



## Case 1

### Maxillomandibular Advancement as Definitive Treatment of Adult Patient with OSA

#### 01. Case summary

A 55-year-old Caucasian male with a chief concern of excessive daytime sleepiness and fatigue. The patient weighed 183lb (83kg) and had a height of 5'9" (1.8m). Current history: Loud snoring during sleep, occasional choking and gasping for air, and inability to fall asleep. Medical history: Gastroesophageal reflux disease (GERD), hypertension, and pollen allergy. Medications: Lisinopril for hypertension, Omeprazole for GERD and Nexium for allergies.

Indicators of sleep apnea: BMI of 25.6 kg/m<sup>2</sup>; Apnea Hypopnea Index (AHI) of 21.2 /hour, moderate severity; Epworth sleepiness scale (ESS) score: 12/24; CBCT measured airway area of 586 mm<sup>2</sup> and airway volume of 19847 mm<sup>3</sup>.

Clinical examination: Concave profile with excessive nasolabial and mentolabial angles, retrusive upper and lower lips position relative to the E-plane; skeletal Class III (maxillary retrognathia), high mandibular angle, chin shifted to the right; Class III molar and canine relationships, retroclined upper and lower incisors, maxillary width deficiency; #17-25 were in posterior crossbite; excessive Curve of Spee; moderate curve of Wilson; both upper and lower midlines were off to the right by 1mm compared to the face; moderate to severe gingival recession; general reduction in alveolar bone height, multiple dental restorations; missing maxillary lateral incisors and mandibular second premolars, maxillary incisors were not restorable and required extraction.

#### 02. Diagnosis & Objectives of Treatment

Patient agreed to have bimaxillary advancement of the upper and lower jaws to improve the concave facial profile; reduce the nasolabial and mentolabial angles, advanced the upper and lower lips forward relative to the E-plane; improve airway area and volume to decrease airway resistance to breathing; centre the chin in alignment with the facial midline, and surgically expand the maxilla to improve width discrepancy.

Eliminate posterior crossbite with maxillary expansion; improve the sagittal position and inclination of the lower incisors; align the dental arch with facial midline; level the Curve of Spee and Curve of Wilson, and prepare space for restoration of the maxillary incisors.

#### 03. Treatment plan

Obtain periodontal clearance prior to comprehensive orthodontic treatment; level the Curve of Spee by relative

intrusion.

MMA Orthognathic surgery comprised of a two-piece LeFort I 9mm advancement of the maxilla and 6mm arch expansion; BSSO with 6mm advancement of the mandible.

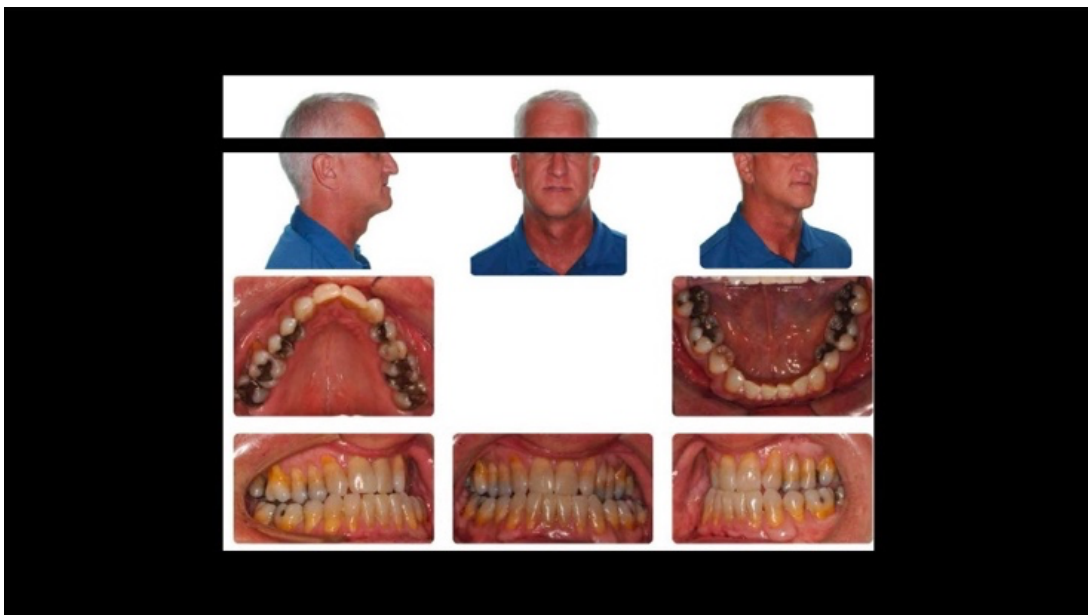
Post-surgical orthodontic treatment to detail occlusion.

