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The Effect of Reverse Chin Cup on Maxillary Deficiency in Growing Patients

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Abstract

Introduction: *Almost half of class III malocclusion is the result of maxillary deficiency. Reverse chin cup has been reported to be effective in treating patients with maxilla deficiency. This study aims to investigate the effect of reverse chin cup on patients with class III malocclusion.*

Material and Methods: *Twenty patients (twelve males and eight females) with skeletal Class III malocclusion were selected. The average age of the patients was 8.6±1.36 years. Twenty-three cephalometric parameters were measured before the orthodontic treatment and compared between the before and after treatment groups.*

Results: *The mean treatment time was 25±8 months. Significant increases were seen in SNA, ANB, Wits, Inclination angle, and N- ME. There was a significant increase in the U1-NA angle and a considerable decrease in the L1-NB angle.*

Conclusion: *The reverse chin cup has been effective in maxillary protraction and increasing SNA, wits, and ANB. Also, it has been well-accepted for children.*

Keywords: *Reverse chin cup, maxillary deficiency, orthodontic treatment, skeletal Class III malocclusion.*

Introduction

One of the most difficult discrepancies to treat is Skeletal class III malocclusion. It occurs due to maxillary skeletal retrusion, mandibular skeletal protrusion, or a combination of both **[**1**]**. Considering that Almost half of class III malocclusion is the result of maxillary deficiency **[**2**]**. Therefore, this has caused treatments to increase the maxilla's growth to have received more attention **[**1**]**. The rate of prevalence varies between different races. In Asians, the incidence of class III is between 4 and 14 percent, but among Caucasians, it is reported between 1 and 4 percent **[**3**]**. The result of early orthodontic treatment in patients with class III malocclusion depends on the patient's face's growth pattern and the treatment **[**4**]**. With increasing age, the treatment becomes more difficult. It is vital to choose the treatment time **[**5**]**. The common belief is that the maxilla cannot be moved after growth cessation. Therefore, Surgery will be required. **[**6**]**. Maxillary deficiency has been reported to be an

important determinant of good prognosis [7, 8]. The treatment may involve stimulation and guidance of maxillary growth with orthopedic forces if the mandible is unaffected [9]. There are many methods to treat maxilla deficiency, such as Frankel's FR-III appliance for stimulating maxillary growth[10], endosseous implants[11], Protraction facemask therapy[12], surgically assisted orthopedic protraction[13], distraction osteogenesis[14], suborbital protraction appliances[15]and using Ankylosed teeth as abutments for maxillary protraction.[16]The tongue plate and tongue appliance have also been used to correct maxillary deficiency[17-19]. The dentoalveolar and skeletal effects of maxillary protraction appliances are chiefly the forward displacement of the maxilla, clockwise rotation of the mandible, protrusion of the upper incisors, and retrusion of the lower incisors [20]. Also, the reverse chin cup has been reported to be effective in treating patients with maxilla deficiency [21]. It is suggested to use the Hickam chin cup when there is a combination of the maxillary retrusion and of the mandibular protrusion [22], and in cases with maxillary deficiency and mandibular excess malocclusion, Chin-cup with vertical post could be used [23]. Based on the limited knowledge about the clinical outcome of treating patients with a reverse chin cup, This study aims to investigate the effect of reverse chin cup on patients with class III malocclusion on Skeletal, dental and soft tissue.

Material and Methods

This retrospective study consisted of twenty patients (twelve males and eight females) with skeletal Class III malocclusion. The average age of the selected patients was 8.6±1.36 years. All subjects gave informed written consent, and all met the following inclusion criteria:

1) Negative overjet
2) Anterior crossbite
3) Class III molar relationship
4) No mandibular shift
5) No congenital disease or endocrine disorders
6) No previous orthodontic treatment and surgical intervention.

