Creating Space with Interproximal Reduction

A Peer-Reviewed Publication
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Educational Objectives
Upon completion of this course, the clinician will be able to:
1. List considerations of tooth anatomy and individual tooth shapes with respect to slenderization
2. List the effect of slenderization on the periodontium
3. List instrumentation that can be used for slenderization as well as their advantages and disadvantages
4. List the steps involved in slenderizing teeth.

Abstract
One of the basic principles of orthodontics is the creation of space to facilitate tooth movement. With appropriate case selection, slenderization offers the ability to safely obtain sufficient space for tooth movement without the need for extractions and without compromising slenderized teeth.

Introduction
Creating space to facilitate tooth movement is one of the basic principles of orthodontics. As patients seek faster orthodontic treatment, extraction is becoming reserved for cases where there is severe crowding, a need for vertical change or control, or where sagittal correction/compensation cannot otherwise be accomplished. For less severe cases there has been an increasing trend towards expansion or interproximal reduction (IPR), with the choice depending on the case. IPR is also known as enamel reduction, stripping, or slenderization.1

Historical and Anthropological Perspectives
The natural interproximal abrasion of teeth was discussed by Black in 1902.2 Since then, numerous studies have addressed interproximal abrasion and reduction. In 1944, Ballard3 described the slenderization technique for the first time. Sheridan4 in labial technique, and Fillión5 in lingual technique, among others, have contributed to the development of the slenderization technique currently in use. Anthropologists have usually found little to no crowding in the remains of primitive dental arches. The theory that primitive humans wore down their teeth more rapidly is difficult to dispute. Foods were much more difficult to masticate, often contained abrasive particles such as sand or bone, and primitive people used their teeth to cut and shred foods. This tooth wear resulted in uncrowded dental arches.

The Need for Slenderization
Modern research has found that as we age, normal mesial drift of the teeth causes crowding in many individuals regardless of whether or not orthodontic treatment was performed. Studies on the occlusions of Aboriginals found that they presented with interproximal wear with loss of up to 14–15 mm of hard tissue over a lifetime as a consequence of non-refined diets, and had no crowding.6,7 Sicher8 stated that it was possible that tooth wear (attrition) has a positive function and asked whether nature sacrifices tooth substance to achieve an increase in functional potentiality. Peck and Peck9 found a relationship between dental size (mesiodistal and labiolingual distances of the inferior incisors) and crowding grade (PI index). Betteridge10 also found a relationship between dental size and crowding grade.

Teeth vary in size between females and males, mostly in the permanent dentition, with men having larger teeth and the maxillary centrals and canines showing the greatest differences.11-16 Bolton17 analyzed the relationships between canine-to-canine widths and molar-to-molar widths in dental arches, and found tooth size discrepancies in approximately 30% of patients. Freeman, Santoro and Alexander18 also observed similar percentages in their studies. Sassouni19 found that Class III facial types and patients with deficient maxillary growth show a greater incidence of anterior tooth shapes and agenesis. Cua-Benward20 found similar results in Class III subjects, and tooth deformities in the lower anterior region in Class II individuals.

Periodontal Considerations
It is apparent from reviewing the literature that there is no negative or positive effect when teeth approximate after slenderization. Investigators studying horizontal and vertical bony defects on posterior teeth found no evidence that narrow spaces between roots were risk factors for periodontal disease. Other investigators found that teeth could function even when the roots were touching and sharing a periodontal ligament. After reviewing several studies, Fillión21 concluded that periodontal state is improved even if slenderization is performed on already aligned teeth and the interdental septum thickness is reduced as a result. Betteridge22 found that fourteen of seventeen slenderization cases had an improved gingival index. Boese23 compared forty patients’ radiographs taken four to nine years post-treatment and found no significant differences in alveolar crest height. Crain24 and Sheridan25 found no significant differences in the gingival index interproximally three to five years post-treatment. Enamel reductions in the above studies were maximum 0.5 mm per proximal surface.

