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Evaluation of maxillary first permanent molar periodontal condition after using three types of rapid maxillary expanders (conventional, hybrid and MSE) after6 months in adolescents. Randomized controlled trial

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ABSTRACT

Objectives: The purpose was to evaluate and measure the impact of three types of maxillary expanders (conventional, hybrid, and maxillary skeletal expander (MSE)on the alveolar bone of the buccal surface of maxillary first permanent molar in adolescents, clinically and by using cone beam computed tomography (CBCT).

Material and Methods: Three groups were included during the study, with a final sample of 46 healthy participants (17 girls and 29 boys) aged 11–16 years. Patients were allocated to groups with the aid of sequentially numbered, opaque sealed envelopes (SNOSE). Group A received conventional hyrax appliance (CH) (5 girls, 10 boys), Group B used hybrid hyrax appliance with two anterior palatal miniscrews (HH) (6 girls, 9 boys), and Group C had the maxillary skeletal expander (MSE) (6 girls, 10 boys). Using Anatomage in vivo 5.19, Dental, skeletal and periodontal parameters were investigated for each group at base line (T1) and after expansion(T2), based on 92 CBCT scans.

Results: Comparisons of normally distributed numerical variables between groups were conducted using ANOVA, then post hoc test (Bonferroni)when the difference was foundand significant. Comparison of baseline and post-treatment values through using the paired t-test.The results of the randomized controlled trial revealed significant variations in the periodontal conditions associated with the three types of rapid maxillary expanders.

Specifically, the study demonstrated that the Conventional expander presented more adverse effects on periodontal health ofupper first permanent molars compared to the Hybrid and MSE.
Conclusion: Instead of being influenced by the type of expansion appliance, the plaque index increased, and the buccal bone thickness decreased. However, the MARPE, especially the MSE, may show less buccal bone resorption in relation to the conventional hyrax appliance.

Keywords: Buccalalveolar bone; Periodontal; Maxillary first molar; Rapid maxillary expansion; Hyrax; Hybrid hyrax and Maxillary skeletal expander (MSE).

INTRODUCTION

An orthopedic treatment that widens the maxillary arch by separating the mid-palatal suture isrecognized with rapid maxillary expansion (RME) is typically used to address a transverse maxillary discrepancy.[1–3]
Since maxillary width growth ceases earlier than anteroposterior and vertical growth, it is important to correct transverse maxillary discrepancies as soon as possible.[4]
During orthodontic treatment, plaque accumulation should be prevented to reduce the risk of harmful inflammation, even though orthodontic movement itself is like inflammation, but in a more aseptic form.[5]
Maintaining periodontal health during orthodontic treatment relies on multiple factors,[6]includingimmunity, medical conditions, diabetes mellitus, smoking habits, the individual's oral hygiene practices, and the buccal bone thickness.[7,8]
The buccal bone of maxillary first molar was immediately affected by both maxillary expansion techniques i.e. rapid (RME) and slow (SME); resulting in vertical and horizontal bone loss.[9–11] Even with injection of platelet rich plasma.[12]but when comparing mixed dentition versus permanent one , the later showed more bone loss.[13]While in SME with leaf expander it showed less bone loss related to first molar.[14]
Even with bonded hyrax, posterior dental tipping with conventional RPE employing hyrax is an unavoidable adverse effect.[15]
When the suture is grinded on the buccal and widened over the palatal point, a considerable amount of expansion accrues in the area.[16,17]
Skeletal and dental maxillary expansion can be achieved through using Miniscrew-Assisted Rapid Palatal Expansion (MARPE).[18–22]while another systematic review showed limited evidence in comparison to conventional hyrax (CH).[23]
HH devices necessitate extra steps, when the midpalatal suture is to be avoided, the paramedian palate offers a good area for palatal implant insertion[24–26]and at the level of the third raugae area.[27] and the bicortical engagement of miniscrew was recommended.[28]
The palatal expander appears to have an impact on periodontal health, and periodontal prophylaxis appears to be effective in controlling it. Even rather than the type of appliance tooth borne or MARPE[29], Treatments with rapid and slow expansion appliances might increase plaque incidence.[30–33]
The periodontal side effects of both maxillary expansion techniques were evaluated, butunfortunately there were no appreciable variations to one another.[34]
Previous studies[9,30,35] have been comparing the effects of RPE and SME, but the comparison of the various expanders used in RPE and its effect on the buccal bone is not well known, hence the aim is to clarify the effect of various RPE appliances on the health of the maxillary first molar buccal bone.
The three types of expanders were compared in a previous article regarding the maxillary sinus and airway[36], however it is unclear how the comparison relates to the assessment of periodontal health.
The findings will contribute valuable insights into orthodontic practices and periodontal care, providing evidence-based recommendations to optimize treatment outcomes for adolescents. Such an evaluation not only enhances clinical understanding but also emphasizes the importance of personalized orthodontic solutions in maintaining periodontal health during key growth phases.

MATERIAL AND METHODS

Sample power analysis

This was a single center, parallel, double blind, (Secondary outcomes assessor and data analyst (randomized controlled trial) with an equal allocation ratio. The sample size was decided through using G*Power free software (version 3.1.9.4)on previous study done by **Brunetto et al**[9]. The research revealed that 45 patients,at least 15 for each groupwere required and to secure this number starting with 54 patients itwas decided to overcome any dropout.

Ethical approval

The Institutional Ethical Committee (confirm the standards for medical research involving human participants) gaveapproval for this study under process number (approval number **775/220**) at Faculty of Dental Medicine at Al-Azhar University. Informed permission papers were signed by the parents or guardians of the children who

were allowed to participate. Consent forms for full-service orthodontic care and research participation were distributed separately, then clinical trial registration number was (**NCT05446714**).

Randomization

To make the randomization processes easier, sequentially numbered opaque sealed envelopes with assigned numbers and coded vehicles were utilized.Participants in this randomised controlled trial (RCT) study were screened at the orthodonticoutpatient clinic,faculty of dental medicine, at Al Azhar University in Cairo, Egypt. The sample consisted of 54 healthy (**17** girls and **37** boys) 11- 16-year-old patients was Finally, 46 healthy (17 girls and 29 boys) 11. 7 -15 .8-year-old patients were analyzed after dropout 6 and exclusion of 2 patients (8 boys).Group A conventional hyrax appliance (CH) (**5** girls and 1**3** boys) became(**5** girls and 10 boys) group B hybrid hyrax appliance with two anterior palatal miniscrews (HH) (6 girls and 12 boys) became (6 girls and 9 boys) and group C MSE (6 girls and 12 boys) became (6 girls and 10 boys) as seen in Consolidated Standards of Reporting Trials (CONSORT) **(Figure 1).**

Inclusion criteria

Maxillary collapse with a skeletal framework underneath, the ages ranged from 11 to 16 years and there were both unilateral andbilateral posterior crossbite. The anterior face's average height, the presence of completely erupted maxillary first permanent molars (M 1). Oral and general competence, absence of gingival or periodontal disease, absence of underlying illnesses or medications that could impair bone quality, periodontal health or result in the failure of orthodontic therapy, and absence of a history of previous orthodontic treatment.

