

Aesthetic Considerations in Orthofacial Surgery

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KEYWORDS

- Aesthetics • Orthognathic surgery • Maxillofacial surgery • Minimally invasive surgical procedures
- Imaging • Three-dimensional • Computed tomography • Cone beam

KEY POINTS

- When an “orthofacial” approach is embraced, surgical planning should focus to improve facial aesthetics, soft tissue support, temporomandibular joint, and upper airway volume, not only regarding occlusal purposes.
- The “Barcelona line (BL) is used to find the most aesthetic sagittal position of the maxilla, where a perpendicular true vertical line through the soft tissue nasion or so-called BL is traced.
- For diagnostic purposes, only a profile smiling picture with the patient in the natural head orientation position suffices to evaluate the relation of the BL with the upper incisor. In the context of surgical planning, the upper incisor should be positioned in or in front of the BL.
- Attractive faces are more protrusive than the cephalometric standards would like to accept.
- The forward reposition of the maxillomandibular complex involves beneficial aesthetic effects because the facial mask is tightened and therefore a reverse facelift is observed with subsequent improvement of nasolabial and labiomental folds and jowl areas.

INTRODUCTION

Orthognathic surgery (OS) indications have evolved substantially over the years due to a popular perception of surgery as a safe and predictable procedure, supported by the improvements in the surgical, medical, and orthodontic fields. Although correcting a dysfunctional occlusal and skeletal deformity used to be the key concern and almost exclusive therapeutic goal a few decades ago, nowadays it is clear that OS goes far beyond the mere correction of hard tissues. Its current uses comprise several functional indications, with the aim of correcting—a part from occlusion—also mastication,¹ phonetics,² temporomandibular joint disorders,³ sleep-related breathing disorders,⁴ and the avoidance of periodontal damage.⁵

Currently, the wish to optimize facial esthetics—in the context of a dysfunctional occlusion or not—has become the main motivation for OS in many cases.⁶ Furthermore, the number of adult patients—not only young adults—who get involved in orthodontic or combined orthodontic-surgical therapy for both functional and/or aesthetic reasons is increasing steadily. It should be highlighted that when a dentofacial deformity (DFD) involves any skeletal hypoplasia of the lower and/or midfacial thirds, the lack of skeletal support accelerates the aging process, because typical unaesthetic facial features may appear precociously, such as poor projection of the lips, the early appearance of a double chin, and deepening of the nasolabial and labiomental folds, among others.⁷

Although the maxillofacial region is the key area of attention when planning an OS procedure, the

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nose, the malar–midface, and the jawline regions are also critical determinants of overall facial esthetics, because the surgical creation of beauty requires the attainment of a correct balance between these three major facial prominences. Besides, the state-of-the-art treatment of DFDs through OS involves the comprehensive management of both the hard and soft tissues to correct any functional and aesthetic disharmonies of the maxillofacial complex.^{7,8}

THE BARCELONA LINE: A DIAGNOSTIC AND SURGICAL PLANNING TOOL

Beauty is a subjective perception conditioned by individual and cultural preferences. Although facial beauty historically has been widely discussed, the contemporary attractive face entails protrusive, angled and defined lines. On the other hand, poor skeletal support of soft tissue manifests with premature facial aging.^{8,9}

From this perspective, in 2010, the senior investigator described the “Upper Incisor to Soft Tissue Plane”¹⁰ (Fig. 1) to trace the most aesthetic sagittal position of the maxilla in the context of DFD diagnosis and surgical planning. Nowadays, this tool has been renamed as “Barcelona line (BL) to ease its designation. In brief, after bearing out the natural head orientation (NHO) position of the head, a perpendicular true vertical line through the soft tissue nasion or so-called BL is traced. Then, the upper incisor should be positioned in or in front of the BL, providing upper lip support (based on adequate upper incisor angulation, or an orthodontically well-planned upper incisor position, with respect to the maxillary plane).

WORKFLOW PROTOCOL FOR ORTHOGNATHIC SURGERY VIRTUAL PLANNING

The BL protocol for OS virtual planning is based on a single cone-beam computed tomography (CBCT) scan (iCAT, Imaging Sciences International, Hatfield, PA, USA) of the head of the patient, with intraoral surface scanning of the dental arches using the Lava Scan ST scanner (3M ESPE, Ann Arbor, MI, USA) for subsequent fusion of the two data sets.¹¹ The data are primarily saved in Digital Imaging and Communications in Medicine format using three-dimensional (3D) software (Dolphin 3D Orthognathic Surgery Planning Software Version 11.8) for computer-assisted simulation surgery.