Contact Locations
As cutting instruments remove enamel during slenderization, rounded contours are flattened. These need to be restored after enamel reduction to restore the contact back to the proper location. Re-familiarizing dental shape and anatomy is important: contact points are more apical as the teeth move from the anterior of the mouth to the posterior, and restoring them to their proper position should be attempted.

Enamel Thickness
Tooth slicing studies have demonstrated that the enamel thickness around teeth is similar in incisors, cuspids, molars, and premolars. A study by Hall26 et al. demonstrated that mandibular lateral incisors have thicker enamel than central incisors. Enamel thickness of the lower central incisor was
determined: 0.77 mm +/− 0.11 mm on the distal enamel thickness and 0.72 mm +/− 0.10 mm on the mesial. The lower lateral incisor measured 0.96 mm +/− 0.14 mm on the distal and 0.80 mm +/− 0.11 mm on the mesial enamel thickness. Enamel thickness in premolars can be well over 1 mm. Several enamel thickness studies allow us to draw the following conclusions27,28,29: The minimal enamel thickness, and not the average values, must be taken into account when determining the enamel quantity that is going to be removed, since it is not possible to know which teeth present minimal thickness. There is no relationship between dental size and enamel thickness; therefore, macrodontic teeth should not be stripped more than microdontic teeth (although aesthetically it is better to carry out the slenderizing on macrodontic teeth). Enamel thickness is slightly greater in the contact point, gradually decreasing in thickness toward the cementoenamel junction. The enamel is slightly thinner in distal than in mesial surfaces. In upper cusps and lower second bicuspids, these differences are greater. The exceptions are upper lateral incisors, whose thickness is slightly greater distally.

Orthodontic treatment

How much enamel can be removed

It is important to know how much enamel can be removed in individual teeth in order to know which cases can be slenderized and which require a different treatment plan. Generally, it is recommended to remove only up to approximately half of the enamel thickness on any surface being reduced. As a rule of thumb, be very conservative; never remove more than 0.3 mm (including polishing) from any single tooth surface, creating space gain of 0.6 mm per contact. Several clinicians have provided their recommendations for slenderization. Boese23 recommends slenderizing half the enamel layer thickness. Berrer31 claims that lower incisors can be stripped by 0.4 mm, which corresponds to a 0.5 mm slenderizing per proximal surface of the lower incisors. Paskow32 allows slenderizing of between 0.25 mm and 0.37 mm. Hudson27 suggests 0.20 mm for central incisors, 0.25 mm for the lateral ones, and 0.30 mm for the lower cuspids, which gives a total of 3 mm for the whole anterior group. Tuverson33 states 0.3 mm per proximal surface of the lower incisors and 0.4 mm in cuspids, which gives, in total, the elimination of 4 mm in the anterior group. Alexander18 permits only 0.25 mm for all the teeth, and Sheridan34 defends a 0.8 mm slenderizing per each surface of posterior teeth and 0.25 mm in the anterior teeth, gaining in total some 8.9 mm.

The concept of removing half the enamel layer would seem to be clinically acceptable. According to Fillión35, it is possible to obtain 10.2 mm of space in the maxilla and 8.6 mm in the mandible if slenderizing is carried out from the mesial surface of the first right molar to the same surface of the left molar. If slenderizing includes the second molar, an additional 0.5 mm in distal surface of the first molar and 0.5 mm in mesial surface of the second molar can be obtained. When planning slenderizing, factors that must be considered include the degree of physiologic abrasion present (contact tips or facets) (Fig. 2), whether the patient has already undergone slenderizing, and the presence of over-dimensioned crowns or fillings.

When slenderizing incisors and cuspids, asymmetries should be compensated for and midlines centered (Fig. 3). In the case of bicuspids and molars, the cusps should remain intercuspated (Fig. 4). The Bolton index is useful to determine the best zone for slenderizing.
Figure 4. Slenderizing of the posterior teeth must improve the occlusion.

