Dentoskeletal Effect of Using Hyrax Expander and Protraction Facemask in Early Treatment of Class III Malocclusion

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ABSTRACT

Objective: To evaluate dento-skeletal effect of maxillary expansion appliance and protraction Facemask in early treatment of skeletal Class III malocclusion

Materials and Method: 18 patients with an age range of (6-12) years with skeletal Class III malocclusions due to maxillary deficiency were selected. Patients received banded hyrax expander for 1 week then attached with face mask(FM) until a positive overjet was achieved. Cephalometric and cast variables were measured before and after treatment to evaluate the dento-skeletal changes produced by treatment.

Results:*Maxillary advancement with increased SNA, ANB* (p<0.001) and (Co-A). Downward and backward rotation of the mandible with decreased SNB and FHN-Pg (p=0.02). An increase in total anterior facial height (p=0.04). Significant increase in both (PP/MP) and (FMA), (p=0.001). Lower incisors retroclination with decreased (L1-NB) measurement (p=0.04). A significant difference in both overjet and overbite (p<0.001). A significant increase in both arch length (p=0.006) and intermolar width (p=0.001).

Conclusion:*Maxillary expansion and protraction using hyrax appliance and Face mask therapy was effective in early management of skeletal Class III maxillary deficiency. Skeletal changes were primarily due to maxillary advancement, mandibular backward and downward rotation with an increase in the vertical facial dimensions.*

KEYWORDS:*Early treatment, Skeletal Class III, maxillary deficiency, facemask, hyrax expansion.*

I. INTRODUCTION

Skeletal Class III malocclusion in growing patients continues to be one of the most challenging problems for many researchers in terms of diagnosis, prognosis and management.⁽¹⁾ It is believed to have a wide spectrum of an underlying skeletal and dental compensation components such as mandibular prognathia, maxillary retrognathia, retroclined mandibular teeth, proclined maxillary teeth, and combination of the above.⁽²⁾ The timing of class III malocclusion treatment has always been somewhat controversial in deciduous and early mixed dentition, and definitive management is recommended to be delayed for severe class III patients.⁽³⁾

Different treatment modalities are considered for orthopedic and orthodontic management of patients with Class III malocclusion.⁽⁴⁾ It includes extraoral appliances such as face mask, chincup and mandibular cervical headgear, or intraoral appliances like Frankel 3 appliance, reverse bionator, Eschler appliance (progenic appliance), removable mandibular retractor and Class III elastics.⁽⁵⁾

Patients with skeletal Class III patterns usually exhibit a deficiency in the transverse maxillary growth.⁽⁶⁾ A combination of a facemask to protract the maxilla along with rapid maxillary expansion (RME) has become a standard protocol in early management of patients with skeletal Class III malocclusions associated with maxillary deficiency.⁽⁷⁾

Facemask therapy aims to correct the discrepancy between centric relation and maximum intercuspation position, protraction of the maxilla, proclination of maxillary anterior teeth and retroclination of mandibular anterior teeth.⁽⁸⁾ While, rapid palatal expansion (RPE) will give the advantage of the expected midpalatal sutures stimulation.⁽⁹⁾

The growing interest in early management of class III malocclusion cases has kindled the necessity of knowing the treatment modalities, different types of facemasks as well as knowledge of palatal expansion, palatine disjunction and its mechanisms.⁽¹⁰⁾ Hence the objective of this study was to evaluate dento-skeletal effect of maxillary expansion appliance and protraction Facemask in early treatment of skeletal Class III malocclusion.

MATERIALS AND METHODS

II.

A sample of 18 patients (8 boys and 10 girls) of an age ranges from 6-12 years with skeletal Class III malocclusions due to maxillary deficiency were selected for this study with the following criteria: normal or protruded mandible, ANB not less than-2 degree, class III molar with anterior cross-bite or edge to edge relationship and no previous orthodontic treatment.

For all patients the following diagnostic records were made, case history including medical and dental history, extra oral and intra oral photograph (Fig.1), orthodontic study casts and panoramic and cephalometric radiographs.



Fig. 1:Shows pre-treatment photographs.

