Dental Implant Workflow in CAD/CAM

By Stratasys

ABSTRACT

Dental implant treatments have experienced an uptrend in recent years. Patients and dental practitioners prefer the more conservative dental treatment protocol, rather than the multi-unit bridge that involves prepping down unaffected teeth. The means by which implants are placed in the bone have become more precise with the advent of emerging technology like cone beam technology and CAD/CAM. The enhanced precision in placement provides better outcomes and longevity for the dental restoration and overall dental health of the patient. This paper demonstrates the advantages of using CAD/CAM in dental implant workflow.

Dental Implant Workflow in CAD/CAM

OVERVIEW

Treatment planning of implant placement has traditionally been performed by reading two dimensional radiographs and conducting visual assessments; it has also relied heavily on the oral surgeon's experience. However, success in implant placement and sustainability depends on multiple factors beyond the aforementioned methods. These variables include bone density, width and girth of the bone, and other patient specific indications. The precise placement of the implants in the bone, including angulation, depth and circumference, all contribute to the success of the implant's osseointegration with the bone. Information gathered through the use of cone beam technology guides implant placement and allows more complex cases to be planned more precisely. This technology, once scanned in the cone-beam apparatus, produces a radiographic digital rendering called DICOM.

A number of CAD software programs have the ability to import cone-beam DICOM files. Once imported, a surgical guide can be designed and produced for highly precise implant placement; at the same time, CAD software can be used to design and manufacture custom implant abutment solutions, as part of the treatment process. Integration of cone-beam and CAD is at the forefront of technology and not widely adopted by all. Even if cone-beam scans and surgical guides are used for implant placement, implant abutments and screw-retained crowns many times are designed and fabricated subsequently, rather than concurrently. Many CAD software providers still offer solutions to integrate digital implant abutment workflow.

IMPLANT WORKFLOW

After an implant has been surgically placed, a recovery period is usually necessary. Healing abutments are placed to maintain the implant out of occlusion, allowing the implant to integrate with the bone. They are also used to help contour the surrounding tissue and ensure proper gingiva contours. To translate the location, angulation and gingival contours of implants to the CAD software, Biomet3i has introduced their Encode® line of healing abutments.

Figure 1: Biomet/3i Encode abutments

Dental Implant Workflow in CAD/CAM

The Encode abutments are coded with a series of flats, grooves or contours that indicate the diameter of the implant. 3M's Chairside Oral Scanner, True Definition, and invisalign®/Cadent's iTero® intra-oral digital impression systems are all capable of scanning the detailed information on the Encode healing abutments. Specialized software is used to identify the implant's depth, angle and position, based on the position and information provided on the Encode abutment.

A digital workflow can now exist, allowing a dentist to scan the Encode healing abutment, followed by the dental technician's design and fabrication of a custom implant abutment or screw-retained crown. A 3D printed or milled physical model can be manufactured by a 3M™ model manufacturing partner or Cadent to verify the position of the implant restoration. A dental laboratory can then precisely create a final restoration to fit over the virtually-produced implant abutment on the physical model.

Major implant companies offer their own custom implant abutment solutions; some are digital and others may be more traditional. For some time there have been third party companies, like Attachments International and Implant Direct, which offer their own branded abutments and abutment parts that are compatible with major implant systems and meet traditional implant needs. Digitally forward companies such as Atlantis™, Glidewell®, and GC Advanced Technologies® are now offering digital solutions that are similarly compatible with major implant systems. Larger laboratories and milling centers are utilizing comparable technology, offering their own variation of the major implant systems' compatible abutments.

IMPLANT SCAN-BODY

A very common digital process for identifying implant positions involves the use of scan-bodies on laboratory-fabricated models. Scan-bodies are usually made out of plastic and have unique geometry. They include flat surfaces, lobes, ridges and other unique contours that help the CAD software accurately identify and precisely position the implant fixture. They may protrude as much as 25mm outside the implant analog. A dentist takes a special implant impression that allows a laboratory to produce a model with an implant replica (analog)

Information gathered through the use of cone beam technology guides implant placement and allows more complex cases to be planned more precisely.

Dental Implant Workflow in CAD/CAM

—

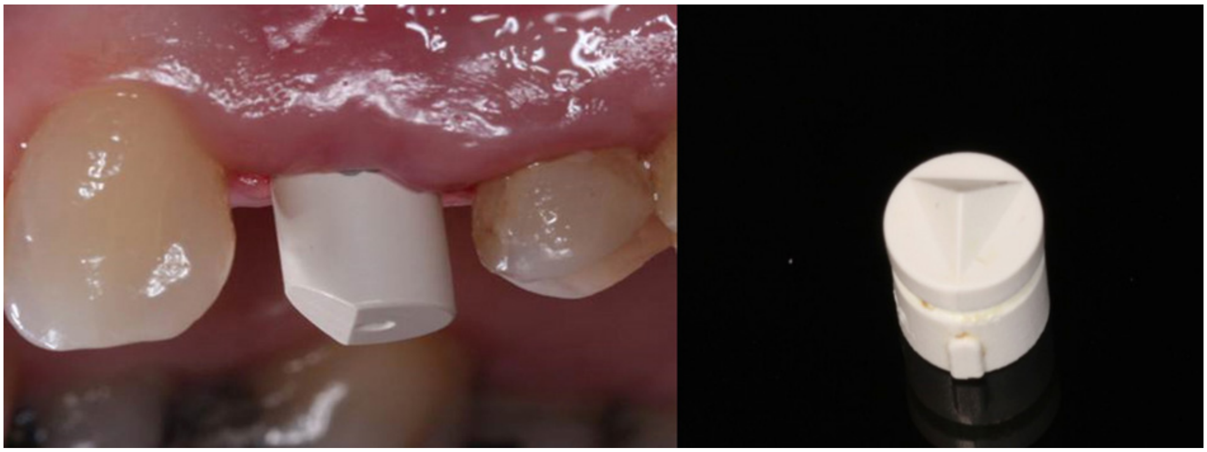

Figure 2: Examples of scan-bodies.

in the precise location of the implant within the patient's mouth. This model provides the location and surrounding dental topography. A scan-body is then placed in the analog and the model is scanned with a laboratory model scanner. An abutment design module, within the dental CAD software, identifies the implant depth, angle and position thereby allowing the custom abutment design to follow.

