



Early Orthopedic Correction of Skeletal Class II Division 1 by Modified Bionator

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Abstract:

Objective: The purpose of this study was to evaluate the early treatment effects of the modified bionator with J-hook on soft tissue of growing patients with skeletal Class II division 1 malocclusion. **Materials and Methods:** This investigation was conducted on 12 patients. All the patients had the following criteria: skeletal Class II division 1 due to mandibular retrusion with maxillary excess. Age ranged from 8-12 (mixed dentition and early permanent dentition). ANB° was more than 6°. Overjet was more than 5 mm. Lateral cephalometric radiographs, photographs and study casts were obtained before and after treatment. The collected data were analyzed using SPSS Version 22.0. The treatment continued for almost 17 months. **Results:** The appliance had dento-skeletal and soft tissue effects, which were established by the following significant changes: improvement of the maxillo-mandibular relationship, slight increase in the anterior facial height, decreased the overjet, stimulation of the forward growth of the mandible, restriction of the forward and downward growth of the maxilla and improvement in the soft tissue profile. **Conclusion:** The modified bionator with J-hook was effective in the treatment of growing patients with class II division 1 malocclusion. The appliance had skeletal effects in the sagittal plane by restricting maxillary growth and stimulating the forward growth of the mandible. The overjet was reduced due to the increased forward growth of the mandible and palatal tipping of upper incisors. The appliance improved the vertical dimension of the face and the facial profile.

Introduction:

Class II malocclusion is one of the most often seen types of malocclusion in ordinary orthodontic treatment. Class II malocclusion is characterized by an incorrect relationship between the upper and lower arches because of skeletal, dental problems or combination of both.^{1,2}

The purposes of early treatment of Class II malocclusion are to modify the pattern of facial growth, correct the sagittal relationship, and improve both soft and hard tissue profiles.³ Class II malocclusion can be corrected in various ways (orthopedic correction forces to stimulate mandibular growth or inhibit maxillary growth, dentoalveolar changes, or surgical repositioning of the mandible in non-growing patients).⁴

Many functional appliances were designed for the treatment of skeletal Class II division 1 malocclusion of growing patients. Among these were the bionator functional appliances.⁵

Excessive growth of the maxilla in patients with class II malocclusion has more of a vertical than anteroposterior discrepancy, and if the maxilla rotates downward, the mandible rotates downward and backward. In growing patients, a high pull headgear is the treatment option, while in non-growing patients, orthognathic surgery is used to correct vertical maxillary excess.⁴ In this study, the modified bionator was reinforced with extraoral orthopedic force by J-hook to support its action by restricting the maxillary growth and allowing the forward growth of the mandible. Indications of such treatment are combination of both maxillary prognathism with mandibular retrognathism or mandibular retrognathism.

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Materials and Methods:

The sample of this study was twelve patients with a mean age of 10.47±1.01 years. The subjects were chosen from clinic of the department of orthodontics, Faculty of Dentistry, Mansoura University.

Inclusion criteria:

- Skeletal Class II division 1.
- Age ranges from 8-12 (mixed dentition and early permanent dentition).
- ANBo more than 6°.
- Overjet more than 5 mm.

Exclusion criteria:

- Unilateral or bilateral crossbite.
- Congenital Craniofacial deformity.
- Previous orthodontic treatment or abnormal oral habits.
- Cleft lip or palate.

Patient records:

For every patient in the sample, the following records were taken:

1. A signed informed consent, describing the following: Aim of the study, features of the modified bionator appliance used in the study, expected benefits and possible drawbacks of using the appliance.

2. Photographs:

• Extraoral Photographs: three photos were taken for each patient pre and post treatment; frontal view during rest, smiling and lateral views.

• Intraoral Photographs: six photos were taken for each patient pre and post treatment; the teeth in occlusion - frontal and lateral (right and left sides) and the overjet photo, also upper and lower occlusal views.

3. Radiographs:

- a) Panoramic x-ray films: were taken pre and post treatment.
- b) Lateral cephalometric x-ray films: were taken pre and post treatment.

4. Impressions and Study casts: proper orthodontic trays sizes were used to take impressions for lower and upper teeth by silicone impression material. These impressions were poured twice; the original casts had been used for construction of the modified bionator and the duplicated casts had been used for study casts by using improved stone material.

