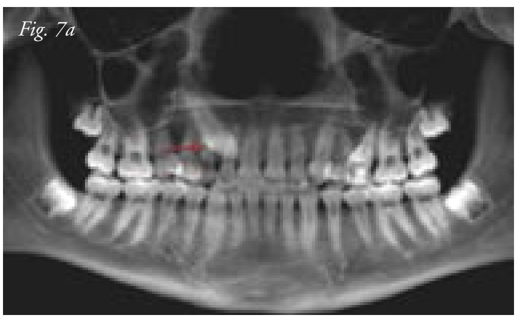
Fig. 7a

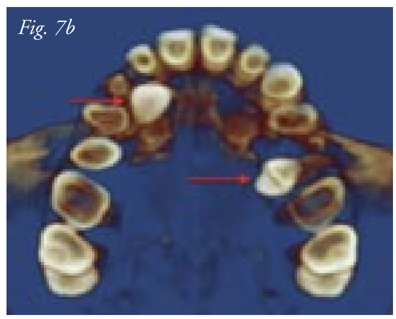
Fig. 7b

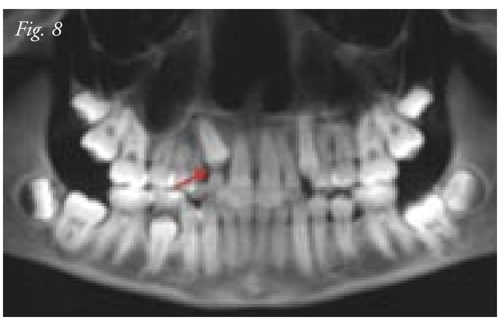
Fig. 8

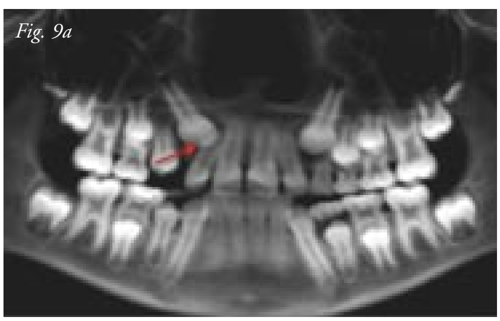
Fig. 9a


Fig. 9b

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these two cases are also at two very different stages of dental development, with the first patient being more mature and approximately two years older.

With this image (Fig. 9b), I was able to diagnose a significant risk for damage of the root of this patient's permanent upper right lateral incisor due to the eruption path of the permanent upper right canine that was not evident on the 2D panoramic X-ray. As a result, I began treatment immediately and was able to protect the root of this patient's permanent upper right lateral incisor from any damage. In my personal professional opinion, if a CBCT scan would have been taken on the first patient a couple of years earlier, I believe the first patient's permanent upper right lateral incisor could have been saved.

A Change in Application

Until 2007, CBCT has been viewed in orthodontics as a diagnosis and treatment planning tool. However, in 2007, the merging of the technologies of CBCT with a technology called SureSmile gave the orthodontist the capability to utilize CBCT not only as a diagnosis and treatment planning tool but also gave us the capabilities for CBCT to become "actively" involved in the treatment of our patients!

SureSmile is a technology first introduced to the orthodontic profession approximately seven years ago. SureSmile's technology incorporates computer hardware, a scanner (intra-oral scanner or CBCT scanner) and their proprietary 3D CAD/CAM software applications in combination with fixed orthodontic appliances or braces. The way SureSmile works is after we bond the brackets on a patient, we then need to scan the patient's teeth and brackets. Using SureSmile's proprietary software, the orthodontist is able to reset the patient's incorrect bite to an ideal bite and then *will bend a customized* SureSmile wire with memory that will move all the teeth into the correct positions at once. As a result, SureSmile allows us to correct our patient's alignment and bite issues with a high degree of precision and also allows us to reduce treatment time by an average of 40 percent.[9,10] My average treatment time prior to SureSmile for all of my full orthodontic and Phase II cases used to be 24 months. My average treatment time with SureSmile for these same cases is now 14 months.

When SureSmile was first introduced, the only option at that time was to utilize an intra-oral scanner to scan the patient. As a result, SureSmile's technology was limited to only capturing the clinical crowns of the teeth in combination with the brackets as illustrated in figure 10. We are not able to see the roots of the teeth because we cannot scan them with the intra-oral scanner.

