GENIOPLASTY: A HISTORICAL REVIEW

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Abstract
Approximately 20% of the population is suffering from craniofacial defects which may demonstrate myriad degrees of functional and aesthetic compromise. The chin is the most eminent osseous portion of the face and therefore one of the most significant structures that affect the harmony of facial esthetics. Chin malposition can affect the size, shape, position, or proportion of the anatomical landmarks in the lower third of the face, resulting in soft tissue deformities that can disturb the balance between the lower third and the rest of the face and can have a negative effect on facial esthetics. Among the various orthognathic surgical procedures, genioplasty is one of the most widely performed surgical procedures used for correcting chin deformities. The term genioplasty is used to describe miscellaneous facial profile concerns starting from orthognathic surgery in conjunction to a facial symmetrical balancing procedure supplementary with soft tissue contours and chin augmentation for those undergoing voluntary craniofacial surgery. This article reviews and addresses the factors to consider while selecting a patient for genioplasty, the surgical options available for treating chin deformities and restoring congruity to the lower face, and possible complications and ways to reduce them. As these subjects have been extensively discussed in the literature, this will serve as a description of existing techniques.
Key Words: Genioplasty, Chin surgery.

INTRODUCTION

The four "esthetic outposts" of the human face are the chin (Latin, mentum) along with the nose and two malar eminences. The soft facial tissues drape over the main facial skeleton architectural promontories, including the malar-midface area, nose, and chin. A well-aligned, symmetrical and perfectly projected chin provides the face with as much (if not more)' esthetic value' and youthfulness as a perfect nose or high cheek bones. Genioplasty is a useful surgical procedure that enables the anatomy of the chin to be changed in all three-dimensional directions. In the correction of dentofacial deformity, genioplasty has become an important method for achieving or restoring global facial balance, facilitating improvement in the profile, balance in the labiomental musculature, and even the nasolabial area of the face. Genioplasty is typically part of malocclusion treatment, which involves orthodontic-surgical-orthognathic combination therapies. Genioplasty can be executed as an adjunctive to various surgical techniques like rhinoplasty or facelift so as to enhance the total esthetic outcome of the prime surgery. Finally, in Treacher-Collins syndrome or OSA patients, this technique is often used in reconstructive or craniofacial surgery and is an efficient means of advancing genioglossus muscle attachment and improving posterior airway space. The methods for patient assessment, variations in surgical access, osteotomy design, fixation method and advantages of the genioplasty techniques have been discussed.[1,2,3,4]

Historical background

"The Study of the Human Face was published by Woolnoth in 1865, in which he described the three facial profiles as smooth, convex and concave. He further suggests that the straight face is considered the most attractive, the young convex and the older looking as concave profile.The use of nasal cartilage as a means for chin augmentation was described in 1934 by Aufricht. In 1942, with Dr. Obwegeser and Trauner, Hofer observed and then published the first paper explaining an extraoral approach to sliding osseous genioplasty. Inlay bone grafts, bovine cartilage grafts, dermis grafts and certain acrylic implants were introduced for genioplasty in the 1950s. In 1957, the first paper on intraoral sliding osseous genioplasty, which continues to be used worldwide today, was written by Trauner and Obwegeser. The versatility of sliding genioplasty was defined in the 1960s by Converse and Wood-Smith, as well as Hinds and Kent. Postoperative follow-up, as predicted for a relatively new technique was quite longer, it started to display some problems that surgeons wanted to improve. In the 1970s, different methods to fix "witch's chin" and deep submental folds were all acknowledged by Gonzales-Ulloa, Loeb and Field. Hydroxyapatite was introduced in the 1980s for use as an inlay or onlay graft or to raise the lower face height of the osteotomized chin. In 1986, Riley and Powell first described the adaptation of genioplasty to achieve functional reconstruction of the upper airway via

genioglossus advancement. Further improvements to the techniques were proposed by Lee and Woodson as well as Hendler et al. Zide and his colleagues wrote a series of articles in the late 1990s to 2007 covering various contemporary aspects of genioplasty assessment, methods, complications and refinements that serve as an excellent basis for surgeons performing this procedure."[5,6,7]

