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DENTOALVEOLAR CHANGES OCCURING WITH CORTICOTOMY ASSISTED SLOW PALATAL EXPNSION

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ABSTRACT

Background: *Maxillary expansion in skeletally mature patients with fused mid palatal suture and circum maxillary resistance makes the conventional non-surgical expansion methods insufficient.* ***Aim:*** *To evaluate the dentoalveolar changes occurring with corticotomy assisted SME.* ***Methods:*** *Sixteen patients (4 males and 12 females) requiring maxillary expansion (mean age:19 years; range: 14-24 years) were divided into two groups:* ***Group A:*** *included 10 patients subjected to buccal alveolar corticotomy before SME and* ***Group B:*** *included 6 patients who had only SME.CBCT images were taken at T1(before) and T2 (after). Inter molar (IMW) and Inter premolar widths (IPmW) as well as root angulations (RA) and buccal bone thickness (BBT) at the level of first molars and first premolars were recorded. T-tests (paired, student) determined the significance (P≤0.05) performed to evaluate the effect of treatment within and between each group.* ***Results:*** *Expansion achieved in corticotomy group was 5.900±0.348mm for IMW and 5.000±0.258mm for IPmW, and was significantly higher than SME only group. Root tipping showed no statistical*

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Highlights : Corticotomy , SME , Dentoalveolar , CBCT

significant differences between both groups. Buccal bone thickness decreased significantly in both groups with no statistical significant differences between both groups. **Conclusions:** *Corticotomy assisted expansion is an efficient and safe treatment and shows a significant increase in IMW and IPmW compared to SME only. Non-significant differences in root angulations between the two groups were noted suggesting that the expansion in corticotomy group was more translatory movement than tipping. The corticotomy procedure does not cause a different response of buccal bone compared to SME only group.*

INTRODUCTION

Transverse maxillary constriction is frequently seen in adolescents and adults due to multifactorial etiology[1,2] leading to decrease of the nasal permeability, bilateral dental maxillary crossbite, compromising esthetics, occlusal stability, and normal mouth functioning[3].Therefore, early treatment is necessary to establish craniofacial equilibrium and myofunctional correction to favor normal growth and development[4]. Maxillary expansion before the pubertal peak exhibits significant and more effective long-term changes at the skeletal level, but when treatment is performed after the pubertal growth spurt, maxillary adaptations to the expansion therapy shift from the skeletal level to the dentoalveolar level[5]. This change is corresponding to the increase of interdigitations between suture processes which become heavy to the extent that a separation of the two halves of the maxilla would not be possible without fracturing the interdigitated processes[6], which makes the correction of maxillary constriction in a skeletally mature patient more challenging[7]. The conventional nonsurgical method of slow expansion used in adults is problematic, limited, and inefficient as it takes a long time and might compromise periodontal health if done beyond a few millimeters[8]. The development of corticotomy assisted orthodontics has provided new solutions to many limitations in the orthodontic treatment of adults. Köle in 1959 suggested that the disrupting of continuity of the cortical layer of

bone leads to moving segments of bone in which the teeth were embedded and allows these outlined blocks of bone to be moved rapidly and somewhat independently of each other[9]. Wilcko developed the current technique named Accelerated Osteogenic Orthodontics (AOO)[10] or Periodontally Accelerated Osteogenic Orthodontics (PAOO)™[11] to enhance tooth movement, subsequently, reducing treatment time via inducing cortical bone injury through linear cutting (corticotomy) and then performing orthodontic treatment. Frost[12] found a direct correlation between the severity of bone injury and the intensity of its healing response, which occurred mainly as a reorganized activity and accelerated bone turnover at the surgical site. This type of healing response was named "Regional Acceleratory Phenomenon" (RAP)[13]. Corticotomy assisted expansion is considered an optimal way to treat mild to moderate maxillary transverse deficiency in adults with greater stability and without compromising periodontal health. Studies about corticotomy assisted expansion like those done by Mossaz et al.[14], Wilcko et al.[11] and Hassan et al.[15] showed the efficiency and safety of such technique in treatment of maxillary constriction and posterior crossbite either unilateral or bilateral in adult, but they did not give full explanation about the dentoalveolar and skeletal changes associated with this type of treatment. The aim of this study is to evaluate the dentoalveolar changes occurred with SME assisted with buccal alveolar corticotomy.

