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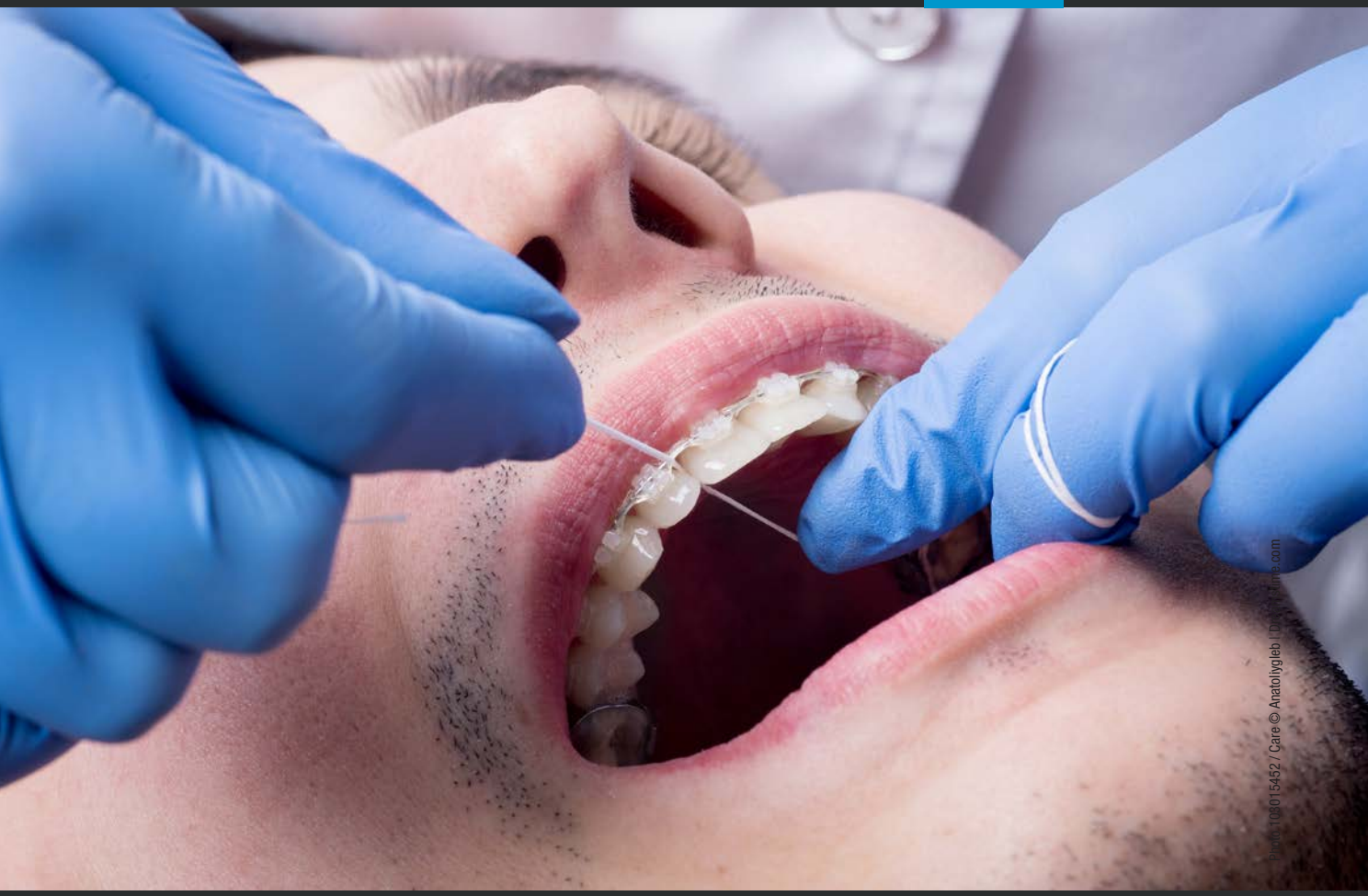

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Brace yourself! Decision-making for orthodontic treatment and periodontal care in patients with periodontal diseases and malocclusion

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Abstract

The American Association of Orthodontists (AAO) estimates that 27% of patients receiving orthodontic treatment in the US and Canada are adults, and therefore may be more likely to present with periodontal diseases and conditions. In fact, it is estimated that the prevalence of periodontitis is 42% in adults >30 years of age, and approximately 50% of adults have at least one site with >1 mm of gingival recession. It is therefore critical to understand the rationale and proper sequencing for periodontal and orthodontic care for common clinical presentations, including periodontitis, thin periodontal phenotype/gingival recession, and esthetically compromised hopeless teeth. After active disease and inflammation are well controlled, integration of periodontal and orthodontic treatment can be used to allow for optimal outcomes based upon the directionality of orthodontic forces, the bony and soft tissue morphology, and the need for esthetic improvements at the sites of hopeless teeth. In these complex cases, a staged, interdisciplinary approach can most adequately treat patients to achieve optimal esthetics, function, and oral health. This course will elucidate the decision-making process and sequencing for periodontal and orthodontic treatment in patients with both malocclusion and periodontal diseases/conditions.

