

Correction of vertical maxillary excess by superior repositioning of the maxilla

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ABSTRACT

يعد تشوه الفك العلوي ذو البعد العمودي (VME) واحداً من اضطرابات نمو الفكين الخلقية ويتميز عادة بظهور جزء من اللثة وكامل القواطع الأمامية أثناء الضحك بصورة غير مقبولة جمالياً وقد يصاحب بعيوب وتشوهات أخرى. يصحح هذا التشوه جراحياً بتقصير الارتفاع العمودي للفك العلوي، وقد يترافق هذا مع عمليات مقدمة الفك العلوي وكذلك عمليات الرد الصاعد في الفك السفلي حتى يتسنى تصويب العلاقة بين الفكين، ويشمل العلاج كذلك في بعض الحالات عمليات أخرى كعملية تجميل الذقن، إذ يعتقد أن لهذه العملية دور في تحسين المظهر الجمالي للوجه وكذلك الأداء الوظيفي. تعرض هذه الورقة العلمية الدور الإيجابي للأسلوب الجراحي في إصلاح التشوهات الخلقية للفك العلوي ذو البعد العمودي ومدى ما تحقق في 4 مرضى يعانون من نمو الفك مع أو بدون تشوهات العظام. يدرك التطور الملحوظ للوجه بإشارة المرضى للأهمية القصوى لجراحة تقويم الفكين، وعلاقته مع تشوه الفك العلوي ذو البعد العمودي ووسائل عمليات انحشار الفك والإجراءات المساعدة.

Vertical maxillary excess (VME) is frequently referred to as one variation of maxillo-mandibular discrepancy, which is often identified by excessive display of incisors and gingiva during smiling. This anomaly is corrected surgically by superior maxillary impaction, which can be combined by other procedures such as, anterior maxillary segmental osteotomy to relieve the maxillary protrusion, or mandibular osteotomy in the form of ramus surgery, or subapical osteotomy to correct the maxillary-mandibular relationship, and to obtain functional occlusion. Adjunctive procedures are undertaken to counteract the associated soft tissue changes, and to establish functional and esthetic facial balance. This article subjectively reports the results of superior repositioning of the maxilla in 4 patients with excessive maxillary growth, with or without other skeletal deformities. The remarkable improvements in facial appearance perceived by patients suggest the best value of orthognathic surgery in the correction

of VME by means of maxillary impaction osteotomy and other adjunctive procedures.

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In many patients with maxillo-mandibular deformity, disproportionate growth of the maxilla causes long facial appearance that is known as vertical maxillary excess (VME). The deformity presents most often in a vertical dimension, with or without anteroposterior or transverse discrepancy. Excessive gingival display (gummy smile) is regarded as the hallmark of this deformity that is essentially not related to altered passive eruption, or short clinical crown of upper anterior teeth, nor hyperactivity or shortage of the upper lip.¹ The facial contour of these patients is often characterized by a long, tapering face with anterior and posterior maxillary overgrowth, a narrow alar base, lip incompetence with a high palatal vault, and a narrow maxillary arch. The mandible appears to be deficient owing to the downward mandibular rotation by the excessive vertical development of the maxilla.² Cephalometric analysis demonstrates steep mandibular and occlusal planes in relationship to the cranial base, and an increase mostly in the anterior facial height with retroposition of the mandible.³

Surgery is very important to correct this deformity, and to achieve esthetic and functional outcomes. The surgical approach involves mainly the upward movement of the entire maxilla, with or without anterior segmental

osteotomy. The maxilla may be sectioned to more than one piece in conjunction with the Le Fort I osteotomy, and it may be combined with mandibular bilateral ramus osteotomy and genioplasty.⁴ The best result is achieved when surgical correction is combined with orthodontic treatment, hence, presurgical orthodontics is aimed to correct teeth alignment, and remove any dental compensation that precludes good dental interdigitation at surgery.⁵ Thus, presurgical orthodontic treatment is expected to produce a significantly much simpler treatment course reducing postsurgical orthodontic time, and allows better overall result.^{6,7} It is believed that superior repositioning surgery in VME would improve both the morphological and functional deficits, resulting in normalization of the facial profile.^{8,9} The overall improvement in facial appearance in addition to stability, and the predictability of the results have made orthognathic surgery the most versatile and effective procedure when carried out with good planning, proper execution, and attention to detail. This paper reviews the surgical protocol, and presents 4 different cases of VME managed by superior repositioning of the maxilla and other orthognathic surgical procedures.

