Rapid maxillary expander vs planas expansion plates

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Abstract

One of the most frequent issues in orthodontics is the contraction of the maxilla, sometimes associated with unilateral or bilateral cross-bite. Correcting the transverse diameters of the maxillary arch can be achieved through various devices, both orthopedic and orthodontic. One of the main limitations of orthodontic devices is the risk of resolving transverse discrepancies solely through dental tipping, with an associated risk of relapse post-treatment.
The aim of this study is to compare the millimetric expansion obtained with an orthopedic device (RME) and an orthodontic device (Planas plates), while also assessing whether this expansion is associated with bodily movement of the dental elements or tipping.
To this end, 37 patients in mixed dentition were selected and divided into two groups: Group I, consisting of 19 subjects treated with Planas plates, and Group II, consisting of 18 subjects treated with RME.
Each patient was scanned at T0 (pre-treatment) and T1 (post-treatment). Distances between the first molars, first premolars (or first deciduous molars), and upper canines were measured at the occlusal, marginal, and alveolar levels. The differences between T1 and T0 were considered significant using the Student's t-test with $p < 0.05$.
The results show that both devices provide a bodily expansion of the middle and posterior sectors. RME is more effective in terms of millimetric transverse expansion, with bodily movement of molars, premolars, and canines. The Planas plates provide satisfactory millimetric expansions with bodily expansion mainly at the molar level.

Keywords: planas plates, rapid maxillary expansion, cross-bite.

Introduction

According to the World Health Organization, malocclusions are the third most common dental issue in public health (1,2). Among these conditions, cross-bites are particularly prominent. They occur when the two dental arches fail to occlude correctly in the lateral or antero-posterior direction. If not corrected with early treatment, they can compromise the craniofacial structure, stomatognathic system, and negatively affect the patient's social and psychological interactions (2).
A cross-bite can present unilaterally or bilaterally and can have either a dento-alveolar or skeletal origin (3). However, the etiology of this malocclusion may stem from a combination of skeletal and neuromuscular factors (4,5).
To correct this deficiency, expansive treatments such as Rapid Maxillary Expansion (RME) are proposed. This technique, used for treating skeletal transverse deficiencies,

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relies on the opening of the median palatal suture, which, in growing patients, is not yet fully ossified (6,7). It was first used by Angle in the 19th century and later reintroduced by Haas (8,9,10). RME has proven to be an effective expansion technique for correcting transverse maxillary deficiencies before the craniofacial growth peak (11,12).

This type of treatment is therefore indicated for individuals whose craniofacial growth has not yet completed the maturation process. The effectiveness of this treatment decreases significantly when the sutures begin to interdigitate, as resistance to the forces exerted on the suture increases (8).

A study by Baccetti et al. (12) identified a biological indicator of the ideal timing for orthopedic expansion using the CVM method, which assesses the maturation of the cervical vertebrae. The data showed that RME produces significantly more favorable skeletal transverse changes when applied before the peak of pubertal skeletal growth.

The ideal timing was defined between CS1 and CS3, which corresponds to the period preceding the pubertal growth spurt (12).

Once the suture maturation process is complete, the treatment loses its orthopedic efficacy, leading to expansion primarily through dental tipping, with no or minimal effect on the basal bones (8,13,14). In patients where suture maturation has been completed, RME can cause pain, periodontal complications, and gingival recessions (8,14,15).

An alternative to rapid palatal expansion was introduced in 1971 by Pedro Planas, who developed the Direct Tracks of Planas (PDTs) as a treatment method for cross-bite in the primary dentition (16).

According to Planas, an early diagnosis of cross-bites significantly facilitates correction. If left untreated, they can lead to permanent skeletal anomalies during growth (17).

Simões was the first to use PDTs to treat both anterior and posterior cross-bites (17,18). Through her studies, she found that PDTs are highly effective in the primary dentition, as they cover the occlusal surfaces of the molars, allowing for a flat posterior occlusion until their exfoliation (4,17).

