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Different hyrax expanders for rapid palatial expansion in adolescents with posterior cross-bite: An original research

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***Abstract*---**The posterior cross bite ranges between 10% and 15%. Hence we aim to compare different hyrax expanders for rapid palatial expansion in adolescents with posterior cross-bite. We compared 30 adolescents aged 11 to 16 years, with posterior crossbite, equally divided to groups, Mini Hyrax group and Hyrax group. Dental effects, Impact on quality of life was assessed with the OHIP-14 questionnaire,

VAS were compared. We observed that no significant differences in dentoalveolar effects, OHIP-14, pain perception between groups. Considering intra-group comparison, the reduction in pain perception among adolescents in the Mini Hyrax group was gradual. Among adolescents in the Hyrax group, a statistically significant reduction between 48 and 72 h was observed. We can conclude that there was no significant difference in dental effects, impact on quality of life and pain perception between adolescents wearing Mini Hyrax and Hyrax expanders in rapid palatal expansion.

***Keywords*---**posterior cross-bite, hyrax expanders, adolescents.

Introduction

The posterior cross bite ranges between 10% and 15%. Haas-type and Hyrax are the most widely used to treat the posterior cross bite. Both expanders produce similar dentoskeletal effects [1-3], but therapy with Hyrax has less irritation on the palate. However in the rapid palatal expansion (RPE) with these bonded expanders Patients may feel the limitations in functions [4]. To overcome this drawback a 2-point palatal expander using Hyrax jackscrew with two arms (two mesial arms cut-off) and anchorage only in the first permanent molars was announced as an alternative to Hyrax for the treatment of individuals in mixed dentition and in the early phase of permanent dentition [5]. Though effective in encouraging the expansion of the upper arch and alveolar process in addition to the opening of the medial palatine suture [6]. However less stable results at the initial phase of the expansion treatment when associated with Hyrax were seen in this [6]. Later a two-arm Hyrax, with upgrading of the dental anchorage including anterior extension of the arms bilaterally and contour of the palatal surfaces of the premolars was made [4,7]. The two-arm Hyrax provokes less speech impairment than the four-arm Hyrax during RPE. Till now very few studies are done to compare dental effects of treatment with Mini Hyrax and treatment with Hyrax and/or Haas expanders has been found in the literature. Hence we aim to compare different hyrax expanders for rapid palatial expansion in adolescents with posterior cross-bite.

Material and Methods

We conducted a prospective observational study. After obtaining the Approval of the Research Ethics Committee and the consent from the patients we included 30 patients. They were divided as two groups 15 in each, Mini Hyrax and Hyrax. We considered adolescents with permanent dentition with transverse maxillary deficiency and uni- or bilateral posterior cross-bite. We excluded those patients with any medical condition or above 19 years. The placement of the appliances were done as per the protocol. Pretreatment and the post treatment after retention period, Intraoral scans were performed and compared later for the primary outcome was transverse linear measurement of the first molars. The secondary outcomes were transverse linear measurement of the first and second premolars; rotation of the first and second premolars, and first molars; buccolingual inclination of the first and second premolars, and first molars. The

OHIP-14 has 14 questions distributed across seven domains: functional limitation, physical discomfort, psychological discomfort, physical dis- ability, psychological disability, social disability, and handicap. The scores for each domain and the total score were evaluated. A higher score indicates a more negative perception of the individual with respect his/her quality of life. VAS was used to measure the pain. Descriptive statistics of the scores thus obtained were compared keeping $p<0.05$ as significant.

Results

We observed that among the groups there was no significant difference between the groups for the age, sex, or the type of the severity. (Table 1). When both the Mini Hyrax, and the Hyrax number of activations, values of transverse distances in the inter first premolars, inter seconds premolars, inter-first molars. Both expanders promoted a significant increase in transverse distances between the first premolars, between the second premolars and between the first upper molars (Table 2). When the dental effects of the two expanders were compared, no differences between groups, except for the buccolingual inclination of tooth 25 was seen ($p = 0.047$). The comparison between Mini Hyrax and Hyrax groups with respect to the OHIP-14 scores at T0 showed a significant difference only in the psychological disability domain ($p = 0.012$). For the other domains and the OHIP-14 total score, no difference was observed ($p > 0.05$) (Table 3).