Case Report. *Patient 1.* A 22-year-old female patient presented to the Oral and Maxillofacial Surgery Clinic of King Saud University, Riyadh, Kingdom of Saudi Arabia (KSA) with a chief complaint of maxillary protrusion. She gave a history of orthodontic treatment with extraction of the 4 bicuspids. Her profile demonstrated a marked bimaxillary protrusion with excessive display of an entire incisor crown, and almost 5 mm of the gingiva during smiling (Figures 1a-c). Intraoral and panoramic radiograph showed evidence of prolonged orthodontic treatment with significant mesial drifting of upper and lower posterior teeth as a result of loss of orthodontic anchorage following extraction of the first bicuspids (Figures 1d & e). A lateral cephalogram verified protrusion of premaxilla, but with a marked retroclination of the upper and lower anterior teeth (Figure 1f). The angle between Sella-Nasion line and Nasion-A point line (SNA) was 87.1° , and the angle between Sella-Nasion and Nasion-B point line (SNB) was 79.5° while the angle between Nasion-point A and Nasion-point B (ANB) was 7.7° , and the mid-facial length was 96.6 mm. The problem was identified as a bimaxillary protrusion with excessive vertical height of the maxilla. On the basis of cephalometric computer prediction and model osteotomy, the treatment plan was to impact the maxilla, and set back the upper and lower jaws by anterior segmental osteotomy after extraction of the first molars, and to improve chin prominence by sliding genioplasty. The pre-surgical orthodontic

treatment was aimed to correct the inclination of the upper and lower anterior teeth. She was accepted as a teaching case, and under general anesthesia, she underwent a Le-Fort I osteotomy to impact the maxilla with simultaneous anterior segmental osteotomy procedure for upper and lower jaws using the basis of Cupar and Kole modification techniques to eliminate the bimaxillary protrusion, following extraction of the upper and lower first molars. Maxillary impaction allowed upward movement by 7 mm anteriorly, and 5 mm posteriorly, and the anterior maxillary segment was moved backward at an average of 5 mm. The nasal septum was trimmed in accordance with the amount of superior positioning of the maxilla. The segmental subapical osteotomy in the lower jaw allowed elimination of mandibular protrusion by approximately 5 mm, and the clinical facial profile improved by inferior border advancement genioplasty. The mobilized maxilla and anterior maxillary and mandibular segments were all stabilized in a new position intraoperatively using archwire, and prefabricated surgical stents. Fixation of the maxilla and anterior mandible segment in addition to the genioplasty were accomplished in the pre-planned position using titanium plates and screws. At the vertical cuts between the second premolar and second molar, intersegmental fixation was re-enforced by wire loops. She was followed up for more than one year post-surgically, and good facial harmony in resting, and smiling positions were achieved (Figures 1g-i). The nasolabial angle, nasal projection, and lip competency were all improved, and the nasal changes with maxillary impaction was minimal, and of no clinical significance. Post-surgical orthodontic treatment was initiated 3 months after surgery, and aimed to normalize the occlusion, and to close the residual spaces. The occlusion was established in class I canine relationship with normal overbite and overjet, but with relatively inadequate dental digitation posteriorly (Figure 1j). The final results were very much appreciated by the patient, and she therefore, chose to discontinue the orthodontic treatment in the first year of her post-surgical orthodontic course. As shown in Figures 1k & l, the post treatment lateral cephalogram and superimposed cephalometric tracings demonstrated upward impaction of the maxilla, and backward movements of the anterior maxillary and mandibular segments. The post-surgical analysis showed relative improvement in SNA (86.6°), SNB (79.7°), and ANB (6.7°) angles as they appeared. The length of the mid-face reduced to 93.5 mm, and the chin was enhanced with advancement genioplasty.

