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A Comprehensive Examination of Surgical Approaches in Periodontal Treatment: An Updated Review

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Abstract:

Background: Periodontitis is a chronic inflammatory condition resulting from dysbiotic microflora in genetically predisposed individuals, affecting approximately 11% of the global adult population. This disease leads to progressive destruction of periodontal tissues, potentially resulting in tooth loss and impaired quality of life. Effective management requires early intervention, primarily through non-surgical therapies such as scaling and root planing. However, surgical approaches are essential for more advanced cases, particularly when non-surgical treatments prove insufficient.

Aim: This review aims to provide a comprehensive examination of various surgical approaches in the treatment of periodontal disease, including techniques for pocket reduction, bone regeneration, and mucogingival defect correction, while highlighting indications, contraindications, and advancements in periodontal surgery.

Methods: This updated review synthesizes the latest literature on periodontal surgery techniques, focusing on indications, procedural details, and outcomes. The review discusses surgical interventions for both pocket reduction and restorative purposes, including gingivectomy, gingival flap procedures, osseous surgery, bone grafting, and mucogingival surgeries. Additionally, the review explores factors that influence the selection of these procedures, such as the severity and location of bone defects, as well as patient health factors.

Results: The review highlights the effectiveness of periodontal surgical interventions in managing advanced periodontitis, emphasizing how they contribute to better long-term outcomes compared to non-surgical treatments. Surgical techniques like osseous surgery and regenerative therapy with bone grafts have shown significant improvements in both clinical attachment levels and overall periodontal health. The review also indicates that surgical intervention should be carefully considered in cases with residual deep pockets or significant bone loss, where non-surgical methods are less effective.

Conclusion: Surgical intervention in periodontal treatment plays a crucial role in managing severe periodontitis and correcting mucogingival defects. When indicated, these procedures significantly enhance periodontal regeneration and functional restoration, leading to improved patient outcomes. Proper patient selection and careful planning are essential to maximizing the benefits of periodontal surgery.

Keywords: Periodontitis, periodontal surgery, gingivectomy, osseous surgery, bone grafting, periodontal regeneration, mucogingival defects.

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Introduction:

Periodontitis is a prevalent chronic inflammatory disorder that arises from dysbiotic microflora in individuals who are genetically predisposed.[1] Severe forms of periodontitis affect approximately 11% of the adult population globally.[2] This condition leads to the progressive degradation of the periodontal supporting tissues around the teeth, often resulting in tooth loss and a decline in the quality of life.[3] Early identification and timely intervention in periodontitis can yield significant economic benefits by averting disease progression, tooth loss, and the need for more invasive treatments.[4] The initial management of periodontitis primarily involves non-surgical interventions. Scaling and root planing are fundamental to this approach, as they markedly decrease the subgingival microbial load by eliminating dental biofilm, calculus, and bacterial endotoxins.[5] Additionally, patient education on oral hygiene is essential in non-surgical treatment, aiming to control biofilm through consistent mechanical removal by the patient.[6] During this phase, addressing periodontal local and systemic risk factors such as overhanging restorations, occlusal interferences, and tobacco use is crucial.[7][8]

Moreover, non-periodontal interventions may be necessary during the initial treatment phase. For example, root canal therapy is indicated to improve the prognosis of teeth with questionable vitality or in preparation for root resection procedures. The extraction of severely infected or non-strategic teeth, such as third or second molars, can significantly enhance the prognosis of the remaining teeth and should be considered early in the treatment plan. The effectiveness of non-surgical periodontal therapy is typically assessed 6 to 8 weeks after scaling and root planing.[5] This follow-up evaluation is designed to identify any persistent signs of periodontitis, such as ongoing gingival inflammation, deep probing depths, continuing attachment loss, gingival recession, or increased tooth mobility. According to the concept of critical probing depth, sites with probing depths of 5 mm or less should generally be treated non-operatively. In contrast, areas with probing depths of 6 mm or more are likely to benefit from periodontal surgery.[9]

Periodontal bone lesions occur as a result of the apical spread of periodontal disease, and understanding the morphology of these bone defects is critical when planning surgical interventions. Bone loss is commonly classified as horizontal or vertical, depending on the pattern of tissue destruction. Additionally, bone defects are described as either shallow or deep, and they may involve up to three walls, depending on the remaining bone structure. The number of walls remaining in the defect influences the potential for periodontal regeneration, while the depth of the defect helps determine whether a resective, regenerative, or tooth extraction approach is most appropriate. Whether the defect is horizontal or vertical also influences whether the alveolar bone requires surgical treatment.

