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THE STATE OF SOFT TISSUE AROUND MULTI-UNIT ABUTMENTS IN CASE OF TOTAL REHABILITATION

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Abstract. The stability and health of soft tissues around dental implants, especially when using multi-unit abutments, in protocols for the total rehabilitation of patients with complete edentulism are critical factors for ensuring the long-term functional and aesthetic success of implant treatment, largely determining both the clinical survival of the structures themselves and the degree of patient satisfaction with the results. Multi-unit abutments offer significant clinical and technical advantages in cases of complete edentulism, including the ability to compensate for implant misalignment, raise the prosthetic platform to a more comfortable level, and simplify prosthetic stages, but their direct interaction with the peri-implant tissue complex requires a deep understanding and careful control. This review systematizes and analyzes current data on the condition of peri-implant soft tissues when using multi-unit abutments in patients undergoing total rehabilitation. The biological aspects of soft tissue complex formation and key surgical, prosthetic, and patient-associated factors affecting its condition are considered. Particular attention is paid to the clinical significance and necessity of having an adequate zone of keratinized gingiva, the influence of various loading protocols on soft tissues, the biocompatibility and mechanical properties of abutment materials, the adequacy of prosthetic constructions to ensure effective hygiene, as well as modern methods of clinical and radiological assessment of soft tissue health. Strategies for the prevention and treatment of possible complications, such as mucositis and peri-implantitis, are discussed in detail, including their early diagnosis and modern approaches to conservative and surgical management. The multifactorial nature of the problem and the imperative need for a comprehensive, individualized approach to achieve predictable, optimal, and stable long-term results in total implant prosthetics using multi-unit abutments, and the review itself is intended to promote the adoption of informed clinical decisions by clinicians.

Keywords: multunit, total rehabilitation, soft tissues, dental implantation, peri-implantitis, biological width, keratinized gingiva, aesthetics of soft tissues, complete adentia, peri-implant mucositis

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ОСОБЕННОСТИ ФОРМИРОВАНИЯ ПРОФИЛЯ МЯГКИХ ТКАНЕЙ ДЕСНЫ В ОБЛАСТИ МУЛЬТИЮНИТ-АБАТМЕНТОВ

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Резюме. Стабильность и здоровье мягких тканей вокруг дентальных имплантатов, особенно при использовании мультиюнит-абатментов, в протоколах тотальной реабилитации пациентов с полной адентией являются критически важными факторами для обеспечения долгосрочного функционального и эстетического успеха имплантологического лечения, во многом определяя как клиническую выживаемость самих конструкций, так и степень удовлетворенности пациентов результатами. Мультиюнит-абатменты предоставляют значительные клинические и технические преимущества при полной адентии, включая возможность компенсации непараллельности имплантатов, выведение ортопедической платформы на более удобный уровень и упрощение протетических этапов, однако их непосредственное взаимодействие с комплексом периимплантатных тканей требует глубокого понимания и тщательного контроля. В настоящем обзоре систематизированы и проанализированы актуальные данные о состоянии периимплантатных мягких тканей при использовании мультиюнит-абатментов у пациентов, проходящих тотальную реабилитацию. Рассматриваются биологические аспекты формирования мягкотканного комплекса, ключевые хирургические, протетические и пациент-ассоциированные факторы, влияющие на его состояние. Особое внимание уделено клиническому значению и необходимости наличия адекватной зоны кератинизированной десны, влиянию различных протоколов нагрузки на мягкие ткани, биосовместимости и механическим свойствам материалов абатментов, адекватности дизайна протетических конструкций для обеспечения возможности эффективной гигиены, а также современным методам клинической и рентгенологической оценки здоровья мягких тканей. Подробно обсуждаются стратегии профилактики и лечения возможных осложнений, таких как мукозит и периимплантит, включая их раннюю диагностику и современные подходы к консервативному и хирургическому ведению. Подчеркивается мультифакториальная природа проблемы и императивная необходимость комплексного, индивидуализированного подхода для достижения предсказуемых, оптимальных и стабильных в долгосрочной перспективе результатов при тотальном протезировании на имплантатах с применением мультиюнит-абатментов, а сам обзор призван способствовать принятию клиницистами обоснованных клинических решений.

