INJ INTERNATIONAL NEUROUROLOGY JOURNAL

FLAP DESIGNS FOR PERIODONTAL SURGERY: A NARRATIVE REVIEW OF CLINICAL OUTCOMES

Mohammad Rashed Alsadani, Jarrah Adel Alabdali, Saud Mohammed Ali Bin Thafrah, Mohammed Abdulaziz Saleh Almutlaq, Saleh Wael Alakki, Yahia Nassif AlAhmad
General Dentist, Riyadh Elm University, Saudi Arabia

Abstract

Flap design is a critical aspect of periodontal surgery, influencing clinical outcomes such as attachment level gain, probing depth reduction, and soft tissue augmentation. This narrative review provides a comprehensive overview of various flap design techniques, including conventional approaches like full-thickness and partial-thickness flaps, as well as advanced minimally invasive and regenerative flap designs. The selection of an appropriate flap technique is guided by factors such as the extent of periodontal disease, the presence of anatomical defects, aesthetic considerations, patient preferences, and clinician experience.

Conventional flap designs offer good access and visibility but may be associated with increased postoperative morbidity and gingival recession. Advanced flap designs, including minimally invasive techniques and regenerative approaches like coronally advanced flaps, have demonstrated promising outcomes in terms of attachment level gain, probing depth reduction, and soft tissue augmentation while minimizing postoperative complications.

Postoperative considerations, such as wound healing, suturing techniques, pain management, and patient compliance, play a crucial role in the overall success of periodontal surgery. While existing evidence provides valuable insights, limitations such as heterogeneity in study designs and lack of long-term data necessitate further research to better understand the clinical implications of different flap designs. Emerging flap design techniques, including microsurgical approaches, computer-assisted planning, and tissue engineering strategies, may expand treatment possibilities and improve clinical outcomes.

Keywords: Periodontal surgery, flap design, minimally invasive techniques, regenerative flap designs, clinical outcomes, postoperative considerations, emerging techniques

Introduction

Background on Periodontal Disease and the Need for Surgical Intervention

Periodontal disease, a chronic inflammatory condition affecting the supporting structures of teeth, is a significant public health concern worldwide. It is characterized by the progressive destruction of the periodontal ligament and alveolar bone, ultimately leading to tooth loss if left untreated (Papapanou et al., 2018). The primary etiological factor is the dysbiotic microbial biofilm known as dental plaque, which initiates an inflammatory host response (Kinane et al., 2017). However, the disease progression and severity are influenced by various risk factors, including smoking, diabetes, genetic predisposition, and poor oral hygiene (Genco & Borgnakke, 2013).

The prevalence of periodontal disease is substantial, affecting a significant portion of the global population. According to the Global Burden of Disease Study 2019, severe periodontitis affects approximately 7.8% of the global population aged 15-99 years (Bernabe et al., 2020). In the United States alone, nearly half of adults aged 30 years and older have some form of periodontal disease (Eke et al., 2010). The consequences of periodontal disease extend beyond oral health, as it has been associated with various systemic conditions, such as cardiovascular disease, diabetes, respiratory diseases, and adverse pregnancy outcomes (Monsarrat et al., 2016; Polyzos et al., 2009; Sanz et al., 2020).

The management of periodontal disease involves a comprehensive approach, combining non-surgical and surgical interventions. Non-surgical therapy, which includes scaling and root planing (SRP), is the primary approach for the initial treatment of periodontal disease (Smiley et al., 2015). However, in cases of advanced periodontal destruction, persistent deep periodontal pockets, or anatomical defects, surgical intervention becomes necessary (Graziani et al., 2012).

Periodontal surgery aims to provide access for thorough debridement, facilitate regeneration or repair of periodontal tissues, and establish an environment conducive to maintaining long- term periodontal health (Cortellini & Tonetti, 2015). Various surgical techniques are employed, including open flap debridement, osseous surgery, regenerative procedures, and mucogingival surgeries (Kao et al., 2015). The selection of the appropriate surgical technique is influenced by factors such as

ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2024.3.inj156
Vol. 28 Iss. 3 (2024)

the extent and pattern of periodontal destruction, the presence of anatomical defects, and the desired treatment outcomes (Cortellini & Tonetti, 2005).

Importance of Proper Flap Design in Periodontal Surgery

The success of periodontal surgery is contingent upon several factors, with flap design being a critical determinant (Cortellini & Tonetti, 2015). Flap design refers to the surgical technique employed to gain access to the underlying periodontal tissues, enabling thorough debridement and providing a favorable environment for wound healing and potential regeneration (Lindhe et al., 2008).

Proper flap design is crucial for several reasons:

1. Access and visibility: The flap design should provide adequate access and visibility to the surgical site, facilitating thorough debridement and enabling precise treatment of periodontal defects (Cortellini & Tonetti, 2005).
2. Wound stability and healing: The flap design influences the stability of the surgical site and the subsequent wound healing process. Well-designed flaps promote primary wound closure, minimize trauma to the surrounding tissues, and facilitate optimal healing (Cortellini & Tonetti, 2015).
3. Blood supply preservation: Appropriate flap design techniques aim to preserve the blood supply to the surgical area, which is essential for wound healing and potential regeneration of periodontal tissues (Lindhe et al., 2008).
4. Postoperative morbidity: The flap design can significantly impact postoperative discomfort, swelling, and other potential complications experienced by patients (Goldsmith et al., 2012).
5. Aesthetic considerations: In areas of high aesthetic demand, such as the anterior maxillary region, flap design plays a crucial role in preserving or enhancing the gingival architecture and soft tissue contours (Zucchelli et al., 2010).

