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EVALUATION OF THE VERTICAL DIMENSION AFTER RAPID MAXILLARY EXPANSION:CONE BEAM COMPUTED TOMOGRAPHIC STUDY

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ABSTRACT

Aim of the study: This study was conducted to evaluate radiographically using cone beam computed tomography (CBCT) the effect of rapid maxillary expansion on the vertical dimension. **Material and Methods:** The current study was conducted on a total sample of thirty young adult orthodontic patients (20 girls and 10 boys) presented with transverse maxillary deficiency with an age ranged from 11-15 with mean of 13.3 ±1.1Y.The patients were distributed randomly in to three equal groups according to the position of center of the expansion screw in relation to the palatal surface of the maxillary first permanent molars. The CBCT were taken before the start of the orthodontic expansion (T1), three months after the last activation immediately after removal of the expander (T2). All patients did not have brackets or wires placed in the maxillary arch until after the T2 records were taken. **Results:** Paired t-test used to statistically test the mean differences between pre-expansion and pos-expansion measurements within each group. One-way analysis of variance (ANOVA) was used to compare among the different three groups. Tukey's post-hoc test was used for pair-wise comparisons among the groups when ANOVA test was significant. The significance level was set at $P \leq 0.05$. **Conclusions:** The different sagittal positions performed in the study may be of little or no clinical significance on the vertical dimension among all groups.

INTRODUCTION

Rapid maxillary expansion (RME) is the most effective orthopedic procedure to increase the maxillary transverse dimension in young patients by opening the midpalatal suture [1-3].

The RPE is the treatment of choice for the patients exhibiting the following conditions: 1) Transverse discrepancies that result in either unilateral or bilateral posterior crossbites involving several teeth. 2) Border line skeletal Class II, Division 1 malocclusions with or without a posterior crossbite. 3) Borderline skeletal Class III maxillary deficiency. 4) Pseudo Class III with maxillary constriction or posterior crossbite [4].

A low tongue position is associated with a narrow palate that may predispose to mouth breathing and also cause upper anterior crowding. Maxillary hypoplasia may cause a Class II malocclusion and may restrict mandibular development in the sagittal or transverse dimensions and may also predispose to a Class III malocclusion associated with extrusion of maxillary first permanent molars then backward and downward rotation of the mandible leading to increasing vertical dimension [5,6].

Regarding the effects of RME treatment on the mandible, several authors have reported that opening of the midpalatal suture causes downward and backward rotation of the mandible and an increase in lower face height as a direct effect of vertical displacement of the maxilla in addition extrusion of maxillary molars play an important role in the iatrogenic bite opening, hence some studies confirm that one must put in consideration the difficulty when dealing with long faces and vertical growth pattern patients [1,6-8] .

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Although RME has been widely used in orthodontics for several decades, the influence of the different sagittal positions of the expansion screw on the vertical dimension needs more elucidation. Therefore, the current study was directed to evaluate the vertical dimension after rapid maxillary expansion with different sagittal expansion screw positions.

MATERIAL AND METHODS

The current study was conducted on a total sample of thirty young adult orthodontic patients (20 girls and 10 boys) presented with transverse maxillary deficiency with an age ranged from 11-15 with mean of 13.3 ±1.1Y.

The research project was explained both verbally and in writing and the objectives of the study were discussed with the patients and parents and a consent form for patient participation in the research project was obtained before commencing the study.

Group allocation:

According to the sagittal position of the expansion screw, the patients were randomly allocated into three equal groups, using online generated randomization plan (Graph Pad) found at the website http://www.graphpad.com/quickcalcs/index.cfm.

- **Group (A):** The centre of expansion screw tangent to a line bisecting the centre of the maxillary first permanent molar (seven girls and three boys) (Figure 1a).
- **Group (B):** The centre of expansion screw tangent to a line bisecting the mesiopalatal cusp of the maxillary first permanent molar (seven girls and three boys) (Figure 1b).
- **Group (C):** The centre of expansion screw tangent to a line bisecting the distopalatal cusp of the maxillary first permanent molar (six girls and four boys) (Figure 1c).

Four-banded Hyrax expanders 9mm screw length (Figure 1) were used and supported bilaterally by first premolars and first molars. The appliance was activated 2 quarter turns at the time of delivery (0.25 mm per each) then it was activated quarter turn at the morning and another one at the evening[9-13] by the patient or parents for 15 days, thus reaching the total amount of expansion of 8 mm in all subjects.[14-17] The patients were seen on third, sixth and tenth days for verification and confirmation of activation process of the appliance. The screw was tied off with a ligature wire, and then covered by a small piece of composite material and kept in Place within the mouth for three months after the last activation of Hyrax expander. No additional orthodontic treatment was initiated in both jaws until after the retention phase has finished.

CBCT were taken before the start of the orthodontic expansion (T1), three months after the last activation immediately after removal of the expander (T2). All patients did not have brackets or wires placed in the maxillary arch until after the T2 records were taken.

