




# Correcting the Broad, Flat and Short Chin Using Modified M-genioplasty

Zhiyang Xie<sup>1</sup> · Sheng Gao<sup>1</sup> · Kaili Yan<sup>1</sup> · Tong Lu<sup>1</sup> · Chao Hu<sup>1</sup> · Shu Wang<sup>1</sup> · Wensong Shangguan<sup>1</sup> · Guoping Wu<sup>1</sup> 



Received: 3 November 2022 / Accepted: 26 February 2023 / Published online: 20 March 2023  
© Springer Science+Business Media, LLC, part of Springer Nature and International Society of Aesthetic Plastic Surgery 2023

## Abstract

**Background** Several genioplasty techniques can narrow the width of the chin. Nevertheless, patients with a broad and short chin who received these methods were unsatisfied with the outcomes. The goal of this study was to analyze the clinical outcomes of modified M-shaped genioplasty for broad, flat and short chin deformity.

**Methods** Thirty-eight patients with broad, flat and short chins were included in this study from January 2019 to December 2021. The preoperative design was performed individually according to the data of the chin and the patient's desire of final chin shape. Narrowing and vertical elongating genioplasty was performed for all the patients with modified M-shaped genioplasty under general anesthesia according to the preoperative designs. All patients have completed the FACE-Q preoperatively and 3 months postoperatively. The results were evaluated by clinical appearances and FACE-Q scores.

**Results** The vertical lengthening of the chin was 2–5 mm, with an average of 3.02 mm. The horizontal narrowing width was 3–6 mm, with an average of 5.6 mm. FACE-Q scores in satisfaction with the chin increased significantly from  $35.34 \pm 9.57$  to  $72.95 \pm 6.81$ . There were no severe complications took place during the time frame of 3–24 months postoperatively.

**Conclusions** The modified M-shaped genioplasty preserved the bone structure in the midsymphyseal area and suprahyoid muscular attachments as far as possible, and the

bone segments may be repositioned quickly. This technique produced reliable and esthetically satisfying results in correcting a short, flat and broad chin, with altered vertical length, slope, width and protrusion three-dimensionally.

**Level of Evidence IV** This journal requires that authors assign a level of evidence to each article. For a full description of these Evidence-Based Medicine ratings, please refer to the Table of Contents or the online Instructions to Authors [www.springer.com/00266](http://www.springer.com/00266).

**Keywords** Mandible · Genioplasty · Short chin · Broad chin

## Introduction

The chin is the most variable part of the lower third of the face, and it plays a key role in the esthetic harmony, as well as the balance of the entire face. Its protrusion and shape are considered as an important features of facial attractiveness [1]. If the chin is underdeveloped or overdeveloped in the sagittal, vertical, or horizontal directions, it will lead to the anomalies in shape, location and size, which will further affect the whole facial contour. In East Asia, people prefer a round, narrow and pointy chin (it is considered attractive, slender and feminine) rather than a flat and broad one (it is considered as strong and masculine, certainly not attractive) [2]. Therefore, the pursuit of smaller appearance and smoothly shaped lower facial contour has been the mainstream in Asians.

In order to satisfy these considerations with facial contouring surgery, several procedures have been proposed and developed, such as the chin T-osteotomy [3], the oblique mandibular chin-body osteotomy [4] and mini

✉ Guoping Wu  
drpwwu@aliyun.com

<sup>1</sup> Department of Plastic Surgery, The Affiliated Friendship Plastic Surgery Hospital of Nanjing Medical University, Nanjing 210029, Jiangsu, China

V-line surgery [5], which are the most widely used surgical procedures for correcting broad chin. For patients present with a short, flat and wide chin, the aforementioned methods cannot elongate the chin vertically; however, the vertical length is another important point to achieve esthetically harmonized lower face. Recently, narrowing and lengthening genioplasty has been paid increasing attention; several authors have shared their new approaches for chin narrowing and vertical lengthening [6–8]. The basic principle of these methods is to narrow and elongate the chin through a central segment resection or transposition at the symphysis. Intraoperative dissection of the genial musculature of the lingual side may lead to additional bleeding and result in many problems, such as palpable mass and bulging in the submental area, thereby the esthetically natural line of the chin may be affected. Thus, the authors introduce a simple and effective method to correct the short, flat and broad chin deformity by using a modified M-shaped osteotomy genioplasty.

