Maxillo-mandibular surgery for obstructive sleep apnoea


ABSTRACT: Many therapeutic approaches, including mandibular surgery, have been proposed for the treatment of obstructive sleep apnoea syndrome. In the largest study of its type yet reported, 54 patients (population A) underwent mandibular surgery: 36 had palato-pharyngoplasty and inferior sagittal osteotomy of the mandible with hyoid myotomy and resuspension, and 18 (population B) had maxillo-mandibular hyoid advancement, a procedure consisting of palato-pharyngoplasty, inferior sagittal osteotomy of the mandible with hyoid myotomy and, several months later, a maxillo-mandibular osteotomy. Criteria for procedure selection and for evaluation of results were pre-set, and clinical and polygraphic follow-up occurred 6-8 months after final surgery. In population A, 32 of the 36 patients had improved; but only 20 were evaluated as "satisfactory". In contrast, all of the population B patients were judged satisfactory. Four of the population B patients received nasal continuous positive airway pressure (CPAP) before any surgery, and both approaches gave similar good polygraphic results. The degree of skeletal craniofacial deficiencies, particularly retrognathia, is crucial for procedure selection. We describe potential procedural risks and problems.


Surgical approaches were the first means of controlling the disabling symptoms of obstructive sleep apnoea syndrome (OSAS). KUHL et al. [1] are credited with performing the first tracheostomy to bypass an obstruction that occurred during sleep in the upper airway of a very obese patient. FUJITA et al. [2] initiated uvulopalatopharyngoplasty (UPPP) in OSAS patients sent for tracheostomy, and nocturnal polygraphic recordings indicated successful long-term results in 45% of these patients [3-5].

Studies of failures of UPPP have led to better presurgical evaluation of the subclinical and often multiple, anatomical upper airway abnormalities presented by OSAS patients. JAMISON et al. [6], after reviewing 155 consecutive cases, concluded that 150 had at least two markedly abnormal anatomical cranio-facial landmarks. Their patients commonly had a normally positioned maxilla, a retroposition of the mandible, a steep mandibular plane, a cranial base flexure with a nasion-sella-basion angle smaller than expected, a downward displacement of the hyoid bone, and a significant increase in the length of the soft palate. ROHWSKI et al. [7], using video-endoscopy, noted the "disproportionate anatomy" of patients with OSAS; and RIVLIN et al. [8] emphasized the overall displacement of the mandibular symphysis. These displacements easily explain the known abnormalities of the soft tissue of the upper airway; the different levels of obstruction during sleep explain the frequent failures in the treatment of OSAS by UPPP, which eliminated only one site of obstruction.

SULLIVAN et al. [9] proposed nasal continuous positive airway pressure (CPAP) during sleep as a home treatment for OSAS. While nasal CPAP is successful in controlling the symptoms of many OSAS patients, follow-up studies have indicated problems with compliance [10]. Between 25 and 30% of patients are noncompliant for reasons that include nasal obstruction and the inconvenience of being attached to a machine every night for many years. These difficulties have led us to investigate new surgical procedures that would correct the abnormal upper airway noted in OSAS.

Surgical procedures

Two maxillo-mandibular procedures have been developed and previously reported by Riley and co-workers [11-13].

Inferior sagittal osteotomy with hyoid myotomy and suspension

This procedure [11] consists of: 1) a limited osteotomy involving the genio-colle, the anterior point of insertion of the tongue muscles; 2) a section through a submental incision of sterno-, stylo- and omo-hyoid muscles; and 3) the suspension of the hyoid bone to
the mandible, anteriorly and superiorly with fascia. The procedure is performed with UPPP, and if necessary, tonsillectomy (figs 1a and 1b).

Maxillo-mandibular and hyoid advancement

This procedure [12] is planned in two steps, usually separated by a 3–4 month interval. Step 1 consists of a combined UPPP and inferior sagittal osteotomy of the mandible. Following orthodontic preparation during the interval, step 2 consists of a maxillo-mandibular osteotomy (i.e., Lefort-one osteotomy and sagittal split mandibular osteotomy), with liposuction of the neck, if indicated (fig. 2). Step 2 was initially performed under the protection of a transient tracheostomy kept in place for 3–4 wks, but the last 25 patients submitted to this procedure have received nasal CPAP immediately post-extubation, thus eliminating the need for tracheostomy [13].

