

Prosthetic rehabilitation of unilateral congenital microtia with an implant-retained auricular prosthesis – a case report

Précis: This case report describes the application of CAD/CAM technology in the prosthetic rehabilitation of unilateral congenital microtia with an implant-retained auricular prosthesis.

Abstract

Microtia is a term applied to congenital anomalies of the auricle, ranging from mild structural abnormalities to complete absence of the external ear and auditory canal. Microtia may occur as an isolated condition or in association with other malformations such as facial clefts, cardiac defects, renal abnormalities, anophthalmia, and limb reduction defects. Surgical reconstruction of the absent auricle is difficult, and the results are often unsatisfactory. Prosthetic rehabilitation is indicated where surgical procedures may not provide predictable aesthetic results. In recent years, significant developments in digital dentistry have seen the widespread application of CAD/CAM fabrication techniques in the production of intraoral implant restorations. The use of digital technologies, however, has not permeated the field of maxillofacial prosthetics to the same extent. This report documents the use of existing dental CAD/CAM technology in the fabrication of an extraoral prosthesis and demonstrates the benefits of employing digital technology in the field of maxillofacial prosthetics.

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Introduction

Maxillofacial prosthetics is a branch of dentistry that deals with the prosthetic rehabilitation of congenital and acquired defects of the head and neck. Modern prosthetic materials and colour systems allow the practitioner to fabricate extremely lifelike facial restorations.¹ In the past, the success of large facial prostheses was limited, due to a lack of adequate retention obtained from skin adhesives or by mechanical means.² The use of osseointegrated implants to retain facial prostheses has become the standard of care in many situations, significantly enhancing patient acceptance due to the superior retention and stability it offers over conventional retention methods.³ Recent advances in digital dentistry have seen the widespread application of CAD/CAM fabrication techniques in the production of intraoral implant restorations.⁴ The use of digital technologies, however, has not permeated the field of maxillofacial

prosthetics to the same extent.⁵ This case report provides an example of the application of CAD/CAM fabrication techniques in the rehabilitation of a maxillofacial defect.

Case report

A 24-year-old male with unilateral microtia of the left ear presented to the Dublin Dental University Hospital with an existing implant-retained auricular prosthesis. The patient was unhappy with this prosthesis, as it had become poorly retentive, noticeably discoloured, and displayed poor adaptation to the underlying tissues (**Figures 1a-1c**). The patient had undergone surgery 14 years previously for removal of auricular remnants at the defect site and placement of two craniofacial implants in the temporal bone. His current auricular prosthesis



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FIGURES 1a-1c: The patient's existing auricular prosthesis, which was poorly retentive, noticeably discoloured, and displayed poor adaptation to the underlying tissues.



FIGURES 2a and 2b: The prosthesis was retained via rider clips that attached to a cast gold holder bar: (a) screwed to two standard abutments; and, (b) splinting the implant fixtures.



FIGURE 3: The single screw test revealed that the cast gold bar was not seating passively on the implant abutments.



FIGURE 4: Four landmarks – the superior margin of the tragus; the junction of the lobe with the side of the face; the junction of the anterior aspect of the helix with the side of the face; and a line indicating the vertical angulation of the ear – were transferred from the unaffected ear to the corresponding location on the defect side.



FIGURES 5a and 5b: The impression was made in a polyether impression material with an impression plaster backing.

was fabricated in the immediate aftermath of this surgical procedure.

Removal of the prosthesis revealed a cast gold holder bar screwed to two standard abutments splinting the implant fixtures (Figure 2a). Two gold rider clips were set in an acrylic sleeve embedded in the silicone prosthesis as the interface between the prosthesis and the implant bar. On removal of the gold bar, granular tissue and erythema of the peri-implant soft tissues was evident, particularly surrounding the superior implant abutment (Figure 2b). The superior abutment displayed some mobility and, on removal, it was noted that the abutment was not fully seated on the implant fixture. The stability of both implant fixtures was assessed, and no movement was evident. Both abutments were reattached, ensuring that they were fully seated on their respective

implants. When reattaching the implant bar, the single screw test was employed to assess its passivity of fit on the implant abutments⁶ and revealed a misfit of the superstructure (Figure 3). The mobility displayed by the superior implant abutment was attributed to torque generated by the ill-fitting bar.