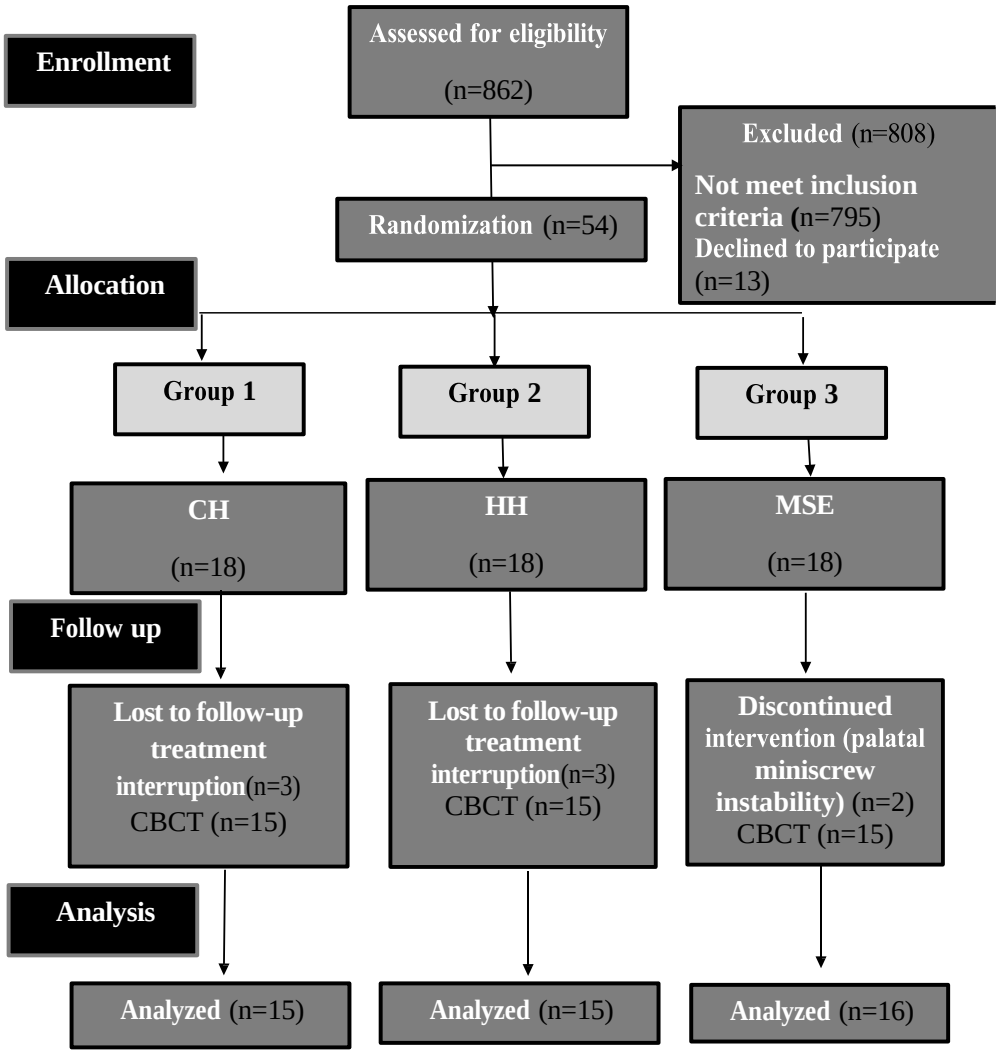


Figure 1: CONSORT flow diagram.

Exclusion criteria

Amalgam filling in M1 or crown and any Craniofacial syndromes include cleft lip and palate.

Discontinuation criteria
Frequently terrible home and oral care practices missed visits that disrupt the study's protocol, regularly malfunctioning appliances with poor activation protocol, and failure to follow a doctor's advice.

Assessment of maxillary width
Both clinical and conventional posteroanterior (PA) radiography were used firstly to measure the maxilla's transverse width,then the accepted patients in the trial asked to perform a cone beam computed tomography (CBCT).

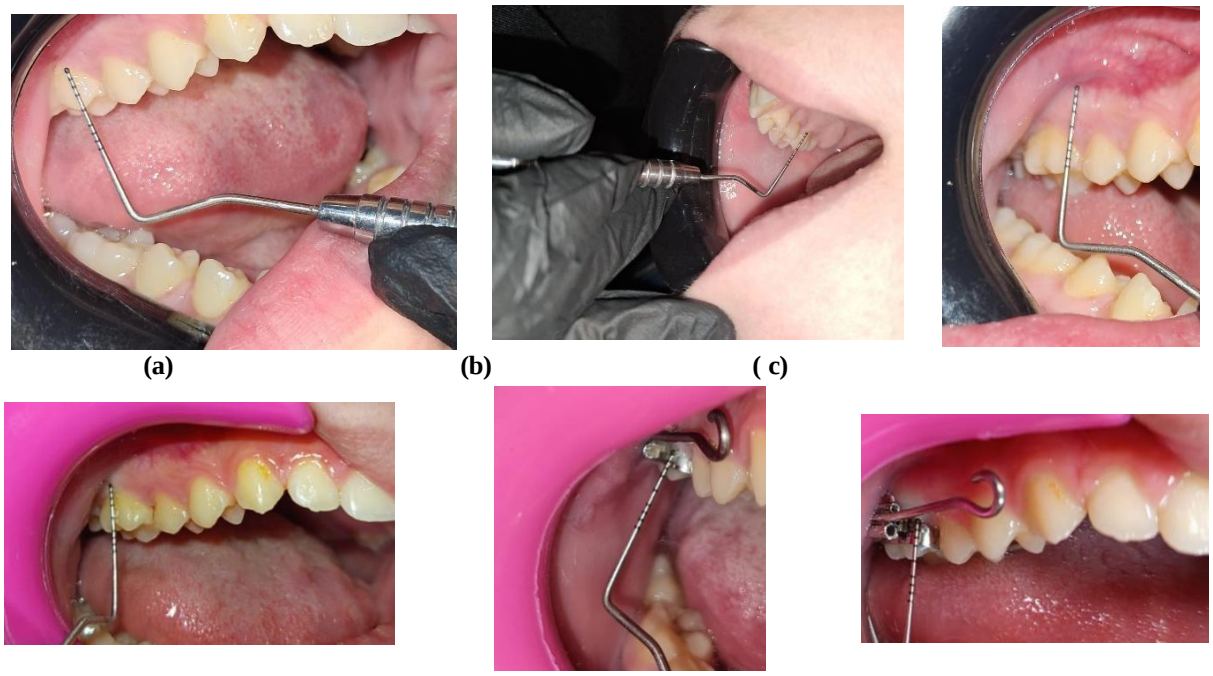
Dental prophylaxis
Every patient received dental prophylactic procedures such as scaling, polishing, and gingival therapy (mouthwash with chlorhexidine). The age of the patient, systemic conditions, patient cooperation, familial and socioeconomic status can influence the periodontal prophylaxis regimen. To standardise the pretreatment oral hygiene measures before expansion, A written homecare instruction sheet was provided to each trial participant and then joined in a specific oral hygiene regimen for one month.

