A CEPHALOMETRIC STUDY OF THE EFFECTS OF SCREW HEIGHT ON RAPID MAXILLARY EXPANSION

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This study was undertaken to compare the skeletal expansion effects of rapid maxillary expansion (RME) using either a shallow or deep height of Hyrax expansion screw. The study includes 16 patients with narrow maxilla and mild to moderate crowding of the maxillary arch. Rapid maxillary expansion was performed in half of the patients with the shallow Hyrax expansion screw and other half with the deep screw. The angular and linear changes related to the maxilla were analyzed with Wilcoxon signed ranking test comparing posterior anterior (PA) cephalometric films obtained before and after rapid maxillary expansion. Both appliances were equally effective in skeletal expansion of maxilla. The deep screw appliance was more effective in increasing the nasal width.

Key words: *Rapid maxillary expansion (RME), Narrow maxilla, Hyrax.*

INTRODUCTION

Narrow maxilla is a challenging problem faced in the daily practice of orthodontics. The use of headgear and functional appliances has demonstrated orthopaedic effects mostly in the sagittal and vertical dimensions. One of the most effective orthopaedic procedures is the transverse separation of the maxillae using Hyrax expansion screw. This procedure has been the subject of interest in orthodontic treatment mechanics because of its potential for increasing arch perimeter to alleviate crowding in the maxillary arch without adversely affecting the facial profile. In addition, it assists in the correction of disharmonies in the transverse plane between the maxillary and the mandibular arches[1-6].

Krebs using metallic implants found that the amount of suture opening was equal to or less than half the amount of dental arch expansion and the suture opening between the incisors was twice the opening between the molars[7]. Debbane in his study on cats found that the degree of opening was greater in the premaxillary region than the maxillary midpalatal suture[8].

Starnbach and Cleall found that palatal expansion affects not only the maxillary midline suture, but also other sutures that articulate the maxilla with the neighboring bones in the craniofacial complex[9]. Hass[1,4], Wertz[10], Sarver and Johnston[11] reported that palatal expansion treatment increases the SNA and ANB angles. It has been reported that the palatine processes of the maxilla were lowered as a result of the outward tilting of the maxillary halves, and the lateral bending of the alveolar processes, which frequently increases the width of the nasal cavity[1,4,5,12].

Using computerised tomography, it was reported that the effects of rapid palatal expansion on the nasal cavity are not uniform. Changes in the nasal dimension are progressively less toward the back of the nasal cavity[13].

The aim of the present study was to assess and compare the skeletal effects of expansion screws at the depth of 0.75mm and 1.25mm to access the effect of screw depth on the skeletal expansion.

MATERIALS AND METHODS

The study involved 16 patients (7 male and 9 females); their average age was 14.2 years. All patients had skeletally constricted maxilla with maxillary first molars and first premolars being present. None of the patients had craniofacial anomalies such as cleft lip and cleft palate. The subjects were divided into two equal groups of 8 patients each. Group 1 with shallow screw and group 2 with deep screw. All patients were treated with Hyrax expansion appliance. Hyrax expansion screw was fixed to its predetermined depth (0.75 or 1.25mm), using a special gauge created for this purpose. The arms of the expansion screw were soldered to the bands that were fitted on the first premolar and first permanent molar. 1.1 mm wire markers were soldered to the molar tubes buccaly for x-ray measurement purposes. The Hyrax device was centered in the maxillary arch and was

sagittaly placed parallel to the mesial half of the permanent first molar and second premolar region.

After cementation, the appliances were activated twice a day with one-quarter turn in the morning and in the evening until the desired expansion was attained. The amount of expansion anticipated was 0.5 mm per day. The expansion was done for an average period of 15.5 days. The study was carried on posterior anterior cephalometric x- ray films. The records were taken before and immediately after expansion.

Cephalometric Analysis

Posterior Anterior

Cephalometric landmark (Fig. 1)

Latero – Orbitale (LO): The intersection point between the external orbital contour laterally and the oblique line.

Nasal Cavity (NC): The most lateral point on the inside surface of the bony nasal cavity.

Mesio – Orbitale: The most mesial point on the contour of the orbit.

Jugal process (J): The point on the jugal process of the maxilla at a crossing with the tuberosity at the maxilla.

Mesio – incisal (MI): The point that connects the mesial crown and the cementum of the central incisor.

Posterior Anterior

Cephalometric measurements (Fig 2)

LOP / LM: The inner angle between left molar pin axis and the Latero - Orbital plane.

LOP / RM: The inner angle between right molar pin axis and the latero – orbital plane.

ILOW: (inter lateral orbital width) The distance between the left and right latero – orbitale point.

IMOW: (inter mesial orbital width) The distance between the left and right mesio – orbitale point.

NW: The nasal width.

IJW: (inter jugular width) The distance between the left and the right jugal processes.