Restorative procedure comprised of extraction of the maxillary central incisors and replaced with partial maxillary prosthesis.

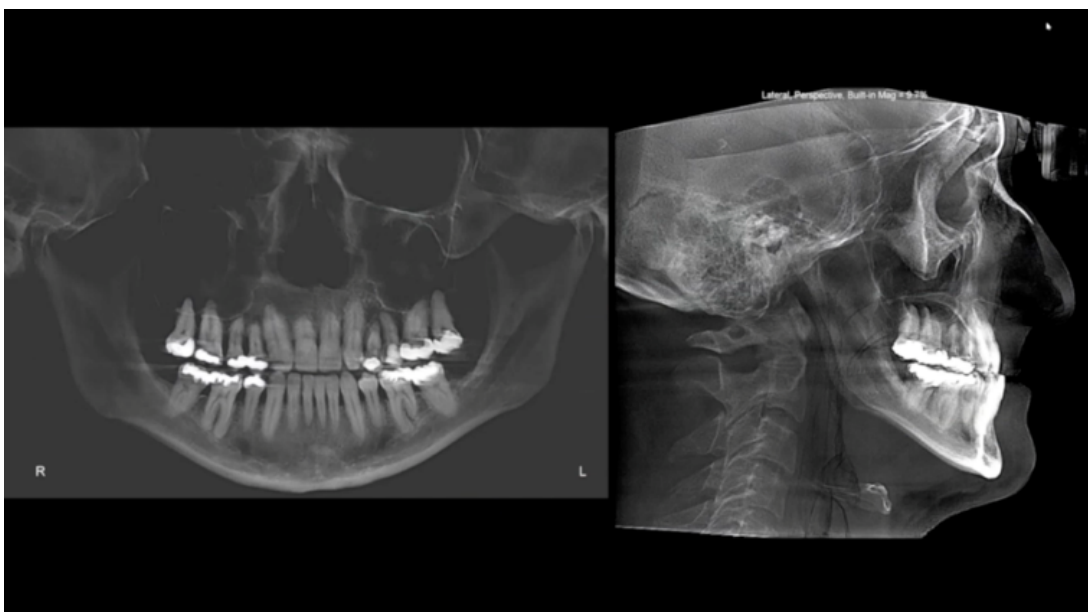
#### 04. Case summary

The overall treatment time for the patients was 24 months. The MMA procedure advance the maxilla and mandible with an increase in SNA angle of 11.4 degrees (from 78.8 to 90.2 degrees), SNB angle of 6.3 degrees (from 80.1 to 86.4 degrees) with a change of ANB angle of 5.2 degrees (1.4 to 3.8 degrees). The vertical height was reduced to normal range, the lower incisors were uprighted, and the upper and lower lip positions were advanced closer to the E-plane. The airway area was increased by 24.6%, airway volume increased by 35.6%, AHI decreased by 96.7%, and the ESS score was decreased from 12/24 to 3/24.

