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Case Report

The role of patient motivation in long-term success of Class II malocclusion treatment: A five-year follow-up case report

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Abstract

Background: Class II malocclusion is the most frequent maxillo–mandibular skeletal discrepancy in preadolescents, typically linked to mandibular retrognathia. Growth-modification appliances are widely used, yet outcomes vary because success hinges on timing, comfort, and sustained compliance. Self-Determination Theory (SDT) highlights that satisfying autonomy, competence, and relatedness needs promotes internal (self-endorsed) motivation, crucial for adherence to removable functional appliances. The Medium Opening Activator (MOA) is a contemporary functional design intended to improve tolerability while simultaneously addressing sagittal discrepancy, deep bite, and lower-incisor control.

Case: We describe the two-stage management of a ten-year-old girl treated first with an MOA during the growth-modification phase, followed by comprehensive fixed therapy. High appliance wear was maintained through autonomy-supportive communication, neutral progress benchmarks, individualized micro-goals, and adaptive twin sibling comparison that provided informational feedback and mutual encouragement. These processes likely supported need satisfaction and internalization, contributing to favourable Class II correction, deep-bite improvement, and long-term stability.

Conclusion: By operationalizing self-determination principles (autonomy-supportive dialogue, informational benchmarks, individualized micro-goals, prosocial encouragement), this case achieved sustained MOA wear, successful Class II correction, and stability at five-year post-treatment follow-up. Need satisfaction (autonomy, competence, relatedness) remains a crucial determinant of removable appliance outcomes; when present, the MOA functions as an effective first-phase intervention in appropriate growing Class II patients.

Keywords: Class II malocclusion, Medium opening activator, Patient compliance, Self-Determination Theory, Intrinsic motivation, Orthodontic adherence

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1. Introduction

Skeletal class II malocclusions are the most common maxilla–mandible skeletal disharmony seen in young patients,[1-3] including in Saudi Arabia,[4-5] of which mandibular retrognathism is the most prevalent.[6] Class II malocclusions are characterized by increased overjet, a deep overbite, and compromised lip competency. Children with class II malocclusions are more prone to incisor trauma during childhood,[7] and treating these young patients not only reduces the risk of trauma but also has a positive effect on their oral health-related quality of life,[8-10] especially since the malocclusion may not self-resolve.[11]

Class II malocclusions can be treated with functional appliances, first developed in Europe about a century ago and now widely used by orthodontists in many countries. Functional appliances work by posturing the mandible forward, altering its vertical and sagittal positions to stretch the muscles and soft tissue to create a pulling force transmitted to the condylar cartilage and dentoalveolar structures.

In this way, the approach leverages the remaining growth potential of the mandible and may increase its effective length, although this effect remains a topic of debate.[12-14] While some studies and systematic reviews report positive dentoalveolar and skeletal outcomes using this approach,

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others suggest that the increase in mandibular length may be clinically insignificant.[13-15] Additionally, the soft tissue envelope surrounding the teeth adapts, allowing for tooth movement and potentially promoting a new, favourable occlusal relationship.[16-18] It is essential to consider these differing perspectives when evaluating the overall impact of functional appliances on mandibular growth, emphasizing careful case selection and close monitoring of treatment progress. This case provides an opportunity to discuss these differing viewpoints.

An activator is a type of Removable Functional Appliance developed at the beginning of the twentieth century by Danish orthodontist, Viggo Andresen.[12] Activators are used in the first phase of treating class II malocclusions in pre-adolescent patients to correct skeletal and dental sagittal deformities.[19] They act by improving the growth of the mandible and altering the dental and muscular relationships.[20,21] Treatment usually starts during the mixed dentition stage and is followed by a period of retention. A second phase of comprehensive orthodontic treatment to finalize the occlusion and dental alignment starts when all permanent teeth erupt. This two-phase treatment approach has been shown to significantly decrease the risk of trauma to the incisors compared with one-phase treatment.[22,23] However, the success rate depends on many factors including time of treatment initiation, the severity of the problem, the amount of remaining growth potential, and patient cooperation. Starting treatment with a functional appliance in the late mixed dentition stage and in children entering their growth spurt is recommended to achieve positive outcomes.[24]

