Chapter 8

Surgically Assisted Maxillary Expansion

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Additional information is available at the end of the chapter

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1. Introduction

An adequate transverse maxillary dimension is a critical component of a stable and functional occlusion. [1] Orthopedic rapid maxillary expansion in skeletally immature patients is the procedure of choice to correct this condition in that age group. However, as skeletal maturity approaches, bony interdigitation increases as the sutures fuse. [2,3] After suture closure or completion of transverse growth, orthopedic transverse maxillary expansion is largely unsuccessful because the expansion is primarily composed of no basal skeletal movement. [4] This phenomenon leads to difficulty separating the maxilla with orthopedic forces alone and bending of the alveolus, dental tipping and minimal maxillary expansion. The result is relapse despite overcorrection, periodontal defects, and malocclusion. [5]

Rapid maxillary expansion can produce unwanted effects when used in a skeletally mature patient, including lateral tipping of posterior teeth [6,7], extrusion [8-10], periodontal membrane compression, buccal root resorption [11-13], alveolar bone bending [7], fenestration of the buccal cortex [13-16], palatal tissue necrosis [17], inability to open the midpalatal suture, pain, and instability of the expansion [7,10,18-20]. Several reasons have been speculated regarding factors that limit orthopedically induced maxillary expansion in skeletally mature patients.

However, a few reports in the literature contradict these findings and state that nonsurgical maxillary expansion is as successful in adults as it is in children [21, 22]. Experiencing more complications, after attempts to orthopedically alter the transverse dimension of the maxilla with advancing age, surgical procedures have been recommended to facilitate correction of transverse discrepancies by Perrson [23], who found evidence of bony union at 17 years in the midpalatal suture. Burston [24], however, found no evidence of synostosis in the same suture by the age of 18 years.

2. Correction of transverse discrepancy via orthodontics

This is successful until the age of approximately 14–15 years depending on the gender of the patient. After this age, orthodontic widening becomes virtually impossible and very painful. In general, it is assumed that closure of the midpalatal suture prevents this type of expansion [25-27].

On the other hand, Mommerts outlined a basic treatment strategy for patients with maxillary constriction, based on age that rapid maxillary expansion should be completed to treat maxillary constriction in patients under the age of 12. From age 14 on, surgically assisted palatal expansion is indicated to release areas of bony resistance in the midface [28].

3. Surgically Assisted Rapid Maxillary Expansion (SARME)

The areas of resistance to lateral forces in the midface are the pyriform aperture (anterior), the zygomatic buttress (lateral), the pterygoid junction (posterior) and the midpalatal synostosis suture (median). Many surgical interventions and techniques have been developed by the identification of these areas of resistance. Surgery assisted maxillary expansion procedures have conventionally been grouped into 2 categories:

1. Segmenting the maxilla during a LeFort osteotomy to reposition the individual segments in a widened transverse dimension, and
2. Surgically assisted rapid maxillary expansion (SARME).

Advantages of SARME over orthodontic therapy and segmental Le Fort procedures include decreased risk of periodontal damage, improved esthetics when smiling, improved nasal air flow, and decreased risk of avascularity. SARME is also a relatively simple procedure and is associated with minimal morbidity. Intraoperative complications are uncommon and there is also less chance of avascularity leading to aseptic necrosis than with segmental Le Fort I procedures. [29, 30] Brown [12] was probably the first who described a technique of SARME with midpalatal splitting. [31] In 1961, Haas described the downward and forward movement of the maxilla that occurs during rapid maxillary expansion because of the location of the craniomaxillofacial sutures. He believed that the hemimaxillas separated from each other develop tipping rather than separating in a parallel fashion due to the strength of the zygomatic buttresses. [32]

Most methods consider the zygomaticomaxillary junction the major site of resistance and perform a corticotomy through the zygomatic-maxillary buttress from the pyriform rim to the maxillopterygoid junction. The midpalatal suture is historically considered the major place of resistance. The pterygoid plates are also a considerable site of resistance but because of the increased risk of injuring the pterygoid plexus by the osteotomy, some chose not to, without losing much mobility. By not releasing the pterygoid junction, the pattern of opening of the maxillary halves is more V-shaped with the point of the V located dorsally [33-37].