Slenderizing should be carried out such that the vertex of the interdental papilla and the contact point remain in the same perpendicular line to the occlusal (vertical) plane (Fig. 5). Otherwise, the teeth will look as if they are incorrectly inclined.

Figure 5. The vertex of the dental papilla and the contact point must be in the same vertical line.

Slenderizing should be carried out such that the interproximal contact point remains at a distance of 4.5–5 mm from the upper border of the bone crest. This ensures that “black gingival triangles” will not be visible due to the absence of the dental papilla. The bone crest height is determined by probing and radiographic examination (Fig. 6).

Figure 6. Measuring the distance from the alveolar bone crest to the contact point area.

**Indications for Slenderization**

Slenderization is indicated when treatment requires space in the dental arches without extractions. It is also indicated in cases where individual tooth sizes prevent a Class I molar and canine relationship.

**Bolton Discrepancy Cases**

In an ideal dentition, Class I canines should create the proper space mesial to the canines to accommodate the lateral incisors and central incisors. Likewise, Class I molars should create enough space to accommodate the first and second premolars, canines and incisors. Other factors include tooth position, overjet, and overbite. In many cases, patients present with tooth size discrepancy, described by Bolton: the Cuspid-to-Cuspid Bolton Index (maxillary or mandibular – 6 teeth) or the first Molar-to-first-Molar Bolton Index (maxillary or mandibular – 12 teeth). Bolton determined that the relation between the upper and lower molar-to-molar tooth size is 91.3 ± 1.91 (Fig. 7). The same cuspid-to-cuspid relation is 77.2 ± 1.65 (Fig. 8).

Figure 7. Molar-to-Molar Bolton Index (12 teeth)

If the “12 teeth” Bolton index is accomplished, the molar Class I relationship is obtained, and if the “6 teeth” Bolton index is accomplished, the Cuspid Class I relationship is obtained. If the patient presents with Bolton discrepancies, it is necessary to compensate for this discrepancy with slenderization of the dental arch in order to achieve a good occlusion. If teeth are too small, space should be opened, and build-ups should be performed. For example:

- A “12 teeth” Bolton excess of the upper arch of 4 mm with a “6 teeth” Bolton excess of the upper arch of 4 mm indicates that slenderization should occur in the upper cuspid-to-cuspid zone.
- A “12 teeth” Bolton excess of the upper arch of 4 mm with a normal “6” Bolton index indicates that slenderization should occur in the upper molars and bicuspids zone.
- A “12 teeth” Bolton excess of the upper arch of 4 mm with a “6 teeth” Bolton excess of the upper arch of 2 mm indicates that slenderization should occur in all the upper teeth

The same principles are used for lower arch Bolton excess.

**Tooth Shape and Slenderization**

Dental shape is of great importance. A rectangular shape allows a wide and stable contact point, without visible spaces.
A triangular shape allows a reduced occlusal or incisal contact point. Patients presenting with triangular teeth may present with “black gingival triangles”. Barrel-shaped teeth have reduced contact points in the middle with apparent separations at the incisal level. It is possible that gingival (triangular teeth) or incisal (barrel-shaped teeth) spaces may not be visible at the start of treatment due to crowding or rotations. It is very important to inform all patients of the potential for the creation of “black triangles” and to document it in the chart prior to starting treatment. Ideally, include the solution to this problem in the treatment plan regardless of whether fixed appliances or clear aligners will be used. Irrespective of the amount of slenderization, and correction of the black triangle, certain patients will not be satisfied with the end result.