Educational objectives

Upon completion of this course, the dental professional should be able to:

1. Critically assess the effects of periodontal inflammation on orthodontic tooth movement and the implications for orthodontic treatment in individuals with periodontitis.
2. Discuss the optimal sequencing for nonsurgical and surgical periodontal care in individuals undergoing orthodontic tooth movement.
3. Evaluate the impact of periodontal phenotype alteration and/or gingival recession treatment for individuals undergoing orthodontic tooth movement.
4. Understand the advantages and disadvantages of orthodontic tooth extrusion for implant site preparation at hopeless teeth with esthetic compromise.

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Introduction

Orthodontic therapy allows enhancement of facial and dental esthetics and can improve function and health of the teeth and supporting oral structures. With recent evidence indicating that 42.5% of American adults have chronic periodontitis[1] and an increasing demand for orthodontic treatment in esthetic-conscious adults,[2] it is important to identify and properly treat patients with periodontitis who are undergoing orthodontic therapy. Previous reports have indicated that in the presence of plaque and gingival inflammation, orthodontic tooth movement can result in further periodontal disease progression and attachment loss.[3,4]

Much evidence supports the need for treatment of active periodontal disease and the control of inflammation prior to initiation of orthodontic tooth movement[5,6] and the control of plaque levels during orthodontic therapy in periodontally susceptible patients.[7,8] Correction of malocclusion has been demonstrated to enhance patient-delivered oral hygiene, and advances in orthodontic therapy—including the use of self-ligating brackets and removable clear aligners—have been proposed to improve patients' ability to perform self-delivered oral hygiene, leading to reduced plaque and gingival inflammation.[9-11]

Given the impact of periodontal health on the success of orthodontic outcomes, it is of critical importance to select a predictable treatment sequence for the adult periodontal-orthodontic patient to allow for treatment and resolution of periodontal inflammation while minimizing treatment time and surgical intervention. A careful evaluation of the following factors is necessary: 1) patient's overall health status and periodontal susceptibility, 2) periodontal diagnosis, 3) malocclusion classification, 4) periodontal bone loss pattern, 5) periodontal phenotype, and 6) oral hygiene levels.

Diagnosis and epidemiology of common periodontal diseases and conditions

Periodontal diseases include inflammatory diseases of the supporting structures around the teeth—the gingiva, periodontal ligament, alveolar bone, and cementum.[12] Research shows all individuals are susceptible to gingivitis, a reversible form of gingival inflammation that may be the precursor to more serious, irreversible forms of periodontal diseases.[13] Gingivitis is caused by dysbiotic dental biofilm and, in general, gingivitis severity is related to the quality and quantity of biofilm accumulated at the gingival margin of teeth. Gingivitis severity may be modified by local (dental biofilm retentive factors and oral dryness) and systemic (smoking, metabolic factors, nutritional factors, pharmacologic agents, sex steroid hormone elevation, and hematologic conditions) factors.[13-15] *Removal of biofilm and local etiologic factors results in the reversal of gingivitis symptoms and reduces local and systemic levels of inflammatory markers in patients with gingivitis.*[13-16] The current periodontitis disease classification system includes grade modifiers, including glycemic control in diabetes mellitus and smoking status, that may modify periodontal disease progression.[17] Further, other systemic diseases including osteoporosis/osteopenia, rheumatoid arthritis, and obesity/metabolic syndrome, have been associated with more severe and/or rapidly progressing periodontal diseases and may be considered in the overall risk-assessment profile for patients with periodontal disease undergoing orthodontic tooth movement.[18]

Periodontitis is a chronic, multifactorial inflammatory disease of the hard and soft tissues supporting the teeth associated with a dysbiotic plaque biofilm, which then causes a host immunoinflammatory response that, over time, may result in progressive destruction of the periodontal ligament and alveolar bone if not adequately resolved.[12,18] Average progression of periodontal disease demonstrates a slow to moderate rate with approximately 0.1 mm of attachment loss and 0.2 teeth lost annually.[19] Groups with the fastest and slowest disease progression differed considerably with accelerated attachment loss associated with access to comprehensive dental care as well as local and/or systemic factors.[18]

In an updated classification system from the American Academy of Periodontitis (AAP) and European Federation of Periodontitis (EFP), individuals are classified with a stage and grade to characterize disease severity and risk of future disease progression.[17,18] Periodontitis stage is assigned as I–IV and is assessed by patients' current disease presentation, including attachment, bone and tooth loss, and the case complexity.[17,18] Periodontitis grade is defined as A–C and is based upon risk and evidence of the rapidity of disease progression over time.[17,18]

The prevalence of periodontitis has been estimated to be approximately 42.5% of US adults over 30 years of age.[1] Of those individuals, 7.8% had severe periodontitis, which was most prevalent among adults 65 years or older, Mexican Americans, non-Hispanic blacks, and smokers.[1] These statistics suggest that the prevalence of periodontitis among US adults is nearly fourfold greater than that of diabetes mellitus[20] and more than sixfold greater than that of coronary artery disease.[21] Periodontitis is extremely prevalent, and after initiation by bacteria and bacterial virulence factors, disease progression and tissue destruction occurs through host-mediated inflammatory pathways,[16] which may vary based upon genetic and other risk factors.[22-25] The result is a chronic immunoinflammatory disease that may pose a significant systemic burden for individuals.[26]

