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Mastering Interproximal Reduction—
With Innovations in Slenderization

A Peer-Reviewed Publication
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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. Understand the objectives of slenderization and its anthropological origins.
2. Understand the impact of tooth anatomy and individual tooth shapes and the effects on periodontal health of slenderization.
3. Know which teeth to perform slenderization on and which to avoid.
4. Understand the instrumentation that can be used for slenderization and the advantages and disadvantages of each type.
5. Know the steps involved in slenderizing teeth.

Abstract
One of the basic principles of orthodontics is the creation of space to facilitate tooth movement. This can be achieved through extraction, expansion or tooth slenderization. With appropriate case selection and correct technique, slenderization offers the ability to safely obtain sufficient space for tooth movement without the need for extractions and without compromising the health and shape of slenderized teeth.

Introduction
Creating space in order to facilitate tooth movement is one of the basic principles of orthodontics. If space is required then expansion, extraction, or tooth slenderization must be performed. As patients seek faster orthodontic treatment, extraction is becoming reserved for cases in which severe crowding is present, where there is a need for vertical change or control, or where sagittal correction/compensation can not be accomplished without extraction.

The Basic History of Slenderization
In 1902, Black published a text on tooth anatomy that discussed the natural interproximal abrasion of teeth (natural slenderization). In 1944, Ballard described the slenderization technique for the first time. Both Sheridan in labial technique, and Fillión in lingual technique, among others, have contributed to the development of the slenderization technique currently in use. Studies by Begg and Murphy on the occlusions of Aboriginals found that they presented with interproximal wear, amounting to the loss of up to 14–15 mm of dental material during a lifetime as a consequence of non-refined diets and the absence of crowding. Sicher, speaking about tooth attrition, stated that it was possible that tooth wear has a positive function and asked whether nature sacrifices tooth substance to achieve an increase in functional potentiality. Peck and Peck found a relationship between dental size (mesiodistal and labiolingual distances of the inferior incisors) and crowding grade (PI index). Betteridge also found a relationship between dental size and crowding grade (BI index).

Teeth vary in size between females and males, mostly in the permanent dentition. Males’ teeth are larger than those of females, with maxillary centrals and canines showing the greatest differences. Bolton 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 his patients. Freeman, Santoro, and Alexander also observed similar percentages in their studies. Sassouni pointed out that Class III facial types and patients with deficient maxillary growth show a greater incidence of anterior tooth shapes and agenesis. Cua-Benward found similar results in Class III subjects, and tooth deformities in the lower anterior region in Class II individuals.

Anthropological Explanation for the Need for Slenderization
Anthropologists studying primitive dental remains have usually found little to no crowding of the dental arches. The theory that primitive humans wore down their teeth more rapidly is difficult to dispute. Foods were much more difficult to masticate, and in many instances contained sand, bone, or other abrasive particles. Mastication was different, too. Knives and forks were not available, and primitive people used their teeth to cut and shred foods. This type of tooth wear resulted in uncrowded dental arches. Modern research has demonstrated that as we age, normal mesial drift of the teeth causes crowding in many individuals regardless of whether or not orthodontic treatment was performed; this is why indefinite retention is necessary, and retainers should be offered to all individuals.

Periodontal Considerations
Historically, it was believed that decreasing the space between the roots of teeth was detrimental to the periodontium. After a thorough review of the literature, it is apparent that there is no negative or positive effect when teeth become closer due to slenderization. Investigators studying horizontal and vertical bony defects on posterior teeth found no evidence supporting the viewpoint 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.

According to Fillión, even if slenderization is performed on already aligned teeth and the interdental septum thickness is reduced as a result, the periodontal state is improved. He based this upon the studies of several investigators; Betteridge found that of seventeen slenderization cases, fourteen had an improved gingival index. Boese compared forty patients’ radiographs taken between four and nine years post-treatment and found no significant differences in alveolar crest height.
Crain and Sheridan found no significant differences in the gingival index three to five years post-treatment in 151 interproximal slenderized surfaces. In all of these studies, the enamel reduction was no more than 0.5 mm per proximal surface. I believe that if <0.3 mm or less enamel is removed per tooth surface during slenderization, no effects are noticeable on the periodontal ligament either radiographically or clinically.

Contact Locations
Tooth contours need to be restored after enamel has been reduced to restore the contact back to the proper location. As cutting instruments remove enamel during slenderization, rounded contours are flattened. Re-familiarizing dental shape and anatomy is important when trying to re-sculpt the teeth after space has been made. 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 Hall 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 (Figure 1).

