

Original Article

Non-surgical treatment of an Angle Class III malocclusion in adults

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Received August 3, 2013; Accepted September 1, 2013; Epub September 25, 2013; Published September 30, 2013

Abstract: Objective: To examine the application of a modified fixed reverse twin-block appliance (TBA) in adults with an Angle Class III malocclusion and anterior crossbite. Participants: Thirty-two adults with an Angle III malocclusion were recruited. An associated temporomandibular disorder (TMD) was found in 18 patients, laterognathism in 21, and both conditions in the remaining 12 patients. Methods: A modified fixed reverse TBA was used to posture the mandible back, divert bite force and centre the dentition. The malocclusion, laterognathism and temporomandibular disorders were concurrently treated. The outcome was evaluated radiographically and the findings were analyzed via Electronic Measurement Scale software. Results: Treatment was shown to be effective and could significantly shorten the course of treatment and avoid orthognathic surgery. The average course of treatment was 14 months, during which time, the mandible was postured back and the dentition was successfully aligned and levelled. Most patients achieved an edge-to-edge occlusion of the anterior teeth after 7-10 days of appliance wear. Most symptoms of TMD were relieved after 1 month and the laterognathism resolved in 4-5 months. Conclusion: A modified fixed reverse TBA was an effective non-surgical strategy for the treatment of selected Angle Class III malocclusions with an anterior crossbite in adults.

Keywords: Anterior crossbite, reverse twin block appliance, temporomandibular disorder, laterognathism

Introduction

An anterior crossbite, not only significantly affects facial aesthetics and the function of the stomatognathic system, but has a tendency to worsen with age. The incidence of anterior crossbite in the Chinese population is high and affected children often present with a hypoplastic maxilla together with a hyperplastic mandible [1].

The recommended age for the treatment of an anterior crossbite is 8-9 years [2]. If adult patients miss the early chance to receive orthodontic treatment, orthognathic surgery or dental camouflage are possible later treatment options. Traditionally, orthognathic management requires pre- and post-surgical orthodontic treatment which increases the costs while the surgery places patients at an anaesthetic and a morbidity risk [3]. The majority of patients are unwilling to accept this treatment. Dental camouflage often provides an unsatisfactory

result as it relies on dentoalveolar manipulation of the arches to manage the skeletal dysplasia and therefore the malocclusion. Camouflage would be justified and simplified if it was feasible to improve maxillo-mandibular relations to compensate for a deficient maxilla. In addition, the treatment options are associated with risk, as an anterior crossbite in adults is often accompanied by temporomandibular joint and muscle disorders (TMD) [4]. Patients may concomitantly develop anterior crossbite and laterognathism (mandibular asymmetry), or anterior crossbite with a unilateral posterior crossbite which often presents with facial disharmony.

Clark et al. developed the traditional twin block appliance (TBA) to overcome the disadvantages of Class II activator treatment [5]. Most TBA research has been conducted to investigate Angle Class II malocclusions characterized by mandibular retrognathia [6-17]. A fixed TBA has been modified from the traditional appliance