All patients and their parents did not accept orthognathic Surgery. All the patients were treated with the reverse chin cup. Lateral cephalograms, Panoramic radiographs, and photos were taken before and after treatment. The following variables were measured in each Lateral cephalogram of the patients:

1-SN-FH: The angle between the SN line and the Frankfurt plane

2-SNA: The angle at the intersection of the SN line and NA line

3-SNB: The angle at the intersection of the SN line and NB line

4-ANB: The angle at the intersection of the NA line and NB line

5-Wits appraisal: The distance between the AO line and the BO line

6-Facial angle: The angle at the intersection of the Frankfurt plane and N-Pog line

7-Y-axis: The angle at the intersection of the SN line and N-Gn line

8-Gonial angle: The angle at the intersection of GO-Gn and Go-Ar lines

9-GoGn-Sn: The angle at the intersection of Go-Gn and SN line

10-N-Me: The distance between the N point and the Me point (or posterior facial height)

11-S-Go: The distance between the S point and with Go point (or anterior facial height)

12-Jarabak index: The ratio of the anterior facial height to the posterior facial height

13-Inclination angle: The angle at the intersection of the N' line perpendicular to the palatal plane

14-U1-SN: The angle of upper incisors relative to SN line

15-U1-NA: The distance from upper incisors to NA line

16-U1-NA angle: The angle of upper incisors relative to NA line

17-L1-mand.: The angle of lower incisors relative to the mandibular plane

18-L1-NB: The distance between the lower incisors and the NB line

19-Interincisal angle: The angle between the maxillary and mandibular incisors

20- L1-NB angle: : The angle of lower incisors relative to NB line

21-Nasolabial angle: The angle between the line tangent to the nasal base and the line tangent to the upper lip

22-Upper lip to E-line: The distance between the upper lip to the Pn-Pog' or E-line

23-Lower lip to E-line: The distance between the lower lip to Pn-Pog' or E-line

All patients received a reverse chin cup and a removable palatal appliance. The upper removable appliance consists of two Adams clasps on the permanent first molars, two C-clasps on the permanent

central incisors, two C-clasps on the permanent lateral incisors, and two C-clasps on the primary canines, and a porous acrylic chin cup with two arms which was bent to form a hook and two hooks was embedded on the palatal canine area of the upper removable appliance. Hooks on porous acrylic chin cup were connected to the hooks on the removable palatal appliance with heavy size,5/16" orthodontic latex elastics(figure3).

It was explained to the patients to use the appliance full time and to remove it only when eating, exercising, contact sports, and brushing their teeth.

The lateral cephalograms of each patient were traced before and after the treatment. The measurement accuracy was determined by tracing each lateral cephalogram twice by the same examiner. No difference between the two measurements was shown by Paired t-test.