Pre-treatment photos



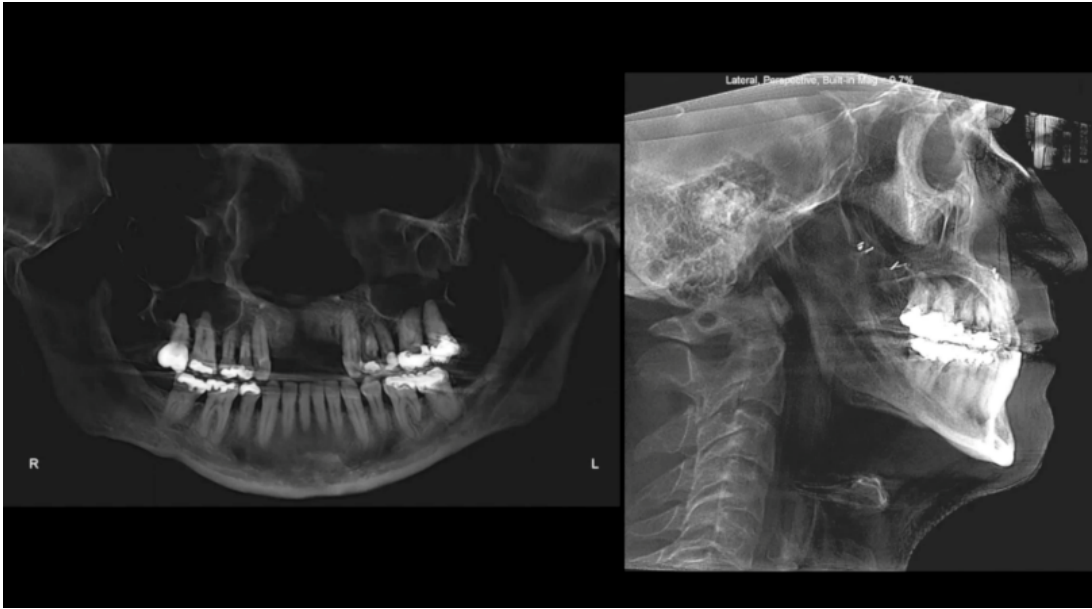
Pre-treatment X-ray



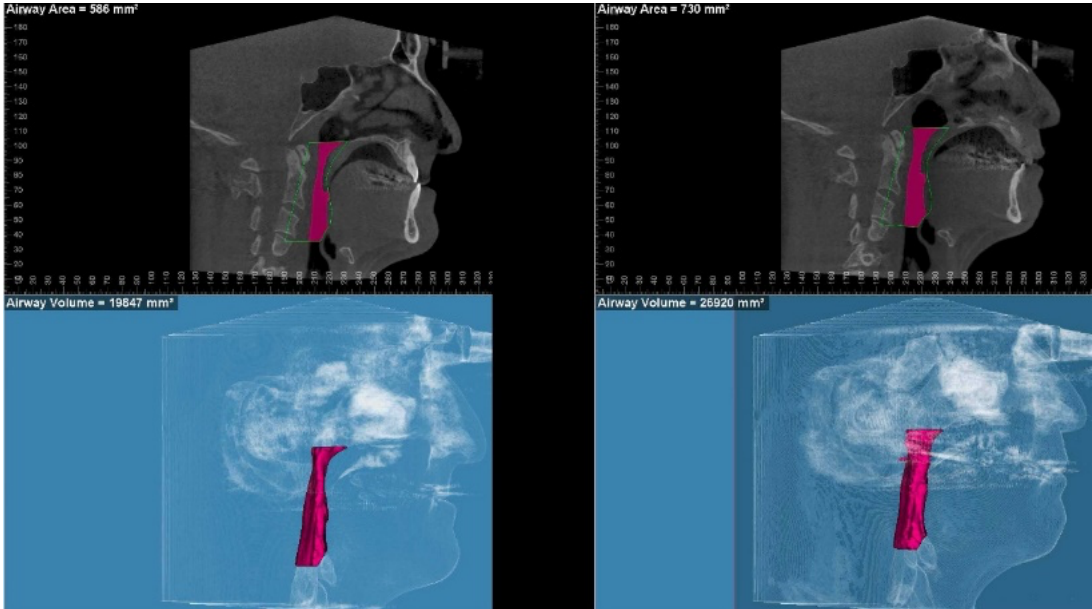
Post-treatment photos



Post-treatment X-ray



Comparison of pre-treatment and post-treatment



## 05. Discussion & Learning

Obstructive Sleep Apnea (OSA) is a condition in which apnea occurs during sleep due to upper airway obstruction, with the loss of oral and nasal airflow, but the central nervous system respiratory drive functions normally and continues to send respiratory motor commands to excite the respiratory muscles, so thoracoabdominal breathing remains, usually accompanied by snoring, sleep structure disorders, daytime sleepiness, and may lead to multi-organ and multi-system damage such as hypertension, coronary artery disease, and Type II diabetes mellitus. Led by Dr. Ngan, Dr. AlSharif and Dr. Clawges provided a lively discussion of the current topical issues in adult OSA, which includes:

[1]. What are the common diagnostic evaluations for adults with OSA?

[2]. What are the common treatment options for adults with OSA?

[3]. What is the long-term stability of OSA treatment in adults?

In recent years, OSA in children and adolescents has also received increasing attention from medical professionals. Finally, Dr. Clawges discussed about the treatment of OSA in children or adolescents.

### 【1】 What are the common diagnostic evaluations for adults with OSA?

#### AHI measurement by PSG is the standard means of diagnosing OSA

In this case report, Dr. AlSharif mentioned that polysomnography (PSG) is the standard tool for diagnosing OSA and that the apnea-hypopnea index (AHI) is a major indicator in determining the severity of OSA. In adults, an AHI between 5 and 20 corresponds to a mild condition, between 20 and 35 corresponds to a moderate condition, and if the AHI is greater than 35, it corresponds to a severe condition. In adults, an AHI of less than 5 corresponds to a normal condition. In this case, the patient's AHI indicator was in a moderate severity range. In addition, Dr. AlSharif introduced the Epworth sleepiness scale (ESS), which is a subjective scale that measures how sleepy a person is during the daytime.