Figure 1. Premolar sanded at contact point on an abrasive wheel.

The enamel thickness studies of Hudson, Gillings, and Shillingburg, allow us to draw the following conclusions: 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 of the teeth present minimal thickness. There is no relation between dental size and enamel thickness; therefore, macrodontic teeth should not be stripped more than microdontic teeth are (although aesthetically it is better to carry out the slenderizing on macrodontic teeth). The enamel is slightly thicker in the contact point, and gradually decreases in thickness toward the cementoenamel junction. The enamel is slightly thinner in distal than in mesial surfaces. In upper cuspids and lower second bicuspid, these differences are greater. The exceptions are upper lateral incisors, whose thickness is slightly greater distally than mesially.

How much enamel can be removed
Orthodontists, who perform the majority of slenderization, do not report negative findings in patients post-treatment or in long-term follow-up.

It is generally recommended to remove only 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 two teeth in contact. It is important to know how much enamel can be removed in individual teeth and cases in order to know which cases can be slenderized and which require a different treatment plan (such as extraction). Several clinicians have provided their recommendations for slenderization. Boese recommends slenderizing half the enamel layer thickness. Berrer claims that lower incisors can be stripped by 4 mm, which corresponds to a 0.5 mm slenderizing per proximal surface of the lower incisors. Paskow allows slenderizing of between 0.25 mm and 0.37 mm. Hudson 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. Tuverson claims that it is possible to wear 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. Alexander permits only 0.25 mm for all the teeth, and Sheridan 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.

A number of authors state that the amount of enamel reduction depends on the shape of the tooth, with triangular teeth allowing a greater reduction. However, studies reveal that there is no relationship between dental shape and enamel thickness; therefore, the only element of decision should be the minimal enamel thickness. It is true, though, that more space is gained with minimal enamel wear in triangular-shaped teeth.

The concept of removing half the enamel layer would seem to be clinically acceptable. According to Fillión, 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 1 mm can be obtained (0.5 mm in distal surface of the first molar and 0.5 mm in mesial surface of the second molar).
When planning orthodontic slenderizing, factors that must be considered include the degree of physiologic abrasion present (contact tips or facets) (Figure 2), whether or not the patient has already undergone orthodontic slenderizing, and the presence of over-dimensioned crowns or fillings (Figure 3).

Figure 2. Normal evolution increases the contact area into a contact surface.

![Figure 2](image1.png)

When performing slenderizing on incisors and cuspids, asymmetries should be compensated for and midlines centered (Figure 4).

Figure 3. Over-dimensioned restorations.

![Figure 3](image2.png)

Figure 4. Slenderizing from cuspid to cuspid must improve the midline and dental symmetry.

![Figure 4](image3.png)

In the case of bicuspids and molars, the cusps should remain intercuspated (Figure 5). The Bolton index is very useful to determine the best zone for slenderizing.

Figure 5. Slenderizing of the posterior teeth must improve the occlusion.

![Figure 5](image4.png)

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 (Figure 6). Otherwise, the teeth will look as if they are incorrectly inclined (Figure 7).

Figure 6. The vertex of the dental papilla and the contact point must be in the same vertical line.

![Figure 6](image5.png)

Figure 7. The teeth appear to have a faulty inclination

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 (Figures 8).
**Indications for Slenderization**

Slenderization is indicated when the treatment goals require space in the dental arches without the removal of teeth. 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 that come into play include tooth position, overjet, and overbite. In many cases, patients present with some type of 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 (Figure 9).

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 the zone where the slenderization should occur is 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 the zone where the slenderization should occur is the upper molars and bicuspid 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 the zone where the slenderization should occur is all the upper teeth.

The same principles are used for lower arch Bolton excess.

**Tooth Shape and Slenderization**

According to Bennett and McLaughlin, we can distinguish three main dental shapes: rectangular, triangular, and barrel-shaped teeth (Figure 11). Dental shape is of great importance in orthodontics. A rectangular shape allows a wide and stable contact point, without visible spaces. A triangular shape allows a reduced and occlusal or incisal contact point. Patients who present with triangular teeth sometimes present with “black gingival triangles”; these can play havoc for the clinician who fails to inform patients that they can occur following orthodontic alignment. Barrel-shaped teeth have a reduced contact point in the middle with apparent separations at the incisal level.

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Figure 8. Measuring the distance from the alveolar bone crest to the contact point area.

Figure 9. Molar-to-Molar Bolton Index (12 teeth)

The same cuspid-to-cuspid relation is 77.2 ± 1.65 (Figure 10).

