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Surgery-First Maxillomandibular Advancement for Obstructive Sleep Apnea with Post-Operative Sequential Clear Aligner Orthodontic Treatment

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Abstract

Maxillomandibular advancement (MMA) is a surgical intervention that reduces the symptoms of obstructive sleep apnea via anterior repositioning of the upper and lower jaws. Pre-operative orthodontic alignment is often a critical component in aiding MMA. Orthodontia are important in intraoperative anchorage for intermaxillary fixation, healthy post-operative occlusion, and post-operative skeletal stability. Sequential clear aligners (SCA) refer to removable orthodontic appliances that are replaced at regular intervals to stimulate dental migration without the use of bonded hardware. These aligners have demonstrated efficacy in aiding orthognathic surgery for dentofacial deformities, which share some technical similarities with MMA for OSA. Here, we explore the treatment protocol for MMA followed by post-operative SCA treatment. Our experiences show that post-operative orthodontic treatment with SCAs results in similarly successful post-operative surgical outcomes given that the patient's pre-operative occlusion is stable.

Keywords: Clear Aligners, Maxillomandibular advancement, sleep apnea, intermaxillary advancement, sleep surgery, sleep medicine

Introduction

Obstructive sleep apnea (OSA) is a common disease of the upper respiratory tract with severe systemic ramifications. It is typically defined by an average apnea-hypopnea index (AHI) of greater than 5 events per hour. OSA affects approximately 10% or more of the population with males at increasingly greater risk than females.[1] It contributes to chronic conditions such as obesity, diabetes, myocardial infarction, and daytime drowsiness that leads to frequent motor vehicle accidents.[1] Many surgical and non-surgical treatment modalities exist, including continuous positive air pressure (CPAP) devices that keep the patency of the airway via exerting artificial inspiratory pressure. Patients may require surgery to permanently increase their airway volume when patients are unable or unwilling to tolerate the non-invasive but bulky fixtures.[2]

Maxillomandibular advancement is a surgical intervention that reduces the apneic and hypopnic episodes via anterior repositioning of the upper and lower jaws, thereby increasing the soft tissue diameters of the naso- and oropharynx.[3] A 2011 review of 39 studies found MMA with or without genioplasty to be predominantly successful, though the success criteria differed slightly from study to study.[2] Interestingly, pre-operative orthodontic alignment is often a critical component in aiding MMA. The orthodontia are important in intraoperative anchorage for intermaxillary fixation, healthy post-operative occlusion, and post-operative skeletal stability.[3]

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Sequential clear aligners (SCA) refer to removable orthodontic appliances that are replaced at regular intervals to stimulate dental migration without the use of bonded hardware. They have become popular alternatives to traditional orthodontics for their comfort, esthetics, and removability which contributes significantly to oral hygiene.[4] In fact, these aligners have demonstrated efficacy in aiding orthognathic surgery for dentofacial deformities, which share some technical similarities with MMA for OSA.[5] The average MMA and orthognathic patient cohorts nonetheless differ in key areas such as age, medical comorbidities, average BMI, and the degree of surgical repositioning.

Here, we explore the treatment protocol for MMA followed by post-operative SCA treatment. A MEDLINE search in July 2020 for keywords “clear aligner” or “Invisalign” with “maxillomandibular advancement” or “bimaxillary advancement” of the English language literature did not yield any relevant results. Our experiences show that post-operative orthodontic treatment with SCAs results in similarly successful post-operative surgical outcomes given that the patient’s pre-operative occlusion is stable.

Case Report

A 39-year-old-male with a two-year history of severe OSA (AHI 114.6 events per hour) with occasional in-sleep premature ventricular complexes (PVCs) presented for surgical management of his nighttime respiratory disturbance. He had previously undergone treatment using CPAP, whose discomfort had led to poor sleep quality. A pre-surgical evaluation demonstrated a fully dentate patient with an Angle’s Class II, retrognathic occlusion that was otherwise stable and reproducible with even bilateral premolar/molar contacts. Virtual Surgical Planning (3D Systems, Rock Hill, SC) was conducted to produce intermediate and final occlusal splints to aid in the surgical advancements of the mandible and the maxilla, respectively.

Intraoperatively, the patient was placed in maxillary and mandibular Erich arch bars. A mucosal incision was made along the bilateral external oblique ridges of the mandible from the first molar to the anterior ramus at the occlusal level of the lower dentition. A sagittal split osteotomy - extending from just superior to the lingula to the cortical bone lateral to the first molar - was initiated on each side with a reciprocating saw then completed using an osteotome. The patient was then placed into the premade intermediate occlusal splint, which advanced the distal mandibular segment by approximately 14mm. Arch bar maxillomandibular fixation (MMF) was conducted and the proximal and distal mandibular segments were fixated using a horizontal 2mm (Stryker Corporation, Kalamazoo, MI) orthopedic plate across each osteotomy site with the condyles fully seated. The inferior alveolar nerve was visualized intact through each osteotomy.

