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Major clinical outcomes of rapid maxillary expansion in bucomaxillofacial surgery: a systematic review

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Abstract

Introduction: The techniques of surgically assisted rapid maxillary expansion (SARME) and non-surgically assisted rapid maxillary expansion (NSARME) are used to correct maxillary development through palatal disjunction. **Objective:** It was analyzed using a systematic review of the literature on the main considerations of the rapid expansion of the maxilla, evidencing its main indications, contraindications, types of expanders, as well as the main dental and skeletal alterations by them produced. **Methods:** The PRISMA Platform systematic review rules were followed. The search was carried out from February to April 2024 in the Scopus, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** 110 articles were found, 34 articles were evaluated in full and 22 were included and developed in the present systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 18 studies with a high risk of bias and 23 studies that did not meet GRADE and AMSTAR-2. Most studies did not show homogeneity in their results, with X^2=73.8%>50%. It was concluded there is still no consensus on which is the best jaw-breaker, and it is necessary to increase the number of clinical and randomized studies, with eligibility criteria that can homogenize the participants. In addition, the literature has clearly shown that bucomaxillofacial surgeons must have the knowledge and clinical experience to be able to indicate the best procedure for each patient, that is, the rapid expansion of the non-surgical or surgical maxilla.

Keywords: Rapid maxillary expansion. Deficient maxillomandibular. Bucomaxillofacial surgery. Aesthetic.

Introduction

In the context of rapid maxillary expansion, transverse deficiencies are the main predictors of dentofacial deformities with high prevalence in dental practice [1,2]. Thus, patients may present with dental crowding, mandibular discrepancies, tooth mobility, multiple dental losses, gingival recessions, respiratory difficulties, repetitive sinusitis, and mouth breathers. In this sense, the techniques of surgically assisted rapid maxillary expansion (SARME) and non-surgically assisted rapid maxillary expansion (NSARME) are used to correct maxillary development through palatal disjunction [1-3].

Rapid maxillary expansion (RME) is an efficient technique in the attempt to compensate for the deficient maxillomandibular relationships initially described by Angell 1 (1860) and Haas (1961) [1]. It has as its main objective the maxillary disjunction through palatal expanders and, therefore, improves the transversal dimension of patients affected by maxillary deficiencies [4].

In this context, NSARME is contraindicated in

patients with complete bone maturation and, for these cases, surgical rapid maxillary expansion (SARME) is indicated, which is preferable with Hyrax or Haas expander [5]. The study of maxillary discrepancies is currently an area of great scientific interest in dentistry. SARME can be performed by maxillary osteotomy and palatine associated with a palatal expander, or LeFort I osteotomy associated with maxillary segmentation [4-9].

From the Haas dental orthodontic expander, many others were developed, including the modified Haas and the Hyrax apparatus. The latter is a supported dento expander that leads to greater posterior dentoalveolar inclinations if compared to the Haas expander [10]. In this scenario, the choice of a breaker for maxillary correction is important and can be selected by the main predictors such as bone structure, alveolar processes, the presence or absence of dental elements, the hygiene of the patient, the dentition to be mixed or not, the need for a greater anterior or posterior increase, dentoalveolar inclinations, interdental distances, vertical destabilization and age [1,11].

Although it is a satisfactory procedure in children and adolescents, the technique of rapid non-surgical expansion presents failures in adult patients because, with skeletal maturation, the response to expansion forces is diminished. The median palatine suture was considered to be the area of greatest resistance to expansion, however, it has been shown that the areas of increased resistance are zygomatotemporal, zygomatrontal, and zygomatomaxillary sutures. Adding to this is the decrease in bone plasticity, which makes the maxillary forces dissipate in the maxilla [3,4].

Several maxillary osteotomies were developed to expand the maxilla laterally, along with rapidly expanding orthodontic procedures [3,12]. More recently, it has been shown that only osteotomies in maxillary abutments are sufficient to achieve expansion. These osteotomies may or may not be complemented by a buccal osteotomy between the roots of the central incisors [12]. The rapid expansion of the surgically assisted maxilla is an effective procedure but is restricted to patients who present only maxillary transverse problems. In cases of deficiencies in other plans, the surgically assisted expansion can be performed as a first surgical time, not excluding the correction of the other plans in a subsequent surgery. Currently, when transverse maxillary deficiency is associated with others, the patient may undergo a single surgical procedure, in which this atresia is corrected with multisegmentated maxillary osteotomy [2,3].