IIW: (inter incisal width) The distance between the mesio incisal points.

Statistical evaluation

The pre expansion, post expansion posterior anterior cephalometric films were traced and measured carefully. The angular and linear changes related to the maxilla were analyzed with Wilcoxon signed ranking test. The mean, standard deviation, minimum, maximum and P values were calculated for each measurement. Dahlberg's method was used for the calculation of the operator's random error. 8 P-A cephalograms were selected at random from the total of 32 available, and they were measured twice by the same investigator.

RESULTS

Inter lateral orbital width (ILOW) showed a significant increase of 2.88mm ($p < 0.05$) in Group II while it decreased slightly by 0.625mm in Group I. The decrease in the first group was insignificant. Inter mesial orbital width (IMOW) showed a slight decrease of 0.13mm in Group I while it increased slightly in the Group II. Changes in both the group were insignificant. Nasal width (NW) increased by 1 mm in Group I and in Group II it increased significantly by 2.88mm ($p < 0.01$). Inter jugular width (IJW) showed an increase of 3mm ($p < 0.05$) in Group I while in Group II the increase was 3.75mm ($p < 0.01$) and more significant. Inter incisal width (IIW) increased by 3.38mm ($p < 0.01$) in both groups with equal significance ($p < 0.01$). Nasal width (NW) is the only measurement that is showing a significant difference between the two groups.

The angles between the lateral orbital plane and the left molar (LOP/LM) showed an increase of 8.25° ($p < 0.01$) in Group I and 6.62° ($p < 0.01$) in Group II. The change was insignificant in between the groups. The angle between the lateral orbital plane and the right molar (LOP/RM) showed an increase of 7.75° ($p < 0.01$) in Group I and significant change of 4.75° ($p < 0.01$) in Group II. Both are insignificant when compared with each other.

DISCUSSION

A significant percentage of patients seeking orthodontic treatment have maxillary constriction. In such cases expansion is carried out to increase maxillary width and also to resolve mild to moderate crowding[14].

The patients' group age in our study ranged from 11 to 17.4 years so as to demonstrate suture opening during the expansion as recommended by Persson and Thilander[15]. All patients showed opening of the palatal suture approximately 7 to 10 days after starting the expansion procedure. This was checked and confirmed using the occlusal radiographs[1,4,5,10,16].

Rapid palatal expansion affects not only the maxillary sutures but other sutures and facial complexes in the head [17,18]. In our study we

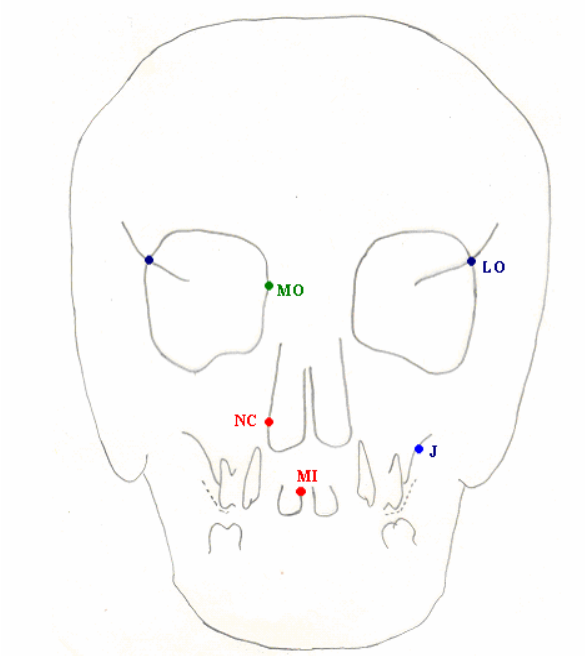

Fig. 1: P-A Cephalometric landmarks

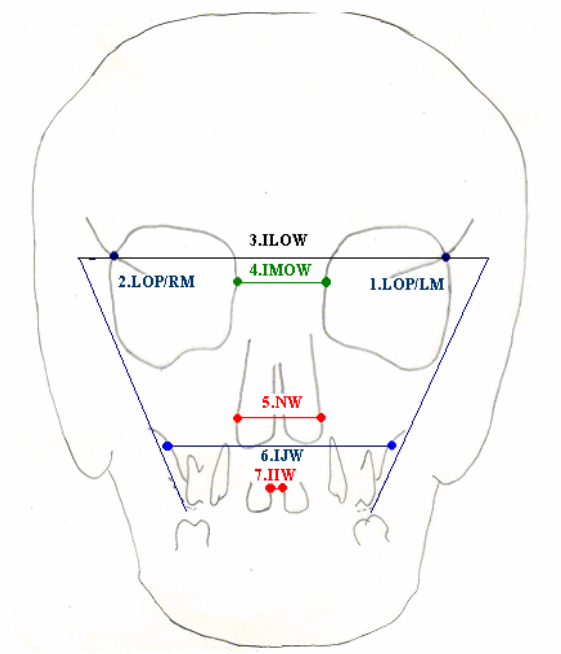

Fig. 2: P-A Cephalometric measurement

Pre and post expansion parameters mean values

Table I: *Pre and post expansion mean value of parameters in the posterior anterior cephalometry of Group I.*