Neuro-occlusal rehabilitation (RNO), using the Direct Tracks of Planas (PDTs) based on Pedro Planas' principles, proves to be an orthopedic advantage for early intervention in transverse maxillary deficiencies. The main goal of RNO is to remove occlusal interferences that cause physiological and morphological dysfunctions, thus facilitating the reprogramming of the patient's orofacial musculature (17,19).

Planas plates, unlike most plates used in functional orthopedics that exert forces or retention, work through "presence." Their action is expressed by positioning them palatally and lingually, inducing slight movement of the teeth in the linguo-vestibular direction without applying significant pressure (20,21).

To ensure a constant and effective action of the plates over time, sliding tracks were added. These tracks allow for continuous contact between the upper and lower plates, keeping them in the correct position (20,22).

The use of these devices allows for a minimal static vertical therapeutic dimension (21).

Although RME and Planas plates employ different methods to resolve maxillary deficiencies, both promote the expansion of a deficient maxillary arch and its coordination with the opposing lower arch (23,2). Therefore, the purpose of this study is to investigate the effectiveness of these two devices, assessing not only the millimetric expansion each provides in the arch, but also examining whether the expansion is associated with dental tipping, and thus evaluating the expansion qualitatively.

Materials and methods

For this retrospective study, 37 patients were selected based on the following inclusion criteria:

1. Caucasian ethnicity;
2. Mixed dentition or early permanent dentition;
3. Presence of the first permanent molars in the arch;
4. High level of compliance in patients treated with Planas' tracks plates, as these are removable devices.

And the following exclusion criteria:

1. Previous orthodontic treatments;
2. Craniofacial syndromes;
3. Cleft lip and/or palate;
4. Previous maxillofacial trauma.

The selected patients were divided into two distinct groups

1°GROUP:

The sample consisted of 19 subjects (10 females and 9 males) with an average age of 8 years and 5 months, treated with Planas' tracks plates—removable orthodontic devices equipped with a central expansion screw, sliding tracks oriented parallel to the Camper's plane. These devices were used to treat patients with Class I malocclusion, or with a mesiodistal inclination, for those with Class II malocclusion. The following therapeutic protocol was prescribed and applied to the patients treated with this type of appliance: half-turn activation (i.e., 1/8 of a turn of the expansion screw), corresponding to an increase in width of 0.125mm, to be repeated twice a week for a total of 0.25mm, until the physiological transverse diameters of the dental arches were restored. To achieve this condition, the plates were worn by the patients for at least 14 hours per day, with an average treatment duration of 9 months (Figure 1).

2°GROUP:

The sample consisted of 18 subjects (10 males and 8 females) with an average age of 8 years and 10 months, treated with a rapid palatal expander, banded on the first permanent molars. The therapeutic protocol applied to the patients in this group was as follows: 2 activations per day for 7 days. Each activation corresponds to a ¼ turn of the screw and an increase in width of 0.25mm. At the second follow-up, one week later, it was assessed whether to continue the activation of the screw for another week if overcorrection had not been achieved (a condition that occurs when the

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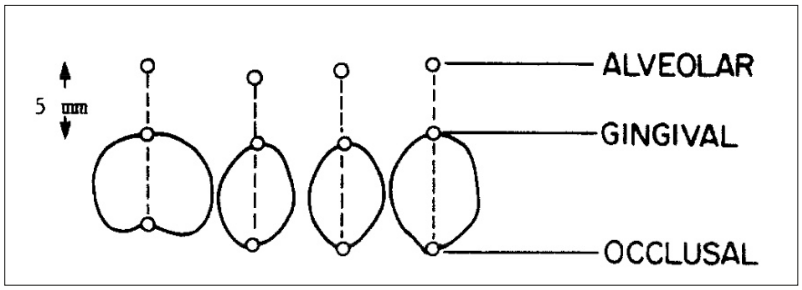

Figure 1. McWade, R. A., Mamandras, A. H., & Hunter, W. S. (1987). The effects of Frankel II treatment on arch width and arch perimeter. American Journal of Orthodontics and Dentofacial Orthopedics, 92, 313–320.

palatal cusp of the upper first molar occludes with the vestibular cusp of the lower first molar), with 1 turn per day, thus one activation per day, until overcorrection was achieved, or to stop the treatment if overcorrection had already been reached after the first week. At each subsequent follow-up, the stability of the expander was checked, and it was kept in place for an average period of 6 months.

