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ORIGINAL ARTICLE CRANIOFACIAL/MAXILLOFACIAL

Single-Stage Mandibular Curved Ostectomy on Affected Side Combined with Bilateral Outer Cortex Grinding for Correction of Facial Asymmetry: Indications and Outcomes

Guodong Song[1] · Xianlei Zong[1] · Xiaoshuang Guo[1] · Jingyi Zhao[1] · Xiaolei Jin[1]

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Abstract

Background Facial asymmetry combined with a prominent mandibular angle is common in the population. Its treatment involves two or three stages of surgeries. Generally, orthognathic surgery is a top priority. However, some patients with no severe occlusion disorders focus on the appearance and could not accept complex therapeutic procedures. This study evaluated the surgical effect of en bloc mandibular angle–body–chin curved ostectomy (MABCCO) combined with traditional mandibular angle curved ostectomy (MACO) and bilateral outer cortex grinding (OCG) to correct facial asymmetry and a prominent mandibular angle.

Methods From September 2013 to November 2017, a total of 40 patients with facial asymmetry and prominent mandibular angle were chosen for this study. The authors performed single-stage surgery of en bloc MABCCO combined with traditional MACO and bilateral outer cortex grinding to correct facial asymmetry. Patient satisfaction was investigated by questionnaires at 6 months postoperation. The effectiveness was then evaluated through cephalometric radiographs, three-dimensional computed tomography, and preoperative and postoperative standard facial photographs.

Results The postoperative results of all 40 cases showed that facial asymmetry was effectively corrected without serious complications, and the square face was also significantly improved with a harmonious mandibular contour. There was a statistical difference between the patient's preoperative and postoperative satisfaction scores ($p < 0.05$). The objective esthetic outcomes evaluated by both surgeons and patients were quite satisfactory.

Conclusion Single-stage surgery of en bloc MABCCO combined with traditional MACO and bilateral OCG was an adaptable option for correction of facial asymmetry and prominent mandibular angle with slight occlusion disorders, which can both largely shorten treatment time and shape a harmonious face.

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.

Keywords Facial asymmetry · Mandibular angle–body–chin curved ostectomy · Mandibular angle ostectomy · Contouring · Indication

Introduction

Facial asymmetry is relatively common in the population with a prevalence of 21–85% [1, 2]. Visible facial asymmetry gives an impression of disharmony and disfavor. Therefore, a desperate desire to improve facial appearance for achieving a symmetric and harmonious facial contour is often required in clinical work.

Facial asymmetric deformity is considered to be initiated by skeletal unbalanced development [3]. Usually, the probability of asymmetric deformity emerging in the mandible is higher than the maxilla [4]. Clinical manifestation contains deviation of the facial midline, deviation of

✉ Xiaolei Jin
doctorjinxiaolei@163.com

[1] Department of Craniomaxillofacial Surgery, Plastic Surgery Hospital, Chinese Academy of Medical Sciences & Peking Union Medical College, No. 33 Ba-Da-Chu Road, Shijingshan District, Beijing, China

the menton, occlusion disturbance, inclination of the occlusion plane, mandibular prognathism, mandibular hypertrophy and mandibular hypotrophy. Baek [5] classified facial asymmetric deformity into four groups according to anatomic features: shift or lateralization of the mandibular body (44% of the patients), ramus height difference with menton deviation to the short side (39%), atypical asymmetry (12%) including deviation of the menton to the short side, prominent angle on the larger side and reverse maxillary canting, and 5% patients with severe maxillary canting, ramus height difference and menton deviation to the short side. Routinely, correction of facial asymmetric deformity is a complicated and long therapeutic process involving two or three stages of operations. Orthognathic surgery (i.e., bilateral sagittal split osteotomy BSSO, intraoral vertical ramus osteotomy IVRO, maxillary LeFort I osteotomy, and genioplasty) is the priority in the first stage. The sequential treatments contain facial contouring surgery and soft tissue plasty. However, some patients with facial asymmetry are only characterized with unilateral or bilateral facial enlargement, canting of the inferior mandibular margin, no or slight deviation of the midline, no or slight deviation of the menton, slight deviation of occlusion and a prominent mandibular angle. They are more likely to be concerned with their appearance and refuse complicated and long-termed orthognathic therapy that requires preoperative and postoperative orthodontic procedures. In this condition, a single-stage facial contouring surgery is an appropriate option.