Ключевые слова: мультиюнит, тотальная реабилитация, мягкие ткани, дентальная имплантация, периимплантит, биологическая ширина, кератинизированная десна, эстетика мягких тканей, полная адентия, периимплантатный мукозит

The rehabilitation of fully edentulous patients remains a significant challenge in modern dentistry, as it leads to considerable functional, aesthetic, and psychosocial impairments, thereby reducing patients' quality of life [1]. Over recent decades, dental implantation has become the gold standard for restoring masticatory function following tooth loss, offering predictable and long-term solutions [2]. There has been a growing interest in tissue-level implants and various transgingival components used for this purpose [3, 4]. Multi-unit abutments (or transmucosal abutments) have become central to full-arch rehabilitation. They effectively address a number of complex clinical challenges, such as compensating for non-parallel implant placement, optimizing the prosthetic platform and emergence profile to facilitate fixation and oral hygiene, and ensuring the passive fit of extensive multi-component prosthetic constructions [5, 6]. Immediate and early loading protocols, commonly used in “All-on-4” or “All-on-X” concepts (including those involving zygomatic and pterygoid implants [3, 7]), are implemented using multi-unit abutments [5]. It is now widely accepted that the high predictability, success rates, long-term prognosis, and stability of dental implant treatment are inextricably linked to the condition of the peri-implant tissues, which function as a combined unit of hard and soft tissue support for the prosthetic restoration [8, 9]. A healthy and stable soft tissue profile around implants and abutments plays a critical protective role by preventing microbial invasion and the development of inflammatory complications such as mucositis and peri-implantitis, while also being essential for achieving satisfactory aesthetic outcomes for the patient [10, 11]. The presence of an adequate zone of keratinized gingiva is particularly important for maintaining this barrier and ensuring the long-term stability of the prosthesis [12, 13]. Histologically, keratinized gingiva is characterized by dense keratinized epithelium, a collagen-rich connective tissue layer, and firm attachment to the periosteum, in contrast to the more movable alveolar mucosa. This specific structure provides the keratinized gingiva with high mechanical strength and resilience to functional loads and hygiene procedures. The use of multi-unit abutments introduces specific considerations in the interaction between the implant-supported restoration and the surrounding soft tissues. Key aspects requiring particular attention in cases involving multi-unit abutments include the establishment of adequate biological width, tissue response to the abutment material, and the design of the prosthetic emergence profile to facilitate effective oral hygiene maintenance [12, 14]. Soft tissue condition is multifactorial and depends on a wide range of parameters, including surgical approach (e.g., presence and width of keratinized gingiva, soft tissue augmentation techniques), prosthetic decisions (abutment material selection, emergence profile, retention type), and patient-specific factors (oral hygiene level, systemic diseases, gingival biotype) [12]. However, despite extensive literature on dental implantation, several aspects concerning the specific interaction between soft tissues and multi-unit abutments in full-arch rehabilitations remain insufficiently investigated. Specifically, there is a need for more long-term comparative studies evaluating different multi-unit abutment materials and designs and their impact on the peri-implant microbiome and tissue immune response. Optimal soft tissue augmentation protocols specifically adapted for multi-unit abutment restorations and their influence on long-term stability and aesthetics have not been fully established. Furthermore, specific risk factors for soft tissue complications when using various multi-unit abutment types in immediate loading protocols in patients with comorbid systemic conditions require additional investigation. The lack of consensus on these aspects highlights the need for further systematization and analysis of available evidence. Given the widespread adoption of full-arch rehabilitations using multi-unit abutments and the recognized importance of soft tissue health for long-term function and aesthetics of implant-supported restorations, this review aims to analyze and synthesize current scientific evidence on factors influencing peri-implant soft tissue conditions around multi-unit abutments.

This review was based on a literature search and analysis of scientific publications in the PubMed, Google Scholar, Scopus, and eLIBRARY databases over the past 8–10 years (primarily from 2013 to 2023). The search included systematic reviews, meta-analyses, randomized controlled trials, prospective and retrospective clinical studies, and relevant review articles focusing on soft tissue conditions around multi-unit abutments in completely edentulous patients. Priority was given to studies with a high level of evidence. Full-text articles in both Russian and English were analyzed. From the identified sources, approximately 16-20 publications that most comprehensively addressed various aspects of the research problem were selected for final analysis and inclusion in the review.