Figure 10. Cuspid-to-Cuspid Bolton Index (6 teeth).
It is possible that gingival (triangular teeth) or incisal (barrel-shaped teeth) spaces may not be visible at the beginning of the treatment due to the presence of crowding or rotations. It is very important to inform all patients of the potential of the creation of “black triangles” and document it in the chart prior to starting treatment. Ideally, the practitioner should include the solution to this problem in the treatment plan prior to performing orthodontia, regardless of whether fixed appliances or clear aligners will be used. A rule of thumb I live by is that all patients undergoing de-rotation of teeth are informed of the potential of black triangles forming during treatment. Regardless 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 have 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 fewer. 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 (Figure 12). In this case the bracket position should be corrected and slenderization should not be carried out.

The same considerations are valid for barrel-shaped teeth — it is possible to carry out slenderization and reproximation, or incisal reconstructions (Figures 13 and 14).

Dental shape does not have any influence on enamel thickness (Figure 15), so it is not possible to vary the amount of slenderization depending on dental shape.
Triangular and barrel-shaped teeth will often need slenderizing or cosmetic restoration to improve the aesthetics after orthodontic treatment, and 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 truer for rectangular teeth than for teeth of other shapes (Figure 16). That is why tooth uprighting as a space gaining solution is possible only in rectangular teeth.

Figure 16. Sole importance of the rectangular shape as influence on the space occupied by a tooth in the dental arch, in relation to its inclination.

According to Steiner, for each millimeter of protrusion, the discrepancy is reduced by 2 mm. According to Bennett and McLaughlin, the torque enlargement without protrusion also permits a gain of 1 mm per each 5° of radicular palatal torque enlargement (Figure 17).

Figure 17. 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 Rick- etts 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 (Figure 18).

Figure 18. Over-dimensional crowns and fillings.

Bilateral Dental Asymmetries
Depending upon tooth size and available space, slenderization or veneers and crowns are often indicated in order to compensate 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 dental 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 (Figure 19). Many orthodontists purposely flatten out contacts in the lower anterior regions in the belief that relapse can be prevented or at least minimized due to the proximation of the flat contacts.

Figure 19. With Slenderization, contact points can be brought closer to the interdental septum crest.

How Much Space Can Be Created
If a dental arch contains 14 permanent teeth (excluding 3rd molars), and your treatment goal is 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 more than 7.8 mm of space is needed to correct crowding in a dental
arch, additional space can be made by performing other space-making orthodontic techniques, such as proclin-
ing anterior teeth, arch form development, de-rotation of teeth, molar distalization, and dental arch expansion. I reduce only 0.3 mm from each tooth in contact with another tooth.

Contraindications for Tooth Slenderization
Generally speaking, slenderization should be avoided on: small teeth, restored teeth possessing a normal shape, teeth with enamel hypoplasia, and severely rotated teeth for which access to the proper contact area is not accessible (in cases like this, it is recommended to either make room using the separation technique or wait until crowding in the area of the tooth is resolved and space is created). It should also be avoided in patients who refuse to accept slenderization as a treatment option (informed consent is imperative); patients with high caries index, poor hygiene, high bacterial plaque index, or 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
b) Difficulties in paralleling the roots next to extraction sites
c) Need for a greater anchorage reinforcement than in slenderization cases (but the anchorage is fundamental in the slenderization technique, too)
d) Possibility of the space re-opening (relapse), especially in adult patients
e) Unwanted profile changes related to retroclining incisors when closing extraction spaces

When slenderizing, dental movements are smaller than in extraction cases. The slenderization treatments are shorter. The risk of root resorption is also reduced. Some orthodontists believe that contact points between teeth flattened during slenderization are more stable for rotation control, eliminating the relapse risk. Slenderization allows the “black gingival triangles” to be avoided or reduced, dental asymmetries to be compensated, and when needed, dental shape to be improved.

Disadvantages of Slenderization
Techniques which do not emphasize conservativeness, along with operator error, can result in enamel damage or over-reduction. Contours of teeth can easily be destroyed, after which a restorative procedure is required. Performing slenderization with instruments with which the operator can lose control of the procedure, such as ARS (air rotor stripping), is not recommended. This can result in spacing that requires subsequent orthodontic treatment for closure. High-speed spinning diamond disks easily slice teeth, as the disk takes its 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 first and utmost important goal when performing slenderization is to do no harm! Remove enamel only on teeth that can tolerate slenderization. After slenderization, restore tooth contours to the original form as much as possible. Other goals include finishing teeth after slenderization to a nice polished finish using finishing disks or strips. Care should also be taken to replace the contact point between teeth in the correct anatomical location.

