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Maxillary Expansion Techniques: A comparative Analysis of SARPE, MARPE and MISMARPE in The management of transverse deficiencies.

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Abstract: *Transverse anomalies are characterized by a deficiency of the maxilla that manifests itself through a posterior crossbite, which brings a series of aesthetic and functional problems to those who suffer from it. Rapid maxillary expansion (RME) has been studied as the standard treatment for these cases. In recent years, a series of new techniques have been introduced that seek to reduce treatment times and obtain more predictable results. These include surgery-assisted techniques (SARPE), mini-implants (MARPE) and a combination of both (MISMARPE). The objective of this article is to describe the principal assisted maxillary expansion techniques, their indications and complications, with emphasis on bone and dental alterations. A narrative review was carried out in PubMed, Scopus and Epistemonikos databases, considering systematic reviews, meta-analyses, randomized clinical trials and observational studies published between 2014 and 2024. A total of 18 articles were included. According to this review, SARPE, MARPE and MISMARPE present clear indications and allow obtaining satisfactory results in the treatment of transverse anomalies. Complications are mostly mild and easy to manage. It is suggested to know the techniques, indications, complications and the time of prescribing them in order to obtain the best results.*

Keywords - *Dentofacial anomalies, rapid maxillary expansion, MARPE, SARPE, MISMARPE.*

I. Introduction

Transversal anomalies are a type of dentomaxillary anomaly characterized by a deficiency of the upper jaw, which can cause a range of aesthetic and functional problems for those affected. Among the most common clinical manifestations are posterior crossbite, cusp-to-cusp occlusion, or non-occlusion, which are typically accompanied by crowding, making proper eruption of the teeth difficult. The worldwide incidence of these alterations is around 10%. They generally manifest at an early age and are caused by genetic factors or the presence of harmful habits. Timely diagnosis is essential to achieve good therapeutic outcomes [1].

In many cases, rapid maxillary expansion (RME) is the treatment of choice for correcting transverse anomalies. The goal of RME is to resolve transverse deficiencies, correct crossbites, increase the available space in the arch for crowding correction, and allow proper dental eruption [2]. Depending on the case needs, rapid expansion may be assisted by miniscrews (MARPE) or surgically (SARPE). In recent years, a technique combining the use of miniscrews with surgery (MISMARPE) has also been described [3,4].

The choice of RME technique is determined by several factors. The most important are the patient'sdegree of maturation, the level of interdigitation of the palatal suture, the millimeters of compression to be expanded, and age, with 15 years being the recommended average age [5].

The objective of this review is to describe the main assisted maxillary expansion techniques, their indications, and complications, with a focus on bone and dental alterations, based on a critical analysis of the available scientific literature.

2. Materials and Methods

A bibliographic review was conducted in the PubMed, Scopus, and Epistemonikos databases through an advanced search. The results of the search are presented in the following flow diagram (Fig. 1), which was created following the recommendations of the PRISMA statement.

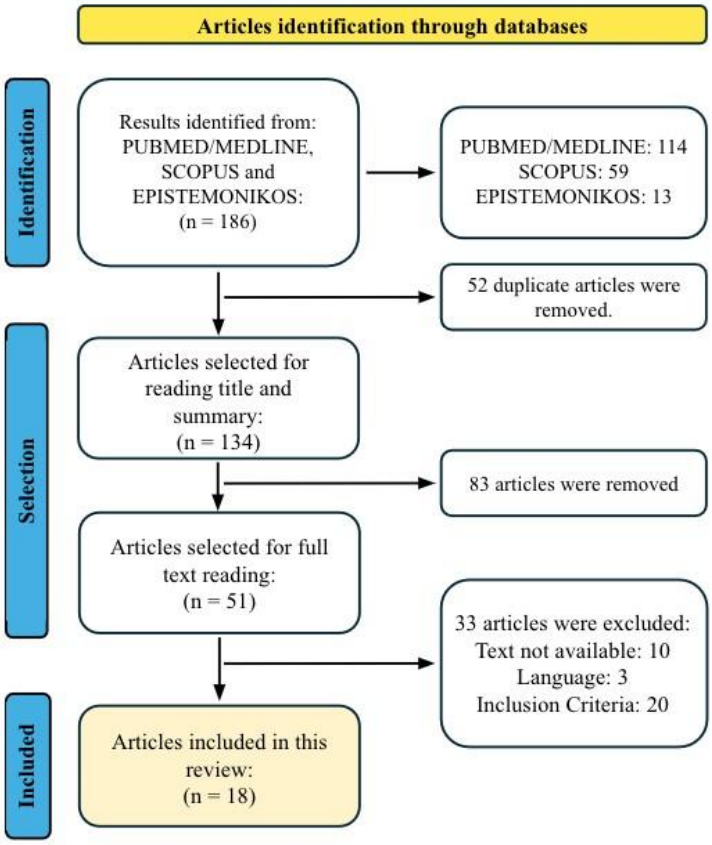

Fig. 1 Flow diagram of articles identification through databases

Respecting the inclusion criteria, randomized clinical trials, systematic reviews with or without meta-analysis, observational studies, and comparative studies published between 2014 and 2024 in English or Spanish were considered. Case reports, narrative reviews, letters to the editor, research involving animal models, and articles not available in full text were excluded.

