

## Orthodontics

### Correction of Class III Posterior Cross-bite with Maxillary Midline Diastema in an Adult Patient using Invisalign®: Report of two cases



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## Abstract

Correction of Class III malocclusions with maxillary deficiency and posterior cross bites in adults can be challenging. Depending upon the severity of the malocclusion treatment options include comprehensive orthodontic treatment with or without surgical aid. With advent of clear aligners systems as Invisalign many patients are seeking orthodontic treatment as an alternative to comprehensive orthodontic treatment with traditional fixed braces.

Two cases with posterior cross-bites are presented here. The first case of a 17-year-old female illustrates the difficulty in correcting posterior cross-bites and the second case of a 35-year-old female demonstrates the treatment of posterior cross-bite and maxillary midline diastema using clear aligners (Invisalign®).

The exploration of using Invisalign® combined with palatal expanders in conjunction with removable elastics to gain desired results was shown to be a useful device for orthodontic correction.

It is described to aid the clinician in the management of maxillary transverse deficiency in skeletally mature patients who desire non-traditional methods.

### || Key Words

Cross-bite, Diastema, Expansion, Invisalign®, Orthodontic Force, Thermoplastic Appliance.

## || Introduction

Malocclusion is commonly found in adults and observed in equal or greater frequency than in children and adolescents.<sup>[1]</sup> Some of the most common problems in adults are crowding, affecting about 24% of women and 14% of men, and spacing, affecting 8% of women and 13% of men.<sup>[1]</sup> Typically those treated by fixed orthodontics show an increase in gingivitis and plaque, while some even experience irreversible bone loss<sup>[2,3]</sup> and decalcification.<sup>[4,5]</sup> However, when clinicians select the appropriate appliance that produces the right force to correct the malocclusion, many enjoy the benefits of orthodontic treatment. Adults are often reluctant to wear fixed appliances despite their need for orthodontic treatment. But with the increased awareness of patients of the need for good oral health and the increase in aesthetic requirement from society, the demand of orthodontic treatment to correct malocclusions without fixed appliances have increased.<sup>[6,7]</sup> In an aesthetically agreeable approach, the Invisalign® system makes it possible for adult patients requiring orthodontic treatment.

The use of clear aligners to move teeth is documented in various articles.<sup>[8-11]</sup> In particular, the Invisalign® appliances for treating malocclusions have recently been described by several different authors whose cases involve extractions, deep bites, anterior and posterior cross-bites, and periodontal complications.<sup>[12-14]</sup> In these patients, the appearance of the smile is their main treatment goal. This article describes the treatment of a unilateral posterior cross-bite with maxillary midline diastema with the Invisalign® system in conjunction with palatal expander and class III elastics. It describes two similar cases of posterior cross-bite, similar malocclusion but with varying results.

A posterior cross-bite can be dysfunctional and unaesthetic as it is a lateral misalignment of the dental arch, where the maxillary posterior dentition is lingual in relation to the mandibular dentition. In a unilateral posterior cross-bite due to shift, one side of the dentition is affected and in order for the posterior dentition to meet together, the lower jaw will have a centric relation-centric occlusion lateral functional shift. This abnormal transverse maxillary/mandibular constriction is a major factor in several malocclusions.

Several methods have been employed to correct a maxillary transverse deficiency in patients including

widening the maxilla, surgically or non-surgically. Other methods may include treating the cause of the cross-bite (e.g. thumb sucking habits, tongue thrust). Although the correction of posterior cross-bite can be complex,<sup>[15]</sup> maxillary expansion is a common orthodontic treatment used for the correction of cross-bites resulting from reduced maxillary width.<sup>[16]</sup> Correction of maxillary transverse deficiency is routinely done in young patients; however, in a skeletally mature patient the osseous articulations of the maxilla with the adjoining bones make it more challenging to treat.<sup>[17]</sup> Hence, once the patient has been properly diagnosed, it is necessary to select the appropriate modality and to determine when adequate expansion has been achieved and how to retain it.