#### CBCT airway reconstruction is a common imaging-aided diagnostic tool

In addition to sleep apnea monitoring and subjective rating scales, imaging measurements such as cephalograms, CT or MRI are also widely used in airway evaluation measurements, as in this case where CBCT reconstructed airway images were used to assess airway area and airway volume. The most common CBCT airway measurement range is up to the palatal plane and down to the level of the most anterior and inferior margin of the C3 cervical vertebrae <sup>[1]</sup>, the same range as applied in this patient. However, previous literature reviews have noted that the use of CBCT measurements to describe airway status is influenced not only by the photographic position, but also by whether the patient is awake or in certain stages of sleep <sup>[1]</sup>. Dr. Ngan also mentions in his discussion that imaging means are not definitive in determining the outcome of OSA treatment and that after a patient undergoes maxillomandibular advancement surgery or wears an intraoral device for treatment, we still need to refer the patient to the sleep specialist for post-treatment sleep apnea monitoring to accurately assess the effect of OSA treatment. Dr. AlSharif cited in the literature that imaging performed immediately after surgery to assess airway status can be distorted, and if there is a time lag between surgery and evaluation, a recurrence may be discovered after surgery. Therefore, when using CBCT to examine post-treatment airway changes, we need to allow sufficient interval for the possible presence of recurrent conditions in the soft tissues to manifest.[2] Similarly, Dr. Clawges mentioned in the discussion session that she would have patients wait at least three months post-operation before returning for a sleep apnea monitoring. And, both Dr. AlSharif and Dr. Clawges reminded everyone that conducting sleep apnea self-monitoring at home tends to underestimate its severity, and if we suspect that OSA is not completely relieved, we would also need patients to come to the lab for on-site monitoring of sleep apnea status post-treatment.

### 【2】 What are the common treatment options for adult OSA patients?

#### CPAP is the first-choice treatment for adult OSA patients, and multidisciplinary modalities need to be considered

As Dr. Heather Clawges pointed out, sleep apnea is a serious long-term issue that increases the risk of hypertension, heart disease or stroke and should be treated seriously. Currently, Continuous Positive Airway Pressure (CPAP) is the first-choice treatment for adult OSA patients. Unfortunately, Dr. Clawges noted that patient tolerance of positive pressure devices is relatively low, with only about 15-17% of patients nationwide able to use them for long periods of time. Therefore, we need to consider multidisciplinary modalities in the treatment of adult OSA patients. During this process, orthodontists and oral

surgeons have provided us with many treatment options. Intraoral appliance is a common treatment option, as is surgery, such as bimaxillary advancement surgery or soft tissue surgery including uvulopalatopharyngoplasty (UPPP). If patient's BMI is too high, then weight loss would also be an effective treatment modality. In addition, there are new treatments, such as the Hypoglossal nerve stimulator or Hyoid advancement, which may be used by ENT specialists. Therefore, when choosing a treatment modality, doctors need to communicate with their patients fully, discussing which treatment modality is most acceptable to them or which one is most effective for them.

### **Bimaxillary advancement surgery can cure adult OSA patients to some extent**

This adult patient underwent Maxillomandibular Advancement (MMA) with orthodontic treatment to improve the symptoms of airway obstruction. Dr. Ngan asked Dr. Alsharif about the success rate of this procedure, and he was interested in whether surgical treatment could cure OSA. Dr. Alsharif believes that MMA is not a definitive cure for OSA and that it will not be able to 100% cure breathing disorders. Tracheotomy is the definitive surgical cure for OSA, which can 100% cure breathing disorders because it totally bypass the blockage area. On the other hand, common soft tissues surgical approaches, including uvulopalatopharyngoplasty (UPPP), or uvulopharyngolift and partial glossectomy, have a success rate of approximately 40-60%. When we evaluate MMA alone, the success rate of the procedure is around 86%, while it has a cure rate of only 43%. The success rate of surgery depends on the degree of reduction of the AHI index. If the AHI is less than 20 after surgery, or there is a difference between the index before and after surgery by more than 50%, it is defined as a surgical success; when the AHI index is less than 5 after the surgery, it is defined as surgical cure. In fact, AHI less than 5 is also a defining criterion for normal values in adults [3]. Review of the case showed that with treatment, the patient's AHI decreased from 21.2 to 0.7 and his ESS decreased from 12/24 to 3/24, which met the criteria for surgical cure. Studies by Holty and Guilleminault have shown that bimaxillary advancement surgery moves the maxillary and mandibular structures forward, thereby expanding the posterior airway space. At the same time, the jaw is the site to which the pharyngeal and lingual tissues are attached, and it reduces the collapse of soft tissues in the pharynx when breathing through negative pressure ventilation. The results of their study showed that all subjects had a statistically significant decrease in Epworth sleepiness scale after MMA [4]. This in fact partly explains the significant improvement in AHI values and ESS after surgery in the case reported by Dr. Alsharif.

