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Case Report

Computer-aided design and 3D printing in maxillofacial prosthodontics: A case of auricular rehabilitation

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Abstract

The replacement of lost or damaged craniofacial structures is a vital aspect of maxillofacial prosthodontics, as it not only restores facial esthetics but also provides psychological reassurance to the patient. This article presents a case report of a patient with a right-sided unilateral auricular defect rehabilitated with a silicone prosthesis fabricated using computer-aided techniques. A conventional impression of the contralateral ear (left) was obtained, and the resulting model was scanned using an optical surface capture device. The digital image was then mirror-imaged with the aid of computer-aided design (CAD) software and subsequently fabricated through three-dimensional (3D) printing.

Keywords: Prosthetic rehabilitation, Auricular prosthesis, Scanner, Computer-aided design (CAD), 3D printing.

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1. Introduction

The fabrication of an extraoral facial prosthesis requires a delicate balance of art and science. Its shape, colour, and texture must harmonise with the surrounding natural tissues to achieve a lifelike appearance. An ideal prosthesis should mimic the missing facial structures so accurately that it is indistinguishable to the casual observer. Ultimately, the success of rehabilitation depends on restoring a patient's confidence to appear in public without fear of unwanted attention.[1]

Maxillofacial reconstruction often involves artificial replacement of both intraoral and extraoral structures, such as the eyes, ears, nose, maxilla, mandible, cranial bones, palate, and even the oesophagus. Depending on the anatomical requirements, prostheses are most commonly fabricated using silicone or acrylic resin. Retention and support of extraoral prostheses can be achieved through osseointegrated implants, residual skin with or without adhesives, natural body cavities, or teeth.[2]

Rehabilitation of unilateral auricular defects presents unique challenges, particularly in replicating the natural convolutions, symmetry, and contours of the contralateral ear. Achieving normal posture and appearance requires careful consideration of esthetics and function. The introduction of advanced medical-grade silicones and intrinsic/extrinsic colorants has significantly enhanced the realism of prosthetic outcomes. Moreover, the integration of digital technologies such as optical scanners and computer-aided design (CAD) has greatly simplified impression-making and reduced the number of preliminary clinical and laboratory steps required for fabricating auricular prostheses. This clinical report describes the prosthetic rehabilitation of a patient with a right-sided unilateral auricular defect using a silicone prosthesis fabricated through a digital workflow.

2. Case Report

A 36-year-old male patient reported to the Department of Prosthodontics, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, with the chief complaint of missing right ear following a road traffic accident six years ago

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(**Figure 1**). On examination, the tragus and antitragus were identifiable, with only the dermal layer present at the defect site. The patient had not undergone prior surgical or prosthetic rehabilitation. Although an implant-retained prosthesis was provided, the patient opted for a digitally designed, externally retained silicone auricular prosthesis.

Three horizontal reference markings were made on the contralateral ear: at the junction of the helix with the side of the head, the midpoint of the tragus, and the junction of the ear lobe with the face. Corresponding markings were transferred to the affected side. Two additional orientation lines were drawn on the defect side: one encircling the defect (dotted line) and another 1 cm away from the edge (solid line) (**Figure 1**).

The external auditory canal was protected with gauze, and petrolatum gel was applied to the adjacent skin and hair. An impression of the defect region was made with irreversible hydrocolloid (ALGITEX, DPI) injected via syringe into the intertragal notch and surrounding tissues, ensuring no compression. A Type V die stone (Ultralight, B.N. Chemicals) cast was obtained from the impression. The left ear was scanned using a dental lab scanner (inEos X5, Dentsply Sirona). Using CAD software (inLabCAD SW20.0.3), the image of the left ear was mirror-imaged and 3D printed (Asiga Pro 4K) to obtain a digital replica of the right ear.

From the 3D-printed model, a two-layered putty index (Photosil Soft, DPI) was prepared. A wax pattern was fabricated by pouring a mixture of baseplate wax (70%), sticky wax (10%), carding wax (10%), and inlay wax (10%) into the putty index. The wax pattern was tried in to evaluate fit, marginal adaptation, horizontal alignment, and ear projection. Characterization of surface details, such as skin pores, was achieved using a small ball burnisher.

