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Relationship between obstructive sleep apnea and orthognathic surgery

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ABSTRACT

The obstructive sleep apnea (OSA) syndrome has become an important issue in the field of medicine. It has been a relatively discreet pathology until now, but its prevalence as well as an important cardiovascular risk factor, has made it a major public health issue. Orthognathic surgery has now made its mark in both OSA and orthodontic treatment. It seemed appropriate to link these three areas. Objective: Describe the implications and the mutual relations between OSA and maxillofacial osteotomies, despite the fact that scientific literature is not very consensual, and identify the present principles to adapt our therapeutic proposal and our treatment plan. The orthodontic specificities will also be described in this type of patient. Means: A multidisciplinary, descriptive study after reviewing the literature (meta-analysis and baseline studies), enriched by each specialist's remarks. Apneic and orthognathic pathologies are obviously multidisciplinary and providing an overview on treatment seemed necessary.

KEYWORDS

Obstructive sleep apnea, sleep apnea syndrome, orthognathic surgery, maxillofacial surgery, bimaxillary osteotomy, maxillomandibular osteotomy, interdisciplinary

INTRODUCTION

Obstructive sleep apnea is a syndrome that is caused by repeated respiratory disruptions of ≥10 seconds during sleep. A fully closed obstruction is an apnea and a partially closed obstruction is called hypopnea. These obstructions are caused by a collapse of the subglottic airways and can be attributed to such anatomical factors, such as bone and soft tissues, and physiological factors. A total of 600 000 patients are currently being treated for this condition in France, amounting up to 5% of the population. OSA prevalence increases in relation to age and body mass index (BMI). Men are more affected than

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women but the gap is smaller after menopause.[64]

Affected patients often complain of drowsiness or fatigue during the day. Generally, patients present heavy snoring and morning headaches. Patients also report having to wake up frequently during the night because of polyuria, even though urinary or prostate problems are not always the case. OSA can lead to serious conditions, it is a risk factor for severe cardiovascular disease (increased risk for arterial hypertension, cardiac rhythm problems, cerebrovascular incidents, and heart attack). It is as important a risk factor as hypercholesterolemia and smoking.

OSA aggravates diabetes and certain ophthalmological conditions like glaucoma. A group of 18-year-old patients in Wisconsin measured a relative risk of cardiovascular mortality multiplied by 5.2 in the case of OSA[5]!

Fragmented sleep caused by respiratory conditions can be responsible for neurocognitive disorders. Patients suffer from various disorders, including attention problems, memory problems, irritability, and even depression. One of the most serious risks associated with attention disorders is falling asleep at the wheel, thereby causing accidents on public roads[55]. The diagnosis of this syndrome requires recording a number of nocturnal parameters: ventilatory, cardiac (by use of a polygraph), and electroencephalographic (polysomnography)[55].

The presence of OSA is therefore determined by adding the number of apneas + hypopneas to create an apnea–hypopnea index AHI. A positive result is a number >5 per hour of sleep (Fig. 1)[5].

OSA can be categorized as light, moderate, or severe. According to the more serious component between the

	A	B	C
OSA is defined by the presence of criteria A or B AND criteria C	*Daily excessive lethargy,* Unexplained by other factors	*At least two of the following criteria which are unexplained by other factors:* – Severe routine snoring – Feelings of stifling or suffocation during sleep – Repeatedly wakes up during sleep nonrestorative sleep – Daily fatigue – Difficulties concentrating – Nocturia (more than one urination per night)	*Positive diagnosis on the polysomnography or polygraph* *(AHI >5)*

Figure 1
How to diagnose OSA in patients?

AHI measurement and the significance of the daily drowsiness experienced. This is generally measured using the Epworth sleepiness scale. Severe OSA will, therefore, be determined by an AHI score >30 or by an AHI >5 and severe daily drowsiness[5].

The reference treatment for sleep apnea syndrome is continuous positive airway pressure (CPAP), which consists of applying continuous pressure to the upper airways to keep them open. In the case of moderate sleep apnea syndrome or CPAP failure, a mandibular advancement orthotic is a possible alternative therapy. It allows the mandible to advance a few millimeters to increase the diameter of the air chain. These two treatments are less invasive and easy to implement, but are not curative and can result in problems[32]. This has fueled the quest to find other therapeutic alternatives.

For obese patients, significant weight loss sometimes causes symptoms of OSA to disappear but this implies long-term care, which could require bariatric surgery. Maxillofacial surgery has proven to be quite effective. Currently maxillomandibular advancement osteotomies are the only interventions where the results are comparable with those of CPAP (reference treatment) with a success rate of approximately 80%, which varies depending on the selected criteria. ENT and orthodontic treatment in preparation for surgery is generally necessary.

