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# DISTRACTION OSTEOGENESIS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA: A NARRATIVE REVIEW

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## ABSTRACT

Obstructive sleep apnea (OSA) presents significant challenges in management, often necessitating innovative treatment approaches. Distraction osteogenesis (DO) has emerged as a promising technique in the correction of craniofacial abnormalities associated with OSA. This narrative review explores the current literature on the application of DO in patients with OSA, focusing on its effectiveness, safety profile, and long-term outcomes. The review examines key studies, including clinical trials and case reports, evaluating the use of DO in various OSA phenotypes and severity levels. Additionally, considerations regarding patient selection, surgical techniques, complications, and adjunctive therapies are discussed. The review underscores the potential of DO as a valuable tool in the multidisciplinary management of OSA, highlighting its ability to address anatomical deficiencies and improve airway patency. However, further research is warranted to elucidate optimal patient selection criteria, refine surgical protocols, and ascertain the comparative effectiveness of DO relative to traditional treatments for OSA.

## KEYWORDS

Obstructive Sleep Apnea, Distraction Osteogenesis, Craniofacial Abnormalities, Maxillomandibular Advancement

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# INTRODUCTION

The term "obstructive sleep apnea syndrome" (OSA) was originally used in 1965 and is credited to Christian Guilleminault. Guilleminault's research on sleep apnea focused mostly on the physiological and endocrinological changes that occur during sleep, as well as the collapse of the upper airway during periods of sleep that lower blood oxygen levels and interfere with sleep. The apnea-hypopnea index was created by Guilleminault and Dement and is used to identify the condition and assign a severity rating.[1] Research from India has revealed that 3.7% to 21% of adults in the general population had OSA.[2]

The two primary types of treatments for obstructive sleep apnea (OSA) are surgical and medication. For a significant number of individuals with OSAS, continuous positive airway pressure (CPAP) remains the go-to medical intervention and the gold standard of care. Adherence and accessibility are two CPAP therapy drawbacks. Crucially, not every OSA patient can accept or tolerate CPAP. Only 46–83% of patients with moderate-to-severe OSA adhere to their prescribed therapy, which is defined as using it for more than four hours on average each night.[3] The worldwide CPAP scarcity in 2021 brought attention to the necessity of customising patient care beyond CPAP. Mandibular advancement devices, upper airway surgery, and positional therapy are common alternative methods to CPAP therapy.

One kind of care for OSAS is surgery, which offers the chance of a long-term recovery. Both soft and hard tissue surgeries have been carried out to expand the area between the posterior airways (PAS). For soft tissue OSAS, uvulopalatopharyngoplasty and tongue base reduction are the most often done procedures.[4] But clinical researches have revealed that rather than being restricted to a particular area along the upper airway, OSAS airway obstruction typically occurred at many levels and, multilayer surgical intervention should be the true focus of efficacy research.[5] A comprehensive analysis conducted recently demonstrated that maxillomandibular advancement surgery (MMA) was a safe and highly effective treatment for individuals with OSAS, with encouraging outcomes in terms of a reduction in the apnea-hypopnea index (AHI). It was determined that by enlarging the entire skeletal framework, MMA might increase the airways in three dimensions. The tongue and soft tissues of the pharynx would therefore be less likely to collapse during inspiration. Additionally, MMA may preserve or even enhance occlusion, which in turn may enhance masticatory function. (6,7)

It is acknowledged that MMA performed by traditional orthognathic surgery has inherent disadvantages. Neurosensory impairments would be permanent if the IAN was seriously injured post mandibular advancement. Additionally, large advancements have a narrower bone contact at the osteotomy site in addition to stretching the surrounding soft tissues more. As a result, they might be more prone to relapse. (8,9)

McCarthy et al. 10 used distraction osteogeneses for the first time on facial bone in 1992 to create new bone after osteotomized bony segments underwent controlled separation using a mechanical apparatus in increments. Distraction Osteogenesis permits the reparative callus to gradually traction, which starts a series of adaptive modifications in the soft tissue. Thus, the possibility that distraction osteogenesis could promote greater skeletal mobility while lowering the risk of skeletal relapse and neurosensory impairment was proposed. Beyond the capabilities of standard orthognathic surgery, the method has been demonstrated to successfully lengthen severely retrognathic mandibles. (11,12) The possible advantages of mandibular distraction osteogenesis (MDO) in patients of OSAS include opening up the upper airway to increase oxygen index of respiratory disruption and saturation.

