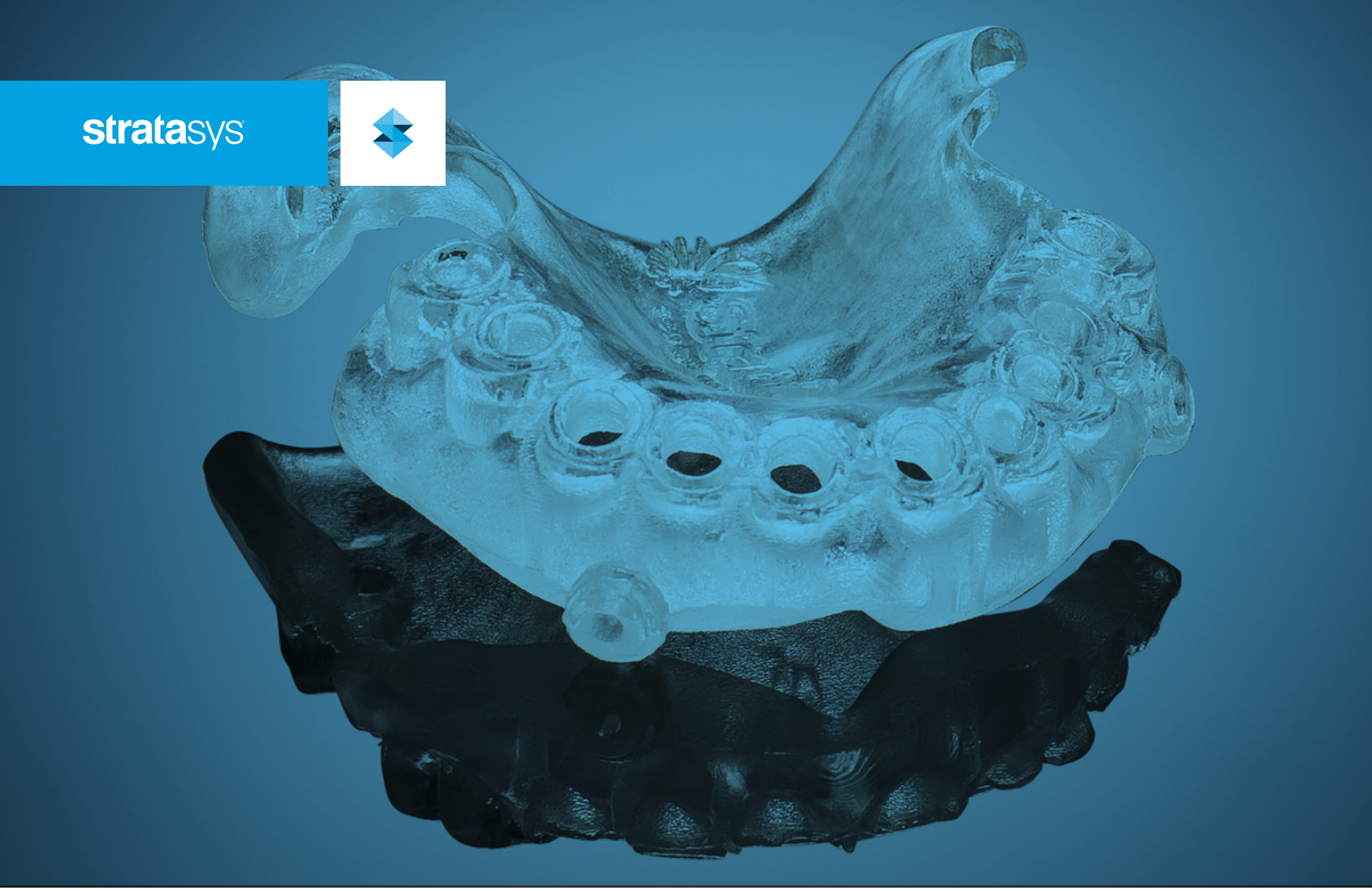

3D Printing and Dental Implants

A NEW METHOD TO CREATE SURGICAL GUIDES ELEVATES THE STANDARDS OF CARE

By Daniel Alter MSc, MDT, CDT

Dental implantology offers a conservative approach to dental treatments for fully or partially edentulous (missing teeth) patients. Placing implants successfully requires a specialized set of skills and expertise to ensure their viability. Digital technology and 3D printing have significantly elevated the rate of success and transformed the workflow and practice of dental implant standards of care. Forward-thinking clinicians and dental laboratories are harnessing the benefits of digital technology to attain the best outcome for their patients, while providing the needed versatility, and cost and time savings. This paper discusses the workflow by which a concise surgical guide may be obtained.

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Dental professionals can create guides for dental implants like this one more efficiently and cost-effectively using 3D printing.

OVERVIEW

Dental patients are searching for options to maintain their oral health's longevity. Implants are a viable solution to replace missing teeth without the need to destroy neighboring healthy dentition. Traditionally, replacing a missing tooth required the patient to undergo a series of preparations on two or more healthy teeth adjacent to the missing tooth to construct a bridge. Although this process satisfied the requirement to replace a tooth, the treatment also cut away tooth structures of the healthy adjacent teeth. Dental implants remove that requirement and are a more conservative approach in replacing the missing tooth. A clinician can place an implant into the site without affecting or damaging the adjacent healthy teeth.

