Subapical Anterior Maxillary Segmental Osteotomy: A Modified Surgical Approach to Treat Maxillary Protrusion

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Background: Anterior segmental osteotomy has become an established surgical technique to achieve functional occlusion and improve the facial profile in the treatment of maxillary protrusion. Postoperative nasal changes, however, are somewhat unpredictable. The here presented subapical anterior maxillary segmental osteotomy has been developed to avoid such unintended nasal changes.

Patients and Methods: Thirty-two patients (29 women and 3 men; age range, 18–40 y; mean age, 22 y) with maxillary protrusion underwent subapical anterior maxillary segmental osteotomy. A horizontal osteotomy was carried out between the apices of the anterior teeth and the piriform aperture, maintaining a distance of approximately 2 to 3 mm to the apices. Lateral to both canines, this horizontal osteotomy was connected with vertical osteotomies carried out along the alveolar socket of the first premolar on the right and left sides. Lateral cephalograms and lateral and en face photographs were taken preoperatively and postoperatively for analysis. All patients were followed up for at least 6 months.

Results: Significant changes were observed in hard tissue parameters except the anterior nasal spine. The nasal tip, the alar base, and the lip width remain to have no significant change. The ratio of the upper lip to the maxillary incisor retraction was 0.64:1. Whereas both the nasolabial angle and the philtrum length were significantly increased, the protrusion of the upper incisors and the vermilion length presented decreased. The intraoperative and postoperative courses were uneventful during the entire follow-up period.

Conclusions: Subapical anterior maxillary segmental osteotomy provides a suitable option in the treatment of maxillary protrusion. It provides improvement of the aesthetic profile without nasal changes.

Key Words: Maxilla protrusion, modified anterior maxillary segmental osteotomy

Orthognathic surgery is considered to be the most important tool to correct severe dentofacial skeletal malformations.1,2 Cohn-Stock in 1921 described the anterior segmental osteotomy of the maxilla for the time; since then, many modifications related to the surgical approaches and osteotomy designs have been developed.3–5 However, a lot of concerns related to this type of segmentalization such as necrosis of the anterior segment, devitalization of teeth, widening of the alar base, and anticlockwise rotation of the nasal tip circulate among surgeons.

To minimize such intraoperative and postoperative complications, the subapical anterior maxillary segmental osteotomy (SAMSO) was developed and performed in overall 32 patients experiencing maxillary protrusion.

PATIENTS AND METHODS

To determine a safe plane of the osteotomy line, a computed tomography of the upper jaw and the midface was performed in 30 Chinese volunteers (age range, 20–35 y) to determine the distances between the apices of the superior canines and the central and lateral incisors and the inferior edge of the piriform aperture. The inclusion criteria for these patients were (1) no dentomaxillofacial deformity, (2) normal adult occlusion, and (3) no history of facial surgery or trauma.

Thereafter, 32 Chinese patients (29 women and 3 men; mean age, 23.4 y; range, 18–40 y) experiencing maxillary protrusion were included in the here presented SAMSO study. The inclusion criteria were (1) no history of congenital oromaxillofacial malformation or (2) facial asymmetry and (3) no previous facial trauma. Written informed consent was obtained from each patient according to the ethical guidelines of Wuhan University.

Among the 32 SAMSO patients, 15 additionally underwent anterior mandibular subapical osteotomy, 8 underwent simultaneous genioplasty, and 3 underwent a bilateral sagittal split osteotomy. The postoperative follow-up period was at least 6 months.

Under general anesthesia, a vestibular incision was carried out from canine to canine in the upper jaw. After subperiosteal dissection, the anterior maxilla up to the piriform aperture was exposed. After extraction of the first premolars, a palatal sulcular incision with submucosal dissection was carried out from canine to canine in the upper jaw. After subperiosteal dissection, the anterior maxilla up to the piriform aperture was exposed. After extraction of the first premolars, a palatal sulcular incision with submucosal dissection was carried out from canine to canine. A vertical osteotomy line was performed running through the alveolar socket of the extracted premolar on both sides. To respect the teeth apices in the anterior maxillary sinus wall and inferior to the piriform aperture during the horizontal osteotomy line, a series of marks 3 mm

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above their contours was made using a fissure bur. Based on these marks, a horizontal osteotomy in the shape of a bull’s horn was carried out between the apex of the anterior teeth and the piriform aperture connecting the vertical osteotomies of the right and left sides (Fig. 1). After its mobilization, the anterior dentoalveolar bone block was trimmed using a vulcanite bur and thereafter repositioned on a prefabricated occlusal splint. After rigid fixation with miniplates, the wound closure was performed with resorbable material. This modified osteotomy did not influence the width of the alar base, the anterior nasal spine, and the septum because of preservation of the inferior rim of the piriform aperture.