Anatomical considerations

Osteology

There is an outer and internal surface of the chin. The ridge on the anterior midline on the external surface is formed in utero by fusion of the mandible. This ridge separates and covers the mental protuberance inferiorly. Slightly raised mental tubercles develop on each side of the protuberance. The IAN (inferior alveolar nerve) exits the mental foramen on either side, proximal to the tubercles and inferior to the second premolar.[8]

Myology

The seven muscles are attached to the chin. Mentalis, DLI (depressor labii inferioris), DAO (depressor anguli oris) partially and platysma comprise the muscles of the anterior surface. The movement of lower lip is carried out by these muscles. The geniohyoid, genioglossus and anterior belly of digastric muscle emerge from the chin's posterior surface. The downward pulling of infrahyoid muscles during speech and swallowing are resisted by these muscles.

Vascularity

The major blood vessels supplying the mandible are branches of the maxillary artery, i.e, from the inferior alveolar artery. Supplemental blood supply was provided from vessels which transverses into the mandible through various accessory foramina specifically at the sites of muscle attachment. There is formation of rich anastomotic network between the additional perforating vessels from the sublingual and submental arteries through the lingual gingiva and muscle insertions .[10]

Innervation

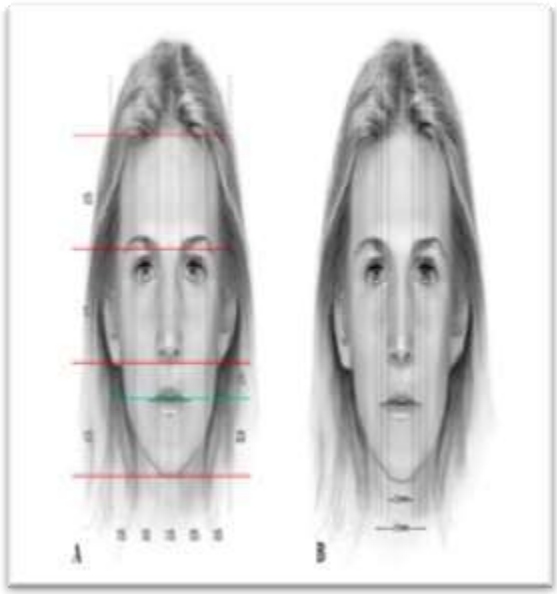
The IAN (inferior alveolar nerve) is located in the mandibular canal, and it may come in contact with the dental roots or just above inferior border of mandible. A branch emerges out from the mental foramen that forms the mental nerve that provides the entire sensation to region of lower lip and chin. The terminal branches of the IAN, i.e, incisor nerve innervates the incisors & canines, travels along the mandible, in front of the mental foramen, and therefore can easily be compromised by osteotomy. In addition, the canal can loop below the mental foramen level and osteotomy should be performed 5-6 mm underneath the foramen in order to prevent direct neurosensory disturbances in the IAN. While the IAN is the main source of innervation, multiple small perforating nerves entering through the accessory foramina provide additional sensory input. A twig from the mylohyoid nerve that comes near the lower border of the jaw in the mental area may innervate the incisors, lower chin or inferior border of the mandible. The genial tubercles are perforated by a branch from the lingual nerve. The incisor plexus formed by the incisor nerve and additional branches inside the genial portion of the mandible. This is eventually compromised to some degree during osseous genioplasty, which may cause post-operatively neurosensory disturbances.[11]

Evaluation

Teeth should be placed in occlusion and the lips in contact with each other (at rest) while conduction evaluation of face.

Frontal analysis

The mandible, from angle to chin, should have a smooth and well-defined lower border along with a certain demarcation of the face from the neck area. The size, form and shape of the mentum should be in accordance with the patient gender and individual facial type.[12]



Transverse dimensions: People with "leptoprosopic" (narrow & long) facial forms typically have pointed chins, transversely retruded chins that, on the other hand, appear separate from the mandible, "dolicoprosopic" (large & wide) faces usually have strong broad chins.[13,14]

Symmetry: The symmetry of the mentum is determined in comparison to the mandible's dental and facial midline.

