Orthodontic malocclusions involving jaw discrepancies and airway problems are best managed with a combination of orthodontic and surgical treatment. The present article describes such a case in which fixed appliances and orthognathic surgery produced a better occlusion, more pleasing soft tissue changes and enhanced airway function.

Diagnosis
A 48-year-old male presented with a Class II, Division I, sub-division malocclusion (Fig. 1).

He was unhappy with his facial aesthetics and noticed that he was getting abnormal tooth wear. His dental occlusion demonstrated moderate attrition and relative small crown size. He showed no tooth structure at rest and his frontal smiling photograph showed very little tooth structure (3mm). The profile photograph shows soft tissue retrusion of both maxillary and mandibular denture bases, an obtuse naso-labial angle and a prominent chin button (macrogenia). A sleep study was not done prior to the patient’s initial examination, however his health history indicated a persistent night-time snoring problem with suspected sleep apnea risk factors.

The National Sleep Foundation has reported that some form of snoring or obstructing sleep apnea (OSA) occurs in 90 million Americans. Approximately 40 percent of patients who are older than 40 years of age snore; half of these people snore every night. An estimated 18 million Americans have OSA and 16 million remain undiagnosed. OSA is associated with higher risk for hypertension, coronary heart disease, stroke, congestive heart failure, atrial fibrillation, mortality as well as behavior and cognitive problems. Both oral appliance therapy and jaw advancement surgery offer significant potential benefits to patients affected by this disorder.

Narrow airways result in an increase in the air velocity and increased negative inspirational pressure. These two factors gradually stretch upper airway soft tissues, primarily the soft palate. This narrowing begins with primary snoring. As the airway narrows, upper airway resistance increases and ends with OSA (http://www.sleepfoundation.org/article/sleep-related-problems/obstructive-sleep-apnea-and-sleep).

The cephalometric evaluations (Fig. 2) show a mesognathic, straight profile with maxillary and mandibular denture base retrusion. The soft tissue profile line shows prominent nose/chin position.
The mandibular plane and occlusal plane are very flat and the vertical dimension is closed. The incisors have normal angular positions but the lower incisor is positionally retruded relative to the AP line.

A pre-treatment cone beam scan was reviewed for diagnostic and treatment planning purposes. Of particular interest were the patient’s history of snoring and the possibility of OSA. The sagittal CBCT view shows the retro-palatal and the retro-glossal airways are narrow and the palate is long (more than 35mm) – all indicating risk factors of airway constriction and sleep apnea issues (Fig. 3, courtesy of Anatomage).14

In reviewing the options for treatment to achieve the patient’s goals, M M A (maxillomandibular advancement) surgery (aka “telegnathic” surgery) was included (Figs. 4a,b**).

This procedure is reported by Prisnell and others to be “highly successful and potentially definitive primary single-staged surgery that may result in significant reduction in OSA-related health risks...”11,12,13

The patient was informed that changing his dental, skeletal and soft tissue issues and OSA risk factors would require orthognathic (telegnathic) surgery, which is a widely accepted approach for the correction of snoring and sleep apnea,8-10 and it would simultaneously improve the result of orthodontic treatment.3,4

The patient was referred to a maxillofacial surgeon for a surgical consultation with a request to consider advancing both the maxilla and mandible and to change his occlusal plane with a vertical down-graft.

Treatment Plan (Orthodontic)
The orthodontic treatment plan involved alignment of both arches and coordination of arch forms using fixed edgewise appliances. Since there was not a severe malocclusion the pre-surgical preparation was not anticipated to require a long time.

Treatment Plan (Surgical)
1. Maxillary three-piece LeFort I osteotomy with advancement and possible down-graft using hydroxyapatite.
2. Bilateral mandibular sagittal split osteotomy with advancement and reduction genioplasty (Arnett Analysis).
Pre-surgical Treatment

Fixed upper and lower edgewise appliances were placed. Since rotational corrections were minimal and only leveling and coordination of arch form was required, the case progressed through NiTi arches and .018SS arches into rectangular TMA arches. The patient requested that we refer him for orthognathic surgery as soon as reasonably possible. When upper 17x25 TMA and lower 16x22 TMA arches were placed with elastic hooks (Fig. 5), the contacts were opened and the upper arch was sectioned between the laterals/cuspids in anticipation of the maxillary surgery. The pre-surgical treatment time was 12 weeks.

Surgical Procedure

The patient underwent the orthognathic surgical procedure with monitored general endo-tracheal anesthesia. The surgery began with the reduction genioplasty as it was intended to have bone available for the eventual LeFort I osteotomy with bone graft. A section of the anterior portion of the chin was removed with a reciprocal saw to reduce the prominence of the chin. The graft was saved for future use.

Next the bilateral sagittal split osteotomies were performed and the mandible advanced forward the planned 7mm. A pre-operative surgical stent made on a SAM II articulator was used to achieve the desired occlusal plane. The surgical models (Figs. 6a,b) show the preparation for the advancement of the mandible and maxilla. An intra-operative splint (not shown) is made from the study models where the mandible is moved to the ideal post-operative position. In this case it was moved forward and downward. When the mandible is perfectly positioned and screws placed, the maxilla is moved forward into the pre-surgery occlusion and fixed to complete the case. The genioplasty was done first to eventually use the bone that is removed as a bone graft in the advanced maxilla.