Horizontal bone defects are characterized by a generalized apical migration of the alveolar bone crest. Radiographically, a distance exceeding 1.9 mm from the cementoenamel junction (CEJ) typically signals substantial bone and attachment loss.[10] Vertical bone defects, also known as intrabony defects, are identified by localized fading of the normally well-defined crestal bone, wedge-shaped radiolucent areas adjacent to the root surfaces, or multiple levels of bone loss. Vertical defects are typically associated with deep probing depths and are indicative of more severe bone destruction. Shallow vertical bone defects, which extend to approximately 3 mm in depth, are easily identifiable on radiographs.[11] A defect is classified as deep if it exceeds 3 mm in depth. Three-wall defects, typically found in posterior regions with broad interproximal bone, consist of the buccal, lingual, and interproximal walls. These defects may also occur in buccal or lingual furcations in areas with bone shelves or exostoses. As the mesiodistal volume of interproximal bone decreases, these three-wall defects may merge into two-wall defects, which are known as interproximal craters, where only the buccal and lingual walls remain. One-wall defects, often observed in areas with narrow interproximal bone, such as closely spaced maxillary molars or anterior teeth like mandibular incisors, are also common. In some instances, localized periodontal bone loss may lead to the

obliteration of interproximal bone, especially in cases where there is proximity between roots, resulting in a localized defect with no remaining walls.

Pseudopockets, which are periodontal pockets with a base coronal to the underlying crestal bone, typically associated with thick fibrous gingiva or altered passive tooth eruption, should be differentiated from true periodontal pockets. A suprabony pocket, characterized by attachment loss and a base coronal to the crestal bone, contrasts with an infrabony pocket, which extends beyond the coronal aspect of the adjacent crestal bone. Infrabony pockets, typically linked to deep probing depths, are associated with vertical bone defects, while suprabony pockets correlate with horizontal bone loss and shallow probing depths.

Periodontal tissues are supplied by a microvascular network that delivers blood flow from various directions. Arterial blood flows from distal to mesial, apical to coronal, and from both the lingual and facial directions toward the interdental papilla. The interproximal tissue receives its supply from blood vessels emerging from the alveolar crest, from the periosteum over the buccal and lingual alveolar cortex, and from capillaries in the periodontal ligament. Buccal and lingual tissues are nourished by vessels running coronally on the soft tissue side of the alveolar periosteum, along with additional superficial blood vessels beneath the mucosa.[12][13] Areas such as the canine-premolar region have a higher density of large superficial blood vessels, while thin buccal tissues may have a more limited blood supply. Incisions should be designed to minimize disruption of these blood vessels, with envelope incisions preferred for simple pocket reduction to reduce intraoperative bleeding. Vertical-releasing incisions, which often intersect with superficial mucosal vessels, may increase bleeding, but if made parallel to mucosal blood vessels, bleeding and scarring can be minimized. Vertical releases over facial mucosa should be avoided due to the reduced blood supply in these areas. When a rectangular flap with two vertical incisions is required, releases should be placed parallel to the mucosal blood vessels to maintain a broad base for the flap.

In designing periodontal flaps, the location of critical anatomical structures must be considered to avoid damage during surgery. For example, in the posterior mandibular region, care must be taken to protect the mental foramen and its associated neurovascular bundle during flap elevation and tissue retraction.[14][15] Similarly, the lingual nerve vascular bundle, which runs near the pterygomandibular raphe to the third molar roots, is particularly vulnerable to injury during inferior alveolar nerve blocks or when reflecting a lingual flap in the third molar region.[16] Vertical releases on the lingual side of the posterior mandible should be avoided. In the maxilla, the greater palatine neurovascular bundle and the incisive papilla must be safeguarded. The greater palatine bundle, which extends from posterior to anterior along the palatal vault, is close to the alveolar ridge and is at risk for injury during surgery.[17] Damage to the greater palatine bundle can lead to prolonged bleeding and healing complications. The incisive papilla, located between the maxillary incisors, contains soft tissue and a vestigial nerve that may need to be cut and elevated during surgery for grafting procedures.

