
An asymmetric magnetic reverse Twin-block appliance for the treatment of a skeletal Class III malocclusion: a case report

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Background: The treatment of a skeletal Class III malocclusion with accompanying mandibular asymmetry is an orthodontic challenge. A skeletal Class III may be associated with a retrognathic maxilla, a prognathic mandible and a mandibular asymmetry can be of dental or skeletal origin or in various combinations. Timely treatment with appropriate biomechanics is crucial for an acceptable and stable result.

Aims: The aim of this article was to introduce a clinically effective asymmetric magnetic reverse Twin-block appliance (AMRTB) for growth modification treatment of an 11-year-old girl who presented with a skeletal Class III malocclusion and accompanying mandibular asymmetry.

Methods: The treatment was comprised of two phases, the first of which was growth modification using the AMRTB for the stimulation of maxillary growth, restraint of mandibular growth, and improvement of the mandibular asymmetry. This was followed by a second phase involving full fixed appliances to optimise the interdigitation and occlusion.

Results: The skeletal Class III relationship and mandibular asymmetry was successfully corrected after two years of treatment. A good facial appearance and pleasing smile aesthetics were achieved. The treatment result was stable after six years of follow-up.

Conclusion: This case demonstrated that the AMRTB was a clinically effective appliance for growth modification treatment in patients with a skeletal Class III malocclusion and mandibular asymmetry.

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Introduction

A skeletal Class III malocclusion with accompanying mandibular asymmetry is a challenging and demanding orthodontic problem. The treatment options to manage this malocclusion usually include growth modification in growing patients, orthognathic surgery in adult patients, or dental camouflage to mask the skeletal discrepancy.¹ An early improvement of a skeletal Class III malocclusion using orthopaedic appliances has been found to

be beneficial for a patient's orofacial aesthetics, lip posture, psychological development, and in reducing the need for later orthognathic surgery.^{2,3} The goals of early growth modification are mainly to promote co-ordinated growth and symmetrical development of the jaws, prevent a disturbance of muscle activity and decrease the risk of craniomandibular disorder during growth.⁴

There have been attempts using orthopaedic or functional appliances to achieve facial growth

modification. These have included the application of a protraction facemask (reverse pull headgear),⁵ a chin cup,^{6,7} a reverse twin block,⁸ the Frankel appliance,⁹ and Class III elastics in combination with temporary anchorage devices (TADs).¹⁰ However, the treatment of a skeletal Class III malocclusion, especially in patients with mandibular asymmetry, still poses orthodontic difficulties. A favourable growth response is considered essential for a successful growth modification outcome.¹¹ The extra-oral component of appliances is uncomfortable and inconvenient for patients to wear, which can subsequently compromise compliance. In addition, the orthopaedic forces generated by conventional appliances (without TADs) are often directly applied to the teeth, resulting in undesirable dentoalveolar effects, such as mesial movement of the maxillary arch and molar extrusion.¹² The protraction facemask has been found to produce a counterclockwise rotation of the maxilla and a clockwise rotation of the mandible, resulting in an increased lower face height.^{13,14} Although there have been some reports on the modification of orthopaedic appliances – for example, a TAD-assisted facemask for maximising the skeletal effect and minimising the dentoalveolar effect¹⁵ – the TAD-assisted approaches are relatively invasive and involve the placement of

miniplates or miniscrews with an increased patient cost.

Therefore, the aim of the present case report was to introduce a clinically effective asymmetric magnetic reverse Twin-block appliance (AMRTB) for growth modification of a skeletal Class III malocclusion with accompanying mandibular asymmetry. The case was reviewed for six years.

Diagnosis and aetiology

An 11-year-old Chinese female and her parents presented for an orthodontic evaluation and voiced a chief complaint of: “I do not like my underbite and asymmetric lower face”. The parents indicated that the unaesthetic facial appearance (concave profile and lower face asymmetry) negatively affected the child’s self-esteem. All were extremely motivated to embark on orthodontic treatment as early as possible. The medical history of the patient was noncontributory. The mandibular first molars had restorative care two years previously. The patient’s father showed a mild dolichofacial pattern and a concave facial profile.

