Surgical Management of Transverse Maxillary Deficiency in Adults

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Abstract Transverse maxillary deficiencies are a common occurrence, prevalent in both syndromic and non syndromic patients. Treatment usually combines a orthodontic-surgical intervention in adults. This article reviews the procedures along with the experience of the authors in the correction of maxillary transverse deficiency in adults.

Keywords Transverse · Maxilla · Mid palatal suture

Introduction

Among the occlusal discrepancies persisting in adults, transverse maxillary deficiency is a common occurrence. These conditions are prevalent in both non-syndromal and syndromal patients. Treatment in an adult is a challenge and generally entails a combined orthodontic—surgical intervention. This helps provide adequate dental arch space by substantially enlarging the maxillary apical base and palatal vault, thus providing space for the tongue and would in turn reduce the chances of relapse.

It is important to note that lateral expansion of the maxilla not only causes dentofacial changes, but also craniofacial structural changes as is evident in the subjective

improvement in nasal breathing associated with enlargement of the nasal valve towards normal values due to the increase of nasal volume in all compartments [1].

An increment in the transverse diameter obtained entirely via bone formation, with no dental compensation, the absence of dental or osseous relapse, and no dental or periodontal damage, represents the ideal goal in treating the narrow maxilla.

Maxillary width deficiencies normally do not present an orthodontic challenge if they are detected before or during the adolescent growth spurt. Correction of these deficiencies with a maxillary rapid palatal expander first popularised more than 40 years ago by Haas [2], yields well-controlled and predictable results. However, once patients are past their growth spurt, which occurs at about the age of 12–13 years in females and 14–15 years in males [3], the protocol for rapid palatal expansion (RPE) is not quite so clear. As the sutures mature, the majority of rapid orthopaedic palatal expansion occurs via dental tipping and alveolar bone bending, rather than skeletal movement. This can cause complications like buccal tipping of teeth, extrusion, root resorption, and fenestration of the alveolar process leading to periodontal side effects [4].

History

The concept of correcting maxillary transverse width discrepancies was first described in 1860 by Angell [5]. Haas reintroduced the concept in 1961 [2] with expansion appliances. Orthodontic/Orthopedic RPE was later found to result in alveolar bending, periodontal membrane compression, lateral tooth displacement and tooth extrusion in adults.

Resistance, relapse, and pain associated with palatal expansion have been attributed to increased rigidity of the

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facial bones, especially the zygomatic buttress and other circum maxillary sutures. Brown [6] first described surgically assisted rapid maxillary expansion (SARME) in 1938, performing only a midpalatal split. After a number of years, SARME with lateral osteotomies only, appeared to be a simpler and more effective procedure [7, 8].

In 1976 Kennedy and associates [9] studied the effects of selected maxillary osteotomies as an adjunct to RPE in mature rhesus monkeys. In 1976 Bell and Epker [10] brought clinical relevance to the question of adult RPE when they advocated these same selected osteotomies in their skeletally mature patients. However, the latter still recommended placement of a chisel in the midpalatal suture from the nasal side, while the former made a palatal incision and with a bur cut through the midpalatal suture. The basis of their recommendations was the increased facial skeletal resistance to expansion noticed at the zygomaticotemporal, zygomaticofrontal and zygomaticomaxillary sutures.

Currently, surgeons perform SARME as an outpatient procedure with GA or IV sedation. This procedure is the first and best example of distraction osteogenesis.

Diagnosis of Maxillary Transverse Deficiency

The diagnosis of transverse maxillary deficiency can often be difficult because there are minimal soft tissue changes associated with it and the discrepancy is easily masked by other skeletal or dental discrepancies.

The Main Clinical Features of the Condition Could Include:

1. Para nasal hollowing
2. Narrow nasal base
3. Deepened nasolabial folds
4. Hypoplastic Zygoma
5. Unilateral or bilateral posterior cross bite
6. Narrow tapering maxillary arch form
7. Narrow and high palatal vault

This is further endorsed by radiographic studies especially the standardised PA Cephalogram. Ricketts has developed a Rocky Mountain Analysis with suggested norms measurements performed by acoustic rhinometry and frontal cephalometry [11].

Treatment Options

The treatment options are either non surgical and surgical. These include:

1. Orthopedic rapid palatal expansion
2. Surgically-assisted rapid palatal expansion

3. Segmental LeFort Osteotomies

Orthopedic Palatal Expansion

This procedure ensures success primarily in children prior to sutural closure. Various appliances have been successfully used to expand the maxilla. One such appliance is the Haas-type Appliance. This has acrylic palatal flanges incorporated into the appliance with the jack-screw. There is less dental tipping in this due to palatal anchorage. Another appliance is the Hyrax appliance with metal framework jack-screw, quite in vogue today.

A modified appliance is the hybrid of Haas and a flat-plane occlusal-coverage splint physically bonded to maxillary teeth recommended in periodontally compromised dentition because it incorporates more teeth. It is helpful in patients with Temporomandibular Dysfunction symptomatology where occlusal modifications are possible when prematurities occur during expansion of the jack-screw.

These appliances are removed after 3–4 months and a retainer then placed to prevent relapse or to begin sagittal correction.

