Surgical management of maxillomandibular advancement in sleep apnea patients: Specific technical considerations

Maxillomandibular advancement is an integral part of the surgical treatment of patients suffering from obstructive sleep apnea. A number of publications report its efficacy and have attempted to define predictive success criteria. However, few authors have shown an interest in the surgical specificity of this intervention and in the difficulties that can be encountered, which differ from those seen in conventional orthognathic surgery. In this article, a series of patients treated with maxillomandibular osteotomy to correct obstructive sleep apnea syndrome (n = 17) are compared with patients who underwent surgery for the correction of dentofacial disharmonies (n = 33). Observations emphasized the importance of respecting a strict surgical and postsurgical protocol to avoid any technical traps linked to maxillomandibular advancement, both in preoperative simulations and during and after surgery. Results concerning sleep parameters will be the subject of a future publication. (Int J Adult Orthod Orthognath Surg 2001;16:305–314)
bimaxillary surgery for dentofacial disharmonies during the same period. This paper will stress the specific pitfalls confronted during treatment and the pre-, peri-, and postsurgical protocols for osteotomized patients suffering from obstructive apneas.

Materials

The series of sleep apnea patients reported in this study received maxillomandibular advancement surgery and consisted of 17 patients (16 male, 1 female) with a mean age of 50 years, the youngest being 33 and the eldest 66 years of age (Table 1). More than half of the subjects (10) were obese, with a Body Mass Index (BMI) greater than or equal to 30. During the same period, 33 additional patients who did not suffer from obstructive sleep apnea were operated on for dentoskeletal disharmony (17 patients received maxillomandibular osteotomy and 16 patients received mandibular osteotomy only).

This group consisted of 23 women and 10 men between 17 and 45 years of age.

All patients had a preliminary visit with the anesthesiologist, who evaluated their general status according to American Society of Anesthesiologists (ASA) scores (1 = patient is in good health, 2 = patient has a serious illness that does not pose major problems in everyday functioning, and 3 = patient can undergo surgery but a serious, underlying pathology is present). Nasotracheal intubation difficulties were evaluated with the help of a mean score calculation (Table 2). Most of the sleep apnea patients had a high intubation score, allowing difficulties in intubation to be predicted. Immediate nasotracheal intubation was performed in 13 patients, and the use of a fiberscope was necessary in the other 4 apnea patients.

On a surgical level, maxillomandibular advancement was preceded by orthodontic preparation in 6 of the sleep apnea patients. In 1 patient, a parietal graft at the level of

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Body Mass Index</th>
<th>Type of sleep-disordered breathing</th>
<th>Reaction to ncPAP</th>
<th>Surgery</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>M</td>
<td>28.9</td>
<td>OSAS</td>
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<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
<td>M</td>
<td>39</td>
<td>OSAS</td>
<td>Discomfort with side effects</td>
<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>F</td>
<td>28.3</td>
<td>OSAS</td>
<td>Discomfort</td>
<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
<td>4</td>
<td>54</td>
<td>M</td>
<td>34</td>
<td>OSAS</td>
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<td>5</td>
<td>44</td>
<td>M</td>
<td>32.3</td>
<td>OSAS</td>
<td>Could not tolerate</td>
<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
<td>6</td>
<td>53</td>
<td>M</td>
<td>26.3</td>
<td>UARS</td>
<td>Discomfort</td>
<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
<td>7</td>
<td>38</td>
<td>M</td>
<td>27</td>
<td>UARS</td>
<td>Not paid for by Social Security</td>
<td>Maxillomandibular osteotomy</td>
</tr>
<tr>
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<td>50</td>
<td>M</td>
<td>36.3</td>
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<td>Discomfort</td>
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<td>58</td>
<td>M</td>
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<td>12</td>
<td>36</td>
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<td>Maxillomandibular after surgically assisted rapid maxillary expansion</td>
</tr>
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<td>54</td>
<td>M</td>
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<td>M</td>
<td>38</td>
<td>OSAS</td>
<td>Discomfort</td>
<td>Maxillomandibular osteotomy</td>
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</table>

OSAS = Obstructive sleep apnea syndrome; UARS = upper airway resistance syndrome; ncPAP = nasal continuous positive airway pressure.
the maxillary osteotomy was performed to ensure stability of the surgical correction, and a complete septoplasty was performed in another patient. Three apnea patients benefited from additional cervical and submental liposuction. All patients benefited from a systematic correction of the septum during advanced Le Fort I osteotomy. Preoperative and immediate and delayed postoperative hemoglobin rates were registered after the total loss of perfused liquids for all patients.