Pre expansion T1 and Post expansion T2 CBCT data were assessed for quality of image using the machine software (CS 3D imaging version 3.2.12; Care Stream, Italy).

Then, T1 and T2 CBCT data were transferred to a personal computer as a DICOM (digital imaging and communications in medicine), data files and were reconstructed at 0.3 mm increments then analyzed by using In vivo (Anatomage) imaging software (version 5.1; USA).

The patients were positioned by adjusting the Frankfort horizontal plane parallel to the floor, The following measurements were assessed for linear alveolar bone measurements according to previous studies,[8,10-13,17] (Table 1).

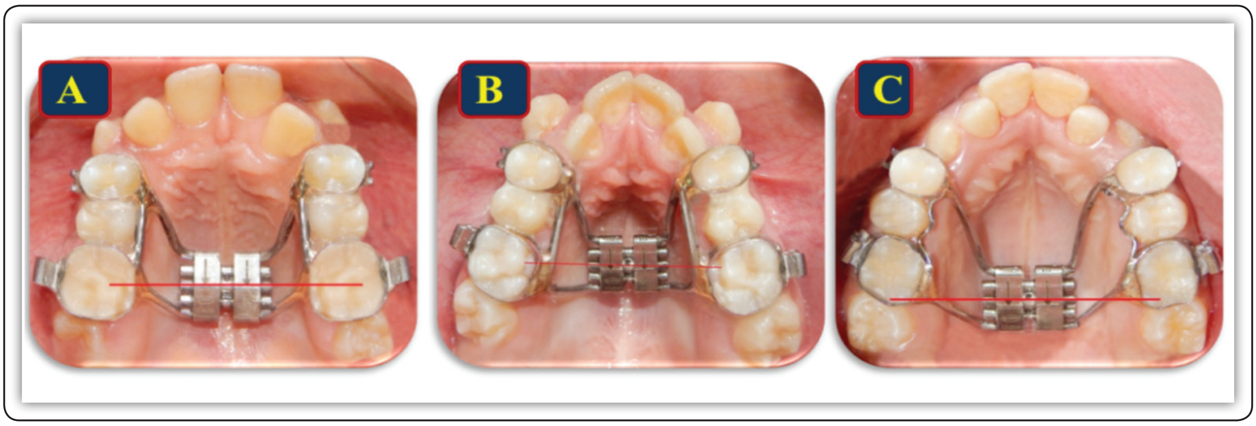

Fig. (1): Different sagittal position of the expansion screw (A) centered (B) Mesial and (C) distal position.

TABLE (1): Definitions of vertical linear measurements used in the study (Figure 2 and 3).

Linear measurements	Definitions
Buccal cusp height (BCH)	Vertical distance on line parallel to ML from the FH to mesiobuccal cusp tip of M1 & buccal cusp tip of P1 for both right and left M1 &P1.
Palatal cusp height (PCH)	Vertical distance on line parallel to ML from the FH to mesiopalatal cusp tip of M1 & palatal cusp tip of P1 for both right and left M1 &P1.
Anterior nasal spine height (ANSH)	Vertical distance on perpendicular line from the FH to the ANS in the sagittal section.
Posterior nasal spine height (PNSH)	Vertical distance on perpendicular line from the FH to the PNS in the sagittal section.

RESULTS

All measurements were performed twice at two weeks interval by the same examiner to determine the intra-examiner error of method.

Paired t-tests were used to test the effect of treatment on the CBCT variables within each group showed highly significant increases $P \leq .05$ for the effect of expansion on the anterior and posterior nasal spine (ANSH and PNSH) in all groups.

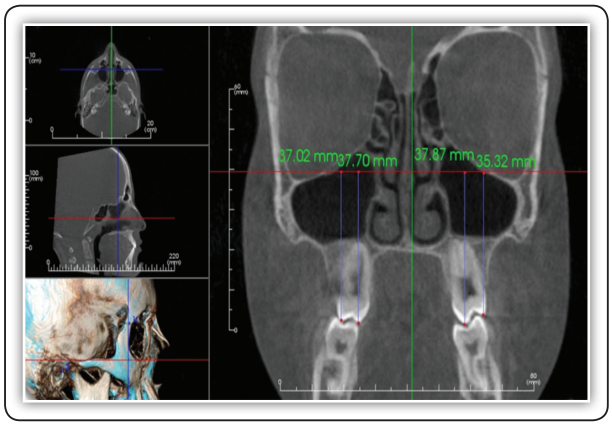

Fig. (2): Buccal and palatal cusp height measurements of maxillary permanent first molar.