### **Abnormal BMI and the presence of central sleep apnea are common contraindications to surgery**

What are the common factors that can lead to a decrease in the success rate of surgical treatment? Or what are the circumstances in which surgery would not be considered as a first-choice treatment? Dr. Clawges pointed out that BMI is the primary consideration, and the higher the BMI, the less likely it is that surgery will be the treatment of choice. For example, in the United States, if a patient wishes to be treated with a Hypoglossal nerve stimulator, his BMI should not exceed 32-35. The second important consideration is central sleep apnea. We need to differentiate between obstructive sleep apnea and central sleep apnea. We know that obstructive sleep apnea can be alleviated by surgery, but central sleep apnea is a completely different situation. It can occur alone or concurrently with obstructive sleep apnea, of which surgery is not a suitable treatment for the latter.

### **【3】 What is the long-term stability of OSA treatment in adults?**

#### **OSA is a lifelong diagnosis that requires long-term follow-up and BMI monitoring**

As a sleep specialist, Dr. Clawges believes that sleep apnea is a lifelong diagnosis accompanied by many long-standing conditions. Dr. Clawges follows up with patients over time, regardless of the type of treatment, and generally at intervals ranging from half a month to a year, depending on their level of cooperation with the treatment. One of the purposes of long-term follow-up is to monitor the patient's compliance with the treatment and the other is to confirm that the patient's BMI is stable. However, if his or her BMI continues to rise, it will affect the efficacy of the current treatment.

#### **In the long-term follow-up after MMA, the likelihood of recurrence of OSA symptoms increases as the patients grow older, but the magnitude of skeletal recurrence in the jaws is very small**

Citing the literature, Dr. Alsharif shared that Camacho et al. performed a long-term postoperative follow-up with OSA patients to assess recurrence 10–30 years after bimaxillary advancement surgery. Results showed that the likelihood of OSA recurrence increased as the patients grew older; even if OSA symptoms were alleviated early on by surgery, recurrence is possible later with weight gain or changes in soft tissues.[5] A study by Alsalty et al. followed up with 25 patients who had undergone MMA

surgery and their skeletal recurrence after ten months post operation was less than 1mm.[6] Similarly, Lee et al. conducted a postoperative follow-up after nine years with 25 patients who had undergone MMA surgery, and they found that the change in SNA and SNB was less than 1 degree over such a long period of time. [7] The magnitude of this change is clinically very small, so even after nine years post operation, skeletal recurrence of MMA surgery is very limited.

#### **【4】 Symptoms and treatment of OSA in children and adolescents**

##### **Most children or adolescents with OSA have enlarged tonsils and adenoids**

Although sleep apnea in adults has received wide attention, it was not until the late 1980s that medical professionals gradually began to understand and learn about the importance of sleep apnea issues in children. Over the past five years, sleep apnea in children has been a growing concern, and Dr. Clawges described the symptoms and treatment of OSA in children or adolescents from her area of expertise. For various reasons, one of the common causes is obstructive sleep apnea. Children can't sleep well, which may cause learning difficulties, difficulty concentrating at school, behaviour problems, increasing symptoms of anxiety, or even issues with bedwetting at night for some children. So, when children have obstructive sleep apnea, they can show many different characteristics than adults, and many specialists are now starting to look at these issues in children. About 80% of such children have enlarged tonsils and adenoids, most of which can be improved simply by appropriate surgical treatment. In fact, in many occasions, dentists are the first specialists to see the children. Dr. Clawges mentioned that when she receives a referral from a dentist, she often finds children with abrasions, crowding, high-arched palate, as well as enlarged tonsils. Usually, in this situation, dentists will refer children to a sleep specialist for further examination and diagnosis.

##### **When using appliances for Skeletal Class II patients to alleviate snoring symptoms, attention to the complications of tooth movement is require**

During the discussion, Dr. Ngan suggests that for adolescent Class II patients, sometimes the appliances used by orthodontists to treat Class II patients are actually similar to the intraoral appliances used to alleviate snoring. In principle, these types of intraoral appliances may be helpful for patients with sleep apnea, but this is short-term, as mentioned above. Dr. Alsharif is more interested in what the long-term effects of these treatments are. For example, when patients uses a Herbst appliance, which moves the lower jaw forward, it exerts force on the teeth at the same time. If this persists in an adult patient's mouth for many years, for example, if the patient wears the appliance for 5-7 years, then it may cause a series of adverse dental side effects, such as anterior openbite or excessive proclination of the lower incisors. If this abnormal tooth movement is not monitored and goes beyond the alveolar bone boundary, it can cause a negative effect on the periodontal tissues, and may cause TMJ disorders over the years. In addition, sometimes the intraoral device may be broken, and if the patient is used to sleeping with such a device, it may be difficult for them to sleep without the device. Although some patients have had relatively good results from this type of treatment, Dr. Alsharif is more interested with the long-term outcome of treatment.