**Results**

The majority of the sleep apnea patients had an ASA score of 2, mostly because of cardiopulmonary insufficiencies, hypertension, or Type II diabetes (Table 3). Only 1 apnea patient had a score of 3, which was related to a myocardial infarct that took place 1 month before surgical intervention immediately following a major obstructive apnea episode. These frequent apneas (of more than 20 seconds) led to cardiac arrhythmias with pauses and necessitated the installation of a pacemaker some months before surgical intervention.

On average, maxillary advancement in the sleep apnea patients was 10 mm, and advancement of the mandible was more substantial. Rigid maxillomandibular fixation was avoided as often as possible so as to avoid obstruction of the upper airway, but ranged from 2 to 42 days in those patients who received it (mean of 13.3 days in 10 patients). In our series, 4 fractures of the proximal fragment, 2 on the medial suspigien level and 2 at the distal vestibular extremity of the proximal fragment, were seen (Table 3). On average, patients remained in the hospital for 8 days.

In the second series of patients, mandibular displacement was on average less significant and consisted of advancements, setbacks, and/or pure asymmetry corrections (Table 4). Maxillomandibular fixation was maintained slightly longer than in the apnea patients and only 2 fractures of the proximal segment were seen in this series of patients (Table 4). Length of hospitalization for these patients was 5 days.

**Discussion**

Comparison of the 2 series of patients has resulted in a number of reflections. First, the BMI of patients with obstructive apneas was most often greater than 30. As a reminder, a normal BMI is less than or equal to 25, and a BMI above 35 is clearly pathologic. We did not respect the customary surgical contraindication for OSAS, that is, a BMI less than 30, as the apnea and the intolerance of the established continuous positive airway pressure in some of our patients were so severe that prompt surgical intervention was deemed necessary. In addition, we were convinced that the OSAS would improve and patients would resume their normal activities, which often leads to a new stability for the patient. The surgery itself also contributes to weight loss during the postoperative healing period. Concerning anesthesia, in spite of relatively high nasotracheal intubation scores, the use of a fibroscope is not the rule, and the tracheotomy performed for apnea patient No. 11 was planned to ensure the patient’s comfort during the postoperative period (this patient had suffered a myocardial infarct 1 month before the intervention).

Orthognathic surgery may involve substantial blood loss. Average blood loss during a Le Fort I osteotomy has been estimated at 400 mL, and during a sagittal mandibular osteotomy, average blood loss is about 200 mL. The fact that many of these patients are fragile makes extreme surgical care all the more important, so as to avoid the non-negligible risks associated with transfusions. In our unit, we do not have experience with blood recuperation, which is considered questionable in light of the surgical endo-oral septic field. In fact, all patients benefited from normovolemic hemodilution and controlled hypotension without reducing the arterial pressure by more than 20%, based on patient norms. Presurgical donation and preoperative treatment by erythropoietin are not practiced in our institution for this type of intervention because of their high costs. Perioperatively, the osteotomy sites were first filtered through an adrenalinized solution and then an incision was made in the least traumatic manner possible, with thermocoagulation...
### Table 2 | Intubation scoring method

<table>
<thead>
<tr>
<th>Characteristic</th>
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<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chin–thyroid cartilage distance</td>
<td>&gt; 6 cm</td>
<td>5–6 cm</td>
<td>&lt; 5 cm</td>
</tr>
<tr>
<td>Mallampati classification</td>
<td>Class I</td>
<td>Class II</td>
<td>Class III or IV</td>
</tr>
<tr>
<td>Mouth opening</td>
<td>35–40 mm</td>
<td>25–35 mm</td>
<td>&lt; 20 mm</td>
</tr>
<tr>
<td>Cervical mobility</td>
<td>Normal</td>
<td>Reduced</td>
<td>Fixed in flexion</td>
</tr>
<tr>
<td>Maxillary incisors</td>
<td>Absent</td>
<td>Normal</td>
<td>Protrusive</td>
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</table>

A score greater than 8 indicates that ventilation and/or intubation will be difficult.

