Surgically-assisted rapid palatal expansion and orthodontic treatment in preparation for Le Fort 1 and sagittal split osteotomy surgery

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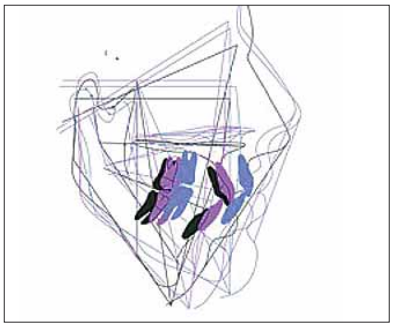
Background: This article reports the treatment of a 15-year old male patient with anterior open bite and a severely narrowed upper dental arch. The young patient complained of occlusal and masticatory dysfunction due to the anterior open bite and difficulties in breathing normally through his nose.

Case report: A posterior crossbite was present on both sides. For the correction of the posterior cross-bite, a surgically assisted rapid maxillary expansion and a presurgical straight wire multibracket tooth alignment was applied. The treatment plan included Le Fort I osteotomy and mandibular setback with a sagittal splitting ramus osteotomy. The total treatment time was 36 months, including five months of post-surgical observation.
After treatment, a stable occlusion was achieved with a Class I molar relationship and a complete open-bite closure. The patient referred remarkable improvements in breathing.

Conclusion: Surgically assisted rapid maxillary expansion and Le Fort 1 osteotomy can be regarded as a safe and effective approach for the treatment of skeletal divergence. Long-term observation of the maxillary arch width after retention is of the utmost importance for the maintenance of a successful treatment outcome.

Key words:
rapid palatal expansion; sagittal split osteotomy; open-bite.



Introduction

Genetic factors have a role in the aetiology of skeletal hyperdivergence associated with anterior open-bite.
The growth pattern of the maxillary base usually follows a forward and upward trend leading to an increase in the anterior vertical dimension at the expenses of the posterior vertical dimension. This results in a reduction of the posterior space available for dentoalveolar eruption (1,2), whereas mandibular growth follows a rotational pattern along the condylar axis resulting in mandibular postero-rotation. The greater this movement, the shorter the ascending branch of the mandibular bone. The result of this diverging movement is an increase in the skeletal vertical dimension. Vertical maxillary excess may involve a maxillary component associated with this mandibular postero-rotation.
Some cases of skeletal divergence develop a correct molar Class I occlusion with overjet and overbite parameters within the normal range, obtained by significant vertical maxillary compensation that causes a 'gummy smile', often accompanied by labial incompetence.
Differential diagnosis between dentoskeletal open-bite and long face syndrome is based on the different stages of dentoalveolar compensation. In the former case, compensation does not develop, as the divergence of the occlusal planes follows skeletal divergence.
The aetiology of open bit often also involves bad habits such as prolonged finger or lip sucking and mouth breathing, aggravating factors that, when expressed on a highly-receptive substrate, worsen the disease (3,4).

Skeletal diagnosis

A 15 year-old male subject was referred to the Galeazzi Institution with the aim to obtain a normal occlusion and correct skeletal relationship (Fig. 1).
The patient simply asked to obtain a normal bite with teeth in contact, to be able to breathe normally through his nose and to close his lips without difficulty.

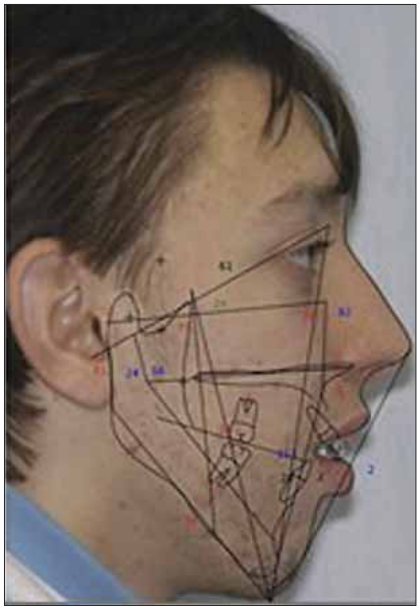


FIG. 1a
Pre-treatment lateral photograph with Ricketts cephalometric tracing.

FIG. 1b
Right side.

FIG. 1c
Front side.