Treating OSA requires a holistic and multidisciplinary approach. This involves not only doctors but also dentists, orthodontists, and other members of paramedical specialties such as lingual rehabilitation, psychotherapy, sophrology, osteopathy, and dietetics.

CRANIOMAXILLOFACIAL ANOMALIES PREDOMINANT IN OSA

The anatomical factors that result in a person's airway to collapse are logically those that decrease endoluminal pressure (the obstructions) increase extraluminal pressure (obesity, posture) or decrease peripheral airway resistance[65].

In children

In children, these anomalies are essentially:

– transverse maxillary deficits because of nasal obstruction. If the nasal obstruction is related to amygdalan hypertrophy (palatal or pharyngeal), the latter is potentially the triggering factor of OSA, it is systematically a mitigating factor;
– mandibular and or maxillary retrognathias.

Failure to treat these skeletal deficits in childhood leads to dysmorphic syndrome in adulthood predisposing subjects to OSA.

In adulthood

In adults six anatomical factors that correlate to the severity of OSA have been established by Costa[14]. The size of the hypopharynx and oropharynx, the inferior/caudal position of the hyoid bone, the hourly mandibular

rotation (hyperdivergence, which does not stretch the tissues far from the respiratory chain.), sagittal maxillomandibular position, and BMI. Complementary studies have statistically shown that adult patients presenting with OSA have longer airways[65], shorter skull base, macroglossia, or elongated the soft palate[20].

The role of excess weight

The quality of sleep is inversely proportional to obesity: a reduction in sleep quantity or quality can contribute to gaining and maintaining excess weight. Obesity can, in turn, be the root cause or at least a mitigating factor in sleep disorders, especially respiratory ones. Lastly, eating habits can influence sleep quality. The prevalence of obstructive sleep apnea syndrome (OSA) is proportional to BMI where 58% obese persons who have a BMI of ≥30 suffer from OSA in France. In cases of severe obesity of BMI of ≥35, we routinely propose a ventilatory polygraph or polysomnography to ensure adequate treatment.

ORTHOGNATHIC SURGERY AND OSA

What are the surgical possibilities to fix this obstructive sleep condition?

Maxillomandibular advancement surgery (MMA) tightens the hyolingual muscle mass; this is associated with an increase in buccopharyngeal volume. It contributes to an increase in the volume of the velo-oropharynx and hypopharynx, a shortening of the airways, and the anteriorization of the tongue and hyoid bone. Tooth or bone-supported maxillary distraction, orthopedic, or postoperative disjunction will permit a significant increase in the retrobasilingual space by elevating the lingual position. However, its effect on the diameter of the nasopharynx remains a topic of debate[1].

Minimal radiological assessment

Profile teleradiography is the exam that is most widely used during the pretherapeutic assessment and follow-up of OSA. This exam measures parameters such as posterior pharyngeal space, distance between the mandible and the hyoid, retroalveolar space (between the anterior vertebral wall and the pharyngeal vellum. It also allows for the diagnosis of major dysmorphias. According to Gokce, there is a good correlation between space, as measured by profile teleradiography, such as retropharyngeal space, and the space measured by tomodensitometry (TDM). The radiological measurement would therefore be reliable and sufficient. The initial narrowness of the (SA)

superior airways, on the teleradiography would be a good indicator of how successful bimaxillary surgery would be. On the other hand, volumetric assessments, of the upper aerodigestive tract, especially in studies, are only possible using tomodensitometry but are conducted in conscious patients, whereas the real physiopathology must be measured in sleeping patients[65]!

Criteria for orthognathic surgery in OSA

We should mention the intricacy of this procedure because OSA has become an indispensable factor in decision making. We must first identify how useful bimaxillary advancement surgery would be, which creates simultaneous tension in all the pharyngeal walls (suprahyoid muscles, palatal muscles, and lateral musculature of the pharynx,) and has shown more successful results than mandibular advancement alone[65]. Since the eighties, bimaxillary advancement surgery has largely supplanted the bilateral sagittal mandibular osteotomy (BSMO) in OSA cases probably because there is a deficiency in the two osseous bases in OSA[26].

There is no "official" distance advancement and as a result there is no linear correlation between the degree of maxillomandibular propulsion and a reduction in AHI[57]. The advancements reported and advised in the majority of cases are made up of 5–10-mm changes for the maxilla and 10–12-mm changes for the mandible[8,57,7].