The top portion of the dental flask was used as the base for fabricating a three-part mold. The master cast and wax pattern were positioned on this base, which was then hollowed out, beaded, and sealed with baseplate wax (Pyrax Modelling Wax). To eliminate undercuts, dental plaster was poured flush with the cast surface. Three orientation grooves were created to aid in repositioning the mold pieces after setting. (**Figure 2**)

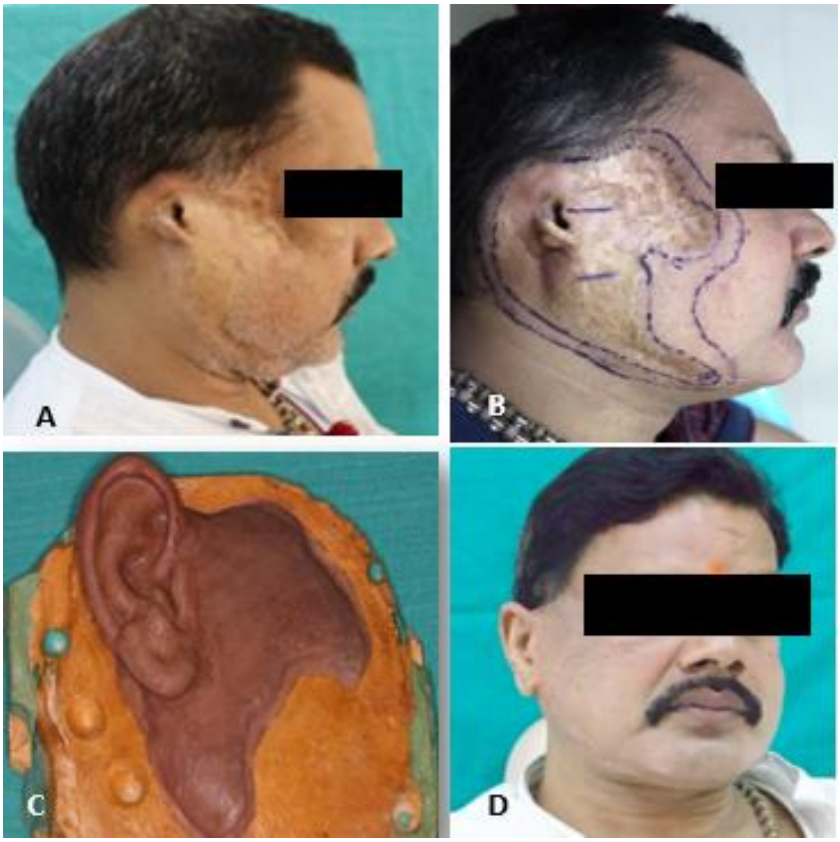

Figure 1: A: Pre-treatment extra-oral photograph of the patient with a missing right ear; **B:** Reference markings based on contralateral ear; **C:** Laboratory prepared ear prosthesis; **D:** Extra-oral photograph of patient with right prosthetic ear.

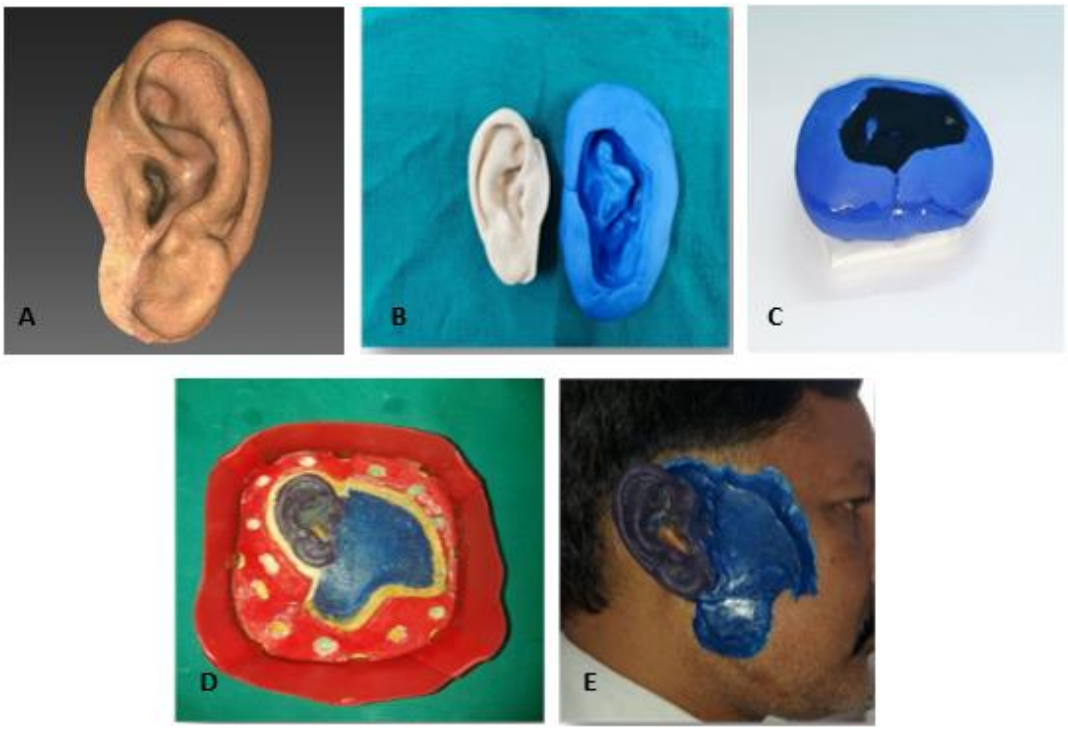

Figure 2: A: 3D scanned left ear of patient; **B:** 3D Printed ear of patient from mirrored scan of left ear and putty index of 3D printed ear; **C:** Wax pour of the putty index; **D:** Adaptation of the wax up of right ear on the cast of right peri-auricular region; **E:** Extra-oral photograph of patient with trial of wax up right prosthetic ear.