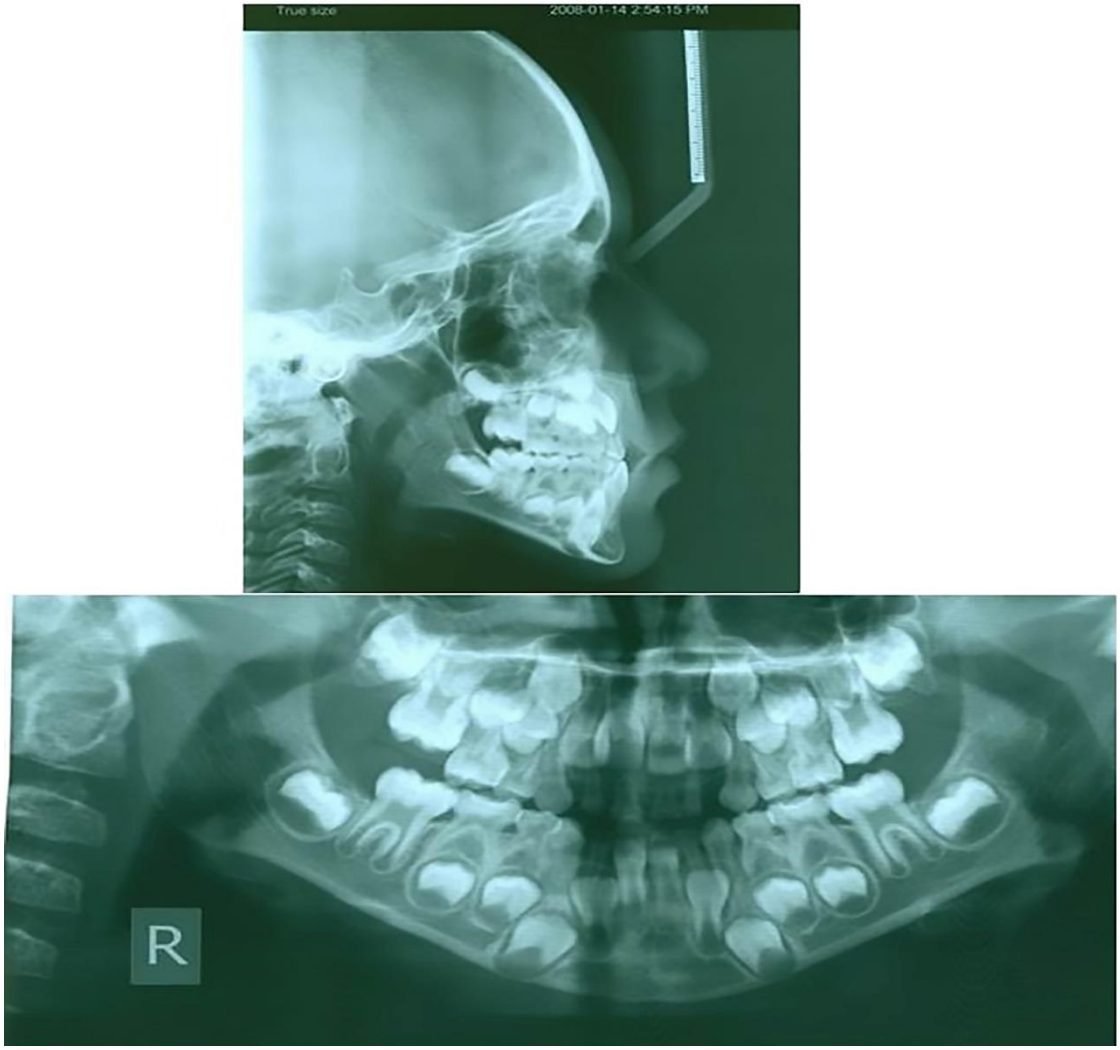

Figure 1: Lateral Cephalogram and OPG of a patient with skeletal Class III malocclusion before treatment