Special consideration is needed prior to placing any dental implants. The location, angulation and size of the implant need to be appropriate and specific to the site, and the clinician should consider the biomechanics of the patient's bone density, sinuses and nerves. Traditionally, surgery was either done by hand, or surgical guides were fabricated on solid stone (gypsum) models or laboratory-fabricated dentures, and holes were pre-drilled to guide the dental surgeon's handpiece. With the advancement of digitization and cone beam computed tomography – also called CBCT – scanning, true guided surgery can be performed.

An intraoral scanner captures an impression of a patient's mouth.

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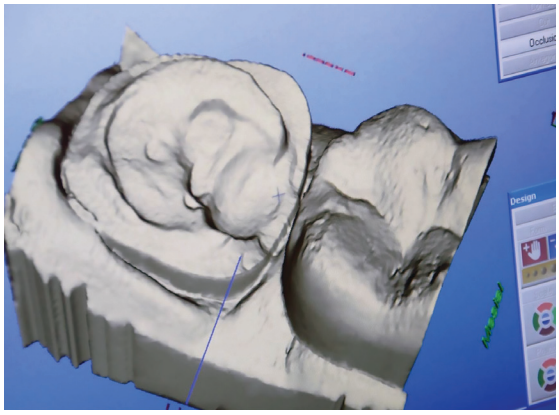

The scan data is processed into an STL file.

GUIDED IMPLANT SURGERY WORKFLOW

The first step in guided implant surgery is to run a cone beam scan on the patient, which provides a wealth of information on the bone, bone density, soft tissue, location and nerves. The DICOM file, or rendering of the patient's anatomy, is integrated into a guided surgery software program. There, the clinician and/or dental technician can virtually place an implant and run a series of tests to ensure its best location outcomes. An impression of the patient's mouth is captured, either digitally with an intraoral scanner or with the analog PVS method, from which a model is created and scanned. This creates an optical scan that provides an STL file that can quickly and simply be overlaid onto the DICOM (cone beam) file and provide a comprehensive STL file to be imported in to the guided surgery software.

In the guided surgery software, the clinician chooses the type of implant system and the implant size. The software automatically generates the implant and allows the clinician to virtually position the implant in the bone. Once the implant and its location are lined up, together with the intraoral scan or optically scanned model, they are integrated and overlaid to become one open-source concise STL file. This comprehensive file can now be manipulated and a surgical guide can be designed.