Isaacson and Ingram [38] and Isaacson et al. [39] mention that historically, the midpalatal suture was thought to be the area of resistance to expansion, but the facial skeleton increases its resistance to expansion as it ages and matures, and that the major site of resistance is not the midpalatal suture but the remaining maxillary articulations. Wertz stated that resistance of the zygomatic arch prevents parallel opening of the midpalatal suture [40]. Many surgeons release the midpalatal suture to improve mobility and to prevent deviation of the nasal septum. Several authors describe two paramedian palatal osteotomies from the posterior nasal spine to a point just posterior to the incisive canal [41-43].

In 1975 and 1976 Bell and Epker demonstrated that the area of increased facial skeletal resistance to expansion was indeed not the midpalatal suture, but the zygomaticotemporal, zygomaticofrontal and zygomaticomaxillary sutures. [44, 45] On the other hand, Shetty concluded that exclusive use of bilateral zygomaticomaxillary buttress osteotomies to facilitate SARME was inadequate. They therefore concluded that complete midpalatal and pterygomaxillary osteotomies were essential for predictable maxillary expansion in adults. [46]

There is a lack of consensus among orthodontists and surgeons about the indications for SARME. Although maxillary expansion may be required for many patients, an accurate diagnosis of maxillary transverse distraction is somewhat ambiguous. This is further complicated by case reports in the literature about orthodontic maxillary expansion or other forms of expansion in adults. The following have been reported in the literature as indications for SARME, all applying to a skeletally mature patient with a constricted maxillary arch.

4. Indications for SARME

1. To increase maxillary arch perimeter, to correct posterior crossbite, and when no additional surgical jaw movements are planned.
2. To widen the maxillary arch as a preliminary procedure, even if further orthognathic surgery is planned. This is to avoid increased risks, inaccuracy, and instability associated with segmental maxillary osteotomy.
3. To provide space for a crowded maxillary dentition when extractions are not indicated.
4. To widen maxillary hypoplasia associated with clefts of the palate.
5. To reduce wide black buccal corridors when smiling.
6. To overcome the resistance of the sutures when OME has failed. [47]

Several authors have shown that surgically assisted maxillary expansion can be carried out using only sedation and local anesthesia when a more conservative surgical technique is chosen. General anesthesia is preferred for invasive techniques. [48-50] Considering all these surgical techniques and discussions of advantages of one technique to another, most surgeons prefer to perform osteotomies on all four areas of resistance.

5. SARME technique

In our clinic, we perform the following protocol routinely. A horizontal incision is made through the mucoperiosteum above the mucogingival junction in the depth of the buccal vestibule, extending from the canine region to the mesial of the first molar. Keeping the incision more distally than the first molar region may cause damage to the pterygoid plexus or Bichat fat sometimes due to abnormal anatomic variations. Damage to pterygoid plexus may not be noticed intraoperatively. The vasoconstrictor effect of local anesthetics could curtail the bleeding during the operation and a postoperative bleeding may occur.

This incision is made in two layers as a safety precaution to any leak after suturing. Any gap or rupture of suture may cause exposure of the surgical bony area. The first layer incision is made on the epithelium and the periosteum is reached with dissection of connective tissue inferiorly, creating a pocket like formation of tissue. The second layer of the incision is then made on the periosteum 6-8 mm below the first layer. This technique forms a two level wound. Suturing this incisions layer by layer creates a more secure postoperative wound (Figure 1).

