An Evidence-Based Approach to Genioplasty

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The Maintenance of Certification module series is designed to help the clinician structure his or her study in specific areas appropriate to his or her clinical practice. This article is prepared to accompany practice-based assessment of preoperative assessment, anesthesia, surgical treatment plan, perioperative management, and outcomes. In this format, the clinician is invited to compare his or her methods of patient assessment and treatment, outcomes, and complications, with authoritative, information-based references.

This information base is then used for self-assessment and benchmarking in parts II and IV of the Maintenance of Certification process of the American Board of Plastic Surgery. This article is not intended to be an exhaustive treatise on the subject. Rather, it is designed to serve as a reference point for further in-depth study by review of the reference articles presented. (Plast. Reconstr. Surg. 127:898, 2011.)

CLINICAL SCENARIO

A 22-year-old woman comes to you for a cosmetic consultation for her retrusive chin. She has class II malocclusion and an asymmetric chin. She has had a previous chin implant and is unhappy with the appearance of her operative result. What is the best evidence to guide you in managing this patient?

Genioplasty is a fundamental technique that can be performed primarily in two ways: osseous genioplasty or alloplastic genioplasty. Osseous genioplasty requires a bone osteotomy, and in general, also requires general anesthesia. Alloplastic genioplasty, also referred to as chin augmentation, involves placement of a prosthetic implant. An important consideration in these surgical procedures is an understanding of facial and soft-tissue relationships. The purpose of this article is to provide a summary of the best available evidence on genioplasty that, when combined with individual patient assessment and clinical expertise, can assist the surgeon in the continuing evolution toward better outcomes.

METHODS FOR IDENTIFYING EVIDENCE

A literature search of PubMed, the Cumulative Index to Nursing and Allied Health Literature, and the Cochrane Library was performed to obtain the best available evidence on genioplasty, with emphasis on preoperative assessment, treatment, and outcomes. The following search terms were combined as appropriate, and PubMed MeSH terms were used when available: “genioplasty,” “chin implant,” “mandibular osteotomy,” “witch’s chin,” “diagnosis,” “facial analysis,” “physical examination,” “preoperative assessment,” “surgical treatment plan,” “risk factors,” “smoking,” “diabetes mellitus,” “hypertension,” “surgery,” “treatment,” “anaesthetics,” “premedication,” “antibiotic prophylaxis,” “pain management,” “analgesia,” “outcomes,” “speech,” “complications,” “postoperative complications,” “hematoma,” “infection,” “seroma,” “surgical wound dehiscence,” “asymmetry,” “lip ptosis,” “gingival retraction,” “bone erosion,” and “capsular contracture.” The initial search was limited to human studies that were published from 1999 to 2009 and indexed as meta-analyses, randomized controlled trials, clinical trials, comparative studies, case series, or case reports; however, additional references were included if deemed necessary for discussion. Studies were excluded if the full text was inaccessible or of non-English language, as the study quality could not be evaluated. Relevant studies were appraised for quality and validity according to criteria published by the Critical Appraisal Skills Programme and assigned a level of evidence with the American Society of Plastic Surgeons Evidence Rating Scale for Therapy (Table 1). Levels of evidence are indicated throughout the text. Evidence ratings were not assigned to

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studies with inadequately described methods and/or worrisome biases or to references included for discussion purposes only (e.g., narrative reviews).

**EVIDENCE ON PREOPERATIVE ASSESSMENT**

Evaluation of the patient for genioplasty includes assessment of the face and the relationship of the maxilla to the mandible. The standard in establishing the clinical relationship between the maxillary and mandibular dentition is the Angle classification (Fig. 1). In this classification, the mesial buccal cusp of the maxillary first molar is assessed in relation to the buccal groove of the mandibular first molar. In class I occlusion, or “normal” occlusion, this cusp fits directly into the buccal groove of the mandibular first molar, whereas in class II occlusion, this cusp is positioned anterior to the buccal groove. In class III occlusion, the maxilla and midface lie anterior to the mandible and chin.