## CLASSIFICATION OF DISTRACTORS

| | | |
|---|---|---|
| RELATION TO THE SKIN SURFACE | EXTERNAL | INTERNAL |
| DIRECTION | UNIVECTOR<br>BIVECTOR<br>MUTIVECTOR | |
| ATTACHMENT MODE | BONE-BORNE | TOOTH-BORNE<br>BONE-BORNE<br>HYBRID TYPE |
| METHOD OF PLACEMENT | SUBCUTANEOUS | SUBCUTANEOUS<br>INTRA-ORAL: SUBMUCOSAL OR EXTRAMUCOSAL |

## STAGES OF DISTRACTION OSTEOGENESIS:

## PLANNING

The first phase of DO is all about getting ready and organising. Successful care requires determining which structure is aberrant and its most likely aetiology. By compensating for the overdevelopment of contralateral structures, DO is utilised to address the underdevelopment linked to hypoplastic or missing structures. The process of determining which structures need to be addressed is essential to organising the kind, course, and intensity of distraction. For diagnostic and treatment planning, a combination of pictures, traditional radiographs (such lateral cephalograms and orthopantomographs), and 3D images is utilised. Stereolithographic models are useful for patient counselling and diagnosis visualisation. To create a surgical stent that correctly transmits the surgical planning to the patient, comprehensive surgical planning and mock-distractor insertion can be carried out on models. Also, the mock-up can direct the distractions during preparation, cutting down on surgery time.[13]

## ORTHODONTICS

Pre-surgical orthodontics seeks to create a stabilized occlusion and aid in guiding skeletal distraction. In order to place the teeth in the best possible position within the basal bone, orthodontic tooth movement preparation may involve decompensation, coordination, levelling, and alignment of the arches. This is similar to the preparation for traditional orthognathic surgery.

It may not be required to start orthodontic treatment right away in younger patients with craniofacial abnormalities who are receiving DO as an interceptive intervention to try to normalise growth and development. Although there is frequently a substantial malocclusion in these patients, the challenges of planning orthodontic treatment and placing a fixed device in the primary and mixed dentitions preclude orthodontic treatment. In order to optimise the skeletal benefit, DO is scheduled for each of these patients, and occlusal discrepancy repair is put off until the permanent dentition is established.

## PRE-DISTRACTION SURGERY

The initial surgical technique serves the dual aims of distractor placement and bone sectioning. The bone is cut in the best possible way to allow the fragments to separate in the intended direction. Whenever feasible, intraoral surgical access is the preferable method for minimising scarring during maxillary and mandibular procedures. But this might severely restrict access; as a result, an extra-oral technique is frequently more suitable. The distractor's placement is crucial since it dictates the direction of expansion. Optimal alignment is ensured during surgery by situating and fastening the distractor prior to the final surgical cut and osteotomy.

## PHASES OF DISTRACTION

### LATENCY PHASE

The time interval that permits the development of a main bone callus between bone division and device activation is known as latency. Distraction protocol differs within a narrow range throughout research. The latency period was between one and seven days. Adult patients were typically permitted to experience a 5-7 day latency period, whereas children or newborns were typically allowed to experience a shorter one.[14] The ideal latency period is one that is neither too short to prevent the formation of a primary osseous callus nor too long to allow calcification.[15]

### DISTRACTION PHASE

The distraction phase lasts from the moment the distractor device makes its initial spin until the desired increase in bone length is attained. Bone development is started by gradually and carefully extending the callus by regularly activating the distractor. The rate and rhythm of distraction are crucial because calcification of the callus starts as soon as the distraction stops. Excessive activation of the distractor can lead to poor healing, elongating and thinning the callus, whereas delaying activation increases the risk of premature calcification and restricted further movement. Better outcomes, according to Ilizarov[16], can be obtained by increasing the distraction rate by 1 mm per day in 4 increments of 0.25 mm each. Most authors concur that distraction rates should not exceed 1 mm per day [18, 19, 20]. In terms of activation frequency, two daily increments of 0.5 mm each appear to be the most recommended. [15-20]

### CONSOLIDATION PHASE

The time following the conclusion of the distraction during which the fragments stabilise at a perfect location is known as consolidation. The distractor is employed as a stiff fixation device after being inactivated with acrylic resin or composites in order for that to occur. While the consolidation stage might last anywhere from four to twelve weeks, eight weeks appears to be enough for bone formation. [22-24]

## CRITERIA OF SUCCESS AND CURE

The American Academy of Sleep Medicine (AASM) guideline clearly established the requirements for surgical success and cure for adult patients, and these criteria were well characterised in the literature.[25] As in previous reviews of OSA surgery, a successful outcome was defined as an AHI (or RDI) <20/h and a ≥50% postsurgical AHI (or RDI). AHI (or RDI) <5/h was established as the cure threshold.[26]

For the patient group of children and infants, there were, however, no established standards for success or cure recorded thus far. The literature most frequently utilised the following criteria for this patient group: the patients' capacity to achieve decannulation after surgery, prevent tracheostomy, or remission of OSA symptoms. However, several studies also employed the same criteria as for the adult group.