Pre-established criteria for surgical selection

The gross indications for each of these surgical approaches had been determined by prior evaluation of several small OSAS patient groups. The degree of skeletal cranio-facial deficiencies, particularly retrognathia, must be moderate for successful results with inferior sagittal osteotomy of the mandible with hyoid myotomy. Candidates for inferior sliding osteotomy should have an SNB angle (i.e., angle measurement from sella (S) to nasion (N) to supramentale (point B) at cephalometric X-ray) >75° and no morbid obesity. These limitations do not apply to maxillo-mandibular hyoid advancement. The usual contra-indications to non-emergency surgery related to significant medical and psychiatric problems are, of course, observed.

Patient population

All 54 patients treated consecutively during a 9 month period, and returning for follow-up, are presented here. Two patients undergoing inferior sagittal osteotomy of the mandible refused to return for the follow-up and could not be included.

Clinical symptoms of OSAS were presented in all patients, who were apprised of the therapeutic options
currently available and the known risks and problems associated with the surgical approaches. The patients presented here had either refused any other treatment or had first tried nasal CPAP (see below) in anticipation of another treatment approach. All obese patients had previously been in weight-loss programmes; one patient had previously lost 99 kg, but had returned to 185 kg at the time of consultation. Following the pre-established criteria outlined above, the patient population was divided into subgroups A and B, based on the degree of: 1) reposition of the mandible (indicated by the SNB angle); and/or 2) obesity and fatty infiltration of the neck; and 3) severity of the syndrome as revealed by the respiratory disturbance index (RDI) and apnoea-linked oxygen desaturation. Patients with one or more “severity” factors, i.e. clear retrusion, marked obesity, and/or many abnormal polygraphic results, were considered from the start to be candidates for the two-step maxillo-mandibular-hyoid advancement (population B, n=18). All other patients (population A, n=36) were considered as candidates for inferior sagittal osteotomy with hyoid myotomy and suspension, a less extensive surgery not involving orthodontic preparation. UPPP, as mentioned previously, was always performed.

Ten of the 54 patients considering mandibular surgery (8 in group A and 2 in group B) had already undergone an unsuccessful UPPP elsewhere. Imaging techniques and fibroptic endoscopy indicated the persistence of a narrow airway behind the base of the tongue. The presurgical recording reported for these patients was the one performed post-UPPP but pre-mandibular surgery.

Patient population A (inferior sagittal osteotomy with hyoid myotomy and suspension) consisted of 36 male patients, mean age 47.5±11.8 yrs; and mean body mass index (BMI) 30.9±5.7 (range 19.2-44), indicating a mixture of slender and obese subjects.

Patient population B (maxillo-mandibular hyoid advancement) consisted of 18 patients, 16 men and 2 women; mean age 41±13.5 yrs (range 18-63 yrs); and mean BMI 31±14 (range 19-41.5), again indicating a mixture of body types. The mean BMI for both groups, however, pointed to a generally overweight population.

Methods

Each subject had: 1) nocturnal polygraphic recording pre- and 6 months post-surgery; 2) evaluation of subjective symptoms pre- and post-surgery; 3) pre-surgical cephalometric roentgenograms and evaluation by fibroptic endoscope; and 4) evaluation of complications during and after surgery. Four patients in population B were also treated with nasal CPAP before any surgery. Polygraphic recordings obtained during sleep allowed comparison between nasal CPAP recordings and postsurgical recordings.

To confirm validity of pre-established criteria and to forestall unnecessary surgery, all patients in population B had a new polygraphic recording a mean of 2 months post step 1 surgery. Although these results are given for completeness of presentation, the overall study compared subjects 6 months after surgery.

Polygraphic recordings and definition of breathing abnormalities

Electroencephalogram, electro-oculogram, chin electromyogram, and electrocardiogram (modified V2 lead) were systematically recorded. Respiration was monitored by uncalibrated inductive respiratory plethysmography; airflow was monitored by thermistors, and arterial oxygen saturation (Sao$_2$) by ear oximetry (Biox). Apnoea, hypopnoea and sleep stages were scored according to standard definitions based upon findings obtained from respiratory, airflow, oximetric and other channels. Hypopnoea was defined as: a) a 50% reduction in maximal thermistor output compared with baseline output; and b) association with a decrease of Sao$_2$ to <92% from baseline of at least 94%, or a drop in Sao$_2$ of at least 3% if baseline was <90%. The RDI or (apnoea + hypopnoea) x 60/total sleep time (TST), which takes into account the number of abnormal breathing events per hour of sleep, was calculated.

