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Case Report
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Correction of anterior crossbite using eight different treatment modalities: A case series

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Highlights

- Anterior crossbite may result from trauma, delayed exfoliation of primary teeth, supernumerary teeth, eruption pathway deviation, maxillary arch deficiency, or repaired cleft lip/palate.
- Timely correction of anterior crossbite is essential to guide skeletal growth, improve occlusal relationships, prevent periodontal damage and tooth wear, and enhance facial esthetics.
- Early anterior crossbite can be corrected with tongue blade therapy, inclined planes, composite slopes, Z-springs, Jackscrew variants, 2×4 appliances, or rapid palatal expansion.

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Abstract

Crossbite is defined as any abnormal buccolingual relationship between opposing incisors, premolars, or molars in centric relation. Anterior crossbite requires timely correction to redirect skeletal growth, improve the tooth–alveolus relationship, increase arch perimeter, prevent potential periodontal damage and dental attrition, reduce the risk of temporomandibular disorders, and enhance esthetics. This case series highlights the correction of anterior crossbite in children using eight different treatment modalities, including Z-spring, bonded resin composite slope, modified removable Jackscrew, modified fixed Jackscrew, anterior inclined plane, tongue blade therapy, hygienic rapid expander (HYRAX), and the 2×4 appliance. When initiated early, anterior crossbite correction can be achieved using simple, cost-effective methods with relatively short treatment durations.

Keywords: Anterior Crossbite; Anterior Inclined Plane; Children; Crossbite; Orthodontic Appliances; Tongue Blade Therapy

INTRODUCTION

Crossbite is any abnormal buccal-lingual relation between opposing incisors, molars, or premolars in centric relation. Crossbite can be of dental or skeletal origin, or a combination of both. A simple anterior crossbite belongs to dental origin presenting with Class I molar relation and the malocclusion occurring due to abnormal axial inclination the teeth involved.[1] In some patients, while closing the mouth, premature contact of the lingually positioned maxillary anterior teeth may result in forward mandibular deviation "locking" the multiple maxillary anterior teeth. This condition is known as pseudo-class III malocclusion as the mandible shifts from Class I to Class III molar relation while closing the mouth only.[2] In skeletal Class III malocclusion, crossbite is due to the presence of basal bone malposition. Anterior crossbite may be caused due to traumatic injuries to the deciduous tooth/teeth leading to the lingual displacement of permanent tooth bud, delayed extraction of the deciduous tooth, labially located supernumerary tooth/teeth, sclerosed tissue barrier resulting from the premature deciduous tooth loss leading to deviated eruption pathway of the permanent tooth, inadequate arch length in maxilla leading to the lingual pathway of permanent tooth while erupting, deleterious oral habits, and repaired cleft lip/palate.[1,3] Posterior crossbites usually results from lingual positioning of the maxillary teeth relative to the mandibular posterior teeth as a result of the tipping of posterior tooth/teeth, alveolar discrepancy, or a combination of both.[1]

Anterior crossbite demands timely correction to redirect skeletal growth, improve tooth-to-alveolus relationship, increase arch perimeter, avoid potential damage to periodontium, reduce dental attrition, prevent the potential for temporomandibular disorders, and for the improvement of esthetics.[1,2,4] Anterior crossbite should be corrected immediately because failing to do so might result in skeletal class III malocclusion which requires major orthodontic treatment or a combination of both the orthodontic and surgical procedures for the correction at a later stage.[1,5,6] Treatment methods for the correction of anterior crossbite are: tongue blade/popsicle therapy, acrylic lower inclined plane, bonded resin composite slope (BRCS) (composite inclined plane), acrylic retainer with lingual spring (Z-spring), fixed appliances with lingual spring (Z-spring), reverse stainless steel crown, rare earth magnetic appliance, Essix based appliances, labial edgewise archwires (2x4 appliance), lower posterior bite plane etc. if adequate space is not available for the movement of the tooth/teeth in crossbite, palatal expansion in conjunction with the crossbite correction appliances are indicated.[1,2,5,7,8]

This case series highlights the anterior crossbite correction in children using 8 different methods that are: Z-spring, bonded resin composite slope, modified removable Jackscrew, modified fixed Jackscrew, anterior inclined plane, tongue blade therapy, 2x4 appliance with Hygenic Rapid Expander (HYRAX), and 2x4 appliance.

