INDONESIAN JOURNAL OF PROSTHODONTICS

CASE REPORT

Preventing black triangles around posterior maxillary implants using customized peek healing abutments: A case report

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Keywords: Black triangle, Customized healing abutment, Dental implant, PEEK (polyetheretherketone)

ABSTRACT

Posterior maxillary implant placement is often challenging due to low bone density, limited soft tissue support, and a higher risk of black triangle formation. Prefabricated healing abutments are manufactured in standard shapes and often fail to guide soft tissue maturation according to individual anatomy. In contrast, custom healing abutments allow precise shaping of the emergence profile and supporting better periimplant tissue healing. A 31-year-old female presented with a missing upper left second premolar and masticatory discomfort. Clinical and radiographic examinations confirmed adequate bone volume for implant placement. An implant (Dentis Implant s-Clean SQ, 4.0 × 10 mm) was placed using a digitally designed and 3Dprinted surgical guide. A custom Polyetheretherketone (PEEK) healing abutment was fabricated and adjusted using flowable composite to mimic the natural gingival contour. This approach minimized repeated abutment disconnection and facilitated soft tissue maturation. After three months, an open-tray impression was made, and a screw-retained zirconia crown was delivered. Custom PEEK healing abutments demonstrate superior adaptation to peri-implant soft tissues, preserve gingival architecture, and effectively prevent black triangle formation compared to prefabricated abutments. Their use is recommended in posterior maxillary implant restorations to enhance functional and biological outcomes. (IJP 2025;7(1):25-31)

Introduction

The primary goal of modern dentistry is to restore patient's oral health in a predictable, functional, and esthetic manner.[1] Conventional removable dentures, although widely used, significantly compromise masticatory efficiency compared to natural dentition. In contrast, implant-supported prostheses are capable of restoring function to near-natural levels.[2]

The utilization of dental implants has grown substantially worldwide, reflecting their clinical relevance and acceptance. In 2023, approximately 12–15 million dental implants were placed globally. Furthermore, the global dental implant and prosthetic market is projected to reach USD 16 billion by 2029, with an annual growth rate of about 7.5%. This significant increase highlights the shift of implant therapy from a specialized option to a mainstream component of contemporary prosthodontics.[2]

Implant dentistry has evolved beyond its initial objective of merely restoring function.[1] Today, long-term success requires achieving both function and esthetics while respecting hard and soft tissue biology and preserving peri-implant bone architecture over decades. This places greater emphasis on proper soft tissue management during the healing phase.[1-4]

Healing abutments are essential components in this process. They connect to the implant and extend through the soft tissue barrier, either during second-stage surgery or at the time of implant placement to avoid an additional procedure. Also known as healing collars, permucosal extensions, or healing cuffs, these components are traditionally fabricated as stock cylindrical abutments but can also be customized to match individual anatomical contours.[5]

Prefabricated healing abutments, which usually come in round and cylinder shapes, have been widely used due to their convenience and time-saving nature.[4] However, their morphology often leads to an unnatural soft tissue profile, resulting in unfavorable esthetic outcomes that may require additional surgery and recontouring procedures. Customized healing abutments (CHAs) aim to develop a custom emergence profile of peri-implant supporting tissue immediately after implant placement.[6]

CHAs is modified in its dimensions and transmucosal area to guide peri-implant tissue into the proper shape. Moreover, it can also be used to protect or seal underlying bone-grafting materials in the immediate placement socket without the need for sutures and to avoid disconnection of the abutment, which may interfere with the osseointegration process.[6] They can be fabricated from materials commonly used in dentistry, such as polyetheretherketone (PEEK), polymethyl methacrylate (PMMA), zirconia, titanium, and resin composite. CHAs can be fabricated directly at the chair side or the indirect method can be used.[4]

This case report aims to highlight the urgency and clinical success of using a customized healing abutment for a maxillary premolar implant to achieve optimal soft tissue contour and prevent the formation of black triangles.