Diagnosis and epidemiology of malocclusion

Worldwide epidemiologic data indicate that malocclusion has the third highest prevalence among oral pathologies, second only to caries and periodontal disease.[27] The underlying causes of malocclusion are multifactorial and include hereditary, congenital, functional, and environmental influences as well as behavioral, nutritional, socioeconomic, and educational factors.[28] Malocclusions can be induced or worsened by deleterious habits, most commonly, nonnutritive sucking habits have been identified as etiologic factors in the primary and mixed dentitions.[29] The prevalence of malocclusions varies in different populations. Studies have reported that incidences of malocclusion vary from 39% to

93%, demonstrating that in most populations, the majority of children have irregular teeth and an occlusal relationship that differs from the ideal.[30]

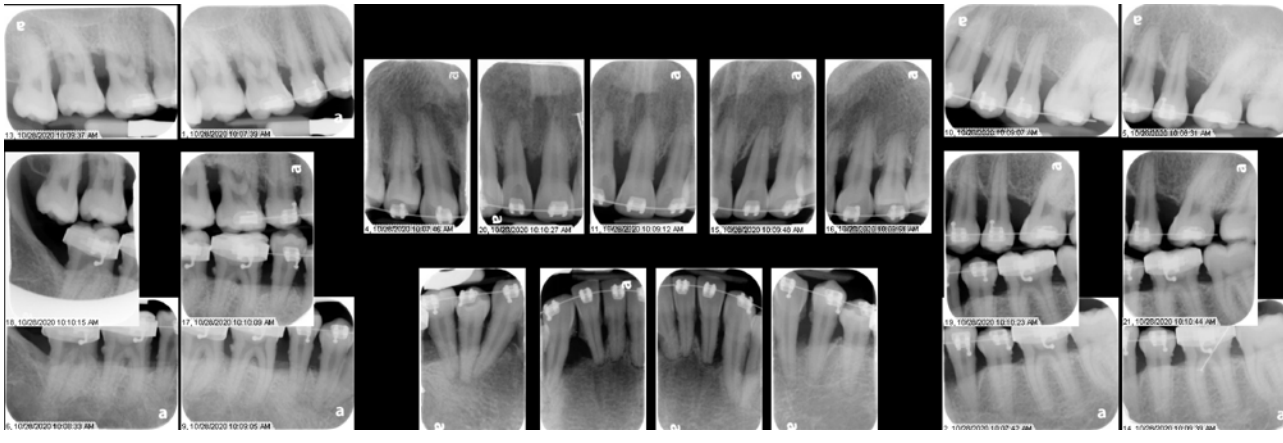
Periodontal risk assessment for individuals undergoing orthodontic therapy

In clinical practice, achieving optimal oral health and esthetic results after orthodontic therapy is dependent upon many patient and treatment factors.

Periodontal conditions: In patients with optimal periodontal health and good oral hygiene, including patients with a reduced, but healthy periodontium, proper orthodontic treatment has not been shown to have a significant long-term impact on periodontal attachment levels and bone levels.[3, 31-33] Conversely, in patients with clinical signs of active periodontal disease—i.e., deep probing depths, bleeding on probing (BOP), and/or the presence of subgingival plaque—orthodontic tooth movements can accelerate the disease process, even in the presence of good oral hygiene practices.[5,32,33] It has also been well established that certain systemic conditions and clinical findings are risk factors for disease progression, including psychosocial stress, tobacco use, systemic immune deficiencies, diabetes mellitus, osteoporosis, autoimmune disorders, and the presence of periodontal pathogens.[33-44]

Periodontal disease severity: Periodontal disease progresses very differently in individual patients. Even in the absence of dental care, patients demonstrate various patterns and rapidity of bone loss.[24] In addition, individual tooth sites may be more at risk for attachment loss based upon clinical findings and anatomical considerations,[22] and tooth mortality is associated with clinical attachment loss, tooth type, and overall periodontal health of the dentition.[45,46] Assessment of periodontal disease progression risk utilizing the grading component of the AAP/EFP periodontitis classification can allow stratification of risk for patients.[19] Patients at high risk—i.e., those in the grade C category—may require more aggressive preorthodontic interventions, enhanced oral hygiene measures, and more frequent periodontal maintenance during and after active periodontal and orthodontic therapy. If tooth movement is undertaken without addressing the periodontal inflammation, significant loss of

FIGURE 1: Preorthodontic panoramic radiograph with severe radiographic alveolar bone loss present



FIGURES 2 and 3: Postorthodontic tooth movement in a patient without periodontal treatment that led to additional attachment and alveolar bone loss

attachment and increased tooth mobility can occur **(figures 1-3)**.

