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CLINICAL REPORT

Fabrication of a bicomponent hybrid orbital prosthesis

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ABSTRACT

This clinical report describes the management of the retention of an orbital prosthesis in a patient with uncontrolled diabetes. The patient, who underwent left orbital exenteration subsequent to severe mucormycosis, posed a challenge for implant placement and for use of adhesives as a method of retention because of the high likelihood of reinfection. Inaccessibility to severe anatomic undercuts along with their arbitrary block out would have caused diminished retention. As a result, an orbital prosthesis composed of a digitally produced hollow conformer and traditionally produced silicone prosthesis was provided using 3-dimensional imaging and rapid prototyping, with optimum retention. (J Prosthet Dent 2019;122:568-72)

The rehabilitation of extensive orbital defects has been challenging, with different retentive mechanisms used to secure prostheses that include eye patches, spectacle frames, denture extensions, magnets, adhesives, and osseointegrated implants.[1] However, each has its own specifications and limitations. Adhesives and double-sided tape have been associated with skin infections, breakdown of margin, and difficulty in prosthesis positioning.[2] Medical conditions such as uncontrolled diabetes, immunodeficiency diseases, and irradiation limit the use of osseointegrated implants.[3,4]

This clinical report describes the management of retention of an orbital prosthesis in a patient with uncontrolled diabetes. The patient, who underwent left orbital exenteration subsequent to rhino-orbital mucormycosis, posed a challenge for implant placement and for prosthetic adhesive use because of the likelihood of reinfection. Using an existing anatomic undercut to retain the prosthesis was considered the option of minimal intervention.[5]

Inaccessibility to severe anatomic undercuts and their arbitrary block out may result in diminished retention.[6] To overcome this challenge, 3-dimensional (3D) digital imaging and rapid prototyping have been adopted.[7] Rapid prototyping has yielded success in terms of precision, esthetics, and reduced treatment time.[8]

This report describes the fabrication of an orbital prosthesis composed of a digitally produced acrylic resin conformer and traditionally produced silicone prosthesis. The 3D visualization of the defect along with precise control over the depth of the favorable undercut used ensured optimum retention of the prosthesis.

CLINICAL REPORT

A 57-year-old man reported to the Department of Prosthodontics, Maulana Azad Institute of Dental Sciences, New Delhi, with the chief complaint of a missing left eye (Fig. 1). A radical procedure of orbital exenteration was conducted to treat rhino-orbital mucormycosis subsequent to uncontrolled diabetes. The defect site consisted of a deep inferior-medial and a shallow superior-medial undercut with an otherwise intact superior, lateral orbital rim and orbital floor. The zygomatic arch was also removed during the procedure, thus making retention of the prosthesis more challenging. The patient had previously been using a silicone orbital prosthesis fabricated using the conventional technique.[9] However, signs of adverse skin

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Figure 1. Preprosthetic image of patient.

reaction were observed because of the use of adhesive. It was thus decided to eliminate the use of the adhesive in the replacement prosthesis.

From a recent magnetic resonance imaging (MRI) scan, digital imaging and communications in medicine (DICOM) images were viewed in a DICOM viewer (RadiAnt; Medixant) (Fig. 2). The inner conformer was then designed by using 3D software (Rhinoceros; McNeel & Associates). This software enabled virtual visualization of the defect and delineation of the boundaries and undercuts created by bony contours. The conformer was designed by using the anatomic undercuts. Special consideration was given to blocking out severe undercuts to facilitate smooth insertion and removal of the prosthesis without jeopardizing retention. Digital surveying was conducted to block out extreme contours. The shallow superior-medial undercut was completely harnessed (Fig. 3 and Supplemental Video 1). The conformer was designed with an internal hollow body to reduce the weight of the prosthesis and to facilitate the hygiene of the entire prosthesis (Fig. 4).

