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TOOTH-BORNE VS BONE-BORNE RAPID MAXILLARY EXPANDERS USING CBCT IMAGES: A NARRATIVE REVIEW

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Abstract

CONTEXT: In the stomatognathic system, there are alterations at the transverse level of the upper jaw which can be treated with expansion devices with dental and skeletal anchorage, these have advantages or disadvantages according to their design and skeletal age.

OBJECTIVE: This narrative review analyzes the scientific literature on the effects of dental-supported and skeletal rapid maxillary expansion with the use of cone beam computed tomography (CBCT).

MATERIALS AND METHODS: An exhaustive search of digital databases was carried out to find relevant publications. Information was searched in English, Spanish and Portuguese. The search was performed in Pubmed, Springerlink, Google Academic, and Scielo. Articles such as editorials, literature reviews, letters to the editor, experimental animal studies and short communications were excluded. Studies such as case controls, systematic reviews, clinical cases, and meta-analyses were included.

RESULTS: Initially, 239 articles were identified and reviewed for relevance. One hundred ninety-nine studies were excluded as they did not meet the eligibility criteria. Forty-one studies were included, among them, 8 systematic reviews from which 2 were extracted data of major relevance, 1 prospective study, 19 clinical trials, 1 case report, 1 finite element study, 1 descriptive study, 1 pilot study, 9 retrospective studies were processed for data extraction.

CONCLUSIONS: MARPE-type devices have a greater skeletal effect to dental-supported devices, and fewer dental-alveolar side effects, however, these effects depend on the skeletal age of the individual, the design and the placement site.

1. INTRODUCTION

Rapid Maxillary Expansion (RME) is a routine procedure for the correction of transverse maxillary defects.[1,2] Although, in general, RME has been recognized as a safe and reliable treatment in growing patients,[3] It can cause alveolar flexion and buccal inclination of the affected teeth, which can favor the appearance of collateral periodontal effects, such as loss of bone thickness and marginal bone level, vestibular inclination of the crown in upper molars, extrusion of molars and greater dental expansion than skeletal expansion.[4,5]

Therefore, the RME device with bone anchorage was introduced in an attempt to reduce or eliminate dental side effects and increase the skeletal expansion ratio.[6,7] Microimplant Assisted Rapid Palatal Expansion with Bone Anchorage (MARPE) was proposed by Lee et al. in 2010[8], to avoid adverse dentoalveolar effects and to allow palatal expansion in patients with late skeletal maturation.[9,10]

The feasibility and predictability of this treatment in patients with advanced skeletal maturation remain controversial due to the increased bony strength of the palatal sutures in late adolescence and a possible dental-periodontal effect of RME.[11] Surgically Assisted Rapid Maxillary Expansion (SARME) has been recommended as a treatment option in these cases,[12] However, increased morbidity and cost issues have resulted in poor patient acceptability. Recently, a mini-screw-assisted rapid palatal expansion procedure was proposed,[13] (MARPE) which allows transverse skeletal correction without severe periodontal side effects in anchored teeth and the biological damage caused by SARME,[14] the load is distributed directly on the upper jaw, there is less rotation and tilt of the jaw complex and less stress on the supporting tissue.[4]

Fundamentally, the use of CBCT allows for providing accurate information on how expansion affects skeletal, dental and periodontal structures, thus CBCT has become safe and simple for planning mini-screw placement in all orthodontic cases requiring skeletal anchorage.[15.16]

In this review, the objective was to analyze the scientific literature on the effects of rapid dental-supported and skeletal maxillary expansion with the use of cone beam computed tomography (CBCT).

2. MATERIALS AND METHODS

An exhaustive search of the electronic database was carried out to find relevant publications. Information was searched in English, Spanish and Portuguese. The keywords used were (Orthodontic Anchorage Procedures OR MARPE) AND (Palatal Expansion Technique/Effects OR Rapid maxillary expansion) AND (Molar) AND (Maxilla). The search was performed in the following databases: Pubmed, Springerlink, Google Academic, and Scielo. Studies such as systematic reviews, prospective studies, clinical trials, case reports, descriptive studies, and retrospective studies were included. Articles such as editorials, literature reviews, letters to the editor, experimental animal studies and short communications were excluded.

