

From Good to Great: How Periodontal Plastic Surgery Enhances Orthodontic Outcomes

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Abstract: The quest for an appealing smile holds significant importance in today's competitive society, impacting individuals' acceptance and self-esteem. Various factors, including tooth shape, position, and gum tissue levels, contribute to smile aesthetics. As the universal expression of human emotion, a smile transcends cultural, linguistic, and socioeconomic barriers, conveying positive emotions like love, joy, and acceptance. Orthodontic treatment, aimed at enhancing dental alignment, must respect biological boundaries to ensure optimal outcomes without compromising periodontal health. This article reviews periodontal interventions necessary before, during, or after orthodontic treatment, covering both hard and soft tissue considerations. It emphasizes the symbiotic relationship between orthodontics and periodontics, highlighting how their collaboration enhances patient care.

Keywords: Interrelationship, Interdisciplinary, Plaque accumulation, Orthodontic treatment, Periodontal treatment, Clinical assessment

I. Introduction

The term "Esthetics" has been of paramount importance since ancient times, originating from the German and French words "asthetisch" and "esthetique," denoting "the science of sensory perception." Greek art, including sculpture, music, architecture, and the human form, evolved by studying beauty and divine proportions associated with esthetics and harmony.¹ Levin introduced the principles of golden proportions in teeth and anterior esthetics in 1978.² In modern society, a pleasant smile is revered as a symbol of beauty, supremacy, and well-being. Authors like Garber and Salama stress the importance of harmony among teeth, lip framework, and gingival scaffold for an ideal smile.³ An interdisciplinary approach, as highlighted by Creagh et al., is crucial for achieving esthetic smiles and functional harmony by managing soft and hard tissues.⁴ Gingival esthetics considerations include biotype, crown dimensions, tooth position, papilla height, and gingival width. Aesthetic appearance significantly impacts acceptance and self-esteem in today's society, transcending language, culture, and socioeconomic differences. The shape and position of teeth, along with gum tissue levels, influences smile aesthetics, which serve as powerful nonverbal communication tools.⁵ Addressing a gummy smile involves exposing maxillary anterior teeth up to premolars and aligning the incisal curve with the mandibular lip's inner curvature, as per Da Silva.⁶ Gingival tissue appearance is crucial for medium or high smile lines, emphasizing color, texture, shape, and architectural harmony. Ideally, the gingival margin should parallel the incisal line, align with horizontal reference lines, and feature a suitable scalloped design with interdental papillae, adjusted as necessary with periodontal support changes. Treatment options, tailored to diagnosis and severity, may include orthognathic, orthopedic, periodontal plastic surgery or mucogingival surgery.

Surgical options for improving dental aesthetics include clinical crown lengthening, which reduces gum exposure and increases the height of anterior teeth. This often requires creating biological space for osteotomy reestablishment. Gingivectomy or gingivoplasty can adjust tooth contours and proportions. Additionally, periodontal and orthodontic procedures help restore crown proportion and harmony. Understanding the etiology and treatment options is essential for effectively addressing unaesthetic smiles. Contemporary dental practices emphasize dento-facial aesthetics, with growing demand for orthodontic treatment in both children and adults.⁷ Advances in dental materials and orthodontic techniques, including the use of ceramic brackets and lingual appliances, have made orthodontic care more appealing to adults.⁸ These patients often require a multidisciplinary approach, integrating orthodontics and periodontics, as their needs are interconnected. Successful orthodontic treatment relies on a healthy periodontium because the periodontal ligament facilitates tooth movement through bone remodeling. Thus, maintaining periodontal health is crucial throughout the entire orthodontic process; from diagnosis and mid-treatment assessment to post-treatment evaluation.⁹ Common orthodontic issues in patients with compromised periodontal health include maxillary anterior teeth proclination, loss of interdental spacing, rotated teeth, super-eruption, pathological tooth migration, tooth loss, and traumatic occlusion. Orthodontic treatment during periodontal therapy can facilitate oral hygiene, reduce bacterial load, correct abnormal gingival and bone patterns, improve aesthetics, and assist with prosthetic replacements. For optimal outcomes, periodontists and orthodontists must collaboratively assess periodontal conditions and select appropriate interventions. Thorough diagnosis in three dimensions (sagittal, vertical, and horizontal) is essential for treatment planning and evaluating soft and hard tissue boundaries. Advances in understanding biological limitations emphasize preventive periodontal interventions to avoid complications.