In this study, patients with facial asymmetric deformity characterized by unilateral and bilateral mandibular hypertrophy with no or slight menton deviation, slight occlusion disturbance and prominent mandibular angle were treated with en bloc mandibular angle–body–chin curved ostectomy (MABCCO) combined with traditional mandibular angle curved ostectomy (MACO) and bilateral outer cortex grinding (OCG) technique. This study highlights a single-stage surgery to achieve an ideal surgical effect by precise design and accurate operation of procedure with the aid of digital techniques.

Patients and Methods

This is a retrospective study. All procedures performed in studies involving human participants were in accordance with the ethical standards of Plastic Surgery Hospital, Chinese Academy of Medical Sciences, Peking Union College, and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Between 2013 and 2017, 40 female patients (mean age = 23, ranging from 18 to 35) who had underwent en bloc MABCCO combined with traditional MACO and bilateral OCG were identified and represented the study sample according to the following criteria: (1) patients with facial asymmetric deformity resulting from mandibular asymmetry, (2) acceptable occlusion with slight deviation, (3) mandible without severe prognathism, (4) no or slight deviation of the midline, (5) no or slight deviation of the menton, (6) no severe canting of the occlusion plane, (7) asymmetric region within the mandibular ramus, body, and chin. Slight deviation was defined as "deviation of midline of the lower tooth from the facial midline, not more than 2 mm". Severe canting was defined as "the canting of the occlusion plane not exceeding 5°." The patients with facial asymmetry due to craniofacial anomalies (i.e., craniostenosis, hemifacial microsomia, progressive hemifacial atrophy) and maxillofacial fracture were excluded. All patients included in the study were followed up at least 12 months after the operation. To ensure careful observation and subjective evaluation, standard facial photographs, cephalometric radiographs and three-dimensional computed tomography (CT) were taken preoperatively and postoperatively. In addition, patient's satisfaction on the treatment outcomes was investigated by questionnaires 6 months after the operation. Responses to questions were coded utilizing Likert-type data with 4° with "very satisfied", "satisfied", "not very satisfied" and "not satisfied" with a quote by 4–1.

Surgical Design

Based on the preoperative three-dimensional CT, Mimics 20.0 software was used for surgical planning. The facial midline was determined first. The horizontal reference line through mandibular occlusion plan was designated as the superior boundary of ostectomy. The cross-points of the horizontal reference line with the posterior border of the mandibular ramus were defined as the highest points (C, D) of ostectomy. On the standard of the mental tubercle (B) on the slender (left) side of the mandible, the anterior boundary point (A) of en bloc MABCCO was determined in the equidistant site to midline on the opposite side. C and A were connected to form a smooth curved osteotomy line along the mandibular inferior border, en bloc MABCCO and OCG were carried out on the short side. The long curved osteotomy line was marked below the inferior alveolar neurovascular bundle to protect it during osteotomy. On the slender side, traditional MACO and OCG were performed. Except for the anterior boundary of the ostectomy that was located below or back of the mental foramen (E), all the procedures of the traditional MACO were identical with en bloc MABCCO (Fig. 1). The side to