The literature analysis reveals the fundamental importance of biological principles, such as establishing adequate biological width and maintaining a sufficient zone of keratinized gingiva, for peri-implant tissue health [10, 12, 13]. Surgical approaches, including keratinized tissue augmentation techniques [15], loading protocols [5], and the one-abutment concept [6, 16], significantly influence tissue response. Prosthetic factors, including multi-unit abutment and suprastructure materials (titanium, zirconia, and PEEK (polyetheretherketone)), emergence profile design, and hygiene accessibility [1], also play crucial roles. Furthermore, patient-related factors such as oral hygiene

level and smoking [1, 11] demonstrate undeniable importance. The available literature provides information on soft tissue assessment methods [17, 18], as well as prevention and treatment strategies for common complications including mucositis and peri-implantitis [11, 19]. These findings form the basis for the subsequent sections of this review, where each aspect will be examined in greater detail.

The biological basis for the formation of the soft tissue complex around implants and multi-unit abutments has distinct characteristics. Peri-implant tissues that form around dental implants possess several fundamental differences from the periodontal tissues surrounding natural teeth. A key distinction is the absence of cementum and a periodontal ligament on the implant surface, resulting in direct contact of connective tissue and epithelium with the abutment or implant surface [10]. Epithelial attachment to the implant occurs through hemidesmosomes, while connective tissue fibers are oriented predominantly parallel to the implant surface, in contrast to the perpendicular insertion into the root cementum characteristic of natural teeth [11]. A zone composed of barrier epithelium and connective tissue forms around the implant, collectively constituting the peri-implant biological width. Its vertical dimension varies but typically averages approximately 3–4 mm [10]. When multi-unit abutments are used, the level of biological width formation shifts coronally to the connection between the multi-unit abutment and implant or, in some cases, even to the connection between the multi-unit abutment and prosthetic construction, depending on the design and placement protocol. According to Z. Chen et al., immediate placement of multi-unit abutments and avoiding subsequent disconnection may promote more stable mucogingival integration and biological width maintenance while minimizing bone resorption [6]. While debates regarding the necessary minimum width of keratinized gingiva for maintaining peri-implant health have persisted for decades, and some authors suggest successful implant function is possible with minimal keratinized tissue, provided impeccable hygiene is maintained [12], most systematic reviews and clinical studies indicate that an adequate zone of keratinized gingiva (typically defined as ≥2 mm in width with adequate thickness) is associated with numerous benefits. These include reduced bleeding on probing, shallower peri-implant pocket depths, decreased risk of gingival recession development and progression, and improved patient comfort during oral hygiene procedures [12, 13, 14]. Keratinized gingiva is considered to form a more effective “biological seal” or “cuff” around the implant/abutment neck, preventing apical epithelial migration and providing better resistance to inflammatory tissue recession [10].

Conversely, the absence or inadequate width of keratinized gingiva can lead to chronic inflammation due to increased mobility of the gingival margin, greater permeability to bacterial toxins, and compromised oral hygiene. This is particularly relevant in the multi-unit abutment areas during full-arch rehabilitations, where prosthetic contours can be complex and the polished surfaces of multi-unit abutments require meticulous cleaning. Under such conditions, keratinized gingiva deficiency may promote plaque accumulation, mucositis development, and ultimately, peri-implantitis [10, 11]. Furthermore, soft tissue thickness — closely related to keratinized gingiva presence and gingival biotype — also plays a crucial role. A thicker biotype is associated with better masking of metallic components, greater marginal bone stability, and reduced susceptibility to recessions [10]. This underscores why evaluating the quantity and quality of keratinized gingiva during treatment planning for implant therapy using multi-unit abutments is critical for predicting long-term outcomes. The surface microtopography and material of multi-unit abutments also significantly influence cellular response and soft tissue barrier formation. While titanium alloys traditionally demonstrate excellent biocompatibility, studies indicate that modified surfaces or alternative materials like zirconia or PEEK may differentially affect fibroblast and epithelial cell adhesion, as well as bacterial colonization [14]. These factors may be important for the long-term stability of soft tissue attachment to multi-unit abutments and prevention of inflammatory complications.

The soft tissue condition around multi-unit abutments in full-arch rehabilitation results from a complex interplay of multiple factors that can be broadly categorized as surgical, prosthetic, and patient-related. The choice of surgical protocol significantly influences outcomes. Implant placement depth and the timing of multi-unit abutment placement can affect biological width formation and marginal bone stability [6]. Immediate placement of multi-unit abutments with subsequent avoidance of disconnection may theoretically minimize tissue trauma [6]. Implant loading protocols (immediate, early, or delayed) also play a significant role, with primary stability being particularly crucial in immediate loading scenarios [5]. Special attention during the surgical phase should be given to soft tissue condition and, when necessary, augmentation — particularly of keratinized gingiva. As previously discussed, an adequate zone of keratinized gingiva is critical for peri-implant tissue health [10, 12, 13]. When deficient (<2 mm width or inadequate thickness), various augmentation techniques should be considered. Indications for keratinized gingiva augmentation before, during, or after implantation using multi-unit abutments include: insufficient keratinized tissue width for

gingival margin stability, thin gingival biotype, recession prevention, enhanced hygiene access, and improved patient comfort.