Utilizing phenotype modification techniques alongside orthodontic treatment is increasingly significant. Addressing crowded arches with dental expansion can risk bony dehiscence and fenestrations, making it crucial to respect tooth movement boundaries for long-term periodontal health. Patients with thin periodontal phenotypes may benefit from phenotype modification therapy, such as hard or soft tissue grafting, to improve periodontal morphology before tooth movement.⁹ The choice of grafting material is essential, especially when moving teeth into grafted bone. This review highlights periodontal procedures that enhance and optimize orthodontic outcomes, focusing on surgical restorative protocols involving periodontal surgery and orthodontic procedures to improve esthetics and function.¹⁰ It emphasizes advancements in materials and technology that minimize errors and discomfort while ensuring maximum safety. Key topics include current trends in periodontal approaches to esthetic dentistry, discussing their advantages, disadvantages, limitations, and recent advances in the field.¹¹

II. Discussion:

Periodontal plastic surgery encompasses procedures to improve gum and surrounding tissue appearance and health, addressing issues like gum recession, uneven gum lines, and exposed tooth roots.¹² Friedman introduced the term "mucogingival surgery" in 1957, referring to procedures aimed at preserving gingival tissue, correcting abnormal frenulum or muscle attachments, and enhancing vestibular depth.¹³ Periodontal plastic surgery encompasses procedures to correct or eliminate anatomic, developmental, or traumatic deformities of the gingiva or alveolar mucosa. The primary goal of periodontal therapy is to restore periodontal health and maintain functional dentition throughout a patient's lifetime. Periodontal surgery is provided in two forms: open periodontal surgery and regenerative surgery.

Examples of open surgery include gingivectomy, open flap surgery for pocket reduction, and resective osseous surgery, while regenerative surgery includes guided tissue regeneration, guided bone regeneration, root conditioning procedures, bone transplants, and periodontal plastic surgery. Various treatment modalities can improve the overall esthetic outcome for patients. These procedures include gingivectomy, lip repositioning with myotomy, botulinum toxin injections, and hyaluronic acid fillers.¹⁴ Lip repositioning creates a split-thickness flap to shorten the vestibule and reduce gingival display by preventing muscle retraction. Caution is needed with insufficient attached gingiva to avoid vertical maxillary excess.¹⁵ Botulinum toxin injections offer temporary relief for gummy smiles due to hyperactive muscles, needing maintenance every 4–6 months. These methods offer diverse options for enhancing esthetic outcomes tailored to individual needs.¹⁶ Hyaluronic acid fillers are favored for correcting gummy smiles due to their low immunogenicity and ease of administration.¹⁷ Laser-assisted lip-repositioning surgery shortens the vestibule and reduces gingival display by suturing maxillary buccal vestibular mucosa to the mucogingival junction, minimizing lip elevator muscle pull as an alternative to orthognathic surgery.¹⁸ Frena connect lips to periosteum and movable mucosa, with mandibular labial, lingual, and maxillary labial frena commonly present. Frenectomy is recommended in periodontal therapy to alleviate strain on the gingival border and facilitate proper oral hygiene, especially for

closing a diastema during orthodontic treatment. It involves surgically removing the frenulum and its bony attachments, while moving the frenulum to a more apical position is termed "frenotomy," ideally performed after canine eruption to avoid tooth separation. The labial frenal attachments categorized as mucosal, gingival, papillary, and papilla penetrating.¹⁹