Basically, maxillomandibular advancement surgery can be proposed in OSA if three criteria are present:

– *When making a diagnosis of OSA during the systematic assessment of an ortho-surgical case*. This "discovery" facilitates a change in rationale when making a decision about osseous base movement; for example, to propose a mandibular advancement over and above what was already planned and to involve the maxilla[26];
– *However, it can also be indicated in the diagnosis of maxillomandibular dysmorphic disorder during OSA assessment*. We are then legitimately authorized to propose this type of treatment to address the skeletal problem in apneic patients [8,26,51];
– *As a recourse in case of failure or intolerance to medical treatments (CPAP and MAO) developed by patients not known to have any dental dysmorphia or anomaly*[8,26,51]. It is estimated that between 20% and 30% of the total number of patients, do not tolerate these treatments. The absence of a retrusive profile must not eliminate this therapeutic possibility, but these patients must be informed of the resulting morphological modifications[3].

Whatever the indication, most specialists recommend a systematic orthodontic preparation to assure optimal tooth mesh and therefore decrease the risk of degradation or late postoperative relapse[3].

This surgical treatment of OSA is functional and must not affect the prognosis. It involves young patients who are aged <65 years and are not obese (BMI <30). There is no severe comorbidity indicating an increased anesthetic risk, but they suffer from severe or

symptomatic OSA. The traditional contraindications found in literature concern the consumption of respiratory depressants such as alcohol or psychotropic drugs or any previous cases of obstructive bronchopneumopathy, cardiovascular or cerebrovascular incidents, and congenital mypopathies[32]. Some teams use surgical procedures in several operatory stages as described by the Stanford group (uvulopharyngoplasty UPPP or advancement of the genioglossus followed by a second-stage balloon atrial septostomy (BAS) in case of failure.) Pirklbauer, after a study on the surgical indications[46], advises that BAS has to be conducted first. Indeed, according to this meta-analysis, BAS is more effective, stable in time, and with less postoperative pain, but the patient can refuse the treatment if it is proposed after an aggressive first treatment. Moreover, a palatal expansion that is practiced in the second position can be complicated by the existence of postoperative scarring (UPPP). The conclusion of this meta-analysis is that BAS should be conducted first in those patients presenting with a skeletal deficit.

Technical Details of Maxillomandibular advancement surgery in OSA

Preoperative measures

Implementing treatment by PPC in the preoperative stage is standard practice. It limits cardiovascular risk and improves the trophicity of the upper airways. It shows the patient how necessary it is to treat this invisible illness. It is a gauge of the patient's motivation before surgery. For some teams, a favorable response to MAO (50% decrease in AHI) would be a good indication of the surgical success of a bimaxillary osteotomy but this is not unanimously accepted and is yet to be confirmed by broader-spectrum studies.

The surgical technique itself

Although similar to classical osteotomies for dysmorphia, it requires certain precautions. According to our experience, the process often requires bone grafts to decrease the risk of pseudarthrosis or relapse. This occurs in cases of minimal contact between the different bone pillars, or on the horizontal mandibular branch. Similarly, mandibular osteosynthesis needs a certain rigidity (double plate, bicortical screw) given the significance of the changes. This type of protocol is most suited to an older population with the consequence being a more cortical bone and thereby more brittle (the focus of piezoelectric motors). It often presents with other cardiovascular risk factors such as diabetes, tobacco consumption and artheromatous conditions,[7] which can theoretically impede bone joints pseudarthrosis, surgical site infections, and decreased hypoesthetic mandibular recovery (14% persistent hypoesthesias in 1 year)[27]. Patients must be warned.

In cases of conservative bimaxillary advancement, in class-I patients for example, the intermediary splint is not necessarily desirable because it can restrict maxillary advancement. No method has yet been found in the literature that indicates the ideal mandibular advancement for each patient that would facilitate the removal of respiratory obstruction.

A recent alternative to the centimetric BAS, according to Zinser[65] and cited

in several articles, involves conducting a bimaxillary osteotomy with little advancement and anticlockwise maxillary rotation (4-mm anterior impaction in this series). Followed by a concomitant mandibular advancement (approximately 10 mm in this case). Posterior maxillary impaction would allow for the creation of a large mandibular projection with a minor maxillary propulsion without any harmful change to the nasaolabial angle or without damaging one's appearance. Nonetheless, this innovation seems debatable to us: the obliquity of the occlusal plane risks the appearance of an open bite if the result deteriorates, and which implicates a risk of relapse that would be more significant than if it were a classic bimaxillary projection? The temporal stability of this new technique, therefore, remains to be seen during long-term follow-up.

