CHAPTER 59

Distraction Osteogenesis Maxillary Expansion (DOME) for Adult Obstructive Sleep Apnea Patients

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1 Introduction

Maxillary morphology plays an important role in the patho-physiology of obstructive sleep apnea (OSA).[1] Guilleminault et al. reported the presence of high and narrow hard palate differentiating OSA between relatives.[2] Maxillary morphology studies have shown greater palatal heights in OSA subjects.[3] Transverse maxillary hypoplasia with a high, arched palate in OSA is associated with increased nasal airflow resistance and inferior-posterior resting tongue position that results in retroglossal airway narrowing.[1,4] Since 2014, Liu, Yoon, and Guilleminault at the Stanford Sleep Medicine and Surgery Center have applied minimally invasive maxillary osteotomies and distraction osteogenesis via mini-implants across the midpalatal suture for maxillary expansion (DOME) in adult OSA patients. This chapter highlights the surgical techniques and management principles.

2 Indications

Pediatric OSA patients with maxillary hypoplasia and high, arched palate who failed tonsillectomy and adenoidectomy have been treated with rapid maxillary expansion (RME). RME achieves maxillary expansion via orthodontic devices that exert pressure on the dental arches bilaterally. This results in an expanded nasal floor and reduced nasal airflow resistance.[4] It widens the distance between upper airway dilator muscles. The tongue also positions more superior-anteriorly, resulting in retroglossal airway increase.[5] There are more studies that show efficacy of maxillary expansion, including 12-year follow-up data, in pediatric OSA.[6–8] There have been limited data for adult OSA patients who have the same maxillary morphology and can benefit from expansion.[9]

For adults with OSA and high, arched palate, previous expansion procedures showed unpredictable outcomes. Classic orthodontic expanders push the dental arches laterally, and although acceptable for correction of malocclusion, they are less effective for nasal obstruction and upper airway resistance, as there is limited expansion of the nasal floor in the palatal midline. The key difference compared with pediatric patients is midpalatal suture fusion in adults. Developmentally, fusion of the midpalatal suture occurs during the early teens, coinciding with a pubertal growth spurt.[10] To effectively expand adults, surgical osteotomies were used to re-create suture lines and weaken the vertical pillars of the maxilla. The osteotomies tended to be more invasive, especially the blind osteotomy at the pterygomaxillary junction.

The advent of bone-anchored expanders with mini-implants has made less invasive surgery possible. Bone-anchored, as opposed to tooth-anchored, expanders are reliable for maxillary expansion without causing dental and periodontal damage.[11,12] The implants anchored across the midpalatal suture line beneath the nasal floor allow physiologic suture expansion, reduce negative dentoalveolar effects, and achieve more nasal expansion than conventional RME.[13,14]

The combination of minimally invasive surgery and bone-anchored expanders takes full advantage of the principles of distraction osteogenesis (DO) and reliably expands the maxilla in adults with OSA and narrow, high, arched palatal vaults (Fig. 59.1).

3 Contraindications

Relative contraindications include patients with significant hypopharyngeal collapse as seen on clinical examination, nasopharyngoscopy, or drug-induced sedation endoscopy, especially if DOME is performed as an isolate procedure. Other relative contradictions include existing periodontal bone loss or inability to follow up with postoperative orthodontic management.
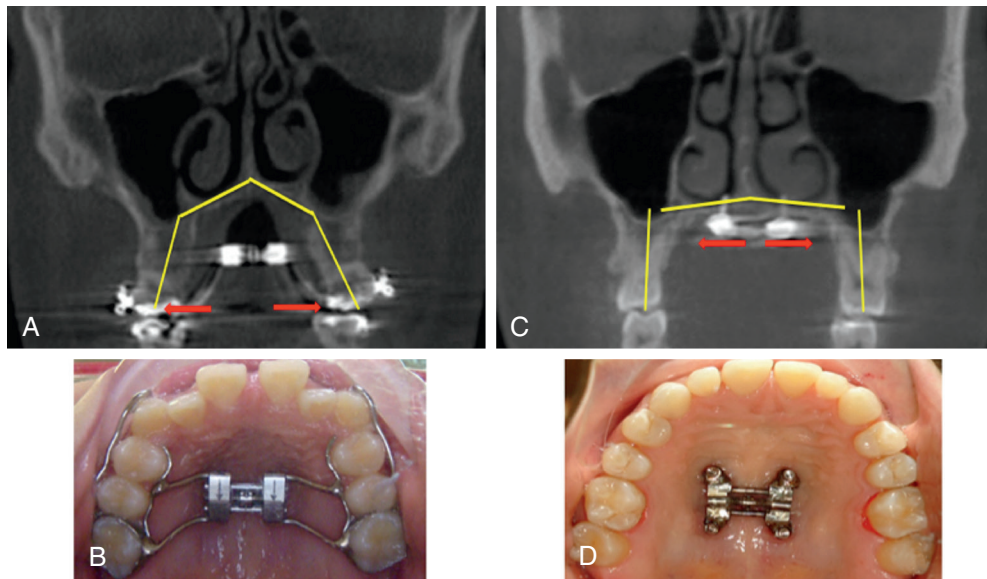
FIG. 59.1 **Comparison of tooth- versus bone-anchored expanders.** (A) The tooth-anchored expander exerts most of its force at the dentoalveolar ridges *(red arrow)*. The morphology of the palate even after expansion remains narrow and high-arched. (B) Intraoral view of the tooth-anchored expander. (C) Bone-anchored expander exerts most of its force across the midpalatal suture *(red arrow)*. The dentoalveolar segments are expanded symmetrically. The nasal floor and palatal vault are widened. (D) Intraoral view of the bone-anchored expander. Note the four mini-implants.