Several activator variations have been developed to improve patient compliance, reduce the side-effect of lower incisor proclination, and/or to provide compatibility with head gear. The Medium Opening Activator (MOA) is a one-piece modified activator which simultaneously addresses deep bite and mandibular retrognathia. It is less bulky than the well-known original activator, making it more comfortable and acceptable to the patient.[25]

The MOA also incorporates an acrylic cap on the lower incisors to limit their proclination and provides an occlusal freeway to induce eruption of the lower molars and allow for relative intrusion of anterior teeth. Here we report a case treated successfully with MOA and followed up for five years. Presenting this case allows us to highlight factors contributing to the success of such an approach, especially the value and importance of internal motivation.

2. Case Presentation

2.1. Case overview

A ten-year-old girl presented with her mother to the university orthodontic clinic seeking consultation as recommended by her paediatric dentist. She was potentially cooperative.

Clinical examination revealed that the patient had good oral hygiene and healthy gingivae. She had a symmetrical face, an average nasolabial angle, average lower facial height, and exhibited a convex profile. She was in the late mixed dentition stage, with upper canines and all premolars about to erupt except the upper left second premolar, which had already erupted (**Figure 1**). She had a 6 mm overjet and 80% overbite. The upper incisors were proclined and protruded. The permanent molars were in a class I relationship on the right side and class II relationship on the left side due to the exfoliation of the primary upper second molar and the resultant drift of the first molar into the leeway space.

Table 1: Comparison of cephalometric measurements before, during, and after treatment.

	Measurement	Mean	Pre-treatment	Mid-treatment (end of MOA stage)	Post-treatment	Five-year follow-up
Sagittal relationship	SNA	82 ± 3	79.2	79.4	80	79.4
	SNB	80 ± 2	73.6	75.8	76	76.8
	ANB	2 ± 2	5.6	3.6	4	2.6
	Wits appraisal	F: -1.17 ± 1.9 M: -0.1 ± 1.77	3	0.9	1.0	0.4
	NPg. - FH	87 ± 3	82	83.0	86.2	84.6
Vertical relationship	Mand. plane to FH	22 ± 5	25.8	27.6	27.7	26.6
	Mand. plane to SN	31 ± 5	35.5	35.7	36	34.7
	Ramus height	44	32.8	35.4	39.9	48.1
Dental relationship (Incisor position)	U Inc. to max. plane	109 ± 6	122	119.8	118	114.4
	U Inc. to NA	6 ± 2	6.9	6.3	5.9	7.4
	U Inc. to L Inc	130 ± 9	118.2	117.7	118.7	128.6
	L Inc. to Mand	93 ± 6	95.8	97.7	97.8	94.2
	L Inc. to NB	5 ± 2	5.6	7.3	7.3	7.7
Soft tissue relationship	Soft tissue convexity	12 ± 4	23.4	20	19	16.4

McNamara analysis	Midfacial length Co-A	85	70.3	71.4	74.4	87
	Mandibular Length Co-Gn	105-108	87.3	91	96	116.5
	Mx/Md Diff Co-Gn - Co-A	20-24	17	19.6	23.6	29.5

Cephalometric analysis confirmed a class II skeletal relationship, normal mandibular divergence to the cranial base and Frankfurt horizontal, and normal inclination of the upper and lower incisors.(**Figure 2**) According to McNamara analysis, the mandible had below average effective length (Co-Gn: 87.3 mm).(**Table 1**) The patient was in the third cervical vertebral maturation stage, which indicated that she was at the peak of the pubertal growth spurt, with considerable growth remaining.

2.2. Treatment objectives and plan

The patient had a mild-to-moderate class II skeletal relationship due to a retrognathic mandible, and she was in a growth stage optimal for correcting the mandibular deficiency. She had a deep bite that could be treated by means of relative intrusion, which acts by holding the incisors in position and allowing for free eruption of the posterior teeth. This approach would be expected to maintain the mandibular divergence and to be compensated by vertical ramus growth in such a growing patient.