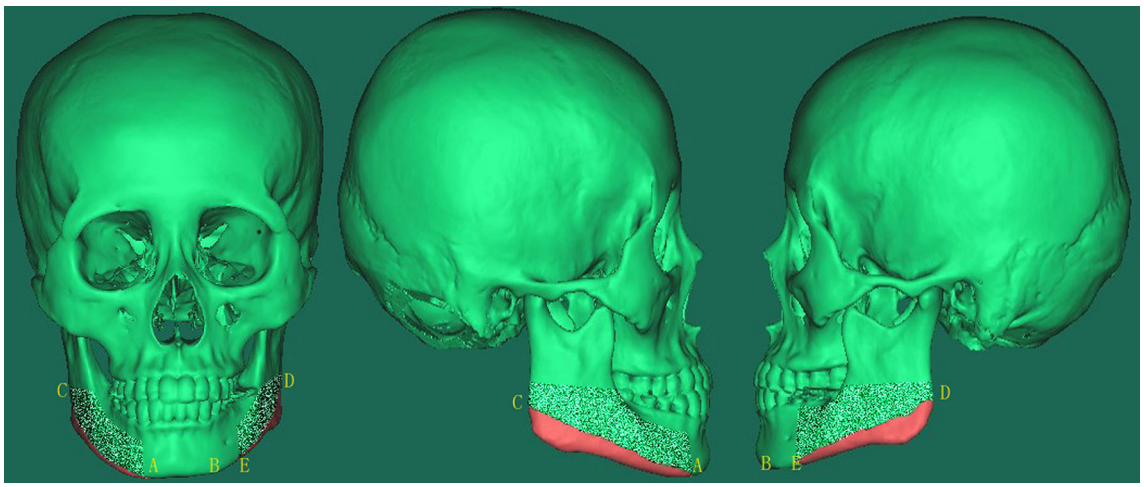

Fig. 1 Surgery design (A and B: mental tubercle; C and D: superior boundary of osteotomy; E: anterior boundary of traditional MACO; red region: removed bone block; frosted region: the region of OCG)

which the facial midline was deviated was referred to as "short" and the other side was referred to as 'slender'.

Operative Technique

All the procedures were carried out under general anesthesia through nasotracheal intubation. Subsequent to the submucosa, muscles, and subperiosteal injection of 0.5% lidocaline, an intraoral mucosal incision was made with a scalpel from the anterior margin of the mandibular ramus to the midline of the inferior tooth on one side. The distance from the outer side of the incision to the mandibular vestibular sulcus was about 5 mm. The total length of incision on one side was about 12 cm. Submucosal muscles and periosteum were then dissected. To avoid nerve injury, the nervus mentalis was carefully separated from the periosteum with vessel forceps. The mandible was fully exposed through subperiosteal dissection from the occlusion plane to the central incisor. The periosteum in the lower margin of the body and posterior margin of the ramus was raised using a curved periosteal elevator. On the short side, the procedure of en bloc MABCCO with OCG was performed on the basis of the preoperative plan. Firstly, the mandibular outer cortex was ground about 4–5 mm thickness, to clearly expose the mandibular angle. The grinding process began at the lateral cortex with a big round burr (diameter = 5 mm), starting superior to the occlusal plane and moving forward to the mental tubercle, including the small area around the mental foramen. Then a small round burr (diameter = 1.5 mm) was used to grind along the inferior margin of the mandible to mark the ostectomy line. Formal ostectomy was conducted with a short and long oscillating saw, respectively, to saw off the outer plate and inner plate along the ground marking until it was inferior to the mental nerve. Then a reciprocating saw was applied for ostectomy of the remaining area. A curved osteotome was used to complete the en bloc curved ostectomy of the mandibular angle, body, and chin while carefully protecting the temporomandibular joint. The bone was not removed until the ligament, the medially attached medial pterygoid, and attached muscles posterior to the mentum were released. The mental nerve was well protected throughout the operation. For achieving an optimal result, grinding of the bone surface and the irregular parts of the cortical segment inferior to the mental nerve with a medium-sized burr (diameter = 3 mm) is undertaken to smoothen the lower border of the mandible. On the contralateral side, a traditional MACO was performed. Except for the anterior boundary of the ostectomy sited below or back of the mental nerve, other procedures were similar with the slender side. After satisfactory hemostasis, the operative wounds were washed with gentamicin solution followed by placement of negative draining tubes and wound closure. Postoperative treatment included cold packs and regular pain medications. Cold packs were carried out for 4 h postoperation. The incision was cleaned twice daily with saline cotton swabs. A semi-liquid diet was required for 1 week, and patients must rinse their mouths with a compound chlorhexidine gargle after eating for prevention of infection. Drainage tubes were routinely removed by the second postoperative day followed by removal of dressings and then application of an elastic mask within 1 week after surgery. The sutures were removed on the 10th day after the operation.