CASE REPORT

Written informed consent from the parent and assent from the patient for the treatment, and publication of the case report in a scientific journal had been obtained from all the patients before the start of the treatment. There was no any significant medical history in any of the patients treated.

Case 1

An 8-year-old female reported with the chief complaint of irregular front teeth. On examination, the patient had a convex facial profile. Intraorally, there was missing 51, anterior crossbite with respect to (wrt) 21 along with left unilateral posterior crossbite (Figure 1a). The patient also

exhibited a forward pathway of mandibular closure suggesting the presence of pseudo-Class III malocclusion. The molar and terminal plane relationships could not be assessed due to the presence of functional shifts. Cephalometric analysis revealed normal facial-maxillo-mandibular relationships. Correction of the crossbite with removable appliance was planned as the patient was motivated to wear the appliance and adequate space for tipping of 21 was present. Insertion of removable acrylic appliance with incorporated Z-spring wrt 21 and posterior bite planes was done (Figure 1b). On the 3-week follow-up visit, correction of crossbite was seen. Along with the correction of anterior crossbite, unilateral posterior crossbite was also corrected, and normal molar relationships were established.

The same patient visited the department after 3 months with another irregular upper front teeth. On examination, there was crossbite wrt. 11 (Figure 1c). To correct the crossbite this time, BRCS (composite inclined plane) method was opted as the patient wished for fixed appliance. The involved mandibular tooth (41) was etched with 37% phosphoric acid (Meta Etchant, Meta Biomed Co., Ltd, South Korea) for 20 seconds, which was then followed by cleaning with water for 20 seconds and drying for 10 seconds till frosty white appearance. A bonding agent (Tetric N-Bond, Ivoclar Vivadent) was applied and light-cured for 20 seconds. Composite (Tetric N-Ceram, Shade A1, Ivoclar Vivadent) inclined place was built on 41 in increment, which was 3-4 mm thick and in 45-degree inclination to the long axis of the tooth (Figure 1d). It was ensured that there was contact between the teeth in crossbite and posterior teeth disoccluded by 2 mm (Figure 1e). The single tooth crossbite was corrected within 3 weeks (Figure 1f).

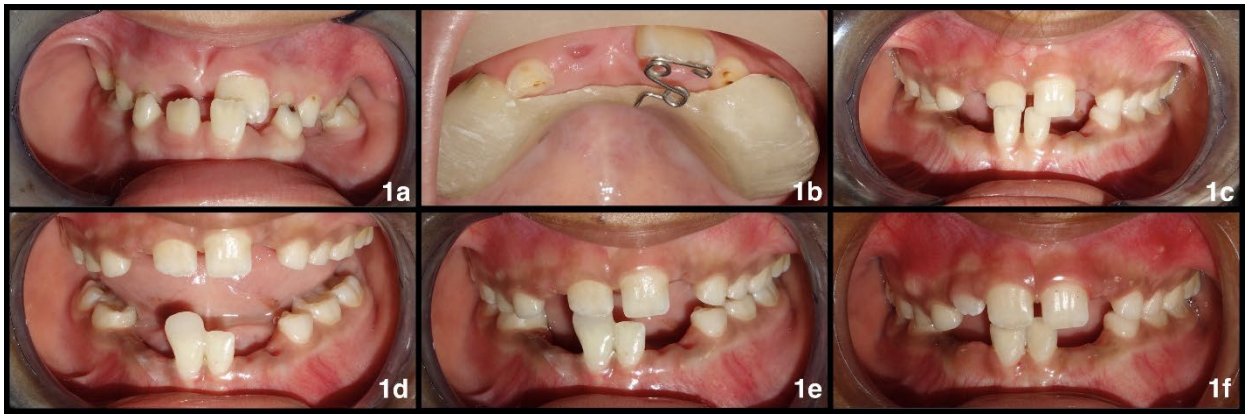

Figure 1. Correction of crossbite with Z-spring and bonded resin composite slope. 1a: Pre-op photograph; 1b: Z-spring on 21; 1c: 3-months follow-up, crossbite wrt 11; 1d-1e: Composite inclined plane build-up on 41; 1f. 3-weeks follow-up