This type of orthopedic expansion typically results in greater canine expansion than molar expansion at a ratio of 3:2. The changes in the rapid palatal expansion is seen in skeletal (sutural opening), dental (tipping) and alveolar (bending and remodeling) components. The possibility of high post-treatment relapse means that at least 50% over-expansion is recommended.

After sutural closure or completion of transverse growth, orthopedic expansion alone is unsuccessful and possible problems include:

1. Inability to activate appliance
2. Severe pain with activation
3. Pressure necrosis under the appliance
4. Bending of alveolar bone
5. Unstable results with relapse
6. The posterior teeth tip leading to poor occlusion and instability.
7. This further leads to clockwise mandibular rotation, opening the bite and increasing facial height.
8. The maxillary posterior teeth are displaced buccally through the alveolus leading to gingival recession, bone loss and root resorption.

Surgically Assisted Rapid Maxillary Expansion (SARME)

The choice of a surgical or non surgical option essentially rests with the treating team consisting of both the

orthodontist and Maxillofacial Surgeon. The factors that govern the choice include:

1. Type of deficiency (dental, skeletal, both)
2. Patient's skeletal growth status
3. Magnitude of discrepancy
4. Status of periodontal tissues

An index has been proposed as a guide in determining the choice of treatment modality. This is the Maxillo-mandibular Transverse Differential Index (MTDI).

- (a) Expected Maxillo Mandibular difference = Expected mandibular width – Expected maxillary width
- (b) Actual MM diff = Actual mandibular width – Actual maxillary width
- (c) Expected – Actual maxillomandibular differential = MTDI

If this value exceeds 5 mm then a transverse deficiency exists and SARME may be indicated.

The recommended indications for surgical intervention are:

1. Maxillary transverse deficiency more than 5 mm
2. Significant deficiency with narrow maxilla and wide mandible
3. Failed orthodontic and/or orthopedic expansion
4. Over 7 mm expansion required making LeFort surgery unstable
5. Significant recession in canine/premolar region
6. Skeletal age 15 years or greater

Surgical Procedure

The procedure is undertaken in our institution under general anaesthesia. Our protocol consists of the following steps:

1. Decompensation of mandibular teeth prior to expansion restricted to correction of teeth inclinations and removal of possible occlusal interferences that may occur during expansion.
2. Hyrax appliance fabrication on maxillary cast and trial in the patient's mouth preoperatively
3. Cementing of the appliance using bands in the molar/premolars preoperatively
4. Maxillary vestibular incision from 1st molar of one side to the other.
5. Exposure of the bone along the predetermined osteotomy.
6. Release of nasal floor mucosa and lateral wall mucosa from maxilla
7. Lateral osteotomy bilaterally from pyriform rim to maxillary tuberosity

8. Release of nasal septum from maxilla
9. Midline osteotomy
10. Check activation of expansion appliance to see completion of cuts
11. Closure of surgical site
12. Post operative anti inflammatory drugs
13. Activation of appliance after 4 days—2 turns per day
14. Suture removal after 7 days
15. Post surgical orthodontic closure of spaces
16. Retention of appliance passively for 3 months
17. Palatal bar replaces appliance for another 3 months

(Fig. 1 and 2).

Evaluation

Serial occlusal radiographs are taken during the expansion phase. One significant finding is the V-shaped opening of the suture with the greatest amount of opening being anteriorly directed, with convergence of the suture opening in the posterior aspect of the palate. The expansion of the maxillary dental arch also shows a V pattern similar to the

Fig. 1 Preoperative picture showing constricted maxillary arch

Fig. 2 Intraoperative photograph showing osteotomy cuts

Fig. 3 Maxilla with expansion in progress

opening of the suture. Another finding is the tendency of both central incisors to move mesially without any orthodontic help into the recently developed midline diastema as the bone consolidation in the midline progresses (Fig. 3).

Cephalometric analyses reveal no significant changes in facial angle, the angle of convexity, and the mandibular plane angle. The soft tissue profile is also preserved in these patients.

Other means of evaluating the maxillary expansion include optical density measurement of the midline suture [11].

Types of Devices

The initial attempts to surgically expand the maxilla used tooth borne devices cemented to the teeth for anchorage. The limits of tooth borne procedures are reflected in the incidence of negative periodontal side effects, buccal tilting, and extrusion of the anchoring teeth, and by the amount of skeletal relapse. These effects are probably owing to the mechanics of the procedure. As conventional devices are tooth-anchored, mechanical stresses are applied to the roots during expansion, and bone movement is not prevented during the consolidation period.

It is to negate these problems that bone borne devices are now being popularized. The clinical advantages of this approach over tooth-borne devices are the possibility of treating periodontally compromised patients and starting active orthodontics during the consolidation phase, reducing the duration of treatment [12].

