AJDS ALAZHAR
Al-Azhar Journal of Dental Science
Vol. 24- No. 4- 443:455- October 2021
Print ISSN 1110-6751 | online ISSN 2682 - 3314
https://ajdsm.journals.ekb.eg
Orthodontic & Pediatric Dentistry Issue *(Orthodontics and Pediatric Dentistry)*

INTERACTION BETWEEN SUBSPINALE AND TWO EXPANSION PROTOCOLS IN CLASS III

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ABSTRACT

Objectives: To assess and compare skeletal,dental and soft tissue changes of three RME protocols using conventional Hyrax, Hybrid Hyrax, and four miniscrew supported Hyrax using alternated expansion and constriction. **Subjects and Methods:** 21 patients enrolled in this study with Class III maxillary deficiency, with an average age of 10.5±6 months, and allocated into three groups of seven patients each. Maxillary expansion was done with conventional Hyrax in Group I. Group II: RME with Hybrid Hyrax. Group III: skeletal four-point supported custom-made Hyrax with four palatal micro-implants and alternating rapid maxillary expansion and contraction. A cephalometric tracing of standardized cephalometric x-ray was performed for each patient before and after expansion for various linear and angular measurements and statistically analyzed. **Results:** SNA angle increased significantly ($p \leq 0.05$) from pretreatment to post-expansion stage in all groups. There was a statistically significant difference between Groups II and III. When the three Groups were compared, a considerable forward movement of point A was detected in both Group I and Group II. The forward movement of point A, the angle of facial convexity and upper lip prominence improved considerably in GII. **Conclusion:** Hybrid Hyrax (Group II) showed a significant improvement in forward position of point A concomitant with a significant sagittal skeletal, dental and soft tissue profile improvement.

KEY WORDS: Hyrax, palatal micro-implant, rapid maxillary expansion, alternating palatal expansion and contraction

INTRODUCTION

Class III malocclusion is multi-factorial, with definite skeletal and dental components including maxillary deficiency, mandibular prognathism, proclined maxillary teeth, and retroclined mandibular teeth [(1,2)], hereditary, ethnic, environmental, habitual, and pathological [(3,4)]. The prevalence of Angle Class III malocclusions varies greatly among and within populations, Middle Eastern nations had a mean prevalence rate of 10.2%. White children, approximately 57% of the patients with either a normal or a prognathic mandible showed a deficiency in the maxilla while Sue et al,reported that; maxillary retrognathism is present in 62% to 67% of all white American class III patients [(5-7)].

In the usual association with transverse maxillary deficiency, that indicates a combined face mask and rapid maxillary expansion (RME) [(8,9)] which disarticulates the circum-maxillary sutures that enhance forward positioning of point A (subspinale) [(10-12)]. Liou and Tsai in 2005[(13)] introduced alternated rapid maxillary expansions and constrictions (Alt-RAMEC) at a rate of 0.5 mm per day for a period up to 9 weeks, which conceded enhancement of the disarticulation effect of the sercum-maxillary sutures [(14-16)].

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DOI: *10.21608/ajdsm.2021.92139.1229*

Tipping of anchor teeth, camouflage skeletal improvement, root resorption and relaps are considered drawbacks of tooth-supported appliances [17-21]. To overcome this problem and maximize the skeletal effect, a hybrid expander (both teeth and bone anchored) was used [22, 23]. A more forward step is the use of pure skeletal anchored expansion appliances such as the (MARPE) appliance [24].

Few data was found regarding alternative expansion and contraction using skeletal supported rapid maxillary expansion appliances and their effect on the position of the Subspinale point. Hence, the present study was planned to evaluate the effect of different rapid maxillary expansion protocols on the position of point A in the course of treatment of class III.

SUBJECTS AND METHODS

A randomized controlled clinical trial was conducted in the Clinical Orthodontic Department, Faculty of Dentistry, Tanta University, Egypt. After getting approval from the ethical committee based on the patient's written acceptance consent. After calculation of the sample size for a study 90% power and 5% level of significance. It was found that a minimum of 7 patients must be under taken for each group. A total of 21 patients (13 males and 8 females) were divided into three groups, with 7 patient for each group. 10 patients or more were taken for each group at the start of treatment to account for attrition.

Inclusion and exclusion criteria:

All patients suffering from skeletal Class III malocclusion due to maxillary deficiency with mean pretreatment age of all patients is 10.5±6 months. Absence of any congenital, hereditary, pathological and traumatic problems, and absence of any previous orthodontic interceptive treatment. No history of any bone diseases or concomitant use of any drugs.

For each patient, an extra and intra-oral photographs and a standardized lateral cephalometric x ray was taken just before insertion of the appliance and after the end of expansion. Two cephalometric x rays were taken for each patient at the start of treatment and at the end of the stage of the expansion. They were then traced twice by two different operators and the average value of the following linear and angular parameters were taken:

Angular and Linear cephalometric measurements

- **Angular measurements (°):** 1) SNA, 2) U1/NA, 3) U1/FH, 4) U1/SN, 5) U1/MP, 6) SN/OP, 7) FH/OP, 8) Lower facial height angle (Xi-ANS/Xi-Pog), 9) H-angle, 10) Nasolabial angle, 11) Nasofacial angle, 12) Merrifield's Z-angle, 13) Soft tissue profile angle, 14) Angle of facial convexity(Figure 1A)