As orthodontists, our specialty is responsible for creating beautiful smiles and correcting bite problems for our patients. However, in the process of moving teeth, we are also moving the roots of the teeth as well. Until recently, there was no technology available to orthodontists that would allow us to be able to accurately evaluate root positions prior to the start of treatment or determine if we were moving the roots of our patient's teeth into the most ideal positions at the completion of their orthodontic treatment.

That is until 2007, when SureSmile gave orthodontists the capability to CBCT scan our patients so that we could evaluate and correct not only the positions of the crowns of their teeth but also the roots of their teeth to a very high degree of precision and accuracy. Several studies have shown that evaluation of root positions utilizing a 2D panoramic radiograph is an inaccurate procedure.[11]

Let us look at what the benefits are with understanding what is happening with both crown and root movement of the teeth while a patient is in orthodontic treatment. With the SureSmile setup of the patient in figure 11 without the roots present, it appears as if this patient has a very nice fitting bite on the patient's right side.

However, let us look at this same patient a bit more closely when displaying the roots of the patient's teeth with all of the teeth in the exact same positions. It is clearly evident in the second image (Fig. 12), as is indicated by the red arrow, that the roots of the permanent upper right first and second premolars are colliding. The concern here is that with the collision of the two roots, this can 1) prevent tooth movement that might go undiagnosed or 2) in the worst case scenario, it might cause damage to the roots of the teeth themselves.

By truly understanding the anatomy of the roots of the teeth, with SureSmile's software applications, this allows the


Fig. 10


Fig. 11

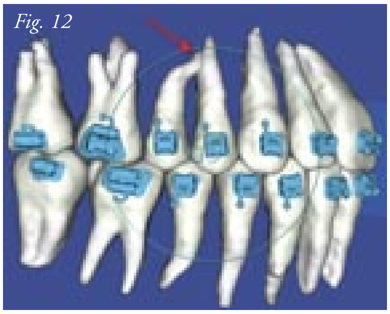
Fig. 12

orthodontist to better position both the crowns and the roots of the teeth into the most ideal positions. This is illustrated in Figure 13a with the red arrow. There is now clearly space between the roots of these two teeth. I have also included before and after photos of the patient's completed case (Figs. 13b-c), which I completed in only 12 months with SureSmile. Without SureSmile, I estimate that it would have taken me approximately 18 months to complete her case.

Another example of the importance of understanding both the crown and root positions for orthodontic treatment with the following patient's images (Figs. 14a-b). As indicated by the red arrows, this patient's permanent lower left second premolar is partially impacted on the day of her SureSmile scan. Obviously there is significant movement of both the crown and the root of the tooth that needs to take place.

With SureSmile's software applications, I am able to reposition both the crowns and the roots of the teeth into the most ideal positions. This is illustrated in this patient's SureSmile setup (Figs. 15a-c) with her before and after photos of the completed case.

Her total treatment time took only 14 months from start to finish with SureSmile, even with the impacted tooth. If I would have treated her case without SureSmile, I would estimate that it would have taken me approximately 20-24 months to complete her case.

With ideal positioning of the crowns of the teeth in combination with the ideal positioning of the roots of the teeth in the bone, this leads to increased stability with the bite and a

