NEU PRESS
Diş Hekimliği Dergisi
Vol: 7 No: 1 Year: 2025 Review Article e-ISSN: 2687-5535
https://doi.org/10.51122/neudentj.2025.147

Single Tooth Implant-Supported Crowns in The Maxillary Anterior Region: Treatment Planning and Prosthetic Options

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Article Info

Article History

Received: 04.06.2024
Accepted: 21.10.2024
Published: 28.04.2025

Keywords:
Esthetics,
Maxilla,
Single-tooth dental implant.

ABSTRACT

With the advancement of technology and prosthetic materials, treating one or more missing teeth with implant-supported crowns and fixed partial dentures has become preferable. This choice is driven by factors such as the preservation of neighboring teeth, which do not require preparation, and the ease of maintaining gingival health. Success in treating single missing teeth in the anterior region must consider esthetics and function. Thus, all details should be carefully considered for ideal treatment from the surgical process of implant placement to the prosthetic process, including the material selection and the type of retention for the prosthesis on the implant. This review discusses implant planning based on the clinical and radiologic evaluation of tooth loss in the maxillary anterior region, emphasizing its impact on the prosthesis. It also covers factors to consider implant prosthetic options, such as the osseointegration of the implant.

Maksiller Ön Bölgede Tek Diş İmplant Destekli Kronlar: Tedavi Planlaması ve Protetik Seçenekler

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 04.06.2024
Kabul Tarihi: 21.10.2024
Yayın Tarihi: 28.04.2025

Anahtar Kelimeler:
Estetik,
Maksilla,
Tek diş dental implant.

ÖZET

Tek veya daha fazla diş eksikliğinin tedavisinde diş destekli yapılan kron ve köprüler, günümüzde teknolojinin ve materyallerin gelişmesi ile birlikte yerini implant destekli sabit restorasyonlara bırakmaktadır. İmplant destekli yapılan tedaviler ile komşu dişlerde madde kaybı olmaması ve dişeti sağlığının korunması gibi avantajlar sağlanmaktadır. Anterior tek diş eksikliğinde sıklıkla tercih edilen implant destekli kronların başarısının değerlendirilmesinde fonksiyon ile birlikte estetik de etkilidir. Klinik başarıyı sağlayabilmek için implant yerleştirmenin cerrahi sürecinden, implant üzerindeki protezin materyal seçimi ve tutuculuk şekline kadar tüm detayların dikkatle düşünülmesi gerekir. Bu literatür derlemesinde maksiller anterior bölgedeki diş kaybının klinik ve radyolojik değerlendirmesine dayalı olarak implant planlaması ele alınmakta ve protetik seçenekler hakkında bilgi verilmektedir.

To cite this article: Yüceer ÖM, Turhan Bal B, Karakoca Nemli S & Bankoğlu Güngör M. Single Tooth Implant-Supported Crowns in The Maxillary Anterior Region: Treatment Planning and Prosthetic Options. NEU Dent J. 2025;7:117-34. https://doi.org/10.51122/neudentj.2025.147

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INTRODUCTION

Implant-supported fixed prostheses have become effective alternatives for the treatment of missing teeth. With the recent technological improvements, these prostheses not only provide function but also give satisfactory esthetic appearance.[1] For this reason, implant placements and implant-supported prostheses must be planned together and conducted with precision, particularly in the maxillary anterior region.[2]

Clinical and radiographic evaluation of the maxillary anterior region

Tooth loss in the maxillary anterior region is observed due to trauma in approximately 6 to 38% of young patients, while it is observed in adults due to caries, periodontal disease, oral habits, and familial reasons such as hypodontia.[3-5] The choice of treatment for a patient with a single missing tooth in the maxillary anterior region depends on several factors, including clinical and radiological assessments, the patient's conditions, access to technology, the experiences of clinicians and dental technicians, and economic factors. Treatment options for single-tooth loss in this region include fixed prostheses, removable partial dentures, orthodontic closure, and dental implants.[6,7] The final decision, reached by considering the advantages and disadvantages of each method, depends on the case.[6] In addition, orthodontic treatment requires multidisciplinary planning and can be used in limited clinical situations and conjunction with implant placement.[7] Fixed prosthetic options can be listed as three-unit tooth-supported or cantilever-fixed prostheses. However, these options have some disadvantages. Tooth preparation is necessary for the application of these treatments. Dental caries formation depending on the patient's oral hygiene habits, or chronic gingivitis and periodontal diseases especially on the subgingival margins of the abutment may be observed.[3,8] According to a systematic literature review conducted at the 3rd European Society for Osseointegration Consensus Conference in 2012, the 5-year estimated survival rate for a single implant is approximately 98%; the 10-year estimated survival rate is approximately 95%; the 5-year estimated survival rate for implant-supported single crowns is approximately 96%; and the 10-year estimated survival rate is approximately 90%.[9] Survival rates of tooth-supported fixed partial dentures were significantly lower than implant-supported prostheses.[10] In case of tooth loss in the maxillary anterior region, clinical evaluation is critical in implant planning. The main factors are summarized in the Table 1.[11-13]