Figure 2: Intra-oral and extra-oral photos of the patient

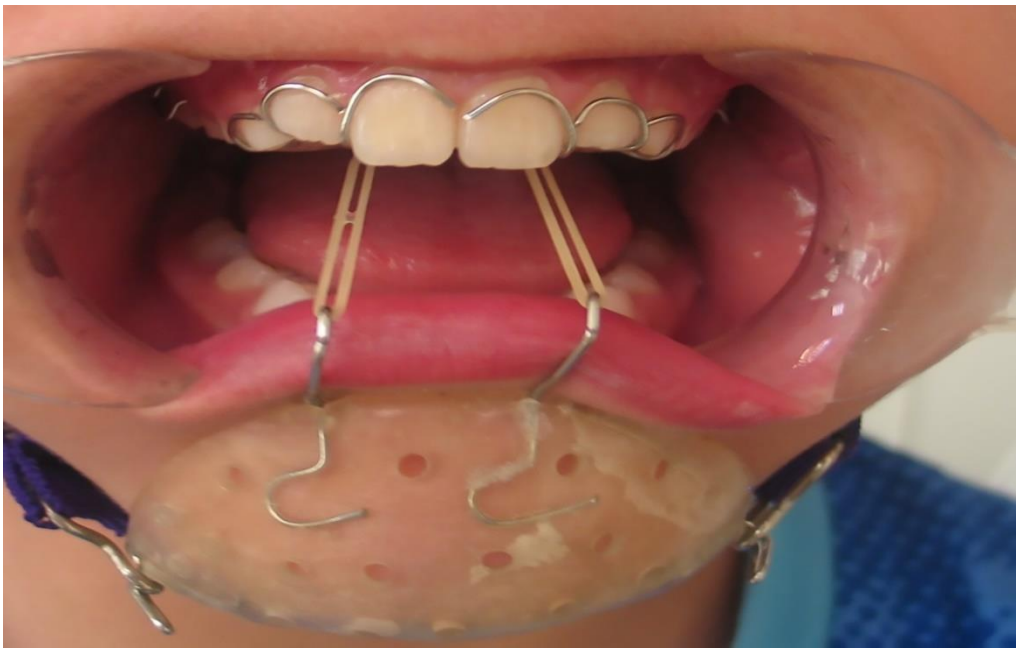

Figure 3: Palatal removable appliance with Six C-clasps (two on the permanent central incisors, two on the permanent lateral incisors, and two on the primary canines) connecting to reverse chin cup

Figure 4: Lateral and frontal view of the patient with reverse chin cup

Results

All the statistical analyses were performed using SPSS software version 25.0 (IBM, Chicago, Illinois, USA). Data are shown as mean ± standard deviation, respectively. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. The Paired t-test or Wilcoxon test was also used to compare the mean outcome quantities before and after in each group. In this study, the value of a P-value less than 0.05 was considered statistically significant.

The mean treatment duration was 25±8 months. In the anterior-posterior dimension, a significant increase has been seen in ANB and Wits) P<001) by 2 degrees and 3.6mm, respectively, and SNA has increased from 78.68 degrees to 80.55 and in this variable p-value is 0.009 (Table1).

The vertical dimension showed a significant increase in Inclination angle and N- ME by 2.8 degrees (p-value:0.015) and 4mm (p-value: 0.02), respectively. Furthermore, Y-axis, Gonial angle, and S-GO were raised by 0.25 degrees,5 degrees, and 2.25mm, respectively; however, these changes were not significant. Moreover, going-sn decreased slightly from 33.05 degrees to 32.95 (Table 2). There was a significant increase in U1-NA angle (P<001) by 6.7 degree and a considerable decrease in L1-NB angle (P<003) by 6.1 degree(Table3)

none of the changes were significant in the soft tissue(Table4).

Table1:Cephalometric variables in anterior-posterior dimension

	Mean(SD) (before)	Mean(SD) (After)	Changes	P-value
SN-FH	9.55(4.19)	9.4(3.36)	+0.15	0.83
SNA	78.65(3.07)	80.55(2.04)	+1.9	0.009
SNB	81.8(2.46)	81.65(2.25)	-0.15	0.85
ANB	-3.1(2.36)	-1.1(2.13)	+2	<0.001
WITS	-5.7(3.66)	-2.1(2)	+3.6	<0.001
FA	88.75(4.87)	88.55(3.59)	-0.2	0.84

Table 2 : Cephalometric variables in vertical dimension

	Mean(SD) (before)	Mean(SD) (After)	Changes	P-value
Y-AXIS	58.6(3.33)	58.85(2.98)	+0.25	0.66
GONIAL Angle	118.4(5.49)	123.4(5.79)	+5	0.72
GOGN-SN	33.05(5.87)	32.95(5.45)	-0.1	0.88
N-ME	110.85(21.65)	114.85(22.55)	+4	0.02
S-GO	71.5(18.49)	73.75(16.15)	+2.25	0.1
JARABACK INDEX	63.95(4.36)	63.95(4.30)	0	0.83
INCLINATION Angle	88.2(6.44)	91(5.59)	+2.8	0.01

Table 3 :Cephalometric variables in dental analysis

	Mean(SD) (before)	Mean(SD) (After)	Changes	P-value
U-SN	82.7(19.1)	72(18.5)	-10.7	0.08
U-NA Angle	28(11.07)	34.7(10.71)	+6.7	<.001
U-NA(MM)	-4.7(3.21)	-4.65(2.43)	+0.05	0.85
L-MAND	92.95(7.96)	87.5(8.27)	-5.45	0.93
L-NB Angle	27.65(7.15)	21.55(8.33)	-6.1	0.003
L-NB(MM)	-6.1(2.86)	-5.9(2.15)	+0.2	0.85
INTERINCISAL Angle	126.9(14.09)	125(13.62)	-1.9	0.4