Malocclusion: Depending upon the diagnosed malocclusion, differing orthodontic strategies can be utilized to achieve optimal results. Teeth that have periodontal bone loss have a more apical center of resistance than those with a healthy periodontium; this results in a smaller distance between the center of resistance and the alveolar bone crest. Therefore, teeth with periodontal bone loss are more prone to tipping than bodily movement, and the moment-to-force values at the bracket level should be increased in order to achieve translation.[47,48] Extraction of severely periodontally involved teeth and tooth movement to treat crowding can yield vast improvements in oral hygiene.[49] Crowding alone has been reported to increase the risk for gingivitis, independently from supragingival plaque levels.[49] In addition, while tooth rotation can be accomplished fairly easily, it can be difficult to maintain due to the slower turnover of the supra-alveolar periodontal and gingival fiber bundles as compared to the periodontal ligament (PDL) fibers.[50,51] Severing these fibers to allow for rearrangement has been accomplished with supracrestal fiberotomy procedures, which can reduce rotational relapse.[52] As definitive periodontal surgery would also sever these fibers, this may be an additional adjunctive benefit of surgical intervention performed after orthodontic tooth movement.

Periodontal bone loss pattern: Orthodontic movement of teeth into plaque-induced intrabony pockets has been performed successfully without disease progression if biofilm elimination and interventions to reduce inflammation have been accomplished.[32] In addition, extrusive tooth movement can be used to yield coronal positioning of connective tissue attachment and depth reduction of one- and two-walled intrabony defects.[53-55] On the other hand, intrusion has been shown to improve the periodontal condition of healthy reduced periodontal tissues when oral hygiene as well as the orthodontic forces are optimal.[56,57] Therefore, definitive guided tissue regeneration and/or osseous surgery in areas with vertical defects may be best treated after orthodontic tooth movements as these movements may alter the defect dimensions, if the patient is able to keep such defects plaque free during active orthodontic treatment.

Periodontal phenotype: Periodontal phenotype is classified as thick or thin, and a thin periodontal phenotype is a risk factor for subsequent gingival recession. While orthodontic tooth movement alone does not necessarily cause gingival recession, labial tooth movements, particularly in patients with a thin periodontal phenotype, can result in bony dehiscences and, in turn, can increase the risk for gingival recession.[58,59] Conversely, in patients with a thick periodontal phenotype and/or in patients receiving lingual movements of labially displaced teeth, gingival recession is less likely to occur and orthodontic treatment may even result in a reversal of underlying bony dehiscences and fenestrations.[58,60-64] A careful assessment of the patient's periodontal phenotype and the necessary tooth movement vectors for optimal results is therefore crucial to determine if surgical gingival augmentation is necessary prior to orthodontic tooth movement.

Oral hygiene levels: Orthodontic brackets and bands, particularly when affixed in the apical third of the tooth crown, can serve as a plaque-retentive factor and hinder oral hygiene in patients undergoing orthodontic tooth movement.[65,66] Both qualitative and quantitative shifts in microbiota toward a more periodontally pathogenic biofilm have been demonstrated six months after the placement of fixed orthodontic appliances.[67,68] Oral hygiene levels, therefore, must be optimal prior to orthodontic treatment, and close maintenance and monitoring during orthodontic therapy is warranted.[69] If deep periodontal pockets that preclude long-term maintenance of good oral hygiene are present, surgical intervention prior to orthodontic therapy for pocket elimination must be considered to eliminate pockets and allow for tooth movement in an environment with eubiotic plaque biofilm.

Treatment of individuals with malocclusion and periodontitis

Orthodontic tooth movement utilizes controlled forces on teeth with fixed or removable appliances resulting in improved alignment of teeth. The tooth movement is generally thought to occur through the pressure-tension theory wherein deflection of the periodontal ligament results in bone resorption on the pressure side and bone deposition on the tension side.[70-73] Since these resorptive and deposition processes utilize the pathways and mediators (e.g., prostaglandins and inflammatory cytokines) that are also activated during periodontal attachment loss, it follows that orthodontic tooth movement in the presence of active periodontal pathology could result in accelerated attachment loss.[74] The existing scientific literature consistently emphasizes the importance of oral hygiene and periodontal maintenance visits during the orthodontic treatment phase of patients with periodontitis. However, differences in the treatment sequence of such cases have been noted due to multiple considerations.

Periodontal tissues respond to orthodontic forces to result in tooth movement, but the use of appropriate forces is

TABLE 1: Periodontal tissue response to orthodontic forces

Forces	Tissue response
Very heavy forces—forces far exceeding PDL capillary blood pressure	PDL on the pressure side of the tooth is crushed, resulting in local ischemia and degeneration of the PDL. This leads to hyalinization and potential ankylosis and/or delay in tooth movement.
Heavy to moderate forces—forces exceeding PDL capillary blood pressure	PDL strangulation at the pressure side results in decreased blood flow and reduced bone resorption.
Light forces—forces less than PDL capillary blood pressure	PDL ischemia without strangulation results in simultaneous bone resorption and formation and more continuous tooth movement.

imperative to avoid delay in tooth movement and/or ankylosis **(table 1)**.[4] Orthodontic movement with appropriate forces has not been shown to accelerate the destruction of the connective tissue attachment on teeth with healthy periodontium[8,75] or in the presence of debrided plaque-induced suprabony lesions.[6,8] In contrast, the development of intrabony pockets was noted on teeth harboring plaque when subjected to tipping and/or intruding movements.[5] Likewise, bodily movement of teeth with inflamed intrabony pockets was associated with a loss of connective tissue attachment.[6] Conversely, tooth movement into intrabony defects treated with open-flap debridement or regenerative therapies had no or improved effect on the attachment levels.[75,76]

Given these findings, orthodontic treatment must be preceded by the elimination of periodontal inflammation and the treatment of plaque-induced lesions.[53] There are exceptions, however, when orthodontic therapy is performed early in the treatment. Such exceptions may include clinical situations in which the elimination of the periodontal infection cannot be accomplished due to unfavorable tooth positions[77] and the presence of periodontally hopeless teeth that will be used for anchorage purposes but eventually have to be extracted at the end of the orthodontic phase.