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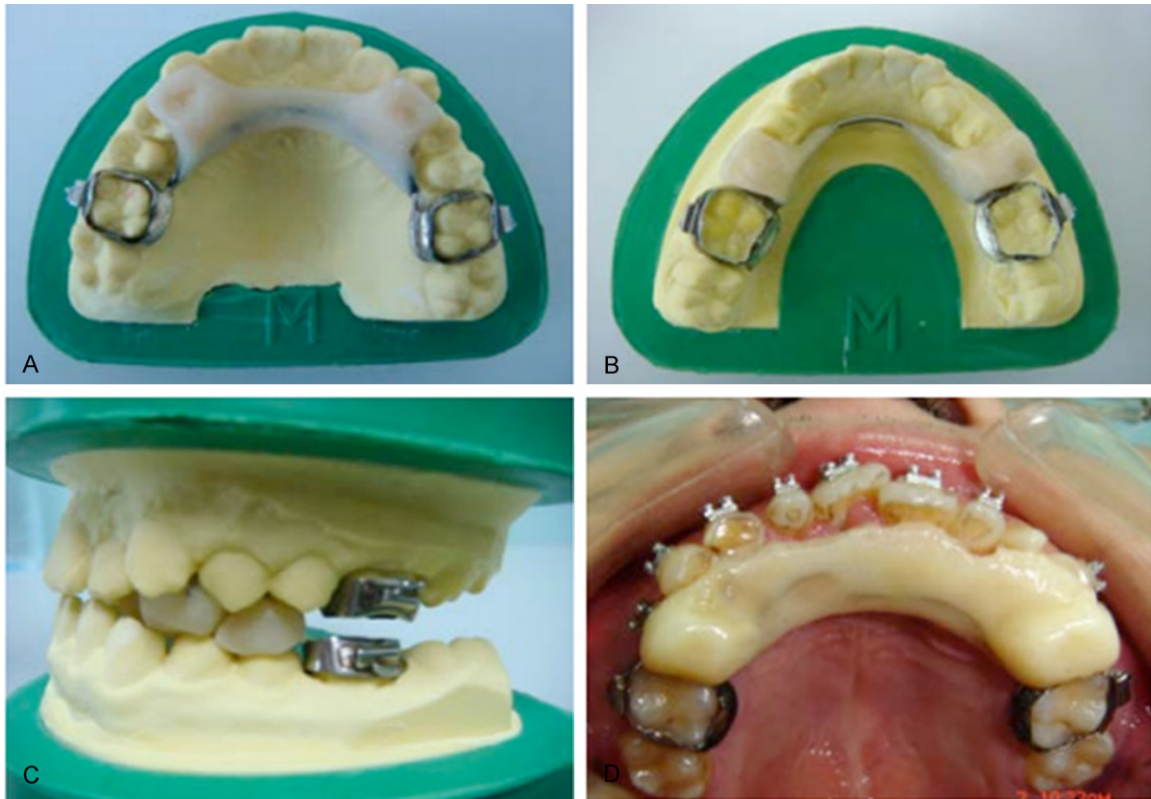


Figure 1. Diagram showing the modified fixed reverse TBA. A and B: Upper and lower appliances. A modified clasp was welded on the palatal side of the molar band and embedded in the plastic base; C: Lateral diagram of fixed TBA and (D) A patient with Angle Class III malocclusion showing the modified fixed reverse TBA in combination with fixed appliances.

and its clinical application was studied in children aged 8-14 years with an Angle Class III malocclusion with an anterior crossbite [18-21]. The modified fixed reverse TBA has been subsequently applied in adults [20].

However, non-surgical functional correction is difficult to achieve in adult patients given the completion of growth and development. The present study aimed to investigate the application of a modified fixed reverse TBA in adult patients presenting with an Angle Class III malocclusion with an accompanying anterior crossbite. It was considered advantageous if the appliance provided a clinically useful, effective, simple, and convenient non-surgical strategy for the treatment of anterior crossbite in adults.

Materials and methods

Modified fixed reverse TBA

The reverse TBA acts to transfer bite force through the interlocking of superior and inferior

appliance occlusal pads located between the premolars. To promote the separation of the occlusion/bite, an alteration in the direction of the dentally-borne bite force assists the mandible to adopt a new position. The upper and lower dentitions are separated by the occlusal pads, which effectively alter the relationship of the molars by encouraging retrusion of the mandible. The clinical effectiveness of this modified TBA has previously been confirmed in children aged 8-14 years [18-21].

In the present study, bands were placed on the upper and lower posterior teeth, following which alginate impressions were taken. The fitted bands were removed and placed in the impression prior to pouring of the plaster cast. A wax registration of maximal mandibular retruded contact position was taken and the prepared casts mounted on an articulator. Care was taken to adjust the mandible to a centered retruded position as mandibular deviation is often found in patients with Angle Class III malocclusions with an associated anterior cross-

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Table 1. Cephalometric changes before and after treatment with the modified fixed reverse TBA

Measurements	Before	After
SNA (°)	77.31 ± 2.16	80.74 ± 2.13*
SNB (°)	81.43 ± 1.22	78.32 ± 1.17**
A-VertT (mm)	34.28 ± 2.73	36.61 ± 1.35
B-VertT (mm)	36.55 ± 1.26	31.78 ± 2.12**
Pr-VertT (mm)	33.21 ± 1.79	38.54 ± 1.13*
Id-VertT (mm)	36.11 ± 3.17	30.18 ± 2.51**
Po-VertT (mm)	22.58 ± 0.15	18.56 ± 1.54*
Go-VertT (mm)	31.75 ± 1.23	37.98 ± 1.05*
ANS-VertT (mm)	37.26 ± 1.04	40.57 ± 1.26
NPo-FH (°)	93.45 ± 2.39	87.52 ± 2.02**
Co-Go (mm)	54.89 ± 1.53	57.14 ± 0.25
Co-Po (mm)	95.26 ± 3.18	93.32 ± 1.03
Go-Po (mm)	59.49 ± 1.35	57.18 ± 2.28
ML-SBL (°)	47.32 ± 2.07	42.11 ± 3.14*
NL-SBL (°)	23.87 ± 1.54	22.15 ± 3.41
Ar-Go-Me (°)	129.22 ± 1.63	126.24 ± 1.39
CondAX-VertT (°)	13.56 ± 2.89	9.58 ± 1.06*
CondAX-ML (°)	134.32 ± 2.36	127.19 ± 2.53*
U1-NA (°)	11.79 ± 3.28	23.31 ± 2.91**
U1-NA (mm)	3.91 ± 3.34	10.61 ± 2.12**
L1-NB (°)	21.62 ± 3.21	12.93 ± 2.83**
L1-NB (mm)	9.45 ± 1.88	3.67 ± 3.27**