Patient 2. A 27-year-old woman was referred from the Orthodontic Clinic to the Oral and Maxillofacial Surgery Clinic, King Saud University, Riyadh, KSA

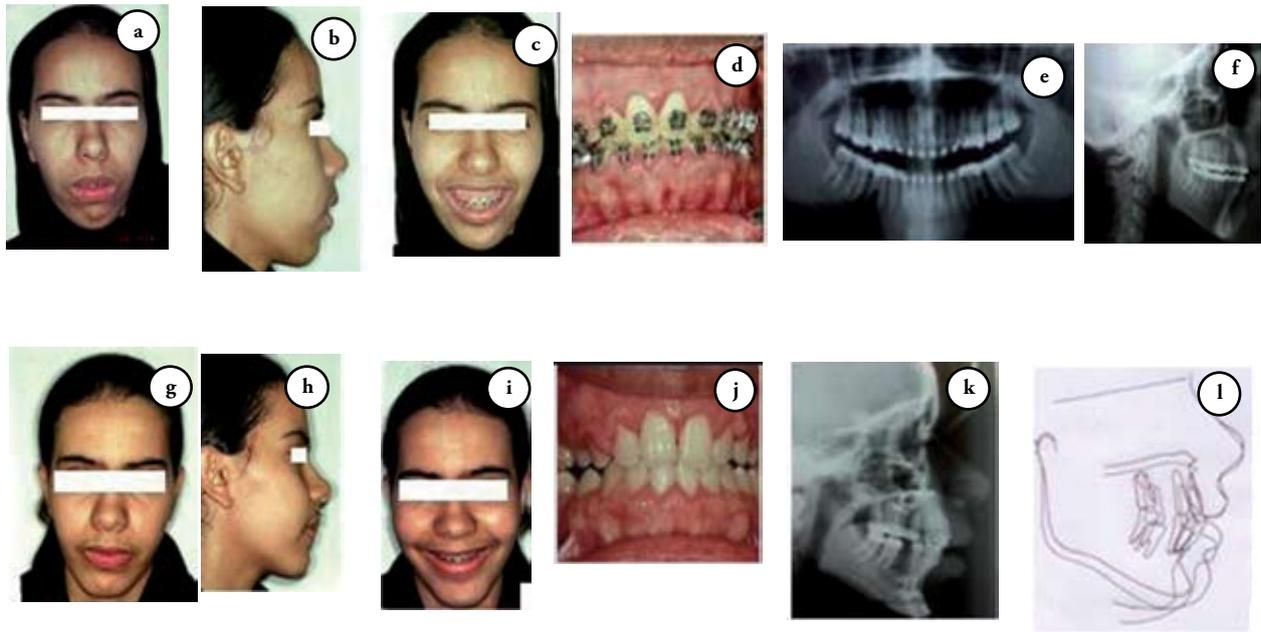


Figure 1 - Profile of patient one showing, a - d) presurgical facial and intraoral photograph, e and f) presurgical radiograph, g - j) postsurgical facial and intraoral photographs, k and l) postsurgical radiographs and superimposed tracing