The fundamental basis for deciding between surgical vs non-surgical expansion for the correction of reduced maxillary widths, by most clinicians, has been the patient's chronological age, as well as their skeletal age.<sup>[18]</sup> It is possible that a chronologically advanced patient is skeletally immature, or vice versa, making skeletal age a very important parameter for case selection. For the predictable correction of posterior cross-bite in adults, it ideally requires surgical expansion; however, these can be associated with certain complications that include significant hemorrhage, gingival recession<sup>[19]</sup> pain, root resorption<sup>[20]</sup> maxillary nerve injury, infection, periodontal breakdown,<sup>[21]</sup> sinus infection,<sup>[22]</sup> and asymmetrical expansion.<sup>[23,24]</sup>

Non-surgical expansion using the Haas/Hyrax rapid palatal expansion (RPE) has been, for the most part, limited to growing patients.<sup>[15]</sup> However, a few articles state that non-surgical expansion is as successful in adults as it is in children.<sup>[15,25]</sup> Most of the correction of maxillary transverse deficiency in an adult occurs at the lateral alveolar process rather than at the skeletal base of the maxilla,<sup>[25]</sup> producing a combination of dentoalveolar modification and dental tipping to correct posterior cross-bite. Although less invasive than surgical expansion, palatal expanders do pose potential complications including pain, tissue swelling, posterior teeth tip, mandibular rotation, and gingival recession.<sup>[26]</sup>

The attempt to correct posterior cross-bites with removable elastics is often limited to buccal flaring of the teeth as well and can cause chronic imbalance of the posterior dentition where the lingual cusps

strike the mandibular teeth first.<sup>[27]</sup> Therefore, in the case of adults, surgical expansion may be required or compromise accepted with flare.

Invisalign® might not be as effective as fixed braces for a few reasons. Primary among them is compliance. It is generally a disadvantage to the clinician where treatment efficacy lies in the hands of the patient, as the appliance can be easily removed. Removable appliances produce intermittent forces, and if not continued for enough hours of the day, they don't have significant effects on tooth movement.<sup>[28]</sup> When the removable appliance is taken out, intermittent forces drop to zero and only when the appliance is reinserted into the mouth do the forces return.

The optimum force for traditional orthodontic tooth movement is 10-100g, where the values depend on the type of movement and size of the tooth. These forces are not affected by the patient and produce more tooth movement than removable appliances unless the removable appliance is continuously present.<sup>[28]</sup> Decreased tooth movement is observed when these removable appliances are worn for shorter durations of time.

Another reason Invisalign® fails is that the occlusion is minimally addressed.<sup>[29,30]</sup> According to Vlaskalic and Boyd,<sup>[31]</sup> while assessing Invisalign® occlusal outcome, it became apparent to them that similar results could have been reached with traditional braces in less time. They concluded that the most important aspects of Invisalign® over braces are that they are aesthetically pleasing, comfortable, and removable, and they reduced plaque accumulation resulting in improved periodontal health.<sup>[32]</sup> However, there are no biomechanical advantages.<sup>[31]</sup>

## || Case Report

### Case 1

#### Diagnosis and Treatment Objectives

A 17-year-old female presented with a bilateral, symmetrically constricted posterior cross-bite (Fig. 1). She was concerned with her bite, as well as crowding of her teeth. Her facial proportions were well-balanced and intraoral examination revealed dental arches with moderate crowding. Class III molar relationships were detected and the patient admitted heavy clenching. Third molars had been extracted prior to treatment.

The patient did not want traditional fixed appliances and expressed interest in the use of clear aligners (Invisalign®).

The objective of the treatment was to align the lower anterior teeth and eliminate the bilateral cross-bite. Pre-treatment, the patient was advised of the difficulty of correcting her bilateral posterior cross-bite with the Invisalign® system. However, the patient insisted on using clear aligners and not traditional fixed appliances.

