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Review Article

Impact of abutment design on soft tissue health in full-mouth replacements

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ABSTRACT

Full mouth replacement is the entire rehabilitation of a completely edentulous arch. Conventional complete dentures and fixed or removable implant-supported dentures are two types of full-mouth replacement. Various factors may impact full mouth replacement outcomes, including abutment design. Dental abutments are used to connect the dental implant and the prosthesis. They can be classified based on fabrication, retention mechanism, material, and microgeometry. The stability of soft and hard peri-implant tissues plays a key role in the long-term success of dental implants. Thus, it is necessary to explore the effects of abutment design on peri-implant soft tissue health. This review aims to explore current evidence about the impact of abutment designs on soft tissue health of dental implants, including full mouth replacement. Customized abutments provide superior support for soft tissue stability compared to prefabricated alternatives. Zirconia abutments may reduce tissue discoloration and marginal bone loss in select cases; however, clinical outcomes vary depending on multiple factors, including implant position, soft tissue phenotype, and surgical technique. Further high-quality, long-term clinical studies are recommended to standardize guidelines for abutment selection in full-mouth rehabilitations.

Keywords: Full mouth replacement, Dental implant, Abutment, Abutment design, Soft tissue health, Peri-implant tissues

INTRODUCTION

Full-mouth replacement is the complete rehabilitation of fully edentulous arches, mainly using conventional complete dentures, removable implant-supported overdentures, or fixed implant-supported prostheses, including hybrid restorations and the All-on-X concept.[1,2] These procedures can improve oral function and esthetics; however, the stability of peri-implant tissues (soft and hard) plays a key role in long-term success. Various factors may impact implant outcomes, including abutment design, which significantly influences soft tissue health and esthetic integration.

Dental abutments are the connectors between the implant fixture and the final prosthesis.[3] They can be classified based on fabrication, retention mechanism, material, and microgeometry.[4-7] These different types of dental abutments can significantly affect peri-implant soft tissue health, including their morphology, thickness, and stability over time. For instance, customized healing abutments, which fit the shape of the extraction socket, have shown better results in keeping the soft tissue shape and stability compared to standard prefabricated abutments.[4]

The nature of soft tissue around an implant differs from those around normal teeth, specifically the direction of connective tissue fibers, the amount of blood supply, the extension of junctional epithelium, and the number of fibroblasts and collagen fibers.[8-10] The contact between soft tissue and the abutment is critical for the maintenance of healthy conditions and for the long-term success of the implant.[8]

Recently, multiple strategies have been developed to decrease biofilm formation and bacterial adhesion on implant abutment surfaces and to induce connective tissue adaptation to the transmucosal part of the implant. These strategies are of relevant clinical interest and can be implemented for the maintenance of soft tissue health. They can also be effective in preventing peri-implant inflammatory diseases. A biologically stable and esthetically full-mouth replacement is highly required; thus, it is critical to investigate the effects of abutment design on peri-implant soft tissue health.

This review aims to explore current evidence about the impact of abutment designs on soft tissue health of dental implants, including full mouth replacement.

METHODS

A comprehensive literature search was conducted in Medline (via PubMed), Scopus, and Web of Science databases up to July 4, 2025. Medical subject headings (MeSH) and relevant free-text keywords were used to identify synonyms. Boolean operators (AND, OR) were applied to combine search terms in alignment with guidance from the Cochrane handbook for systematic reviews of interventions. Key search terms included: “Full mouth replacement” OR “full mouth rehabilitation” AND “abutment” OR “abutment design” AND “soft tissue” OR “peri-implant tissue”.

Summaries and duplicates of the found studies were exported and removed by EndNote X8. Any study that discusses the impact of abutment design on soft tissue health in full-mouth replacements and is published in peer-reviewed journals was included. Studies in all languages were considered. Full-text articles, case series, and abstracts with related topics were included. Case reports, comments, and letters were excluded.

DISCUSSION

Full mouth replacement

Full mouth replacement is the full rehabilitation of a complete edentulous arch, either mandibular, maxillary, or both. Various treatment techniques are available; treatment choice depends on the number of implants, prosthesis type, and material used. Types of full mouth replacement are mainly conventional complete dentures, removable implant-supported dentures, and fixed implant-supported prostheses (hybrid or all-on-X).[1,2] Conventional complete dentures are removable acrylic prostheses supported by soft tissue that are mainly used in patients with remarkable bone loss or financial difficulties. Their main advantages are affordability and non-surgical nature, while their shortcomings include poor retention, bone resorption, and limited chewing efficiency.[1]

