Academy News

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"Output": The final step in digital diagnosis and treatment

By Dr. Stephen M. Schmitt

Advances in digital imaging, solid modeling, and manufacturing are beginning to impact the way we provide implant treatment in our daily practice. We commonly use computed tomography, digital radiographs and photographs for patient evaluation and to communicate with other providers. In the near future, we will be able to integrate this information as three-dimensional data about our patients in a virtual design process that will reduce costs and improve quality. Many of the tools needed for virtual diagnosis and treatment planning have already been created and are used in industry. These same tools and techniques can be easily used in implant dentistry.

Dr. Stephen M. Schmitt

Computed Tomography & Imaging

Many are familiar with digital imaging using computed tomography. In this process, two-dimensional images (slices) are joined to create a three-dimensional virtual computer model of bone, teeth and soft tissues. With this model, it is a simple process to position virtual implants and teeth in their proper orientation to plan for implant placement and bone grafting. This model can also be used to create a digital "drill guide" to use at the time of surgery (Figure 1).

Image data about a patient can also come from clinically scanning the patient's teeth or by scanning models of the patient. Image data from extracted teeth following placement of immediate dentures can also be used to create three-dimensional files for the design of a final restoration (Figure 2).

Imaging can also simplify implant impression procedures, as images of healing abut-

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Interactive treatment planning featured at AO in San Francisco: see page 5

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"Output": The final step in digital diagnosis

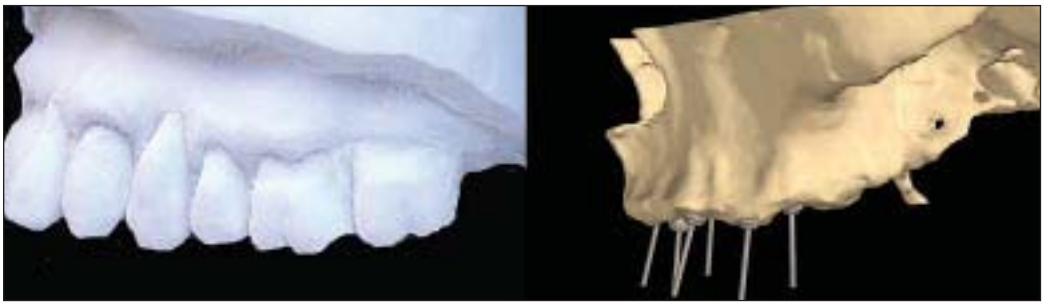

Figure 1: Presurgical cast and virtual model of implant placement.

Figure 2: Extracted teeth and their virtual image.

Figure 3: Healing abutments, computer generated pattern and clinical casting.

Figure 4: Virtual design illustrating tooth position and access to implant.

ments and tissue can be used to design the definitive restoration. We can determine the exact position of each implant since we know the length of the abutments. We can create restorations without removing healing abutments. This saves time and reduces the number of components and instruments needed in the restorative process. It also expands the number of people who can provide implant treatment, since the design process is accomplished at a service center with specialists who understand the many complex problems associated with implant care. Once the design of the restoration has been determined, we can send this information back to the clinician via the Internet with a free viewing program that allows evaluation of the design before its manufacture.

Digitally Manufactured Castings

We can make the actual pattern for the casting several ways, but all of the processes create patterns one layer at a time. Some machines use a laser to cure a photoactive polymer or project light onto a chip with thousands of miniature mirrors that reflect light. Some use inkjet technology to "print" wax as shown in Figure 3. Each system cuts the virtual computer model into slices and then creates the actual three-dimensional part by joining these multiple slices or layers together in an automated process. Once we have created the pattern, it can be invested and cast using conventional alloys and casting processes.