The intra-group comparisons revealed that the OHIP-14 scores across time among Mini Hyrax wearers were similar to those of the Hyrax wearers. In both groups, the functional limitation scores and the physical discomfort scores were significantly higher in T1 than in T0, indicating a worsening of these two domains within the 14 days after the place- ment of expanders ($p < 0.016$). In both groups, the handicap scores were significantly higher in T0 than in T2, indicating an improvement of this domain 6 months after the placement of expanders ($p < 0.016$). In both groups, the social disability scores and the total scores were significantly higher in T1 than in T2, indicating an improvement 6 months after the activation of the expander ($p < 0.016$). The inter-group comparisons demonstrated no difference between groups with respect to the OHIP-14 scores at T1 and OHIP-14 scores at T2, controlling for the scores at T0 ($p > 0.05$). (Table 4.) The highest scores related to the perception of pain during the activation phase of the devices were found in 24 h and from this point forward, there was a reduction in scores up to 7 days for both expander wearers. The pain reduction in the Mini Hyrax group was gradual over the four times, while in the Hyrax group, there was a significant reduction between 48 h and 72 h. Considering the inter-group comparison for each of the four observation times, no statistical difference was observed (Table 5).

Table 1
Distribution of adolescents regarding sex, posterior crossbite, and angle classification

	Mini Hyrax N (%)	Hyrax N (%)	*p* value
Sex			
Male	8 (53.3)	7 (46.7)	1.000[a]
Female	7 (46.7)	8 (53.3)	
Posterior crossbite			
Bilateral	5 (33.3)	4 (26.7)	0.811[b]
Unilateral right side	6 (40.0)	5 (33.3)	
Unilateral left side	4 (26.7)	6 (40.0)	
Angle classification			
Class I	5 (33.3)	6 (40.0)	1.000[b]
Class II	4 (26.7)	4 (26.7)	
Class III	6 (40.0)	5 (33.3)	

[a]Pearson's chi-square test
[b]Fisher's exact test

Table 2
Comparison of the changes during treatment (T2–T0) between the two groups

