Sliding Genioplasty for Correction of Chin Abnormalities

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**Background:** Correction of chin underprojection has a significant effect on facial symmetry. Alloplastic chin implants and sliding genioplasty represent the accepted methods of chin augmentation. While both procedures may be used for retrognathia or microgenia, the sliding genioplasty may also be used in chin asymmetry, prognathia, and vertical height discrepancies. We report our finding from a 5-year review of our experience with sliding genioplasty.

**Objectives:** To evaluate the results of sliding genioplasties performed by residents and private practitioners, to illustrate the versatility and ease of this procedure, and to confirm the excellent clinical results obtained with minimal complications.

**Design:** Retrospective case review.

**Setting:** University center and private practice.

**Patients:** Forty-three patients, aged 16 to 52 years (mean age, 21 years), underwent sliding genioplasty alone (8 patients) or with concomitant orthognathic surgery (35 patients).

**Main Outcome Measures:** Patient satisfaction, physician satisfaction, chin movement, bone resorption, and other complications.

**Results:** Mean value of chin advancement was 8 mm in cases of isolated sliding genioplasty and 4 mm when performed with orthognathic surgery. Average setback for prognathic correction (6 patients) was 2 mm. Less than 0.5 mm of bone resorption was encountered. Temporary unilateral mental nerve paresthesia was noted in 1 patient. Thermal injury to the lower lip occurred in 1 patient. Thirty-seven of 43 patients were extremely satisfied with their cosmetic result; 5 patients were very satisfied; and 1 patient was dissatisfied because of the resultant occlusion. Physician satisfaction correlated closely with that of the patients. Follow-up ranged from 6 months to 5 years, with an average follow-up of 2.3 years.

**Conclusions:** Our findings indicate excellent esthetic results with minimal complications. Unlike alloplastic chin implants, sliding genioplasty allows correction of many chin abnormalities, including underprojection, overprojection, chin asymmetries, and/or vertical-height abnormalities. This underused technique is simple and effective and should be included in the options of the facial plastic surgeon.

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**Goals in augmentation of the mentum include the creation of an esthetically pleasing contour and establishing proportionate facial height. Two principal methods are available for chin augmentation—allodermic implantation and sliding genioplasty. Sliding genioplasty has often been neglected by the facial plastic surgeon and been more favored by the oral maxillofacial surgeon. It is beyond the scope of this article to debate whether allodermic augmentation or osseous genioplasty is the superior choice. Both methods have achieved considerable success with correcting the underprojected mentum. Alloplastic implants have been recognized as technically easy to perform with a low complication rate. Advocates of sliding genioplasty stress that chin abnormalities in all 3 dimensions can be addressed, making it a more versatile procedure.**

Historically, Hofer² is credited as the first to describe the anterior horizontal osteotomy of the mandible in 1942. Sir Harold Gillies³ treated a patient with Treacher-Collins-Franchetti syndrome in 1947 with an open-approach genioplasty. Since then, Converse and Wood-Smith⁴ have popularized the procedure. Many surgical subspecialties have embraced the technique of osseous genioplasty, making...
PATIENTS AND METHODS

PATIENTS

Forty-three (29 female and 14 male) consecutive patients who underwent a sliding genioplasty from 1995 to 1999 were retrospectively reviewed. They were aged 16 to 52 years, with a mean age of 21 years. Most (35 patients) underwent a combined genioplasty with orthognathic surgery (Figure 3A-B), whereas 8 patients underwent genioplasty alone (Figure 4A-D). In 2 patients alloplastic implants were removed prior to orthognathic surgery. Thirty-two patients had advancement genioplasty with orthognathic surgery (Figure 3). Setback genioplasty was performed on 6 patients, 3 of whom also had orthognathic surgery. Of the remaining 5 patients who had genioplasty alone, 4 underwent advancement and 1 had correction of asymmetry (Figure 5).

Surgical procedures were performed in a university setting and in a private practice. All procedures were performed as ambulatory, unless concomitant orthognathic surgery required maxillomandibular fixation and a hospital stay. The maximum hospital stay was 2 days. Patients' medical records noted the surgical goals, level of satisfaction for the patient and the surgeon, amount of osseous movement, operative time, evidence of bone resorption on follow-up cephalogram, and other complications. Follow-up was 6 months to 5 years, with an average of 2.3 years.