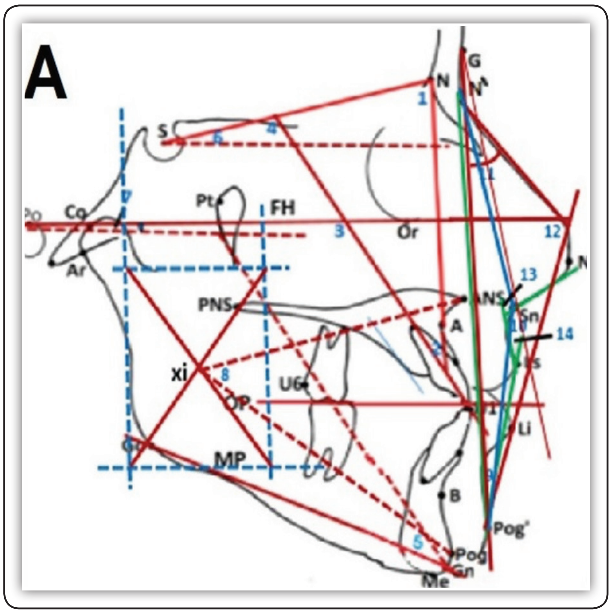

FIG (1A) ANGULAR CEPHALOMETRIC MEASURMENTS

- **Linear measurements (mm):** 1) U1-NA, 2) U1 protrusion, 3) Maxillary protrusion, 4) U6-PTV, 5) Wits appraisal, 6) Convexity at point A, 7) Maxillary length, 8) Nose tip-H line, 9) Upper sulcus depth, 10) Ls-E line, 11) Upper lip prominence, 12) Upper lip thickness/strain ratio, 13) Maxillary prognathism (Figure 1B)

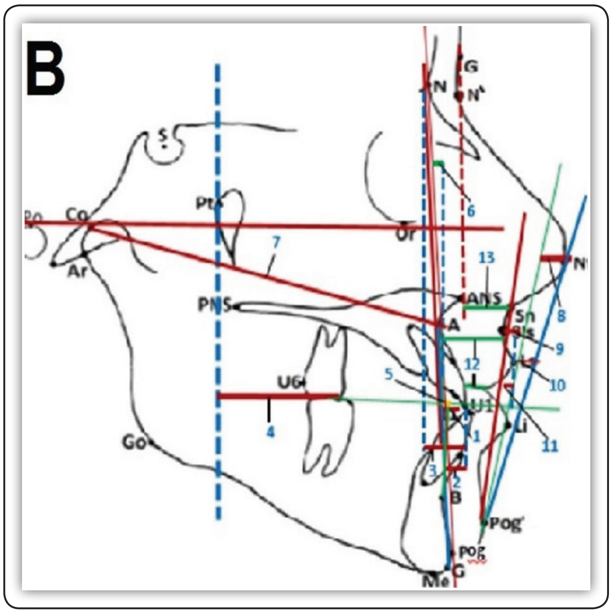

FIG (1B) LINEAR CEPHALOMETRIC MEASURMENTS

GROUP I: conventional Hyrax expander*group: which is activated twice daily equal to 0.5 mm. (fig 2A)

GROUP (II): Hybrid Hyrax (skeletal and tooth anchored): 7 patients were treated with Hybrid Hyrax, which was supported anteriorly opposite the first premolar by two micro implants and supported posteriorly by two molar bands on the first permanent molars. The patient was instructed to activate the screw in a similar manner to group I (fig: 3A, 3AA)

GROUP (III): 4 Micro implant supported Hyrax. Two anteriors and two posteriors were used and the activation was carried out according to Liou and Tsai [13], in the form of alternating expansion and constriction**. Fig: (4A). The parents were instructed to open and close the Hyrax screw alternately by 1 mm/day (two turns in the morning and two turns in the evening) for 7 successive weeks.

The micro implants were inserted into the custom made eyelets of the Hyrax 3 mm away from the mid-palatal suture in the contact between the canine and the first premolar anteriorly and the first and second permanent molar posteriorly[25].

In all groups, the patients were advised to regular brushing and avoid any analgesic drugs, and visit the clinic on the basis of 2 visits per week for close follow up with daily use of a mouthwash (chlorhexidine mouth wash), cleaning the mini-screws (3M orthodontic micro-implant) 2mm diameter and 11 mm length with a soft brush and the use of non-steroidal anti-inflammatory analgesics for only one day following screw insertion. Clinical assessment of the stability of the appliance, palatal screws, soft tissue health around the screws, oral hygiene evaluation,

For group II and III where micro-implants were included activation by expansion or alternative expansion and contraction in both groups respectively were done immediately after insertion of the appliance the orthodontic micro-screws depends on primary stability which gained from bone grip

After completing the RME and Alt-RAMEC procedures, orthodontic treatment continued according to the predetermined treatment plan. Lateral cephalometric radiographs were used to assess the treatment outcomes of RME and alternated expansion and constriction.

Statistical analysis

Quantitative data was expressed as mean ± SD (t. test), by SPSS V (20)***. ANOVA TEST and independent-samples T test of significance was used when comparing between two means and one-way analysis of variance (ANOVA) was used when comparing between more than two means were done with $p \leq 0.05$ is considered statistically significant where $p \leq 0.001$ is considered statistically highly significant.

* Leone A2620 rapid expander (Leone orthodontic products, Sesto Fiorentino, Firenze Italy

** Custom made four microimplant supported Hyrex (3M™ Unitek™ TAD 3M Oral Care 2510 Conway Avenue St. Paul, MN 55144-1000 USA)

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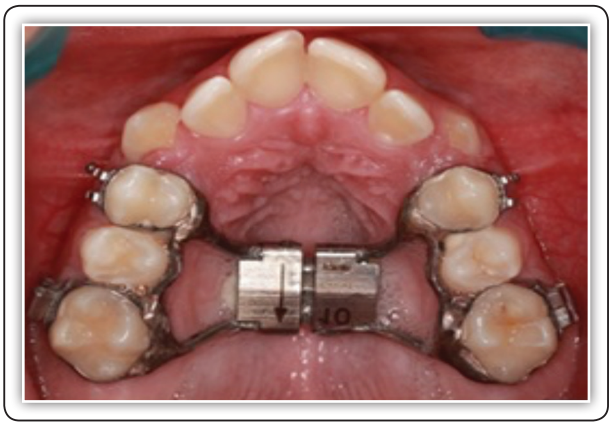