Appliance Construction:

It started by a wax bite registration with the mandible advanced 4mm from the started distal occlusion. After that, the cast was adjusted on articulator guided by the registered wax bite for appliance construction. The bionator was made with some modifications to wires and acrylic components (Figure 1). The acrylic block reached from 2-3 mm behind the first molars or to the distal aspect of second molar if existed from one side to the other with minimal extent and thickness to encourage full-time wear. It covered 2-3 mm of mucosa from the lingual gingival margins of the lower and upper teeth. The mandibular anterior teeth were screened from tongue pressure by the anterior part of the acrylic. The maxillary front acrylic extended and covered the incisal edge of the upper anterior teeth where the modified Southend clasp was embedded into it. Palatal bar was made from rigid 1.2 mm wire. Its purpose was to encourage the mandible and tongue to adopt in anterior posture. Vestibular wire was separated from the middle third of mandibular incisors by a thickness of paper. At the lower canines, the arch was turned upwards and distally to form the buccinator loop, which reached nearly to the mesial aspect of the upper first permanent molars. It stood about 2 mm clear of the posterior teeth. Its purpose was to hold off the buccal segments from the cheek pressure to encourage arch widening. After completing the buccinator loop opposite the middle of the deciduous first molars or lower first premolars, the wire ascended upward before turning inward clear of the teeth above the canines and first premolars embrasures, to be embedded in the acrylic. Modified Southend clasp was made from 0.9 mm stainless steel wire to withstand the headgear force without distortion. It consists of curved sections which passed around the cervical margins of the upper central incisors (to provide retention for the appliance), and two coils just before the wire were embedded into acrylic at the labial portion of the appliance (where the appliance attached with the J-hook). Ball clasps were placed at the mesial and the distal of upper first molars or second premolars if were erupted, which provide and improve the retention for the appliance. After construction of the modified bionator appliance, a high-pull headgear with J-hook was attached to coils of modified Southend clasp. The used J-hook applied 400-500g of force per side to provide an orthopedic effect in order to restrict the growth of the maxilla. The patients were instructed to wear the modified bionator appliance nearly full-time and J-hook up to 14 hours per day (as recommended by Orton et al.⁶). When

the mandible achieved full activation, another wax bite was obtained. This procedure was continued until the overjet was corrected.

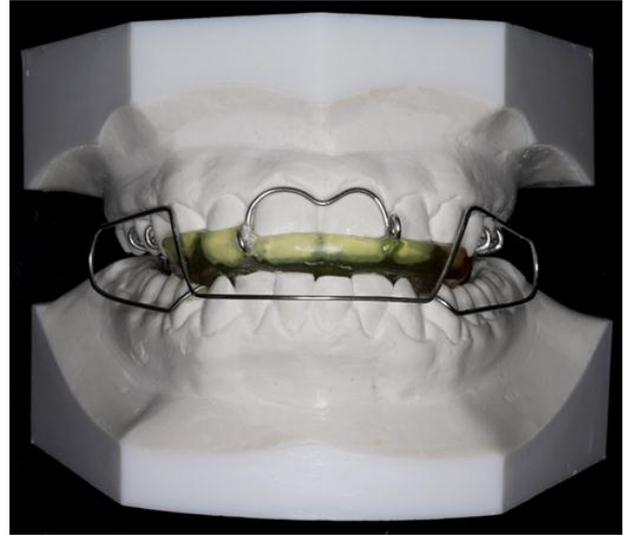


Figure (1): The modified bionator on study cast model.

Soft tissue measurements and statistical analysis:

Cephalometric reference points:

Nasion (N): The most anterior point of the frontonasal suture in the median plane.

Sella (S): The point representing the midpoint of the hypophysial fossa (sella turcica).

A point –Subspinale: The deepest point at midline concavity on the maxilla between the anterior nasal spine and prosthion.

B point –Supramentale: The point at the deepest midline concavity on the mandibular symphysis between infradentale and Pogonion.

Incisor superius (Is): Tip of the crown of the most anterior maxillary central incisor.

Incisor inferius (Ii): Tip of the crown of the most anterior mandibular central incisor.

Columella (CoI): The most anterior point on the Columella of the nose.

