

AESTHETIC REHABILITATION OF A MAXILLARY ANTERIOR IMPLANT WITH COMPROMISED ANGULATION USING A CAD-CAM CUSTOMIZED ABUTMENT: A CLINICAL REPORT

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Abstract

Implant rehabilitation in the anterior maxilla demands precise implant positioning and prosthetic planning to achieve optimal aesthetics and function. However, compromised implant angulation may adversely affect emergence profile, screw access positioning, and overall aesthetic outcomes. Customized CAD-CAM implant abutments provide a prosthetically driven solution for correcting angulation discrepancies and improving soft tissue support in such situations. This clinical report describes the aesthetic rehabilitation of a missing maxillary central incisor using an implant-supported prosthesis with a CAD-CAM customized abutment. A 3.0 × 10 mm ADIN implant was placed in the edentulous site. During the prosthetic phase, compromised implant angulation necessitated the fabrication of a digitally designed customized abutment to achieve favourable emergence profile and aesthetics. Following CAD-CAM fabrication and prosthetic rehabilitation, satisfactory aesthetic integration and patient satisfaction were achieved. This report highlights the role of customized CAD-CAM abutments in managing aesthetic challenges associated with compromised implant angulation in the anterior maxilla.

Keywords: CAD-CAM, customized abutment, anterior implant, aesthetic rehabilitation, implant angulation, digital workflow

Introduction

Replacement of a missing maxillary anterior tooth with an implant-supported prosthesis is considered a predictable treatment modality for restoring aesthetics and function. However, achieving an ideal aesthetic outcome in the anterior maxilla remains clinically challenging because of the high aesthetic demand and the need for harmonious peri-implant soft tissue architecture. Buccal bone resorption following tooth loss or trauma may compromise implant positioning and emergence profile, especially in the aesthetic zone. In such situations, implant placement is often performed using a two-stage surgical protocol to facilitate osseointegration and preserve peri-implant hard and soft tissue stability.

Non-ideal implant angulation or labial implant positioning can adversely affect the final prosthetic outcome by producing unfavourable screw access, compromised crown contour, and inadequate soft tissue support. Conventional stock abutments may provide limited correction in these cases and may not adequately restore

the desired emergence profile. Recent advances in CAD-CAM technology have enabled fabrication of customized implant abutments with improved precision, enhanced emergence profile control, and superior aesthetic integration. Customized CAD-CAM abutments allow individualized prosthetic correction according to implant angulation and peri-implant soft tissue requirements, thereby improving the final aesthetic outcome¹.

This clinical report describes the aesthetic rehabilitation of a maxillary anterior implant with compromised angulation using a CAD-CAM customized abutment.

Case Presentation

A 24 year old male patient presented to the Department of Prosthodontics and Crown and Bridge with a missing maxillary central incisor

following previous trauma. The patient expressed concern regarding compromised aesthetics and requested a fixed replacement option. Clinical examination revealed an edentulous space in relation to the maxillary central incisor with associated labial hard tissue deficiency (Fig. 1). Adjacent teeth were clinically healthy and oral hygiene status was satisfactory.

Radiographic evaluation using orthopantomogram revealed adequate bone height for implant placement (Fig.2). Based on the clinical and radiographic findings, implant-supported rehabilitation was planned. Due to the presence of labial bone deficiency and the need to achieve predictable osseointegration and soft tissue healing, a two-stage implant placement protocol was selected.

Under local anaesthesia and standard aseptic precautions, a crestal incision was placed and a



Fig. 1: Preoperative intraoral view showing the missing maxillary central incisor and labial hard tissue deficiency.



Fig. 2: Preoperative orthopantomogram showing adequate bone height for implant placement.



Fig. 3: Crestal incision and full-thickness mucoperiosteal flap reflection at the implant site.



Fig. 4: Sequential osteotomy preparation according to the implant manufacturer's drilling protocol.



Fig. 5: Placement of the 3.0 × 10 mm implant with the cover screw in position.

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full-thickness mucoperiosteal flap was reflected to expose the surgical site. Sequential osteotomy preparation was performed according to the manufacturer's drilling protocol under copious

saline irrigation. A 3.0×10 mm ADIN implant was placed in the edentulous site with an insertion torque of 45 Ncm, indicating satisfactory primary stability. Following implant placement, a cover screw was secured and the flap was repositioned



Fig. 6: Primary closure of the surgical site following implant placement.