Profile analysis

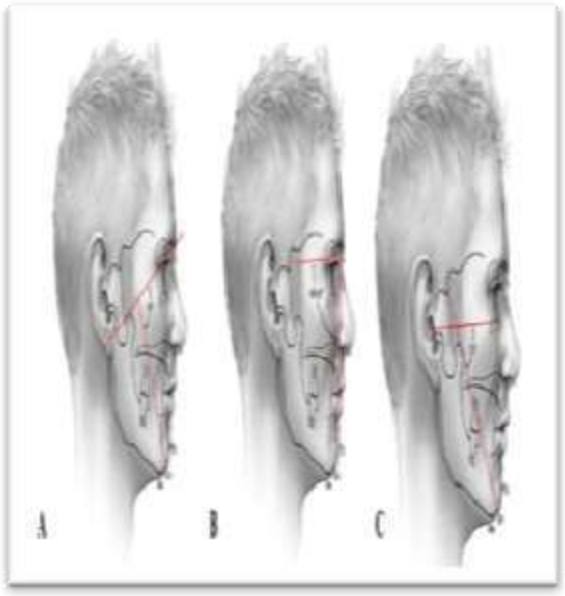
The anteroposterior site of the lower lip, the labio-mental fold height and width, and the chin button shape are the key factors accountable for the determining the chin contour or shape. The balanced amalgamation of the all these structures along with the cervicomental area, will help in attaining an esthetically pleasing and an attractive

chin. When the profile evaluation is performed, the head should be placed in natural posture.[15]

Labiomental fold: The LF (labiomental fold) forms an angle in between the tangent of the line to the chin's superior convexity and the lower lip which is around ±130. This angle is normally obtuse in cases of Class III and acute in cases of Class II.

Lip-chin-submental angle: This angle is created by the inferior and submental tangent of the labrale inferius and pogonion (lip-chin line) and around ±121° for females and ±126° for males. The angle in deficient chins is obtuse and acute in excessive anteroposterior chins. The lip-chin-submental angle will increase due to excessive submental fat, lower lip procumbence, and excessive submental bulk.

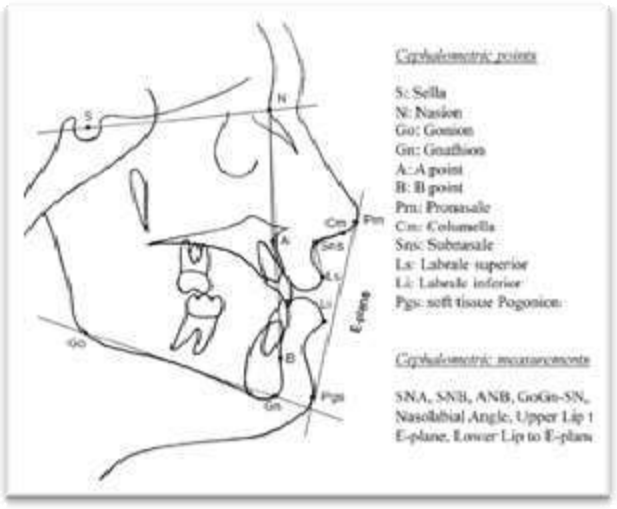
Chin-neck length: This dimension is measured from the "submental point of the neck to the menton (Me) of soft tissue" and measured around 42 ± 4. This calculation is typically increased in cases of Class III and reduced in cases of Class II.[16]



Chin throat angle (cervico-mental angle): "Submental tangent & neck tangent" (±121° for females and ±126°for males) form a chin-neck angle. Macrogenic individuals will have an acute angle, whereas microgenic will have an obtuse angle.[17]

Radiographic evaluation

Lateral cephalometric analysis: Relationships between the craniofacial complex's different hard and soft tissue structures are assessed through lateral cephalometric radiograph study. It is a valuable guide for diagnosis and rehabilitation preparation, forecasting effects of care and assessing improvements in soft tissue & hard tissue subsequent to therapy.