The pretreatment facial photographs (Figure 1) indicated a concave profile, a retrusive upper lip, an



Figure 1. Pretreatment facial and intraoral photographs.

everted lower lip and lower facial asymmetry with the chin shifted to the left. An intraoral evaluation (Figures 1 and 2) revealed the presence of an early permanent dentition, a deep anterior crossbite with an increased overbite (6.5 mm) and a reverse overjet (-3 mm) and full unit Class III molar and canine relationships. There was a mild crowding (2 mm) in the maxillary arch and 2 mm of space in the mandibular arch. The depth of the mandibular curve of Spee was 4 mm. The maxillary and mandibular arch forms were not co-ordinated as the lower dental midline was 3 mm to the left of the facial midline. A functional examination indicated that the mandible could be retruded 1.5 mm; however, the anterior

teeth still maintained a crossbite relationship in the retruded contact position. The patient reported no pain in the temporomandibular joint region and no apparent oral habits.

A cephalometric analysis (Figure 3 and Table I) indicated a retrognathic maxilla and a prognathic mandible. The ANB angle was -3.0° , the Wits appraisal was -7.5 mm, and the mandibular plane was normal relative to the cranial base ($SN-MP = 31.0^\circ$). The mandibular incisors were lingually inclined ($L1$ to $MP = 89^\circ$) to compensate for the Class III skeletal discrepancy. The patient had not reached menarche. Her cervical vertebrae stage (CVS) was three.

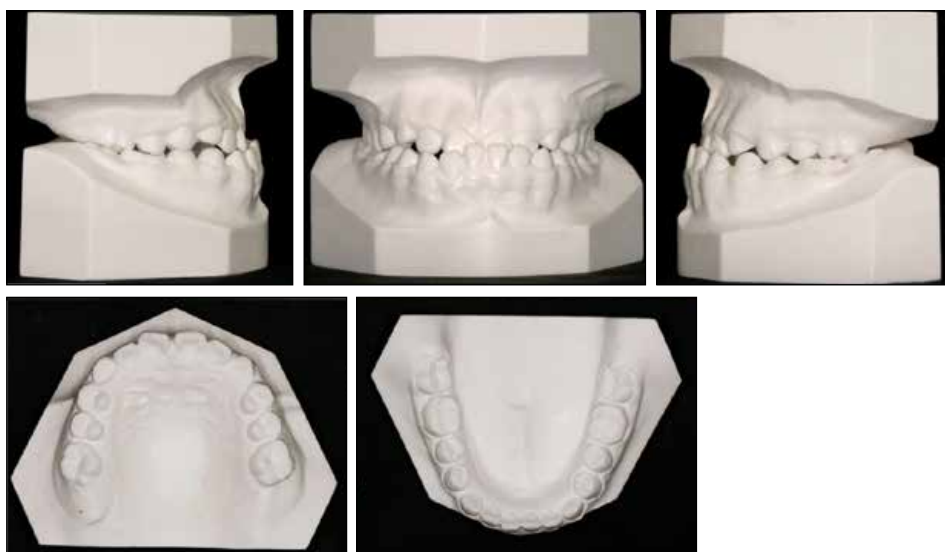


Figure 2. Pretreatment dental casts.

Table I. Cephalometric analysis at various stages of the two-phase treatment.