Table4 :Cephalometric variables in Soft Tissue

	Mean(SD) (before)	Mean(SD) (After)	Changes	P-value
NASOLABIAL Angle	109.95(13.8)	111.4(13.35)	+1.45	0.22
UPPER LIP TO E-LINE	-3.3(2.62)	-2.8(2.76)	+0.5	0.15
LOWER LIP TO E-LINE	0.15(2.16)	-0.55(2.74)	-0.7	0.12

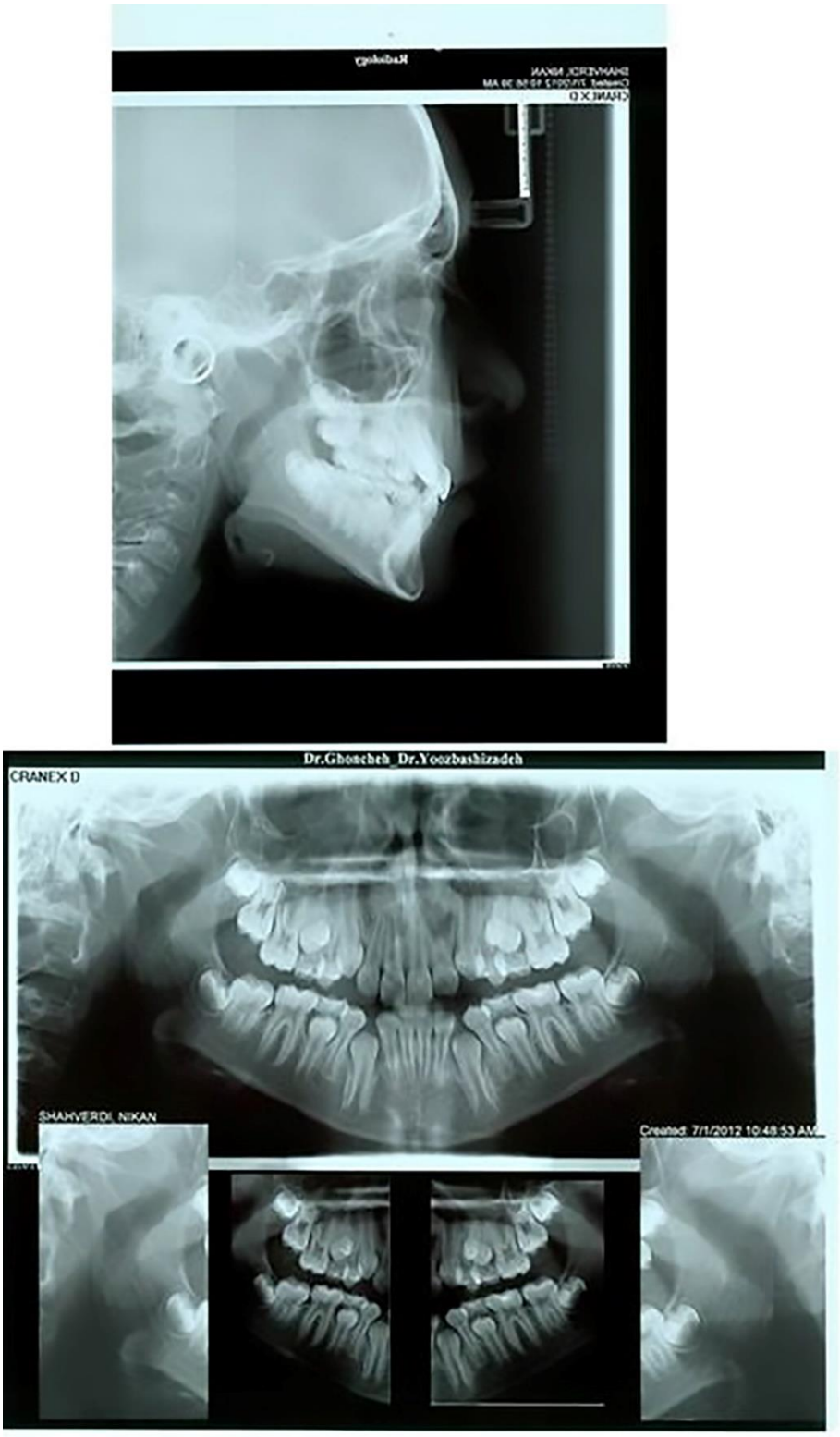

Figure 5: Lateral Cephalogram and OPG of the patient after completing the reverse chin cup treatment

Figure 6: Intra-oral and extra-oral photos of the patient after completing the reverse chin cup treatment

Discussion

With regard to the anterior-posterior dimension, positive overjet was achieved in all patients. Also, results have shown that the reverse chin cup has raised SNA, ANB, and Wits appraisal significantly, whereas SNB has decreased slightly; however, it was not significant. Since ANB has increased significantly, reverse chin cup can be used in the treatments in which the correction of the maxillomandibular discrepancies is needed. In the vertical dimension, A significant increase was seen in two variables (Inclination angle and N- ME) while three variables (Y-axis, Gonial angle, and S-GO) were raised, but their value was not significant. The non-changing number of the jaraback index shows that the patients did not have significant vertical facial growth. It has been reported that reverse chin cup can cause downward and backward movement of the mandible**[**24**]**. It has also been said that the main factor in the success of reverse chin cup treatment is its effect on the mandible**[**25**]**. In this study,

the decrease of Gogn-sn and SNB is shown. However, These changes were not significant. If the force applies to the posterior maxilla, It causes the downward movement of the maxilla and the backward movement of the mandible[21]. For this reason, In the present study, the force of the reverse chin cup has applied on the anterior part of the maxilla, and The positive overjet of the patients was mostly achieved by the forward movement of the maxilla. Also, there was an increase in the inclination