The rapid expansion of the surgically assisted maxilla is an effective and safe procedure for the correction of transverse deficiency in adult patients [1,3]. Among its advantages, we can mention the speed to obtain the expansion, the safety for corrections of up to 14mm, and the possibility of using local anesthesia, which reduces the cost of the procedure. A correct diagnosis of the transversal deficiencies of the maxilla and a treatment plan performed jointly by the orthodontist and the maxillofacial surgeon make possible the correct correction of these deficiencies and the satisfaction of the patients [1-3].

Therefore, the objective of the present study was to analyze using a systematic review of the literature on the main considerations of the rapid expansion of the maxilla, evidencing its main indications, contraindications, types of expanders, as well as the main dental and skeletal alterations by them produced.

Methods

Study Design

The present study followed the international systematic review model, following the rules of PRISMA (preferred reporting items for systematic reviews and meta-analysis). Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 03/19/2024. The methodological quality standards of AMSTAR-2 (Assessing the methodological quality of systematic reviews) were also followed. Available at: https://amstar.ca/. Accessed on: 03/19/2024.

Data Sources and Research Strategy

The literary search process was carried out from February to April 2024 and was developed based on Scopus, PubMed, Web of Science, Lilacs, Ebsco, Scielo, and Google Scholar, covering scientific articles from various to the present. The descriptors (MeSH Terms) were used: *"Rapid maxillary expansion. Deficient maxillomandibular. Bucomaxillofacial surgery. Aesthetic"* and using the Boolean "and" between the MeSH terms and "or" between historical discoveries.

Study Quality and Risk of Bias

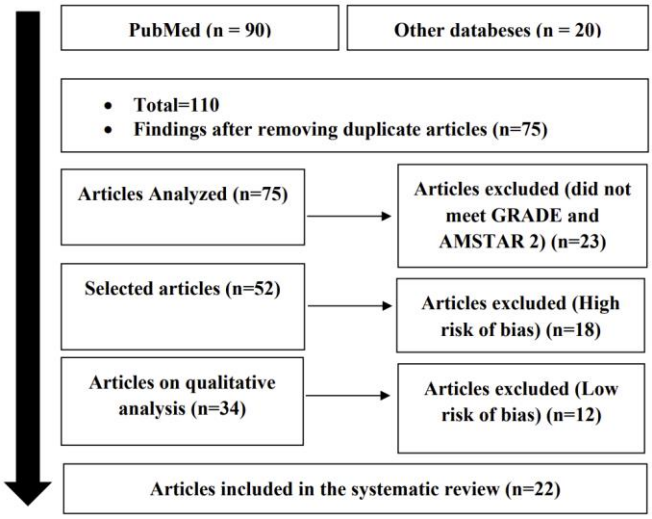
Quality was classified as high, moderate, low, or very low in terms of risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. The low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using the Cohen test (d).

Results and Discussion

Summary of Findings

A total of 110 articles were found that were subjected to eligibility analysis, with 22 final studies being selected to compose the results of this systematic review. The studies listed were of medium to high quality (Figure 1), considering the level of scientific evidence of studies such as meta-analysis, consensus, randomized clinical, prospective, and observational. The biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies showed homogeneity in their results, with X^2=73.8%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 18 studies with a high risk of bias and 23 studies that did not meet GRADE and AMSTAR-2.

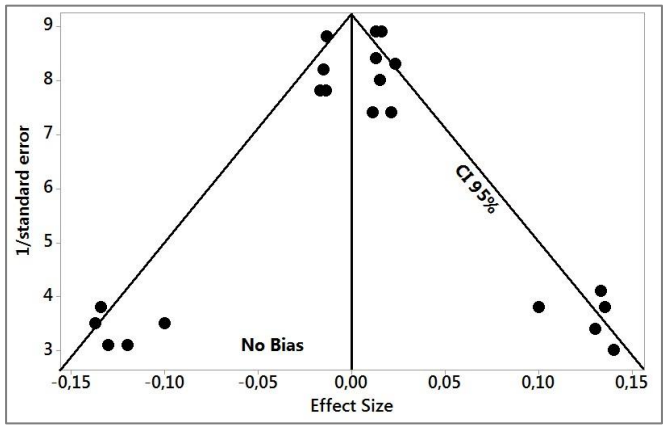
Figure 1. The article selection process by the level of methodological and publication quality.



Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using the Cohen Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both between studies with a small sample size (lower precision) that are shown at the bottom of the graph and in studies with a large sample size that are presented at the top.

Figure 2. The symmetric funnel plot suggests no risk of bias among the small sample size studies that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=22 studies).



Source: Own Authorship.

Major Approaches and Clinical Results

The main considerations regarding the use of SARME and NSARME were listed (Table 1). The surgical expansion of the maxilla with an expander, and local anesthesia is used in 100.0% of clinical cases [1-3]. Maxillary multi-segmentation solves almost all clinical cases where maxillary atresia is present, allowing the accurate correction of this atresia and correct positioning of the teeth in occlusion, with important postoperative stability. Thus, the surgical expansion of the maxilla with the use of the Hyrax expander has become a poorly indicated procedure, since the great majority of patients with maxillary atresia also have other vertical and/or sagittal bony bases of the face. In this context, however, the rapid expansion of the surgically assisted maxilla presents as a safe and easy procedure to be performed in the office and is also a low-cost and acceptable procedure for patients [3,4].

Table 1. Major Considerations on the SARME and NSARME.

Major Considerations On The SARME and NSARME	References
✓ SARME is indicated for complete bone maturation, transverse deficiencies greater than 5mm, isolated transverse deformities, transverse deformities associated with vertical and / or anteroposterior deformities, and in transverse maxillary deficits with greater involvement in the anterior region.	[1,3]
✓ NSARME is indicated for patients with incomplete bone maturation, and there is no consensus in the literature regarding the best age for treatment.	[3,12]
✓ The Hyrax expansor are better hygienic and indicated for SARME, while the Haas have better distribution of forces because they have an acrylic covering that rests on the palate.	[13]
✓ Both NSARME and SARME improve upper airflow, decreasing respiratory distress, since they promote the increase of the air cavity.	[1,2]
✓ There is no significant improvement in the results of the expansion when the osteotomy of the pterygoid pillar is performed.	[1,4]

✓ SARME is more clinically stable when compared to the segmental expansion and is also recommended for clinical cases with marked discrepancy and vestibular slope of molars.	[1,2]
✓ The contraindications of this procedure are excessive maxillary prognathism, bimaxillary protrusion, isolated crossbites and patients with excessive vertical development of the face;	[2,3]

Source: Own Authorship.

A recent clinical study evaluated and classified complications in patients treated for maxillary transverse deficiency using surgically assisted rapid maxillary/palatal expansion (SARME/SARPE) under general anesthesia. The retrospective study covered 185 patients who underwent surgery for skeletal deformity in the form of maxillary constriction or in which maxillary constriction was one of its components treated by a team of oral and maxillofacial surgeons from one center (97 women and 88 men, aged between 15 years and to 47 years old). In the study group, complications were found in 18 patients (9.73%). Early complications were found in nine patients, while late complications were also found in nine patients. Early complications include lack of possibility of distraction, necrosis of the palatal mucosa, perforation of the maxillary alveolar process caused by the distractor, and asymmetric distraction. Late complications include root resorption of the upper incisors, lack of bone formation in the distraction gap, and necrosis of the upper incisors [14].

Furthermore, the arches that were segmented are also easier to orthodontically terminate after surgical treatment, to the extent that some experienced orthodontists systematically prefer upper arch segmentation not only to treat it transversally but also to finalize better and faster clinical cases [1-4]. In the historical follow-up of the scientific works, the authors Garib et al. (2014) [15] used the Haas and Hyrax expanders in 11 girls between 11 and 14 years of age, divided into two groups and did not observe, for transverse maxillary expansion, representative differences in the two groups; however, the inclination of maxillary premolars was superior in Hyrax expanders.

Other authors obtained satisfactory results in their study employing the SARME technique, where they performed a LeFort I osteotomy, separating the pterygoid blades and activation of the Hyrax expander apparatus. The authors stated that an ERM treatment should take into account the age group of the patient [12].

