



Smile Design for the Adolescent Patient — Interdisciplinary Management of Anterior Tooth Size Discrepancies

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ABSTRACT Adolescent patients often seek orthodontic treatment to correct spacing of the maxillary anterior teeth. If the spacing is caused by a tooth size discrepancy that affects one or more anterior teeth, an interdisciplinary treatment plan involving orthodontic, restorative, and periodontal treatment is recommended to achieve a harmonious esthetic result. This article describes a clinical approach for treatment of these complex cases, focusing on the importance of tooth form, gingival esthetics, and treatment sequencing.

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Despite the increase in adult orthodontic treatment demand over the last few years, children and adolescents still comprise the majority of the orthodontic patient population. Within this younger population, there has been a shift from traditional treatment goals, such as ideal occlusion and cephalometric standards, to include goals embodying principles of micro-esthetics and soft tissue harmony.^{1,2} This has caused the orthodontic profession to place a greater emphasis on gingival esthetics, tooth form, and on interdisciplinary care in general. One area in which all of these principles can be directly applied is the

interdisciplinary treatment of anterior tooth size discrepancies (TSD).

A TSD in the adolescent patient involving a diminution of maxillary anterior tooth size or altered tooth morphology may cause multiple anterior esthetic concerns such as interdental diastemata, gingival margin discrepancies, and poor clinical crown proportions. Treatment is complicated by the fact that the dento-gingival complex is subject to significant growth-related changes during the treatment period. In this patient population, an esthetic and stable result is best achieved by combined interdisciplinary care of the orthodontist, periodontist, restorative dentist, and pediatric dentist.

The contemporary interdisciplinary team is skilled at correcting a single tooth discrepancy, such as a small lateral incisor.^{3,4} However, when additional anterior teeth are involved, or when other significant hard and soft tissues discrepancies are present, a more thorough interdisciplinary approach is necessary to achieve excellent results. Clinical observation has led to identification of eight important factors when considering interdisciplinary treatment of significant anterior TSD.

Tooth Size

When the clinician is planning the correction of interdental spacing, a thorough tooth size analysis should be performed to determine the existence of a TSD. This should be done by measurements of individual teeth with a caliper that registers measurements within a 10th of a millimeter, and by performing a Bolton analysis, which compares the overall tooth mass in one arch relative to the other and can detect a TSD.⁵ Othman and Harradine recommend a 2 mm discrepancy to be considered as a clinically significant threshold.⁶

If no TSD is detected, the space can often be closed successfully with orthodontic treatment alone (FIGURE 1). If, however, the tooth size analysis confirms that a TSD indeed exists, interdisciplinary treatment to enhance the size of the anterior teeth should be considered. Often, the first step in treatment planning is a diagnostic wax-up, which serves as a blueprint for the subsequent interdisciplinary treatment (FIGURE 2), and may be performed by the members of the interdisciplinary team, or by a skilled lab technician.⁴ This step is especially important when the patient is missing one or more teeth, either as a result of traumatic loss or congenital absence.



FIGURE 1A. A patient with generalized spacing, but no measurable tooth size discrepancy.



FIGURE 1B. No interdisciplinary treatment was necessary and spaces were closed with orthodontic treatment alone.



FIGURE 2A. An adolescent patient with a generalized TSD characterized by a peg lateral No. 7, tapered and narrow central incisors, and congenitally missing No. 10.



FIGURE 2B. A diagnostic wax-up allowed the interdisciplinary team to envision the final size and shape of teeth Nos. 7-9, and helped to determine the correct amount of space to be left for implant replacement of No. 10.



FIGURE 3. This 13-year-old female presented with a chief complaint of spacing. Note the peg lateral No. 7 and the tapered (shovel-shaped) central incisors. Interdisciplinary treatment with orthodontic space management and cosmetic composite resin bonding of Nos. 7, 8, and 9 resulted in satisfactory dental esthetics. Failure to address the morphology of the central incisors would have caused esthetic failure of the case, due to a lack of proper mesial and distal contours, contact points, and embrasure spaces.