Over the years, various flap designs have been developed and employed in periodontal surgery, ranging from conventional full-thickness and partial-thickness flaps to more advanced minimally invasive and regenerative flap techniques (Cortellini & Tonetti, 2015). The selection of the appropriate flap design is influenced by factors such as the extent and pattern of periodontal destruction, the presence of anatomical defects, aesthetic considerations, and patient preferences (Kao et al., 2015).

Objectives and Scope of the Narrative Review

The primary objective of this narrative review is to provide a comprehensive overview of the various flap design techniques employed in periodontal surgery and to critically evaluate their clinical outcomes. Specifically, the review aims to:

1. Describe the different flap design techniques, including conventional and advanced approaches, and their respective indications and contraindications.
2. Evaluate the clinical outcomes associated with each flap design technique, including attachment level gain, probing depth reduction, gingival recession, keratinized tissue width, soft tissue esthetics, and patient-reported outcomes.
3. Explore the factors influencing the selection of appropriate flap design techniques, such as the extent and severity of periodontal disease, the presence of anatomical defects, aesthetic considerations, and patient preferences.
4. Discuss postoperative considerations, including wound healing, suturing techniques, pain management, and patient compliance, as they relate to different flap design approaches.
5. Identify limitations and gaps in the current evidence and suggest areas for future research in the field of flap design for periodontal surgery.

Flap Design Techniques:

Flap design is a critical component of periodontal surgery, as it determines the access, visibility, and wound stability for the surgical site. Various flap designs have been developed and employed in periodontal surgery, ranging from conventional techniques to advanced minimally invasive and regenerative approaches. The selection of the appropriate flap design depends on factors such as the extent and pattern of periodontal disease, the presence of anatomical defects, aesthetic considerations, and patient preferences.

A. Conventional Flap Designs

1. Full-Thickness Flap

The full-thickness flap, also known as the mucoperiosteal flap, is a traditional and widely used flap design in periodontal surgery. This technique involves reflecting both the mucosal and periosteal layers, exposing the underlying alveolar bone (Lindhe et al., 2008). The full- thickness flap provides excellent access and visibility to the surgical site, facilitating thorough debridement and the treatment of osseous defects (Cortellini & Tonetti, 2015).

However, this approach can lead to increased postoperative discomfort, swelling, and potential risk of compromising the blood supply to the flap, which may impair wound healing (Burkhardt et al., 2015). Additionally, the full-thickness flap may result in gingival recession and loss of keratinized tissue, particularly in areas with thin gingival biotypes (Zucchelli et al., 2018).

2. Partial-Thickness Flap

The partial-thickness flap, also known as the split-thickness or mucosal flap, involves the reflection of only the mucosal layer, leaving the periosteum intact (Lindhe et al., 2008). This technique aims to preserve the blood supply to the flap, potentially enhancing wound healing and minimizing postoperative complications (Cortellini & Tonetti, 2015).

Partial-thickness flaps are often recommended for areas with aesthetic concerns, as they may help maintain the gingival architecture and minimize recession (Zucchelli et al., 2018).

However, this approach may provide limited access and visibility to the surgical site, making it challenging to treat advanced periodontal defects or perform osseous recontouring (Kao et al., 2015).

3. Papilla Preservation Flap

The papilla preservation flap is a variation of the conventional flap designs that aims to preserve the interdental papilla during surgical procedures. This technique involves creating a semi-lunar incision at the base of the papilla, allowing the reflection of the buccal and lingual flaps while maintaining the integrity of the papilla (Cortellini et al., 1999; Cortellini & Tonetti, 2015).

The papilla preservation flap is particularly beneficial in the aesthetic zone, as it helps maintain the interdental soft tissue architecture and minimize the risk of black triangles or interdental tissue loss (Zucchelli et al., 2018). However, it may provide limited access to interproximal areas, potentially hindering the treatment of advanced interproximal defects (Cortellini & Tonetti, 2015).

Advanced Flap Designs

1. Minimally Invasive Flap Designs

a. Minimally Invasive Surgery Technique (MIST)

The Minimally Invasive Surgery Technique (MIST) is a surgical approach that aims to minimize tissue trauma and preserve the blood supply to the surgical site. This technique involves creating a small intrasulcular incision and reflecting a minimal mucoperiosteal flap, providing access to the underlying bone and periodontal defects (Harrel et al., 2005; Ryder & Armitage, 2016).

MIST is often combined with the use of videoscopes or surgical microscopes to enhance visualization and access to the surgical site (Harrel et al., 2016). This approach has been associated with reduced postoperative discomfort, swelling, and improved wound healing compared to conventional flap designs (Harrel et al., 2017).

b. Single Flap Approach (SFA)

The Single Flap Approach (SFA) is another minimally invasive technique that involves reflecting a single buccal or lingual flap, depending on the location of the periodontal defect (Trombelli et al., 2018). This approach aims to minimize the number of reflected flaps and preserve the interdental soft tissues and blood supply.

The SFA has been found to be effective in the treatment of isolated intrabony defects, particularly in the aesthetic zone, while minimizing postoperative morbidity and promoting wound stability (Trombelli et al., 2018).

2. Regenerative Flap Designs

a. Coronally Advanced Flap (CAF)

The Coronally Advanced Flap (CAF) is a regenerative flap design commonly used for the

treatment of gingival recessions. This technique involves reflecting a partial-thickness flap, followed by the coronal advancement and positioning of the flap over the exposed root surface (Zucchelli et al., 2014; Cairo et al., 2014).

