Combined Stereophotogrammetry and Laser-Sintered, Computer-Aided Milling Framework for an Implant-Supported Mandibular Prosthesis: A Case History Report

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This case history report describes the fabrication of a mandibular prosthesis for an edentulous patient with four implants. Impressions were made with a photogrammetry system, and the framework was manufactured using cobalt-chromium laser sintering, later milled at the implant connection level, and then coated with a composite resin. The described protocol suggests that the employed manufacturing technologies readily lend themselves to routine management of the edentulous mandible, although further research and long-term clinical data are clearly needed. *Int J Prosthodont 2018;31:60–62. doi: 10.11607/ijp.5259*

Passive fit of an implant-supported prosthesis is believed to improve its long-term outcome and is an important criterion for maintaining successful osseointegration.[1] Fulfilling this objective depends on the accuracy of the employed clinical protocol, from impression making to framework manufacturing.

Impressions may be made with conventional methods using impression materials in custom trays or digitally by means of an intraoral scanner. Photogrammetry is a technique using three-dimensional (3D) coordinate measurements to determine the spatial position between the presence of two or more implants from photographic images.[2,3] It is also currently used to record the position of multiple implants that may be present.

Subsequent framework fabrication has traditionally relied on a casting technique; however, the introduction of automated processing technologies, such as direct metal laser sintering (DMLS) or computer-aided milling, now offers exciting alternatives for prosthesis fabrication.[4]

This report describes the use of new computer-assisted technologies in the fabrication of a fixed implant-supported mandibular prosthesis in an edentulous patient.

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Case History

A 69-year-old male patient presented at the University Complutense Dental Clinical Faculty in Madrid, Spain and requested prosthodontic treatment for his compromised masticatory function associated with his few remaining teeth. The diagnostic criteria included clinical examination, intraoral pictures, radiographic examination (ie, panoramic film and computed tomography [CT]), and diagnostic cast assessment. No contraindications to a preprosthetic surgical intervention were present, and an implant-supported prosthesis was prescribed.

Four implants (TSV, Zimmer Dental) were placed. Following a healing period, their position was recorded using a photogrammetry technique (PIC Camera, PicDental) (Fig 1a).

Patient data, the arch to be rehabilitated, implant data (area, position, and technical data), and the scan bodies code (PIC abutment) were recorded and introduced into the system (PIC Pro Software). PIC abutments were screwed onto the implants and the PIC camera took the pictures, creating a stereolithography (STL) file (PIC file) (Fig 1b). A mandibular irreversible hydrocolloid impression (Hydrogum 5, Zhermack), with the healing abutments screwed onto the implants, was taken, poured in stone (GC Fuji Rock EP, GC), and digitized by an extraoral scanner (Dental Wings) to create a second STL file to record the patient's soft tissues. This file was aligned and merged with the PIC file using Exocad software (Exocad), resulting in a new digital archive integrating the soft tissues and the implant positions (Fig 2a). The working model was fabricated out of epoxy resin by STL. The antagonist arch was also recorded and digitized by

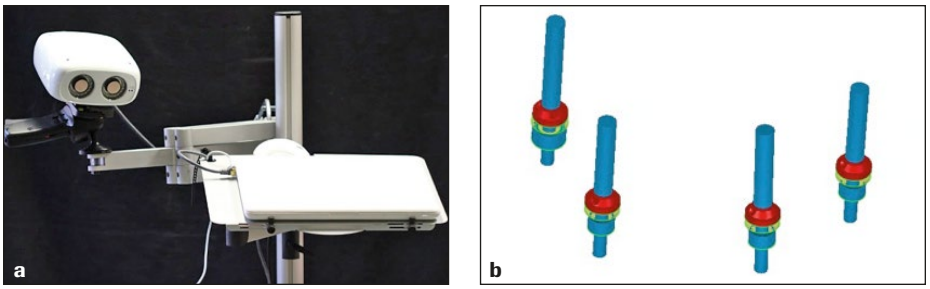

Fig 1 **(a)** PIC camera device. **(b)** PIC file showing implant position vectors.