### Table 3 | Results of presurgical evaluation and surgery in sleep apnea patients

<table>
<thead>
<tr>
<th>Patient</th>
<th>ASA score</th>
<th>Intubation score</th>
<th>Intubation</th>
<th>Maxillary advancement (mm)</th>
<th>Mandibular advancement (mm)</th>
<th>Perioperative complications</th>
<th>Duration of MMF (days)</th>
<th>Postoperative complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>7</td>
<td>Nasotracheal</td>
<td>10</td>
<td>10</td>
<td>High bad split</td>
<td>42</td>
<td>Maxillary abscess</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>8</td>
<td>Nasotracheal</td>
<td>10</td>
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<td>None</td>
<td>0</td>
<td>Mandibular miniplate infection</td>
</tr>
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<td>10</td>
<td>14</td>
<td>None</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>8</td>
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<td>10</td>
<td>10</td>
<td>None</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>9</td>
<td>Fibroscopy</td>
<td>10</td>
<td>15</td>
<td>Low bad split</td>
<td>42</td>
<td>Mandibular miniplate infection</td>
</tr>
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<td>1</td>
<td>8</td>
<td>Nasotracheal</td>
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<td>9</td>
<td>None</td>
<td>0</td>
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<td>7</td>
<td></td>
</tr>
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<td>9</td>
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<td>10</td>
<td>18</td>
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<td>6</td>
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<td>Nasotracheal</td>
<td>11</td>
<td>9</td>
<td>None</td>
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<td>10</td>
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<td>3</td>
<td>12</td>
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<td>13</td>
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<td>10</td>
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<td>7</td>
<td>Mandibular miniplate infection</td>
</tr>
</tbody>
</table>

A score greater than 8 indicates that ventilation and/or intubation will be difficult.

High bad split = fracture of the lateral cortex along the line or at the level of the medial horizontal osteotomy; low bad split = fracture of the lateral cortex along the line or at the level of the lateral vertical osteotomy; MMF = maxillomandibular fixation.
Seventeen patients underwent bimaxillary osteotomy and 16 patients underwent mandibular osteotomy for dentofacial disharmony did not suffer from obstructive sleep apnea.

Positive numbers indicate forward movement, and negative numbers indicate backward movement.

MMF = Maxillomandibular fixation.

### Table 4 Characteristics of non-apnea patients in study

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Skeletal deformity</th>
<th>Perioperative complications</th>
<th>Mandibular movement (mm)</th>
<th>Maxillary movement (mm)</th>
<th>Duration of MMF</th>
<th>Postoperative complications</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
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<td>None</td>
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</tr>
<tr>
<td>2</td>
<td>38</td>
<td>F</td>
<td>Open bite</td>
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<td>+5</td>
<td>+3/posterior impaction</td>
<td>7</td>
<td>None</td>
</tr>
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<td>45</td>
<td>M</td>
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<td>+9</td>
<td>7</td>
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<tr>
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<td>36</td>
<td>F</td>
<td>Class II</td>
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<td>+3/impaction 4</td>
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<td>12</td>
<td>43</td>
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<td>25</td>
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<td>Bad scar mucosa</td>
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to reduce bleeding as much as possible. In our series of patients, analyses of hemoglobin rates showed that these simple measures often sufficed, guaranteeing a postoperative recovery rate that is both comfortable for the patient and sufficient to stimulate the hematopoietic system and regain preoperative blood mass within a reasonable period of time. On the surgical level, we were confronted with 4 fractures of the proximal fragment in the apnea patients (24%) and only 2 fractures in those who did not have apneas (6%). According to studies, fractures of the proximal fragment typically occur in 1% to 3% of cases and in up to 17% of cases. From our results, the frequency is clearly higher in patients with apneas, although our sample is rather small.