Fig. 7: Implant exposure showing compromised angulation and an unfavourable emergence profile.



Fig. 8: Open-tray implant-level impression made using elastomeric impression material.

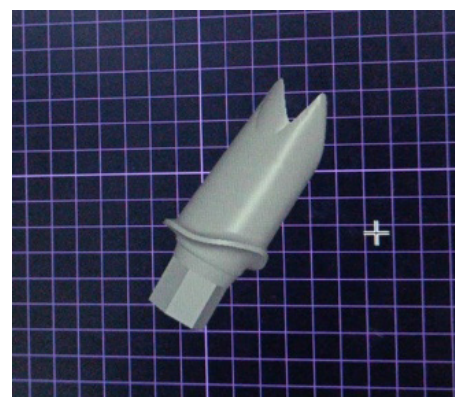
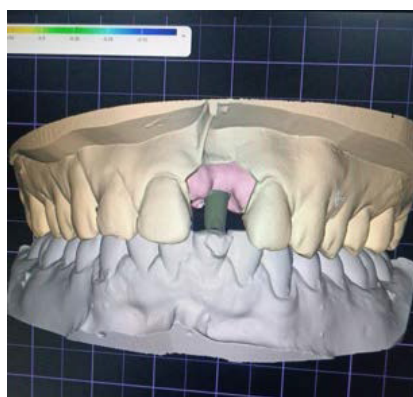
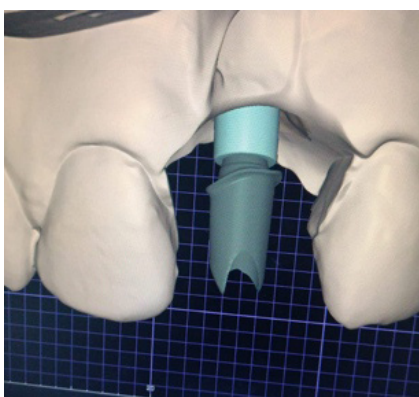


Fig. 9: CAD-CAM digital design and fabricated customized abutment.



Fig. 10: Preoperative and postoperative extraoral and intraoral views demonstrating the final aesthetic rehabilitation with the zirconia crown.

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and sutured to obtain primary closure (Fig. 3, 4, 5, 6). Postoperative instructions and medications were provided to the patient. Healing during the postoperative period was uneventful.

Following a healing period of four months, second-stage surgery was performed and the implant was exposed. Clinical evaluation during the prosthetic phase revealed compromised implant angulation with an unfavourable emergence profile in the aesthetic zone. (Figure 7, 8). To overcome these limitations and improve aesthetic integration, a customized CAD-CAM abutment was planned. During the prosthetic phase, an open-tray implant level impression was made using elastomeric impression material and transferred to the dental laboratory for definitive prosthetic rehabilitation.

In the laboratory phase, the definitive cast was digitally scanned after attaching a scan body to transfer the implant position accurately into the digital workflow. A customized implant abutment was digitally designed using CAD-CAM software to improve the emergence profile and compensate for compromised implant angulation. The customized abutment was subsequently milled and clinically evaluated for fit, retention, and soft tissue support (Fig. 9).

After satisfactory verification of the customized abutment, a zirconia crown was fabricated and cemented (Fig.10). The definitive prosthesis demonstrated satisfactory aesthetics, functional rehabilitation, and harmonious integration with the adjacent dentition. The patient was evaluated periodically after prosthesis delivery at 3 weeks, 3 months, and 6 months follow-up appointments. Clinical evaluation during follow-up revealed satisfactory peri-implant soft tissue health, functional stability, and maintenance of aesthetic outcome, with no evidence of prosthetic or biological complications. The patient

expressed satisfaction with the final treatment outcome.

Discussion

Achieving predictable aesthetic and functional outcomes in anterior implant rehabilitation requires precise coordination between surgical implant placement and prosthetic reconstruction. Implant position, angulation, and depth play a decisive role in determining the final emergence profile, peri-implant soft tissue contour, and long-term biomechanical stability. Mal-positioned implants in the aesthetic zone present significant restorative challenges because even minor deviations in implant angulation can adversely affect crown contour, gingival architecture, phonetics, and occlusion. Previous studies have emphasized that rehabilitation of malaligned implants often requires customized restorative approaches to achieve acceptable aesthetic integration and prosthetic harmony².