Glabella (G): The most prominent anterior point in the midsagittal plane of the forehead.

Subnasale (Sn): The point at the junction of the Columella and the upper lip.

Labrale superius (Ls): The most anterior point on the convexity of the upper lip.

Labrale inferius (Li): The most anterior point on the convexity of the lower lip.

Soft tissue pogonion (Pg`): The most anterior point on the soft tissue chin in the midsagittal plane.

Cephalometric reference line and planes:

Sella-Nasion plane (SN): Reference line joining sella and nasion points.

Mandibular plane (MP): Plane joining Gonion and Gnathion points.

Steiner's S-line (S line): Line joining (Pg`) and midpoint of the curve "S" formed by the lower border of the nose.



Table (1): Skeletal, dentoalveolar and soft tissue measurements.

Measurements	Definition
Skeletal measurements	
SNA	The angle between point A, Nasion and Sella
SNB	The angle between the SN and NB planes
ANB	The angle between NA and NB lines (ANB = SNA – SNB)
Dentoalveolar measurements	
Is-SN	The angle between Sella-Nasion plane and the long axis of the maxillary central incisor
Ii-MP	The angle between mandibular plane and the long axis of the mandibular central incisor
Soft tissue measurements	
Nasolabial angle	The angle between Columella, Subnasale and Labrale superius
G`-Sn-Pg`	The angle between Glabella, Subnasale and soft tissue Pogonion
Ls-S line	The distance between the Labrale superius to S line
Li-S line	The distance between the Labrale inferius to S line

The measurements illustrated in (Table 1) were obtained before and after treatment on cephalometric x-ray. The collected data were analyzed by using SPSS Version 22.

Results:

The means, standard deviations and paired t-test changes results of the soft tissue, skeletal and dentoalveolar measurements before and after treatment are mentioned in (Figure 2) and (Table 2).

Skeletal measurements:

There was no statistically significant difference in SNA° (P > 0.05), while the SNB° showed a significant statistical increase (P ≤ 0.05), and the ANB° showed a significant statistical decrease (P ≤ 0.05).

Table (2): Comparison of change in soft tissue, skeletal and dentoalveolar measurements between pre and post treatment.

Parameter	Before treatment	After treatment	Difference	t-test	(P) value
	(Mean ± SD)	(Mean ± SD)	(Mean ± SD)		
SNA^(o)	82.75±2.53	82.42±2.71	0.333±0.985	1.17	=0.266
SNB^(o)	74.0±2.09	77.58±2.31	-3.58±1.08	11.46	<0.001*
ANB^(o)	8.75±1.82	4.83±1.80	3.92±1.08	12.52	<0.001*
Is-SN^(o)	110.25±10.9	105.33±7.1	4.92±4.75	3.58	=0.004*
Ii-MP^(o)	97.17±7.18	97.33±7.35	-0.16±0.85	0.89	=0.987
Nasolabial angle	101.25±7.79	108.25±9.13	-7.0±8.69	2.78	=0.02*
G`-Sn-PG`^(o)	25.50±2.47	20.67±2.49	4.83±2.76	6.07	<0.001*
Ls-S line (mm)	4.67±2.46	1.92±2.68	2.75±1.36	7.02	<0.001*
Li-S line (mm)	2.67±2.15	3.72±2.71	-1.05±0.28	5.48	<0.001*

*p ≤ 0.05 (significant)