Microgenia (also known as micognathia or retrognathia) can be evident as a deficiency in both the sagittal and vertical planes. Cephalometrics relates the position of the face and skull base to the position of the maxilla and mandible. Whereas formal osseous cephalometrics using normative values for maxillary and mandibular relations to the skull base remains the criterion standard, it is important to note that they are not necessary in most cases, and most patients can be well served by a combination of determination of soft-tissue relationships based on appropriate photographs and a determination of the Angle occlusal relationship noted above. These soft-tissue points are often based on the traditional osseous landmarks (Figs. 2 and 3). These landmarks are used for reference in both the vertical and sagittal planes. A practical soft–tissue assessment guide is to use the technique of Gonzales-Ulloa with two imaginary lines of the face: the Frankfort horizontal, extending horizontally from the upper margin of the external auditory meatus to the lower orbital rim; and a second line perpendicular to the Frankfort horizontal that runs through the soft–tissue nasion. Ideally, both the upper and lower lips will touch this perpendicular line and the point of anteriormost projection of the chin (pogonion). An additional assessment relies upon a “vertical” line from subnasale through the upper lip vermilion–cutaneous border, which should be approximately 2 mm in front of the lower lip vermilion-cutaneous border and 2 to 4 mm in front of pogonion.

In the vertical plane, it is essential to determine whether the decrease in facial height is caused by a vertical maxillary deficiency, a decrease in vertical chin height, or a decrease in both (Level IV Evidence). In determination of vertical maxillary height, the most relevant clinical finding:

### Table 1. American Society of Plastic Surgeons Evidence Rating Scale for Therapy

<table>
<thead>
<tr>
<th>Level of Evidence</th>
<th>Qualifying Studies</th>
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<tbody>
<tr>
<td>I</td>
<td>High-quality, multicenter or single-center, randomized controlled trial with adequate power; or systematic review of these studies</td>
</tr>
<tr>
<td>II</td>
<td>Lesser-quality, randomized controlled trial; prospective cohort study; or systematic review of these studies</td>
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<tr>
<td>III</td>
<td>Retrospective comparative study; case-control study; or systematic review of these studies</td>
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<td>IV</td>
<td>Case series</td>
</tr>
<tr>
<td>V</td>
<td>Expert opinion; case report or clinical example; or evidence based on physiology, bench research, or “first principles”</td>
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*Fig. 1. The Angle classification: class I, normal occlusion—mesial buccal (anterior and lateral) cusp of first maxillary molar is positioned in groove of first mandibular molar; class II, cusp is positioned anterior to the buccal groove; class III, cusp is posterior to the buccal groove.*
is the amount of “show” of the maxillary incisors with the lips in repose. The ideal amount of incisor show has been noted to vary between 2 and 3 mm and may include up to a full dental crown during smiling. In the absence of vertical maxillary deficiency, a decrease in lower facial height should be attributed solely to vertical deficiency of the chin (Level IV Evidence). The distance between the glabella and subnasale should ideally equal the distance between the subnasale and the menton (Fig. 2), and the distance between subnasale and the lower lip vermilion–cutaneous border should equal the distance between the lower lip vermilion–cutaneous border and the menton. Rosen finds this last relationship to be less reliable as a predictor of those who would benefit from genioplasty (Level IV Evidence).

The surgeon must also consider existing soft-tissue relationships, such as lip strain and the labiomental fold. Lip strain is the puckered appearance of the chin created by the contraction of the mentalis muscle in an attempt to raise the lower lip and achieve lip closure. The depth of the labiomental fold must be considered carefully because genioplasty will influence the shape and depth of the fold (Level V Evidence).

In complex cases, it may be necessary to use a formal osseous cephalometric examination to determine the relative relation of the skull base to the maxilla and to the mandible, and thereby the relation of the relationship of the maxilla (midface) to the mandible (lower face). The Steiner analysis is based on a line is drawn from the sella to the nasion (SN), and from the nasion to the A-point (maxilla) and from the nasion to the B-point (mandible). This creates three angles: SNA relates the position of the midface to the skull base, SNB relates the position of the mandible to the skull base, and ANB relates the position of the midface to the mandible. These relationships may determine whether orthognathic surgery is necessary in addition to genioplasty.

Ultimately, the surgeon must make the determination of why the jaw appears small, and must make the determination of what is necessary for appropriate evaluation. It has been reported that 84 percent of patients requesting aesthetic enlargement of the chin had a small or retrusive mandible (class II pattern), which was responsible for the patient’s perception of a small chin (Level V Evidence). Many patients with a “small chin” will have previously undergone orthodontics to compensate for their occlusion. They most frequently will not want to undo their previous orthodontia and, rather than correct the underlying disorder, will instead want improvement through genioplasty. It is incumbent on the surgeon to understand this and the limits of what can be accomplished.

