Maxillomandibular advancement for obstructive sleep apnea syndrome

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Maxillomandibular advancement enlarges the entire pharynx by pulling anteriorly the bony skeletal structures. It is performed in sleep apnea patients who refuse or fail to use continuous positive airway pressure. It is constantly associated to esthetic modifications but not necessarily disgraceful. Perioperative breathing complications can occur which implies a good cooperation between the surgeon and the anesthesiologists in the operating room and in the following hours in the ICU. Hypoesthesia of the lower lip and chin is the most frequent long term complication. Nevertheless, bimaxillary advancement is one of the most effective treatments for OSAS even on a long term basis. © 2012 Elsevier Inc. All rights reserved.

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Obstructive sleep apnea syndrome (OSAS) affects 2-4% of the general population. Because it is associated with cardiovascular and metabolic complications, it requires a good management and an appropriate follow-up. Several pathophysiological factors are noted. One of them is often mentioned: the imbalance between the maxillofacial bony structures (“squeletal box”) and the pharyngeal soft tissue volume/compliance.

Numerous surgical techniques have been developed by otolaryngologists to reduce the soft tissue volume or to put tension on these structures, whether directly or indirectly by reinserting them in a more forward position. Because they are performed by otolaryngologists who are first-line managers of patients with OSAS, these techniques are generally the first used.

The bony structures can also be malformed. The maxilla and mandible are sometimes abnormally narrow transversely. They can also be positioned backward relative to the skull base. Bimaxillary advancement surgery increases the volume of the “squeletal box” of the face and thus corrects the mismatch between the soft tissues and their container. The surgical technique used for OSAS is the same as for orthognathic surgery. However, it is less commonly performed than soft tissue surgery because it is more complex and more often performed by maxillofacial surgeons who have generally less contact with OSAS.

Surgical technique

Preoperative workup

A complete workup including the following items is required before bimaxillary advancement surgery:

- Facial photographs are taken for esthetic comparison purposes.
- A lateral skull radiograph is performed for cephalometric analysis to quantify the degree of maxillomandibular insufficiency and to plan the advancement needed.
- To allow the appropriate mandibular advancement, it is necessary to create an interim splint (see surgical technique). Dental casts are produced and mounted on a semiadjustable articulator to provide an exact assessment of the anatomic position of the maxilla and the mandible. A model plateform is used to simulate the planned movements of the 2 bones.

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Then the interim splint is created using the advanced mandibular cast referenced to the uncut mounted maxillary cast. It will be disinfected before the intervention and will be available to the surgeon when the time comes.

If the day before surgery dental arch bars are put in place under local anesthesia, the procedure can be shortened. The arches will allow intermaxillary fixation at the end of the procedure or several days after.

Operative technique

Bimaxillary advancement surgery combines 2 different procedures: a bilateral sagittal split of the mandible followed by a Le Fort I maxillary osteotomy under general anesthesia.

Sagittal split of the mandible (technique of Obwegeser–Dalpont)

Preparation for the split

The lateral aspect of the mandibular body, the retromolar triangle, and the inner portion of the ramus are infiltrated with xylocaine/epinephrine in the submucosal and subperiosteal planes. A bite block and a tongue depressor are used to expose the operative field.

The incision is carried out directly to the periosteum with a cold blade, starting at the level of the first premolar anteriorly and curving medially on the retromolar trigone posteriorly. On the anterior portion, care is taken to keep about 1 cm of unattached mucosa laterally to the gum to facilitate wound closure.

The subperiosteal plane is dissected with a periosteal elevator, anteriorly to expose the mental nerve and inferiorly to show the inferior border of the mandible. Superiorly, the anterior portion of the ascending ramus is exposed, and the lower temporalis muscle fibers are cut up to the coronoid process. Medially, the periosteum is raised to show the mandibular foramen and the lingula (spine of Spyx). Pledgets soaked with an epinephrine solution can be placed in that space to reduce bleeding.

A 2-mm cutting burr is used to cut the outer cortex of the mandibular bone vertically at the level of a region between the first and second premolar depending on the planned advancement (Figure 1A). The cut must extend to the lowest part of the bone and should not be too deep to prevent alveolar nerve damage. Starting at the top of this cut, a dotted line is drilled through the upper cortex of the mandible, laterally to the molars on the anterior part and in the middle of the retromolar triangle posteriorly. A second vertical cut is then made on the inner cortex of the ascending ramus, posterior to the lingula. A Lindeman burr is used to make a continuous cut through the dotted line, and this cut is slightly enlarged with a large caliber burr to facilitate the insertion of the osteotomes.