In addition, facial photographic records are obtained to complete the preoperative study

protocol. Patients are previously instructed by trained personnel to achieve the key points of photographic records for OS diagnosis and planning purposes: the patient breathing quietly without swallowing, sitting upright in the NHO position; indicating the patient to look straight ahead at a point in front of them at eye level (looking into a mirror); and the tongue in a relaxed position (Fig. 2).

For accurate virtual surgical planning, the BL protocol consists in a sequence of reproducible steps:

1. Definition of the desired final occlusion in the physical dental models.
2. Digital scanning of final occlusion and introduction of the 3D software for subsequent fusion with the CBCT data set.
3. Virtual head orientation according to the NHO position from the lateral resting facial picture. Then, this is considered the true horizontal line (see Figs. 2; Fig. 3).
4. Once the mandibular and maxillary osteotomies are designed, surgical repositioning of the maxillomandibular complex is virtually simulated. From the previously established final occlusion, maxilla and mandible are together positioned into class I.
5. The BL is traced: a true vertical line perpendicular to the true horizontal line based on the NHO position is drawn, crossing the soft tissue nasion.
6. The maxillomandibular complex is moved all together as a block with its upper incisor in or in front of the BL (see Fig. 3); it is extremely important that the upper incisor has the appropriate angulation or a well-orthodontically planned position with respect to the maxillary plane.
7. The dental and facial midlines are aligned, and the maxillomandibular complex is repositioned in all spatial planes (pitch, roll, and yaw) to set the virtual treatment objectives.
8. Clockwise or counterclockwise (CCW) rotation of the maxillomandibular complex is performed to achieve a proper occlusal plane.
9. Adequate projection of the chin is checked. In general terms, pogonion should be in or ahead the BL and the angle between occlusal plane lower incisor–pogonion should be around 90°. So, if necessary, a genioplasty is planned accordingly.
10. The exact vertical maxillary positioning is defined intraoperatively ensuring 2 to 3 mm of upper incisor exposure with relaxed upper lips.

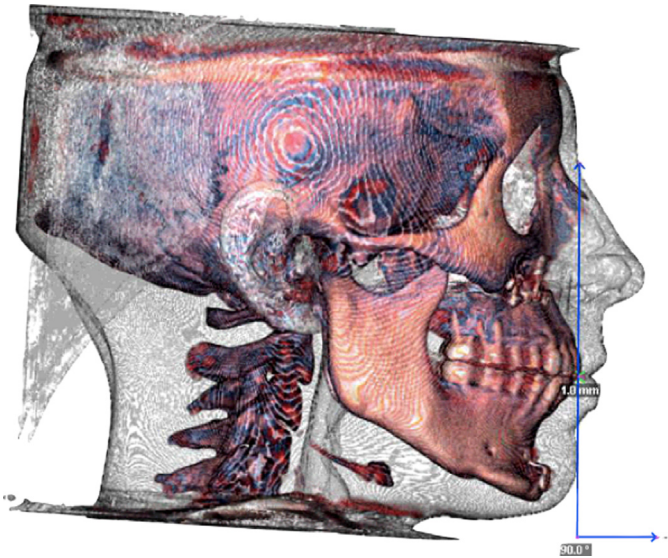


Fig. 1. "Upper Incisor to Soft Tissue Plane" or so-called "Barcelona line" (BL) to trace the most aesthetic sagittal position of the maxilla: after bearing out the natural head orientation, a perpendicular true vertical line through the soft tissue nasion or so-called BL is traced. Then, the upper incisor should be positioned in or in front of the BL.

FUNCTIONAL AND AESTHETIC ORTHOFACIAL IMPACT AFTER ORTHOGNATHIC SURGERY FOLLOWING THE BARCELONA LINE PROTOCOL

When an "orthofacial" instead of an "orthognathic" approach is embraced, surgical planning should focus to improve the outcomes in terms of facial

aesthetics, soft tissue support, temporomandibular joint, and upper airway volume, not merely considering jaws reposition for occlusal correction.