Case 2

An 8-year-old male reported with the chief complaint of mass in the upper part of his mouth for 2 months. The patient had a straight facial profile. On intra-oral examination, there were 2 masses; 1 on the maxillary midline involving the labial frenum (Figs. 2a, 2b) and other on the dorsal surface of the tongue. There was presence of anterior segmental crossbite as well (Figure 2c). The patient had a mesial step terminal plane relationship on both the right and left sides. Cephalometric analysis revealed an SNA angle of 78 degrees and an SNB angle of 80 degrees.

Surgical removal of the swellings was done under local anesthesia (2% Lignocaine with 1:200000 Adrenaline). A modified removable Jackscrew appliance with posterior bite planes was fabricated. Removable nature of the appliance would facilitate for easier activation of the Jackscrew, which was also desired by the parents of the patient. The screw was placed along the anteroposterior direction. On the seventh post-operative day, insertion of the appliance was done (Figs. 2d, 2e). The patient was advised to activate 1 turn-in every 5 days. Crossbite was corrected within 6 weeks (Figure 2f).

Case 3

A 6-year-old female presented with the chief complaint of irregular upper front teeth. On the extra-oral examination, patient had a straight facial profile.

Intra-oral examination revealed the presence of anterior segmental crossbite (Figure 3a). The patient had a mesial step terminal plane relationship on both the right and left sides. Cephalometric analysis revealed an SNA angle of 80 degrees and SNB angle of 79-degree. Modified fixed Jackscrew appliance was planned as the patient had segmental crossbite, and patient opted for fixed appliance. In this appliance, band fabrication was done on 55 and 65, which was then followed by impression making. On the model, a 0.9 mm stainless-steel wire was soldered to 55 and 65. The Jack screw was placed along the anteroposterior direction and attached to the stainless-steel wire with cold cure acrylic resin. Cementation of the appliance was done, and occlusal height was raised by 2 mm using type II restorative glass ionomer cement (GIC) (GC Corporation, Tokyo, Japan) on 55 54 64 65 (Figure 3b). The patient was then advised to activate 1 turn in every 2 days. Crossbite was corrected within 3 weeks (Figure 3c).

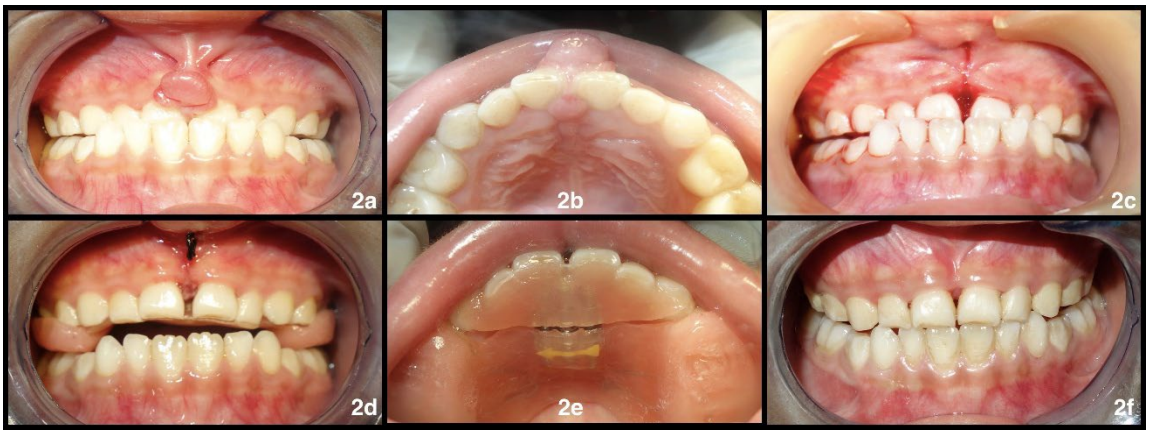

Figure 2. Correction of crossbite with modified Jackscrew appliance. 2a-2b: Pre-op photographs; 2c: Surgical removal of the masses; 2d-2e: Insertion of modified Jackscrew appliance; 2f: 6-weeks follow-up