Facial angle: The FH plane & a line drawn from Pogonion and Nasale form this angle (mean 82 to 95 degrees).[18]

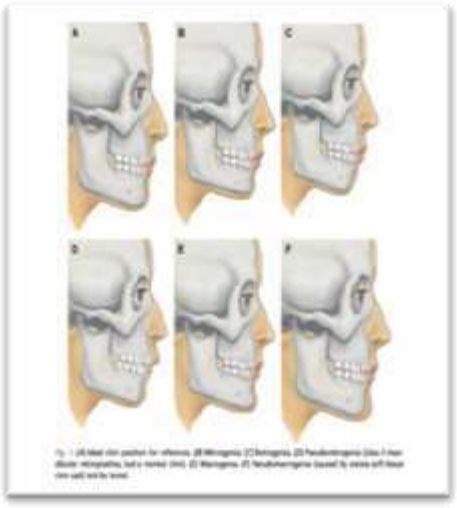
Facial contour angle: A line that connects Sn and Pogonion (Pog) (lower facial plane - LFP) and lines drawn from upper facial plane - UFP (G¥ to Sn). The mean angle is from -12 to -14 degrees for females and from -11 to -13 degrees for males.

E-line: The aesthetic plane is drawn from the "Pronasale (tip of the nose) to Pogonion (Pog)." The lower lip must be 2 mm behind it, while 4 mm behind the line. An almost symmetrical Cupid's bow should form the profile behind the esthetic plane.[19]

Postero-anterior cephalometric analysis: This radiograph can help to differentiate between the chin, dentition, maxilla, and mandible asymmetry. Occlusal cants and facial asymmetry can be appreciated on these radiographs.

Chin Classification[20,21,22,23]

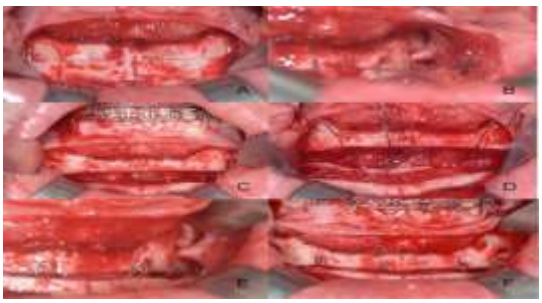
Class	
1	"Macrogenia: horizontal, vertical, combined"
2	"Microgenia: horizontal, vertical, combined"
3	"Combined: horizontal macro/ vertical microgenia, horizontal microgenia/ vertical macrogenia"
4	"Asymmetric: a) short, b) normal, c) long anterior facial height"
5	"Witch's Chin: soft tissue ptosis"
6	"Pseudomacrogenia: normal bony volume with excess soft tissue volume"
7	"Pseudomicrogenia: normal bone volume with retrogenia secondary to excessive maxillary growth and clockwise rotation of mandible"
8	"Iatrogenic malposition"



Surgical technique

1. Sliding genioplasty
   - Advancement
   - Setback
   - Reduction
   - Transverse
   - Interpositional
   - Jumping
   - Double sliding
   - Tandem
   - Centering
   - Stepped
   - M-shaped
   - Extended
2. Sagittal genioplasty
3. Sagittal curving osteotomy
4. Splitting advancement genioplasty
5. Chin shield osteotomy
6. Distraction genioplasty
7. Horizontal-T genioplasty
8. Zig zag genioplasty
9. Propeller genioplasty
10. Genioplasty for genioglossus advancement
    - Inferior border osteotomy
    - Rectangular osteotomy
    - Modified 2-piece osteotomy
    - Rotational genioplasty
11. Balcony genioplasty
12. Alloplastic genioplasty

