"Once you've tried it, you can't drink anything else"

Author_ Dr Jay B. Reznick, USA

Fig. 1

Fig. 2

Fig. 1_Pre-op view of failing tooth #10 in a 70-year-old female patient.

Fig. 2_Pre-op radiograph showing a horizontal fracture, root canal treatment and a cast post.

Fig. 3_CEREC 3D virtual model with proposal of provisional restoration.

_Way back in 2005, I was listening to a speaker discuss a new way of placing dental implants that would revolutionise the process. He showed a video of an elderly Swedish man strolling into a dental clinic with a bag full of ill-fitting dentures, and walking out later that same day with fully implant-supported final prostheses. The process used 3-D computed tomography (CT) imaging to plan the implant placement, and then a custom surgical guide was made that facilitated the flapless placement of a dozen or so implants so precisely that only minimal adjustments would be necessary to the prefabricated fixed bridges. The cost of this treatment was about US$100,000, rendering it beyond reach for the majority of patients.

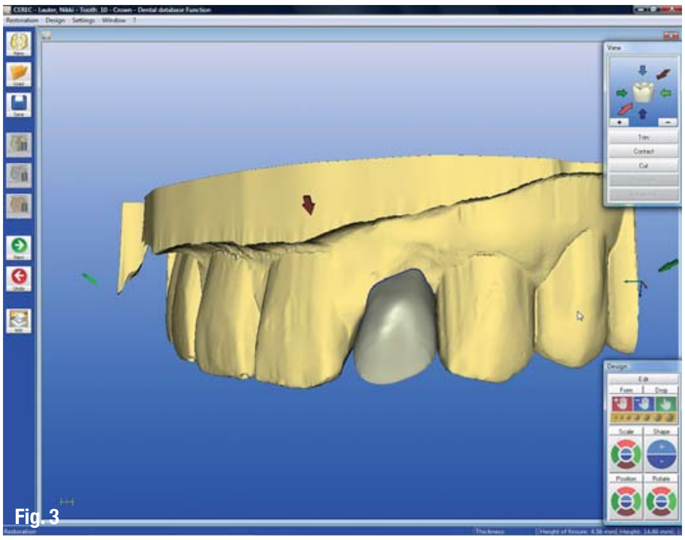


Fig. 3

This was an enlightening moment for me, as I saw the potential in this technique. As soon as it was available in the US and the cost became more reasonable, I vowed to bring this technology into my practice so that my patients could benefit from this amazing innovation.

Early in 2006, I flew to Chicago and took the Nobel-Guide training course, and within a short time I had half a dozen cases under my belt. I was amazed by how quickly and accurately I could place multiple implants, and that most patients needed only a few post-operative ibuprofens and were back at work the next day. Soon thereafter, I acquired SimPlant software and began using both methods for treatment planning and placing implants.

These two pioneering systems opened the door for the current tidal wave of CT-guided implant surgeries. For those of you not familiar with the concept, CT-guided implant surgery uses 3-D CT imaging to evaluate the bony anatomy of the edentulous jaw, uses this for implant planning, and then accurately transfers the treatment plan to the patient at surgery using a custom surgical guide that controls the position, angle, and depth of each drill and implant fixture. It is so accurate that a custom provisional or even final prosthesis can be made that is delivered with minimal, if any, adjustment needed. It is a panacea for the restorative dentist because implant placement is completely prosthetically driven, not dictated by the surgeon's whim if there are anatomical surprises when the tissue is flapped open. The anatomy is known with 3-D accuracy before surgery, and should bone or tissue augmentation be necessary to position the implants properly, this information is known ahead of time and additional procedures are planned. The result is perfectly placed implants in ideal bone that are straightforward to restore and function properly nearly all of the time.

