

SHORT-TERM TRANSVERSE EFFECTS OF HYRAX AND HAAS PALATAL EXPANDERS IN GROWING PATIENTS: A PROSPECTIVE COMPARATIVE CLINICAL STUDY

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Abstract

This prospective comparative clinical study evaluated the short-term transverse effects of two commonly used palatal expanders, the Hyrax and Haas appliances, in growing patients with transverse maxillary deficiency. Thirty subjects were included and equally allocated into two groups: Hyrax (n = 15) and Haas (n = 15). Transverse measurements, including intercanine width, intermolar width, and palatal width, were recorded at baseline (T0), at the end of active expansion (T1), and three months later (T2). At baseline, no statistically significant differences were identified between the groups in age, sex distribution, or transverse parameters. Both appliances produced significant increases in all measured dimensions from T0 to T1, and the values remained above baseline at T2. A slight reduction between T1 and T2 was observed in both groups, consistent with short-term post-expansion settling. The Hyrax group showed slightly greater mean transverse gains than the Haas group; however, the between-group differences were modest and did not reach statistical significance. Within the limitations of this study, both expanders were effective for short-term maxillary transverse correction, with comparable clinical performance during the early post-expansion period.

Keywords: rapid maxillary expansion, palatal expander, Hyrax, Haas, transverse maxillary deficiency, orthodontics.

Introduction

Transverse maxillary deficiency is a common orthodontic problem encountered in growing patients and is frequently associated with posterior crossbite, dental crowding, palatal constriction, and altered occlusal relationships. In clinical practice, rapid maxillary expansion (RME) remains one of the most widely used orthopedic approaches for correcting this discrepancy during growth, owing to its ability to increase maxillary transverse dimensions through opening of the midpalatal suture and concomitant dentoalveolar adaptation [1-3]. Different appliance designs have been proposed for this purpose, among which the Hyrax and Haas expanders are the most extensively used and investigated [1,2].

The distinction between these appliances is biomechanically relevant. The Hyrax expander is a tooth-borne device, whereas the Haas appliance is traditionally considered tooth-tissue-borne because of its acrylic palatal coverage, which may influence the distribution of expansion forces and the resulting dentoskeletal response [1,3]. Comparative investigations have shown that both appliances are effective in increasing maxillary transverse dimensions, although differences may exist in the relative proportion of skeletal and dentoalveolar effects, as well as in their impact on adjacent structures [1,3]. In addition, CBCT-based evidence has raised attention to possible adverse effects such as root resorption, which may vary according to appliance design and mode of anchorage [4].

Beyond the immediate orthopedic correction, the clinical relevance of maxillary expansion depends on the stability and biological quality of the induced changes. Long-term analyses and meta-analytic data suggest that rapid palatal expansion produces measurable and clinically useful transverse gains, although part of the correction may undergo subsequent adaptation or relapse, depending on patient-related and appliance-related factors [2,5]. These aspects justify continued comparison between commonly used expanders, especially in growing patients, where treatment timing and tissue responsiveness are favorable for orthopedic intervention.

The interest in rapid maxillary expansion has also expanded beyond purely occlusal correction. Several studies have reported that RME may affect the nasal cavity and upper airway, potentially improving nasal airflow and reducing airway resistance through enlargement of the maxillary complex and surrounding skeletal structures [6,7]. Systematic reviews and meta-analyses have supported the concept that expansion can induce three-dimensional changes in the nasal and upper airway compartments, although the magnitude and clinical persistence of these effects remain variable across studies [8]. Likewise, three-dimensional imaging has demonstrated that the effects of expansion are not limited to the dentoalveolar region, but may also involve circummaxillary sutures and adjacent craniofacial bones [9].

