Evaluation of Sagittal Change in the Maxilla and Incisor Inclination Following Rapid Palatal Expansion Using Cone Beam Computerized Tomography

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ABSTRACT

Objective: To measure the sagittal changes in the maxilla via angular change in point A with Sella Nasion plane and incisor to palatal plane before (T1) and after (T2) rapid palatal expansion with bonded expander.

Study Design: Quasi-experimental study.

Place and Duration of Study: Armed Forces Institute of Dentistry Rawalpindi Pakistan, from Feb 2017 from Jan 2018.

Methodology: 30 patients both male and female presenting to orthodontics department AFID between the ages of 9 and 12 years, with transverse maxillary deficiency were given a bonded hyrax appliance with an activation schedule of 2 turns per day, the retention period was 2 months followed by further retention with a removable plate. Two cone beam computerized tomography evaluations were done. One pre-expansion (T1) and the other after 2 months of retention (T2).

Results: 30 children 16 males (53%) and 14 females (47%) with a mean age of 11.03 ± 0.76 years were studied showing that from pre-treatment to post-treatment Sella Nasion point A value changed insignificantly from 77.03 ± 2.81 to 77.2 ± 3.02and 1 to palatal plane changed insignificantly from 111.82 ± 5.74 to 110.8 ± 5.80. Paired sample t-test results confirmed the statistically insignificant change in Sella Nasion point A and 1to Palatal Plane.

Conclusion: Following rapid palatal expansion with a bonded expander in growing patients the change in maxillary location in the sagittal dimension and the change in inclination of incisor to palatal plane following expansion was insignificantly affected statistically and hence clinically.

Keywords: Rapid palatal expansion, Cone beam computerized tomography, Incisor inclination to palatal plane, Sella nasion to point A-angle

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INTRODUCTION

Maxillary bone located right in the middle of the facial skeleton with the skull above and the mandible below has esthetic and functional implications playing a role in the development of both the Class II and Class III malocclusions, airway affects and TMJ as well.[1,2] This bone that develops intramembranously has a short growth potential after birth lasting till about 6-7 years with potential to exceed and fall short in all the three dimensions, governed by both environmental and genetic influences.[3-5] The importance of early dimensional correction via palatal expansion and early intervention when it comes to the maxilla has been reviewed extensively in literature.[6] Thus palatal expanders varying from the most simple to the most complex have been used over the years, their aim being to achieve a transverse correction and secondary change in the sagittal dimension not only at the level of the basal bone but the dentition itself, the surrounding structural bones of the face, airway changes,[7] and positive soft tissue facial effects.[8]

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Cone beam computerized tomography although presents with the issue of increased radiation exposure compared to conventional radiography however it is established as being superior to dental casts and lateral cephalograms in posttreatment skeletal changes following rapid palatal expansion. It is claimed that it overcomes the short comings of magnification, distortion, super-imposition of structures, and rational errors observed in two-dimensional imaging giving a true life size image.[9,10]

Rapid palatal expansion is considered a mechanism to alter the sagittal maxillary bone and dental position hence preventing the development of a Class III malocclusion primarily due to maxilary deficiency. However considering this as the sole mechanism without the use of an additional external or internal protractive force remains questionable.[10]

In view of the accuracy associated with cone beam computerized tomography evaluations this study was planned to view the effects of bonded palatal expander on change in angular measurement of point A indicating a change in the maxillary position and incisor to palatal plane depicting a change in the dentition of the maxilla in the sagittal plane to be able

to achieve predictable clinical outcomes in terms of the specificity in appliance selection when dealing with maxillary deficiency leading to Class III malocclusion.

METHODOLOGY

This quasi-experimental study was carried out in Armed Forces Institute of Dentistry from February 2017 till January 2018.

Inclusion Criteria: Patients of either gender between the ages of 9 and 12 years were enrolled who presented with transverse maxillary deficiency.

Exclusion Criteria: Adult, syndromic cases and those having previous orthodontic and orthopaedic intervention were excluded.

Using previous literature as reference,change in angular measurement of point A to cranial base that is SNA in degrees (Pre-expansion Mean 74.97 ± 0.96 and post-expansion 76.76 ± 0.08)and incisor to palatal plane that is 1 to PP in degrees (Pre-expansion Mean 111.57 ± 1.79 and post-expansion 110.18 ± 2.04) in the sagittal dimension of the maxilla as done by Ayse T. Altug Atac and colleagues,[11,12] and using Open Epi Info calculator with confidence interval of 95%, power of test at 80% minimum sample size was calculated to be at 30.

Approval has been taken from the Ethical Review committee of Armed Forces Institute of Dentistry (IRB form no.905/Trg-ABP 1K2). Informed consent was taken from the Parent or guardian of the child to undergo two cone beam computerized tomography exposures.