### Treatment Progress

The patient was prescribed 15 aligners, upper and lower and a total of 2.5 mm Interproximal Reduction (IPR) mesial to the first molars to correct the Bolton discrepancy. IPR was completed within the first two months of treatment. The patient was compliant with aligners. After completion of the 15 sets, the patient's lower anterior teeth were well aligned but there was no change to her posterior cross-bite. Refinement impressions were taken and the patient was prescribed an additional 14 aligners for the upper and 5 aligners for the lower. At the end of refinement the patient's poster occlusion was still not corrected. ClinCheck projection (Fig. 2) showed an improvement of her malocclusion with satisfactory resolution of her cross-bite and alignment of her teeth in both arches. Regular appointments were made in 4-6 week intervals to assess her aligner fit, patient compliance, and tooth movement.

### Treatment Results

The patient's occlusion made minimal changes. The mandibular crowding was resolved; however the bilateral posterior cross-bite showed little to no improvement despite ClinCheck projections. Invisalign cannot fix posterior cross-bite as expanders can due to the lack of anchorage. Post-treatment results overall showed incomplete correction of her malocclusion (Fig. 3).



Fig 1. Case 1: Pre-treatment photographs



Fig 2. Case 1: ClinCheck superim position of predicted outcome



Fig 3. Case 1: Post-treatment photographs

## Case 2

### Diagnosis and Treatment Objective

A 35-year-old female presented with chief complaint of spacing between her front teeth and biting issues. Pre-treatment photographs, panoramic and cephalometric radiographs (Fig. 4-6) were taken along with initial records. The patient was diagnosed with class III dental and skeletal with symmetrically constricted posterior cross-bite with shift, anterior cross-bite and maxillary midline diastema.

The patient was presented with multiple treatment options, including surgical expansion and comprehensive orthodontic treatment. The treatment objective was to use a Hyrax palatal expander to correct the posterior cross-bite. A Hyrax palatal expander was used to correct the posterior cross-bite followed by use of the Invisalign system to close spaces, improve class III dental relation and obtain ideal overjet and overbite.

### Treatment Progress

The expander was turned once every third day for approximately 13 weeks, for a total of 6 mm at the screw. The expander after deactivation was left a month to stabilize with expander in place and subsequently removed and post-expansion records were taken (Fig.7). Invisalign ClinCheck superimpositions of predicted outcome were assessed (Fig. 8).

The amount of interproximal reduction performed to correct the Bolton discrepancy was a total IPR of 0.2 mm in the upper arch and a total IPR of 3.4 mm in the



Fig 4. Case 2: Pre-treatment photographs



Fig 5. Case 2: Pre-treatment panoramic radiograph



Fig 6. Case 2: Pre-treatment cephalometric radiograph





Fig. 7. Case 2: Post expansion photographs



Fig. 11. Case 2: Post-treatment photographs



Fig. 8. Case 2: ClinCheck superimpositions of predicted outcome



Fig. 12. Case 2: Post-treatment panoramic radiograph

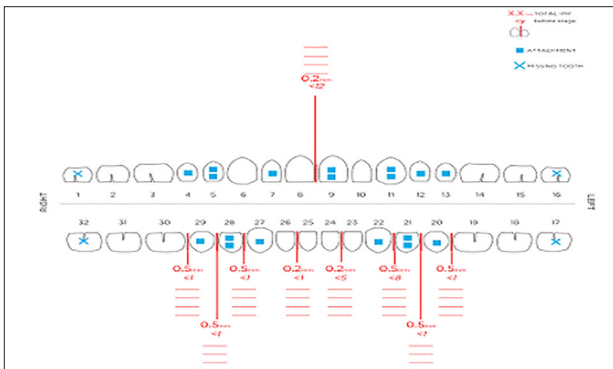


Fig. 9. Case 2: Invisalign® treatment overview indicating amount and size for interproximal reduction