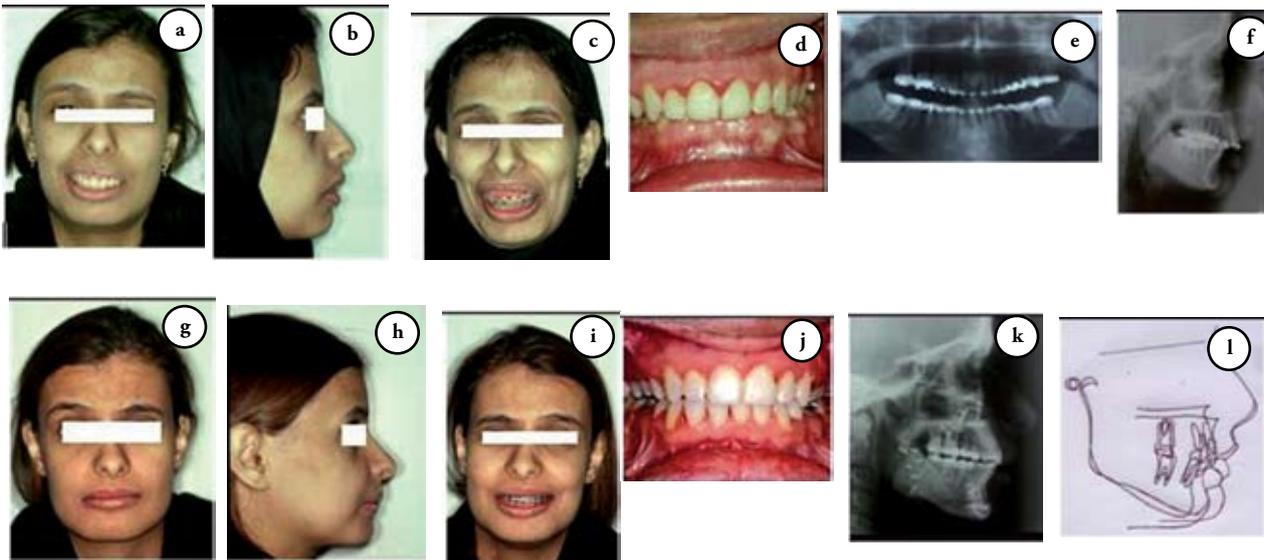


Figure 2 - Profile of patient 2 showing, a - d) presurgical facial and intraoral photograph, e and f) presurgical radiograph, g - j) postsurgical facial and intraoral photographs, k and l) postsurgical radiographs and superimposed tracing

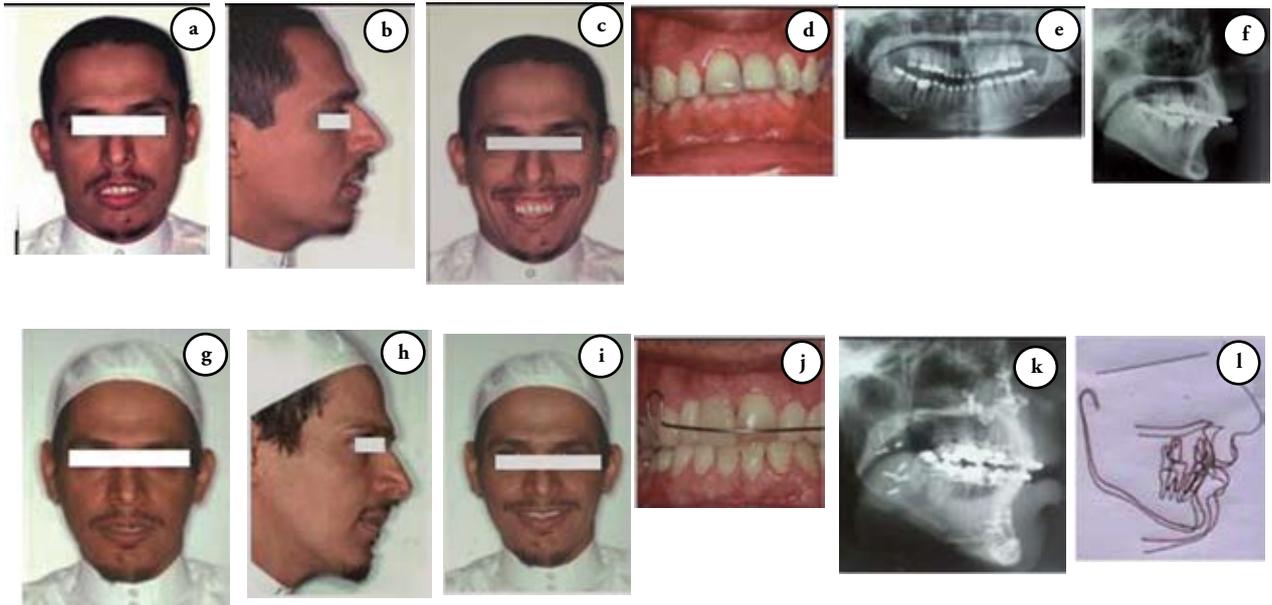


Figure 3 - Profile of patient 3 showing, a - d) presurgical facial and intraoral photograph, e and f) presurgical radiograph, g - j) postsurgical facial and intraoral photographs, k and l) postsurgical radiographs and superimposed tracing

