Trends in Dental Implants

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Using a series of case studies, Frank Higginbottom, DDS, Baylor College of Dentistry, Dallas, Texas, USA, discussed several of the trends that promise to revolutionize the field of implant dentistry. These include digital radiography, which can be used to plan surgery and aid in placement; computer-aided design (CAD) and computer-aided manufacturing (CAM), which can improve impression accuracy; and new hydrophilic surface technology and materials (eg, titanium and zirconium) that produce stronger and longer-lasting implants.

Healing speed has progressed and improved throughout time. Bone healing occurs faster with rough surfaces. Efforts to speed up osseointegration include using titanium-sprayed surfaces (1974); sandblasted large-grit acid-attacked (SLA) surfaces (1998); and, currently, hydrophilic surfaces (SLActive), which were developed in 2006. In one study [Schwarz F et al. *J Clin Periodontol*. 2007], dogs who received SLActive implants exhibited a complete defect fill at 12 weeks after implant placement compared with SLA implants, which showed only the development of dense connective tissue at 12 weeks with no significant increase in mean values of new bone height, percentage of linear fill, percentage of bone-to-implant contact, or area of new bone fill. Dr Higginbottom noted that the more stable the implant at placement, the shorter the time that is required for osseointegration and uncovering.

Combining the new surface technology with the new materials (eg, titanium) improves the physical properties of the implant and speeds up integration. Roxolid, an alloy composed of titanium and zirconium, is the first material exclusively developed for dental implants. It has increased material strength (by 50% compared to pure titanium), decreased overall treatment time, and reduced the need for additional bone-grafting procedures [Steinemann SG. *Periodontology*. 2000; Kobayashi E et al. *J Biomed Mater Res*. 1995].

Imaging from dental implants is becoming more sophisticated as 2D technology such as periapical (which highlights only 1 or 2 teeth at a time) and panoramic (which shows upper and lower teeth) film is replaced by digital radiography. Cone-beam computed tomography systems (CBCTs) are a variation of traditional computed tomography (CT) systems that capture data using a cone-shaped x-ray beam. CBCT provides higher resolution and allows greater manipulation than traditional CT scans. These data are used to reconstruct a 3D image of the dental, and oral and maxillofacial, regions of the patient's anatomy and are more accurate than other radiographic diagnostic tools (Table 1). CBCT also allows for easy patient positioning and has only limited radiation exposure.

In the past, impressions for implant dentistry were usually performed using malleable and plaster materials to record the implant position, surrounding structures, and connections. Currently, digital scans can record the x-, y-, and z-axis of the tooth position or implant scan body and the surrounding hard and soft tissues in the form of a Standard Tessellation Language file suitable for 3D imaging. Digital impressions can be taken and measured with devices, such as the iTero, 3m True Definition, Cerec, E4D, 3Shape, Carestream 3500, and Glidewell IOS Fastscan.

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Table 1. Comparison of Radiographic Accuracy of Diagnostic Tools

Tool	Average Distortion, mm	Maximum, mm
Panoramic	0–3	7.5
Periapical	1.9	5.5
Cone-Beam Computed Tomography scan	0.0	0.2

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The iTero enables the clinician to take a 3D digital scan of the patient's teeth and bite, make adjustments in real time, and transmit the file wirelessly for processing at a partnering laboratory, where the final restoration can be crafted with never-before-achieved precision and accuracy. Using radiographic markers, a diagnostic template is first fabricated. Radiographs of the template are sent to the laboratory to facilitate the fabrication of a surgical template. The template can be used to place a greater number of implants in optimal positions with 3D precision.

Parallel confocal and triangulation sampling are the 2 digital-imaging approaches currently available in the dental industry. Parallel confocal systems use laser and optical scanning to digitally capture the surface and contours of the tooth and gingival (sub- and supra-) tissues. Scanners that use the triangulation and sampling method typically apply 1 angled cone of light to capture a single image at 15 000 μm. Triangulation requires teeth to be coated with expensive and cumbersome scanning powder, whereas the parallel confocal approach does not. Temporary abutments and crowns as tissue formers may be used at this point to prepare the tissues before the final impression.

Color-coated scan bodies that contain screws are used during digital impression and model scanning to ensure the most accurate process for the location of implant positions and angulations. These implants may have internal connections to minimize the forces transmitted to the fastening screw when lateral external forces may act on the prosthesis. There are 18 different scan bodies and 89 different connections

These virtual designs of copings, abutments, and framework replace the older techniques of waxing and investment casting. After obtaining the virtual impression, CAM planning systems and milling can be used to produce the restorations and aid in the selection of impression material with controlled and constant properties and reduced cost. Zirconia and titanium abutments can be CAD or CAM milled. Full-contour, all-ceramic restorations are then milled to fit the abutment or a coping, which is milled to accept layered porcelain to finish the desired restoration with optimal aesthetics.

Provisional restoration may be used in the short term to provide coverage and support while the final implant is being manufactured. An analog embedded in the printed model is often used during fabrication of this material. Analog copies can cause problems, however, because distortions can occur when materials go from liquid to solid. Guided surgery can aid in accurate positioning and more depth control for implant placement, can reduce chair time and patient pain, and can increase the potential for minimally invasive surgery.

Dental implants have become a popular treatment option. Regardless of the approach, good treatment planning is essential. The process must include attention to each of the following decision points: when to uncover the implant (based on stability at the time of placement), the type of tissue former to be placed (mostly depends on aesthetic concerns), the final implant abutment type (determined by the occlusion, the biologic width, and aesthetic concerns), and selection of the impression material. Making the correct decision for each step prior to the impression stage will facilitate an accurate and aesthetic implant restoration.