The second component of the mold, termed the wedge, extended along the auricular tubercle, lobule of the ear, and helical undercut. The third component consisted of the top portion of the mold. Separating medium was applied, and dental stone was poured on the posterior aspect of the wax pattern, extending just below the superior border of the helix and continuing down to the base of the helix and the junction of the lobule with the face, ensuring no undercuts. Finally, the lid was placed, clamped, and the third pour was completed with plaster after the second pour had set, using a similar grooving technique.

Following the dewaxing process, the flask was immersed in hot water, and the wax was boiled out, leaving behind a three-piece mold. Room-temperature vulcanizing (RTV) silicone (Technovent M511 Platinum Silicone, South Wales, UK) was selected for fabrication. The base and catalyst were mixed in a 10:1 ratio using broad, even strokes to achieve a homogeneous consistency. Intrinsic colorants (Technovent) were incorporated into the silicone to replicate the laminar structure of skin, with gradual addition of pigments to reproduce subsurface details such as freckles and blood vessels. Once the appropriate shade was obtained, the silicone was packed into the mold and left to polymerize at room temperature for 24 hours. To prevent air entrapment, the flask was placed in a desiccator with a sealed lid. After 24 hours, the prosthesis was retrieved, carefully trimmed, and tried on the patient. Surface characterization was enhanced using extrinsic coloration, creating a more lifelike result (**Figure 1**). The extrinsic stains were cured by blowing dry air with a syringe (Dispovan, India), producing a natural matte finish.

The prosthesis was then delivered to the patient (**Figure 1**). He was instructed to apply medical-grade skin adhesive (Technovent, South Wales, UK) to the fitting surface and wait two minutes prior to placement. Post-insertion, the patient received instructions regarding hygiene, use, and follow-up care. At the 24-hour recall, the patient reported improved comfort, esthetics, and satisfaction with the lightweight prosthesis. He was scheduled for routine follow-up visits, during which detailed guidance for prosthesis maintenance and cleanliness was reinforced.

3. Discussion

Fabrication of a unilateral auricular prosthesis is more challenging than a bilateral one because it must harmonize precisely with the contralateral natural ear. Key challenges include capturing an accurate impression of the defect without tissue distortion, positioning the prosthesis to align with the healthy ear, sculpting precise morphology, and matching the skin tone and color of the opposite side. To address these challenges, digital scanning can accurately capture anatomical details and facilitate replication of the ear.[4] The position of the unilateral prosthetic auricle is determined by evaluating the relationship of the contralateral ear with facial landmarks, which is then transferred to the defect site for accurate placement.[5,6]

Silicone remains the material of choice for facial prostheses due to its lifelike appearance, flexibility, and soft tissue–like consistency. Its superior mechanical, chemical, and physical properties allow it to adapt to moving soft tissues. Silicone is available in a range of hues to closely mimic skin texture and complexity. However, environmental factors such as moisture, sunlight, UV radiation, and temperature fluctuations can lead to gradual hardening and discoloration, typically requiring replacement every 9–12 months.[7,8]

Detention is a critical factor influencing prosthesis acceptance. In this case, a medical-grade adhesive (Technovent ProBond) was used. Alternative retention methods include hair bands, eyeglass frames, or craniofacial implants with magnets or bars. While implant-retained prostheses offer superior stability, they require surgical intervention and a healing period of three to four months for osseointegration. Adhesively retained prostheses may be challenging for patients to position correctly, and the adhesive may weaken over time. In some cases, hypersensitivity reactions to adhesives have been reported.[9]

4. Conclusion

This report demonstrates the application of intraoral scanning and a computer-aided digital workflow in fabricating a precise, lifelike unilateral auricular prosthesis. The method enabled creation of an exact mirror image of the patient's natural auricle from both frontal and posterior perspectives. Intrinsic and extrinsic colorants were applied to match the patient's skin tone and achieve realistic surface characterization. Retention was achieved using medical-grade adhesive, with anterior margins concealed by the hairline and posterior borders blended seamlessly with surrounding skin. The patient expressed high satisfaction with the esthetic outcome, comfort, and confidence. This case highlights an innovative, straightforward, and precise approach to auricular prosthesis fabrication and provides guidance for prosthodontists, technology developers, and researchers.

5. Declaration of Patient Consent

The authors confirm that informed consent was obtained from the patient for publication of images and clinical information.

6. Source of Funding

None.

7. Conflicts of Interest

There are no conflicts of interest.

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