Measurements	Differences between groups T0 Mean (SD)[a]	Mini Hyrax-group T2–T0 Mean (SD)	Hyrax-group T2–T0 Mean (SD)	Difference between groups Mean (SD)	*p* value[a]	Effect size	CI (95%)	Coefficient (95% CI)/*p* value[b]
Distance 14–24 (mm)	0.50 (3.55)[c]	6.55 (0.72)	6.51 (1.19)	0.04 (0.90)	0.914	0.04	− 0.66–0.74	− 0.17 (− 0.87–0.52)/0.608
Distance 15–25 (mm)	− 1.14 (7.19)[c]	6.38 (0.64)	6.09 (1.01)	0.29 (0,86)	0.347	0.34	− 0.36–1.04	− 0.33 (− 0.94–0.28)/0.276
Distance 16–26 (mm)	0.35 (5.51)[c]	6.23 (0.68)	5.93 (0.75)	0.30 (0.72)	0.272	0.41	− 0.29–1.11	− 0.27 (− 0.78–0.24)/0.290
Rotation 14 (°)	− 3.09 (12.92)[c]	0.76 (5.48)	0.27 (5.30)	0.49 (5.34)	0.803	0.09	− 0.61–0.79	− 1.06 (− 5.08–2.94)/0.588
Rotation 24 (°)	− 1.18 (11.09)[c]	0.62 (5,98)	− 0.84 (6.11)	1.46 (5.92)	0.512	0.24	− 0.46–0.94	− 1.14 (− 5.90–3.60)/0.623
Rotation 15 (°)	− 6.31 (13.23)[c]	1.05 (6.06)	1.77 (3.03)	− 0.72 (4.12)	0.682	0.15	− 0.55–0.85	0.83 (− 3.09–4.76)/0.666
Rotation 25 (°)	− 1.85 (13.36)[c]	− 1.05 (5.77)	0.48 (3.31)	− 1.53 (4.22)	0.380	0.32	− 0.38–1.02	2.05 (− 1.08–5.19)/0.190
Rotation 16 (°)	− 3.29 (10.02)[c]	0.07 (2.57)	− 1.10 (3.94)	1.17 (3.36)	0.341	0.35	− 0.35–1.05	− 1.06 (− 3.78–1.65)/0.427
Rotation 26 (°)	− 4.29 (10.09)[c]	0.67 (3.55)	− 0.68 (3.83)	1.35 (3.61)	0.322	0.36	− 0.34–1.06	− 2.26 (− 4.68–0.16)/0.067
Inclination 14 (°)	0.39 (7.49)[c]	10.81 (5.84)	11.27 (5.25)	-0.46 (5.12)	0.822	0.08	− 0.62–0.78	0.14 (− 4.01–4.30)/0.943
Inclination 24 (°)	0.59 (8.16)[c]	11.78 (5.09)	9.25 (6.31)	2.53 (5.89)	0.238	0.43	− 0.27–1.13	− 2.76 (− 7.07–1.54)/0.199
Inclination 15 (°)	0.34 (7.29)[c]	10.16 (4.19)	10.43 (3.41)	-0.27 (3.29)	0.848	0.07	− 0.63–0.77	0.02 (− 2.92–2.96)/0.989
Inclination 25 (°)	− 0.18 (12.66)[c]	12.17 (3.35)	9.47 (3.75)	**2.70 (3.46)**	**0.047**	0.71	0.01–1.41	− 2.68 (− 5.42to − 0.04)/0.049
Inclination 16 (°)	− 2.09 (10.41)[c]	1.75 (4.45)	1.53 (3.03)	0.22 (3.98)	0.876	0.05	− 0.65–0.75	− 0.52 (− 3.47–2.41)/0.715
Inclination 26 (°)	0.60 (13.90)[c]	2.79 (3.51)	1.79 (2.90)	1.00 (3.26)	0.404	0.31	− 0.39–1.01	− 0.84 (− 3.33–1.63)/0.489

[a]Student *t* test (independent samples). Level of significance $p < 0.05$. *SD* standard deviation, *CI* confidence intervals, *disp* displacement, *mm* milimeters, ° degrees. Rotation measurements: means with negative sign indicates counterclockwise rotation, Inclination measurements: mean with negative sign indicates lingual inclination of teeth on the right side and buccal inclination of teeth on the left side
[b]Regression analysis assessing differences between Mini-Hyrax and Hyrax groups of the dental changes (T2–T0), controlling for the dental measures at T0, participants' age and number of activations of the appliance. Level of significance $p < 0.05$
[c]Denotes no difference between groups. $p > 0.05$

Table 3
Comparison of OHIP scores at T0 between Mini Hyrax wearers and Hyrax wearers

	Mini Hyrax T0 Mean (SD)	Hyrax T0 Mean (SD)	*p* value[a]
FL	0.73 (1.22)	0.73 (1.10)	1.000
FD	2.47 (1.80)	1.80 (1.14)	0.240
PD	3.87 (2.41)	2.53 (2.16)	0.123
FD	0.73 (1.16)	0.47 (0.74)	0.461
PD	3.13 (2.29)	1.27 (1.38)	0.012
SD	1.60 (1.84)	0.60 (1.12)	0.086
HC	0.80 (1.14)	0.40 (0.73)	0.265
SCO	13.33 (8.04)	7.80 (6.80)	0.051

T0: pretreatment
[a]Student *t* test (independent samples)
SD standard deviation, *FL* functional limitation, *FD* physical discomfort, *PD* psychological discomfort, *FD* physical disability, *PD* psychological disability, *SD* social disability, *HC* handicaps, *SCO* total score

Table 4
Intragroup and intergroup comparison of the 7 dimensions and the total score of the OHIP-14