Statistical Analysis

Statistical analysis was performed with SPSS statistical software for Windows, version 17.0 (SPSS Inc, Chicago, IL). A Wilcoxon signed-rank test was used to analyze the

patient's satisfaction rate. A value of $p < 0.05$ was considered statistically significant.

Results

Forty female patients underwent the identical surgical procedures for correcting facial asymmetric deformity. All the incisions healed without infection, dehiscence or hematoma. Generally, facial swelling occurred on the second postoperative day and became obvious from the fourth day. On the seventh day, swelling gradually subsided. It was almost 1 month until complete recovery. However, the degree of swelling was always related with patient age, the volume of soft tissue, surgical injury and so on. Patients were discharged 1 week after the operation. They were followed up for 12 months with no serious complications such as facial paralysis, obvious drooping of the lower face, or dysfunction of the facial muscles. Thirteen patients complained of inferior lip numbness in the early stage but reported remission of the symptoms within 6 months after operation. All the patients were satisfied with surgical outcomes. The satisfaction score (mean ± SD) was 1.23 ± 0.75 preoperation and 3.75 ± 0.63 postoperation. The Wilcoxon signed-rank test indicated that the patient's satisfaction was significantly improved after the operation ($p < 0.05$). Comparison of the preoperative and postoperative facial photographs and radiographs suggested that both sides of the face in each patient were basically symmetric and the width of the facial lower one-third part had been considerably reduced. The mandibular angular area was more harmonious with the adjacent facial structures, and the facial contour was more natural.

Case 1

A 20-year-old female patient with facial asymmetry and prominent mandibular angle presented to our department for correction. Her right face was plumper than the left side. The preoperative CT showed that the midline of the inferior teeth was deviated to the right with slight partial occlusal deformity. The patient did not accept orthognathic surgery due to the lengthy therapeutic process. Eventually, the strategy of facial contouring plasty was adopted. Detailed preoperative evaluation and planning were done so that both the surgeon and the patient understood and agreed upon the treatment. The right side of the mandible was treated by en bloc MABCCO with OCG while the left side received traditional MACO with OCG. Six months after the operation, the facial asymmetric deformity was basically corrected, and the lower facial contour became obviously narrower, more natural and more harmonious (Figs. 2, 3).

Fig. 2 Preoperative views of a 20-year-old woman in case 1 (**a**). Postoperative views after MABCCO on the right side and MACO on the left side combined with bilateral OCG (**b**). Six-month postoperative views showed that the facial contour was symmetric and the lower face was narrow. The contour of the lower mandible margin was smooth from the mandibular angle region to the mental region