## Patients and Methods

### Patients

Thirty-eight patients (5 males and 33 females), ranging in age from 20 to 41 years (average of 27.3 years) underwent narrowing and lengthening genioplasty from January 2019 to December 2021 were enrolled in this retrospective study at the Affiliated Friendship Plastic Surgery Hospital of Nanjing Medical University. All the patients came for narrowing and lengthening the chin to achieve an esthetically harmonious lower face were hospitalized for treatment. Among them, 16 cases complained with a simple short and square chin, 14 cases with a short and square chin combined with bilateral mandibular angle prominent, and the other 8 cases complained with a broad and short chin after mandibular angle osteotomy. All the patients were asked to complete the FACE-Q<sup>TM</sup> appearance of the chin questionnaire preoperatively and at least 3-month follow-up visits; FACE-Q scores were calculated for each scale. The mean FACE-Q score ranged from 0 to 100, with higher scores reflecting higher level of satisfactory with their appearance. The inclusion criteria were as follows: ① patients with broad and short chins who were scheduled to undergo genioplasty for narrowing and lengthening the chin; ② patients consented to the surgical approach and participated in the follow-up voluntarily; ③ the follow-up period was at least 3 months. The exclusion criteria including: ① patients with previous mandible injury or genioplasty; ② patients who did not cooperate with surgery and follow-up. All studies on human material were approved by the ethics committees of the Affiliated

Friendship Plastic Surgery Hospital of Nanjing Medical University and were performed in conformity with the Declaration of Helsinki.