Patients received banded hyrax expander as shown in Fig.2 through bands fitted to the first permanent molars or the maxillary second deciduous molars. A stainless steel wire of 1.5 mm diameter was used to connect the molars' bands to the palatal expansion Hyrax screw by soldering. Two palatal arms were extended from the hyrax screw to anterior teeth and fitted on their palatal surface. Vestibular wire soldered to the buccal sides of the bands was extended until the canine region and ends with hooks for application of extra-oral elastics of protraction facemask.



Fig. 2:Shows Banded Hyrax expansion appliance.

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Maxillary expansion was started according to Rapid Maxillary Expansion (RME) protocol. Patients also received posterior bite planes for bite opening during protraction. After 1 week a petit-type face mask (hubit, korea) was attached through an extra oral elastics from hooks at the canines region to the facemask horizontal bar with a force vector of 450-500 gm/side as shown in Fig.3.



Fig. 3:Shows Face mask adjustment and elastic attachment.

Cephalometric and cast variables was measured before and after treatment to evaluate the dento-skeletal changes produced by treatment. Data from cephalometric measurements were analyzed with IBM SPSS software package version 20.0. Statistical significance of the obtained results was judged at the 5% level.

III. RESULTS

Post treatment results showed considerable improvement in patients' soft tissue profile, with a positive overjet. Maxilla had advanced sagittally with an increase in the vertical dimension (facial height) after active treatment as shown in Fig. 4,5.



Fig. 4:Shows post treatment photographs.

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Fig. 5:Shows pre and post treatment cephalometric radiographs.

Due to maxillary advancement, there was a statistical significant increase in both (SNA), (p<0.001) and (Co-A), (p=0.02). Due to downward and backward rotation of the mandible, there was a statistical significant decrease in both (SNB), (p=0.026) and (FHN)-Pg), (p=0.02). Concerning (ANB) and (Wits appraisal), Paired test showed a statistical significant increase (p<0.001). There was an increase in total anterior facial height (p=0.04) with significant increase in both (PP/MP) and (FMA), (p=0.001). (Table 1,2).

Skeletal Cephalometric	Pre-treatment X±SD	Post-treatment X±SD	test of significance	Mean difference	% of change
measurements					
SNA	78.17±2.1	80.71±2.1	t=5.8 p<0.001	2.5	3.2%
Co-A	69.0±8.7	74.0±4.6	t=2.7 p=0.02*	5	7.2%
(FHN)-A	-0.67±3.0	-0.33±3.3	t=0.33 p=0.75	0.33	50.7%
ANS-PNS	42.17±3.4	43.58±2.2	t=1.77 p=0.11	1.4	3.3%
SNB	79.8±2.1	78.46±2.2	t=2.6 p=0.026*	1.33	1.7%
Pg-NB	-0.21±1.3	-0.17±1.2	t=0.16 p=0.88	0.04	33.3%
Co-Gn	94.42±8.0	98.33±7.4	t=1.59 p=0.14	3.9	4.1%
(FHN)-Pg	1.25±6.3	-5.4±6.9	t=3.41 p=0.006*	6.67	3.32%
ANB	-1.63±1.9	2.25±1.6	t=6.8 p<0.001*	3.88	38.0
Wits appraisal	-6.5±2.1	-2.88±2.0	t=5.3 p<0.001*	3.63	55.7

Table 1: pre and post treatment sagittal skeletal cephalometric measurements.

Table 2: pre and post treatment vertical skeletal cephalometric measurements

Skeletal Cephalometric measurements	Pre-treatment X±SD	Post-treatment X±SD	test of significan	ce Mean difference	% of change
Postorior facial height	58 0+3 7	50 1+5 1	t-0.12 n-0.01	0.17	0.4%
Fosterior factal fieight	50.9±5.7	39.1±3.1	t=0.12 p=0.91	0.17	0.4 70
Total anterior facial height	95.9±4.1	99.8±5.6	t=2.26 p=0.04	* 3.8	4.01%
Lower anterior facial height	54.3±3.3	56.1±3.9	t=1.61 p=0.14	1.8	3.3%
SN/PP	10.5±3.4	10.5±2.4	t=0 p=1.0	0	0
Occl/SN	20.5±3.7	20.54±3.56	t=0.04 p=0.97	0.04	0.2%
GoGn/SN	37.7±5.3	39.9±5.3	t=2.7 p=0.02	* 2.2	5.8%
PP/MP	28.6±7.3	32.3±6.0	t=4.3 p=0.001	* 3.7	12.9
FMA	27.6±5.6	34.9±7.8	t=6.2 p<0.001	* 7.3	26.4

Lower incisors showed retroclination with decreased (L1-NB) measurement (p=0.04). A significant difference was obvious in both overjet and overbite (p<0.001). Upper lip was protruded significantly in relation to S line (p<0.001). (Table3). For cast analysis, there was a significant increase in both arch length (p=0.006) and intermolar width (p=0.001). (Table4).

