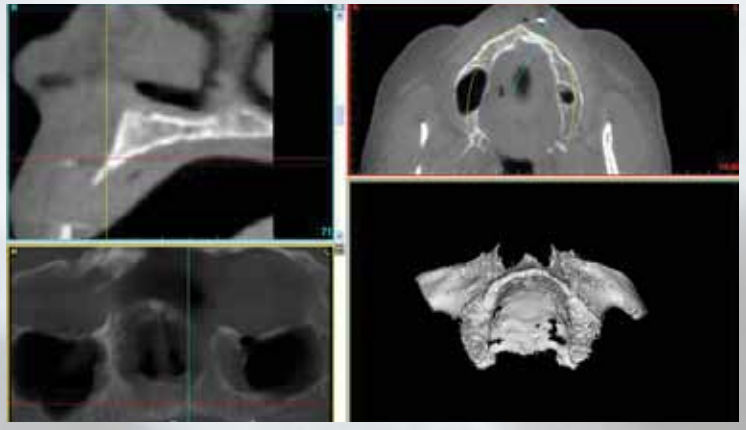
CT Planning for Implants:

Don't Let a Panoramic Fool You

by **Timothy F. Kosinksi, DDS, MAGD, MS**

CT scanning software is fast becoming a viable tool in the diagnosis and treatment of dental implant position and placement. In areas where contours and width and height of bone are difficult to determine with conventional radiographic techniques, CT scanning software allows diagnostic determination if bone quantity and quality exists and can be used to virtually place dental implants using the computer program before surgical intervention. This is an outstanding tool in discussing the risks involved in surgical implant procedures and can help the clinician and the patient visualize the case. Used in critical anatomic situations and for placing the implant in an ideal position in bone, CT planning software, such as SimPlant® (Materialise Dental, Glen Burnie, Md.), eliminates possible manual placement errors and matches planning to prosthetic requirements. This innovative tool makes surgical placement of implants less invasive and more predictable, increasing treatment acceptance and reducing patient anxiety. Prosthetic reconstruction is thus made simpler because the implants are appropriately positioned to allow for fabrication of the final prosthesis.



Preoperative CT scan

Simple two-dimensional images created using conventional radiographic techniques may no longer be an adequate and predictable technique for proper implant placement.

Fabrication of a stable, comfortable maxillary removable complete denture using dental implants as the support mechanism begins with careful diagnosis and case planning. Simple two-dimensional images created using conventional radiographic techniques may no longer be an adequate and predictable technique for proper implant placement. The surgeon's experience and manual placement techniques greatly influence the final functional and esthetic result. Any laboratory technician can tell you that implants often are placed in poor position or angulation, making prosthetic fabrication difficult or compromising retention.

Dental implants provide an outstanding treatment option, demonstrating dramatic improvement in denture stability and increased chewing efficiency. There is an increase in quality of life that is rewarding to the dentist and gratifying for the patient. The use of endosseous implant designs, such as the Sybron dental implant system, has proven to have an outstanding prognosis and are reliable as retainers for overdentures.

The patient treated in the case illustrated in this photo essay is a 57-year-old African American female who has worn a conventional maxillary complete denture opposing an old IMZ® (IMZ GmbH; Schwäbisch Gmünd, Germany) implant-retained overdenture for the past 14 years *(Fig. 1)*. There were no medical contraindications to dental implant therapy. After maxillary tooth removal years ago, several maxillary complete dentures were fabricated over time. The dentures were not completely acceptable to the patient because of functionality and esthetic concerns. Form and function diminished over the years, and the patient was anxious for a stable maxillary dentition.

Several options were discussed with the patient, including fabrication of a new conventional denture or a possible

Figure 1: *A preoperative properly fabricated conventional maxillary complete denture is shown.*

Figure 2: *The preoperative panoramic radiograph appears to illustrate good height of bone to accept dental implants in the pre-maxillary area.*

Figure 3, 4: *Occlusal and facial view of edentulous ridge. Again, it appears there is adequate bone width and height to accept dental implants in preparation for an implant-retained maxillary overdenture.*

Figure 5: *Underside of a properly fabricated, well-fitting conventional maxillary denture, which will be duplicated to fabricate the Scan Appliance and eventually the Universal SurgiGuide.*

Figure 6: *A Scan Appliance fabricated from the conventional denture. Note gutta-percha placed in at least eight planes.*

