Case Report: Surgical-orthodontic management of posttraumatic obstructive sleep apnea syndrome

The correction of obstructive sleep apnea is an additional benefit of two-jaw surgery in the treatment of a severely compromised malocclusion.

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In 1976, Guilleminault et al.[1] first defined obstructive sleep apnea syndrome. The diagnosis of this malfunction could only be confirmed when the patient had presented 30 episodes of apnea, each lasting 10 seconds or more, during a 7-hour sleeping session. Sleep apnea has been associated with various syndromes, including Franceschetti-Treacher-Collins, Apert, Crouzon, and Pierre Robin. Juvenile temporomandibular ankylosis may also generate a retroposition of the mandible and lead to sleep apnea syndrome. More often, however, sleep apnea syndrome could simply be related to insufficient forward growth of the mandible or, as in the case reported here, to traumatic injury during childhood.

In this patient, nasal or buccopharyngeal airflow was obstructed in spite of the efforts of the respiratory muscles. A compensatory diurnal hypersomnia is often a secondary effect leading the patient to seek a cure. In severe cases, hypoventilation may result in anoxic seizure or even sudden death.[2]

Various treatments using removable appliances have been tested to help patients recover normal breathing and sleep.[3] Different types of surgery have also been advocated to achieve permanent remission of the symptoms. Palatopharyngoplasty, genioglossus advancement combined with suspension of the hyoid bone, and more recently, mandibular advancement with or without simultaneous maxillary advancement seem particularly promising techniques.[4] However, each patient's situation is unique and must be analyzed and treated individually.

The following case report is of particular interest, as the treatment plan involved two surgical phases plus orthodontic treatment.

History

This 30-year-old white male was referred for consultation by his wife, who reported that he snored and had numerous episodes of apnea during sleep. He reported that at age 6 he had been injured in a car accident and received a trauma to the face. He probably suffered an open fracture of the symphysis and a condylar fracture on the right side, with associated loss of deciduous dentition and permanent tooth germs. He had been treated with wire osteosynthesis and maxillomandibular fixation. Permanent maxillary canines and first premolars had been extracted later to compensate for the missing teeth.

Figure 1 A-C
Initial facial photograph. Note severe asymmetry and hypoplasia of the middle and lower thirds of the face.

