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Advances in Methods of Maxillary Transverse Expansion

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Abstract

In view of the common clinical problem -- maxillary transverse deficiency, a variety of maxillary expansion methods have emerged and achieved good results in recent years. In order to expand narrow maxilla and maxillary dental arch, clinicians could choose the following several methods: non-surgically assisted simple dental anchorages expansion, surgically assisted maxillary rapid expansion, microimplant-assisted rapid palatal expansion, repetitive rapid palatal expansions and stealth arch extenders according to the mature stage of mid-palatal sutures and malocclusion types. With a comprehensive diagnosis and treatment, the coordinate maxillomandibular width could be obtained by means of these methods

Keywords: Maxilla; Palatal Expansion Technique; Mid-Palatal Suture

Introduction

Maxillary transverse deficiency is one of the most common clinical skeletal malocclusions. It is mainly manifested as insufficient transverse width of maxilla and upper dental arch, crossbite or buccal crossbite of posterior teeth. These are often accompanied by sharp rounded dental arch, crowded anterior teeth, obvious buccal corridor, deep and narrow palatine crest, mandibular lateral deformity and so on, which are not conducive to maxillofacial function and aesthetics of patients. A coordinate maxillomandibular width is crucial for stable transverse intercuspal relationship, stable mandible position, comfortable condylar position, functional coordination of maxillofacial nerve and muscle system, as well as a stable long-term curative effect.

In 1860, Angle used the rapid palatal expansion (RPE) firstly to overcome the bone resistance though orthopedic force generated by dental arch expanders to separate sutures of maxilla and palate so as to correct the deficient transverse width. With the problem of insufficient transverse width of maxilla and upper arch becoming more and more prominent, various techniques of maxillary expansion have emerged over the years. In addition to RPE, maxillary expansion methods mainly include: slow palatal expansion (SPE), microimplant-assisted rapid palatal expansion (MARPE), surgically assisted maxillary rapid expansion (SARME), repetitive rapid palatal expansions (RRPE), and stealth arch extenders. Clinicians could choose the appropriate expansion method clinically according to the mature stage of mid-palatal sutures and malocclusion degree, as well as the age of patients and clinicians' own clinical experience. In this paper, the advances of maxillary expansion techniques are reviewed.

Non-surgically Assisted Simple Dental Anchorages Expansion:

In clinical practice, the techniques of non-surgically assisted simple dental anchorages expansion include RPE and SPE, in which both molars and premolars are used as anchorages teeth. The expansion force generated by expanders will directly act on anchorages teeth then transfer to palatal sutures,

so as to overcome the resistance of peripheral bone sutures and realize the opening of palatal sutures. The differences between RPE and SPE are the power and speed of the force.

Rapid Palatal Expansion (RPE)

RPE is currently widely used in clinical practice, which refers to the rapid opening of palatal sutures before significant teeth movements through strong orthodontic force. The commonly used RPE expanders clinically include Hyrax and Hass expanders, whose expanding speed is generally in the range of 1.4-3.5mm per week. Jafari et al.1-3 suggested that maxillary and palatal sutures had significant wedge-shaped changes in both vertical and horizontal dimensions in the process of RME. In coronal view, the whole mid-palatal suture was opened into a pyramidal shape with the bottom on palatal side and the top facing nasal bone. Horizontal cuneate was with base in incisor region and top in posterior maxilla.

Bone maturation index 1-4 is the ideal time for RPE, which means the early stage of bone maturation. If the growth and development peak was missed, usually for females over 12 to 13 years old and males over 14 to 15 years old, the effect of RPE would be significantly reduced or even ineffectual. Therefore, the groups with deficient transverse width mainly suitable for RPE are as follows: those in the bursting stage of growth and development, whose mid-palatal suture has not calcified to form a solid bone bond and their mid-palatal suture can be opened by simple dental anchorages, as well as those who have mildly or moderately insufficient arch width without surgical assistance.

Easy chair-side operation for clinicians and no invasive surgical assistance to achieving a certain degree of bone expansion for patients are its advantages. At the same time, our attention should be paid to :(1) Patients with dolichofacial pattern and open bite should be used carefully to avoid mandibular clockwise rotation caused by the inevitable lower position of upper molar palatal cusp resulting from the way of simple dental anchorages, which could lead to deterioration of facial aesthetics and open bite, airway closure as well as temporomandibular joint(TMJ) shift. (2) Clinicians should be aware that RPE cannot form true skeletal expansion due to improper selection of applicable patients. As Berger4 mentioned that it only forms buccal inclination of anchorage teeth, periodontal ligament stretch and damage, soft tissue swelling, gingival recession and even buccal root resorption, bone fenestration.

