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Review Article

Treatment of maxillary transverse deficiency with rapid expansion of the palate with mini-implant: a review

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ABSTRACT

One of the most prevalent malocclusions is maxillary constriction, which is a narrowing of the upper arch; its etiology is multifactorial, including mainly genetic factors and parafunctional habits. It is characterized by a posterior crossbite that can be unilateral or bilateral, total or partial, and may even not occur in cases with simultaneous constriction of the mandibular arch. Transverse deficiency or maxillary hypoplasia affects facial growth and the integrity of the dentoalveolar structures. Therefore, it must be corrected as soon as it is diagnosed. As the maxilla widens, the midpalatal suture and the intermaxillary suture expand. When they are not fused, it is connective tissue and behaves viscoelastically in response to externally applied forces. In order to effectively treat any dentofacial deformation, an early diagnostic and therapeutic approach is required.

Keywords: Maxillary expansion, Cross bite, Transverse maxillary deficiency, Maxillary hypoplasia, Miniscrew-assisted rapid palatal expansion, Rapid maxillary expansion

INTRODUCTION

One of the most prevalent malocclusions is maxillary constriction, which is a narrowing of the upper arch (Figure 1) where some of its typical characteristics are posterior crossbite (Figure 2) which can be unilateral or bilateral, anterior dental crowding, palatal vault high and decreased distance between the lateral walls of the nasal cavity.[1]

Its etiology is multifactorial, mainly including genetic factors and parafunctional habits, it is generally associated with nasal obstruction, so the respiratory pattern can influence the development of certain malocclusions.[2,3] In order to effectively treat any dentofacial deformation, an

early diagnostic and therapeutic approach is required so it is necessary to determine the type of maxillary deficiency and analyze the changes in the soft tissues, since isolated deformations in the anteroposterior or vertical part are more frequent. Assessment can be done using cast analysis, clinical assessments, cephalometric tracings, radiographic measurements, and with an odontogram (Figure 3).[4]

EMBRYOLOGY

Cranial sutures are membranous spaces left between the bony plates of the skull as the bones grow and develop. These intermediate fibrous sutures act as flexible joints between developing bones, allowing the skull to change shape and grow as it develops. Under normal conditions, complete fusion of the skull bones occurs until adulthood, there are various sutures located in the skull and maxillofacial area (Figure 4).[5] The premaxilla is an important component derived from the premaxillary outline, composed of an alveolar process, the four upper incisors, the palatal plate of the premaxilla, and the processus stenonianus. The development of the premaxillary bone is related to the movement of the nasal septum during fusion of the secondary palate, only the labial side of the premaxillary suture is fused, while the other sides remain patent much later, such as fusion with the vomer at the age of 15 years.[6]

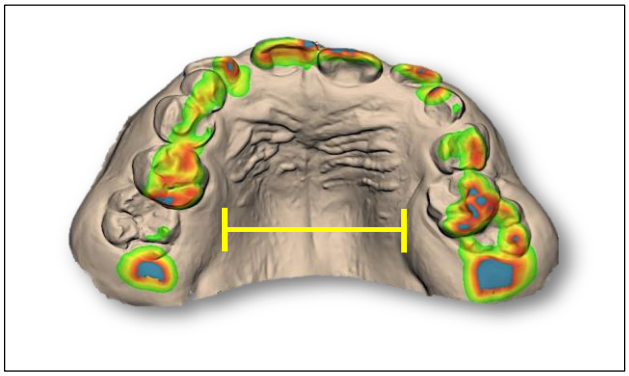

Figure 1: The narrowing of the posterior area is marked with a yellow line. Note the deep palatal vault.

Figure 2: (A) Edge-to-edge posterior bite, right side; (B) anterior crossbite in the canine area with midline deviation, frontal view; and (C) posterior crossbite, left side.