Measurements	Chinese norm	Pre-treatment	Post-growth modification	Post-fixed treatment
SNA($^\circ$)	82.8	75.5	79.0	79.5
SNB($^\circ$)	80.1	78.5	78.0	78.5
ANB($^\circ$)	2.7	-3.0	1.0	1.0
Wits appraisal (mm)	-1.15	-7.5	-2.2	-1.8
SN-MP($^\circ$)	32.5	31.0	32.0	33.5
FMA($^\circ$)	27.3	25.0	26.0	26.5
Y-axis($^\circ$)	66.3	67.0	68.6	69.3
U1 to SN($^\circ$)	105.7	103.0	104.0	106.7
U1 to NA($^\circ$)	22.8	22.0	23.4	25.6
U1 to NA (mm)	5.1	4.6	5.3	6.4
L1 to NB($^\circ$)	30.3	20.5	20.6	24.0
L1 to NB (mm)	6.7	3.9	3.9	4.6
L1 to MP($^\circ$)	92.6	89.0	89.0	90.5
U1 /L1($^\circ$)	125.4	135.0	134.0	130.5
Upper lip (mm)	-1.4	-3.0	1.1	1.0
Lower lip (mm)	0.6	4.5	1.0	0.5

Treatment objectives

- (1) To improve the facial profile and symmetry;
- (2) To correct the Class III skeletal discrepancy through stimulation of maxillary growth and the restraint of mandibular growth;
- (3) To correct the anterior crossbite and achieve Class I molar and canine relationships and a normal overjet and overbite;
- (4) To co-ordinate the dental arches and obtain coincidence of the dental and facial midlines.

Treatment alternatives

Four proposed treatment options were discussed with the patient and parents.

Option 1: Two-phase treatment, including growth modification using a protraction facemask (with or without TAD assistance), or TAD-assisted Class III elastics, followed by full fixed appliances. Miniscrews would be used to enhance anchorage and the stimulation of maxillary growth. Full fixed appliances would follow to level and align the dental arches, to co-ordinate the mandibular and facial midlines, and to establish Class I canine and molar relationships.

Option 2: Two-phase treatment (growth modification with the AMRTB followed by full fixed appliances). The AMRTB would be used to promote sagittal growth of the maxilla, inhibit mandibular growth, and to improve the midfacial deficiency and mandibular asymmetry. Full fixed appliances would then be used to level and align the dental arches, to co-ordinate the mandible midline and the facial midline, and to establish Class I canine and molar relationships.

Option 3: Camouflage treatment. Full fixed appliances using Class III elastics to procline the maxillary anterior teeth and retrocline the mandibular incisors in order to mask the maxillary and mandibular skeletal discrepancy.

Option 4: Observation and orthognathic surgery following the completion of patient's growth since there was a strong family history of a sagittal skeletal discrepancy.

Option 2 was chosen because the family was firmly against any type of surgery and concerned about compliance associated with uncomfortable extra-oral appliances. The patient and parents were informed about the possibility of orthognathic surgery after the cessation of growth if unfavourable growth occurred and the Class III skeletal discrepancy worsened.

Treatment progress

The first phase of treatment started with the AMRTB to attempt growth modification (Figure 4). The AMRTB was constructed from maxillary and mandibular removable appliances with two $6 \times 4 \times 3 \text{ mm}^3 \text{ Nd}_2\text{Fe}_{14}\text{B}$ magnetic units encapsulated in the occlusal acrylic blocks of each appliance. The upper magnets were located inferior to the upper canine, and the lower magnets were placed in the acrylic splints superior to the mandibular posterior teeth. The acrylic blocks were designed with ramps to induce retrusion of the mandible during mouth closure. The magnetic units on each side were placed in a repelling configuration, and the opposing sides were covered with a thin layer of acrylic (0.3 mm thickness). The initial repulsive magnetic forces were 300 grams per

