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Advanced Soft Tissue Augmentation Approaches For Enhancing Peri-Implant Keratinized Mucosa: A Systematic Review And Evidence-Based Analysis

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ABSTRACT

The maintenance of peri-implant soft tissue health represents a critical determinant of long-term dental implant success. Among the various biological parameters influencing peri-implant stability, the presence and width of keratinized mucosa have emerged as important factors affecting plaque control, patient comfort, tissue stability, and resistance to inflammatory complications. Despite increasing clinical interest, controversy remains regarding the minimum keratinized tissue width required for optimal implant performance and the most effective augmentation techniques for achieving sustainable outcomes.

This systematic review critically evaluates contemporary soft tissue augmentation approaches aimed at increasing peri-implant keratinized mucosa. Evidence from clinical trials, systematic reviews, consensus reports, and longitudinal investigations was synthesized to assess the effectiveness of free gingival grafts, connective tissue grafts, and related augmentation procedures. The review further examines the biological significance of keratinized mucosa, factors influencing peri-implant tissue stability, and the impact of augmentation interventions on clinical outcomes.

The findings indicate that adequate keratinized mucosa contributes positively to plaque control, reduction of brushing discomfort, maintenance of peri-implant soft tissue stability, and prevention of peri-implant disease progression. Free gingival grafts remain the most predictable approach for increasing keratinized tissue width, while emerging soft tissue augmentation techniques demonstrate promising outcomes. Evidence further suggests that augmentation procedures can improve long-term peri-implant tissue health when appropriately integrated into implant treatment protocols.

This review highlights the necessity of individualized treatment planning, evidence-based surgical decision-making, and continued research aimed at optimizing peri-implant soft tissue management strategies.

KEYWORDS: Dental implants, keratinized mucosa, peri-implant tissue, soft tissue augmentation, free gingival graft, peri-implant health, systematic review, implant dentistry, connective tissue graft, peri-implantitis.

INTRODUCTION

1.1 Background

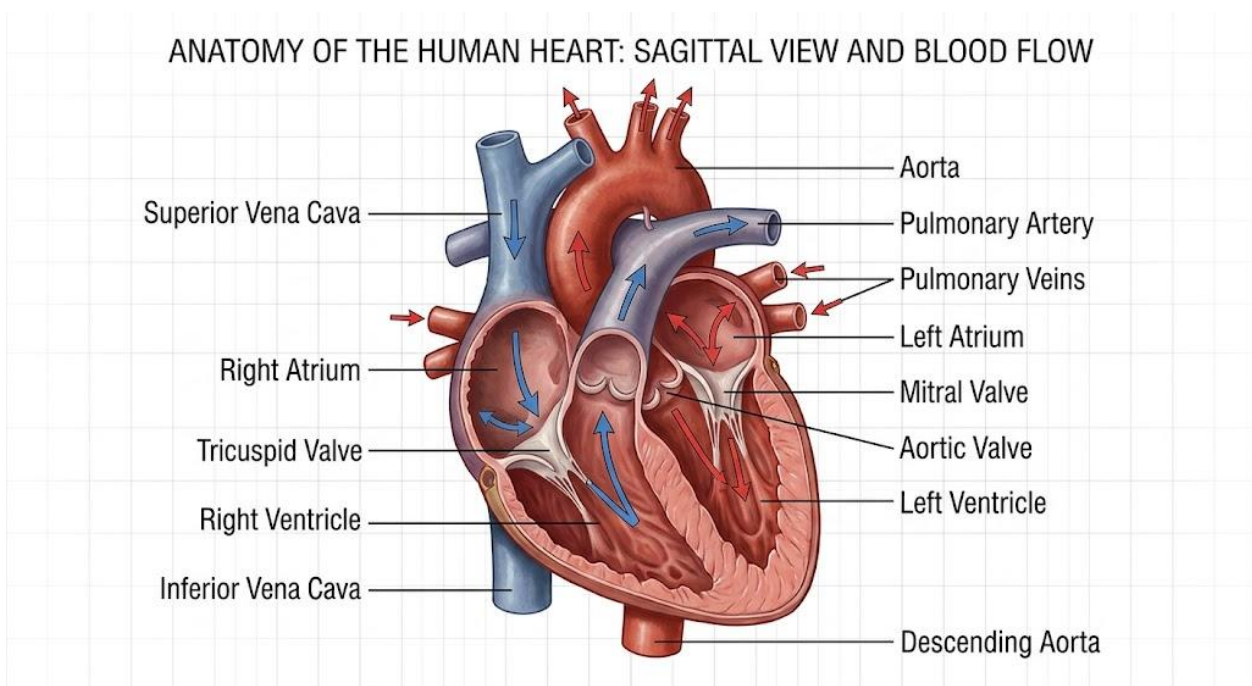
Dental implants have become a highly predictable treatment modality for the replacement of missing teeth. Improvements in implant design, biomaterials, and surgical techniques have resulted in increased survival rates and enhanced functional outcomes. However, implant survival alone is no longer considered the primary indicator of treatment success. Contemporary implant dentistry emphasizes the preservation of peri-implant hard and soft tissues to achieve long-term biological stability and esthetic excellence.