Dimensions OHIP 14	T0 Mean (SD)	T1 Mean (SD)	T2 Mean (SD)	Statistical difference T0-T1-T2	T0 Mean (SD)	T1 Mean (SD)	T2 Mean (SD)	Statistical difference T0–T1–T2	Statistical difference Coef. (95% CI) *p* value	Statistical difference Coef. (95% CI) *p* value
	Mini Hyrax				Hyrax				Mini Hyrax x Hyrax (T1 × T0)	Mini Hyrax x Hyrax (T2 × T0)
FL	0.73 (1.22)[a]	2.53 (2.06)[b]	1.93 (1.28)[ab]	0.031*	0.73 (1.10)[a]	2.60 (1.18)[b]	2.13 (1.88)[ab]	0.010*	0.06 (– 1.21–1.34) 0.916**	0.20 (– 1.02–1.42) 0.740***
FD	2.47 (1.80)[a]	3.93 (2.15)[b]	2.87 (2.03)[ab]	0.048*	1.80 (1.14)[a]	3.87 (1.76)[b]	2.40 (1.50)[a]	0.001*	0.13 (– 1.36–1.63) 0.859**	– 0.50 (– 1.90–0.88) 0.463***
PD	3.87 (2.41)[a]	2.40 (2.61)[a]	1.60 (2.26)[a]	0.088*	2.53 (2.16)[a]	2.47 (2.13)[a]	2.00 (1.55)[a]	0.646*	0.26 (– 1.61–2.14) 0.774**	0.32 (– 1.22–1.68) 0.673***
FD	0.73 (1.16)[a]	0.87 (1.06)[a]	0.47 (0.83)[a]	0.391*	0.47 (0.74)[a]	1.93 (2.05)[a]	1.00 (1.36)[a]	0.065*	1.07 (– 0.18–2.33) 0.091**	0.59 (– 0.26–1.44) 0.167***
PD	3.13 (2.29)[a]	2.20 (1.74)[a]	1.53 (1.76)[a]	0.196*	1.27 (1.38)[a]	1.47 (1.76)[a]	0.67 (0.72)[a]	0.051*	– 0.94 (– 2.43–0.54) 0.206**	– 1.15 (– 2.28–0.03) 0.052***
SD	1.60 (1.84)[ab]	1.20 (1.74)[a]	0.53 (0.99)[b]	0.038*	0.60 (1.12)[ab]	0.67 (1.17)[a]	0.13 (0.35)[b]	0.009*	– 0.31 (– 1.48–0.85) 0.583**	– 0.32 (– 0.91–0.26) 0.272***
HC	0.80 (1.14)[a]	0.40 (0.82)[ab]	0.00 (0.00)[b]	0.030*	0.40 (0.73)[a]	0.40 (0.82)[ab]	0.07 (0.25)[b]	0.049*	0.02 (– 0.61–0.67) 0.930**	0.06 (– 0.08–0.20) 0.390***
SCO	13.33 (8.04)[ab]	13.53 (7.12)[a]	8.93 (5.67)[b]	0.026*	7.80 (6.80)[ab]	13.40 (8.49)[a]	8.33 (5.86)[b]	0.040*	– 0.08 (– 6.49–6.32) 0.978**	– 0.70 (– 5.41–4.01) 0.762***

T0 pretreatment, *T1* 14th day of the appliance activation, *T2* after 6 months retention period, *SD* standard deviation, *FL* functional limitation, *FD* physical discomfort, *PD* psychological discomfort, *FD* physical disability, *PD* psychological disability, *SD* social disability, *HC* handicaps, *SCO* total score
*ANOVA test for repeated measures, Level of significance $p < 0.05$
For comparison of pairs T0 X T1, T0 X T2, T1 X T2 in Mini-Hyrax group and Hyrax group, paired *t* test was employed. Different letters indicate significant difference. Bonferroni correction. Level of significance $p < 0.016$
Coef coefficient
**Regression analysis assessing differences between Mini-Hyrax and Hyrax groups of the OHIP-14 scores at T1, controlling for the OHIP-14 scores at T0. Level of significance $p < 0.05$
***Regression analysis assessing differences between Mini-Hyrax and Hyrax groups of the OHIP-14 scores at T2, controlling for the OHIP-14 scores at T0. Level of significance $p < 0.05$