If the crown has a triangular shape, the distance between the bone crest and the contact point is relatively long. These cases show more tendency to an absence of the interproximal papilla. Tarnow et al. demonstrated that if the distance from the contact point to the end of the interdental bone crest is 5 mm or less, the papilla is present in 100% of the cases. If this distance is 6 mm, the papilla is found in 56% of cases, and if it is 7 mm or more, the papilla is present only in 27% or less. If the crown has a triangular shape, the distance between the bone crest and the contact point is relatively long. These cases show more tendency to an absence of the interproximal papilla. Tarnow et al. demonstrated that if the distance from the contact point to the end of the interdental bone crest is 5 mm or less, the papilla is present in 100% of the cases. If this distance is 6 mm, the papilla is found in 56% of cases, and if it is 7 mm or more, the papilla is present only in 27% or less. From the bone crest end to the papilla end, the distance is always 4.5 mm. “Black gingival triangles” are not always the result of an enlarged distance between the contact point and the bone crest. According to Bennett and McLaughlin, a “black gingival triangle” can appear as a consequence of a bracket malpositioning with respect to inclination (Fig. 9). In this case the bracket position should be corrected and slenderization should not be carried out.

Figure 9. Black gingival triangle following bracket malpositioning

The same considerations are valid for barrel-shaped teeth — it is possible to carry out slenderization and re-approximation, or incisal reconstructions (Fig. 10, 11). Triangular and barrel-shaped teeth often require slenderizing or cosmetic restoration to improve the aesthetics after orthodontic treatment; this should be considered before finishing the case and debonding the brackets. Rectangular-shaped teeth do not show any “black triangles”, and slenderization is usually not favorable as too much tooth reduction is required to gain sufficient space in the dental arch. According to Andrews, teeth that are tipped more mesiodistally occupy more space in the dental arch than teeth in a more vertical position do. Bennett and McLaughlin emphasize that this fact is truest for rectangular teeth (Fig. 12). Thus, uprighting as a space gaining solution is possible only in rectangular teeth.

Figure 10. Barrel-shaped teeth and visible incisal spaces (according to Bennett and McLaughlin).

Figure 11. Slenderization and re-approximation as a solution for visible incisal spaces.

Steiner states that for each millimeter of protrusion, the discrepancy is reduced by 2 mm. Torque enlargement without protrusion permits a gain of 1 mm per 5° of radicular palatal torque enlargement (Fig. 13).

Figure 12. Sole importance of the rectangular shape as influence on the space occupied by a tooth in the dental arch, in relation to its inclination.

Figure 13. Gain of 1 mm of space.

While tooth shape has no influence on enamel thickness, it is aesthetically more advisable to slenderize large (macrodontic) teeth rather than small (microdontic) teeth. The “Golden Proportion” described by Ricketts between upper central
incisors and lateral incisors can be taken into account, too. If crowns and fillings are over-dimensionalized, these should be re-shaped to give the tooth back its normal dimensions.

Bilateral Dental Asymmetries
Depending upon tooth size and available space, slenderization or veneers and crowns are often indicated in order to compensate for dental asymmetries, especially in the upper anterior teeth.

Adult Patients
Adults show more pulp retraction, and therefore slenderizing can be carried out with less risk of dentinal sensitivity than in young patients.

Patients with Low Caries Index
Slenderization should be carried out only in patients with a low caries index and good oral hygiene, to avoid increased caries susceptibility.

Multiple Tooth Rotations
In patients with multiple rotations, slenderization can provide wider interproximal contact facets that make relapse less likely (Fig. 14). Many orthodontists purposely flatten out contacts in the lower anterior region in the belief that relapse can be prevented or minimized due to the proximity of the flat contacts.

How Much Space Can Be Created
If a dental arch contains 14 permanent teeth (excluding 3rd molars), and your treatment goal is to remove 0.3 mm of enamel on each tooth in contact with another tooth, you can perform slenderization and gain 0.6 mm of space between 13 interproximal contacts. This totals a maximum amount of space of 7.8 mm. If even more space is needed to correct crowding in a dental arch, this can be made by performing other space-making orthodontic techniques, such as proclining anterior teeth, arch form development, de-rotation of teeth, molar distalization, and dental arch expansion.