Even though I did not use CT-guided surgery for every implant case, I probably completed a hundred cases or more in those first two years. It was a very time-consuming process. I had to have the laboratory make a radiographic template, arrange for the patient to have a CT scan, have the scan redone should the technician not have followed the protocol exactly, import the DICOM files into the software program, clean up the scatter, treatment plan the implants, and then see the patient for a second consultation to review the treatment plan. Because of the significant time and effort required to complete a computerised treatment plan, I generally reserved this process for the more complicated cases or those for which accurate implant placement was critical. Most cases were done the 'old-fashioned way' during this period.

My next revelation came in 2007, when I first saw the GALILEOS cone-beam computed tomography (CBCT) scanner and started thinking about incorporating this into my practice. The beauty of it was not the scanner itself, as most CBCT scanners on the market render a good image; it was the software. GALAXIS and GALILEOS Implant were developed with the dentist in mind, as opposed to most other CT viewing and implant-planning programmes, which were modified from existing medical CT software. With very little instruction, I was able to navigate through the images and start planning implant surgery like an expert.

Sirona, the manufacturer of GALILEOS, hit a home run, in my opinion, when they considered the entire work flow in designing the software suite that was included with their machine. With the simple click of a tab, the same software programme used for viewing the scan diagnostically could quickly and easily be used for treatment planning implants, and then ordering a custom surgical guide.

Once I had brought GALILEOS into my office, life became easier. Now, as soon as my patient was scanned, using a radiographic template, the images could be brought up on the monitor, and then implant planning could begin immediately. What previously took at least 30 minutes of my time and two patient visits was now possible in less than 5 minutes in a single appointment. As a result, cases that I previously considered to be too simple to treat using CT-guided surgery techniques were now suitable candidates. Before I knew it, I was utilising this technology for practically every implant case. The only exception was a case in which a patient could not wait the seven working days that it currently takes to have the surgical guide manufactured. CT-guided implant surgery has the benefits of increased accuracy of implant placement through a smaller, minimally invasive incision. Another major benefit to the implant surgeon is decreased surgical time, which allows one to schedule more patients and more procedures in the day. Of course, this is of little benefit if treatment planning becomes very time-intensive. The beauty of the GALILEOS Implant/siCAT system is in the integration of work flow that makes the implant planning phase rapid and effortless. An additional plus is improved inventory control. Instead of requiring a variety of implant sizes for a single case, the exact fixture diameter and length are predetermined, so only a single fixture has to be ordered per site.

We have traditionally relied on panoramic radiographs and study models to plan our implant placement. Surgical stents have always been used in implantology to aid in this process. The traditional surgical

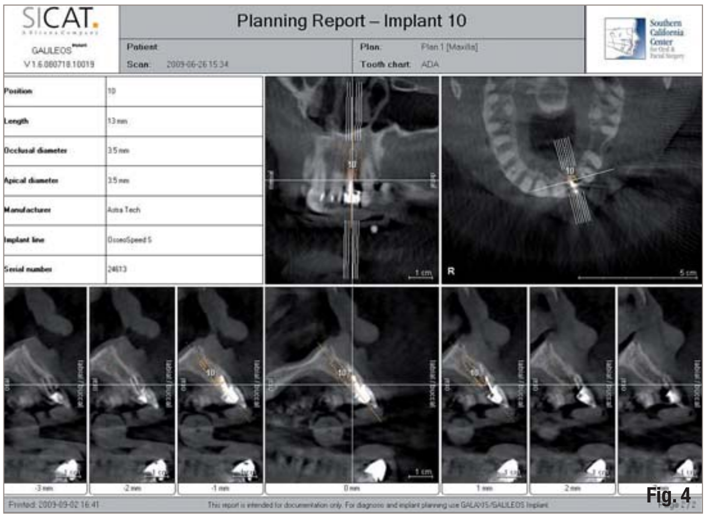


Fig. 4

Fig. 4_GALILEOS treatment planning report demonstrating position of implant in relationship to existing restoration.