For these reasons, an MOA was chosen as the first stage of treatment to enhance mandibular lengthening to correct the class II skeletal relationship and the deep bite (**Figure 3**). Since the lower incisors were in a good position and angulation relative to the mandible, we aimed to minimize the induced proclination effect of typical activators by using acrylic caps on the incisors. The asymmetric molar classification was due to dental findings and did not reflect true skeletal asymmetry, and the plan was to address this later during fixed appliance therapy.

No extraction was planned, since there was only mild crowding in the upper or lower arches and the incisors were in an acceptable position to their corresponding jaws. Therefore, a second phase was planned for finishing and detailing only, which was achieved with a fixed orthodontic appliance (0.022'' x 0.028'' MBT).

2.2. Treatment progress

After discussing the treatment plan with the patient and parents, the MOA was constructed to advance the mandible symmetrically to a nearly edge-to-edge position. The advancement was planned to be symmetric, as there were no radiographic nor clinical signs of skeletal asymmetry. Any remaining dental asymmetries were planned to be corrected during the second phase of treatment using fixed appliances. The appliance was inserted, and the patient was instructed to wear it 16 hours each day for nine months. She was cooperative and motivated to compete with her twin brother, who was also scheduled to have orthodontic treatment. This internal motivation was key to achieving the favourable outcomes, as the patient was religiously committed to wearing the appliance.

There was no need to expand the upper arch, since no relative posterior cross bite was present upon advancing the mandible to the optimum overjet. The patient was seen one week after insertion and once every month thereafter for adjustments and monitoring of progress. During each follow-up visit, photos of aligned teeth and beautiful smiles were shared with the patient to enhance motivation. Again, the patient's twin brother was another important source of motivation, as they both received treatment at the same time and started competing on who would have the better result.

By the end of phase I (**Figure 4 A**), the overjet was corrected, the overbite had improved, and the upper premolars had erupted. At that point, the patient was ready for bonding with a fixed orthodontic appliance to maintain the results, since the MOA was no longer retentive due to the exfoliating primary teeth and the newly erupting permanent teeth. Fixed 0.022'' MBT prescription brackets were bonded. During levelling and alignment, the upper canine and lower second premolar spaces were maintained using coils. The archwires were upgraded progressively from 0.014'' NiTi, 0.018'' NiTi, 0.016 x 0.025'' upper NiTi, 0.019 x 0.025'', then to 0.017 x 0.025'' TMA. During the finishing stage, anterior turbos were placed to optimize the overbite and class II elastics were used for two months.

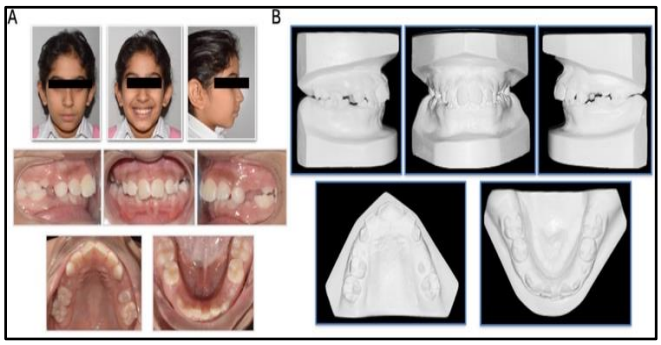

Figure 1: A: Pre-treatment photographs. B: Pre-treatment models

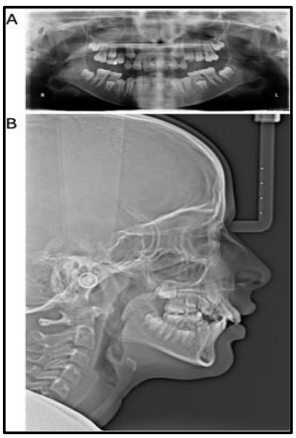

Figure 2: Pre-treatment radiographs.