Split

Various osteotomes are used to perform the split. At first very thin, their size is gradually increased. Curved osteotomes are used anteriorly. They are directed toward the outer cortex to keep the alveolar nerve in contact with the medial cortex. A separator is positioned on the inferior border cut to apply a constant split pressure. The split is performed carefully and gradually, using slight torsion

Figure 1  (A) Mandibular osteotomy. Preparation of the split: Drawing of the cut with a burr at the level of the second premolar. (B) Sagittal split. The integrity of the alveolar nerve is checked.
movements and driving the osteotomes deeper until the fragments are properly separated.

After the split is performed, the position of the alveolar nerve is verified. If needed, it is dissected from the proximal fragment to protect it during the advancement (Figure 1B). The same procedure is performed on the opposite side.

Advancement and fixation

A traction wire is passed around the 4 inferior incisors. The mandible is advanced, and the teeth are positioned over the intermediate interdental splint. The occlusion is fixed in that position using four 4/10 metal wires secured on the arch bars (Figure 2).

Rigid fixation of the fragments is performed using 1 adjustable miniplate at the level of the anterior vertical cut on each side. The posterior fragment is pulled through the incision using forceps, and the nonadjustable side of the plate is fixed to its distal end (Figure 3). The plated proximal fragment is pushed back to its original position. The advancement is performed using a distractor and measured using a caliper. For obstructive sleep apnea, 10 mm at least is usually necessary (Figure 3). Two millimeters should be added to the planned advancement to account for the width of the cut itself. The lower border of both fragments should be aligned, and no gap should be left. The plaque can be bent to ensure good contact. The first screw is placed in the adjustable hole, and the advancement is measured a second time before securing it. The other screws are placed thereafter. Care must be taken to protect the mental nerve during this step.

Once rigid fixation is done on both sides, bicortical screws are placed on both mandibular angles using a transjugal approach (Figure 3). After the screws are tightened, it is important to make sure they involve both cortices by gently trying to pull them apart.

Le Fort I maxillary osteotomies and advancement

Preparation for osteotomies

The subperiosteal plane of the upper gingivobuccal sulcus is infiltrated with xylocaine/epinephrine. The incision is carried out directly to the periosteum using a cold blade, from 1 first molar to the other. A 1-cm cuff of unattached gingival mucosa is kept to facilitate wound closure. At the level of the frenulum of the upper lip, a v-shaped incision is made.

A periosteal elevator is used to dissect the subperiosteal plane, posteriorly as far as the maxillary tuberosity, superiorly to show the infraorbital pedicle, medially to uncover the border of the piriform aperture, and inferiorly to expose the imprints of the dental roots. The anterior nasal spine should also be completely released. Pledgets soaked with epinephrine can be placed posterior to the maxillary tuberosity to reduce venous bleeding. The mucosa of the floor of the nasal fossae is raised using a curved elevator for the first 2-3 cm and a straight elevator for the posterior part. The
lower septum and lateral nasal walls are also dissected using a torsion movement of the elevator. Constant bony contact is important to avoid mucosal tears. Soaked pledgets can also be left in this space.

**Le fort I osteotomies**

Retractors are placed to protect the nasal mucosa and lateral soft tissues. A reciprocating saw is used to cut the anterior part of the maxillary bone, starting at the zygomaticomaxillary buttress up to the lateral nasal wall (Figure 4). The cuts should be symmetrical on both sides and away from the dental roots.

The pterygoid plates are separated from the maxillary bone. This step is best performed with a manual osteotome. The lateral nasal walls and the posterior part of the maxillary bone are cut with a thin osteotome. The cartilaginous and bony nasal septum is freed from the nasal crest using a U-shaped osteotome.

If a need for impaction was determined in the preoperative planning, a uniform slice of bone could be removed on all osteotomies.

**Advancement and fixation**

Maxillomandibular fixation is released. A distractor is used to verify the mobility of the lower fragment of the maxillary bone. Any remaining attachment (especially at the posterior aspect of the maxillary sinus) is cut. Forceps are then used to mobilize the fragment (Figure 5). The movements must be unrestricted in all directions. Gradual anterior traction allows muscle stretching in preparation for fixation. The superior dental arch should reach its final position without excessive tension.