Several surgical techniques are commonly employed to increase the zone of keratinized gingiva:

- The free gingival graft (FGG) is regarded as the gold standard for augmenting keratinized tissue width. Typically harvested from the hard palate and transplanted to the recipient site, it provides a predictable increase in the keratinized zone but may cause aesthetic concerns due to color mismatch and donor site scarring [10, 15].
- The apically positioned flap can be used to increase the zone of attached gingiva when sufficient keratinized tissue height exists but is positioned too coronally.
- Collagen matrices (allogeneic, xenogeneic, or synthetic) offer an alternative to autogenous grafts by reducing donor site morbidity and operative time. Although some studies demonstrate comparable outcomes to FGG in the short term [15], others report greater shrinkage and less predictable formation of truly keratinized tissue compared to autografts in the long term. Nevertheless, they can effectively enhance soft tissue thickness, with the choice of a specific matrix depending on clinical circumstances and surgeon preference.
- The connective tissue graft (CTG) is primarily used for increasing soft tissue thickness or recession coverage, but can also augment the keratinized zone when combined with coronally advanced flap techniques [20].

The optimal timing for keratinized tissue augmentation — whether before, during, or after implant placement — remains debated and depends on specific clinical circumstances and the selected technique. Some surgeons prefer to establish an adequate zone of keratinized tissue prior to implant installation to create more favorable conditions for implantation. Others perform augmentation simultaneously with implant placement, during second-stage surgery (in two-stage protocols), or even following multi-unit abutment connection.

Incision design and suturing techniques should be atraumatic. Regarding prosthetic considerations, the design and material of multi-unit abutments and suprastructures are critically important [14]. The prosthetic emergence profile should facilitate a smooth transition and avoid creating plaque-retentive areas. The feasibility of maintaining proper hygiene is directly dependent on the prosthesis design [1]. The suprastructure retention type (typically screw-retained with multi-unit abutments) and precise passive fit of the prosthesis on the abutments are crucial for preventing complications [5, 6]. Patient-related factors also play a significant role. Individual oral hygiene level is paramount [1, 11]. Smoking and systemic conditions such as uncontrolled diabetes mellitus can adversely affect the prognosis [11]. Gingival biotype (thin or thick) likewise influences soft tissue response, with patients exhibiting thin biotypes being more susceptible to recession following surgical and prosthetic procedures [10]. The presence of a thin gingival biotype frequently coincides with keratinized tissue deficiency, compounding risks and making preoperative augmentation particularly relevant.

Comprehensive and regular assessment of peri-implant soft tissues around multi-unit abutments constitutes an essential component of initial treatment planning, prosthetic phase completion, and crucially, long-term monitoring of full-arch implant rehabilitations. This evaluation incorporates clinical, radiographic, and in select cases, aesthetic and microbiological parameters to enable early detection of incipient pathological changes.

Clinical parameters form the foundation for routine assessment and must be documented at each maintenance visit. These include:

- The Plaque Index (PI) reflects patient hygiene status and bacterial plaque accumulation on visible abutment and prosthesis surfaces. While multiple PI scoring systems exist (e.g., Silness and Löe), consistent application of one system is vital for reliable longitudinal comparison. Regular PI monitoring serves not only diagnostic purposes but also facilitates patient motivation and hygiene technique refinement [1].
- The Bleeding on Probing (BoP) index represents the most reliable early clinical indicator of soft tissue inflammation (mucositis) [11]. Absence of BoP typically signifies tissue health and peri-implant stability, whereas persistent BoP — particularly at multiple sites around a single abutment — warrants close attention and potential intervention. Probing around multi-unit abutments requires careful technique using standardized periodontal probes (preferably plastic or titanium to minimize abutment surface damage) with controlled light force (approximately 0.20-0.25 N), assessing BoP 15–30 seconds post-probing.
- Probing Depth (PD) is measured from gingival margin (or prosthesis edge when serving as reference) to peri-implant sulcus/pocket base at multiple locations per abutment (typically 4–6 sites). Progressive PD increase, especially when concomitant with BoP, may indicate attachment loss and peri-implantitis development [11]. Notably, physiological PD values around implants and multi-unit abutments often exceed natural tooth measurements (e.g., 3–5 mm) due to distinct soft tissue attachment anatomy and abutment height. Therefore,

monitoring temporal changes relative to post-prosthetic baseline values proves more significant than absolute depth measurements.