Gingival &Periodontal examination
Before beginning orthodontic expansion treatment (T1), one month following the last expansion screw activation (Tm), and six months following the last activation (T2), gingival and periodontal examinations were conducted on all patientsincluded the followings
Plaque index (PI),[37] Gingival index (GI),[37] were assessed firstly followed by clinical crown length (CCL), Sulcus probing depth (SPD), Bone probing depth (BPD), and Width of the attached gingiva (AGW). Because the Periodontal biotype is essential in the prognosis of aesthetic, functional, and biological views, measurements were objectively observed.The tip of periodontal probe can differentiate between a thin biotype or a normal one depending on visibility or disappearance respectively.
M1 were measured bilaterally with a periodontal probe **(Figure 2).** Before, during and after the expansion treatment, plaque control was carried out by scaling and encouraging dental hygiene practices. To prevent potential harm to the periodontal tissue, patients with an index score of three were eliminated. Oral healthinclude gingival condition were tracked based on the PI and GI.
To determine if a tooth has periodontal disease or not, the following standards were applied:

1. A purulent discharge from the gingival crevice or gingival necrosis, enlargement, or inflammation surrounding the teeth.
2. Depthof gingival crevice was 3 mm or more.
3. More than 1 mm of tooth mobility in any direction.
4. Alveolar bone resorption that extends beyond the cementoenamel junction (CEJ) in an apical direction i.e. dehiscencewhich demonstrated by radiography.

Plaque index (PI):
The examination of plaque and debris was conducted on M1 buccal, mesial, distal, and palatal surfaces through using the Silness and Loe (1964) approach.[37]A score of 0 meant no visible plaque, while a score of 5 indicate covering of more than two thirds ofM1 endangering oral health. **(Figure 2 a &b).**
Gingival index (GI):
Gingival index (GI) was evaluated using the same four surfaces used in PI assessment of M1: buccal, mesial, distal, and palatal surfaces with the same approach.[37]**(Figure 2 a &b).**
Clinical crown length (CCL):
It was measured between the mesiobuccal cusp tip of M1 and the curve of the free gingival border.**(Figure 2 a).**
Keratinised gingival length (KGL):
It was measured between the mucogingival junction and the gingival margin. (Figure 2 c).
Sulcus probing depth(SPD):
It was measured at the midbuccal surfaces of bilateral M1.
Bone probing depth (BPD):
Local anaesthesia was administered to the bilateral M1 and the bone probing depth (BPD) was measured. The tip of the probe was slowly introduced in the sulcus until resistance was clearly felt.
Attached gingival width (AGW):

It was obtained byexcluding the SPD from the KGL.



(a) **(b)** **(c)**

(d) **(e)** **(f)**

Figure 2: Gingival and periodontal evaluation (a) plaque, gingival index&CCL (b) Palatal surface assessment and (c)KGL (d) SPD (e) and (f) Assessment of PI during treatment.

A jackscrew was given by the hyrax**(Figure 3 a)** with screws that were 9 or 1**0** mm width**(Figure 3 d)** (Firenze, Italy: Leone Orthodontics and) in group A and B while in group C MSE**(Figure c)**was used through covering biocritical involvement, four mini-implants (diameter=1.8 mm, length=11 mm)secured into the MSE jackscrew with four holes by a special driver, **(Figure 3 e).**Two arms of soft titanium were soldered toM1 bands bilaterally. The first permanent molars were banded (American orthodontic) and the expansion screw arms were soldered to the two segments (CH and HH) or four segments in MSE cases**(Figure 3 a, b & c).**

Expansion appliances were constructed by the same orthodontictechnician.Upon delivery, and after cementation with glass ionomer cement (Medicem)and antiseptic solution (Betadine) was applied on the palate at the miniscrew insertion site, and little amount of local anesthesia was applied, each patient received two quarter turns(0.25 mm each)daily For 17 days, the patient or parents at the morning applied one quarter turn and another one in the evening, the average expansion of about 8 mm.Activation protocol of MSE was 4 turns per day since it is a hexagonal shape screw each turn equal 0.133 mm so four turns will be equivalent to 0.53 mm resulting in total activation of nearly 8 mm after 16 days.Finally,after reaching the desired expansion, fixation of the screw was achieved by light cure flowable composite.

The protraction face mask in class III cases was postponed till the 6 months evaluation period was finished.

CBCTwas performed on each patient at baseline (T1) and six months after the last RPE activation(T2). Routine orthodontic data was also collected before and after therapy.Using Anatomage in vivo 5.19, Dental, skeletal and buccal bone parameters were investigated for each group.

(a) **(b)** **(c)**

(d) **(e)**

Figure 3: Expanders of the study (a) Conventional hyrax (b) Hybrid hyrax (c) MSE (d)Hyrax screw (e) MSE keys and miniscrews.

The following CBCT measurements were selected:
-**Nasal floor molar**: measured at the most inferior level of the nasal floor parallel to Frankfort horizontal plane.
-**Hard palate maxillary width 6**:distance between maxillary lateral walls at the level of the nasal floorparallel to Frankfort horizontal plane.
-**Molar distance**:the distance between the mesiobuccal cusps of the right and left molarsparallel to Frankfort horizontal plane.
-**Molar rotation**:the lines passing through mesiobuccal cusp and distopalatal cusp tip of the right and left molars with the mid palatal plane.
-**Molar inclination**:the lines passing through mesiobuccal cusp and palatal root apex of the right and left molars with the mid sagittal plane.

-The thickness of the buccal bone of the right and left M1 was measured linearly in the coronal view at three different levels: 3 mm, 6 mm, and 9 mm apical to the CEJ buccally. **(Figure 4).**
-**BT3**= Bone thickness at 3mm apical to CEJ.
-**BT6**= Bone thickness at 6mm apical to CEJ.
-**BT9**= Bone thickness at 9mm apical to CEJ.
-**MBHR**= Right marginal bone height: vertical distance from most protruded point above buccal bone crestto mesiobuccal cusp of right M1.
-**MBHL**= Left marginal bone height: vertical distance from the most protruded point above buccal bone crestto mesiobuccal cusp of left M1.
-**BHR**= Right bone height:vertical distance from buccal bone crest to mesiobuccal cusp of right M1.
-**BHL**= Left bone height: vertical distance from buccal bone crest to mesiobuccal cusp of left M1.