METHODS

Initial consultation included a complete medical history and physical examination, including a dental history with occlusal evaluation along with standard facial photographs, lateral cephalogram, anteroposterior skull x-ray film series, and dental panoramic tomogram (Orthopantomograph; Siemens Corp, Iselin, NJ). Functional and cosmetic goals were determined. In addition, if skeletal or dental deformities were present, dental models were sculpted. This information was used to advise the patient about the available surgical options. If a skeletal abnormality existed, orthodontic realignment with orthognathic surgery was suggested. When the patient desired only cosmetic correction and his or her deformity could be addressed by either treatment modality, options for both alloplastic implant and sliding genioplasty were discussed. Recommendation was based on the severity of the deformity and concomitant facial procedures being considered. Criteria described by Sykes and Frodel were used in the decision-making process. They recommended treatment of mild to moderate abnormalities with either alloplastic implantation or osseous genioplasty, whereas in severe abnormalities only sliding genioplasty was recommended.

If sliding genioplasty was considered, cephalometric tracings and measurements were completed. Cephalometric points SNA and SNB (S indicates sella; N, nasion; A, subspinale; and B, supramentale) were plotted to assess the sagittal relationship between the anterior skull base and the maxilla and mandible, respectively (Figure 6). Soft tissue measurements were assessed by pogonial position vis-à-vis a vertical line traced through the subnasale and perpendicular to the Frankfort plane. The outline of the vermillion of the upper lip, vermillion of the lower lip, and the soft tissue pogonion was measured in relationship to this line. Normal values for these measurement areas follow: vermillion of the upper lip, 0 mm (±2 mm from reference); vermillion of the lower lip, −2 mm (±2 mm from reference); and soft tissue pogonion, −4 mm (±2 mm from reference) (Figure 7). Ideal vertical facial-height dimensions were obtained according to the Powell and Humphreys method, namely, the lower third of the face (subnasale to menton) should approximate 57% of the lower two thirds of the face, and the middle third of the face (nasale to subnasale) should make up 43% of the lower two thirds of the face. In repose it is acceptable to have 0 to 3 mm of maxillary incisal show. Incisal show beyond this indicates maxillary vertical excess. Anteroposterior x-ray films were helpful to assess chin asymmetry in the transverse dimension.

Once deficiencies are measured, the amount and direction of movement can be planned. Up to 8 mm of bony advancement, a 1:1 ratio of soft tissue to bony translation exists. Osseous advancement of the chin beyond 8 mm requires freeing the muscular attachments for maximal movement of the bony segment. However, the ratio of soft tissue to bony movement decreases to approximately 1:0.6 despite freeing the musculature because of excessive resorptive forces by the presumed overlying tissues. Less predictable ratios are reported for vertical movements. Special consideration was paid to the labiomental fold because it has an appreciable effect on the final cosmetic result. The depth of the fold will generally increase with advancements and/or vertical shortening and decrease with vertical lengthening.

Although sliding genioplasty under local anesthesia has been reported with good results, all patients in our series underwent general anesthesia according to the surgeon's preference. Unless a concomitant rhinoplasty was performed, nasoendotracheal intubation was favored. The procedure has been well described by Sykes and Frodel. Some of the salient points of the surgery will be included herein. In making the gingivobuccal incision, it is crucial to leave an adequate cuff of mucosa for ease of closure and mentalis muscle to avoid lower lip and chin ptosis. Subperiosteal dissection is carried out laterally to identify the

Continued on next page
mental nerve, which is generally located between the first and second premolars at the level of the origin of the mentalis muscle or 2 to 4 mm below the level of the bicuspid teeth. It is deep to the midportion of the depressor anguli oris. Dissection is then taken inferolaterally to permit a longer osteotomy and thereby prevent unsightly mandibular notching. Periosteum at the inferior margin of the mandible should be left intact to assure a broad pedicle for vascular integrity. Skeletal midline should be carefully preserved by inscribing a reference line in the midline to prevent postoperative iatrogenic asymmetries.

Although straight saws have been used with success, we find a sagittal saw with a 30° bend allows for an even cut while minimizing soft tissue trauma (Figure 8 and Figure 9). Lateral cuts should be 4 to 5 mm below the mental nerve foramina to compensate for the path of the inferior alveolar nerve. Fixation can be achieved with wires or plates. When wire fixation is used, there is the potential for increased bone resorption due to greater periosteal dissection as well as possible drop of the bony segment due to muscle pull. We use a single 4-hole titanium plate (Stryker-Leibinger, Dallas, Tex) with 12-mm screws for males and 10-mm screws for females. A larger screw is used if the posterior cortex of the mandible is not engaged at these lengths.