From the patient-centered perspective, treatment acceptance is also influenced by discomfort and pain during activation. Recent evidence indicates that self-perceived pain may differ among expansion appliances, making the evaluation of treatment burden clinically relevant when selecting the most appropriate device for young patients [10]. Furthermore, randomized investigations have suggested that rapid maxillary expansion may influence nasal ventilation, thereby reinforcing the functional dimension of this orthopedic procedure [11]. Comparisons between rapid and slow expansion protocols, as well as between tooth-borne and bone-anchored systems, have further highlighted the importance of appliance design in shaping the final dentoskeletal response [12,13]. Systematic evidence also indicates that fixed jackscrew expanders can produce distinct dentoskeletal effects depending on activation protocol and anchorage characteristics [14], while more recent controlled studies continue to confirm the skeletal benefits of maxillary expansion in the treatment of transverse discrepancies such as posterior crossbite [15].

In our study, further comparative evaluation of Hyrax and Haas expanders remains justified, particularly when focusing on short-term transverse outcomes in growing patients. Such analysis may provide clinically relevant information regarding the magnitude of correction achieved during active expansion and its early post-expansion stability.

Materials and Methods

Study design and ethical considerations

Our prospective comparative clinical trial was conducted to evaluate the short-term effects of two commonly used palatal expanders, the Hyrax and Haas devices, in growing patients presenting with transverse maxillary deficiency. The study aimed to compare the transverse dentoalveolar changes produced by the two devices over a three-month observation

period. The study protocol was designed in accordance with the principles of the Declaration of Helsinki for research involving human subjects. Before initiation of treatment, informed consent was obtained from the parents or legal guardians of all participants, and children's consent was obtained whenever appropriate.

Study sample

A total of 30 subjects were included in the study. Patients were allocated into two equal groups according to the type of palatal expander used:

- Hyrax group (n = 15)
- Haas group (n = 15)

All patients were recruited from individuals referred for orthodontic treatment, presenting with clinically diagnosed transverse maxillary constriction requiring rapid maxillary expansion.

Inclusion criteria

The inclusion criteria were as follows:

- 1.growing patients in the mixed or early permanent dentition stage;
- 2.presence of transverse maxillary deficiency diagnosed clinically and confirmed by orthodontic evaluation;
- 3.indication for palatal expansion as part of the orthodontic treatment plan;
- 4.absence of previous orthodontic treatment affecting maxillary transverse development;
- 5.good general health and ability to comply with treatment and follow-up visits.

Exclusion criteria

The exclusion criteria were:

- 1.craniofacial syndromes or congenital anomalies affecting maxillary development;
- 2.cleft lip and/or palate;
- 3.severe periodontal disease or poor oral hygiene;
- 4.systemic conditions influencing bone metabolism;
- 5.incomplete records or failure to attend follow-up assessments.

Orthodontic appliances and activation protocol

Two types of tooth-borne palatal expanders were used in the present study:

- the Hyrax expander, consisting of a rigid jackscrew connected to bands on the posterior teeth without acrylic palatal coverage;
- the Haas expander, consisting of a central expansion screw combined with acrylic palatal coverage, is designed to distribute expansion forces over both teeth and palatal mucosa.

All appliances were fabricated according to standard orthodontic laboratory procedures and cemented under routine clinical conditions. After cementation, expansion was initiated following a standardized activation protocol of 0.25 mm per turn, twice daily (0.5 mm/day), until the desired transverse correction was achieved based on clinical assessment. Expansion was considered complete when adequate overcorrection was obtained, according to the individualized treatment plan.

Observation time points

Measurements were recorded at three predefined time points:

- T0: before appliance activation;

- T1: at the end of active expansion, approximately 2-3 weeks after appliance activation, depending on the achievement of the planned transverse correction;
- T2: 3 months after T1, to assess short-term post-expansion stability.

This design allowed the evaluation of both the immediate effects of active expansion and the short-term maintenance of the achieved transverse changes.

Clinical measurements

The primary transverse parameters assessed in this study were:

1. intercanine width (mm);
2. intermolar width (mm);
3. palatal width (mm).

The measurements were obtained using standardized models of orthodontic studies and/or digital dental models derived from intraoral scans. All linear measurements were recorded in millimeters using reproducible anatomical landmarks. We defined intercanine width as the linear distance between the tips of the cusps of the maxillary canines. Intermolar width has been defined as the linear distance between the tips of the mesiooral cusps of the first maxillary permanent molars. Palatal width is defined as the transverse distance between the corresponding palatal landmarks at the level of the posterior maxillary segments. To reduce measurement bias, all measurements were performed by the same calibrated examiner under standardized conditions.