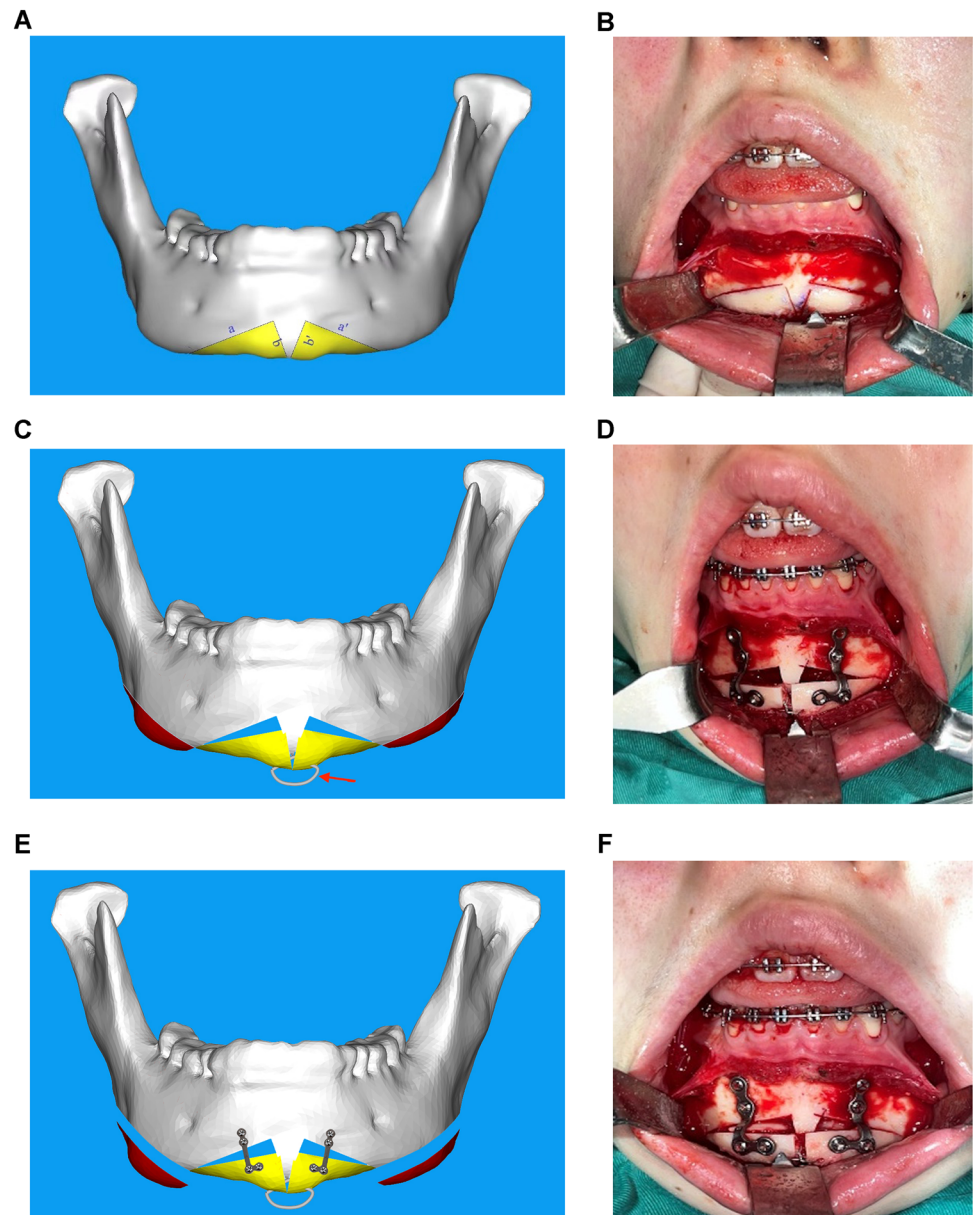
### Preoperative Design

A three-dimensional facial skeleton scan was performed for each patient using a CBCT scanner (HiRes3DCBCT, Large V Instrument Corporation Ltd, Beijing, China.) preoperatively. All the data of patients were saved in digital imaging and communications in medicine (DICOM) format and imported into ProPlan CMF3.01 software (Materialise, Leuven, Belgium) for 3D reconstruction of the facial skeleton image. The preoperative design of the patient was performed individually on the 3D reconstructed image according to the width and length of the chin and refers to the patient's desired final chin shape. The amount of advancement and lengthening was determined following the criteria. Firstly, the ratio of the distance from the subnasale to the stomion and the distance from the stomion to gnathion is 1:2. Secondly, in facial profiles, the Ricketts' esthetic line as a reference line for the chin prominence. Based on the patients' preferences and the location of the mandibular canal, the chin osteotomy line was employed as the anterior beginning point of the mandibular angle curved osteotomy line for those who needed mandibular osteotomy at the same time.

### Surgical Procedure

All the operations were performed through an intraoral approach under general anesthesia with nasotracheal intubation. The chin area was completely exposed lateral to the mental foramen via a conventional intraoral vestibular incision and subperiosteal dissection. The osteotomy line was marked on the bone with methylene blue as planned, two symmetrical osteotomy lines a, b and a', b' were designed on both sides of the middle line of the chin (lines a and a' were more than 5 mm below the mental foramen), and a, b and a', b' formed the "M" osteotomy lines (Fig. 1A and B). After completing the osteotomies along the marked line with a reciprocating saw, a V-shaped bony strut in the middle and bilateral two segments were formed. The medial ends of both bone segments converge with the V-shaped bony strut in the center with a steel wire which passing through the drilled hole, and the lateral ends move medially along the lines a and a', respectively (Fig. 1C and D). According to the correction of the facial profile is needed, the position of the bone segment was further adjusted in the anteroposterior dimension to reach the preoperatively designed position and fixed with miniplates and screws. To achieve a smooth and natural curve of the mandibular lower border, the bony steps, which produced

**Fig. 1** Schematic design of osteotomy line and intraoperative view. **A** Line a, b and line a', b' forming a M-shaped osteotomy line; **B** intraoperative osteotomy lines were marked. **C** The medial ends of both bone segments converge with the V-shaped bony strut with a steel wire (red arrow) and the lateral ends move medially along the lines a and a', to lengthen and narrow the chin. **D** Intraoperative view of the V-shaped bony strut in the center, the two lateral bone segments were approximated at the midline with a wire, moved downward and forward to change the length, width and protrusion of the chin, and fixed with miniplates and screws. **E** After the bone segments were fixed with miniplates and screws, osteotomy of bilateral lower mandibular margin to remove the bony steps on both sides. **F** The gap between the bone segments were filled with bone fragments of the resected mandibular inferior edge or mandibular angle bone segments