- The Clinical Attachment Level (CAL) offers superior accuracy in assessing peri-implant tissue conditions compared to PD alone, as it references gingival margin position against fixed abutment or implant landmarks (e.g., abutment rim or implant-abutment junction). Temporal CAL changes indicate progressive tissue loss, though prosthetic contours often complicate CAL measurement around multi-unit abutments, necessitating reliance on PD dynamics and radiographic findings.
- Keratinized Mucosa Width (KMW) is measured from gingival margin to mucogingival junction. As previously discussed, adequate KMW (typically >2 mm) promotes tissue health and hygiene maintenance [12], with progressive reduction serving as an early warning sign.
- Gingival recession, characterized by exposure of the multi-unit abutment surface or the implant itself, can lead to aesthetic problems, hypersensitivity, and increased risk of further plaque accumulation. The degree of recession is measured in millimeters from the cementoenamel junction (where applicable to adjacent teeth) or from the presumed ideal gingival level to the actual gingival margin.
- Suppuration (the presence of exudate or pus upon palpation or probing) is a sign of an active inflammatory process and often indicates peri-implantitis.

Radiographic evaluation is essential for monitoring marginal bone levels around implants that support multi-unit abutments. Standardized periapical radiographs using the parallel technique are most commonly employed, with panoramic radiographs (orthopantomograms) used less frequently due to their reduced accuracy in assessing mesiodistal bone levels. Cone-beam computed tomography (CBCT) may be indicated for complex diagnostic cases or when planning surgical intervention for peri-implantitis, enabling precise evaluation of bone defect dimensions and morphology. Progressive bone level changes observed on serial radiographs compared to the baseline examination obtained after definitive prosthesis delivery serve as a crucial diagnostic indicator of peri-implantitis [11]. Monitoring radiographs should be obtained at 1–2-year intervals, or more frequently based on clinical indications.

Aesthetic indices such as the Pink Esthetic Score (PES) and its modifications provide objective assessment tools for soft tissue aesthetics, particularly in anterior full-arch rehabilitations [17]. The PES evaluates multiple parameters including gingival margin levels, gingival contour, papillary presence and form (when applicable to the prosthetic design), along with gingival color and texture. Although originally validated for single implants, the PES framework can be adapted for multi-unit abutment restorations by focusing on gingival contour harmony and its integration with the patient's smile line. Microbiological and biochemical marker analysis may be utilized in complex cases. Systematic monitoring of these parameters facilitates early detection of developing complications [1, 18].

Despite high success rates of full-arch rehabilitations, soft tissue complications may still develop. Peri-implant mucositis manifests as reversible soft tissue inflammation without bone loss, primarily induced by bacterial plaque accumulation [1, 11]. Management strategies encompass enhanced individual oral hygiene, professional debridement, and when indicated, antiseptic therapy [1, 11, 18]. Peri-implantitis represents an inflammatory pathology accompanied by progressive bone destruction [11] with multifactorial etiology [11, 19]. Therapeutic approaches may combine non-surgical modalities (surface decontamination, antibiotic therapy) with surgical interventions (access flap surgery, regenerative or resective techniques) [19]. Soft tissue recession, which can result from various etiological factors and cause aesthetic compromise [10], may require mucogingival surgical correction [10]. Soft tissue hyperplasia frequently develops secondary to chronic irritation or inflammation and is managed through etiology elimination and tissue excision.

Achieving optimal soft tissue health upon prosthetic completion and maintaining long-term stability necessitates implementation of structured supportive peri-implant therapy (SPT) [1, 18, 19]. Essential SPT components include scheduled recall visits, professional maintenance care, patient motivation with hygiene reinforcement, occlusal evaluation and adjustment [2], alongside early complication detection and intervention [11, 19]. Sustainable soft tissue stability remains unattainable without consistent patient cooperation and ongoing professional supervision [18].