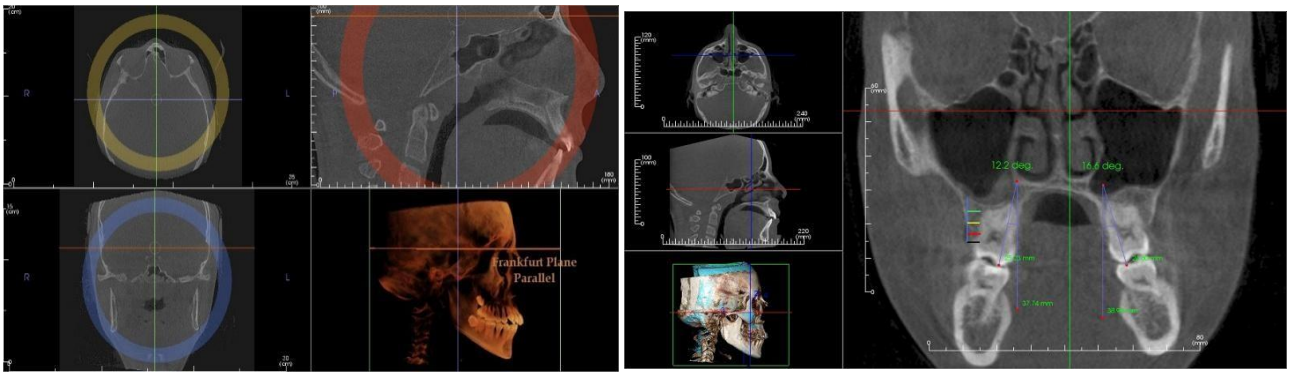


Figure 4: CBCT measurements of BBT and M1 inclination.

RESULTS
The sample consisted of 54 healthy (17 girls and 37 boys) 11- 16-year-old patientsFinally, 46 healthy (17 girls and 29 boys) 11. 7 -15 .8-year-old patients were analyzed after dropout 6 andexclusion of 2patients(8 boys).Group A conventional hyrax appliance (CH) (5 girls and 13 boys) became5**)** girls and 10 boys) group B

hybrid hyrax with two anterior palatal miniscrews (HH) (6 girls and 12 boys)became (6 girls and 9boys) and group C MSE (6 girls and 12 boys) became (6 girls and 10 boys).
In a three-week period, 21 cases (seven from each group) underwent inter- and intra-examiner reliability tests. Individual examiners varied from significant (k = 0.62) to less than chance (k =0.2) and the mean intra-examiner agreement was marginally greater than the mean inter-examiner agreement, although it was still only fair (k =0.3).

Statistical analysis
The Statistical Package for Social Sciences (SPSS) version 20 was used.The normality checking using Shapiro-Wilk tests. Comparisons of normally distributed numerical variables among groups were conducted using ANOVA, then post hoc test (Bonferroni) when the difference was foundand significant. Paired t test to compare the change within the group. P-values ≤0.05 were considered significant.

I- Demographic data
Age: Patients' age ranged from 11.7 to 15.8 years. The difference in age among groupswas found non significant (p=0.19), **(Table 1, Figure 5)**
Cross bite: In Butterfly hyrax, 73.3% of cases were bilateral, in comparison to 53.3% and 56.3% bilateral cases in Hybrid hyrax and MSE respectively; No significant difference among groups was found (p=0.477), **(Table 2, Figure 6)**
Malocclusion: In Butterfly hyrax and Hybrid hyrax, 73.3% of cases were class 3, in comparison to 75% class 3 cases in MSE; No significant difference among groups was found (p=0.993), **(Table 3, Figure 7)**

Table 1: Age comparison among groups (ANOVA test)

	Mean	Std. Dev.	Min	Max	P value
Butterfly hyrax	14.50	1.04	11.70	15.80	0.190 ns
Hybrid hyrax	13.96	1.21	11.70	15.40	
MSE	13.81	.98	12.10	15.10	

p≤0.05 was significant, ns=non-significant

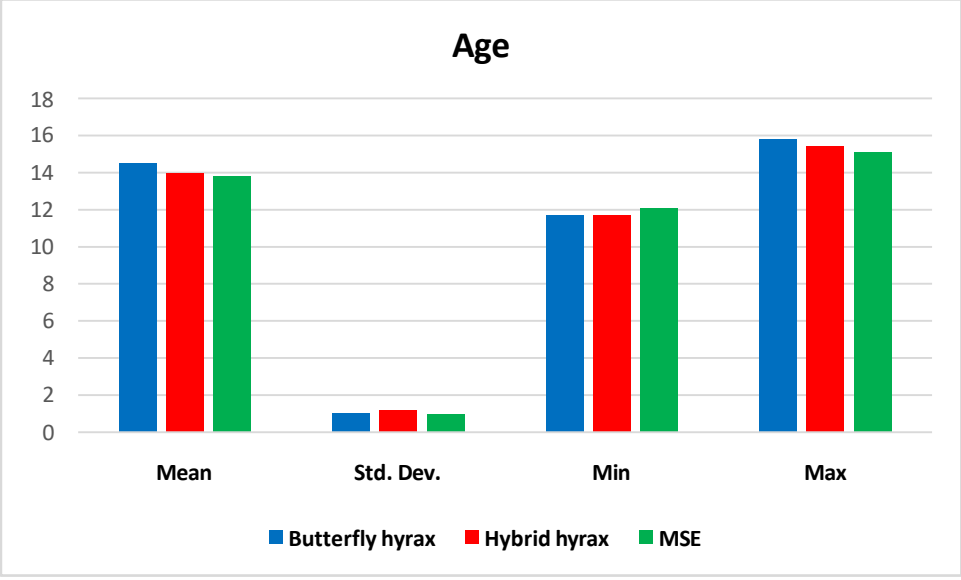


Figure 5: Bar chart illustrates mean age in different groups.