Definition of Sao$_2$ indices

Several indices of Sao$_2$ were calculated. Mean nocturnal Sao$_2$ was calculated using the formula of BRADLEY et al. [14]: the highest and lowest Sao$_2$ of each polygraphically recorded "epoch" were measured. Because the pattern of desaturation and resaturation in OSA approximates a sine wave, the mean Sao$_2$ of each polygraphic epoch, i.e. 30 s, was estimated by averaging the high and low values. Mean nocturnal Sao$_2$ for TST was then calculated using the mean values of all epochs.

To further focus on events leading to significant oxygen desaturation, even if short-lived, we calculated the number of Sao$_2$ drops related to apnoea and hypopnoea <80% and, with the RDI, calculated the number of Sao$_2$ drops per hour of sleep (O$_2$-80-I). The time spent at an Sao$_2$ below 90% (T<90%Sao$_2$) during nocturnal sleep is self-explanatory.

Indices of sleep disturbance

Using the criteria of RECHTSCHAFFEN and KALES [15], sleep was scored in 30 s epochs. We performed statistical analyses on the percentage of Stages 1 and 3-4 non-rapid eye movement (NREM) and rapid eye movement (REM) sleep during TST.

Cephalometric roentgenograms

Lateral cephalometric roentgenograms were obtained with the Wehmer cephalostat, using the technique of RILEY et al. [16]. Tracings of the roentgenograms were
made on an acetate sheet and specific angles in degrees, or dimensions in mm, were selected for further analysis (fig. 3). This information was supplemented by a visual inspection of the region by fibreoptic endoscopy performed on a supine patient. The BMI was calculated by the method of Khosla and Lowe [17] (weight [in kg] × 10,000/height² [in cm]).

Pre-surgical cephalometric findings. Mean SNA angle was 81.1±2.2° (range 71–91°); mean SNB angle 79.0±3.2° (range 70–84°); mean PNS-P distance 44.0±5.9 mm (range 33–56 mm); mean MP-H distance 26.2±8.0 mm (range 10–44 mm) mean; pas distance 4.5±2.3 mm (range 1–10 mm).

Pre-surgical nocturnal polygraphy. Sleep disturbance was present with an increased percentage of Stage 1, and decreased percentage of Stage 3–4 and REM sleep. RDI and SaO₂ indices were abnormal, with clear variation in severity within the group. No significant cardiac arrhythmias were noted in the recording with the exception of brady-tachycardia with apnoeas (table 1).

Table 1. – Population A: Inferior sagittal osteotomy with hyoid myotomy and resuspension in 36 patients (mean±sd)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>Pre-surgery</th>
<th>Post-surgery</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>TST</td>
<td>min</td>
<td>376±58</td>
<td>397±53</td>
<td>ns°</td>
</tr>
<tr>
<td>S1</td>
<td>%</td>
<td>42.6±19.5</td>
<td>32.1±14</td>
<td>p&lt;0.03*</td>
</tr>
<tr>
<td>S3-4</td>
<td>%</td>
<td>3.8±5.5</td>
<td>6.4±7.2</td>
<td>ns°</td>
</tr>
<tr>
<td>REM sleep</td>
<td>%</td>
<td>10.5±5.5</td>
<td>14.3±4.3</td>
<td>p&lt;0.009*</td>
</tr>
<tr>
<td>SaO₂</td>
<td>%</td>
<td>93.7±2.1</td>
<td>94.6±1.0</td>
<td>p&lt;0.02**</td>
</tr>
<tr>
<td>T&lt;90% SaO₂</td>
<td>%</td>
<td>22.7±33.5</td>
<td>1.8±5.1</td>
<td>p&lt;0.02**</td>
</tr>
<tr>
<td>O₂&lt;80%</td>
<td>%</td>
<td>8.0±17.8</td>
<td>6.4±17.2</td>
<td>p&lt;0.02**</td>
</tr>
<tr>
<td>RDI</td>
<td></td>
<td>48.7±25.4</td>
<td>24.5±22</td>
<td>p&lt;0.0001**</td>
</tr>
</tbody>
</table>

*: matched pair t-test; **: Wilcoxon signed rank test; ns: non-significant; TST: total sleep time; S1, S3-4 (NREM), and REM: sleep stages as percentage of total sleep time; SaO₂: arterial oxygen saturation; T<90% SaO₂: percentage of total sleep time spent with SaO₂ below 90%; O₂<80%: number of SaO₂ drops ≤80% per hour of sleep; RDI: respiratory disturbance index; NREM: non-rapid eye movement; REM: rapid eye movement.