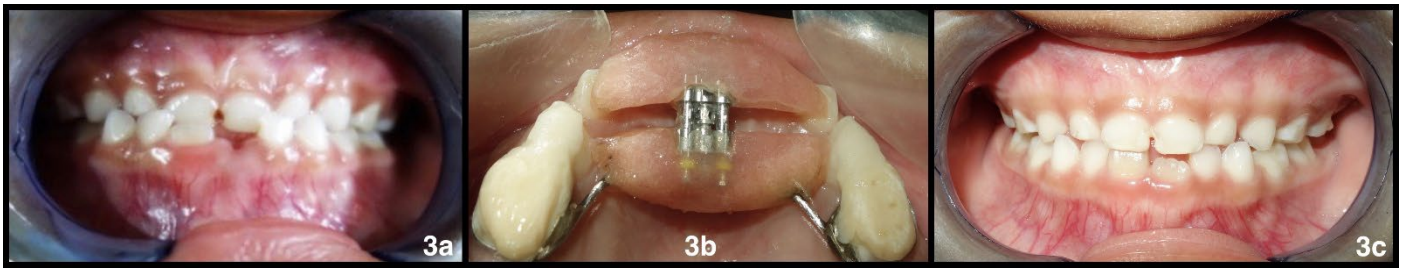

Figure 3. Correction of crossbite with modified fixed Jackscrew appliance. 3a: Pre-op photograph; 3b: Insertion of modified fixed Jackscrew appliance; 3c: 3-weeks follow-up

Case 4

A 12-year-old female reported with the chief complaint of irregular upper teeth. The patient had convex facial profile and anterior crossbite wrt. 21 and 31 (Figure 4a). The patient had Angle's Class I molar relationship on both the right and left side. Maxillo-mandibular relationship was normal according to the cephalometric analysis. Correction of such single tooth crossbite can be achieved with simple appliances like inclined plane also. So, acrylic inclined plane was fabricated covering the lower anterior teeth from canine to canine. The inclined plane was cemented using Type I luting GIC (GC Corporation, Tokyo, Japan) (Figure 4b). Crossbite correction was achieved in 2 weeks (Figure 4c).

Case 5

An 8-year-old female reported with the chief complaint of deposits in the upper front teeth. On examination, the patient had a convex facial profile. Intra-orally, there was generalized stain and developing anterior crossbite wrt 11 (Figure 5a). The patient had Angle's class I molar relationship on both the right and left sides. Cephalometric analysis revealed a normal facial-maxillo-mandibular relationship. For the correction of this developing single tooth crossbite, tongue blade therapy was planned. Patient was advised to place the tongue depressor behind the tooth in crossbite and push the tongue forwardly using the chin as a fulcrum (Figure 5b). Patient was instructed to perform the procedure for 15 minutes once every day for 7 days. Crossbite was corrected within 1 week (Figure 5c).

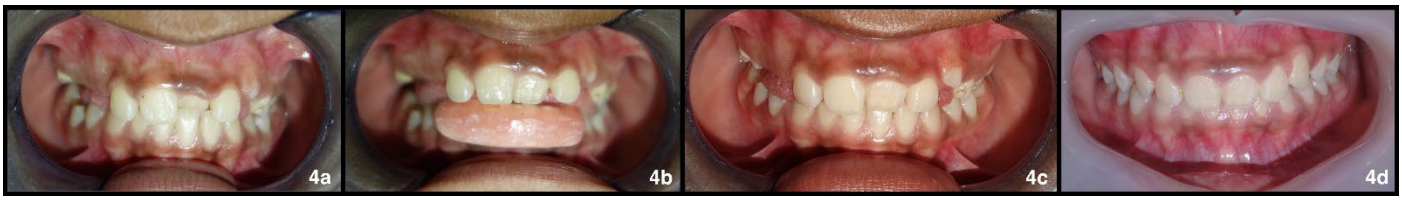

Figure 4. Correction of crossbite with the anterior inclined plane. 4a: Pre-op photograph; 4b: Insertion of the anterior inclined plane; 4c: 2-weeks follow-up; 4d: 6-months follow-up