by the bilateral repositioned bone segments at the inferior edges of the mandible, were trimmed laterally on both sides using a reciprocating saw and bur. For those who needed mandibular angle osteotomy simultaneously, according to the preoperative design, long curve osteotomy of the mandibular angle was carried out at the end of the chin osteotomy line to eliminate the bone steps bilaterally. If further narrowing of the mandible body was required, mandibular corticectomy was subsequently performed. The gap between the bone segments were filled with bone fragments of the resected mandibular inferior edge or mandibular angle bone segments (Fig. 1E and F). After hemostasis was satisfied, the incision was closed layer by layer using 4-0 absorbable sutures with interrupted suturing

techniques. Prophylactic antibiotics were given for 2 days, and the sutures were removed 10 days postoperatively.

### Statistical Analysis

The FACE-Q scores are presented as the mean with standard deviation; the data were analyzed using SPSS version 26.0 software (SPSS Inc., Chicago, IL, USA). The 2 groups were compared by Dunnett's *t* test in a one-way analysis of variance. *P* values <0.05 were considered statistically significant.



## Results

All procedures were completed successfully, with vertical lengthening of the chin of 3 mm (18 cases), 2 mm (10 cases), 4 mm (9 cases) and 5 mm (1 case), with a mean of 3.02 mm. The chins were narrowed horizontally from 3 to 6 mm (mean 4.6 mm). The postoperative follow-up period was 3–24 months (averaged 10.6 months). There were no postoperative complications such as hematoma, wound dehiscence, accidental fracture, surgical site infection, or permanent neurosensory impairment. Thirty-eight patients experienced varied degrees of sensory disturbance in the lower lip area, but all recovered within 3 months. FACE-Q scores of the patients in satisfaction with the chin increased significantly from preoperative mean score of  $35.34 \pm 9.57$  to  $72.95 \pm 6.81$  postoperatively ( $P < 0.001$ ). All patients were satisfied with changes that made their facial contours improved (Figs. 2, 3, 4).

## Discussions

The chin is the most important part of the lower third face and plays an important role in the esthetics of the entire face. The size, shape, position and proportion of the chin in relation to the other elements of the face contribute to facial balance and harmony [7]. Furthermore, changes in both the vertical and horizontal positions of the chin, not only have a significant impact on the appearance of the lower lip and labial groove, but also on the contour of the neck. Therefore, the goal of lower facial contouring surgery is to improve the facial harmony and balance. There are many aspects that should be considered when planning surgical treatment for patients who seek cosmetic surgery for recontouring lower face. Firstly, the proportion and balance of all parts of the face should be considered. According to the most utilized canons of equal thirds, an “ideal” facial contouring is that the vertical heights of the upper, middle and lower thirds of the face are all equal. Particularly within the lower third, the ratio of the distance from the subnasale to the stomion and the distance from the stomion to the gnathion is 1:2. The length of the designed

**Fig. 2** A 25-year-old female was admitted to the hospital with a broad lower face and a short, flat and broad chin; mandibular angle long curve osteotomy and modified M-shaped genioplasty osteotomy were performed. The chin was lengthened 3mm, advanced 6mm and narrowed 4mm. Preoperative (A, B, C) and 2-year postoperative photographs (D, E, F)





**Fig. 3** A 23-year-old female complained with a broad, flat and short chin after mandibular angle osteotomy underwent modified M-shaped genioplasty with the chin lengthening 3mm and narrowing 4 mm. Preoperative (A, B, C) and 2-year postoperative photographs (D, E, F)