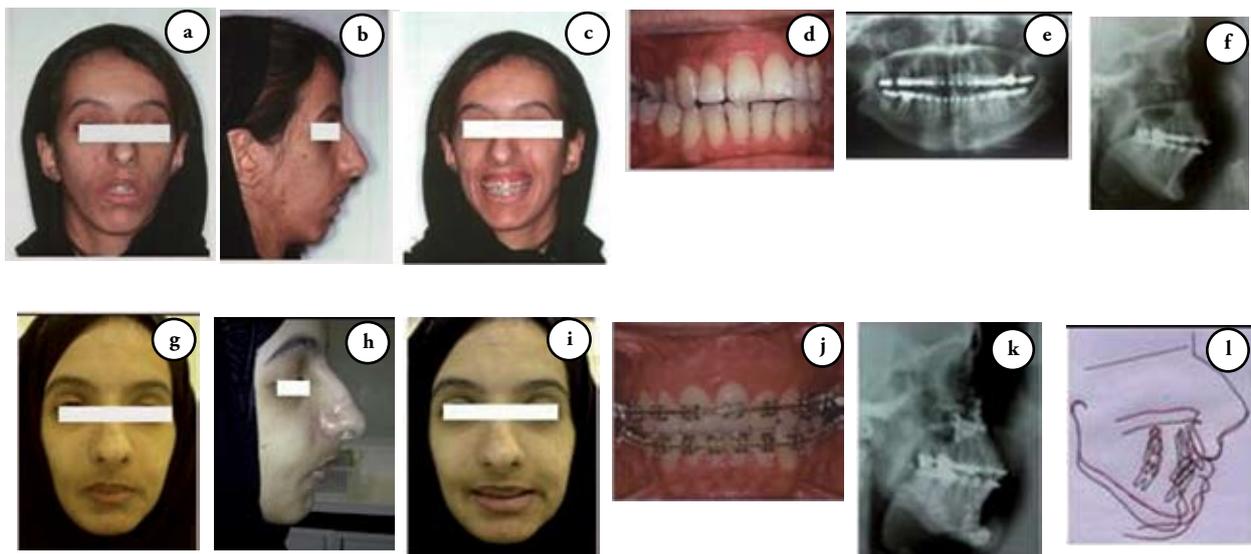


Figure 4 - Profile of patient 4 showing, a - d) presurgical facial and intraoral photograph, e and f) presurgical radiograph, g - j) postsurgical facial and intraoral photographs, k and l) postsurgical radiographs and superimposed tracing

with a chief complaint of maxillary protrusion. The pretreatment facial profile demonstrated a marked protrusion of the maxilla, and an increase in vertical maxillary height (Figures 2a-2c). The lower jaw was apparently in retrognathic position, and the chin was deficient. Intraorally, there was an anterior deep bite of 10 mm for the overjet and the overbite (Figure 2d). Further radiographical examination demonstrated excessive vertical facial height (95.5 mm), and maxillary protrusion with significant mandibular shortening (Figures 2e & 2f), and the diagnosis was VME with mandibular retrognathism and retrogenia. The SNA was recorded as 88° , SNB was 78° , and ANB was 10.3° . The presurgical orthodontics were carried out for almost 2 years to level the arch, and to correct the curve of Spee. The surgical plan was impaction of the maxilla, and advancement of the mandible and chin. Surgery was performed under general anesthesia after obtaining her consent as a teaching case. The maxilla was impacted 6 mm simultaneously with maxillary setback via tuberosity osteotomy by 3 mm. Impaction of the maxilla was achieved via a high Le Fort I osteotomy utilizing an alternative approach to pterygomaxillary separation, and facilitated by sufficient reduction of the nasal septum and the palatal septal crest. This was followed by advancement of the lower jaw (5 mm) utilizing bilateral sagittal split osteotomy (BSSO). The facial profile was further improved with sliding genioplasty of approximately 4 mm. The principle of rigid fixation was utilized for upper and lower jaw osteotomies using titanium miniplates and screws, and lag screws for BSSO. Three months after surgery, orthodontics was initiated for final alignment and occlusal adjustment. The protrusive and elongated mid-facial appearance was significantly improved in resting and smiling positions (Figures 2g-2i). The nasal projection was maintained as it was with no clinical changes in the nasal base, and both lips were in competent posture. The severe deep bite and overjet were corrected, and the occlusion was normalized in Class I canine and molar relationship (Figure 2j). The post-treatment lateral cephalogram and superimposed cephalometric tracings showed marked upward movement of the maxilla with mandibular advancement, and the chin in new position (Figures 2k & 2l). Analysis of SNA was recorded as 85.2° , SNB was 82.9° , and ANB was 2.3° angles postsurgically, and the mid-facial length was 93.6 mm.