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## Case 2

### Transverse Deficiency in an Adult with Clear Aligners and PAOO procedures

#### 01. Case summary

C.F. is a 72-year-old white male who was unhappy with his smile and has discomfort during chewing and biting. Patient has a habit of smoking. Patient had a hearing problem with strong personality who had been referred to several places for treatment prior to this visit, but had not received a treatment plan that was satisfactory for the patient.

Facial aesthetic and proportional analysis showed an increased width of the buccal corridors not so perfect smile arc. Extraoral examination revealed a straight facial profile with a blunt nasolabial angle and a normal mentolabial angle. The upper and lower lips were in a retracted position relative to the E-plane.

Intraoral examination revealed crowding in both arches; narrow arches (V-Shape); anterior edge-to-edge occlusion; presence of posterior crossbite; thin periodontal phenotype; multiple gingival recessions and root exposures; most notably at the maxillary palatal and mandibular canine labial; multiple crown restorations and residual root at tooth #26.

Other conditions included bruxism, jaw popping and apical shadows at tooth #37.

#### 02. Diagnosis and Treatment Objectives

Narrow upper and lower dental arches require expansion to decrease the width of the buccal corridors and improve facial smiling aesthetics.

Correcting anterior edge-to-edge occlusion and posterior crossbite to improve overjet and overbite.

#### 03. Treatment Options

SARPE procedure after periodontal treatment and restorative work after comprehensive orthodontic treatment with clear aligners.

No treatment due to compromised periodontal condition.

Comprehensive orthodontic treatment with clear aligners only after periodontal PAOO procedure, restorative works, and endodontic works. The patient accepted treatment option [3].

#### 04. Processing and evaluation

##### Post-treatment Evaluation

Treatment was completed in 27-month period, the patient with two sets of clear aligners. The PAOO procedure was carried out first in the mandibular right canine region before initiating the aligner treatment. The patient was asked to suspend wearing the aligner for 1 week after the procedure. The second PAOO procedure was implemented in the mandibular canine to canine region when patient was wearing aligner #17. The patient was instructed to suspend wearing the aligner for 3 days after the second procedure and wear the current aligner for 2 weeks before starting a new one. Measurements of the pre-and post-treatment models showed an increase in mandibular intercuspid width from 24.5 mm to 27.0 mm, and correction of posterior crossbite and anterior edge-to-edge occlusion. The buccal corridor width was decrease in the frontal smile image and an improvement in facial smiling esthetics.

Pre-treatment photos





Pre-treatment X-ray



Post-treatment photos



## 05. Discussion and learning

In 2001, the Wilcko brothers introduced the concept of "Periodontal Assisted Accelerated Osteogenic Orthodontics (PAOO)", which referred to combining selective alveolar corticotomy and bone grafting to accelerate the process of alveolar bone demineralization and remineralization during orthodontic movement.[1] Comparing the pre- and post-treatment results in this case, it can be seen that the assistance of PAOO is indispensable in adults with skeletal width abnormalities that requires arch expansion. The following questions were answered during the Q&A session conducted by Dr. Peter Ngan, Dr. Arif Salman, and Dr. Guan Guoqiang:

- [1] What are the indications of PAOO?
- [2] What is the treatment procedure of PAOO?
- [3] What is the success rate of PAOO?
- [4] How does PAOO work with orthodontic procedure?

**【1】** What are the indications for PAOO?

**PAOO can be used to reduce periodontal risks during orthodontic tooth movement, to expand the envelope of transverse discrepancy and to accelerate the tooth movement.**

Dr. Arif Salman pointed out that during the orthodontic treatment of any patient, if the orthodontist anticipates that the movement of the teeth will go beyond the alveolar bone boundary, or if the target position of the tooth is too close to the labial-buccal bone cortex, it will be beneficial for the patient to accept the PAOO procedure prior to orthodontic tooth movement, otherwise there may be a risk of gingival recession, fenestration or dehiscence after the treatment. The most common form of orthodontic tooth movement in clinical treatment is arch expansion or decompensation of the dental arches due to skeletal malocclusion. It has been shown that the thickness of the alveolar bone on the labial-buccal side of the teeth can be significantly reduced with conventional maxillary expansion or labial movement of the anterior teeth [2]. Therefore, the goal of PAOO is primarily to maintain the health of the periodontal tissues and make them as healthy as possible. We know that the biological characteristics and anatomical morphology of periodontal soft and hard tissues are the main factors limiting the range of orthodontic movement, called the "Envelope of Discrepancy" by Dr. William Proffit.[3] If orthodontic treatment is combined with the PAOO procedure with bone grafting, the range of orthodontic tooth movement can be expanded. On the other hand, PAOO has been shown to be effective in shortening the orthodontic treatment period in various animal experiments and clinical trials. Studies have shown that PAOO can reduce treatment time to 1/3 to 1/2 compared with conventional orthodontic treatment.[4,5]