3. Selection of studies

Initially, 239 articles were identified and reviewed for relevance. One hundred ninety-nine studies were excluded based on eligibility criteria. Forty-one studies were included, including 8 systematic reviews from which 2 were extracted data of major relevance, 1 prospective study, 19 clinical trials, 1 case report, 1 finite element study, 1 descriptive study, 1 pilot study, 9 retrospective studies were processed for data extraction, and 1 retrospective study was processed for data extraction.

3.1 Rapid Maxillary Expansion Devices (RME)

3.1.1 Expansion devices without skeletal anchorage

The studies reviewed evaluated the Hyrax device, which consists of a horizontal screw secured to the maxillary molars and premolars with orthodontic bands connected by 0.036" steel wire. In this treatment, heavy force is applied to the anchored teeth beyond the limits required for orthodontic movement, resulting in hyalinization of their periodontal ligament and thus transferring the load to the maxilla, allowing the opening of the mid-palatal suture.[4]

3.2 Expansion devices with mini-screws

In the systematic review and meta-analysis, Copello et al.[4] refer that "MARPE devices have been recommended as a suitable therapy for the correction of a transverse maxillary deficiency in patients in whom the mid palatal suture is partially or fused".

To enhance expansion and reduce dental side effects, several types of skeletally anchored RMEs have been developed. These devices can provide different results depending on their design and the activation protocol.[17]

Lee et al.[8] in 2010, described for the first time the efficacy in the palatal expansion of a mini hybrid screw and tooth-anchored expander (MARPE) in a single case report of a 20-year-old individual. Coloccia et al.[15], in a systematic review state, that "Maxillary expansion has evolved in recent years. It shows that hybrid anchorage expansion with two mini-screws and anchorage of upper first molars did not show the undesirable effect of excessive dentoalveolar expansion, so it was considered an alternative method to SARPE (Surgically Assisted Rapid Palatal Expansion) in late adolescents in need of skeletal expansion". After 10 years, a recent meta-analysis confirmed that "mini-screw assisted rapid palatal expansion (MARPE) could decrease buccal alveolar bone loss compared to conventional palatal expansion"[4]

3.2.1 MARPE device design

Tooth-supported RME devices (Hyrax)[18–20,21,22,23,24] , supported by bone [18–20], supported by teeth and bone (MSE)[25,24,26,27,28,29] and the bone and tissue supported (C-Expander)[25,23,30] behave differently. In addition, the position of the expander can alter the fulcrum position and expansion pattern, which is essential to understanding the expansion configuration of each device.[31]

3.2.2 Tooth- and bone-supported jaw expansion devices (MSE)

The Maxillary Skeletal Expander (MSE) is a particular type of MARPE device that differs from the others because it promotes the bicortical coupling of the four mini-screws on the palate bone and the nasal floor. [27]

Moon et al.[25] describe that the tooth and bone-supported maxillary expansion device is composed of four stainless steel arms between 1.5mm and 1.8mm in diameter welded to the molar bands to stabilize the MSE and an expansion screw to stabilize the posterior tooth segment. Four custom stainless-steel tubes, (inner diameter: between 1.8mm and 2.0 mm; outer diameter: 3.0 mm; length: 3.0 mm) laser welded directly or indirectly to the leveling screw body. This device has four 1.5 mm diameter, 11 mm long mini-screws placed in the posterior part of the palate with bicortical anchorage (Figure 1).

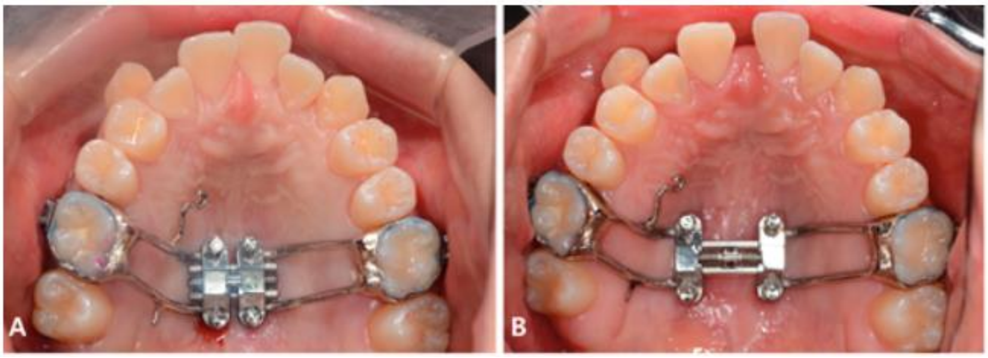

Figure 1. Tooth bone-borne maxillary expander MSE. A: before RME. B: after RME. Reproduced from Moon et al. 2019[25], with permission from EH Angle Orthodontists Research & Education Foundation, INC