Closure is accomplished in layers. The mentalis muscle is resuspended with 3-0 interrupted, buried polyglactin (Vicryl; Ethicon, Somerville, NJ) sutures. Mucosa is then reaproximated with a running 3-0 chromic suture. The skin is redraped at the level of the labiomental fold with skin adhesive such as Mastisol (Ferndale Laboratories, Ferndale, Mich) and sterile tape (Steri-Strip; 3M, St Paul, Minn). Patients were advised to maintain a soft diet and to rinse their mouths frequently with a saline solution until the first postoperative visit at 1 week.

Figure 1. Angle’s skeletal classification is based on the first molar teeth relationship in the sagittal plane. The mesial buccal (MBC) cusp of the maxillary first molar lies in the buccal groove (BG) of the mandibular first molar in class I occlusion. In class II occlusion the MBC is anterior to the BG. In class III the MBC is posterior to the BG.

Figure 2. Asymmetry of the chin can be addressed by a sliding genioplasty as shown.

Figure 3. Preoperative (A) and postoperative (B) lateral views of a patient who underwent orthognathic surgery and chin advancement.
Figure 4. Preoperative (A and B) and postoperative (C and D) frontal lateral views of a patient who underwent rhinoplasty, cervical liposuction, and chin advancement.

Figure 5. Peroperative (A) and postoperative (B) lateral views of a patient who underwent a correction for an asymmetric chin.
reported a patient satisfaction rate of 85% to 90% for alloplastic mentoplasty and 90% to 95% for osseous genioplasty. However, each method of chin augmentation has its own unique disadvantages and complications. Morbidity associated with alloplastic mentoplasty include bone resorption, infection, extrusion, dehiscence, inappropriately sized implant, asymmetry, displacement, capsular contraction, lower lip retraction, and chin ptosis.\(^7\)\(^8\) Bone resorption has been blamed on many factors, from subperiosteal insertion to tension caused by the overlying skin, subcutaneous tissue, or musculature. Pearson and Sherris,\(^9\) however, showed no significant difference between supraperiosteal and subperiosteal placement of the Silastic implants in a study on adult hounds. Even though clinically bone resorption due to implant placement is not a significant problem, Robinson and Shuken\(^10\) do show at least some degree of bone loss in many of their patients. Further, some investigators argue that severe chin retrusion corrected with a large alloplastic implant may produce an unnaturally deep labiomental sulcus. Osseous genioplasty has its own associated complications: mental nerve injury, malunion, nonunion, irregularities, step-type deformities, asymmetry, lip drop, overcorrection, and undercorrection. Undercorrection is better accepted than overcorrection of the chin. If the chin is placed beyond the plane of the lower lip, a disharmonious profile results. Done properly, the augmentation of the chin performed as a lone procedure or done in conjunction with other procedures yields an esthetically pleasing result.

Of historical interest, autograft augmentation with nasal bone or cartilage was popularized by Aufricht in the late 1950s.\(^11\) Unfortunately, this technique has been associated with an increase in infections. Kelly et al\(^12\) described a patient who developed an infection 40 years after her autograft procedure.

Common alloplastic implant materials include Silastic (solid silicone; Michigan Medical Corporation, Santa Barbara, Calif), Gore-Tex (W. L. Gore & Associates, Flagstaff, Ariz), and Mersilene mesh (Ethicon, Somerville, NJ). Gross et al\(^13\) reported a 14-year experience with the use of Mersilene mesh. It was found to be safe and well tol-
erated. The only disadvantage in using Mersilene mesh was the time needed to fold and shape the mesh.13

We have found the sliding genioplasty to have similar success. A significant advantage of the sliding genioplasty is the ability to correct chin deformities in 3 dimensions: coronal asymmetry (Figure 2), vertical microgenia with or without retrogenia, and vertical macrogenia with retrogenia and prognathia.14 We contend that facility with genioplasty allows treatment of more complex deformities. We describe the findings of our 5-year experience with sliding genioplasty performed by residents in a teaching hospital and by a single private practitioner. This article will demonstrate the ease and versatility of this procedure and illustrate the excellent esthetic outcomes.

RESULTS

The main outcome measures of our study were patient satisfaction, physician satisfaction, chin movement, bone resorption, and other complications. We also evaluated operative time, which ranged from 15 minutes to 1 hour 45 minutes. The average time was 45 minutes. The broad range of time was because of the inclusion of cases that the residents performed.