Respecting the dentoalveolar housing is crucial in treatment planning to avoid long-term stability issues and periodontal health risks. Pushing teeth beyond their bony envelope can lead to bony dehiscences and fenestrations. There's a correlation between anterior alveolar bone thickness and facial type, with high-angle patients often exhibiting thinner bucco-lingual bone width. Orthodontic treatment, particularly with fixed appliances, complicates oral hygiene and increases plaque retention, posing risks for periodontal disease.²⁰ Despite gingival inflammation potentially protecting periodontal attachments, maintenance of oral hygiene remains challenging, especially around molar bands prone to food impaction. Gusmao identified factors such as tooth angulation, chronic periodontitis, and dental crowding associated with gingival recession.²¹ Subgingivally positioned orthodontic bands can exacerbate inflammation and attachment loss, leading to gingival hyperplasia and pseudo pockets, which typically resolve after removal. Proper placement of brackets and bands helps prevent hyperplasia, while clear aligner systems are advantageous for an intact periodontium by applying controlled forces to remodel tissues. Orthodontic treatment complements periodontal therapy by correcting tooth misalignment, halting disease progression, and enhancing oral function and aesthetics. Typically initiated after periodontal disease control, orthodontics can improve bone defects in infra-bony areas with good plaque management and inflammation control.²² Orthodontic extrusion adjusts tooth attachment, modifying crown height or the gingival margin without compromising bone integrity or causing irregularities. For clinical crown lengthening, supra-gingival fibrotomy during orthodontic extrusion is preferred over crestal bone osteotomy, particularly for treating vertical periodontal defects and enhancing bone density in implant preparation. Controlled, gradual tooth movement with minimal root torque is recommended to minimize complications.²³

Effective coordination between orthodontic and periodontal treatments is crucial for optimal aesthetic outcomes, addressing issues such as overeruption and papilla loss. An interdisciplinary team of orthodontists and periodontists ensures comprehensive care. Factors like tooth shape, root angle, and bone loss guide the management of open interdental spaces, assessing contact points, bone crest distance, papillary height, root divergence, and tooth form. Complete periodontal therapy before orthodontics is essential to reduce inflammation. Surgical periodontal treatments, such as open-flap debridement for persistent moderate pockets, may be necessary. Regenerative periodontal therapy for shallow bone defects before orthodontics can potentially prevent the need for surgery during treatment. Deep intra-bony defects may prevent orthodontic treatment due to unfavorable conditions. Ideally, periodontal therapy concludes 3-6 months before starting orthodontic treatment.²⁴ Proclination of teeth can resolve crowding but risks gingival recession, as optimal periodontal health requires sufficient keratinized gingiva. Incisor proclination in areas lacking adequate gingival and bone support may worsen recession, possibly requiring mucogingival surgery. Orthodontic movements within the "bone envelope" are generally safe, supported by research in mandibular prognathism cases undergoing orthognathic surgery.²⁵ Lingual tooth movements can increase labiolingual gingival widths, while labial movements may decrease them, particularly in vulnerable areas. Even gingival margins among the six maxillary anterior teeth are essential for esthetic appeal. To achieve a balanced smile, the gingival margins of the maxillary central incisors should be approximately 1 mm below their cement enamel junction (CEJ) and align with the cuspid margins. Adjacent teeth may have slightly lower margins. Uneven margins may not require adjustment if not visible. Deeper sulci in shorter teeth may necessitate gingivectomy. A thicker incisal edge may indicate overeruption or abrasion.²⁶

Coordination between orthodontic and periodontal treatments is crucial for managing issues like overerupted teeth and missing interdental papilla effectively. Gentle orthodontic forces should be used to intrude overerupted teeth, timed before appliance removal to reduce relapse risk. Addressing concerns such as missing gingival papillae or open gingival embrasures is vital for achieving optimal esthetic outcomes. An interdisciplinary team of orthodontists and periodontists ensures comprehensive care and improved outcomes. Orthodontic intervention can be beneficial for managing open interdental spaces, typically caused by tooth shape, root angle, or bone loss. Key factors to assess include the distance between contact points and bone crest, papillary height, root divergence extent, and tooth form. Identifying whether the issue lies with tooth contacts or the papilla is crucial. If the problem is with the papilla, underlying periodontal issues may be responsible for the lack of bone support.²⁷ To address open embrasures, treatments like enameloplasty, tooth movement, and selective composite resin additions may be necessary. New papilla formation can occur through soft tissue compression after proximal recontouring and orthodontic tooth approximation. Evaluating open embrasures caused by tooth contact issues requires a periapical radiograph of the central incisors. If root angulations are