The final interdental splint is positioned, and occlusion is obtained. Maxillomandibular fixation is performed using
four 4/10 metal wires. Anterior traction can be aided with a metal wire passed around the incisors, similar to the technique described for the mandible.

Before rigid fixation is performed, burr holes are made through the zygomaticomaxillary buttresses on the upper and lower fragments, and 4/10 metal wires are passed through them. They are left untightened at this stage (Figure 6). They will help prevent posterior open bite.

Rigid fixation is performed using 1 preformed miniplate on each side. The plates must clear the infraorbital foramen and dental roots. The plates are first secured to the lower fragment with 5-mm screws and then to the upper fragment after fine-tuning (Figure 6). They will help prevent posterior open bite.

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The posterior metal wires are tightened, and maxillomandibular fixation is removed.

Surgical field is cleaned with saline. All wounds are closed using absorbable sutures. A VY suture is performed on the maxillar mucosa on the midline. Blocks of the infraorbital and mental nerves are performed using bupivacaine.

The intermaxillar fixation is secured either at the end of the surgical procedure or 1 or 2 days after and is left in place for 3-4 weeks. A liquid diet is prescribed for >4 weeks. Dental and gum hygiene are mandatory for that period.

differences with orthognathic surgery

The OSAS patient

The typical OSAS patient is middle aged, obese, and has significant comorbid medical conditions. He/she has a high potential cardiovascular morbidity with a higher risk for elevated blood pressure (which might remain undiagnosed because it occurs during the night), coronary artery disease, cardiac arrhythmia, neurovascular disease, and diabetes. To avoid postoperative complications, all these factors need to be assessed and properly managed before surgery.

Orthodontic considerations

One-third of OSAS patients show craniofacial abnormalities, with a predominance of dental malocclusion class II. In such a case, correcting the malformation itself in addition to improving sleep apnea appears logical. This might require an orthodontic preparation that could last between 12 and 18 months. However, this is seldom performed for several reasons. First, the patient who undergoes bimaxillary advancement usually has severe OSAS and has failed most available treatments. If continuous positive airway pressure (CPAP) therapy is not possible, the potential cardiovascular complications and the cognitive impairments related to the disease (sleepiness, irritability, memory loss, and concentration difficulties) usually preclude waiting such a long time before surgery. Second, the teeth and gums in middle-aged patients are not always healthy enough to bear an orthodontic therapy. Third, the patient’s primary concern is not esthetics. Finally, the cost of such treatment is generally high and is rarely reimbursed by our medical system. For all these reasons, the preoperative relationship between the maxilla and the mandible is maintained for most patients.

Perioperative anesthetic management

Perioperative anesthetic management is of high importance. A preoperative consultation is mandatory to determine the risk of cardiovascular morbidity during the procedure. The preoperative consultation helps screen for cardiovascular risk factors that should be controlled before surgery, especially hypertension and high blood glucose levels for diabetic patients. The expected difficulty of intubation and risk of aspiration must be properly appreciated, as patients with a Mallampati grade 3 or 4 have a 20% risk of difficult intubation.

A fiberscope must be present in the operating room and will be used if there is the slightest difficulty for intubation. An arterial catheter will be positioned to measure blood pressure. A BIS may be used to monitor the depth of anesthesia.

Preoxygenation using a facial mask will be performed before intubation. Nasotracheal intubation is used, which may be accomplished either under local anesthesia or under sedation (using a fast-action nondepolarizing curare and hypnotics). The endotracheal tube is secured to the columnella with a suture.

During the procedure, arterial blood pressure must be controlled. The concentrations of anesthetic drugs will be decreased in advance to allow awakening to coincide with the end of the intervention. The extubation should be conducted on the operating room table. Antibiotics, anti-inflamm-
matory drugs, and analgesics will be prescribed for the postoperative period.

The postoperative period needs to be carried out in an intensive care unit for 24 hours. The patient will be in a semiseated position. Oxygen supplementation is administered if necessary. Aspiration of the nasal cavity should be performed. Control of blood pressure and pain is essential to avoid postoperative bleeding. Ice packs will be placed on the patient’s cheeks. Some authors advocate CPAP use during the postoperative period to prevent the occurrence of apneas caused by swelling and hematomas secondary to the surgical procedure. However, it is not always easy to use because the patient did not initially support CPAP and because the nasal cavities are full of blood and secretions.