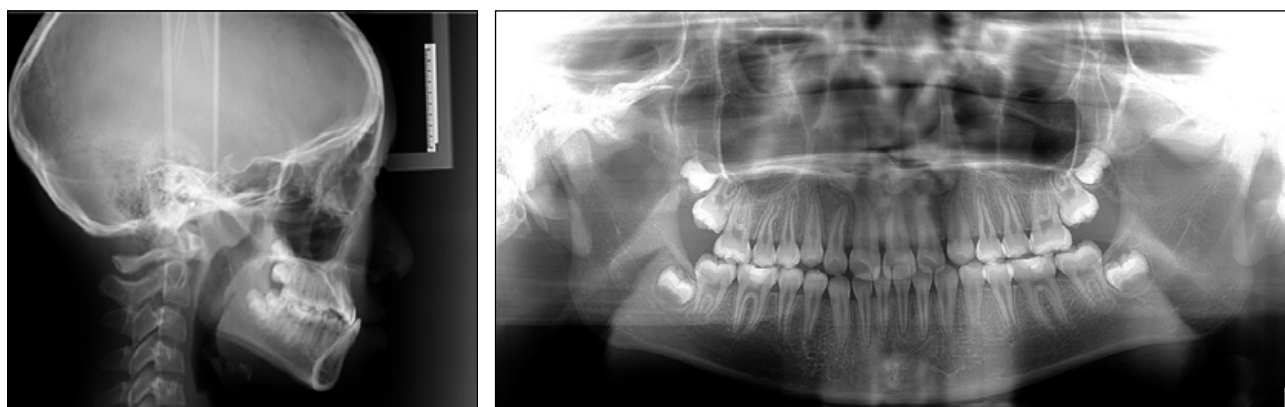


Figure 3. Pretreatment radiographs.

side, producing intermaxillary reciprocal forces to advance the maxilla and simultaneously retract the mandible. To produce a differential orthopaedic force to correct the mandibular asymmetry, the distance between the two opposing magnets was asymmetrical; that is, 0.5 mm and 1.0 mm on the right and left sides, respectively. The directions of the repulsive magnetic forces were parallel to the occlusal plane at the position of maximal mouth closure.

The patient was required to wear the AMRTB for 24 hours per day and recalled for an examination two weeks after the first delivery of the appliance. Thereafter, the appointment intervals were four weeks. After 4.5 months, there was a 5 mm clearance between the two opposite magnetic units on each side, and the

incisor crossbite was corrected. The distance between the two opposing magnets increased with time as the sagittal skeletal discrepancy improved, resulting in a reduction of the repulsive force. Hence, there was a requirement for periodic incremental adjustment of the magnetic units in the acrylic blocks. To continue the correction of the deviated mandibular midline, the AMRTB was reactivated by adding two thinner $\text{Nd}_2\text{Fe}_{14}\text{B}$ magnets ($6 \times 4 \times 1\text{mm}^3 \text{Nd}_2\text{Fe}_{14}\text{B}$) into the right upper block only (Figure 5). Following another two months, an asymmetrical reactivation was performed by adding two new additional magnet slides into the right upper block and only one magnet slide into the left upper block. During the growth modification treatment with the AMRTB, a total of



Figure 4. Intraoral photographs with the AMRTB.



Figure 5. Intraoral photographs with the reactivated AMRTB.



Figure 6. The facial and intraoral photographs after the first phase of treatment.



Figure 7. The radiographs after the first phase of treatment.

four slides of magnetic blocks were added on the right side, but only one magnetic slide was added on the left side.

In total, the AMRTB was worn for 12 months until a positive overjet and a coincident lower midline were almost achieved (Figure 6). The maxillary and mandibular midline discrepancy improved from 3 mm to 1 mm. A cephalometric analysis after growth modification (Figure 7 and Table I) showed that the SNA angle increased from 75.5° to 79.0°, the ANB angle increased by 4.0° (from -3.0° to 1°), and the U1-SN angle increased from 103.0° to 104.0°. There

was no change in the L1 to NB angle and L1 to MP angle. The FMA angle increased by 1.0°. These values indicated that the maxilla was advanced, the mandible was restrained, and the inclination of upper anterior teeth changed slightly during the AMRTB treatment.