3.2.3 Bone and tissue-supported jaw expansion device (C - EXPANDER)

The bone and tissue supporting the maxillary expansion device distribute the force to the palatal tissue and basal bone. It is composed of an expansion screw supported by four mini-screws, with a diameter of 1.8 mm and a length of 8.5 mm implanted through the acrylic part of the expander. Two anterior mini-screws are placed between the canines and the first premolars and two posterior mini-screws between the second premolars and the first molars[25] (Figure 2).

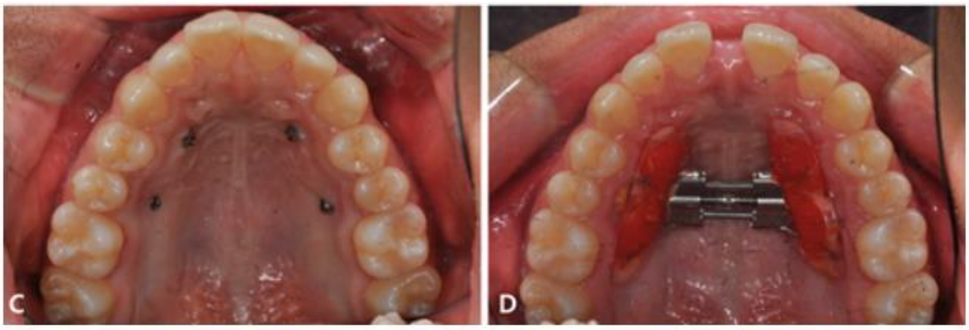

Figure 2. Tissue bone-borne maxillary expander (C-expander) before treatment (C) and after expansion (D). Reproduced from Moon et al. 2019[25] with permission from EH Angle Orthodontists Research & Education Foundation, INC

In the study by Lee et al.[32] in terms of stress distribution, an RME supported by bone and tissue (C-Expander) placed on the palatal slope showed the lowest stress concentrations without buccal tilt of the dentition compared to other types of RMEs, including a bone RME with mini-screws placed near the mid-palatal suture.

3.2.4 Bone-supported jaw expansion device

Celenk-Koka et al.[18] mention that the device has two expansion screw extension arms that were placed and laser-welded onto the copings in the laboratory, the appliances were mechanically inserted into the heads of the miniscrews and retained by friction. Four miniscrews (1.8 mm × 9 mm, Orlus, Ortholution Co, Seoul, Korea) were placed at a palatal distance of 6 to 8 mm from the gingival margin of the teeth with perpendicular insertion into the alveolar bone between the roots using a contra-angle handpiece (Unitek REF 504-315, 3M Unitek, Monrovia, California). The anterior mini-screws were placed bilaterally between the roots of the first and second premolars, and the posterior mini-implants were placed between the roots of the second premolars and first molars (Figure 3).

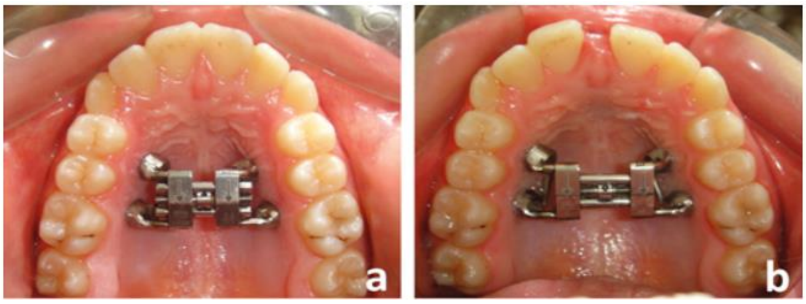

Figure 3. Pre- (a) and post-expansion (b) occlusal photographs of a patient from the miniscrew-supported (bone-borne) RME group. Reproduced from Celenk Koca et al. 2018[18]

Celenk - Koca et al.,[18] report that these new expander designs offer more bone anchorage than traditional RMEs on teeth; however, the results varied significantly from device to device due to the difference in device design. Even with bone anchorage, significant dentoalveolar changes have been reported in several MARPE studies.[31,33,34]

Clinical control studies demonstrated that placing the expansion screw in the posterior part of the palate, medial to the zygomatic buttresses, distributes the separation force along the entire length of the suture and thus promotes a more parallel division.[27,31]

3.2.5 Dresden Bone Anchored RME

Lagravère et al.[21] report that it was first used in Germany for the correction of maxillary constriction in adults undergoing surgical EMR, as reported by Tausche et al.[21,35] is a design supported by a palatal implant on one side and a mini-screw on the other side.