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DOI 10.46934/ijp.v7i1.327

Figure 1. **Patient's facial profile in lateral and frontal view.**

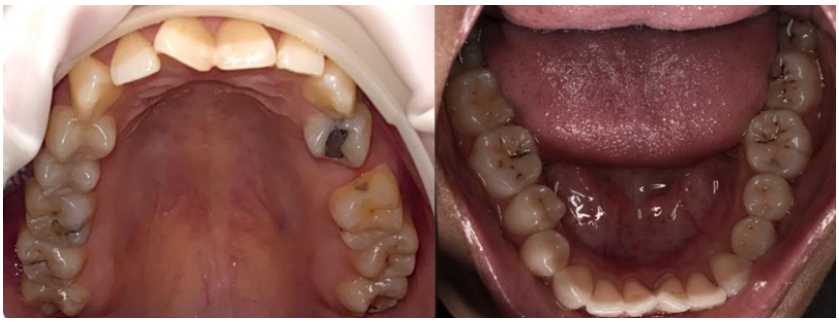

Figure 2. **Intraoral photographs of the patient.**

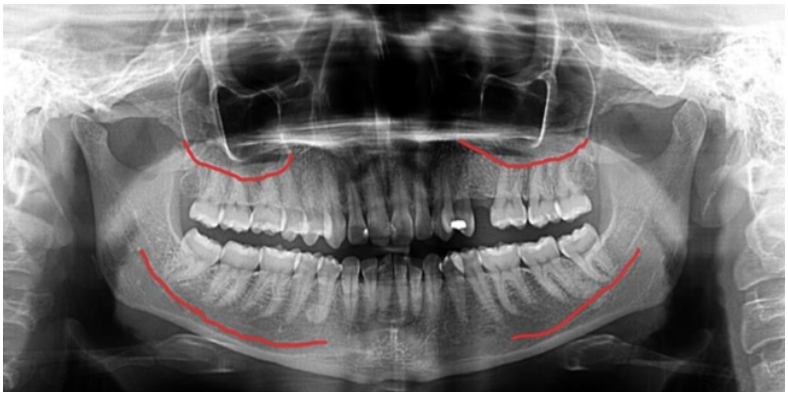

Figure 3. **Panoramic radiograph.**

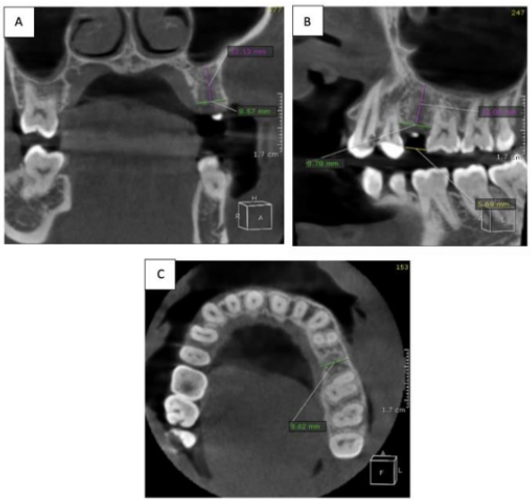

Figure 4. **CBCT image showing the planned implant site in region 25 with composite fiducial markers for radiographic reference, displayed in three views : A. Coronal view, B. Sagittal view, C. Axial view.**

Case Report

A 31-year-old female patient presented to the Prosthodontics Department of RSGM Unpad with complaints of impaired esthetics and difficulty chewing due to the loss of the upper left premolar approximately one year earlier. The tooth had previously undergone root canal treatment; however, recurrent infection and pain occurred, leading to extraction. The patient reported that post-extraction healing was uneventful.

The patient expressed psychological discomfort and embarrassment while smiling due to the missing tooth. She had never worn any type of dental prosthesis and requested a fixed, non-removable replacement. Her medical history was non-contributory, with no systemic diseases, no known allergies, and no current medication use.

Clinical Examination

Extraoral findings: The patient exhibited an ovoid and symmetrical facial form, a convex facial profile, and a temporomandibular joint within normal functional limits, with no signs of abnormality.

Intraoral findings: Superficial carious lesions were observed on teeth 17, 16, 26, 27, 28, 38, 37, 36, 45, and 46. Tooth 24 presented with an amalgam restoration. Tooth 25 was missing.

During the first visit, comprehensive data collection was performed, including anamnesis, extraoral and intraoral photographs, panoramic radiograph, Cone Beam Computed Tomography (CBCT), and maxillary–mandibular impressions for study models using irreversible hydrocolloid (Aroma Alginate, GC). Prior to CBCT acquisition, fiducial markers made of flowable composite resin were placed to serve as radiographic reference points for accurate transfer of anatomical landmarks and implant planning. CBCT analysis revealed that the bone density at the site of tooth 25 corresponded to Misch's classification of D3 bone quality, characterized by a thin, porous cortical layer and relatively dense trabecular bone, with a density range of 350–850 HU. The vertical height of the alveolar bone, measured from the alveolar crest to the floor of the maxillary sinus, was approximately 12.06 mm figure 3.