Figure 3: Medium Opening Activator (MOA) delivered.

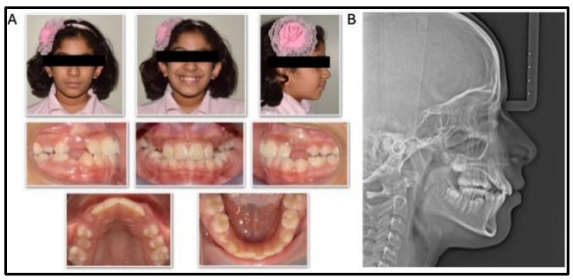

Figure 4: Mid-treatment intra- and extra- oral photographs and lateral cephalogram.

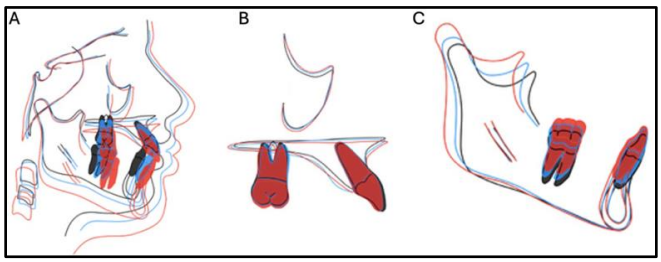

Figure 5: Superimposition of pre- (black), mid- (blue), and post-treatment (red) cephalometric tracings. A: overall superimposition, B: maxillary superimposition, C: Mandibular superimposition.

Figure 6: Post-treatment extra- and intra-oral photographs.

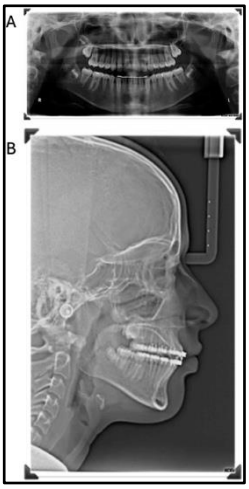

Figure 7: Post-treatment panoramic X-ray and near end of treatment cephalometric radiograph.

Figure 8: Five-year follow-up records. A: Follow-up cephalogram. B: Follow-up extra- and intra-oral photographs

2.3. Treatment outcomes

After phase I of treatment, which lasted for nine months, the skeletal relationship of the upper and lower jaws had improved.(**Figure 4 B**) Consequently, the facial convexity and chin position improved as confirmed by cephalometric analysis.(

Table 1) The final cephalometric radiograph was taken near the end of phase II. The overall superimposition revealed downward and forward growth of the skeletal and facial structure and slight backward rotation of the mandible. The

regional mandibular superimposition revealed that the mandibular length (Co-Gn) increased by about 4 mm, the height of mandibular first molar (mandibular plane perpendicular through the mesial cusp of the lower first molar)[26] had increased by 3 mm, while the mandibular plane angle was maintained.(**Figure 5**) The proclination of the lower incisors relative to the mandible plane was approximately two degrees. Intraoral examination showed improvement of the overjet, overbite, and sagittal molar relationship. After fixed orthodontic appliance treatment for 18 months, the patient was satisfied. Moreover, the overjet, overbite, and neutroclusion of the canines and molars were successfully optimized.(**Figure 5-Figure 7**)

Additional records were taken five years after treatment to monitor outcomes. As shown in **Figure 8**, the patient maintained persistent class I canine and molar relationships and excellent dental alignment. There was some gingival recession as a natural maturation process, leading to elongation of the clinical crowns. As indicated by cephalometric analysis (

Table 1), all skeletal and soft tissue components showed prominent growth. The upper and lower incisors showed some degree of retroclination, which could be explained by skeletal growth of their corresponding jaws.

3. Discussion

The choice of using a removable functional appliance to treat class II malocclusion could be considered controversial,[27] as many studies have claimed that spontaneous correction occurs as the patient grows,[28] although there is evidence to the contrary.[11] Functional appliances tend to increase the total treatment time and complexity, depend on patient cooperation, and may cause tissue damage,[15,29-31] so their use must be considered carefully.