The bibliographic search in the various databases yielded a total of 186 articles. Of these, 52 were removed for being duplicates, leaving 134 articles for title and abstract screening. 51 of these were selected for full-text review. Finally, 18 articles were included in this review, as they met the inclusion and exclusion criteria.

Of the included articles, 50% (n = 9) were observational studies, 33.3% (n = 6) were systematic reviews, 11.1% (n = 2) were randomized clinical trials, and 5.6% (n = 1) were comparative studies. On the other hand, 44.4% (n = 8) corresponded to the SARPE technique, 44.4% (n = 8) to MARPE, and 11.2% (n = 2) to MISMARPE. This difference in techniques may be due to the fact that the latter is the most recent technique and, therefore, less studied to date.

III. LITERATURE REVIEW

3.1 Surgically Assisted Rapid Palatal Expansion (SARPE):

Surgically assisted rapid palatal expansion (SARPE) is a procedure whose purpose is to correct transverse deficiencies and is characterized by the surgical separation of the already consolidated palatal suture in cases where conventional orthopedic appliances are not indicated. The surgical procedure is accompanied by the use of expansion devices with dental or skeletal support to promote progressive expansion of the suture (Fig. 2) [6].

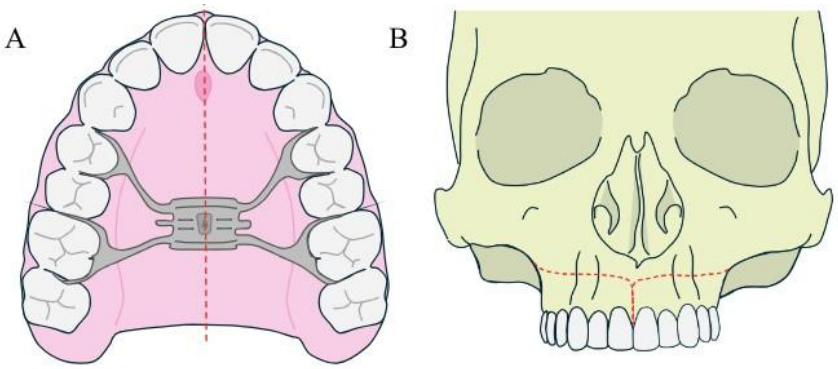

Fig. 2 SARPE illustration; A. Representation of maxillary expansion device. B. Representation of maxillary osteotomies.

Over the years, a series of variations to the technique have been described, including lateral pterygopalatine, nasal, septal, and palatal osteotomies. The conventional technique includes a Leefolt I osteotomy with or without pterygopalatine disjunction, accompanied by a sagittal osteotomy at the midline. It is recommended to install the expander one week before the procedure to allow for a separation between the central incisors that facilitates the sagittal osteotomy. Once the osteotomies are completed, it is recommended to activate the expander to ensure proper separation, after which it is left inactive for seven days [7]. Rachmiel et al.described a variation involving two L-shaped osteotomies,

starting horizontally at the pterygoid level and continuing vertically between the canines and lateral incisors, achieving satisfactory results for correcting transverse discrepancies [6].

SARPE indications have been widely studied and documented. Loriato et al. described a series of cases in which this procedure is indicated, including failed orthopedic expansions, cases where orthopedic appliances are contraindicated, unilateral posterior crossbites, craniosynostosis with premature palatal suture fusion, preparation for orthognathic surgery as a method of decompensation, patients with fused palatal sutures, and mild to moderate discrepancies requiring expansion greater than 5mm [7].

Reported results after SARPE are satisfactory, with molar expansions ranging from 6 to 9mm. In this regard, a systematic review by Gogna et al. concluded that SARPE achieves significant skeletal and dental expansion that remains stable; However, more clinical trials are recommended to understand long-term stability [8]. On the other hand, a randomized clinical trial by Ribeiro et al. evaluated the effect of orthodontic retention devices after expansion, concluding that no additional retainers are necessary beyond the expander itself [9].