4 Alternative Treatment Options

Continuous positive airway pressure remains the first-line treatment for all patients, although frequently patients with nasal obstruction due to maxillary hypoplasia and high, arched palate are placed on bilevel positive airway pressure (BiPAP) to first bypass nasal resistance. Even though the Apnea/Hypopnea Index may not be high for these patients, they are placed on BiPAP, which can be challenging for adherence. Septoplasty, turbinate reduction, and nasal valve operations are first-line options for patients with nasal obstruction, with or without transverse maxillary hypoplasia, though there is less room to make an impact if the internal nasal valve angle is acute or the nasal floor is narrow. Various forms of palatopharyngoplasty procedures may be effective, particularly for patients with Friedman stage I classification.

5 Anesthesia

General anesthesia with a reinforced oral tube is preferred. Balanced intravenous anesthesia aimed at prevention of postoperative nausea and vomiting is recommended.

6 Techniques

6.1 Positioning

The patient is placed in a supine position with a shoulder roll for slight neck extension.

6.2 Required Instruments

Bovie electrocautery, #9 periosteal elevator, toe-out retractor, curved Freer elevator, reciprocating saw, 15 blade, piezo-electric saw, straight osteotomes, and 3-0 chromic sutures are required.

6.3 Expander Placement With Mini-Implants

We recommend any expander that allows mini-implants to be placed across the midpalatal suture into the hard palate. This is usually placed by the orthodontist any time before surgery.

6.4 Surgical Procedure

Two 1-cm incisions are made 1 cm above the maxillary mucogingival junction bilaterally, over the premolar dentition. Subperiosteal dissection is made towards the piriform rim medially and the maxillary buttress laterally. The infraorbital nerve foramen is the superior extent of dissection. Le Fort level I osteotomies are created with the reciprocating saw, tunneling medially to the piriform rim and laterally to the maxillary buttress.

A vertical incision is made between the maxillary incisor roots. Usually a primordial groove of the midpalatal suture is seen. A piezo-electric saw, which does not cut the mucosa of the palate across the maxillary alveolus, is used to deepen the groove. Osteotomes are used in sequential fashion to wedge open the midpalatal suture. A diastema is seen immediately as the suture opens (Video 59.1, Fig. 59.2).

The expander is then turned to ensure symmetric and easy separation of the maxilla bilaterally, until a 2-mm diastema is created (Video 59.2). Closure of the three small wounds is performed using 3-0 chromic sutures.

7 Postoperative Care

Depending on the severity of OSA, patients can either be discharged on the day of surgery or monitored overnight. Pain control with a combination of oral nonsteroidal antiinflammatory drugs and narcotic medication is adequate. Regular diet is resumed within a week. Limited epistaxis and nasal

congestion are expected from the Le Fort I osteotomies in the early postoperative period.

Patients turn the expander daily, resulting in an expansion of 0.25 to 0.5 mm. For most patients, 1 cm of expansion at the nasal floor is achieved within a month. Orthodontic brackets are then placed to close the diastema, and the expander is left in place to prevent relapse during the co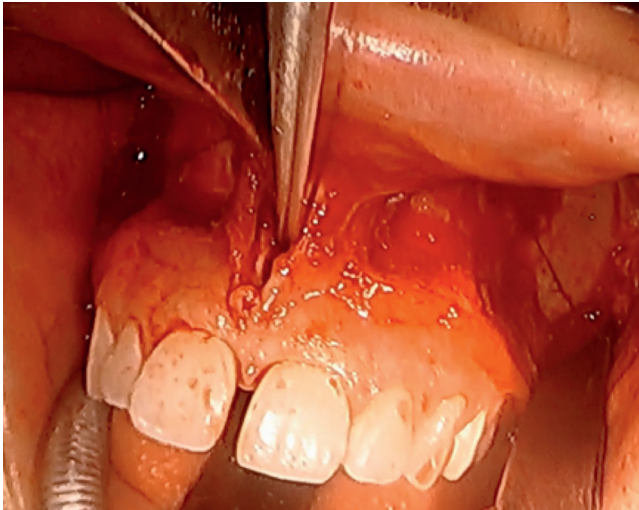nsolidation period. The consolidation period is the period between cessation of traction forces and removal of the distractor. Typically the consolidation phase is 3 months[15–17] for pediatric craniofacial DO, but we recommend a consolidation period of 6 to 8 months to allow complete skeletal calcification in adults. The expander remains in place while the orthodontist rapidly restores proper occlusion (Fig. 59.3).