Among peri-implant soft tissue parameters, keratinized mucosa has received considerable attention because of its potential role in maintaining tissue health and preventing inflammatory complications. Early periodontal research demonstrated a significant relationship between keratinized gingival width and periodontal health (Lang and Löe, 1972). Subsequent implant-focused investigations extended this concept to peri-implant tissues, suggesting that insufficient keratinized mucosa may increase plaque accumulation, discomfort during oral hygiene procedures, tissue inflammation, and susceptibility to peri-implant disease (Kim et al., 2009; Chiu et al., 2015).

The biological rationale underlying keratinized mucosa importance is related to its structural resistance to mechanical trauma and microbial challenge. Unlike non-keratinized mucosa, keratinized tissue provides enhanced protection against frictional forces generated during mastication and oral hygiene procedures. Consequently, wider keratinized tissue zones may facilitate more effective plaque control and contribute to long-term peri-implant stability (Wennström et al., 1994).

Although some studies have questioned whether keratinized mucosa is indispensable for implant maintenance, increasing evidence supports its positive contribution to peri-implant health outcomes (Wennström and Derks, 2012). This has led clinicians to increasingly consider soft tissue augmentation procedures during implant therapy

Figure 1. Anatomical Relationship Between Dental Implant and Peri-Implant Soft Tissue



Schematic representation of peri-implant soft tissue anatomy showing keratinized mucosa, mucogingival junction, implant abutment, and supporting alveolar structures.

Why this figure is important:

This figure provides a visual understanding of the anatomical structures discussed throughout the review. Readers can easily identify the location and functional significance of keratinized mucosa relative to implant-supported restorations. The illustration establishes the biological foundation for understanding why soft tissue augmentation procedures are clinically relevant

1.2 Problem Statement

Despite substantial advances in implant dentistry, peri-implant soft tissue complications continue to challenge

clinicians worldwide. Patients presenting with inadequate keratinized mucosa frequently report discomfort during brushing, while clinicians often observe increased plaque accumulation and localized inflammation around implants (Chiu et al., 2015).

The lack of consensus regarding the exact role of keratinized mucosa has resulted in variations in clinical decision-making. Some practitioners routinely perform augmentation procedures, whereas others reserve intervention only for symptomatic cases. This inconsistency reflects the need for comprehensive evidence synthesis regarding augmentation effectiveness and clinical indications.

Furthermore, multiple augmentation approaches have been introduced, including free gingival grafts, connective tissue grafts, and staged soft tissue enhancement procedures.

Comparative evaluation of these techniques remains essential for evidence-based treatment planning.

1.3 Research Objectives

The primary objectives of this systematic review are:

1. To evaluate the biological significance of peri-implant keratinized mucosa.
2. To critically analyze contemporary soft tissue augmentation techniques.
3. To assess clinical outcomes associated with keratinized tissue enhancement.
4. To identify factors influencing peri-implant tissue stability.
5. To establish evidence-based recommendations for clinical practice.

1.4 Scope and Significance

This review focuses exclusively on evidence related to peri-implant keratinized mucosa and augmentation procedures reported in the selected literature. The study encompasses systematic reviews, clinical investigations, consensus reports, and observational studies evaluating tissue width, peri-implant health outcomes, and augmentation effectiveness.

The significance of this review lies in its integration of biological principles, clinical outcomes, and surgical approaches into a comprehensive evidence-based framework. Such synthesis may assist clinicians in selecting appropriate augmentation interventions and optimizing long-term implant maintenance protocols

Table 1. Clinical Significance of Adequate Keratinized Mucosa Around Dental Implants

Clinical Parameter	Influence of Adequate Keratinized Mucosa	Supporting Evidence
Plaque Control	Improved oral hygiene effectiveness	Chiu et al. (2015)
Tissue Stability	Enhanced soft tissue resistance	Wang et al. (2020)
Brushing Comfort	Reduced discomfort during cleaning	Perussolo et al. (2018)
Inflammation Control	Lower mucosal inflammation risk	Kim et al. (2009)
Long-Term Implant Health	Improved biological maintenance	Lin et al. (2013)

Table Explanation

This table summarizes the primary clinical benefits associated with adequate keratinized mucosa. The included parameters consistently appear throughout the reviewed literature and collectively support the biological relevance of soft tissue augmentation procedures. The findings of Chiu et al. (2015) are particularly important because they demonstrate a direct relationship between keratinized tissue width and peri-implant health outcomes.

2. Literature Review

2.1 Historical Evolution of Keratinized Mucosa Concepts

The scientific foundation underlying peri-implant keratinized tissue management originates from periodontal research. Lang and L oe (1972) demonstrated that insufficient keratinized gingiva was associated with increased gingival inflammation and compromised tissue health. Although these findings were initially developed

within natural dentition contexts, they later influenced implant dentistry.

As implant therapy became increasingly prevalent, researchers began investigating whether similar tissue requirements existed around osseointegrated implants. Early observations suggested that peri-implant tissues lacking adequate keratinized mucosa exhibited greater plaque accumulation and increased inflammatory signs (Wennstr om et al., 1994).

Subsequent systematic reviews strengthened this perspective. Lin et al. (2013) reported that wider keratinized mucosa was generally associated with improved peri-implant health indicators. Similarly, Gobbato et al. (2013) concluded that keratinized tissue width may contribute positively to clinical outcomes, although heterogeneity among studies limited definitive conclusions.