Nevertheless, activators have a documented success rate of 60%.[19] In the current case, our decision to use an MOA was based on the patient's developmental stage. Being preadolescent, it was reasonable to use a functional appliance to redirect the remaining growth potential and improve the sagittal as well as vertical discrepancies. Moreover, these appliances are stable, maintain oral hygiene, have positive effects on psychological wellbeing, and are more acceptable to patients. Compliance is facilitated by most of the wearing time being at night.[32-35]

As expected with young patients, cooperation and commitment could have been problems. This patient, however, had a twin brother who was undergoing orthodontic treatment. Her inner drive for a sense of competition and accomplishment was obvious, so we anticipated good cooperation.

The MOA was chosen for first-stage treatment since it was expected to enhance mandibular lengthening to correct the class II skeletal relationship as well as deep bite by allowing the lower molars to erupt. It also had the advantage of a minimal proclination effect of the lower incisors due to the incorporated acrylic cap.

The superimposition confirmed the skeletal effects of the functional appliance; the mandibular length increased 2 mm after phase 1 and continued to increase thereafter. This observation is consistent with elimination of the intercuspal locking effect, which allowed the mandible to grow sagittally.[36] MOA has proven efficacy for treating deep bite cases, and the extrusion of lower molars and the compensating ramal growth were sufficient to decrease the deep bite from 80% to 30% during phase I. Consequently, the mandibular plane angle was controlled and only changed by a negligible amount, which might have been due to a tracing error. The final stage of treatment was bonding a fixed orthodontic appliance to align the teeth in their arches and retain the results of the first stage. In our case, this phase lasted for eighteen months, so the total treatment time was two years and three months.

The long-term stability of the results demonstrates the value of using MAOs for class II treatment. That said, these appliances require excellent patient compliance and motivation.[37,38] In this case, this was achieved by building solid internal motivation with the patient, which was further facilitated by a sibling undergoing simultaneous orthodontic treatment and their desire to compete. In Self-Determination Theory terms, our clinical aim is to satisfy autonomy, competence, and relatedness so that appliance wear becomes self-endorsed rather than externally driven. When siblings undergo treatment concurrently, inevitable comparison can be channelled into informational support instead of a win–lose contest. Provide informational performance benchmarks and feedback (neutral side-by-side timelines of appliance fit), emphasize the shared journey and co-experienced challenges (e.g., both navigating initial pressure after activations), and offer choice over engagement style (how each prefers to log wear hours or review progress) to preserve autonomy. Use collaborative, individualized micro-goals that reinforce prosocial encouragement (“reminding each other to commit to appliance wear to accelerating outcomes for both”). Framed this way, comparison becomes informational (competence), jointly experienced (relatedness), and self-endorsed (autonomy), rather than controlling competition. Satisfying these needs supports internalization, shifting adherence from ‘keeping up’ toward a personally valued, self-regulated habit of appliance wear. This constellation converts raw comparison into sustained, higher-quality motivation. [39,40]

4. Conclusions

This case illustrates that a medium opening activator (MOA) can be considered for carefully selected preadolescent patients presenting with mild to moderate Class II malocclusion, deep bite, and acceptable or slightly proclined lower incisors. In addition to dento-skeletal suitability, the patient's internal (self-endorsed) motivation, fostered through autonomy-supportive communication, informational progress benchmarks, collaborative micro-goals, and prosocial encouragement, is a critical selection and management factor. Orthodontists should intentionally build and monitor autonomy, competence, and relatedness need satisfaction before and during removable appliance therapy to optimize adherence and maintain treatment outcomes.

5. Declarations

5.1. Ethics approval and consent to participate

This study was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration. The patient provided informed consent.

6. Consent for Publication

The patient provided consent for publication of the images.

7. Data Availability

All data are presented within this manuscript.

8. Source of Funding

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9. Conflict of Interest

None.

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