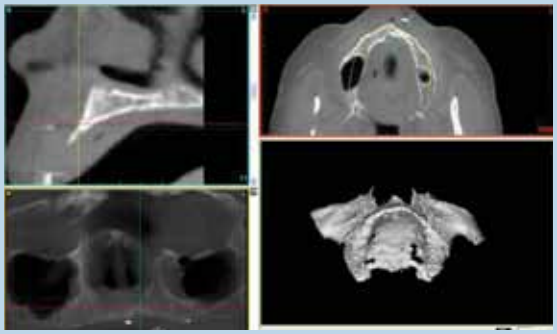


Figure 7: *The CT digital plan illustrates panoramic cross-sectional and axial views, as well as a 3-D rendering of the patient's maxilla. Simple panoramic radiographs or periapicals do not produce the 3-D image achieved with CT scanning. Note the thinness of bone in the pre-maxillary area; this is not acceptable for conventional implant placement. Without CT diagnosing, we would have flapped the gingival and found inadequate bone for implant placement.*

Figure 8: *Using the planning software from SimPlant allows for fabrication of a stable SurgiGuide that will allow us to precisely place the dental implants where we virtually determined the best position to be.*

implant-retained prosthesis. Initial diagnosis of the maxillary ridge determined by palpitation and panoramic radiographic evaluation appeared to indicate adequate bone height and width to strategically place four implants in the pre-maxilla to support an implant-retained overdenture, likely using individual Locator® attachments (Zest Anchors; Escondido, Calif.) *(Fig. 2–4)*. The posterior vertical bone was minimal because of the large maxillary sinuses. The amount of anterior pre-maxillary bone was difficult to precisely determine by radiographic interpretation alone but looked adequate. The ridge was thin, but how thin would need to be determined by reflecting the soft tissue and visually evaluating the crest of the ridge at the time of implant placement.

The patient's main concern was that the existing maxillary case was not stable, and her ability to chew and function had diminished. Her quality of life had been compromised by the loss of her upper teeth. Discussion of the use of CT technology to determine the exact amount of bone available and the use of CT planning software to determine the precise position of potential implants helped motivate the patient to consider dental implant reconstruction. It also allowed for another tool to determine the size, type and position of implants to be surgically placed.[1]

There was significant facial resorption in the maxilla, so it was determined that an implant-retained maxillary overdenture with proper lip support would best serve the patient. Sybron dental implants were chosen because of their innovative design. This system improves the dentist and patient's access to superior and more effective treatment. The SybronPRO™ XRT (Sybron International; Orange, Calif.) implant design incorporates micro-threads, a mount-free delivery system and self-tapping threads. The implant is a self-threading system. A placement tool is firmly seated into the implant body and is used for the insertion using a handpiece reduced to 35 rpm and 25 Ncm of torque. An internal hex or octa pattern allows for great stability of the platform-switching abutments. The reliability and innovation demonstrated in the Sybron surgical and prosthetic techniques made this the implant of choice for the case.

There are concerns with any surgical procedure, especially those in the sinus area or in bone where nerves are located. These concerns have popularized a newer concept in implant dentistry: digital treatment planning. We are now able to utilize software to quickly visualize the patient's anatomy in three dimensions. The computer software allows us to simulate the placement of implants accurately before ever touching the patient. A surgical guide, created from the 3-D images, helps us place the dental

implants in the proper predetermined positions, often in a flapless procedure. This technique is proving to be a cost-effective solution to assist the implant dentist in planning an esthetic and functional final result and minimizing any possible surgical challenges.

It is critical to make sure that the final tooth positions are established before there is any surgical intervention.

The technology behind digital treatment planning and guided surgery is based on planning algorithms used clinically for years. CT scans and 3-D planning software can really improve the clinician's predictability and safety.

Guided surgical techniques can be used for:

- Single-tooth edentulous spaces
- Single-tooth immediate extractions
- Partially edentulous spaces
- Fully edentulous maxillary and mandibular overdenture cases
- Fully edentulous maxillary or mandibular full-arch permanent restorations

The surgical cases are, therefore, driven by the final esthetic and functional result. It is important to listen to your patients carefully to determine their goals and desires and design the implant reconstruction accordingly. It is critical to make sure that the final tooth positions are established before there is any surgical intervention. Placing the dental implants in the jaw before understanding tooth/implant position can be disasterous.[2,3,5]

A CT planning and placement system like SimPlant provides a high level of comfort and safety for the patient by reducing surgical and restorative time. This is done by utilizing an accurate 3-D plan prior to implant placement. There are obvious advantages, including:

- Easy visual understanding for clear case presentations
- Reduced surgical chairtime
- Reduced restorative chairtime in certain cases because of ideal implant positioning

Figure 9: *The Universal SurgiGuide is placed into the mouth and the stabilizing pins positioned. This SurgiGuide does not move once the stabilizing pins are placed, allowing for accurate guided placement of the dental implants.*

Figure 10: *Universal SurgiGuide in place with a 2 mm drill key*

Figure 11: *The first drill used to initially determine angulation is the Lindemann Guide. The total depth is measured and marked on the drill.*

Figure 12: *The Lindemann drill is positioned to the predetermined depth through the 2 mm drill key.*

Figure 13, 14: *A 2.2 mm key is positioned and the 2.2 mm diameter Twist drill is used to the established depth. Soft tissue thickness is included in the total drill depth.*

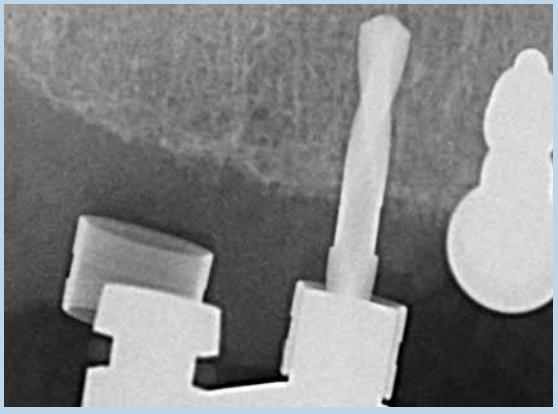


Figure 15: *Periapical of 2.2 mm Twist drill illustrating the predetermined depth and angulation*

Figure 16: *A 2.8 mm key guide positioned and 3.3 mm Twist drill used to depth. The actual diameter of this Twist drill is 2.8 mm.*

- Reduced stress for the clinician and the patient
- Avoidance of surprises during surgery
- Optimal implant placement for long-term implant and prosthetic success
- An improved esthetic result

Before the CT scan, a Scan Appliance is fabricated by the laboratory. This aids in visualization of the optimal prosthetic outcome. The teeth are positioned properly in wax and then processed into a hard appliance to illustrate what the case will look like when it's finished before it's even started. In this case, the proper-fitting conventional maxillary complete denture was duplicated *(Fig. 5)*. All appropriate dental anatomy is included. The Scan Appliance is placed in the mouth during the CT scan *(Fig. 6)*. This allows the clinician to see the ideal position of the teeth on a 3-D model. The entire 3-D image is analyzed and the implant planning and simulation of implant placement completed using the computer. The surgical placement of the implants can be done in a conventional manner using the newly created surgical guide to help direct the implants in the ideal position, often in a flapless procedure *(Fig. 7)*. The implants are placed in the desired depth using the computer software and the surgical guide.

The use of CT planning software to determine the precise position of potential implants helped motivate the patient to consider dental implant reconstruction.

In this case, we utilized the Universal SurgiGuide® (Materialise Dental). It consists of a single SurgiGuide. Keys, based on the drill diameters, are placed in the sleeves in the SurgiGuide to guide each drill.

It is imperative that the implants be placed as nearly parallel as possible in all three dimensions to the long axis of the bone and to each other. The implants in the right maxilla are parallel to each other, as are the implants in the left maxilla. A clear Universal SurgiGuide was fabricated using the information created with the CT scanning

software *(Fig. 8)*. The guide is used to correctly position the implants in the first molar and cuspid areas to maximize stability of the final implant-retained prosthesis. No retraction of the soft tissue was needed because the CT indicated in three dimensions the length, width and position of the implants to be used.

We are now able to utilize software to quickly visualize the patient's entire mouth anatomy in three dimensions.

Figure 9 illustrates the stable Universal SurgiGuide in the mouth with the stabilizing pins positioned. This Universal SurgiGuide does not move once the stabilizing pins are placed, allowing for accurate guided placement of the dental implants. Figure 10 illustrates the Universal SurgiGuide in place with the 2 mm key.

The Sybron system is simple and precise. The first drill used to initially determine angulation is the 2 mm Lindemann drill. This is a very sharp drill with a point *(Fig. 11)*. The Lindemann drill is positioned to the predetermined depth through the 2 mm drill key *(Fig. 12)*.