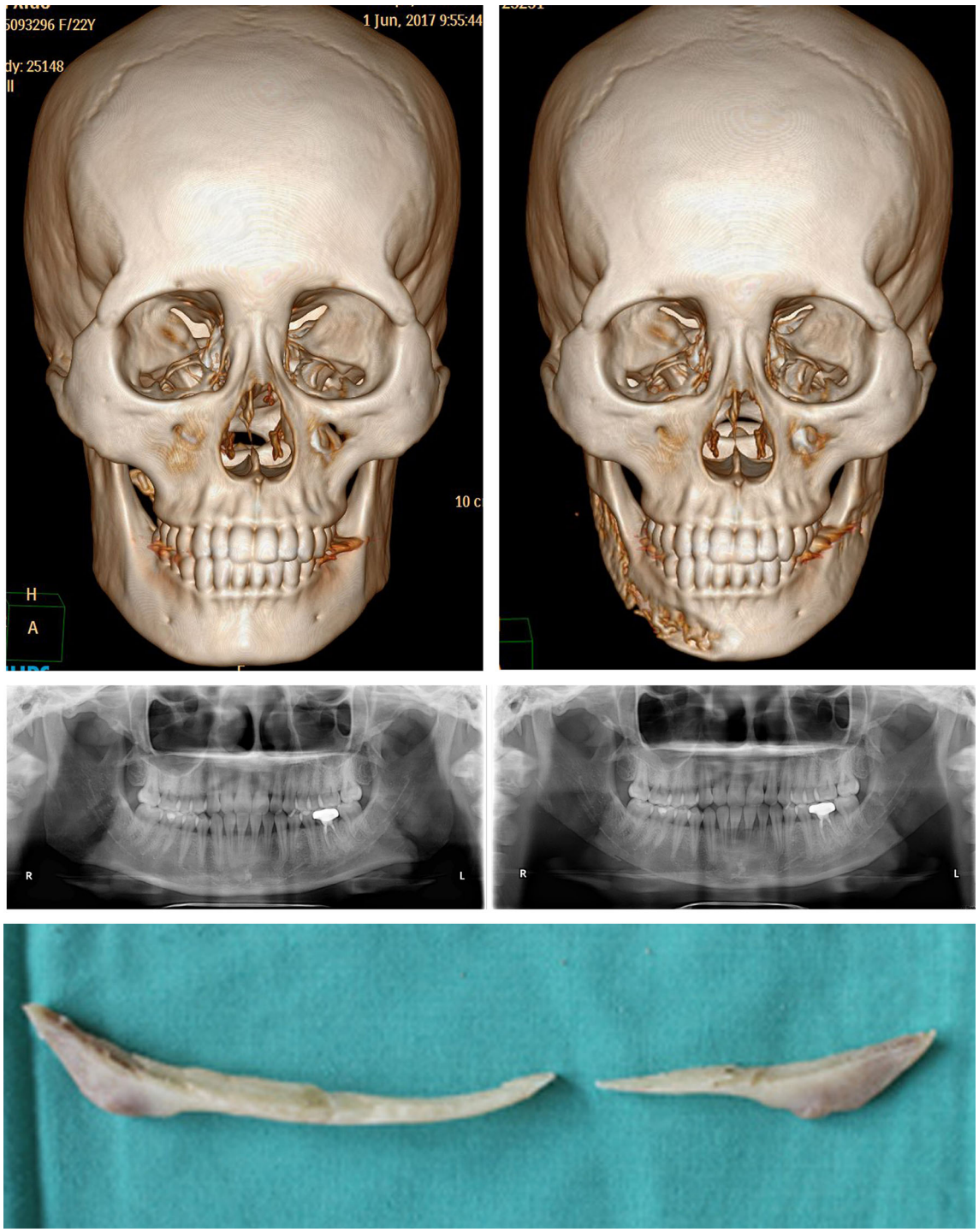

Fig. 3 Preoperative (above left) and postoperative (above right) three-dimensional (3D) computed tomography images. Preoperative (middle left) and postoperative (middle right) X-ray. The removed bone block (below row)

Case 2

A 23-year-old female patient came and required correction of her facial asymmetry and prominent mandibular angle. Her right face was more hypertrophic than the left side. The preoperative CT showed that the midline of the inferior teeth was deviated to the right with a slight partial occlusal deformity. The patient underwent en bloc MABCCO with OCG on the right side, while the left side was treated with traditional MACO and OCG. Six months

after the operation, the facial asymmetric deformity was completely corrected, and the patient was very satisfied with the effect (Fig. 4).

Case 3

An 18-year-old female patient with a facial asymmetric deformity and prominent mandibular angle underwent en bloc MABCCO with OCG on the right side and traditional MACO and OCG on the left. The 12-month postoperative facial photograph showed that the face was symmetric and exhibited an acceptable facial contour compared with the preoperative photograph (Fig. 5).

Discussion

Facial asymmetry caused by facial skeletal imbalances is a common complaint among patients. Although slight asymmetry is not readily perceived by the average layperson and has no clinical consequences requiring surgical treatment, some patients still have the esthetic requirement to correct it [6, 7]. Facial asymmetry not only exhibits appearance deformity but also presents disorders of mastication, pronunciation and breathing. Until now, the etiology in most cases for this unbalanced development is unclear. Jae-Young Kim analyzing the patients of facial asymmetry with mandibular prognathism by the TML system found that mandibular asymmetry can initiate compensatory growth of the maxilla and soft tissue asymmetry [8]. Baek [5] classified facial asymmetry into four types and suggested that the most common deformity was primarily in the mandible. Nevertheless, in the East Asian population, patients with facial asymmetry frequently have a square appearance in the facial skeletal structure [9]. A prominent mandibular angle gives an impression of masculine toughness, because Asians usually have flat, bulky eyelids and a low nose. Oriental women prefer to have an ovoid, slender facial contour due to Asian racial cultural background. According to the Eastern esthetic viewpoints, facial symmetry is the primary importance of esthetic feature. Facial length is averagely divided into three parts (the upper third: frontal hairline to brow bow; the middle third: brow bow to nasal floor; the lower third: nasal floor to gnathion), and facial width is equal to the width of five eyes. Therefore, asymmetric facial contour appears to be disproportionate and discordant. For acquiring a symmetric and harmonious facial contour, a surgical procedure is generally required by patients.