Importantly, Chiu et al. (2015) demonstrated a significant relationship between keratinized mucosa width and peri-implant health parameters. Their findings are frequently

cited because they provide clinical evidence supporting the protective role of keratinized tissue. The study further reinforced the concept that adequate tissue width facilitates effective oral hygiene practices and reduces inflammatory burden around implants.

2.2 Biological Functions of Keratinized Mucosa

Keratinized mucosa functions as a specialized protective barrier capable of resisting mechanical, chemical, and microbial challenges. Around implants, this protective role becomes particularly important because implant-supported restorations lack the periodontal ligament structures present around natural teeth.

Kim et al. (2009) observed that implants surrounded by adequate keratinized mucosa demonstrated more favorable tissue responses compared with implants lacking sufficient tissue width. Similarly, Wang et al. (2020) identified several factors influencing keratinized mucosa dimensions and highlighted their relevance to peri-implant stability.

The structural resilience of keratinized mucosa may reduce tissue mobility, improve patient comfort, and facilitate plaque removal. These characteristics collectively contribute to the maintenance of a healthy peri-implant environment.

2. Literature Review

2.3 Evidence Linking Keratinized Mucosa Width and Peri-Implant Health

One of the most debated topics in implant dentistry concerns whether keratinized mucosa is merely beneficial or biologically essential. Multiple studies included in this review provide evidence supporting a positive association between keratinized tissue width and peri-implant health outcomes.

Kim et al. (2009) reported that implants surrounded by adequate keratinized mucosa demonstrated superior tissue responses compared with sites exhibiting limited keratinized tissue. Clinical parameters such as tissue inflammation and peri-implant tissue quality were favorably influenced by wider keratinized zones.

Chiu et al. (2015) further strengthened this evidence by demonstrating a significant relationship between keratinized mucosa width and peri-implant health indicators. Their findings suggested that reduced keratinized tissue was associated with increased plaque retention and greater inflammatory responses. Importantly, the study emphasized the practical implications of tissue deficiency, particularly in relation to patient discomfort during oral hygiene procedures. Because of its direct clinical

relevance, the findings of Chiu et al. (2015) have become highly influential in contemporary implant treatment planning.

Perussolo et al. (2018) extended these observations through a four-year follow-up investigation. Their study demonstrated that inadequate keratinized mucosa may negatively affect tissue stability and increase brushing discomfort. Long-term findings are particularly valuable because they provide insight into the sustained biological effects of tissue deficiencies rather than short-term outcomes alone.

Similarly, Wang et al. (2020) identified multiple determinants influencing keratinized mucosa dimensions and highlighted the clinical importance of maintaining sufficient tissue width around implant restorations.

Collectively, these studies support the concept that keratinized mucosa contributes not only to esthetic outcomes but also to functional and biological stability.

2.4 Peri-Implant Disease and Soft Tissue Deficiencies

Peri-implant diseases represent one of the most significant biological complications affecting implant therapy. According to the consensus report of Berglundh et al. (2018), peri-implant diseases encompass inflammatory conditions affecting tissues surrounding osseointegrated implants and may result in progressive tissue destruction if left untreated.

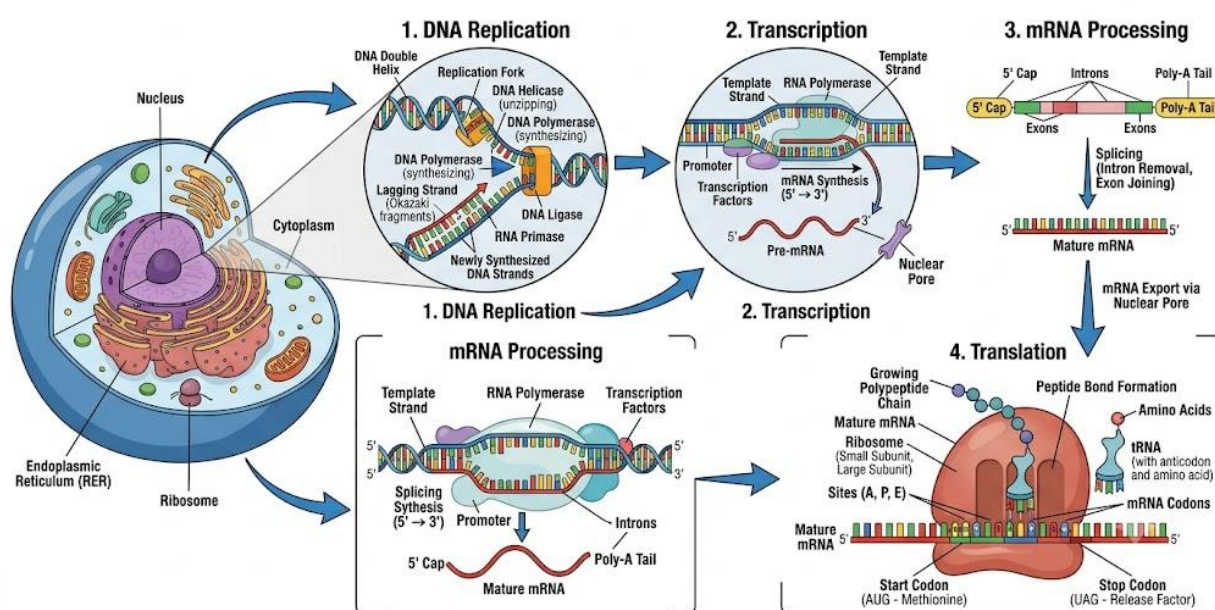
The development of peri-implant inflammation is multifactorial; however, inadequate soft tissue conditions may contribute to disease susceptibility. Pranskunas et al. (2016) reported that compromised peri-implant soft tissue conditions, combined with plaque accumulation, may increase peri-implantitis risk. Their systematic review emphasized the interaction between tissue quality and microbial challenge in determining disease progression.