angle, which shows the counter-clockwise rotation of the maxilla. Due to the U1-NA angle increase in this research, it seems that the reverse chin cup has protruded the maxillary incisors. Also, considering the decrease of the L1-NB angle, the reverse chin cup has caused the retrusion of the mandibular incisors. In addition, the straps which connected the high pull cap to the chin cup was creating a force that operated as a posterior bite block, so posterior teeth were kept in contact with each other in order to achieve posterior impaction of the maxilla. It has been reported that maxillary forward movement can be done with different appliances[21], Like the face mask, which is a standard treatment for Class III malocclusion[26]. In the face mask, the applied force is spread between the chin and the forehead. As a result, it creates fewer backward movements in the maxilla. On the other hand, In the reverse chin cup, the force is wholly transferred to the chin, which causes more backward movement in the mandible[27]. However, Large extra oral appliances reduce patient cooperation due to their appearance. Therefore, patients do not wear them regularly, and they may not have unsatisfactory results [9]. Using the reverse chin cup is an acceptable method for most young children[28]. In this study reverse chin cup used was similar to Chin support with cranial straps (Hickham)[29], and A porous acrylic chin pad was used to provide a better air vent and reduce skin irritation [21]. Reverse chin cup was used to correct skeletal problems. Additional fixed appliance treatments have been used to complete treatment and correct dental problems such as crowding(figure 4-5). Since it is stated that after the treatment with the clockwise rotation, the maxilla may move backward and downward, it is essential to continue the use of orthodontic appliances until the growth stop[30]. Because there is limited research available on reverse chin cup, Further studies with larger sample sizes are required to validate our findings.