FIG (2A) Pre-treatment by conventional Hyrax expander

FIG (2B) Post-treatment by conventional Hyrax expander

FIG (2BB) Pre and post-treatment extra-oral case

FIG (3A) Pre-treatment by Hybrid Hyrax

FIG (3B) Post-treatment by Hybrid Hyrax

FIG (3AA) Pre-treatment cepalometric x-ray

FIG (3BB) Post-treatment cepalometric x-ray (Group II)

FIG (4A) Pre-treatment with 4 micro-implant supported custom made Hyrax

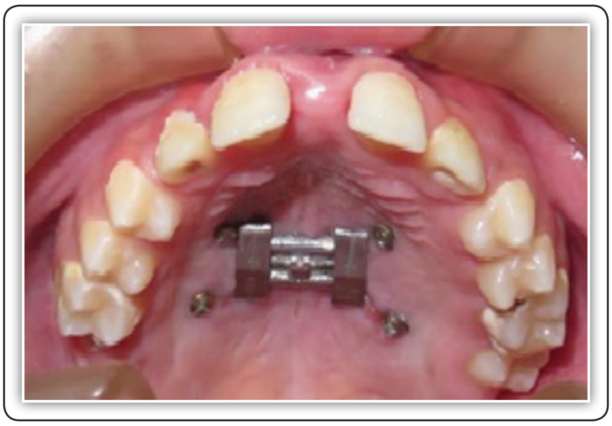

FIG (4B) Post-treatment with 4 micro-implant supported custom made Hyrax

RESULTS

Changes in measurements of SNA, H-angle, U1/NA, Z-angle and soft tissue profile angle were significantly different within all groups between the pretreatment and post expansion stages. The angle of facial convexity and lower facial height angle increased significantly in group II and group III respectively. Also, significant upper incisor protrusion was found according to SN, FH and mandibular planes only in groups II and III. Whereas changes in measurements of SN/OP, FH/OP, nasolabial and nasofacial angles were insignificant within all groups (Table 1 and 2) (Fig 2B, 2BB, 3B,3BB,4B 5-7).

TABLE (1): Changes and comparison of the cephalometric angular measurements after expansion.

Angular measurements (degree)º		GI Conventional Hyrax expander	GII Hybrid MARPE	GIII Hybrid MA-Alt-RAMEC	Comparison between groups	
SNA	**Pre**	77.15 ± 1.35	79.86 ± 1.23	79.77 ± 1.07	**P1**	**0.001***
	Post	78.65 ± 1.13	81.65 ± 1.41	80.95 ± 1.36	**P2**	**0.001***
	T test	**2.153**	**3.028**	**2.161**	**P3**	**0.273**
	P value	**0.022***	**0.007***	**0.045***		
H-angle	Pre	11.07 ± 1.13	11.43 ± 3.21	10.25 ± 1.64	**P1**	**0.076**
	Post	13.64 ± 1.82	15.86 ± 2.41	14.00 ± 2.43	**P2**	**0.759**
	T test	**3.174**	**2.923**	**3.379**	**P3**	**0.176**
	P value	**0.008***	**0.013***	**0.005***		
U1/NA	Pre	19.12 ± 1.07	20.00 ± 3.70	21.16 ± 2.45	**P1**	**0.466**
	Post	23.26 ± 1.38	24.21 ± 3.04	24.79 ± 2.29	**P2**	**0.156**
	T test	**6.269**	**2.332**	**2.859**	**P3**	**0.607**
	P value	**0.001***	**0.038***	**0.014***		
U1/FH	Pre	110.43 ± 1.15	107.28 ± 1.75	104.00 ± 1.44	**P1**	**0.275**
	Post	112.14 ± 1.91	111.05 ± 1.65	110.25 ± 1.45	**P2**	**0.059**
	T test	**2.028**	**4.149**	**8.089**	**P3**	**0.354**
	P value	**0.065**	**0.001***	**0.001***		
U1/SN	Pre	100.23 ± 2.87	97.14 ± 2.40	94.57 ± 2.20	**P1**	**0.949**
	Post	102.43 ± 5.03	102.57 ± 2.64	100.29 ± 2.23	**P2**	**0.324**
	T test	**1.012**	**4.036**	**4.829**	**P3**	**0.106**
	P value	**0.335**	**0.002***	**0.041***		
U1/MP	Pre	45.22 ± 2.41	46.57 ± 2.36	44.71 ± 2.43	**P1**	**0.047***
	Post	43.81 ± 2.27	41.14 ± 2.24	39.43 ± 2.74	**P2**	**0.006***
	T test	**1.405**	**4.423**	**3.809**	**P3**	**0.225**
	P value	**0.282**	**0.001***	**0.003***		
Nasolabial angle	Pre	86.86 ± 2.08	95.29 ± 2.16	91.86 ± 2.28	**P1**	**0.004***
	Post	88.29 ± 2.83	93.00 ± 2.11	90.14 ± 2.25	**P2**	**0.201**
	T test	**1.079**	**2.007**	**1.416**	**P3**	**0.030***
	P value	**0.302**	**0.068**	**0.181**		

P≤ 0.05 (Non-significant) *p ≤ 0.05 (significant) P1: I & II, P2: I & III and P3: II & III

TABLE (2): Changes and comparison of the cephalometric angular measurements after expansion.