Methods:

Sixteen patients (12 females and 4 males) requiring maxillary expansion therapy as part of their comprehensive orthodontic treatment were included in this study. All treatment was started after October 2012 and all patients were selected from the outpatient clinic of the orthodontic department; Faculty of Dentistry, Suez Canal University, Ismailia, Egypt. The study protocol was approved by the Institutional Review Board of Suez Canal university, Ismailia, Egypt. The mean age of patients was 19 years old ranging from (14-24 years). Inclusion criteria were the presence of transverse maxillary constriction with posterior crossbite or collapsed arch requiring maxillary expansion, minimum age was 14 years old at the beginning of treatment. Exclusion criteria were craniofacial abnormality,

presence of medical conditions which may interfere with surgery, and having orthodontic appliances prior to the start of maxillary expansion. Adequate records were collected before treatment which are dental and medical history, photos, casts, CBCT, and signed informed consent. Ten patients (two males and eight females) with a mean age of 19.3 ± 2.91 years were subjected to alveolar corticotomy 1week before SME, and 6 patients (two males and four females)with a mean age of 18.1±3.76 years had SME only. Coricotomy was done in the first group as a selective buccal alveolar corticotomy from the first premolar to the first molar mesial, distal, and apical) bilaterally according to the technique described by Murphy et al.[16] (Figure1). Each patient had CBCT images taken prior to orthodontic treatment (T1) and immediately after the completion of maxillary expansion (T2) using Hygienic banded expansion appliances. Patients were instructed to turn the screw 3 times per week with 1/4mm change per turn until an adequate amount of overexpansion achieved evaluated by clinical observation when the lingual cusps of upper molars become in touch with buccal cusps of lower molars, then the appliance was replaced by a Trans Palatal Arch (TPA) with extended arms for at least 3 months after expansion for retention. Orthodontic treatment was continued with a full bonded straight wire preadjusted appliance (Figure2(a), (b), (c), (d)).

Imaging Device: Imaging was carried out by Cranex 3D X-ray machine (Soredex, Tuusula, Finland) at 85 kVp, 15 mA, 6FOV, and 12.6 s.

Image Manipulation: The images were reconstructed by the special software program of Cranex 3D X-ray machine named On Demand 3D software (Build 1.0.9.1332, Cybermed, Seoul, Korea), with this software it is possible to view the different cuts at increasing magnifications for better accuracy. To evaluate the immediate dental and alveolar changes following SME, linear (mm) and angular measurements (degrees) were taken at T1 and T2.

1- Linear Measurements:

Palatal expansion at the maxillary first molars and first premolars was measured on 3D reconstructed occlusal image and the following measurements were recorded.

- **Intermolar Width (IMW):** Measured as a straight line joining the mesiobuccal cusps tips of the first molars **(Figure 3(a)).**
- **Interpremolar Width (IPmW):** Measured as a straight line joining the buccal cusps tips of first premolars **(Figure 3(a)).**

Two-dimensional coronal images were created perpendicular to the midsagittal plane to measure the buccal bone thickness in molar and premolar areas.

- **Buccal Bone Thickness(BBT):**Buccal bone measurements of the maxillary first molars and first premolars were measured from root surface to the outer most margin of buccal bone at the level of their trifurcation and bifurcation points, respectively **(Figure 3(b)).**

2-Angular Measurements:

Two-dimensional coronal images were created perpendicular to the midsagittal plane to measure.

- **Root Angulation (RA)**:Measured the angle buccolingually created by a line connecting the palatal causp tips and root apices of molars and premolars (long axis) to the midsagital plane**(Figure 3(c))** .

STATISTICAL ANALYSIS

T1 and T2 data were tabulated and statistical analysis was carried out using SPSS software (SPSS, 2008). Means and standard deviations were calculated for each parameter. Paired t-test (SPSS, analyze, compare means, and dependent-samples t-test) was used to test the effect of treatment on different parameters within each group ($P \leq 0.05$). Student t-test (SPSS, analyze, compare means, independent-samples t-test) was used to test the effect of different parameters between groups. To test intraexaminer reliability, 10 patient records at T1 and T2 were randomly selected and all measurements were repeated and intraclass correlation coefficients (ICCs) were calculated.

