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RESEARCH ARTICLE

Relevant Aspects in Surgical Expansion Osteotomies Used in the Management of Maxillary Atresia for Efficiency and Stability

Kerlison Paulino de Oliveira*, Valmir Braga de Aquino Mendonça, Rômulo Dias de Oliveira and Marco Aurélio Medeiros da Silva

Department of Oral and Maxillofacial Surgery (post-graduate, ABO/RN, Brazil)

***Corresponding author:** *Kerlison Paulino de Oliveira, Department of Oral and Maxillofacial Surgery, SESAP/RN, Brazil, Tel: +55-84-3221-2809, E-mail: kerlisonpaulino@hotmail.com*

Abstract

To obtain a functional and stable occlusion, it is important to have an adequate transverse maxillary dimension. It is estimated that 8 to 18% of patients seeking an orthodontic assessment present alterations to that dimension associated to multiple etiological factors. Orthopaedic palatal expansion is a successful treatment before palatal suture closure, which occurs around 14 to 15 years of age in males and 15 to 16 in females. However, once bone maturity has occurred, such procedures have poor results. The preferable indication is surgically assisted rapid maxillary expansion which is also recommended in cases of severe maxillary atresia accompanied by tilting, or when there is real unilateral, maxillary deficiency or horizontal bone loss, etc. We discuss this technique, when it is indicated, its efficacy, stability, possible complications according to the indication, and factors that contribute to its success.

Keywords

Surgery, Palatal expansion technique, Transverse maxillary deficiency, Dental occlusion

Introduction

Harmony of the proportions is of fundamental importance to ensure facial equilibrium and the proper functioning of the stomatognathic apparatus. Orthodontists frequently identify deficiencies in the form of alterations and their multi-factor etiologies can include congenital, iatrogenic or traumatic causes [1]. It is well-known that, anatomically, to ensure satisfactory aesthetic and functional relations among the dental elements, the maxillary arch needs to be broader than the mandibular arch. When the equilibrium is disturbed by uni or bilateral posterior cross-biting, parafunctional buccal habits, alterations in swallowing, respiratory dysfunctions or hereditary or congenital problems then we can detect alterations in those relations. It has been estimated that maxillary transverse deficiency affects 15% of adolescents and as much as 30% of the adult population [2].

Clinical and radiographic examinations and the study of models help in the diagnosis of maxillary transverse deficiency [3]. Clinical indicators for the presence of transverse deficiency are: paranasal sinus hypoplasia, shortening of the nasal base, deepening of the nasogenial groove and zygomatic hypoplasia. Cross-biting, dental crowding, mal-positioning of the teeth in the palatine region, narrowing of the superior arch and high narrow palatine can also be part of this condition leading to negative space in the buccal passage and alterations in the soft tissues. In radiographic terms, superimposing frontal cephalometric radiographs taken over a period of time allows for comparisons of linear measurements [4,5].

Transverse maxillary Atresia is associated to functional and aesthetic harm involving unilateral or bilateral cross-biting, vestibular or palatine inclination of the posterior teeth, ogival palate, narrow maxillary arch, evidence of negative space in the buccal corridor and alterations to the soft tissues among which we can mention narrow alar base, and flattening of the paranasal region [4,5]. The causes of those discrepancies include, hereditary causes, traumatic damage, whether iatro-

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genic or not, eruption disturbances, inadequate length of the arch, macroglossia and parafunctional habits [3]. The aim of this review is to discuss this technique, when it is indicated, its efficacy, stability, possible complications and factors that contribute to its success.

Materials and Methods

The search was conducted in the Bireme, Medline, Lilacs and BBO databases including studies conducted in humans and animals. The articles should accomplish surgical expansion procedures required to produce consistent and stable maxillary expansion in adults. The search included the keywords "Surgically Assisted Rapid Maxillary Expansion" and "Surgical maxillary disjunction". The exclusion criteria were articles that discussed only non-surgical expansion and those that only described orthodontic techniques.

The following periodicals were included in the literature review: American Journal of Orthodontics and Dentofacial Orthopedics, Dental Press Journal of Orthodontics, Journal of Applied Oral Science, Journal of Oral and Maxillofacial Surgery, Medicina Oral Patología Oral y Cirugia Bucal, Revista de Cirurgia e Traumatologia Buco-maxilo-facial, Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, The Angle Orthodontist, The European Journal of Orthodontics and The International Journal of Adult Orthodontics & Orthognathic Surgery.