Once the design was finalized, the conformer was rapidly prototyped in polylacticacid (PLA) by fused deposition modeling (FDM; Sagmarks Pvt Ltd) by using a high-resolution 3D printer (Form 2; FormLabs) (Fig. 5). A trial was done on the patient to evaluate fit and stability. The

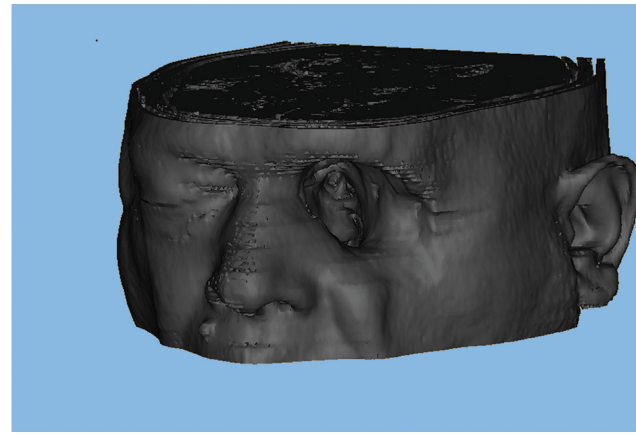

Figure 2. DICOM image of defect. DICOM, digital imaging and communications in medicine.

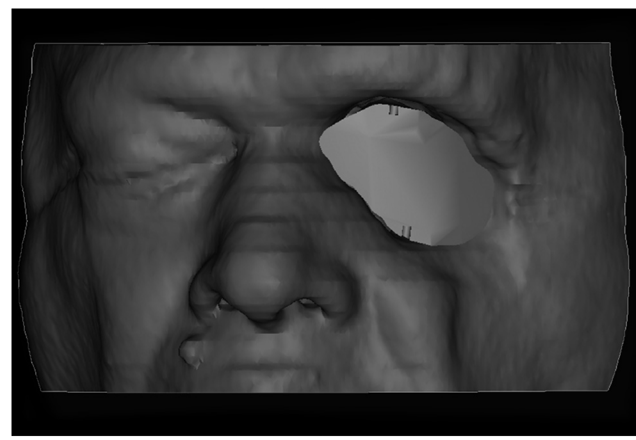

Figure 3. Delineation of defect by conducting digital surveying.

patient was instructed to perform functional movements, including bending his head forward, opening and closing his jaw, and raising his eyebrows to verify retention.

The PLA structure was then duplicated in heat-polymerizing polymethyl methacrylate (PMMA) resin (Trevalon; Dentsply Sirona) to ensure biocompatibility of the prosthesis.[10] This involved duplication of the PLA conformer in agar (Delta; Vijai Dental Depot). The resultant mold was poured with wax, which was then invested, boiled out, and formed with heat-polymerizing resin (Trevalon; Dentsply Sirona). The conformer could not be directly invested in plaster owing to the presence of rigid undercuts and incomplete burnout of the polylactic acid. At this stage, the retention and stability of the heat-polymerized conformer was reevaluated within the defect (Fig. 6). Once verified, the external silicone prosthetic component (Cosmesil; Principality Medical Ltd) was fabricated manually. The wax pattern was completed, and the symmetry was verified using grid software (Grid#; Jinpeng Wang). The iris disk was carefully positioned (Fig. 7).