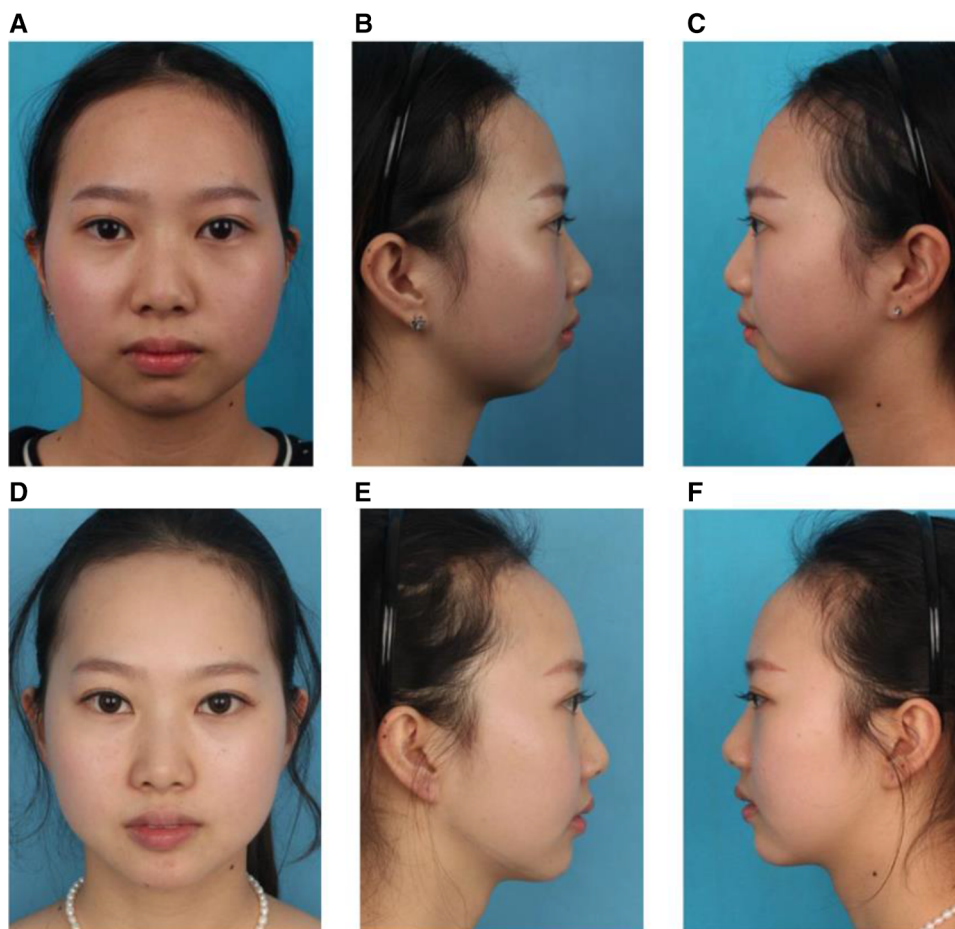


postoperative chin is determined by the above criteria. In addition, surgical planning must be taken into account the harmonization of transverse width and vertical height of the face, and the patient's ethnic, cultural background and perceptions also should be considered.

For the patients with a broad and flat chin, some authors reported such as T-shaped osteotomy genioplasty [3, 9], oblique mandibular chin-body osteotomy [4], inverted V-shape osteotomy [10], mini V-Line surgery [5], Mandibular Angle-Body-Chin Curved Osteotomy [11], U-Shaped osteotomy [12], One-Piece mandibuloplasty [13] and so on, to achieve a satisfactory lower facial morphology. However, for broad chin with vertical deficit cases, it is necessary to increase the vertical length and change the flat lower margin of the chin. Those methods narrow the chin and change the slope of the lower margin, but do not increase the vertical length and cannot achieve the lower facial harmony. As for the patients with insufficient vertical length of the chin, several investigators suggest that extending the chin downwards with interpositional graft between the fragments, and fix them through osteosynthesis. Such as horizontal osteotomy genioplasty or T-shaped genioplasty, downwards and advanced the bone fragment

as well as filling the interpositional gap with autogenous bone grafts obtained from the skull, iliac crest and resected mandibular angle [14–17]. However, the harvest of bone grafts from skull or iliac is not only a complicated and traumatic procedure, but also has donor site morbidity. In order to avoid these shortcomings, various alloplastic materials have been used as interpositional grafts, such as fresh-frozen bone, hydroxyapatite and coral [18–20]. However, all the materials have low torsional resistance, are easy to break and have high risk of infection. Anquetil et al. [6] described a novel technique that an inverted trapezoid osteotomy used as a wedge to elongate the chin without any interpositional bone graft; all the patients achieved good esthetic and morphometric outcomes. This method cannot narrow and alter the slope of the parasymphysis border, which may lead to square chin deformity or bony steps on both sides of the chin as well as bone nonunion in case of soft tissue embedded in interpositions. Lee et al. [8] designed a procedure to extend the chin by using the abandoned central segment in narrowing genioplasty to rotate 90 degrees as a pedicled interpositional graft, succeed in making the slope of the chin steeper and producing a more slender lower facial contour.