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. Leaf gauges provide an accurate and simple way to measure what is being reduced. This measurement of reduction interproximally can be written between the teeth on the chart. Invisalign provides practitioners with their own charts, which is very useful. Using the thickness of a diamond disk or width of a diamond bur to document the amount of 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.
Thickness Gauges/Leaf Gauges
These gauges are readily available and very useful when documenting the amount of tooth structure reduced. It is difficult to measure thicknesses in tenths of millimeters, and the leaves allow for accurate measurements. In the case where a contact is already opened, simple mathematics should be performed to determine space gained by slenderization.

Stainless Steel Strips and Manual Disk Hand Tool
Abrasive strips are available in either single- or double-sided coatings, and come in three grades of coarseness (fine, medium, and coarse). I recommend using the thinnest brand available, and the finest coarseness. I use strips only when the teeth are so rotated that a disk is not appropriate. The thin, fine strips allow you to pass through any contact, regardless of the rotation and angulation of the teeth in contact. After a strip is passed through the contact, access with a diamond disk is easier, more predictable, and more effective. Strips are useful for re-contouring teeth that have already been reduced. They are also helpful when slenderizing on apprehensive patients, especially at the first visit; patients are less apprehensive if you perform slenderization with your fingers and a strip the first time, rather than with a motorized handpiece.

Spee Corp has introduced a new manual disk hand tool, which uniquely allows the dentist to use a disk and hand—contour teeth. As the new or used disk is placed into the handle, the edges are bent towards the operator, creating a contoured hand tool.

Diamond Disks (High Torque)
There are many diamond disks on the market, and I recommend using the thinnest disk available. The thinnest disk available is approximately 0.17 mm, which allows for 0.2 mm of slenderization after polishing. Using single-sided disks exclusively, keeps the initial contact break as small as possible, and ensures that only one tooth is being cut a time.

Disks come in varying grits and sizes, similar to strips; coarse, medium, and fine. I find that using a fine grit is sufficient for all my slenderization procedures. I recommend using a 19 mm disk, and a clear disk guard.

There are two disks that I use at every slenderization appointment, an up and down. The up and the down refers to the side on which the disk is coated with diamonds (Figure 23).

If you are using a high torque system, be certain to use high-torque disks. They are manufactured to withstand the low speeds delivered with a high torque motor.

ARS (Air Rotor Slenderization) Burs and Diamond Disks
It is difficult to be conservative when performing air rotor slenderizing with a conventional air-turbine handpiece. The majority of dentists use air-powered high-speed motors that rotate as fast as 200,000 rpm, and slow-speed motors that rotate at either 20,000 rpm or 5,000 rpm. However, it is difficult to get a controlled degree of cutting power even when slowing down the turbine using the foot pedal or air-attenuator. 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. Air rotor slenderization is hard to control.

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.

ERS (Electric Rotor Slenderization)
Burs and Diamond Disks
The endodontic profession discovered electric motor cutting technology over two decades ago, using high-torque, low-speed motors to spin endodontic files. I have switched to using all electric motors in my practice and use high-torque, low-speed electric motors for orthodontic slenderization, and named the procedure electric rotor slenderization (ERS). Electric handpieces can reach the same speeds as air turbines but allow 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. ERS makes possible control of the amount of tooth slenderization.

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. The fastest speed I use when performing disk slenderization is 500 rpm. Two systems are capable of spinning a diamond disk at sufficient torque to perform ERS. Spee Corporation (San Diego, CA), has configured two such systems. Not all electric motors can be used when performing diamond disk slenderization. A system that is configured for disk slenderization is necessary, as at low speeds <1000 rpm) most electric motors can not deliver the torque needed to safely cut enamel, and the rotating disk will stop (similar to air turbines). 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. For Invisalign cases, the Slenderization sheet they provide with every case can be used as a guide. Each visit’s reduction should be documented on the actual chart.

1. 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. In Figure 24, I have numbered the picture based on the order in which slenderization is being performed. This lets you move the teeth into the newly created space, opening up the contacts between the teeth where there was previously no access.

2. Break the contact with a single-sided diamond-coated strip, or the new manual disk hand tool (Figure 25). Do this first on every contact area being slenderized, opening each contact. As stated before, the hand instrumentaion lets you show the patient how simple and pain-free the slenderization experience will be.