8 Complications

Major complications such as nonunion; malunion; oronasal fistula; and skeletal, nasal, sinus, or odontogenic infections have not been reported with DOME. Minor asymmetric maxillary expansion has occurred, but within the range of orthodontic correction. Resolution of V_2 paresthesia in the anterior maxilla takes place over 1 to 6 months. Maxillary central incisors occasionally show signs of decreased perfusion, but there has been no loss of dentition.

9 Treatment Options for Failure

More studies are required to define the exact phenotype, including age and dynamic airway characteristics, of patients who benefit most from DOME. The early Stanford experience suggests the adult OSA patients with narrow and high, arched palate improve the most with DOME if they also have an acute internal nasal valve angle, narrow nasal floor, no significant septal deviation or turbinate hypertrophy, and severe cross-bite recalcitrant to palatopharyngoplasty.

For adults with moderate to severe OSA, multilevel or multistage treatments remain the hallmarks of effective surgical treatment. We have performed DOME in conjunction with genioglossus/genioplasty advancements. Some patients underwent palatopharyngoplasty or maxillomandibular
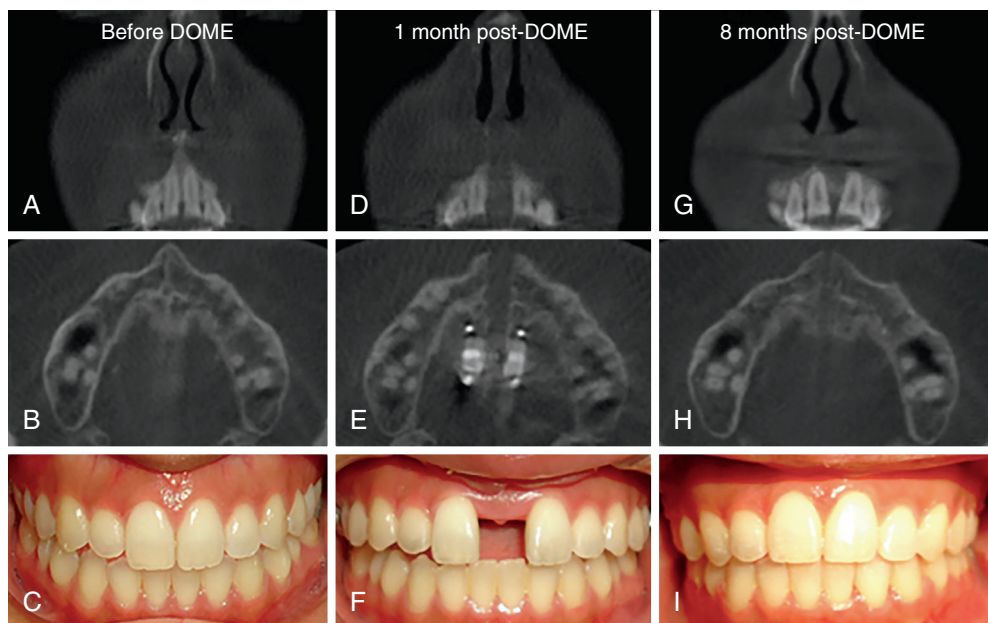

FIG. 59.2 Opening of the midpalatal suture. Thin straight osteotomes are used to "wedge" the suture apart. Note that there are actually three osteotomes. The last osteotome is inserted between the first two and gently tapped for the controlled midpalatal suture opening. The diastema (gap between incisors) suggests that the separation is made.

FIG. 59.3 Distraction osteogenesis maxillary expansion (DOME) treatment course. (A–C) A 23-year-old woman with mild OSA who presents with normal occlusion, narrow nasal floor, and high, arched palate. She previously underwent septoplasty and turbinate reduction. Her maxilla was expanded within 1 month after DOME. (D–F) Note the symmetric expansion at the nasal floor, along the hard palate, and dentoalveolar segments. (G–I) Orthodontic braces were applied to move teeth back to occlusion, and the nasal floor and palatal expansion were maintained.

advancement after DOME. Upper airway stimulation is another option for post-DOME patients who usually have resolution of circumferential collapse of the velum.

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