A scan of the working model was performed using an intraoral scanner (IOS) to fabricate the surgical guide. Implant position and dimensions were planned using the Implant Planning Software (ImplanStation). The mesiodistal width of the edentulous area in region 25 to the proximal surfaces of adjacent teeth measured 6.52 mm. The narrowest buccolingual dimension, located at the mid-crestal area, was 8.78 mm. The alveolar ridge exhibited lingual resorption, resulting in a narrower crest compared to the middle and vestibular regions.

Based on these anatomical considerations, a Dentist Implant s-Clean SQ with a length of 9.0 mm and a diameter of 4.0 mm was selected. This implant size

DOI 10.46934/ijp.v7i1.327

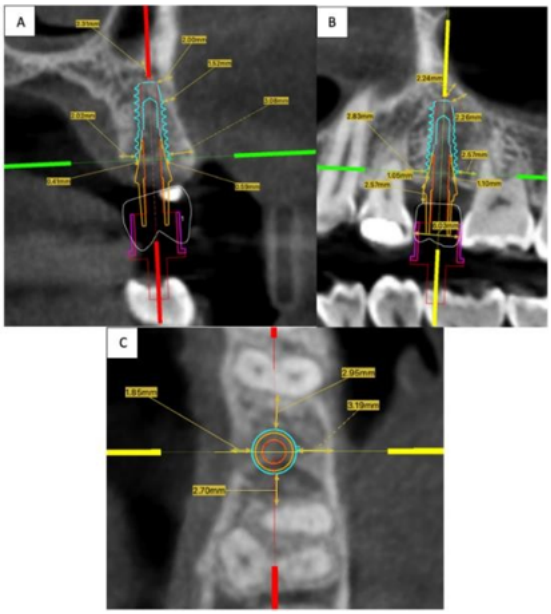

Figure 5. Digital planning of implant position and prosthetic design using ImplantStation software displayed in: A. Coronal view, B. Sagittal view, C. Axial view.

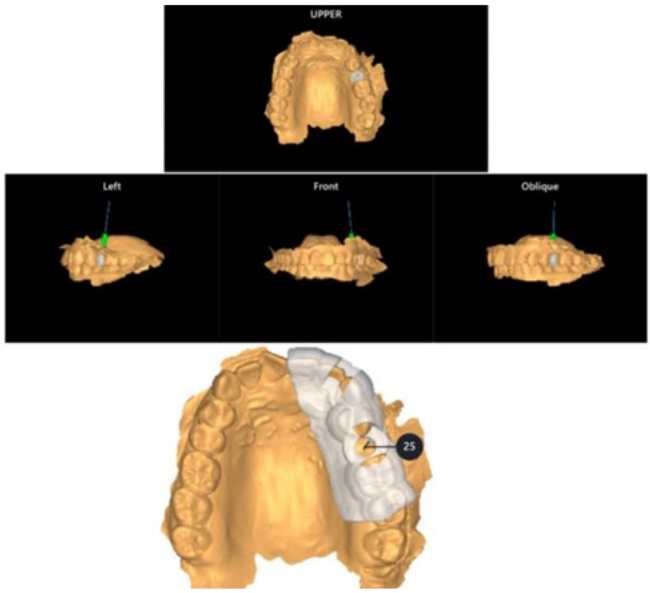

Figure 6. Digitally surgical guide design.

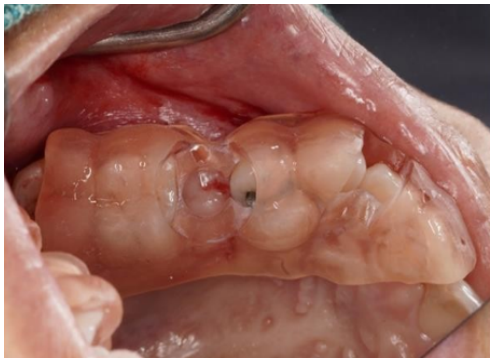

Figure 7. Try in surgical guide .

and design were chosen to optimize buccal bone thickness by placing the implant in a subcrestal position of approximately 2.57 mm. Implant angulation and position were also aligned with the opposing occlusal contacts. The planned implant position is shown in figure 5.