Indications for Periodontal Surgery

Periodontal Surgery for Pocket Reduction

Periodontal surgery is recommended for the management of residual deep pockets following non-surgical therapy, particularly when the prognosis of the teeth is deemed "likely" rather than "hopeless" [18][19]. The indication for specific periodontal surgical procedures is contingent on the type of pocket, as outlined below.

- **Gingivectomy**: This procedure is indicated when there is residual pocketing due to excessively thick, fibrous gingival tissue, without the presence of an underlying bone defect. It is particularly effective when the gingiva is the primary contributing factor to pocketing.
- **Wedge Procedure**: The wedge procedure is employed in cases where residual pocketing occurs at the distal or mesial surfaces of teeth, particularly where excessively thick gingival tissue is present. This is commonly seen at the most distal tooth in the arch, adjacent to thick gingival tissue found in regions such as the maxillary tuberosity or the retromolar pad.

- **Gingival Flap Procedure**: This procedure can be used as a monotherapy for suprabony pockets, which are characterized by residual pocketing without an underlying bone defect. The flap allows access to root surfaces for the removal of calculus and dental biofilm. Additionally, it is utilized as a monotherapy for infrabony pockets associated with shallow bone defects, especially in the anterior maxilla. Furthermore, the gingival flap procedure plays a crucial role in regenerative therapy by providing surgical access to bone defects, facilitating the regeneration of lost periodontal structures.
- **Osseous Surgery**: Osseous surgery is indicated as a monotherapy for infrabony pockets that are associated with shallow bone defects or irregular bone contours. More commonly, it is part of a regenerative therapy protocol, wherein it provides necessary access to bone defects and aids in improving bone defect morphology, thereby enhancing the overall periodontal outcome.
- **Bone Grafting, Guided Tissue Regeneration, Biologics, or Their Combinations**: These advanced procedures are indicated for infrabony pockets with deep bone defects that are conducive to regenerative efforts. The application of bone grafting, guided tissue regeneration, biologics, or a combination of these therapies serves to promote the regeneration of bone and soft tissues, thereby addressing the deeper bone defects that characterize such pockets.

Periodontal Surgery for Restorative or Esthetic Purposes

Clinical Crown Lengthening:

The primary indication for clinical crown lengthening is the presence of subgingival caries, coronal fractures, or restorative margins that cannot be restored through conventional procedures. In these cases, crown lengthening offers a viable solution by enabling the proper isolation and restoration of the tooth, provided the tooth remains restorable. The indications for crown lengthening include several essential requirements for both the teeth undergoing the procedure and adjacent teeth. Bone removal should expose sufficient healthy tooth structure to facilitate restoration, with at least 4 mm of axial wall preparation required. The procedure must also allow for adequate occlusal reduction to ensure minimal restorative material thickness. In the case of root-canal-treated teeth, bone removal should facilitate the preparation of a 1 mm ferrule. Moreover, it should create enough space for soft tissue attachment, resulting in a minimal sulcus (approximately 3 mm). Bone removal must also maintain a favorable crown-to-root ratio and avoid tooth mobility. Additionally, care must be taken to ensure that bone removal does not expose nearby furcation entrances. The aesthetic concerns regarding longer tooth appearance and gingival recession should not be significant in these cases.

Crown Exposure:

This is typically performed in cases of altered passive eruption, commonly referred to as a "gummy smile," where the bone is either approximating or covering the cementoenamel junction, resulting in an excess of gingival display. If no restoration is needed, crown exposure may be used to adjust the appearance of the gingiva. Additionally, gingivectomy may be indicated for cases of altered passive eruption, where excess gingiva is covering the tooth, yet crestal bone remains 2 mm apical to the cementoenamel junction. This procedure can also address gingival enlargement caused by genetic factors or medication, as well as the removal of pigmented gingiva (though pigmentation often recurs long-term).

Periodontal Surgery for Mucogingival Defects

Free/Autogenous Gingival Grafts:

Free or autogenous gingival grafts are used for the correction of mucogingival defects, as well as to gain keratinized gingiva in areas where it may be insufficient. This procedure is also employed to deepen the vestibule, thereby enhancing the overall esthetic and functional outcomes of the periodontal tissues.