Pathological tooth migration is considered a common complication in moderate to severe periodontitis.[78,79] Teeth most affected are in the maxillary anterior sextant and present with a facial and incisal displacement, leading to the formation of diastemata.[79] These teeth frequently demonstrate mobility and significant intrabony defects due to the disease process. Orthodontic intrusion was found to be successful in realigning the migrated teeth following surgical and/or nonsurgical periodontal treatment.[49,57] In addition, there is histological evidence of new cementum and connective tissue attachment formation when teeth are intruded under good oral hygiene measures.[59] It is hypothesized that stretching of the periodontal ligament fibers creates a natural barrier against the downgrowth of epithelial cells along with the increased turnover rate of these cells due to the orthodontic stimulation.[57]

Deep intrabony defects, conversely, are often treated with regenerative periodontal therapies to help restore the supporting structures of the tooth. When combined with orthodontic treatment, there is scarce and controversial evidence on the treatment sequence. While it has been suggested to regenerate the defect prior to initiation of orthodontic therapy by some authors,[76,80,81] others have proposed tooth movement following the control of periodontal inflammation but prior to regenerative therapies in order to create a more suitable defect for that purpose.[82,83]

Other modalities of orthodontic movements, such as uprighting of mesially inclined teeth and orthodontic extrusion, have been shown to reduce deep intrabony pockets and defects.[84,85] Tipping the tooth distally minimizes the intrabony defect by widening it, while the presence of furcation involvement may worsen or remain the same. Orthodontic extrusion has been shown to lead to a decrease in intrabony defect depth by coronally positioning the connective tissue attachment. In addition, teeth with normal periodontal support that are bodily moved into an edentulous area with reduced bone height were found to maintain their connective tissue attachment and radiographic bone levels.[53] This suggests that periodontally involved teeth could be moved with minimal risk into edentulous sites demonstrating reduced alveolar bone height following appropriate control of periodontal inflammation.

Treatment of individuals with malocclusion and gingival recession and/or thin periodontal phenotype

Tooth malposition, ectopic eruption, aberrant frenum position, and overall periodontal phenotype can predispose and/or cause mucogingival deformities during or after orthodontic tooth movement for patients.[86,87] Furthermore, the directionality of orthodontic tooth movement may result in gingival recession and/or minimal/lack of keratinized or attached gingival tissue. As such, considerations for gingival grafting and indications for either prophylactic mucogingival surgery (i.e., prior to initiation of orthodontic tooth movement) or reconstructive mucogingival surgery (i.e., after completion of orthodontic tooth movement) should be assessed **(table 2)**.

TABLE 2: Considerations for prophylactic or reconstructive mucogingival therapy

Patient, treatment, and site-specific factors that influence the timing of mucogingival therapy in patients planned for orthodontic treatment	
Indications for prophylactic mucogingival therapy	Indications for reconstructive mucogingival therapy
Severe gingival recession	Narrow and/or minimal gingival recession
Minimal/lack of keratinized gingiva	Thick periodontal phenotype
Poor oral hygiene	Good oral hygiene
Thin periodontal phenotype	Planned lingual/palatal tooth movement
Other predisposing local factors (e.g., aberrant frenum position)	Impingement on gingival tissues by opposing dentition (intervention may not be necessary)
Planned labial tooth movement	

Gingival recession is the migration of the gingival margin apical to the cementoenamel junction (CEJ) with loss of gingiva, connective tissue attachment, and crestal bone.[12] Other mucogingival deformities include inadequate width and/or thickness of attached or keratinized gingiva. These mucogingival deformities may be present prior to the initiation of orthodontic tooth movement or may develop during orthodontic tooth movement in patients at high risk for progressive recession. The timing of intervention is dependent upon the existing risk profile and

planned orthodontic tooth movement.[87]

In patients with optimal oral hygiene and minimal gingival recession defects, careful orthodontic tooth movement can be undertaken in most cases with mucogingival surgery planned for after completion of orthodontic therapy. In instances where diastema closure and tooth retraction are planned, this may positively impact the gingival margin position and/or overall periodontal phenotype.[88] In these situations, completion of the orthodontic tooth movement prior to definitive treatment of the gingival recession is advisable. Conversely, in patients with suboptimal oral hygiene, significant pretreatment gingival recession, and/or if planned orthodontic tooth movement is unfavorable, prophylactic gingival recession prior to initiation of tooth movement can reduce the risk of significant soft tissue defects and gingival inflammation. Expansion of arch size has been associated with an increase in gingival recession after orthodontic treatment.[89,90] It has also been established that preintervention mucogingival grafting is stable during and after orthodontic therapy.[91] Interdisciplinary care and treatment planning involving the periodontal surgeon and the orthodontist are critical to identify the proper sequence for mucogingival treatment.