The areas of bone resistance in the jaw are palatine suture, frontal suture, zygomatictemporal suture, intermaxillary suture, and, mainly, the pterygoid process, where some surgeons opt for separation since the risk of damage to the pterygoid plexus is large [1,3]. In a comparative study with 31 randomly divided patients, where the Group used the Hyrax expander and Group B the Haas expander, Scanavini et al. (2016) [13] found that Hyrax expanders demonstrated a higher risk of relapse.

In the sequence, Claro et al. (2006) [16] found significant changes in intercanal and intermolar distances using the Hyrax orthodontic appliance, thus proving a greater posterior cross-sectional increase. Thus, SARME is a safe, easy-to-perform technique and the intercurrences are usually contingent. In addition, patients are satisfied.

Still, the option for the best surgical technique of SARME is to observe some clinical criteria: transverse deficiencies greater than 5mm; isolated transverse deformities; transverse deformities associated with vertical and/or anteroposterior deformities and transverse maxillary deficits with greater involvement in the anterior region [1,3,12].

A systematic review work showed the results of some studies that used the rapid surgical expansion technique associated with a Hyrax maxillary expander in 20 patients between 15 and 54 years, obtaining a satisfactory mean final result [1]. In addition, other authors used the Hyrax and Haas appliances in 62 patients who needed rapid maxillary expansion and observed greater expansion at the first molars and maxillary premolars crowns in Hyrax appliances [5].

In the study by Rossi et al. (2011) [17], the vertical and anteroposterior effects of rapid maxillary expansion were evaluated cephalometrically using a study of 26 children, 14 females, and 12 males, with a mean age of 8.7 years, presented posterior crossbite and maxillary narrowing. A McNamara-type device made of clear acrylic resin covering the posterior teeth was used, and an expander screw was located on the palatine raphe between the second deciduous molars. The rapid expansion of the maxilla using a breaker with an occlusal acrylic cover did not promote vertical cephalometric alterations and sagittal lesions. The vertical changes were small and transient.

The work of Melgaço et al. (2013) [18] was analyzed in 31 patients with Angle Class I malocclusion, transverse palatal, and lingual changes in patients submitted to rapid maxillary expansion. The sample was divided into 2 groups, Group 1 consisting of 17 patients treated with the Haas expander, and Group 2, with 14 patients treated with Hyrax. No statistically significant differences were found when comparing the Haas and Hyrax devices.

In the study by Baratieri et al. (2014) [19], to evaluate employing computed tomography the transversal dimensions of the nasomaxillary complex of patients submitted to rapid maxillary expansion performed a study in 30, 18 of the male gender and 12

of the female. The patients were divided into two groups, and the control group consisted of 10 boys and 5 girls with a mean age ranging from 9 years to 4 months. The treated group consisted of patients who needed maxillary expansion, composed of 8 boys and 7 girls, with a mean age of 9 years and 6 months, who underwent Haas expander treatment. Was Haas and the activation protocol proposed by Haas and at the time of installation of the activation of a complete revolution (0.8mm), followed by daily activations of ¼ back in the morning and ¼ back in the evening. Therefore, there was a significant increase in the widths between the molars, maxillaries, palatal, and nasal concerning the control group.

Woller et al. (2014) [20] evaluated by computer tomography the changes that occur in the maxillary sutures in children submitted to the rapid expansion of the maxilla treated with a Hyrax-type device, carried out a study in 25 patients (10 men, 15 women) who presented discrepancies of the maxilla. The exclusion criteria selected were patients with craniofacial anomalies, including cleft lip and palate, and patients using orthodontic appliances before initiation of treatment with rapid maxillary expansion. Each patient was scanned twice: T0 and T1. The first image (T0) was obtained before the expander was installed, and the second image (T1) was obtained after the last activation of the device. Thus, there was a large displacement of the medial palatine suture, but this displacement also occurs in other sutures, such as frontonasal, intermaxillary, and zygomaticomaxillary.

Izuka et al. (2015) [21] analyzed the short-term effects of rapid maxillary expansion on the upper airway dimensions, as well as evaluating the impact of this therapy on quality of life, employing computed tomography studies, performed a study on 25 respirator patients with 14 women and 11 men. A standardized questionnaire was performed with the parents before and after the rapid maxillary expansion, aiming to evaluate if there was an improvement in the patient's quality of life. CT scans were performed before treatment, and then modified Hyraxtype appliances were installed. Therefore, rapid maxillary expansion promoted a significant improvement in the quality of life of mouth-breathing patients with maxillary atresia.