Taken from Lagravère et al.[21] a) tooth-anchored; b) bone-anchored expander; c) Dresden B-RME: Mini-Hyrax jackscrew supported by palatal implant (implant-side) on one side and TAD (TAD- side) on the other

3.3 ACTIVATION

According to Coloccia et al.[15] in the systematic review describes that the activation protocols in MARPE were almost the same in 10 studies [18–22,24,27,28,30,31], being two-quarters of a round per day. But the amount of expansion was different for all studies because it depends on the amount of skeletal discrepancy. It is important to emphasize that different types of MARPE devices were used in these studies. Finally, all studies described that the end of activation is when the occlusal contact between the palatal cusps of the upper posterior teeth and the vestibular cusps of the lower posterior teeth were overcorrected by the skeletal discrepancies.

Cantarella et al.[27] in 15 subjects with a mean age of 17.2 years; range, 13.9-26.2 years indicates that the expansion rate was two quarter turns per day (0.25 mm each) until an inter-incisal space appeared, then activation was performed once per day which corroborates Moon et al.[25] After the expansion, the MARPE remained blocked for at least 3 months to stabilize the expansion.

Zong et al.[26] suggest starting maxillary expansion 2 weeks after mini-screw placement and the rate of activation depends on the chronological age of the patient, as Copello et al.[4] report that the screw opening started after a healing period of seven days after the insertion of the anchorage devices.

4. Dental and skeletal alveolar effects of hyrax vs. marpe

The studies mentioned in the manuscript report that the greatest effects are produced on the height, width and flexion of the alveolar bone, as well as on the intermolar inclination and width and on palatal and nasal expansion, which are detailed below.

4.1 Alveolar changes

4.1.1 Loss of alveolar height at the level of the first permanent molars.

A systematic review conducted by Khosravi et al.[36], where the inclusion criteria are patients over 18 years of age, the evidence shows that in MARPE the loss of alveolar ridge height is from 0.24 mm to 1.24 mm.

Jia et al.[17,29] report that there is greater benefit in the use of bone- and tooth-supported devices, comparing the MSE versus the Hyrax they found 0.4mm on the right side; 0.7mm on the left side and 1.56 right; 1.95 left respectively.

While Moon et al.[25] report that the devices supported by tissue and bone (C-Expander) have less reduction of alveolar height $p < 0.01$ compared to the MSE (Table 2).

4.1.2 Loss of vestibular alveolar bone width at the level of the first permanent molars

In 28 patients who participated in a controlled clinical study conducted by Lin et al.[23] In the C-expander group and Hyrax group, there was a less alveolar bone loss, but it was not significant ($p > 0.05$).

However, Celenk-Koca et al.[18] a lower loss of vestibular alveolar bone was observed, being statistically significant $p < 0.01$ in the group treated with the bone-supported device compared to Hyrax for both premolars and molars (Table 1).

4.1.3 Flexion of the alveolar bone

Lin et al. [23] observed that alveolar flexion was 2 times more in the Hyrax group compared to the C-expander group except in the second molar region (Table 2).
Whereas Moon et al.[25] the group treated with the MSE presented less flexion of the alveolar bone at 0.74° compared to the C expander at 2.18° (Table 2).
Bazargani et al.[24] found greater alveolar bone bending effects on the palatal slopes on the right side and less on the left side comparing the MSE with the Hyrax device, the authors concluded that there was no significant difference (p=0.78) (p=0.41) between the two groups (Table 3).

4.2 Dental changes

4.2.1 Buccal inclination of the first permanent molars.

Bazargani et al.[24] indicate that on the right side there was greater inclination, while on the left side it was less, when purchasing the MSE with the Hyrax devices, however, there was no statistical difference $p< 0.05$ between the two groups of dental-supported (Hyrax) and tooth and bone supported (MSE) on alveolar inclination after 1 year (Table 3).
Some studies [23,21,20,18] show that molar inclination was significantly higher with the Hyrax device compared to bone-supported, bone-tooth-supported and bone-tissue-supported devices (Tables 1,2,3).