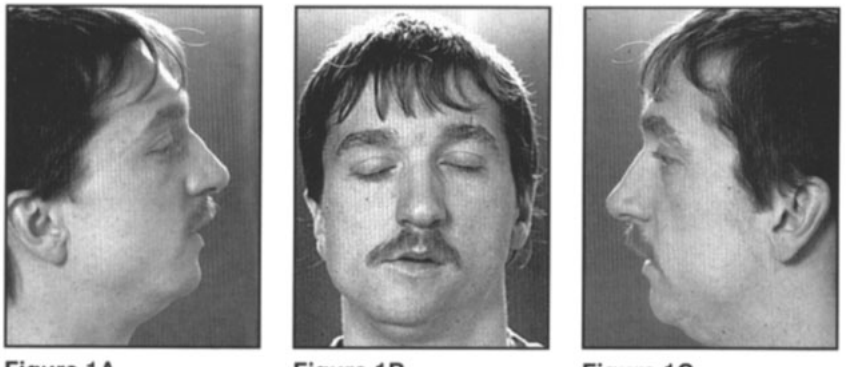

Figure 1A Figure 1B Figure 1C

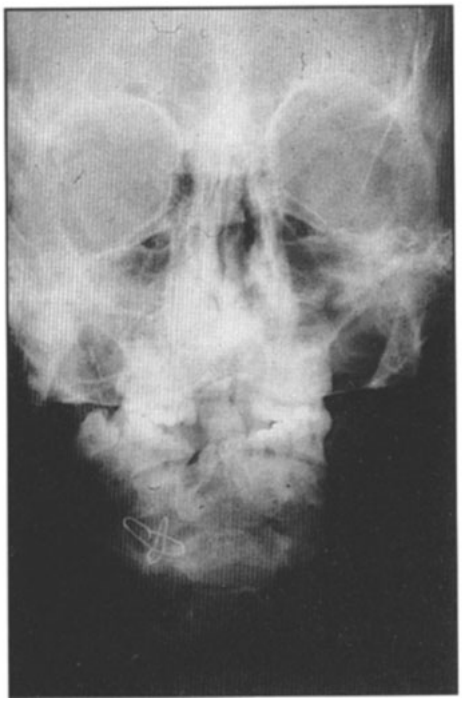

Figure 2A

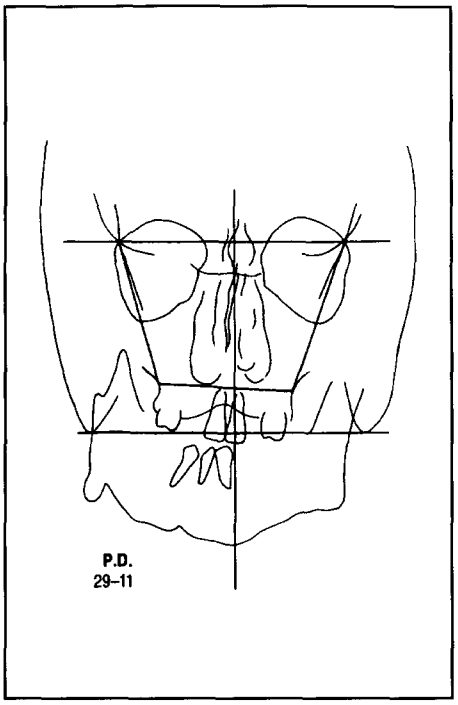

Figure 2B

Figure 3A

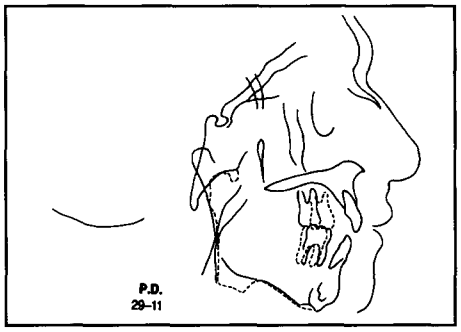

Figure 3B

Figure 2 A-B
Pretreatment posteroanterior radiograph and tracing. Lower third is deviated to the right, right condyle is absent, and mandible is distorted.

Figure 3 A-B
Pretreatment lateral headfilm and tracing. Note the constricted pharyngeal airway space and the retrusive maxilla and mandible.

Diagnosis

Facial examination revealed a severe asymmetry, with the chin rotated to the right. The left hemiface appeared hypoplasic, Figure 1A, and the right profile showed a retrognathic mandible and double chin. The upper midface was underdeveloped, Figure 1B. The left side demonstrated an even more severe hypoplasia of the middle third, and scar tissue could be observed in the chin area, Figure 1C.

The frontal and lateral headfilms confirmed these observations. On the PA radiograph, the nasal septum appeared distorted, with the upper midline 4 mm to the right and the lower midline indistinguishable, Figure 2A-B. Cephalometric analysis showed a retrusive maxilla (SNA 68°) and an even more underdeveloped mandible (SNB 63°). The right condyle was absent and a large antegonial notch deformed the mandibular corpus on the right side. The pharyngeal airway space was extremely narrow (2 mm), Figure 3A-B.

Dentally, the patient presented with an anterior open bite starting from the second premolars on both sides, with a Class II molar relationship on the right side and Class I on the left. The maxillary canines and first premolars were absent, and the maxillary arch was tapered and abnormally narrow. The mandibular arch was also constricted and all permanent incisors and canines were missing. The mandibular left deciduous dentition was retained with high mobility due to apical root infection, Figure 4A-E.

The panoramic radiograph revealed a severely deformed mandible. Both coronoid processes were hyperplasic with partial ankylosis of the left side. The lower right third molar was impacted. The osteosynthesis ligature wires were still present in the symphysis region, Figure 5.

Maximum mouth opening was reduced at 20 mm.

All-night polysomnographic recording revealed 182 apneic episodes (lasting 10 seconds or more) during a 6-hour total sleep time. Sleep pattern was abnormal, constituted by stages 1 and 2 only; stage 4 and REM sleep were absent.