Dentoalveolar and soft tissue measurements	Pre-treatment X±SD	Post-treatment X±SD	test of significance	Mean difference	% of change
U1-NA	24.72±7.7	29.06±6.1	t=1.68p=0.13	4.3	17.6
U1-NA	3.89±2.5	4.61±2.1	t=1.14p=0.29	0.72	18.5
L1-NB	26.9±4.6	24.9±5.2	t=2.25p=0.04*	2.05	7.4
L1-NB	3.0±2.7	4.2±1.5	t=1.48p=0.17	1.21	40
U1/PP	114.8±7.2	120.1±6.2	t=2.04p=0.07	5.28	4.6
IMPA	87.9±5.5	86.1±5.7	t= 1.29p=0.22	1.86	2.05
Interincisor angle	131.67±10.8	125.7±11.1	t=2.1p=0.07	6.0	4.5
Overjet	-2.29±1.8	2.67±0.92	t=8.5p<0.001*	4.9	16.6
Overbite	-3.25±1.9	2.25±0.98	t=6.7p<0.001*	5.5	30.7
UL-S	-1.4±1.6	1.21±1.7	t=5.5p<0.001*	2.6	1.86
LL-S	2.2 ± 2.8	1.21±1.7	t=1.06p=0.31	1.0	45.5
Nasolabial angle	112.38±14.6	107.5±9.6	t=1.16p=0.27	4.87	4.3

Table 3. Pre and 1	nost treatment	dentoalveolar	and soft	tissue	measurements
Table 5. Fre and	post treatment	uentoarveolar	and som	ussue	measurements

Table 4: pre and post treatment cast measurements

measurement	Pre-treatment X±SD	Post-treatment X±SD	test of significance	Mean difference	% of change
Inter canine width	31.14±4.8	32.3±5.8	t=1.47p=0.19	1.18	3.8
inter molar width	44.3±4.6	47.26±4.4	t=5.7p=0.001*	2.94	6.6
Arch length	58.9±13.5	71.23±4.9	t=3.37p=0.006*	12.25	20.8

IV. DISCUSSION

A number of treatment modalities for patients with developing class III maxillary deficiency are available such as extraoral appliances (protraction facemask) and intraoral appliances which may be removable or fixed appliances.⁽²⁾

The best timing to intervene a developing Class III malocclusion have been advocated by many clinicians.⁽¹¹⁾ This study comprised 18 patients with an age range of (6-12) years to achieve an early orthopedic correction by modifying craniofacial skeletal growth and preventing progressive irreversible soft tissue or bony changes. In agreement with that, Ngan et al.⁽¹²⁾, Woon et al.⁽¹³⁾ and Proffit⁽¹⁴⁾ have reported that class III management best timing should be in patients less than 10 years of age to enhance the orthopedic effect.

Maxillary expansion is usually conjugated with maxillary protraction to achieve maxillary disarticulation and initiating a cellular response which allows a more positive reaction to protraction forces.^(15,16) For this reason, each patient in this study received a hyrax expansion appliance for one week. The same appliance design was used by **Vaughn et al.**⁽¹⁷⁾, **Do-deLatour et al.**⁽¹⁸⁾ and **de ALMEIDA et al.**⁽¹⁹⁾ to achieve maxillary expansion prior to protraction. Although, **Vaughn et al.**⁽¹⁷⁾ and **Kim et al.**⁽²⁰⁾ demonstrated that, whether to expand or not, facemask therapy produced an equivalent changes in the dentofacial complex and improved the Class III malocclusion.