It should also be noted that some malocclusions—e.g., dentoskeletal class II, division II—result in tooth positions that can impinge on the opposing gingival soft tissues. In these cases, orthodontic treatment to eliminate impingement must be performed prior to any periodontal procedure.[92] When the impingement has been eliminated as a part of the correction of malocclusion, spontaneous coronal migration of the gingival margin (i.e., "creeping attachment") may be seen.[92]

Orthodontic therapy as a mode of site preparation for dental implants

Orthodontic extrusion, or forced eruption, has long been identified as a method for treating teeth deemed nonrestorable due to coronal fracture and/or subgingival dental caries to restore ferrule in cases where clinical crown lengthening may compromise adjacent teeth.[83,93] Similar techniques have been described to augment soft and hard tissue contours to allow preparation for dental implant placement.[94-96] Salama and colleagues astutely commented that "a hopeless tooth is not a useless tooth" in their discussion of the utility of forced eruption for implant site preparation.[94-96] Orthodontic extrusion allows for new bone formation at the crestal aspect of the alveolar bone along the surface of the alveolar bone proper in response to tension on the periodontal ligament.[97,98] Further, an increase in soft tissue volume, particularly in the apical-coronal direction, may positively impact the position of interdental papilla and gingival margin after implant placement and restoration.[90,93]

Given the ability to predictably enhance vertical bone and soft tissue volume, orthodontic extrusion has been identified as a useful treatment modality for implant site development, particularly in the esthetic zone.[99] It is important to see patients frequently during orthodontic extrusion to adjust teeth to avoid occlusal interferences and evaluate patient dentinal hypersensitivity and/or the need for intentional endodontic treatment.[100] The four-dimensional vectors of the tooth movement should account for the position and thickness of buccal and palatal bone to ensure optimal hard and soft tissue enhancements.[98] After the forced eruption, stabilization and retention for a minimum of four to six months allows for bone maturation prior to minimally traumatic tooth extraction and immediate implant placement.[98]

Clinical decision-making for interdisciplinary treatment in patients with malocclusion and periodontal diseases and conditions

According to the American Association of Orthodontists (AAO), one in four orthodontic patients is an adult.[2] Given the high prevalence of periodontal disease in individuals over the age of 30,[1] screening for periodontal disease in orthodontic patients and interdisciplinary delivery of care ensures promotion of health and optimal treatment outcomes. Orthodontic tooth movement in patients with periodontal diseases and conditions requires careful interdisciplinary planning and consideration of malocclusion and periodontal clinical presentation. Adjunctive orthodontic tooth movement can be employed to address minor vertical defects associated with tooth inclination, and careful assessment of periodontal and gingival health is necessary to avoid orthodontic tooth movement in the presence of inflammation and subsequent loss of attachment.

Conclusion

Orthodontics and periodontics are complementary dental specialties. Orthodontic therapy requires appropriate forces on the periodontal ligament resulting in consistent tooth movement. Identification of individuals with known risk factors for periodontal diseases and conditions should be routine practice during initial treatment planning for orthodontic care. Periodontal treatment to control inflammation and reduce plaque biofilm accumulation should be initiated prior to orthodontic tooth movement, and maintenance therapy should be provided at appropriate intervals during active orthodontic care. The sequencing of periodontal and orthodontic therapy should take into consideration the types and severity of periodontal defects and disease, the type and direction of orthodontic tooth movement, and other risk factors for periodontal disease progression. Interdisciplinary care should begin at the initial treatment plan to allow for optimal long-term outcomes for health and esthetics.

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QUESTIONS

1. What percentage of US adults 30 years and older have periodontitis?
   A. 30.1%
   B. 36.4%
   C. 42.5%
   D. 74.5%

2. Which of the following is not associated with an increased prevalence of periodontitis among US adults?
   A. Increased age
   B. Lower educational achievement
   C. Female gender
   D. Lower socioeconomic status

3. Average progression of periodontal disease demonstrates a slow to moderate rate of disease progression with approximately ___ teeth lost annually.
   A. 0.2
   B. 0.5
   C. 1
   D. 2

4. Periodontitis among US adults is nearly ___ times greater than that of diabetes mellitus.
   A. 2
   B. 4
   C. 6
   D. 10

5. All of the following are underlying causes of malocclusion except:
   A. Hereditary or congenital causes
   B. Environmental influences
   C. Nutritional factors
   D. Gender

6. Studies have reported that incidences of malocclusion vary from 39% to 93%. In most populations, the majority of children have irregular teeth and an occlusal relationship that differs from the ideal.
   A. Both statements are true.
   B. The first statement is true; the second statement is false.
   C. The first statement is false; the second statement is true.
   D. Both statements are false.