For each patient, digital scans were performed using the iTero intraoral scanner both before treatment (T0) and at the end of treatment (T1). In both sets of scans, to assess the amount and type of expansion achieved, the distances between the first molars, the first premolars, and the upper canines were measured using the MyCadent digital measurement system. In patients with mixed dentition, instead of measuring the first premolars, the measurements were taken on the first deciduous molars. The widths were evaluated at three distinct reference points, following McWade's protocol: occlusal, marginal, and alveolar (24).

1. **Occlusal**:
   - At the level of the canine, on the cusp tip.
   - At the level of the premolar, on the vestibular cusp tip.
   - At the level of the molar, on the medial groove between the mesio-vestibular cusp and the disto-vestibular cusp.

In mixed dentition, the occlusal reference points are the same, except for the premolar reference point, which is absent. In this case, the medial groove between the mesio-vestibular and disto-vestibular cusps of the first deciduous molars is used as the occlusal reference point (Figgs 1, 2, 3).

2. **Marginal**:

This is located along the vestibular cervical margin of the tooth, by drawing a line from the occlusal point that intersects the gum at the midpoint of its mesio-distal distance.

3. **Alveolar**:

This is located on the alveolus by extending, 5mm apical to the cervical margin of the tooth, the line connecting the occlusal and marginal points.

The widths measured at the three reference points were evaluated based on two hypothetical scenarios:

1. **Translation of the dental elements**: If no significant difference was found between the average increases in distances at the occlusal and alveolar points, it could be concluded that the dental elements had undergone bodily movement. In other words, each point on the tooth would have changed its position by the same amount and in the same direction, suggesting a complete translation of the teeth, accompanied by similar changes in the alveolus.
2. **Tipping movement**: Conversely, if the increase at the occlusal point was greater than at the alveolar point, a tipping movement of the tooth would be hypothesized. This implies that the tooth tilted without significant, or with minimal, expansion of

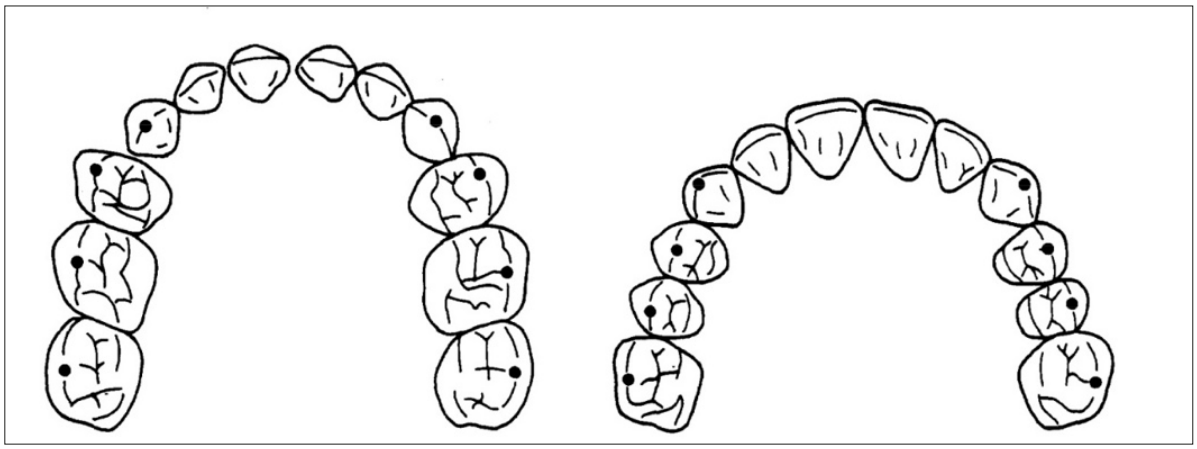

Figure 2, 3. McWade, R. A., Mamandras, A. H., & Hunter, W. S. (1987). The effects of Frankel II treatment on arch width and arch perimeter. American Journal of Orthodontics and Dentofacial Orthopedics, 92, 313–320. **3**. McWade, R. A., Mamandras, A. H., & Hunter, W. S. (1987). The effects of Frankel II treatment on arch width and arch perimeter. American Journal of Orthodontics and Dentofacial Orthopedics, 92, 313–320.

the bone bases.