Table 5
Intragroup and intergroup comparison of the pain perception using the visual analogical scale (VAS)

Observational times	Groups						Effect size (95% CI)	*p* value
	Mini Hyrax			Hyrax				
	Median	Min–Max	Mean	Median	Min–Max	Mean		
24 h	45.30	0.00–96.80	37.35 A	35.57	0.00–91.84	38.96 A	0.05 (– 4.00–4.10)	0.847
48 h	27.19	0.00–91.37	35.46 A	27.72	0.00–83.44	31.06 A	0.16 (– 0.54–0.86)	0.653
72 h	15.77	0.00–93.56	25.63 AB	9.44	0.00–75.78	22.37 B	0.12 (– 0.58–0.82)	0.967
7 days	8.22	0.00–71.59	15.32 B	4.85	0.00–64.77	16.21 B	0.04 (– 3.23–3.31)	0.844

Intergroup comparison (Mini Hyrax versus Hyrax): Mann-Whitney test. Level of significance $p < 0.05$
Intragroup comparison (between pairs of time): Wilcoxon test. Level of significance $p < 0.05$.
Same letters: not significative statistical difference. Different letters: significant statistical
CI confidence interval

Discussion

In our study the wearing of both expanders increased the transverse distances of premolars and molars, varying from 5.93 to 6.55 mm, similar to what has been reported elsewhere. The tooth rotation varied from − 1.05° to 1.77°, without a specific direction for each type of expander and without a statistically significant difference between them, as reported in another study [7,8], in which tooth rotation was minimal and did not aggravate any relevant clinical disadvantages. There was an increase in the buccal inclination of pre- molars, from 9.25° to 12.17°, and of molars, from 1.53° to 2.79°. Herein, the magnitude of the increase in the buccal inclination of premolars was greater than the findings of the literature [4, 9]. The difference between premolars and molars is probably justified by the greater proximity of the jackscrew to the molars' center of resistance. The only statistically significant difference between individuals wearing Hyrax and Mini Hyrax was for the upper left second premolar. However, the mean difference was only 2.70°, with no relevant clinical significance.

Several studies have used the palatal rugaes as reference structures in model superimpositions for assessing changes in tooth position resulting from growth and aging as well as orthodontic treatment [10,11]. In our study we showed that the impact on QOL across time among Mini Hyrax wearers was very much alike to that of the Hyrax wearers. The worsening of function and discomfort 14 days after the bonding of the expander may be elucidated by the placement of the orthodontic device itself and the activation of screw and forces applied for the expansion. The improvement in handicap, social disability and the overall quality of life 6 months after treatment onset may be due to the recognition of the adolescent that he/she is on the way towards malocclusion treatment and the wearing of an orthodontic device is perceived as a normal circumstance over the course of treatment.

The absence of differences in the impact on quality of life between the wearers of both orthodontic expanders (inter-group comparison) may be related to the vertical position of the expander jackscrew. The small size of Mini Hyrax, initially considered an advantage, may also represent a limitation, if the jackscrew is placed too far from the palatal vault, since there is less area of contact between

the device and the tongue. In our study, the vertical position of the jackscrew was close to the resistance center of the first molars. The reduction in pain perception between the observation times was subtle and only between 24 h and 7 days, a significant difference was observed. On the other hand, pain perception among Hyrax wearers reduced significantly between 48 h and 72 h during the activation of the expander. This information may be supportive for the clinician during the counseling of patients wearing Mini Hyrax or Hyrax regarding pain and discomfort. The limitation of our study was no long term follow up and the number of the participants.

Conclusions

We can conclude that there were no significant differences regarding dental effects during RPE, quality of life, pain perception between adolescents Mini Hyrax wearers and Hyrax wearers.

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