7. In patients with periodontal health and good oral hygiene, including patients with a reduced but healthy periodontium who maintain optimal oral hygiene and health during treatment, orthodontic therapy results in:
   A. Improved periodontal health
   B. No change in periodontal health
   C. Loss of periodontal attachment
   D. Gingival recession

8. Patients with periodontitis who are designated at high risk (i.e., those in the grade C category) who will undergo orthodontic treatment may require all of the following except:
   A. Aggressive preorthodontic interventions
   B. Increased frequency of periodontal maintenance visits during and after active periodontal and orthodontic therapy
   C. Prophylactic gingival grafting
   D. Enhanced oral hygiene instruction and compliance

9. Teeth that have periodontal bone loss have a more ___ center of resistance than those with a healthy periodontium, resulting in a ___ distance between the center of resistance and the alveolar bone crest.
   A. Apical; smaller
   B. Coronal; smaller
   C. Apical; larger
   D. Coronal; larger

10. Teeth with periodontal bone loss are ___ prone to tipping than bodily movement, and the moment-to-force values at the bracket level should be ___ in order to achieve translation.
    A. Less; increased
    B. Less; decreased
    C. More; increased
    D. More; decreased

11. Orthodontic movement of teeth into plaque-induced intrabony pockets when biofilm elimination and interventions to reduce inflammation have been accomplished does not result in additional attachment loss. Intrusive tooth movement can be used to yield coronal positioning of connective tissue attachment and depth reduction of one- and two-walled intrabony defects.
    A. Both statements are true.
    B. The first statement is true; the second statement is false.
    C. The first statement is false; the second statement is true.
    D. Both statements are false.

12. In patients with a thin periodontal phenotype, ___ tooth movements can result in bony dehiscences and, in turn, increase the risk for gingival recession.
    A. Lingual
    B. Mesial
    C. Rotational
    D. Labial

13. Orthodontic brackets and bands are generally attached more ___ in a patient who has had attachment loss.
    A. Coronally
    B. Apically
    C. Mesially
    D. Lingually

14. Orthodontic tooth movement employs forces on teeth that impact the periodontal ligament. Deflection of the periodontal ligament results in:
    A. Bone deposition on the pressure side
    B. Bone atrophy on the tension side
    C. Bone resorption on the pressure side
    D. Bone ankylosis at the tension side

15. Both controlled orthodontic tooth movement and periodontal attachment loss involve the same pathways that result in bone resorption including:
    A. Prostaglandins
    B. Inflammatory cytokines
    C. Osteoclastic activation
    D. All of the above

16. Bodily movement of teeth with inflamed intrabony pockets was associated with no loss of connective tissue attachment. Tooth movement into intrabony defects treated with open-flap debridement or regenerative therapies had no or improved effect on the attachment levels.
    A. Both statements are true.
    B. The first statement is true; the second statement is false.
    C. The first statement is false; the second statement is true.
    D. Both statements are false.

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QUESTIONS

17. In most cases, periodontal treatment to reduce plaque levels and inflammation should be performed prior to initiation of orthodontic therapy. Exceptions include all of the following except:
    A. When elimination of the periodontal infection cannot be accomplished due to unfavorable tooth positions
    B. Periodontally hopeless teeth that will be used for anchorage purposes but eventually have to be extracted at the end of the orthodontic phase
    C. In areas with intrabony defects where orthodontic extrusion will take place
    D. There are no exceptions.

18. Pathological tooth migration is considered a common complication in moderate to severe periodontitis, and the teeth most commonly affected are:
    A. Mandibular posterior teeth
    B. Mandibular anterior teeth
    C. Maxillary posterior teeth
    D. Maxillary anterior teeth

19. In a patient with deep intrabony defects who is treatment planned for orthodontic treatment, the proper sequence of treatment is:
    A. Orthodontic tooth movement prior to any periodontal therapy
    B. Periodontal regeneration at the intrabony defect prior to initiation of orthodontic treatment
    C. Tooth movement after the control of periodontal inflammation and prior to regenerative therapies
    D. There is no definitive order of treatment based upon the scientific literature.

20. Orthodontic extrusion has been shown to lead to ___ in intrabony defect depth by coronal positioning of the connective tissue attachment.
    A. A decrease
    B. An increase
    C. No change
    D. Widening of the angle

21. Which of the following has not been shown to predispose a patient to mucogingival deformities during and/or after orthodontic tooth movement?
    A. Tooth malposition
    B. Lingual/palatal planned tooth movement
    C. Aberrant frenum position
    D. Thin periodontal phenotype

22. Which of the following is not an example of a mucogingival deformity?
    A. Gingival inflammation
    B. Gingival recession
    C. Inadequate width of attached or keratinized gingiva
    D. Inadequate thickness of attached or keratinized gingiva

23. Gingival recession is:
    A. Development of a periodontal pocket through loss of attachment and inflammatory bone loss
    B. Loss of gingival tissue only without loss of connective tissue attachment or alveolar bone
    C. Migration of the gingival margin apical to the cementoenamel junction with loss of gingiva, connective tissue attachment, and crestal bone
    D. Loss of enamel and/or cementum tooth structure resulting in a V-shaped defect on the tooth root

24. In patients with optimal oral hygiene and minimal gingival recession defects, careful orthodontic tooth movement can be undertaken in most cases with mucogingival surgery planned for after completion of orthodontic therapy. In instances where diastema closure and tooth retraction are planned, this may positively impact the gingival margin position and/or overall periodontal phenotype, and completion of the orthodontic tooth movement prior to definitive treatment of the gingival recession is advisable.
    A. Both statements are true.
    B. The first statement is true; the second statement is false.
    C. The first statement is false; the second statement is true.
    D. Both statements are false.