Designing the surgical guide in the software provides the clinician with the freedom to achieve the optimal results and best treatment protocols, elevating the standard of care. It is fast and easy to plot the location and borders of the guide. Once the plot is selected and all involved areas are considered, the software virtually generates a hole where the drill guide sleeve can be attached.

"This technology provides us with the freedom to do anything possible; if it's possible, we can do it."

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This implant surgery guide was 3D printed in the bio-compatible material.

"The 3D printed surgical guide technology allows me to gain the best aspect of every single guide out there—we can now do more," says Dr. Richard Nejat DDS, a diplomat at the American Board of Periodontology and a periodontist in New York. "This technology provides us with the freedom to do anything possible; if it's possible, we can do it."

Once the implant surgery guide is designed, it is simple to export the comprehensive STL file to a 3D printer to provide a quick and seamless surgical guide. The guide is printed in the Stratasys® bio-compatible (MED610) material, which is certified for contact with the oral environment for a short duration. Specifically, the material is approved for short-term mucosal-membrane contact of up to 24 hours. The hole accepts either a metal sleeve that is glued into the guide, or a predetermined hole is 3D printed and used with a drill-guided sleeve that fits on the dental drill and guides the clinician to the location and depth of the desired implant placement.

REALIZING THE BENEFITS

Dr. Nejat follows the same workflow mentioned above, and broadened his restorative protocol with the use of dual scans. The dual scans provide an additional level of treatment – the patient is scanned while wearing a denture and then again without wearing the denture (this can also be achieved digitally). The dual scans provide more information on guided surgery, because now the data of the patient's teeth or desired future teeth placement is included in the treatment plan and not just bone and site considerations.

Dr. Nejat's office uses the Objet OrthoDesk™ 3D Printer to 3D print the surgical guides for his practice. Guides are printed in the bio-compatible material – a PolyJet™ material – that is deposited in 28-micron layers and built up to full geometry with support material. The support material is later removed, leaving an accurate, clear surgery guide with a hole to guide the drill. These guides can be printed on an as-needed basis or be bundled and printed in batches of seven surgical guides in a seven-hour print cycle. The print time depends on the height of the surgical guide; the higher the guide, the more passes the print head needs to make and the longer the print job will take.

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The Objet OrthoDesk 3D Printer

There are multiple benefits in 3D printing surgical guides in clinical environments. Dr. Nejat says there are three key benefits, with the first being complete customizable control of the surgical guide and treatment protocol. “I can use any implant system and customize the guides to the way I want them to be and as I see it best suits for my patient’s needs and their desired outcomes,” he says.

This was not the case before he could 3D print his own surgical guides. All too often, using an outside vendor to manufacture these guides impeded the process, like the limited options for specific diameters, positioning and support. The main limitation with outside vendors was turnaround time and cost: it typically took two weeks to receive guides, which ranged in cost from $300 to $500 each. With 3D printing, Dr. Nejat now captures the desired attributes from multiple surgical guide vendors and incorporates them into his own 3D printed surgical guide.

The second benefit of digital dentistry Dr. Nejat highlights is a significantly faster treatment protocol and patient turnaround time. A patient can come in, be assessed and both begin and complete treatment in a considerably shortened time period. This enhances the patient’s dental experience, and provides a quicker and better outcome. Lastly, an in-house 3D printer generating these surgical guides provides a significant cost savings: Dr. Nejat estimated a robust average cost savings of 50 percent to 85 percent from previously outsourced surgical guide options.

CONCLUSION

Dental professionals are constantly seeking to improve and elevate the standards of care for their patients; digital technology and 3D printing make this goal easier to attain. Forward-thinking professionals are using these technological solutions to obtain diverse treatments and services for their existing and future clientele. This technological solution provides a business model for practitioners and dental laboratories that is cost-effective, enhancing precision and significantly elevating dental treatments. This results in a better dental experience for the patient and increased longevity and viability of the implant-supported restoration.

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