4.2.2 Intermolar width

Lin et al.[23] determined that the intermolar width at the level of the crowns was greater in the Hyrax device (2.3±1.2 mm) than in the C-expander (Table 2).
Mehta et al.[19,21] The bone-supported device presented a greater intermolar width (5.24 mm) than the Hyrax group (4.2 mm), which is not statistically significant (Table 1).
On the contrary, Kavand et al.[20] found that the intermolar width was greater in Hyrax devices compared to bone-supported devices (p= 0.3241).

4.3 Skeletal Changes

4.3.1 Palatine width

Mehta et al.[19] found greater palatal width with the bone-supported devices (2.07 mm) than the Hyrax (1.1 mm) which is statistically significant, (Table 1) while Kavand et al. [20] compared palatal width, which was greater in the bone-supported devices than in the Hyrax group, but there was no significant difference ($p > 0.05$).

4.3.2 Nasal floor width

Celenk Koca et al.[18] report that there was a significant difference in nasal floor width using the bone-supported devices (2.9±1.7mm) compared to the Hyrax group (1.2±1.1).

While Bazargani et al.[24] used the Dresden Bone-Borne device and Lagravère et al.[21] the device supported by bone and teeth, and finding greater expansion in the width of the nasal floor, despite this, both authors found no significant differences (Table 4 and Table 3) which is corroborated by Khosravi et al.[36] and Lagravère et al.[21] which presented similar results in dental and skeletal expansion but did present a significant difference in comparison with the control group.

5. DISCUSSION

In this narrative review, it was decided to classify and group the data obtained by device design, which are shown in Tables 1, 2, 3 and 4 to obtain more accurate results.
Three of the selected studies compared the bone-anchored MARPE device alone and the Hyrax device with dental anchorage.[18–20]

Celenk Koka et al.[18] showed that in patients 13.69 ± 1.74 years of age, no statistically significant differences in intermolar width were found (Table 1), coinciding with Metha et al.[19] y Kavand et al.[20] Several factors may have influenced the results mentioned above, among them, it is important to highlight that being in adolescence and not yet having skeletal maturity is an advantage for Hyrax.

In the palatine width, Metha et al.[19] and Celenk Koca et al.[18,20] observed that the device transmitted by bone anchorage provided greater expansion at the level of the palatal suture being statistically significant, likewise Kavand et al.[20] The results indicate that in the width of the nasal floor they found greater effectiveness in the bone anchorage device with a value of $p > 0.05$.

While in the external maxillary width located in the depth of the concavity of the lateral external walls of the maxillary sinuses Metha et al.[19,20] and Kavand et al.[20] agree that expansion presented similar results in the bone-supported and tooth-supported device with no significant statistical difference.

It is worth mentioning that decreased buccal alveolar bone thickness and the presence of bone dehiscences are commonly reported after routine EMR, especially in anchorage teeth, such effects are caused by osteoclast resorption that occurs when the teeth cross the vestibular table.[37–40]

Celenk Koka et al.[18] demonstrate that in the devices with skeletal anchorage there is less loss of buccal alveolar bone being -0.10±0.1 while the conventional RME -0.24±0.2 with a statistically significant difference $p< 0.05$.
It has been reported that almost half of the expansion obtained at the alveolar level after an RME procedure is due to alveolar flexion towards the vestibular.[41] The same occurs with some MARPE devices, the maxillary halves show a buccal rotation, with the center of rotation located near the frontonasal suture.[41] For this reason, buccal tooth inclination and alveolar flexion occur. However, Celenk Koca et al.[18] indicate that alveolar bending is lower $p< 0.05$ in bone-borne devices.

Regarding molar inclination in this group, only Kavand et al.[20] take this measure into account and add that it was higher in the device with dental anchorage, the results being higher on the right side than on the left and statistically significant.

Among the articles found two of them reported by Lagravère et al.[21] and Davami et al.[22] use the Dresden Bone-anchored Maxillary Expansion and the Hyrax Rapid Palatal Expansion in 13-14-year-old patients.[21]

In the results found Lagravère et al.[21] state that the intermolar width is greater in the Hyrax type dental anchorage device, where $p< 0.05$, while Davami et al.[22] (Table 4) The Dresden type device presents greater intermolar width, although no statistically significant difference was found between the two devices. This finding may be because they take different brands to measure the intermolar width or that the device does not present a greater benefit.