One cone beam computerized tomography exposure was done at T1 i.e before placement of bonded palatal expander. Upper and lower casts were then taken with bite registration. The appliances were fabricated in the laboratory following articulation taking care to ensure that the occlusal surfaces in contact with the mandibular dentition did not have indexing to allow complete expansion of the maxillary dentition and possible up-righting of the opposing teeth. Activation of the expander was done at 2 turns/ day (0.25mm/turn) by the patients attendant who were explained the procedure and demonstrated at the time of insertion till slight overcorrection is achieved that is the palatal cusp slopes of the maxillary molars rest against the buccal cusp slopes of the mandibular molars. A four weeks retention period was given prior to appliance removal in order to allow for the achieved results to be stabilized. At appliance removal a second cone beam computerized tomography was done and measurements recorded that is T2. The result of the expansion were retained by a removable full coverage palatal plate to be worn full time by the patient for 6-8 months until the change had become permanent and the results stable. The changes in the variables i.e angular measurement of Sella Nasion point A as given in Figure-1 and Incisor to palatal plane as given in Figure-2 at T1 and T2 were recorded by measurement tool given in cone beam computerized tomography software.

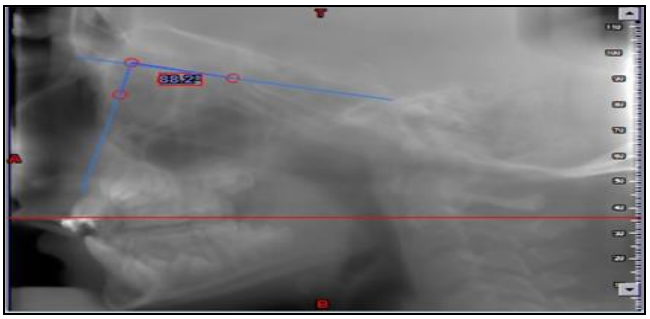

Figure-1: Sella nasion point A.

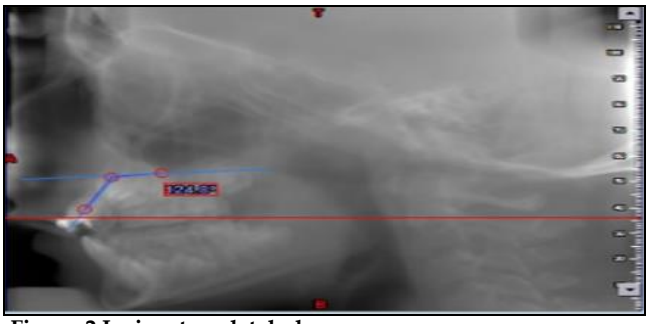

Figure-2 Incisor to palatal plane.

SPSS version 21.0 was used for data analysis. For quantitative variables mean and standard deviation was used Mean difference in values between T1 and T2 and standard deviation (SD) was studied using Paired sample t-test. The level of significance was kept at ≤0.05.

RESULTS

In this study a total of 30 patients 14 females (46.7%) and 16 males(53.3%) were treated with a mean age of 11.03 ± 0.76 years. Mean and standard deviation was calculated for all quantitative variables as given in Table-I. When the same data was analyzed for both females and males separately no statistical difference was found between the two groups showing that the change was similar and the response to expansion was independent of sexual dimorphism as shown in Table-II. Mean change in the Sella Nasion to point A and Incisor to palatal plane at T1 and T2 is given in Table-III. The change in SNA value and 1/PP value

following rapid palatal expansion with bonded hyrax was measured on CBCT . Paired sample t-test was used to analyse the change that had taken place following the expansion, results of which were given in Table-IV. There was no significant difference in the values of SNA at T1 (M=77.03, SD=2.81) and T2 (M=77.22, SD3.03); t (29) =.875, *p*=0.389.

Incisor inclination to palatal plane also remained insignificant with values at T1 (M=111.82, SD=5.74) and T2 (M=110.82, SD=5,80); t (29) =-1.438, *p*=0.161.

system.[14] This sutural disarticulation is believed to allow for the forward movement of the Maxilla. Maxillary sagittal movement is questionable in all studies showing a forward as well as backward movement following rapid expansion. Chung *et al*,[16] evaluated the changes following rapid palatal expansion in addition to the transverse dimension found a slight maxillary forward movement induced by the procedure but it was found to be too small to be clinically significant. At the same time maxillary downward

Table-I: Descriptive statistics.

Descriptive Statistics				
	N	**Minimum**	**Maximum**	**Mean ± SD**
Age of the Patient (Years)	30	10.00	12.00	11.03 ± 0.76
Sella Nasion Point A Pre Expansion (T1)	30	71.00	82.50	77.03 ± 2.81
Incisor to Palatal Plane Pre Expansion (T1)	30	102.50	121.90	111.82 ± 5.74
Sella Nasion Point A Post Expansion (T2)	30	71.40	86.00	77.22 ± 3.03
Incisor to Palatal Plane Post Expansion (T2)	30	97.20	118.00	110.82 ± 5.77

Table-II: Descriptive statistics for sexual dimorphism.