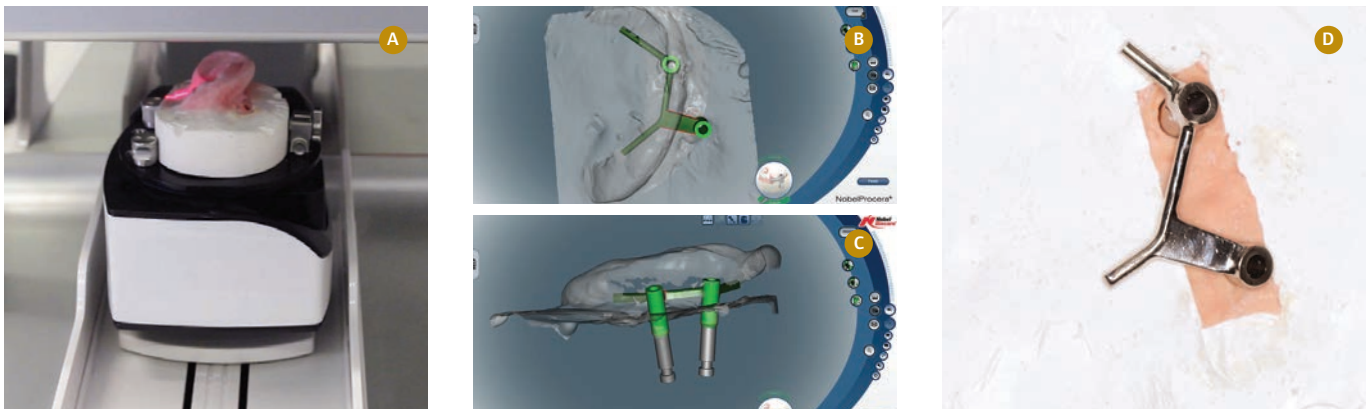
Clinical and laboratory procedures

With the patient sitting in an upright position and looking directly ahead, a modified ear-bow, with a miniature spirit level mounted across its front edge, was used to transfer the following landmarks from the unaffected ear to the corresponding location on the defect side (Figure 4):

- ▶ the superior margin of the tragus;
- ▶ the junction of the lobe with the side of the face;
- ▶ the junction of the anterior aspect of the helix with the side of the face; and,
- ▶ a line indicating the vertical angulation of the ear.



FIGURES 6a-6c: An impression of the contralateral ear was made and poured in dental stone for use as a reference when carving the prosthetic pattern in wax.



FIGURES 7a-7d: 3D scans of the implant model and wax pattern were obtained and CAD/CAM technology was used to produce a milled titanium superstructure.



FIGURES 8a and 8b: An acrylic housing to hold the retentive clips was processed in self-cure acrylic resin and incorporated into the wax pattern.

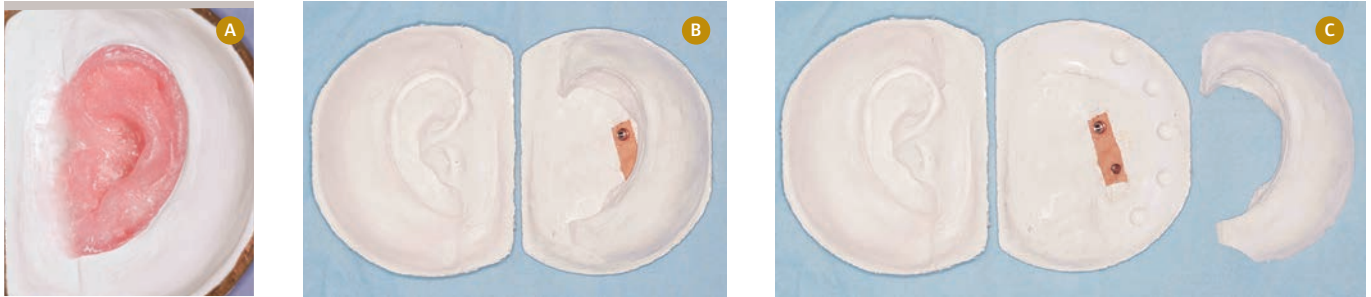
FIGURES 9a and 9b: The implant bar and wax pattern were tried on the patient.

Two open tray impression copings were splinted with resin to stabilise them within the impression before a polyether impression material was applied over the defect site (**Figure 5a**). A layer of thick gauze was then adapted over the polyether material before it set to provide retention for an impression plaster backing, added to support the impression and minimise distortion (**Figure 5b**). An alginate impression of the contralateral ear was also made for reference when carving the prosthetic pattern in wax.