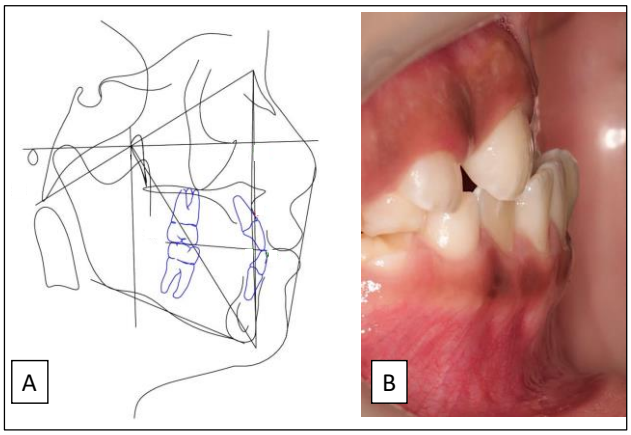

Figure 3: (A) Ricketts cephalometric; the patient presents class I molar relationship, class III skeletal relationship, incisor biretrusion and a forward position of the lower incisor; and (B) shows the clinical image in a patient with anterior crossbite, lateral view.

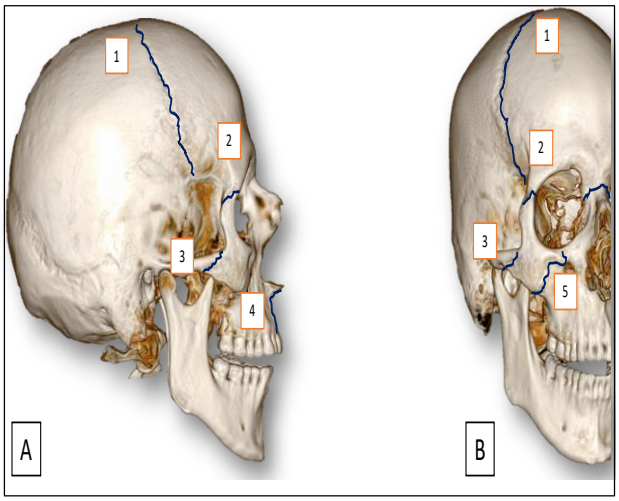

Figure 4: Cranial sutures.
Highlighted in blue line: 1- coronal suture, 2- frontozygomatic suture, 3- zygomaticotemporal suture, 4- intermaxillary suture, and 5- zygomaticomaxillary suture.

The premaxilla is connected to the maxilla, the basal bone, the vomer and the frontal bone by means of the corresponding sutures, all the sutures remain patent except the premaxillary-maxillary suture which begins to fuse from birth.[5] The development of the maxilla involves the two maxillary processes clustering around the buccal fossa, where the two processes appear divided and constricted in the midline. It is estimated that during the 5th week of gestation, the nasal placodes appear on the upper part of the lip. The lateral tissues together with the tissue medial to the nostrils, form the medial nasal process, contributing to the formation of the lips. By the sixth week, the widened fossa becomes a laterally extending cleft that fuses with each maxillary process and mandibular arch. A ridge of tissue surrounds each nostril. The three parts of the upper lip fuse and unify the lip, later the orbicularis muscle grows and provides support for the lips. In the seventh week of gestation, the nostrils appear more centrally located. The fusion and merging of the tissue masses leads to a recognizable facial form.[7]

MANDIBLE FORMATION

The mandible, a first pharyngeal arch derivative, originates from neural crest cells that take their position within the mandibular and maxillary prominences during the fourth week after conception. After the formation of the mandibular division of the trigeminal nerve, interactions between the mandibular ectomesenchyme and the mandibular arch epithelium result in the formation of an osteogenic membrane (membranous ossification). Meckel's cartilage, the initial non-ossifying template for early mandibular growth, forms between 41 and 45 days after conception. At the sixth week of life, a single ossification center for each half of the mandible forms lateral to Meckel's cartilage, at the bifurcation of the inferior alveolar nerve and artery into its mental and incisive branches. From this center, ossification

proceeds ventrally to the body and dorsally, contributing to the mandibular ramus.[7] In general, the structures of the head and neck are derived from the cephalic portion of the neural tube, which gives rise to the five pairs of branchial arches, each arch consisting of 3 layers: outer ectoderm, an intermediate layer composed of cells of the neural crest containing mesenchyme and an inner layer of endoderm. Development of the face begins in the 4th week of embryonic age with the stomodeus, a ventral depression located just caudal to the developing brain, which becomes the mouth.[8]