Figure 1a shows the toothless casts of the jaws of an apnea patient who was a candidate for maxillomandibular advancement. Presurgical simulation consisted first of maxillary advancement, which created a considerable gap of more than 20 mm between the maxilla and mandible (Fig 1b). Two consequences resulted. First, it was necessary to mesialize the proximal vestibular slot of the sagittal osteotomy to lengthen the proximal fragment and to maintain a sufficient contact surface for the stability and the consolidation of the osteotomy site after the advancement of more than 10 mm. Moreover, the localization of the sagittal suspigien osteotomy must be precise, underneath the merging of the lingual and vestibular cortices, located a maximum of 5 to 7 mm above the Spix backbone (Figs 2a and 2b). The concavity of the internal side of the mandibular condyle sometimes conceals the entrance of the inferior alveolar nerve into the dental canal. It is therefore necessary to facilitate access to the condyle to avoid working blindly and bringing about an undesired fracture. One solution consists of starting the surgical intervention by mandibular advancement. Since it is not possible at first to create an intermediate surgical positional model of the corrected mandible and the uncorrected maxilla, if the planned maxillary movement is not solely horizontal, it is necessary to perform a double-key repositioning at the level of the platforms of the casts in a semiajustable articulator (Fig 3a). This allowed us to simulate the intervention by starting with the desired maxillary movement (Fig 3b), position the mandible (Fig 3c), and then after the fact to create an intermediate positional model of the corrected mandible and the uncorrected maxilla, with the maxilla back in its original placement (Fig 3d). The intervention can then start with the mandibular advancement. Unfortunately, the maxillary advancement is more limited on an anatomic level than the mandibular advancement, and the posterior repositioning of the maxilla into its original position can create occlusal interferences, modifying the vertical dimension in the articulator and becoming a source of error in executing the intermediate resin positioning cast. To avoid
later modification of the mandibular position, it is therefore preferred, as much as possible, to start surgery with the maxillary advancement. The osteotomy mandibular slots would have been completely realized beforehand, with the mandible remaining unscathed thanks to the medulla. The lingual slot would have been realized as close as possible to the Spix backbone, where the inferior alveolar nerve enters the dental canal. Since different repositioning casts are available, a decision regarding the best operational sequence would have based on clinical factors.

Figs 2a and 2b  The merging of the lingual and vestibular cortices is located a maximum of 5 to 7 mm above the Spix backbone (S). (Above) Sections taken at different levels in the mandible above the Spix backbone show the quick fusion of the vestibular and lingual cortices. The slot of the lingual osteotomy and the sagittal gap must therefore be close to the emergence of the vasculonervous bundle.

Fig 3a  Equipped casts in the articulator, which is double based with magnetized keys in plaster to allow the repositioning of the casts.

Fig 3b  Simulation of the maxillary advancement, showing the planned orientation of occlusion, and realization of a magnetic key for positioning in the articulator.

Fig 3c  Simulated mandibular advancement compared to the maxillary advancement.

Fig 3d  Repositioning of the maxilla back to its original position can be performed, thanks to a removable plaster key.
Spiessl has described a variation that frees the internal side of the mandibular condyle by cutting a notch and thus eliminates the overhang of the anterior edge (Fig 4). We did not employ this procedure, as it renders the proximal fragment unnecessarily more fragile, as the 2 fractures of the condyle occur at this point after execution of the aforementioned notch. The mandibular splitting takes time and must be executed with great caution, all the more since the fragment is long in its horizontal position. Rigid osteosynthesis contributes to a reduction in maxillomandibular fixation. In the correction of dentofacial anomalies, we usually keep patients in maxillomandibular fixation for 5 to 6 days, based on the definitive positioning model, to avoid harmful movements by premature contact and to wait for a reduction in edema and postoperative pain. The patient will then be more conscientious of the oral cavity and of the new dental contacts after the 8-day period. With patients suffering from apneas, use of a positive air-pressure mask in the immediate postoperative phase is discouraged because it leads to facial edema and discomfort—not to mention the fact that, as candidates for maxillomandibular advancement surgery, these patients have already been shown to be resistant or non-responsive to the mask.