Based on the literature findings, rapid maxillary expansion is a feature used in orthodontic practice, where the middle palatine suture is opened and the craniofacial complex sutures are disorganized [1,2]. However, it is not always possible to achieve its opening, since, at the end of facial growth, its ossification occurs. Therefore, the closure of the medial palatine suture is determinant in situations of failure of rapid maxillary expansion [3].

NSARME Indications and Contraindications

The procedure of rapid expansion of the maxilla by the opening of the medial palatine suture is indicated in the treatment of malocclusions with real and relative maxillary deficiency; of chronic nasal disability who exhibit nasal respiratory problems and with problems related to arch length [1]. As contraindications, excessive maxillary prognathism, bimaxillary protrusion, isolated crossbites, and patients with excessive vertical development of the face are mentioned. To promote the opening of the medial palatine suture, there are several breaker devices, the most used being the dentifrice holder (Haas), the dento-support (Hyrax), and the dentosupport with occlusal acrylic cover [1-3].

Thus, as a literary corollary, the NSARME technique is adequate for patients with incomplete maxillary bone maturation and transverse maxillary deficiency that cannot be corrected by fixed apparatus. Another indirect benefit of maxillary expansion techniques is the improvement of upper airflow reducing respiratory distress, and promoting the increase of air cavity [8,9].

The most accepted age for performing NSARME varies widely according to the literature, being proposed for patients with a maximum age of 14 years in women and 16 years in men, according to [10]. Some authors were successful with the age range between 15 and 54 years, using the NSARME technique with a Haas expander in a 19-year-old patient, contradicting the authors who affirmed the efficacy of the technique only in patients with incomplete bone maturation [8,9].

Therefore, there is no consensus in the literature regarding a fixed age for NSARME indication. Still, there is an ineffectiveness of this technique in adult patients who have already surpassed the peak of growth. In addition to bone consolidation as a limiting factor. In addition, Rossi et al. (2011) [17] stated that the NSARME technique is contraindicated in cases of multiple dental absences, large dentoalveolar inclinations for vestibular, gingival recession, alveolar bone loss, posterior dental mobility and in adult patients with advanced skeletal maturation.

SARME Indications and Contraindications

SARME is indicated for patients with more advanced age and consequent complete bone maturation, for transverse deficiencies greater than 5.0 mm, isolated transverse deformities, transverse deformities associated with vertical and/or anteroposterior deformities, and in transverse maxillary deficits with greater involvement in the region previous [5,7,12].

In this sense, transverse deficiencies should be analyzed through clinical examination, analysis of gypsum models, cephalometric and occlusal radiographs

in an attempt to visualize prevalent alterations such as anterior and posterior cross bites, dentoalveolar inclinations, lack of dental elements, prognathism or retrognathism, gingival recession, alveolar bone loss, posterior dental mobility and skeletal maturation, to select the appropriate maxillary expansion technique [7,12].

Major Considerations of Ideal Expander

The modified Haas circuit breaker produces a lower dentoalveolar slope than the Hyrax appliances, in addition to increasing the interdental distance between the canines. Also, the acrylic cover in the Haas expander directs the force vector to the center of resistance of the maxilla, increasing the transverse dimension, and not affecting the sagittal dimension, besides not provoking dental orthodontic movement [1,13].

The Hyrax appliances have a higher interdental increase between the molars and premolars and a posterior transverse increase, according to Garib et al. (2014) [15] and Claro et al. (2006) [16]. Other authors, however, did not observe significant clinical differences between Haas and Hyrax [5]. However, Kilic et al. (2008) [22] indicate the use of the modified Haas circuit breakers as it directs its tensile force to the center of the maxilla, not affecting the inclination of the teeth. In addition, the literature states that the use of Hyrax circuit breakers presents a higher risk of recurrence when compared to Haas.

Conclusion

It was concluded there is still no consensus on which is the best jaw-breaker, and it is necessary to increase the number of clinical and randomized studies, with eligibility criteria that can homogenize the participants. In addition, the literature has clearly shown that bucomaxillofacial surgeons must have the knowledge and clinical experience to be able to indicate the best procedure for each patient, that is, the rapid expansion of the non-surgical or surgical maxilla.

CRediT

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Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Peer Review Process

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