An intraoral incision placed for osseous genioplasty with the help of various instruments including the scalpel, radiowaves, electrocautery or laser. The incision is placed along the labial surface on the contrary of the vestibular depth or near the dentition. The lateral aspects of the incision requires special care so that it should not transect the terminal branches of the mental nerves. In order to fully expose the anterior mandible, careful dissection of mentalis muscles done and a full thickness subperiosteal flap is raised. The mental foramina & neurovascular structures are recognised and exposed on both sides. The midline and para-midline areas are outlined with a pencil until sufficient exposure is reached and markings are made with piezosurgical saw or sagittal saw to leave a permanent guide for the operation. Importantly, in order not to damage the mental nerves, the osteotomy should remain at least 4.5 mm under the mental foramen and preferably nearer to 6 mm underneath the foramen. The surgical aspects of labeling, exposure of surgical site, nerve detection and fixation are demonstrated. The osteotomy is performed with the help of reciprocating, sagittal oscillating, or piezosurgical instruments. Variations of osteotomy angulation are possible and tailored depending on the desired consequences of the operation. In order to provide symmetry, try to hold the saw in one plane and allow a uniform repositioning base. Once the osteotomized section is broken down, the lingual pedicle and soft tissues in the floor of mouth must be carefully examined.[24]



Sliding genioplasty

The benefit of resolving a group of chin anomalies, from underprojection, overprojection and vertical height differences to transverse asymmetries, is provided by sliding genioplasty. In order to correct chin retrusion, it provides a feasible alternative to alloplastic mentoplasty. The part of the osteotomized segment can be slided anteriorly or posteriorly and results considerable changes in the vertical dimension of the lower third of the face.[25]

Advancement genioplasty

It is used when chin lacks projection and is elongated vertically. It is indicated for correction of severe micrognathia, mandibular prognathism, asymmetry and facial imbalance in short face patients.[26]

Stepladder/two-tiered genioplasty

It is performed for sagittal advancement with insignificant changes in the height of the lower facial third. The inferior segment is displaced sagitally over an already advanced proximal segment by making two osteotomies.[27]

Graft genioplasty or interpositional genioplasty or vertical lengthening

The improvement is accomplished by placing bone graft in between the osteotomized segments to forwardly place the chin and raise the lower height of the face.[28]

Reduction genioplasty

Parts of bone are removed in the cases of reduction genioplasty. Two horizontal osteotomy cuts are made which are parallel to each other and to the occlusal plane and the section in between the osteotomies is resected after the caudal cut is made. The height of the lower third of face is significantly decreased by this operation. Patient should be warned about the possibility of certain level of soft tissue ptosis and requirement of adjunctive procedure should be advised.[29]

Oblique sagittal split sliding genioplasty

This procedure has numerous benefits over formerly defined methods. The chin is moved along the oblique sagittal slopes, which increases contact between the bone and also confirms less defects or disproportion in the final outcomes. The oblique angle of the sagittal cut gives the segment in the superoinferior plane greater versatility of motion, allowing the vertical angles to be more controlled. The vertical osteotomy cut is placed 5 mm apart from the foramen and is in the oblique sagittal plane to avoid damage to the nerves. This is harmless and flexible technique, and may be conducted to manage countless deformities of the chin involving vertical, sagittal, or transverse abnormalities.[30]

Distraction genioplasty

Increased bone formation occurred not only between the two osteotomy surfaces, but also adjacent to the distraction region, resulting in increased coverage of the lower incisor roots. Distraction osteogenesis was done to correct mandibular retrusion. The distraction leads to formation of bone in between the two osteotomized fragments and bone surfaces around the osteotomized sites. Osteogenesis appears to occur in the region where, during active distraction, the periosteum is extended away from the bone surface, where it forms a kind of tent rounding out the phase between the surfaces of the osteotomized segments. It is also advocated for providing extreme mandibular retrusion often combined with inadequate lower incisor buccal bone coverage and it may therefore make sense to do genioplasty distraction before orthodontic care to obtain better conditions for lower incisor orthodontic movements.[31]