The respiratory distress index (RDI) was 37. (RDI is the number of hypopneas and apneas per hour of sleep. An RDI greater than 5 is abnormal, and values greater than 20 are believed predictive of significant long-term cardiovascular risk.) Oxyhemoglobin saturation ($Sa0_2$) was below 90% (N=100%) during 33% of the sleeping time.

Treatment objectives

1. Eliminate obstructive sleep apnea (and snoring).
2. Increase mouth opening and improve jaw function.
3. Improve facial and dental symmetry.
4. Eliminate dental openbite.
5. Increase arch width, recover proper arch form, and create space for two dental units in the mandible.
6. Obtain a bilateral Class I molar relationship.

Figure 4A

Figure 4B

Figure 4C

Figure 4A-E
Initial intraoral photographs.

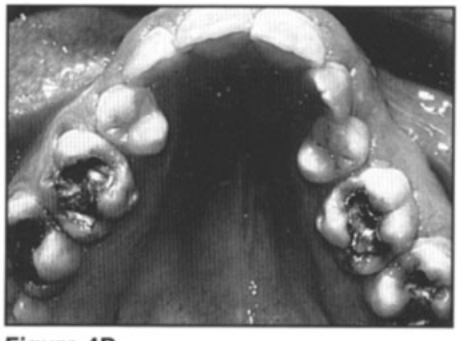

Figure 4D

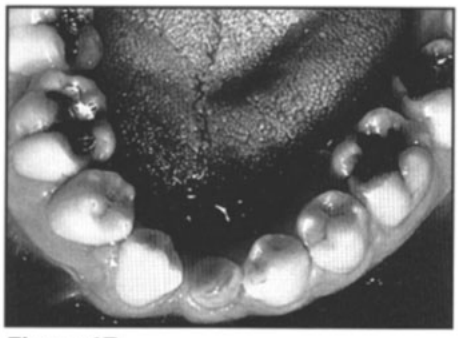

Figure 4E

Treatment plan

Both the maxilla and mandible had to be protracted surgically to fulfill the first treatment objective. However, a conventional approach of surgical orthodontic treatment could not be applied because proper arch form could not realistically be achieved with orthodontic treatment prior to surgery. The mandibular arch form was extremely distorted, so an initial attempt was made to remodel the maxillary arch first using surgically assisted rapid maxillary expansion and orthodontic treatment. The newly created maxillary arch shape would then serve as a guide to reconstruct the mandibular arch form during the second phase of treatment, which would include orthodontic tooth movement to create space for two anterior dental units as well as surgery (bimaxillary osteotomies).

During the retention period, a re-evaluation of the bone structure and the width of the lower anterior space that had been created would indicate whether a bonded bridge or dental implant should be used in the area.

Treatment progress

A Hyrax expansion appliance was cemented to the maxillary second premolars and molars (Figure 6A-B). A coronoidectomy was performed on the left side and four wisdom teeth were extracted. A corticotomy was also performed bilaterally on the maxilla to relieve the resistance to maxillary expansion. The Hyrax appliance was activated 4 days later and then reactivated every day for 1 month. It remained in place for 3 months and then was replaced by a maxillary plate, which the patient wore for another 3 months. At that time, full fixed orthodontic therapy was initiated to obtain proper alignment and root torque of the maxillary teeth and to open a space between the mandibular first premolars.

The second phase of surgery occured 11 months after the initiation of orthodontic tooth movement. The surgery was carefully planned in three planes of space using setups, prediction tracings, and articulator mounting. A LeFort I osteotomy was performed to rotate and advance the maxilla and to correct the tilted occlusal plane by unilateral impaction. An intermediate splint was used to achieve correct position of the maxilla, which was fixated with miniplates. The mandible was also rotated and advanced using a bilateral sagittal split osteotomy. Finally, a step-genioplasty was performed to enhance the symmetry and to pull the hyoid bone forward even more. Bicortical screws were inserted bilaterally to stabilize the mandibular segments, and miniplates were used for the chin osteotomy.