The removable implant-supported dentures are dentures retained by 2-4 implants with attachments such as locators, balls, or bars. They help to improve retention and stability and preserve bone. Removable implant-supported dentures achieve high patient satisfaction and cost less than fixed solutions. However, they are still removable, requiring periodic attachment maintenance [2]. Fixed implant-supported prostheses are full-arch fixed prostheses on 4 or more implants, often with tilted distal implants to avoid bone grafting. Examples of materials used in this type are titanium-acrylic hybrid, zirconia, or PEEK. They are associated with high implant survival and favorable patient-reported outcomes. Advantages of this type are their fixed nature, natural function, and aesthetics. Avoidance of bone grafts via angulated implants is also a major advantage. However, it is expensive and has a high risk of technical complications such as screw loosening and tooth fracture.[2] Complications of full mouth replacement include biological complications, including peri-implant mucositis, peri-implantitis, and bone loss, and mechanical complications, including screw loosening or fracture, acrylic tooth fracture in hybrids, and prosthesis misfit or wear.[11]

Abutments design

Dental abutments are used in connecting the dental implant (fixture) and the prosthesis (crown, bridge, or denture). They are considered critical components in implant prosthodontics. Different types of abutments are available, classified based on fabrication, based on retention mechanism, based on material, or based on design and use. Each type is designed for specific clinical indications and prosthetic requirements. Dental abutments can be classified based on fabrication into customized abutments and prefabricated abutments.[4] Customized abutments are the integration of computer-aided design (CAD) and computer-aided manufacturing (CAM)-designed based on digital or conventional impressions.

Materials used in this type of abutment are titanium, zirconia, or gold alloy. Customized abutments are ideal for esthetic zones, suboptimal implant angulation, and unique soft tissue contours. They result in better emergence profiles and esthetics.[4]

On the other hand, prefabricated abutments have standardized sizes that can be selected and adjusted chairside. Materials of prefabricated abutments are usually titanium, zirconia, or stainless steel. They are typically used when perfect implant positioning is achieved. They are also cost-effective and time-saving. The main limitation of prefabricated abutments is their limited customization, making them unfit for all anatomical situations.[4]

Dental abutments can also be classified based on retention mechanism into cement-retained abutments and screw-retained abutments.[5] In cement-retained abutments, the prosthesis is cemented onto the abutment. They are good for esthetic regions and hide screw access; however, cement remnants may lead to peri-implantitis. In screw-retained abutments, the prosthesis is secured with a screw through the crown. Retrievability is crucial in this type of abutment. They are suitable for full-arch restorations and are repaired and maintained easily.[5] Furthermore, dental abutments can be classified based on material into titanium abutments and zirconia abutments.[6]

Titanium abutments are biocompatible, strong and corrosion-resistant; however, they may shine through thin gingiva (greyish hue). They are more suitable for posterior regions and high-load areas.[6] Zirconia abutments are tooth-colored and have excellent esthetics; however, they are brittle with higher fracture risk in thin designs. They more suitable for anterior regions and thin biotype patients. Additionally, dental abutments can be classified based on design and use into healing abutments, temporary abutments and angled abutments.[12-14]

Healing abutments are cylindrical and used temporarily to contour soft tissue during healing. They are placed after implant uncovering or immediate implant placement.[13] Temporary abutments are made of plastic or titanium. They support provisional restorations and facilitate esthetic and functional testing before definitive prosthesis.[14] Angled abutments are pre-angled (usually 15-30°) abutments used to compensate for misaligned implants. They typically restore angulated implants while achieving a proper prosthetic path.[12]

Abutment impact on soft tissues

Effects of abutment materials

A recent network meta-analysis examined the effects of abutment materials on peri-implant soft tissue, using the outcomes marginal bone loss, recession, plaque index, probing depth, and bleeding on probing.[15] The study found a significant reduction in bone resorption in zirconia abutment groups compared to titanium groups.[16-18] Additionally, predictive interval plots showed that zirconia and gold abutments performed better than other materials regarding the marginal bone loss outcome. Thus, according to this meta-analysis, zirconia abutments outperformed titanium abutments in preserving marginal bone levels. However, another previous study found no significant difference in marginal bone levels between zirconia and titanium abutments.[19] This superiority of zirconia can be explained by enhanced hard and soft tissue integration.[20] As surface roughness can significantly affect cellular response, zirconia abutments can potentially improve soft tissue adhesion due to their rough surfaces compared to the polished surfaces at the mucosal-bone interface of titanium abutments.[21,22] Paul et al reported similar fibroblast behavior between zirconia and three-dimensional-designed titanium abutments.[23]

Nevertheless, these findings cannot be generalized universally. A previous study examined cell adherence and viability and showed no significant difference across zirconia, alumina, disilicate, and titanium, regardless of surface roughness.[24] This finding aligns with another study that reported comparable soft tissue morphogenesis in a canine model for both zirconia and titanium. Another review found no significant difference in peri-implant soft tissue behavior (e.g., discoloration), survival rates, and marginal bone loss across different abutment materials, including discoloration among titanium, zirconia, gold, and alumina abutments. Notably, the review reported that zirconia showed the least tissue discoloration (84.8%), alumina had the least marginal bone levels (81.4%), and titanium exhibited the highest survival rate (97.9%).[25]

Meta-analysis found no difference in plaque index between zirconia groups and titanium groups.[15] It also found no significant differences in probing depth between zirconia groups and titanium groups after 1 year, 3 years and 5-7-year follow-up.[16-18,26] Probing depth of soft tissues is based on different factors such as abutment design, gingival phenotype and implant position. However, these factors were not consistently reported in previous studies. These confounding variables may dilute any potential effect of abutment material on probing depth.