## RESPIRATORY OUTCOMES

Researches have shown that in both adult and children, the AHI/RDI shows a significant improvement. In the adult group, the lowest oxygen saturation (SpO2) improved from the preoperative range of 67% to 77% to the postoperative range of 90.3% to 98.2%. 27-29. Authors like, Li et al, Rachmiel et al and Wang et al reported a found a substantial rise in the PAS dimension in both the adult and paediatric groups based on cephalometric measures. [27, 28, 30]

## COMPLICATIONS

In the adult and paediatric populations, the literature reported complication rates ranging from 0% to 25% and 0% to 20%, respectively. The frequently mentioned issues in both adult and paediatric populations comprise localised infections of the wounds surrounding the distractors' exits, temporary facial nerve palsy, numbness in the chin and lower lip, anterior open bite following distraction, and distractors' mechanical failure. There have also been reports of other difficulties, such as a kid dying from various medical issues or needing a postoperative tracheostomy because of concurrent medical illnesses.

## DISCUSSION

Millions of individuals worldwide suffer from the potentially dangerous condition known as obstructive sleep apnea (OSA) syndrome. While many of these people go undiagnosed, those that are frequently show poor adherence to the nocturnal application of continuous positive airway pressure (CPAP), a very successful nonsurgical treatment. Several surgical techniques have been suggested to control and, in certain situations, cure OSA.

Creating a comprehensive database and identifying the various degrees of obstruction—which might be nasal, nasopharyngeal, oropharyngeal, hypopharyngeal/retro lingual, or a mix of these sites—are essential to the effective surgical management of OSA. Nasal reconstruction, uvulopalatopharyngoplasty (UPPP), advancement genioplasty, mandibular osteotomy with genioglossus advancement, and hyoid myotomy and suspension are among the most often done surgeries. Advancement genioplasty combined with maxillomandibular advancement (MMA) may be necessary in more severe situations.

It has been demonstrated that MMA is a very successful treatment option for OSAS patients. Le-Fort I (LF-I) osteotomies are typically used to advance the maxilla, while distraction osteogenesis or a classic sagittal split osteotomy may be used to advance the mandible. The efficacy of MMA using conventional methods has been thoroughly examined and validated, nevertheless, the available information regarding MDO is very scant.

The majority of research on OSAS patients treated with MDO in the literature was done on paediatric patients, and many of these individuals had craniofacial abnormalities or deformities. There are multiple explanations for this circumstance. Due to the presence of developing tooth germs or the ongoing growth of the facial skeletons, traditional orthognathic surgery was rarely undertaken on paediatric patients. As a result, MMA through orthognathic

surgery was not typically performed on this patient population. For these patients, MDO would be the only technique to extend the jaw and clear the airway. Additionally, children with significant respiratory distress and potential tracheostomy due to severe airway obstruction are among the paediatric patients requiring surgical intervention for OSAS. Usually, a significant amount of mandibular advancement is required, and only MDO can accomplish this significant advancement beyond what is possible with traditional orthognathic surgical techniques. According to studies, significant progress with MDO has improved oxygen saturation and AHI, allowing for the decannulation of children who were dependent on tracheostomies. This has decreased the likelihood of developing tracheostomy-related morbidities such as laryngomalacia, laryngeal stenosis, and chronic bronchitis.30

Despite its potential, distraction osteogenesis for OSAS remains a relatively novel and specialized intervention. Challenges associated with this approach include the need for careful patient selection, comprehensive preoperative evaluation, and meticulous surgical technique. Additionally, the duration of treatment and postoperative rehabilitation process can be lengthy, requiring close monitoring and management by a multidisciplinary team.

Furthermore, while distraction osteogenesis may offer significant benefits for certain patients with anatomical predispositions to OSAS, it is not a one-size-fits-all solution. Individual variations in anatomy, severity of sleep apnea, and underlying comorbidities must be carefully considered when determining the appropriateness of DO as a treatment option. In conclusion, distraction osteogenesis represents a promising adjunctive therapy for select patients with obstructive sleep apnea syndrome. Continued research and clinical experience will be crucial in further elucidating its role, optimizing patient outcomes, and expanding access to this innovative treatment modality.

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