Literature Review

Expansion of the maxillary arch is currently accepted as a treatment to correct transverse skeletal and dental discrepancies and was first described by Angle in 1860 and one hundred years later, popularized by Haas. The rapid expansion concept directed at obtaining a skeletal widening of the maxilla was reviewed by Goddard in 1890 and then by Landsberger in 1910. The technique seems to have disappeared in the 1950s but subsequently a series of studies began to emphasize the skeletal movements involved rather than the dental ones [6].

The use of rapid maxillary expansion in adult patients without recourse to surgical assistance has tended to lead to relapses insofar as the palatine suture inter-digitations increase with the increased skeletal maturity [7]. According to those authors, the dento-alveolar movements become greater to the detriment of the skeletal movements [2,8,9]. Adverse side-effects such as pain during the activation of the apparatus, dental extrusion and periodontal complications can be present when there is excessive alveolar movement and are partly caused by expansion (RME) [2,4,8]. The loss of periodontal insertion was greater among adult patients than among adolescents that had been submitted to Rapid Maxillary Expansion (RME). Thus we can see that RME among adults is a very limited procedure and their results are neither as predictable nor as stable [2,9,10].

Thus we can see that RME among adults is a very limited procedure. The possible limitations are in the perimeter of the expansion achieved, with essentially dental characteristics; instability of the results with frequent relapses; pain during the expansion process, secondary to the tissue ischemia; ulcer formation and edema stemming from compression of the soft palate tissue provoked by the expander; occlusal instability of the posterior teeth; periodontal harm with dental extrusion and radicular and bone reabsorption [2,10].

SARME is recommended when the skeletal discrepancy exceeds 5 mm, or when there are cases of a short maxilla and a wide mandible, or when there has been an orthodontic failure, or a greater degree of expansion is required, or for the prevention of periodontal alterations, or in the presence of significant nasal stenosis, or in patients who have achieved skeletal maturity [1]. Transverse expansion of the maxilla is used in an endeavor to obtain more space in the upper arch in order to avoid exodontias even when there is no evidence of posterior cross-biting [2].

Any procedure designed to free the areas of greatest resistance and ensure efficient, stable maxillary expansion must necessarily have recourse to osteotomies. There are three main vertical support columns involved: the lateral nasal wall region, the zygomatic and the pterygomaxillary buttresses. Current tendency in surgical procedure seeks achieve satisfactory, stable results using techniques that are as non-invasive as possible [4].

Bell and Epker reported 15 cases in which all the maxillary articulations were sectioned. A lateral corticotomy was performed from the pyriform aperture to the maxillary tuberosity and the palatine suture was sectioned. The procedures were carried out with the patient under a general anesthetic or a local anesthetic plus sedation [2].

Glassman, et al. [11] found that only lateral maxillary osteotomies associated to the installation of an expander achieved the desired separation of the inter-maxillary suture as confirmed by occlusal radiography and the diastemas between the upper central incisors. The expander was activated right after the osteotomies starting on the third day and going on until the desired expansion was achieved. Lehman, too, reported that Surgically Assisted Rapid Maxillary Expansion (SARME) could be carried out in adults when a minimally invasive surgical technique is used involving the lateral walls of the maxilla. In the procedure described there was no separation of maxilla and pterygoid plates and no invasion of the pterygo-maxillary junction [12].

Bays & Greco [13] considered that the median palatine suture and the zygomatic buttress were problematic areas and they began to use combined lateral and palatine osteotomies. The bilateral osteotomies were made from the pyriform aperture to an area close to

the pterygoid plates but the latter were not separated and, therefore, not freed. The separation of the maxilla was achieved using a chisel cutting towards the palatine between the central incisors for about 1.0 to 1.5 cm. Those authors used intravenous sedation associated to a local anesthetic.

The liberation of the pterygomaxillary suture has been described as being the most controversial [9,14], because of the high risk it poses of hemorrhagic complications. The palatine vessels, however, are not at risk of being damaged because inferior traction and mobilization of the maxilla to separate the pterygomaxillary region are not routinely carried out [14].