Table 2: Distribution of cases according to cross bite and comparison between age between groups (Chi square test)

CROSS_BITE		Groups			P value
		Butterfly hyrax	Hybrid hyrax	MSE	
	Unilateral	4 (26.7%)	7 (46.7%)	7 (43.8%)	0.477 ns
	Bilateral	11 (73.3%)	8 (53.3%)	9 (56.3%)	
Total		15	15	16	

p≤0.05 was significant, ns=non-significant

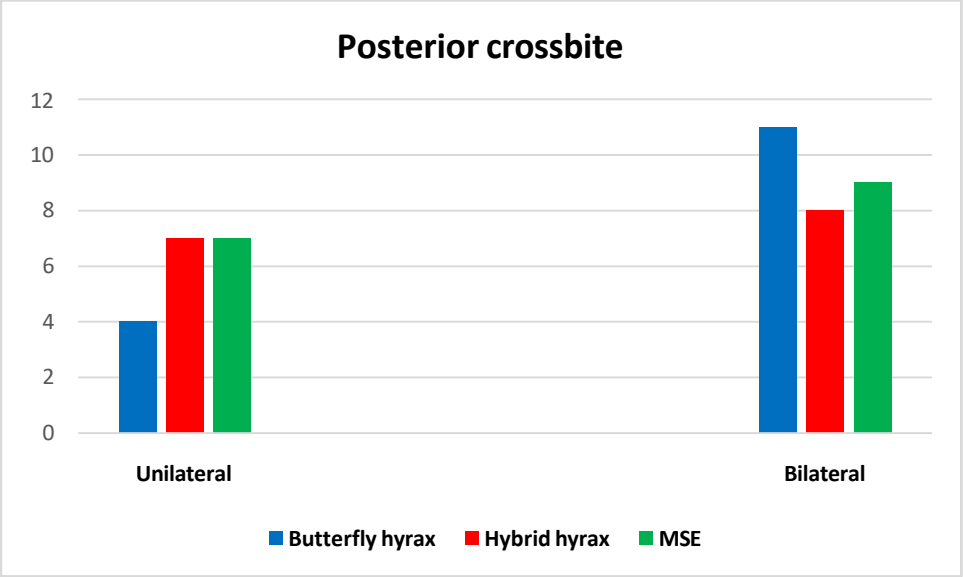


Figure 6: Bar chart illustrates distribution of unilateral and bilateral cases in different groups.

Table 3: Distribution of cases according to cross bite and comparison between age between groups (Chi square test)

MALOCCLUSION		Groups			P value
		Butterfly hyrax	Hybrid hyrax	MSE	
	Class 1	4 (26.7%)	4 (26.7%)	4 (25%)	0.993 ns
	Class 3	11 (73.3%)	11 (73.3%)	12 (75%)	
Total		15	15	16	

p≤0.05 was significant, ns=non-significant

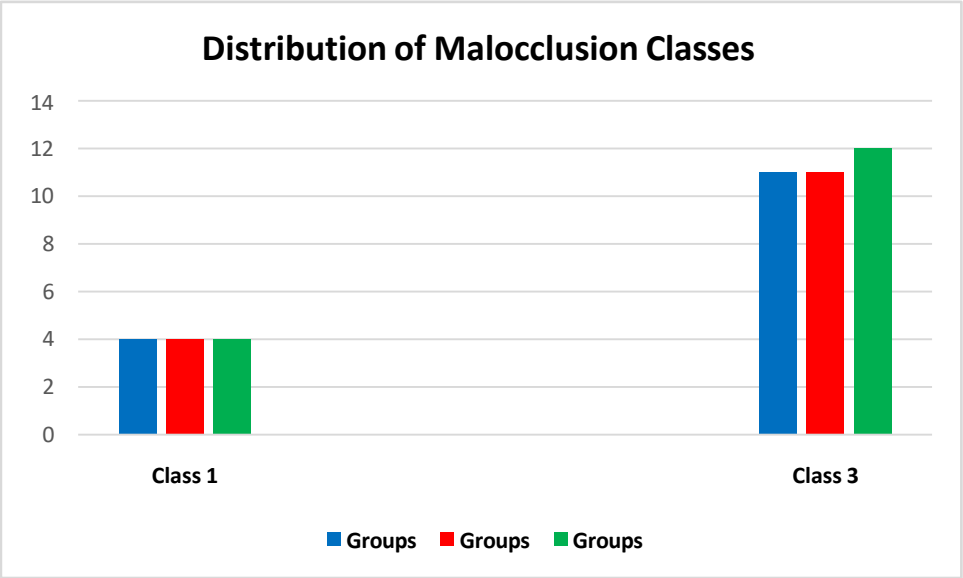


Figure 7: Bar chart illustrates distribution of malocclusion classes in different groups.

II- Outcomes

I- Comparison between the three groups

- **Molar distance:**The difference in pre values among groups was found non-significant(p= 0.094). Regarding post treatment, Hybrid hyrax mean value (52.21±2.59) was significantly higher than that recorded in Butterfly hyrax (49.43±2.41) (p= .016). Moreover, significant difference among groups was found regarding the amount of change (difference) by treatment (p=0.000), the MSE has highest value (8.88±1.58), followed by Hybrid hyrax (7.24±1.77) and the lowest value recorded in Butterfly hyrax (5.88 ± 1.39), **(Table4, Figure 8).**

- **Molar rotation:**The difference in pre and post values among groups was found non-significant(p= 0.175; p=0.207 respectively in right side and p=0.06; p=0.07 in left side). No significant difference among groups was found regarding the amount of change (difference) by treatment (p=0.503 in right side and p=0.757 in left side), **(Table4, Figure 8).**
- **Nasal floor molar:**No significant difference among groups was found in pre values (p= 0.058) and post value (p=0.397).Significant difference among groups was found regarding the amount of change (difference) by treatment (p=0.000), MSE has the highest result (4.38±0.85), followed by Hybrid hyrax (2.6±1.04) and the lowest value recorded in Butterfly hyrax (2.2± 1.49), **(Table5, Figure 9).**
- **Hard palate maxillary width 6:**No significant difference among groups was found in pre values (p= 0.083). The post treatment value, in MSE (64.31±1.8) was not significantly different from butterfly Hyrax (63.59±2.15), but was significantly higher than that recorded in Hybrid hyrax (62.04±2.68), (p= .023). The mean value of amount of change (difference) recorded in MSE (5.91±0.92) was significantly higher than that recorded in Butterfly hydrax (3.37±0.96) and Hybrid hyrax (3.17±1.54), (p= .000). **(Table5, Figure 9).**
- **Molar inclination:** There was no significant difference between groups, regarding pre and post values (p= 0.353; p=0.734 respectively in right side and p=0.312; p=0.892 in left side). The mean value of amount of change (difference) recorded in MSE was significantly higher than that recorded in Butterfly hydrax and Hybrid hyrax, (p= .000 in right side and p=0.003 in left side). **(Table5, Figure 9).**
- **Gingival and plaque index:**No significant difference among groups was found, regarding pre and post values (p= 0.00; p=0.734 respectively in right side and p=0.312; p=0.892 in left side). The mean value of amount of change (difference) recorded in MSE (**0.9±0.3 &0.8±0.23)** was significantly lesser than that recorded in Butterfly hydrax and Hybrid hyrax, (p= .000 in right side and p=0.003 in left side). **(Table 6, Figure 10 & 11).**
- **Buccal bone thickness and height:**No significant difference among groups was found,, regarding pre and post values (p= 0.353; p=0.734 respectively in right side and p=0.312; p=0.892 in left side). The mean value of amount of change (difference) recorded in MSE was significantly lesser than that recorded in Butterfly hydrax and Hybrid hyrax, (p= .000 in right side and p=0.003 in left side). **(Table 7, Figure 12).**