A final occlusal splint was maintained in place for 10 days, and orthodontic finishing details were initiated 4 weeks later. The patient was seen monthly. The orthodontic appliances were removed during the fifth month, with the exception of those on the maxillary incisors, which were left in place for an additional month. A panoramic radiograph was taken and the decision

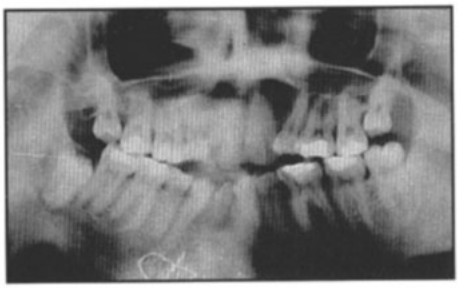

Figure 5

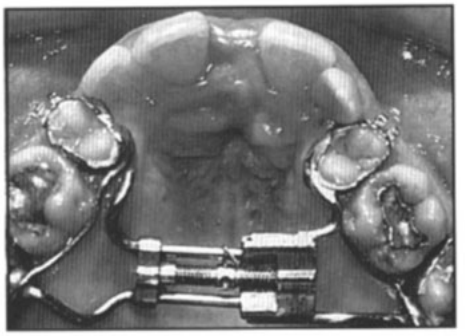

Figure 6A

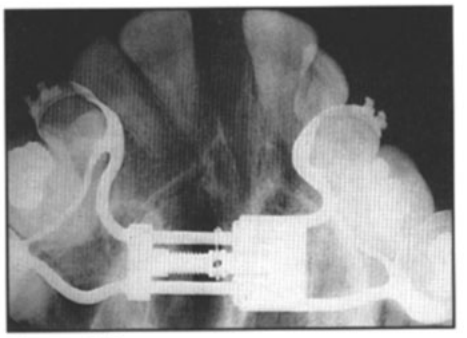

Figure 6B

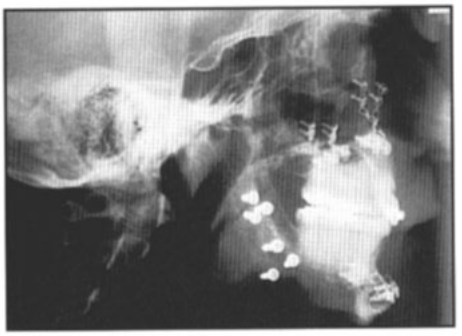

Figure 7A

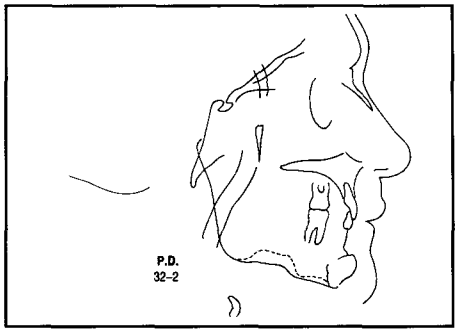

Figure 7B

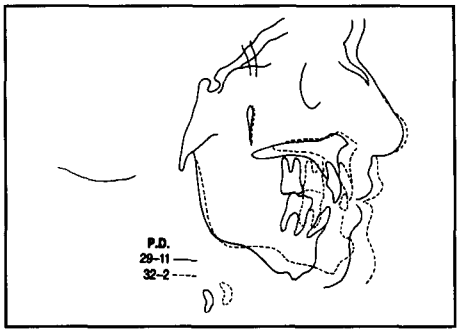

Figure 8

Figure 5
Pretreatment panoramic radiograph.

Figure 6 A-B
Occlusal photo and radiograph following surgically assisted maxillary expansion.

Figure 7A-B
Posttreatment lateral headfilm and tracing.

Figure 8
Superimposed tracings. Note protraction of the hyoid bone by the large mandibular advancement and the genioplasty.

Figure 9 A-B
Final facial photographs.

Figure 9A

Figure 9B

was made to bond a temporary bridge between the mandibular first premolars and to reevaluate the site for dental implants in 3 years, after healing and bone reorganization were complete. Removable retainers were placed and the patient was instructed to wear them constantly for 6 months, and then at night for another 6 months.

Results

Final records were taken 6 months into the retention phase (11 months after the second surgery). Overall, the patient's facial esthetics had improved, although the chin button remained deviated to the right. The retrognathic appearance of the profile had been reduced and the double chin eliminated.