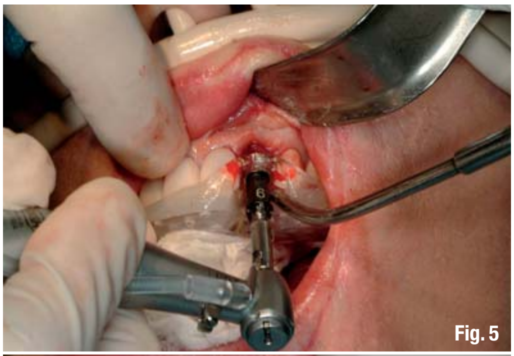


Fig. 5


Fig. 6


Fig. 7

Fig. 5_Placement of implant through siCAT surgical guide using Facilitate Surgical Guide.
Fig. 6_Provisional abutment attached to immediately placed implant.
Fig. 7_Provisional crown on implant immediately after placement.

Fig. 8_Post-implant cross-sectional CBCT image demonstrating good position and angulation in relationship to provisional prosthesis.

Fig. 9_Tangential slice CBCT showing implant and provisional restoration immediately after placement.

guide is made from a wax-up on a stone model that does not allow representation of the true bony anatomy of the underlying edentulous ridge nor the position of adjacent tooth roots. There are various styles of surgical guides that have been in use, ranging from thermoplastic sheets to solid acrylic replicas of the final prosthesis. These guides only estimate the position for the initial drill, leaving this up to the discretion of the surgeon, and do not control the depth of drilling. Sequential osteotomies are then generally drilled free hand. This introduces many opportunities for aberrant implant positioning. Even in the hands of the most experienced implant surgeons, up to 20 % of implant placements vary from their intended position. Dentists need only look in their favourite implant textbook or journal to find examples of textbook cases that are less than perfect. And, I have never met a restorative dentist who has not had his or her share of similar experiences.

Often, these restorative challenges can be managed with custom abutments and other prosthetic tricks, which significantly increase the dentist's laboratory bill and affect the profitability of the case. However, in some cases, the only solution is either to not restore the fixture or to remove it and start over. Anatomical variations also pose challenges, such as a high lingual mylohyoid concavity, a surprise pneumatised sinus, or a divergent root that came a little too close to the implant fixture. We do not like to have to deal with these complications, but even the best of us have faced them more than we like to admit.

Many of my surgical colleagues are of the opinion that CT-guided surgery is unnecessary because they have been placing implants for many years using the technique they learned 15 or more years ago. I completed my surgical training in 1990, and have done more implants than I can count since then. And for the most part, I have a very high success rate, with minimal problem cases of which to speak. But, am I perfect? Of course not. Are my colleagues any better? I don't think so. I strongly believe that CT-guided techniques will become the standard of care for implantology within the next ten years, or sooner. Those clinicians reading this article have already demonstrated an understanding of what new technologies can do for the practice of dentistry. I'm sure that few of you who own dental CAD/CAM systems could imagine practising without them and the benefits that this technology gives to your patients and your practice. The same holds true for CBCT and guided implant surgery.

In September 2009, I was honoured to be the surgeon for the introduction and first live demonstration of the integration of GALILEOS CBCT data with that from a CEREC digital impression and prosthetic proposal. CEREC uses surface-scanning technology to capture a digital impression of the hard and soft tissues around an area where a dental implant is being considered. GALILEOS uses a radiographic source and sensor to image the bony anatomy in the area of interest. The multiple views are then processed by a computer to create a 3-D image of the teeth and bone, which can be viewed in an infinite number of cross-sectional cuts. Both types of images are nothing more than a set of digital data translated into an image that can be viewed on a monitor. Merging these two sets of numbers appears to be a simple process. However, I am not a software engineer; I am just a dentist. Luckily for us,