The surgical guide was designed according to the digital plan and 3D printed as a resin try-in prototype figure 6. It was evaluated intraorally to assess adaptation, retention, and stability. The patient was then instructed to prepare for the first-stage surgery and prescribed prophylactic antibiotics and analgesics to be taken one hour prior to the procedure. Once the try-in guide was confirmed to fit properly, instructions were given to fabricate the final surgical guide for use at the next appointment.

At the subsequent visit, the first-stage surgery was performed for implant fixture placement. The procedure began with preparation of sterilized instruments and materials, followed by disinfection of the surgical field. Local anesthesia was administered via infiltrative injection at the mucobuccal fold in the region of tooth 25. Sequential osteotomy was performed using an initial drill, followed by step drills with diameters of 2.2 mm and 3.5 mm, and finalized at 4.0 mm to a depth of 9 mm at 800–1200 rpm, with intermittent drilling and continuous saline irrigation. A Dentis implant fixture (4.0 mm diameter, 9.0 mm length) was inserted at 40 rpm; irrigation was discontinued during fixture insertion. The implant was placed in a subcrestal position approximately 2 mm below the alveolar crest, as planned. Primary stability was assessed using a manual torque wrench, showing a final insertion torque of 45 Ncm. figure 8.

A temporary PEEK healing abutment (N-Hex PEEK, 4.5 mm diameter, Dentis) was connected to the implant. Flowable composite resin (Palfique LX5, Tokuyama Dental) was applied to the rigid cap to gradually shape the emergence profile, using the diagnostic wax-up and putty index as guidance. The composite was light-cured for 20 seconds. Additional composite was layered incrementally to mimic the anatomy of tooth 25. The customized healing abutment was removed, polished extraorally, and reinserted figure 9.

Sutures were placed at the mesial and distal interdental areas using 4-0 blue nylon sutures with a 21 mm reverse-cutting needle to minimize tissue trauma. Occlusion was evaluated to ensure there was no contact with the opposing dentition and the abutment surfaces were smooth. The patient received postoperative instructions and was scheduled for suture removal one week later.

At the fifth visit, three months after implant placement, successful osseointegration between the implant and the surrounding bone was clinically confirmed. The procedure proceeded with impression making using the open tray technique due to the

DOI 10.46934/ijp.v7i1.327

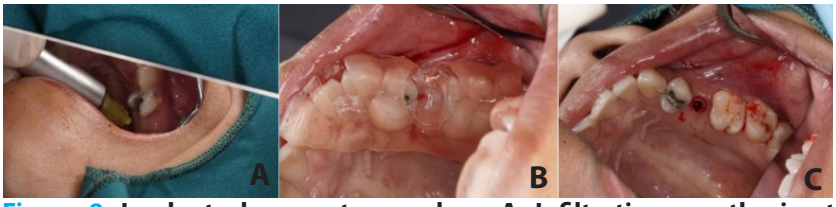

Figure 8. Implant placement procedure: A. Infiltration anesthesia at region 25; B. Placement of the surgical guide; C. Insertion of the dental implant.

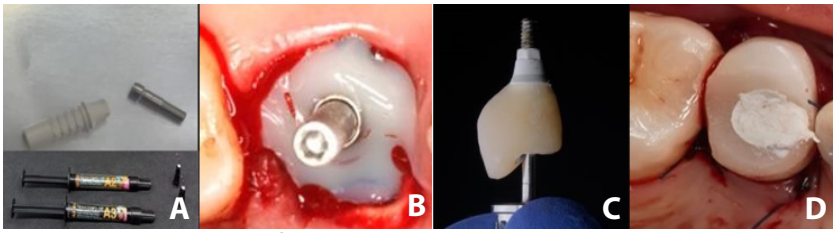

Figure 9. Placement of the Customized Healing Abutment: A. PEEK abutment and composite resin, B. Intraoral fabrication of the customized healing abutment, C. Customized healing abutment refined extraorally, D. Occlusal view of the customized healing abutment.