On the lateral headfilm, SNA was 74° and SNB 71°. The pharyngeal airway space had opened 8 mm (to a total of 10 mm), Figure 7A-B. The cephalometric superimposition showed that significant maxillary and mandibular advancement had occurred. The chin was protracted 21 mm and the hyoid bone 11 mm, Figure 8.

Occlusal results were also quite satisfactory considering the number of missing teeth. The molars were brought into a Class I relationship and the openbite and dental midlines corrected. Lateral excursions rested on the maxillary first and mandibular second premolars, Figure 10A-E.

The panoramic radiograph showed excellent bone healing at the osteotomy sites. Root parallelism, while not perfect between the maxillary lateral incisors and first premolars, had improved, Figure 11.

The prognosis for future placement of implants in the mandibular anterior region was good.

Polysomnographic recordings taken 3, 8, and 14 months later showed that the obstructive sleep apnea had been eliminated: The RDI was below 5, $Sa0_2$ was greater than 95%, sleep organization was restored, and mouth opening had increased from 20 mm to 40 mm.

Discussion

The success rate of orthognathic surgery in the treatment of obstructive sleep apnea is very high. Riley et al.[4] reported a 61% reduction in symptoms following advancement of the genioglossus and suspension of the hyoid bone, and 100% success with maxillary and mandibular advancement surgery. The present case, in which sleep apnea syndrome was totally eliminated, confirms these findings. On the other hand, when the mandible is set back surgically to correct

Figure 10A

Figure 10B

Figure 10C

Figure 10D

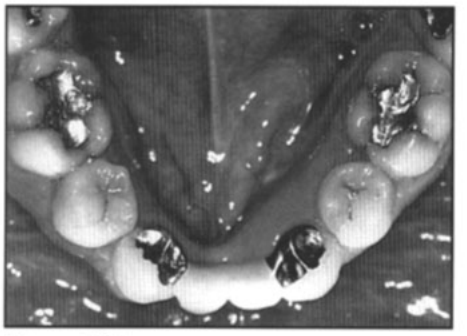

Figure 10E

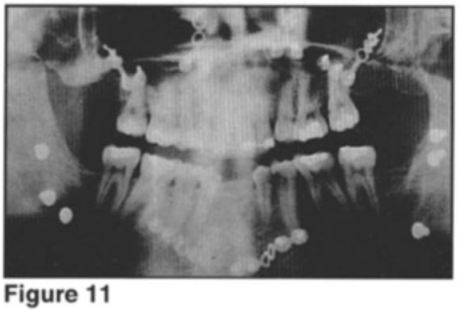

Figure 11

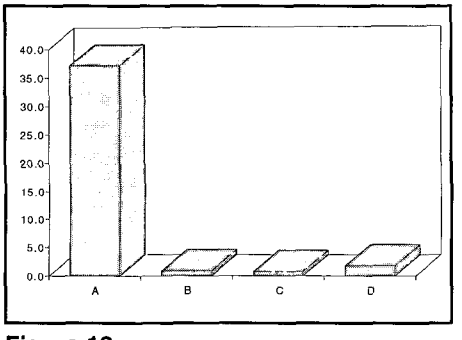

Figure 12

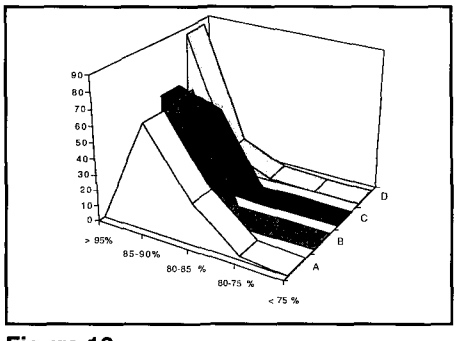

Figure 13

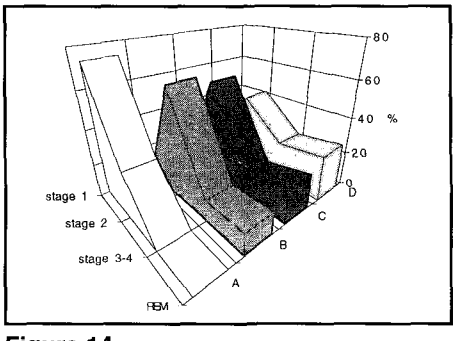

Figure 14

mandibular prognathism, the hyoid bone and the tongue also move back, reducing the pharyngoaerial space and possibly inducing temporary or permanent sleep apnea.