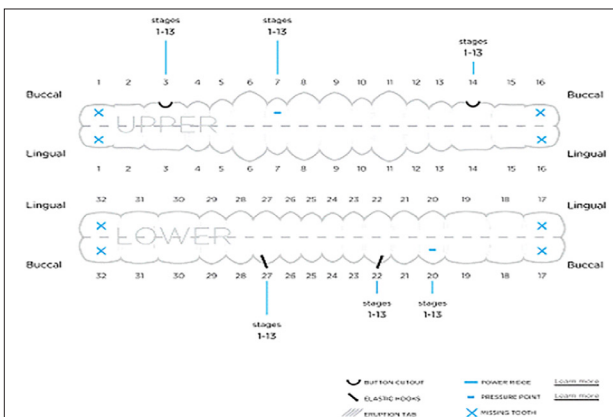


Fig. 10. Case 2: Invisalign® tooth movement assessment and indicates sites for cutouts to attach class III elastics



Fig. 13. Case 2: Post-treatment cephalometric radiograph



Fig. 14. Case 2: Post-treatment final records

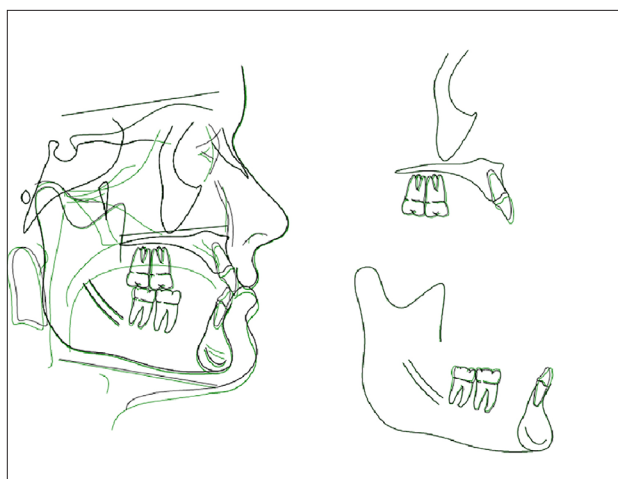


Fig. 15. Case 2: Pre/Post-treatment cephalometric radiographs superimposed

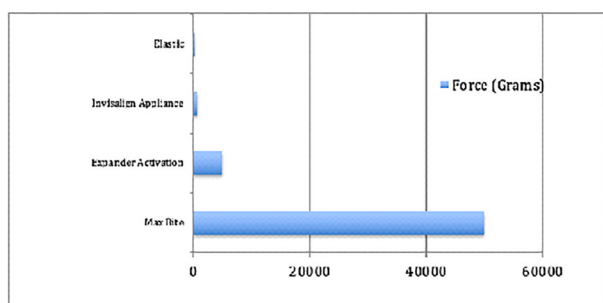


Fig. 16. Comparison between forces applied/experienced during a) maximum occlusal contact, b) forces applied to the dentition with a fixed expander during palatal expander activation, c) forces applied with Invisalign®, and d) maximum forces applied with cross-bite elastics

lower arch (Fig. 9) and Invisalign tooth movement were also undertaken (Fig. 10). Initial trays were delivered with 3/16H CL3 elastics bilaterally and instructions to be worn full time. Buttons for elastics were bonded on U6's. Planned active treatment included 13 upper and 13 lower arch aligners. Appointments were made every 4-6 weeks to assess tray fit and patient compliance. IPR was completed within the first month. A 2mm over-expansion of the maxillary dental arch was achieved.

### Treatment Results

At the end of 13 aligners the patient was in class I occlusion with ideal overjet and overbite. The upper and lower anterior were aligned and maxillary spaces were closed. It was decided not to do further refinement and the patient was retained with a bonded upper retainer and upper/lower essex retainers. Post-treatment photographs, panoramic and cephalometric radiographs were taken along with final records. (Fig. 11-14). Superimposition of the initial and final cephalometric radiographs (Fig.15) show that the lower incisors were tipped back approximately 2 degrees, primarily due to IPR and class III effect. This would have also given the needed overjet to correct the anterior cross-bite and close anterior diastema. All objectives were achieved and the final result was excellent. Post-treatment results showed correction of the posterior cross-bite, as well as the midline diastema.

