Bimaxillary Protrusion: An Overview of the Surgical-Orthodontic Treatment

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ABSTRACT

Bimaxillary protrusion is a commonly seen deformity in Asian populations. This condition is characterized by protrusive and proclined upper and lower incisors and an increased procumbency of the lips. It is usually combined with lip incompetence, gummy smile, mentalis strain, and anterior open bite. Facial aesthetics is the primary concern of these patients. Successful treatment depends on a thorough evaluation and understanding of this dentofacial deformity. Typical orthodontic treatment includes retraction and retroclination of maxillary and mandibular incisors after extraction of the four first premolars. Orthognathic surgery is required to correct significant skeletal problems. Anterior subapical osteotomies and extraction of premolars can correct sagittal excess of the jaw bones and relieve dental crowding. Segmental maxillary osteotomies are performed to treat patients with an associated exaggerated curve of Spee and vertical maxillary excess. Differential intrusion of anterior and posterior maxilla/maxillary segments with clockwise rotation of the occlusal plane is a useful technique for treatment of anterior open bite and creation of a consonant smile arc. Le Fort I osteotomy with setback sometimes provides an alternative to segmental maxillary osteotomies. Meticulous planning and execution of osteotomies in accordance with surgical planning are essential for aesthetic and functional outcome.

KEYWORDS: Bimaxillary protrusion, Wassmund, Kölle, one-splint technique, Asian, aesthetic surgery

Bimaxillary protrusion is one of the most prevalent dentofacial deformities in the Asian population. Bimaxillary protrusion refers to a protrusive dentoalveolar position of maxillary and mandibular dental arches that produces a convex facial profile. Orthodontic treatment alone or combined with orthognathic surgery are treatments of choice. Orthodontic treatment often involves extraction of the four first premolars with subsequent retraction and/or up-

righting of the incisors. When required, orthognathic surgery may include some combination of Le Fort I osteotomy, bilateral sagittal split ramus osteotomy (BSSO), and upper and lower anterior subapical osteotomies (ASOs). The goals of this article are to discuss (1) the clinical characteristics and treatment planning of bimaxillary protrusion in Asians and (2) the surgical techniques currently in use for correction of this deformity.

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CLINICAL CHARACTERISTICS OF BIMAXILLARY PROTRUSION

The main features of patients presenting bimaxillary protrusion are malocclusion with dentoalveolar flaring of both the maxillary and mandibular anterior teeth that cause protrusion of the lips and produce a convex facial profile. Bimaxillary protrusion is often accompanied by various degrees of lip incompetence (defined as a resting lip separation of more than 4 mm), mentalis strain, gummy smile, and anterior open bite. The typical anteroposterior relationship tends to be a class II malocclusion with mandibular deficiency, but it can be anything from severe class II to class III.

It should not be assumed that because a patient presents with incisor protrusion and lip incompetence or gummy smile that the appropriate diagnosis is bimaxillary protrusion. Lip incompetence and gummy smile are not necessarily caused by dentoalveolar flaring alone. Other causes exist. The assessment of the deformity and the treatment will therefore differ. Lip incompetence can be due to maxillary vertical excess or simply produced by having a short upper lip. Simple incisor retraction will not treat either problem. As for the gummy smile, it can be simply caused by a short upper lip or by an incomplete passive crown eruption (crown length less than 9 mm).¹ One must evaluate carefully individual physical sequelae as there might be separate or coexisting problems that require their own treatment plan. Examples of such treatments are periodontal crown lengthening and/or cheiloplasty combined with orthognathic surgery.

TREATMENT PLANNING

Facial aesthetics are the patient's most important concern when they seek treatment for bimaxillary protrusion. However, careful and complete skeletal, dental, and soft tissue evaluation must be performed. This includes clinical examination of the patient, analyzing cephalometric and panoramic studies, as well as performing prediction tracings and dental model studies. Keeping in mind the patient's aesthetic concerns as well as dental function are key to treatment success.

Skeletal assessment includes examining for symmetry and anteroposterior and vertical position of both the maxilla and mandible. It also includes assessing the health of the temporomandibular joint and of the mandibular ramus. Pathologic lesions must be ruled out.

Dental assessment consists of verifying the occlusion type, dental crowding, incisor inclination, presence of anterior open bite or deep bite, posterior cross-bite, and arch coordination.

Soft tissue evaluation includes both static and dynamic assessment. The following findings are noted: proportion of the face (rule of thirds), facial profile, nasolabial angle, mentolabial fold, interlabial gap, rest-

ing lip posture, mentalis strain, presence of gummy smile, anterior teeth show at rest and during smile, as well as an assessment of the smile arc.²

If orthodontic treatment alone is judged insufficient to correct dentoalveolar flaring, surgery is considered. The simplest procedure for minor cases of bimaxillary protrusion would consist of four first premolar extractions and performing anterior segmental osteotomies of the mandible and maxilla through the extraction sites. The goal would be to setback the segments as well as reduce the labial flaring of the incisors. However, other procedures are often needed to solve these cases appropriately.