The preoperative and postoperative records consisted of lateral cephalograms and lateral and frontal photographs. Postoperative measurements were collected 6 months postoperatively. The reference planes chosen for the measurements were the Frankfort horizontal plane (H line) and the nasion vertical plane, which is perpendicular to the FH plane (V line; Fig. 2). The following landmarks were used:

1. Soft tissue nasion (N): the deepest point on the concavity overlying the area of the frontonasal suture.
2. Pronasale (Prn): the most prominent or anterior point of the nose tip.
3. Columella point (Cm): the most anterior point on the columella of the nose.
4. Subnasale (Sn): A point located at the junction between the lower border of the nose and the beginning of the upper lip at the midsagittal plane.
5. Labrale superius (Ls): The most prominent point on the vermilion border of the upper lip in the midsagittal plane.
6. Incisor anterius (IA): The most prominent point on the maxillary incisor as determined by a tangent to the incisor passing through the subspinale.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Distance, Mean (SD), mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central incisor to the apertura piriform</td>
<td>10.8 (2.8)</td>
</tr>
<tr>
<td>Lateral incisor to the apertura piriform</td>
<td>12.6 (3.2)</td>
</tr>
<tr>
<td>Canine to the apertura piriform</td>
<td>7.9 (2.1)</td>
</tr>
</tbody>
</table>

FIGURE 1. A, Schematic view of SAMSO showing the undulating horizontal osteotomy line 3-mm above the canine and the tooth apices. B, Subperiosteal dissection and horizontal osteotomy are performed inferior to the anterior nasal spine and the piriform aperture.

FIGURE 2. Cephalometric landmarks.

FIGURE 3. Frontal view of the face. a, Inner canthal width. b, Nasal width. c, Philtrum length. d, Vermilion length. e, Lip width.
In the lateral aspect, 2 linear and 2 angular measurements were evaluated: upper lip (Ls to V line) and incisor protrusions (IA to V line), nasolabial angle (Cm-Sn-Ls), and nasal tip inclination (N-Pn to H line).

In the frontal aspect, 4 linear measurements were evaluated: nasal width (alar base to alar base), lip width (commissure to commissure), philtrum length (Sn to stomion), and vermilion length (top of the Cupid’s bow to the stomion; Fig. 3). The ratios between these measurements were calculated, too.

The preoperative and postoperative changes were calculated by subtraction of the corresponding values for each patient. Data were analyzed with version 11.0 of the Statistical Package of Social Sciences software (SPSS Inc, Chicago, IL). The Wilcoxon signed-rank test was used to analyze the differences between preoperative and postoperative measurements. The Spearman correlation was used to analyze the correlation between hard and soft tissue changes. A statistical result of 0.05 was considered significant.

### RESULTS

The distance between the apices of the canines and the piriform aperture was shorter than the one between the apices of the superior incisors and the piriform aperture (Table 1).

In the lateral aspect, the height of the nasal tip, the position of the Sn point, and the nasal tip inclination did not significantly change. The protrusion of the upper lip and the upper incisor was significantly decreased, whereas the nasolabial angle was increased (Table 2). In the frontal aspect, the nasal and lip widths remained unchanged; meanwhile, the philtrum length significantly increased, and the lip thickness decreased (Table 3).

The ratio between the upper lip retraction and the maxillary incisor retraction was 0.64:1. Spearman’s correlation for the upper lip movement and the upper incisor movement was 0.42 (Fig. 4).

### TABLE 2. Measurements of Soft Tissue Changes Related to Lateral Photographs

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Cephalometric Point</th>
<th>Preoperative, Mean (SD)</th>
<th>Postoperative, Mean (SD)</th>
<th>Change, Mean (SD)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of the nasal tip, mm</td>
<td>Prn to the V line</td>
<td>37.62 (4.21)</td>
<td>37.60 (4.20)</td>
<td>0.00 (0.27)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Sn position, mm</td>
<td>Sn to the V line</td>
<td>21.32 (3.09)</td>
<td>21.38 (3.21)</td>
<td>0.06 (0.32)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Upper lip protrusion, mm</td>
<td>Ls to the V line</td>
<td>29.93 (3.90)</td>
<td>26.45 (3.79)</td>
<td>3.47 (0.82)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Upper incisor protrusion, mm</td>
<td>IA to the V line</td>
<td>18.47 (2.37)</td>
<td>13.08 (2.91)</td>
<td>5.39 (0.91)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Nasolabial angle, degrees</td>
<td>Cm-Sn-Ls</td>
<td>81.6 (9.17)</td>
<td>96.9 (9.72)</td>
<td>15.4 (5.1)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Nasal tip inclination, degrees</td>
<td>N‘-Prn to the H line</td>
<td>61.0 (4.74)</td>
<td>61.0 (4.88)</td>
<td>0.0 (0.57)</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