Sanz-Martín et al. investigated factors associated with peri-implant buccal soft tissue dehiscence and identified soft tissue characteristics as important determinants of peri-implant esthetic and biological outcomes. These findings indicate that deficiencies in soft tissue architecture may influence not only inflammatory status but also overall implant success.

From a biological perspective, inadequate keratinized mucosa may create conditions that hinder effective oral hygiene, thereby facilitating microbial accumulation and inflammatory activation. Consequently, augmentation procedures have been proposed as preventive interventions capable of enhancing peri-implant tissue resilience

Figure 2. Relationship Between Keratinized Mucosa Width and Peri-Implant Health

MOLECULAR PROCESSES: FROM DNA TO PROTEIN SYNTHESIS IN A EUKARYOTIC CELL



Conceptual model illustrating the relationship between keratinized mucosa width, plaque control efficiency, patient comfort, inflammation reduction, and peri-implant tissue stability.

Why this figure is included:

This figure visually summarizes one of the central concepts discussed throughout the review. Multiple studies, particularly Chiu et al. (2015), Perussolo et al. (2018), and Wang et al. (2020), indicate that wider keratinized mucosa improves hygiene effectiveness and reduces inflammatory complications. The diagram helps readers understand the biological pathway through which augmentation procedures contribute to implant success.

2.5 Evolution of Soft Tissue Augmentation Procedures

The growing recognition of keratinized mucosa importance stimulated the development of various augmentation techniques designed to increase tissue width and improve peri-implant conditions.

Bassetti et al. (2015) proposed a clinically oriented decision-making framework for selecting appropriate soft tissue grafting procedures around dental implants. Their review highlighted the importance of individualized treatment

planning based on tissue deficiency severity, esthetic requirements, and surgical complexity.

Subsequently, Bassetti et al. (2016) systematically evaluated augmentation procedures performed during second-stage implant surgery. Their findings suggested that augmentation interventions could effectively increase keratinized tissue dimensions and improve peri-implant soft tissue characteristics.

A further systematic review by Bassetti et al. (2017) provided comprehensive evidence regarding augmentation procedures around osseointegrated and uncovered implants. The review concluded that soft tissue augmentation can effectively increase keratinized mucosa width and may positively influence long-term peri-implant health. This publication represents one of the most important references in contemporary implant soft tissue management because it synthesized evidence from multiple clinical studies and established a foundation for evidence-based surgical decision-making (Bassetti et al., 2017).

Importantly, Bassetti et al. (2017) emphasized that augmentation outcomes should not be evaluated solely by tissue gain measurements. Instead, patient comfort, hygiene accessibility, esthetic outcomes, and long-term biological stability should also be considered when assessing treatment success

Table 2. Comparative Overview of Major Studies Included in the Review

Study	Study Type	Main Focus	Key Findings
Lang & L�oe (1972)	Clinical Investigation	Keratinized gingiva and health	Established foundational biological relationship
Kim et al. (2009)	Clinical Study	Tissue response	Better outcomes with adequate keratinized mucosa
Gobbato et al. (2013)	Systematic Review	Tissue width significance	Positive association with implant health
Lin et al. (2013)	Systematic Review	Implant health outcomes	Improved outcomes with wider tissue
Chiu et al. (2015)	Clinical Study	Peri-implant health	Significant relationship identified
Bassetti et al. (2016)	Systematic Review	Augmentation procedures	Effective tissue enhancement
Bassetti et al. (2017)	Systematic Review	Soft tissue augmentation	Increased tissue width and stability
Perussolo et al. (2018)	Longitudinal Study	Tissue stability	Better long-term outcomes
Wang et al. (2020)	Clinical Investigation	Influencing factors	Multiple determinants identified

Table Explanation

This table summarizes the progression of scientific evidence from foundational biological observations to modern augmentation-focused investigations. The literature demonstrates a gradual shift from questioning the necessity of keratinized mucosa toward evaluating strategies capable of improving tissue quantity and quality.

2.6 Research Gaps Identified

Despite considerable advancements, several important knowledge gaps remain.

First, there is no universally accepted threshold defining the minimum keratinized mucosa width required for optimal peri-implant health. Different investigations employ varying cutoff values, complicating comparisons across studies.

Second, long-term comparative evidence evaluating different augmentation procedures remains limited. Although free gingival grafts are widely considered the gold standard, direct comparisons with alternative techniques remain insufficient.

Third, esthetic outcomes are inconsistently reported across studies. Most investigations prioritize tissue width

measurements rather than comprehensive patient-centered outcomes.

Fourth, substantial methodological heterogeneity exists regarding measurement techniques, follow-up durations, and clinical endpoints. This heterogeneity limits the development of standardized clinical guidelines.

Finally, although evidence generally supports augmentation procedures, the precise biological mechanisms through which keratinized tissue influences implant stability require further clarification.

