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Skeletal Effect of Reverse Twin Block and Face Mask in Early Treatment of Skeletal Class III Malocclusion

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ABSTRACT

Objective: To evaluate the skeletal effect of reverse twin block and face mask in early treatment of skeletal Class III malocclusion. Materials and Methods: A sample of 10 patients (6 boys and 4 girls) with skeletal Class III malocclusions due to maxillary deficiency in pre-pubertal growth period and an age range from 6-12 years were selected for this study. The patients received reverse twin block(RTB) for two months then attached with face mask(FM) until achieved a positive overjet. A bilateral force of 400g was applied to the maxilla from elastic traction to the face mask appliance. 3D cephalometric measurements were used pre- treatment and after correction of skeletal Class III by RTB and FM to evaluate skeletal effect of the appliances. Data from the 3D cephalometric measurements were analyzed with SPSS version 21 software. Statistical significance was inferred at a P value ≤ 0.05. and highly significant ($p \leq 0.001$). Results: Forward maxillary growth as the SNA and ANB angles was increased (p=.005), downward and backward rotation of mandible as the SNB was decreased (p =.033). The maxillary and the mandibular lengths were increased (p=.003). FMA and Sn-Go.Gn angles were increased significantly (p = .022 and p = .023 respectively).On the other hand, total facial heights, anterior, posterior and lower anterior facial height were increased (p = .022 , p = .023 and p <.001 respectively). Conclusion: Face mask therapy with reverse twin block was effective in early treatment of skeletal Class III malocclusions due to maxillary deficiency and produce skeletal changes. Skeletal changes were primarily a result of anterior movement of the maxilla, backward and downward rotation of the mandible with increase in the vertical facial dimensions.

INTRODUCTION

Skeletal Class III malocclusions were generally viewed as a problem of the mandible (Jacobson, A., *et al*., 1976). However, a developing Class III malocclusion may be due to maxillary deficiency, mandibular excess or both (McNamara, J.A., 1987). Maxillary deficiency with a normal or slightly mandibular excess represents high percentage of skeletal Class III cases (Cha, K.S., 2003; Ngan, P., *et al*., 1992; Ngan, P., *et al*., 1996; Baik, H.S., 1995; Nanda, R., 1980).

One of the most challenging methods in orthodontic is treatment of skeletal abnormality of Class III, it needs early diagnosis, intervention and long term stability (Campbell, P.M., 1983). Early mixed dentition is the best timing for orthopedic management in Class III malocclusions (Mermigos, J., *et al*., 1990; Cozza, P., *et al*., 2004; Kim, J.H., *et al*., 1999; Baccetti, T., *et al*., 1998; Ngan, P.W., *et al*., 1997). Abnormality in skeletal Class III may be modified the growth by inhibition or reorientation the growth of the mandible and/or stimulation the growth of the maxilla by traction (Cahng, H.F., *et al*., 1997; *et al*., 1999; Proffit, W., *et al*., 2013). The treatment for children having skeletal Class III malocclusion with maxillary deficiency is preferred by anterior advancement of the maxilla where bone is formed at the posterior sutures, this can be occur by the reverse pull

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head gear or face mask. (Baccetti, T., *et al*., 1998; Cahng, H.F., *et al*., 1997; *et al*., 1999; Proffit, W., *et al*., 2013; Silva, O.G., *et al*., 1998).

The facial mask with forehead and chin support has become popular during recent years for early maxillary protraction due to the simplicity of the appliance and better patient acceptance. Protraction face mask attached with different intraoral appliances such as, removable acrylic plates, fixed molar bands and temporary skeletal anchorage devices. (Petit H: 1983)

The twin block is a functional appliance treated skeletal class II cases. Clark has modified the appliance to be corrected Class III malocclusion, known as the Class III twin block or reverse twin block appliance, the modification by reversing the angulation of the inclined planes to correct arch relationships by maxillary advancement, while using the lower arch as the means of anchorage. Three-way expansion screw may incorporate to the Class III twin block appliance to combine transverse and sagittal expansion. (Clark, W.J., 2015)

This study aimed to evaluate the skeletal effect of this technique (functional orthopedic system) which combined a face mask with reverse twin block in early stage to treatment skeletal Class III malocclusion due to maxillary retrusion. The efficiency of this technique was evaluated not only clinically, but also using cone beam computed tomogragh (CBCT) to test the effect of this treatment.