SARPE is considered a safe procedure, though not without complications. It has been reported that around 21.9% of patients experience some type of complication, with the most frequent being asymmetric expansion. Other reported complications include bleeding, reversible paresthesia, mild to moderate pain, alveolar and periodontal alterations, and rarer issues such as hematomas, tinnitus, and excessive tearing [10]. Regarding asymmetric expansion, various studies report a higher incidence when pterygopalatine disjunction was not performed or was incomplete, but all agree that further studies are needed to demonstrate this association [7].

A retrospective study by Smeets et al. assessed the relationship between patient age and complication rates. They found that approximately 50% of the evaluated patients experienced some form of complication, with reversible sensory disturbances and pain being the most common. Age was found to significantly increase the incidence of dental and alveolar complications, and sensory disturbances increased in intensity and duration. The study concluded that complications are mostly mild, but SARPE should preferably be performed at a younger age whenever possible [11].

Regarding bone alterations, SARPE has been associated with a considerable increase in dehiscences (195%) and a decrease in fenestrations, as pre-existing fenestrations are converted into dehiscences during expansion. The most affected teeth are the first molars, followed by the first premolars. As a result, proper evaluation of the patient before recommending the procedure is crucial to prevent potential complications [12]. Periodontal alterations have also been studied, and SARPE appears to be a safe procedure that does not negatively affect the patient's periodontal status. However, a slight increase in external apical resorption of the anterior teeth has been observed, and further studies with longer follow-up are needed to draw definitive conclusions [13].

3.2 Miniscrew-Assisted Rapid Palatal Expansion (MARPE):

Miniscrew-assisted rapid palatal expansion (MARPE) is a technique for transverse maxillary expansion using miniscrews, employed in young adults whose palatal sutures have not yet consolidated (Fig. 3). Its goals are to open the palatal suture, correct transverse deficiencies, maximize orthopedic separation of the maxilla, and reduce complications associated with conventional expansion methods [14].

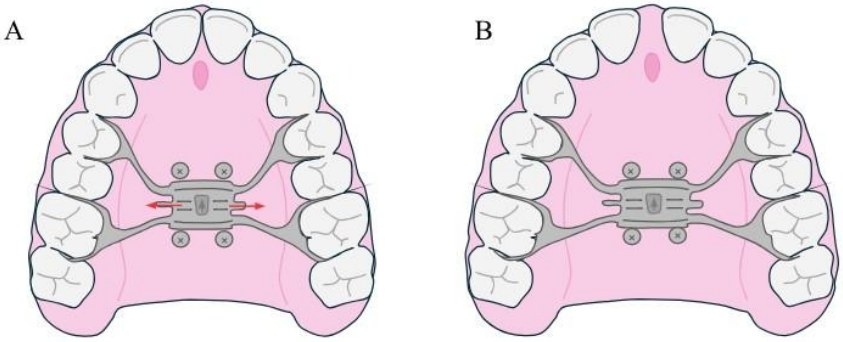

Fig. 3 MARPE illustration; A. Representation of expansion device associated with miniscrews. B. Post expansion results with a visible interincisal gap.

The technique involves the installation of an expander with skeletal support by incorporatingminiscrews, which help distribute forces directly to the basal bone, ensuring stable results once the disjunction is complete [14]. Success rates are reported to be around 92%. This technique is indicated for skeletally mature and periodontally healthy patients with mild to moderate discrepancies of less than 7mm [15].

MARPE treatment allows for adequate maxillary expansion, less than that achieved with SARPE but greater than conventional expansion. Several studies have reported skeletal expansions of about 2.5mm and dental expansions of 6.5mm at the molar level, which translates into 40 to 55% greater expansion than in conventional cases, achieved within 20 to 35 days. The best results are obtained in the prepubertal stage, while pubertal and post pubertal stages result in greater dental than skeletal effects [15,16].

In addition to expansion, MARPE leads to a series of additional effects. Ventura et al. reported changes in molar tipping ranging from 2 to 8 degrees [14]. Changes at the middle facial third have also been described, such as an increase in nasal volume due to forward and downward mobilization, accompanied by widening of the nasal cavity [15].

Regarding MARPE stability, it has been studied by various authors. Lim et al. concluded that after one year of follow-up, the expansion results remained stable in most patients. However, bone alterations observed during the initial evaluation increased considerably with the treatment [17]. On the other hand, Huang et al. found that after 12 months of follow-up, there was a significant reduction in intermolar and alveolar width, with reductions of approximately 1.56 and 0.55 mm, respectively [18]. Due to the heterogeneity of results and the short follow-up periods, further studies are needed to accurately assess the long-term stability of MARPE.