Outcome measures

The primary outcome was the change in intermolar width between T0 and T2.

The secondary outcomes included:

- change in intercanine width;
- change in palatal width;
- intragroup changes across T0, T1, and T2;
- between-group differences in treatment-induced changes during the intervals T1-T0, T2-T1, and T2-T0.

Statistical analysis

Analyses were performed using IBM SPSS Statistics 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean \pm standard deviation (SD), while categorical variables were reported as absolute frequencies. Baseline intergroup comparisons were performed using the independent samples t-test for continuous variables and the chi-square test for categorical variables. Changes over time within each group were assessed using repeated measures analysis of variance (ANOVA) across T0, T1, and T2. Intergroup comparisons of treatment-induced changes were performed by analyzing the differences between time points ($\Delta T1-T0$, $\Delta T2-T1$, and $\Delta T2-T0$) using the independent samples t-test. A value of $p < 0.05$ was considered statistically significant.

Results

Baseline characteristics of the study groups

A total of 30 subjects were included in the study, with 15 patients allocated to the Hyrax group and 15 to the Haas group. The baseline demographic and transverse maxillary characteristics of the study groups are summarized in Table 1. No statistically significant differences were found between groups at T0 in terms of age, sex distribution, intercanine width,

intermolar width, or palatal width (all $p > 0.05$), indicating that the two groups were comparable before treatment initiation.

Table 1. Baseline demographic and transverse characteristics of the study groups at T0

Variable	Hyrax (n = 15)	Haas (n = 15)	p-value
Age (years)	10.8 ± 1.4	11.1 ± 1.6	0.58
Sex (male/female)	8/7	7/8	0.71
Inter canine width (mm)	28.4 ± 1.9	28.1 ± 2.1	0.66
Intermolar width (mm)	43.2 ± 2.3	42.8 ± 2.5	0.63
Palatal width (mm)	31.6 ± 1.8	31.2 ± 1.9	0.54

Intragroup changes over time

Both treatment groups showed significant increases in transverse maxillary dimensions over the observation period. In the Hyrax group, intercanine, intermolar, and palatal widths increased significantly from T0 to T1 and remained greater than baseline values at T2. A similar pattern was observed in the Haas group, with statistically significant changes across the three points for all measured transverse parameters (Table 2, all $p < 0.001$).

Table 2. Intragroup changes in transverse dimensions across the three observation time points.

Variable	Time point	Hyrax (n = 15)	p-value	Haas (n = 15)	p-value
Inter canine width (mm)	T0	28.4 ± 1.9		28.1 ± 2.1	
	T1	32.6 ± 2.0		31.8 ± 2.2	
	T2	32.2 ± 1.8	<0.001	31.5 ± 2.0	<0.001
Intermolar width (mm)	T0	43.2 ± 2.3		42.8 ± 2.5	
	T1	49.1 ± 2.4		48.3 ± 2.6	
	T2	48.7 ± 2.2	<0.001	47.9 ± 2.4	<0.001
Palatal width (mm)	T0	31.6 ± 1.8		31.2 ± 1.9	
	T1	35.8 ± 1.9		35.0 ± 2.0	
	T2	35.4 ± 1.7	<0.001	34.7 ± 1.8	<0.001

Data are presented as mean ± standard deviation. Intragroup comparisons across T0, T1, and T2 were performed using repeated measures ANOVA. A p -value < 0.05 was considered statistically significant.

Between-group comparison of treatment-induced changes

The magnitude of treatment-induced changes was further compared between the Hyrax and Haas groups by analyzing the differences recorded over the three study intervals: T1–T0, T2–T1, and T2–T0. As shown in Table 3, both expanders produced clinically relevant increases during the active expansion phase. The Hyrax group showed slightly greater mean increases in

intercanine, intermolar, and palatal widths between T0 and T1. Between T1 and T2, both groups exhibited a slight reduction in transverse measurements, consistent with short-term post-expansion settling. Overall, the net transverse gains at T2 remained higher in the Hyrax group; however, the intergroup differences were modest and did not reach statistical significance for the evaluated parameters.