In the view of Epker and Wolford [15], a sub-total Le fort 1 osteotomy separating all the bony articulations of the maxilla should be undertaken to achieve expansion. According to Pogrel, et al. [10] and Bays and Greco [13], it is more advantageous to adopt a less invasive technique whereby the osteotomies are only carried out in the areas of greatest resistance; a procedure that does not necessarily imply a hospital internment for the patient.

To Antilla, et al. [12] it is clear that there is no consensus regarding the minimal osteotomy required to facilitate maxillary expansion and that the question posed by Pogrel [10], namely "What is the minimum procedure required to produce consistent, stable maxillary expansion in adults?" could be answered in the following way: more extensive osteotomies could be indicated for older patients, taking into account that the surgical procedure should be in accordance with the type of expansion and the degree of expansion required [3,12].

Complications

Lanigan and Mintz report that SARME procedures have traditionally involved low morbidity but they are not entirely risk-free and the authors call for surgeons to exercise caution to avoid possible complications. In regard to the SARME procedure as such, one of the most frequent complications is aseptic necrosis and irritation caused by the pressure applied by the expander [16].

Defects that can follow palatine expansion achieved with osteotomy in the area of the central incisors include bone defects, dental mobility, and loss of vitality, external radicular reabsorption, tooth loss, gingival thinning and gingival recession. The treatment plan must include recent periapical radiography, so that, should it prove necessary, an orthodontic separation of the roots can be stimulated prior to the surgical procedure [17].

Among the Trans- and post operatory complications, Le Fort 1-level osteotomies also pose the risk of neurological lesions. The commonest of those are cases of lesions of the trigeminal nerve in which 25% of patients present a reduction in nociception. Lesions of the trochlear (IV) and of the parasympathetic fibers of the lachrymal nerve have been also registered [18].

Hemorrhage is another complication that has been reported, as in the case of patients where bleeding was strong enough to keep them in hospital for an extra day [19]. One case that was reported of orbital compartment syndrome stemming from retro-bulbar hemorrhage resulted in permanent blindness in a 34-year-old woman patient with a transverse maxillary deficiency. There was another case of temporary, partial paralysis of the oculomotor nerve [16].

Dergin, et al. report a retrospective clinical study identifying complications and assessing their incidence, with the aim of informing the professional who indicates these procedures. Sixty patients underwent SARME according to their protocol at Istanbul, Turkey. Twelve patients (20%) suffered from nasal bleeding. Three patients informed excessive lacrimation postoperatively. Pain and numbness were also reported, but they were temporary findings [20].

Such cases show that the forces associated to the expansion can be diffusely transmitted to the cranial-facial complex. They are capable of producing aberrant fractures that may attain the pterygopalatine fossa, the orbit, the base of the cranium and may lead to important lesions to neurovascular structures such as those that have been reported for the post operatory period of Le Fort 1-type osteotomies [16].

Discussion

Statistics show that in the United States only 9.4% of the population has posterior cross bite caused by atrophic maxillas [21]. However, Proffit, et al. [22] go beyond that statement and declare that 30% of adults who seek professional help to treat dentofacial deformities have a transverse maxillary deficiency.

Radiographic and cephalometric analyses show that diagnosing transverse deficiency is an objective task. However, the clinical impact of the soft parts of the face may not be so obvious and there is also the possibility of it being masked by more outstanding craniofacial alterations [2].

Ensuring that the orthodontic treatment coincides with the growth phase of the patient's life is an important factor in dentition stability. If dental professionals are to make use of maxillary orthopedics, it needs to be applied at an opportune moment. One study has shown that transverse maxillary growth had already concluded in 95% of boys and 98% of girls by the time they were 12-year-old. That means non-surgical expansion methods must only be considered for periods prior to that age [23].

The same study corroborated the fact that among boys, the biggest growth in the wideness measurement was achieved with the 7 to 11 age group and for girls with the 6 to 11 age group. The study also reported that

most girls completed growth in width of the maxilla at 15 years of age whereas for most boys, transverse maxillary growth was completed at 17 years of age. The authors underscore that the inter-maxillary suture can actually become fused a little before those ages [23].

Authors state that the greater the age the greater the need for more extensive surgery. Various papers have reported on the risks of failures in orthopedic expansion endeavors and also on the high rate of relapses following that procedure in adults. Orthopedic maxillary expansion failures can occur at earlier stages, according to some authors. In a study undertaken by Ribeiro Jr, et al. [3] there was orthopedic expansion failures in three patients with ages from 17.4 to 22.8.