Post-surgical evaluation. At the 6 month follow-up evaluation and recording, four patients, despite greatly reduced snoring, felt little change subjectively when compared with baseline. No patient had lost weight, and three patients had gained >10 kg weight. (Three months post-surgery, an additional patient with intermittent asthma was treated by a high dosage of corticosteroid for a serious episode and thus added significant weight increase to the severe asthmatic problem). All other patients reported "improvement", with significant decrease of EDS and generally improved daytime activities and quality of life.

Post-surgical polygraphic recording. As shown in table 1 and figure 4, there was an overall statistical improvement of nearly all monitored variables; however, the standard deviations for some of the mean values were
wide, indicating a subgroup with limited objective improvement. Subjective improvement was more moderate for 16 of the 36 patients. To better understand the differences between "moderate" and "good" results, a new analysis was performed, comparing the baseline presurgical data of two subgroups, whose division was based upon postsurgical polygraphic recording data (see Table 2). Subjects with a postsurgical RDI ≤ 20 and \( T < 90 \)% Sao 2 ≤ 51% were placed in the good result group, which included 20 patients. All other subjects were in a "moderate" result group of 16 patients, even if they reported subjective improvements.

**Moderate or no improvement versus good.** The presurgically collected baseline variables of the two subgroups, i.e., RDI, the sleep indices (\%Sl, \%S3-4, \%REM sleep, TST), the Sao 2 indices (\( O_2 < 80 \)-I, \( T < 90 \)% Sao 2), the cephalometric variables (nas, MP-H, SNA, SNB, PNS-P), age, and BMI were compared, using non-parametric Mann-Whitney U statistics. RDI (\( p < 0.007 \)) and \( O_2-80-I \) (\( p < 0.02 \)) for the two groups differed to a statistically significant degree. Note that the pre-surgical RDI was clearly higher in the subjects with "good" results, who tended pre-surgically to present more drops < 80% Sao 2 than the subjects with "moderate" results. None of the other variables investigated, in particular the cephalometric variables, was statistically significant. The only mild trend involved BMI: the "good" results group had a heavier than the "moderate" results group. Surprisingly, statistical comparison indicated that patients with a more severe disorder, as defined by RDI and several Sao 2 indices derived from polygraphy, generally had better results than patients with mild problems (Table 2).

**Complications of the procedure.** Since this surgical procedure is also performed as step 1 of maxillomandibular hyoid advancement, complications noted in the 54 patients following this surgery are grouped together here.

Patients undergoing UPPP simultaneously with the procedure presented the usual discomfort seen with this surgery, whilst patients who had previously undergone UPPP complained much less of local pain during the ten initial post-surgical days. Nasal reflex with fluid intake was observed in all patients during the immediate post-surgical period. Although all patients experienced transient mental nerve paraesthesia, none had permanent paraesthesia at the 6 month follow-up. Oedema of widely varying severity was noted during the first few days, but was not necessarily more significant than that noted with UPPP alone, as shown by systematic cephalometric roentgenograms.