Tooth Form

The maxillary lateral incisor is commonly affected by the TSD and may present with a deficient mesio-distal width and inciso-gingival height. A specific phenotypic variant of the small lateral incisor is the "peg" lateral incisor (FIGURE 3), in which there is a characteristic conical shape of the clinical crown that tapers from the cervix of the tooth towards the incisal edge.¹⁴ The maxillary central incisor may also be involved in the TSD, and often displays a flat and tapered mesial or distal contour (FIGURE 3). TSD of the central incisor is often over-

looked, but is important to address as part of the overall treatment plan due to the prominent position of the central incisor in the dental arch.⁷ When the canine is involved in the TSD, a "hooked" appearance of the canine may be unesthetic and create the perception of interdental spacing. This type of canine may benefit from inclusion in the restorative treatment phase.

Tooth Proportions

Achieving ideal tooth shape and proportion is an important goal of esthetic and interdisciplinary dentistry



FIGURE 4A. This 14-year-old male presented with generalized spacing caused by an anterior TSD affecting the morphology of all four maxillary incisors. In addition, No. 11 was impacted, and there was a mandibular asymmetry causing the mandibular dental midline to deviate to the left.



FIGURE 4B. Poor smile esthetics.



FIGURE 4C. Bracket on No. 10 was placed more incisally than usual to maintain the gingival margin height and avoid extrusion of the dento-gingival complex. Vertical space was created for lengthening No. 10 restoratively.



FIGURE 4D. All four incisors were bonded. Note the increased length of No. 10. After the bonding, it appeared that the central incisors were distally inclined due to the addition of composite on the distal aspect, so the central incisors were rebracketed to tip the crowns slightly mesially.



FIGURE 4E. Six-month post-treatment. No. 11 has gingival recession due to its initial ectopic eruption and will need a gingival graft.



FIGURE 4F. Post-treatment smile. Note the improvement in facial esthetics due to restoration of proper tooth form and arch width.



FIGURE 4G. Pretreatment dental cast: Anterior view.



FIGURE 4H. Pre-treatment dental cast: Maxillary occlusal view.



FIGURE 4I. Post-treatment dental cast: Anterior view.



FIGURE 4J. Post-treatment dental cast: Maxillary occlusal view.

and is increasingly becoming a routine part of orthodontic treatment goals.⁸ The width-to-length ratios of the maxillary central and lateral incisors are 78-85 percent and 73-76 percent respectively.^{9,10} The tooth-to-tooth width ratio of the maxillary lateral and central incisors has been recommended to be between 50-74 percent based on visual assessment by lay people and dentists, but is closer to 78 percent if based on available data of tooth widths.¹¹ Significant deviations from ideal

clinical crown proportions may be caused by a TSD, incisal attrition, altered passive eruption, or gingival inflammation.

When a TSD only affects the lateral incisors, the central incisors may be used as a guide to establish the appropriate width of the lateral incisors based on ideal inter-tooth proportions. However, when the central incisors are also involved in the TSD, the interdisciplinary team must carefully plan for the restoration of both the central

and lateral incisors. This requires the practitioner to determine the ideal width of all four incisors and should be accomplished by means of a diagnostic wax-up, provisionalization, or by careful measurement and observation.

Occlusion

If a patient has a significant overjet, such as in a moderate or severe class II malocclusion, a reasonable treatment plan may involve closing the maxillary spacing with orthodontics alone, even in the presence of a documented TSD. This will allow reduction of the overjet by retraction of the anterior teeth. If, however, a patient does not exhibit excess overjet, such as in a class I or class III malocclusion, closing the space orthodontically without restorative dentistry may be detrimental for the functional occlusion due to possible over-retraction of the incisors. This may cause multiple long-term problems such as increased occlusal wear on the anterior teeth, crowding of the lower incisors, or relapse of the spacing. Furthermore, orthodontic space closure may lead to a constriction of the anterior arch width and may adversely affect smile esthetics.