In the case present, the severe facial asymmetry, maxillary and mandibular retrognathism, and dental openbite were also criteria in favor of bimaxillary surgery. The abnormal shape of both the maxilla and mandible made the treatment planning more complicated. Although two phases of surgery are ordinarily not recommended, this alternative was imposed by the severity of the skeletal and dental deformities. Surgical maxillary expansion is considered a very unstable procedure when performed in conjunction with a LeFort I osteotomy.[7,8] On the other hand, recent reports have shown that large transverse maxillary discrepancies can be successfully treated with conventional rapid maxillary expansion combined with bilateral or unilateral corticotomies.[9-12] For that reason, this

Figure 10 A-E
Final intraoral photographs.

Figure 11
Posttreatment panoramic radiograph.

Figure 12
Respiratory Distress Index (RDI) before (A), 3 months (B), 8 months (C), and 14 months (D) after the two surgical procedures.

Figure 13
Oxymetry (SaO_2) preoperatively (A), 3 months (B), 8 months (C), and 14 months (D) after the second operation.

Figure 14
Sleep pattern showing the predominance of light sleep, 1 and 2 stages before the operation (A), and the restoration REM sleep and 3 and 4 stages sleep after 3 (B), 8 (C), and 14 months (D).

procedure was selected as a first phase of treatment, in order to reconstruct an acceptable maxillary arch prior to bimaxillary advancement and genioplasty.

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References

1. Guilleminault C, Tilkian A, Dement WC. The sleep apnea syndromes. Ann Rev Med 1976;27:465-484.
2. Richter M, Chausse JM, Berner M. Syndrome d'apnées obstructives du sommeil et ankylose temporo-mandibulaire. Correction pour l'adult et l'enfant. Rev Stomatol Chir Maxillofac 1989;90:313-319.
3. Lowe AA, Fleetham JA, Ryan CF, Mathews B. Effects of a mandibular repositioning appliance used in the treatment of obstructive sleep apnea on tongue and muscle activity. In: Issa FG, Surrat PM, Remmers JE, eds. Sleep and respiration. New York: Wiley-Liss, 1990;395-405.
4. Riley RW, Powell N, Guilleminault C. Obstructive sleep apnea syndrome: a surgical protocol for dynamic upper airway reconstruction. J Oral Maxillofac Surg 1993;61:742-747.
5. Wickwire NA, White RP, Proffit WR. The effect of mandibular osteotomy on tongue position. J Oral Surg 1972;30:184-190.
6. Riley RW, Powell NB, Guilleminault C, Ware W. Obstructive sleep apnea syndrome following surgery for mandibular prognathism. J Oral Maxillofac Surg 1987;45:450-452.
7. Medland WJA, Phillips C, Turvey TA. Stability after transverse surgical expansion of the maxilla with Lefort 1 osteotomy. J Oral Maxillofac Surg
8. Turvey TA. Maxillary expansion: a surgical technique based on surgical-orthodontic treatment objectives and anatomical considerations. J Maxillofac Surg 1985;13:51-58.
9. Kennedy JW, Bell WH, Kimbrough OL, et al. Osteotomy as an adjunct to rapid maxillary expansion. Am J Orthod 1976;70:123-137.
10. Glassman AS, Nahigian SJ, Medway JM, et al. Conservative surgical orthodontic adult rapid palatal expansion: sixteen cases. Am J Orthod 1984;86:207-213.
11. Alpern MC, Yurosko JJ. Rapid palatal expansion in adults with and without surgery. Angle Orthod 1987;57:245-263.
12. Mossaz CF, Byloff FK, Richter M. Unilateral and bilateral corticotomies for correction of maxillary transverse discrepancies. Eur J Orthod 1992;14:110-116.