Regarding the perioperative protocol, patients presenting with OSA are at risk of a difficult intubation (estimated at 20%[8]). The required nasotracheal intubation can be conducted under fiberscopic guidance in case where intubation difficulty is predicted[8]. Most authors agree on the need to use as few opioids as possible, for example, respiratory depressors in the postoperative stage.[32] Similarly, they agree on 24-h intensive care monitoring for these patients[7].

Efficiency of orthognathic surgery for OSA

The regular criteria for success of bimaxillary surgery for OSA are those identified by the Stanford team: AHI <15 and 50% reduction of AHI[4].

– *Functionally*: in the meta-analysis of 12 series involving 298 patients with severe OSA and for whom PPC has failed, Jalbert[32] finds the success rate of maxillary surgical advancement of 65%–100% (with an average of approximately 88.5%). According to the series, an average reduction of AHI of 60/h to 9/h.

Similar results, again according to the Stanford criteria, are noted in Holty's meta-analysis[26] of 627 patients (significant reduction in AHI from 64 to 9.5/h) and in Pirklbauer's analysis (65%–100% success)[46]. This AHI correction reflects a polysomnographic improvement superimposable to that obtained by ventilation PPC (medial reference treatment)[46]. Some additional improvements have been observed, these are related to sleep normalization, improvement in arterial pressure, and the quality of daily life (Epworth scale significantly improved after orthognathic surgery[27,46]).

The degree of mandibular advancement is not necessarily predictive of success in OSA[26]. Using PPC is no longer theoretically necessary from the day after surgery.[65] Nonetheless, standard conventions recommend performing a control polysomnography 3–6 months after the operation for an objective evaluation before stopping all medications. Clinical follow-up at least at 1-year intervals is necessary thereafter[8].

Patients' opinions of secondary facial modifications in advancement surgery for OSA. Nasal expansion, prognathism in patients, preoperative orthofrontal profile, and opening of the nasolabial angle[7] have all been examined by many authors. These studies have found many favorable results, with no functional or

morphological adverse outcomes[8,57]. Blumen, in his series, could only find 5% morphological dissatisfaction after BAS in regards to OSA. This seems to be confirmed by other authors.[26] The majority of patients admit to finding their appearance younger and more seductive. The morphological and skeletal analysis quite evidently shows more favorable esthetic results (Fig. 2-7) in patients with retrognathia[7] but BAS also has

Figure 2
Patient presenting with severe OSA (AHI at 83/h) with significant maxillomandibular retrognathia but in dental class I, with hyperdivergence. A centimetric bimaxillary advancement surgery was performed with concomitant genioplasty. The value at 1-year follow-up is 6/h. Preoperative Profile.

Figure 3
Face preoperative phase.

Figure 4
Preoperative Teleradiography.

Figure 5
Postoperative Profile 1 (1 year).

Figure 6
Postoperative face.

Figure 8
OSA patient with AHI of 27/h presenting with a class I with open bite. After refusing PPC, a centimetric BAS was done despite the ethnic biproalveoli and a multiband treatment permitting the alignment and closure of the open bite. In the postoperative period, we notice that the profile has finally been somewhat modified. AHI has changed to 7/h. Preoperative Profile.

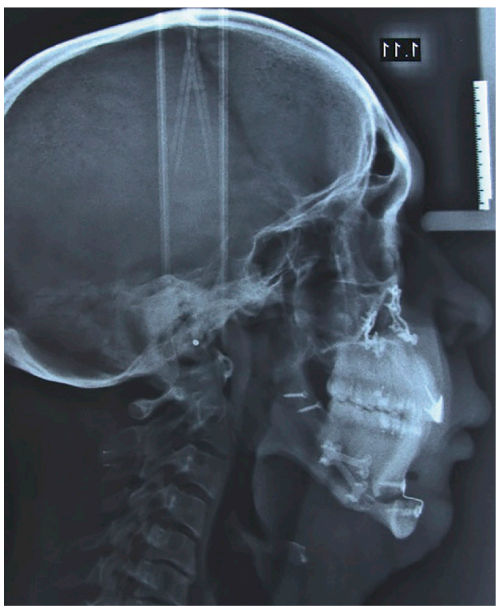


Figure 7
Postoperative teleradiography.

Figure 9
Preoperative Teleradiography.

Figure 10
Postoperative profile.