The measurements, performed with the MyCadent system, have an accuracy of one-tenth of a millimeter (0.1 mm). The variations between T1 and T0 for the three widths (molar, premolar, canine) at each reference point (occlusal, marginal, alveolar) were evaluated using a Student's t-test and considered statistically significant for p-values < 0.05.

Results

The results obtained show that the group treated with Planas plates exhibited statistically significant expansion at the intercanine occlusal and marginal levels; at the interpremolar occlusal, marginal, and alveolar levels; and at the intermolars occlusal, marginal, and alveolar levels. The only expansion that was not statistically significant was the intercanine alveolar expansion achieved with Planas plates, although the transverse diameters still showed a positive change at time T1 (Tables 7, 8, 9).

On the other hand, the group treated with the Rapid Palatal Expander (RPE) showed a statistically significant increase in the transverse diameters at the occlusal, marginal, and alveolar levels, corresponding to the canines, premolars, and molars (Tables 10, 11, 12).

In addition to the magnitude of the expansion, the quality of the expansion was considered. Specifically, the aim was to understand whether the increase in the maxillary transverse diameters was due to bodily movement of the dental elements, or whether it was simply the result of tipping of these elements, i.e., their vestibular inclination.

For this purpose, in both groups, the alveolar expansion was compared with the occlusal expansion at the canine, premolar, and molar levels, and the percentage of alveolar displacement was calculated. In the group treated with Planas plates, the alveolar displacement of the canines represented 38.96% of the expansion; the alveolar displacement of the premolars accounted for 43.67% of the expansion; and the displacement at the molars was alveolar in 86.38% of cases (Table 13). In the group treated with the Rapid Palatal Expander, the alveolar displacement at the canines represented 67.91% of the expansion; the alveolar displacement at the premolars was 80.91%, and at the molars it was 98.62% of the expansion (Table 14).

From the analyzed data, it emerges that the diameters at T0 were more constricted in group 2 (patients treated

Table 7. Treatment with Planas Direct Tracks

	INTERCANINO								
	OCCLUSALE			MARGINALE			ALVEOLARE		
	T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
Media	31,57894737	33,29473684	1,715789474	34,53157895	36,08947368	1,557894737	35,14210526	35,81052632	0,668421053
Dev. Standard	2,807644119	2,395243825	1,5910385	2,90689843	2,535064044	2,095051256	3,928289957	3,480723861	1,93392308
Student T-test			0,000178187			0,004531343			0,149271046

Table 8. Treatment with Planas Tracks Plates

INTERPREMOLARE								
OCCLUSALE			MARGINALE			ALVEOLARE		
T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
38,19473684	40,68947368	2,494736842	42,04736842	43,75263158	1,705263158	44,8	45,88947368	1,089473684
2,550702231	3,575362412	2,436863577	2,630455901	3,146315026	2,063565868	2,857543623	3,06084497	1,740017477
		0,000300952			0,002037879			0,013768654

Table 9. Treatment with Planas Tracks Plates

INTERMOLARE								
OCCLUSALE			MARGINALE			ALVEOLARE		
T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
47,58421053	50,17368421	2,589473684	51,69473684	53,69473684	2	53,96315789	56,2	2,236842105
3,827279736	3,521022911	1,371898416	3,686231693	3,876205717	1,492201952	3,578052004	3,775947269	2,168258525
		1,64017E-07			1,55933E-05			0,000278977

