TECHNOLOGY

The why, the how, and the now.

INTEGRATION

Cone Beam Tomography and the Future of Implant Planning

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For many years, the dental profession has relied on panoramic images for radiographic diagnosis. Tooth position, pathology, bone conditions, and implant planning have been accomplished using 2-dimensional images, often clarifying the view with additional peri-apical radiographs taken at various angles. In more complex situations, patients have been sent to imaging centers or hospitals for computed tomography (CT) scans and/or magnetic resonance imaging. Radiologists are often required to interpret the data of these sometimes confusing images.

During the past 2 years, a number of new instruments have been introduced that allow a practitioner to perform similar scans in the dental office. Called cone beam tomography units, these new acquisition units are smaller, limited CT scanners, which take images of the maxilla, mandible, and temporomandibular joint areas. The operator chooses the area (volume) to be scanned and accurately sets the unit to direct its exposure to that anatomical area. Some of the new units are iCAT (Imaging Sciences International, Inc, Hatfield, PA), 3D Accuitomo (J. Morita USA, Irvine, CA), NewTom Volumetric Scanner (APerio Services, LLC, Sarasota, FL), CB MercuRay® (Hitachi Medical Systems America, Inc., Twinsburg, OH), 3D Panoramic X-Ray CT Scanner (Asahi Roentgen Ind Co, Ltd, Kyoto, Japan), ILumaCT (IMTEC Imaging, Ardmore, OK), 3D Cone Beam CT (TeraRecon, San Mateo, CA), as well as upcoming machines from Sirona, Planmeca, Kodak Dental Imaging, and other more familiar names.

Unfortunately, the cost of these units currently starts at about $150,000 and can run as high as $500,000. Some of the current digital panoramic machines will soon have upgrades available to allow similar scans with the existing base unit. To afford these systems, dental offices have tried several approaches. One is to buy the unit and let all of the area practitioners send patients for scans at a typical charge of $300 to $400. Others have banded together to share a machine, while a few enterprising dentists have set up dental imaging centers as a standalone for referrals.

An initial problem, however, is that most dentists are not trained to read the various slices (Figure 1) and make a decent diagnosis. Several new software companies have come to the rescue. This new software takes the multiple slices and digitally reconstructs them into a 3-dimensional model (Figure 2). This opens up new vistas when planning situations that require implants. Less than 20% of practitioners place implants and most of these are specialists, primarily oral surgeons and periodontists. Dentists properly trained in this discipline have a clear knowledge of ridge anatomy as well at the ability to perform flap entry and closure. With the use of the CT scans and advances in software, a system has been devised that not only lets the practitioner know where the best placement for the implant should be but, with some templates, actually guides the practitioner though the steps of preparation and placement.

SEQUENCE

The first step is basic diagnosis and treatment planning. A determination is made based on numerous factors to place one or more implants. Full-arch impressions and diagnostic wax-ups will still ensure the best end result no matter what method is being used. (Note that even this process is to be done on the computer.) An acrylic template, which resembles a nightguard, is fabricated by the laboratory, which the patient wears during the CT scan. Small metal ball bearings are embedded in strategic areas or coatings are painted on the template to act as radio opaque markers for orientation and calibration by the software. The patient wears this during the scan (it is critical that this appliance is accurately manufactured and seated) (Figure 3).

Once the scan is completed there are several software options available. The earliest entries, SimPlant® (Materialise, Ann Arbor, MI) and Compu-Guide Surgical Template System™ (Implant Logic Systems, Ltd, Cedarhurst, NY), take the information and create a "surgical guide" as well as a kit of guide drills and the matching implants. Nobel Biocare (Yorba Linda, CA) has recently introduced "Teeth in An Hour™," which uses a similar system, along with I-Guide (iDent Imaging, Inc, Ft. Lauderdale, FL) and others. These surgical guides, however, are not made in the traditional laboratory acrylic fashion. These guides are created by computer-aided design (CAD) units using processes called stereolithography and rapid prototyping. These manufacturing methods have been available for a long time in the manufacturing/machine shop industry and have only recently entered into the dental area. An early well-known application is Invisalign® (Align Technology, Inc, Santa Clara, CA), which uses impression scanning, computer analysis, and virtual modeling.