**Table 2. Results of inferior sagittal osteotomy with hyoid myotomy and resuspension: "Good" versus "Modest" groups (mean ±sd).**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>&quot;Good&quot; results</th>
<th>&quot;Modest and no improvement&quot; results</th>
<th>&quot;Modest&quot; results</th>
<th>Wilcoxon SRT*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Wilcoxon SRT*</td>
<td>Wilcoxon SRT*</td>
<td>Wilcoxon SRT*</td>
<td>Wilcoxon SRT*</td>
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<tr>
<td></td>
<td></td>
<td>Pre-surg</td>
<td>Post-surg Statistical significance</td>
<td>Pre-surg</td>
<td>Post-surg Statistical significance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TST</td>
<td>min</td>
<td>373±56</td>
<td>399±55</td>
<td>400±47</td>
<td>NS</td>
</tr>
<tr>
<td>S1</td>
<td>%</td>
<td>47.6±21.7</td>
<td>26.4±8.6</td>
<td>36.0±15.0</td>
<td>NS</td>
</tr>
<tr>
<td>S3-4</td>
<td>%</td>
<td>3.6±4.7</td>
<td>8.2±2.6</td>
<td>4.0±4.7</td>
<td>NS</td>
</tr>
<tr>
<td>REM S1</td>
<td>%</td>
<td>10.6±5.5</td>
<td>15.4±4.3</td>
<td>14.8±17.7</td>
<td>NS</td>
</tr>
<tr>
<td>Sao 2</td>
<td>%</td>
<td>93.0±2.6</td>
<td>95.0±0.3</td>
<td>94.7±4.0</td>
<td>NS</td>
</tr>
<tr>
<td>T&lt;90% Sao 2</td>
<td>%</td>
<td>8.0±9.0</td>
<td>0.5±0.2</td>
<td>1.6±2.3</td>
<td>NS</td>
</tr>
<tr>
<td>( O_2-80-I )</td>
<td></td>
<td>15.6±22.6</td>
<td>0.20±0.8</td>
<td>0.04±0.14</td>
<td>NS</td>
</tr>
<tr>
<td>RDI</td>
<td></td>
<td>58.7±28.2</td>
<td>14.0±5.9</td>
<td>36.0±14.8</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note that the "modest" results group includes four patients who significantly increased weight post-surgery and deteriorated after the first 2 months post-surgery. Most patients immediately post-surgery initially had a mild to moderate problem.* Wilcoxon signed rank test; \( \times \times \) includes the four patients who reported no subjective improvement; \( \times \times \times \) excludes the four patients who reported no subjective improvement. Abbreviations as in Table 1.
As with UPPP alone [18], intermittent complete and partial upper airway obstruction during sleep with \( \text{Sao}_2 \) drops was noted, in association with repetitive apnoeas, in patients monitored during the first four post-surgical days. The recent systematic use of nasal CPAP immediately post-surgery for a mean of three weeks has avoided the above problems.

Mandibular fracture of the anterior mandibular fragment was not observed in the 54 patients reported here. Only two patients (out of >100), who still awaited a 6 months’ follow-up and are thus not reported here, experienced mandibular fracture when the osteotomy was inadvertently extended close to the alveolus. They were conservatively treated by arch bar application; the fracture in situ was not of consequence at the 3 months’ follow-up. One patient had a hyoid suspension that was too superior and anterior, resulting in continuous regurgitation and risk of aspiration pneumonia. The suspension was partially released within the first few days post-surgery. At long-term (6 month) evaluation, no significant relapse, or speech or swallowing difficulties have been noted. Patients have been free of problems for the 8 months’ to 3.5 years’ current follow-ups.

Population B: maxillo-mandibular hyoid advancement (n=18)

Pre-surgical complaints and symptoms. All patients complained of severe EDS and loud snoring at night. Frequent apnoeas had been noted by a spouse in all cases. In addition, 16 patients complained of frequent disrupted nocturnal sleep with awakenings; 8 had violent, abnormal movements during sleep; 12 had nocturia; 13 reported heavy sweating at night; 8 had frequent headaches on awakening; 7 had daily morning confusion; 11 talked in their sleep; 3 walked in their sleep; 3 presented with frequent nocturnal enuresis; 1 had recurrent night terrors; 4 complained of hearing loss; and 7 patients were on hypertensive medication.

Pre-surgical cephalometric findings. Mean SNA was 78.1±2.7° (range 72–82°); mean SNB 73.7±3.2° (range 67–80°); mean MP-H distance 29.6±4.0 mm (range 17–41 mm); mean PNS-P distance 42.6±5.5 mm (range 35–52 mm); and mean pas distance 3.4±1.2 mm (range 1.5–5.5 mm).