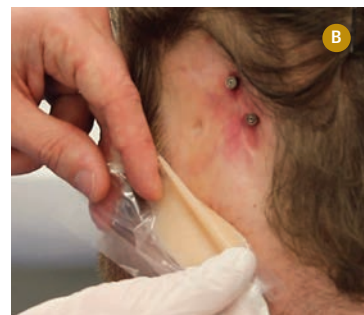
With the aid of the orientation marks and the stone cast of the contralateral ear (**Figures 6a-6b**), a model of the left ear was shaped in modelling wax (**Figure 6c**). 3D scans of the implant model and wax pattern were made (**Figure 7a**), and CAD software was used to design a fixture-level implant bar to fit within the confines of the wax pattern, with 3mm clearance from the skin surface

(**Figures 7b-7c**). CAD/CAM technology made it possible to cantilever the bar from the inferior implant so that the retentive clips could be ideally positioned beneath the antihelix of the prosthesis, providing maximum stability and resistance to dislodgement.⁷ The finalised digital design was manufactured in titanium using computer numerical control (CNC) milling technology (**Figure 7d**). The milled titanium bar was assessed for fit on the master cast before three gold rider clips were fixed to the bar and a clear acrylic housing to retain the clips was processed in self-cure acrylic resin (**Figures 8a-8b**). The wax pattern was then modified to incorporate the acrylic clip assembly.

The new titanium bar and wax pattern were tried on the patient and assessed for shape, orientation and fit (**Figures 9a-9b**). Required adjustments to the wax pattern were made chair side before it was invested in a three-part mould



FIGURES 10a-10c: The wax pattern was invested in type III dental stone to create a three-part mould.



FIGURES 11a and 11b: A two-part vinyl addition silicone was mixed on a glass pallet with intrinsic pigments and coloured flocking to produce multiple coloured swatches, replicating the skin tones of the surrounding tissues and the patient's unaffected ear.

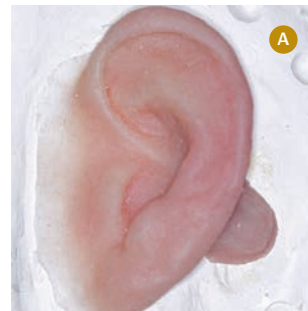
with type III dental stone (Figures 10a-10c). At the next clinical appointment, a two-part vinyl addition silicone was mixed on a glass pallet with intrinsic pigments and coloured flocking to produce multiple coloured swatches, replicating the skin tones of the surrounding tissues and the patient's unaffected ear (Figures 11a-11b). A thin coat of primer was applied to the outer surface of the acrylic clip assembly before the various silicone swatches were packed into their respective positions within the mould and cured in an oven to the manufacturer's specifications.

The prosthesis was tried on the patient to assess the fit before excess silicone was trimmed from the edges as appropriate. Extrinsic stains were applied and sealed with a silicone sealant (Figures 13a-13c). Written instructions on care and maintenance of the prosthesis and surrounding tissues were given to the patient and explained in detail, placing particular emphasis on the importance of maintaining healthy tissues at the implant sites.

Discussion

During the treatment planning process, a number of options were considered for the rehabilitation of this case. Fabrication of a new auricular prosthesis to attach to the existing implant bar was ruled out once it was determined that the cast gold bar did not seat passively on the implant abutments.

Dispensing of the bar and clip interface in favour of magnetic connections was also considered. Magnetic coupling between the implant fixtures and the prosthesis facilitates ease of access for hygiene procedures around the implant abutments, and magnetic forces aid in prosthesis placement, both features being of particular advantage to patients with poor manual dexterity or visual impairment.^{2,7} It is reported, however, that bar-clip attachment provides better retention than magnetic systems for auricular prostheses.⁸ In addition, placement of three implants in a non-linear alignment is recommended to achieve optimum retention for magnetically retained auricular prostheses,² whereas two implants are considered sufficient for bar-clip retention systems.⁹ Considering the patient's age, active lifestyle and the presence of only two craniofacial implants, it was decided that the most appropriate available



FIGURES 12a and 12b: The cured silicone prosthesis was processed to incorporate the acrylic clip assembly.

treatment option was the fabrication of a new, passively fitting implant bar to retain, support and stabilise a new silicone auricular prosthesis.

CAD/CAM fabrication technologies were employed in the design and manufacture of the new implant bar as they are less labour intensive and allow for more versatility in relation to the bar design when compared with traditional casting techniques.¹⁰ Moreover, CNC milled titanium frameworks have shown statistically better precision of fabrication and fit compared to conventional cast frameworks.¹¹ Shrinkage and porosity associated with casting procedures can result in a misfit between the cast framework and the mating implant fixtures, with distortion tending to increase in proportion to the length of the cast bar.^{11,12} If the superstructure does not fit passively on the supporting implants, stresses are generated at the implant interface, which can lead to complications such as screw loosening, bone loss and implant failure.¹³ A passive fit can be restored by sectioning the cast framework and reconnecting the segments with solder; however, soldered joints are inherently weaker and more susceptible to fracture than solid castings.¹²

In this case the implant bar was designed using NobelProcera CAD software (Nobel Biocare). This software is intended for use with intraoral prostheses but was easily manipulated to enable scanning and design for this auricular



FIGURES 13a-13c: Fitting the finished prosthesis.

prosthesis. The software made it possible to design the bar in such a way that the retentive elements were positioned ideally beneath the antihelix of the prosthetic ear, providing optimal aesthetics and biomechanics.⁷ The implant bar was then precision milled from a homogenous block of medical-grade titanium to produce a high-strength, low-density superstructure that fit accurately and passively on the supporting implant fixtures.¹⁰

Conclusion

CAD/CAM technology is now routinely used in the fabrication of dental restorations;¹⁴ however, there is a gap in the literature regarding the use of milled titanium substructures for use with implant-retained maxillofacial prostheses. This report documents the use of existing dental CAD/CAM technology in the fabrication of extra-oral prostheses and demonstrates the benefits of employing digital technology in the field of maxillofacial prosthetics.