Lateral Sliding / Pedicle Flap:

The lateral sliding or pedicle flap procedure is indicated for the correction of single, localized gingival recession or mucogingival defects. This approach is especially useful when there is a normal

amount of keratinized gingiva adjacent to the defect, allowing for the transfer of healthy gingival tissue to cover the affected area.

Connective Tissue Grafts and Acellular Dermal Matrix Grafts:

These grafting techniques are employed for the correction of gingival recession defects. They help to increase the thickness of gingival or mucosal tissue, providing enhanced tissue support and improved esthetic outcomes for patients with significant gingival recession.

Contraindications for Periodontal Surgery

Absolute Contraindications:

Absolute contraindications for periodontal surgery include cases where tooth removal and complete denture therapy are more suitable than surgical intervention. This is typically observed in cases of hopeless dentition, which is often characterized by over two-thirds bone loss at most teeth, including crucial teeth such as canines and first molars, along with generalized significant tooth mobility, making periodontal surgery unfeasible.

Relative Contraindications:

Relative contraindications pertain to patient factors that could impair treatment outcomes or increase the likelihood of complications. Smoking is a notable factor, as it is associated with less favorable outcomes following periodontal surgery. Specifically, smoking is linked to a less successful reduction of probing depths and attachment gain, and often leads to more significant gingival recession [20]. Additionally, diabetes mellitus is a risk factor for postoperative complications, including heightened swelling, flap dehiscence, and delayed wound healing [21]. Immunosuppressive medications or conditions may elevate the risk of postoperative infections. Furthermore, medications that interfere with angiogenesis and bone resorption can pose a risk for jaw osteonecrosis, though the specific postoperative risk remains unclear. The risk is typically small in patients taking oral bisphosphonates, but more significant in those who have received intravenous bisphosphonates as part of cancer treatment. However, individuals with medical conditions such as diabetes, cardiovascular disease, coagulopathies, or immunosuppressive states like HIV can still undergo periodontal surgery, provided their glucose levels, cardiovascular function, and relevant laboratory parameters are within safe limits.

Age does not represent an absolute contraindication to periodontal surgery, though it may negatively affect the procedure's success. With advancing age, fibroblasts in the tissues exhibit increasing senescence, which results in slower wound healing. This slower healing process can lead to a higher risk of tissue tears during surgery and greater bruising due to the increased fragility of blood vessels. For periodontal pocket reduction surgery, several local factors may hinder regeneration, attachment gain, and pocket reduction. These include root proximity, tipping or rotation of teeth, tooth mobility, thin mucosal tissue, and the orientation of furcation entrances. Additionally, other factors such as enamel pearls, cervical enamel projections, denticles, ridges, root grooves, and impacted teeth may diminish the chances of successful outcomes. Crown lengthening may be contraindicated if the restorative margins extend into furcations or require excessive bone removal. Similarly, crown exposure is not recommended for excessive gingival display caused by hyperactive lip muscles, skeletal maxillary excess, or a short upper lip. Free gingival grafting and autogenous connective tissue grafting procedures may be challenging in cases where the palatal vault is shallow, contains a palatal torus, or has thin palatal tissue. Moreover, pedicle flaps are difficult to perform in cases involving broad gingival defects and are less likely to succeed if adjacent gingival tissues are limited.

Preparation for Periodontal Surgery

A preprocedural antiseptic rinse may be effective in reducing viral and bacterial load in the aerosol produced by ultrasonic and rotary instrumentation, thus decreasing the risk of airborne transmission of

pathogens [22]. For patients experiencing dental anxiety, anxiolytic measures can be implemented, ranging from nitrous oxide inhalation to preprocedural oral anxiolytics (e.g., 0.125 mg triazolam administered one hour before the procedure). For more significant anxiety, options such as oral sedation, intravenous sedation, or general anesthesia may be utilized. Typically, periodontal surgery can be performed with standard local anesthesia techniques, using common dental anesthetics such as 2% lidocaine with 1:100,000 epinephrine. The administration of 2% lidocaine with 1:50,000 epinephrine just before making incisions is particularly useful in controlling bleeding during flap incision and elevation. To enhance pain control following surgery and minimize reliance on analgesics, long-acting anesthetics like bupivacaine can be applied immediately after the procedure. Periodontal surgery personnel often prescribe preemptive non-steroidal anti-inflammatory drugs (NSAIDs) for pain management and antibiotic prophylaxis in patients at risk of infection. Similarly, if bone graft materials or biologics containing growth factors are used during surgery, dexamethasone may be prescribed to reduce postoperative swelling and pain associated with it. This multi-faceted approach ensures optimal surgical outcomes and promotes a smooth recovery process.