Regarding the width of the nasal floor, according to Lagravère et al.[21] similar values between both devices, Type Dresden 1.31 mm followed by Hyrax 1.27 mm (Table 4).

Regarding the width of the vestibular alveolar bone at the molar level, Lagravère et al.[21] indicate that there is no statistically significant difference in the dental and skeletal anchorage devices, being greater in the Dresden type device at 1.51mm and Hyrax at 1.40mm, otherwise, Davami et al.[22] reports that the skeletal anchorage device has less reduction of the vestibular alveolar bone width (1.74±2.48) while the dental anchorage device shows 3.11±2.18mm, however, Davami et al.[22] does not indicate the *p*-value. Both treatment groups showed a slightly asymmetric expansion. Dental asymmetry in the Hyrax device was greater than in the Dresden type, especially in the premolar area.

The systematic review by Copello et al.[4], shows that the width or thickness of the alveolar bone is smaller in the MARPE devices, being *SMD=0.55; 95% CI: 0.29-0.80;* $p<0.0001$*,* however, the author clarifies that the quality of evidence is low.

Cantarella et al.[27] describe only the dental and skeletal anchorage device (MSE) without comparing it with another and it is observed in individuals 13.9-26.2 years of age that there was an expansion of 4.75±2.59 at the level of the anterior nasal spine and *4.33±1.74* at the level of the posterior nasal spine, an additional data revealed by this article is the separation of the right (1.35±1.79) and left (2.17±2.45) pterygo maxillary process demonstrating the skeletal effect on the adjacent sutures.

On the other hand, in the study conducted by Moon et al.[25] comparing the MSE devices with the C-Expander in subjects between 18 and 19 years of age, it was observed that there was a statistically significant difference in the intermolar width, with greater dentoalveolar expansion in the devices supported by bone and teeth (4.91mm) than in the devices supported by bone and tissue (4.01mm) $p<0.05$.

Molar inclination was higher for the group treated with bone- and tooth-supported devices; another study presents similar results,[29] this may be due to stress accumulating on the anchor teeth and hard palate and the diameter of the micro implants was 1.5 and the holes for the micro implants in the expansion devices were 2 mm in diameter causing an initial direct load on the teeth.[26,29]

Meanwhile, the alveolar inclination was higher for the group supported by bone and tissue (1.4°) compared to those supported by bone and teeth (0.2°) being statistically significant, similar results showed in other studies.[23,30]

In terms of external maxillary expansion there was no statistically significant difference between bone and tooth-supported devices (2.45mm) and bone and tissue-supported devices (2.38mm), so both devices generate similar expansions (Table 2).

But when comparing bone- and tissue-supported devices with tooth-supported devices (Hyrax), as in the study of Lin et al.[23] in which subjects between 17 and 18 years of age participated, the Hyrax devices achieved greater intermolar width $(p=0.035)$.

The amount of alveolar bone flexion towards the vestibular was more than twice as much in the group treated with tooth-supported devices than the bone and tissue-supported devices with statistically significant values (p=0.027), this greater alveolar bone flexion in the dental anchorage devices is due to the two halves of the maxillary bone being rotated, with the central expansion vector at the frontonasal suture in the coronal plane.[31]

The skeletal changes that occur according to Bazargani are as follows et al.[24] when expansion is performed in patients aged 9.3 ±1.3 years are greater for patients treated with bone and tooth-supported devices (2.3mm) while those with tooth-supported devices (1.8mm). As for the alveolar inclination when comparing the bone and tooth-supported (5.4° right and -3.5° left) it was greater than the tooth-supported (5° right and 4.5 left) and no statistically significant difference was found between the two groups. The molar inclination showed that the bone and tooth-supported molar inclination was lower on the left side and higher on the right side.[24]

Likewise, Khosravi et al.[36] who conducted a recent systematic review found that both tooth-supported and tooth and bone-supported devices give the same results in terms of quantity in terms of tooth inclination.

6. LIMITATIONS

In the present investigation, limited literature was found in which jaw expansion was compared with devices of the same design, age, activation, and benchmarks to measure the effects produced.

7. CONCLUSIONS

It was found that in the bone-supported devices there was greater expansion in the external maxillary, intermolar and palatal width in patients aged 13.69 ± 1.74 compared to those aged 14.7 ± 1.4.