Angular measurements (degree)°		GI Conventional Hyrax expander	GII Hybrid MARPE	GIII Hybrid MA-Alt-RAMEC	Comparison between groups	
Nasofacial angle	Pre	140.00 ± 2.83	141.43 ± 2.43	135.86 ± 2.08	P1	0.327
	Post	140.75 ± 2.00	141.86 ± 2.06	135.00 ± 2.04	P2	0.001*
	T test	0.568	0.362	0.781	P3	0.001*
	P value	0.577	0.727	0.450		
SN/OP	Pre	20.71 ± 2.29	19.43 ± 2.76	18.43 ± 3.55	P1	0.204
	Post	20.00 ± 2.99	18.14 ± 2.12	18.00 ± 2.16	P2	0.177
	T test	0.501	0.982	0.273	P3	0.904
	P value	0.627	0.346	0.789		
FH/OP	Pre	11.57 ± 1.51	12.43 ± 2.16	11.86 ± 2.27	P1	0.455
	Post	11.13 ± 2.45	12.11 ± 2.30	11.62 ± 1.86	P2	0.680
	T test	0.402	0.268	0.219	P3	0.669
	P value	0.693	0.793	0.832		
Merrifield's Z- angle	Pre	69.71 ± 2.36	68.71 ± 2.56	69.57 ± 1.72	P1	0.277
	Post	76.15 ± 3.82	78.00 ± 1.97	74.00 ± 2.94	P2	0.261
	T test	3.792	7.608	3.436	P3	0.011*
	P value	0.003*	0.001*	0.005*		
Soft tissue profile angle	Pre	150.29 ± 1.99	154.43 ± 1.48	152.71 ± 2.05	P1	0.001*
	Post	153.00 ± 1.33	158.00 ± 1.51	154.87 ± 2.17	P2	0.032*
	T test	3.579	5.338	2.287	P3	0.003*
	P value	0.002*	0.001*	0.034*		
Angle of facial convexity	Pre	10.29 ± 1.80	9.75 ± 2.50	10.45 ± 2.64	P1	0.461
	Post	13.00 ± 4.55	14.43 ± 2.00	12.35 ± 2.69	P2	0.751
	T test	1.468	3.869	1.331	P3	0.127
	P value	0.169	0.002*	0.207		
Lower facial height angle Xi-ANS/Xi-Pog)	Pre	44.86 ± 1.08	42.43 ± 1.74	45.14 ± 1.10	P1	0.088
	Post	46.14 ± 1.93	44.29 ± 1.80	47.00 ± 1.62	P2	0.384
	T test	1.532	1.968	2.509	P3	0.012*
	P value	0.152	0.073	0.027*		

P> 0.05 (Non-significant) *p ≤ 0.05 (significant) P1: I & II, P2: I & III and P3: II & III

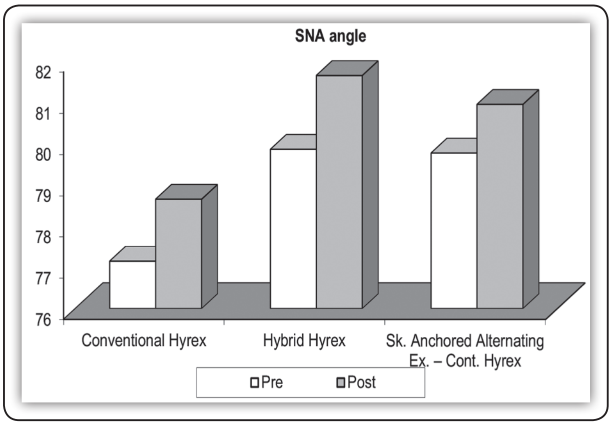

FIG (5) SNA angle mean changes

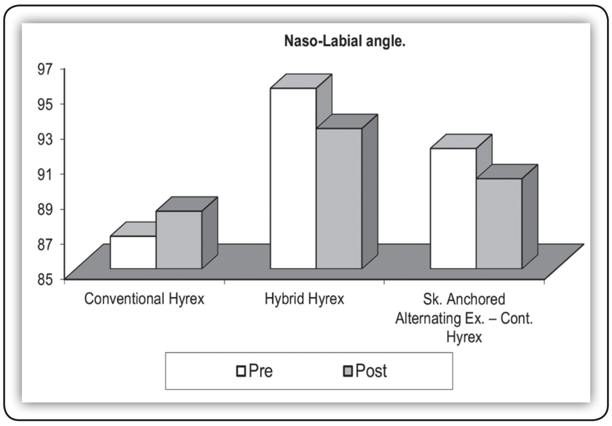

FIG (6) Nasolabial angle mean changes

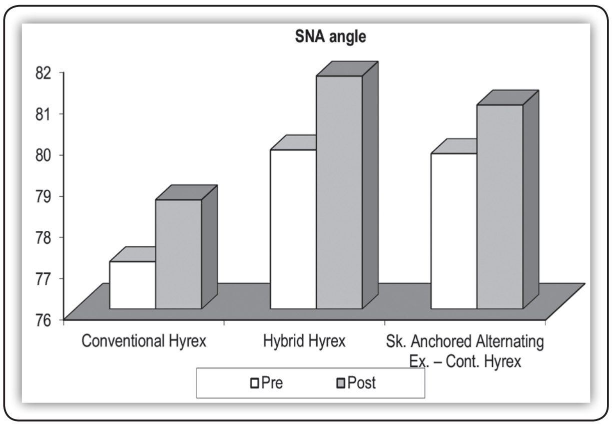

FIG (7) Nasofacial angle mean changes

Changes in measurements of Nt-H line and U1 protrusion were significantly different within all groups between the pretreatment and post expansion stages. The upper lip prominence, maxillary length, maxillary protrusion, maxillary prominence and convexity at point A changed significantly in both groups I and II, while Wits appraisal showed significant change in both groups II and III. However, the measurements of upper sulcus depth, U1-NA and U6-PTV changed insignificantly within all groups. P1, P2 and P3 among groups revealed that there were no significant differences in Nt-H line, U1/NA, U6-PTV, Wits appraisal and convexity at point A. (Table 3 and 4) (Fig8-10).

TABLE (3): Changes and comparison of the cephalometric linear measurements after expansion.