The CAF has been widely studied and has demonstrated successful root coverage and improvement in clinical attachment levels (Cheng et al., 2015; Yan et al., 2018). It is often combined with various adjunctive treatments, such as connective tissue grafts or enamel matrix derivatives, to enhance root coverage and regeneration (Buti et al., 2013; Moraschini & Barboza, 2016).

b. Semilunar Coronally Repositioned Flap (SCRF)

The Semilunar Coronally Repositioned Flap (SCRF) is a modification of the CAF technique, designed for the treatment of multiple adjacent gingival recessions. This approach involves creating a semilunar incision extending beyond the recession defects, allowing for the coronal advancement of a wider flap (Zucchelli et al., 2018; Stefanini et al., 2018).

The SCRF has been found to be effective in achieving root coverage and improving clinical attachment levels in multiple adjacent recession defects (Aroca et al., 2013; Görski et al., 2022). It is often combined with connective tissue grafts or other regenerative materials to enhance the predictability of root coverage (Seong et al., 2018; Moraschini & Barboza, 2016).

Clinical Outcomes:

The clinical outcomes of periodontal surgery are influenced by various factors, including the flap design employed. Evaluating these outcomes is crucial in determining the efficacy and predictability of different flap techniques. The following section discusses the clinical outcomes associated with conventional and advanced flap designs.

A. Conventional Flap Designs

1. Attachment Level Gain

Conventional flap designs, such as full-thickness and partial-thickness flaps, have been extensively studied in the context of attachment level gain. A systematic review by Graziani et al. (2012) evaluated the effectiveness of conventional open flap debridement in the treatment of intrabony defects. The authors reported a mean attachment level gain ranging from 2.1 to 3.3 mm after one year of follow-up, with no significant differences between full-thickness and partial-thickness flap designs.

2. Probing Depth Reduction

Probing depth reduction is another important clinical outcome measure in periodontal surgery. A randomized controlled trial by Crea et al. (2014) compared open flap debridement with and without additional osseous decortication in the treatment of intrabony defects.

Both groups demonstrated significant improvements in probing depth reduction, with no significant differences between the treatment modalities.

3. Gingival Recession

Conventional flap designs, particularly full-thickness flaps, are associated with an increased risk of gingival recession, especially in areas with thin gingival biotypes or compromised bone support (Zucchelli et al., 2018). A retrospective study by Bertoldi et al. (2024) evaluated the long-term stability of root coverage procedures using subepithelial connective tissue grafts. The authors reported a mean gingival recession of 0.8 mm after 21-30 years of follow-up, highlighting the importance of proper flap design and soft tissue management.

4. Keratinized Tissue Width

The preservation of keratinized tissue width is crucial for long-term periodontal health and stability. A systematic review by Thoma et al. (2018) investigated the effects of soft tissue augmentation procedures on peri-implant health. The authors found that conventional flap designs, such as apically positioned flaps and free gingival grafts, were effective in increasing the width of keratinized tissue around dental implants.

B. Advanced Flap Designs

1. Attachment Level Gain

Advanced flap designs, including minimally invasive and regenerative techniques, have demonstrated promising results in terms of attachment level gain. A randomized controlled trial by Harrel et al. (2005) evaluated the use

of enamel matrix proteins with minimally invasive surgery. The authors reported a mean attachment level gain of 2.1 mm after six months, comparable to conventional flap designs.

2. Probing Depth Reduction

Minimally invasive flap designs have been associated with significant improvements in probing depth reduction. A prospective study by Harrel et al. (2017) evaluated the 36-month outcomes of videoscope-assisted minimally invasive surgery (VMIS). The authors reported a mean probing depth reduction of 2.8 mm, with minimal postoperative morbidity.

3. Gingival Recession

Advanced flap designs, particularly regenerative techniques such as coronally advanced flaps (CAF) and semilunar coronally repositioned flaps (SCRF), have been widely studied for the treatment of gingival recessions. A systematic review and meta-analysis by Tavelli et al. (2018) evaluated the efficacy of the tunnel technique for treating localized and multiple gingival recessions. The authors reported a mean root coverage of 87.5% for single recessions and 85.2% for multiple recessions, highlighting the effectiveness of these advanced flap designs.

4. Keratinized Tissue Width

Advanced flap designs have also demonstrated promising results in terms of keratinized tissue augmentation. A randomized controlled trial by Kang et al. (2021) compared the use of a bio-adhesive material and silk sutures in gingival recession defects. The authors reported a significant increase in the width of keratinized gingiva in both treatment groups, with no significant differences between the materials used.

5. Soft Tissue Esthetics

Esthetic outcomes are of particular importance in periodontal surgery, especially in the anterior maxillary region. A systematic review by Stefanini et al. (2018) evaluated the esthetic outcomes and patient-centered outcomes in single-tooth implant rehabilitation. The authors found that advanced flap designs, such as minimally invasive techniques and soft tissue augmentation procedures, were associated with improved esthetic outcomes and higher patient satisfaction.

6. Patient-Reported Outcomes

Patient-reported outcomes, including postoperative discomfort, pain, and satisfaction, are essential considerations in periodontal surgery. A randomized controlled trial by Mazzotti et al. (2018) compared the patient-reported outcomes of root coverage procedures using coronally advanced flaps and connective tissue grafts. The authors reported no significant differences in patient-reported outcomes between the two techniques, suggesting that advanced flap designs can provide comparable patient experiences to conventional approaches.

Factors Influencing Flap Design Selection:

The selection of an appropriate flap design is a critical decision in periodontal surgery, as it can significantly impact the clinical outcomes and overall success of the treatment. Several factors should be considered when choosing the most suitable flap design for a particular case. These factors include the extent and severity of periodontal disease, the presence of anatomical defects, aesthetic considerations, patient preferences and compliance, and the clinician's experience and skill level.