During the second phase, the full fixed appliances (0.022-inch slot, Damon Q self-ligating brackets with high-torque, Ormco, CA, USA) were bonded on both arches. After six months of levelling and alignment with sequential nickel-titanium arch wires (0.014 to 0.017×0.025-inch Ni-Ti), the lower dental midline remained 0.5 mm to the left side. Therefore,

rectangular stainless steel arch wires (0.018×0.025-inch) with lower anterior segments incorporating 5° of lingual root torque were engaged. A unilateral Class III elastic (100 grams) was applied only on the right side for three months to correct the deviated lower midline (Figure 8).

After another 12 months, the first molars and canines were successfully positioned in a Class I relationship, the maxillary and mandibular arch forms were

co-ordinated, and the dental midlines were coincident with the facial midline (Figures 9 and 10).

The total active treatment time was 24 months, including 12 months of AMRTB growth modification and 12 months of fixed appliance treatment. After removal of the appliances, the patient was referred to a general dentist for the restoration of the mandibular right first molar.



Figure 8. Progress intraoral photographs.



Figure 9. Post-treatment facial and intraoral photographs.

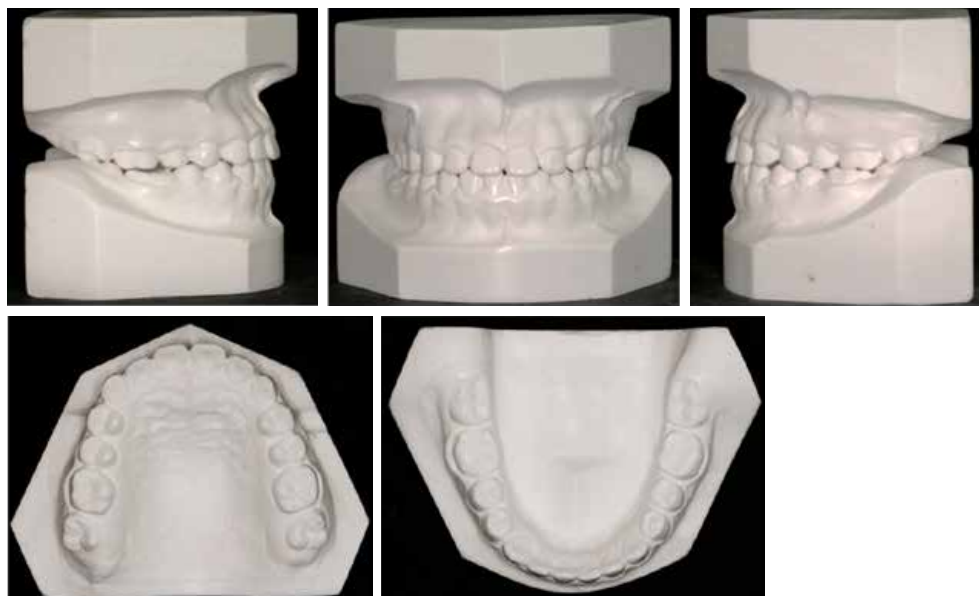


Figure 10. Post-treatment dental casts.



Figure 11. Post-treatment radiographs.

Clear vacuum formed retainers were provided for retention. The patient was followed for six years (Figures 12 and 13).

Treatment results

The post-treatment records demonstrated that the treatment objectives were achieved. The post-treatment photographs showed a straight profile, a symmetrical face and a well-aligned dentition (Figure 9). The upper midline was coincident with the facial midline and the lower midline was slightly to the left. Normal overbite and overjet were achieved, and a Class I canine and molar relationships were established.