Table 1: Factors to be considered in implant planning[11-13]

Adjacent teeth	• Caries • Endodontic treatment • Periodontal health • Trauma • Amount of tooth structure available for retention
Occlusion	• Intermaxillary distance and occlusal relationship • Bruxism or parafunctional activity
Width and volume of the edentulous area	• Mesio-distal and labio-lingual width • Amount of available bone and soft tissues
Patient condition	• Complete skeletal growth • Patient age and systemic condition • Patient's habits (use of medicine, alcohol, cigarette)
Restoration design and material	• Metal or ceramic • Cemented or screw-retained implant prostheses • Cantilever or resin bonding systems

Clinical examination should be made together with a radiographic examination in implant planning. Periapical, panoramic, cephalometric, and occlusal radiographs are used for radiographic examination. Panoramic radiography, one of the most widely used imaging techniques, has the advantage of comprehensive visualization of facial bones and teeth, but the disadvantages, such as two-dimensional imaging, distortion, and magnification cause this technique to be inadequate during planning. Thus, Cone Beam Computed Tomography (CBCT) is preferred by developing technology. CBCT offers high-resolution and three-dimensional imaging.[14]

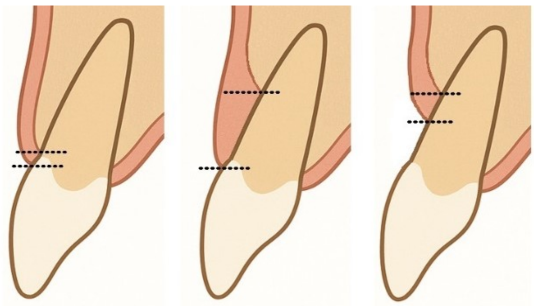
Implant planning in the maxillary anterior region

The position of the dental implants should ideally be planned according to the final prosthetic outcome to achieve the desired esthetic and physiological loading position. The maxillary anterior region has great importance for the esthetic appearance; therefore, positioning the implants according to the prosthesis becomes even more essential in this region.[12] Considering the history of implant applications, in addition to bone augmentation methods, soft tissue regenerative surgery has gained importance due to esthetic concerns. As a result, recently successful treatment includes not only the osseointegration of the implant but also the optimization of the soft and hard tissues around the implant.[15] From this point of view, pre-implant augmentation procedures, precision in implant placement, optimal implant position and angulation, management of peri-implant soft tissue, and the quality of the prosthetic restoration should be considered for successful implant-supported prostheses.[16] Furthermore, the quantity and quality of bone in the edentulous area after tooth extraction, the surgical planning including three-dimensional analysis, the management of soft tissue, the relationship of the implant site with adjacent teeth, the implant placement protocols, the requirement for hard and soft tissue augmentation, smile line, patient expectation, the factors such as pre-existing pathology, and the position of the implant and the neck design of the implant should be evaluated.[13,17-20]

The quantity and quality of the bone in the edentulous area or after tooth extraction:

When evaluating the quantity and quality of bone in the maxilla, its anatomical relationship with the nasal cavity, maxillary sinus floor, and incisive canal should also be evaluated. The vertical height and sagittal width of the alveolar bone are vital factors for implant planning. Since the bone on the labial surface of the roots is usually thin, fracture during extraction or collapse after extraction may occur.[19] The bone structure in the anterior and premolar regions of the maxilla, characterized by fine porous bone on the labial side, very fine porous-dense compact bone on the nasal side, and thick cortical bone on the palatal side, is classified as Type III bone.[21] There are three different types of sockets after tooth extraction (Figure 1):

Figure 1: Different types of sockets after tooth extraction[13]



a) Type 1 socket: The most favorable clinical situation for implant treatment is the presence of adequate amounts of bone and healthy soft tissues.
b) Type 2 socket: There is inadequate labial bone thickness, and implant placement can result in gingival recession.
c) Type 3 socket: There is a loss in both hard and soft tissues.
Type 2 sockets can be clinically misleading because they appear similar to Type 1 sockets before extraction. However, in Type 2 sockets, this soft tissue is supported by the underlying tooth root, not the labial bone. If the labial bone is partially missing in Type 2 sockets, gum recession is likely to happen. [13]

Surgical planning, including three-dimensional analysis of hard and soft tissues:

When placing implants in the esthetic zone (such as the anterior region of the maxilla), CBCT is important to determine the quantity of existing buccal bone, need for bone grafting, estimation for width and length of the implant to be placed, and the sagittal position of the root in the presence of teeth. Determination of the buccal bone thickness influences the decision of immediate loading.[18]

Management of the soft tissue according to biotype:

Tooth morphology is associated with the characteristics of the gingiva. It should be considered that generally, square-shaped teeth are associated with thick, and triangular-shaped teeth are associated with a thin gingival form. Gingival form influences implant planning by affecting bone thickness. In a patient with a thin gingival phenotype, the labial bone thickness is approximately 0.6 mm, while in a patient with a thick phenotype, the labial bone is 1.2 mm thick, which also affects the positioning of the implant.[22] Soft tissue phenotype is one of the factors that influence the contour of the restoration. If the existing soft tissue is thin and less keratinized, it is more prone to recession. Therefore, in the presence of a gingiva with a thin phenotype, a flatter or concave contour should be created to prevent gingival recession related to the restoration contour.[12,13] The height of the papilla is crucial for creating a natural-looking smile, particularly in the esthetic zone. An adequate amount of attached gingiva is also important for the health and stability of the gingival tissues around the implant.[19]

The relationship of the implant site with adjacent teeth:

Maintaining a horizontal distance of 1.0 to 1.5 mm between a natural tooth and an implant is generally recommended. This recommendation is based on the typical vertical and horizontal bone loss around implants, which is approximately 1.5 to 2.0 mm vertically and 1.0 to 1.5 mm horizontally. By maintaining this distance, the risk of bone resorption and potential damage to the adjacent tooth or implant is minimized.[23] Limitations in bone quantity in the mesiodistal dimension may be caused by the root position of adjacent teeth. The roots of the adjacent teeth may encroach into the space where an implant is to be placed and reduce the width of the bone available.[24] Clinical studies indicate that 60 to 70% of cases with a horizontal distance of less than 2.5 to 3 mm between the implant and the adjacent tooth do not have an interproximal papilla. However, cases with a horizontal distance of 2.5 to 4 mm between the implant and the adjacent tooth tend to have an interproximal papilla.[25,26]

Implant placement protocols:

Implant treatment can be performed with the healing of the alveolar bone after tooth extraction, or today, especially for esthetic reasons, it can be performed immediately after extraction following various protocols.[1] Immediate implant placement reduces the number of surgical operations and treatment time; however, it is essential to evaluate the hard tissue required for the ideal positioning of the implant and keratinized gingival tissue, which is important for prosthetic treatment.[27,28]

A classification for the timing of implant placement after tooth extraction has been established based on the evaluation of hard and soft tissues:[1]

a) Implant placement after extraction, immediate placement (Type 1):

It has been suggested that immediate placement of implants reduces alveolar bone resorption, a key factor in enhancing treatment outcomes in the anterior maxillary esthetic region. This reduction in bone resorption can decrease the need for additional bone augmentation procedures, making the immediate placement protocol preferable. However, questions have been raised regarding the advantages of immediate placement, as factors such as inadequate primary stability and improper implant positioning may impair the outcome of subsequent prosthetic restoration.[17] The amount of available bone, the presence of acute infection, and the need for atraumatic extraction affect the preference for immediate implant placement.[12] Implants placed immediately after extraction can be restored immediately. Correctly shaped morphology of the abutment allows repositioning of the peri-implant soft tissue. Esthetic results depend mainly on the stability or remodeling of the soft and hard peri-implant tissues.[29]

b) Early placement with soft tissue healing (Type 2) and partial bone healing (Type 3):

In the late 1990s, early implant placement with partial soft/hard tissue healing was developed. This method involves a healing period of 4 to 8 weeks after extraction before placing the implants. During this time, soft tissue healing occurs, utilizing the keratinized mucosa covering the socket. This helps implant placement by reducing postoperative complications. Nonetheless, delaying implant placement by 3 to 4 weeks after extraction may lead to loss of the papilla. Therefore, supporting the papilla after extraction is critical.[12]

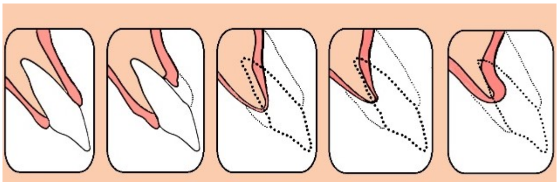
c) Late placement (Type 4):

Late implant placement is influenced by site- and patient-related factors. Site-related factors include the presence of an infected tooth requiring healing, extraction of a hopeless tooth in a growing patient, and trauma-related tooth loss which need time for healing. Patient-related factors include comorbidities influencing implant success. If a late implant placement protocol is decided, the possibility of bone resorption during the healing process should be considered. Graft materials can be placed into the socket after extraction to prevent resorption and deformity later. However, the choice of graft materials for this procedure remains controversial.[17]

Hard and soft tissue status and the need for augmentation:

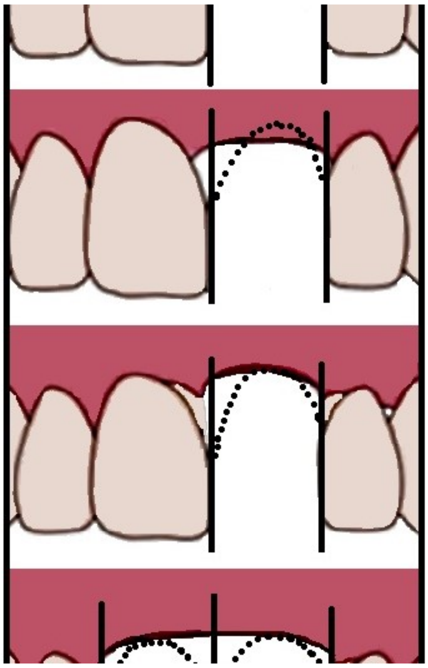
The thickness, height, and contour of the labial alveolar bone can significantly affect a patient's facial expression and smile line and the transmission of functional forces.[24] The amount of vertical and horizontal bone loss and the presence of the buccal bone determine the quantity and the type of graft material needed (Figure 2).[12] To place a standard implant in 3.75 to 4 mm diameter, the required bone thickness is 6 mm in the bucco-lingual direction and 5 to 6 mm in the mesio-distal direction.[30]

Figure 2: Vertical and horizontal alveolar bone loss[24]



Peri-implant mucosa height follows the alveolar bone; however, providing an interproximal papilla around an implant is complex and may not be fully controlled by the design of implant components or surgical interventions. While bone height and thickness play crucial roles in determining soft tissue level around implants, other factors, including tooth morphology, the position of the interdental contact point, and the arrangement and quality of soft tissue fibers, also influence soft tissue. The absence of various types of fibers around implants poses a significant challenge in managing the soft tissue around implants. The lack of papilla causing a black triangle between the implants is a major problem in the esthetics of implant-supported fixed prostheses. The type of temporary prosthesis used during the healing period plays a critical role in achieving the desired healing of the soft tissue.[24] Palacci and Ericsson[31] introduced a classification system in 2001 to aid clinicians in visualizing the outcomes and limitations of implant treatment. This system categorizes implant sites into four classes based on the extent of vertical and horizontal tissue loss (Figure 3).[24,32] The clinician should not expect to go directly from class IV to class II or from class III to class I with a single surgical procedure. However, class IV cases can be converted into Class II cases through a series of procedures. A total gain of 4 to 5 mm in soft tissue height can be achieved with surgical interventions. Bone augmentation procedures can provide a height gain of 2 to 3 mm. Soft tissue augmentation can provide an additional 2 mm, while surgical crown lengthening can add 1 to 2 mm more, potentially gaining a total of 3 to 4 mm. A staged surgical approach can further increase soft tissue height by 5 to 6 mm. These combined attempts can significantly enhance the success of implant treatment. Therefore, hard and soft tissue augmentation affects implant placement and subsequent prosthetic restoration.[24]

Figure 3: Palacci-Ericson classification[24]



Vertical loss: Class I, intact or slightly reduced papilla; class II, limited papilla loss (less than 50%); class III, severe papilla loss; class IV, absence of papilla (edentulous ridge).
Horizontal loss: Class A, intact or slightly reduced buccal tissues; Class B, limited loss of buccal tissue; Class C, severe loss of buccal tissue; Class D, excessive loss of buccal tissue, often with a limited amount of adherent mucosa.

Smile line:

In an ideal smile line, the lip displays 75 to 100% of the maxillary central incisors and the interproximal gingiva. A high smile line exposes the full length of the maxillary anterior teeth and the surrounding gingiva. A low smile line shows less than 75% of the anterior teeth.[19] Since the mean lip lines of females are 1.5 mm higher that of males, 1 to 2 mm of gingival exposure during a maximum smile can be considered normal in women. It has been reported that an average of 0.7 mm of gingiva is visible during the smile in women, while in men, an average of 0.8 mm of the clinical crown is covered by the upper lip.[33] The support and visibility of the vermillion line during a smile are greatly affected by the anatomy of the upper alveolar bone, the placement of implants, the surrounding tissue around the implants, and the shape of the teeth.[24,33] Low smile provides advantages for esthetical results of implant treatment.

Patient expectation:

Implant prostheses are intended to provide function and esthetics to patients, but it is difficult to meet these expectations in some cases. The patient should be informed about the final results of the prosthesis to avoid the disappointment.[24]

Position of the implant:

The optimal implant position is achieved by positioning the implant shoulder approximately 1 mm palatal from the origin of the adjacent teeth. Placing the implant too labially, also called entering the dangerous zone, can cause buccal bone resorption and subsequent gingival recession.[23] In such cases, if the implant is deeply embedded in the bone to correct this malposition, the gingival level of prosthetic restoration would be higher than the other teeth. Furthermore, in some of these cases, removal of the implant, hard tissue augmentation, and a new implant placement are required.[13] A risk with implant placement is inserting the implant too palatally, which may require an over-contoured implant-supported crown.[23] In natural teeth, the presence of periodontal ligaments with adequate blood supply allows the tooth to remain stable even if the width of the labial alveolar bone supporting the tooth is less than 1 mm.[34] However, bone support around the implant is important for an implant without periodontal tissue support. According to the study by Miyamoto et al.,[26] vertical bone resorption and the resulting gingival recession could be prevented if 2 mm or higher labial bone thickness was maintained.