*P < 0.05; **P < 0.01.

bite. The dental midlines were aligned, but the mesioincisal corners of the upper and lower central incisors are not good guides in those cases in which teeth have been lost or in severe malocclusions. If accompanied by laterognathism, the retruded mandible may be centered by adjusting the direction of the occlusal pads.

The retentive component of the traditional TBA is the Clark clasp. The fitted band was modified with the clasp, which was welded on the palatal side of the band and embedded in the plastic base. The bite-blocks, with a ramp angle varying between 40°-70°, were located in the premolar region of the upper and lower appliances. The anterior crossbite was opened appropriately to vertically clear the reverse lock. If the ramp angle was too shallow, the malocclusion was maintained and muscle activity not stimulated; if the angle was too large, adaptation of the temporomandibular joint (TMJ) was difficult. If maxillary expansion was required, a midline expansion device was incorporated into the maxillary baseplate.

The reverse TBA was cemented to the molars and the patients allowed to adapt to the device for one week. The remaining teeth were then bonded and levelled and aligned with archwires of increasing diameter (**Figure 1**). When the anterior teeth achieved an edge-to-edge occlusion, the occlusal pads were gradually adjusted to reduce their height and facilitate a controlled decrease in facial height.

Patients

Thirty-two adult patients (19 males and 13 females), each with an Angle Class III malocclusion with an anterior crossbite, were recruited. Concomitant TMJ clicking, pain or headache was found in 18 patients, laterognathism in 21 and laterognathism and TMJ dysfunction in 12 patients. The patients were aged between 18-28 years, and all had an anterior crossbite involving at least 4 teeth. SNA was no more than 82 degrees and SNB not less than 80 degrees. Facial profiles were straight or concave. The mandibles of all patients could be postured to achieve an edge-to-edge incisal relationship. All patients rejected surgical intervention and none received adjunctive treatment related to the management of the TMJ dysfunction.

Methods

Cephalometric radiographs were taken before and after orthopaedic treatment by an experienced technician. Points and lines were drawn in accordance with standard measurements (**Table 1**), and the final tracing was scanned and measured with Electronic Measurement Scale software [22]. Measurements were performed twice and the means values obtained.

The stable basicranial line (SBL) was used as a skull reference system [23]. A tangent to the ethmoidal cribellum through Point T was used to form a straight line Vertical T perpendicular to SBL (**Figures 2, 3**). These basicranial structures are similar among subjects aged > 4-5 years, and therefore were used as references to record changes and longitudinal observations of the mandible and maxilla after treatment [23]. Data were compared with the analysis of variance (ANOVA) and t-test using SPSS version 10.0 for Windows. A value of $p < 0.05$ was considered statistically significant.

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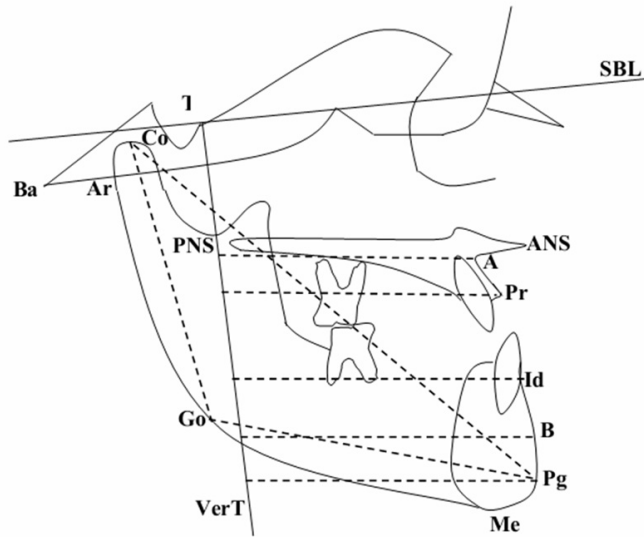


Figure 2. Linear measurements used for the assessment of sagittal relationships and mandibular dimension.