**Fig. 4** A 19-year-old girl with a receding, flat and short chin underwent modified M-shaped genioplasty; the chin was lengthened 3 mm and advanced 8 mm. Preoperative (A, B, C) and 2-year postoperative (D, E, F) photographs (D, E, F)



Another method to correct a short and wide lower face was reported by Lee et al. [7], in which they designed an upside-down trapezoidal shape osteotomy in the center and the distal segment was removed; in this way, the chin was narrowed and elongated by bilateral bony segments which were approximated in the center and fixed with the central upside-down trapezoidal segment. Both methods narrow and lengthen the chin without interpositional grafts, and achieve excellent stability after genioplasty. The advantage of both methods comes from the central pedicled bone flap or bone strut with the muscle attached to the posterior side, thereby reducing the risk of potential complications associated with bone graft. However, both of them are complicated procedures with prolonged surgery time. In addition, the removal of the distal part or rotation of the central segment may damage the suprahyoid muscular attachments.

Lee et al. [21] developed an M-genioplasty, in which the bone segments in the middle and both sides of the chin are resected in a wedge shape and the preserved bone segments are rotated to be fixed together with the main segment. Keyhan et al. [22] introduced zigzag genioplasty to narrow and shorten the chin. In these methods, the oblique

osteotomy lines are similar to that of M-genioplasty. However, the location and amount of resected bone segments are different. In zigzag genioplasty, the central V-shaped strut was preserved, and the resected bone segments are close to the V-shaped strut bilaterally. In both methods, the authors obtained satisfactory results without severe complications. Nevertheless, some cosmetic problems, such as palpable bony step, irregular margin, jowl redundancy and mentalis hyperactivity, were observed in a few cases [16]. However, both methods are designed for transverse reduction of chin, rather than sagittal and vertical chin augmentation. Farina et al. [23] reported the M-shaped genioplasty for sagittal and vertical chin augmentation. The osteotomy line is almost the same as the above two methods except not reaching the submental margin at the middle line. After osteotomy, the bone segment is advanced and descended to the preoperatively designed position and fixed without bone graft in the interposition. In this way, the slope of the chin cannot be changed, and there may be obvious gaps in between the bone segments, which may be embedded by soft tissue, which result in bone nonunion and bony steps at the lower edge of the mandible. Combining these methods, we

designed a modified M-shaped osteotomy of the chin, in which the central V-shaped strut was preserved; both the distal bone segments were moved downward along with line b and b' medially, which were also be advanced to the desired position to reach the length and protrusion of pre-operative design. After fixing the bone segments with miniplates and screws, the line a, b, line a', b' and the two bone segments formed two triangle structures on both sides of the central V-shaped strut. This triangular structure, which is stable, strong and pressure tolerated after surgery, facilitates the position the bone segments intraoperatively. Furthermore, the preservation of the central V-shaped strut not only preserves the attachments of the suprahyoid muscle at the mid mental line, but also keeps the most important anatomical portion of the symphysis area intact. After osteotomy, the bony segmental blocks can be setback and advanced, up and downward flexibly, which can resolve the problem of the curvature, length and protrusion of the chin. The bone removal is flexible during the operation, which resulted from adjusting the osteotomy volume on both sides and the angle between the distal bone segments on both sides of the central V-shaped strut, the chin asymmetry can be effectively corrected and narrowed to different degrees. By combining genioplasty with mandibular angle long curve osteotomy, the entire slope of the mandibular lower border can be altered completely without any bony steps. For patients who underwent genioplasty alone, to obtain a smooth contour of the lower mandibular border, a reciprocating saw and burs were used to trim the bony steps at the chin-mandible junction. Bony gaps between the segments can be present to some degree after fixation, bone fragments from the mandibular angle or chin-mandible junction were used for bone graft to the gaps. In fact, it is not a significant concern if the bony gap without bone graft does not contribute to contour deformity. With this modified M-shaped genioplasty, the chin was flexibly altered in the vertical length, slope, width and protrusion three-dimensionally, and the patients' outcome satisfaction with the chin measured by FACE-Q questionnaire has been significantly improved.