MODEL ANALYSIS

They allow for static and dynamic analysis of the arches, constituting a very important tool for planning.[9] The study is carried out in the three planes of space: transverse, anteroposterior or sagittal and vertical, each one of them considering each arch independently and the relationship between them is studied with the models mounted on an articulator in centric relation (a) transverse analysis, the reference plane used to determine transverse deviations (unilateral or bilateral compression of the arches, symmetry, lateral crossbites) is the median sagittal plane; (b) anteroposterior or sagittal analysis, the analysis of sagittal problems (overjet, canine and molar relationship, and dental positions in the mesiodistal direction of the lateral sectors) takes the transversal plane as the reference plane; and (c) vertical analysis, for the study of dental positions in a vertical sense (overbite or overbite, under or supra eruption of one or a group of teeth), the occlusal plane is used, which is considered as the horizontal plane.

TRANSVERSE MAXILLARY DEFICIENCY

Transverse maxillary deficiency is a common finding among populations, mostly presented with a unilateral or bilateral posterior crossbite. The posterior crossbite is reported to be the most prevalent type of malocclusion occurring between 8% and 22%.[10,11]

Transverse deficiency or maxillary hypoplasia affects facial growth and the integrity of the dentoalveolar structures. Therefore, it must be corrected as soon as it is diagnosed. It is characterized by a posterior crossbite that can be unilateral or bilateral, total or partial, and may not even occur in cases with simultaneous constriction of the mandibular arch, it can present problems such as excessive vertical alveolar growth, crowding, deep and narrow palate with a distance intermolar length less than 31 mm, measured from the cervical margins, as well as large dark spaces in the buccal corridor, thus characterizing transverse maxillary deficiency, can be associated with as follows-

Relative transverse discrepancy

The posterior teeth do not show adequate cusp-transverse fossa relationship in centric relation, it is relative when the posterior teeth occlude correctly. For example: a posterior crossbite is removed when the arches articulate in a class I canine relationship.[12]

Absolute transverse discrepancy

Posterior teeth do not show adequate cusp-transverse fossa relationship in centric relation, it is absolute if after articulating a class I canine relationship on the casts, the crossbite is still present. Its origin can be skeletal or dental, the magnitude of the discrepancy is determined by study models.[12,13]

Adequate treatment of transverse deficiencies required in skeletally immature patients is with rapid maxillary expansion (RME) that involves opening the midpalatal suture since with age, there is an increase in fusion by bone apposition after suture closure. . Transverse maxillary expansion is almost impossible; however, it has a high relapse rate of the palatal suture due to its inherent recovery and insufficient bone regenerative capacity. To avoid relapse, current treatments include excessive

expansion and prolonged use of retainers, having practical disadvantages and unsatisfactory therapeutic effects. Bioactive compounds are currently being developed to try to reduce the relapse rate and shorten the retention time by accelerating bone regeneration.[14]

Surgically assisted EMR (SARME) is an effective method of treating transverse maxillary deficiency in skeletally mature, non-growing patients. It is a combination of orthodontic and surgical procedures that causes considerable expansion of the maxillary apical base and palatal vault, providing a dental arch space, this technique may include bilateral osteotomy of the zygomatic pillars and palatal suture with or without separation of the pterygoid processes.[15] Lee et al suggested a non-surgical approach to RME as an alternative to optimize the potential of skeletal expansion in patients with advanced skeletal maturation using mini-implants (miniscrew-assisted rapid palatal expansion, MARPE), this MARPE applies forces to the miniscrews placed close to the midpalatal suture, differently from other techniques, which apply forces to the teeth or periodontium, therefore avoiding the need of osteotomies.[16-18] MARPE is a less invasive option than SARME, has a skeletal effect, fewer dentoalveolar effects, no surgical risks and reasonably stable results, in addition to being more affordable financially. There is also rapid maxillary expansion assisted by mini-implants (MARME) or maxillary expansion by distraction osteogenesis (DOME) which are alternatives to obtain skeletal correction of the moderate to severe maxilla, can be performed with or without skeletal anchorage, however when skeletal anchorage is used, skeletal expansion is more effective and reduces dental side effects after surgically assisted rapid palatal expansion (SARPE).[19,20]