The optimal depth for implant placement is typically around 1 mm below the enamel-cement junction of the neighboring teeth.[23] Deep implant placement may result in deep periodontal pockets around the implants. However, bone resorption of coronally placed implants is similar to that of apically placed implants.[35] The depth of implant placement is vital for the contour of the restoration and long-term prognosis of the implant.[13]

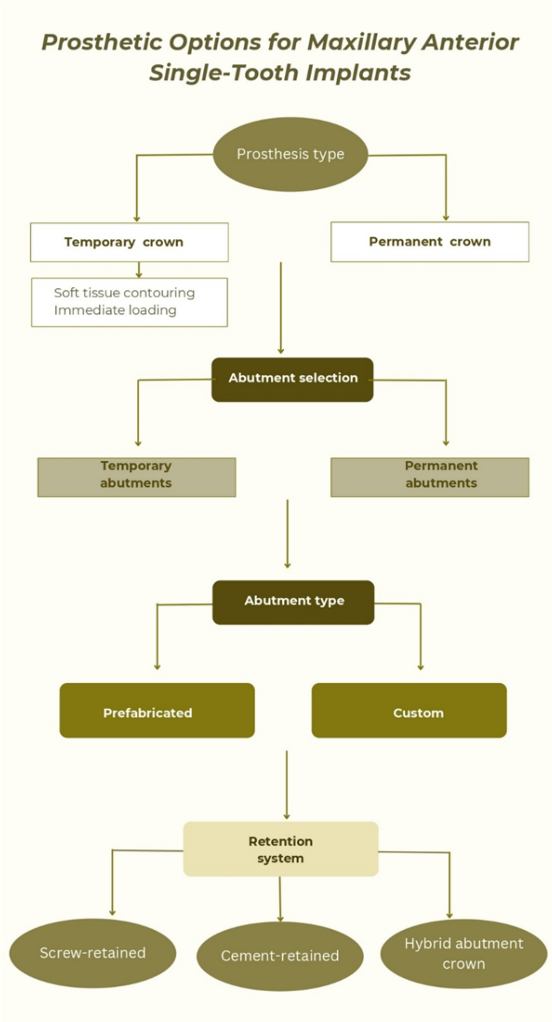
Implant neck design:

The implant neck design affects the relationship between the implant, the prosthesis, and the surrounding soft tissue, thereby affecting marginal bone, the level of the implant, and the long-term health of these tissues.[20,36] Hartog et al.[20] compared the effect of three different implant neck designs on the preservation of marginal bone. They found no significant difference in rough or smooth necks, but the neck design with micro-grooves resulted in higher bone loss and deeper pockets. On the contrary, Nickenig et al.[37] reported that marginal bone loss was higher in smooth-neck implants compared with rough-neck implants and that the micro-grooved design might reduce the marginal bone loss.

Prosthetic Options

Function and esthetics play an important role in implant-supported treatments for the rehabilitation of tooth loss in the maxillary anterior region. The prosthetic options are summarized in Figure 4. The factors affecting these prosthetic outcomes are abutment selection, prosthesis type, soft tissue repositioning with temporary crowns, and occlusion.

Figure 4: Prosthetic options for maxillary anterior single-tooth implants



Abutment selection:

Abutment selection includes factors such as screw- or cement-retention, abutment material, implant-abutment connection type, abutment selection time, and production method of the abutment.

Screw/cement-retained abutments: The fixation of an implant-supported prosthesis on the implant is achieved by screws or by types of luting cement to the abutment, which is screwed onto the implant.[38] Cement-retained prostheses are preferred in single-unit restorations, although favorable long-term clinical results have been reported for cemented and screwed prosthetic restorations.[38,39] However, both cement and screw-retained prostheses have advantages and disadvantages.[38,40] In cement-retained prostheses, prefabricated or customized abutments are needed, and the restoration is cemented onto the abutment. Residual cement around the peri-implant tissue after cementation can cause peri-implantitis.[41,42] Furthermore, in case of a complication, removing a cement-retained prosthesis can be more challenging without damaging the prosthesis.[38] This system is preferred because it is easy to provide passive fit and tolerate improper implant angle.[40,43] The most crucial benefit of screw-retained restoration is the ease of removal of the prosthesis for different purposes such as hygiene protocols, repair, and surgical intervention requirements.[43] In addition, when the interocclusal distance is limited to 4 mm, good retention can be achieved with screw-retained restorations.[40] The ideal screw hole should be placed in the palatal or oral surface of the restoration, which is not visible. However, the horizontal and angular position of the implant may cause the position of the screw hole at the labial site, which may adversely affect the esthetics of the prosthesis.[43,44] For these reasons, implant positioning is critical in screw-retained restorations. Also, the production technique is more complex, and complications such as screw loosening and porcelain fracture may be observed during intra-oral use.[45] Screw-retained restorations are preferred in the anterior regions because it is difficult to remove the cement when the implant is placed deeply in the posterior regions.[46] Freitas et al.[47] reported that there is more stress concentration in screw-retained restorations than in cement-retained restorations, resulting in more screw/implant fractures. Edmondson et al.[48] reported that the need for an angled abutment is common in the anterior region, and screw-retained abutments can tolerate angles up to 15 degrees. According to Chee et al.[40], screw-retained restorations can be preferred for the anterior implants since screw hole access has no role in occlusion.