Although achievement of both functional and aesthetic goals has been the main objective of treatment planning of OS, most of the classical cephalometric analyses were centered on the false presumption that occlusion correction will result in ideal facial profiles.¹² However, from the early days, Peck¹³ found attractive faces to be more protrusive than the cephalometric standards would like to accept. Since then, several investigators have described different analysis focusing on the maxillary sagittal forward positioning to achieve facial attractiveness.^{10,14–16}

Regarding specifically the advantages of the BL protocol, we should mention that for diagnostic purposes, only a profile smiling picture with the patient in the NHO position suffices to evaluate its relation with the upper incisor, making clinical diagnosis easier and less invasive than radiologic analysis. Besides, the soft tissue Nasion point is not modified by surgery, which eases surgical planning and postoperative follow-up.

When using the BL protocol in Caucasian people, usually a forward maxillomandibular movement is required regardless of the initial occlusal situation of the patient or the amount of maxillo-mandibular discrepancy. Even most class III patients need some degree of mandibular advancement, as most patients present an underlying maxillary sagittal hypoplasia instead of a mandibular sagittal excess. Mandibular setback only appears to be necessary in a minority of

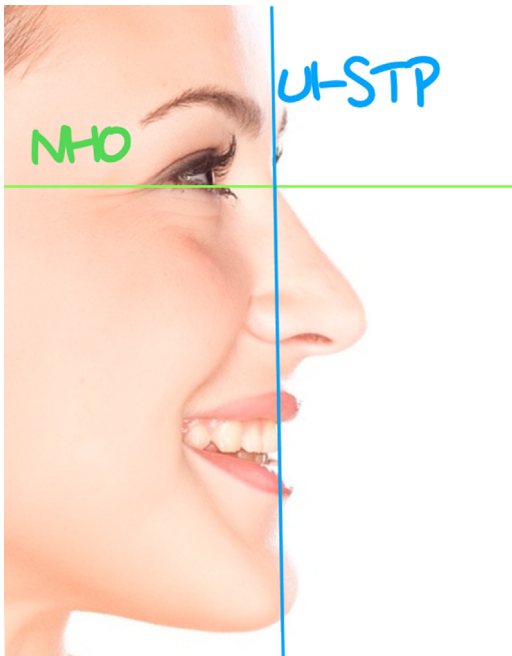


Fig. 2. A profile smiling picture with the patient in the natural head orientation to evaluate the relation of the "Barcelona line" with the upper incisor.

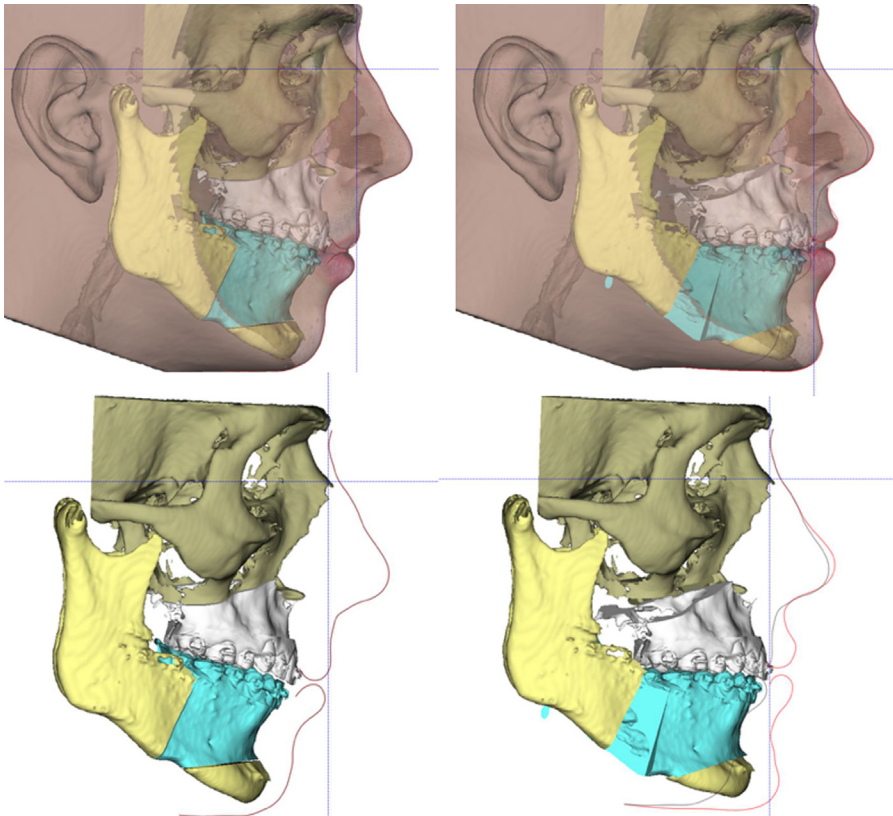


Fig. 3. Virtual planning according to the "Barcelona line," where the upper incisor is positioned in front of the BL.

cases, which are mostly coincident with a hemimandibular elongation or hyperplasia, an underlying acromegaly, or in cleft or syndromic patients.