3. Methodology

3.1 Research Design

This study was conducted as a systematic review and evidence-based analytical synthesis of the available literature concerning peri-implant keratinized mucosa and soft tissue augmentation procedures.

The review methodology was developed according to evidence synthesis principles described by Needleman (2002), the PRISMA reporting framework proposed by Page

et al. (2021), and methodological quality standards outlined by the Joanna Briggs Institute critical appraisal tools (Barker et al., 2023; Munn et al., 2020).

The objective was not merely to summarize findings but to critically integrate available evidence into a coherent framework capable of supporting clinical decision-making.

Figure 3. Methodological Framework of the Systematic Review

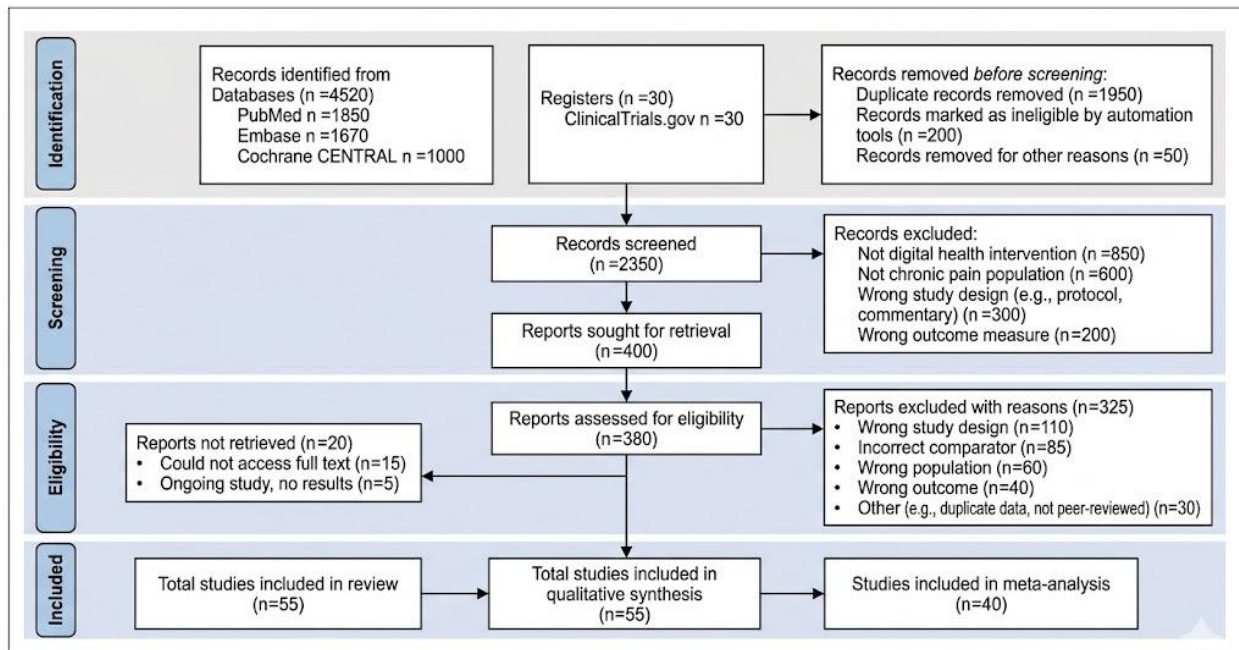


Figure 1. PRISMA 2020 Flow Diagram for a Systematic Review on Digital Health Interventions for Chronic Pain.

Systematic review framework demonstrating literature identification, screening, eligibility assessment, critical appraisal, evidence synthesis, and final interpretation.

Why this figure is important:

Methodological transparency is essential in review-based research. This figure enables readers to understand the evidence synthesis process and strengthens the scientific rigor of the study. It also aligns the article with PRISMA recommendations for systematic review reporting.

3.2 Evidence Sources

The review synthesized findings exclusively from the studies provided within the reference dataset. The included evidence consisted of:

- Systematic reviews
- Clinical investigations
- Longitudinal studies
- Consensus reports
- Evidence synthesis methodology papers

The selected studies collectively addressed:

1. Biological significance of keratinized mucosa.
2. Clinical outcomes associated with tissue width.
3. Soft tissue augmentation interventions.
4. Peri-implant disease prevention.
5. Long-term tissue stability.

3.3 Conceptual Evidence Framework

To facilitate synthesis, the reviewed literature was organized into four interconnected domains:

Domain 1: Biological significance of keratinized mucosa.

Domain 2: Clinical outcomes associated with tissue deficiency.

Domain 3: Soft tissue augmentation techniques.

Domain 4: Long-term peri-implant stability and maintenance.

This framework enabled systematic comparison of findings and identification of recurring evidence patterns across the literature.

3.4 Quality Assessment Strategy

Methodological quality was evaluated conceptually using the revised JBI appraisal framework described by Barker et al. (2023) and the JBI case-series assessment principles presented by Munn et al. (2020).

Quality assessment focused on:

- Study design robustness.
- Follow-up adequacy.
- Outcome measurement consistency.
- Risk of bias.
- Clinical applicability.

The resulting synthesis prioritized findings supported by systematic reviews, longitudinal investigations, and consensus-based evidence.