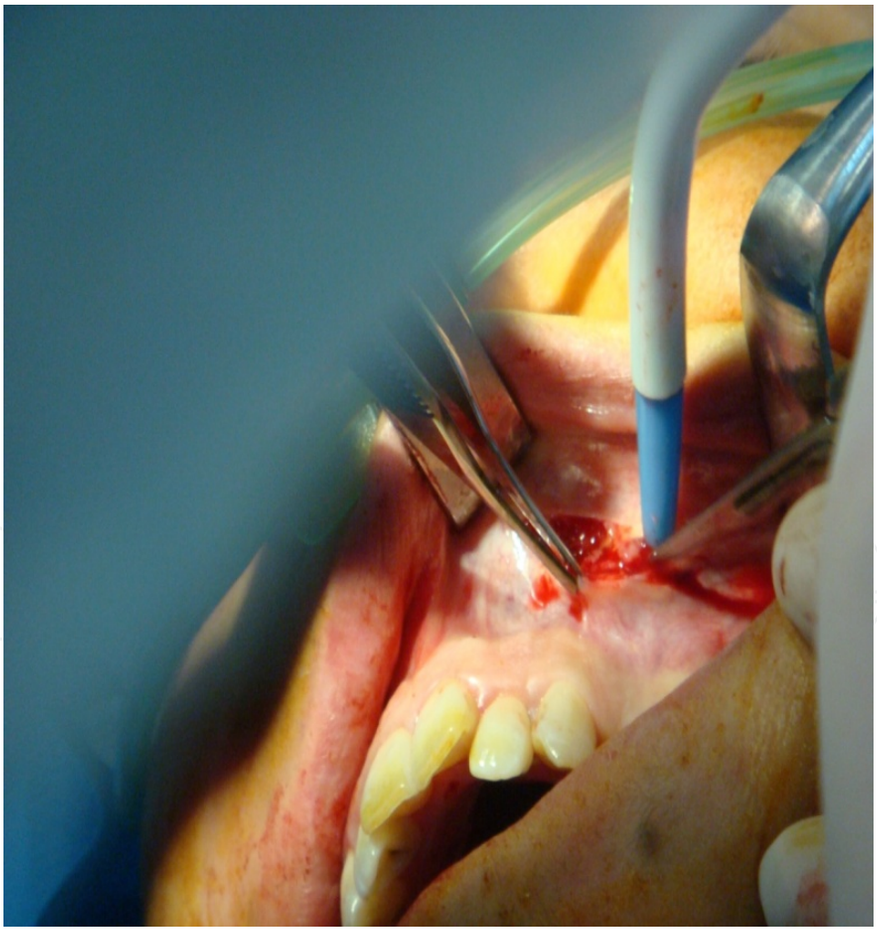

Figure 1. Dissection through the connective tissue from epithelial incision to periosteal incision beveled in order to create a pocket-like tissue wound.

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Nasal mucosa should be elevated gently from the lateral nasal wall. Because the SARME is not a down fracture procedure, nasal bleeding can be easily controlled with nasal tampons which should be considered as a minor complication if patient has no coagulopathy. The maintenance of the blood supply requires an appropriate surgical procedure, with careful manipulation of soft tissues and ensuring the periosteum remains intact. [51]

A horizontal low-level osteotomy is made through the lateral wall of the maxilla 5-6 mm superior to the apices of the anterior and posterior teeth with tiny round burs (Figure 2) and then an osteotome, microsaw or piezo-surgery device, on the same level is used to make the bone cuts; the osteotomy extends from the inferolateral aspect of the pyriform rim posteriorly to the inferior aspect of the junction of the maxillary tuberosity and pterygoid plate (Figure 2). Working with piezo-surgery devices would clearly be more secure but take more operative time. At this point, retractors should be used gently to prevent infraorbital nerve damage.

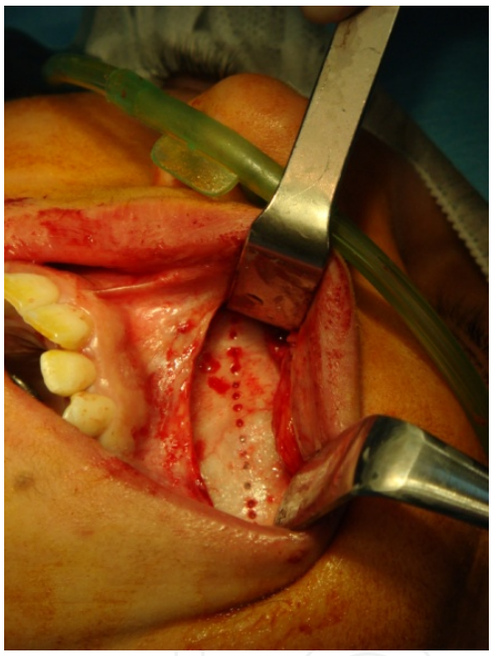

Figure 2. After marking the osteotomy route with a tiny round bur

The maxilla is separated from the pterygoid plate with a curved osteotome (Figure 4).