In such cases where mandible setback is required, as it involves both functional and aesthetic drawbacks, CCW rotation of the mandible can be performed in some cases with a relatively prominent mandible. Mandibular CCW rotation can be also combined with setback to minimize the side effects of the latter.

On the other hand, mandibular advancement also presents other functional advantages over its setback, such as better long-term stability^{17–19} and pharyngeal airway enlargement.²⁰ For the latter, forward movement of the maxillomandibular complex not only pulls forward the anterior pharyngeal wall but also enlarges the oral cavity and thus the tongue is better positioned anteriorly, and finally posterior airway space is less collapsed by the base of the tongue.^{21,22} In this context, the maxillomandibular advancement has shown to be the most effective option for treating sleep-related breathing disorders in patients with an underlying DFD, with an 87.5% success rate.⁴ Specifically, bimaxillary advancement and mandibular occlusal

plane changes by CCW rotation are the most significant contributors for upper airway enlargement²⁰ (Fig. 4).

ORTHOGNATHIC SURGERY IN THE AGING FACE

Facial aging process involves both soft (skin, fat, and muscles) and hard (facial skeleton) tissues. Although soft tissues migrate downward due to the effects of gravity and adipose and muscular tissue atrophy and wrinkles appear on the skin, the skeletal changes are generated by its resorption.^{23,24}

Conventional antiaging surgeries were merely focused on skin pulling through face-lifting procedures. However, as Levine and colleagues²⁵ reported the importance of the role of bone in facial aging process, the concept of returning lost volume, mainly due to the loss of adipose tissue and bone resorption, to the face through fat grafting or fillers has become popular,^{26–28} and a new philosophy based on facial skeletal expansion is now a matter of interest.²⁹

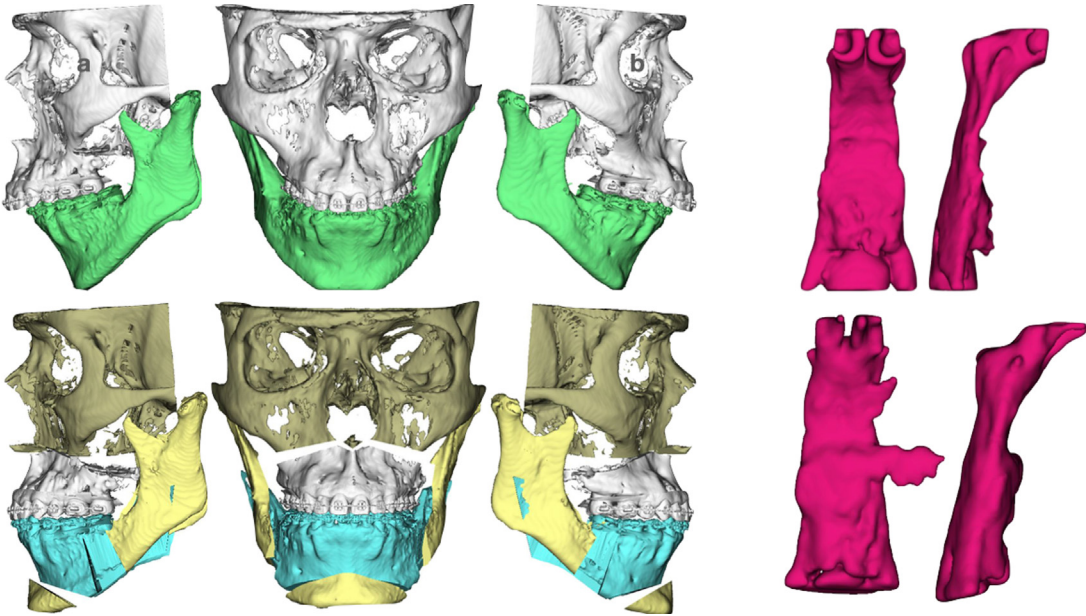


Fig. 4. Preoperative and postoperative CBCTs showing enlargement of the upper airway after orthognathic surgery planned according to the BL protocol with forward and counterclockwise movement of the maxillamandibular complex.