Figure 1: Corticotomy

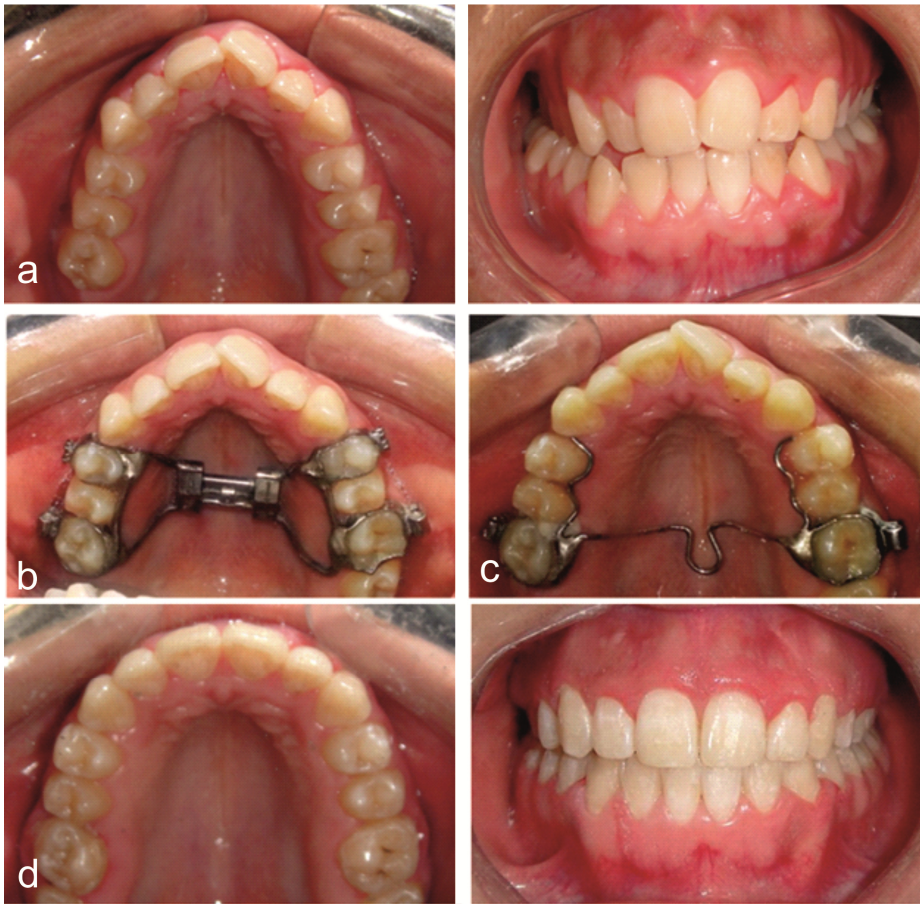

Figure 2: a: Preoperative, **b:** HYRAX appliance, **c:** TPA with extended arms, **d:** Postoperative