Clinical manifestation of facial asymmetry generally includes deviation of the facial midline, menton deviation, occlusion deviation, over-bite of occlusion,prominent mandibular angle, and discrepancy of thickness on the bilateral mandible. Usually, facial asymmetry is firstly treated by orthognatic surgery to correct the deviation of

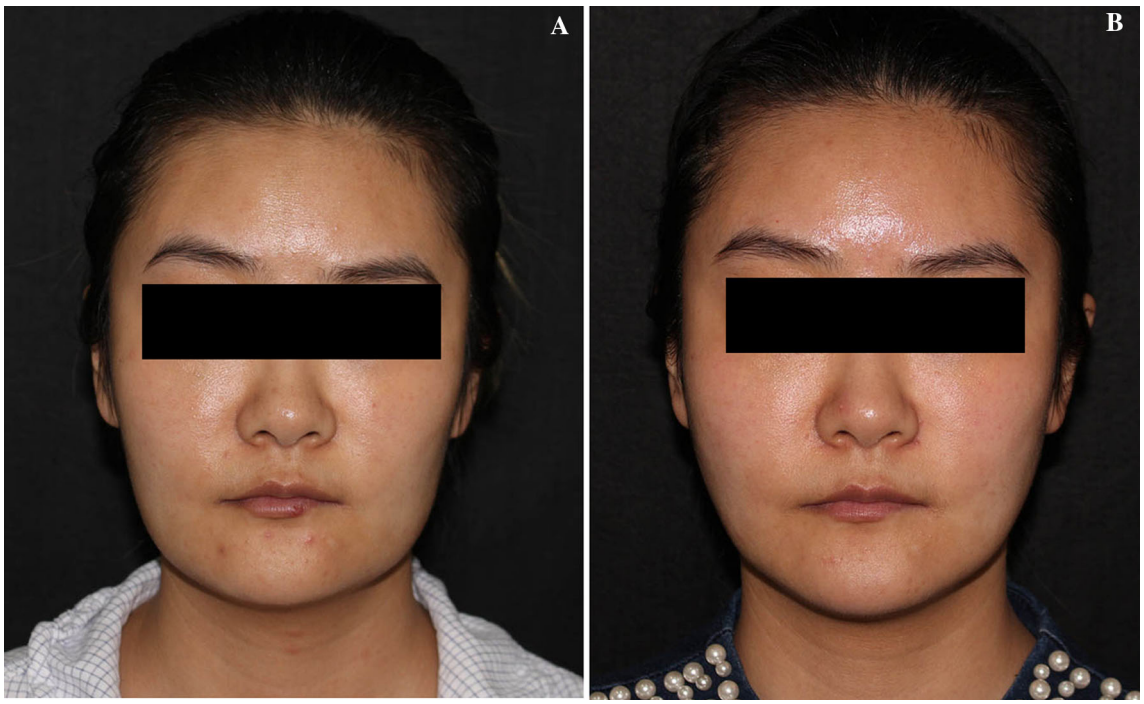

Fig. 4 Preoperative views of a 23-year-old woman in case 2 (**a**). Postoperative views after MABCCO on the right side and MACO on the left side combined with bilateral OCG (**b**). Six-month postoperative views showed that the facial contour was symmetric and slender

Fig. 5 Preoperative views of an 18-year-old woman in case 3 (**a**, **c**). Postoperative views after MABCCO on the right side and MACO on the left side combined with bilateral OCG (**b**, **d**). Twelve-month postoperative views showed that the facial contour was symmetric and slender

occlusion. In the next stage, facial contouring strategies (i.e., mandibular angle ostectomy, splitting corticectomy, and fat transplantation) are performed to additionally correct facial imbalance. This is a complicated and lengthy therapeutic process. However, in clinical works, we found some patients with facial asymmetry and similar clinical

syndromes including no or slight deviation of the menton, slight deviation of the occlusion, asymmetric mandibular length, prominent mandibular angle and discrepancy of thickness on the bilateral mandible. Their chief complaints focus on facial asymmetry and a square face, so that they are not willing to spend a lot of time in the therapeutic process. For these patients, we performed a single-stage surgery of MABCCO on the one side and traditional MACO on the other side combined with bilateral OCG to achieve a predictable surgical effect in this study.