Linear measurements (mm)		**GI Conventional Hyrax expander**	**GII Hybrid MARPE**	**GIII Hybrid MA-Alt-RAMEC**	**Comparison between groups**	
Nt-H line	**Pre**	3.00 ± 0.82	3.29 ± 1.70	3.43 ± 1.62	**P1**	**0.726**
	Post	7.43 ± 2.76	7.91 ± 2.21	7.63 ± 1.72	**P2**	**0.873**
	T test	**4.068**	**4.382**	**4.701**	**P3**	**0.796**
	P value	**0.002***	**0.001***	**0.045***		
Upper sulcus depth	**Pre**	4.29 ± 1.11	4.43 ± 2.23	4.57 ± 2.07	**P1**	**0.015***
	Post	4.24 ± 1.11	4.65 ± 2.14	4.89 ± 1.95	**P2**	**0.660**
	T test	**0.082**	**0.193**	**0.302**	**P3**	**0.038***
	P value	**0.934**	**0.854**	**0.771**		
Ls-E line	**Pre**	3.86 ± 1.35	3.29 ± 1.11	4.00 ± 1.15	**P1**	**0.001***
	Post	2.73 ± 1.62	2.06 ± 1.46	2.55 ± 1.27	**P2**	**0.857**
	T test	**1.418**	**1.769**	**2.243**	**P3**	**0.001***
	P value	**0.182**	**0.101**	**0.045***		
Upper lip prominence	**Pre**	3.57 ± 0.98	3.14 ± 0.90	3.57 ± 1.51	**P1**	**0.438**
	Post	5.22 ± 1.11	5.75 ± 1.35	4.11 ± 1.07	**P2**	**0.081**
	T test	**2.951**	**4.263**	**0.769**	**P3**	**0.027***
	P value	**0.012***	**0.001***	**0.455**		
Upper lip thickness/strain ratio	**Pre**	1.20 ± 0.06	1.16 ± 0.25	1.48 ± 0.42	**P1**	**0.443**
	Post	1.03 ± 0.04	1.10 ± 0.23	1.44 ± 0.32	**P2**	**0.006***
	T test	**6.241**	**0.471**	**0.203**	**P3**	**0.042***
	P value	**0.001***	**0.649**	**0.845**		
U1-NA	**Pre**	2.57 ± 1.99	2.29 ± 1.80	3.29 ± 2.06	**P1**	**0.926**
	Post	3.72 ± 2.34	3.85 ± 2.75	3.47 ± 2.99	**P2**	**0.865**
	T test	**0.992**	**1.263**	**0.132**	**P3**	**0.809**
	P value	**0.341**	**0.233**	**0.898**		
U1 protrusion	**Pre**	3.57 ± 1.13	4.14 ± 1.68	3.29 ± 1.11	**P1**	**0.002***
	Post	5.14 ± 1.21	7.71 ± 1.80	5.29 ± 0.76	**P2**	**0.843**
	T test	**2.502**	**3.842**	**3.934**	**P3**	**0.003***
	P value	**0.028***	**0.002***	**0.002***		

P> 0.05 (Non-significant) *p ≤ 0.05 (significant) P1: I & II, P2: I & III and P3: II & III

TABLE (4): Changes and comparison of the cephalometric linear measurements after expansion.

Linear measurements (mm)		GI Conventional Hyrax expander	GII Hybrid MARPE	GIII Hybrid MA-Alt-RAMEC	Comparison between groups	
U6- PTV	**Pre**	23.43 ± 1.99	24.43 ± 1.99	24.91 ± 2.21	**P1**	**0.381**
	Post	24.29 ± 2.29	25.57 ± 2.94	25.00 ± 1.41	**P2**	**0.712**
	T test	**0.748**	**0.852**	**0.053**	**P3**	**0.781**
	P value	**0.468**	**0.412**	**0.962**		
Wits appraisal	**Pre**	-1.67 ± 0.58	-2.00 ± 3.61	-2.33 ± 0.58	**P1**	**0.766**
	Post	1.38 ± 0.58	1.95 ± 4.93	1.00 ± 2.65	**P2**	**0.717**
	T test	**9.832**	**1.712**	**3.249**	**P3**	**0.661**
	P value	**0.001***	**0.113**	**0.007***		
Maxillary length	**Pre**	85.14 ± 2.22	87.43 ± 2.37	85.43 ± 2.55	**P1**	**0.080**
	Post	88.65 ± 2.98	91.57 ± 2.73	87.14 ± 2.49	**P2**	**0.324**
	T test	**2.503**	**3.028**	**1.269**	**P3**	**0.008***
	P value	**0.028***	**0.010***	**0.228**		
Maxillary Protrusion	**Pre**	5.29 ± 1.11	5.86 ± 2.34	4.86 ± 2.61	**P1**	**0.001***
	Post	3.11 ± 1.80	9.43 ± 1.72	6.15 ± 1.95	**P2**	**0.010***
	T test	**2.729**	**3.251**	**1.049**	**P3**	**0.006***
	P value	**0.018***	**0.007***	**0.315**		
Maxillary prognathism	**Pre**	10.57 ± 0.98	9.57 ± 2.07	8.29 ± 2.21	**P1**	**0.432**
	Post	12.78 ± 1.80	13.71 ± 2.43	10.86 ± 2.41	**P2**	**0.117**
	T test	**2.851**	**3.433**	**2.081**	**P3**	**0.048***
	P value	**0.015***	**0.005***	**0.060**		
Convexity at point A	**Pre**	6.71 ± 0.98	7.65 ± 2.16	6.67 ± 2.00	**P1**	**0.855**
	Post	4.43 ± 1.50	4.23 ± 2.41	4.96 ± 3.26	**P2**	**0.703**
	T test	**3.372**	**2.802**	**1.182**	**P3**	**0.642**
	P value	**0.006***	**0.016***	**0.260**		

P> 0.05 (Non-significant) *p ≤ 0.05 (significant) P1: I & II, P2: I & III and P3: II & III