Figure 13 and 14 illustrate the 2.2 mm drill key guide in position and the 2.2 mm diameter Twist drill used to establish depth. The black lines are clearly delineated: 7 mm, 9 mm, 11 mm, 13 mm and 15 mm. Soft tissue thickness is incorporated in the drill depth. Figure 15 shows the periapical radiograph of the 2.2 mm Twist drill at the proper depth and angulation as determined by the CT scanning software. A 2.8 mm key is positioned in Figure 16, and a 3.3 mm Twist drill is used to depth. The actual diameter of the 3.3 mm Twist drill is 2.8 mm. Figure 17 illustrates the periapical radiograph of the 3.3 mm Twist drill to proper predetermined depth. Note the proximity of the maxillary sinus.

The remaining three implant sites were then prepared. Figures 18–21 show the identical steps listed above but with an increased osteotomy size for a 4.8 mm diameter Sybron dental implant. The actual diameter of the 4.8 mm Twist drill is 4.2 mm, which is the osteotomy size used for a 4.8 mm dental implant *(Fig. 22)*. The Sybron implants

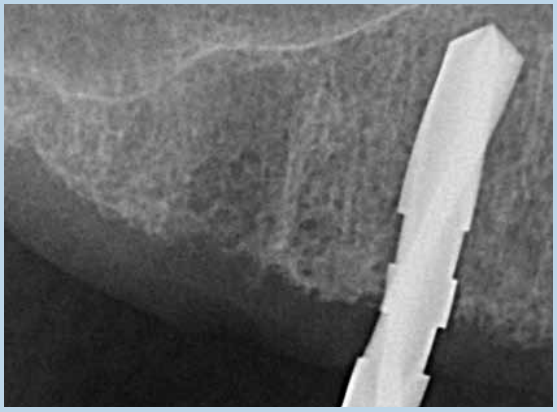


Figure 17: *Periapical radiograph of 3.3 mm Twist drill in position*

Figure 18: *Drilling the distal osteotomy with a 2.2 mm key*

Figure 19: *A 2.8 mm key in position for the 3.3 mm Twist drill (actual drill diameter 2.8 mm).*

Figure 20: *A 3.5 mm key in position. The 4.1 mm Twist drill is used (actual drill diameter 3.5 mm).*

Figure 21: *A 4.2 mm key is seen in position. The 4.8 mm Twist drill is used (actual drill diameter 4.2 mm).*

Figure 22: *After the osteotomies are completed, the SurgiGuide is removed. A tissue punch removes any soft-tissue tags.*

Figure 23: *A 3.3 x 13 mm SybronPRO XRT dental implant is threaded into the tooth #5 position.*

Figure 24: *A 4.8 x 9 mm SybronPRO XRT dental implant is threaded into the tooth #3 position.*

In this case, splinting the implants in the maxilla will improve the long-term prognosis of the implants themselves.

are self-tapping, so the osteotomy preparation is slightly smaller than the final implant diameter. This allows for excellent initial stability and retention.

Figure 23 and 24 show threading into bone of a 3.3 x 13 mm SybronPro XRT dental implant in the tooth #5 area and a 4.8 x 9 mm implant in the #3 area. On the contralateral side, a 3.3 x 13 mm implant was placed in the #12 area and a 4.8 x 11 mm in the #14 area. Figure 25 shows the occlusal view of the four Sybron implants placed using this flapless technique. Note there is little or no bleeding from the site, and no sutures are necessary. The final periapical radiographs show the positioning of the maxillary right and left posterior implants *(Fig. 26, 27)*. The patient's existing conventional maxillary complete denture was seated during the entire healing process. A final CT scan was taken to document and confirm the placement of the implants as compared to the virtual preoperative placement using the SimPlant CT scanning software *(Fig. 28a, 28b)*.

When selecting an appropriate attachment for the overdenture, it is important to consider the amount of interocclusal space available. Retention requirements, ease of use and lifespan of attachment should also be considered.

Conventional denture and implant impression techniques will be used to create the final esthetic contours. We will create an outstanding functional and esthetic result, meet the patient's expectations and eliminate the gagging reflex caused by the old full-palate conventional complete denture. It is this author's opinion that splinting the implants in the maxilla will improve the long-term prognosis of the implants themselves.