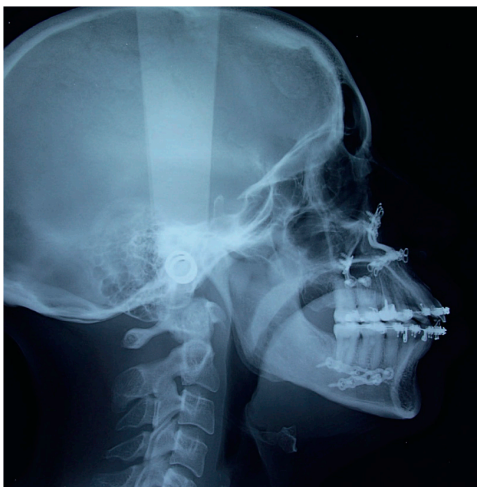


Figure 11
Postoperative Teleradiography.

good results in patients without retrognathia, even in biproalveolar cases (Fig. 8-11).

– *The radiological study of supraglottic airways after BAS shows an increase in their sectional surface and therefore their volume*, (Fig. 4 and 7), but these airways are also shortened because of the ascension and anteriorization of the hyoid bone[65];
– *The temporal stability of results is a question raised in all surgical techniques. In OSA, the literature has found no significant modification of the initial results years later after BAS* (*8 years after the study conducted by Ubaldo*)[57] except in patients having significantly increased their BMI[8,3].

Studies analyzing morbidity and mortality are rare after this type of procedure. Holty's meta-analysis has found no mortality out of 455 cases of severe OSA treated with bimaxillary surgery and a "serious" rate of complications of approximately 1% (acute pulmonary edema, heart attack.) A retrospective review from American Society of Anesthesiologists (ASA) of 3593 patients presenting with OSA and operated on in a surgical procedure under sedation, found a significantly more frequent onset of postoperative events such as hypoxemia, a need for reintubation, the onset of pulmonary edema or heart attack which prolonged the patients' hospital stay[42].

OSA AND ORTHOGNATHIC SURGERY: THE GREAT DEBATE

The esthetic morphological and occlusal improvement of patients is the goal of any orthognathic surgery. However, there can also be functional consequences to consider when making a decision as to osseous base movement. Receding mandibular surgery, used in isolation (SBMO) or in conjunction with a Lefort 1 advancement osteotomy (bimaxillary surgery) for the correction of class-III disorders, are known for restricting the pharyngeal spaces[20]. But is this modification temporary or permanent? And if such is the case, to what extent does it contribute to causing authentic OSA? The response to this double question is controversial because we have found six biases in different studies:

– The rebound is most often weak if it lasts 6 months or 1 year[17]! Now we know that this type of symptomology is multifactorial and develops later;
– Each series relies on different cephalometric planes, which induces a segmentation of the non-superimposable air volumes;
– There is a lack of studies where the methodology applied was rigorous;
– The techniques involved with tomodensitometry are not revealed or the pharyngeal dimensions differed according to the cephalic position during the exam[17];
– Movements of the osseous bases are not superimposable from one series to another;
– Studies do not always differentiate the patients' genders in their analysis whereas there seems to be a difference in the results between men and women, as Mattos underlines in his meta-analysis[40].

Volumetric modifications of the pharynx after receding mandibular surgery

Most teams have measured a significantly decreased pharyngeal space after surgery, others do not find any significant modification in this volume, and some others confirm a difference that diminishes over time[23,33]. Receding mandibles could decrease the volume of the hypopharynx without any linear relation[14].

According to Hasebe[23], immediately after the mandible recedes, the hyoid bone, whose position is an anatomical factor recognized in the onset of OSA, is displaced downward and backward parallel to the tongue. Then its clinical progression differs according to the authors, with some indicating a stable placement, whereas others indicate a return to the initial position[23]. This adaptability is explained, according to Gokce,[20] by a compensation of the craniofacial posture, which requires an anticlockwise rotation of the chin with the head extended.

After an isolated receding mandible, most studies are of course in favor of a decrease in the supraglottic aerial volume of the hypopharynx and oropharynx; however, the nasopharynx

remains stable regardless of the procedure. This pharyngeal volume reduction after mandibular receding seems proportionally more significant in women than in men according to the study conducted by Kim[35]. After bimaxillary surgery, the results are disparate: for some authors, it is diminished[28,29], whereas others believe that it is conserved or even increased[31].

Maxillary advancement is indeed a known cause of nasopharyngeal and velopharyngeal space expansion[20]. On the other hand, there is less pharyngeal space reduction in bimaxillary surgeries than in cases of mandibular rebound isolated by an equivalent overhang[33].

Postural adaptation probably plays a role here because it has been revealed that the retropharyngeal space increases during cephalic extension and decreases during cephalic flexion[33].

Functional Respiratory modifications after mandibular rebound surgery

Just as before, some teams say that the appearance of iatrogenic OSA is illusory or transitory, whereas others describe it as permanent or even likely to worsen with time[18].