Table 4: Descriptive statistics and comparison between (ANOVA test) and within group (i.e. between pre and post value) (paired t test) regarding molar distance and rotation right & left

	GROUP	Pre		Post		Amount of change (post-pre)			P Within group
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Median	
Molar distance	Butterfly hyrax	43.55	1.97	49.43[b]	2.41	5.88[c]	1.39	5.77	.000*
	Hybrid hyrax	44.79	4.27	52.21[a]	2.59	7.42[b]	1.77	7.50	.000*
	MSE	42.14	3.25	51.01[ab]	2.56	8.88[a]	1.58	8.95	.000*
	P value bet. groups	.094ns		.016*		.000*			
Molar rotation right	Butterfly hyrax	58.32	4.68	59.57	4.74	1.25	.67	1.10	.000*
	Hybrid hyrax	61.50	4.54	62.54	4.42	1.04	.58	1.10	.000*
	MSE	61.95	7.38	62.99	7.26	1.04	.65	0.90	.000*
	P value bet. groups	.175ns		.207 ns		.503 ns			
Molar rotation left	Butterfly hyrax	59.75	5.31	61.17	5.27	1.42	.51	1.50	.000*
	Hybrid hyrax	64.31	5.57	65.55	5.46	1.25	.82	1.10	.000*
	MSE	60.43	5.65	61.90	5.54	1.48	1.06	1.20	.000*
	P value bet. groups	.060 ns		.070 ns		.757 ns			

p≤0.05 was significant, ns=non-significant

Post hoc test: Means with the same superscript letter do not differ significantly within the same comparison.

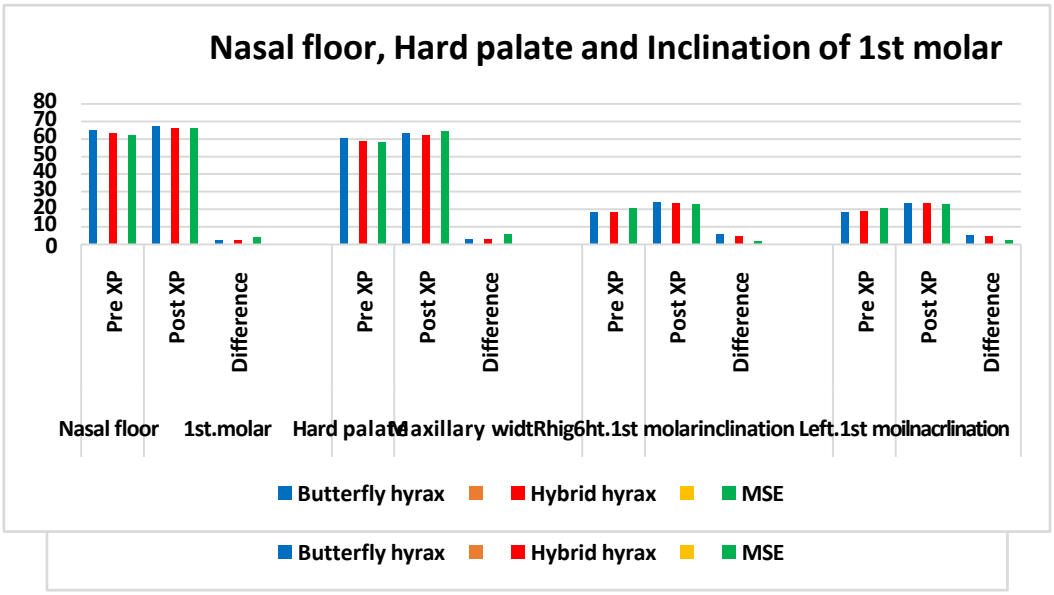


Figure 8: Bar chart illustrates mean value of molar distances and rotation in different groups

Table 5: Descriptive statistics and comparison between (ANOVA test) and within group (i.e. between pre and post value) (paired t test) regarding nasal floor, hard palate width of maxillary first molar; and inclination right & left

	GROUP	Pre		Post		Amount of change (post-pre)			P Within group
		Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Median	
Nasal floor 1st.molar	Butterfly hyrax	65.13	5.07	67.33	1.67	2.20 [b]	1.49	1.80	.003*
	Hybrid hyrax	63.48	3.13	66.08	2.80	2.60[b]	1.04	2.40	.000*
	MSE	62.00	3.36	66.38	3.07	4.38[a]	.85	4.45	.000*
	P value bet. groups	.058ns		.397ns		.000*			
Hard palate Maxillary width 6	Butterfly hyrax	60.43	2.49	63.59[ab]	2.15	3.17 [b]	1.54	3.10	.000*
	Hybrid hyrax	58.67	2.99	62.04[b]	2.68	3.37[b]	.96	3.40	.000*
	MSE	58.39	2.44	64.31[a]	1.80	5.91[a]	.92	6.10	.000*
	P value bet. groups	.083ns		.023*		.000*			
Right.1st molar inclination	Butterfly hyrax	18.58	4.41	24.24	5.32	5.66[a]	1.52	5.80	.000*
	Hybrid hyrax	18.43	5.33	23.27	5.20	4.85 [a]	2.10	6.00	.000*
	MSE	20.74	5.06	22.82	4.77	2.08[b]	1.30	1.70	.000*
	P value bet. groups	.353ns		.734ns		.000*			
Left.1st molar inclination	Butterfly hyrax	18.45	4.34	23.67	6.07	5.21[a]	2.74	6.30	.000*
	Hybrid hyrax	19.09	3.08	23.71	3.68	4.62[a]	1.62	4.90	.000*
	MSE	20.49	3.78	23.01	3.53	2.52[b]	1.31	2.35	.000*
	P value bet. groups	.312ns		.892ns		.003*			

p≤0.05 was significant, ns=non-significant,Post hoc test: Means with the same superscript letter do not differ significantly within the same comparison

Figure 9: Bar chart illustrates mean value of Nasal floor, Hard palate and molar inclination in different groups

Table 6: Descriptive statistics and comparison between (ANOVA test) and within group (i.e. between pre, during and post value) (paired t test) regarding gingival and plaque index score measurements among the three groups.