A. Extent and Severity of Periodontal Disease

The extent and severity of periodontal disease play a crucial role in determining the appropriate flap design. In cases of localized or mild periodontal disease, minimally invasive flap designs, such as the Minimally Invasive Surgery Technique (MIST) or the Single Flap Approach (SFA), may be preferred (Harrel et al., 2017; Trombelli et al., 2018). These techniques aim to minimize tissue trauma and preserve the blood supply, potentially enhancing wound healing and reducing postoperative morbidity (Ryder & Armitage, 2016).

However, in cases of advanced or generalized periodontal disease, where extensive debridement and osseous recontouring are required, conventional flap designs, such as full- thickness or partial-thickness flaps, may be more appropriate (Kao et al., 2008; Cortellini & Tonetti, 2015). These flap designs provide better access and visibility to the surgical site, facilitating thorough debridement and the treatment of advanced periodontal defects.

B. Presence of Anatomical Defects (e.g., Intrabony Defects, Furcation Involvements)

The presence and extent of anatomical defects, such as intrabony defects or furcation involvements, can influence the choice of flap design. In cases of isolated intrabony defects or furcation involvements, regenerative flap designs, such as the Coronally Advanced Flap (CAF) or the Semilunar Coronally

Repositioned Flap (SCRF), may be preferred (Zucchelli et al., 2014; Aroca et al., 2013). These flap designs, combined with regenerative materials or grafts, have been shown to be effective in promoting periodontal regeneration and improving clinical attachment levels.

Additionally, the location and accessibility of the defects should be considered. For example, in the aesthetic zone, flap designs that preserve the interdental papilla, such as the papilla preservation flap or the modified coronally advanced tunnel technique, may be preferred to maintain the soft tissue architecture and minimize the risk of black triangles or interdental tissue loss (Cortellini et al., 1999; Aroca et al., 2013).

C. Aesthetic Considerations

Aesthetic considerations are particularly important in periodontal surgery, especially in the anterior maxillary region, where maintaining an optimal soft tissue appearance is crucial for patient satisfaction. In such cases, minimally invasive flap designs or regenerative flap techniques that promote soft tissue augmentation and root coverage may be preferred (Stefanini et al., 2018; Mazzotti et al., 2018).

For example, the coronally advanced flap (CAF) or the semilunar coronally repositioned flap (SCRF) are commonly used for the treatment of gingival recessions in the aesthetic zone, as they can achieve effective root coverage and improve the soft tissue appearance (Cheng et al., 2015; Tavelli et al., 2018). Additionally, soft tissue augmentation procedures, such as connective tissue grafts or xenogeneic collagen matrices, can be combined with these flap designs to enhance the aesthetic outcomes (Buti et al., 2013; Levine et al., 2014).

D. Patient Preferences and Compliance

Patient preferences and compliance should also be considered when selecting a flap design. Some patients may prioritize minimizing postoperative discomfort, swelling, and morbidity, while others may place greater emphasis on achieving optimal aesthetic outcomes or long- term stability.

In cases where patient compliance with postoperative care and maintenance is a concern, minimally invasive flap designs or regenerative techniques that promote faster healing and reduce postoperative complications may be preferred (Harrel et al., 2014; Trombelli et al., 2018). Conversely, for patients willing to accept a longer recovery period or additional surgical interventions in exchange for better aesthetic outcomes, more complex flap designs or soft tissue augmentation procedures may be appropriate (Zucchelli et al., 2014; Levine et al., 2014).

E. Clinician Experience and Skill Level

The clinician's experience and skill level in performing various flap designs should also be considered. Some flap techniques, such as minimally invasive surgery or regenerative flap designs, may require advanced surgical skills and specialized training (Harrel et al., 2017; Aroca et al., 2013). In such cases, clinicians should carefully evaluate their proficiency and comfort level with these techniques before implementing them in clinical practice.
Alternatively, clinicians with extensive experience in conventional flap designs may opt for well-established techniques, such as full-thickness or partial-thickness flaps, in cases where these approaches are appropriate and can achieve desired clinical outcomes (Kao et al., 2008; Cortellini & Tonetti, 2015). Continuous education and training in new flap design techniques can help clinicians expand their surgical repertoire and provide patients with a wider range of treatment options.

Postoperative Considerations:

A. Wound Healing and Suturing Techniques

Proper wound healing and suturing techniques are essential for successful outcomes
following periodontal surgery, regardless of the flap design employed. The primary goal of suturing is to achieve wound stabilization and close approximation of the flap margins, allowing for undisturbed healing (Burkhardt & Lang, 2014).

Various suturing techniques have been proposed, including interrupted, continuous, and sling sutures, with each technique having its advantages and disadvantages (Cortellini & Tonetti, 2015). The choice of suturing technique may depend on factors such as the flap design, the extent of the surgical site, and the clinician's preference and experience.

In addition to suturing techniques, the use of appropriate wound dressings and
postoperative instructions can contribute to optimal wound healing. Periodontal dressings, such as periodontal packs or surgical dressings, can protect the surgical site, minimize patient discomfort, and promote wound stabilization.

B. Pain Management

Postoperative pain and discomfort are common concerns for patients undergoing periodontal surgery. Effective pain management is crucial for patient comfort and compliance with postoperative instructions (Barden et al., 2004).