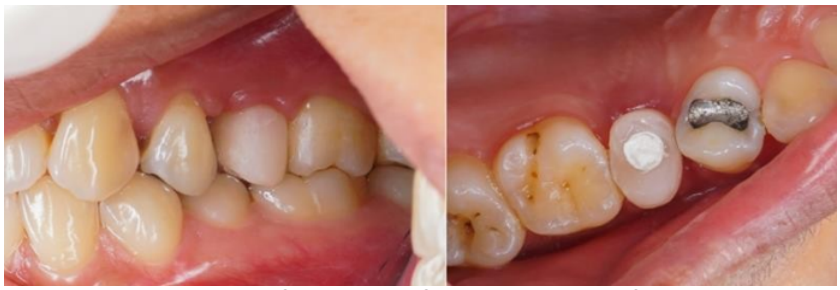

Figure 10. One-week follow-up after placement of the customized healing abutment.

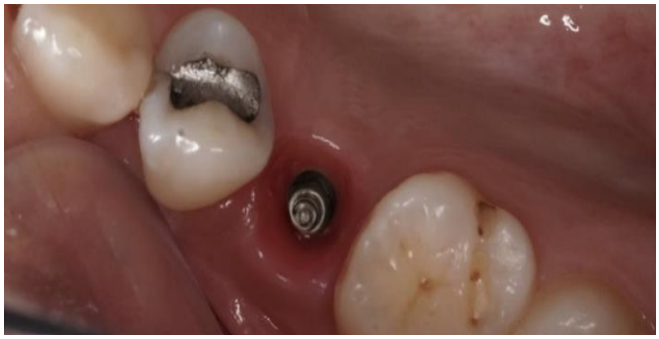

Figure 11. Removal of the customized healing abutment showing the formed emergence profile.

patient's adequate mouth opening. The session began with sterilization of the operative field followed by removal of the customized healing abutment from the implant fixture figure 11. An impression coping was then attached and secured using a long central screw to ensure stability. A perforated custom tray was tried intraorally to verify proper positioning.

The impression was made using a one-step technique with polyvinyl siloxane (PVS) material in putty and light body consistency figure 12. Light body material was applied around the impression coping and the occlusal surfaces of adjacent teeth, followed by insertion of the putty and light body mixture into the tray, which was then positioned in the patient's mouth until polymerization was complete. After the material set, the long central screw was loosened, allowing the impression coping to be removed along with the impression when the tray was detached. Bite registration was performed using elastomeric material, and tooth shade selection was carried out using a shade guide. The customized healing abutment was subsequently reattached to the implant.

In the laboratory phase, an implant analog was connected to the impression coping within the impression, and the master cast was poured. The implant crown was digitally designed figure 13, and after verification, it was fabricated using zirconia material shade A2 with a screw-cement-retained design. This workflow ensured accurate transfer of the implant position from the oral cavity to the working model and facilitated the fabrication of an anatomically precise, functional, and esthetically satisfactory restoration.

At the sixth visit, one week after the impression procedure, the zirconia crown was inserted and tightened using a screwdriver. Prior to crown placement, the periimplant soft tissues were evaluated to ensure they were free of inflammation and infection. Following insertion, proximal contact was assessed using dental floss, ensuring the floss could pass through the contact areas smoothly without obstruction. The crown was then tightened using a torque wrench to a final torque of 25 Ncm. Occlusal contacts were evaluated using articulating paper and adjusted as necessary. The screw access hole was sealed using Teflon tape and composite resin, followed by a postoperative radiograph. The patient was instructed to maintain optimal oral hygiene by brushing twice daily, using dental floss or mouthwash, and to return for follow-up after one week.

At the seventh visit, one week after crown insertion figure 15, a follow-up evaluation was performed. The patient reported no discomfort during function or at rest. Occlusion and proximal contacts were reassessed, and the peri-implant tissues were confirmed to be free of inflammation or infection. The patient was advised to maintain meticulous oral hygiene and attend regular follow-up appointments every six months.

Discussion

Implant planning and placement require a high degree of accuracy to avoid anatomical complications and ensure optimal prosthetic outcomes.[1,7,8] Fiducial markers are reference objects placed on or in the patient's anatomy (or in a radiographic template) that appear clearly on volumetric imaging such as CBCT, enabling accurate registration of datasets for guided implant placement.[9] For prosthodontic implant restorations, precise registration enhances the fit and position