Techniques or Treatments Focused on Gingival Tissue Removal

Gingivectomy

Gingivectomy is a procedure frequently performed when residual periodontal pockets are associated with abnormally thick gingiva without any underlying bone defects. This condition is often observed in cases of pseudopockets, which may arise from altered tooth eruption, genetic factors, or medications such as those causing drug-induced gingival overgrowth. However, the applicability of gingivectomy is generally limited in most cases of pocket reduction, as it does not address bony defects, and the pocketing resulting from enlarged gingival tissue typically recurs. Additionally, although gingivectomy can be used to remove pigmented gingiva, the pigmentation may reappear over time [23][24].

Wedge Procedure

Another excisional technique employed in specific cases is the proximal or distal wedge procedure. This approach is typically used when pocketing is confined to the distal or mesial tooth surfaces, particularly in areas with thick gingival tissue, such as the maxillary tuberosity, retromolar pad, or edentulous spaces. The wedge procedure is applicable only when there are no underlying bone defects. In this technique, the thickest part of the gingival tissue is excised using a square or wedge-shaped incision with converging cuts. A pyramid-shaped section of the gingiva is removed, and the remaining edges are sutured together to complete the procedure.

Gingival Flap Procedures

Gingival flap procedures are generally employed when residual pocketing remains without an associated bone defect, except in cases involving generalized bone loss, such as in suprabony pockets. These procedures are also referred to as "open flap debridement" or "surgical scaling and root planning." Widman was one of the pioneering surgeons to describe the gingival flap technique for pocket reduction [27]. Depending on treatment objectives, personal preferences, and local anatomical considerations, clinicians may choose from a variety of incision designs, instruments, and suturing techniques. Variations in gingival flap procedures primarily differ in the number and locations of incisions, as well as the extent of flap reflection. A prominent variant is the modified Widman flap, which utilizes sulcular, submarginal, and connecting incisions to achieve minimal tissue reflection and removal. This approach leads to minimal gingival recession, and the resulting improvement in attachment and probing depth is most likely due to the formation of a junctional epithelium [28].

The modified Widman flap is commonly used as a control treatment in clinical trials evaluating different periodontal surgery techniques. This technique is distinct from a conventional gingival flap in that the incisions are kept close to the root surface, and the tissue is only reflected sufficiently to gain access to the root. Conceptually, the apically positioned flap can be considered the opposite of the modified Widman flap. In this approach, extensive flap reflection occurs, and the flap margins are sutured apically to the

alveolar crest, securing the tissue to the vestibular periosteum. The apically positioned flap is often combined with osseous surgery to achieve minimal interdental thickness and maximal reduction of probing depth. However, this technique is typically associated with significant generalized gingival recession, contrasting with the minimal recession observed in the modified Widman flap.

Conclusion:

Periodontal disease, especially in its severe form, represents a significant clinical challenge due to its destructive nature on both hard and soft tissues around the teeth. Early detection and non-surgical treatments such as scaling and root planning are effective for less advanced stages, but surgical intervention becomes necessary as the disease progresses. This review has explored the various surgical approaches available for managing periodontitis, each with distinct indications and advantages. The gingivectomy procedure, effective for managing thick, fibrous gingiva, offers a solution to shallow pockets without underlying bone defects. On the other hand, procedures like gingival flap surgery and osseous surgery provide access to deeper periodontal pockets, where more severe bone loss is present. These techniques aim to eliminate plaque, tartar, and bacterial toxins, while also reshaping the bone and soft tissue to promote better oral hygiene and attachment. Advanced regenerative procedures, such as bone grafting and guided tissue regeneration, play a critical role in the treatment of deep vertical bone defects. By facilitating the regeneration of lost periodontal tissues, these treatments not only address the underlying bone defects but also help in the preservation of natural teeth. Additionally, mucogingival surgeries, including connective tissue and autogenous gingival grafts, provide solutions to aesthetic and functional concerns, particularly in cases of gingival recession or inadequate keratinized tissue. The selection of an appropriate surgical approach is influenced by several factors, including the severity of the disease, the location of the defect, and the patient's general health. While periodontal surgery has proven to be effective in achieving long-term success, it is essential that it be approached cautiously in patients with certain contraindications, such as uncontrolled systemic diseases or poor oral hygiene. Furthermore, the use of minimally invasive techniques and careful flap design can reduce complications such as bleeding and promote faster healing. Ultimately, periodontal surgery, when indicated and performed appropriately, contributes to significant improvements in periodontal health, reduces the risk of tooth loss, and enhances the overall quality of life for patients. The evolving field of periodontal surgery continues to incorporate advanced techniques, which hold promise for even better outcomes in the future.