Variables		Right			Left			Statistics			
		Pre	During	Post	Pre	During	Post	F-value			
								Side	Pre	During	Post
CH	M1	0±0	0.33±0.1	1.125±0.1	0±0	0.375±0.2	1.2±0.22	RT	1 ns	0.055 ns	0.252 ns
HH	M1	0±0	0.3±0.1	1.25±0.2	0±0	0.2±0.1	1.075±0.1	RT	1 ns	0.999 ns	0.052 ns
MSE	M1	0±0	0.35±0.1	0.9±0.3	0±0	0.375±0.2	0.8±0.23	RT	0.12 ns	0.589 ns	0.130 ns
Statistics F- value	M1	1 ns	0.69 ns	0.617 ns	1 ns	0.1694 ns	0.229 ns				

p≤0.05 was significant, ns=non-significant

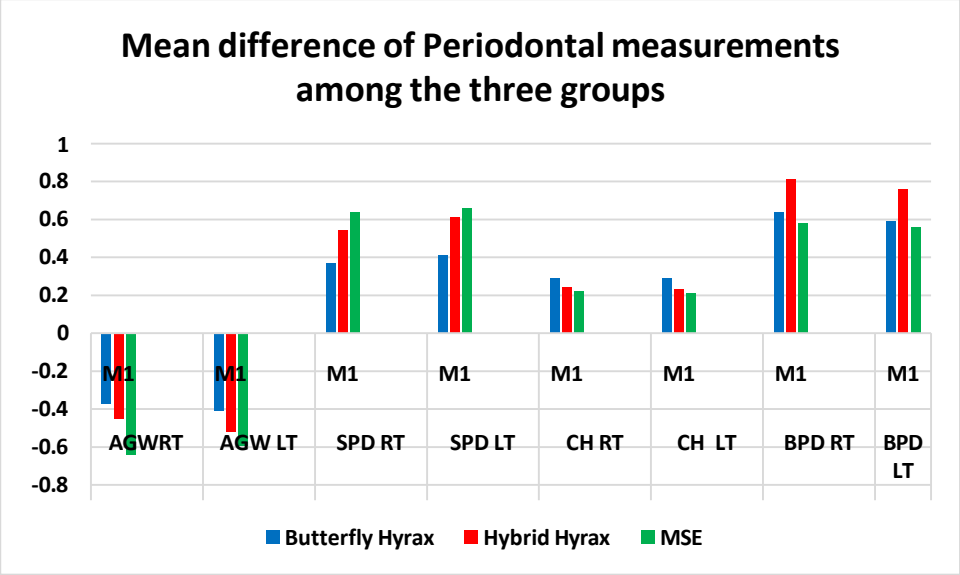


Figure 10: Comparison of the mean difference in periodontal measurements among the three groups

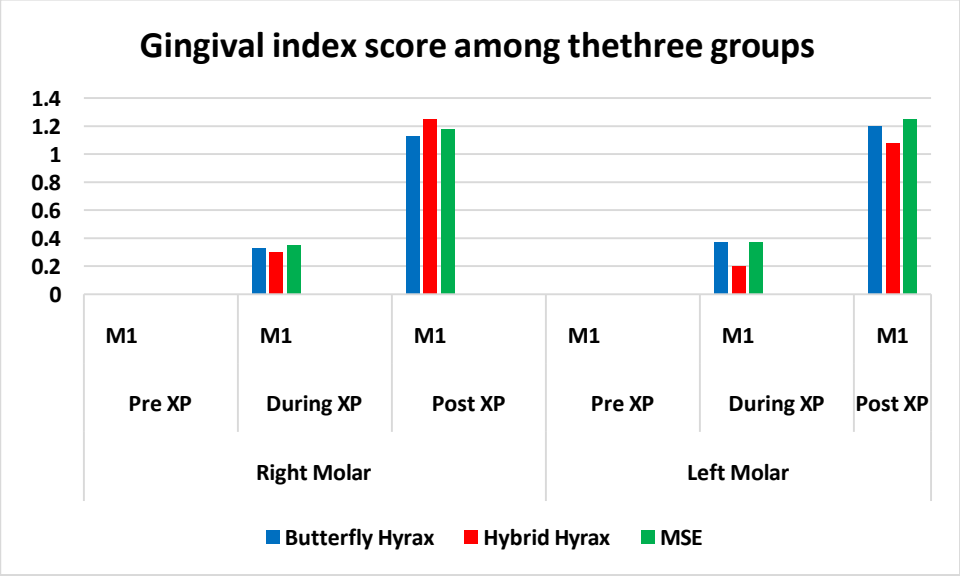


Figure 11: Comparison of the mean difference in gingival index score measurements among the three groups

Table 7: Descriptive statistics and comparison between (ANOVA test) and within group (i.e. between pre and post value) (paired t test) regarding Bone thickness and height measurements among the three groups.

Variable		CH	SD	HH	SD	MSE	SD	DF	F	Sig
BT 3 R	M1	-0.94	.21	-1.05	.03	-1.3	.25	42	2.23	.076 ns
BT 3 L	M1	-1.0	.24	-1.03	.07	-1.2	.26	42	2.31	.286 ns
BT 6 R	M1	-0.89	.19	-0.83	.20	-1	.31	42	.423	.235 ns
BT 6 L	M1	-0.75	.01	-0.85	.15	-1.01	.39	42	1.368	.252 ns
BT 9 R	M1	.122	.01	-0.15	.05	-0.21	.04	42	2.43	.353 ns
BT 9 L	M1	.124	.02	.122	.07	-0.22	.02	42	1.573	.242 ns
MBH R	M1	-0.653	.03	-0.83	.26	-0.9	.23	42	2.371	.260 ns
MBH L	M1	-0.72	.09	-0.81	.12	-0.94	.18	42	.578	.361 ns
BH R	M1	0.25	.02	0.35	.05	0.15	.04	42	.401	.427 ns
BH L	M1	0.28	.05	0.32	.02	0.19	.08	42	.675	.319 ns

p≤0.05 was significant, ns=non-significant
BT3= Bone thickness at 3mm
BT6= Bone thickness at 6mm
BT9= Bone thickness at 9mm
MBHR= Right marginal bone height
MBHL= Left marginal bone height
BHR= Right bone height
BHL= Left bone height
M1= maxillary first molar