Abutment material: Titanium, stainless steel, gold, zirconia, alumina ceramic, and Polyetheretherketone (PEEK) can be used as abutment materials.[49,50] Good long-term results have been documented for single crowns using titanium and gold abutments. However, these materials have esthetic drawbacks in the anterior region in thin soft tissues or peri-implant mucosal recession.[44,51,52] Prestipino et al.[53] reported that densely sintered alumina ceramics had low corrosion, high biocompatibility, and low thermal conductivity; however, their mechanical durability was less than metal abutments.[44] Glauser et al.[55] first described densely sintered yttrium-stabilized zirconia as an alternative ceramic abutment. As zirconia abutments have good mechanical properties and peri-implant tissue response similar to titanium abutments, they have emerged as an alternative material. The grayish-bluish appearance caused by titanium abutments can be overcome with zirconia material.[56,57] In addition to esthetic advantages, ceramic abutments have high corrosion resistance, biocompatibility, and less bacterial adhesion.[58] Foong et al.[59] compared the fracture resistance of titanium and zirconia abutments in their study. As a result, fracture localization was observed at the abutment in zirconia abutments, while screw fracture was observed in titanium abutments. Bidra et al.[60] reported that fractures were reported in 1.15% of the abutments examined used in the anterior region. All fractured abutments were made of alumina or zirconia while no fractures were observed in titanium abutments. In a systematic review and meta-analysis, Laleman et al.[61] investigated the biological, technical, and esthetic outcomes of zirconia, alumina, and titanium abutments on peri-implant tissues after a minimum of one year of use. The study found that all three materials—zirconia, alumina, and titanium—performed similarly in terms of biological effects on peri-implant tissues, with no significant differences in marginal bone loss, probing depth, or abutment survival. However, ceramic abutments, such as zirconia and alumina, were more prone to fractures, whereas titanium abutments presented minor esthetic limitations. Despite these differences, both materials delivered satisfactory esthetic results. In a systematic review, Davoudi et al.[62] investigated the effects of CAD-CAM zirconia abutments on peri-implant health and compared the esthetic outcomes to other abutment types, such as stock abutments and titanium abutments. While pink esthetic and white esthetic scores were similar between CAD-CAM zirconia and other abutments, zirconia showed better soft tissue color, contour, and gingival recession outcomes, especially in thin soft tissue areas. Zirconia abutments also had lower bacterial colonization and improved soft tissue stability compared to titanium, reducing inflammation and peri-implantitis risk. Customizable CAD-CAM zirconia abutments offered better adaptation to patient anatomy, enhancing soft tissue stability and aesthetic outcomes. Long-term studies suggested stable soft tissue and bone levels over time, with minimal gingival recession. Despite promising results, the review calls for more high-quality, long-term studies to confirm these findings.[62] There is difficulty in soft tissue attachment to the surface of zirconia abutments, which are prominent for esthetic purposes. To solve this problem, micro and macro processes affecting soft tissue integration on the zirconia abutment surface have been developed. These processes include polishing, sandblasting, acid etching, plasma treatment, biomimetic coating, and UV treatment.[63] It was stated that soft tissue cells attach better to smooth polished surfaces.[64] Valantijiene et al.[65] also reported that periodontal cells showed better results around ultra-polished zirconia abutments than conventionally polished zirconia abutments.

Abutment-implant connection type: The type of abutment-implant connection imposes mechanical and functional limitations. Different types of interface designs have been developed, each having inherent advantages and disadvantages.[66] The external hexagonal connection type facilitates prosthesis placement and provides an anti-rotation mechanism. However, it can cause complications under high occlusal loads because a micro-gap has arisen with this connection.[67,68] In contrast, internal hexagonal connections facilitate load distribution and provide an antibacterial sealing because the implant-abutment connection interface area is increased, and the micro-gap with the morse taper is reduced. It has been reported that internal connections provide a more stable abutment-implant connection and reduce bone loss.[67,69] According to Misch,[15] implant and abutment designs with internal hexagonal connections remain the most widely used method. The study by Vetromilla et al.[67] showed that the morse-taper connection reduced bone loss and revealed successful results.

Abutment selection time: In the standard prosthetic protocol applied after implant application, the separation and reconnection of prosthetic components are involved. The replacement of these prosthetic components can disrupt the mucosal barrier due to the mobility of the peri-implant tissue they contact, potentially leading to bone loss.[70-72] In today's practice, where the goal is to minimize soft and hard tissue loss, the "one abutment at one time" concept has been developed. This concept aims to place the permanent abutment during the implant application instead of attaching a healing abutment.[73] To evaluate this concept, Canullo et al.[73] conducted an implant treatment with immediate loading in place of extracted premolar teeth in 32 patients. Half of the patients received temporary abutments, while the other half were treated with the "one abutment at one time" concept, where permanent abutments were placed during the implant procedure. Follow-up results indicated that patients with permanent abutments experienced a bone gain of approximately 0.2 mm. In the study conducted by Grandi et al.[74], it was observed that 0.5 mm of bone was preserved when abutments placed during surgery were not removed, compared to the use of temporary abutments and abutment replacement. However, this amount is considered clinically insignificant.