Degree of advancement

The minimal effective advancement is impossible to determine beforehand. Some have proposed to use the same advancement as needed for an effective oral appliance. However, oral appliances do not advance the mandible in the same plane as surgery does and do not displace the maxilla. Given the importance of the intervention, most authors suggest to achieve maximum advancement, ie, to normalize the cephalometric measurements on a lateral x-ray and to produce a minimum advancement of 10 mm at the level of the mandible. The length of mandibular advancement usually varies from 10 to 12 mm. Maxillary advancement is the same or less (5-10 mm) taking into account that the mandible does a counterclockwise rotation during the advancement.

Combined surgical procedures

Three types of surgical procedures can be performed concurrently to bimaxillary advancement. Upper airway impairment from edema or a hematoma can result from bimaxillary advancement surgery. Few authors perform a preventive tracheostomy to help the patient breathe and facilitate aspiration of the secretions in the immediate postoperative period. Tracheostomy is temporary and removed after a few days.

Procedures that can improve the efficiency of maxillo-mandibular advancement can also be performed, especially if there is a specific complaint such as nasal obstruction. In this case, a septoplasty and/or lower turbinectomy may be carried out even if bimaxillary advancement often spontaneously improves nasal breathing. Other authors have performed a genioglossus advancement using a genioplasty or a maxillary distraction osteogenesis and more rarely a mandibular symphyseal distraction osteogenesis.

Finally, some procedures allow for some modifications of the patient’s esthetics. They can correct some adverse esthetic effects resulting from a large advancement in a patient with a normal preoperative cephalometric analysis. They can also further advance a patient’s chin position if it was retruded before surgery.

Indications–contraindications

Bimaxillary advancement surgery is indicated in a patient with severe sleep apnea syndrome or moderate OSAS with severe daytime sleepiness. The patient must have failed to use of CPAP and/or an oral appliance. Some authors advocate its use after treatment of the pharyngeal soft tissues (phase II of Stanford) and others perform it in the first place in the presence (or absence) of skeletal bone abnormalities.

Contraindications can be related to either general or local factors. Age of the patient (>65 years old), an unstable cardiovascular status, and for some, but not for all, obesity preclude the use of this therapy. The presence of central sleep apnea syndrome and alveolar hypoventilation are elements that explain some cases of failure of this surgery. Poor teeth and gum status increase the risk of infectious problems. A massive edentulous state makes surgery more difficult.

Results

Bimaxillary advancement is the most effective and definitive treatment among all therapeutic options (outside of tracheostomy) for sleep apnea syndrome. It is effective on clinical symptoms such as snoring, daytime sleepiness, and quality of life. It is also effective on objective polysomnographic elements—ventilation and sleep. Short-term success rates range from 80 to 100% when success is defined as a decrease in the apnea–hypopnea index <20 and a reduction of more than 50% of the preoperative index.

A meta-analysis comprising 22 studies evaluated 627 patients. Cure (defined as an apnea–hypopnea index <5 events/hr of sleep) was obtained in 43.2% of the cases. Mean apnea–hypopnea index decreased from 63.9 ± 26.7 to 9.7 ± 1 0.7 hours. The effectiveness of the procedure has been found to be comparable with that of mechanical ventilation. It remains effective in the long-term (more than 24 months) in the absence of weight gain. The predictors of surgical success are a younger age, a lower BMI, a lower AHI, and a larger maxillary advancement.

Side effects and complications

Functional side effects

The most frequently reported complication is hypoesthesia of the lower lip and chin, which is constant in the immediate postoperative period but may be permanent in 11–86% of cases. Masticatory apparatus disorders can also be observed.

Esthetic

Cosmetic changes are noticed by most of the patients and their family. There is an enlargement of the nostrils, an
opening of the nasolabial angle, a widening of the lower face, and a prognathism for patients with a normal preoperative maxillomandibular complex position. The procedure, however, is regarded as unsatisfactory by only 5.2% of the patients.

Complications

Complications are rare. Bleeding requiring surgery (1.3%), swelling, hematoma (20% of cases), superinfection, and pseudarthrosis are rather rare. No deaths have been reported.

Conclusions

Maxillomandibular advancement is one of the most effective therapeutic options for treating patients with severe sleep apnea syndrome who fail to respond to other treatments such as CPAP or oral appliance. Informed consent should be obtained from these patients, especially if they are young. Frank and clear information about not only the effectiveness of this procedure but also its potential functional and esthetic side effects should be given. Finally, it requires trained surgical and anesthetic teams to operate in a safe environment, to limit the perioperative risks, and to perform a large and stable advancement.

References


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