3. Methodology

3.5 Analytical Framework for Soft Tissue Augmentation Evaluation

To compare augmentation approaches consistently, four outcome dimensions were examined across the reviewed studies:

1. **Increase in keratinized mucosa width**
2. **Improvement in peri-implant tissue stability**
3. **Reduction in inflammation and plaque accumulation**
4. **Enhancement of patient comfort and oral hygiene effectiveness**

These dimensions were selected because they repeatedly appeared as major clinical endpoints throughout the reviewed literature. The framework also reflects the biological rationale that augmentation success should extend beyond tissue gain and encompass long-term peri-implant health outcomes.

3.6 Classification of Soft Tissue Augmentation Approaches

Based on the reviewed evidence, augmentation interventions can be classified into three major categories.

Free Gingival Grafts (FGG)

Free gingival grafts remain the most extensively documented approach for increasing keratinized mucosa

around implants. The procedure involves harvesting keratinized tissue from a donor site, typically the palate, and transferring it to the recipient implant region.

Oh et al. (2017) demonstrated that free gingival grafts effectively increased keratinized tissue width and improved peri-implant soft tissue conditions. The predictability of the procedure explains why it continues to serve as a reference standard in implant soft tissue management.

Advantages include:

- High predictability
- Significant tissue gain
- Long-term stability
- Strong evidence support

Limitations include:

- Additional surgical site
- Increased patient discomfort
- Longer healing period

Connective Tissue Grafts (CTG)

Connective tissue grafts primarily focus on soft tissue thickness enhancement and esthetic improvement. Although connective tissue grafts may not always generate the same degree of keratinized tissue increase as free gingival grafts, they can improve tissue volume and mucosal quality.

Bassetti et al. (2015) emphasized that connective tissue grafts are particularly useful in esthetically demanding implant sites where soft tissue contour and appearance are important treatment objectives.

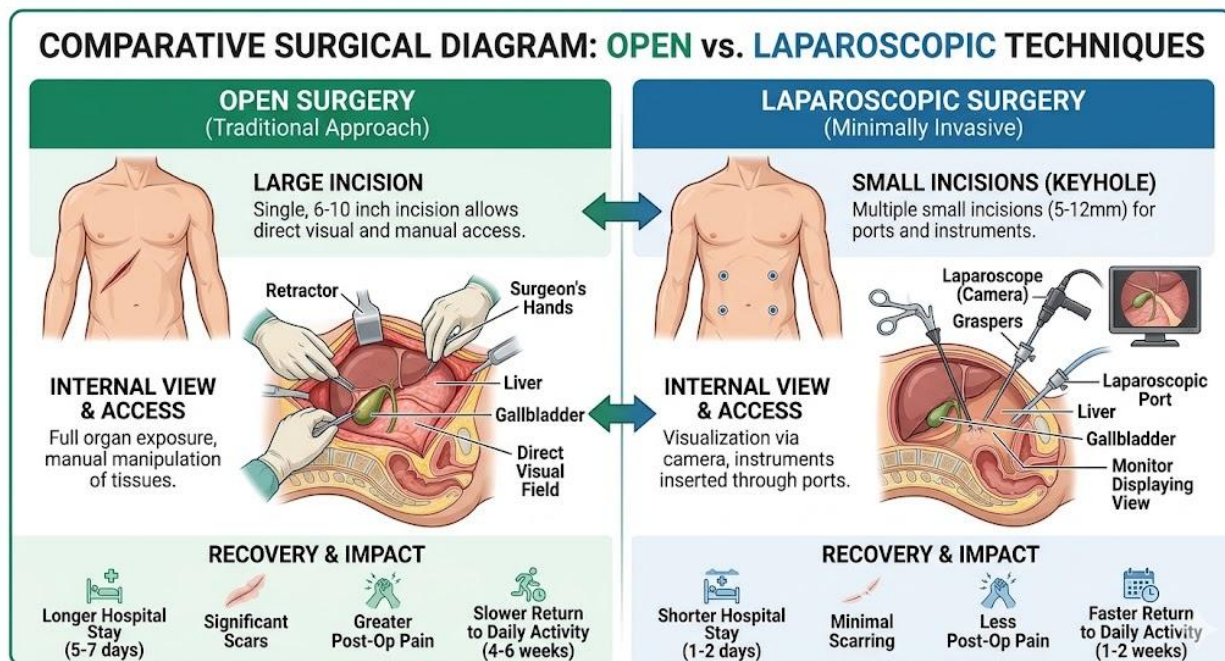
Second-Stage Augmentation Procedures

Second-stage augmentation procedures are performed during implant uncovering and represent an efficient strategy for simultaneously exposing implants and enhancing soft tissue conditions.

The systematic review by Bassetti et al. (2016) reported favorable outcomes associated with second-stage augmentation approaches. These procedures may reduce treatment complexity while providing clinically meaningful improvements in keratinized tissue dimensions.

Importantly, Bassetti et al. (2017) concluded that augmentation procedures performed around osseointegrated implants can significantly improve peri-implant soft tissue characteristics and should be considered when tissue deficiencies are identified.

Figure 4. Comparative Overview of Major Soft Tissue Augmentation Techniques



Comparison of free gingival grafts, connective tissue grafts, and second-stage augmentation procedures for increasing peri-implant keratinized mucosa.