FIG. 1d
Left side.

The patient showed the typical adenoid face, nasal voice, labial incompetence and dental open-bite, which resulted in relational difficulties. He had a Class II malocclusion with greatly reduced transverse diameters, and a severely ogival palate. This generated a reduction in volume of the nasal fossae and consequently reduced nasal patency, forcing the subject to breathe through his mouth.
The mandibular plane and gonial angle were greater than normal and had caused extensive mandibular postero-rotation. The ascending branch, however, was adequately sized: a favourable prognostic factor when it comes to surgical anterorotation. The occlusal planes were cephalometrically divergent and caused an open bite beyond the first premolars (Fig. 2).
The facial analysis confirmed the skeletal cephalometric data: the convex profile and increased vertical dimension caused an open nasolabial angle and labial incompetence, while the soft-tissue pogonion was set back from the true vertical line (TVL).
The chin-neck angle was favourable for surgical rotation.
On a frontal view, the vertical maxillary excess and the transverse deficiency caused a slight protrusion of the sclera and the smile line showed the severe dentoskeletal open bite and gummy smile. The interzygomatic distance was reduced and the gonial angles were underpronounced on account of the mandibular postero-rotation.

Dental diagnosis

- Molar Class II occlusion.
- Reduced transverse diameters.
- Medium - high teeth crowding.

- Anterior open-bite.
- Midlines corresponding with skeletal midlines.
- Poor periodontal health due to a combination of factors: the patient's poor oral hygiene, the result of mouth breathing and the absence of dental occlusion, which impaired the tongue's cleaning effect on teeth.

The aim of the treatment plan was to threedimensionally reposition the maxillary and mandibular bones, rotate the occlusal planes in order to close the open bite, allow nose breathing and harmonize the facial tissues.

The cosmetic and functional expectations of the young patient were, of course, quite high. He was very motivated and very keen to cooperate in any possible way since the start of the treatment.

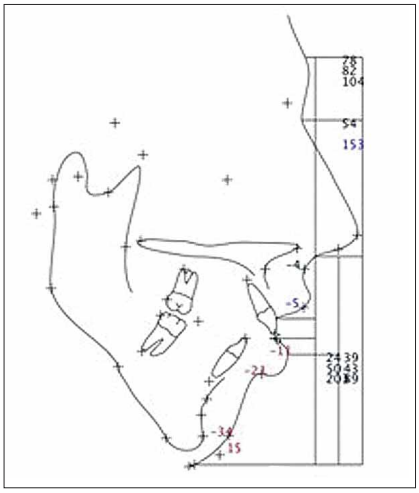


FIG. 2
Pre-treatment Ricketts cephalometric tracing, the patient is a Class II malocclusion and had a skeletal severe anterior open bite.

FIG. 3a
Intraoral photograph of the upper arch with palatal expander in situ.

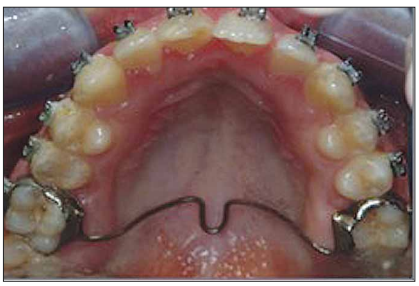


FIG. 3b
Intraoral photograph of the upper arch after surgically-assisted rapid palatal expansion.

Treatment plan

In the treatment plan the following steps were scheduled:

- surgically-assisted rapid palatal expansion;
- presurgical orthodontic treatment using multibracket appliances on both dental arches;
- maxillary and mandibular osteotomy surgery;
- post-surgical orthodontic treatment;
- post-treatment orthodontic retention;
- craniofacial physiotherapy;
- routine oral hygiene recalls.

SURGICALLY-ASSISTED RAPID PALATAL EXPANSION

This approach was chosen due to the significant height of the palatal vault, that implied a reduction in air space and lack of room for dental alignment along the arch.

The surgical option was chosen despite the fact that the patient was 16 years old when the appliance was placed and there was a technical possibility that expansion could be obtained without performing an osteotomy (5-9).

A Haas-type Rapid Expander anchored by 4 bands was cemented onto the first molars and first premolars (Fig. 3). The operation was performed under general anaesthesia. The central screw was activated in the operating room with 8 full turns, equal to 2 mm.