Table 3. Between-group comparison of treatment-induced changes ($\Delta T1-T0$, $\Delta T2-T1$, $\Delta T2-T0$)

Variable	Interval	Hyrax (n = 15)	Haas (n = 15)	p-value
Intercanine width (mm)	$\Delta T1-T0$	4.2 ± 0.8	3.7 ± 0.9	0.11
	$\Delta T2-T1$	-0.4 ± 0.3	-0.3 ± 0.4	0.42
	$\Delta T2-T0$	3.8 ± 0.9	3.4 ± 0.8	0.18
Intermolar width (mm)	$\Delta T1-T0$	5.9 ± 1.0	5.5 ± 1.1	0.29
	$\Delta T2-T1$	-0.4 ± 0.3	-0.4 ± 0.3	0.88
	$\Delta T2-T0$	5.5 ± 1.0	5.1 ± 1.1	0.31
Palatal width (mm)	$\Delta T1-T0$	4.2 ± 0.7	3.8 ± 0.8	0.14
	$\Delta T2-T1$	-0.4 ± 0.3	-0.3 ± 0.3	0.37
	$\Delta T2-T0$	3.8 ± 0.8	3.5 ± 0.8	0.26

Data are presented as mean ± standard deviation. Intergroup comparisons of treatment-induced changes were performed using an independent-samples t-test. Negative values in the $\Delta T2-T1$ interval indicate a slight reduction after completion of active expansion. A p-value < 0.05 was considered statistically significant.

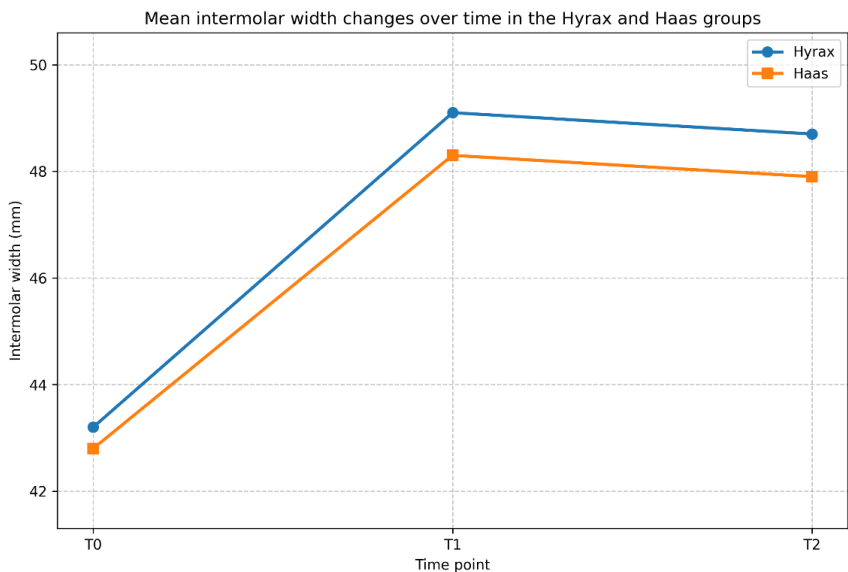


Figure 1. Temporal changes in mean intermolar width in the Hyrax and Haas groups.

These trends are also illustrated in Figure 1, which shows the temporal evolution of mean intermolar width in the two study groups. Both appliances showed a marked increase from T0 to T1, followed by a slight decrease at T2, while remaining above baseline.

Discussion

In our study, we evaluated the short-term cross-sectional effects of two widely used palatal expansion devices, Hyrax and Haas expanders, in growing patients with maxillary transverse deficit. Both devices produced significant increases in intercanine, intermolar, and palatal width, from baseline to the end of active expansion, and these increases remained above baseline values at the three-month follow-up. Although the Hyrax group showed slightly higher average growth than the Haas group, the differences between the groups were modest and did not reach statistical significance. These findings suggest that both appliances are clinically effective for short-term maxillary expansion, with relatively similar cross-sectional results in the early post-expansion period.