Contraindications for Tooth Slenderization
Slenderization should generally be avoided on teeth that are small; restored with a normal shape; have enamel hypoplasia; or are severely rotated whereby the proper contact area is not accessible (in such cases, it is recommended to either make space with separators or wait until crowding in the area is resolved). Slenderization should be avoided in patients who do not accept slenderization as a treatment option (informed consent is imperative); patients with a high caries index, poor oral hygiene, rectangular-shaped teeth; and young patients with large pulp chambers.

Advantages of Slenderization
Slenderization minimizes potential consequences created by extraction, which can include:

a) Difficulties in complete space closure and in paralleling the roots next to extraction sites
b) Need for greater anchorage reinforcement than in slenderization cases (anchorage is still fundamental in the slenderization technique)
c) Possibility of the space re-opening (relapse), especially in adult patients
d) Unwanted profile changes related to retroclining incisors when closing extraction spaces.

When slenderizing, dental movements are smaller than in extraction cases and treatment is shorter. The risk of root resorption is also reduced. Slenderization allows “black gingival triangles” to be avoided or reduced, dental asymmetries to be compensated for and, when needed, dental shape to be improved.

Disadvantages of Slenderization
Techniques that are not conservative, together with operator error, can result in enamel damage or over-reduction (which can require subsequent orthodontic closure). Tooth contours can easily be destroyed, after which a restorative procedure is required. Performing slenderization with instruments with which loss of control can occur is not recommended. High-speed spinning diamond disks easily slice teeth, taking their own path while spinning, and are not recommended. To control the reduction of tooth structure, a low-speed, high-torque handpiece should be used.

Treatment Planning
Deciding which teeth to slenderize is very important. It is recommended to perform Bolton analyses on all cases to determine whether the anterior or posterior teeth need slenderization. In cases presenting with minor isolated crowding, such as a case with Class I molar and canine, slenderization
should be performed in the segment of the dental arch where the crowding exists.

**Slenderizing Goals**
The most important goal when performing slenderization is to do no harm! Remove enamel only on teeth that can tolerate slenderization. Take care to replace the contact point between teeth in the correct anatomical location after slenderization, to restore tooth contours to the original form as much as possible and to polish the enamel using finishing disks or strips.

**Instruments Used to Slenderize**

**Slenderization Chart**
It is very important to document all slenderizations you perform. A diagram similar to a periodontal chart is recommended and slenderization measurements can be written between the teeth on the chart.

**Thickness Gauges/Leaf Gauges**
Leaf/thickness gauges are readily available and provide an accurate and simple way to measure interproximal reductions. Using the thickness of a diamond disk or width of a diamond bur to measure slenderization performed is pointless; even if only passed between the contacts once, the amount of slenderization will most likely be larger than the width of the cutting instrument. In the case where a contact is already opened, simple mathematics should be performed to determine space gained by slenderization.

**Stainless Steel Strips**
Abrasive strips are available with single- or double-sided coatings, and in fine, medium, and coarse grits. Strips are useful when the teeth are so rotated that a disk is not appropriate. In addition, thin, fine strips allow you to pass through any contact, regardless of rotation or angulation of the teeth. After a strip is passed through the contact, access with a diamond disk is easier, more predictable, and more effective. Strips are also useful for re-contouring teeth that have been reduced. In addition, patients are less apprehensive if you perform slenderization the first time manually with a strip, rather than with a motorized handpiece. Strip holders aid manual slenderization. IDEAL\(^{\text{®}}\) strips can be hand-held or inserted into a contra-angle handpiece that performs a reciprocating motion of 1.6 mm to achieve reduction.

**Diamond Disks (High Torque)**
Diamond disks are available in varying thicknesses and grits (fine, medium and coarse), similar to strips. Using the thinnest disk available (~0.17 mm) allows for 0.2 mm of slenderization after polishing. Single- and double-sided disks are available. Using only single-sided disks keeps the initial contact break as small as possible, and ensures that only one tooth is being cut a time. A fine grit disk is usually sufficient.