Three days after surgery, screw activation was repeated for a total of 11 mm.

Weekly recalls were scheduled to check the extent of expansion reached, and the healing of both the vestibular suture and the postoperative swelling. The screw was then sealed using composite resin.

The rapid expander was worn for 6 months.

PRESURGICAL ORTHODONTIC TREATMENT WITH A MULTIBRACKET APPLIANCE

The orthodontic treatment aiming at dental alignment started before the palatal expansion in the lower arch. The extraction option was taken into consideration during planning, but it was later decided that the arches could be prepared using orthodontic techniques to maintain the number of teeth and check the periodontal risk, especially in the lower incisors.

The Straight-wire technique was used, with pre-angled brackets and Ni-Ti archwire progression in the early phases, by fitting a full-thickness 0.17 X 0.25 steel arch-wire.

Transverse relapse was controlled at the initial phase, after the first rapid palatal expansion, and later while using a rigid palatal splint. The splint and transpalatal bar were maintained during the second surgical phase.

ORTHOGNATHIC SURGERY

The surgical repositioning of the bone bases was performed with a Le Fort I osteotomy with 9 mm anterior and posterior vertical impaction, combined with extensive resection of the cartilaginous and bone nasal septum, in order to avoid secondary dislocations.

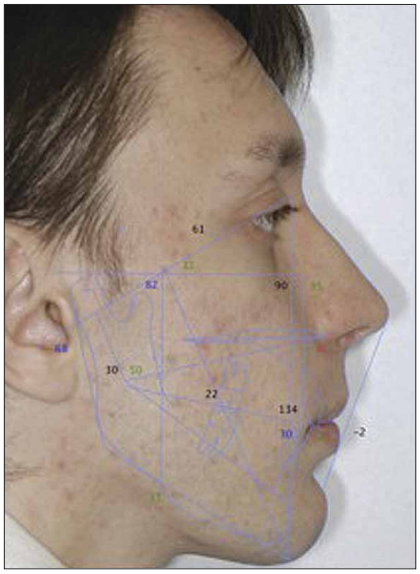


FIG. 4a
Post-treatment lateral photograph with Ricketts cephalometric tracing.

FIG. 4b
Right side.

FIG. 4c
Frontal side.

FIG. 4d
Left side.

The mandibular osteotomy allowed to disengage the temporomandibular joint from the lower arch. This allowed the mandibular arch to follow the whole upward vertical movement of the maxilla, bringing the teeth into occlusion.
The mandibular ramus was then bilaterally stabilized, to avoid loss of its physiological inclination.
The last step of the procedure was the osteotomy of the mental symphysis, with a 4-5 mm advancement to achieve better cosmetic results and an improved profile (10-11).

POST-SURGICAL ORTHODONTIC TREATMENT
Eight weeks after surgery, following routine check-ups and occlusal splint treatment, another orthodontic phase was undertaken to correct occlusal stability and intercuspidation. (Fig. 4).

RETENTION
After the finishing procedures, the fixed appliance was removed. The patient was given an Essix retainer in the upper jaw to wear during the day and a removable appliance to wear at night, to maintain transverse stability.
Moreover the lower incisors were splinted together at the lingual side.
A removable appliance was fitted to maintain correct occlusal relationships (12).
The patient was encouraged to improve labial competence with myofunctional exercises.

Results

Good balance was obtained between the soft tissues, bone and teeth, improving the patient's appearance, breathing and masticatory function, joint stability and, undoubtedly, also his self-confidence.
Cephalometric and cosmetic analysis confirmed that the goals set had been achieved: this means the attainment of a skeletal I Class and an Angle I Class. The line of the profile is straight.
Our young patient reported an improvement in airways patency.
The significant vertical and sagittal skeletal displacements were well-tolerated in terms of neuromuscular compensation and tendency to relapse.
The two-year follow up confirmed the stability of the case.