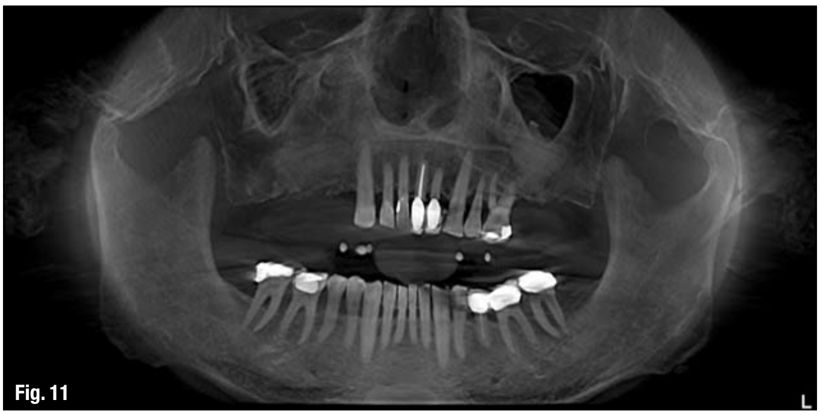
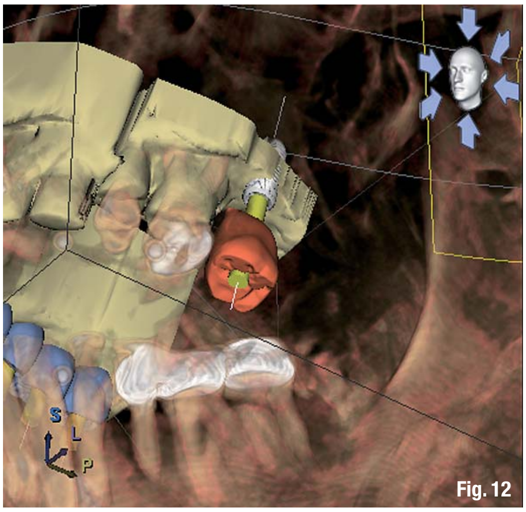


Fig. 10_Clinical photograph of provisional restoration at three months after surgery.

Fig. 11_Panoramic CBCT reconstruction of a 62-year-old male patient missing multiple teeth in the maxilla. Bilateral sinus-lift procedures had been performed six months prior.



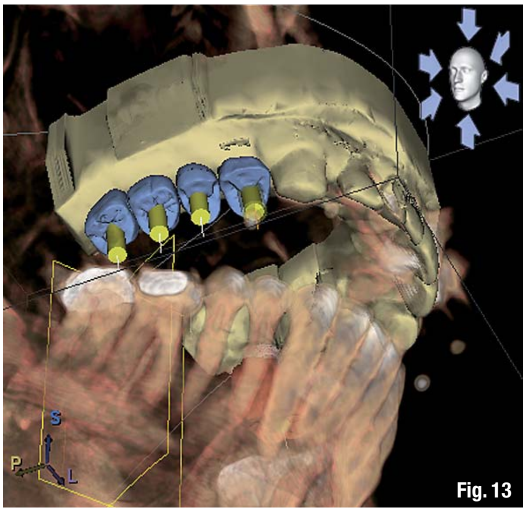


Fig. 12_3-D image reconstruction from GALILEOS Implant software showing implant planning for tooth #15, based on imported CEREC virtual model and prosthetic proposal.

Fig. 13_3-D image reconstruction from GALILEOS Implant software showing implant planning for teeth #2 to 5, based on imported CEREC virtual model and prosthetic proposal.

there are some smart people at siCAT, Sirona's software subsidiary in Germany, whose mandate was to do just that. Their efforts have changed implant dentistry forever. With the integration of CEREC and GALILEOS, we now have the opportunity to practise real digital implantology. The restoration of a patient's missing dentition can be treatment planned in virtual reality, without the need for physical impressions, pour-up study models or wax-up prostheses. The ability to visualise the patient's bony- and soft-tissue anatomy in relationship to the proposed prosthesis is a tremendous advantage in attempting to follow the principles of prosthetically driven implant dentistry. This facilitates restoration, optimises functional forces on the implant fixture, and improves long-term implant success.