**Air Rotor Slenderization Burs and Disks**
Air rotor slenderization is hard to control and it is difficult to be conservative. The majority of dentists use air-powered high-speed motors at up to 200,000 rpm, and slow-speed motors that rotate at 20,000 rpm or 5,000 rpm. It is difficult to obtain a controlled degree of cutting power even when slowing down the turbine. Achieving a controlled speed using the foot rheostat is difficult, as the air running through the motor can compress and alter the speed regardless of where the pedal is.

**Burs**
When using a high-speed air turbine, to keep the bur spinning fast enough to cut you must use high rpms, which decreases the dentist’s ability to be conservative and to avoid gouging of enamel and over-reduction.

**Diamond Disks**
Conventional slow-speed air motors with standard straight-nose handpieces have insufficient torque at slow speeds to cut tooth structure for slenderization procedures when using diamond-coated disks; after the motor has been attenuated down, it will basically stop under any pressure. Air-powered slow-speed motors need to rotate at 4,000–20,000 rpm to create enough torque to perform slenderization. At these speeds, the diamond disk can easily bind when breaking contact, resulting in soft- and hard-tissue damage; the spinning diamond-coated disk can also take a path other than the one the dentist desires, cutting into dentin.

**Electric Rotor Slenderization Burs and Disks**
Electric handpieces can reach the same speeds as air turbines while allowing you to reduce the spinning bur or disk down to revolutions as low as 100 rpm. With low speeds and high-torque cutting power that you control, safety and accuracy are now achievable with electric rotor slenderization (ERS).
Depending upon the electric motor and the configuration of the straight-nose handpiece (rpm reduction), practitioners can perform diamond-disk slenderization at speeds that put control into the clinician’s hands. An electric motor system that is configured for disk slenderization is necessary, as at low speeds (<1000 rpm) most electric motors cannot deliver the torque needed to safely cut enamel and the rotating disk will stop (similar to air turbines). The fastest speed I use when performing disk slenderization is 500 rpm. Unlike disks in air turbines at high speed, if the diamond disk is slightly bent it can still be used at low speed and does not need to be immediately replaced.

**Slenderizing Technique**

It is important to first review the written treatment plan. Each reduction should be documented on the chart.

Firstly, look at a picture of the dental arch you are planning on performing orthodontics on, and create a sequence of where you are going to begin slenderization based on rotations and access to contact points. Figure 17 shows numbers that represent the order in which to perform slenderization. This lets you move the teeth into the newly created space, opening up the contacts between the teeth where there was previously no access.

For every contact that is to be slenderized, first open the contact manually with a single-sided diamond-coated strip (Fig. 18). As stated before, this also lets you show the patient how simple and pain-free slenderization will be.

Next, use a new single-sided disk (up or down depending on which tooth is being slenderized) to increase the thickness of the space made using the diamond strip. Using an ERS slow-speed handpiece at low speed and high torque with high-torque diamond disks is effective. Clear disk guards are available that fit over diamond disks leaving the cutting area exposed while protecting the adjacent tooth that is not being slenderized. These clear disk guards can be used manually with the finger rests or over the handpiece (Fig. 19).

Make the initial measurement using a leaf gauge (Fig. 20). The space made will be approximately 0.2 mm, due to the width of the disk that has already been used. If 0.5 mm total slenderization is required and only half of this will be done at the first visit, there is no need for final polishing. This will be accomplished at the last visit, when the remaining 0.2 mm of slenderization occurs.

When completely satisfied with the amount of space created, contour the contacts and polish the surfaces. A diamond or carbide polishing bur can be used in an electric motor handpiece, keeping the bur spinning at ~500 rpm.