Other studies clearly set out to adopt less invasive techniques that would make it possible to obtain the safe and reliable surgical separation of the palatine using local anesthetic only, thereby offering the patient at least a minimum level of comfort and security [12]. General anesthetic is the best choice, however, for SARME given that the patient will undergo surgery without experiencing any discomfort or pain during the course of the operation. Local anesthetic is accompanied by pain during the operation and it is difficult to deal with any eventual accidents when the patient is under this kind of anesthesia [3].

Another procedure used to correct transverse discrepancies of the maxilla is segmented Le Fort 1 osteotomy. It is usually adopted when the patient presents transverse deficiency together with vertical and/or sagittal discrepancies in the middle third of the maxilla. SARME can be used for an initial intervention of a two stage plan that calls for a Le Fort 1 osteotomy [21].

Lateral movement predominates during maxillary expansion. If the design of the osteotomy is of the "ramp" type addressing the lateral wall, the maxilla may become both laterally and downwardly displaced. That downward movement affects the spatial position of the mandible and it will consequently exhibit inferior and posterior rotation. That in turn may lead to cephalometric alterations [3].

Experimentally, Ilizarov demonstrated that a healing period of five days is sufficient to allow for capillaries to cross the area of the osteotomy and to verify that the expansion of 0.5 to 1.0 mm per day has not surpassed blood supply capacity [3]. It is therefore important that the beginning of expansion should not be earlier than the fifth day after the operation. Expansion needs to be slow, consisting of a ¼ turn of the expansion screw once in the morning and once at night. That rate can be varied according to the patient's age and skeletal maturation as well as to the degree of expansion desired [3,24].

Maintenance of the healthy condition and integrity of the soft tissues involved during the activation of the expander contributes towards achieving greater stability of the maxillary reorganization and avoiding any relapse. Should there be resistance to the expansion; in cases where the desired degree of expansion is particularly high, then rapid expansion is the methodology to adopt. However, a resting period of five to seven days should be allowed for each 5 mm of expansion achieved [3].

As regards suturing the alar base of the nose, even though it is usually only indicated for maxillary impaction and advancement surgery, it is important that it should be carried out in order to prevent any widening of the nasal base, albeit that preventative measure means that undesirable aesthetic alterations may emerge [3].

In regard to the withdrawal of the apparatus, it is recommended that it should be removed in the third month after the expansion. However, there are other references stating that after four months the surrounding soft tissues have not yet adapted and that the force emanating from the buccal musculature is capable of provoking relapses. Thus it is important to take occlusal radiographs to detect whether there is indeed any new bone formation in the region of the median palatine suture [3]. According to Salgueiro, et al. the pattern of suture opening is mainly related to the patient's age and the surgical technique employed. In his study, it did not prove possible to observe a complete bone formation in the respective suture at the end of the contention period in question (180 days) [25].

Malmstrom and Gurgel [26] assessed new bone formation in the palatine suture by means of digitalized occlusal radiographs taking measurements at 30, 60, 90 and 120 days after SARME. Optical density increased by the end of the 120 day contention period but it was not equal to the values obtained in the initial stage. Thus the period was insufficient for the re-establishment of optical density and the complete formation of new bone tissue in the suture in the patients that were studied. In regard to stability, the superior inter-molar distance increases after SARME and remains stable at three and six months after the expansion [7]. Facial width did not alter but the nasal and maxillary widths both increased immediately after the procedure was carried out, then remained stable as measured at three and six months after the expansion [7,27].

Conclusions

1. It is essential that the definition of the technique to be employed should be made by analyzing the context of the clinical deformity diagnosed and its intensity. The selected procedure must be efficacious, because any failure in the result will introduce the possibility of risks associated to a new intervention.
2. SARME is an efficient procedure with a minimum of complications whenever it is correctly indicated.

When there are deformities in other planes present, then segmented Le Fort 1 osteotomy must be considered insofar as it corrects other associated deformities.

3. The need to expand the anterior region of the maxilla does not necessarily call for an all-out osteotomy of the pterygomaxillary region. Thus a median sagittal osteotomy of the palatine associated to transverse maxillary osteotomies liberating the nasomaxillary and zygomatic-maxillary pillars would seem to offer the best efficacy-morbidity relation in cases that require an expansion of the anterior and middle regions of the maxilla.

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