The MMF was released, the intermediate splint was removed, and the maxilla was exposed via bilateral vestibular incision from the premolars to the midline. The infraorbital nerves were visualized and preserved. The lower third of the nasal mucosa was carefully dissected from its bony attachments. A maxillary osteotomy - from the zygomaticomaxillary suture to the pyriform rim bilaterally - was initiated on each side with a reciprocating saw then completed using an osteotome. The maxillary segment was downfractured with gentle pressure. A midline palatal osteotomy conducted between the two maxillary central incisors using an ultrasonic handpiece to increase the alveolar arch width for improved dental intercuspation and occlusal stability. The maxillary segment was placed into the final splint, which also

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advanced the maxillary segment by approximately 10mm, and arch bar MMF was again conducted. The maxillomandibular complex was rotated upwards and bony interferences were removed along the walls of the nasal cavity and the maxillary sinuses. The two osteotomized maxillary segments were fixated to the midface using two vertical, L-shaped 1.7mm (Stryker Corporation, Kalamazoo, MI) orthopedic plates across each osteotomy site.

The patient was placed on strict sinus precautions and soft diet for 6 weeks post-operatively. Follow-up CT scans demonstrated appropriate hardware placement and condylar rests. MMF was released at 10 days, arch bar removed at 6 weeks, and occlusal splint removed at 8 weeks. He then underwent SCA treatment (Align Technology, San Jose, CA) for a period of approximately 5 months, at which point he demonstrated adequate canine Class I occlusion, maxillary and mandibular dental midlines coincidental with the facial midline, even bilateral molar occlusion, as well as adequate esthetic outcomes. Orthodontic treatment duration was decreased likely because of extensive post-operative osseous remodeling.[6] However, the patient was forced to cease treatment at this time because of unforeseen changes in personal finances.

A post-treatment polysomnography was conducted, which demonstrated a complete resolution of OSA with AHI of 2.9 events per hour. His Epworth score was rated at 9 which was not indicative of excessive daytime sleepiness.[7] In-sleep EKG showed no evidence of PVCs and the patient also endorsed subjective improvements to daily sleep quality.

Discussion

Sleep surgery such as MMA remains a staple for medical sleep intervention. Although conservative modalities like CPAP can be effective, poor tolerance of the airway machines remains a key issue with up to 50% of users refusing to continue treatment.[8]

Traditionally, MMA was accompanied by extensive pre-operative and occasionally post-operative multibracket orthodontic treatment, which may be associated with pain, gingival inflammation, alveolar bone loss, and dental injury.[9–11] Dental literature demonstrates that individuals treated with removable appliances showed decreased inflammatory responses and lower counts of anaerobic bacteria that could be associated with dehiscence and post-operative infection.[10] Furthermore, SCAs may reduce the overall treatment time for cases requiring mild to moderate dental realignment.[4] Because of the discomfort associated with traditional orthodontics, the use of SCAs may also help reduce the perceived barriers to treatment in many individuals at risk of OSA complications.

Despite its advantages, SCAs are less effective in treating large inter- and intra- dental arch discrepancies and require careful patient selection.[4] They also require good patient compliance, as these removable appliances require consistent use for 20 to 22 hours each day.[5]And because SCAs are readily removable, additional intraoperative measures like Erich arch bars are required to facilitate MMF. Arch bars may be similarly unhygienic and likely more uncomfortable when compared to traditional orthodontics, though their use is typically limited to less than 6 weeks of total treatment. Other alternatives such as intermaxillary fixation screws or hybrid MMF systems could help decrease these disadvantages further.

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SCA-assisted MMA offers an esthetic, hygienic, and comfortable alternative to MMA aided by traditional orthodontics. SCAs are generally associated with greater patient satisfaction[11] and with appropriate patient selection, can deliver results on par with the gold standard.

The current report demonstrates a typical protocol for the treatment of patients with 1) OSA not responsive or untreatable with conservative modalities, 2) ability to tolerate significant maxillomandibular advancements, 3) a stable pre-operative occlusion, 4) mild-to-moderate dental arch discrepancies, 5) a surgically-experienced SCA team, and 6) a high health awareness and good treatment compliance. Further studies with larger subsets of patients may be beneficial, though identification of patients meeting all six criteria is not always readily accomplished.

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