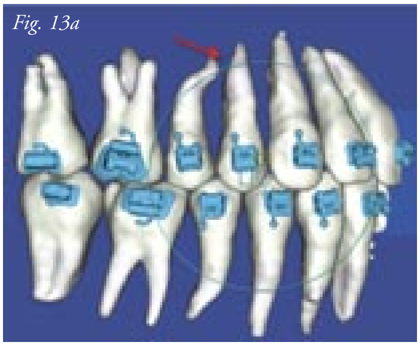
Fig. 13a


Fig. 13b


Fig. 13c

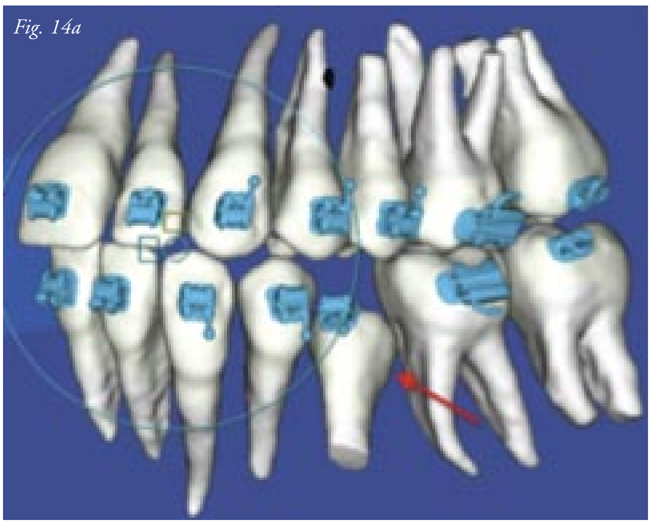
Fig. 14a

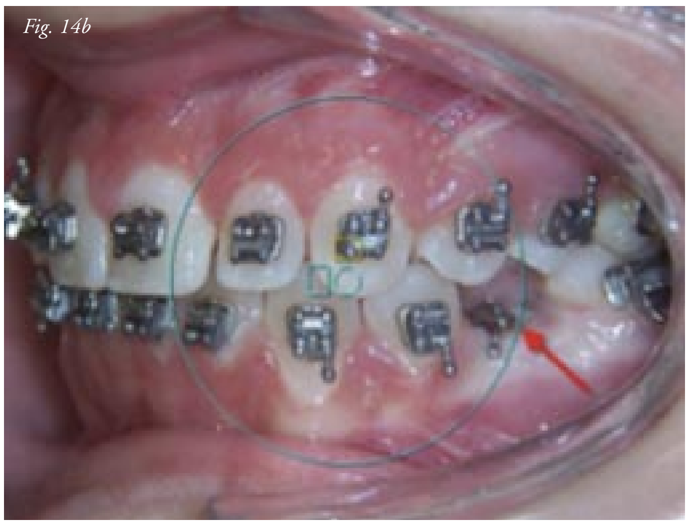
Fig. 14b

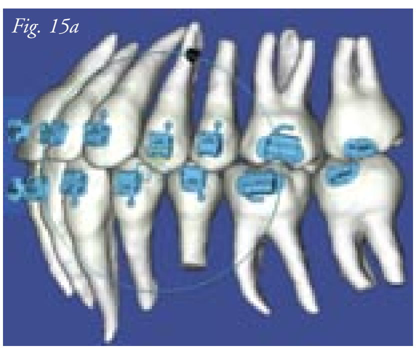
Fig. 15a


Fig. 15b


Fig. 15c

continued on page 58

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decreased potential for orthodontic relapse in the future. This also leads to greater periodontal stability for the long-term, resulting in a decreased potential for gum recession and bone loss as we age.[12] I personally feel that it is phenomenal that we now have these capabilities for the orthodontist to be able to predictably determine both crown and root movement because of the integration of the technologies of CBCT and SureSmile.

In conclusion, I would like to review one final case to illustrate the tremendous benefits which CBCT has to offer both to us, the clinicians, and our patients.

This young lady presented to me for a new patient examination in July of 2011 (Fig. 16). She was 13 years and 11 months. Her father is a general dentist and has been monitoring her dental needs on an annual basis. She has a Class I malocclusion with mild spacing present in both maxillary and mandibular arches. An iCAT scan was recommended by me after my initial clinical evaluation. Upon further evaluation of her lateral cephalogram (Fig. 17a) and panorex (Fig. 17b), it appears that this is a very straightforward orthodontic case and could be considered a "routine" orthodontic case by some.