Vertical maxillary excess can be corrected by superiorly repositioning the maxilla via a Le Fort I osteotomy with or without segmental osteotomies. If one moves the maxilla superiorly without operating on the mandible, the mandible will need to rotate to come into occlusion with this new (more superiorly placed) maxillary occlusal plane. The chin point will therefore move upward and forward. For a patient with mandibular deficiency, the effect of this mandibular repositioning can be quite useful. In contrast, differential intrusion of anterior and posterior maxilla with clockwise rotation of the occlusal plane coupled with a BSSO setback can counter this unwanted effect in some patients with class III skeletal problems. Differential maxillary intrusion can also provide treatment for an anterior open bite as well. This rotation technique of the maxillo-mandibular complex can improve the smile arc in most of our patients and resting lip posture in some of them (Fig. 1).

Segmental maxillary osteotomies after a formal Le Fort I osteotomy can be used to correct remaining step deformities in the curve of Spee. Simultaneously, the posterior segments can also be split for better arch coordination (transverse maxillary plane adjustment). BSSO to advance or setback the mandible and mandibular inferior border osteotomy to reposition the chin (vertical elongation or advancement) are added as required by individual cases.

SURGICAL TECHNIQUE

The surgical treatment plan for the patient with bimaxillary protrusion may include some combinations of the Le Fort I osteotomy, BSSO, and upper and lower ASOs. At our center, we prefer to use only a final splint, and the mandibular osteotomy is performed first. Surgical steps are summarized in Table 1.

Bilateral Sagittal Split Ramus Osteotomy

The technique of BSSO performed at our center is modified from that described by Hünsuck.³ The anterior osteotomy is extended anteriorly, to about 1 cm posterior to the mental foramen (around the position of the first

Figure 1 (A) A 24-year-old woman with bimaxillary protrusion. Preoperative frontal view. (B) Preoperative profile view. (C) Preoperative frontal smile. Note the relatively flat smile arc and gummy smile. (D) Twelve months after Le Fort I three-piece osteotomy, Kölle procedure, and genioplasty; postoperative frontal view. (E) Postoperative profile view. (F) Postoperative frontal smile. Note the consonant smile arc.

Table 1 Step-by-Step Correction of Bimaxillary Protrusion with the "One-Splint Technique"

Step	Surgical Site	Description
1	Mandible	Bilateral sagittal ramus osteotomy without splitting
2		Premolar extractions, ASO, and segment fixation with interdental wires
3		Bilateral sagittal split osteotomy completion
4	Maxilla	Premolar extraction and creation of palatal tunnels
5		Le Fort I osteotomy
6		ASO
7	Chin	Posterior segmentalization as needed
8		IMF, osteosynthesis of the maxilla followed by the mandible
9		Genioplasty as needed
10		IMF release. Verify for centric occlusion and centric relation.

molar). This facilitates later intraoral placement of plate and screws. The medial cortex of the mandibular angle stays with the proximal segment during splitting. Full detachment of the pterygomasseteric muscle sling and osteotomy of the medial cortex of the mandibular angle are then accomplished. This technique allows for a greater amount of mandibular repositioning with good long-term stability.⁴ Simultaneous mandibular angle contouring is a common adjunct procedure for facial enhancement in Asian females with a "square-face" deformity.⁵ The medial cortex of the mandibular angle, on the proximal segment, can also provide good-quality bone grafts if necessary.⁶

Anterior Subapical Osteotomy of the Mandible (Kölle Procedure)

When upper and/or lower ASOs are to be performed, they can be done through the extraction spaces. Typically, these are the bilateral first premolars. The extractions can be done either at the time of surgery or earlier during presurgical orthodontic treatment. Alternatively, interdental osteotomies can be performed between parallel roots of the canines and premolars or as required by individual cases.

The soft tissue dissection and exposure is very similar to a genioplasty. Bilateral mental nerves are identified and well preserved during dissection. The labial periosteal-gingival bridges at the sites of extraction or interdental osteotomy are kept intact to avoid a vertical scar that may be apparent during smile and to preserve an optimal blood flow to the anterior segment. The subperiosteal dissection proceeds lingually in the zone where the osteotomy will be performed. Lingual dissection on the future segment should be minimal to prevent damage to its blood supply, which is derived from the mucoperiosteal bridges and the remaining attachment of the genioglossus muscle.