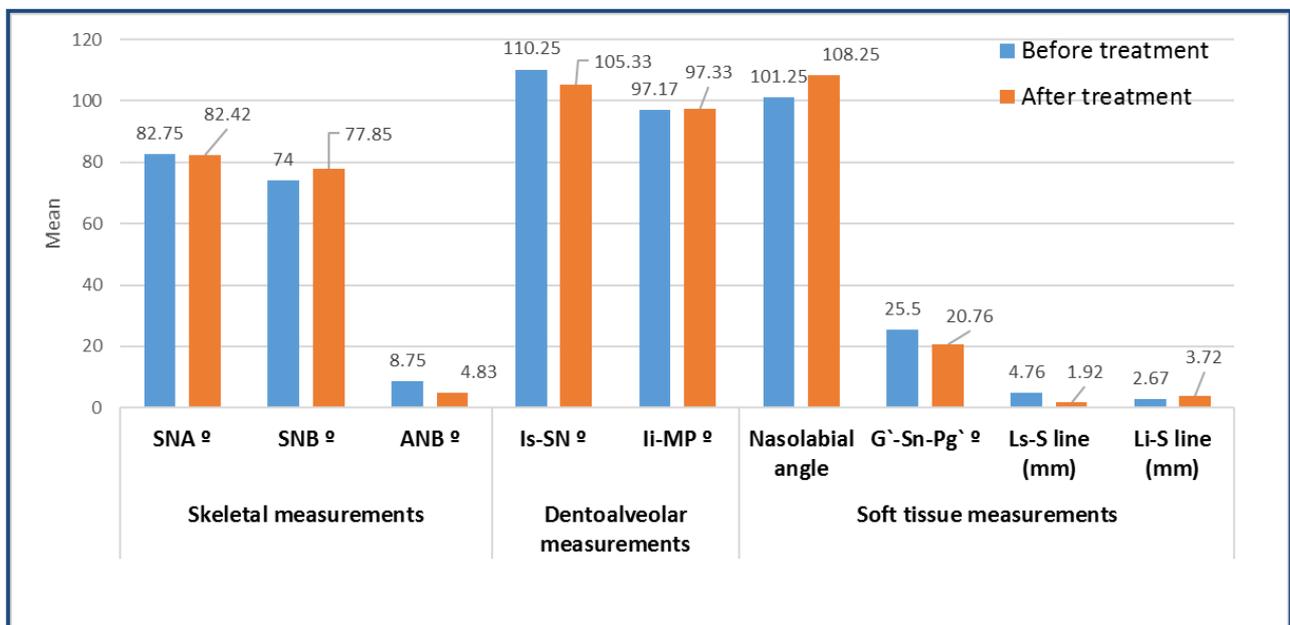


Figure (2): Before and after treatment differences in skeletal, dentoalveolar and soft tissue measurements.

Dentoalveolar measurements:

There was a significant statistical decrease in maxillary incisor angulation as represented by (Is-SN) angle ($P \leq 0.05$). On the other hand, the mandibular incisor angulation as represented by (Ii-MP) angle increased. However, the difference was statistically insignificant.

Soft tissue measurements:

In angular measurements, there was a significant increase in nasolabial angle ($P \leq 0.05$) while the soft tissue facial convexity that measured by (G`-Sn-PG`) angle was significantly decreased ($P \leq 0.05$). In linear measurements, there was a significant decrease in (Ls-S line) ($P \leq 0.05$), while the (Li-S line) significantly increased ($P \leq 0.05$).

Discussion:

The functional appliances improve the soft tissue measurements besides the skeletal measurements improving. Also, soft tissues changes reflect those changes in the underlying hard tissues. Attractiveness and facial appearances showed a significant improvement after treatment as a result of changed muscle balance.

Early treatment of children with Class II division 1 malocclusion by modified bionator appliance combined with high pull headgear revealed a restriction effect on the forward growth of the maxilla. This is due to the distal reactive force generated on the maxilla as a result of mandibular advancement by the bionator appliance in addition to the headgear force applied to the anterior part of the appliance by the J-hook. The SNA° showed no statistically significant change but there is still a decrease in SNA° value (0.333 ± 0.985). Small restrain of maxillary growth was also reported by Freeman et al.⁷. On the other hand, this result was in disagreement with Bigliuzzi et al.⁸, this difference could be due to the use of high pull headgear in this study.

The anterior border of the mandibular apical base showed a forward position compared to frontal cranial base represented by a significant increase in SNB° value. This could be due to the action of the intraoral appliance that encouraged the skeletal changes, the adaptive response to the new forward position of the mandible, which may be an outcome of condylar growth stimulation. The forward position of the mandible caused stretching and elongation of tendons and muscle fibers which in turn led to pulling the muscular attachments at the bone surface, which induces bone remodeling processes. The result of this study was in agreement with the result stated by Cozza et al.⁹ and Almeida-Pedrin et al.¹⁰ While these results were in disagreement with Freeman et al.⁷ who reported insignificant changes in SNB angle.