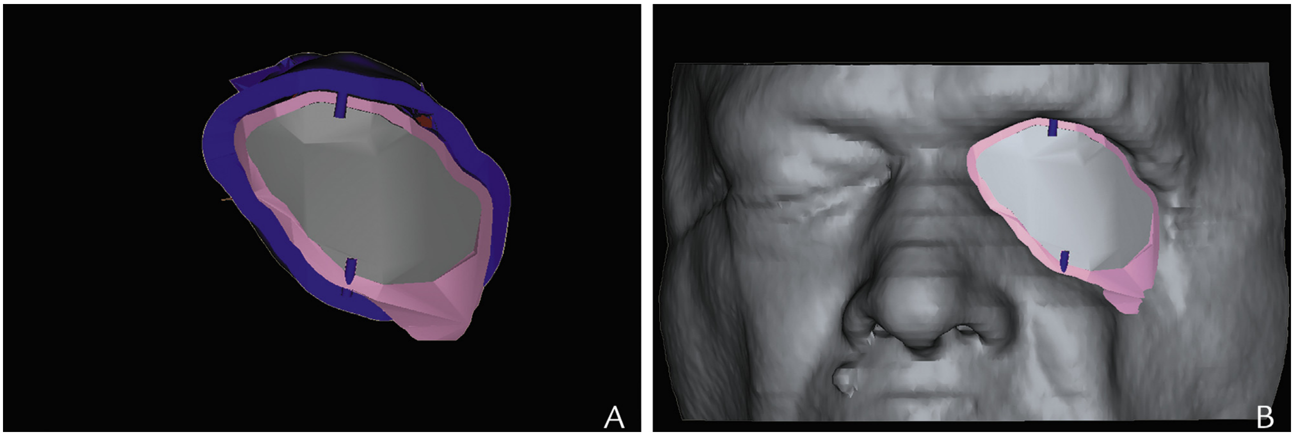

Figure 4. A, Designing hollow conformer. Pink boundary signifies hollow conformer and blue boundary depicts bony contours of defect. B, Placement of hollow conformer in defect.

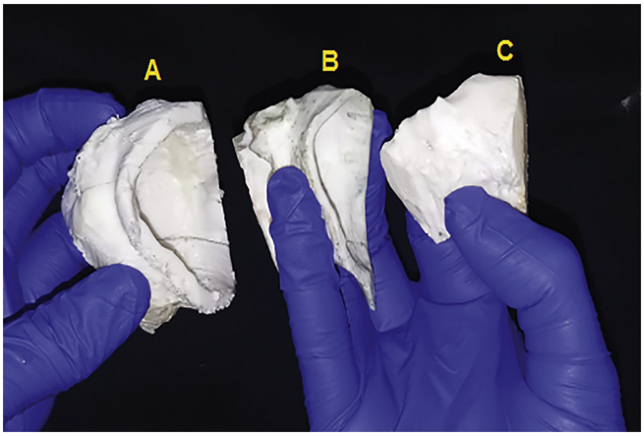

Figure 5. Three-dimensional–printed hollow conformer. Images signify succession of treatment planning. A, Defect boundary. B, Hollow conformer. C, Carved out solid defect.

A lid of autopolymerizing resin was fabricated on the frontal aspect of the conformer, which was grooved to retain the silicone portion. Hence, the silicone was attached to the acrylic resin conformer with the help of mechanical interlocking, together with the application of an adhesive (A-330G; Technovent) on the surface of the resin. Once finalized, the inner conformer and the external wax pattern were oriented with the help of light-body polyvinyl siloxane (Affinis; Coltène). Flasking, boil out, and packing of the combined conformer and wax pattern were carried out. After boil out, the room temperature–vulcanizing silicone (Cosmesil; Principality Medical Ltd) was dispensed and mixed with intrinsic colors (Functional Intrinsic 2; Factor 2) to obtain the base shade. The obtained prosthesis was finished and shaded extrinsically to match the surrounding skin shade. The definitive prosthesis was evaluated for fit, esthetics, and comfort (Fig. 8, Supplemental Video 2).

The patient was given instructions regarding the maintenance of the prosthesis. He was also instructed to keep the defect area clean, with emphasis on the fragility of the prosthesis. As the prosthesis was extrinsically stained, he was advised to avoid direct exposure to sunlight. The patient was evaluated periodically for a period of 6 months.

Figure 6. Acrylic resin conformer evaluated for fit and retention while performing movements including opening and closing of mouth and raising eyebrows.

Figure 7. Wax pattern of definitive silicone prosthesis over hollow conformer.

Figure 8. Definitive prosthesis.

During the follow-up period, fading of the extrinsic stains was noticed, but the retention was not compromised.

DISCUSSION

Rehabilitation of defects as a result of exenteration involves a multidisciplinary approach. For this patient, the presence of a large orbital defect eliminated the possibility of a surgical intervention. It was therefore decided to rehabilitate the defect prosthetically.

The present method relied on anatomic undercuts for retention. However, unlike the conventional method, in which the undercuts are blocked arbitrarily, the use of digital surveying ensured optimum blocking. This ensured predictability in terms of retention. The patient was able to carry out functional movements including mastication, speaking, and smiling without loss of retention. Use of a digital approach was not only efficient but also ensured uniform hollowing.

Silicone material has been associated with fungal and bacterial growth.[11] Use of acrylic resin for the internal conformer was therefore advantageous. Digital imaging also resulted in little or no discomfort to the patient. The data used to fabricate the internal conformer can be saved, thereby eliminating the need for a repeat scan, as well as steps in future prosthesis fabrication.