DISCUSSION

Angle class III malocclusion is the most common in children, the etiology of this malformation is maxillary deficiency, mandibular excess or a combination of both. Maxillary deficiency explains a large percentage of these malocclusions; however, the pathogenesis of maxillary deficiency is still unknown. Animal studies have shown that early ossification of the premaxillary-maxillary suture can induce extensive craniomaxillofacial morphologic abnormality.[5] Transverse maxillary deficiency may be associated with sagittal or vertical problems of the maxilla or mandible. It may contribute to unilateral or bilateral posterior crossbite, anterior dental crowding, and unesthetic black buccal corridors on smiling. An adequate transverse dimension is important for stable and proper functional occlusion. Surgically, assisted rapid palatal expansion has been the treatment of choice to resolve posterior crossbite in skeletally mature patients.[15]

The correct diagnosis of the severity of transverse deficiency is essential to achieve adequate treatment. In order to make the best therapeutic decision on the different cases of maxillary hypoplasia in patients with advanced skeletal maturation, the different factors must be comprehensively assessed. There are several risk factors for obstructive sleep apnea (OSA), one of them is maxillary hypoplasia, which is characterized by partial or total obstruction of the upper respiratory tract, is associated with arterial hypertension and an increased risk of presenting cardiovascular diseases and even death. Patients with maxillary hypoplasia have nasal obstruction, a low position of the tongue below and behind the oral cavity, the distance between the nasal walls and the nasal septum appears decreased, which makes the passage of air lead to greater resistance by airway volume, it is suggested that maxillary expansion improves OSA in adults in the short term.[19] Maxillary expansion (ME) has been used since the 1860 to mechanically widen the upper jaw, creating more space around the arch. Widening the maxilla expands the midpalatal suture (MPS) and the intermaxillary suture (IMS). When they are not fused, it is connective tissue and behaves viscoelastically in response to externally applied forces, [21] It has been shown that the activation of anchored miniscrews, for slow maxillary expansion (SME= one turn per day) vs fast maxillary expansion (RME= 2 turns per day), SME provides a better experience for the patient, however there is no statistical difference. EMR patients reported headaches and dizziness.[22] Due to the modification of palatal rhytids secondary to maxillary expansion, it has been shown that the use of orthopedic treatments specifically RMS does not significantly alter the pattern of palatal rhytids in growing subjects, RME can produce greater orthopedic changes with more tilt than skeletal expansion.[23]

CONCLUSION

Early clinical evaluation and imaging studies are crucial to determine the proximity to the roots and sinuses before making the decision about the use of any of the maxillary expansion modalities, especially at a young age where the cranial sutures are not yet fused.

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REFERENCES

1. Magnusson A, Bjerklin K, Nilsson P, Jönsson F, Marcusson A. Nasal cavity size, airway resistance, and subjective sensation after surgically assisted rapid maxillary expansion: a prospective longitudinal study. Am J Orthod Dentofacial Orthop. 2011;140(5):641-51.
2. El H, Palomo JM. Airway volume for different dentofacial skeletal patterns. Am J Orthod Dentofacial Orthop. 2011;139(6):e511-21.
3. Cappellette M, Nagai LHY, Gonçalves RM, Yuki AK, Pignatari SSN, Fujita RR. Skeletal effects of RME in the transverse and vertical dimensions of the nasal cavity in mouth-breathing growing children. Dental Press J Orthod. 2017;22(4):61-9.