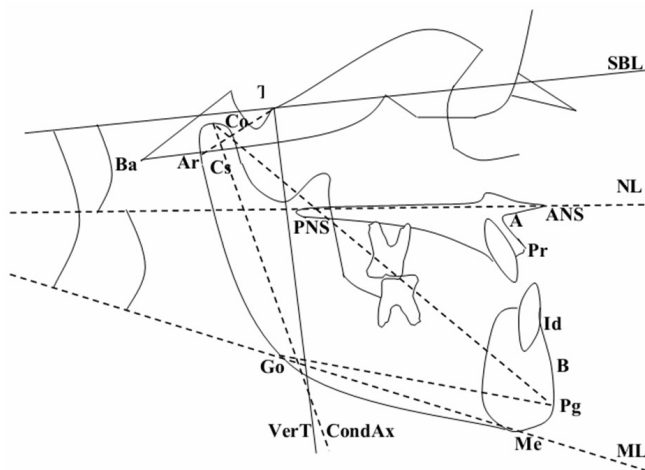


Figure 3. Angular measurements used for the assessment of cranial base angulation, vertical relationships and mandibular ramus and condyle inclination.

Results

The average course of treatment was 14 months (range: 7-20 months). Most patients could achieve an edge-to-edge occlusion of the anterior teeth when relaxed 7-10 days after the insertion of the fixed reverse TBA. The mandible was retruded in most patients. The use of bands with the reverse TBA allowed fixed appliance alignment and levelling of the upper and lower dentitions, while repositioning the mandible and shortening the course of treatment. The anterior crossbite improved through labial

tipping of the upper anterior teeth and the retroclination of the lower anterior teeth. The anterior crossbite correction was also attributed to an improved relationship between the mandible and maxilla following reverse TBA treatment (Figures 4-6). The improvement in facial profiles was produced mainly by the mandibular repositioning, and the labial proclination of the upper anterior teeth had a beneficial effect on the maxillary soft tissues.

Clinical observations revealed that the TMJ dysfunction in the majority of patients was significantly relieved at 1 month. After 4-5 months of maintenance treatment with the fixed reverse TBA, joint clicking, pain and headache improved or were absent in 18 patients. TMJ dysfunction was not observed in patients without symptoms before treatment. The mandibles of 21 patients with laterognathism were adjusted to a centric position and after 4-5 months, the laterognathism was also corrected (Figure 6). The longest follow-up period was 3 years in 12 patients which revealed that anterior overjet and overbite were stable and normal, and neither TMJ dysfunction nor laterognathism recurred.

Review observations revealed that Id-VerT and L1-NB were significantly reduced, as a result of the lingual inclination of the lower incisors. Further decreases in SNB, B-VerT, Po-VerT and NPo-FH and an increase in the Go-VerT were also observed, which suggested that the mandibles had been effectively retruded. The decreases in the CondAX-VerT and CondAX-ML demonstrated that CondAX had altered relative to the reference system. No significant changes were observed in the Co-Go, Go-Po, Co-Po and Ar-Go-Me measurements. The decrease in the ML-SBL suggested the absence of posterior and inferior clockwise mandibular rotation. SNA, Pr-vertT and U1-NA all significantly increased, indicating the labial proclination of the upper anterior teeth. A-VerT and ANS-VerT remained unchanged, which implied little treatment effect

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Figure 4. A female patient aged 19 years presented with Class III malocclusion and upper left canine loss, bilateral TMJ clicking, pain and headache and was treated with a modified fixed reverse TBA for 10 months. A: Before treatment; B: Soon after the commencement of treatment; C: During treatment, (D) Soon after treatment and (E) One year after treatment.

on the maxilla. NL-SBL did not significantly decrease, suggesting the absence of a counter-clockwise rotation of the palatal plane.