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فحص شامل للأساليب الجراحية في علاج أمراض اللثة: مراجعة محدثة

الملخص:

الخلفية: التهاب اللثة هو حالة التهابية مزمنة ناتجة عن ميكروبات غير متوازنة لدى الأفراد المعرضين وراثياً، وتؤثر على حوالي 11% من السكان البالغين في العالم. يؤدي هذا المرض إلى تدمير تدريجي للأنسجة اللثوية، مما قد يؤدي إلى فقدان الأسنان وتأثيرات سلبية على جودة الحياة. يتطلب العلاج الفعّال التدخل المبكر، بشكل رئيسي من خلال العلاجات غير الجراحية مثل تنظيف الأسنان وتخطيط الجذور. ومع ذلك، فإن الأساليب الجراحية أساسية للحالات الأكثر تقدماً، خاصة عندما تكون العلاجات غير الجراحية غير كافية.

الهدف: تهدف هذه المراجعة إلى تقديم فحص شامل للأساليب الجراحية المختلفة في علاج أمراض اللثة، بما في ذلك تقنيات تقليص الجيوب، وتجديد العظام، وتصحيح العيوب المخاطية اللثوية، مع تسليط الضوء على المؤشرات، والموانع، والتطورات في جراحة اللثة.

الطرق: تقوم هذه المراجعة المحدثة بتلخيص أحدث الأدبيات حول تقنيات جراحة اللثة، مع التركيز على المؤشرات، وتفاصيل الإجراءات، والنتائج. تناقش المراجعة التدخلات الجراحية لتقليص الجيوب ولأغراض ترميمية، بما في ذلك إزالة اللثة، وإجراءات الرفع اللثوي، والجراحة العظمية، وزرع العظام، والجراحة المخاطية اللثوية. بالإضافة إلى ذلك، تستعرض المراجعة العوامل التي تؤثر على اختيار هذه الإجراءات، مثل شدة وموقع العيوب العظمية، وكذلك العوامل الصحية للمريض.

النتائج: تبرز المراجعة فعالية التدخلات الجراحية في علاج التهاب اللثة المتقدم، مشيرة إلى كيف تساهم هذه التدخلات في تحقيق نتائج أفضل على المدى الطويل مقارنة بالعلاجات غير الجراحية. أظهرت تقنيات الجراحة العظمية والعلاج التجديدي باستخدام زرع العظام تحسناً كبيراً في مستويات التعلق السريرية والصحة اللثوية بشكل عام. كما تشير المراجعة إلى أن التدخل الجراحي يجب أن يتم النظر فيه بعناية في الحالات التي تحتوي على جيوب عميقة متبقية أو فقدان عظم كبير، حيث تكون الطرق غير الجراحية أقل فعالية.

الخلاصة: تلعب التدخلات الجراحية دوراً مهماً في علاج التهاب اللثة الشديد وتصحيح العيوب المخاطية اللثوية. عند الضرورة، تعزز هذه الإجراءات بشكل كبير تجديد اللثة واستعادة الوظائف، مما يؤدي إلى تحسين نتائج المرضى. إن اختيار المرضى المناسبين والتخطيط الدقيق هما الأساس لتحقيق أقصى استفادة من جراحة اللثة.

الكلمات المفتاحية: التهاب اللثة، جراحة اللثة، إزالة اللثة، الجراحة العظمية، زرع العظام، تجديد اللثة، العيوب المخاطية اللثوية.