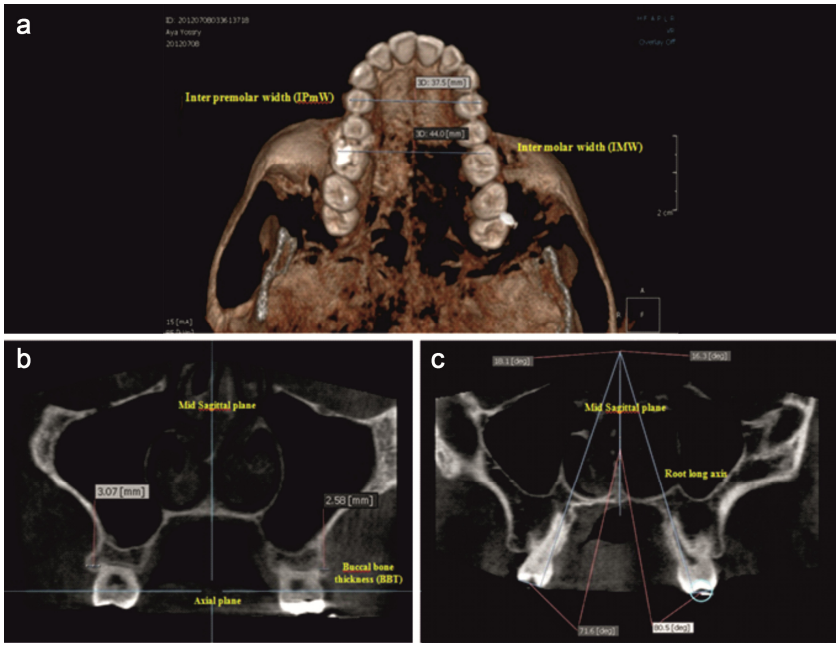

Figure 3: a: Intermolar width (IMW), **b:** Buccal bone thickness (BBT), **c:** Root angulation (RA)

RESULTS

ICC was high ranging from 0.85to 0.99 with a mean 95% confidence interval (CI) of 1.00.

The effect of treatment within both groups is shown in Tables 1 and 2 and the effect of treatment between both groups is shown in Table 3.

A. Linear Measurements

Expansion Effect

Paired t-test ($P \leq 0.05$) showed statistically significant increase in IMW and IPmw between T_1 and T_2 time points in corticotomy and control groups. Corticotomy group showed significant increase in IMW about 5.900±0.348mm and IPmW increase was 5.000±0.258mm. These values were larger than the values in the control group by (2.4 mm) in IMW and (1.7mm) in IPmW.

Change in Buccal Bone

Paired t-test (P≤0.05) showed statistically significant decrease in BBT between T_1 and T_2 time points in the corticotomy group, the decrease in average molar BBT was-0.800±0.200 mm,and in average premolar the decrease in BBT was -0.700± 0.153mm. Student t-test showed statistically insignificant differences in BBT change between control and corticotomy groups except for left premolars.

B. Angular Measurements

Palatal Root Tipping

Paired t-test (P≤0.05) showed statistically significant increase in RA between T_1 and T_2 time points in the corticotomy group except left premolar. Also, student t-test showed statistically insignificant differences in RA change between control and corticotomy groups in all teeth.

Table 1: Effect of treatment within control group

		T1		T2		Mean difference	S.D. difference	p
		Mean	S.D.	Mean	S.D.			
Expansion	IMW	50.00	1.155	53.500	1.176	3.500	0.619	0.002 **
	IPrMW	40.00	0.894	43.333	1.256	3.333	0.558	0.002 **
BBT	UR6	2.833	0.401	2.167	0.307	-0.667	0.211	0.025 *
	UL6	2.500	0.224	2.000	0.365	-0.500	0.224	0.076 NS
	UR4	1.333	0.211	0.500	0.224	-0.833	0.307	0.042 *
	U L4	1.667	0.333	0.333	0.211	-1.333	0.422	0.025 *
RA	UR6	13.667	2.728	15.833	2.227	2.167	2.120	0.354 NS
	UL6	14.667	3.303	20.167	3.978	5.500	2.668	0.094 NS
	UR4	4.167	1.621	9.000	2.113	4.833	0.654	0.001 ***
	UL4	5.000	1.549	9.167	3.219	4.167	1.869	0.076 NS

S.D. = Standard deviation. P = Probability level for the effect of treatment (paired t).

NS = Insignificant (P>0.05) *= Significant at p≤0.05

** = Significant at p≤0.01 ***= Significant at p≤0.001

Table 2: Effect of treatment within corticotomy group

		T1		T2		Mean difference	S.D. difference	p
		Mean	**S.D.**	**Mean**	**S.D.**			
Expansion	IMW	44.90	0.640	50.800	0.611	5.900	0.348	0.001***
	IPrMW	37.60	0.400	42.600	0.400	5.000	0.258	0.001***
BBT	UR6	3.10	0.180	1.900	0.277	-1.200	0.291	0.003 **
	UL6	2.80	0.249	2.000	0.211	-0.800	0.200	0.003 **
	UR4	1.30	0.153	0.800	0.249	-0.500	0.167	0.015 *
	U L4	1.40	0.163	0.900	0.233	-0.500	0.224	0.050 *
RA	UR6	15.40	0.846	21.700	1.491	6.300	1.257	0.001 ***
	UL6	16.40	0.933	21.500	0.719	5.100	1.027	0.001 ***
	UR4	5.00	0.978	11.000	2.821	6.000	2.113	0.019 *
	UL4	4.10	0.948	8.200	1.948	4.100	2.238	0.100 NS