Patient 3. A 34-year-old man presented to the Oral and Maxillofacial Surgery Clinic, King Saud University, Riyadh, KSA with a chief complaint of maxillary protrusion and gingival display on smiling. Clinical examination revealed excessive vertical clinical facial height associated with deep bite (Figures 3a-3c).

Intraorally, the overjet was 9 mm, and the overbite showed to be more than 5 mm (Figure 3d). The SNA was 83.5° , SNB was 74.7° , and ANB was 8.8° . The problem was identified as VME and mandibular retrognathism, and confirmed by radiographical analysis (Figures 3e & 3f). He underwent presurgical orthodontic to align the teeth, and to correct the curve of Spee for a period of almost 2 years. On the basis of clinical and radiographical analysis utilizing the cephalometric prediction, the surgical treatment plan was performed on the study model, and includes impaction of the maxilla for 6 mm, and to allow mandibular advancement via ramus osteotomy.

Under general anesthesia, impaction of the maxilla by 6 mm was performed with reduction of nasal septal cartilage and palatal septal crest. In conjunction with spontaneous mandibular autorotation, BSSO was performed for a setback movement of the mandible for 2-4 mm. Sliding genioplasty by 4 mm was considered to improve the facial profile. The clinical outcomes of orthognathic surgery demonstrate significant improvement in the profile, and in the midfacial vertical height (94.7 mm) for resting and smiling position (Figures 3g-i). The postsurgical orthodontic treatment was carried out to establish a stable occlusion, resulting in class I canine and molar relationships, and a normal overjet and overbite (Figure 3j). The lip competence was attained successfully compared to 12 mm interlabial gap preoperatively, and the nasolabial angle increased slightly, but with acceptable nasal widening. The post-treatment lateral cephalogram and superimposed cephalometric tracings showed a marked movement of the maxilla in upward direction (Figures 3k & 3l) with improvement of SNA to 77.4° , SNB to 76° , and ANB to 1.4° .

Patient 4. A 23-year-old woman was referred from the Orthodontic Clinic to the Oral and Maxillofacial Surgery, King Saud University, Riyadh, KSA for surgical correction of facial deformity. Front view and lateral profile demonstrated increased clinical facial height with marked gingival exposure on smiling. The zygomatic bones and chin were both deficient, and the mandible was lying in the retrognathic position (Figures 4a-4c). Intraorally, she had bilateral posterior cross bite, deep anterior overbite and increased overjet, and the palate was in the form of a V shape. After clinical and radiographical evaluation (Figures 4d & 4f), she was diagnosed with VME associated with excessive gingival display, severe transverse discrepancy, retruded mandible and retrogenia with bilateral zygomatic hypoplasia. The SNA was 77.9° , SNB was 74.2° , and ANB angle was 3.7° , and the mid-face length was 79.1⁰ mm. The first stage of treatment was aimed to correct

the transverse discrepancy by surgically assisted-rapid palatal expansion (SA-RPE). Surgery was performed under general anesthesia utilizing the modification technique of Bell and Epker utilizing a Le Fort I osteotomy, anterior to the pterygopalatine junction, and with conjunction of mid-palatal section. The expansion of the maxilla was undertaken by activation of hyrax palatal expander in accordance with a setup protocol. This was followed by orthodontic treatment to close the created mid-line diastema, and to correct the arch form and the curve of Spee. The use of SA-RPE at this stage of the surgical management instead of 2 pieces Le Fort I osteotomy for the correction of both the vertical and transverse discrepancies was due to the maxilla being very small in size, and a staged procedure would always decrease operating time, and the likely postoperative complications. The surgical orthognathic plan was determined on the basis of cephalometric computer prediction, which includes impaction of the maxilla, and augmentation of the hypoplastic zygoma and microgenia, in addition to the improvement of maxillary mandibular relationship. The surgery was performed under general anesthesia in accordance to model osteotomy, and it included impaction of the maxilla by 8 mm, assisted by reduction of the nasal septal cartilage and palatal septal crest. The hypoplastic zygoma was augmented with onlay autogenous bone graft harvested from the anterior iliac crest. In conjunction with spontaneous mandibular autorotation, the mandibular position improved with BSSO, performed for a setback movement of 3 mm to normalize the occlusion posteriorly. The facial profile was improved further by advancement genioplasty for approximately 4 mm, and all osteotomy lines were stabilized using the principle of rigid fixation by titanium plates and screws.