Discussion

The combination of orthodontic and surgical treatment made it possible to achieve the targets set: expansion of the transverse maxillary diameter and control over the skeletal vertical dimension.
After the first surgically-assisted rapid palatal expansion and dental alignment procedures were performed, a rotation of the occlusal plane was achieved by mandibular anterorotation.
From a skeletal viewpoint there was a vertical maxillary excess, despite having achieved a molar I Class occlusion and closure of the anterior open bite during the first phase of treatment.
As illustrated in detail, the second surgical stage modified the skeletal pattern in order to obtain a better balance between soft tissues, skeletal components and occlusion with a significant improvement in the facial harmony. In other words, if a maxillary osteotomy is performed, the mandible autorotates with a condylar fulcrum. This movement normally changes too much the inclination of the ramus so that condylar problems and instability may occur. For this reason, when the vertical upward movement of the maxilla is greater than 4-5 mm, it is always advisable to perform mandibular osteotomy.
This justified our decision to perform a two-staged surgical approach.
Transverse relapse factors also have to be considered. The first expansion operation favoured the presence of 2 conditions: the first,

FIG. 5a
Comparison between pre-treatment and post-treatment lateral photographs.

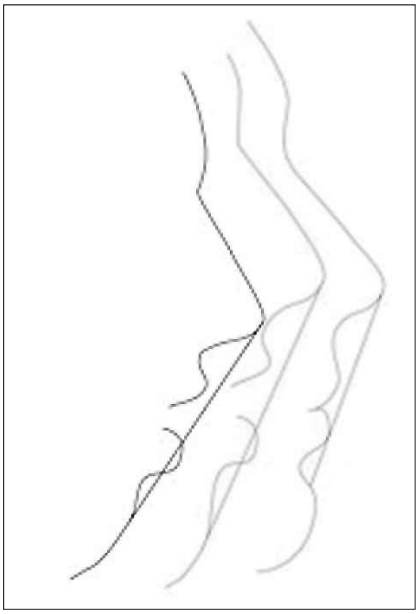


FIG. 5b
Comparison between pre-treatment and post-treatment lateral photographs.

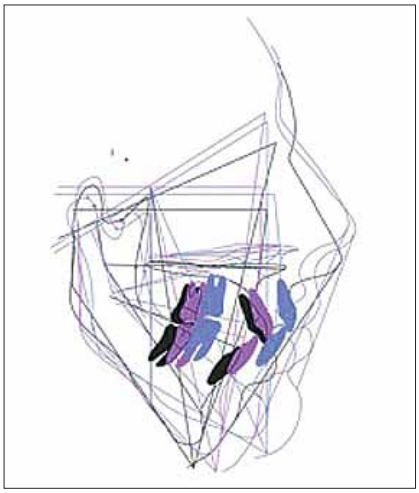


FIG. 6
Pre-treatment (black line), after surgically-assisted rapid palatal expansion (pink line) and post-treatment (blue line) Ricketts cephalometric tracings. Look at mandibular anterorotation and vertical dimension reduction after surgically-assisted rapid palatal expansion.

of an orthodontic nature, allowed dental alignment without extractions, the second, of a surgical type, made it possible to expand and impact the maxilla, reducing the risk of excess strain on the palatal mucosa (Fig. 5a-b).
Moreover the first surgery improved airways patency, which helped the patient breathing through his nose and contributed to conditioning the neuromuscular tissues prior to the corticotomy and mandibular rotation.
This latter factor may have contributed to the satisfying result achieved and to the neuromuscular maintenance of occlusal stability.
During the mandibular anterorotation procedure, the elongation of the suprahyoid muscles was slight and labial competence was easily maintained. Transverse stability assisted by the removable retainer appliance was also stimulated by the higher, palatal posture of the tongue, which is able to keep the lips completely closed. In a short period of time it has been obtained the relaxation of the mental muscle. The patient had obtained complete nasal breathing, due to wider palatal vault, reduction of nasal resistance and improvement of nasal breathing.
However not all patients increase the nasal breathing after maxillary expansion because of the habit of oral breathing. In our case the autorotation of the mandible obtained the complete muscular closure of the lips and consequently a complete nasal breathing (Fig. 6).

Conclusion

Good stability of the neuromuscular system, occlusion and nasal function were obtained.
The combination of surgically-assisted palatal expansion and maxillary and mandibular osteotomy can provide satisfactory results. The two step procedure has the benefit to increase and lower the maxillary vault, creating an anatomical situation that could decrease the level of difficulty at the second surgical intervention.
However, further clinical studies are required to confirm the effectiveness of this treatment approach.

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