Abutment production method: Abutments are categorized as either prefabricated or custom-designed. Prefabricated abutments offer advantages such as low cost, availability, and reduced chairside time for patients. However, they have disadvantages including inadequate gingival emergence profile and lack of retention-contributing surfaces due to their cylindrical structure. Creating additional grooves on the abutment surface may be necessary to prevent rotation. Prefabricated abutments can be made of titanium or ceramic materials. Customized abutments are usually designed like a prepared tooth. This provides the desired result in terms of both retention and esthetics. They also facilitate correcting the implant angle. However, relatively higher cost and dependence on the experience of the technician limit their use.[43,75] Lops et al.[76] compared the sealing of prefabricated or custom-made abutments after screw tightening. It was found that the prefabricated ones had a higher sealing volume. In another study by Lops et al.[77], the effect of the type of abutment used on the gingiva was examined, and it was reported that prefabricated abutments positively affected the papillary gingival level. It is thought that custom-made abutments are more effective in obtaining the appropriate emergence profile of the restoration.[78]

Types of Prostheses:

Today, a variety of prosthetic materials are available for implant-retained fixed prostheses. These materials include metal-supported ceramics, zirconia-based ceramics, lithium disilicate ceramics, hybrid ceramics, and high-performance polymers.[79,80] The choice of prosthetic material is crucial and involves considering several factors to ensure the long-term success, stability, functionality, and esthetics of the restoration.[81] These factors include the individual design of the implant-supported prosthesis, number of implants, implant location, type of implant-abutment connection, esthetic requirements, masticatory forces, and occlusion.[79] Metal-ceramic restorations have been commonly used for their strength, durability, and satisfactory esthetics.[81] With advancements in materials science, zirconia ceramics have become more popular due to their enhanced mechanical properties, high biocompatibility, and esthetics.[82,83] However, high fracture rates of veneer porcelain have also been observed in the veneered zirconia-supported prostheses. Monolithic zirconia without veneer porcelain has been reported to be more fracture-resistant, which is expected to reduce fracture incidence.[84] According to Rammelsberg et al.[85] restorations with substructures made of chromium cobalt alloys showed lower failure rates than noble metal alloys such as gold. For zirconia and lithium disilicate ceramics, monolithic restorations are found to have significantly lower fracture risks than veneered restorations. Zembic et al.[86] evaluated 54 all-ceramic crowns cemented to zirconia abutments in the anterior and premolar regions, demonstrating a 90.7% success rate after 11 years with minor fractures and screw loosening as complications. Despite being made of leucite-reinforced ceramic, which has lower strength than zirconia and lithium disilicate, no ceramic fractures were observed.

Metal-free restorations are becoming increasingly important in dental practice, primarily due to the growing emphasis on esthetics. PEEK, a high-performance polymer, has shown excellent mechanical properties for various dental applications. PEEK frameworks can be coated with composite resin, a suitable option for implant-supported fixed prostheses for patients with metal allergies. Additionally, PEEK material can be seen as an alternative to titanium or zirconia due to its high-quality mechanical properties. However, PEEK is used for both long-term temporary and permanent prosthetic treatments.[84] In addition to these types of prostheses, with the development of CAD-CAM systems, manufacturers have produced hybrid abutments by combining the durability of titanium with the esthetics of ceramics.[58] Customized CAD-CAM abutments and titanium base abutments have gained significant popularity because they integrate seamlessly into digital workflows, which enhances cost-efficiency.[87] Prostheses with hybrid abutments are produced in two ways: hybrid abutment crown and hybrid abutment and separated crown.[88] Instead of one-piece zirconia abutments, zirconia abutments or abutment-crowns cemented on a titanium spacer increase success. In addition to zirconia ceramics, lithium disilicate, hybrid, and zirconia-reinforced lithium silicate ceramics can be used to produce abutment crowns on titanium inserts.[58,89] Strasding et al.[87] stated that titanium base abutments are favored for their mechanical strength and compatibility with ceramic superstructures, making them ideal for both single and multiple-unit restorations. Zirconia and lithium disilicate ceramics are suggested for final restorations, with zirconia suited for posterior regions and lithium disilicate for the anterior, depending on esthetic considerations. While titanium abutments excel in durability, zirconia offers better esthetics but carries a greater risk of fracture. They highlighted the importance of selecting abutments and materials carefully, considering mechanical properties, aesthetic needs, and factors such as implant location and patient preferences.