Zigzag Genioplasty

The superior-medial displacement of bone fragments along the slopes of an inclined plane is accomplished in the zigzag genioplasty. The degree of inclination for these slopes will be assessed prior to surgery with the help of OPG which is traced with respect to the vertical and transverse movements, height and width of mandibular symphysis, the dimensions of residual bone segments after ostectomy procedure, the location of anterior lower teeth apices, the site of mental foramina, and symmetrical or asymmetrical reduction. Zigzag genioplasty results in decreasing the vertical and transverse measurements of the chin and its symmetry or asymmetry. The technique also causes the mental sagittal projection to be decreased and has been used to decrease the height of the mandibular body simultaneously. A simple geometric equation allows the chin to be mobilized according to the needs of each patient in the vertical, horizontal, and sagittal directions. This design maintains the attachments of suprahyoid muscles and the most essential anatomical part of the symphysis region; an esthetic and natural facial appearance is created by narrowing the broad chin by this technique. It aids in safeguarding the bone present in the symphysis area, diminished chances of symmetric transposition of the chin, slight change in location of mentolabial fold, the likelihood of mutual reduction of the height of mandibular body & corrections in the asymmetric chin, slight neurosensory disturbances, consistent and steady surgical technique, comparatively lower risk of problems, minimal chances of injury to apices of teeth, and discrepancies in preferring the techniques of the osteotomy.[32]

Tenon-mortise genioplasty

Genioglossus advancement was accomplished by executing a tenon mortise type of genioplasty. The purpose of this technique is to achieve volumetric expansion of the hypopharyngeal space through genioglossus muscle advancement. The minimum advancement which was attained with this type of procedure was 10 mm. The lateral fixation of the fragments was performed to eliminate the possibility of fracture. For patients suffering from mild to moderate obstructive sleep apnea, this form of mortised genioplasty for long-term genioglossus advancement with UPPP serves as an effective method. The treatment for Uvulopalatopharyngoplasty (UPPP) was performed when there was anatomical obstruction at the soft palate. The combination of surgical procedures provide greater success rates than UPPP alone if anatomical obstructions occur at the base of the tongue as well as the level of the soft palate.

Soft tissue changes after genioplasty

The resulting soft tissue adjustment can differ according to vector of the movement. The ratio of soft tissue progression to the bone was unsurprisingly estimated to be **0.9:1** with progressive genioplasty. Additional advantages include increased length of submental region and cervicomental angle, enhanced lower lip association with eversion to the lower incisors, and total development of the genial-tongue-hyoid musculature which can have a practical impact in people with habit of snoring. The chin's soft tissues adopt vertical lengthening with a **1:1** ratio of bony movement. However, the reduction of osteotomies has a less consistent impact on

the soft tissues due to the exuberance of the existing soft tissue. The horizontal reduction causes transition in the soft tissue that meets the **0.6:1** ratio, while the ratio is **0.25:1** for vertical reduction. The clinical examination when the chin is repositioned during the operation, and not the quantitative analysis available, should assess the final cosmetic appearance of the soft tissue, although these ratios are beneficial.[33]

Complications of Genioplasty[34,35,36]

1. Soft tissue
- Hematoma
- Scar
- Buccal overgranulation
- Wound dehiscence
- Cellulitis
- Abscess (early/late)
- Draining fistula
- Capsular contracture
- Skin bunching/dimpling
- Skin necrosis

2. Muscle
- Chin ptosis
- Mentalis muscle dysfunction
- Lower lip retraction

3. Nerve
- Chin hypoesthesia/dysaesthesia

4. Bone / tooth
- Root damage
- Mandibular bone resorption

5. Technical
- Implant malposition
- Underaugmentation / overaugmentation

Conclusion

Extensive historical evidence relating to facial assessment is revealed in the literature on the chin and genioplasty procedures. The significance of the mentum and its position in providing esthetics, harmony and balance of the face are emphasized. The abnormalities in the mentum causes distress perception of one's personality. The comprehensive knowledge and understanding of regional anatomy permits the surgeon to safely execute operating procedures with good likely results. There are various choices for correcting the jaw defects, including fillers, grafts, orthognathic surgery, or mixture of these methods. The appropriate genioplasty procedures can be conducted by reviewing the evidence-based analysis documented in the literature. Fortunately, complications are rare and easy to treat surgically in general. Whilst new technologies can become accessible in the future era, but the existing are options already reliable in providing satisfactorily outcomes. The usage of custom made implants has a substantial role in the syndromic patients as they permit technique to correct unusual anatomical issues with minimal chances of morbidity. The advancements in virtual surgical planning provide surgeons the capability to perform modification in simple or complicated chin abnormalities. The surgeon is able to execute minor but essential improvements or drastic changes in the whole shape of the lower third of the face through genioplasty procedures.

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