**Separating Teeth**

Use of a wedge to open up contacts prior to slenderization can be painful for patients and also means that slenderization visits must be spaced out due to the 5-day wait required for separators to work; additionally, it is difficult to measure the space being created by slenderization due to the space created by the separators. You may see 3 mm of space, when in fact 2.5 mm of this space was made by the separator and will relapse by the next visit. Instead, using a single-sided diamond-coated disk with a high-torque electric motor enables the disk to easily move through the contact for slenderization that is accurate, and safe for the adjacent tooth. Clear disk guards can also be used.

**Additional Considerations**

**Slenderize Contacts Only**

Due to severe malpositioning of teeth, it is often necessary to slenderize between teeth with false contacts. The case...
in Figure 21 shows the contact between the upper right lateral incisor and upper right central incisor on the palatal surface of the central. Slenorization should only occur on the mesial aspect of the lateral incisor at this time. It would be impossible to make access between the lateral and central without damaging the central.

Figure 21. Malpositioned contact due to malpositioned teeth

Slow It Down
Do not create too much space! Perform slenorizing procedures slowly, removing only minimal amounts of enamel needed for the tooth movement. There have been many legal cases where dentists over-reduced enamel during orthodontic treatment, with the result that crowns were required. In all cases, the dentist who performed the IPR lost. Take your time and do no harm!

References
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1. The natural interproximal abrasion of teeth was discussed in 1902 by __________.
   a. White
   b. Black
   c. Miller
   d. none of the above

2. Primitive humans wore down their teeth more rapidly due to __________.
   a. foods then being more difficult to masticate
   b. foods containing abrasive particles
   c. the use of teeth to cut or shred foods
   d. all of the above

3. Studies on the occlusions of Aboriginals found that they presented with interproximal wear with loss of up to __________ of hard tissue over a lifetime.
   a. 12–13 mm
   b. 13–14 mm
   c. 14–15 mm
   d. 15–16 mm

4. __________ found a relationship between dental size and crowding grade.
   a. Betteridge
   b. Peck and Peck
   c. Sicher
   d. a and b

5. It is apparent that there is no negative or positive effect on the periodontium when teeth approximate after slenderization.
   a. True
   b. False

6. All clinicians recommend that the same amount of enamel can be removed during slenderization.
   a. True
   b. False

7. Crain and Sheridan found significant differences in the gingival index interproximally three to five years post-treatment.
   a. True
   b. False

8. There is no relationship between dental size and enamel thickness or between dental shape and enamel thickness.
   a. True
   b. False

9. Compared to other dental shapes, more space is gained with minimal enamel wear in __________ teeth.
   a. b)rd-shaped
   b. rectangular-shaped
   c. triangular-shaped
   d. ovoid-shaped

10. The concept of removing half the enamel layer during orthodontic slenderization would seem to be clinically acceptable.
    a. True
    b. False

11. A “black gingival triangle” can appear as a consequence of bracket malpositioning.
    a. True
    b. False

12. According to Fillión, it is possible to obtain __________ of space in the maxilla and __________ in the mandible if slenderizing is carried out from the mesial surface of the first right molar to the mesial surface of the left molar.
    a. 8.2 mm; 10.6 mm
    b. 8.6 mm; 10.2 mm
    c. 10.2 mm; 8.6 mm
    d. 10.0 mm; 8.2 mm

13. Slenderization should be carried out such that the interproximal contact point remains at a distance of __________ from the upper border of the bone crest.
    a. 3.5–4.0 mm
    b. 4.0–4.5 mm
    c. 4.5–5.0 mm
    d. 5.0–5.5 mm

14. If the crown has a triangular shape, the distance between the bone crest and the contact point is __________.
    a. relatively wide
    b. relatively short
    c. relatively long
    d. none of the above

15. Slenderization is indicated __________.
    a. when treatment requires space in the dental arches without extractions
    b. when treatment requires expansion after extraction
    c. in cases where individual tooth sizes prevent a Class I molar and canine relationship
    d. a and c