Rigid fixation was achieved with trans-buccal positional screws. This now produced a temporary Class III occlusion. Then a three-piece LeFort I osteotomy was performed to achieve a stable occlusion. The maxilla was wired intra-operatively to the mandible and then rigidly fixed. A 4mm gap was then evident at the maxillary osteotomy cuts reflecting the inferior movement of the maxilla. This was then grafted with the bone taken from the genioplasty and rigidly fixed as well. The intermaxillary fixation was then released and an excellent occlusion was achieved. Pre-surgical measurement of the distance between nasion and the lower border of the central incisors was 69mm and post-operatively measured 75mm reflecting the 6mm downgraft and repositioning of the maxilla to allow for proper occlusal angle and tooth show at rest and smiling. He left the operating room with four elastic rubber bands allowing for early mandibular movement.

The patient tolerated the procedure well. Operative time was approximately two and a half hours and blood loss was 300cc.
Post-surgery

A cone beam scan was taken post-surgery to evaluate the surgical procedure (Figs. 7a,b,c,d,e) using the Invivo5 software. This shows the placement and type of rigid fixation that was used in the surgery.

Post-surgical Orthodontic Treatment

The patient presented on April 10, 2010, two weeks after surgery, with a typical post-surgical open bite (Fig. 8).

Post-op radiographs show the radiographic results of the surgery (Figs. 9a,b).

A combination of vertical elastics plus Class III (right) and Class II (left) elastics were started to settle the occlusion while the surgical process was healing. Within four weeks post-surgery the occlusion was being guided into place very satisfactorily and the Class III/Class II elastics were adjusting the midline. Finishing arches (17x25 TMA) were used in both arches to do final detail adjustments. The patient was absolutely excellent with the elastics which made a significant contribution to the finishing of the occlusion.
On September 22, 2010, it was determined that the case was ready for appliance removal (Fig 10).

Upper and lower Hawley retainers were placed two days following removal of the appliances. The patient was instructed to wear the retainers full time for three months and then halftime after.

**Treatment Results**

A Class I occlusal result was achieved and the maxillary/mandibular skeletal retrusion was corrected. The post-operative cephalometric tracing shows the new positions of the maxilla and mandible (Fig. 11) and the superimposition tracing vividly demonstrates the AP changes that were accomplished (Fig. 12).

Table 1 shows the significant measurable changes that occurred. The significant changes are noted in red. Each of these changes brings the skeletal and dental structures into very close approximation to the norms for the Down’s analysis. These changes were the projected goals of the treatment to achieve the profile changes that were desired by the patient. The only change that is not vividly demonstrated in the final tracing was the result of the down-graft of the maxilla. This is partly due to the re-contouring of the chin outline with the genioplasty. The surgical discussion stated that the Na-upper incisor measurement increased 6mm. The superimposition tracing and Table 1 shows a final change in the Na-ANS measurement of 3mm. This reflects, to some degree, the results of the surgical treatment in the chin area. However, the smiling photo shows a very satisfactory improvement in tooth display (Fig. 13).

The surgical result remains stable during the post-surgical treatment and after removal of the appliances. The retention photos were taken November 1, 2010, eight months post-surgery.

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<th>Table 1: Cephalometric Data</th>
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<td>Facial Height (UFH:THF)</td>
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The patient experienced complete elimination of snoring and has no symptoms of OSA following the surgery. In addition, an airway comparison from the pre- and post-op CBCT scans shows noticeable improvement in the airway physical structures and change in the linear airway measurements (Figs. 14a,b).

The volumetric changes in the airway are shown in Figs. 15a,b. The color codes range from red to white, with red being very low to white being above 500mm² in volume (courtesy of Anatomage Invivo5).

Additional evaluations were done with the Invivo5 software using the superimposition functions (Figs. 16a,b,c,d).

Discussion
This case demonstrates the level of excellence that orthognathic surgery treatment can produce. There is significant improvement in the balance of the maxillo-mandibular skeletal components and the soft tissue relationships as observed in the frontal and profile photographs. The techniques used in this case are considered "routine" in orthognathic and facial trauma surgery and contributed to the excellent results.5,6 Rigid internal fixation of the skeletal components (maxilla/mandible/chin) has been shown to result in little or no relapse.5,6
The goals in this case were to utilize maxillo-mandibular advancement (MMA) in the treatment of the Class II malocclusion, the lack of tooth display, the skeletal and soft tissue profile imbalance as well as addressing the airway disorder risk factors (OSA) to maximize the airway space and improve the airway resistance problem.9,10 Maxillary advancement advances the palatal soft tissues forward and upward and opens the nasal valve. Mandibular advancement brings the base of the tongue and the palatoglossus muscle forward and improves the position of the hyoid bone.

The patient was highly satisfied with the final functional and aesthetic result and reported absence of snoring and a significant improvement in his quality of sleep. His compliance with all phases of the treatment contributed significantly to the successful outcome (Figs. 17a,b,c,d).

Thanks to Anatomage for supplying the 3D images included in this case report using their Invivo5 software. The use of CBCT scans contributed significantly to the pre-treatment planning and post-treatment evaluation and documentation of the results.

References
12. Li KK; Surgical therapy for adult obstructive sleep apnea. Sleep Med Rev 9:201, 2005

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