Figure 5. Correction of crossbite with tongue blade therapy. 5a: Pre-op photograph; 5b: Tongue blade therapy; 5c: 3-weeks follow-up; 5d: 6-months follow-up

Case 6

An 8-year-old male was referred for the correction of irregularly placed upper front teeth. The patient's mother reported that the patient's father has forwardly placed lower front teeth. The patient had a straight facial profile, and he was wearing Nance palatal arch as well as lingual holding arch space maintainers. According to the patient's mother, the space maintainers were inserted 3 months back. There were missing 54 and 64; narrow palate, anterior segmental crowding and

crossbite, and edge-to-edge bite on the posterior segment bilaterally (Figure 6a). Cephalometric analysis revealed SNA and SNB angles to be 80 and 81-degrees, respectively, ANB of -1-degree suggesting the presence of skeletal class III tendency.

Considering the presence of narrow palate and crowding, HYRAX was planned initially to expand the maxilla for correction of crowding and crossbite. A bonded type of HYRAX appliance was fabricated and inserted ensuring that there was 2 mm of inter-incisal clearance (Figs. 6b, 6c). Parents were advised to activate the screw 2 turns in the morning and evening every day (Timms schedule)[9] for 2 weeks period. Once the palatal cusp of the upper posterior teeth approximated the buccal cusp of the lower posterior teeth, activation of the appliance was stopped. During the activation period, spacing between 11 and 21 was created and there was the correction of anterior and posterior crossbites at the end of the activation period (Figure 6d). After the activation phase, the appliance was continued for 6 months to allow for reorganization of the mid-palatal suture. After 6 months, the HYRAX appliance was discontinued and transpalatal arch with an extended arm was inserted. For the alignment and leveling of incisors, a 2x4 appliance was used (Figure 6e).

Case 7

A 4-year-old male presented with the chief complaint of irregular upper front teeth. On extra-oral examination, the patient had a straight facial profile. Intra-orally, the patient was in the primary dentition stage with an anterior segmental crossbite (Figure 7a). The patient had a mesial step terminal plane relationship on both the right and left sides. Cephalometric analysis revealed both the SNA and SNB angles of 80 degrees. Considering the age of the patient and limited compliance, crossbite correction with 2x4 appliance was planned. Molar bands with buccal tubes were cemented on 55 and 65. Posterior occlusal height was raised by 2 mm with type II GIC. Metal brackets with a 0.018" slot (MIM Mini Bracket, Prolinx GMBH, Germany) were bonded on the labial aspects of the maxillary incisors (52 51 61 62). A nickel-titanium (Ni-Ti) 0.012" round archwire was placed into the bracket slots and then into the molar tubes. The wire was stabilized in its position using orthodontic modules (Figure 7b). Positive overjet was achieved within a period of 3 weeks (Figure 7c). Once the brackets were debonded, GIC placed to raise the occlusal height was removed. After debonding proximal stripping of 52 51 61 62 63 was done followed by application of 5% sodium fluoride varnish (V-varnish, Vericom Co. Ltd. Korea.