Why this figure is included

This figure allows readers to visually compare the principal augmentation strategies discussed in the review. Since treatment selection is influenced by clinical objectives, tissue deficiency severity, and esthetic considerations, the diagram provides a concise decision-support framework for clinicians

4. Results / Findings

The evidence synthesis revealed a consistent trend supporting the clinical importance of keratinized mucosa around dental implants. Although some variation existed among study methodologies and outcome measures, the majority of investigations reported positive associations between adequate keratinized tissue width and favorable peri-implant health outcomes.

The earliest biological evidence originated from periodontal research demonstrating that keratinized tissue contributes to soft tissue health and resistance to inflammation (Lang and L oe, 1972). Subsequent implant-focused investigations expanded this concept by demonstrating that implants surrounded by adequate keratinized mucosa generally exhibit improved tissue responses compared with implants lacking sufficient tissue width (Kim et al., 2009).

Systematic reviews by Gobbato et al. (2013) and Lin et al. (2013) identified recurring evidence suggesting that wider keratinized mucosa contributes to improved plaque control, reduced mucosal inflammation, and enhanced peri-implant stability. Although methodological heterogeneity limited the strength of pooled conclusions, the direction of evidence remained largely consistent.

Particularly influential findings emerged from Chiu et al. (2015), who reported a significant relationship between keratinized mucosa width and peri-implant health parameters. Their investigation demonstrated that insufficient keratinized tissue was associated with compromised peri-implant conditions and increased difficulty in maintaining oral hygiene. The findings of Chiu et al. (2015) therefore provide important clinical justification for augmentation procedures in appropriately selected patients.

Longitudinal evidence further reinforced these conclusions. Perussolo et al. (2018) observed that adequate keratinized mucosa positively influenced peri-implant tissue stability while simultaneously reducing brushing discomfort over a four-year observation period. Such long-term evidence strengthens the argument that keratinized tissue contributes to sustained biological health rather than only short-term improvements.

With respect to augmentation procedures, free gingival grafts emerged as the most predictable intervention for increasing keratinized tissue width. Clinical evidence from

Oh et al. (2017) demonstrated significant tissue gains and favorable peri-implant outcomes following grafting procedures. Similarly, the systematic reviews conducted by Bassetti et al. (2016) and Bassetti et al. (2017) consistently reported positive effects of augmentation procedures on peri-implant soft tissue conditions.

Collectively, the reviewed evidence indicates that soft tissue augmentation is capable of increasing keratinized mucosa dimensions, improving peri-implant tissue quality, facilitating oral hygiene practices, and supporting long-term **implant maintenance**

Table 3. Summary of Major Findings

Outcome Variable	Evidence Trend	Clinical Impact
Keratinized tissue width	Positive association	Improved stability
Plaque control	Improved	Better oral hygiene
Patient comfort	Increased	Reduced brushing discomfort
Tissue inflammation	Reduced	Enhanced peri-implant health
Augmentation effectiveness	Favorable	Increased tissue dimensions
Long-term maintenance	Improved	Better implant prognosis

Table Explanation

The findings consistently indicate that adequate keratinized mucosa contributes to multiple dimensions of implant success. The observed benefits extend beyond esthetic considerations and include measurable improvements in biological stability, maintenance effectiveness, and patient-centered outcomes.

5. Discussion

The findings of this systematic review support the growing consensus that keratinized mucosa plays an important role in peri-implant tissue maintenance. While implant survival can occur in the absence of extensive keratinized tissue, evidence increasingly suggests that adequate tissue width facilitates conditions favorable for long-term biological success.

One of the most important observations emerging from the reviewed literature is the distinction between implant survival and implant health. Earlier debates often focused on whether implants could survive without keratinized mucosa. Contemporary evidence instead emphasizes whether peri-implant tissues remain healthy, stable, and comfortable over extended periods. This shift in perspective helps explain why recent investigations have increasingly supported augmentation procedures.

The repeated findings reported by Chiu et al. (2015), Perussolo et al. (2018), and Wang et al. (2020) indicate that keratinized mucosa contributes to improved plaque control

and tissue stability. These benefits are clinically meaningful because plaque accumulation remains one of the primary etiological factors underlying peri-implant disease development.

The systematic reviews conducted by Bassetti et al. (2016) and Bassetti et al. (2017) further strengthen the argument for augmentation interventions. Their analyses demonstrate that augmentation procedures can effectively increase keratinized tissue dimensions and improve peri-implant soft tissue conditions. Importantly, Bassetti et al. (2017) emphasized that treatment success should incorporate patient comfort, tissue stability, and maintenance capability rather than relying exclusively on dimensional measurements.

Despite these encouraging findings, several limitations remain evident. Study heterogeneity continues to challenge direct comparison among investigations. Differences in patient populations, surgical protocols, outcome definitions, and follow-up periods contribute to variability across studies.