Patient satisfaction was determined by a written questionnaire completed at the 6-month follow-up appointment. The survey ranked satisfaction on a 4-point scale with 1 indicating dissatisfied; 2, satisfied; 3, very satisfied; and 4, extremely satisfied. Thirty-seven (86%) of the 43 patients were extremely satisfied with their results; 5 (11.6%) of the 43 patients were very satisfied. One patient was unhappy with his dental occlusion and deemed his outcome unsatisfactory. The surgeons felt extremely satisfied in 39 (90.6%) of the 43 cases and very satisfied in 4 (9.4%) of the 43 cases. Through postoperative photographic analysis, the operating surgeon ranked his results (using the same 4-point scale).

Mean value of chin advancement was 8 mm in cases of isolated sliding genioplasty and 4 mm when performed with orthognathic surgery. Average setback for prognathic correction (6 cases) was 2 mm. When orthognathic surgery is done, there is movement of the mandible, thus requiring less movement of the chin. There were more combination cases done rather than sole genioplasties (Table 1).

One-year cephalograms were performed if the patient or surgeon noted any clinical evidence of bone resorption or movement (Figure 11). No greater than 0.5 mm of resorption was noted in any case. No major complications from sliding genioplasty were encoun-

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Table 1. Procedures and Average Movement

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Total No. of Patients</th>
<th>Average Movement, mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced genioplasty with orthognathic surgery</td>
<td>32</td>
<td>4</td>
</tr>
<tr>
<td>Set back genioplasty with orthognathic surgery</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Set back genioplasty alone</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Advancement genioplasty with rhinoplasty and cervical liposuction</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Advancement genioplasty with rhinoplasty</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Advancement genioplasty alone for asymmetry</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

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Figure 9. A, Operative photographs demonstrate the midline marking needed to prevent iatrogenic asymmetry. B, Plate in place.

Figure 10. A prebent 4-hole titanium plate with millimeter markings gives rigid fixation keeping the distal segment in place.

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tered. Three (6.9%) short-term complications were seen. One patient had unilateral mental nerve paresthesia, which resolved in 1 month with no residual deficit. A poorly guarded cautery tip caused a lower lip burn that healed within 1 week. A patient with orthodontic braces had poor healing of the intraoral incision but opted not to have it addressed. We believed that the braces may have prevented proper oral hygiene. No revision surgical procedures were necessary. There were no cases of infection, excessive hemorrhage, nonunion, malunion, bone necrosis, iatrogenic asymmetry, movement of the distal segment, or a need for plate removal (Table 2).

COMMENT

It is well established that chin position and proportion have a significant influence on facial profile and harmony. In evaluating the profile of patients who seek cosmetic enhancement of the face, the published norms of facial ratios and radiographic cephalometric measurements serve as valuable guides in determining midface and lower face proportions. Poor chin projection is frequently unappreciated by patients seeking reduction rhinoplasty. It is the responsibility of the consulting surgeon to call attention to the profile deficits of the lower third of the face and to recommend treatment when appropriate.

Figure 11. Preoperative (A) and postoperative (B) lateral cephalometric radiographic views. Preoperative (C) and postoperative (D) panoramic views (Orthopantomography; Siemens Corp, Iselin, NJ) of the same patient.
In addressing the underprojected chin, alloplastic mentoplasty and sliding genioplasty both represent viable surgical options. Our experience with sliding genioplasty confirms previous reports of excellent cosmetic results with minimal risk of adverse effects. Our results indicate excellent outcomes attainable at all levels of training. The diverse nature of clinical settings (private practice vs resident training program) in our study attests to the safety and ease of performance of this procedure.

As mentioned, sliding genioplasty offers the distinct advantage of addressing a host of chin abnormalities, from underprojection, overprojection, vertical-height disparities to transverse asymmetries. Riley and Powell24 have reported on orthognathic surgery and related osteotomies for obstructive sleep apnea. Studies are investigating the benefits of sliding genioplasty in the patient with retrognathia and obstructive sleep apnea syndrome.

Distraction osteogenesis is being met with favorable results from oral maxillofacial surgeons and plastic surgeons; yet osseous techniques are not widely taught in otolaryngology–facial plastic training programs. It is our hope that this article will refocus attention to the sliding genioplasty to correct chin retrusion. We recommend that this technique be more widely included in otolaryngology–facial plastic training programs and in the options afforded the facial plastic surgeon.

**CONCLUSIONS**

Sliding genioplasty offers a viable alternative to alloplastic mentoplasty to correct chin retrusion. Our results demonstrate a very high patient satisfaction (42 patients, 98%) and good cosmetic result with low morbidity. Unlike alloplastic mentoplasty, sliding genioplasty allows for correction of many chin abnormalities. We recommend that this technique be more widely included in otolaryngology–facial plastic training programs and in the options afforded the facial plastic surgeon.

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**REFERENCES**