The risk of bleeding increases if the pterygoid plates are separated from the maxilla. If the pterygoid plates are separated from the maxilla, the most common sources of hemorrhage after SARME are the terminal branches of the maxillary artery, especially the posterior superior alveolar artery, and the pterygoid venous plexus. Turvey and Fonseca showed that the mean distance from the most inferior part of the pterygomaxillary junction to the most inferior part of the internal maxillary artery is 25 mm. During pterygomaxillary separation, pterygoid osteotomes should be correctly positioned and variations of this anatomy should be taken into account. [52] The pterygoid region should always be packed with moistened gauzes until suturing to avoid excessive blood loss and less postoperative swelling or hematoma.

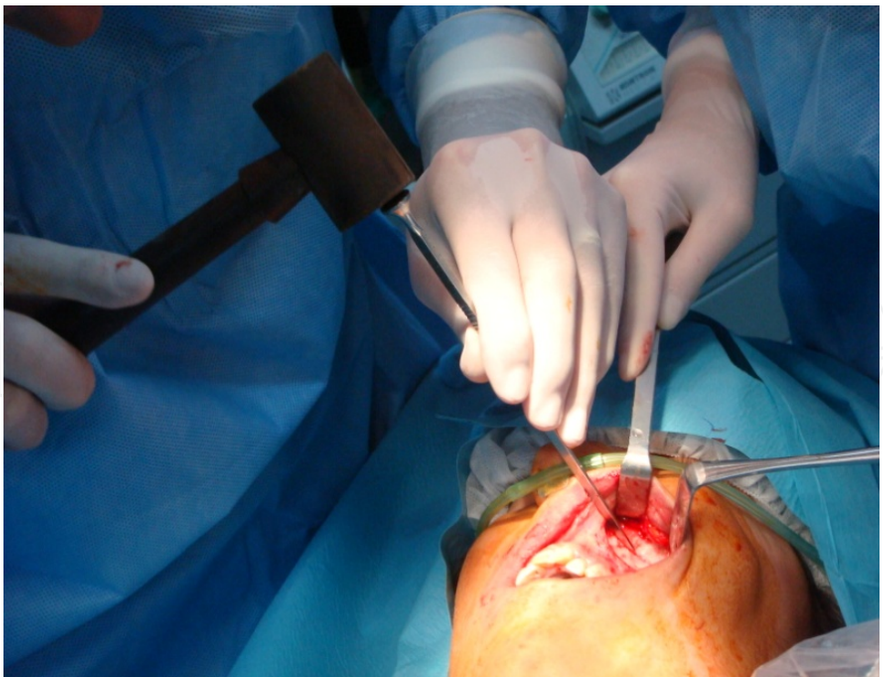

Figure 3. Osteotomy with an osteotome through the marked osteotomy line

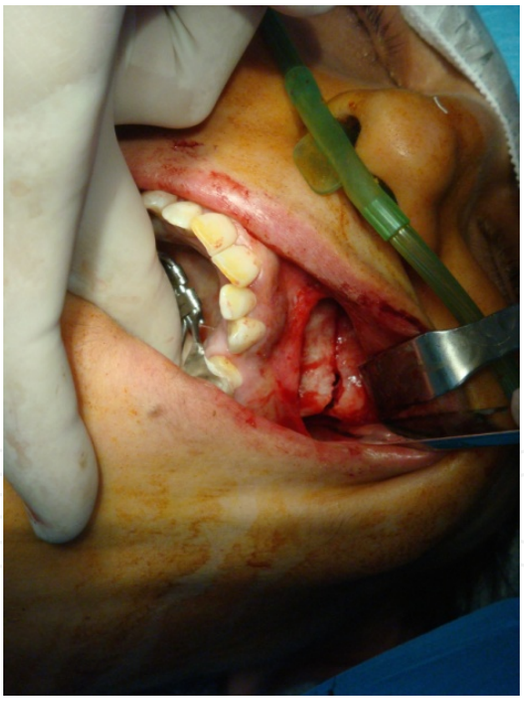

Figure 4. Separation of the pterygoid plate with a curved osteotome. Note the position of the finger to feel the osteotome intraorally