Surgical Procedures

The surgical procedure for maxillary expansion has seen a horde of variations down the ages. Amongst the procedures described are:

1. Surgery restricted to the midpalatal suture [13].
2. Osteotomy only in the bilateral lateral wall, from the piriform opening to the maxillary tuberosity without releasing the pterygoid lamina and with no osteotomy in the median palatine suture [7].
3. Lateral maxillary wall corticotomy combined with a midpalatal osteotomy.
4. Combination of both techniques (Osteotomies in the median palatine suture and in the bilateral lateral wall without releasing the pterygoid lamina) [14].
5. Subtotal Le Fort I osteotomy associated with median palatine suture osteotomy. Because they consider the results to be more stable in the long term [15].

Discussion

The possible limitations of RPE in adults led to the surgical options being used as a viable option. However the controversy regarding success of RPE in adults is far from over with conflicting studies advocating both modalities in adults.

The choice of the device has seen a decisive shift from tooth borne to bone borne due to the advantages of the latter. Bone-borne distraction causes less segmental angulation than tooth-borne distraction [16].

In the first article evaluating skeletal and dental changes on the posteroanterior and lateral cephalograms after the use of a Trans Palatal Distractor [17], the amount of skeletal expansion (5.25 mm) was greater with bone borne devices than tooth borne devices like Haas and Hyrax expanders. The reason for this could be the direct transmission of force to the maxilla at the top of the palatal vault and thus closer to the center of resistance than with a tooth-borne appliance.

One absolute contraindication to using tooth borne devices is the presence of a low palatal vault.

SARME was initially performed doing a subtotal Le Fort I osteotomy with pterygoid dysjunction. This was modified by Glassman et al. [18] who restricted the osteotomy to maxillary lateral corticotomies. They used two incisions on either side of the pyriform rim to cut the anterior wall of maxilla and a midline vertical incision to get a midline osteotomy between the central incisors.

Gorback and Infante [19] in an earlier reference have used the palatal approach by stripping the palatal mucosa and making a midline osteotomy. The lateral cuts were made using three vertical incisions, tunneling through them and completing the cuts. This however mobilised the palatal and buccal mucosa compromising the vascularity. This is only of historical interest.

Fig. 4 Closure of the midline space after maxillary expansion

Another modification has been a Le Fort I osteotomy with no dysjunction of pterygomaxillary junction or midline palatal split [1] (Fig. 4).

The main change in surgical modality down the ages has been a more conservative approach, doing away with pterygomaxillary dysjunction and not resorting to a maxillary down fracture.

The significant finding of a V shaped opening of the midline is endorsed by the studies by Adkins et al. [20] who showed that for every millimeter of transpalatal width increase in the premolar region there is a 0.7 mm increase in available maxillary arch perimeter.

Friedrich and Mossaz [21] have established that maxillary skeletal expansion by SARME is mainly a lateral rotation of the two maxillary halves with only minimal horizontal translation.

Among the possible postoperative complications one can encounter in SARME are sinus infection, devitalization of the teeth (if osteotomy is performed too close to the apices of the teeth), extrusion of teeth fixed to the Hyrax appliance, or nasal bleeding.

However there are contemporary clinicians treating maxillary transverse deficiency who do not subscribe to the clear demarcation between treatment of the transverse maxillary deficiency in children and those in adults. Proffit [22] reports that by late teens, interdigitation and areas of bony bridging across the suture develop to the point that maxillary expansion becomes impossible. This is based on the study by Melsen [23], who did a cadaveric study.

Other radiographic studies [24] have demonstrated that the midline palatal suture frequently begins to close during the early teens and that maxillary expansion is best performed before the end of adolescence. It is generally assumed that the palatal suture is a straight-running oronasal suture and that the radiographic path projects through this suture [25].

However according to Stuart and Wiltshire [26], midpalatal sutures, do not always run straight. If an occlusal

film does not show a suture, it may be because the suture runs in an oblique direction in relation to the radiographic path or because the bone structures (such as the vomer) project above the suture. This finding is based on earlier research [27], which found that if a 5% midpalatal sutural closure is set as a limit for splitting the intermaxillary suture, this 5% closure will not have been reached in most patients younger than 25 years of age. Recent research indicates that a “radiologically closed” midpalatal suture is not the histological equivalent of a fused or closed suture. Therefore the authors advocate non surgical expansion in adults too. Handelman et al. [28] have treated 47 adult cases using RPE with minimal relapse. Their maxillary retention was however kept for 5 years.

The common finding of a maxillary constriction predominantly in the anterior region led Özgür Pektas et al. to devise a modified osteotomy to manage this condition [29].

Another modification aims at achieving maximum bone to bone contact in the mid palatal region by oblique osteotomy [30].

Another aspect of debate has been the need to overcorrect due to inherent possibility of relapse. Betts and Ziccardi [31] state that overcorrection is unnecessary while others like Pogrel et al. [32], advocate that to prevent undesired results and late relapse, it is necessary to promote an overexpansion during the treatment, varying from 0.5 to 2.0 mm on each side.

There is no consensus in contemporary literature regarding the choice of treatment modality in adults, the surgical technique, the type of distractor used (tooth-borne or bone-borne), the existence, cause and amount of relapse and whether or not overcorrection is necessary. Ultimately the clinician must decide for each individual adult patient whether it is best to expand the maxilla with nonsurgical RME or SARME. Having these two viable options greatly enhances our ability to treat cases of maxillary arch deficiency.

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