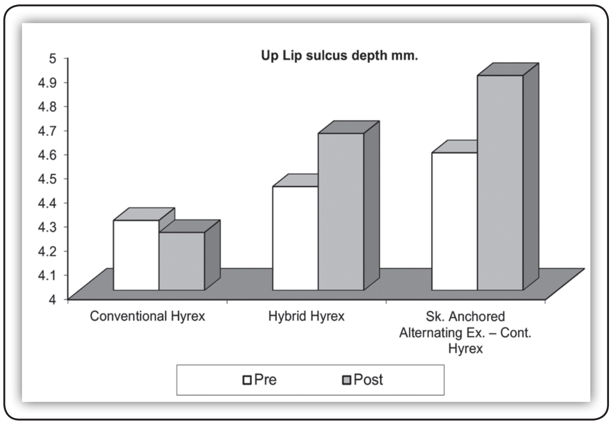

FIG (8) Upper sulcus depth mean changes

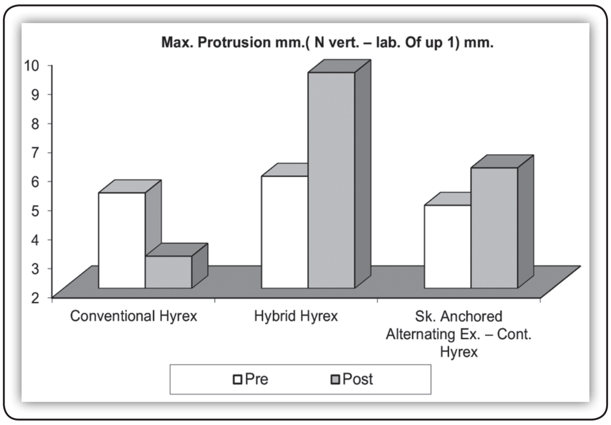

FIG (9) Maxillary protrusion mean changes

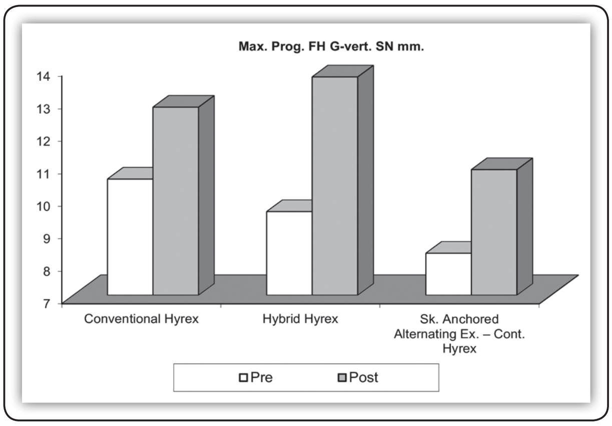

FIG (10) Maxillary prognathism mean changes

DISCUSSION

Class III malocclusion is complex, with distinct skeletal and dental components; its incidence in the mixed dentition period ranges from 0.7% to 12.6% for different populations [26]. Most physicians encourage early detection of skeletal class III malocclusion since later stage treatment options may be restricted to camouflage or surgery [27]. Since most patients in skeletal class III malocclusion acquire a maxillary deficiency, the approach of extending the maxillary expansion has been promoted. In this case, RME is often used before protraction to correct transverse discrepancy and to loosen circum-maxillary sutures[28,29].

Liou and Tsai in 2005 [13] used an alternate treatment procedure (Alt-RAMEC protocol) for the first time to disarticulate the circum-maxillary sutures without significant maxillary expansion [30-32] Furthermore, Liou and Tsai's [13] investigations were conducted on Class III patients with unilateral cleft lip and palate, for whom anatomies are different, and hence different responses may be achieved if applied to Class III individuals without cleft lip and palate. Furthermore, a study of the literature found a controversy among proponents of the RME itself; some investigators maintained that the maxilla somewhat travels forward with the aid of the RME, while others demonstrated that the maxilla moves backward [32].

As a result, the current study aims to assess the efficacy of the alternating maxillary rapid expansion and constriction protocol in conjunction with surgical palatal screws in the management of skeletal Class III patients. According to the findings of this study, the maxilla advanced as a result of RME (SNA, convexity at point A, and Wits appraisal); SNA increased considerably in all three groups, with Group I, Group II, and Group III having differences of 1.5, 1.79, and 1.18, respectively. In Group I and Group II, the amount of point A coming forward could be intercepted as a significant reduction in the convexity at point A, while in Group III, it was insignificant. This result was in agreement with other studies such as Haas [30], Sari et al [33], Chung and Font [34], and others [32,35-37].

Da Silva Filho et al [38], on the other hand, did not anticipate any major changes in the SNA angle following RME. Likewise, Sarver and Johnston [39] and Asanza et al [40] found backward maxillary displacement following the use of bonded rapid maxillary expansion devices. This contrast may be related to differences in appliance design, participants, development stage, expansion mechanics, and sample variability in each study.

Consequently, based on the relapse of anterior-posterior cephalometric changes after RME [41-43], these contradictory results could be explained by differences in assessment timing. In some studies, analysis was performed immediately after expansion, whereas in others, assessments were performed after the retention period. TADs were utilized in the present study to prevent undesired dentoalveolar side effects. Nevertheless, upper incisor proclination could not be avoided, as evidenced by a significant increase in U1/NA, U1/FH, U1/SN, U1-NA, and U1 protrusion, particularly in Group II and Group III, more than in Group I. This might be because the arms that link the palatal TADs to the hybrid Hayrax are naturally flexible. The same conclusions were reached by Al-Mozany et al[36], Chong et al[44], and Kajiyama et al[45]. Celebi and Celikdelen[32] found significant upper incisor retrusion in both the RME and alternating rapid maxillary expansion and constriction groups. The variations might be explained by differences in mechanics. A common belief is that the parameters of the facial axis and lower anterior facial height stay constant over time and are unaffected by natural growth. Hence, any changes in these parameters might represent changes in the skeletal vertical dimension caused by orthodontic treatment [46].