MATERIALS AND METHODS

This study was conducted on 10 patients (6 boys and4 girls) selected from the clinic of the Orthodontic Department, Mansoura University. All of the patients were growing with ages ranging from 6 – 12 years, skeletal Class III with retruded maxilla (SNA ≤ 80) (Abdalla, E.M.A., 1986) and normal mandible or slightly protruded, Class III molar relationship, zero or negative overjet, no abnormal oral habits, good oral hygiene, no previous orthodontic treatment and free medical history.

All the required orthodontic records were taken and analyzed (extra oral and intra oral photographs, study model, and radiographs). Three extra oral and (Figure1) five intraoral photographs (Figure 2) were taken for every patient. Hand wrist radiograph was taken to evaluate the skeletal age, all patients were in stage one or two of ossification. Cone beam computed tomography (CBCT) were taken for each patient to given accurate measurement and from CBCT, orthopantomogram and lateral cephalometric radiograph (Figure 3) were taken.

All records were made before the treatment and after correction of skeletal Class III by reverse twin block and face mask except the hand wrist x-ray film which was taken only before treatment.

The angular and linear measurements from 3D cephalometric (Table 1) were used to evaluated skeletal effects that were brought by the reverse twin block combined with face mask therapy in patients with skeletal class III due to deficiency in maxilla (Geeta Verma, *et al*., 2014; Baek, S.H., *et al*., 2010).

***Fabrication of reverse twin block appliance*:**

The construction bite was registered in centric relation with 2 mm of inter-incisal clearance. Clark's reverse twin block were constructed from hot or cold-cured acrylic resin as in this research, with inclined planes at 70° directing occlusal forces downwards and backwards. Maxillary appliance of the reverse twin block modified by incorporating 3 - dimensional screw (Bretoni type) for transverse as well as sagittal expansion of the arch. A lower labial bow, delta or a dam clasps on upper and lower first molars (0.7 mm diameter stainless steel wire) and eyelet clasps or C clasp (according to the case) on upper anteriors were fabricated for retention purposes. Hooks (0.9 mm stainless steel wire) at the canine/premolar region was soldered to upper a dam clasps for the attachment of face mask elastics. (Baccetti, T., *et al*., 1998; Clark, W.J., 2015).

Fig. 1: Pretreatment extra-oral photographs (frontal, smile, and lateral view).

Fig. 2: Pretreatment intraoral photographs (views from frontal, lateral right and left, and occlusal of maxilla and mandible).

Fig. 3: Pretreatment CBCT (orthopantomogram and lateral cephalometric radiograph).

Table 1: Comparison between pre and post groups regarding skeletal measurements.

Items	Pre (n=10)	Post (n=10)	Test of significance	p-value
	Mean ± SD	Mean ± SD		
SNA	78.56 ±2.17	80.32 ±1.82	t=3.716	0.005*
SNB	81.54 ±2.74	80.55 ±2.34	t=2.522	0.033*
ANB	-2.98 ±2.21 Median=-2.11	-0.22 ±2.15 Median=0.31	Z=2.80	0.005*
ANS-PNS	41.75 ±2.93	44.49 ±2.60	t=4.06	0.003*
Gn-Go	66.10 ±3.41	67.63 ±2.60	t=2.57	0.003*
FMA	23.90 ±3.87	26.30 ±3.99	t=2.769	0.022*
Sn-Go.Gn	32.15 ±4.35	34.39 ±5.02	t=2.731	0.023*
N-ANS	45.88 ±2.82	46.87 ±3.03	t=5.831	<.001**
ANS-Me	56.17 ±4.49	59.42 ±4.75	t=5.874	<.001**
N-Me	100.74 ±3.18	106.30 ±6.00	t=3.952	0.003*
S-Go	63.04 ±4.78	66.28 ±5.58	t=5.086	0.001*

t: paired t-test . Z: wilcoxon signed rank test. * statistically significant p ≤0.05, . ** highly significant p <.001.

Fig. 4: Upper and lower of reverse twin block appliance on the study models.

Treatment progress:

Reverse twin block appliance were fitted and prescribed for fulltime wear or leaved during the eating with maintenance of proper oral hygiene. First recall visit was after one week and instructions for expansion of screw in both directions. Transverse screw was activated twice in the week to correct the posterior cross bite if found or for disarticulation and sagittal screw was activated also twice in the week to correct the anterior cross bite when the anterior teeth retroclined or in upright position.