divergent, brackets can adjust root positions. For properly angled roots, open contacts might stem from abnormal tooth shapes, such as wide, triangular, or bell-shaped teeth, leading to black triangles due to point contact near the incisal edge. Diastema closure and interproximal enamel reduction can effectively restore the absent papilla.²⁸ The ideal maxillary gingival display for an appealing smile is 1-2 mm. Excessive gingival display, often seen in Angle class II division 2 malocclusions, can be managed with orthodontic intrusion of the maxillary incisors. Age-related gingival display reduction should be considered when diagnosing gummy smiles.

Before orthodontic treatment, assess potential causes such as a dynamic upper lip or maxillary issues. Treatment options vary and may include maxillary impaction or LeFort I osteotomy for adults, and first bicuspid extractions with high pull J-hook headgear for pediatric patients to prevent progression. Some patients exhibit delayed gingival margin migration, short clinical crowns, and increased labiolingual gingival tissue thickness, indicating a gummy smile.²⁹ Esthetic interventions for gingival repositioning are best delayed until early adulthood due to potential gingival level changes during adolescence. Botox can temporarily correct gummy smiles due to a low upper lip or philtrum.³⁰ Corticotomy-assisted orthodontics (CAO), pioneered by Henry Köle in 1959, accelerates orthodontic treatment by making precise incisions in cortical bone to aid tooth movement while preserving dental and periodontal health. Köle's method involves vertical lingual and buccal incisions with a subapical horizontal osteotomy, treating tooth and bone as a "bony block."³¹ Corticotomy-assisted orthodontics (CAO) enhances local tissue reactions, speeds bone turnover, and accelerates tooth movement. Benefits include shorter treatment durations, simpler arch expansion, reduced root resorption, better post-orthodontic stability, and a lower risk of relapse.³² Düker's 1975 study on beagle hounds, later refined by Köle, confirmed no damage to the pulp or periodontium following corticotomy and orthodontic tooth movement.³³ Modern techniques use wide flaps for full alveolar bone exposure and precise interproximal cuts, reducing the forces needed for tooth movement without causing root resorption or periodontal damage. Periodontally Accelerated Osteogenic Orthodontics (PAOO), or "Wilckodontics," introduced by Wilcko et al. in 2001, utilizes full-thickness labial and lingual flaps, bone grafts, and cortical bone surgery to accelerate orthodontic treatment, potentially leading to scarring.

A 2009 modification by Wilcko et al. further halved orthodontic treatment times or more. It has been shown to decrease treatment duration, increase bone thickness, and sometimes eliminate the need for orthognathic surgery.³⁴ The Regional Acceleratory Phenomenon (RAP), highlighted by Wilcko, attributes rapid tooth movement to surgical trauma that stimulates tissue, promoting bone remodeling via frequent remineralization and demineralization cycles.³⁵ Defined by Frost in 1983, RAP is a local tissue response to noxious stimuli, leading to tissue regeneration at rates 10–50 times faster than normal. In orthodontics, RAP, initiated by corticotomy, enhances bone tissue reshaping around tooth roots. This process begins shortly after incisions, peaks within the first two months, lasts up to four months, and gradually diminishes over 6 to 24 months. It continues as long as teeth are moving; upon completion of orthodontic movements, the effect subsides, and supporting alveolar bone remineralizes.³⁶ Typically, orthodontists activate archwires in fixed appliances one week before surgery. Rapid tooth movement aims for treatment completion within four to six months, returning to normal movement thereafter. Wilcko et al. reintroduced surgical orthodontic therapy by combining corticotomy with alveolar grafting, initially called Accelerated Osteogenic Orthodontics and later known as Periodontally Accelerated Osteogenic Orthodontics (PAOO).³⁷ It addresses crowding, rapidly retracts canines, facilitates impacted tooth eruption, expands the maxillary arch, and speeds up orthognathic surgery. Benefits include improved post-surgery stability, decreased resistance to tooth movement in areas of bone removal, enhanced bone quantity and periodontal tissue strength through grafting, and reduced root resorption while preserving anatomical variations. Piezopuncture, using ultrasonic surgical equipment to penetrate the bony cortex through the gingiva, was studied by Kim et al. in 2013.³⁸