Slow Palatal Expansion(SPE)

SPE refers to the expansion of upper arch and mid-palatal suture though gentle orthodontic force, whose expanding speed is generally in the range of 0.4-1.2mm per week clinically. Lgravere5 reported that although SPE works slowly and has a longer course of treatment, the force provided by SPE is closer to physiology when compared with RPE, which can maintain the integrity of mid-palatal suture, and achieve a more stable long-term prognosis of expansion. Consistent with the applicable groups of RPE, the best time to achieve skeletal expansion is the burst of growth and development. The younger the age, the stronger the skeletal effect is obtained.

At present, the skeletal and dental effects acquired by RPE and SPE are still controversial. Christie6 and Herold7 showed that the skeletal effect of RPE was larger than that of SPE, which may be related to the accumulation and eruption of the force and speed exerted by RPE in a relatively short time. Martina 8, however, believed that RPE and SPE produced similar skeletal and dental effects when mid-palatal suture was opened, and their difference was not statistically significant. SPE showed less forward and downward maxillary movement than RPE observed from sagittal dimension9, and Bassarelli et al.10,11,12 reported that mandible showed backward and downward movement with that change, and mandibular planes increased after SPE as well. In conclusion, appropriate expansion methods should be selected to achieve a therapeutic effect according to the specific situation, rather than SPE or RPE only.

Surgically Assisted Maxillary Rapid Expansion (SARME)

In order to achieve maximum skeletal effects, SARME help patients with calcified mid-palatal sutures in maxillary expansion through surgical assistance. As early as 1938, Brown has performed a split auxiliary expansion of mid-palate suture. With the development of medical technology, simple palatine corticotomy and maxillary buccal corticotomy have been applied in maxillary expansion and achieved success. Up to now, the maxillary expansion surgery for adult patients is mainly Le fort I osteotomy and Le fort I osteotomy + mid-palatal suture osteotomy, and the latter is the classic SARME.

SARME is mainly suit for adults whose mid-palatal suture has been calcified and fused, as well as patients with severe upper arch and maxilla stenosis. It can achieve more skeletal effect by reducing bone resistance greatly and avoid overmuch buccal inclination of anchorage teeth. In view of the specific implementation time, different researches give us different references. CBCT was used to divide mid-palatal suture into five stages (A, B, C, D and E) so as to indicate its maturity by Angelieri13. The study indicated that mid-palatal suture in stage C began to fuse, and the application of dental anchor

age expansion would produce a smaller skeletal effect than that in stage A and B. 84.4% people are in stage D or E over 18 years old, so surgically assisted maxillary expansion should be carried. Handelman 14 suggested that SARME should be used for patients with transverse deficiency over 5mm in upper dental arch and who are over 16 years old. Candido et al. 15,16 reported that when SAMPE achieves a great skeletal effect, it not only has a positive effect on the volume of upper airway, but also can make the position of TMJ disc relatively stable. Raafat17 suggested that it is also conducive to the counterclockwise rotation of mandible and the anteroposterior movement of hyoid bone, as well as the improvement of forward head posture. What should be noted is that the surgical process is complicated and may cause complications such as nosebleed, periodontal tissue injury, intraoperative infection and neurovascular injury during and after surgery18. In order to shorten operation time, reduce tissue trauma and complications of patients, surgeons should constantly refine their own surgical operations.

Microimplant-Assisted Rapid Palatal Expansion (MARPE)

MARPE refers to the maxillary skeletal expansion with 2-4 screw implants implanted in hard palate. Different from the above mentioned methods, MARPE transfers dental anchorage into skeletal anchorage, which could break through age limit and reduce inclination and movement of anchorage teeth, achieving skeletal opening of mid-palatal suture to the greatest extent and stable long-term prognosis.

The principles of MARPE include dental expansion, alveolar bone expansion and palatal opening. Regarding the proportion of skeletal effect, Kartalian19 reported it accounted for 40% by analyzing in CBCT images. Garrett20 indicated that skeletal effect was 55% at first premolars and accounted for 38% at first molar. Altug21 and Harzer22 indicated that although both dental and skeletal anchorage could lead to buccal inclination of anchorage teeth, studies still showed that skeletal anchorage expansion could produce smaller dental effect, which is worthy of promotion and application.