Preoperative precise design is the key to obtaining the expected surgical effect. According to CT examination, we firstly determine the feature of mandibular deformity. Mandibular measurements include the height of the mandibular ramus, the height of the mandibular body, the thickness of the bilateral mandible, the degree of mandibular angle and the distance from the inferior alveolar nerve to the inferior margin of the mandible. On the standard of the mental tubercle of the slender side, the site of equal distance from the midline to the standard mental tubercle is to determine the prozone point of MABCO on the opposite side. On the slender side, the traditional MACO is performed. The ostectomy prozone lies below or back of the mental nerve. The superior boundary of the ostectomy should not exceed the height of the occlusion plane. The region of grinding on the short side ranges from the mandibular ramus parallel to the occlusion plane to the mandibular body and chin body, while the region of grinding on the slender side is only restricted to the extent of the mandibular ramus and body.

In the clinic, mandibular angle ostectomy is routinely performed to correct a square face. Generally, a mandibular angle ostectomy contains three strategies: en bloc MABCCO described by Zhang Chao et al., traditional MACO described by Gui Lai et al., and "V-line" ostectomy described by Hsu et al. [10–12]. In this study, we combined MABCCO and traditional MACO to correct facial asymmetry and a prominent mandibular angle. In our opinion, the "V-line" ostectomy has considerable disadvantages as follows: the mandibular inferior border is unlikely to be naturally curved as a reciprocating saw is used to create the "double-line" ostectomy, easily causing a second mandibular angle. Secondly, the reciprocating saw is hard to place perpendicularly to the mandibular bone due to the limited operative space. This may result in an oblique ostectomy plane with the inner cortex lower than the outer cortex and jeopardize the esthetic outcomes. These limitations or disadvantages are unlikely to occur with a long curved ostectomy.

The techniques of mandibular OCG and splitting corticectomy are used to reduce the width of the mandible [10, 13]. In our study, mandibular OCG was performed. Compared with splitting corticectomy, mandibular OCG can precisely correct a discrepancy in the thickness of the bilateral mandible, and at the same time avoids exposure of the marrow cavity to reduce hemorrhage and the occurrence of accidental fracture.

Except orthognathic surgery, some surgeons attempt to correct facial asymmetry by repositioning the chin with a genioplasty technique. Although the inclination of the skeletal structure may be corrected to some degree, the remnant depression and ladder on both sides of the chin often lead to the decreased satisfaction in patients. In this study, we distinctly emphasize that a single-stage surgery of en bloc MABCCO combined with traditional MACO and bilateral OCG is an optimal option for treating patients with facial asymmetry and a square face. This strategy can largely shorten the treatment time, create a natural and harmonious facial contour, and save medical costs for patients.

This strategy has its limitations. For patients of facial asymmetry with mandible prognathism, severe occlusion deviation and severe deviation of the midline and menton, this strategy is not suitable. In these cases, orthognathic treatment should be applied to correct the deformity. Additionally, the postoperative reattachment and remodeling of the dissected soft tissue is a long process. There is no further evaluation of long-term results of soft tissue recurrence. However, the surgical effect of the included patients had good stability within the 1-year follow-up.

Conclusion

This study shows that single-stage surgery of en bloc MABCCO combined with traditional MACO and bilateral OCG was an optimal selection for correction of facial asymmetry with slight occlusion disorders. Furthermore, the combined technique can simultaneously correct a prominent mandibular angle and create a delicate and harmonious facial contour.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of Plastic Surgery Hospital, Chinese Academy of Medical Sciences, Peking Union College and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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