Using this type of system can solve many problems. Since the position of the implants, teeth, soft tissues and opposing occlusion can all be easily joined into a virtual model, the design process becomes much more scientific and precise. Problems can be detected early and corrected before any parts are bought or patterns made. Angulation problems (Figure 4) may require more than one pattern. The virtual design will indicate the ideal position for each specific tooth and its relationship to the supporting implants and soft tissue. Many implant restorations are unique and require special design changes. Since the form of each tooth and the supporting castings have already been

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"An Integrated Approach for Utilization of Emerging Technologies in Medicine and Dentistry," *The Sixth International Conference of Rapid Prototyping*, June 4-7,1995, Dayton, Ohio.

"Changing Peoples' Lives with Rapid Prototyping and Manufacturing," *The 3rd Annual Eugene C. Gwaltney Manufacturing Symposium* presented and published at the Georgia Institute of Technology, October 1, 1996.

"Digitally Designed Denture Attachments," in *Collaborative Techniques*, Volume 3, Number 2, Summer 2003.

and treatment ...continued from page 1

Figure 5. Computer generated pattern and primary gold casting.

Figure 6. Secondary pressed-to-metal casting and primary gold casting.

created, it is possible to generate the primary casting attached to implants or abutments and the secondary casting can be cemented to it (Figure 5).

In addition, we can also create the form of the ceramic from the computer model using pressed to metal technology. This dramatically reduces the amount of time a technician needs to spend on the ceramic build-up, since the form of the pressed ceramic has already been created from the computer model. The technician needs only to add the veneering porcelain to characterize the restoration (Figures 6, 7 and 8).

Cost Saving Process

Digitally designed implant restorations also help reduce the cost of providing implant care. The cost of individual implant components is dramatically reduced or eliminated, because most of the components are saved in the computer as a "library" of virtual parts designed to fit any of the many implants and abutments. If a casting failure occurs, it is a simple process to "print" a new pattern without labor costs. Since the final design of a specific restoration is a three-dimensional computer model, we can easily determine the cross-sectional area, volume, length of cantilevers and use finite element analysis—all before the restoration has been made.

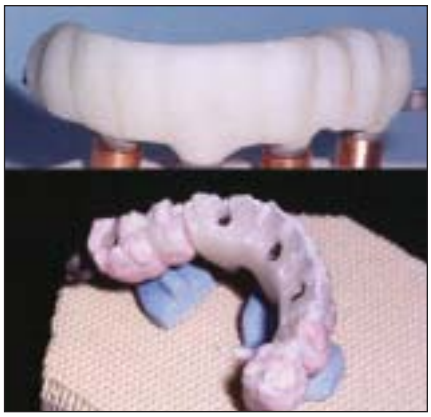

Figure 7. Pressed ceramic and characterization.

Figure 8. Final restoration.

Illustrated Academy history ready for publication; traces growth from 1982 to 2003 Boston Meeting

A history of the Academy, illustrated with photos and other graphics that help to preserve the excitement of the arrival of the technology behind osseointegration, is now ready for publication.

Dr. **Akshay Kumar**, Hackensack, NJ, head of an AO history committee, compiled and wrote the history, drawing on the Academy's archives, interviews with original members and founders, and information provided by others in response to articles in Academy News.

The history traces the Academy's growth from 1982, when Dr. **Per Ingvar Brånemark** and his Swedish colleagues described the concept of osseointegration to a North American audience at Toronto, Ontario, Canada, to last year's Boston Annual Meeting, the first co-sponsored by the American Association of Oral and Maxillofacial Surgeons (AAOMS), the American Academy of Periodontology (AAP), and the American College of Prosthodontists (ACP).

"The Academy has grown as the field of dental implants has risen to great heights," said Dr. Kumar. "The efforts and accomplishments of the original members and founders need to be recognized."

Other members of the history committee are Drs. **Charles L. Berman**, New York, NY, **Jorge E. Barrios**, New York, NY, and **Stephen J. Chermol**, West Chester, PA.

The Academy's Board will consider publication of the history at its meeting in San Francisco.