The present study findings indicated a non-significant increase in lower facial height angle in all groups, which might be due to the extrusive impact of the expansion mechanics utilized in the present study. These findings were similar to those of Patel et al [27] and Al-Mozany et al [36] but with a significant difference. Furthermore, the current study findings revealed a significant increase in the following measures in all groups: H-angle, Merrifield's Z-angle, soft tissue profile angle, and Nose tip-H line in all groups. A significant increase in the angle of facial convexity only in Group II, and upper lip prominence in Group I and GroupII more than in Group III. The previous findings may be interpreted as forward advancement of the upper lip and improvement in total facial convexity, particularly in Group II, resulting in an improved soft tissue profile and favouring the Hybrid Hyrax group (Group II). This might be related to the significant maxillary skeletal and dental changes seen in that group. Al-Mozany et al [36], Parayaruthottam et al [47], and Almuzian M. et al [31] also reported significant forward movement of the upper lip, only in the alternating rapid maxillary expansion and constriction group. Celebi and Celikdelen [32], on the other hand, observed backward migration of the upper lip in both the RME and alternating rapid maxillary expansion and constriction protocols and explained this difference as a compensation between soft tissue and skeletal alterations.

CONCLUSION

The hybrid rapid palatal expansion strategy resulted in more significant forward movement of the Subspinale (A point), as well as more skeletal and dental maxillary corrections, soft tissue profile improvement, and more Class III corrections than the conventional tooth-born Hyrax or alternating rapid maxillary expansion and constriction techniques, even though the latter strategy is purely skeletal supported.

RECOMMENDATIONS

In situations of mild class III malocclusion caused by maxillary antero-posterior and transverse deficiency, Hybrid rapid palatal expansion can produce a significant improvement if used as an initial step in the treatment strategy.

REFERENCES

1. Proffit WR. Contemporary orthodontics. 4th ed. St Louis, Mo: Mosby; 2007: 689-707.
2. L. Cevidanes, T. Baccetti, L. Franchi, J. A. McNamara Jr., and H. De Clerck, "Comparison of two protocols for maxillary protraction: bone anchors versus face mask with rapid maxillary expansion," The Angle Orthodontist, 2010; 80(5): 799–806.
3. Daher W, Caron J, Wechsler MH. Nonsurgical treatment of an adult with a Class III malocclusion. Am J Orthod Dentofac Orthoped. 2007; 132(2): 243- 51.
4. M. B. Khan and A. Karra, "Early treatment of class III malocclusion: a boon or a burden?" International Journal of Clinical Pediatric Dentistry, 2014; 7(2): 130–6.
5. Behbehani F, _Artun J, Al-Jame B, Kerosuo H. Prevalence and severity of malocclusion in adolescent Kuwaitis. Med Princ Pract 2005;14:390-5.
6. Guyer EC, Ellis EE 3rd, McNamara JA Jr, Behrents RG. Components of Class III malocclusion in juveniles and adolescents. Angle Orthod 1986;56:7-30.
7. Sue, G., S. J. Chanoca, P. K. Turley, and J. Itoh. Indicators of skeletal class III growth. J Dent Res 1987. 66:343.
8. Muthukumar K, Vijaykumar NM, Sainath MC. Management of skeletal Class III malocclusion with face mask therapy and comprehensive orthodontic treatment. ContempClin Dent. 2016; 7(1):98-102.