Palatal width is greater and alveolar bone width loss is less in bone-supported devices, while alveolar flexion and molar tilt are less in bone- and tissue-supported devices. Limited evidence was found.
As for the Dresden-type expansion device, due to its complexity in design, elaboration and limited results, its use in the clinic would present difficulties.

The findings found when comparing the devices supported by bone and tooth presented greater intermolar width and inclination compared to the devices supported by bone and tissue, which presented greater alveolar inclination.

In the tooth and bone-supported devices, there is not enough scientific evidence on alveolar and molar inclination, however, the scarce evidence found indicates that there are different values on the right and left sides and it is greater in the Hyrax.

Both bone and tissue-supported devices and tooth and bone-supported devices have a greater skeletal effect than Hyrax.

It is essential to individualize the maxillary compression characteristics to choose the device design and optimize its effects.

RECOMMENDATIONS

To deepen the changes obtained in the long-term dental alveolar and skeletal effects.

ANNEXES

Table 1. Comparison between RME TOOTH-BORN and BONE-BORNE devices

AUTHOR	Celenk-Koca, T., Erdinc, A. E., Hazar, S., Harris, L., English, J. D., & Akyalcin, S. (2018).		Mehta, S., Wang, D., Kuo, C. L., Mu, J., Vich, M. L., Allareddy, V., Tadinada, A., & Yadav, S. (2021)		Kavand, G., Lagravère, M., Kula, K., Stewart, K., & Ghoneima, A. (2019).	
DISEÑO DEL ESTUDIO	Ensayo clínico aleatorizado		Ensayo controlado aleatorio		Estudio Retrospectivo	
MUESTRA	40		60		36	
APPLIANCE	Bone - Borne	Tooth - borne (Hyrax)	Bone - Borne	Tooth - borne (Hyrax	Bone - Borne	Tooth - borne (Hyrax)
AGE	13.81 ± 1.23	13.84 ± 1.36	13.69 ± 1,74	13.9 ± 1,14	14.7 ± 1.4	14.4 ± 1.3
Intermolar Width (mm)	4.5 ± 1.3	4.2 ± 1.7	5.24	4.2	3.1±1.2	4,5±0,4
p	*0.52*		*0.382*		*0.3241*	
Palatal Width (mm)	-	-	2.07	1.1	2.2±0.3	1.5±0.4
p	-		*0.001*		*0.0840*	
Nasal Floor Width (mm)	2,9±1.7	1,2±1,1	-		-	
p	0.001		-	-	-	-
External Maxillary Width (mm)	-	-	1.47	1.27	1.7±0.4	2.2±0.4
p	-	-	*0.748*		*0.3493*	
Buccal bone thickness R (mm)	-0,10±0,1	-0,24±0,2	-	-	-	-
p	*0.046*		-		-	
Alveolar Inclination R (mm)	1.3 ± 2.1	-3.9 ± 3.4	-	-	-	-
p	*0.000*		-		-	
Tooth Inclination R (mm)	-	-	-	-	0,4±0,9	3,0±0,7
p	-		-		*0.0446*	
Tooth Inclination L (mm)	-	-	-	-	1,4°±0,7	2,3°±0,7
p	-		-		*0.3671*	

Table 2 Description RME TOTH BONE-BORNE & TISSUE BONE BORNE; TOOTH-BORNE & TISSUE BONE BORNEW appliances