Incisal Edge Position

Although a decreased mesial-distal width of an anterior tooth is often the most obvious element of a TSD, it is common for an anterior tooth, particularly the lateral incisor, to also be vertically deficient.⁴ Addressing the vertical aspect of tooth form with an interdisciplinary approach will help establish the proper width-to-length ratio of the clinical crown, and will enable the restorative dentist to create an esthetically pleasing restoration.

To meet the demands of normal occlusion and acceptable esthetics, the incisal edge of the maxillary lateral incisor should be slightly apical to the incisal



FIGURE 5A. A 13-year-old female presented with a class I occlusion, with bilateral maxillary impacted canines and a TSD affecting the morphology of the maxillary central and lateral incisors.



FIGURE 5B. Intraoral view displaying interdental spacing, small tooth size, and a gingival margin height discrepancy between the central and lateral incisors.



FIGURE 5C. The lateral incisors were orthodontically intruded to correct the gingival margin discrepancy between the central and lateral incisors.



FIGURE 5D. After the gingival margins were leveled, direct composite restorations were performed on all four maxillary incisors and the brackets were replaced.



FIGURE 5E. The shape of the composite restorations was adjusted in the finishing stage of orthodontic treatment with an abrasive strip.



FIGURE 5F. One-year post-treatment photograph shows that a stable and esthetic result was achieved through the combined efforts of the interdisciplinary team.



FIGURE 5G. Excellent smile esthetics due to enhancement of tooth size and proper alignment of gingival margin.



FIGURE 5H. Pretreatment dental cast: Anterior view.



FIGURE 5I. Pretreatment dental cast: Maxillary occlusal view.



FIGURE 5J. Post-treatment dental case: Anterior view.



FIGURE 5K. Post-treatment dental case: Maxillary occlusal view. Note the harmonious anterior tooth size.



FIGURE 6A. A 13-year-old male presented with small maxillary lateral incisors. Orthodontic treatment was initiated to center the lateral incisors in preparation for restorative treatment to enhance their mesial-distal width.



FIGURE 6B. Prior to the restorations, short clinical crowns were noted. Gingival inflammation (due to poor oral hygiene) and excessive pocket depth were the main etiologies of the short crown height.



FIGURE 6C. Excisional gingivectomies were performed prior to the composite bonding to increase the clinical crown length.

edge of the central incisor. However, if the incisal edge of the lateral incisor is in an excessively apical position relative to the adjacent central incisor, yet the gingival margin is in the correct vertical position, the lateral incisor should be maintained in this vertical position during orthodontic treatment and will be restored to its proper incisio-gingival length during the restorative phase (FIGURE 4). It is important for the orthodontist to consider this factor when determining the initial vertical position of the bracket. The lateral incisor bracket should be placed further incisally than usual, to avoid extruding the incisal edge and the gingival complex.

Gingival Margin Position

Gingival considerations must also be considered when assessing the vertical dimension of maxillary anterior teeth, particularly the lateral incisor. If the incisal edge of the lateral incisor is in a normal vertical position, but the gingival margin is coronal to its ideal position, the tooth may be intruded during orthodontic treatment to achieve a harmonious



FIGURE 6D. Direct composite veneers were placed on Nos. 7 and 10.



FIGURE 6E. Brackets were replaced for orthodontic finishing.



FIGURE 6F. Intraoral view on the day of orthodontic appliance removal.



FIGURE 6G. The finished result with regard to gingival and smile esthetics.



FIGURE 7A. Fourteen-year-old female undergoing phase II orthodontic treatment.



FIGURE 7B. Note the generalized spacing caused by a severe TSD. Due to the harm that orthodontic space closure and retraction of the incisors may have caused to the patient's facial esthetics, an interdisciplinary plan was initiated to ultimately restore all six maxillary anterior teeth.