There seems to be a correlation between the increase in the number of obstructive events (apneas/hypopneas) and the amount of mandibular rebound, particularly in overweight patients whose adaptation mechanisms are less effective[16]. Therefore, after isolated mandibular rebound, just as after bimaxillary surgery, the literature identifies the immediate degradation of nocturnal arterial saturation and ventilatory parameters; however, the measurements could return to their preoperative level in 6 months[23,34,37].

How do you explain this reversibility? Hasebe[23] shows a progressive adaptation of posture and soft tissue after surgical rebound, but this adaptation can be rendered inadequate by certain exterior factors (obesity, age, and posture). These factors facilitate the continuation of the iatrogenic illness, OSA.

In his meta-analysis of 47 articles of which 14 were selected for their scientific value, Fernandez[17] has not found any significant difference in terms of preoperative and postoperative AHI levels with these two techniques. Uesugi[58] and Hochban[24] seem to confirm this lack of significant difference in their respective analyses. Kitagawara finds no significant postoperative symptoms (snoring, nocturia) following one of these two techniques[36].

Thus, current scientific data finds no incidence that a rebound of orthognathic surgery (isolated mandibular or accompanied maxillary advancement) can result in the onset of permanent OSA.

Nonetheless, all the authors conclude, concerning the correction of class-III disorders, that they prefer to perform a simple bimaxillary surgery rather than an isolated mandibular rebound if it is morphologically and clinically possible[17,41,36]. Bimaxillary surgery gives a better esthetic result, affects the airway volumes less, and allows the practitioner to go beyond the adaptability limits of the cervicofacial tissue according to Jeon[33]. Some studies also hint at an improvement in AHI and rhonchopathy after such a bimaxillary osteotomy[20] but none have determined from which overhang it was better to visualize it.

Volumetric modifications after transverse direction modification

The subject is rarely explored but the tomodensitometric study by Vinha[61] suggests that after a distraction or expansion of the maxilla, the tongue spreads out against the palate, which advances and partly liberates the oropharynx, but once again the rebound is weak and the possibility of the degradation of this result has not yet been excluded.

DETAILS OF ORTHODONTIC PREPARATIONS IN SURGICAL CASES PRESENTING WITH OSA

In OSA surgery, orthodontic preparation is often necessary and always useful, apart from cases of bi-retrognathia, in class-I cases without a transverse or vertical anomaly.

It is not a question of describing the orthodontic preoperative preparation techniques because they are identical to any conventional preparation for orthognathic surgery, which have been written about for a long time[19].

The details regarding OSA surgery can be found elsewhere. We are in effect accustomed to conducting preoperative treatments for esthetic or articular reasons. With OSA, it is about correcting a morphological obstruction of the airways.

It is therefore essential to emphasize the following:

– The information and psychological support given to the patient are important because the surgery will often cause significant morphological modifications that were not part of the initial request;
– Patients needing a mandibular or bimaxillary advancement can profit from preliminary testing of mandibular advancement orthosis;
– We must not to create any esthetic problems and respect the muscular equilibrium of the patient[48].

The major principles of orthodontic preparation remain the same:

– To compensate the versions and dental migrations resulting from basal discrepancies;
– To correct ectopic teeth;
– To make the two arches congruent in relation to one another; coordination phase.

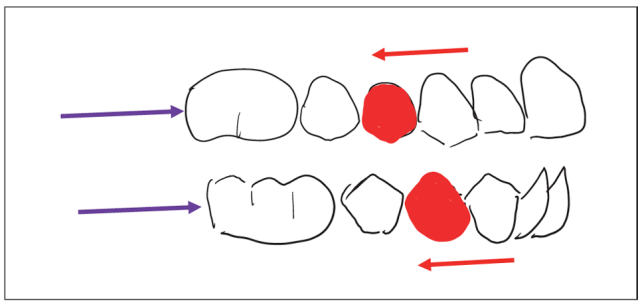
Nonetheless, as defined by ventilatory indication, they sometimes cause conceptual differences in the path and direction of the future displacements. We will try to demonstrate this in the following diagram with an illustration for class-II patients (the most frequent class of apnea sufferers).

Angle Class I with biproalveolar conditions (Fig. 12a)

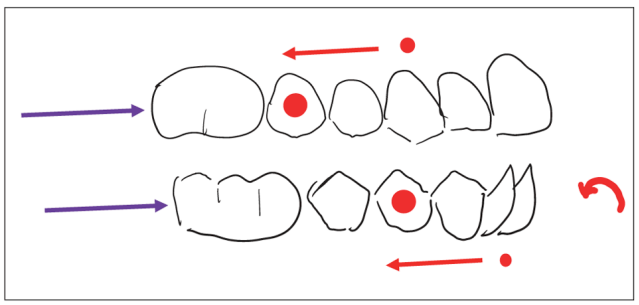
Treatment with four premolars extracted to correct the biproalveoli and/or obstruction before bimaxillary surgery.