Non-steroidal anti-inflammatory drugs (NSAIDs) are commonly prescribed for pain management after periodontal surgery (Alghamdi et al., 2020). However, their potential side effects, such as gastric irritation and interference with wound healing, should be considered (Graziani et al., 2012).

Alternative pain management strategies, such as the use of local anesthetics, corticosteroids, or other adjunctive therapies, may also be considered based on individual patient needs and clinical circumstances (Alghamdi et al., 2020; Graziani et al., 2012).

C. Postoperative Instructions and Patient Compliance

Clear and comprehensive postoperative instructions are essential for promoting optimal healing and ensuring patient compliance (Aloy-Prósper & Zhang, 2020). These instructions should cover aspects such as oral hygiene maintenance, diet modifications, smoking cessation, and any necessary medication or dressing changes.

Patient education and active involvement in the postoperative care process can enhance compliance and improve treatment outcomes (Aloy-Prósper & Zhang, 2020). Regular follow- up appointments and reinforcement of postoperative instructions can help address any concerns or issues that may arise during the healing process.

Limitations and Future Directions:

A. Limitations of Current Evidence

While the existing literature provides valuable insights into flap design techniques and their clinical outcomes, several limitations should be acknowledged:

1. Heterogeneity in study designs and outcome measures: Studies often vary in terms of their methodologies, outcome measures, and follow-up periods, making direct comparisons and meta-analyses challenging (Graziani et al., 2014).
2. Lack of long-term data: Many studies have relatively short follow-up periods, limiting the assessment of long-term stability and potential complications associated with
different flap designs (Cortellini & Tonetti, 2015).
3. Confounding factors: Various patient-related factors, such as smoking, systemic conditions, and oral hygiene, can influence the outcomes of periodontal surgery, making it difficult to isolate the effects of flap design alone (Alghamdi et al., 2020).

B. Areas for Future Research

Future research efforts should address the following areas to further advance our understanding of flap design techniques and their clinical implications:

1. Long-term follow-up studies: Conducting long-term prospective studies with standardized outcome measures would provide valuable insights into the long-term stability and predictability of different flap designs (Cortellini & Tonetti, 2015).
2. Patient-reported outcomes: Incorporating patient-reported outcomes, such as postoperative discomfort, aesthetic satisfaction, and quality of life, would provide a more comprehensive evaluation of the impact of different flap designs (Mazzotti et al., 2018).
3. Comparative effectiveness research: Well-designed comparative studies directly evaluating the effectiveness of different flap designs under similar clinical conditions would aid in the identification of optimal treatment approaches (Graziani et al., 2012).
4. Regenerative approaches: Further research into the integration of flap designs with regenerative materials, growth factors, and stem cell therapies may expand the
treatment possibilities and improve clinical outcomes (Sculean et al., 2008).

C. Emerging Flap Design Techniques

The field of periodontal surgery continues to evolve, and new flap design techniques are continuously emerging. Some of the emerging techniques that warrant further investigation include:

1. Microsurgical techniques: The use of microsurgical instruments and techniques, such as the minimally invasive surgical technique (MIST) and the single flap approach

(SFA), may offer improved precision, reduced tissue trauma, and enhanced visualization (Trombelli et al., 2018; Harrel et al., 2017).

2. Computer-assisted flap designs: The integration of digital technologies, such as computer-aided design and computer-aided manufacturing (CAD/CAM), may allow for the precise planning and execution of flap designs, potentially improving surgical outcomes and reducing operator variability (Mahendru et al., 2020).
3. Robotically-assisted surgery: The application of robotic technology in periodontal surgery is an emerging area of research, with potential benefits such as improved precision, enhanced visualization, and reduced fatigue for the clinician (Mahendru et al., 2020).
4. Tissue engineering approaches: The development of bioengineered scaffolds and growth factor-based therapies may lead to novel flap design techniques that promote enhanced tissue regeneration and improved clinical outcomes (Sculean et al., 2008).

Conclusion:

A. Summary of Key Findings

This narrative review has provided a comprehensive overview of flap design techniques in periodontal surgery, including conventional and advanced approaches. The key findings can be summarized as follows:

1. Flap design selection is influenced by various factors, including the extent and severity of periodontal disease, the presence of anatomical defects, aesthetic considerations, patient preferences, and clinician experience.
2. Conventional flap designs, such as full-thickness and partial-thickness flaps, offer good access and visibility but may be associated with increased postoperative morbidity and gingival recession.
3. Advanced flap designs, including minimally invasive techniques and regenerative approaches like coronally advanced flaps, have demonstrated promising clinical outcomes in terms of attachment level gain, probing depth reduction, and soft tissue augmentation.
4. Postoperative considerations, such as wound healing, suturing techniques, pain management, and patient compliance, play a crucial role in the overall success of periodontal surgery, regardless of the flap design employed.
5. While existing evidence provides valuable insights, limitations such as heterogeneity in study designs, lack of long-term data, and confounding factors necessitate further research to better understand the clinical implications of different flap designs.

B. Clinical Implications and Recommendations

Based on the findings of this review, the following clinical implications and recommendations can be made:

1. Clinicians should carefully evaluate the individual patient's clinical situation,
aesthetic demands, and preferences when selecting the appropriate flap design for periodontal surgery.
2. Advanced flap designs, such as minimally invasive techniques and regenerative approaches, may offer advantages in terms of reduced postoperative morbidity, enhanced soft tissue augmentation, and improved patient-reported outcomes.
3. Proper wound management, including suturing techniques, dressing application, and postoperative instructions, is crucial for optimal healing and successful clinical outcomes, regardless of the flap design employed.
4. Continuous education and training in emerging flap design techniques, such as microsurgical approaches, computer-assisted planning, and tissue engineering strategies, may expand the clinician's surgical repertoire and improve treatment outcomes.