### **The acting site of PAOO depends on the periodontal phenotype and the direction of orthodontic teeth movement**

Dr. Ngan noted in the superimposition of the pre- and post-treatment models of this case that the maxillary cuspids were also expanded to some extent without the assistance of PAOO when the mandibular cuspids were expanded with PAOO. Could it be that the level of PAOO assistance needed is different for different arch segments during expansion? Dr. Salman personally did not think so. He proposed that the periodontal phenotype can be different from patient to patient or from one area of the mouth to another for the same patient, and we must analyze the individual tooth position of each patient on a case-by-case basis. Periodontal phenotypes are used to classify the condition of periodontal tissue and periodontal diseases based on gingival thickness angle, keratinized gingival width and alveolar bone thickness.[7] For Dr. Salman, if the patient's periodontal phenotype is thin, then he will consider periodontal surgery regardless of whether the area is in the maxillary canine or in the anterior segment of the mandible. Although more patients have thin labial-buccal alveolar bone in the maxillary premolar and mandibular anterior regions, which cannot even be shown in the CBCT sagittal section, only the root surface is covered with a thin layer of bone cortex. In fact, PAOO is possible in any segment of the dental arch, and it can be considered as long as the patient's gingival condition falls into the thin periodontal phenotype, or if, judging from the direction of orthodontic teeth movement, the final position of the teeth will be too close to the lateral or labial bone cortex or move beyond the bone boundary. [8]

### **[2] What is the treatment procedure of PAOO?**

#### **PAOO includes soft tissue flapping, corticotomy and selective bone grafting**

Dr. Salman mentioned in the discussion that PAOO procedure generally consists of three steps, soft tissue flapping, corticotomy and selective bone grafting. The classic Wilko procedure includes a soft tissue flap for both the labial and buccal or lingual-palatal flaps [1], and a modified corticotomy on one side of the dental arch only. In order to reduce unnecessary trauma to the soft and hard tissues, there are currently various types of non-flap corticotomies, mainly piezocision, laser-assisted corticotomy (LAFC) and micro-osteoperforations (MOP).[9-11] In recent years, on top of corticotomy, clinicians have tried to add various bone grafting materials to increase the volume of the alveolar bone in order to avoid the adverse effects on periodontal tissues during orthodontic treatment. Dr. Salman mentioned that if we focus specifically on randomized controlled clinical studies or prospective studies, we will find that there are two types of bone grafting materials used in research, one is deproteinized bovine bone mineral graft (DBBM) and the other is bioactive glass. If we also look at case report studies, we can see that the use of allograft has been reported in these studies as well. Dr. Salman emphasized that all of the bone grafting materials mentioned above have been successfully used in the PAOO procedure. Although the rate of resorption and remodeling varies among different bone grafting materials, there is no evidence suggesting that any one material has a significant advantage over others in terms of clinical outcomes.

### **[3] What is the success rate of PAOO treatment?**

#### **The efficacy of PAOO bone augmentation needs further research**

Dr. Guan, in discussing the efficacy of current bone grafting materials commonly used to assist corticotomy, suggested that in regard to clinical studies related to the efficacy of selective bone grafting, what we are interested in are how much new bone can

be generated after the grafting procedure is performed. Dr. Guan illustrated that if, for example, the bone graft could produce 4 mm gain in bone width, and if the cortical bone on the labial side of the cuspid could produce 4 mm of bone width, then as we can see from the few cases he treated, after healing, the remaining bone volume might only be about 50%. If we consult the literature on the evaluation of the success of bone augmentation procedures in recent years, we can see recent CBCT studies have shown that during retraction of maxillary anterior teeth, the alveolar bone volume in the maxillary anterior segment can be increased immediately after PAOO, but the subsequent augmentation decreases, with the magnitude of decrease varying depending on the root proportion, while no relevant report for the time being in other tooth positions. [12]