The surgical outcomes demonstrated a remarkable improvement in patient profile, and the midfacial vertical height was significantly reduced (Figures 4g-4i). Although the nose appears to be relatively big for the face, a rhinoplasty was thought to be needed, which she declined for personal reason. Post-surgical orthodontic was carried out further to establish a stable occlusion in Class I canine and molar relationships, and to correct the overjet and overbite (Figure 4j). The post-treatment lateral cephalogram and superimposed cephalometric tracings showed a marked movement of the maxilla in the upward direction, and the SNA changed to 77.9°, SNB to 74.2°, and ANB to 3.7° (Figures 4k & 4l).

Discussion. Vertical deformity is one component of a wide spectrum of the dentofacial deformities. They present in the form of vertical excess, or vertical deficiency of the maxilla, or the mandible. They

sometimes exists in association with anteroposterior, transverse, and asymmetrical discrepancies. Vertical maxillary excess however, is a well recognized deformity, but with unknown pathogenesis.⁹ It has been described classically as the long-face syndrome (dysmorphic type), the most recognized variant of vertical deformity.¹⁰ Its correction demands a well-planned and orchestrated orthodontic preparation, followed by orthognathic surgery. Although the nature of the deformity in growing patients dictates primarily the restraint and control of the excessive vertical growth,¹¹ superior repositioning of the maxilla has proved to be a useful surgical method for adult patients with little, or no growth potential.⁴

While the amount of tooth and gingival exposure during smiling (gummy smile) is the main reason for seeking orthognathic surgery,¹ gingival display can be exaggerated by the length of the lips, their intrinsic muscle tone, the width of the mouth, and broad smile reflecting an individual's personality. Although, myoectomy and partial resection of the levator labii superioris, a procedure popularized by plastic surgeons, is attempted to approach the problem of upper gum exposure secondary to anatomical shortage of the upper lip, this procedure may not eliminate the cause of the deformity in maxillo-mandibular deficiency. The superior repositioning of the maxilla is the surgery of choice for the reduction of VME. It utilizes most often the Le Fort I osteotomy, or its modifications.⁴ High Le Fort I osteotomy is preferable when VME is accompanied by maxillary-zygomatic deficiency, but with normal naso-ethmoidal projection. This technique can be supplemented with augmentation of the malar bone with autogenous bone graft, or allograft materials.¹²

Setback movement of the maxilla is needed in conjunction with the reduction of vertical maxillary excess in patients who may present clinically with anterior maxillary protrusion. This movement is achieved by anterior segmental maxillary osteotomy (ASO), a procedure most frequently indicated for correction of vertical and/or anteroposterior excess of the maxillary alveolar process. Although, ASO is associated with variable complications, it is often prescribed for the correction of bimaxillary protrusion deformity in patients with acceptable posterior occlusion after the extraction of bilateral first bicuspids. It can be carried out simultaneously with the Le Fort I osteotomy utilizing the down fracture technique to approach the nasal apparatus.¹³ Furthermore, minimal setback of maxilla can be achieved via tuberosity osteotomy in conjunction with superior repositioning of the maxilla. This posterior movement must be insured with no direct negative effect on the posterior nasal pharynx, that

may compromise the air way. The transverse maxillary deficiency is traditionally corrected by orthopedic intervention in growing patients. However, the surgical technique of utilizing the principle of SA-RPE was used successfully to correct the transverse discrepancy.¹⁴ It is based on a latency period, and specific rate and rhythm of distraction. Despite the controversy in employing SA-RAE as the first stage of surgical management, it seems that the staged procedure has the advantages of decreasing operating time, and overall complications. The SA-RPE is aimed to widen the maxilla during presurgical orthodontics, and then a Le Fort I osteotomy is carried out to reposition it in one piece.