Angle Class II by mandibular retrognathia (Fig. 12b)

Decompensation of the mandibular incisal vestibular region if there is no possible posterior diastema. 15/25/34/44.



a)



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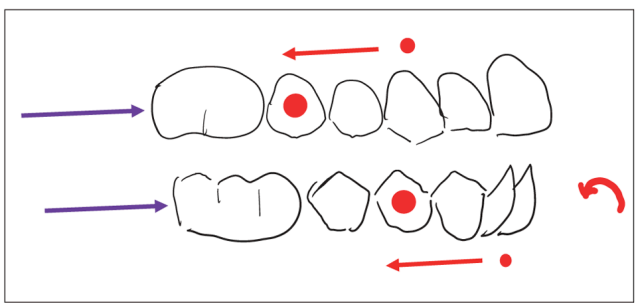

c)

Figure 12
a, b, c) Purple arrow = surgical displacement, red arrow = orthodontic displacement, curved arrow = correction of the versions, red teeth = extracted tooth, red point = nonsystematic extraction.

Angle Class II by maxillary prognathia

– No esthetic problems: correction of the eventual mandibular incisal vestibular region and coordination, having mandibular advancement surgery;
– Esthetic issues linked to maxillary prominence (Fig. 12c): treatment with extractions 14/24/34/44 or 14/24/35/45 to create conditions of a maxillary surgical advancement and improve the overhang to increase mandibular advancement.

In class III, it will, of course, be the inverse but making sure to adapt the conditions with the greatest possible advancement surgery, within the authorized limits with respect to the esthetic equilibrium.

Class III by maxillary retroagnathia

Extractions only in the case of dentomaxillary disharmony. Correction of the maxillary incisal vestibular region and coordination before maxillary advancement surgery.

Class III by mandibular prognathia

– No esthetic issues: correction of the mandibular incisal lingual regions and coordination before maxillary advancement surgery;
– Esthetic problems linked to mandibular prominence: treatment with extractions 14/24/34/44 or 15/25/34/44 to rebound the mandibular incisivocanine block while correcting the maxillary incisal vestibular regions to create conditions for maxillary surgical advancement;

Maxillary Endognathia

They must be corrected by previous surgical disjunction after the orthodontist implants an intermaxillary disjunctor. This correction must happen before commencing the orthodontic preparation for decompensation of sagittal and vertical directions and therefore allow the return of normal nasal respiration[61].

Some supplementary precise actions are important:

– Depending on the buccodental history of the patient, it is not always possible to complete the extractions that would be needed. It may therefore be necessary to resort to miniscrew anchorages to manage the tractions capable of creating the required discrepancies.
– As well as the sagittal corrections, as with any preoperative preparation, the decompensation movements before corrective osteotomies for vertical and transverse anomalies, must be taken into account[9,38,49].

ASSOCIATED SURGICAL TECHNIQUES

Other surgical protocols

In conjunction with the osteotomies, other surgical "curative" protocols have been proposed: uvulopalatopharyngioplasty (UPPP) hyopexia, genioplasties, glossectomies, etc. Their common denominator is their lack of objective evaluation, especially in the long term (degradation of early results), making their indication subjective, or even according to some authors contraindicated[4,65]. Their aim is to raise an obstacle to a precise level in the subglottic airways but the obstruction rarely sits in a single level of the pharynx[3].

Lingual volume reduction by surgery

It has been a possibility in many surgical options which include: central partial glossectomy, linguoplasty, minimally invasive surgery, and submucous resection. It would appear that there is a benefit to AHI but the protocols are too disparate to provide any proof of the medium to long-term efficiency in OSA cases[43,56]. Lingual surgery could eventually be recommended for light to moderate OSAHS with a purely lingual obstacle without any skeletal anomaly[8].

Hyoid bone suspension

The hyoid bone suspension has not shown any significant efficacy in UPPP (approximately 30%)[22].

UPPP

UPPP used to be a common practice and it consists of creating a reduction in the pharyngeal velum and amygdalan pillars. It is no longer recommended in severe cases of OSA because the success rate is inconsistent at 50%[53].

Genioglossus advancement surgery

Quadrangular osteotomy within the symphseal region permitting cortical lingual advancement and genioglossus muscles inserted on the posterior surface[2]. Stability of the ventilatory osteotomy results have not been demonstrated.