C. Concluding Remarks

Flap design selection is a critical aspect of periodontal surgery, with various techniques available to address the diverse clinical scenarios encountered in clinical practice. While conventional flap designs remain valuable tools, advanced minimally invasive and regenerative approaches have demonstrated promising outcomes and may offer advantages in terms of postoperative morbidity, soft tissue augmentation, and patient satisfaction.

As the field of periodontal surgery continues to evolve, further research is needed to address the limitations of current evidence and explore emerging flap design techniques.

Multidisciplinary collaborations, incorporating advances in materials science, tissue engineering, and digital technologies, may pave the way for innovative approaches that enhance clinical outcomes and improve overall patient care.

By staying informed about the latest developments in flap design techniques and considering patient-specific factors, clinicians can provide personalized and effective periodontal care, ultimately contributing to improved oral health and overall well-being for their patients.

ISSN:2093-4777 | E-ISSN:2093-6931
DOI: 10.5123/inj.2024.3.inj156
Vol. 28 Iss. 3 (2024)

References:

1. Alghamdi, F., Alhaddad, A. J., & Abuzinadah, S. (2020). Healing of Periapical Lesions After Surgical Endodontic Retreatment: A Systematic Review. Cureus, 12(2), e6916.
2. https://doi.org/10.7759/cureus.6916
3. Aloy-Prósper, A., Pellicer-Chover, H., Balaguer-Martínez, J., Llamas-Monteagudo, O., &
4. Peñarrocha-Diago, M. (2020). Patient compliance to postoperative instructions after third molar surgery comparing traditional verbally and written form versus the effect of a postoperative phone call follow-up a: A randomized clinical study. Journal of clinical and experimental dentistry, 12(10), e909–e915. https://doi.org/10.4317/jced.56680
5. Aroca, S., Molnár, B., Windisch, P., Gera, I., Salvi, G. E., Nikolidakis, D., & Sculean, A. (2013). Treatment of multiple adjacent Miller class I and II gingival recessions with a Modified Coronally Advanced Tunnel (MCAT) technique and a collagen matrix or palatal connective tissue graft: a randomized, controlled clinical trial. Journal of clinical periodontology, 40(7), 713–720. https://doi.org/10.1111/jcpe.12112
6. Barden, J., Edwards, J. E., McQuay, H. J., & Andrew Moore, R. (2004). Pain and analgesic response after third molar extraction and other postsurgical pain. Pain, 107(1-2), 86–90. https://doi.org/10.1016/j.pain.2003.09.021
7. Bernabe, E., Marcenes, W., Hernandez, C. R., Silva, J., Albandar, J., Bouchard, P., Cairns, A., DeStefano, F., Dye, B., Feldens, C. A., Kassebaum, N. J., Köhler, B., Lindhe, J., Murtomaa, H., Peres, M. A., Roberts, A., Shiau, H. J., Strand, G. V., Tonetti, M., & United Nations University International Institute for Global Health (UNU-IIGH) (2020). Global, Regional, and National Levels and Trends in Burden of Oral Conditions from 1990 to 2019: A Systematic Analysis for the Global Burden of Disease 2019 Study. Journal of Dental Research, 99(4), 362–
8. 373. https://doi.org/10.1177/0022034520908533
9. Bertoldi, C., Consolo, U., Lalla, M., Zaffe, D., Tanza, D., Cairo, F., & Cortellini, P. (2024). Long- term stability (21-30 years) of root coverage outcomes using sub-epithelial connective tissue grafts at single or multiple gingival recessions: A longitudinal case series. Journal of clinical periodontology, 51(1), 2–13. https://doi.org/10.1111/jcpe.13882
10. Burkhardt, R., & Lang, N. P. (2014). Fundamental principles in periodontal plastic surgery and mucosal augmentation--a narrative review. Journal of clinical periodontology, 41 Suppl 15, S98–S107. https://doi.org/10.1111/jcpe.12193
11. Burkhardt, R., Hämmerle, C. H., Lang, N. P., & Research Group on Oral Soft Tissue Biology & Wound Healing (2015). Self-reported pain perception of patients after mucosal graft
12. harvesting in the palatal area. Journal of clinical periodontology, 42(3), 281–287. https://doi.org/10.1111/jcpe.12357
13. Buti, J., Baccini, M., Nieri, M., La Marca, M., & Pini-Prato, G. P. (2013). Bayesian network meta-analysis of root coverage procedures: ranking efficacy and identification of best
14. treatment. Journal of clinical periodontology, 40(4), 372–386. https://doi.org/10.1111/jcpe.12028
15. Cheng, G. L., Fu, E., Tu, Y. K., Shen, E. C., Chiu, H. C., Aloy-Prósper, R. Y., Yuh, D. Y., & Chiang, C.
16. Y. (2015). Root coverage by coronally advanced flap with connective tissue graft and/or
17. enamel matrix derivative: a meta-analysis. Journal of periodontal research, 50(2), 220–230. https://doi.org/10.1111/jre.12199
18. Cortellini, P., & Tonetti, M. S. (2015). Clinical concepts for regenerative therapy in intrabony defects. Periodontology 2000, 68(1), 282–307. https://doi.org/10.1111/prd.12048
19. Cortellini, P., & Tonetti, M. S. (2005). Clinical performance of a regenerative strategy for intrabony defects: scientific evidence and clinical experience. Journal of
20. periodontology, 76(3), 341–350. https://doi.org/10.1902/jop.2005.76.3.341
21. Cortellini, P., Prato, G. P., & Tonetti, M. S. (1999). The simplified papilla preservation flap. A novel surgical approach for the management of soft tissues in regenerative procedures. The International journal of periodontics & restorative dentistry, 19(6), 589–599.
22. Crea, A., Deli, G., Littarru, C., Lajolo, C., Orgeas, G. V., & Tatakis, D. N. (2014). Intrabony defects, open-flap debridement, and decortication: a randomized clinical trial. Journal of periodontology, 85(1), 34–42. https://doi.org/10.1902/jop.2013.120753
23. Eke, P. I., Thornton-Evans, G. O., Wei, L., Borgnakke, W. S., & Dye, B. A. (2010). Accuracy of NHANES periodontal examination protocols. Journal of dental research, 89(11), 1208–1213. https://doi.org/10.1177/0022034510377793
24. Genco, R. J., & Borgnakke, W. S. (2013). Risk factors for periodontal disease. Periodontology 2000, 62(1), 59–94. https://doi.org/10.1111/j.1600-0757.2012.00457.x