After 2 months, the patients were followed by Petit type face mask (Figure 5) to wear for 12-16 hours/day . Extra-oral elastics were attached from the hooks on intra-oral appliance to the horizontal bar on the face mask and the direction of traction would be almost 30° to the occlusal plane. The size of the elastics in this study was individually selected for each patient, different sizes were tried and the force was measured by a force gauge until 400 g of force per side were achieved. (Mermigos, J., *et al*., 1990) Instructions were given for the patients to wear the appliance 12-16 hours per day (after school hours and during sleep) and to take it off for meals and for sports and change the elastics daily.

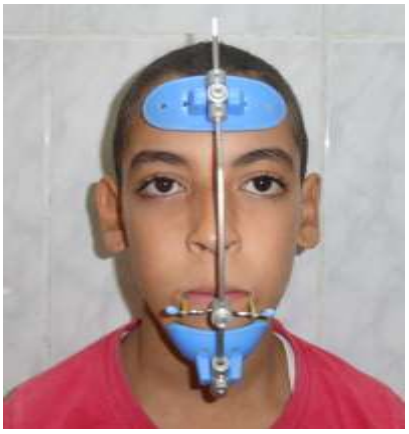

Fig. 5: Placement of Petit face mask.

Treatment was continued until achieved a positive overjet, all cases were corrected from 10-15 months and the patients were recalled for follow-up on monthly basis. After correction of skeletal class III malocclusion (Figures 6, 7, 8), slight posterior open bite was noted due to posterior bite blocks. In the retention phase, RTB appliance was continued up to 1 year for maintenance of the orthopedic correction gained by maxillary advancement[24] and the follow up is continue to observation the growth.

Fig. 6: Post-treatment extra-oral photographs.

Fig. 7: Post-treatment intra-oral photographs.

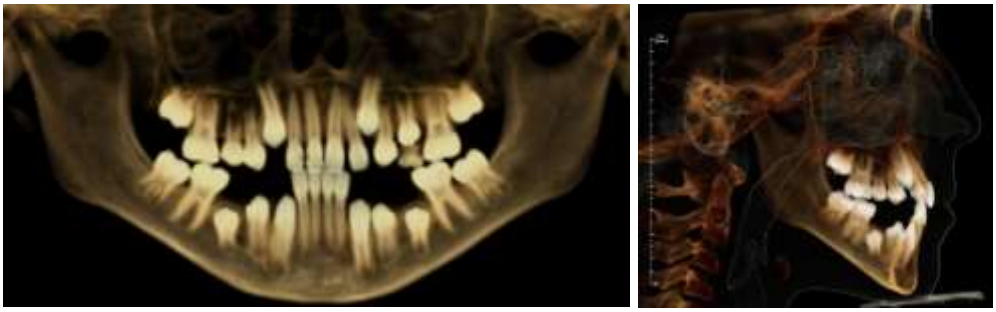

Fig. 8: Post treatment CBCT (orthopantomogram and lateral cephalometric radiograph).

Statistical analysis:

Data from the 3D cephalometric measurements were analyzed with SPSS version 21. The normality of data was first tested with Shapiro wilk test. Continuous variables were presented as mean ± SD (standard deviation) for parametric data and Median for non-parametric data. Paired groups were compared with paired t-test for parametric data and wilcoxon signed rank test for paired non parametric data. The results was considered non-significant when the probability of error is more than 5% ($p > 0.05$), significant when the probability of error is less than 5% ($p \leq 0.05$) and highly significant when the probability of error is less than 0.1% ($p \leq 0.001$).

Results:

The results from 3D cephalometric measurements were presented in (Table1), showed that, forward maxillary growth as the SNA and ANB angles was significantly increased (p=.005), downward and backward rotation of mandible as the SNB was significantly decreased(p =.033). The maxillary length (ANS-PNS) and The mandibular length (Gn-Go) were significantly increased (p=.003).

FMA and Sn-Go.Gn angles were increased significantly (p = .022 and p = .023 respectively). On the other hand, the anterior facial heights, upper N-ANS and lower ANS-Me were highly significant (p <.001). Total facial heights, anterior N-Me and posterior S-Go were increased significantly (p=.003 and p=.001 respectively).

Discussion:

Skeletal Class III has always been one of the most challenging malocclusions that can face an orthodontist, it needs early diagnosis and intervention and long term stability. Early mixed dentition or even in deciduous dentition is the best timing for orthopedic management in Class III malocclusions. (Baccetti, T., *et al*., 1998)

The objective of this study was conducted to assess skeletal changes from reverse twin block combined with face mask in correction of skeletal Class III malocclusion result from retrusion of maxilla.