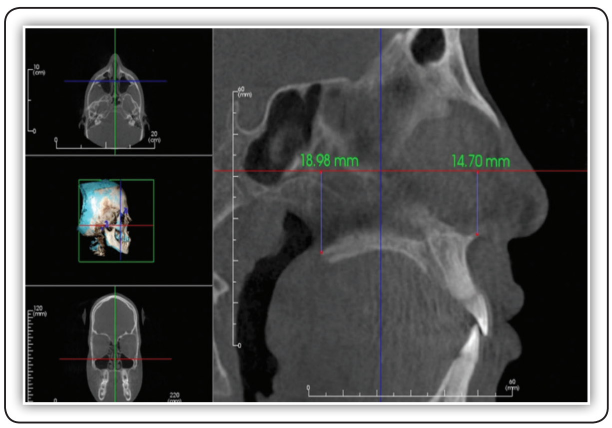

Fig. (3): Anterior & Posterior nasal spine height.

On the other hand the right buccal cusp height (BCHRT) at M1 in group A, left buccal cusp height (BCHLT) at P1 in group B and right palatal cusp height (PCHRT) at P1 in group C, showed no significant changes $P > .05$.

TABLE (2): Descriptive statistics and test of significance (ANOVA) for comparison the mean difference of CBCT vertical buccal, palatal cusp height and skeletal linear measurements among the three groups.

Variable (mm)		Group A		Group B		Group C		ANOVA		
		MD	SD	MD	SD	MD	SD	DF	F	Sig
BCH RT	**M1**	.64	.975	.69	.347	.99	.635	27	.773	.472NS
	P1	1.3	1.27	.78	.414	.79	.416	27	1.80	.184NS
BCH LT	**M1**	1.03	.746	.72	.439	1.12	.567	27	1.27	.295NS
	P1	1.7	1.48	1.5	13.5	.8	.346	27	.985	.387NS
PCH RT	**M1**	1.6	.835	1.1	.467	1.14	.419	27	2.71	.084NS
	P1	1.3	.904	1.4	.546	.88	.325	27	2.21	.125NS
PCH LT	**M1**	1.5	.892	1.3	.572	1	.580	27	1.30	.289NS
	P1	1.1	.619	1.3	.282	1.17	.457	27	.296	.746NS
ANSH		**.91**	.324	1.3	.240	.93	.338	27	5.460	.144NS
PNSH		**.316**	.0686	.224	.1175	.226	.134	27	2.269	.123NS

MD = Mean difference, SD= standard deviation, SE = Standard Error, NS= non-significant, Significant at P = Probability $P \leq 0.05$, DF= degree of freedom No= 30.

One-way analysis of variance (ANOVA) was done to test the mean differences of treatment effect on each variable measured among groups. The significance level was set at $P \leq 0.05$ (Table 2).

DISCUSSION

Rapid maxillary expansion is very common treatment strategy in patients with constricted maxilla and posterior crossbite [2].

Unfortunately, studies investigating the effects of expansion screw sagittal positions for the maxillary arch after rapid maxillary expansion on the vertical dimension were limited to comparing the conventional Hyrax with fan shape palatal expander [18,19], which exhibited very large span between the two positions. Therefore, the purpose of this study was to evaluate radiographically the effect of rapid maxillary expansion on the vertical dimension with different short span sagittal positions of the expansion screw limited to the palatal surface of maxillary permanent first molar.

CBCT show a significant advantage because all defects including buccal and lingual defects could be detected and quantified. [20]

In the present study the BCH at the right and left maxillary first permanent molars and premolars level were increased. thus, clarify an extrusive movement of M1 and P1, this was in agreement of previous studies of Garib et al, [21] Araugio et al, [22] and Rungcharassaeng et al. [23]

The results of BCH & PCH in the current study were in disagreement with Lin et al, [24] since they mentioned that alveolar bone bending in the hyrax group was more than twice that observed in the bone born group. The hyrax appliance produced a greater buccal inclination of the posterior teeth that exceeded the amount of alveolar bending and buccal cusp intrusion, since the sample was older age than the present study leading to increase in orthodontic expansion with little orthopedic one. Also they depended on the measurements from the NF which may affected by maxillary expansion while in the present study the FH was used as a reference in measuring the cusp height.

On the other hand there was no statistical significant difference among the three groups.

As regards the evaluation of ANS and PNS points showed some displacement. ANS point had an average of downward displacement, but this was not statistically significant (P >.05). PNS had a little downward displacement in comparison to ANS, which also was not statistically significant (P >.05), this was in agreement with Woller et al.[25] and Faronato et al,[26] showed no significant change at posterior vertical dimension.

Studies have shown contradictory results regarding the tipping of the palatal plane, with some studies showing the anterior tipping was greater than that at the posterior aspect resulted in a downward movement of the maxilla, more at ANS than at PNS,[2,3,27,28], which creates an increase in the palatal plane angle and upper face dimensions, while other reported that the posterior tipping was greater than that at the anterior aspect, while Woller et al[25], showed no significant tipping. Even with some relatively large downward measurements, this study showed the tipping of the palatal plane is not significant with RME; this was in agreement with Corekc et al [19], Woller et al [25] and Faronato et al,[26].

The results of the current study have shown a statistically non-significant difference in the mean change of the CBCT skeletal linear measurements among the three groups. Therefore, the null hypothesis stating that no significant difference among the three groups was accepted.

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