Genioplasty (osseous or augmentation) can also be used to address contour irregularities, chin prominence, or chin breadth. In addition, osseous genioplasty can be used to address chin asymmetry.
**EVIDENCE ON ANESTHESIA**

There are practical anesthetic considerations for the surgeon in genioplasty surgery. In the case of chin augmentation with an alloplastic implant, this can frequently be accomplished under local anesthesia or regional nerve block anesthetic (bilateral mental nerve block). In contrast, osseous genioplasty requires general anesthesia for both management of pain control and safe management of the airway (intraoral secretions and bleeding).

**EVIDENCE ON SURGICAL TREATMENT PLAN**

Genioplasty may be performed alone or in combination with orthognathic surgery. It may be performed as an osseous genioplasty or with an alloplastic implant. Overall patient and physician satisfaction with the outcomes of genioplasty were high.

Gui et al. report on their experience from China with 500 osseous genioplasties and 150 chin augmentations with implants (fixated with screws) (Level IV Evidence).\(^9\) They report that the aesthetic results were satisfactory to the patient and the surgeon. Based on their experience, they conclude that the osseous genioplasty has a broader applicability and broader range of clinical problems that can be addressed, including severe, complicated, or multiple operation cases. They favor its use in the majority of cases. They recommend chin augmentation for modest retrogenia and “chin shape modification.” Jones and Vesely report experience with 54 osseous genioplasties and eight chin augmentations (Level IV Evidence).\(^3\) They report their preference being osseous genioplasty because of its versatility and its long-term stability. They report a high degree of patient satisfaction, with few long-term complications.

Hoenig reports on a series of 474 patients who underwent orthognathic surgery, 155 of whom also underwent sliding genioplasty and 35 of whom underwent isolated genioplasty (Level V Evidence).\(^10\) The average advancement was 4.5 mm. The results were judged to be excellent by 73.2 percent of the patients and good by 23.6 percent.

In detailed analyses, the stability of the advanced osseous genioplasty segment appears high. Talebzadeh and Pogrel performed a retrospective comparison of 20 patients (11 underwent genioplasty alone and nine underwent genioplasty plus mandible advancement) and found a relapse rate of 0.38 mm at the pogonion at 12 months, with no difference in relapse between the cases that underwent genioplasty alone and those that underwent both genioplasty and mandibular advancement (Level III Evidence).\(^11\) They found that there was no correlation between the degree of advancement and the relapse rate. Shaughnessy et al. likewise report that the stability of sliding genioplasty is very high, and report a mean relapse of only 8 percent 3 years after osseous genioplasty (interosseous wires in 11 patients and plates in 10 patients) when the average advancement was 8.4 mm (Level IV Evidence).\(^12\) They report a soft-tissue-to-bone advancement ratio of 0.9:1. Troulis et al. describe an osseous genioplasty with an extended osteotomy extending to the antegonial notch designed to minimize stepoff at the lateral mandible (Level IV Evidence).\(^13\) Their mean advancement of 8.7 mm was stable at 6 months, as assessed by cephalography. Furthermore, they report that the ratio of soft-tissue change to bony change was 0.85:1. Chang et al. report a series of 43 patients who underwent osseous genioplasty, either alone (n = 8) or with orthognathic surgery (n = 35), and report that 37 patients were extremely satisfied and five patients were very satisfied (Level IV Evidence).\(^14\)

Dolce et al. report a prospective randomized trial of the impact of wire fixation compared with rigid fixation on soft-tissue changes in mandibular advancement orthognathic surgery in 127 patients, performed in association with genioplasty in 59 patients (Level II Evidence).\(^15\) The variable was the fixation type in the bilateral sagittal split osteotomies, as all but five patients underwent plate-and-screw fixation of the genioplasty. Dolce et al. report that in the group that underwent wire fixation of bilateral sagittal split osteotomies with genioplasty, only 10 percent of the advancement of the lower lip was maintained at 2 years, whereas 50 percent of the advancement of the pogonion was maintained. In contrast, in the group that underwent rigid fixation of bilateral sagittal split osteotomies plus genioplasty, 28 percent of the lower lip advancement was maintained, and 71 percent of the advancement of the pogonion was maintained. Dolce et al. subsequently reported 5-year follow-up with comparable results (Level II Evidence).\(^16\) The soft-tissue-to-hard-tissue advancement approximated 1:1 in the groups.