In the present case, the implant exhibited compromised angulation and an unfavourable emergence profile following second-stage surgery. Conventional stock abutments were unable to adequately compensate for the implant trajectory because of their standardized form and limited corrective capability. Bhavana et al. reported that prefabricated abutments may not provide sufficient correction in implants placed outside the ideal restorative axis and highlighted the advantages of customized abutments in such situations³. Therefore, a customized CAD-CAM abutment was selected to redirect the prosthetic axis and establish improved aesthetic harmony with the adjacent dentition.

Customized implant abutments have become an important treatment option for rehabilitation of mal-positioned implants, particularly in the anterior maxilla. Customized abutments permit

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individualized contouring of the transmucosal profile, improved soft tissue support, correction of implant angulation, and better distribution of occlusal forces. Cavallaro and Greenstein discussed the practical application of angled implant abutments in correcting implant divergence and improving prosthetic alignment in aesthetically demanding situations⁴. Similarly, Sikri and Sikri emphasized that customized and angled abutments can conservatively manage compromised implant positioning while improving aesthetics and function without the need for implant removal⁵.

The introduction of CAD-CAM technology has significantly improved the precision and predictability of implant prosthodontics. Digital workflows minimize laboratory inaccuracies associated with conventional waxing and casting procedures while improving marginal adaptation and reproducibility. Barros et al. demonstrated that CAD-CAM customized abutments allow accurate correction of implant angulation and facilitate fabrication of restorations with improved biomechanical and aesthetic outcomes in mal-positioned implants⁶. In the present case, the digital workflow facilitated fabrication of a customized abutment that successfully corrected the prosthetic emergence profile and harmonized with the surrounding dentition.

Peri-implant soft tissue management is another important determinant of aesthetic success in anterior implant rehabilitation. The contour and emergence profile created by the abutment significantly influence gingival adaptation, papillary support, and mucosal stability. Jivraj and Chee emphasized that proper treatment planning in the aesthetic zone is essential for achieving harmonious peri-implant soft tissue architecture and natural-looking implant restorations⁷. Verma et al. reported that patient-specific customized abutments provide improved

soft tissue support and natural gingival contours in implants with compromised positioning⁸. Similarly, the customized abutment in the present case aided in achieving favourable peri-implant soft tissue adaptation and improved crown contour despite the compromised implant angulation.

Biomechanical considerations remain critical in implants restored with angled or customized abutments. Improper implant angulation can increase stress concentration at the implant-abutment interface and may predispose the restoration to complications such as screw loosening, component fracture, and peri-implant bone loss. Pathak et al. noted that excessive implant angulation and rotational discrepancies may compromise screw joint stability and long-term implant success. Long-term clinical success of angulated abutments has nevertheless been reported by Sethi et al., who demonstrated favourable outcomes when appropriate prosthetic planning and occlusal control were maintained⁹. Therefore, careful occlusal adjustment and elimination of excursive interferences were performed in the present case to minimize unfavourable loading conditions.

Comparative studies have demonstrated that customized CAD-CAM abutments exhibit superior marginal fit, improved emergence profile, enhanced aesthetics, and better peri-implant tissue response compared to stock abutments. Târtea et al. concluded that customized CAD-CAM abutments provide greater prosthetic accuracy and improved peri-implant tissue adaptation because of their individualized design characteristics¹⁰. These findings support the treatment strategy employed in the present case.

Management of mal-positioned implants using customized abutments and screw-

retained restorations has also been reported to provide predictable rehabilitation while maintaining retrievability and facilitating long-term maintenance¹¹. In the present case, the customized CAD-CAM abutment enabled successful aesthetic and functional rehabilitation without the need for additional invasive surgical intervention.

Although customized CAD-CAM abutments provide several clinical advantages, long-term follow-up remains essential because restorations supported by compromised implant angulation may still be susceptible to biomechanical complications over time. In the present case, follow-up evaluations at three weeks, three months, and six months demonstrated satisfactory peri-implant soft tissue health, stable prosthesis, absence of screw loosening, and favourable patient satisfaction regarding aesthetics and function.

Conclusion

Customized CAD-CAM abutments provide a predictable and conservative treatment option for rehabilitation of mal-positioned anterior implants. In the present case, the customized abutment successfully corrected the prosthetic emergence profile, improved peri-implant soft tissue adaptation, and achieved satisfactory aesthetic and functional outcomes without additional surgical intervention. Regular follow-up demonstrated stable peri-implant tissues and favourable patient satisfaction.

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