Discussion

The presented results showed that the fixed reverse TBA had favourable effects in the treatment of adult Class III malocclusions. The modified TBA had the advantages of simple fabrica-

tion, compact structure, little foreign-body sensation and little influence on oral function. The device was not patient-dependent because it was fixed. Maxillary arch expansion could be performed at the same time as the management of the malocclusion. The use of bands and the fixed nature of the appliance enabled the attachment of brackets while the mandible was repositioned via the occlusal ramps. Therefore, alignment and levelling and upper

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Figure 5. A 19-year-old female patient with an Angle Class III malocclusion and congenital absence of 5 maxillary teeth. A: Labial inclination of the upper anterior teeth. There was difficulty in the denture restoration in this case; B: The brackets were cemented, the mandible was set back and the upper and lower dentitions were aligned. Tooth positions were adjusted to facilitate prosthetic treatment; C: The anterior teeth achieved the edge-to-edge occlusion after 1 week; D: Denture restoration of 11 teeth was achieved after 7 months of treatment (wearing fixed reverse TBA for 4 months) and (E) Pantomograms before (left) and after (right) treatment.

and lower incisor correction could be concurrently achieved. As a result, oral function and dentofacial aesthetics rapidly improved while surgical risks were avoided. The occlusal pads raised the bite and eliminated upper anterior tooth interference and facilitated mandibular setback and the retraction of the lower anterior teeth. The elimination of the anterior tooth

interference was vital for the backward adjustment of the mandible.

During treatment, not only were the labial and lingual inclinations of the incisors altered but the overall distal displacement of the mandible and the lower molars combined to adjust the Class III molar relation. Therefore, the anterior

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Figure 6. A 28-year-old female patient with an Angle Class III malocclusion accompanied by laterognathism. Treatment with a modified fixed reverse TBA was performed over 4 months. The mandible was set back and the upper and lower dentitions were leveled and aligned. A: Before treatment and (B) After 4 months of treatment.

crossbite and the molar position were corrected without extracting teeth. Some patients with anterior crossbite had also experienced tooth loss (**Figures 4-6**). The fixed reverse TBA effectively retruded the mandible and rapidly corrected the malocclusion, which facilitated later prosthetic restoration.

The importance of wearing a functional appliance full time has been emphasised, as it maximises the efficacy of treatment [23]. However, compliance issues generally mean that the majority of functional appliances are worn less than full time. The fixed TBA has a unique advantage, as the appliance cannot be removed, even while eating. Clinical studies have demonstrated that the majority of patients can achieve an edge-to-edge occlusion of the anterior teeth soon after the commencement of treatment, which may be mainly due to changes in the masticatory muscles [21]. The rapid improvement in facial aesthetics further increased the acceptance and confidence of patients. When compared with other methods, the shortened course of treatment was a significant advantage of this modified TBA.

The overwhelming majority of patients with anterior crossbite have an altered position of the condyle [24, 25]. The occlusal pads of the fixed reverse TBA raise the bite and encourage adaptational improvement in condyle position. A posterior and inferior displacement of the condyle can produce a palliative effect on the TMJ and facilitate an improvement or complete

recovery of a disturbed disc-condyle relationship within a short period following the start of treatment [19]. In the subsequent 4-5-month maintenance period, joint clicking, pain and headache in 18 patients resolved. TMJ dysfunction was not induced in any asymptomatic patient during the study.

The orthodontic treatment of laterognathism or mandibular asymmetry has long been recognised in the field of orthodontics as a difficult condition frequently requiring tooth extraction. Treatment is further complicated when the laterognathism is accompanied by an anterior crossbite. The modified fixed reverse TBA, in combination with fixed appliances, was able to effectively alter the position of the mandible and concurrently treat laterognathism (**Figure 6**). Post-treatment stability was verified at a 3-year review. Anterior overbite and overjet remained normal, and there was no recurrence of the laterognathism.

The modified fixed reverse TBA has the ability to provide non-surgical treatment which reduces the risk, the likelihood of surgical difficulties and cost, for patients with serious maxillary and mandibular deformity.

Conclusions

The modified fixed reverse TBA has the advantages of compact structure, comfort, and reduced disruption to oral function, as well as a low reliance on patient compliance. The full

time wear of this appliance can effectively retrude the mandible and shorten the course of treatment in adult patients. The overall setback of the mandible and angular improvements of the upper and lower incisors rapidly and effectively corrected anterior crossbites in adults.

The modified fixed reverse TBA has beneficial effects on concomitant TMJ dysfunction and laterognathism while not inducing TMJ dysfunction in patients without symptoms.

Reverse TBA treatment is not applicable in patients whose mandibles cannot be retruded. However, the reverse TBA can be clinically used as a new, effective, simple, and convenient non-surgical strategy for the treatment of an Angle Class III malocclusion with an anterior crossbite in selected adults.

Disclosure of conflict of interest

None.

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