Table 10. Treatment with Rapid Palatal Expander

	INTERCANINO								
	OCCLUSALE			MARGINALE			ALVEOLARE		
	T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
Media	29,44444444	33,32222222	3,87777778	32,6	36,11666667	3,51666667	33,71666667	36,35	2,63333333
Dev. Standard	2,332184591	1,690998854	1,578366824	2,058268833	1,26036876	1,585318673	2,078531722	1,481354706	1,437317763
Student T-test			8,40184E-09			3,7392E-08			5,38909E-07

Table 11. Treatment with Rapid Palatal Expander

INTERPREMOLARE								
OCCLUSALE			MARGINALE			ALVEOLARE		
T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
36,07777778	39,97777778	3,9	39,49444444	43,63888889	4,144444444	41,7	44,85555556	3,155555556
2,239631155	2,245139994	1,839117435	2,017124401	1,887774566	1,804967727	2,431895896	1,729067148	1,303489535
		7,12129E-08			2,26914E-08			1,04505E-08

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Table 12. Treatment with Rapid Palatal Expander

INTERMOLARE								
OCCLUSALE			MARGINALE			ALVEOLARE		
T0	T1	T1-T0	T0	T1	T1-T0	T0	T1	T1-T0
49,01666667	53,06666667	4,05	51,09444444	55,52777778	4,433333333	53,06111111	57,05555556	3,994444444
2,791425948	2,252057882	1,394632568	2,9800261	2,065061046	1,3813889	2,909849175	2,024038544	1,644410219
		6,71543E-10			1,42364E-10			9,93823E-09

Table 13. Percentage of alveolar displacement obtained with Planas appliance

PLANAS	MEAN OCCLUSAL DISPLACEMENT (mm)	MEAN ALVEOLAR DISPLACEMENT (mm)	ALVEOLARE DISPLACEMENT %
Upper canine	**1,715789474**	**0,668421053**	**38,95705523**
Upper premolar	**2,494736842**	**1,089473684**	**43,67088607**
Upper molar	**2,589473684**	**2,236842105**	**86,38211382**

Table 14. Percentage of alveolar displacement obtained with Rapid Palatal Expander

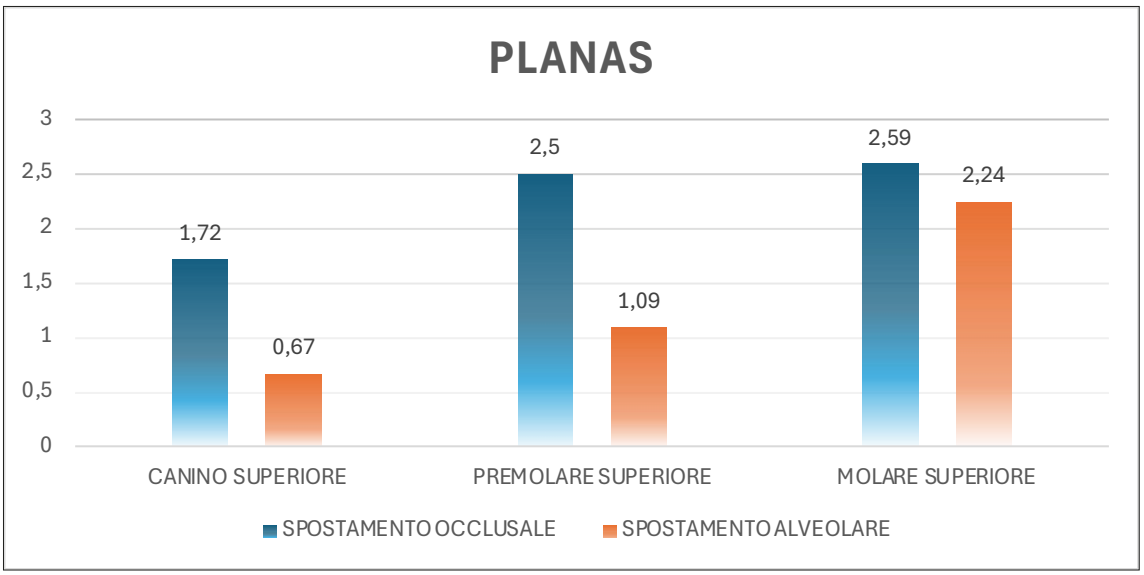
RME	MEAN OCCLUSAL DISPLACEMENT (mm)	MEAN ALVEOLAR DISPLACEMENT (mm)	ALVEOLARE DISPLACEMENT %
Upper canine	**3,87778**	**2,63334**	**67,90844246**
Upper premolar	**3,9**	**3,15556**	**80,91179487**
Upper molar	**4,05**	**3,994445**	**98,6282716**