25. Which of the following are associated with increased gingival recession during and/or after orthodontic treatment and therefore an indication for prophylactic mucogingival therapy?
    A. Suboptimal oral hygiene
    B. Severe gingival recession
    C. Expansion of arch size
    D. All of the above

26. Which of the following is not an indication for reconstructive (delayed) mucogingival therapy?
    A. Narrow and/or minimal gingival recession
    B. Impingement on gingival tissues by opposing dentition (intervention may not be necessary)
    C. Thin periodontal phenotype
    D. Good oral hygiene

27. Orthodontic extrusion results in:
    A. New bone formation at the crestal aspect of the alveolar bone
    B. An increase in soft tissue volume
    C. Elimination of intrabony defects
    D. All of the above

28. After the forced eruption for implant site preparation, stabilization and retention for a minimum of ___ month(s) allows for bone maturation prior to minimally traumatic tooth extraction and immediate implant placement.
    A. 1
    B. 4–6
    C. 6–9
    D. 12

29. Which of the following is not a major consideration when determining the sequencing of periodontal and orthodontic therapy?
    A. The types and severity of periodontal defects and disease
    B. The type and direction of orthodontic tooth movement
    C. The age of the patient
    D. Additional risk factors for periodontal disease progression

30. The PDL response to very heavy orthodontic forces is:
    A. PDL on the pressure side of the tooth is crushed, resulting in local ischemia and degeneration of the PDL, leading to hyalinization and potential ankylosis and/or delay in tooth movement
    B. PDL strangulation at the pressure side, resulting in decreased blood flow and reduced bone resorption
    C. PDL ischemia without strangulation results in simultaneous bone resorption and formation and more continuous tooth movement
    D. PDL resorption and eventual ankylosis

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Educational Objectives

1. Critically assess the effects of periodontal inflammation on orthodontic tooth movement and the implications for orthodontic treatment in individuals with periodontitis.
2. Discuss the optimal sequencing for nonsurgical and surgical periodontal care in individuals undergoing orthodontic tooth movement.
3. Evaluate the impact of periodontal phenotype alteration and/or gingival recession treatment for individuals undergoing orthodontic tooth movement.
4. Understand the advantages and disadvantages of orthodontic tooth extrusion for implant site preparation at hopeless teeth with esthetic compromise.

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   Objective #1: Yes No Objective #3: Yes No

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5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	20.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	21.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	22.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	23.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	24.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	25.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
11.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	26.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
12.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	27.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
13.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	28.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
14.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	29.	Ⓐ	Ⓑ	Ⓒ	Ⓓ
15.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	30.	Ⓐ	Ⓑ	Ⓒ	Ⓓ

EXAM INSTRUCTIONS
All questions have only one answer. If mailed or faxed, grading of this examination is done manually. Participants will receive confirmation of passing by receipt of a Verification of Participation form. The form will be mailed within two weeks after receipt of an examination.

COURSE EVALUATION AND FEEDBACK
We encourage participant feedback. Complete the evaluation above and e-mail additional feedback to Rachel McIntyre (rmcintyre@endeavorb2b.com) or Laura Winfield (lwinfield@endeavorb2b.com).

COURSE CREDITS AND COST
All participants scoring 70% or higher on the examination will receive a verification form for three (3) continuing education (CE) credits. Participants are urged to contact their state dental boards for CE requirements. The cost for courses ranges from $20 to $110.

PROVIDER INFORMATION
Endeavor Business Media is an ADA CERP–recognized provider. ADA CERP is a service of the American Dental Association to assist dental professionals in identifying quality providers of continuing dental education. ADA CERP neither approves nor endorses individual courses or instructors, nor does it imply acceptance of credit hours by boards of dentistry. Concerns about a CE provider may be directed to the provider or to ADA CERP at ada.org/cerp.

Endeavor Business Media is designated as an approved PACE program provider by the Academy of General Dentistry. The formal continuing dental education programs of this program provider are accepted by the AGD for fellowship, mastership, and membership maintenance credit. Approval does not imply acceptance by a state or provincial board of dentistry or AGD endorsement. The current term of approval extends from 11/1/2019 to 10/31/2024. Provider ID# 320452. AGD code: 490.

Dental Board of California: Provider RP5933. Course registration number CA code: 03-5933-22127. Expires 7/31/2024. "This course meets the Dental Board of California's requirements for three (3) units of continuing education."

Endeavor Business Media is designated as an approved provider by the American Academy of Dental Hygiene Inc. #AADHPNW (January 1 2022 - December 31, 2024). Approval does not imply acceptance by a state or provincial board of dentistry. Licensee should maintain this document in the event of an audit.

RECORD KEEPING
Endeavor Business Media maintains records of your successful completion of any exam for a minimum of six years. Please contact our offices for a copy of your CE credits report. This report, which will list all credits earned to date, will be generated and mailed to you within five business days of receipt.

CANCELLATION AND REFUND POLICY
Participants who are not 100% satisfied can request a refund by contacting Endeavor Business Media in writing.

IMAGE AUTHENTICITY
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