Pre-surgical nocturnal polygraphy. A significant sleep disturbance was seen, with a greatly increased percentage of Stage 1 NREM sleep and significant decreases in percentage for both Stage 3–4 and REM sleep (table 3). The RDI was always elevated, with lowest \( \text{Sao}_2 \) always occurring during REM sleep. \( \text{Sao}_2 <80\% \) was seen in all patients at least once during the night. Sinus arrest, in association with sleep apnoea, and lasting 3–5 s was seen at least once in three patients. Premature ventricular complexes (PVCs) were seen at a rhythm of 1–2 min during sleep in five subjects. One subject had one episode of atrio-ventricular block (Mobitz type II) in association with apnoea. All subjects presented the classic brady-tachyarrhythmia seen with sleep apnoea.

Post-surgical evaluation: subjective report. Six months following the last surgical procedure, BMI was not significantly different from pre-surgical measurement. Subjectively, all patients reported significantly improved daytime alertness, greater energy, the ability to cope with daily chores, the disappearance of frequent morning headaches, an improved mood, an impression of being “sharper” with “better memory”, and the disappearance of snoring, abnormal movements and restless sleep. Three patients presented some PVCs during sleep, but well below the rate of 1–2 per min/24 h of the pre-surgical nocturnal period. The two other PVC-positive patients had less than 50 PVCs during total sleep time. No other cardiac arrhythmias were seen.

Post-surgical polygraphic variables. Polygraphic recording results are indicated in table 3. Statistically, with the exception of a mildly decreased and nonsignificant TST, all other variables showed highly significant differences. All \( \text{Sao}_2 \) indices indicated a good maintenance of \( \text{Sao}_2 \) (table 3). Pre-surgery, Pearson coefficient correlation had indicated significant correlation between mean \( \text{Sao}_2 \) and \( O_2 \)-80-1 (-0.55); mean \( \text{Sao}_2 \) and % \( T<90\% \) \( \text{Sao}_2 \) (0.96); \( O_2 \)-80-1 and % \( T<90\% \) \( \text{Sao}_2 \) (0.87). These correlations were again found post-surgery: mean \( \text{Sao}_2 \) (0.54); mean \( \text{Sao}_2 \) and % \( T<90\% \) \( \text{Sao}_2 \) (-0.54); \( O_2 \)-80-1 and % \( T<90\% \) \( \text{Sao}_2 \) (0.73). The correlation coefficient between RDI and BMI following surgery was 0.46, indicating that the few persistent apnoeas during sleep were still seen in morbidly obese patients (BMI >38). Post-surgically, the elevated percentage of Stage 1 NREM sleep, an index of some sleep disturbance, also correlated with the RDI (0.54). But the mean percentage of Stage 1 NREM sleep was highly improved statistically over the pre-surgical value. Polygraph recordings a mean of 2 months after step 1 surgery, and before step 2, indicated, as expected, that sleep apnoea had not been controlled. The mean RDI was 39±26 and the mean \( O_2 \)-80-I was 8±9.)
Complications of the procedure. The potential complications (i.e. nasal reflux, transient nerve paraesthesia, mandibular fracture of the anterior mandibular fragment) are not only those reported for inferior sagittal osteotomy and hyoid myotomy, but also some that are more specifically related to step 2 of the procedure; in particular, possible damage to the inferior alveolar nerve during its difficult dissection. As in population A, nasal reflux, oedema, and transient mental nerve paraesthesia were observed in all patients during the immediate post-surgical period following UPPP and step 1 surgery. No significant complications were otherwise noted in this group. Paradoxically, the maxillo-mandibular hyoid advancement, i.e. step 2 of the surgery, leads to fewer complaints of pain and significant discomfort than are reported for UPPP. Partial facial sensory paraesthesia was noted in five patients in the period preceding the 6 month post-surgical follow-up. At this follow-up, however, there was no evidence of any of the following: velo-pharyngeal insufficiency, impaired speech or swallowing, persistent facial paraesthesia, persistent pain, or significant relapse. The longest clinical follow-up is 3 yrs, with a mean of 10 months, and this patient population has been free of any long-term complication.