The osteotomy lines are marked with a pencil (Fig. 2). The horizontal osteotomy line is drawn at least

5 mm inferior to the canine roots. If a genioplasty will be performed, an adequate bony bridge must be maintained to avoid an unplanned fracture of the mandible. Because the mental nerve canal is known to sometimes loop up to 5 mm anterior to its foramen, the vertical osteotomy lines are designed to not encroach within 5 mm of the mental foramen. Adequate bone (at least 1 mm) to support the roots of the adjacent teeth, usually canine and second premolars, should be preserved.

The osteotomies are accomplished with a combination of burs and saws. After complete mobilization of the segment, it is fitted into position according to the dental cast and surgical splint. Care is taken to optimally position the segment with proper incisor inclination. One must understand that the splint can only control the tip of the crowns, but does not prevent improper inclination of the segment. The surgeon needs to refer to the dental cast during these adjustments. Any unwanted vertical discrepancy of the arch must also be eliminated.

Figure 2 Marking the osteotomy lines for the Kölle procedure.

Once the segment is in a satisfactory position, temporary interdental wires are placed across the osteotomy sites. If a BSSO is necessary, we perform the bilateral sagittal ramus osteotomies without fracture (splitting) completion, then the Kölle procedure, followed by completion osteotomies of the mandibular ramuses for better control of the segment (Table 1).

Le Fort I Osteotomy

The Le Fort I osteotomy is performed in accordance with that described by Bell and Proffit.^{7,8} The lateral and medial maxillary wall osteotomies are parallel to the occlusal plane (Fig. 3) instead of being in a “high horizontal” position or with an “anterior step-cut.” This technique is quite straightforward and will not result in any vertical positional change during sagittal repositioning of the maxilla.

The osteotomy of the pterygomaxillary suture is made with a right-angled oscillating saw. This makes a full-thickness cut through the junction. A thin osteotome, 10-mm wide, is used to cut the parts of the medial, lateral, and posterior maxillary walls that have remained intact. A Dautrey-Munro curved osteotome is then reinserted in the pterygomaxillary junction to verify the completeness of the saw osteotomy (Fig. 4). If the osteotomies are performed correctly, downfracture of the maxilla can be completed with simple digital pressure. This is thought to prevent uncontrolled propagation of potential fracture lines or deforming force to the orbital apex and skull base, as has been reported with classic forceful downfracture of an incompletely osteotomized maxilla. We have had no

Figure 3 Le Fort I osteotomy.

major complications with this technique, such as visual disturbances.^{9,10}

Maxillary Repositioning after Le Fort I Osteotomy

Maxillary setback and/or intrusion (impaction) are frequently required for adequate treatment of bimaxillary protrusion. Concomitant setback and intrusion of the maxilla are often quite difficult to perform because of bony interference in areas that can be difficult to access for the surgeon. To facilitate this kind of maxillary repositioning, bone can be removed from three critical areas: (1) the pterygoid process (we typically prefer not to

Figure 4 (A) Osteotomy of the pterygomaxillary suture with a right-angle oscillating saw. (B) Pterygomaxillary disjunction with a Dautrey-Munro osteotome.

fracture the pterygoid process to prevent intraoperative bleeding and provide a better posterior buttress for the maxilla); (2) the maxillary tuberosity; (3) the junction with the palatine bone after extraction of the third molars.

Maxillary setback alone can sometimes provide an alternative for treating maxillary excess without any extraction or upper anterior segmental osteotomy in the following situations: (1) there is no orthodontic reason for extracting the anterior teeth (there is no dental crowding, the curve of Spee is adequate, etc.); (2) the upper incisors proclination can be treated adequately with a Le Fort I osteotomy and clockwise rotation.

Anterior Subapical Osteotomy of the Maxilla (Wassmund Procedure)

As in the lower arch, ASO of the maxilla can be done through extraction spaces or with interdental osteotomies. At our center, typically the first premolars are extracted at the time of orthognathic surgery and osteotomies are performed through these spaces. After extraction, the palatal mucosa is elevated subperiosteally. The subperiosteal tunnels meet in the midline. Preserving the mucoperiosteum integrity is critical as it is the main blood supply to the segment. The width of the palatal tunnel should be around 10 to 12 mm. This will prevent the palatal mucosa from kinking after setback (Fig. 5). If a Le Fort I osteotomy is part of the surgical plan, it is made at this time (Table 1). The labial gingival bridges at the sites of extraction or interdental osteotomy are kept intact to avoid a vertical scar that could show during smiling.

The osteotomy lines for the ASO are drawn. The horizontal osteotomy of the Le Fort I or ASO should be kept at least 5 mm above the canine roots. The lateral osteotomies of the ASO should be designed according to the upper incisor angulation. Some bone has to be

Figure 5 Creation of a palatal tunnel for the Wassmund procedure.

Figure 6 Marking the osteotomy lines for the Wassmund procedure. Note the wedge-shaped osteotomy area.

removed to allow for adequate repositioning of the anterior segment. These “osteotomies” are usually of a trapezoid or wedge shape at either end of the segment (Fig. 6). This will facilitate rotation of the segment to correct incisor proclination and provide good bony contact. At least 1 mm of bone should be preserved around teeth roots at all times.