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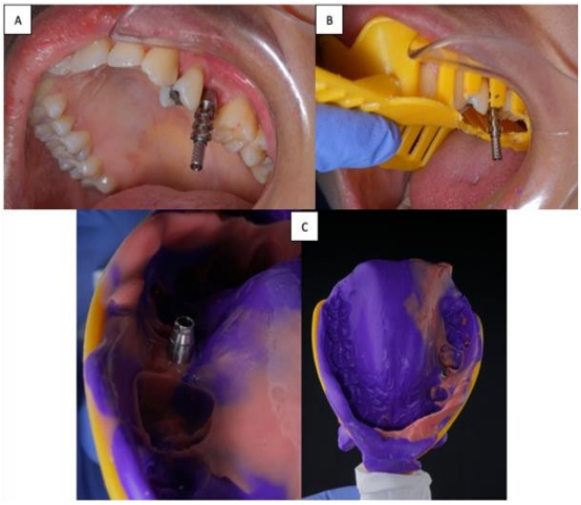

Figure 12. Open-tray impression procedure: A. Impression coping connected to the implant in region 25, B. Perforated impression tray positioned intraorally, C. Completed open-tray impression with the impression coping incorporated in the impression.

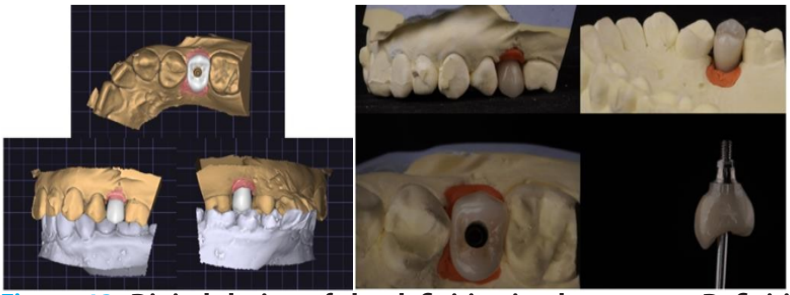

Figure 13. Digital design of the definitive implant crown; Definitive implant crown fabricated from zirconia.

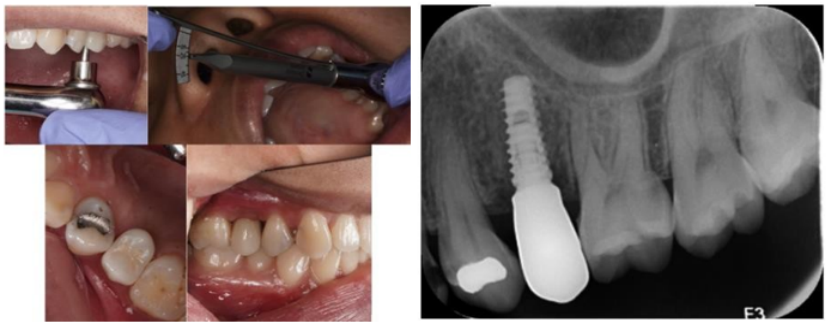

Figure 14. Insertion of the definitive implant crown.

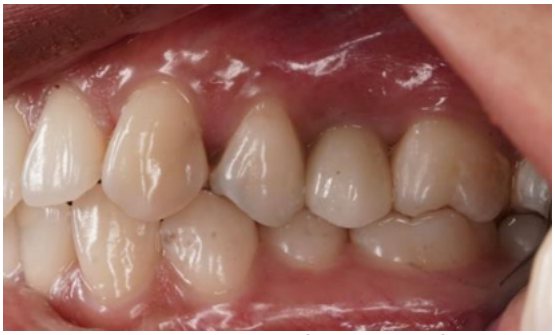

Figure 15. One-week post-insertion follow-up of the implant prosthesis.

of the final prosthesis, reduces misalignment, and supports long-term success of the implant-prosthetic complex.[7,9]

Implant placement in the posterior maxillary region often presents complex biological and biomechanical challenges. This area typically exhibits low bone density, limited keratinized mucosa, and variable ridge morphology, all of which affect primary stability and peri-implant soft tissue response.[2,5,6] In addition to osseointegration, the long-term success of implant therapy now strongly depends on proper soft tissue management, particularly in developing a natural emergence profile and maintaining interdental papillae.[5,6,10]

Conventional prefabricated healing abutments are widely used due to their convenience and efficiency. However, their cylindrical, uniform shape fails to reproduce the natural tooth neck anatomy, resulting in an unnatural gingival contour and inadequate guidance of soft tissue healing. Consequently, this may lead to a flattened gingival architecture, poor papilla regeneration, and the development of open gingival embrasures or "black triangles," which compromise esthetics and hygiene.[4,6,7,11]