However, after sending her iCAT scan to an oral radiologist, it was discovered that a radiopacity was present in her

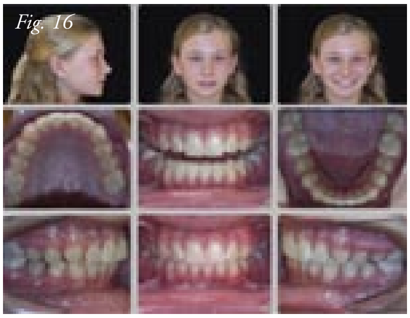


Fig. 16

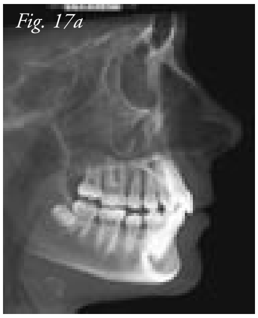
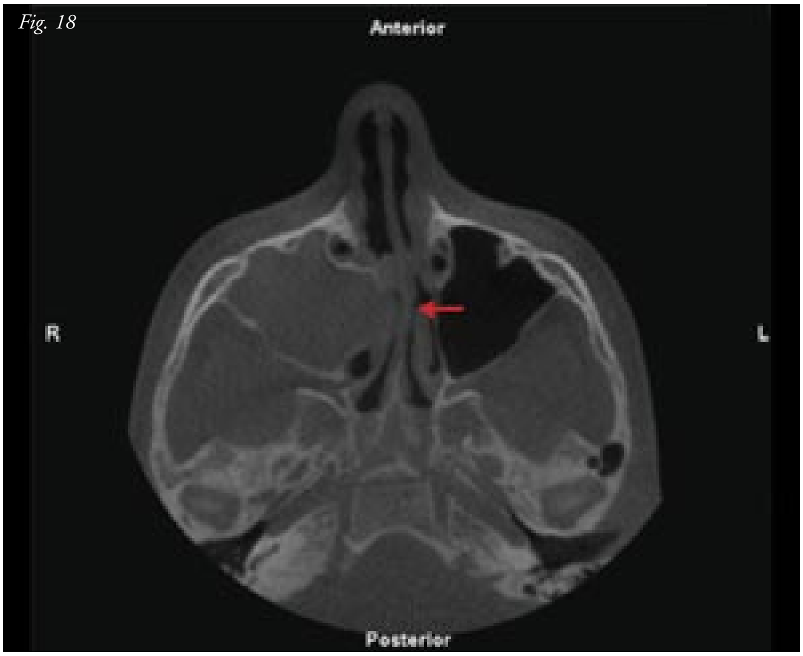


Fig. 17a


Fig. 17b

Fig. 18



tion for the development of the technology of CBCT to provide our patients with a low-radiation 3D imaging alternative to medical CT. However, CBCT still affords us all the benefits of medical CT with 3D imaging. This has led to an improved quality of care with diagnosis and treatment planning for our patients. With the integration of the technologies of CBCT and SureSmile, CBCT now has an additional benefit as it is being utilized with the active therapeutic care of our patients. Diagnosis and treatment planning with actual treatment of our patients are all transitioning from the 2D into the 3D world. It is my belief that CBCT will be considered the standard of care in orthodontics in the very near future, especially since the technology has now advanced to bring the radiation exposure levels to our patients down to levels that are very comparable to a digital panorex and lateral cephalogram. ■

right maxillary sinus with distortion and bowing present of the posteriolateral wall of her right maxillary sinus as is evidenced by the red arrow in the axial cross section (Fig. 18).

As a result, an ENT referral was immediately given to the family for further evaluation and treatment. The reason that I would like to conclude with this case is because this case truly demonstrates the importance of CBCT in diagnosis and treatment planning, especially as our profession of orthodontics continues to advance with the technological changes that are making us better clinicians and allowing us to provide a higher quality of care. The question needs to be asked, What if an i-CAT scan had never been taken on this patient and her pathology had gone undiagnosed for several years because the pathology was not evident in the 2D radiographs? Without a doubt, I think we all know that this young lady would have a much greater risk with health issues directly related to this.

In my practice, I never consider any case to be a "routine" orthodontic case until that case has been completed and I have had an opportunity to re-evaluate. I treat each and every case that comes through my practice with "universal precaution" while completing my diagnosis and treatment planning. Radiographic imaging is only recommended when I see the need for it. As clinicians, we must understand that there are risks that we are exposing our patients to when we are making these recommendations and we must minimize these risks by controlling the amount of radiation exposure to the patient and making certain that the benefits will outweigh the risks. With CBCT, we now have the capabilities to do so.

In summary, I personally believe that our esteemed profession of dentistry should be given significant credit and recogni-

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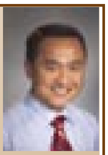
Author's Bio



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