Soft tissue health around multi-unit abutments represents a critical determinant for long-term success in full-arch rehabilitations. The significance of keratinized mucosa remains a key focus of discussion. Current evidence demonstrates that while some investigators report no direct correlation between keratinized mucosa absence and peri-implantitis development when optimal hygiene is maintained [12], the predominant body of literature confirms that an adequate zone of keratinized tissue (≥2 mm width with sufficient thickness) provides substantial clinical benefits. These advantages include improved soft tissue health parameters evidenced by reduced bleeding on probing, shallower peri-implant pocket depths, decreased risk of gingival recession development and progression, and

enhanced patient comfort during oral hygiene procedures [10, 12, 13]. This proves particularly relevant for complex multi-unit abutment restorations where patient-administered hygiene may be compromised. Consequently, decisions regarding keratinized tissue augmentation should follow individualized assessment while considering potential long-term advantages, especially in patients exhibiting thin gingival biotypes or elevated risk for inflammatory complications [10, 15].

The one-abutment concept — involving definitive multi-unit abutment placement during implant surgery without subsequent disconnection — continues to gain prominence with growing literature support [6, 16]. According to X. Rodríguez et al., this protocol minimizes soft tissue and underlying bone trauma, promoting establishment of a stable biological seal while reducing microbial contamination risk at the implant-abutment interface. Multiple investigations confirm reduced bone resorption and superior soft tissue outcomes with this approach [16]. However, it should be noted that most available studies concentrate on single implants or short-span fixed partial dentures. Further long-term randomized controlled trials are warranted to validate these benefits specifically in the context of multi-unit abutments within full-arch rehabilitations, where distinct biomechanical conditions and extended prosthetic spans may significantly influence clinical outcomes.

The material composition of multi-unit abutments and adjacent prosthetic components significantly influences surrounding soft tissue responses. Titanium remains the established gold standard, valued for its exceptional biocompatibility and mechanical durability [14]. Recent investigations have increasingly explored alternative materials, with zirconia gaining attention for superior aesthetic properties (eliminating grayish translucency through thin gingival tissues) and demonstrated reductions in bacterial adhesion compared to titanium in certain studies [14, 21]. Polyetheretherketone (PEEK) presents theoretical advantages due to its bone-like elastic modulus, potentially enabling more physiological stress distribution and damping effects; however, its long-term color stability and soft tissue interactions in the oral environment necessitate further evaluation. The impact of these diverse materials and their surface modifications — including polishing, anodization, and bioactive coatings — on long-term soft tissue attachment stability, inflammatory responses, and peri-abutment microbiome formation requires comprehensive comparative assessment through rigorously designed clinical trials.

Prosthetic design — particularly emergence profile and hygiene accessibility — serves as a cornerstone for maintaining peri-implant soft tissue health [1]. Overcontoured margins, inadequate prosthesis cleansability, or excessively tight, compressive mucosal contact inevitably precipitate chronic inflammation, plaque accumulation, and create conditions favoring peri-implantitis development [5, 6]. Contemporary CAD/CAM technologies offer unprecedented capabilities for fabricating precision restorations with optimized emergence profiles and submarginal contours [21]. However, clinical translation of these advantages remains contingent upon comprehensive understanding of biomechanical principles, soft tissue biology, and the technical expertise of both the prosthodontist and dental technician. Individual patient factors — including hygiene capability and manual dexterity — must be carefully considered during prosthetic design selection.

Peri-implant soft tissue health around multi-unit abutments constitutes a fundamental determinant of long-term treatment success and stability in full-arch rehabilitations. The integrity of these tissues depends on complex interactions among biological factors, surgical protocols, prosthetic design considerations, and maintenance hygiene. An adequate zone of keratinized mucosa demonstrates a significant association with enhanced tissue stability [10, 12, 13], with augmentation procedures indicated in cases of deficiency [15]. Immediate abutment placement protocols minimizing disconnection events may improve tissue preservation outcomes [6, 16]. Substantial clinical importance attaches to abutment and suprastructure material selection, emergence profile design, and hygiene accessibility [1, 14], while precise prosthetic passive fit remains imperative [5]. Meticulous plaque control and structured supportive therapy provide the foundation for complication prevention [1, 11, 18, 19]. Despite current evidence, further investigation is warranted regarding material impacts, augmentation methodologies, and digital workflow applications [21]. Clinical recommendations encompass comprehensive treatment planning, minimally invasive protocols, biocompatible material utilization, passive fit verification, and active patient participation in SPT. Achieving sustainable soft tissue health and aesthetics demands clinician expertise in biological principles, interdisciplinary collaboration, and meticulous execution. Future advancements depend on continued technological innovation and refined understanding of biological interactions.

ADDITIONAL INFORMATION

Author contribution. Thereby, all authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

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