Therefore, in elder people, the forward reposition of the maxillomandibular complex involves beneficial aesthetic effects because the facial mask is tightened and therefore a reverse facelift is observed.^{12,30–32} In other words, nasolabial and labiomental folds (**Fig. 5**) as well as the jowl (**Fig. 6**) may disappear without the necessity of performing a complementary face-lifting procedure.

Occasionally, the normal aging process entails the formation of a visible bulge in the area of the submandibular salivary glands that disrupts the planar and smooth surface of a youthful appearing neck. In these cases, the submandibular space

can be suspended through an intraoral approach in the context of a bilateral sagittal split osteotomy (**Fig. 7**), improving the jawline contour, and thereby yielding a neck-rejuvenating effect.³³

However, other procedures can be performed concomitantly with the OS when required, such as lipofilling, implants placement, bichectomy, or malar augmentation, among others.^{28,34–36}

MANAGEMENT OF THE MAXILLARY SOFT TISSUE IN THE SAGITTAL DIMENSION

The 3D maxillary repositioning after Le Fort I osteotomy has different effects on the nasolabial region and the overall facial aesthetics. These



Fig. 5. Preoperative and postoperative pictures showing improved double-chin, nasolabial and labiomental folds area after orthognathic surgery planned according to the BL protocol with forward and counterclockwise movement of the maxillamandibular complex.



Fig. 6. Preoperative and postoperative pictures showing improved jowl area after orthognathic surgery planned according to the BL protocol with forward and counterclockwise movement of the maxillamandibular complex.

effects are related to the used surgical technique as well as to both the direction and magnitude of maxillary repositioning, and commonly include changes in the alar base dimension and morphology, the nasolabial angle, the position and shape of the upper lip, and the nasal tip projection.^{37,38}

As previously mentioned, according to the BL protocol, most Caucasian patients with an underlying DFD undergoing OS require forward maxillary surgical movement. It may result upturning of the nasal tip, widening of the alar base, flattening and thinning of the upper lip, down-turning of the

oral commissures, and loss of vermillion of the upper lip. To minimize these side effects, the following pitfalls and recommendations should be considered:

- The degree of subperiosteal dissection and the degree of flap elevation may play an important role in changes in the perinasal soft tissues in this area. Therefore, a gentle subperiosteal dissection limited to osteotomy and fixation hardware placement area should be considered. Also, the pterygomaxillary disjunction should be performed through a

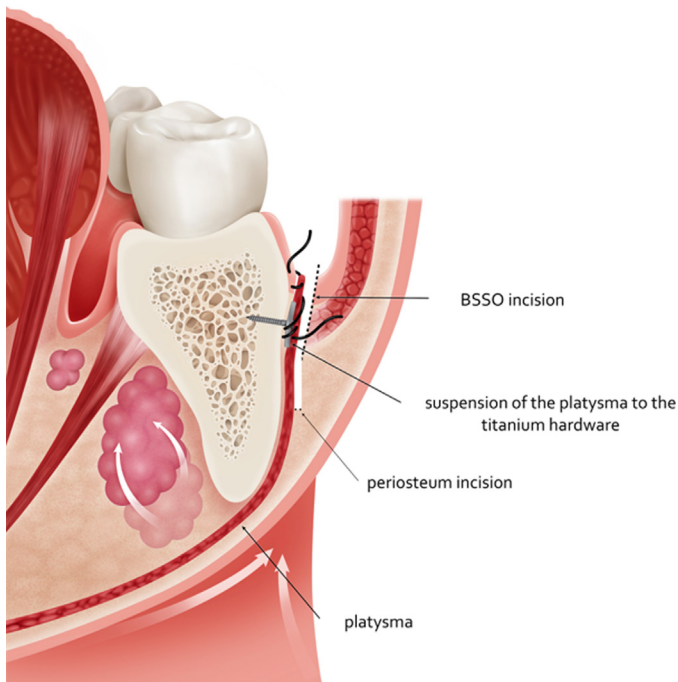


Fig. 7. Suspension of the platysma of the upper aspect of the submandibular space to achieve a neck-rejuvenating effect. BSSO, bilateral sagittal split osteotomy. (From Hernández-Alfaro F, Guijarro-Martínez R, Masià-Gridilla J, Valls-Ontañón A. Jawline Contouring Through an Intraoral Approach in the Context of Bilateral Sagittal Split Osteotomy: A Proof-of-Concept Report. *J Oral Maxillofac Surg.* 2019;77(1):174-178.)