Each patient in this study received a Petit- type facemask attached to the Hyrax expansion appliance. The force required for maxillary protraction usually ranges from 300 to 600 g per side.⁽¹⁵⁾ Extra oral elastics were attached from hooks at the canines region to the horizontal bar of facemask with a force of 150 gm per side at the beginning for two weeks, then 300 gm/side for 1 month and increased up to 450-500 gm/side to the end of the treatment. The same treatment protocol was used by Ngan et al.⁽¹⁵⁾, Lione et al.⁽²¹⁾ and Nienkemper et al.⁽²²⁾

Results showed forward maxillary advancement as demonstrated by significant increase in SNA (p<0.001). The same results were reported by protraction appliances studies as Ngan et al.⁽¹⁵⁾, Nienkemper et al., Baccetti et al., Aslan et al., Hong et al., Ge et al. and Moon et al.⁽²²⁻²⁷⁾ It showed also a statistical significant decrease in both (SNB), (p=0.026) and (FHN)-Pg), (p=0.02) due to downward and backward rotation of the mandible. This result was in harmony with Ngan et al.⁽¹⁵⁾, Nienkemper et al.⁽²²⁾Aslan et al.⁽²⁴⁾ and Moon et al.⁽²⁷⁾

The statistical significant increase in the total anterior facial height (p=0.04), GoGn/SN (p=0.02), PP/MP and FMA (p<0.001) due to significant clockwise rotation of the mandibular plane which was also reported by Ngan et al.⁽¹⁵⁾, Moon et al.⁽²⁷⁾ and Vieira et al.⁽²⁸⁾

The significant decrease in (L1-NB) measurement (p=0.04) due to lingual tipping of the lower incisors was in agreement with that reported by Vieira et al.⁽²⁸⁾ and Aslan et al.⁽²⁴⁾ The upper lip was protruded

significantly in relation to S line (UL-S), the same was demonstrated by **Bozkaya et al.**⁽²⁹⁾ Cast analysis showed an increase in intermolar width and arch length. This is attributed to maxillary expansion and protraction as demonstrated by **Ngan et al.**⁽³⁰⁾

V. CONCLUSION

The following conclusions were drawn:

- Maxillary expansion and protraction using banded hyrax appliance and Face mask therapy was effective in early management of skeletal Class III malocclusions due to maxillary deficiency and produce skeletal changes.
- Skeletal changes were primarily due to maxillary advancement, mandibular backward and downward rotation with increase in the vertical facial dimensions.
- Dental changes were represented by retroclination of mandibular incisors and correction of overjet and overbite.