9. Kongo E. Treatment of Maxillary Retrusion-Face Mask with or without RPE? Balk J Dent Med. 2018; 22(2): 93-97.
10. Položaj kefalometrijske točke “A” nakon širenja Nepca. Cephalometric Point “A” Position Following Palatal Expansion. Acta Stomatol Croat. 1997; 31(2): 91-98.
11. Wilmes B, Ngan P, Liou EJ, Franchi L, Drescher D. Early class III facemask treatment with the hybrid hyrax and Alt-RAMEC protocol. J ClinOrthod. 2014; 48(2):84-93.
12. Canturk B. H. and Celikoglu M. “Comparison of the effects of face mask treatment started simultaneously and after the completion of the alternate rapid maxillary expansion and constriction procedure,” Angle Orthodontist. 2015; 85(2): 284–91.
13. Liou EJW, Tsai WC. A new protocol for maxillary protraction in cleft patients: repetitive weekly protocol of alternate rapid maxillary expansions and constrictions. Cleft Palate-Cran J. 2005; 42(2):121-7.
14. Liou EJ. Effective maxillary orthopedic protraction for growing Class III patients: a clinical application simulates distraction osteogenesis. Prog Orthod 2005; 6(2): 154-71.
15. Liou EJ. Toothborne orthopedic maxillary protraction in Class III patients. J Clin Orthod 2005; 39(2): 68-75.
16. D. Kaya, I. Kocadereli, B. Kan, and F. Tasar, “Effects of facemask treatment anchored with miniplates after alternate rapid maxillary expansions and constrictions; a pilot study,” Angle Orthodontist. 2011; 81 (4): 639–46.
17. Shapiro PA, Kokich VG Uses of implants in orthodontics. Dent Clin North Am. 1988; 32(3): 539-550.
18. Smalley WM, Shapiro PA, Hohl TH, Kokich VG, Branemark PI Osseointegrated titanium implants for maxillofacial protraction in monkeys. Am J Orthod Dentofacial Orthop.1998; 94(4): 285-95.
19. Parr JA, Garetto LP, Wohlford ME, Arbuckle GR, Roberts WE Sutural expansion using rigidly integrated endosseous implants: an experimental study in rabbits. Angle Orthod .1997; 67(4): 283-90.
20. Harzer W, Reusser L, Hansen L, Richter R, Nagel T, et al. Minimally invasive rapid palatal expansion with an implantsupported hyrax screw. Biomed Tech (Berl) .2010; 55(1): 39-45.
21. Kolge NE, Patni VJ, Potnis SS, Kate SR, Fernandes FS, et al. Pursuit for Optimum Skeletal Expansion: Case Reports on Miniscrew Assisted Rapid Palatal Expansion (MARPE). J Orthod Endod..2018; 4(2).39-45.
22. De Clerck HJ, Cornelis MA, Cevidanes LH, Heymann GC, Tulloch CJ. Orthopedic traction of the maxilla with miniplates: a new prespective for treatment of midface deficiency. J Oral Maxillofac Surg. 2009; 67(10): 2123-9.
23. MacGinnis M, Chu H, Youssef G, Wu KW, Machado AW, et al. The effects of micro-implant assisted rapid palatal expansion (MARPE) on the nasomaxillary Complex: a finite element method (FEM) analysis. Prog Orthod .2014; 15(52):1-15.
24. Lee KJ, Park YC, Park JY, Hwang WS. Mini screw assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. Am J Orthod Dentofacial Orthop. 2010; 137(6): 830-39.
25. Carrillo R , Buschang P. Palatal and mandibular miniscrew implant placement techniques. JCO 47(12):737-43.
26. Alhammadi MS, Halboub E, Fayed MS, et al. Global distribution of malocclusiontraits: A systematic review. Dent Press J Orthod 2018; 23(6): 1-10.
27. Patel U, Baswaraj, Agrawal C, Ramani A, Lalakiya H. Early orthopaedic correction of class III malocclusion with alternate rapid maxillary expansion and Constriction (ALT-RAMEC) and face mask: case report. IJAR. 2015; 3(12):1288 –91.
28. Ngan P, Hagg U, Yiu C, Merwin D, Wei SH. Soft tissue and dentoskeletal profile changes associated with maxillary expansion and protraction headgear treatment. Am J Orthod Dentofacial Orthop 1996; 109(1):38-49.
29. Saadia M, Torres E. Sagittal changes after maxillary protraction with expansion in class III patients in the primary, mixed, and late mixed dentitions: a longitudinal retrospective study. Am J Orthod Dentofacial Orthop 2000; 117(6): 669-80.
30. Haas AJ. Long-term posttreatment evaluation of rapid palatal expansion. Angle Orthod 1980; 50(3):189-217.
31. Mohammed Almuzian, Elise McConnell, M. Ali Darendeliler, Fahad Alharbi & Hisham Mohammed. The effectiveness of Alt-RAMEC combined with maxillary protraction in the treatment of patients with a class III malocclusion: a systematic review and meta-analysis, J Orthod 2018; 45(4); 250-9.
32. Çelebi F, Çelikdelen M. Comparison of the Changes Following Two Treatment Approaches: Rapid Maxillary Expansion Versus Alternate Rapid Maxillary Expansion and Constriction. Turk J Orthod 2020; 33(1): 1-7.
33. Sari Z, Uysal T, Usumez S, Basciftci FA. Rapid maxillary expansion. Is it better in the mixed or in the permanent dentition? Angle Orthod 2003; 73(6): 654-61.

34. Chung CH, Font B. Skeletal and dental changes in the sagittal, vertical, and transverse dimensions after rapid palatal expansion. Am J Orthod Dentofacial Orthop 2004; 126(5): 569-75.

35. De Rossi M, Stuani MBS, Da Silva LAB. Cephalometric evaluation of vertical and anteroposterior changes associated with the use of bonded rapid maxillary expansion appliance. Dental Press J. Orthod. 2010; 15 (3):569-75.

36. Al-Mozany SA, Dalci O , Almuzian M , Gonzalez C , Tarraf NE and Ali Darendeliler M. A novel method for treatment of Class III malocclusion in growing patients. Prog Orthod. 2017; 18 (40):1-8.

37. Kongo E. Treatment of Maxillary Retrusion- Face Mask with or without RPE? Balk J Dent Med, 2018; 22: 93-97.

38. Da Silva Filho OG, Boas MC, Capelozza Filho L. Rapid maxillary expansion in the primary and mixed dentitions: a cephalometric evaluation. Am J Orthod Dentofacial Orthop 1991; 100(2): 171-9.

39. Sarver DM, Johnston MW. Skeletal changes in vertical and anterior displacement of the maxilla with bonded rapid palatal expansion appliances. Am J Orthod Dentofacial Orthop. 1989; 95(6):462-6.

40. Asanza S, Cisneros GJ, Nieberg LG. Comparison of Hyrax and bonded expansion appliances. Angle Orthod. 1997; 67(1):15-22.

41. Reed N, Ghosh J, Nanda RS. Comparison of treatment outcomes with banded and bonded rapid palatal expansion appliances. Am J Orthod Dentofacial Orthop. 1999; 116(1):31-40.

42. Bramante FS, Almeida RR. Estudo cefalométrico em norma lateral das alterações dentoesqueléticas produzidas por três expansores: colado, tipo Haas e Hyrax. Rev Dental Press Ortod Ortop Facial. 2002; 7(6):19-41.

43. Claro CAA, Ursi W, Chagas RV, Almeida G. Alterações ortopédicas ântero-posteriores decorrentes da disjunção maxilar com expansor colado. Rev Dental Press Ortod Ortop Facial. 2003; 8(5):35-47.

44. Chong Y-H, Ive JC, Artun J. Changes following the use of protraction headgear for early correction of Class III malocclusion. Angle Orthod. 1996; 66(5):351–62.

45. Kajiyama K, Murakami T, Suzuki A. Comparison of orthodontic and orthopedic effects of a modified maxillary protractor between deciduous and early mixed dentitions. Am J Orthod Dentofac Orthop. 2004; 126(1):23–32.

46. Kocadereli I, Telli AE. Evaluation of Ricketts' long-range prediction in Turkish children Am J Orlhod Dentofacial Orthop. 1999; 11 5 (5):5 15-20.

47. Parayaruthottam P, Antony V, Francis PG, Roshan G. A retrospective evaluation of conventional rapid maxillary expansion versus alternate rapid maxillary expansion and constriction protocol combined with protraction headgear in the management of developing skeletal Class III malocclusion. J Int Soc Prevent Communit Dent 2018; 8 (4): 320-26.