Comparison of nasal CPAP and maxillo-mandibular hyoid advancement treatment. Four patients initially treated with nasal CPAP secondarily underwent maxillo-mandibular hyoid surgery. Using the Wilcoxon signed rank test, we compared the poligraphic results obtained during nasal CPAP treatment with those obtained 6 months post-surgery, selecting TST, percentage of Stages 1, 3-4, and REM sleep, RDI, mean Sao2, T<90% Sao2, and O2-80-I for comparison. Not only were all results nonsignificant (the p value closest to indicating a trend was only p<0.109, for percentage of S 1 and S3-4 comparison), but the mean values for most variables were also very close, e.g. mean RDI=10.9±8 vs 9.8±9, mean Sao2=95% with both treatments; similarly, T<90% Sao2 and O2-80-I=0 with both procedures.

Conclusions

Although there are now many proposed treatments for OSAS, their indications, long-term results, and complications are often poorly documented. Tracheostomy is probably the only exception to the rule [19, 20]. In addition to problems already mentioned with respect to CPAP non-compliance, a 5 yr follow-up of weight-loss trial for treatment of OSAS, also performed in our clinic, demonstrated >90% failure [20].

This is the first report to consider a large OSAS patient population submitted to maxillofacial surgery. Although the surgical techniques are not new, and have been performed for other indications [4-12], their application to OSAS is new. The indications for surgery were based upon a careful analysis (using cephalometric roentgenograms, fibreoptic examination, nocturnal poligraphic monitoring, and subjective complaints) of the anatomical abnormalities found in the upper airway of OSAS patients.

Although all 54 patients underwent inferior sagittal osteotomy (step 1 of the maxillo-mandibular surgery), the results of the two surgical procedures are different. Outside the research protocol, all patients undergoing maxillo-mandibular surgery (population B) had regular follow-ups, including poligraphic recording, between step 1 and step 2. These follow-ups preceding step 2 indicated that, in all cases, despite improvement compared with baseline, abnormal findings persisted during poligraphic recordings. Maxillo-mandibular-hyoid advancement gave very good results overall (the best obtained by far with any surgical procedure, other than tracheostomy, performed in our clinic over the past 10 yrs) at 6 months' follow-up. In the four patients who were also initially treated with nasal CPAP, but who preferred surgery as a long-term treatment, we found that similar positive results were obtained with both procedures. Although morbid obesity was seen in our population treated with maxillo-mandibular surgery (one patient weighed 185 kg at the time of surgery), none had major lung disease or was a significant carbon dioxide (CO2) retainer, with CO2 tension always <44 torr when awake and seated.

The good results at 6 months' follow-up are also of theoretical interest, as they demonstrate that action directed only toward upper airway anatomical factors can completely control a severe OSAS, even with significant obesity in non-CO2-retainer patients.

Patients selected for inferior sagittal osteotomy and hyoid myotomy alone showed a more mixed response. For various reasons, four patients did not improve, and all four gained significant weight post-surgically. The gain in airway space may be sufficient for a certain weight, but an abrupt, marked increase over the weight at the time of surgery may again compromise the airway. As a group, subjects with "moderate
improvement" were initially less severely affected and less obese than subjects considered to have had "good" results. Patient by patient analysis indicated that several of the "modest" results were seen in patients with more marked maxillo-mandibular abnormalities, i.e., with SNB angles of 74–75° (despite the fact that when the overall cephalometric variable results were compared between "good" and "moderate" groups, there was no statistical significance). Because of the mild to moderate clinical symptomatology and polygraphic recording data, we initially put these patients into group A. This was erroneous: inferior sagittal osteotomy with hyoid myotomy and suspension, in general, will give moderate results even in moderately affected patients, if the SNB angle is <76°.

However, small SNB angles and excessive BMI could not explain the total number of "modest" results. Other cephalometric variables may be indicative, but we have not been able to identify them in this study. Other factors, not considered in the study, would perhaps have been indicative, e.g., degree of mild to moderate COPD, amount of nightly alcohol intake, importance of sleep deprivation, etc. It must be emphasized, however, that we did not consider these factors for group B either, and these patients had very good results from the maxillomandibular surgery. Finally, none of the patients reported here had a major lung disease with significant daytime blood gas derangement, a condition that we did not consider for group B either.

References

donné des résultats analogues très satisfaisants. Les critères de sélection déduits de cette étude, les problèmes, non résolus, associés au groupe A, les risques potentiels liés à ce type de chirurgie, et les complications observées, sont eux aussi résumés. Le degré des déficiences squelettiques cranio-faciales, et particulièrement la rétrognathie, est essentiel pour la sélection du traitement.