Customized healing abutments (CHAs) provide a more biologically oriented and individualized approach. By adapting the transmucosal contour to the patient's gingival morphology and tooth anatomy, CHAs guide peri-implant mucosal maturation in a controlled manner, promote a natural emergence profile, and support the preservation or regeneration of the interdental papilla.[3,10,11] In addition, CHAs help establish a continuous mucosal seal around the implant neck, which is essential to prevent bacterial penetration and maintain marginal bone stability.[6,12]

An important advantage of CHAs over prefabricated abutments is their ability to reduce repeated abutment disconnection and reconnection during the healing phase, which is known to disrupt epithelial attachment and trigger inflammatory responses in the peri-implant mucosa.[12,13] Maintaining a single abutment from implant placement to the final restoration—known as the "one abutment, one time" concept—helps preserve the integrity of the mucosal seal and prevents micro-movements at the implant–abutment interface.[6,11]

Material selection for CHA fabrication plays a critical role in its biological and esthetic performance. In recent years, polyetheretherketone (PEEK) has gained popularity as a material for temporary and healing abutments, replacing conventional metals such as titanium. PEEK exhibits an elastic modulus (3–4 GPa) similar to cortical bone, providing a more favorable stress distribution at the implant platform.14 Furthermore, PEEK demonstrates excellent biocompatibility, chemical stability, and low plaque affinity, making it highly suitable for mucosal healing.[15,16]

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Biologically, soft tissues surrounding PEEK abutments show less inflammation and more stable epithelial attachment compared with titanium. Milinkovic et al. reported significantly lower inflammatory cell infiltration around PEEK abutments, while Shomurodov and Mirkhusanova found more favorable mucosal tissue health in PEEK compared with titanium groups. Similarly, Suphangul et al. demonstrated that PEEK surfaces inhibit bacterial adhesion and biofilm accumulation, leading to reduced plaque retention.[13,15,16]

From an esthetic standpoint, the light ivory color of PEEK closely resembles the surrounding gingival tissues, preventing the "gray shine-through" effect commonly observed with metallic abutments, particularly in patients with thin gingival biotypes.[6,14] This advantage enhances the visual harmony of peri-implant soft tissues and improves patient satisfaction.

In the context of one-stage implant surgery, where the healing abutment is immediately placed during implant insertion and remains transgingivally exposed, PEEK has demonstrated distinct biological advantages over metal. PEEK promotes faster and more stable mucosal sealing, lower plaque accumulation and peri-implant inflammation. When combined with a customized design, PEEK CHAs support the one abutment, one time protocol, reducing tissue trauma and preserving the epithelial seal from the earliest stages.[11,12] Although titanium provides superior mechanical strength, this limitation is clinically insignificant during the healing phase, where occlusal load is minimal. Therefore, PEEK is considered the material of choice for customized healing abutments in one-stage implant protocols, as it enhances biological stability, peri-implant hygiene, and esthetic outcomes.[6,12,14]

Overall, the clinical results of this case report align with current literature demonstrating that customized PEEK healing abutments significantly improve soft tissue adaptation, maintain papilla height, and prevent black triangle formation. The use of PEEK also supports superior peri-implant mucosal health and esthetic integration. Thus, the application of customized PEEK healing abutments represents a biologically driven and contemporary approach in implant dentistry—one that prioritizes soft tissue stability, esthetic integrity, and the long-term success of implant restorations.

Conclusion

The combination of a customized healing abutment (CHA) and the use of polyetheretherketone (PEEK) material provides a synergistic advantage in achieving biologically stable peri-implant soft tissue outcomes, besides its esthetic advantage. CHA enables precise control of the transmucosal contour, supports papilla formation, and maintains a natural emergence profile, while PEEK enhances these effects through its excellent biocompatibility, low plaque affinity, and gingiva-like color that improves esthetic integration. In one-stage implant surgery, where mucosal healing and osseointegration occur simultaneously, the use of a customized PEEK healing abutment promotes faster soft tissue maturation, stable mucosal sealing, and reduced inflammatory response compared with metallic abutments. Within the limitations of this case, the clinical outcomes suggest that customized PEEK healing abutments represent an optimal approach for peri-implant soft tissue management, combining biological stability, functional success, and improved esthetic results in implant rehabilitation.

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