4. Betts NJ. Surgically Assisted Maxillary Expansion. Atlas Oral Maxillofac Surg Clin North Am. 2016;24(1):67-77.
5. Ruan WH, Han WQ, Huang ML, Huang KL, Jin LL. Premaxillary-maxillary suture development in the first trimester : An ultrasound study. J Orofac Orthop. 2019;80(1):25-31.
6. Ruan WH, Winger JN, Yu JC, Borke JL. Effects of induced premaxillary suture fusion on the craniofacial morphology in growing rats. Arch Oral Biol. 2008;53(1):79-86.
7. Goldberg M. Embryology and Development: Mandible, Maxillary, Deciduous and Permanent Teeth. JSM Dent. 2019;7(1):1116.
8. Zohrabian VM, Poon CS, Abrahams JJ. Embryology and Anatomy of the Jaw and Dentition. Semin Ultrasound CT MR. 2015;36(5):397-406.
9. Baciu ER, Budală DG, Vasluianu RI, Lupu CI, Murariu A, Geleţu GL, et al. A Comparative Analysis of Dental Measurements in Physical and Digital Orthodontic Case Study Models. Medicina (Kaunas). 2022;58(9):1230.
10. Petrén S, Bondemark L, Söderfeldt B. A systematic review concerning early orthodontic treatment of unilateral posterior crossbite. Angle Orthod. 2003;73(5):588-96.
11. Eldin NF, Elkordy SA, Fayed MS, Elbeialy AR, Eid FH. Transverse Skeletal Effects of Rapid Maxillary Expansion in Pre and Post Pubertal Subjects: A Systematic Review. Open Access Maced J Med Sci. 2019;7(3):467-77.
12. Andrucioli MCD, Matsumoto MAN. Transverse maxillary deficiency: treatment alternatives in face of early skeletal maturation. Dental Press J Orthod. 2020;25(1):70-9.
13. Dakhil N, Bin Salamah F. The Diagnosis Methods and Management Modalities of Maxillary Transverse Discrepancy. Cureus. 2021;13(12):e20482.
14. Zhao H, Wang X, Jin A, Wang M, Wang Z, Huang X, et al. Reducing relapse and accelerating osteogenesis in rapid maxillary expansion using an injectable mesoporous bioactive glass/fibrin glue composite hydrogel. Bioact Mater. 2022;18:507-25.
15. Teja PH, Teja SS, Nayak RS, Bagade A, Sharma MR. Correction of transverse maxillary deficiency and anterior open bite in an adult Class III skeletal patient. APOS Trends Orthod. 2016;6:166-70.
16. Lee KJ, Park YC, Park JY, Hwang WS. Miniscrew-assisted nonsurgical palatal expansion before orthognathic surgery for a patient with severe mandibular prognathism. Am J Orthod Dentofacial Orthop. 2010;137(6):830-9.
17. Carlson C, Sung J, McComb RW, Machado AW, Moon W. Microimplant-assisted rapid palatal expansion appliance to orthopedically correct transverse maxillary deficiency in an adult. Am J Orthod Dentofacial Orthop. 2016;149(5):716-28.
18. Brunetto DP, Sant'Anna EF, Machado AW, Moon W. Non-surgical treatment of transverse deficiency in adults using Microimplant-assisted Rapid Palatal Expansion (MARPE). Dental Press J Orthod. 2017;22(1):110-25.
19. Oliveira LT, Abreu LG, Silveira GS, de Araújo VE, Oliveira DD. Does surgically assisted maxillary expansion improve obstructive sleep apnoea in adults? A systematic review and meta-analysis. Evid Based Dent. 2022.
20. Sangsari A, Chinipardaz Z, Carrasco L. Following Surgically Assisted Rapid Palatal Expansion, Do Tooth-Borne or Bone-Borne Appliances Provide More Skeletal Expansion and Dental Expansion? J Oral Maxillofac Surg. 2017;75(10):2211-22.
21. Fuhrer RS, Romanyk DL, Carey JP. A comparative finite element analysis of maxillary expansion with and without midpalatal suture viscoelasticity using a representative skeletal geometry. Sci Rep. 2019;9(1):8476.
22. ElNaghy R, Al-Qawasmi R, Hasanin M. Do patient-reported outcomes of miniscrew-supported maxillary expansion in adolescent patients differ between slow and rapid activation protocol? Evid Based Dent. 2023;24(1):28-9.
23. Lanteri V, Cossellu G, Farronato M, Ugolini A, Leonardi R, Rusconi F, et al. Assessment of the Stability of the Palatal Rugae in a 3D-3D Superimposition Technique Following Slow Maxillary Expansion (SME). Sci Rep. 2020;10(1):2676.

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