FIGURE 7C. Following initial orthodontic space management, the space was limited to the maxillary anterior teeth.



FIGURE 7D. Maxillary occlusal view of orthodontic space preparation.



FIGURE 7E. Due to the short clinical crown heights of the lateral incisors, orthodontic intrusion was necessary to level the gingival margins and achieve a pleasing gingival esthetic outcome.



FIGURE 7F. Composite restorations were planned for all six anterior teeth. At this stage, the maxillary incisors have been bonded to an ideal width in order to determine the proportions of the lateral incisors and canines. The orthodontic brackets were replaced when the restorations were completed.

gingival margin relationship with the adjacent teeth¹² (FIGURE 5). The restorative phase will then involve vertical restoration of the incisal edge (in addition to the mesial-distal enhancement).²⁴

If a coronally positioned gingival margin is due to inflammation (FIGURE 6) or altered passive eruption of the gingival tissue (FIGURE 7), an excisional gingivectomy may be performed prior to restoration to achieve the desired height of the restoration and contour of the gingival margin.¹² If the coronally positioned gingival margin is due to altered passive eruption of the osseous crest, periodontal treatment should be delayed until growth has ceased, at which time esthetic crown lengthening procedures with definitive osseous surgery should be performed to allow for establishment of the correct biologic width and to provide long-term stability of the corrected gingival margin.¹³

Restorative Material

Restoration of small maxillary incisors in the adolescent patient is often done with direct composite resin bonding.³

Contemporary composites are esthetic, durable, and relatively affordable. Another advantage of composite resin is that it can be adjusted, if necessary, while the patient is still undergoing orthodontic treatment. The main disadvantage of composite resin is the potential for discoloration or degradation, and therefore the possible need for multiple replacements over the lifetime of the patient.

Another option for restorative materials is a lab-fabricated, indirect porcelain restoration, such as a veneer or a crown. While porcelain may offer excellent esthetics and may have a longer life span than composite, the main clinical disadvantage of a porcelain restoration for treating adolescent patients with a TSD is that it can only be placed after completion of orthodontics. Thus, the ability to use orthodontics to fine-tune spacing and crown form (FIGURES 4 AND 5) after the restorative treatment is lost.

It is also important to consider that the typical adolescent patient may undergo a number of years of vertical growth and general maturation of

the gingival tissues after completion of orthodontic treatment. It may therefore be prudent to delay definitive porcelain restorations until vertical growth has ceased and stable gingival margins are achieved. At that point, the composite restorations can be removed and be replaced with veneers or crowns, depending on the amount of underlying tooth structure.

Treatment Timing and Sequencing

Treatment of adolescent patients displaying a significant TSD should be initiated when the patient has a full complement of permanent teeth, in order for the restorative dentist to have good access to the clinical crown during the restorative phase of interdisciplinary treatment. It is advantageous to perform composite restorations during active orthodontic treatment in order to enable ideal spacing prior to the restorative phase and to allow for any necessary modification of the spacing or restorations during the finishing stages of orthodontics. On the day of the restorations, the brackets should be

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FIGURE 7G. The second stage of the restorative treatment involved enhancement of the lateral incisors and canines. The short clinical crown height on the canines was due to altered passive eruption and was addressed with excisional gingivectomies to allow restorative access to the distal of the lateral incisors and the mesial of the canines.



FIGURE 7H. Two-week healing of the gingivectomies was excellent.



FIGURE 7I. Six-month post-treatment photographs.



FIGURE 7J. Interdisciplinary treatment of the anterior teeth created good tooth proportions.



FIGURE 7K. Three-quarter view. Excellent smile esthetics were achieved by restoring the anterior teeth to a normal size and by avoiding orthodontic retraction of the anterior teeth.



FIGURE 7L. Another view of smile esthetics. Porcelain veneers are planned on all six maxillary anterior teeth after final maturation of the gingival tissues to improve the shade match and to provide a long-term restorative solution. Since mild gingival asymmetry remains, further crown lengthening with removal of osseous tissue may be indicated at that time.