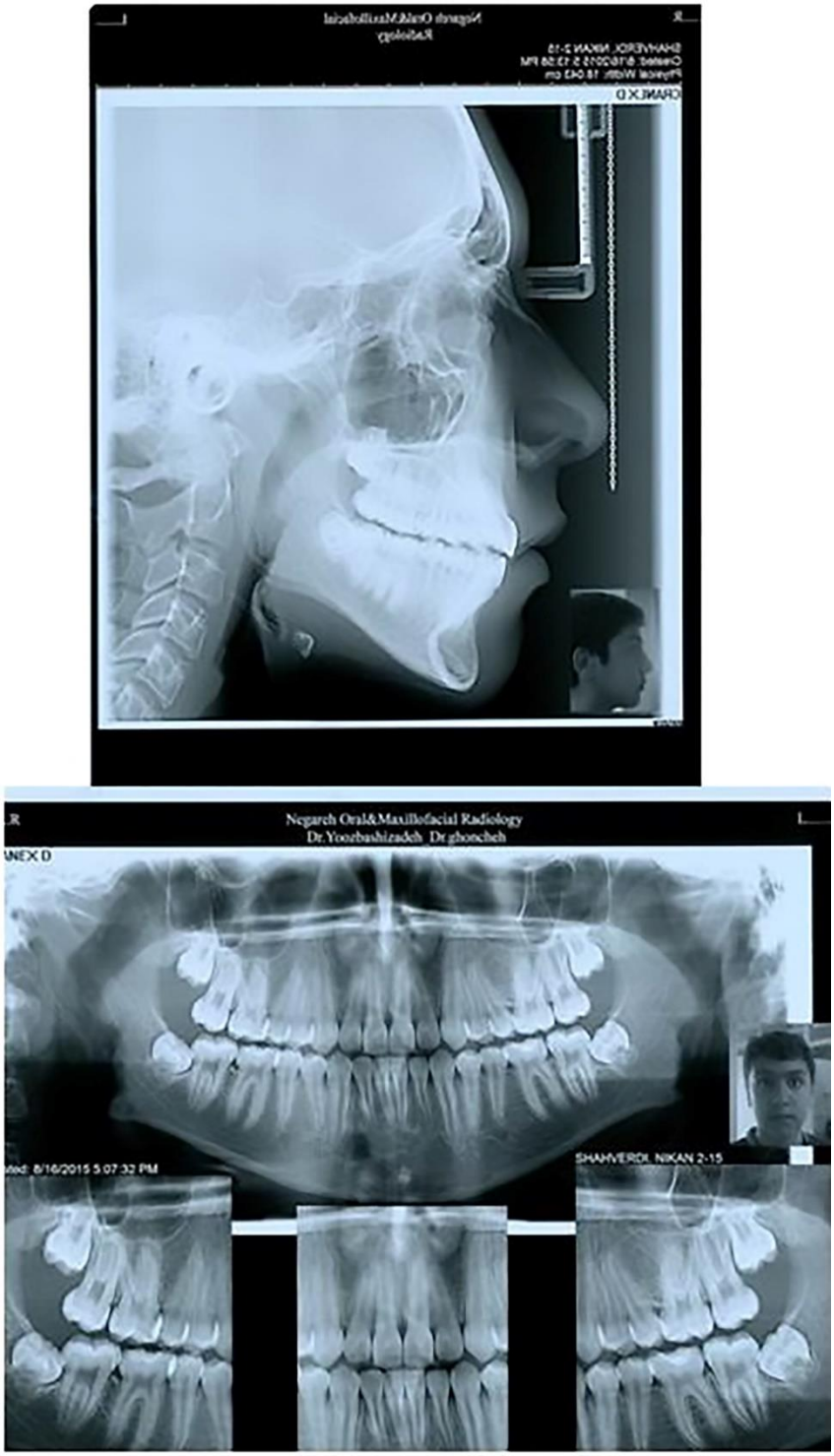

Figure 7: Lateral Cephalogram and OPG of the patient after completing treatment with fixed appliance

Figure 8: Intra-oral and extra-oral photos of the patient after completing treatment with a fixed appliance

Conclusion

In this study, the Reverse chin cup has been effective in maxillary protraction and increasing SNA, wits, and ANB. Furthermore, Due to the smaller size compared with other large extraoral appliances, children have also accepted it well.

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