### || Discussion

The Invisalign® system uses a computer-assisted technology that produces a series of clear plastic appliances, which when successively worn will generate small incremental changes to obtain tooth corrections. Simon et al. quantified the initial force systems that were delivered by an aligner and measured the force systems generated by aligners. These forces by removable thermoplastic aligners generate about 744g and changed exponentially while worn by patients.<sup>[33]</sup> Unlike traditional fixed appliances that use torsion for changing the axial inclination of incisors, clear aligners use multiple balanced force vectors that produce translation or axial inclination changes of a tooth.<sup>[33]</sup> However, aligners do not always begin in their seated position because of sliding movements that happen between the inner surface of the aligner

and the teeth. Thus, the force systems of aligners are constantly changing as the patient occludes his or her teeth.<sup>[34]</sup> The aligner material is flexible in nature and allows some play to occur within it therefore may not deliver the proper amounts of force to move teeth so that it becomes ineffective at moving teeth. As the thermoplastic material experiences morphological changes during occlusion in an intraoral environment, it may ultimately affect its ability to move teeth into a desired position. These morphological changes may also influence the durability of the aligner during the treatment period.<sup>[35,36]</sup>

Furthermore, occlusal forces generated during swallowing, chewing and maximum biting effort were recorded and can create forces as much as 50 Kg.<sup>[37]</sup> The force systems generated by removable thermoplastic appliances have been significantly less than those generated by occlusal maximum biting. Therefore, the Invisalign® system must overcome these heavy occlusal forces to have a significant effect on tooth movement. These intermittent thermoplastic forces alone don't overcome the maximum occlusal forces, which may be in part why some patients treated by the Invisalign® system ultimately fail to see results and difficulty can be found in correcting malocclusion.

Similarly, force produced on a tooth or teeth by removable elastics depends on several factors including site of application, health, age of patient, diameter and length of root, and patient compliance. It can vary in elastic type according to force, which can be: high pull, which gives about 71g of force; medium pull, which gives about 128g of force; or heavy pull, which can generate as much as 184g of force.<sup>[36]</sup> Due to force degradation and elastic fatigue, these elastics don't apply continuous force but are intermittent and do not have the force to overcome occlusal biting force and to allow sufficient tooth movement.

Palatal expansion has been known to be an effective adjunct to traditional orthodontics rather than simply as an appliance to correct posterior cross-bites.<sup>[39]</sup> The use of a rigid, fixed palatal expander, such as a Haas/Hyrax appliance, may be concomitantly used with Invisalign® and cross-bite elastics to treat mature patients with maxillary width deficiency.<sup>[27]</sup> These expanders require frequent activations and generate heavy forces as much as 2-5 Kg per quarter-turn.<sup>[40]</sup> Forces maintained between activations are continuous, even though the force declines as tooth movement

occurs. The continuous forces by the palatal expanders that are not affected by what the patient does produce substantial amounts of force and have a significant effect on tooth movement for the correction of posterior cross-bites. Fig.16 shows comparison between forces applied/experienced during maximum occlusal contact; forces applied to the dentition with a fixed expander during palatal expander activation; with Invisalign® and maximum forces applied with cross-bite elastics. While there are various appliances in the armamentarium of orthodontics, the clinician treating malocclusion must consider which appliance produces the right force to correct the malocclusion, and not by choice of appliance alone. In doing so, the occlusal forces can be overcome and significant tooth movement can be achieved.

## || Conclusion

Case 2 demonstrates that the Invisalign® system can be effective when used with a palatal expander. This is especially true when the patient wanted to have as much of her treatment as possible with Invisalign® and looked for an alternative to conventional fixed orthodontics for its favorable aspects, which include comfort, removability, superior aesthetics, and improved periodontal status. Invisalign treatment alone may not be ideal to correct posterior transverse discrepancies. The satisfactory outcomes were also facilitated by her compliance to the treatment plan. This case report demonstrates that the Invisalign® method, combined with the use of palatal expanders and class III elastics, can be effective in treating adults with a unilateral posterior cross-bite with midline diastema.

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