Simpler surgical gestures

Simpler surgical gestures have proven their efficiency in OSA symptomatology or in reinforcing medical treatments: they are more facilitative than curative.

Nasal surgery

Nasal surgery (septoturbinoplasty) improve the Epworth scale values, improve nasal respiration, and increase nasal mask tolerance but not improve AHI[30]. Septoplasty, preferably endoscopic, is recommended to improve chronic nasal obstruction with very severe septal deviation and turbinoplasty for nasal obstructions of the decubitus ulcer. All the apneic patients must have an ENT exam with nasal endoscopy to look for any respiratory chain anomalies. Medical treatment is recommended for all OSA patients who have rhinitis or chronic inflammatory rhinosinusitis[8].

Amygdalectomy

Amygdalectomy is the only surgical treatment that has proven to be effective in children. It is associated with adenoidectomy and normalizes or significantly diminishes AHI in young patients who have amygdala hypertrophy stage III or IV and an AHI of < 30[52]. In children, it is argued, with increasing popularity, that only one intracapsular amygdalectomy should be performed because the curative effect on OSA is comparable and the postoperative effects are significantly better[60].

Advancement genioplasty and impaction

Traction on the genioglossus muscles sometimes improves OSA but it is rarely a long-term solution. On the other hand, it allows patients presenting with buccal respiration and results in a slight relaxation of the bottom lip, which is essential for labial occlusion and nasal respiration.

PARAMEDICAL CARE IN SLEEP APNEA PATIENTS UNDERGOING SURGERY

OSA and orthognathic surgery have a common multidisciplinary need, particularly when it comes to the joint paramedical care that we are going to summarize.

Specialized Kinesiology

Specialized kinesiology is an essential element for such patients. If we had to select any specific details these would include:

Obtaining permanent nasal ventilation

Buccal respiration modifies the position of the tongue at rest, causing an atony of the anterior and posterior muscles and a lack of rigidity of the pharyngolingual membranes[62]. This positional anomaly moves the base of the tongue to posterosuperior position, thereby shrinking the oropharynx. Effective nasal ventilation is achieved through medical or surgical

correction of the obstruction. Nasal and oropharyngeal hygiene maintenance is crucial and includes washing (in stages) and gargling. Patients must also do specific exercises:
– They must automatically assume the correct lingual position at rest and decrease glossoptosis;
– Rebalance the oropharyngeal muscular chains;
– Rehabilitate deglutition and phonation disorders associated with lingual dysfunctions;
– In the postoperative period of a maxillomandibular osteotomy, decrease the postoperative edema and make sure the mouth is as wide as before and achieve pain control[13].

Holistic rehabilitation of the patient's posture

The tongue cannot be rehabilitated in an isolated way because it is integrated into the physiological system, described among others by Léopold Busquet[10]. Postural studies[44] provide evidence of high cervical hyperextension in apnea patients which clears the airways. The airways experience loss of cervical lordosis and compensatory thoracic kyphosis, therefore, causing abdominal muscular tension. It is necessary to decrease this tension and then attach a reprogramming motor[11], particularly at the level of the deep postural muscles in the cervical region.

Respecting certain hygiene and dietary rules[59]

It is essential to improve symptomatology in AHI patients:
– Holistic nutritional care to achieve weight reduction;
– Avoid taking benzodiazepines, opioids, and alcohol in the evening;
– Positional treatment: avoid the prone position during sleep;
– Avoid copious evening meals;
– Try to avoid sleep deprivation.

Psychological factors

Lastly, it is also beneficial to take charge of psychological factors such as stress management and anxiety in certain patients. That can be an ideal time to introduce sophrological care to optimize sleep quality.

CONCLUSION

The specialists: the orthodontists and the maxillofacial surgeon, must in 2015 bear in mind certain principles concerning OSA. This pathology adds a third challenge to the occlusal and morphological objectives, that is, to improve nocturnal respiration or at least not let it deteriorate. This sometimes forces us to think differently in the long-term. Taking this pathology into account requires, first of all, the awareness of how to detect it, in adults as well as children and how to conduct a" basic" polysomnography, particularly for patients presenting with dysmorphia so as not to miss it. If some points are still being debated or in the process of being validated, the major principles are

unanimously accepted. We also need to consider that the need for interceptive orthodontics in children runs a relative risk of surgically-induced OSA. Also important is the effective continuation of orthognathic surgery, indicated in different types of patients and not exclusively reserved for failures in medical treatments. Indeed, in many cases where the syndrome is detected and patients present a proven risk for dysmorphia, they should be able to benefit from orthodontic/maxillofacial advice but that implies establishing solid multidisciplinary networks.

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