S.D = Standard deviation.

P = Probability level for the effect of treatment (paired t).

NS = Insignificant (P>0.05)

* = Significant at p≤0.05

** = Significant at p≤0.01

***= Significant at p≤0.001

Table 3: Effect of treatment between control and corticotomy groups

			Group				
		Treatment	Control		Corticotomy		P
			Mean	S.D.	Mean	S.D.	
expansion	IMW	Before (T1)	50.000	2.828	44.900	2.025	0.001 ***
		After (T2)	53.500	2.881	50.800	1.932	0.040 *
		Difference	3.500	1.378	5.700	0.949	0.002 **
	IPmW	Before (T1)	40.000	2.191	37.600	1.265	0.014 *
		After (T2)	43.333	3.077	42.600	1.265	0.510 NS
		Difference	3.333	1.225	5.300	0.675	0.002 **
BBT	UR6	Before(T1)	2.833	0.983	3.100	0.568	0.499 NS
		After (T2)	2.167	0.753	1.900	0.876	0.546 NS
		Difference	-0.333	0.516	-1.000	0.667	0.055 NS
	UL6	Before(T1)	2.500	0.548	2.800	0.789	0.428 NS
		After (T2)	2.000	0.894	2.000	0.667	1.000 NS
		Difference	-0.833	0.408	-0.800	0.632	0.910 NS
	UR4	Before(T1)	1.333	0.516	1.300	0.483	0.898 NS
		After (T2)	0.500	0.548	0.800	0.789	0.428 NS
		Difference	-0.833	0.753	-0.400	0.516	0.191 NS
	UL4	Before(T1)	1.667	0.816	1.400	0.516	0.433 NS
		After (T2)	0.333	0.516	0.900	0.738	0.122 NS
		Difference	-1.500	0.837	-0.500	0.516	0.005 **
RA	UR6	Before(T1)	13.667	6.683	15.400	2.675	0.471 NS
		After (T2)	15.833	5.456	21.700	4.715	0.039 *
		Difference	2.333	4.926	6.400	4.115	0.097 NS
	UL6	Before(T1)	14.667	8.091	16.400	2.951	0.543 NS
		After (T2)	20.167	9.745	21.500	2.273	0.679 NS
		Difference	5.333	6.470	5.100	3.247	0.924 NS
	UR4	Before(T1)	4.167	3.971	5.000	3.091	0.645 NS
		After (T2)	9.000	5.177	11.000	8.919	0.627 NS
		Difference	4.667	2.160	6.200	6.563	0.592 NS
	UL4	Before(T1)	5.000	3.795	4.100	2.998	0.606 NS
		After (T2)	9.167	7.885	8.200	6.161	0.788 NS
		Difference	4.500	4.506	3.800	7.254	0.836 NS

S.D.= Standard deviation. P = Probability level for the effect of group (Student t test).
NS = Insignificant (P>0.05) * = Significant at p≤0.05
***= Significant at p≤0.00

DISCUSSION

The aim of the current study was to evaluate dentoalveolar changes occurring with corticotomy assisted slow maxillary expansion.