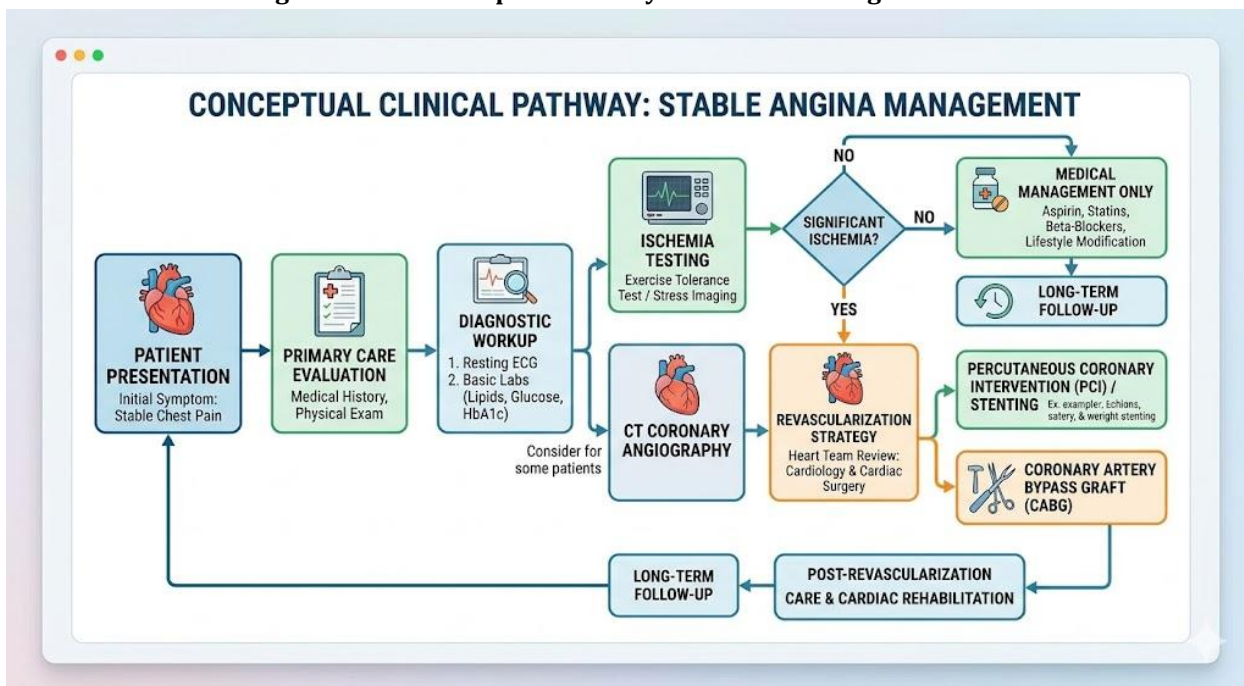
Furthermore, no universally accepted threshold exists regarding the minimum keratinized tissue width necessary for optimal implant health. While most evidence supports the value of adequate tissue dimensions, the exact quantitative requirement remains unclear.

From a clinical perspective, the evidence supports individualized treatment planning. Not every implant

patient requires augmentation; however, patients presenting with inadequate keratinized tissue, brushing discomfort, recurrent inflammation, or compromised hygiene access may benefit substantially from intervention.

Future investigations should prioritize standardized measurement protocols, multicenter randomized trials, and long-term patient-centered outcomes. Such research will help refine clinical guidelines and improve evidence-based decision-making

Figure 5. Clinical Impact Pathway of Soft Tissue Augmentation



Proposed pathway illustrating how soft tissue augmentation increases keratinized mucosa width, improves oral hygiene efficiency, reduces inflammation, enhances tissue stability, and ultimately contributes to long-term implant success.

This figure integrates the primary findings of the review into a single conceptual framework. It provides readers with a visual representation of the biological and clinical mechanisms through which augmentation procedures influence implant outcomes.

Why this figure is included

Table 4. Clinical Recommendations Based on Evidence Synthesis

Clinical Scenario	Recommended Approach
Limited keratinized tissue	Consider augmentation
Brushing discomfort	Evaluate tissue enhancement
Recurrent inflammation	Assess mucosal deficiency
Esthetic concerns	Consider connective tissue graft
Severe tissue deficiency	Free gingival graft preferred
Maintenance difficulties	Augmentation may be beneficial

Table Explanation

These recommendations are derived from recurring evidence patterns observed throughout the reviewed studies. The table provides practical guidance while acknowledging the need for individualized treatment planning.

6. Conclusion

This systematic review demonstrates that keratinized mucosa represents an important component of peri-implant soft tissue health and long-term implant maintenance. Evidence from clinical investigations, longitudinal studies, consensus reports, and systematic reviews consistently indicates that adequate keratinized tissue contributes to improved plaque control, enhanced patient comfort, greater tissue stability, and reduced inflammatory complications.

Among available interventions, free gingival grafts remain the most predictable technique for increasing keratinized mucosa width, while connective tissue grafts and second-stage augmentation procedures provide valuable alternatives depending on clinical objectives. The comprehensive evidence synthesized by Bassetti et al. (2017) further supports the effectiveness of augmentation procedures in improving peri-implant soft tissue outcomes.

The findings of Chiu et al. (2015) were particularly influential in demonstrating a direct relationship between keratinized mucosa width and peri-implant health. Combined with long-term observations from Perussolo et al. (2018) and biological evidence from Wang et al. (2020), these studies reinforce the importance of maintaining adequate keratinized tissue around implants.

Although additional high-quality research is required to establish definitive quantitative thresholds and standardized treatment protocols, current evidence supports the integration of soft tissue augmentation into comprehensive implant therapy when clinically indicated. Such an approach has the potential to enhance biological stability, facilitate maintenance, and improve long-term treatment success.

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