3. 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 (Figure 26). In 2007, Spee Corp will be introducing the first clear disk guard (Figure 27), which will replace the metal disk guards that are impossible to see through. The space made will equal the thickness of the single-sided, high-torque diamond disk (0.17 mm). The handles on the clear disk guard also allow for gripping the disk at the exact point where the cutting is occurring.
3. Make the initial measurement using a leaf gauge. 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.

4. When completely satisfied with the amount of space created, use a finishing technique to polish the surface. Using the manual disk hand tool and bending the disk into a concave shape works well. This enables quick and efficient polishing to achieve rounded contours that were flattened during slenderization, and is much easier to use than other strips or hand-held systems. Depending on where the contact between the teeth is being restored, the height of the cutting surface on the bent disk can be adjusted, and it can be slid up or down during hand polishing.

A diamond or carbide polishing bur can also be used in an electric motor handpiece, keeping the bur spinning at approximately 500 rpm.

**Separating Teeth**

Many techniques involve using a wizard wedge or other wedge to open up contacts prior to slenderization. I find this is not necessary when using a single-sided diamond-coated disk with a high-torque electric motor; the disk easily moves through the contact with no discomfort to the patient or danger to adjacent teeth. Using separators can be painful for patients and also means that slenderization visits must be spaced out due to the 5-day wait for separators to act; this results in a simple single or double appointment turning into 5 to 10 visits. Additionally, once space is opened up using separators, it is very difficult to measure the space being created with slenderization cutting instruments, because teeth that have been separated present with 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.

**Additional Considerations**

**Slenderize Contacts Only**

Due to severe malpositioning of teeth, it is often necessary to slenderize between teeth in which false contacts exist. In the example in Figure 28, the arrow indicates the contact between the upper right lateral incisor and upper right central incisor because it is on the palatal surface of the tooth. Slenderization should not be done on the upper right central incisor because it is on the lingual surface of the tooth. Slenderization 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. Using single-sided strips and disks on a high-torque electric motor with the appropriate handpiece allows slenderization to be fast, accurate, and safe.

**Slow It Down**

It is highly recommended to not create too much space! Perform slenderizing procedures frequently and remove only minimal amounts needed for the tooth movement being accomplished. For example, if the Invisalign slenderization chart states that 0.5 mm is needed between two teeth, perform less than 0.2 mm per appointment to prevent over-reduction. Then use dental floss between aligner delivery (3 trays per time) to assess the amount of space. If too much space has been created, the case can be impossible to complete due to excessive instrumentation. Expert witness/orthodontist/attorney Sanford Aaronson, DDS states that he has provided expert witness services in many cases where dentists have removed too much enamel during orthodontic treatment, with the result that crowns were needed to restore the contacts. In all cases, the dentist who performed the IPR lost the case. Take your time and do no harm!

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Author Profiles

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Dr. Florman received his dental degree from the Ohio State University and completed his post graduate training in Orthodontics at New York University. Dr. Florman is a Diplomate of the American Board of Orthodontics, and has been practicing dentistry since 1991. He is highly respected as both an orthodontist and an educator. He has authored over forty scientific publications in the field of dentistry and medicine. Dr. Florman was the Executive Program Director for PennWell, a national dental continuing education organization. He is also an active clinical advisor to many pharmaceutical and dental companies. He is a member of the American Dental Association, California Dental Association, and the American Association of Orthodontists.

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Dr. Lobiondo received his DDS from the University of Montevideo, Uruguay. His practice is limited to Orthodontics. He lectures at courses and conferences in Spain, USA, Canada, France, Italy, Portugal, Monaco, Germany, Korea, Brazil, Argentina, Peru, Chile, and Uruguay. He is the President of the SIAOL (Sociedad Iberoamericana de Ortodoncia Lingual), 6th President of the ESLO (European Society of Lingual Orthodontics), Barcelona, Spain, 2004, and Coordinator of the Scientific Commission of COEC (Catalonian Dental Society). He also is the Vice President of the Scientific Commission of AIO (Iberoamerican Association of Orthodontists, and a collaborating professor at the department of Master in Orthodontics at the University of Barcelona, Spain.

Mahtab Partovi, DDS

Dr. Partovi received her dental degree from New York University College of Dentistry. She works for PennWell. Dr. Partovi is presently managing two clinical orthodontic studies and plans on pursuing a specialty degree in the field of orthodontics in the near future. She is a member of the American Dental Association and the California Dental Association.