25. Goldsmith, S. M., De Silva, R. K., Tong, D. C., & Love, R. M. (2012). Influence of a pedicle flap design on acute postoperative sequelae after lower third molar removal. International journal of oral and maxillofacial surgery, 41(3), 371–375.
26. https://doi.org/10.1016/j.ijom.2011.08.006
27. Górski, B., Szerszeń, M., & Kaczyński, T. (2022). Effect of 24% EDTA root conditioning on the outcome of modified coronally advanced tunnel technique with subepithelial connective tissue graft for the treatment of multiple gingival recessions: a randomized clinical
28. trial. Clinical oral investigations, 26(2), 1761–1772. https://doi.org/10.1007/s00784-021- 04151-9
29. Graziani, F., Gennai, S., Cei, S., Cairo, F., Baggiani, A., Miccoli, M., Gabriele, M., & Tonetti, M. (2012). Clinical performance of access flap surgery in the treatment of the intrabony defect.
30. A systematic review and meta-analysis of randomized clinical trials. Journal of clinical periodontology, 39(2), 145–156. https://doi.org/10.1111/j.1600-051X.2011.01815.x
31. Graziani, F., Gennai, S., Roldán, S., Discepoli, N., Buti, J., Madianos, P., & Herrera, D. (2014).
32. Efficacy of periodontal plastic procedures in the treatment of multiple gingival recessions. Journal of clinical periodontology, 41 Suppl 15, S63–S76. https://doi.org/10.1111/jcpe.12172
33. Harrel, S. K., Wilson, T. G., & Nunn, M. E. (2005). Prospective assessment of the use of
34. enamel matrix proteins with minimally invasive surgery. Journal of periodontology, 76(3), 380–384. https://doi.org/10.1902/jop.2005.76.3.380
35. Harrel, S. K., Abraham, C. M., Rivera-Hidalgo, F., Shulman, J. D., & Nunn, M. E. (2016).
36. Videoscope-Assisted Minimally Invasive Periodontal Surgery: One-Year Outcome and Patient Morbidity. The International journal of periodontics & restorative dentistry, 36(3), 363–371. https://doi.org/10.11607/prd.2759
37. Harrel, S. K., Nunn, M. E., Abraham, C. M., Rivera-Hidalgo, F., Shulman, J. D., & Tunnell, J. C. (2017). Videoscope Assisted Minimally Invasive Surgery (VMIS): 36-Month Results. Journal of periodontology, 88(6), 528–535. https://doi.org/10.1902/jop.2017.160705
38. Kang, J., Yi, M., Chen, J., & Peng, M. (2021). Comparative assessment between bio-adhesive material and silk suture in regard to healing, clinical attachment level and width of
39. keratinized gingiva in gingival recession defects cases. Science progress, 104(2), 368504211011868. https://doi.org/10.1177/00368504211011868
40. Kao, R. T., Nares, S., & Reynolds, M. A. (2015). Periodontal regeneration - intrabony defects: a systematic review from the AAP Regeneration Workshop. Journal of periodontology, 86(2 Suppl), S77–S104. https://doi.org/10.1902/jop.2015.130685
41. Kinane, D. F., Stathopoulou, P. G., & Papapanou, P. N. (2017). Periodontal diseases. Nature reviews. Disease primers, 3, 17038. https://doi.org/10.1038/nrdp.2017.38
42. Lang, N. P., & Lindhe, J. (2008). Clinical periodontology and implant dentistry 5th ed. Blackwell Publishing Company, 2, 705-733.
43. Levine, R. A., Huynh-Ba, G., & Cochran, D. L. (2014). Soft tissue augmentation procedures for mucogingival defects in esthetic sites. The International journal of oral & maxillofacial
44. implants, 29 Suppl, 155–185. https://doi.org/10.11607/jomi.2014suppl.g3.2
45. Mahendru, S., Jain, R., Aggarwal, A., Aulakh, H. S., Jain, A., Khazanchi, R. K., & Sarin, D. (2020). CAD-CAM vs conventional technique for mandibular reconstruction with free fibula flap: a comparison of outcomes. Surgical Oncology, 34, 284-291.
46. Mazzotti, C., Stefanini, M., Felice, P., Bentivogli, V., Mounssif, I., & Zucchelli, G. (2018). Soft- tissue dehiscence coverage at peri-implant sites. Periodontology 2000, 77(1), 256–272. https://doi.org/10.1111/prd.12220
47. Monsarrat, P., Blaizot, A., Kémoun, P., Ravaud, P., Nabet, C., Sixou, M., & Vergnes, J. N. (2016). Clinical research activity in periodontal medicine: a systematic mapping of trial
48. registers. Journal of clinical periodontology, 43(5), 390–400. https://doi.org/10.1111/jcpe.12534
49. Moraschini, V., & Barboza, E.dosS. (2016). Use of Platelet-Rich Fibrin Membrane in the Treatment of Gingival Recession: A Systematic Review and Meta-Analysis. Journal of periodontology, 87(3), 281–290. https://doi.org/10.1902/jop.2015.150420
50. Papapanou, P. N., Sanz, M., Buduneli, N., Dietrich, T., Feres, M., Fine, D. H., Flemmig, T. F.,
51. Garcia, R., Giannobile, W. V., Graziani, F., Greenwell, H., Herrera, D., Kao, R. T., Kebschull, M., Kinane, D. F., Kirkwood, K. L., Kocher, T., Kornman, K. S., Kumar, P. S., Loos, B. G., … Tonetti, M.
52. S. (2018). Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on
53. the Classification of Periodontal and Peri-Implant Diseases and Conditions. Journal of clinical periodontology, 45 Suppl 20, S162–S170. https://doi.org/10.1111/jcpe.12946
54. Polyzos, N. P., Polyzos, I. P., Mauri, D., Tzioras, S., Tsappi, M., Cortinovis, I., & Casazza, G. (2009). Effect of periodontal disease treatment during pregnancy on preterm birth incidence: a metaanalysis of