Ramirez describes a matrix implant system consisting of alloplastic implant components made of high-density porous polyethylene and designed to augment both the chin and jowl area along with mandibular angle implants.\(^17\) He reports favorable results in 13 patients, and reports that patient satisfaction was high. The complications with the approach were manageable and
included implant displacement and infection (one each) (Level V Evidence).\textsuperscript{17}

The mentalis muscle is the only muscle that has clinical significance during the surgical approach to genioplasty. Zide and McCarthy provide an analysis of the mentalis muscle anatomy and its influence on lower lip position (Level V Evidence).\textsuperscript{18} They present a series of three cases with symptoms varying from a droopy chin to lower lip incompetence and drooling following either orthognathic surgery or placement of a prosthetic implant, and report a technique for repair using suture fixation of the mentalis muscle origin through holes drilled in the alveolar bone segment, and report favorable results in all three cases. Preservation and precise reattachment of the mentalis muscle during genioplasty affect outcome. Chau shu et al. looked at the impact of precise reattachment of the mentalis muscle on the soft-tissue response to genioplasty in a comparative study, and found that the mean vertical discrepancy of lower lip position between the control group (11 patients) and the 10 patients who underwent isolation and precise reattachment of the mentalis muscle was 6 mm, with the control group having the undesirable effect of increasing lower lip position and dental show (Level III Evidence).\textsuperscript{19}

Rosen reports a method for analysis of the vertically deficient chin and reports a technique for correction of vertical and sagittal deficiency of the chin using a horizontal sliding genioplasty and coralline hydroxyapatite as a vertical interposition graft (Level IV Evidence).\textsuperscript{5} He reports complete vertical stability in eight patients with 11 months' follow-up. In a subsequent article, Rosen reports on the soft-tissue findings evident in genioplasty patients and the impact of genioplasty on these soft-tissue findings (Level V Evidence).\textsuperscript{2} He reports that the vast majority of patients seeking chin augmentation have a class II skeletal relationship and that abnormalities in the soft-tissue labiomen tal fold were evident in 88 percent of 68 patients, and were closely linked to vertical lower facial height. Those patients with decreased lower facial height (40 percent) showed exaggerated, deep ened labiomen tal folds with procumbent lips. Those patients with increased lower facial height (25 percent) demonstrated shallow, effaced folds and a pattern of lower lip strain. Significantly, Rosen reports that isolated sagittal advancement of the chin and/or advancement and vertical shortening deepened the fold, whereas simultaneous advancement and vertical lengthening tended to deemphasize the fold. Shaughnessy et al. also noted a deepening of the labiomen tal fold with sagittal advancement (Level IV Evidence).\textsuperscript{12} In a third article focused on genioplasty, Rosen describes the fact that in many individuals requesting chin enlargement, a weak chin is only one aspect of the class II deformity.\textsuperscript{6} Also present were a procumbent, retrusive lower lip, excessive labiomen tal fold depth, and decreased to normal lower facial height, present in 51 percent of patients seeking chin enlargement. He cautions that to avoid unfavorable aesthetic results, the chin should not be advanced beyond the retrusive lower lip. He further points out that lower lip position is the only component over which osseous genioplasty has no control (Level V Evidence).\textsuperscript{6} In 32 patients with the aforementioned deformity, in which a modest sagittal advancement of 4.2 mm was performed with a mean vertical displacement of 7.9 mm, he reports that the combination of vertical and horizontal movement leads to an increase in the lower facial mass effect, a favorable improvement in the labiomen tal fold, and reduced aesthetics.\textsuperscript{6}

Genioplasty has also been used to narrow a chin that appears too broad and U-shaped. Park and Noh describe resection of a 6- to 12-mm vertical midline segment of a genioplasty segment in 39 patients to narrow mandible width and increase femininity. All patients reported “great satisfaction” with the procedure.\textsuperscript{20}