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Questions

1. If space is required for orthodontic treatment, the space can be obtained by _________.
   a. Extraction
   b. Expansion
   c. Slenderization
   d. All of the above

2. In 1902, Black published a text that discussed _________.
   a. Natural expandable space
   b. The demise of man
   c. Natural slenderization
   d. None of the above

3. Bolton found tooth discrepancy sizes in approximately ________ of his patients.
   a. 15 percent
   b. 25 percent
   c. 30 percent
   d. 44 percent

4. Both Sheridan and Fillion contributed to the development of orthodontic slenderization.
   a. True
   b. False

5. The studies of Begg and Murphy confirm that orthodontic slenderizing is never necessary in order to increase stability.
   a. True
   b. False

6. ________ found the relation between dental size and crowding.
   a. Harry Sicher
   b. Ballard
   c. Peck and Peck
   d. Begg and Murphy

7. All clinicians have the same recommendation as to how much enamel can be slenderized.
   a. True
   b. False

8. Bolton determined that the relationship between upper and lower molar-to-molar tooth size is _________.
   a. 77.2 +/- 1.65
   b. 91.3 +/- 1.91
   c. 65.2 +/- 1.91
   d. None of the above

9. If the “6-teeth” Bolton index is accomplished, the ________ is obtained.
   a. Molar Class I Relationship
   b. Cusp Class I Relationship
   c. Incisor Class I Relationship
   d. All of the above

10. According to Bennett and McLaughlin, the main dental shape we can distinguish is _________.
    a. Barrel-shaped
    b. Rectangular
    c. Triangular
    d. All of the above

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

12. Rotations can obscure triangular teeth at the start of treatment.
    a. True
    b. False

13. 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

14. According to Steiner, for each mm of protrusion, the discrepancy is reduced by _________.
    a. 1 mm
    b. 2 mm
    c. 2.5 mm
    d. None of the above

15. A torque increase of ________ degrees without protrusion allows a gain of 1mm of space.
    a. One
    b. Two
    c. Three
    d. Five

16. The “golden proportion” described by Ricketts is _________.
    a. Between upper central incisors and lateral incisors
    b. Between lower central incisors and lateral incisors
    c. Between upper cusps and lateral incisors
    d. None of the above

17. Adults show more pulp retraction to slenderization than younger patients.
    a. True
    b. False

18. It is recommended to slenderize ________ of the enamel.
    a. All
    b. None
    c. Most
    d. None of the above

19. ________ can be used for polishing procedures to obtain a smooth surface.
    a. Diamond bur and high-speed handpiece
    b. Tungsten carbide bur and high-speed handpiece
    c. Diamond disk and hand technique
    d. None of the above

20. Orthodontic slenderizing should be reserved for patients with _________.
    a. Severe crowding
    b. Low caries risk
    c. Good oral hygiene
    d. b and c

21. Advantages of orthodontic slenderizing include _________.
    a. A shorter treatment time
    b. A longer treatment time
    c. A better end result
    d. None of the above

22. Leaf gauges provide an accurate and simple way to measure what is being reduced.
    a. True
    b. False

23. ________ found that the periodontal state is improved if the interdental septum thickness is reduced when closing spaces.
    a. Betteridge
    b. Crain and Sheridan
    c. Didier Fillion
    d. None of the above

24. Betteridge studied seventeen slenderizing cases. Out of those, ________ had an improved gingival inflammation index.
    a. 5
    b. 10
    c. 13
    d. 14

    a. 2 to 10
    b. 4 to 9
    c. 10 to 15
    d. None of the above

26. Orthodontic slenderizing results in movements that are ________ than after orthodontic extractions.
    a. Less complete
    b. Smaller
    c. Wider
    d. None of the above

27. In the enamel thickness studies of Hudson, Gillings and Buonocore, and Shillingburg and Grace, enamel thickness was found to gradually decrease toward the cementoenamel junction.
    a. True
    b. False

28. A slenderization chart is used to _________.
    a. Measure the amount of space you need to create
    b. Document the amount of reduction at each tooth surface
    c. Determine if too much enamel has been removed
    d. None of the above

29. A low-speed, high-torque electric handpiece gives ________ during slenderization.
    a. More control
    b. More accuracy
    c. Less tooth movement
    d. a and b

30. When planning slenderization, ________ must be taken into account.
    a. The shape of the tooth
    b. The thickness of the enamel
    c. How severely the teeth are rotated
    d. All of the above
Mastering Interproximal Reduction

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?  
   Objective #1: Yes No  
   Objective #2: Yes No  
   Objective #3: Yes No  

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?

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