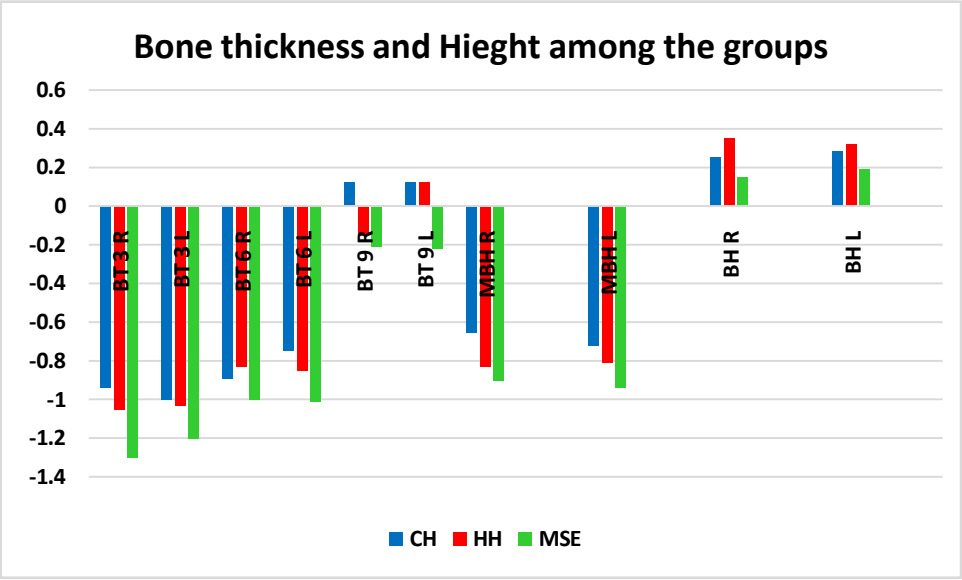


Figure 12: Bone thickness and height measurements among the three groups.

DISCUSSION

It was not possible to blind the patients or the practitioners to the procedures due to the nature of the clinical work, but the groups to which the patients were assigned were hidden from the outcome assessors.[38]

Because the activation period lasted 16 days as standardiation and decrease the bias,[10,35]this period is a non-significant in the facial growth curve, and because all of the patients were expected to pass the peak of maxillary growth, it was not possible to have a group mimic skeletal pattern to the treated sample act as control due to ethical concerns. [39]

In the current investigation, CBCTs were employed to measure the linear variables. Numerous studies[40–42] have shown that precise linear and angular dento-skeletal measurements can be obtained using CBCT images. A little systematic mistake was discovered in study,[40] but it wasn't until multiple data were combined that it became statistically significant.

The large field of view, which increased sensitivity to scatter noise and consequently reduced spatial resolution, was one of the image quality limitations. However, full skull exposure was required to enable proper skull orientation and to correlate the measurements to more standardised reference planes, such as FH and MSP.[43,44] This result was consistent with earlier researches that used CBCT as an assessment tool.[6,42,45–47]

Since the mesiobuccal root is typically more noticeable and has more changes when compared to the distobuccal root, it was assessed.[6,9] Additionally, because the maxillary first and second premolars consistently were not banded, it was excluded from the analysis.

In order to stabilise the skeletal expansion, prevent metallic artefacts during CBCT exposure at T2,[48] and give a chance for bone deposition at the midpalatal suture, extensive orthodontic treatment had to be temporarily delayed until an adequate retention period, six months after active maxillary expansion was completed.[35]

Furthermore, the emergence of the midline diastema was not unexpected. Since several factors can affect the degree of diastema, including the perioral musculature, frenum attachment, tongue position, and transeptal fibre strength,hence the width of the diastema was not assessed because it was most likely not a valid indicator of sutural expansion.[49,50]

All groups had identical plaque and gingival indices at baseline (T1) (score zero); however, despite strict adherence to oral hygiene, alterations throughout time occurred. Plaque management was done at each appointment, and as treatment progressed, the index value increased until it reached the acceptable limit. Gingival biotype and individual anatomic variation may have had an impact on periodontal health. Therefore, before beginning orthodontic treatment, a comprehensive evaluation of the degree of attached gingiva and periodontal health is advised, this was advocated by previous study of Pinto et al.[51]

Stressing the need of maintaining proper dental hygiene is also crucial for the greatest possible treatment outcome. Before beginning orthodontic treatment, oral hygiene guidelines should be given, and they should be reiterated at each maintenance appointment. This was consistent with previous studies.[52–55]

Gingival score (T1-T2-T3) for the right first molar revealedno significant difference among groups, as indicated by ANOVA test where(Fvalues=1>0.05) pre-treatment, (F values= 0.6863>0.05) during treatment andF values= 0.6171>0.05) post- treatment, while for the left first molar thedifference between groups in M1 was statistically non-significant as indicatedby ANOVA test where (F values=1>0.05) pre-treatment, (F values=0.1694>0.05) during treatment and F values= 0.229>0.05) post- treatment, this was concomitant with previous reports.[56–58]

The average rise in TI at the M1 both right and left side across the groups was noted in the current study; with no difference suggesting a symmetrical effect of expansion, which was consistent with other research.[6,59,60] and was at odds with earlier researches.[46,47] Since the molars in Akin et al [46] which employed a different device with a different activation technique in patients with actual unilateral posterior crossbite, had more tipping (7.3) degree on the affected side than on the unaffected side (2.5)degree.[46]

The teeth inclination was significant in hyrax group 1 CH, it might berelated to the significant force that was produced and abruptly applied to the first molar crowns in CH while in HH and MSE it was less due to the anchorage added by the miniscrews that can add skeletal effect to the palatal bone and suture this was in agreement with previous studies[9,35,61–64]

It would be predicted for buccal bone apposition as teeth return to their initial positions.[6,65]

The marginal bone height,bone hieght and buccal bone thikcness of M1 have been demonstrated to be correlated with rapid maxillary expansion operations, since unequal changes on the buccal bone may indicate that the identical alterations, which are indicated by differences in the clear feedback reaction to heavy stresses on the buccal side, are not the same, this was in agreement with previous studies.[6,46,47,60]

The buccal physical tooth movement with minimal tipping was recommended Although there may be some restrictions, such movements can result in buccal bone apposition this was in accordance with previous study.[66]

Even with the injection of platelet-rich plasma (PRP),[12] the buccal bone of M1 was noticeably affected by both maxillary expansion protocols, resulting in vertical and horizontal bone loss. PRP, which is often used to enhance healing and regeneration, did not appear to mitigate the adverse effects on the alveolar bone associated with these expansion techniques. This highlights the complexity of bone response to dental procedures and the need for careful consideration of treatment protocols to minimize potential bone loss this must be put in consideration or it might be different when using MSE.[45,67]

In the current study the MSE tends to exert less force on the surrounding gingival and periodontal tissues compared to Conventional expanders, thus potentially reducing the risk of periodontal complications and also their superior ability to induce skeletal expansion and promote alveolar stability, as supported by previous findings on the skeletal effects of these devices.[63,64,67,68]

CONCLUSIONS

Instead of the kind of expansion appliance, the plaque index rose, and reduction of buccal bone thickness existed; however, the MARPE, particularly the MSE, may exhibit less buccal bone resorption than conventional hyrax.

Since palatal expansion always results in a short-term increase in transverse dimension, it is a successful technique for treating dental posterior crossbite.

LIMITATIONS

Assesment of gender differences, hormonal effect and absence of a passive group as a control for moral and medical-legal concern.

Using three dimension printed expansion appliance instead of bands might promote beter gingival hygiene.

Genotype and phenotype of gingival tissue should be considered.

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