This study consisted of 10 patients selected based on certain criteria . All the selected patients were in the pre-pubertal growth period with skeletal Class III malocclusion due to maxillary retrusion. Assessment of the development stage was based on hand wrist maturity indicator due to there was no significant difference between the hand wrist analysis and the cervical vertebral analyses for assessing skeletal maturation (Pichai, S., *et al*., 2014).

The patient selection criteria were based on number of clinical and cephalometric finding that indicated the presence of maxillary deficiency. Presence of straight or concave facial profile, deficient mid-face region, insufficient amount of upper incisors show on the smiling, presence of anterior crossbite sometimes

accompanied by unilateral or bilateral posterior cross bite as described by several authors Haas *et al*. (2002), Guyer *et al*. (1986), Mouakeh (2011), Chang *et al* (2005), Chen *et al* (2008), Choi el al. (2010) and Wolfe *et al* (2011). The sample did not contain a control group as an ethics of profession refused to leave the patient without treatment.

In this study each one of the patients received Petit- type FM attached to intra-oral removable functional appliance RTB. The Petit- type FM as chosen instead of Delaire- type of FM due to its relatively smaller size which makes it more appealing to the children from the esthetic point of view (2000).

Reverse twin block appliance were fitted and prescribed for fulltime wear or leaved during the eating. After 2 months, patients were followed by Petit type face mask to wear for 12-16 hours/day after school hours and during sleep and to take it off for meals and for sports. The patients were also instructed to change the elastics at least once every 24 hours.

Regarding the amount of protraction forces used in this study was 400g applied to the maxilla measured by a force gauge. This protocol was in accordance to that followed by Mermigos *et al*. (1990). The forces were directed at an angle of 30° downward to the occlusal plane from the elastic traction to the facial mask appliance as was advocated by Tanne *et al*. (1989) and Yan *et al*. (2013).

Treatment was continued for a period of 10- 15 months during which the patients were recalled for follow-up on monthly basis. Most of the treatment effect of the face mask occur within 6-13 months as mentioned by Mermigos *et al*. (1990). After correction of skeletal class III malocclusion, RTB appliance was continued up to 1 year for maintenance of the orthopedic correction gained by maxillary advancement (2015) and the follow up is continue to observation the growth.

Conventional cephalometric radiography is limited in its application by the expression of 3D structures onto a 2D plane. As a result, the superimposition of anatomical structures interferes with landmark identification and can lead to magnification and distortion of the image obtained. In contrast, CBCT imaging in association with computer software allows anatomical structures to be properly represented in all three viewing planes sagittal, coronal, and transverse. Landmark identification is also greatly enhanced in CBCT images with magnification and adjustments in contrast (Genevive, L., 2015), so in this study CBCT were taken for each patient to given accurate measurement.

The skeletal changes from this study divided in to sagittal and vertical changes. The sagittal skeletal changes showed that, forward maxillary growth as the SNA was significantly increased (p=.005), This result was in agreement with other protractor appliances studies of McNamara (1987), Cozza *et al*. (2004) and Yavuz *et al*. (2012).

SNB angle was significantly decreased (p=.033) as rotation of mandible occurred in downward and backward direction. This finding was in harmony with Campbell (1983), McNamara (1987), Ngan *et al*. (1992), Cozza *et al*. (2044) and Yavuz *et al*. (2012). ANB angle was significantly increased (p=.005), This outcome was in agreement with those of Hegmann and Rüther (2003) and Kulbersh *et al*. (1998).

The maxillary length (ANS-PNS) and the mandibular length (Gn-Go) were significantly increased (p=.003). This outcome was in agreement with those of Verma *et al* (2015). Regarding the vertical skeletal changes, showed that, FMA and Sn-Go.Gn angles were increased significantly (p = .022 & p =. 023 respectively). On the other hand, the anterior facial heights, upper N-ANS and lower ANS-Me were highly significant (p <0.001) .Total facial heights, anterior N-Me and posterior S-Go were increased significantly (p = .003 & p= .001 respectively). Simillar results were previously described in the literature by Mermigos *et al*. (1990), Baik (1995) and Altug and Arslan (2006). where it was suggest that the chin cap part of FM exerts downward and backward force on the mandible causing it to rotate in clockwise direction and hence contributes greatly to correction of the maxillo-mandibular relationship and the anterior cross bite.

***Conclusion**:*

Face mask therapy with reverse twin block was effective in early treatment of skeletal Class III malocclusions due to maxillary deficiency and produce skeletal changes. Skeletal changes were primarily a result of anterior movement of the maxilla, backward and downward rotation of the mandible with increase in the vertical facial dimensions.

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