Superior repositioning of the maxilla leads to mandibular autorotation in forward and upward directions, and the magnitude of rotation is predicted often as a proportion of the amount of the superior impaction.¹⁵ Changes in the mandibular position after maxillary superior positioning is evident during model osteotomy performed on adjustable articulator and during cephalometric prediction. Following the determination of the proper position of the maxilla, the mandible is allowed to autorotate until the mandibular dentition contacts the maxillary dentition. At this point the mandible is appropriately related to the maxilla, and therefore, mandibular surgery may appear to be unnecessary. Slight discrepancy between the actual and ideal mandibular position is correctable with small movements of the maxilla in anteroposterior and/or vertical planes to accommodate the position of the autorotated mandible. Such adjustment must not compromise the planned ideal position that was determined previously. A large discrepancy on the other hand necessitates concomitant mandibular surgery by either advancement, or setback movements.

While genial segment or chin surgery is often contemplated to improve patient's facial balance, and to correct vertical discrepancy,¹⁶ chin surgery is assessed after repositioning of the maxilla and mandible to the surgically planned position, and the need for genioplasty is determined by the esthetic preference of the patient and surgeon. Several factors must be taken into consideration for genioplasty such as, the lower facial height, and the amount of soft tissue overlying the chin. One of the advantages of augmentation of the chin via inferior border osteotomy is that the ratio of soft tissue to hard tissue change is quite predictable. Patient one in this series showed severe maxillary excess associated with protrusion and convexity in profile, and the mesial drifting of the posterior teeth after orthodontic extraction contributed significantly to the complexity of this case. The backward movement of the maxillary anterior segment necessitates extraction of at least one tooth in each quadrant. Since the first bicuspids

were extracted during previous orthodontic treatment, extraction of either canines, or second premolars was not acceptable for esthetic reasons. The first molars were therefore, chosen for extraction in the course of surgical treatment allowing posterior movement of the anterior segment of the maxilla. Similar extractions performed in the mandible have allowed normalization of the occlusion, and the facial profile was improved by genioplasty. The bidirectional movement utilized in this case contributed to the marked improvement of the maxilla. Adding to the fundamental challenges in surgical correction of VME, patient 2 presented with VME and maxillary protrusion with mandibular deficiency that was associated with deep bite. The deep bite and curve of Spee were both corrected by the presurgical orthodontics. Alignment of the upper jaw was enhanced with posterior movement via tuberosity osteotomy, since upward movement of the maxilla alone would not reduce the maxillary protrusion, nor compensate for mandibular deficiency. Simultaneously, the mandibular advancement improved the facial profile and normalized the occlusion by both the mandibular autorotation and the BSSO. Patient 3 on the other hand presented with the same problem as patient 2, but with no maxillary protrusion. Following presurgical orthodontics, the maxilla was superiorly repositioned, and the maxillo-mandibular relationship was corrected by BSSO. Similarly, the chin improved with inferior border osteotomy. In patient 4, the transverse maxillary deficiency that accompanied VME, and the lower arch deficiency were the major challenges for patient management. Subsequent to palatal expansion, superior impaction of the maxilla shortened the clinical facial height, and the malar prominence improved with onlay bone grafting. The maxillo-mandibular relationship was corrected by ramus surgery, and the facial profile optimized by genioplasty.

In summary, the impaction of the maxilla in all presented cases was facilitated by partial resection of the nasal septum and palatal septal crest to prevent buckling and nasal deviation, and subsequent airway problems. The preservation of the nasal spine contributed significantly in the prevention of flaring of the nose, which was augmented by the application of alar cinch sutures. The impaction of the maxilla was performed in reference to the vertical holes and the external nasal pin by the removal of sufficient quantities of bone from the anterior and posterior parts of the maxilla, the mobilized maxilla fixed in its telescopic position with flush contact at the piriform region, and the zygomatico-maxillary junction in accordance to the preplanned position with 4 plates secured, and a minimum of 8 screw fixation. The maxilla and anterior segments were correctly placed in the planned position with the aid of

an intermediate stent, in reference to the mandibular dental arch, however, imperfect repositioning was corrected post-surgically with elastic traction. The upward movement varies from one case to another, and was always determined by the accepted labial exposure of upper anterior teeth. When the anterior or posterior open bite was forecasted following upward movements of the maxilla, the impaction is performed in 2 different levels in order to avoid shortening of the anterior or posterior facial height. Vertical repositioning of the maxilla has proven to be one of the most stable orthognathic surgeries, and with its increased stability, it offers a significant benefit, particularly for long-faced patients.

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