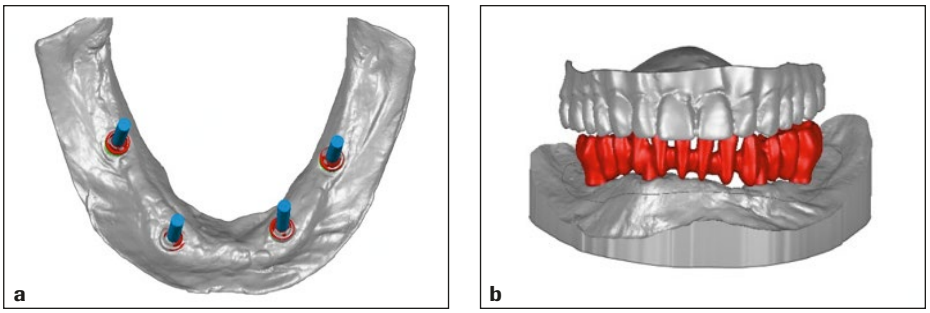

Fig 2 **(a)** Alignment of the PIC file and second digitized model showing patient's soft tissues using Best-fit (Exocad). **(b)** Frontal aspect of the framework design.

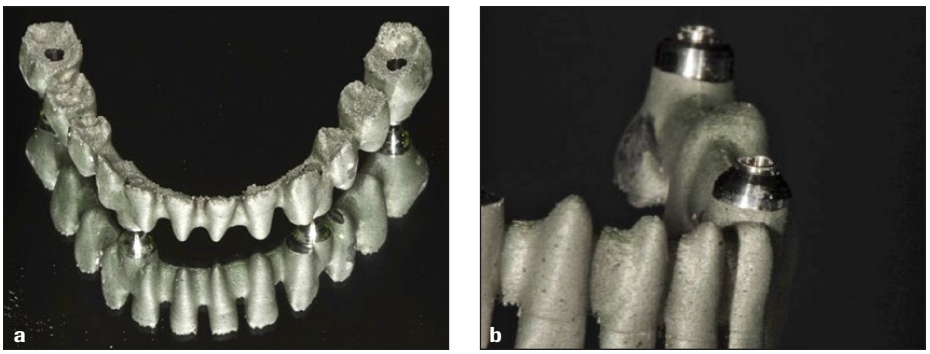

Fig 3 **(a)** View of the laser-sintered Co-Cr framework. **(b)** Detail of the milled connections.

Fig 4 Occlusal view of the finished implant-supported mandibular prosthesis.

the extraoral scanner. A denture wax try-in was made to determine the teeth position and to verify the vertical dimension. The tooth test was then scanned to allow the two arches to be related in the software.

The metal framework was designed with Exocad software in STL format (Fig 2b) and laser sintered (ConceptLaser) with a cobalt-chromium (Co-Cr) powdered base metal alloy (Fig 3a). The connection of the framework to the implants was sintered oversized to be later milled by five-axis milling (Ultrasonic 10, DMG Mori) to create an optimal fit (Fig 3b).

Passive fit was checked in the patient's mouth using Sheffield test, screw resistance test, and visual fit probe test, and intraoral radiographs were made. All tests indicated a correct fit between the implant prosthetic connections and the framework. The technician finished the prosthesis with a composite resin (Signum Composite, Heraeus Kulzer) (Fig 4). Lastly, the prosthesis was screwed onto the implants, and occlusal adjustments were carried out to achieve a bilateral balanced occlusion, given that the opponent arch was an overdenture.

The patient was examined at 1 week, 6 months, 1 year, and 2 years follow-up, with no technical (ie, screw loosening or fracture, prosthesis complications) or biologic (ie, health of peri-implant tissues, peri-implant marginal bone loss) complications. Patient satisfaction regarding function and esthetics was positive at all examinations.