with RPE), and by the end of the RPE treatment, post-treatment diameters were similar to those obtained using the Planas plates.

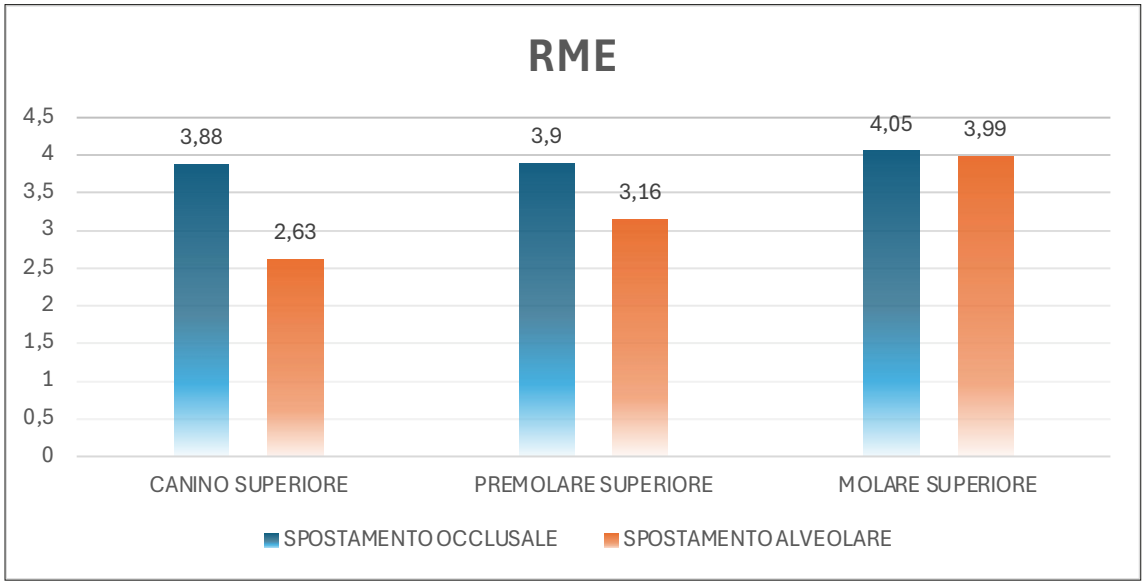
The variations in arch width are greater in the sample treated with RPE compared to the sample treated with Removable Plates.

The Planas plates (Graph n. 1), caused vestibularization of the canines by 3.88 mm occlusally, 3.52 mm marginally, and 2.63 mm alveolarly; the premolars underwent changes of 3.9 mm occlusally, 4.15 mm marginally, and 3.16 mm alveolarly; the molars expanded by 4.05 mm occlusally, 4.43 mm marginally, and 3 mm alveolarly.

The RPE (Graph n. 2), on the other hand, caused changes at the canine level of 1.72 mm occlusally, 1.56 mm marginally, and 0.67 mm alveolarly; at the premolar level, the changes were 2.5 mm occlusally, 1.71 mm marginally, and 1.09 mm alveolarly; at the molar level, the changes in the vestibular direction were 2.59 mm occlusally, 2 mm marginally, and 2.24 mm alveolarly.