FIGURE 8A. A 13-year-old female presented for orthodontic treatment with generalized maxillary spacing, congenitally missing maxillary right lateral incisor (No. 7), and a small left lateral incisor (No. 10).



FIGURE 8B. Since the maxillary midline was deviated to the right, routine orthodontic mechanics to move the midline to the left could have caused space loss for restoration of No. 10.



FIGURE 8C. A decision was made to bond No. 10 early in treatment to prevent restorative space loss during midline correction, and to help the orthodontist develop a symmetric space for No. 7 implant restoration.



FIGURE 8D. At the conclusion of orthodontic treatment, an acceptable tooth size was accomplished for No. 10 and a symmetric amount of space was left for No. 7.



FIGURE 8E. Hawley retainer with pontic for No. 7.



FIGURE 8F. The final result shows correction of the midline, and proper space preparation for the eventual implant restoration of No. 7.

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removed by the orthodontist to allow for unfettered restorative access, and then should be replaced when the restorations are completed.⁴ The restorative dentist should not attempt to fill all of the space, but should rather focus on achieving ideal crown form. If spacing remains, it will be closed by the orthodontist in the finishing stage of orthodontic treatment.

In cases with a congenitally missing lateral incisor and a contralateral small or peg lateral incisor, it is especially important to restore the small lateral incisor during the early stages of orthodontic treatment, prior to definitive space management. Early restoration of the appropriate width of the small lateral incisor serves as a guide for the space that should be left for replacement of the contralateral missing lateral incisor (FIGURE 8) and will avoid loss of restorative space for the small lateral incisor while configuring the space for the missing lateral incisor.

When a generalized TSD affects both the central and lateral incisors, restoration can be performed either simultaneously or in two stages. For the latter, the central incisors should generally be restored first (FIGURE 7) to set the proper proportions for the lateral incisors.

Discussion

The specific goals of treating adolescents with tooth size discrepancies are: the attainment of excellent static and functional occlusion, excellent gingival and smile esthetics, and harmonious tooth form. In most cases, these goals can best be met with an interdisciplinary approach.¹⁴ By applying contemporary principles of smile design to each case, and following an appropriate sequence of treatment, clinical success can readily be achieved. In addition to orthodontic space management in the horizontal dimension, vertical tooth position and vertical

gingival margin control are important in achieving an ideal restorative result.

Patients considering treatment for significant TSD should undergo a thorough informed consent process to understand the scope of work — orthodontic, periodontal, and restorative — that may be needed to achieve a satisfactory result. Patients must also be aware that ongoing maintenance of the restorations may be needed, and that they may best be served over the long term by converting composite restorations into porcelain restorations when gingival development is complete.

Conclusion

This article has outlined clinical principles for treating adolescent patients with a significant TSD. The comprehensive interdisciplinary approach should include the following distinct stages:

- 1) Interdisciplinary diagnosis and treatment plan.
- 2) Orthodontic space management. Leveling and alignment of the dentition, achievement of an ideal static and functional occlusion, and management of mesial-distal positioning of the maxillary anterior teeth in preparation for the restorative treatment.
- 3) Vertical management. Assessment of the incisal edge/gingival margin relationships for possible need of orthodontic intrusion, excisional gingivectomies, or definitive crown lengthening procedures.
- 4) Restorative phase. Ideal restoration of anterior teeth with direct composite resin bonding, based on principles of tooth form and proportionality.
- 5) Finishing. Orthodontic finishing details and modification of the composite restorations, as needed.
- 6) Retention/Long-term follow-up: Establishment of an effective orthodontic retention plan and a long-term follow-up protocol to monitor stability of the

interdisciplinary result. In addition, the future option of definitive restorations with porcelain veneers or full-coverage crowns should be fully discussed. ■■■■

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