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References

1. Raghoobar, G.M., van Oort, R.P., Roodenburg, J.L., Reintsema, H., Dijkers, F.G. Fixation of auricular prostheses by osseointegrated implants. *J Invest Surg* 1994; 7 (4): 283-290.
2. Federspil, P.A. Implant retained epistheses for facial defects. *Laryngorhinootologie* 2009; 88 (Suppl. 1): S125-S138.
3. Karayazgan-Saracoglu, B., Zulfikar, H., Atay, A., Gunay, Y. Treatment outcome of extraoral implants in the craniofacial region. *J Craniofac Surg* 2010; 21 (3): 751-758.
4. Abdullah, A.O., Muhammed, F.K., Zheng, B., Liu, Y. An overview of computer aided design/computer aided manufacturing (CAD/CAM) in restorative dentistry. *J Dent Mater Tech* 2017; 7 (1): 1-10.
5. Machado, V., Bettoni Cruz de Castro, F., Jaeger, C., Rodrigues Alfenas, E., Silva, N.R.F.A. CAD/CAM beyond intraoral restorations: maxillofacial implant guide. *Compend Contin Educ Dent* 2019; 40 (7): 466-472.
6. Kan, J.Y., Rungcharassaeng, K., Bohsali, K., Goodacre, C.J., Lang, B.R. Clinical methods for evaluating implant framework fit. *J Prosthet Dent* 1999; 81 (1): 7-13.
7. Beumer, J., Ma, T., Marunik, M., Roumanas, E., Nishimura, R. Restoration of facial defects. In: Beumer, J., Curtis, T.A., Marunik, M. (eds.). *Maxillofacial Rehabilitation: Prosthodontic and Surgical Considerations*. Ishiyaku EuroAmerica; St Louis, 1996: 377-453.
8. de Sousa, A.A., Mattos, B.S. Magnetic retention and bar-clip attachment for implant-retained auricular prostheses: a comparative analysis. *Int J Prosthodont* 2008; 21 (3): 233-236.
9. Wright, R.F., Zemnick, C., Wazen, J.J., Asher, E. Osseointegrated implants and auricular defects: a case series study. *J Prosthodont* 2008; 17 (6): 468-475.
10. Gosavi, S., Gosavi, S., Alla, R. Titanium: a miracle metal in dentistry. *Trends Biomater Artif Organs* 2013; 27 (1): 42-46.
11. Ortorp, A., Jemt, T., Bäck, T., Jälevik, T. Comparisons of precision of fit between cast and CNC-milled titanium implant frameworks for the edentulous mandible. *Int J Prosthodont* 2003; 16 (2): 194-200.
12. Swallow, S.T. Technique for achieving a passive framework fit: a clinical case report. *J Oral Implantol* 2004; 30 (2): 83-92.
13. Kapos, T., Ashy, L.M., Gallucci, G.O., Weber, H.P., Wismeijer, D. Computer-aided design and computer-assisted manufacturing in prosthetic implant dentistry. *Int J Oral Maxillofac Implants* 2009; 24 (Suppl.): 110-117.
14. Davidowitz, G., Kotick, P.G. The use of CAD/CAM in dentistry. *Dent Clin North Am* 2011; 55 (3): 559-570.

CPD questions

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1. Prosthetic rehabilitation of maxillofacial defects is indicated:

- ☐ A: Where surgical procedures may not provide predictable aesthetic results
- ☐ B: For small, less complex defects
- ☐ C: For defects involving mobile soft tissues

2. For optimum retention of a magnetically retained auricular prosthesis, what is the recommended amount and placement of the implant fixtures?

- ☐ A: Two implants placed in a non-linear alignment directly beneath the antihelix
- ☐ B: Three implants placed in a linear alignment directly beneath the antihelix
- ☐ C: Three implants placed in a non-linear alignment directly beneath the antihelix

3. Bar and clip retention is preferred to magnetic retention for implant-retained maxillofacial prostheses when:

- ☐ A: The patient has poor manual dexterity or is visually impaired
- ☐ B: The implant fixtures have significantly divergent axes
- ☐ C: Where optimum retention and stability is required