The dentist has an obligation to provide his or her patients with the most innovative, proven techniques available. CT scans and scanning software like the SimPlant program make surgical placement of dental implants rather routine. Anatomical anomalies are virtually determined before ever touching the patient. With better implant placement comes

more routine and predictable prosthetic reconstruction. The dentist must educate himself or herself with treatment modalities in order to best serve patients. Many surgical therapies can be performed by the trained general dentist, and certainly all general dentists should be able to restore these cases simply and easily. The predictable results only reinforce the modality. Maintenance is rather routine, with a design of the bars that allows easy access with a proxy brush. As with any other dental appliance, professional evaluations and periodic radiographs are mandated.

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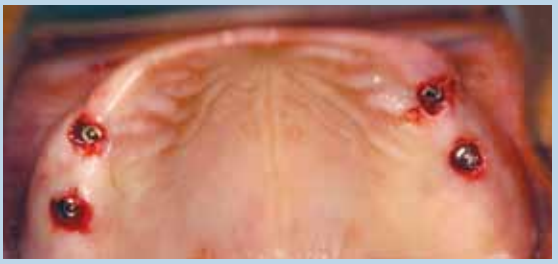

Figure 25: *Occlusal view of the four Sybron implants placed using a flapless technique. Note there is little or no bleeding from the site; no sutures were required.*

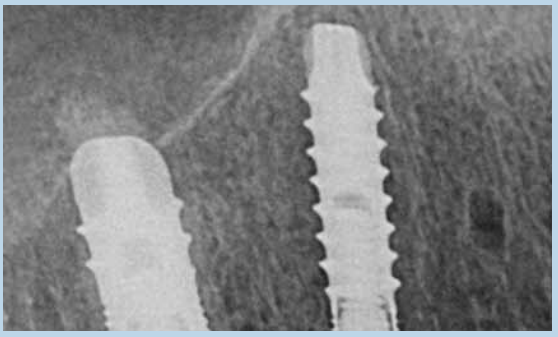

Figure 26: *Periapical of maxillary right posterior implants in place*

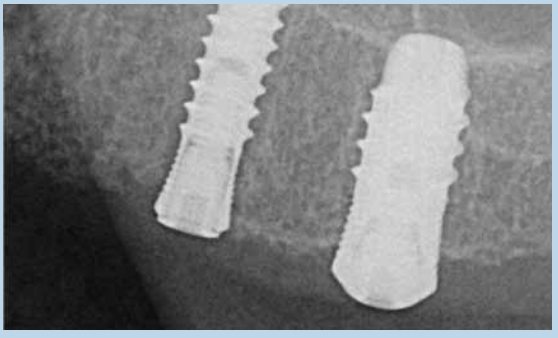

Figure 27: *Periapical of maxillary left posterior implants in place*

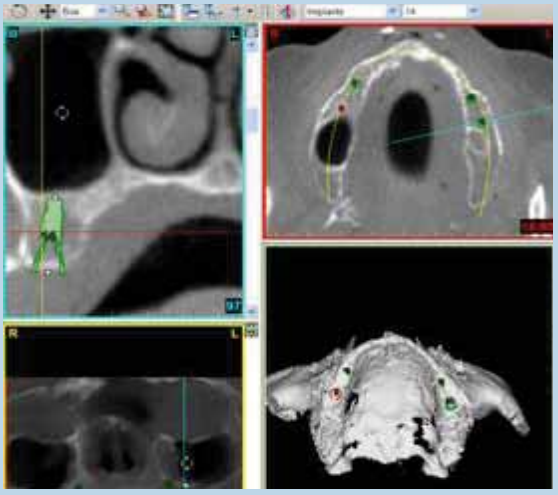

Figure 28a: *Preoperative virtual plan*

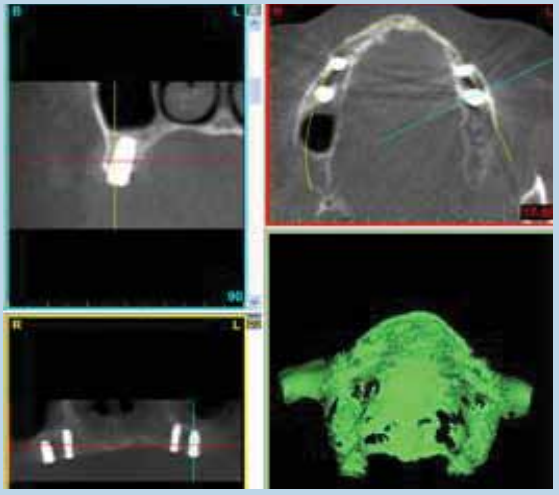

Figure 28b: *Post-operative CT scan. Note the precise positioning of the implants, which were virtually positioned using planning software and placed through a guided procedure.*