The Benefits of Computer-Assisted Tomography in Diagnosis and Treatment Planning

Dentists have a variety of radiographs available for implant diagnosis and treatment planning. These include periapical, panoramic, conventional tomography, and computer-assisted tomography. The panoramic radiograph is the most frequently used dental x-ray for dental implant treatment and is also the least accurate. Distortion can range from 25 to 30 percent. The average distortion of a periapical radiograph has been estimated at five to ten percent. Conventional tomography also exhibits considerable dis-

Figure 1. Upon clinical examination, it appears there is sufficient width of bone for placement of an implant in the maxillary anterior. (See Figures 2 and 3 on page 2)
Figure 2. Without the use of CBCT scanning, unpleasant surprises can occur on flap reflection, which in this case revealed insufficient bone for placement of a second implant.

Figure 3. Fortunately, a CBCT scan was done prior to treatment planning which ensured a proper diagnosis and plan for ridge augmentation for future implant placement.

The amount of valuable information available with CBCT scanning is well worth the minimally-elevated level of exposure compared with traditional films. Films produced by the CBCT scanner can be viewed in three planes of space. Typical formatting of the CT data produces panoramic, axial, and cross-sectional oblique views.

Utilizing one of several available software programs, the clinician can simulate the placement of implants on the computer screen.

Readily available case planning programs provide the clinician the opportunity to "place" implants in optimal positions, making certain that the sites chosen will provide sufficient surrounding bone for each implant and good positioning of the implants in relation to each other. The locations of the implants can be altered to provide proper functional positioning.

Additionally, the clinician can measure the quality (density) of alveolar bone surrounding each implant fixture.

CBCT planning software permits the clinician to:

- Measure distance, angle and position of implants relative to other anatomic structures, teeth and implants
- Analyze bone density
- Identify the mandibular nerve and the presence of an anterior loop
- Simulate bone grafts
- Predict the final prosthetic outcome
- Place implants for orthodontic anchorage
Figures 4 and 5. This cross-sectional view of the mandibular anterior ridge reveals a very severe lingual undercut due to angulation of the bone. With the information from this CBCT scan, the accurate implant length can be determined to prevent lingual perforation.

With CBCT, clinicians can avoid such complications as perforating the buccal/lingual plates, severe bleeding episodes, violating the neurovascular bundle, perforating a sinus, damaging an adjacent tooth, overlooking anatomy like a bifurcated mandibular canal, an extension of the mandibular nerve, other anatomic variations or pathology which needs to be treated prior to implant placement.

Implant planning software can reformat the CT into a three-dimensional image from which a stereolithographic model can be constructed.

The model is machined with CAD/CAM technology into an accurate anatomic replica of the jaw.

Once a treatment plan is selected, a customized surgical drill guide can be constructed. Built directly from the selected treatment plan and based on the patient’s exact measurements, these guides ensure safe, predictable implant surgery.

Three surgical guides are available: mucosa supported, bone supported and tooth supported.

The opportunity for restorative practitioners to set surgical performance standards for implant placement marks a paradigm shift in implant dentistry.

In an era which places a high value on esthetics, exquisite implant placement is important to ensure that the implant-supported restoration is indistinguishable from the tooth it is replacing.

**CT Scanning in Orthodontics**

The use of the CBCT scan in orthodontics also portends a new era in diagnosis and treatment. Historically, the examination tools most commonly used in the diagnosis of malocclusion are the panorex in combination with intraoral and cephalometric radiographs.

Caprioglio et al reported this technique is reliable in about 60 percent of cases.

CBCT scanning gives orthodontists revolutionary new information for treatment and care that isn't possible with conventional two-dimensional radiography.

The applications of 3D imaging in orthodontics include:

- 3D treatment planning
- 3D soft and hard tissue prediction (simulation)
- Three-dimensionally fabricated and precisely-machined archwires
“Computer-assisted dentistry will become increasingly valuable for its increased accuracy .... As the cost of computerized tomography declines and the demand for such sophisticated diagnostic methods increases, CT Scans will inevitably become the Standard of Care.”

Published studies have shown CBCT scanning is superior to conventional dental radiography in the detection of vertical root fractures. Youssefzadeh reported that conventional radiography only showed fracture lines in about a third of all cases while CBCT scanning revealed fracture lines in 100 percent of cases.

Restorative Applications

Restorative dentists have for many years been using three-dimensional computer imaging combined with a precise, diamond-cut milling machine to produce ceramic inlays, onlays, veneers and crowns in a single office visit.

State-of-the-art computer-imaging software is combined with a high speed diamond bur and disk milling machine that precisely carves the new crown or veneer from a solid block of tooth-colored ceramic without the need of an outside laboratory.

In conclusion, computer-assisted dentistry will become increasingly valuable for its increased accuracy.

Three-dimensional images can provide the patient with visual evidence of the treatment the clinician is proposing, along with the potential limitations of treatment due to variations in their individual anatomy.

Furthermore, it assists patients in making an informed health care decision prior to commencing treatment.

The current costs of this methodology have been a deterrent to some clinicians.

However, once the clinician learns to work with computer-generated models, the savings in intraoperative time and the predictability of treatment more than makes up for the expense.

As the cost of computerized tomography declines and the demand for such sophisticated diagnostic methods increases, CT scans will inevitably become the Standard of Care.