The relationship between maxillary and mandibular growth is an important variable. In this respect, mandibular growth stimulation and maxillary restriction. This study revealed that the treatment of patients with Class II division 1 relationship by modified bionator with high pull headgear produced an improvement between the mandible and the maxilla in the sagittal plane. This is due to the significant increase of (SNB°) due to the forward growth of the mandible in combination with the insignificant decrease of (SNA°) induced by the appliance in this study. This can be expressed by the

significant reduction of (ANB°). Similar findings have been reported by Almeida-Pedrin et al.¹⁰ While these results were in disagreement with Freeman et al.⁷ who reported insignificant changes in ANB angle after the first phase of treatment.

Regarding the inclination of maxillary incisor, there were noticeable changes in the axial inclination of the maxillary incisor, the measure represents the upper incisor angulation (Is-SN) was decreased significantly, this might be due to the distal force on the upper anterior component of the modified bionator by J-hook, this finding agreed with Almeida-Pedrin et al.¹⁰, Cozza et al.⁹ and Lange et al.¹¹

The position of lower incisors in Class II treated with functional appliances is critical. Excessive labial proclination of lower anterior teeth is an unwanted effect because it reduces the potential for orthopedic effects.

The axial inclination of the lower incisors (Ii-MP) angle showed a slight non-significant increase, which indicates a slight proclination of lower anterior teeth. This result is maybe consequent to mesial force on the mandibular incisors induced by the protrusion of the mandible. This result was in agreement with Cozza et al.⁹ and Lange et al.¹¹ This could be due to the action of capping the anterior teeth with acrylic in their study give a similar result of the acrylic that cover the lingual surface of lower anterior teeth that used in this study which did not permit their retroclination, In the same time the flexibility of the labial wire permit a small amount of the lower anterior teeth proclination. However, Luder¹² had reported significant proclination of lower incisors during functional appliance treatment in spite of capping. While these results were in disagreement with Almeida-Pedrin et al.¹¹ who reported a significant increase in the lower anterior teeth proclination, the difference could be due to variations in sample size or the design of the bionator that was not cleared in their study. On the other hand, Freeman et al.⁷ noticed significant retroclination in lower anterior teeth.

There was a slight significant increase in nasolabial angle. This may be due to retraction and retroclination of the upper incisors after the treatment. These outcomes were similar to Cozza et al.⁹ and Daokar et al.¹³ but were in disagreement with Varlık et al.¹⁴ as he explained, "The upper incisor was retracted mostly by incisal edge retraction, with a little lingual displacement of the cervical point. This tipping probably resulted in less alteration in the upper lip".

There were significant improvements in the relation of the upper lip to S line (Ls-S line). This could be due to the J-hook with the extraoral traction effects on the upper anterior teeth (retraction and retroclination). These outcomes were similar to Cozza et al.⁹ While these results were in disagreement with Freeman et al.⁷, which could be due to the difference in the position of the headgear attachment to the appliance that was close to the posterior teeth in their study.

The results of the present study showed significant forward advancement of the lower lip in relation to S line (Li-S line). During the treatment, the patients were instructed to maintain a lip seal over the appliance that could be changed the perioral muscles posture and tonicity. In addition, this could be due to the more forward position of the mandible after treatment. These results were in line with Lange et al.¹¹ In contrast, this study's results were in disagreement with Freeman et al.⁷, who



reported no significant soft tissue differences after the first phase of treatment, which may be due to the difference in sample size, treatment duration or treatment mechanics.

There was a significant decrease in the facial convexity ($G-Sn-Pg'$), this could be due to the subnasale being restricted in forwarding development because of the J-hook effect in restricted the forward growth of the maxilla. At the same time, the significant forward growth of the mandible in the sagittal plane could affect the position of the soft tissue pogonion by advancing it in a more forward position. These results were in line with the results of Lange et al.¹¹, who reported a significant decrease in facial convexity.

Conclusion:

This study showed that using the combination of the modified bionator with J-hook in treatment of growing patients with class II division 1 malocclusion was an effective appliance. The appliance had skeletal effects in the sagittal plane by restricting maxillary growth and stimulating the forward growth of the mandible that was reflected on enhancing the soft tissue profile (Figure 3 and 4).