P- A Measurements		Before				After			
		Mean	SD	Min	Max	Mean	SD	Min	Max
ILOW	Mm	94.625	5.10	87	103	94.000	5.29	87	103
IMOW	Mm	25.875	.99	25	27	25.750	1.49	23	28
NW	Mm	33.875	2.17	31	36	34.875	1.64	32	37
IJW	Mm	61.750	5.52	52	70	64.750	5.52	55	72
IIW	Mm	0.375	0.74	-1	1	3.750	1.28	2	6
LOP/LM	<	90.000	0	90	90	98.250	1.39	97	101
LOP/RM	<	90.000	0	90	90	97.750	2.49	95	102

Table 2: *Pre and post expansion mean values of parameters in the posterior anterior cephalometry of Group II.*

P- A Measurements		Before				After			
		Mean	SD	Min	Max	Mean	SD	Min	Max
ILOW	Mm	89.750	4.83	81	96	92.625	3.66	87	97
IMOW	Mm	23.250	1.49	21	26	23.375	1.60	21	25
NW	Mm	31.250	1.67	29	34	34.125	2.80	30	39
IJW	Mm	58.875	4.67	50	65	62.625	3.78	54	66
IIW	Mm	0.000	0.53	-1	1	3.375	0.74	3	5
LOP/LM	<	90.000	0	90	90	96.625	2.26	94	100
LOP/RM	<	90.000	0	90	90	94.750	4.90	86	99

Table 3: *The difference in parameters presented respectively in the Posterior Anterior cephalometry.*

P – A Measurements		Group 1					Group 2				
		Mean	SD	M	M	P	Mean	SD	m	M	P
ILOW	Mm	-0.63	3.20	-8	2	1.00	2.88	3.68	0	11	0.02*
IMOW	Mm	-0.13	1.25	-2	1	0.68	0.13	0.99	-1	2	0.72
NW	Mm	1.00	1.31	-1	3	0.07	2.88	1.55	1	5	0.01*
IJW	Mm	3.00	3.30	-3	8	0.05*	3.75	1.83	1	7	0.01*
IIW	Mm	3.38	0.92	2	5	0.01*	3.38	1.06	2	5	0.01*
LOP/LM	<	8.25	1.39	7	11	0.01*	6.63	2.26	4	10	0.01*
LOP/RM	<	7.75	2.49	5	12	0.01*	4.75	4.89	-4	9	0.02*

m: minimum , M: maximum

Table 4: *Significance of differences between Group I and Group II.*

P – A measurements	P value
ILOW	0.08
IMOW	0.55
NW	0.03*
IJW	0.60
IIW	1.00
LOP/LM	0.06
LOP/RM	0.31

observed that inter lateral orbital width (ILOW) showed a significant increase ($P < 0.05$) of 2.88 mm in group 2 (deep screw) while decreased slightly by 0.625mm in group 1 (shallow screw). The difference is due to the positioning the screw deep which makes it nearer to the orbital skeletal complex and this makes a fulcrum of opening in the nasal cavity or even more superior. This leads to an increase in the inter lateral orbital width when we open the maxillary suture. Shallow screw position will put the fulcrum near to the fronto-maxillary suture or more inferior, so opening the maxillary suture by RPE will produce a pivotal effect with portions above the fulcrum area moving medially. This may explain the negative inter lateral orbital width found in the shallow screw group.

Nasal width (NW) increased by 1 mm in group 1, while in group 2 it increased 2.88mm which was significant ($p < 0.01$). This increase in the nasal width was due to the separation of maxillary halves that laterally moved the outer walls of the

nasal cavity. It has been reported[1,4,10,18-20] that there is an increase in the nasal width immediately following the expansion.

There was a statistically significant change ($p < 0.05$) between them the nasal widths when comparing both groups. This was the only significant change between the two groups in our study. So deep screw height has more expanding effect on the nasal cavity due to close distance between the screw and the nasal cavity which makes the screw nearer to the center of resistance of the nasal cavity. Inter jugular width (IJW) of both the groups increased significantly but there was no difference between the two groups. Inter incisal width (IIW) of both the groups increased significantly which is also reported by Haas[1] in his study.

CONCLUSION

As a result of this study we conclude that deep screw rapid maxillary expansion was more effective in solving nasal constriction than shallow screw rapid maxillary expansion. The other skeletal expansion effects of shallow and deep positioned screw are equally effective.

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