TABLA2

AUTHOR	Moon, H. W., Kim, M. J., Ahn, H. W., Kim, S. J., Kim, S. H., Chung, K. R., & Nelson, G. (2020)		Lin, L., Ahn, H. W., Kim, S. J., Moon, S. C., Kim, S. H., & Nelson, G. (2015)	
DISEÑO DEL ESTUDIO	Estudio retrospectivo		Estudio retrospectivo	
MUESTRA	48		28	
APPLIANCE	Tooth bone-borne	Tissue bone-borne	Tooth - borne (Hyrax)	Tissue bone-borne (C-expander)
AGE	19,2	18,1	17,4	18,1
Intermolar Width (mm)	4,91	4,01	4,45	3,46
P	0.040		0.035	
External Maxillary Width (mm)	2,45	2,38		
P	0.859			
Palatal Width (mm)	-	-	1,14±0,47	1,99±1,18
P	-		0.0043	
Buccal bone thickness R (mm)	-0,67	-0,13		
P	0.000			
Alveolar Inclination R (mm)	0,74	2,18	3,62	1,43
P	0.004		0.0277	
Alveolar Inclination L (mm)	0,88	2,35	3,67	0,66
P	0.001		0.0083	
Tooth Inclination R (mm)	2,77	0,10	5±2.35	1,16±1.2
P	0.000		0.0001	
Tooth Inclination L (mm)	2,03	0,03	8.09±5.86	1,15±1.05
P	0.001		0.0011	
Buccal Dehiscence R (mm)	1,15	0,13	0,44	0,11
P	0.010		*0,0000*	
Buccal Dehiscence L (mm)	1,51	0,03	*0,63*	*0,11*
P	0.001		*0,0000*	
Buccal alveolar bone height loss R	1,15	0,13	-0,91	-0.54
P	0,010		*0.279*	
Buccal alveolar bone height loss L	1,51	0,03	-0,59	*-0,27*
P	0,001		*0.0381*	
Transverse distances of tooth Crown (mm)			4,45	3,46
P			*0,0000*	
Transverse distances of tooth Apex (mm)			2,79	2.03
P			*0,001*	

Table 3. Comparison between RME TOTH BONE-BORNE & TOOTH-BORNE

AUTHOR	Bazargani, F., Lund, H., Magnuson, A., & Ludwig, B. (2021)	
DISEÑO DEL ESTUDIO	Ensayo controlado aleatorizado	
MUESTRA	52	
APPLIANCE	Tooth bone-borne (MSE)	Tooth - borne (Hyrax)
AGE	9,3	9,3
Nasal Floor Width (mm)	2.3	1.8
P	*0.16*	
Buccal bone thickness R (mm)	0.1	0.4
P	*0.15*	
Buccal bone thickness L (mm)	0.4	0.4
P	*0.94*	
Alveolar Inclination R (°)	5,4	5
P	*0.78*	
Alveolar Inclination L (°)	*3,5*	*4,5*
P	*0.41*	
Tooth Inclination R (°)	3,8	3.4
P	*0.69*	
Tooth Inclination L(°)	2.5	4.7
P	*0.009*	

Table 4. Changes before and after of RME TOTH BONE-BORNE & TISSUE BONE BORNE appliances.

AUTHOR	Chen Zong, Bojun Tang, Fang Hua, Hong He, Peter Ngan (2019)	Cantarella, D., Dominguez-Mompell, R., Mallya, S. M., Moschik, C., Pan, H. C., Miller, J., & Moon, W. (2017).	Li, Q., Tang, H., Liu, X., Luo, Q., Jiang, Z., Martin, D., & Guo, J. (2020)	Yi, F., Liu, S., Lei, L., Liu, O., Zhang, L., Peng, Q., & Lu, Y. (2020).	Park, J. J., Park, Y. C., Lee, K. J., Cha, J. Y., Tahk, J. H., & Choi, Y. J. (2017)
DISEÑO DEL ESTUDIO	-	Ensayos clínicos retrospectivos			
MUESTRA	22	15	22	19	14
APPLIANCE	Tooth bone-borne (MSE)	Tooth bone-borne (MSE)	Tooth bone-borne (MSE)	Tissue bone-borne (C-Expander)	Tooth bone-borne (MSE)
AGE	14.97 ± 6.16	13,9–26,2	18-35	19.95 ± 4.39	16-26
Intermolar Width (mm)	5.41±2.18	-	-	3.92±2.36	5,4 +- 1,7
Palatal Width (mm)	3.34±1.75	4,75±2,59 ENA	2,3±1,2	-	-
	-	4,33±1,74 ENP	-	1.25±0.69	-
Nasal Floor Width (mm)	2.28±1.54	-	-	1.77±1.48	-
External Maxillary Width (mm)	-	-	2,0±1,0	1.67±1.17	1.7±1.8
Buccal bone thickness R (mm)	-	-	-	-	-0.6±1.0
Buccal bone height loss (mm)					1.7±2.5
Tooth Inclination R	2,33	-	-	-	-
Tooth Inclination L	2,63	-	-	-	-
Width of opening in Rt pterygoid process (mm)	-	1,35±1,79	-	-	-
Width of opening in Lt pterygoid process (mm)	-	2,17±2,45	-	-	-

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