The surgical guides can be used in several ways. In some of these systems, a flap is performed and the surgical guide is placed and affixed directly on the bone. In others, the guide is affixed to the dentition or, if edentulous, accurately to the existing ridge. Specific-sized, depth-limited drills are used for entry, precisely angled by the guide (Figure 4). Implants are placed, the guide is removed, and healing caps are installed. Software can also create abutments and prosthetics using standard laboratory techniques or CAD-based rapid prototyping. Some other products currently available are Implant3D (Media Lab Software, La Spezia, Italy), ImplantMaster (iDent Imaging, Inc.), CADImplant (CADImplant, Inc, Medfield, MA), or the Compu-Guide Surgical Template System™ (Implant Logic Systems, Ltd., Cedarhurst, NY).

Because the scans and diagnostic tools are so precise, there is a shift away from flap-oriented surgery to simply working directly through the mucosa (Figure 5). This leads to fewer postoperative issues from the surgical site. If bone augmentation or grafting are required, traditional techniques are used. However, the computerized planning can easily predict these situations, eliminating surprises during the procedure itself.

Tactile Technologies (Rehovot, Israel) has taken the technology to another level with the Implant Location System by using a device with several micropins that actually go through the tissue and map the bone so the operator can see the progress on the computer screen in real

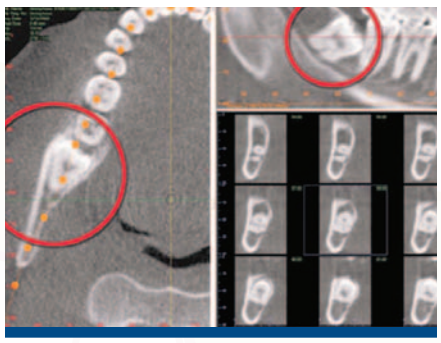

Figure 1 An example of a traditional CT slice.

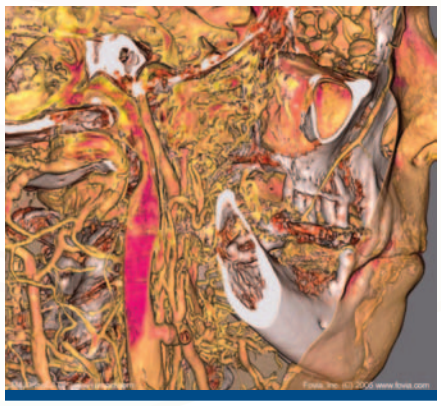

Figure 2 This 3D image from an ILuma OrthoCAT is an example of how new software takes multiple slices and digitally reconstructs them into a three-dimensional model.

Figure 3 An iDent acrylic template with metal ball markers. The metal ball bearings are embedded in strategic areas to act as radio opaque markers for orientation and calibration by the software.

Figure 4 Depth-limited drills are precisely angled by the surgical guides.
Top: An iDent surgical template is in position for 2 single implants (no flap).
Bottom: An iDent surgical template with operator drill in place.

Figure 5 With the precision offered by the scans and diagnostic tools, there is a shift from flap-oriented surgery to working directly through the mucosa. Shown here is an iDent flapless hole ready for implant.

time. The system builds the surgical guide immediately, eliminating the laboratory processing steps and patient visits. While this is difficult to explain in print, a clearer description is available on the Web at www.tactile-tech.com.

CONCLUSION

This year will bring a number of new products, procedures, and paradigm shifts to the planning and placement of implants and prostheses. Many of the implant companies have training courses and hands-on centers. Groups such as Dental Radiographic Technicians (www.aadmrt.com) or online resources such as the CT Imaging Forum hosted by Dr. Scott Ganz (drganz.com) allow open discussion of the latest advances as well as a chance to get advice from numerous experts in the field. Keep your eyes and ears wide open.

ACKNOWLEDGMENT

The author thanks Eliezer Ganon of Columbus, Ohio (www.designtechnologygizmo.com) for his relentless quest for new information in this area.