Discussion

Photogrammetry permits placement of the planned and precise positions of the implants, plus the preparation of a computer-aided design/computer-aided manufacturing (CAD/CAM) structure with a proper fit.[2,3] It is performed quickly and allows for accurate impression making, even in the presence of blood and despite the patient not being completely immobile.[2]

DMLS is a promising technology, recording lower discrepancies than for cast Co-Cr.[4] However, the accuracy of DMLS is questioned because of the surface roughness of the laser-sintered metals, which might deform the implant head when screwed to it. Very few studies have compared the fit of cast Co-Cr, DMLS, and computer-aided milling, and the results are controversial.[5] The present case report presents a combination of DMLS and milling (sintermilling) to fabricate the framework. The DMLS significantly reduces production costs and provides better anatomical reproduction. The connection of the structure to the implant was milled to achieve an adequate passive fit of the prosthesis.

This preliminary, single case history report from a developing prospective clinical trial suggests clinical promise. However, it is readily acknowledged that long-term outcome studies are needed if the described technologies are to be recommended for routine clinical practice.

Conclusions

Prosthodontic management of a single edentulous mandibular arch with a prosthesis fabricated using photogrammetry combined with sintermilling appears to provide an accurate technique for obtaining a passive framework fit. Further studies are necessary to fully determine the merits of these new technologies.

Acknowledgments

The authors reported no conflicts of interest related to this study.

References

1. Wee AG, Aquilino SA, Schneider RL. Strategies to achieve fit in implant prosthodontics: A review of the literature. Int J Prosthodont 1999;12:167–178.
2. Agustín-Panadero R, Peñarrocha-Oltra D, Gomar-Vercher S, Peñarrocha-Diago M. Stereophotogrammetry for recording the position of multiple implants: Technical description. Int J Prosthodont 2015;28:631–636.
3. Sánchez-Monescillo A, Sánchez-Turrión A, Vellon-Domarco E, Salinas-Goodier C, Prados-Frutos JC. Photogrammetry impression technique: A case history report. Int J Prosthodont 2016;29:71–73.
4. Oyagüe RC, Sánchez-Turrión A, López-Lozano JF, Suárez-García MJ. Vertical discrepancy and microleakage of laser-sintered and vacuum-cast implant-supported structures luted with different cement types. J Dent 2012;40:123–130.
5. Tamac E, Toksavul S, Toman M. Clinical marginal and internal adaptation of CAD/CAM milling, laser sintering, and cast metal ceramic crowns. J Prosthet Dent 2014;112:909–913.

Literature Abstract

Fixed vs Removable Complete Arch Implant Prostheses: A Literature Review of Prosthodontic Outcomes

The aim of this study was to compare the prosthodontic outcomes of implant-supported, fixed complete dentures to those of implant overdentures. A literature search was performed in the Cochrane Library and Medline (PubMed) databases with MeSH terms for studies that included implant-supported fixed complete dentures and implant overdentures, with the results based on studies that compared both types of prostheses. The following six categories of comparative studies were identified in the literature: *(1)* implant and prosthesis survival; *(2)* prosthesis maintenance/complications; *(3)* bone changes; *(4)* patient satisfaction and quality of life; *(5)* cost effectiveness; and *(6)* masticatory performance. It was determined that both the fixed and removable prostheses were associated with high implant survival rates; however, both types were also impacted by the need for postplacement mechanical maintenance or prosthetic complications. More maintenance/complications occurred with implant overdentures than with fixed complete dentures, and residual ridge resorption was greater with implant overdentures. Patient satisfaction was high with each prosthesis, with three studies reporting higher satisfaction with fixed complete dentures and five studies finding no difference. All but one study on cost effectiveness indicated implant overdentures were more cost effective. Based on two studies, it appears that masticatory performance with implant-supported fixed complete dentures is comparable to that with implant overdentures. Multiple factors must be considered when determining whether an implant-supported fixed complete denture or implant overdenture is best suited for a completely edentulous patient.

Goodacre C, Goodacre B. *Eur J Oral Implantol* 2017;10(suppl):S13–S34. **References:** 108. **Reprints:** Charles Goodacre, cgoodacre@llu.edu
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