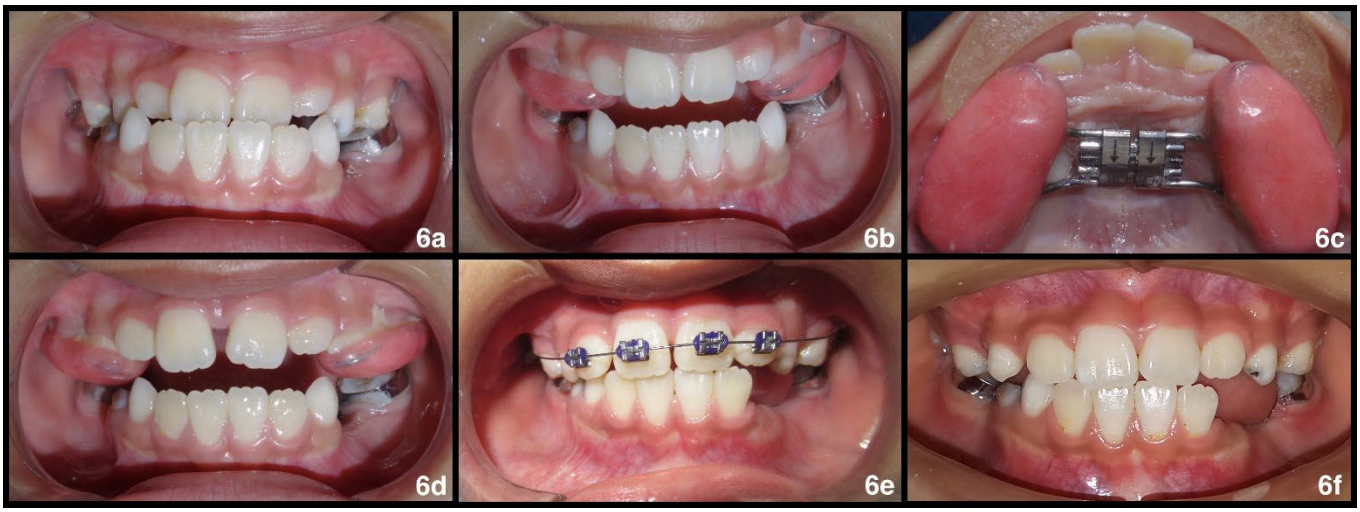

Figure 6. Correction of crossbite with HYRAX expander and 2x4 appliance. 5a: Pre-op photograph; 5b-5c: Insertion of HYRAX appliance; 5d: 2-weeks follow-up; 5e: 2x4 appliance; 5f: 6-months follow-up

Figure 7. Correction of crossbite with 2x4 appliance. 7a: Pre-op photograph; 7b: 2x4 appliance; 7c: 3-weeks follow-up

DISCUSSION

Prevalence of crossbite has been shown to range from 6.8-38.4% worldwide,[10] with the prevalence of anterior crossbite being 2.2-12%.[5,7] Among Nepalese children in the primary dentition stage, the prevalence of crossbite malocclusion is 7.2% (5.8% and 1.4% for anterior and posterior crossbites, respectively).[11] Historically, orthodontic treatment was provided mainly for the adolescents. Interest continues to be expressed in the concept of preventive, interceptive as well as the adult orthodontic treatment. Many clinicians seek to modify skeletal, muscular, and dentoalveolar abnormalities before the transition into the full permanent dentition. A thorough knowledge of the craniofacial growth and development of the dentition, along with the orthodontic treatment must be used in diagnosing and reviewing possible interceptive treatment options before recommendations are made to the parents.[2,5]

Early diagnosis and successful treatment of the developing malocclusions like anomalies of tooth number, morphology and position, crossbites, deleterious oral habits, open bite, airway problems, developing skeletal discrepancies, and periodontal problems can have both the short and long-term benefits while achieving the goals of occlusal harmony, function, and dentofacial esthetics.[1,2,5]

Crossbite malocclusion, be it anterior or posterior, dental or skeletal, should be treated as early as possible.[1,2,5] Simple appliance designs are usually adequate to achieve correction of the dentoalveolar anterior crossbites. Diagnoses should be made with the consideration of following clinical findings: number of tooth/teeth involved, inclinations of the maxillary and mandibular incisors, mandibular closure pattern, facial profile, family history, and cephalometric analysis. Treatment of the crossbite results in improved intra-arch alignment, inter-arch occlusion, and function. The treatment plan should be formulated after the evaluation of factors like incisor positioning, stage of teeth eruption, degree of overbite, and the space available for the tooth/teeth movement.[2]