REFERENCES

- [1] Almeida MR, Almeida RR, Oltramari-Navarro PV, Conti AC, Navarro Rde L, Camacho JG. Early treatment of Class III malocclusion: 10-year clinical follow-up. J Appl Oral Sci. 2011;19(4):431-9.
- [2] Azamian Z, Shirban F. Treatment options for class III malocclusion in growing patients with emphasis on maxillary protraction. Scientifica(Cairo);2016;2016: 8105163.
- [3] Yelampalli M R, Rachala M R. Timely management of developing class III malocclusion. J Indian SocPedodPrev Dent 2012;30:78-84
- [4] Toffol LD, Pavoni C, Baccetti T, Franchi L, Cozza P. Orthopedic treatment outcomes in Class III malocclusion. A systematic review. Angle Orthod. 2008;78(3):561-73.
- [5] Al-Khalifa HN. Orthopedic Correction of Class III Malocclusions during Mixed Dentition. Open Journal of Stomatology. 2014;4:372-380.
- [6] Celikoglu M, Oktay H. Effects of maxillary protraction for early correction of class III malocclusion. Eur J Orthod 2014;36(1):86-92.
- [7] Muthukumar K, Vijaykumar NM, Sainath MC. Management of skeletal Class III malocclusion with face mask therapy and comprehensive orthodontic treatment. ContempClin Dent 2016;7(1):98-102.
- [8] Almeida RR, Alessio LE, Almeida-Pedrin RR, Almeida MR, Pinzan A, Vieira LS. Management of the Class III malocclusion treated with maxillary expansion, facemask therapy and corrective orthodontic. A 15-year follow-up. J Appl Oral Sci. 2015;23(1):101-9.
- [9] Wilmes B, Ngan P, Liou EJ, Franchi L, Drescher D. Early class III facemask treatment with the hybrid hyrax and Alt-RAMEC protocol. J ClinOrthod. 2014;48(2):84-93.
- [10] Freire AB, Nascimento LEAG, Lira ALS. Effects induced after the use of maxillary protraction appliances: A literature review. Dental Press J Orthod. 2012;17(4):122-8.
- [11] Ngan P, Moon W. Evolution of Class III treatment in orthodontics. Am J OrthodDentofacialOrthop. 2015;148(1):22-36.
- [12] Ngan P. Early timely treatment of class 3 malocclusion. SeminOrthod 2005;11:140-5.
- [13] Woon SC, Thiruvenkatachari B. Early orthodontic treatment for Class III malocclusion: A systematic review and meta-analysis. Am J OrthodDentofacialOrthop. 2017;151(1):28-52.
- [14] Proffit W, Fields HW, Jr. Contemporary Orthodontics. 3rd ed. St. Louis, Missouri: Mosby; 2000.
- [15] Ngan P, Cheung E, Wei S. H. Y. Comparison of Protraction Facemask Response Using Banded and Bonded Expansion Appliances as Anchorage. Seminars in Orthodontics. 2007;13(3):175–185.
- [16] Gautam P, Valiathan A, Adhikari R. Skeletal response to maxillary protraction with and without maxillary expansion: a finite element study Am J OrthodDentofacialOrthop. 2009;135(6):723-8.
- [17] Vaughn GA, Mason B, Moon HB, Turley PK. The effects of maxillary protraction therapy with or without rapid palatal expansion: a prospective, randomized clinical trial. Am J OrthodDentofacialOrthop. 2005;128(3):299-309.
- [18] Do-deLatour TB, Ngan P, Martin CA, Razmus T, Gunel E. Effect of alternate maxillary expansion and contraction on protraction of the maxilla: a pilot study. Hong Kong Dent J 2009;6:72-82.
- [19] Almeida RR, Alessio LE, Almeida-Pedrin RR, Almeida MR, Pinzan A, Vieira LS. Management of the class III malocclusion treated with maxillary expansion, facemask therapyand corrective orthodontic. A 15-year follow-up. J Appl Oral Sci. 2015;23(1):101-9.
- [20] Kim JH1, Viana MA, Graber TM, OmerzaFF, BeGole EA. The effectiveness of protraction face mask therapy: a meta-analysis. Am J OrthodDentofacialOrthop. 1999;115(6):675-85.

- [21] Lione R, HuancaGhislanzoni LT, Defraia E, Franchi L, Cozza P. Bonded versus banded rapid palatal expander followed by facial mask therapy: analysis on digital dental casts. Eur J Orthod. 2016;38(2):217-22.
- [22] Nienkemper M, Wilmes B, Franchi L, Drescher D. Effectiveness of maxillary protraction using a hybrid hyrax-facemask combination: a controlled clinical study. Angle Orthod. 2015;85(5):764-70.
- [23] Baccetti T, McGill JS, Franchi L, McNamara JA Jr, Tollaro I. Skeletal effects of early treatment of Class III malocclusion with maxillary expansion and face-mask therapy. Am J OrthodDentofacialOrthop. 1998;113(3):333-43.
- [24] Aslan BI, Qasem MA, Dinçer M. Maxillary protraction in a case with miniscrew bone anchorage. J Orthod Res 2013;1:77-81
- [25] Hong H, Ngan P, Han G, Qi LG, Wei SH. Use of onplants as stable anchorage for facemask treatment: a case report. Angle Orthod. 2005;75(3):453-60.
- [26] Ge YS, Liu J, Chen L, Han JL, Guo X. Dentofacial effects of two facemask therapies for maxillary protraction. Angle Orthod. 2012;82(6):1083-91.
- [27] Moon W. Class III treatment by combining facemask (FM) and maxillary skeletal expander (MSE). SeminOrthod 2018; 24:95–107.
- [28] da Luz Vieira G, de Menezes LM, de Lima EM, Rizzatto S. Dentoskeletal effects of maxillary protraction in cleft patients with repetitive weekly protocol of alternate rapid maxillary expansions and constrictions. Cleft Palate Craniofac J. 2009;46(4):391-8.
- [29] Bozkaya, E, Yüksel, AS, BozkayaS. Zygomatic miniplates for skeletal anchorage in orthopedic correction of Class III malocclusion: A controlled clinical trial. Korean J. Orthod. 2017;47(2):118-29.
- [30] Ngan P, Yiu C, Hagg U, Wei SHY. Cephalometric and occlusal changes following maxillary expansion and protraction. Eur J Orthod. 1998;20:237–254

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