During the immediate postoperative phase, patients with apneas spent the first night in an intensive care unit, and when returned to the hospitalization room, were cared for by nursing personnel aware of their pathology. Moreover, for this purpose a specific surveillance chart was established in our department. Hospitalization was a little longer for patients with apneas than for those without apneas. This can be explained by our desire to wait for the facial edema to subside more completely and to control certain polygraphic parameters before their return home. On the orthognathic level, the character of the apnea certainly does not excuse us from correcting the dentoalveolar anomaly with presurgical orthodontics and then making associated surgical modifications if necessary. Moreover, the intubation scores reflect an increased frequency of retrognathia among patients with apneas.

The rate of postoperative complications was higher in patients with apneas than in patients operated for pure dentofacial anomalies. Four patients presented an infection of the osteosynthesis plaque in the mandible within 1 month after surgery. Two of these patients were diabetic. Moreover, it was more difficult to motivate these patients to maintain optimal dental hygiene. They are less conscientious about their dental hygiene than those patients who seek orthodontic-surgical treatment for the correction of dentoalveolar dysmorphosis. Another patient with apnea presented with postoperative bronchopneumonia. This patient (ASA 2) presented with preoperative chronic obstructive bronchopneumonia. The appropriate treatment, anti-biotherapy ablation of the material, allowed the successful resolution of the complication. In spite of the extension of the proximal fragment, we were not confronted with bony necrosis at the level of these fragments.

Conclusions

Maxillomandibular advancement osteotomy is a legitimate technique for the treatment of obstructive sleep apnea syndrome. The procedure requires great rigor in both presurgical planning and in the sur-
gical technique itself. Essentially, perioperative complications concern mandibular osteotomy sites and seem more frequent than in patients who undergo osteotomies for standard correction of dentofacial dysmorphosis. Postoperative complications are also more frequent. These complications do not hinder the expected final result.

The advanced age of the apnea patients in this sample could be a reason for the higher rate of complications, but we attribute the higher rate mostly to the substantial size of the skeletal movements performed. Nevertheless, we do not think that these interventions must be viewed as a last resort, all the more so since uvulopalatopharyngoplasty, which is very popular in the treatment of obstructive sleep apneas, is not without risk or chance of failure. A strict protocol must be respected to manage any difficulties and to reduce the incidence of complications. We recommend the following:

- Controlled hypotension and normovolemic hemodilution during surgery
- Meticulous infiltratation of the operative sites with the help of an adrenalized solution
- Assurance of correct hemostasis
- The creation of 2 intermediate positioning casts in a double platform with repositioning keys in plaster, which can show the clinician whether to start the intervention with the maxillary osteotomy or with the mandibular osteotomy, according to the difficulty of access to the mouth
- Initiation of surgery with the realization of the mandibular slot as close as possible to the Spix backbone and without realizing the gap
- Extension of the mesial sagittal slot of the mandibular osteotomy to increase the contact surface between the proximal segment and the toothed segment, the gap at this level being prudent and progressive to respect the integrity of the vestibular cortex of the horizontal branch
- Avoidance of the Spiessl notch to keep the condyles from becoming more fragile
- When possible, advancement of the maxilla before advancement of the mandible, in light of the anatomic constraints, and then quick cleaving of the mandible as the slots are realized at the beginning of the intervention
- Insurance of stable osteosynthesis to avoid maxillomandibular fixation and to facilitate respiration
- Extension of the length of hospitalization by a few days to control oxymetric and polygraphic parameters
- Motivation of the surgical care team through the use of a specific postoperative surveillance chart of patients at risk
- Motivation of the patients toward developing optimal oral hygiene

References


19. Pirsig W. There is no rationale for destructive UPP or LAUP in treating patients with snoring and obstructive sleep apnea [abstract 178]. In: Vth World Congress on Sleep Apnea, Marburg, 1997:48.