MARPE is simple and easy to operate when compared with SARME. It is less invasive for patients, which not only reduces the probability of postoperative infection, but also reduces the time of postoperative pain. It should be noted that for MARPE, the maintenance of oral hygiene is very important for avoiding peri-screw implants infection. It is recommended to use interdental brushes to keep peri-screw implants clean, and regular chlorhexidine mouthwash could also work. Iodine glycerin should be used if there is inflammation and hyperplasia of soft tissue around screw plants, and the laser could eliminate proliferated soft tissue if necessary. The most important thing is to prevent screw implants from falling off and the serious consequences such as aspiration.

Repetitive Rapid Palatal Expansions (RRPE)

RRPE is a kind of maxillary expansion with repetitive weekly protocol of alternate rapid maxillary expansions and constrictions so as to activate bone sutures and achieve greatly skeletal effect.

A large number of studies have shown that RRPE could release more perimaxillary sutures and remove their resistance relatively completely when compared with simple expanding. The method applies not only to maxillary transverse deficiency. For skeletal Class III patients with maxillary retraction, cleft lip and palate patients with maxillary insufficient development in sagittal dimension, maxillary skeletal expansion combined with maxillary anterior traction can achieve an ideal anterior movement of maxilla and obtain greatly histological reconstruction23-25, which means that for some elderly skeletal Class III patients with or without maxillary transverse deficiency, Class III traction could work well. Maino et al.26-28 reported that RRPE combined with anterior traction could promote more maxillary forward movement than simply anterior traction, but its long-term effect and stability still need follow-up observation. In addition, Liou29 showed that Two-hinged expanders could achieve asymmetric expansion with smaller amount at the back of maxilla and larger amount at the front.

Stealth Arch Extender

With the development of material science and people's requirement on aesthetics and comfort of orthodontics, invisible orthodontic treatment is gradually emerging, and some achievements have been made in upper arch expansion as well.

Vacuum formed aligners is a transparent orthodontic device designed and manufactured with the help of three-dimensions scanning technology and computer-aided design, which could realize exact control of orthodontic force and tooth position in different stages. Patients are free to remove and wear braces, replacing them by sequence to achieve a small range of tooth movement and finally the ultimate treatment goal. Vacuum formed aligners are well utilized by orthodontists all around the world because of the improved esthetics and comfort, together with the reduction of chair-side time. Different from the above methods, stealth arch extenders only produce dental effect. It is suitable for patients with mild arch narrow, which could be improved only by buccal movement or buccal inclination of

posterior teeth.

It is worth noting that although invisible orthodontic could obtain visual treatment target through software, the target cannot reach 100% and the predictability is lower than traditional fixed orthodontic30. Stealth arch extenders could effectively achieve dental expansion, and materials of invisible appliance, time of braces wearing, accessories design and preset expansion amount of molars all may affect its expansion effect31

.Conclusion

The expansion of maxilla and upper dental arch could be achieved by the above methods, so as to deal with the individualized difference of insufficient transverse width. According to the mature stage of mid-palatal sutures and the degree of malocclusion, clinicians should choose an appropriate maxillary expansion method to achieve the best therapeutic effect.

(1) For children and adolescents before growth and development peak or just in this period, non-surgically assisted simple dental anchorages expansion—RPE and SPE can be adopted. Soft strength could not only effectively expand the maxilla, but also won't make patients feel obvious pain.

(2) For young adults who are at the end of their growth spurt or whose mid-palatal suture has not been completely calcified, MARPE should be adopted to solve the problem of insufficient maxillary width and avoid surgical risks.

(3) In the face of adults with complete growth and complete calcification of mid-palatal sutures, SARME should be considered so as to obtain more skeletal expansion effects.

(4) For skeletal Class III patients with or without maxillary narrow who have sagittal maxillary hypodevelopment, RRPE is feasible to fully activate maxillary sutures and could achieve more maxillary forward movements combined with anterior traction.

(5) For patients with mild upper arch narrow, which could be improved only by buccal movement or buccal inclination of posterior teeth, stealth arch extenders could solve the problem of uncoordinated maxillomandibular width effectively, at the same time with beauty, comfort, convenience and other advantages.

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