The post-treatment cephalometric analysis and superimposition (Figures 11 and 14) indicated that the Class III skeletal discrepancy was improved (the ANB angle increased from -3.0° to 1.0°). The SNA

increased from 75.5° to 79.5° , indicating that A-point moved forward. SNB remained unchanged (78.5°) throughout treatment, indicating that restraint of mandibular growth was achieved. However, the SN-MP angle increased (from 31.0° to 33.5°) and the FMA angle increased from 25.0° to 26.5° , indicating a clockwise rotation of the mandible. The inclination of the maxillary incisors increased from 103.0° to 106.7° and the mandibular incisors slightly proclined following treatment (the LI-MP angle increased, from 89.0° to 90.5°). The post-treatment panoramic radiograph showed good overall root parallelism with no signs of alveolar bone or root resorption (Figure 11).

At the six-year review, the records (Figures 12 and 13) indicated that the correction of the skeletal Class III and mandibular symmetry was stable.



Figure 12. Facial and intraoral photographs at six years of retention.



Figure 13. Radiographs at six years of retention.

Discussion

A skeletal Class III malocclusion with mandibular asymmetry significantly affects facial aesthetics, psychological well-being, and a patient's quality of life. The present case report described a growing female patient with a skeletal Class III malocclusion and mandibular asymmetry. The AMRTB with asymmetric activation of an orthopaedic force was used to correct the sagittal discrepancy and asymmetry. After treatment, maxillary sagittal forward growth enhancement was successfully achieved, with a significant incremental change in the SNA and ANB angles; the SNB angle remained stable, indicating

a restriction of mandibular growth. The treatment results were stable after a six-year follow-up.

It has been found that at least 21–67% of patients with prognathia or retrognathia have facial asymmetries and more than 85% of patients show deviation toward the left side.^{16–18} Early growth modification has been found to be beneficial for these patients in eliminating the potential restriction of maxillary growth, reducing the negative impact on skeletal and dysfunctional development, preventing progressive irreversible and undesirable soft tissue change and improving facial aesthetics.¹⁹ However, traditional functional/orthopaedic appliances used for Class III