Recommendation:

Further studies are needed to evaluate the long-term stability of the dento-skeletal changes induced by modified bionator with J-hook.

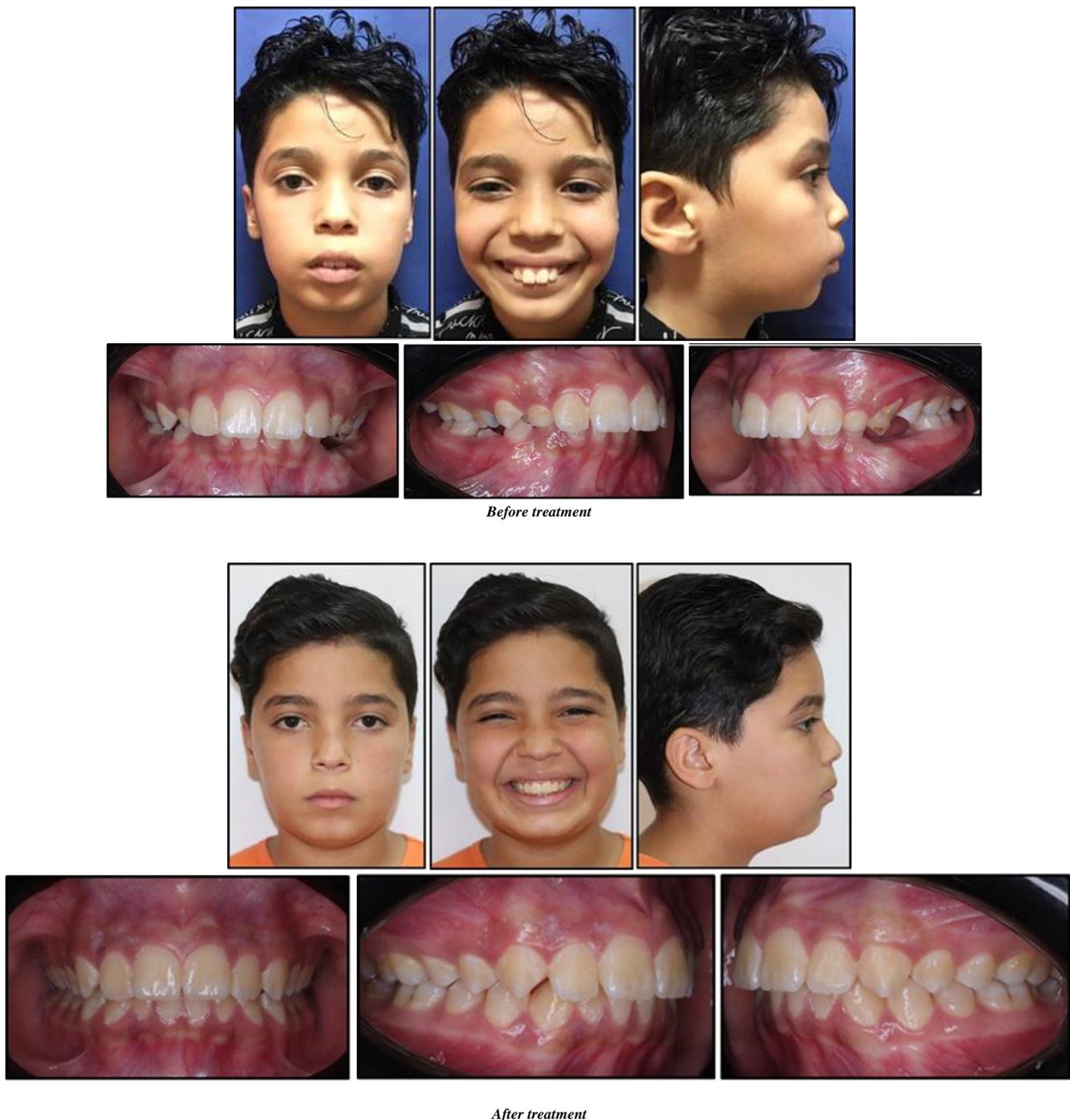


Figure (3): Extra-oral and Intra-oral photographs of a patient before and after treatment.



Before treatment



After treatment

Figure (4): Lateral cephalometric x-rays before and after treatment.

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