Temporary crowns and soft tissue contouring:

Esthetically pleasing implant prostheses require a temporary restoration to contouring peri-implant soft tissue. The advantage of provisional prostheses is the ability to transfer the final prosthesis emergence profile to permanent restorations. The choice between temporary prostheses depends on timing, interocclusal space, longevity, ease of fabrication and modification, ease of removal, esthetic demands, and economic considerations.[90] Before implant placement, the provisional restoration is often a removable prosthesis with an oval body placed immediately in the post-extraction site or an adhesive fixed restoration, such as in Maryland, to preserve the natural appearance.[91] Following implant placement, the most straightforward approach is to utilize a screw-retained provisional restoration. Healing caps are inadequate to establish the contours and emergence profile of a crown because they are narrower than the tooth's emergence profile. Screw-retained provisional restorations enable easy placement and removal; thereby, the restoration and shape of the peri-implant mucosa can be modified. However, the torquing value of the provisional abutment is essential. Nedir et al.[92] recommended 30 Ncm for an instantaneously loaded single implant insertion torque. However, in cement-retained provisional restorations, it is more difficult to manage bleeding and ensure ideal tissue health due to the cement.[40] According to Castellon et al.[93] provisional restorations had advantages such as preservation of the interdental space, gingival remodeling, and improvement of patient comfort. Chee et al.[91] reported that removable or fixed provisional restorations made in the provisional stage could improve soft tissue esthetics. According to a review by Lewis et al.[94] there was no evidence that any provisional restoration showed superior clinical results; however, provisional restoration construction was effective in conditioning the gingiva and providing patient satisfaction.

Emergence profile management can be accomplished through either a customized anatomical screw-retained provisional restoration or a customizable PEEK support with a straight or slightly contoured customized anatomical screw retainer. These approaches help to contour the soft tissues around the implant and provide a natural and healthy appearance. The recommendation for a screw-retained restoration is partly based on the risk of excess cement causing complications in nearby tissues. Using a screw-retained approach reduces the likelihood of leaving residual cement, which can lead to issues such as inflammation, tissue damage, and implant failure. A screw-retained provisional restoration offers the advantage of applying pressure to the soft tissue, which can help to improve the transition zone during tissue healing. When applied correctly, this pressure can positively influence soft tissue thickness, which is crucial for achieving long-term esthetic outcomes around implants. However, excessive or inappropriate pressure from the provisional can lead to mucosal thinning and potential gingival recession. To avoid these issues, the provisional restoration should be adjusted gradually over time (usually about 5 minutes) to reach the correct height of the proposed mucosal border. It is important to note that excessive pressure during adjustment can cause whitening of the tissue, indicating that the pressure is too high. Initially, the provisional restoration may have a poor contour, but through tissue maturation and several adjustments, the contouring can be corrected to achieve the desired esthetic outcome.[18]

In immediate implant treatment following tooth extraction, standard temporary crown applications often struggle to provide the desired aesthetics due to the materials used. Instead, to quickly create a temporary crown, facilitate the shaping of soft tissue, and achieve better aesthetics, a temporary crown can be made using the crown of the extracted tooth.[95] In the clinical report published by Deliberador et al.[95], they placed implants in place of extracted maxillary anterior teeth. For the temporary crown, they separated the crown from the root of the extracted tooth, prepared the crown to fit the abutment, and cemented it with resin cement. After a 12-month follow-up, they found the clinical results to be good in terms of preserving the natural shape and function of the tissues. In the case conducted by Giacomo et al.[96], they separated the buccal surface of the extracted tooth and fixed it to the abutment with resin cement, shaping and polishing it appropriately. As a result, they achieved a simple, quick, low-cost, and aesthetic outcome. In the clinical study conducted by Passos et al.[97], they used a polyvinyl siloxane index, referencing the patient's tooth before extraction, for the temporary crown in a patient who had undergone extraction and implant planning for central incisor tooth due to trauma. This allowed them to create a temporary crown that closely resembled the extracted tooth and facilitated the formation of papillae, enabling immediate loading. When the patient returned six months later, they removed the temporary crown, placed a scan body, and took an intraoral scan to design and mill the permanent restoration using a CAD-CAM system.

Occlusion:

The direction, intensity, and duration of chewing forces on implants influence the surrounding bone density and thickness. Forces that are not aligned with the implant's long axis can stress the bone and lead to bone loss. Angular forces on implants correlate with reduced alveolar bone thickness and height. Occlusal adjustment is crucial to align chewing forces with the implant's long axis for a better prognosis. Prosthetic treatment planning and follow-ups are necessary to ensure implant restorations meet requirements for proper occlusion and phonetics.[24,98]

CONCLUSION

The main purpose of implant-supported prostheses is to fabricate restorations with long-term success. However, restoring a single tooth loss with an implant-supported prosthesis can be challenging, especially in the maxillary anterior region. This region has functional and esthetic importance. Therefore, to meet the expectations of both the clinician and the patient, detailed planning for the implant and prosthetic treatment, selection of the appropriate abutment and prosthetic materials, and soft tissue recontouring should be performed.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics *committee* approval was not obtained.

Financial Support

The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: ÖMY, MBG, ALiterature review: ÖMY, BTB, SKN, MBG, Writing: ÖMY, BTB, SKN, MBG.

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