The observed increases in transverse dimensions are consistent with previous randomized and comparative studies reporting that both Hyrax- and Haas-type expanders are capable of generating substantial orthopedic and dentoalveolar changes in growing patients [1,3]. Weissheimer et al. demonstrated that both appliance types produced immediate transverse gains, although some differences were noted in the distribution of dentoskeletal effects [1]. Similarly, Araújo et al., using tomographic evaluation, confirmed that both expanders induced significant maxillary changes in children, supporting the concept that appliance design may influence biomechanics without necessarily resulting in major short-term differences in overall clinical expansion [3]. The present results align with this interpretation, as both groups showed parallel patterns of improvement over time.

An important finding of the current study is the slight reduction in transverse values between T1 and T2 in both groups. This pattern likely reflects early post-expansion settling rather than true therapeutic failure. Such short-term adaptation has been described in previous studies investigating stability after maxillary expansion, and it should be interpreted within the biological context of remodeling after orthopedic separation of the midpalatal suture [2,5]. The persistence of net transverse gains at T2 in both groups suggests that the correction remained clinically meaningful despite this minor reduction. In this regard, the long-term meta-analysis by Cannavale et al. supports the overall effectiveness of rapid palatal expansion while also emphasizing that some relapse-related adaptation may occur over time [5,16,17].

The relevance of these findings extends beyond simple arch-width correction. Rapid maxillary expansion is increasingly recognized as a procedure with broader craniofacial and functional implications, including changes in the nasal cavity, upper airway, and circummaxillary structures [6-9]. Although the present study did not directly assess airway volume or nasal resistance, the transverse gains observed here are compatible with the structural changes reported in previous imaging-based investigations [7-9]. Moreover, recent randomized and systematic evidence suggests that RME may positively influence nasal ventilation and upper airway morphology, particularly in children with transverse constriction and functional impairment [11,18,19]. These broader effects reinforce the orthopedic significance of early expansion therapy.

Another clinically relevant aspect concerns the patient's experience and treatment burden. The choice of braces in pediatric orthodontics should not be based solely on skeletal response, but also on comfort, tolerance, and biological side effects. Recent studies have shown that the perception of pain during maxillary expansion can vary with device design and activation protocol [10,17]. In parallel, CBCT evidence indicates that braces worn from the teeth and those worn from the tissue may differ in their impact on the tooth roots and surrounding tissues [4]. Therefore, even when cross-sectional results seem similar, the decision between Hyrax and Haas devices should also consider patient-centered and biological variables.

Our study has several limitations. The sample size was relatively small, the follow-up period was limited to three months, and only linear cross-sectional parameters were evaluated. Furthermore, patient-reported outcomes were not included for the airways, periodontal, or

patients. Future studies should include longer observation periods, three-dimensional skeletal assessments, and functional variables while examining the influence of the vertical growth pattern and treatment timing on the expansion response [12-16]. However, within the confines of this study, both the Hyrax and Haas expanders demonstrated predictable short-term efficiency, with the Hyrax device showing an insignificant tendency toward slightly higher cross-sectional gains.

Conclusions

Both Hyrax and Haas palatal expanders proved effective in producing short-term transverse maxillary correction in growing patients with maxillary constriction. Significant increases were observed in intercanine, intermolar, and palatal widths after active expansion, and these gains remained above baseline values at the three-month follow-up. Although the Hyrax appliance showed a tendency toward slightly greater transverse increases, the intergroup differences were limited and did not reach statistical significance. Overall, both devices demonstrated predictable clinical performance during the early phase of orthopedic maxillary expansion. From a clinical perspective, the present findings suggest that the choice between Hyrax and Haas expanders may not depend solely on the magnitude of short-term transverse gain, since both appliances achieved comparable outcomes. Appliance selection should therefore also consider additional factors such as biomechanics, patient comfort, oral hygiene management, tissue response, and clinician preference. Given the limited sample size and relatively short follow-up period, further studies with larger cohorts, longer observation intervals, and three-dimensional assessment protocols are needed to clarify potential differences in stability, dentoskeletal effects, and patient-reported outcomes between the two expansion systems.

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