In conjunction, a sagittal palatal osteotomy is carried out, running from the midline of the alveolar bone, between the central incisors, to the posterior nasal spine. First a vertical incision is made along the labial frenulum between the central incisors. Then an osteotome is positioned

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in the central incisor interradicular space and manipulated to achieve equal and symmetric mobilization of the anterior maxilla. The forefinger is positioned on the incisive papilla to feel the redirected osteotome as it transects the deeper portion of the midpalatal suture (Figure 5).

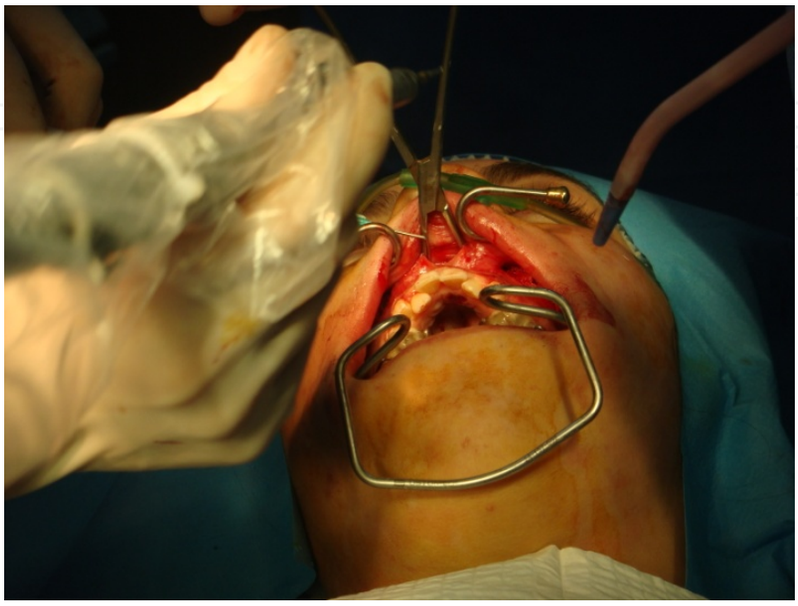

Figure 5. An easy way of traction of midline incision to reach and perform midpalatal osteotomy

Releasing the anterior nasal spine to improve mobility and to prevent deviation of the nasal septum is useful. Lateral nasal walls on both sides should be checked and released with osteotomes. A lateral nasal wall osteotomy might cause damage to the descending palatine artery and this could be minimized by limiting the extent of the osteotomy posterior to the pyriform rim to 35 mm in men and 30 mm in women [52].

Before the osteotomies the Hyrax appliance is activated to obtain easy palatal separation for about 8-10 turns, for maximum aperture and diastema formation. An immediate gap between central incisors should be observed intraoperatively after the osteotomies are performed. This is followed by immediate regression, leaving a 1 mm gap. Patients should receive postoperative prophylactic antibiotics and analgesics for 7 days postoperatively (Figure 6).

A surgically assisted maxillary expansion procedure is essentially a combination of osteogenic distraction with controlled expansion of soft tissues. Some principles must be followed to ensure that bone repair occurs in osteogenic distraction namely:

- Preservation of blood supply in the region
- Stability of the distractor and bone fragments
- Adequate latency period
- Adequate rate and frequency of activation and
- Observance of the retention period.