The major limitation of this study that must be acknowledged is its retrospective nature and the lack of control. In addition, we also do not include a direct comparison to patients who underwent other genioplasty procedures. Despite these limitations, we believe that this approach may be useful for surgeons considering lower facial recontouring for their properly selected patient.

## Conclusions

The chin plays an important role in balance and harmony of the face. As facial contouring surgery becomes more and more popular, we should pay full attention to genioplasty surgery. The modified M-shaped genioplasty technique produced reliable and esthetically satisfactory results in correcting the short, flat and broad chin with altered vertical length, slope, width and protrusion three-dimensionally. This method not only preserved the bone structure in the midsymphyseal area and suprahyoid muscular attachments as far as possible, but also repositioned the bone segments quickly with the preserved central bone strut. Thus, it is a simple and easy operation with reliable, stable results and relatively low morbidity.

**Author Contribution** All authors contributed to the study's conception and design. Material collection and the first draft of the manuscript were performed by ZX. Data collection and analysis were performed by SG and KY. The design and execution of the operation were performed by TL, CH, SW and WS. The design, formulation, implementation of surgical and research programs, and revision of the paper were performed by GW. And all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

**Funding** The authors received no financial support for the research, authorship and/or publication of this article.

## Declarations

**Conflict of interest** The FACE-Q Craniofacial Module, authored by Drs. Anne Klassen and Karen Wong, is the copyright of McMaster University and The Hospital for Sick Children. The FACE-Q can be used free of charge for non-profit purposes. The authors declare that they have no conflicts of interest to disclose.

**Ethical Approval** The study was approved by the Ethics Committee of the Affiliated Friendship Plastic Surgery Hospital of Nanjing Medical University and was conducted in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

**Informed Consent** Informed consent was obtained from all subjects involved in the study. Written informed consent was also obtained from the patients to publish this paper.

## References

1. Shokri T, Rosi-Schumacher M, Petrauskas L, Chan D, Ducic Y (2021) Genioplasty and mandibular implants. *Facial Plast Surg* 37(6):709–715. <https://doi.org/10.1055/s-0041-1735307>
2. Park S (2021) Cosmetic bone-contouring surgery for Asians. *Facial Plast Surg Clin North Am* 29(4):533–548. <https://doi.org/10.1016/j.fsc.2021.07.001>
3. Deschamps-Braly J (2019) Feminization of the chin: genioplasty using osteotomies. *Facial Plast Surg Clin North Am* 27(2):243–250. <https://doi.org/10.1016/j.fsc.2019.01.002>