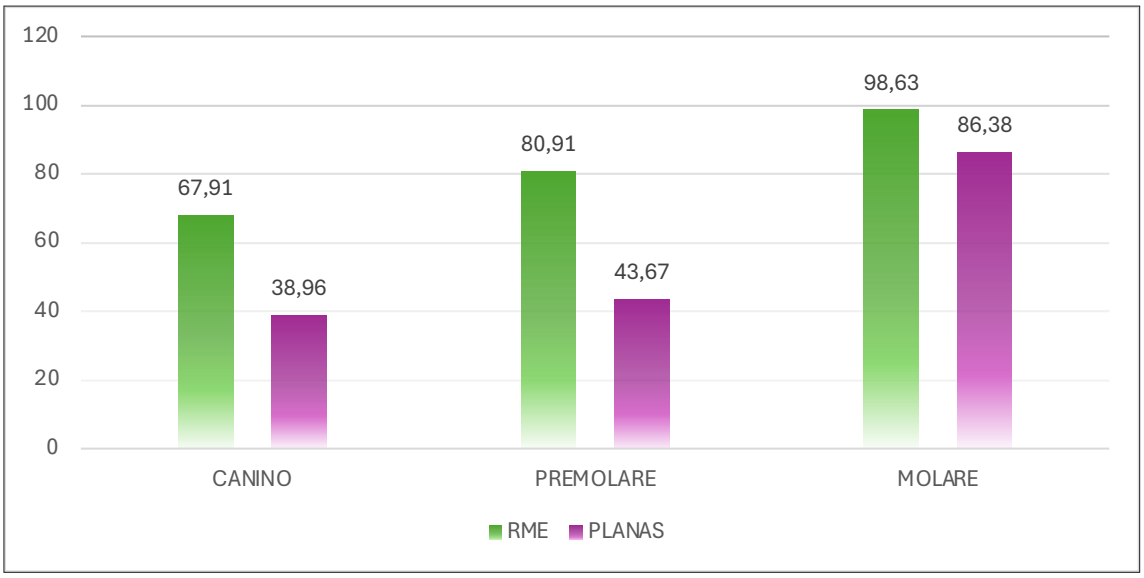
Graph 1: Comparison between occlusal and alveolar changes (mm) obtained with Planas



Graph 2: Comparison between occlusal and alveolar changes (mm) obtained with RME

However, in order to further deepen the study, it was decided to integrate the measurements and quantify the alveolar expansion obtained with the Rapid Palatal Expander (RPE) and the Planas plates. To this end, for both devices, the alveolar width variation was compared with the occlusal width variation in all three sectors of the arch.

The results revealed a greater alveolar expansion at the canine (67.9%), premolar (80.9%), and molar (98.6%) levels for the Rapid Palatal Expander, compared to that



Graph 3: Comparison between the % of bodily movement with both appliances

obtained with the Planas plates (39.0%, 43.7%, 86.4%) (Graph n. 3).

Discussion

In growing patients, one of the most commonly encountered issues is the transverse deficit of the maxilla. To remedy a skeletal contraction, the use of orthopedic devices is preferred, with the Rapid Palatal Expander (RPE) being the cornerstone. Conversely, the use of removable devices is often discouraged. This preference is mainly based on the belief that the expander addresses the tipping phenomenon of teeth in the middle and posterior sectors, unlike removable plates.

Every treatment ultimately aims to achieve a satisfactory transverse correction, not only quantitatively but also qualitatively. This means a real expansion that minimizes coronal-vestibular tipping and the associated risk of relapse as much as possible.

The following study aims to shed light on this debate by qualitatively and quantitatively evaluating the expansion obtained with the Rapid Palatal Expander (RPE) and

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with Planas plates. The expansion was assessed based on the variation in intercanine, interpremolar, and intermolar widths at three different levels: occlusal, marginal, and alveolar. This approach clarified the nature of the expansion: a “pure” expansion, achieved through the bodily movement of the dental elements, or a “relative” expansion, resulting from coronal tipping.
From the measurements taken, the Planas track plates promoted a statistically significant expansion of the crowns of the canines, premolars, and molars at the occlusal level (i.e., at the cusps), as well as at the marginal level (i.e., at the gingival margin). A similarly significant alveolar expansion was observed in the premolar and molar regions, but not at the canines. This aspect may be related to the presence of a vestibular arch terminating between the canine and the first premolar, providing greater stability to the device. The addition of resin at this point may have created a pre-contact at the coronal level, away from the center of resistance of the tooth, leading to a tipping motion rather than a bodily movement.
Satisfactory results were also obtained with the Rapid Palatal Expander: statistically significant changes were observed in the transverse diameters at the canines, premolars, and molars across all three levels: occlusal, marginal, and alveolar.
Consequently, it can be stated that both devices effectively perform their transverse expansion action in the maxillary arch. The changes in arch width were greater in the sample treated with RPE compared to the sample treated with removable plates.