16. Torque enlargement without protrusion permits a gain of 1 mm per 5° of radicular palatal torque enlargement.
    a. True
    b. False

17. The “golden proportion” described by Ricketts is between __________.
    a. upper central incisors and lateral incisors
    b. lower central incisors and lateral incisors
    c. upper cuspsids and lateral incisors
    d. none of the above

18. Barrel-shaped teeth have reduced contact points in the __________ with apparent separations at the incisal level.
    a. cervical third
    b. incisal third
    c. middle
    d. none of the above

19. Based on research, uprighting as a space gaining solution is possible only in rectangular teeth.
    a. True
    b. False

20. Adults show more pulp retraction, and therefore slenderizing can be carried out with less risk of dental sensitivity than in young patients.
    a. True
    b. False

21. Orthodontic slenderizing should be reserved for patients with __________.
    a. severe crowding
    b. low caries risk
    c. good oral hygiene
    d. a and c

22. In patients with multiple rotations, slenderization can provide __________ interproximal contact facets that make relapse less likely.
    a. narrower
    b. wider
    c. shorter
    d. none of the above

23. Leaf gauges provide an accurate and simple way to measure enamel reduction.
    a. True
    b. False

24. Slenderization should generally be avoided on teeth that are __________.
    a. small; hypoplastic
    b. severely rotated
    c. restored with a normal shape
    d. all of the above

25. When slenderizing, dental movements are smaller than in extraction cases and treatment is shorter.
    a. True
    b. False

26. Slenderizing techniques that are not conservative, together with operator error, can result in enamel damage or over-reduction.
    a. True
    b. False

27. When completely satisfied with the amount of space created during slenderization, the contacts should be contoured and the surfaces polished.
    a. True
    b. False

28. Clear disk guards help protect the adjacent tooth during slenderization.
    a. True
    b. False

29. A slenderization chart is used to __________.
    a. record periodontal changes
    b. document the amount of reduction at each tooth surface
    c. determine if too much enamel has been removed
    d. none of the above

30. A low-speed, high-torque electric handpiece gives __________ during slenderization.
    a. more control
    b. more accuracy
    c. less tooth movement
    d. a and b
Creating Space with Interproximal Reduction

Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp. For Questions Call 216.398.7822

Educational Objectives

1. List and describe the considerations of tooth anatomy and individual tooth shapes with respect to slenderization and its effects on periodontal health.
2. Know which teeth to perform slenderization on and which to avoid.
3. List and describe the types of instrumentation that can be used for slenderization and the advantages and disadvantages of each type.
4. List the steps involved in slenderizing teeth.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?

<table>
<thead>
<tr>
<th>Objective #1:</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective #2:</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Objective #3:</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

2. To what extent were the course objectives accomplished overall?

| 5 | 4 | 3 | 2 | 1 | 0 |

3. Please rate your personal mastery of the course objectives.

| 5 | 4 | 3 | 2 | 1 | 0 |

4. How would you rate the objectives and educational methods?

| 5 | 4 | 3 | 2 | 1 | 0 |

5. How do you rate the author’s grasp of the topic?

| 5 | 4 | 3 | 2 | 1 | 0 |

6. Please rate the instructor’s effectiveness.

| 5 | 4 | 3 | 2 | 1 | 0 |

7. Was the overall administration of the course effective?

| 5 | 4 | 3 | 2 | 1 | 0 |

8. Do you feel that the references were adequate?

| Yes | No |

9. Would you participate in a similar program on a different topic?

| Yes | No |

10. If any of the continuing education questions were unclear or ambiguous, please list them.

___________________________________________________________________

11. Was there any subject matter you found confusing? Please describe.

___________________________________________________________________

12. What additional continuing dental education topics would you like to see?

___________________________________________________________________

AGD Code 373

PLEASE PHOTOCOPY ANSWER SHEET FOR ADDITIONAL PARTICIPANTS.