Various factors have been evaluated in relation to MARPE success. Patient age has been linked to a lower success rate, with decreased skeletal expansion levels. However, the degree of maturation of the palatal suture is not significantly related to success rate, though several studies have reported lower expansion levels, higher recurrence rates, and greater complications in patients with more interdigitated sutures [19]. Therefore, a thorough evaluation of suture maturation is essential before recommending MARPE.

As for complications associated with MARPE, these can be divided into dentoalveolar and periodontal. Dentoalveolar complications include thinning of the vestibular cortical bone of the first molar, apical displacement of the alveolar crest in the first molars and premolars, unwanted tipping

changes in molars, alveolar bone flexion, and asymmetric expansion. No complications related to the appearance or progression of periodontal disease have been described, but inflammation around the miniscrews has been reported, which resolves completely with good hygiene and after appliance removal [20].

A clinical trial by Chun et al. compared the results and complications between MARPE and conventional RME, concluding that MARPE achieves better expansion results with a lower incidence of complications, reducing the occurrence of fenestrations, dehiscences, and periodontal alterations [21].

3.3 Minimally Invasive Surgically and Miniscrews Assisted Palatal Expansion (MISMARPE):

MISMARPE is a minimally invasive technique that combines SARPE with the use of miniscrews from MARPE (Fig. 4). The combination of surgical disjunction of the palatal suture with the benefits of miniscrews enables acceptable maxillary expansion in skeletally mature adult patients [4,22].

This procedure is characterized by being performed under sedation, on an outpatient basis, and in the dental chair, which reduces complications associated with general anesthesia used in SARPE, intervention costs, and procedure duration. The surgical procedure does not include pterygopalatine disjunction, thereby reducing morbidity and increasing treatment compliance [4]. The installation of the skeletal support expander involves a 7-day latency period after surgery, followed by activations of a quarter turn every 12 hours, allowing for controlled maxillary expansion [22].

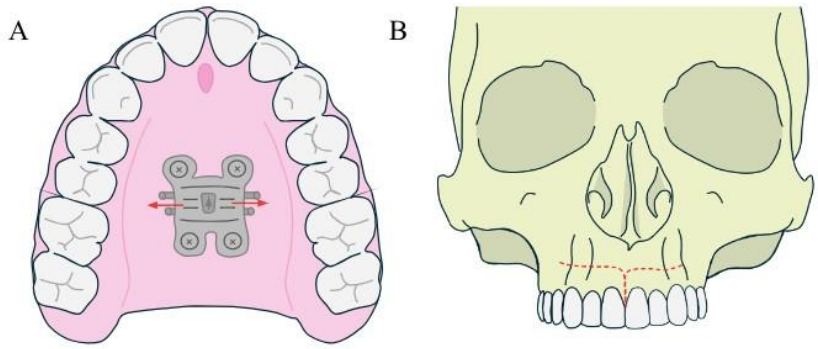

Fig. 4 MISMARPE illustration; A. Representation of expansion device associated with miniscrews. B. Representation of minimally invasive maxillary osteotomies.

MISMARPE is considered a comparable treatment to SARPE and MARPE in terms of results. Its main advantages include better force distribution, as forces are transmitted directly to the palatal bone via the miniscrews, reducing dental complications seen with devices having dental or mixed support. This also helps explain the higher success rates achieved with MISMARPE [22].

Since it is a technique described only a few years ago, there are no long-term studies or high-level evidence available to assess long-term stability. Regarding complications, studies included in this review report a lower incidence compared to SARPE and MARPE cases. The most frequent complications are bleeding, pain, sinusitis, gingival recessions, inflammation around the miniscrews, and hygiene difficulties [4,22].

MISMARPE appears to be an effective treatment for managing transverse alterations, with lower morbidity than conventional treatments and even SARPE and MARPE. It´s use in adult patients with mature palatal sutures makes it an ideal replacement for SARPE. However, despite promising initial results, more studies with higher levels of evidence are needed to determine protocols, long-term follow-up, and complication rates before it can be considered the treatment of choice for managing transverse deficiencies.

IV. CONCLUSIONS

SARPE and MARPE are well-studied rapid maxillary expansion techniques with clear indications and established protocols. Their use results in highly satisfactory outcomes that far exceed those obtained with conventional techniques in both young and adult patients.

Dentoalveolar and periodontal complications reported in the literature are mostly mild and manageable, making assisted maxillary expansion techniques safe to perform in daily practice.

According to this review, MISMARPE appears to be a promising technique, minimizing associatedcomplications. However, it lacks high-level evidence and long-term studies to support its outcomes. This review suggests the development of new studies to support its use and evaluate its long-term stability and complication incidence.

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