Removable appliances are easy to place and remove, inexpensive, comfortable, require less chairside time, and are easily tolerated by the patients. Removable appliances are easy to clean, so these appliances facilitate better oral hygiene maintenance as compared to the fixed appliances. Palatal anchorage can be used to move the selected tooth/teeth.[5,12] However, patient compliance is poor as compared to the fixed appliances, and at the same time movement of multiple teeth can be cumbersome. In the present case series also, the time taken for crossbite correction was longer in patients wearing removable appliances (average 6 weeks) as compared to the patients wearing fixed appliances. Apart from the faster correction of anterior crossbite, patient compliance was better with the fixed appliances.

Removable appliance with incorporated palatal spring (Z-spring) and posterior bite plane is commonly used method to manage the single-tooth anterior dental crossbite.[12] Stainless steel wires of diameter 0.020/0.022 inches are used to fabricate the Z-springs. Z-springs can also be

incorporated with the palatal wire of Nance palatal arch or palatal wires that are soldered onto the molar bands. The efficiency of this spring is very good if properly oriented. Disadvantages of Z-springs can be the slippage of spring and breakage. In order to void slippage, a small "button" of composite can be placed on the lingual surface of the tooth in crossbite which will create a retentive undercut for maintaining the cervical orientation of the spring. Incorporation of "posterior bite planes" allows for the disocclusion of the "locked" tooth and at the same time, breakage of the springs is minimized. The use of fixed or removable springs can correct the anterior crossbite within 1-12 weeks.[2] In cases 1 of this case series, the posterior bite plane was incorporated along with the removable Z-spring appliance, and crossbite along with the pseudo-Class III malocclusion was corrected within 3 weeks.

Inclined planes are also frequently used for the correction of anterior crossbite malocclusions. Acrylic extensions are fabricated covering the lower anterior teeth which are designed to engage the lingual surface of the maxillary tooth in crossbite. Upon closure of the jaw, the inclined plane directs the maxillary tooth labially into a positive bite relation. The inclined plane is fabricated using self-curing acrylic resin which should cover the mandibular canine-canine segment. The angulation of the incline should be 45-degrees and it should be contacted only to the maxillary tooth in crossbite. The inclined plane should extend about ¼ inch posteriorly from the incisal edges of the mandibular anterior teeth to prevent the patient from biting behind the inclined plane. There should be no more than 1-3 mm of disocclusion of posterior teeth at function. Once the proper position of the appliance is verified, the appliance is cemented using luting cements. Anterior inclined planes are simple to fabricate and it can also be used in case of limited anchorage. There are many disadvantages of lower inclined plane appliances. Apart from being unesthetic, the inclined planes can cause discomfort to the patient due to disocclusion of the maxillary and mandibular teeth, limitation on food intake, gingival irritation of the mandibular anterior teeth, dislodgement of the appliance, and there is an increased tendency to traumatic injury. Inclined planes should not be worn for more than 2 weeks as there might be the chance of posterior teeth supra-eruption owing to disocclusion, which might ultimately lead to anterior open bite.[2,7,13,14] In the present case series (case 4), single-tooth crossbite was corrected using an inclined plane within 2 weeks.

Anterior crossbites can also be corrected by building up composite resin slope on the lower anterior tooth/teeth associated with the crossbite. This method is a safe, quick, easy to build up, esthetically acceptable, and a lesser expensive alternative for anterior dental crossbite correction.[15,16] Sari et al. have emphasized that there are certain criteria which have to be fulfilled in order to choose bonded resin composite slope to correct the crossbite, viz., "anterior crossbite is not more than one-third crown length, the tooth is not rotated, there is sufficient mesiodistal space for the labial movement of the tooth, and the problem is solely of dental origin".[16] In case 1, the patient fulfilled all the criteria and a successful result was achieved within weeks' time. Tongue blade therapy is one of the simplest methods that can be used for the correction of developing anterior crossbite. Tongue blade therapy can be considered as a good treatment option for children who are cooperative and can understand the instructions. If the instructions are followed properly in terms of frequency, duration, and accuracy of practice, crossbite correction can be achieved even within 24-72 hours by this method. This method is patient-friendly in terms of chairside time and expenses, but the correction of established crossbite usually requires intense tongue blade therapy. In such situations, other methods of crossbite correction would be better preferred.[2,17,18]