Gender of the patient		**n**	**Minimum**	**Maximum**	**Mean ± SD**
Male	Sella Nasion Point A Pre Expansion	16	72.00	82.50	77.05 ± 2.85
	Incisor to Palatal Plane Pre Expansion	16	102.50	121.90	111.28 ± 6.37
	Sella Nasion Point A Post Expansion	16	72.60	86.00	77.06 ± 3.25
	Incisor to Palatal Plane Post Expansion	16	97.20	118.00	111.11 ± 6.71
	Valid N (listwise)	16			
Female	Sella Nasion Point A Pre Expansion	14	71.00	81.00	77.01 ± 2.86
	Incisor to Palatal Plane Pre Expansion	14	103.50	120.80	112.43 ± 5.08
	Sella Nasion Point A Post Expansion	14	71.40	81.00	77.41 ± 2.86
	Incisor to Palatal Plane Post Expansion	14	100.00	116.80	110.48 ± 4.75
	Valid N (listwise)	14			

Table-III: Meanchange in sella nasion to point a and incisor to palatal plane.

	T1 (n=30)	**T2 (n=30)**	**Change**	***p*-value**
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	
Sella Nasion Point A	77.02 ± 0.81	77.22 ± 3.03	0.19 ± 1.21	0.05
Incisor to palatal plane	111.82 ± 5.74	110.82 ± 5.81	-1.00 ± 3.82	0.05

Table-IV: Paired Sample t-test for change in sella nasion point A and incisor to palatal plane after expansion.

		Mean ± SD	**Std. Error Mean**	***p*-value**
Group 1	Sella Nasion Point A Post Expansion-Sella Nasion Point A Pre-Expansion	0.19 ± 1.21	0.22091	0.389
Group 2	Incisor to Palatal Plane Post Expansion-1 to Palatal Plane Pre Expansion	-1.00 ± 3.82	0.69756	0.161

DISCUSSION

Rapid palatal expansion as an orthopaedic procedure carried out during the growing years, is an established modality to cater for the transverse maxillary deficiency.[13-15] However, the sagittal and vertical effects of the procedure on the maxilla and it's dentition remain inconclusive in literature. Rapid palatal expansion not only results in opening of the mid palatal suture but also the circum-maxillary sutural displacement was also noted following the procedure. Similarly, Wertz and Dreskin,[17] showing that maxilla moved downward and backward in some patients and downward and forward in others after rapid palatal expansion. Karaman,[18] showed that maxilla moved forward. Habeeb *et al*,[19] using cone beam computerized tomography evaluated the sagittal and vertical changes in the maxilla following expansion observed forward movement of the maxilla after rapid expansion at the same time a greater vertical displacement was

observed at the ANS then at the PNS. All the studies did show changes in the maxillary sagittal dimension however all were not clinically significant which confirms with the results of the present evaluation showing that the SNA angle did not change statistically showing no maxillary movement and hence no clinically relevant effect of the procedure on the position of the maxilla. Therefore, rapid palatal expansion alone cannot be considered a means to treat maxillary deficiency, however it's combination with a protraction face mask or Class III elastics to implants has shown a forward and down-ward sagittal movement that is clinically significant and considered a means of treating maxillary deficiency in the growing years and till adolescents if done with the expansion procedure.[12] A clinically significant effect of transverse maxillary expansion in the growing years in terms of sagittal movement has yet to be established.

Incisor inclination has been shown to both increase and decrease following the rapid expansion due to an increase in the arch perimeter uprighting any proclined teeth or causing a reduction in the angulation. Dreskin,[17] Habeeb *et al*,[19] showed retroclination of maxillary incisors however, Hazar,[20] showed proclination of dentition. A retroclination of the dentition refutes the results of a gain in arch perimeter to relieve mild to moderate crowding since retroclination decreases the arch perimeter. However, the actual gain in the arch width and perimeter as a result of the procedure is due to the posterior increase in the transverse dimensions rather than an anterior saggittal change.[21,22] This study showed a retroclination of the anterior dentition but it was neither clinically nor statistically significant. At the same time a small statistical change of the incisor cannot be confirmed till the time variables of the degree of crowding, arch length discrepancy, the number of erupted teeth and their positioning has been controlled to consider this variable separately.

LIMITATIONS OF THE STUDY

In this study point A has been taken to view the sagittal maxillary position which is questionable as it remodels with most manipulations in the anterior maxillary segment. At the same time maxillary rotation has not been taken into account. Unit maxillary length would be better variable to view the effects on the maxilla.

With regards to incisor inclination variables dealing with arch length discrepancy, the number of erupted teeth and their positioning has not been controlled to consider incisor inclination variable solely.

CONCLUSION

Following rapid palatal expansion with bonded hyrax it was observed that no statistical or clinically significant change in sagittal position of the maxilla took place hence without a protraction force spontaneous sagittal maxillary correction does not seem to be a possibility. At the same time incisor position with reference to palatal plane retroclined but neither was it clinically nor statistically significant therefore the anticipation of worsening dental changes in a borderline overbite patient does not seem to be a point of concern.

Conflict of Interest: None.

Author's Contribution

HP:, AA:, AAB: Research Work.

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