For ease of use, and in order to benefit from scan flags for multiple implant solutions, Elos Accurate®* offers several options in scanning custom abutments (dental attachments) and bridges for the dental market. Elos Accurate is a high precision scan body specifically made for 3Shape scanners, but can also be adapted for additional scanning systems.

The Elos Accurate utilizes three unique components. First, a PEEK cylinder with excellent optical properties makes the geometry easily recognizable to the scanner and eliminates the

Figure 3: Abutment scan-body

* The Elos Accurate product line currently consists of the following systems: NobelReplace™, NobelActive™, Brånemark™, AstraTech Osseospeed™, Biomet 3i Certain Osseotite™, Biomet 3i Certain™ External Hex, Straumann Bonelevel™, Zimmer Screwvent™ and Neoss Implant System™.

Library files for 3Shape scanners are included with the scan bodies.

Figure 4: Abutment bridge with CEREC

need for optical spraying. Then, a color-anodized titanium interface makes the implant/analog connection durable so that it can be used repeatedly and its color-coded scan flags can choose the correct scan flag for the correct implant size. Finally, a titanium screw is integrated into the PEEK cylinder to ensure that the screw is not lost. What's more, the same screw is used for all implant sizes and systems, so separate screwdrivers are not necessary.

Implant abutment manufacturers produce their own unique scan-bodies. Glidewell branded scan-bodies are the only ones that can be used to scan, design and fabricate Glidewell branded abutments. Similarly, Atlantis scan-bodies can only be used for Atlantis abutments. Generally an abutment manufacturer creates scan-body libraries that are added to CAD software programs. Glidewell and NT Trading have scan-body libraries available for 3Shape and exocad®-based CAD programs, while Atlantis has partnered with Dental Wings® to offer their scan body library. The scan-bodies mentioned are all approved for external use on laboratory models; however, great efforts are being forged to provide intra-oral scan-bodies for use in intra-oral scans. Straumann has an approved workflow that utilizes an intra-oral scan body that can be scanned by the iTero digital impression system. Theoretically other scan-bodies could be used intra-orally, but FDA approvals of the process and materials may be in question.

Many are familiar with the Sirona® custom abutment solution using scan-bodies, precision titanium bases, and abutment meso blocks. The inLab™ 4.2 software extends this capability to multi-abutment bridges. The process is similar to manufacturing a single implant abutment in that you first image the scan-body and then proceed to design the abutment(s). It is now possible to create two parallel abutments and a full contour bridge — a complete digital solution with a single design.

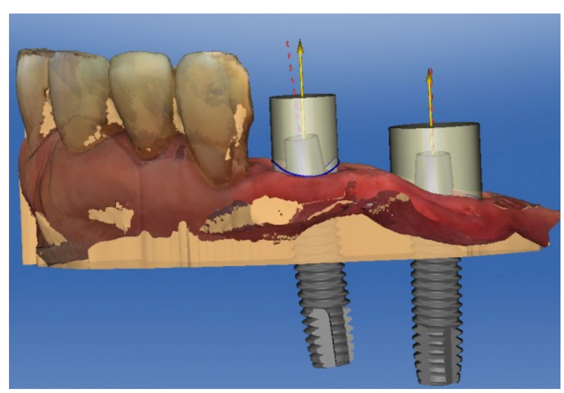

Figure 5: Abutment bridge with Sirona inLab 4.2 software

SOFTWARE SOLUTIONS FOR IMPLANT ANALOGS	SUPPORTED ANALOGS AND SCAN BODIES
3Shape	Glidewell, NT Trading, 3i, GC Advanced Technology (Medentika® and other European implant systems)
exocad	Glidewell, NT Trading, CAMLOG, Medentika, Weiland, Zfx (Zimmer)
Dental Wings	Atlantis, Straumann
Procera	Nobel Biocare®

Figure 6: Software solutions for implant analogs, support analogs and scan bodies

CONCLUSION

Dental implant treatment plans are becoming increasingly popular, and by embracing digital technology, the precision, success and longevity of the implant treatment dramatically increases. It is recommended that dental professionals remain at the forefront of such technologies in order to maintain a competitive position. Aligning themselves with like-minded digital companies that share similar enthusiasm and excitement for the future will yield multiple shared benefits. The final outcome is an enhanced dental implant treatment protocol for the patient.

info@stratasys.com

STRATASYS.COM

HEADQUARTERS
7665 Commerce Way, Eden Prairie, MN 55344
+1 888 480 3548 (US Toll Free)
+1 952 937 3000 (Intl)
+1 952 937 0070 (Fax)

2 Holtzman St., Science Park, PO Box 2496
Rehovot 76124, Israel
+972 74 745-4000
+972 74 745-5000 (Fax)

THE **3D PRINTING SOLUTIONS** COMPANY