Solihat in 2022 had used tongue blade therapy to correct the anterior crossbite in which the patient was consulted and managed via teledentistry, that has opened the horizon for use of tongue blade therapy among patients living in remote places of countries like Nepal.[17] In case 5, the patient was cooperative and the tooth in crossbite (11) was partially erupted. With the proper selection of treatment modality, the crossbite was corrected in a week.

Jack screw appliance is commonly used for the slow expansion of maxillary arch. Hence the frequency of activation of the screw should be lesser as compared to the rapid expanders like HYRAX, and the amount of expansion achieved is also lesser.[1] Jack screws can also be modified and used to move the tooth/teeth in sagittal plane. To achieve movement in the sagittal plane, the direction of screw should be placed parallel to the sagittal plane. Such modification can be used to move the segment of arch like in case of the anterior segmental crossbite.[19,20] With proper planning of the appliance design, show expanders like jackscrew can also be used to move single tooth or the segment of arch as per the requirement as in case 2 and 3 of the present case series.

Rapid palatal expanders like HYRAX are usually preferred for the bilateral crossbites with maxillary constriction which requires 6-8 mm of expansion. Study by Rosa et al. has shown spontaneous correction of anterior crossbite with rapid palatal expansion in the mixed dentition stage.[21] In case 6 also, with rapid palatal expansion, anterior segmental crossbite was corrected. Selection of anchorage poses a challenge in the mixed dentition stage as the teeth are in the dynamic phase of exfoliation and eruption. The primary molars and permanent first molars are the best anchorage for the rapid palatal expansion.[2] In the present case, anchorage was obtained from the primary canine, second molar and the permanent first molar, and the design prepared was bonded type. The activation schedule varies depending on the age of patients and form of the appliance used. The recommendation given by Timms or Zimring and Issacson is followed by most of the clinicians.[22] The same expander or TPA can be used as a retainer, as retention for minimum of 3 months is necessary after rapid palatal expansion.[2,22]

The 2x4 appliance is a sectional fixed appliance that involves banding on molars and bonding of brackets on the incisors. There are many advantages of a 2x4 appliance as this therapy allows for the control of teeth movement in 3 dimensions, and this therapy can also be used in the patients where the number of abutment teeth required for the retention of appliance is less. Apart from requiring less time for treatment completion, less patient cooperation is required in this therapy.[3,6] This therapy requires increased chairside time for the placement, adjustment and removal of the appliance, and there is risk of injury to the developing teeth if excessive biomechanical movement is performed. This therapy is more expensive as compared to the removable appliances, and there is a chance of decalcification of teeth due to difficulty in oral hygiene maintenance.[2,3] Lee et al. have outlined 4 factors before considering 2x4 appliance therapy: "adequate space in the dental arch to reposition the tooth, sufficient overbite to hold the tooth in position following correction, the apical position of the tooth in crossbite that is the same as it would be in normal occlusion, and Class I occlusion".[23] Apart from these criteria, the molars which are designed to be banded should be fully erupted.[24] In the present case number 7, 2x4 therapy was opted as the cases fulfilled the criteria given by Lee et al.

Timely and successful intervention of crossbite malocclusion in the present case series benefited the patients in terms of treatment cost and duration. Apart from that, positive perception of the patients towards timely dental visits was also established.

CONCLUSIONS

Anterior crossbite correction, if started early, can be achieved using simple methods like tongue blade therapy, acrylic lower inclined plane, bonded resin composite slope, Z-spring, Jackscrew and its modifications, 2x4 appliance, rapid palatal expansion appliance, within a short duration. This case series emphasizes the timely management of anterior crossbite, which proves to be beneficial in terms of preventing possible complications, requiring short treatment duration, and imposing a lesser financial burden on the patient.

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