The osteotomy is done carefully while protecting the surrounding soft tissues. If a three-piece Le Fort I osteotomy is indicated, parasagittal split of the posterior maxillary segment is performed (Fig. 7).

Pearls for the “One-Splint” Technique

At our center, we prefer to use only one final occlusal splint. We believe that this allows better three-dimensional positioning of the maxillo-mandibular complex (MMC), especially in cases of facial asymmetry. We

Figure 7 Parasagittal split of posterior maxillary segments.

Figure 8 (A) Facial proportions. (B) Rickett's E-line in Asians.

believe that the aesthetic results are also superior as the position of the MMC can be adjusted on the table. After the completion of all osteotomies, the patient is put into intermaxillary fixation (IMF) with a single final splint. The maxilla is temporarily fixed with wires according to the surgical plan. The sagittal, transverse, and vertical dimensions of the facial appearance including dental and facial midlines, symmetry, dental display, and profile are evaluated and adjustments are made accordingly.

Landmarks such as glabella, nasal tip, tip of Cupid's bow, upper dental midline, lower labial frenulum, and nasal pyriform aperture are checked to determine a coherent dental and facial midline. To determine an adequate teeth show, the nasal base is gently pushed into anatomic position to compensate for nasotracheal tube traction. Experience has shown that maxillary incisor display between 2 and 3 mm is reliable with this technique. The distance between lower eyelid margins and mouth corners should be symmetric. In the profile view, the nasolabial angle, lip protrusion, soft tissue pogonion, and facial proportions are examined. A ruler is used to estimate if all the pertinent landmarks conform to Rickett's E-line (Fig. 8).

After all these intraoperative criteria for symmetry and aesthetics have been met, osteosynthesis of the maxilla is performed. The mandible is then fixed intra-orally with two 2.0-mm plates bilaterally (Fig. 9). The IMF is released and the occlusion is double-checked.

Genioplasty

If it was established earlier that a genioplasty was required, the IMF is re-done. Genioplasty is performed last. It is a powerful tool to achieve better facial proportions, more pleasing profile, and to restore lower-face symmetry. The osteotomy line should stay at least 5 mm below the mental foramen to avoid inferior alveolar nerve injury.

DISCUSSION

All patients should be informed of possible apparent upper lip lengthening, deepening of nasolabial folds, and widening of the nasal base after surgery. With aging, the soft tissue sagging makes these effects more evident. Decreased gingival display during smiling and decreased dental display at rest can also develop. It is crucial to reach a fine balance between optimal anterior dentoalveolar retraction and preservation of some lip fullness. Although we prefer to use the "one-splint" technique, we sometimes still perform a traditional two-splint technique depending on the orthodontist. The surgical sequence will be different (Table 2). All the intraoperative guidelines mentioned previously are still verified intraoperatively. If there are any doubts about the final facial aesthetics, the case is discussed with the orthodontist and adjustments are made on the table.

Figure 9 The plate and screw fixation for BSSO.

Table 2 Step-by-Step Correction of Bimaxillary Protrusion with the Classic "Two-Splint Technique"

Step	Surgical Site	Description
1	Mandible	Bilateral sagittal ramus osteotomy without splitting
2	Maxilla	Premolar extractions and creation of palatal tunnels
3		Le Fort I osteotomy
4		ASO
5		Posterior segmentalization
6		IMF with intermediate splint. Osteosynthesis of maxilla.
7	Mandible	Premolar extraction, ASO, and segment fixation with interdental wires
8		Bilateral sagittal split osteotomy completion
9		IMF with final splint. Osteosynthesis of the mandible.
10	Chin	Genioplasty as needed
11		IMF release. Verify for centric occlusion and centric relation.

CONCLUSION

Successful treatment of patients with bimaxillary protrusion depends on careful listening to the patient's concerns and establishing a personalized treatment plan with the orthodontist. Improvement in facial aesthetics is usually the most important concern of patients with bimaxillary protrusion who seek treatment.

Extraction of premolars and anterior subapical osteotomies can correct sagittal excess of jaw bones and relieve dental crowding. Segmental maxillary osteotomies are adopted to treat patients with an exaggerated curve of Spee and vertical maxillary excess. Differential intrusion/impaction of anterior and posterior maxilla/maxillary segments with clockwise rotation of the occlusal plane is a useful technique for treatment of anterior open bite. It has the added advantage of creating a consonant smile arc. Le Fort I osteotomy with setback sometimes provides an alternative to segmental maxillary osteotomies. Meticulous planning and execution of the osteotomies in accordance with the surgical plan are essential for optimal aesthetic and functional outcomes.

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