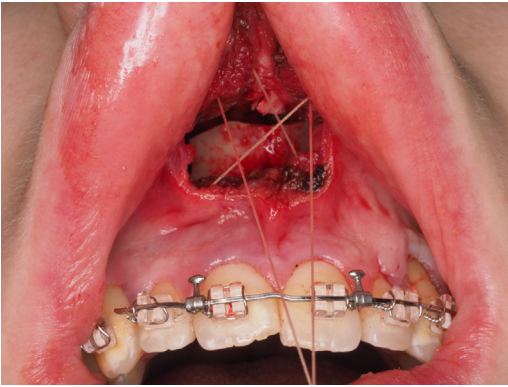


Fig. 8. Alar cinch suture to counteract widening of the alar base: inter-alar cross strap.

minimally invasive approach, such as the “twist” technique.³⁹

- Most muscle insertions around the alar base area are detached during the conventional maxillary access, but the functions of the unaffected muscles with outer insertions remain unchanged. As the soft tissues are pulled by the remaining muscles, freeing of the facial muscles from the nasolabial area and the anterior nasal spine allows the muscles to be retracted laterally. Moreover, modifications of the traditional Le Fort I osteotomy that preserve the insertions of the perinasal musculature and the preexisting position of the anterior nasal spine and nasal septum through a subspinal osteotomy have been reported with excellent clinical outcomes.^{40,41}
- In the same context, an alar cinch suture may counteract widening of the alar base: the fibroaerolar tissue of the base of the nose and the nasalis muscle are identified and with a suture it is pulled downward to the midline like a strap (**Fig. 8**).

- Finally, after muscular layer suture, a V–Y closure of the mucosa endorsed to counteract the detrimental effects of the Le Fort I osteotomy in the nasolabial region, as it thickens and projects the upper lip (**Figs. 9** and **10**).

SUMMARY/DISCUSSION

To sum up, current concept of “orthofacial” instead of “orthognathic” approach is preferable, because skeletal reposition of the jaws should not merely consider jaws reposition for occlusal correction but also to improve several outcomes in terms of facial aesthetics, soft tissue support, temporomandibular joint function, and preservation or enlargement of the upper airway volume.

For these purposes, the BL protocol has been proven as an adequate and predictable tool for diagnosis and surgical planning of DFD, which is used to trace the most aesthetic and functional sagittal position of the maxilla. In the diagnostic field, only a profile smiling picture with the patient in the NHO position suffices to evaluate its relation with the upper incisor, making clinical diagnosis easier and less invasive than radiologic analysis. On the other hand, surgical planning entails in most cases expansive maxillomandibular movements, regardless of the initial occlusal situation of the patient, or the amount of maxillomandibular discrepancy. Consequently, besides the good aesthetic results, it also improves soft tissue support providing an anti-aging effect and enlarges the upper airway volume, solving most sleep-related breathing disorders.

Finally, proper perinasal and upper lip soft tissue management after OS in terms of a subspinal osteotomy, an alar cinch suture, and a V–Y closure of the mucosa are essential to achieve better outcomes.

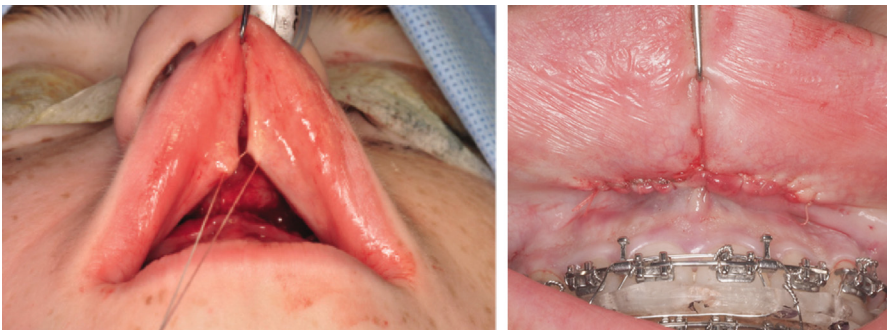


Fig. 9. V–Y closure of the mucosa to improve upper lip projection.



Fig. 10. Upper lip projection and length before and after V-Y closure of the mucosa.

CLINICS CARE POINTS

- Before starting surgical planning, ensure proper natural head orientation position of the virtual head.
- Use patient-tailored surgery instead of standardized surgeries according to patient's and surgeon's preferences.
- When deciding the sagittal maxillary position, keep in mind the volume and quality of the upper lip area.
- When pharyngeal airway is assessed, both volume and areas of constriction should be taken into account.

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