Genioplasty and genioglossus advancement with a “hyoid myotomy” have also been advocated for treatment of obstructive sleep apnea, with clinical and polysomnographic success noted in 23 of 31 patients (Level V Evidence).\textsuperscript{21} Similarly, Santos Junior et al. report favorable results using genioplasty to treat obstructive sleep apnea in 10 nonobese patients, as judged by a 50 percent improvement in polysomnographic data and lateral radiographs of the soft tissue of the pharynx.\textsuperscript{22}

\textbf{EVIDENCE ON POSTOPERATIVE OUTCOMES}

Sensory loss does occur following osseous genioplasty, although it is almost always transient. Gui et al. noted transient lower lip numbness in almost all patients. They reported that only one of 500 patients had persistent numbness after 1 year (Level IV Evidence).\textsuperscript{9} In the series by Hoenig of 180 genioplasties (155 with orthognathic surgery), 15 percent had numbness at 1 year, but all those that had only isolated genioplasty had complete recovery of nerve function at 1 year (Level V Evidence).\textsuperscript{10} Troulis et al. assessed neurosensory function after extended genioplasty and demonstrated functional sensory return in 12 of 12 pa-
tients within 6 months after an “extended” genioplasty (Level IV Evidence).13 Chang et al. report a series of 43 patients who underwent osseous genioplasty, either alone \( (n = 8) \) or with orthognathic surgery \( (n = 35) \), and report one case of transient numbness, one electrocautery burn, and one delay in healing of the lower lip sulcus (Level IV Evidence).14

Revision of genioplasty and chin augmentation is uncommon but occasionally necessary. In the series of 500 genioplasties reported by Gui et al., four patients underwent revision, two because the chin was “too strong” and two because of contour irregularities (Level IV Evidence).9 Of their 150 implant chin augmentations, two patients underwent revision to reduce the implant. Of the eight implant chin augmentations reported by Jones and Vesely, one required removal, narrowing, and replacement.3 Of their 54 osseous genioplasties, one required the genioplasty to be reversed because of lower lip dysfunction, one developed chin ptosis, and one required cauteryization of granulation tissue of the intraoral incision.

Infection is relatively uncommon. Jones and Vesely report that two of eight implants required removal because of infection.3 By contrast, in the series of 125 implants reported by Gui et al., there were no infections or alloplastic reactions (Level IV Evidence).9 Of the 474 patients reported by Hoenig, of which 180 underwent genioplasty, 15 developed mucosal dehiscence with exposure of the underlying bone (Level V Evidence).10 Four of these had undergone placement of \( \beta \)-tricalcium phosphate in the genioplasty. All healed with daily irrigations and antibiotics.

**SUGGESTED TREATMENT FOR CLINICAL SCENARIO**

When practicing evidence-based medicine, the surgeon should consider the strength of the available evidence and integrate the evidence with his or her clinical expertise and the patient’s values and preferences to develop an appropriate treatment plan. The treatment plan below is an example of how the surgeon might use the evidence to care for this particular patient.

Evaluation of this patient will include a discussion of this patient’s concerns, clinical assessment of occlusal status and implant stability, and lateral and frontal radiographs (or cephalograms) to assess the implant position and potential secondary osseous changes or implant shift. Clinical photographs are essential to document and determine the soft-tissue relationships in the vertical and sagittal planes, including lip position, labiomental fold, and projection of the chin. An assessment must be made by the surgeon, in discussion with the patient, about the severity and extent of the mandibular hypoplasia seen in this class II malocclusion. The patient needs to be made aware of the cause of her deformity—mandibular hypoplasia. In addition, a determination of the possible role for orthognathic surgery versus genioplasty, and its limitations, should be discussed (Level V Evidence).6 The presence of lip strain and the depth of the labiomental fold, and their contribution to the patient’s dissatisfaction, should also be determined (Level V Evidence).6 Based on the experience of Gui et al. and others, the osseous genioplasty should be strongly considered for secondary surgery, and particularly in the case of asymmetry (Level IV Evidence).9 The osseous genioplasty has the potential to treat a broader range of disorders than does an implant, and asymmetry may be more amenable to osseous correction.3 Depending on the depth of the labiomental fold and vertical relationships of the face, the horizontal repositioning of the bone may also require a vertical repositioning (Level V Evidence).6 A detailed evaluation of mentalis function should also be performed and assessed for its potential contribution to the patient’s unhappiness.

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**REFERENCES**


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