4. Zhang Z, Tang R, Tang X, Yu B, Niu F, Gui L (2010) The oblique mandibular chin-body osteotomy for the correction of broad chin. *Ann Plast Surg* 65(6):541–545. <https://doi.org/10.1097/SAP.0b013e3181d37770>
5. Lee TS, Kim HY, Kim T, Lee JH, Park S (2014) Importance of the chin in achieving a feminine lower face: narrowing the chin by the “mini V-line” surgery. *J Craniofac Surg* 25(6):2180–2183. <https://doi.org/10.1097/SCS.0000000000001096>
6. Anquetil M, Perrin JP, Praud M, Mercier J, Corre P, Bertin H (2020) Vertical lengthening genioplasty: a new osteotomy technique. *J Stomatol Oral Maxillofac Surg* 121(2):159–162. <https://doi.org/10.1016/j.jormas.2019.09.008>
7. Lee TS, Kim HY, Kim TH, Lee JH, Park S (2014) Contouring of the lower face by a novel method of narrowing and lengthening genioplasty. *Plast Reconstr Surg* 133(3):274e–282e. <https://doi.org/10.1097/01.prs.0000438054.21634.4a>
8. Lee S, Kim BK, Baek RM, Han J (2013) Narrowing and lengthening genioplasty with pedicled bone graft in contouring of the short and wide lower face. *Aesthetic Plast Surg* 37(1):139–143. <https://doi.org/10.1007/s00266-012-0019-7>
9. Jegal JJ, Kang SJ, Kim JW, Sun H (2013) The utility of a three-dimensional approach with T-shaped osteotomy in osseous genioplasty. *Arch Plast Surg* 40(4):433–439. <https://doi.org/10.5999/aps.2013.40.4.433>
10. Kim TG, Lee JH, Cho YK (2014) Inverted V-shape osteotomy with central strip resection: a simultaneous narrowing and vertical reduction genioplasty. *Plast Reconstr Surg Glob Open* 2(10):e227. <https://doi.org/10.1097/GOX.0000000000000169>
11. Zhang C, Teng L, Chan FC, Xu JJ, Lu JJ, Xie F, Zhao JY, Xu MB, Jin XL (2014) Single stage surgery for contouring the prominent mandibular angle with a broad chin deformity: en-bloc Mandibular Angle-Body-Chin Curved Osteotomy (MABCCO) and Outer Cortex Grinding (OCG). *J Craniomaxillofac Surg* 42(7):1225–1233. <https://doi.org/10.1016/j.jcms.2014.03.004>
12. Lai C, Jin X, Zong X, Song G (2019) En-Bloc U-Shaped osteotomy of the mandible and chin for the correction of a prominent mandibular angle with long chin. *J Craniofac Surg* 30(5):1359–1363. <https://doi.org/10.1097/SCS.0000000000005126>
13. Kim SC, Kwon JG, Jeong WS, Na D, Choi JW (2018) One-Piece mandibuloplasty compared to conventional mandibuloplasty with narrowing genioplasty. *J Craniofac Surg* 29(5):1161–1168. <https://doi.org/10.1097/SCS.0000000000004458>
14. Baek RM, Han SB, Baek SM (2001) Surgical correction of the face with the square jaw and weak chin: angle-to-chin bone transfer. *Plast Reconstr Surg* 108(1):225–232. <https://doi.org/10.1097/00006534-200107000-00036>
15. Li J, Hsu Y, Khadka A, Hu J, Wang D, Wang Q (2011) Contouring of a square jaw on a short face by narrowing and sliding genioplasty combined with mandibular outer cortex osteotomy in orientals. *Plast Reconstr Surg* 127(5):2083–2092. <https://doi.org/10.1097/PRS.0b013e31820e9203>
16. Perez Villar A, Krebs Rodrigues FL, Gomes PL (2020) Sliding genioplasty using mastoid bone interpositional graft. *Facial Plast Surg Aesthet Med* 22(6):483–485. <https://doi.org/10.1089/fpsam.2020.0147>
17. Kim GJ, Jung YS, Park HS, Lee EW (2005) Long-term results of vertical height augmentation genioplasty using autogenous iliac bone graft. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 100(3):e51–e57. <https://doi.org/10.1016/j.tripleo.2005.04.020>
18. Bertossi D, Albanese M, Nocini PF, D’Agostino A, Trevisiol PP (2013) Sliding genioplasty using fresh-frozen bone allografts. *JAMA Facial Plast Surg* 15(1):51–57. <https://doi.org/10.1001/jamafacial.2013.224>
19. Rosen HM (1988) Surgical correction of the vertically deficient chin. *Plast Reconstr Surg* 82(2):247–256. <https://doi.org/10.1097/00006534-198808000-00006>
20. Layoun W, Guyot L, Richard O, Gola R (2003) Augmentation of cheek bone contour using malar osteotomy. *Aesthetic Plast Surg* 27(4):269–274. <https://doi.org/10.1007/s00266-003-2129-8>
21. Lee JB, Han JW, Park JH, Min KH (2018) Lower facial contouring surgery using a novel method: M-genioplasty. *Arch Plast Surg* 45(6):572–577. <https://doi.org/10.5999/aps.2018.00682>
22. Keyhan SO, Khiabani K, Hemmat S, Varedi P (2013) Zigzag genioplasty: a new technique for 3-dimensional reduction genioplasty. *Br J Oral Maxillofac Surg* 51(8):e317–e318. <https://doi.org/10.1016/j.bjoms.2013.01.013>
23. Fariña R, Valladares S, Aguilar L, Pastrian J, Rojas F (2012) M-shaped genioplasty: a new surgical technique for sagittal and vertical chin augmentation: three case reports. *J Oral Maxillofac Surg* 70(5):1177–1182. <https://doi.org/10.1016/j.joms.2011.02.137>

**Publisher’s Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.