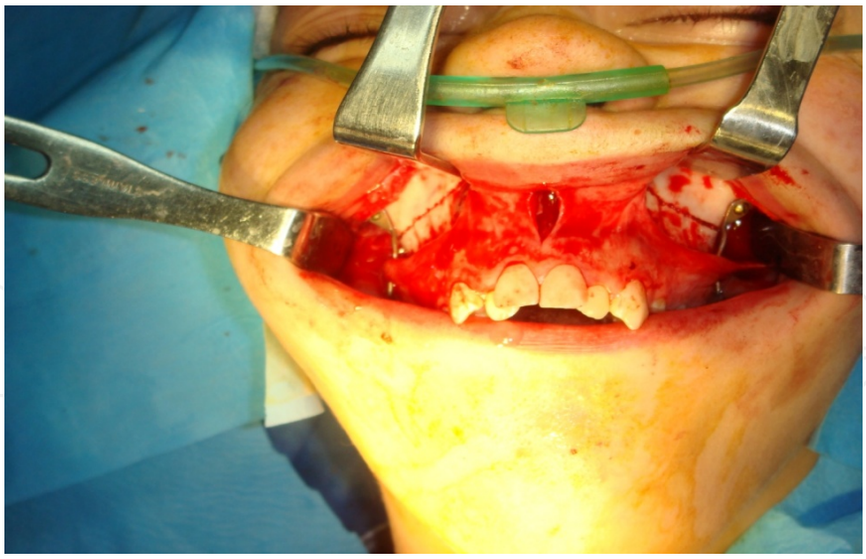

Figure 6. View of a completed osteotomy. Also zygomatic retention plates are implemented for orthodontic purposes.

The technique is based on a 5-day period of rest after corticotomy before the expansion starts. This gives the tissue time to form the first callus but is too short for consolidation.

Four phases of new bone formation can be described.

1. The first is a fibrovascular hematoma; between days 5 and 7 collagen fibers are formed that will arrange parallel to the distraction vector.
2. Second, the bone formation follows the collagen fibers through intramembranous ossification; from the outside to the inside.
3. Third, remodeling phase of the new bone.
4. Fourth, formation of solid compact bone with the same texture as the surrounding (old) bones.

When the distraction is performed too fast, the collagen fibers lose contact and there is no ingrowth of new bone, causing nonunion or malunion. In cases of a too slow distraction premature consolidation can occur and the required elongation cannot be reached [53].

Latency is considered to be the time interval between osteotomy and the appliance start-up and varies from 0 to 14 days in experimental and clinical studies. [54-56]

Activation rate is the amount of daily bone distraction (in millimeters); it varies from 0.25 to 1.0 mm.

Frequency represents the number of times the appliance is activated per day. [57] De Freitas et al recommend the expansion procedure with an overexpansion index of 23% above the desired measurements to compensate for relapse [58].

Retention period at the end of the distraction is necessary for the neoformed bone tissue to acquire the necessary resistance to bear the tipping forces. In experimental and clinical studies this period can vary from one to six months. [54, 59]

SARME procedures have traditionally been reported to have low morbidity especially when compared with other orthognathic surgical procedures. However, many complications have been reported in the literature varying from life-threatening epistaxis to a cerebrovascular accident, skull base fracture with reversible oculomotor nerve paresis and orbital compartment syndrome. [60-64]

Rapid maxillary expansion can produce unwanted effects when used in a skeletally mature patients, including lateral tipping of posterior teeth, extrusion, periodontal membrane compression, buccal root resorption, alveolar bone bending, fenestration of the buccal cortex, palatal tissue necrosis, inability to open the midpalatal suture, pain, and instability of the expansion. [6-8,10-15,17,28,46]

Complications associated with SARME reported in the literature also include significant hemorrhage, gingival recession, injury to the branches of the maxillary nerve, infection, pain, devitalization of teeth and altered pulpal blood flow, periodontal breakdown, sinus infection, alar base flaring, extrusion of teeth attached to the appliance, relapse, and unilateral expansion. [60,61,65-73] Postoperative bleeding starting on the third week due to the rupture of greater palatine artery, rupture of inferior nasal mucosa or any damage of venous plexus during the expansion procedure may even be observed. Segments or sharp prominences of bone in the intrapalatinal region could be considered to abrade or lacerate these tissues while the expansion procedure is processed. Moreover postoperative hemorrhage, pain, sinusitis, palatal tissue irritation/ulceration, asymmetrical expansion, nasal septum deviation, periodontal problems and relapse were reported as minor complications; and although SARME is considered a procedure with little risk of serious complications, several complications were discussed.

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