There were statistically significant differences in IMW and IPmw between T_1 and T_2 time points in SME only and corticotomy groups. Corticotomy group showed an increase in IMW about5.900±0.348mm and the IPmW increase was 5.000±0.258mm, these values were larger than the values in SME only group by (2.4 mm) in IMW and (1.7mm) in IPmW. These results show the effect of corticotomy in enhancing the efficiency of expansion due to RAP and are in accordance with results published from Mossaz et al.[14] who treated unilateral crossbite with corticotomy in the affected side and found that the operated side showed more than twice the amount of skeletal expansion than the non-operated side. In SME only group, the increase in IMW was 3.500 ±0.619mm and in IPmW was 3.333 ± 0.558 mm, these results were in agreement with Akyalcin et al.[17], who showed that the IMW increased an average of 3.95mm after expansion. On other hand, the amount of expansion in corticotomy group was larger than that of Domann CE et al.[18], who found that the expansion achieved after RME was 4.7788 ± 2.8474 mm for IPmW and 4.6943 ± 3.2198 mm for IMW.It is important to mention that the studies whose results are different in IMW and IPmW values were done in samples with younger mean age and with different methodology producing skeletal and dentoalveolar expansion rather than only dentoalveolar expansion produced in our study.

In the present study, the buccal bone change in corticotomy group showed that the decrease in the average molar BBT was -0.800±0.200mm and in the average premolar the decrease in BBT was -0.700±0.153mm. The results of our study were not different from the results concluded by Garib et al. [19] who showed that the buccal bone plate thickness decreases between 0.6-0.9 mm during rapid expansion, and Domann CE et al.[18] who found that the thickness of the buccal bone decreased on all observed roots connected to Hyrax after RME, the decrease was

about -0.73 mm in BBT of molars but the decrease in premolar BBT was -0.35 in premolars. Also, our results were in accordance with Pangrazio-Kulbersh et al.[20] who found that the amount of bone lost after RME was -0.59 mm (MRt), -0.72 mm (PMRt), -0.50 mm (MLft), and -0.57 mm (PMLft).In our study, the student *t*-test showed statistically insignificant differences in BBT change between SME only and corticotomy groups except for left premolars. These results indicated that the corticotomy did not affect the amount of buccal bone loss during the expansion procedure despite of not using a bone graft. The buccal bone regeneration after expansion was not measured in this study, but it was anticipated as Akyalcin et al.[17] compared the effect of maxillary expansion on the buccal plate of the maxillary first molars and maxillary first premolars, and found that the decrease between T_1(before) and T_2 (after) was observed for all the teeth and an increase between T_2 and T_3 (2-3 years after expansion)was found in the buccal bone thickness.

In our study, significant increase of root tipping in corticotomy group in average molar root angulations was 5.600±0.267^o, in average premolar the increase in root angulations was 5.200±1.373^o.Our results were comparable to the results published by Christie et al.[21] who found that the average of buccal tipping of the molars with a bonded Haas expander was 5.91^o, and Domann CE et al.[18] who evaluated the immediate effects of RME with Hyrax appliances on the dentoalveolar complex and found a significant tipping of the palatal roots of the maxillary right and left premolars (Rt premolar 5.737^o/ Lt premolar 7.637^o) and maxillary right and left molars (Rt molar 1.168^o / Lt molar 1.925^o).In the present study, student *t*-test showed statistically insignificant differences in root angulation change between SME only and corticotomy groups in all teeth. These results showed that the greater expansion gained in corticotomy group was due to dentoalveolar expansion rather than dental tipping. The corticotomy initiated RAP which is characterized by an increase in cortical bone porosity because of increased osteoclastic activity and physiologic events such as calcium depletion and diminished bone densities occurred according to Yaffe et al.[13], decreased cortical bone density following the corticotomy leads to gain more expansion with non-significant increase in root tipping .

CONCLUSIONS

1. Corticotomy assisted SME is considered a safe and efficient technique to increase transverse maxillary dimensions.
2. Corticotomy assisted expansion showed significant increase in arch widths (IMW and IPmW)compared to SME only group.
3. Corticotomy assisted SME showed significant decrease in buccal bone thickness of all teeth attached to the appliance.
4. No significant difference in BBT change between both groups except left premolars, and corticotomy did not affect the amount of buccal bone loss during the expansion procedure despite of not using a bone graft.
5. Significant increase of RA occurred in corticotomy group except the left premolars.
6. No significant differences in RA were found between both groups suggesting that the greater expansion gained in corticotomy group was due to dentoalveolar expansion rather than dental tipping.

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