### TABLE 3. Measurements of Soft Tissue Changes Related to the Frontal Photographs

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Preoperative, Mean (SD), mm</th>
<th>Postoperative, Mean (SD), mm</th>
<th>Change, Mean (SD), mm</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal width</td>
<td>38.50 (3.15)</td>
<td>38.75 (4.37)</td>
<td>0.25 (2.59)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Lip width</td>
<td>47.00 (3.91)</td>
<td>48.45 (4.68)</td>
<td>1.45 (3.27)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>Philtrum length</td>
<td>9.81 (0.78)</td>
<td>14.80 (1.22)</td>
<td>5.00 (0.61)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Lip thickness</td>
<td>9.90 (1.37)</td>
<td>8.30 (1.14)</td>
<td>1.60 (0.62)</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

FIGURE 4. Correlation between hard and soft tissue changes.

FIGURE 5. Frontal view preoperatively (A) and postoperatively (B).
FIGURE 6. Lateral view preoperatively (A) and postoperatively (B).

All patients were satisfied with the postoperative healing phase and the ultimate aesthetic result (Figs. 5 and 6). No severe complication and relapse were noted throughout the entire study period.

DISCUSSION

Conventional anterior maxillary segmental osteotomy has been established to correct maxillary protrusion in the posterior, inferior, and superior directions. It also demonstrated a good stabilization and a relatively small amount of relapse. However, perioperative and postoperative complications like deep bite, bony necrosis, and devitalized teeth still remain of concern. In conventional approaches, the vertical osteotomy is performed along the alveolar sockets after premolar extraction, extending up to lateroinferior piriform aperture, influencing therefore the nasal septum and the anterior palatal region. The anterior segmental bone block includes the inferior rim of the piriform aperture and the anterior nasal spine. During this procedure, the anterior nasal spine, the inferior rim of the piriform aperture, and the nasal skeletal base will change their position, resulting in postoperative nasal tip inclination and increased nasal width.

The here presented modification (SAMSO) provides a dentoalveolar segmental osteotomy, which anticipates the inferior piriform aperture and the anterior nasal spine, preventing thereafter unintended postoperative nasal changes.

The 3-mm distance superior to the apices of the incisors and the canines was enough to prevent damage to the tooth roots.

Up to this date, only a few studies reported profile changes after upper anterior maxillary segmental osteotomy. The ratios of the upper lip to the maxillary incisor retraction were 0.5:1, 0.43:1, and 1:3, whereas the ratio in the here presented study was 0.64:1. These variations may be encountered because of different surgical techniques, the amount of the posterior movement of the upper anterior teeth, the lip thickness and strength, the amount of fatty tissue and musculature, and the race. In addition to the sagittal change of the lip position, its thickness was significantly reduced and the philtrum length could be increased. The nasolabial angle increased from 81.6 to 96.9 degrees, resulting in less prominent upper lips and consecutively more prominent nasal tip projections. The nose as a whole, however, was left unchanged as the measurements of the nasal tip height, the Sn position, and the nasal tip inclination revealed.

To the authors’ estimation, this novel modified surgical technique is indicated for maxillary protrusion in class 1 occlusions or for maxilla-mandibular protrusions; the limitations of SAMSO are that the range of posterior movement of the anterior dentoalveolar block is limited to the amount equal to the width of the first premolar (approximately 5 mm) and that the range of impaction is approximately 3 mm. In patients with a short distance between the inferior rim of the piriform aperture and the tooth apices, the osteotomy 3 mm above the apex might affect the integrity of the inferior piriform aperture. Such patients are considered to be not suitable for the here presented SAMSO technique.

To conclude, SAMSO does not affect the integrity of the piriform aperture and the nasal soft tissues, avoiding therefore postoperative unfavorable nasal changes. Limited subperiosteal dissection combined with any palatal incision guarantees a good blood supply of the bony segment and minimizes the postoperative swelling. The osteotomies are performed only on the maxillary dentoalveolar bone, enabling a simpler approach than when performing the more traditional one. This might contribute to a shorter operation time. Together with less perioperative and postoperative complications, this technique might represent a good treatment option in suitable patients.

REFERENCES