Another benefit of CT-guided implant surgery is the ability to perform the procedure through a minimal incision. This is possible because the underlying 3-D bony anatomy is known preoperatively. Also, since the surgical guide directs the position, angulation and depth of each drill, the surgical time is significantly reduced. This translates to an easier post-operative course for the patient. Because the implant is placed in the ideal position, functional loads on the implant fixture are more ideal. This helps maintain optimal peri-implant bone levels and reduces the failure rate. The resulting time saved can be used by the surgeon to schedule another consultation, surgery, or recreational activity.

The following cases demonstrate the types of implant treatment plans that can be treated using 3-D CT-guided surgical techniques through the integration of GALILEOS and CEREC.

_Case I

This first patient was a 70-year-old woman with a failing maxillary left lateral incisor. The tooth had been treated endodontically many years before and had a post-retained fixed prosthesis that was subject to repeated failures (Fig. 1). The tooth was not restorable and a decision was made to remove the tooth and replace it with an immediately placed dental implant and provisional prosthesis (Fig. 2). The patient understood and agreed that the immediate implant and prosthesis would not be placed in function for three months after placement.

A stone study model was made, and the crown of tooth #10 was removed. This modified model was captured by CEREC in order to create a digital model that represented the site after tooth extraction. The opposing dentition was captured in a Futar D

Fig. 14_Panoramic reconstruction of CBCT showing proposed implant positions and abutment screw paths.

Fig. 15_Prepared siCAT surgical guide for Facilitate Surgical Guide.

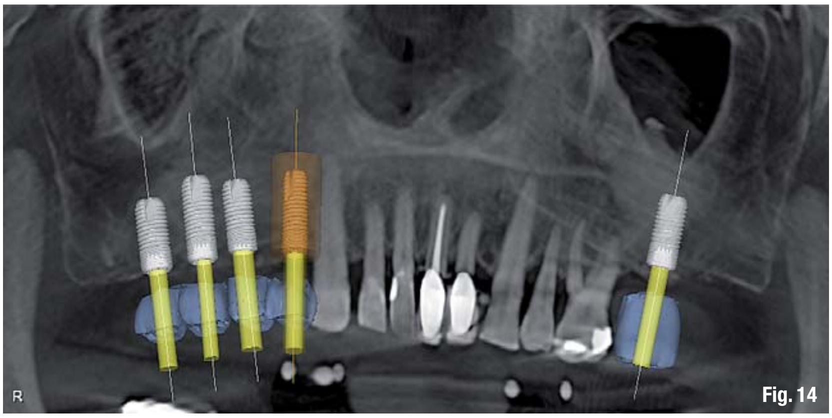


Fig. 16

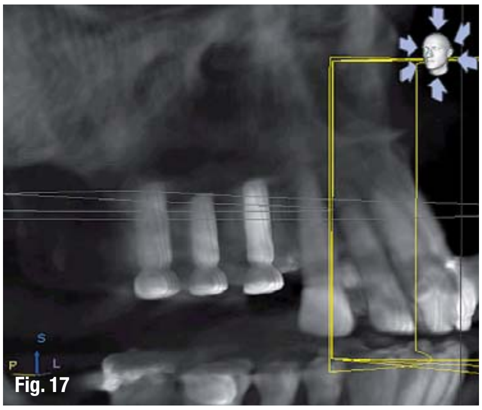


Fig. 17

Fig. 16_Post-op panoramic CBCT reconstruction showing position of placed implants.

Fig. 17_3-D reconstruction of post-op CBCT showing placed implants in the right maxillary posterior region.