### **PAOO has been shown to accelerate tooth movement in some areas of the dental arch**

Unlike the effectiveness of bone augmentation, which remains to be proven, the effectiveness of PAOO in accelerating tooth movement can be confirmed by several studies. The effect of PAOO in accelerating tooth movement is mainly based on the Regional Acceleratory Phenomenon (RAP), a tissue response to nociceptive stimulus, where local fracture trauma can trigger transient bone loss and a significant increase in bone remodeling. Based on this principle, compared with conventional orthodontic means, PAOO can move teeth by 2-3 times the distance in 1/3 to 1/4 of the time. From literature review, we know that PAOO-assisted orthodontic treatment can speed up the alignment and leveling phase by 39%-47% or the maxillary anterior teeth inversion phase by 44%-61%. [12]

### **【4】 How dose PAOO work with orthodontic procedure?**

#### **It is recommended to start orthodontic teeth movement within 1-2 weeks after PAOO surgery**

During the treatment of this case, Dr. Guan used clear aligners with PAOO for the expansion and alignment of the maxillary and mandibular arches. During the discussion, Dr. Ngan was interested in the wearing and replacement of clear aligners in this type of treatment. Dr. Guan pointed out that the key to the operation is to start the tooth movement within two weeks after the operation; sometimes he would shorten it to within a week. So, it is crucial to start the tooth movement within 1-2 weeks after the operation. As mentioned before, the theoretical basis of PAOO is the phenomenon of regional acceleration, which generally peaks 1-2 months after surgery, usually lasts about 4 months and gradually disappears after 6-24 months. [13] In animal experiments, bone volume was significantly reduced within 2 weeks after corticotomy compared with conventional orthodontic treatment, and bone density gradually decreased within 14 days [14], as seen through Micro-CT. In this case, the first PAOO procedure was performed and the patient started wearing aligners after one week, but the second time the patient started wearing the aligners after only 3-4 days, as prescribed. So, Dr. Guan reminded us that the key is to start moving the teeth as early as possible and avoid long waiting times. In addition, if a patient is wearing clear aligners instead of traditional fixed braces, each set of braces should not be worn for less than a week. So, the patient in this case wore each set of braces for at least two weeks as prescribed. In other patients with poor periodontal conditions, Dr. Guan requires his patients to wear each set of braces for at least three weeks, sometimes longer.

#### **PAOO before orthodontic treatment helps to reduce the periodontal risks associated with teeth movement, and PAOO after initial alignment helps to accelerate teeth movement**

Another question of particular clinical interest to our orthodontists was when is the optimal time to refer a patient for periodontal surgery if the patient needs PAOO. Dr. Salman mentioned during the discussion that the best evidence consensus published in 2019 by the American Academy of Periodontology stated no clear evidence that patients get a more favorable treatment outcome when PAOO is performed before as compared to during orthodontic treatment. [15] So, PAOO can be performed before or during orthodontic treatment. If the orthodontist is concerned that the teeth may move beyond the cortical bone boundary during orthodontic treatment, it is better to perform PAOO before treatment, but sometimes if it is a borderline case and he or she needs to wait and see the status of tooth movement and the need for surgery can be performed during treatment. On the other hand, if the orthodontist wants to accelerate teeth movement, then he or she can prescribe the aligner or braces for initial alignment before submitting a referral to the periodontist for surgery. At this stage, the orthodontist can take advantage of the local accelerated restorative phenomenon following the decortication to accelerate the orthodontic teeth movement. So, Dr. Salman believes that a more appropriate arrangement is to first have a periodontal consultation before orthodontic treatment begins to see if PAOO-assisted orthodontic teeth movement is appropriate, and then schedule the procedure to meet specific needs. It should not be overlooked that PAOO has corresponding contraindications in clinical application and should be avoided in patients receiving bisphosphonates long-term, taking corticosteroids or nonsteroidal anti-

inflammatory drugs, patients with advanced periodontitis, hemostatic disorders, at risk of infective endocarditis, immunosuppressed patients and patients with any disorder that prevents bone reconstruction [16].

Finally, Dr. Guan used the case of miniplate-assisted arch expansion on one of his teenage patients as an example to re-emphasize the importance of osteological remodeling during orthodontic tooth movement. He mentioned that more and more doctors and scholars are now advocating for rapid maxillary arch expansion, but in the obsessive pursuit of speed, changes in basic bone biology has been ignored– the teeth move and the bone will remodel with it. Dr. Guan believes that we as orthodontists should slow down. When he performed treatment with clear aligners, he asked patients to wear aligners for 2-3 weeks, and for some patients with compromised periodontal tissues, he even asked them to wear braces for 4 weeks. This long-term maintenance to allow enough time for the bone to remodel, which, in Dr. Guan's opinion, is the key to treatment. He believes that whether we perform RPE or surgically assisted arch expansion, or simply a LeFort I type of osteotomy, the efficacy needs further and in-depth research.

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