The meta-analysis also found no difference in recession between zirconia groups and titanium abutments.[15-18] Soft tissue recession may represent a long-term adaptation to abutment geometry and implant positioning.[10] A previous systematic review reported that the width of the abutment does not affect soft tissue health or esthetics.[27] However, the macro-geometry of the abutment may influence soft tissue compression and displacement. Compression may result in apical mucosal shift, while decompression can result in coronal displacement. This mechanical effect could outweigh the impact of material type.

Furthermore, zirconia abutments showed surface under the cumulative ranking curves (SUCRA) of 83.3% in plaque index, 87.0% in bleeding on probing, and 65.0% in probing depth outcome, suggesting that zirconia abutments performed better than titanium and alumina abutments.[15] More studies are needed for gold abutments, as a comparison was made only about marginal bone level. Notably, alumina abutments achieved the best results in recession and marginal bone loss outcomes.

Prefabricated and customized healing abutments

A recent study evaluated the effects of different healing abutments, including prefabricated and customized healing abutments, on peri-implant tissues in implant sites.[4] The stability of both soft and hard tissues is crucial for long-term implant success, since the formation of peri-implant tissue starts shortly after implant placement.[28-30] The stability of peri-implant tissues may be influenced by different factors such as tissue quality and quantity, surgical procedure, and abutment design.[31,32] The study compared prefabricated with customized healing abutments by focusing on three key differences: dimensions, macrogeometry, and emergence angle.[4]

Regarding dimensions, the prefabricated abutments are circular and standardized in size, forming a space around the socket, particularly in the buccolingual area. This space may require sutures. The study reported more midfacial tissue change in the prefabricated group (−0.607±0.421 mm) compared to the customized group (−0.3557±0.227 mm), due to the size mismatch caused by prefabricated abutments that may hinder their ability to support soft tissue contours.[33] On the other hand, customized healing abutments are designed to match the patient's socket dimensions based on intraoral scans and CBCT data, replicating the cross-section at the cementoenamel junction.[4]

Concerning macrogeometry, customized healing abutments are designed in a concave shape to diverge from the fixture–abutment interface gradually, finishing at the cementoenamel junction, creating more space at proximal sites. This may favor the stability of the papilla height compared to the straight profile. This is evident in the results of the study, as a smaller reduction in papilla height was observed in the customized group (−0.7258±0.540 mm) compared to the prefabricated group (-1.179±0.5238 mm) at the 6th month.[4] Furthermore, tissue alterations in the case of distal papilla were lower in the customized group (-0.600±0.750 mm) than the prefabricated group (-1.232±0.829), aligning with studies showing improved gingival papilla preservation with customized designs.[34-36] A systematic review further supported that concave transmucosal profiles better preserve marginal bone levels.[37]

About the emerging angle, the wider angle of customized abutment allows the emergence profile to mimic the natural root, aiding soft tissue architecture preservation. Multiple studies found a greater reduction in buccal volume in the 1st and 4th months in the customized group compared to the prefabricated group.[35,38,39] However, the wide emergence angle of customized abutments may increase apical pressure on the midfacial tissue, resulting in greater midfacial height reduction. This is in line with previous reports of midfacial recession following immediate implants.[34,35,40,41]

Despite these differences between customized and prefabricated healing abutments, both showed no significant differences in marginal bone change after 6 months, with mesial marginal bone loss of 0.283±0.465 mm and distal marginal bone loss of 0.359±1.274 mm for the customized group, and mesial marginal bone loss of 0.428±0.867 mm and distal marginal bone loss of 0.158±0.353 mm for the prefabricated group.[4] According to these findings, customized abutment seems to influence soft tissue more than hard tissue. The aesthetic outcomes were also positively affected by the positive trend in tissue preservation. Multiple studies measured esthetic changes using the pink esthetic score (PES) and reported a minor negative change in the customized group and a significant negative PES change in the prefabricated group.[42-44]

Additionally, it has been reported that tooth position can affect outcomes. The customized abutment groups demonstrated better buccal soft tissue preservation in anterior and premolar regions due to palatal implant positioning and greater space for buccal tissue, while the posterior regions did not demonstrate significant changes, mainly due to differences in implant positioning.[4]

CONCLUSION

Abutment design plays a critical role in maintaining soft tissue health and esthetic outcomes in full-mouth implant restorations. Evidence suggests that customized abutments, particularly those with concave transmucosal profiles and wide emergence angles, are more effective in preserving peri-implant soft tissue contours and papillary architecture compared to prefabricated alternatives. Overall, optimal abutment selection, balancing biological integration, esthetics, and prosthetic requirements, is essential for the long-term success of full-arch implant rehabilitation. Further high-quality, long-term clinical studies are recommended to standardize guidelines for abutment selection in full-mouth rehabilitations.

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