(Kettenbach) bite registration and the prosthetic proposal was created in CEREC (Fig. 3). The digital model and prosthetic proposal were then imported into GALILEOS. The ideal implant size and position were determined within the GALILEOS scan, based on the bony anatomy data, as well as the mucosal surface and prosthetic data from CEREC (Fig. 4). The treatment planning data, along with the stone model and a special scanning template were sent to siCAT, and a custom surgical template was returned.

This template was used in surgery once the tooth had been atraumatically extracted in order to direct the placement of the implant fixture into the site of tooth #10. The position, angulation, and depth of implant placement were all controlled by the guide, so that the implant was placed exactly where it had been planned in the 3-D imaging software (Fig. 5). A provisional abutment was placed (Fig. 6), and the patient was sent to her dentist for a digital impression and fabrication of a CEREC-produced provisional crown (Fig. 7). The procedure to remove the tooth and place the implant took under ten minutes. Post-operative GALILEOS scan images indicated accurate implant placement (Figs. 8 & 9). At the three-month follow-up appointment, the provisional restoration was stable. The gingival architecture and tissue health were excellent (Fig. 10).

_Case II

This second case illustrates the tremendous power of the integration of GALILEOS and CEREC for treating the partially edentulous patient. This patient was a 62-year-old man with moderate bone loss due to smoking. He was otherwise healthy. He was missing teeth #2 to 5 and 15, and had undergone bilateral sinus-lift surgery to augment the bony deficiency in the posterior maxilla (Fig. 11). In preparation for implant placement, a GALILEOS CBCT scan was performed with a siCAT scanning template. A full-arch digital impression was acquired with the CEREC AC unit, and then prosthetic proposals were designed for teeth #2 to 5 and 15. This data was then imported into GALILEOS for implant planning (Figs. 12 & 13). The position of the implants was verified (Fig. 14) and the surgical guide was ordered from siCAT (Fig. 15). This was used to place four Astra Tech dental implants accurately using the Facilitate Surgical Guide (Astra Tech). Post-operative radiographs demonstrated that all four implants were accurately placed and in accordance with the treatment plan (Figs. 16 & 17). The patient had an uneventful post-operative course.

One of my favourite cocktails is the Vesper Martini, which was introduced to the world in the novel *Casino Royale* when James Bond asked the bartender to mix him this variation on his standard drink. Bond named the drink after Vesper Lynd, his love interest in the story because, he confessed, as with her, once you've tasted it, that's all you want to drink. CT-guided implant surgery is no different for me. After years of planning and placing dental implants the old-fashioned way I learned in residency, I was given a taste of a new way to do so. It was a radical change at first, but once I knew the recipe, I realised that it was a faster, better and more accurate way to treat my patients. Now, I can't drink anything else. Hopefully, you will give it a taste too and agree._

_about the author

cosmetic dentistry

Dr Jay B. Reznick is a Diplomate of the American Board of Oral and Maxillofacial Surgery. He received his dental degree from Tufts University, and his MD degree from the University of Southern California, and trained in Oral and Maxillofacial Surgery at LA County-USC Medical Center. His special clinical interests are in the areas of facial trauma, jaw and oral pathology, dental implantology, sleep disorders medicine, laser surgery and jaw deformities. He also has expertise in the integration of digital photography, 3-D imaging, and CT-guided implant surgery in clinical practice.

He frequently lectures at continuing education meetings, and has published articles in the *Journal of the American Dental Association; Journal of the California Dental Association; Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology; Compendium of Continuing Education in Dentistry; DentalTown Magazine; CE Digest;* and *Gastroenterology.* Dr Reznick is a founder of OnlineOralSurgery.com, which educates practising dentists in basic and advanced oral surgery techniques. He serves on the editorial and advisory boards of a number of journals and organisations. He is the Director of the Southern California Center for Oral and Facial Surgery (www.sccofs.com) in Tarzana in California, and a consultant for various dental and surgical manufacturers. He can be contacted at jreznick@sccofs.com.