A prerequisite to adopting this method is the presence of one or more favorable anatomic undercuts. The expensive equipment involved in the fabrication of the inner conformer makes it less cost-effective than the traditional method.

CONCLUSIONS

This method of fabricating an orbital prosthesis is predictable yet less complex in its approach. It is especially recommended for patients in whom orbital implants cannot be placed or where prolonged use of adhesive may result in infection.

REFERENCES

1. Pruthi G, Jain V, Sikka S. A novel method for retention of an orbital prosthesis in a case with continuous maxillary and orbital defect. J Indian Prosthodont Soc 2010;10:132-6.
2. Kiat-amnuay S, Gettleman L, Khan Z, Goldsmith LJ. Effect of adhesive retention on maxillofacial prostheses. Part I: skin dressings and solvent removers. J Prosthet Dent 2000;84:335-40.
3. Diz P, Scully C, Sanz M. Dental implants in the medically compromised patient. J Dent 2013;41:195-206.

4. Naujokat H, Kunzendorf B, Wiltfang J. Dental implants and diabetes mellitus-a systematic review. Int J Implant Dent 2016;2:5.
5. Wadud A, Jamayet N, Srithavaj T, Alam M. Use of anatomical undercut in adhesive retained orbital prosthesis: an alternative to osseointegration to improve retention and reduce margin gap. Br J Med Med Res 2015;6:841-7.
6. Curi M, Oliveira M, Molina G, Cardoso C, De Groot Oliveira L, Branemark P, et al. Extraoral implants in the rehabilitation of craniofacial defects: implant and prosthesis survival rates and peri-implant soft tissue evaluation. J Oral Maxillofac Surg 2012;70:1551-7.
7. Ye H, Ma Q, Hou Y, Li M, Zhou Y. Generation and evaluation of 3D digital casts of maxillary defects based on multisource data registration: a pilot clinical study. J Prosthet Dent 2017;118:790-5.
8. Tasopoulos T, Kouveliotis G, Polyzois G, Karathanasi V. Fabrication of a 3D printing definitive obturator prosthesis: a clinical report. Acta Stomatol Croat 2017;51:53-9.
9. Shrestha B, Goveas R, Thaworanunta S. Rapid fabrication of silicone orbital prosthesis using conventional methods. Singapore Dent J 2014;35:83-6.
10. Frazer R, Byron R, Osborne P, West K. PMMA: an essential material in medicine and dentistry. J Long Term Eff Med Implants 2005;15:629-39.
11. Ariani N, Vissink A, van Oort RP, Kusdhany L, Djais A, Rahardjo TB, et al. Microbial biofilms on facial prostheses. Biofouling 2012;28:583-91.

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Noteworthy Abstracts of the Current Literature

Functional outcomes and quality of life after segmental mandibulectomy and reconstruction with a reconstruction plate or bone graft compared to a digitally planned fibula free flap

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Purpose. To compare oral function and health-related quality of life (HRQoL) in patients reconstructed with either a reconstruction plate or a free vascularized bone flap with or without 3D planning.

Material and methods. Patients from the Institute for Reconstructive Sciences in Medicine, University Medical Center Utrecht, and Radboud University Medical Center were included. This cross-sectional study assessed objective masticatory performance with the mixing ability test (mixing ability index [MAI]), maximum bite force, maximum mouth opening, and HRQoL. Differences between groups were analyzed using analysis of variance or Kruskal-Wallis test for continuous variables and chi-square test for categorical variables.

Results. Six patients with digitally planned resections and reconstructions were included. For comparison, five patients treated with freehand bone reconstruction and four patients treated with plate reconstruction were also included. Mixing ability was superior in 3D-planned reconstructions (MAI: 20.7 ± 6.7) compared to plate reconstructions (MAI: 30.0 ± 0.1, P=.017) and freehand reconstructions (MAI: 29.5 ± 1.1, P=.017). Maximum mouth opening, bite force, and HRQoL differences did not reach statistical significance.

Conclusions. This study indicated a possible benefit to masticatory performance of adequate surgical planning for one-phase reconstruction using 3D technology. A larger prospective study is necessary to gain more evidence regarding this finding.