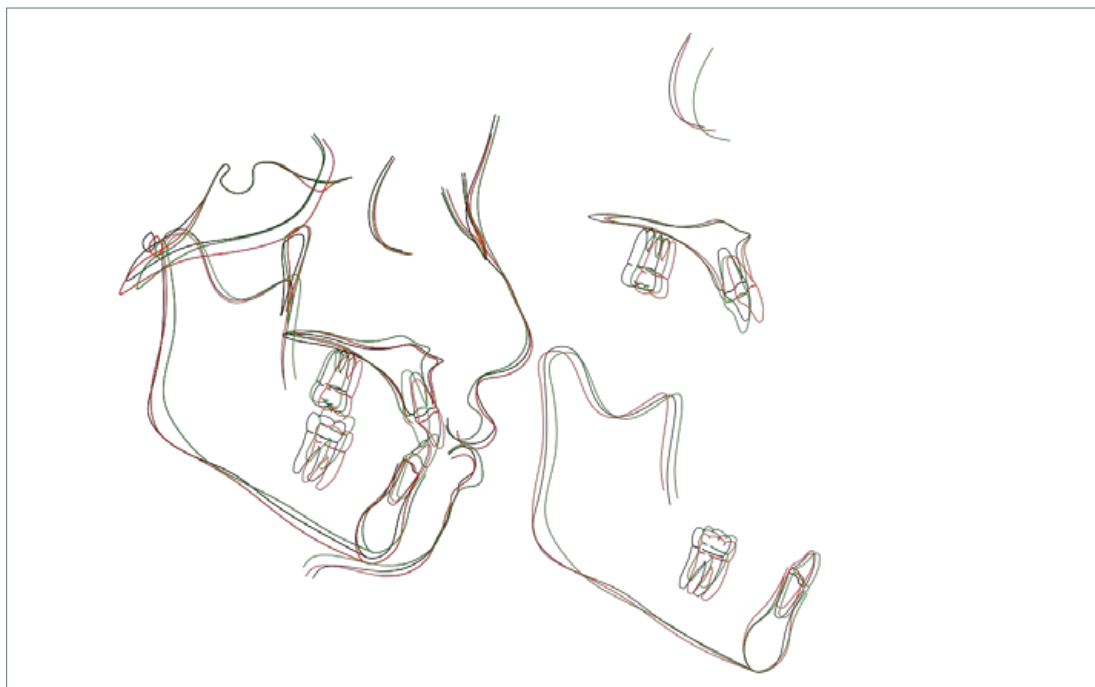


Figure 14. Superimposed tracings (green, pretreatment; black, after growth modification; red, post-treatment).

malocclusions, such as a protraction facemask, have limitations related to quality of life, patient compliance and adverse effects.²⁰ Furthermore, the activation of traditional functional appliances is often symmetrical, which does not work well in cases of mandibular asymmetry.

Following the introduction of rare-earth magnets in the late 1950s,²¹ those that generate static magnetic fields have been advantageously used in orthodontic research and practice.^{22,23} For example, the attractive or repulsive magnetic forces could be used for palatal expansion,²⁴ open bite correction^{25,26} and the treatment of a Class III malocclusion.^{27,28} A clinical study involving 32 growing subjects demonstrated favourable results using a magnetic twin-block appliance for the treatment of a skeletal Class III malocclusion.²⁷ A previous study examining rhesus monkeys found that a repelling magnetic appliance could be efficient in the treatment of a Class III malocclusion with a retrognathic maxilla.²² A recent clinical trial using a magnetic orthopaedic appliance for the early treatment of 36 patients with skeletal Class III malocclusions reported that the SNA angle increased by 1.89° and the ANB angle improved by 2.28°.²⁹ However, to date, there has been no study on the application of magnetic functional application for the treatment of skeletal Class III malocclusion with mandibular asymmetry.

One of the advantages of the AMRTB is the capability of asymmetrical reactivation for the correction of mandibular asymmetry during growth. In the present case, the magnets were asymmetrically added into the right and left acrylic blocks during the treatment, resulting in differential repelling forces for growth modification as well as the simultaneous correction of the lower midline. However, it is also important to note that asymmetrical reactivation for midline correction had limitations, as a Class I buccal relationship was achieved in the present case after the AMRTB treatment but there was still a 1 mm midline discrepancy even though an unequal number of magnets were added between the sides. The number of the additional magnets that are needed for periodic appliance reactivation depends on the distance between the maxillary and mandibular magnetic blocks and the value of the activation force that the clinician plans to generate. Usually, two opposite Nd₂Fe₁₄B magnetic blocks (6 × 4 × 3 mm³) can generate 300 grams of force. However, the AMRTB is convenient for patients to wear because of the small size and the absence of extra-oral components. Patients are also able to wear the AMRTB for a full period of 24 hours, which guarantees that forces are engaged constantly. In addition, the AMRTB used in the present study provided a more favourable environment for the patient's future growth and an

aesthetic facial appearance, resulting in improved psychological development.

The passive self-ligating brackets with high-torque (Damon Q) were used in the present case for the second phase of fixed appliances treatment. The proclination of the lower incisors was well controlled by using this bracket system and arch wires with anterior lingual root torque, resulting in adequate uprighting and decompensation of the mandibular anterior teeth (L1-MP increased by 1.5°). In addition, mechanics that applied unilateral Class III elastics from the upper right second premolar to the lower right canine were employed to correct the lower dental midlines. However, it is important to note that long-term use of intermaxillary elastics on one side should be minimised, as it may lead to an imbalance of the muscles of the stomatognathic system and contribute to a temporomandibular disorder, migraine or local pain.

Conclusion

An asymmetric magnetic reverse Twin-block appliance (AMRTB) was clinically effective in the growth modification of a skeletal Class III malocclusion with mandibular asymmetry. There was significant improvement in the facial profile and symmetry and good stability at a six-year review.

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