randomized trials. American journal of obstetrics and gynecology, 200(3), 225–232. https://doi.org/10.1016/j.ajog.2008.09.020
55. Ryder, M. I., & Armitage, G. C. (2016). Minimally invasive periodontal therapy for general practitioners. Periodontology 2000, 71(1), 7–9. https://doi.org/10.1111/prd.12132
56. Sanz, M., Marco Del Castillo, A., Jepsen, S., Gonzalez-Juanatey, J. R., D'Aiuto, F., Bouchard, P., Chapple, I., Dietrich, T., Gotsman, I., Graziani, F., Herrera, D., Loos, B., Madianos, P., Michel, J. B., Perel, P., Pieske, B., Shapira, L., Shechter, M., Tonetti, M., Vlachopoulos, C., … Wimmer, G. (2020). Periodontitis and cardiovascular diseases: Consensus report. Journal of clinical
57. periodontology, 47(3), 268–288. https://doi.org/10.1111/jcpe.13189
58. Sculean, A., Nikolidakis, D., & Schwarz, F. (2008). Regeneration of periodontal tissues: combinations of barrier membranes and grafting materials - biological foundation and preclinical evidence: a systematic review. Journal of clinical periodontology, 35(8 Suppl), 106–116. https://doi.org/10.1111/j.1600-051X.2008.01263.x
59. Smiley, C. J., Tracy, S. L., Abt, E., Michalowicz, B. S., John, M. T., Gunsolley, J., Cobb, C. M., Rossmann, J., Harrel, S. K., Forrest, J. L., Hujoel, P. P., Noraian, K. W., Greenwell, H., Frantsve- Hawley, J., Estrich, C., & Hanson, N. (2015). Systematic review and meta-analysis on the nonsurgical treatment of chronic periodontitis by means of scaling and root planing with or without adjuncts. Journal of the American Dental Association (1939), 146(7), 508–24.e5. https://doi.org/10.1016/j.adaj.2015.01.028
60. Stefanini, M., Felice, P., Mazzotti, C., Mounssif, I., Marzadori, M., & Zucchelli, G. (2018).
61. Esthetic evaluation and patient-centered outcomes in single-tooth implant rehabilitation in the esthetic area. Periodontology 2000, 77(1), 150–164. https://doi.org/10.1111/prd.12215
62. Tavelli, L., Barootchi, S., Nguyen, T. V. N., Tattan, M., Ravidà, A., & Wang, H. L. (2018). Efficacy of tunnel technique in the treatment of localized and multiple gingival recessions: A
63. systematic review and meta-analysis. Journal of periodontology, 89(9), 1075–1090. https://doi.org/10.1002/JPER.18-0066
64. Thoma, D. S., Naenni, N., Figuero, E., Hämmerle, C. H. F., Schwarz, F., Jung, R. E., & Sanz- Sánchez, I. (2018). Effects of soft tissue augmentation procedures on peri-implant health or
65. disease: A systematic review and meta-analysis. Clinical oral implants research, 29 Suppl 15, 32–49. https://doi.org/10.1111/clr.13114
66. Trombelli, L., Farina, R., Minenna, L., Toselli, L., & Simonelli, A. (2018). Regenerative
67. Periodontal Treatment with the Single Flap Approach in Smokers and Nonsmokers. The International journal of periodontics & restorative dentistry, 38(4), e59–e67. https://doi.org/10.11607/prd.3615
68. Zucchelli, G., Mele, M., Stefanini, M., Mazzotti, C., Marzadori, M., Montebugnoli, L., & de Sanctis, M. (2010). Patient morbidity and root coverage outcome after subepithelial
69. connective tissue and de-epithelialized grafts: a comparative randomized-controlled clinical trial. Journal of clinical periodontology, 37(8), 728–738. https://doi.org/10.1111/j.1600- 051X.2010.01550.x
70. Zucchelli, G., Tavelli, L., Ravidà, A., Stefanini, M., Suárez-López Del Amo, F., & Wang, H. L. (2018). Influence of tooth location on coronally advanced flap procedures for root
71. coverage. Journal of periodontology, 89(12), 1428–1441. https://doi.org/10.1002/JPER.18- 0201