The RPE produced the following changes:
Canines: 1.72 mm occlusal, 1.56 mm marginal, 0.67 mm alveolar.
Premolars: 2.5 mm occlusal, 1.71 mm marginal, 1.09 mm alveolar.
Molars: 2.59 mm occlusal, 2 mm marginal, 2.24 mm alveolar.
The Planas track plates, on the other hand, resulted in the following changes:

Canines: 3.88 mm occlusal, 3.52 mm marginal, 2.63 mm alveolar.
Premolars: 3.9 mm occlusal, 4.15 mm marginal, 3.16 mm alveolar.
Molars: 4.05 mm occlusal, 4.43 mm marginal, 3 mm alveolar.
The more substantial expansion achieved with the Rapid Palatal Expander is attributed both to the orthopedic action of the device and to the fact that the device is fixed, unlike the removable Planas plates.
However, to further explore the study, we decided to integrate the measurements and quantify the alveolar expansion obtained with both the Rapid Palatal Expander and the Planas track plates. For this purpose, the alveolar width changes were compared to the occlusal width changes in all three sectors of the arch. The results showed a greater alveolar expansion at the canine (67.91%), premolar (80.91%), and molar (98.63%) levels with the Rapid Palatal Expander, compared to the expansion achieved with Planas plates (38.96%, 43.67%, 86.38%).

As a result, the expansion obtained with the RPE protocol was not only more efficient in terms of quantity but also in terms of quality, as it was associated with bodily dental movement in all three sectors. In contrast, the Planas plates exhibited alveolar expansion almost equal to occlusal expansion only in the molar sector, with bodily movement of these elements. The percentage of alveolar expansion in the premolar and canine sectors was notably lower than that of occlusal expansion, confirming the occurrence of vestibulo-coronal tipping of these elements. Based on these observations, we can continue to hypothesize that the lingual resin at the vestibular arch, which lies between the canine and premolar, interferes with the pure translatory movement fundamental to the Planas philosophy (24,25,26).
Nevertheless, in the molar sectors, bodily movement in expansion was noted with both protocols. In fact, while the expander acts on the median palatal suture and expands the maxilla orthopedically, the Planas plates are designed in such a way that the resin only contacts the equator of the dental elements, promoting bodily movement and resulting in a corresponding basal expansion of the maxilla (20).
Undoubtedly, the results align with the age of the two groups recruited for the study. The fact that the patients were in mixed or early permanent dentition ensured two homogeneous groups where the use of an expander could favor primarily orthopedic, and minimally orthodontic, action. If the patients had been older, the interdigitation of the median palatal suture and the increased internal resistance of the maxilla would have reduced the purely orthopedic effect of the RPE, favoring coronal tipping (28,29).

Conclusions

In light of the results obtained, both the Planas track plates and the Rapid Palatal Expander (RPE) can be considered effective devices for resolving transverse maxillary deficiency. The RPE is more effective in terms of transverse millimetric expansion and minimizing coronal tipping at the canine, premolar, and molar levels. The Planas plates allow for satisfactory millimetric expansions, with bodily movement occurring only at the molar level. Therefore, except in cases where separation of the median palatal suture is required, such as in cases of reduced nasal airway diameter, the Planas track plates may represent a valid alternative to the use of the RPE.
However, the limitations of this study must be considered, such as the modest sample size and the lack of a control group.
For the future, it might be worth expanding the sample size and comparing it to a control group. Additionally, it could be interesting to analyze the samples not only immediately post-treatment but also in the long-term post-treatment phase.

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