Micro-osteoperforations (MOPs), as shown in a clinical study by Alikhani et al., increased tooth movement rates by 2.3 times. However, systematic reviews have questioned this, citing insufficient evidence to support MOPs alone for rapid tooth movement.³⁹ Piezocision-facilitated orthodontics, introduced by Sivarajan et al. in 2020, utilizes piezosurgery as a minimally invasive technique.⁴⁰ This method enables rapid tooth movements without the need for extended treatment or high-risk surgical procedures. Additionally, it preserves the tunnel technique and bone and soft tissue grafting. Piezosurgery offers further benefits, such as being safer, less traumatic, and less invasive. In some cases, piezocision can be combined with Invisalign to shorten treatment time while meeting patients' aesthetic preferences. The literature indicates that, unlike traditional orthodontics, the piezosurgery method does not cause increased root resorption or periodontal trauma.⁴¹ The use of Cone Beam Computed Tomography and 3D diagnosis has provided a method to diagnose and assess alveolar bone thickness prior to and during orthodontic treatment. The limitation of this imaging should also be kept in

mind, as alveolar thickness and voxel size of even 0.125 mm may not correlate with the presence or absence of a thin buccal alveolar bone covering, which may lead to an overestimation of any bony dehiscences and fenestrations.⁴²Köle in 1959 was the first one to describe this procedure, and he believed it permits rapid tooth movement because the continuity and thickness of cortical bone offers the most resistance to tooth movement.⁴³Generson in 1987 described a surgical approach involving vertical and subapical corticotomies to expedite orthodontic treatment for open bite malocclusion through alveolar decortication. He demonstrated stability after extrusive movement of anterior teeth in severe anterior open bite cases.⁴⁴Periodontal phenotype assessment can be done through direct visualization, probing, endodontic files, ultrasonic devices, or Cone Beam Computed Tomography.

A thin phenotype typically has a scalloped gingival contour, triangular teeth, and a narrow band of keratinized tissue, whereas a thick phenotype features flatter contour, square teeth, and a wider band of keratinized tissue.⁴⁵ Wilcko in 2015 noted an increase in keratinized tissue height after alveolar decortication and augmentation.⁴⁶Thick phenotypes are more resistant to inflammation, attachment loss, and tissue recession. Orthodontic treatments can improve function and aesthetics, with better occlusion alignment facilitating oral hygiene. Displacing teeth beyond the alveolar bone can risk dehiscence and recession, while redirecting roots into the alveolar process can enhance bone levels and reduce recession. The prognosis for complete root coverage in recession surgery depends on the recession's severity and tooth position. Positioning roots within the alveolar envelope before surgery can reduce prominence and aid attachment creeping for better outcomes. However, the clinical link between orthodontic correction of tooth position and spontaneous repair of gingival recession hasn't been systematically studied. Several authors suggest that the prognosis for complete root coverage in mucogingival surgery depends on recession severity and tooth position. Moving roots towards the alveolus center before surgery may improve recession and reduce dehiscence. However, the association between orthodontic correction and spontaneous gingival recession repair has not been systematically investigated.⁴⁷

III. Conclusion

Periodontal treatment now prioritizes aesthetics, necessitating skilled clinicians and interdisciplinary planning. Meeting patient expectations in aesthetics requires specialized training and clear treatment plans with tailored consent forms. "Team dentistry" achieves optimal outcomes through close collaboration in diagnosis, planning, treatment, and follow-up. Addressing challenges in orthodontics-periodontics integration, such as maintaining oral hygiene and managing tooth movement in infra-bony defects, is crucial before clinical trials.

Understanding these challenges is vital for raising patient awareness and advocating for integrated treatment options. Dental professionals should actively engage dental societies to highlight the importance of such comprehensive approaches.

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