



A Revision Mandibuloplasty: Causes, Indications, Surgical Methods and Treatment Outcomes

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Abstract

Background This paper aims to propose a classification system to categorize patients undergoing revision mandibuloplasty according to their dissatisfaction types. This paper also introduces various appropriate revision techniques and evaluates their outcomes. Through this classification system and suggested surgical techniques, surgeons can settle the disappointments experienced by patients after their primary mandibuloplasty, by realizing more natural-looking results.

Methods The study subjects consisted of 184 patients who underwent a revision mandibuloplasty from October 2010 to March 2016, conducted by a single surgeon at a single institution. The authors were able to classify the dissatisfaction into two primary types—(1) lack of an overall slender frontal facial contour and (2) unnatural and asymmetrical overall facial appearance due to over- or inaccurate resection of the bone. A self-evaluation of patient's subjective satisfaction based on the scale from 1 to 5, both after the primary operation and after revision surgery, was compared.

Results Dissatisfaction type I accounted for 145 patients (78.8 percent). The number of patients classified into

dissatisfaction type II was 39 (21.2 percent). Of the patients categorized into type I, those undergoing revision surgeries due to an under-corrected mandibular tubercle and parasymphysis showed the most remarkable improvement in self-satisfaction score after reoperation—from 2.3 to 4.0. **Conclusion** To realize a natural-looking outcome in facial look through mandibular contouring, it is important not only to carefully consider the ratio and shape essential for an optimal slender facial contour, but also to minimize unnecessary resection of the bone.

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Keywords Mandibuloplasty · Revision surgery

Introduction

Many Asian women have a desire for Westernized facial appearances, especially a slender zygoma, mandible and chin. Within Asian cultures, the rectangular-shaped facial contour, a so-called box-shaped face or square-jaw, is deemed less feminine, rather even somewhat masculine [1, 2]. Accordingly, reduction malarplasty and reduction mandibuloplasty or genioplasty are currently well-accepted practices. Various surgical methods and techniques have been suggested, and active research is ongoing to evaluate the outcomes of each [3, 4].

As the surgeries for the above-mentioned aesthetic purposes increased in incidence, so did the secondary revision procedures due to dissatisfaction after the primary surgery. In general, revision surgeries are due to an initial

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failure of careful considerations on overall balance and harmony of facial appearances, and a lack of accurate preoperative planning and delicate surgical techniques.

Each patient differs in the reasons for undergoing a secondary mandibuloplasty. Planning and performing revision procedures, operators should take into account each patient's desires after the first surgery. There is much to take into consideration—whether the amount of bone resection was too excessive or insufficient, the extent and process of resection were executed appropriately, etc. [3]. It is of crucial importance to specify each patient's exact desires and thus to develop concrete methodology and objective goals for revision surgery.

This paper aims to categorize the patients receiving a revision mandibuloplasty according to their dissatisfaction types, to understand the leading cause of unsatisfactory outcome after the primary surgery and finally to introduce various revision techniques and evaluate their outcomes. We propose a classification system with appropriate surgical techniques that can help address the disappointments experienced by patients after primary mandibuloplasty.

Patients and Methods

Patients

Abiding by the Declaration of Helsinki, the study subjects consisted of 184 patients who underwent a revision mandibuloplasty. All data reviewed had been entered into a computerized database. The medical data from an inpatient database were retrospectively collected from October 2010 to March 2016 from a single institution. All operations were planned and performed by a single surgeon (Lee SW).

A thorough preoperative planning including direct consultation with the patient regarding his or her desires preceded each surgery. Facial photographs were taken before surgery at different perspectives—frontal, right and left lateral at 45°, submentovertebral and smile view. Six months postoperatively, the photographs were repeated to evaluate the surgical outcomes. Imaging tools including cephalometric analysis, panoramic radiographic images and three-dimensional computed tomographic scans were also obtained before and after surgery to objectively compare the differences.

Etiology of Reoperation

We were able to classify the etiology of patient dissatisfaction into two primary types. The two types are (1) lack of an overall slender frontal facial contour and (2) unnatural and asymmetrical overall facial appearance due to over- or inaccurate resection of the bone. We further

stratified each type according to more specific causes. In this way, each dissatisfaction type was subdivided into three smaller categories.

Surgical Strategies According to the Dissatisfaction Type

Each dissatisfaction type was addressed with individualized preoperative planning and six different types of surgical methods.

Type I: Lack of Overall Slender Frontal Facial Contour

When the amount of bone resection was solely considered in the primary operation, and no consideration was made regarding the overall facial contour, patients were likely to be displeased with the final outcome. In these cases, through careful preoperative imaging and physical examinations, various measurements were taken including the width of the mandibular lower border angle and chin and the ratio between the width and length of the chin.

- (a) Under-resection of the mandibular angle: 11.0 percent of the patients fell under this category. In this case, completion of previously inadequate mandibular angle resection was the main objective of the revision surgery. Furthermore, if no cortical osteotomy was done in the primary surgery, cortical bone resection was performed.
- (b) Under-corrected mandibular tubercle and parasymphysis: This subtype was the most common reason for revision surgery among dissatisfaction type I (47.0 percent). We have previously described surgical techniques for revision genioplasty in this circumstance [5].
- (c) Overall unsatisfactory outcome on both mandibular angle and chin: In these instances, insufficient bone resection was not an issue. Instead, we speculate that inappropriate surgical techniques were carried out. To overcome overall dissatisfaction, revision orthognathic surgery was done to rotate the chin in a clockwise direction and to correct the class III malocclusion [6].

Type II: Unnatural and Asymmetrical Overall Facial Look Due to Over- or Inaccurate Resection of the Bone

Dissatisfaction type II consisted of patients whose major disappointments were due to an overall unnatural and asymmetrical look. If an excessive amount of bone was excised, the osteotomy was not properly executed due to technical error or lack of accuracy in preliminary preoperative planning. In these cases, patients ended up with an

unacceptable outcome. As in type I, different surgical methods were designed to approach each individual patient.

- (a) Over-resection of the mandibular angle: This subtype accounted for 5.0 percent of the entire revision mandibuloplasty subjects. In these cases, the over-resected portion of mandible was regenerated using bone cement which was reconstructed using a three-dimensional remodeling technique. After a sterilization process, the tailored implant was placed into the desired space and fixed using plates and screws (Fig. 1).
- (b) Over-resection of the mandibular tubercle and parasymphysis: This subtype comprised 4.0 percent of the entire study population. Here, we used an autologous bone graft to recover over-resected mandibular tubercle and parasymphysis. If the mandibular angle was under-resected, free bone graft from this area was considered as a donor site. However, this technique bears a potential risk of soft tissue depression over the parasymphysis area, which can overly thin the chin unnaturally. Even after revision surgery, deficient soft tissue was a remaining problem. Therefore, we often corrected the depressed soft tissue using filler or fat grafting.
- (c) Overall irregular lower mandibular border: Most common dissatisfaction among type II, this subtype, accounted for 12.0 percent of the study subjects. For the revision of these patients, we excised a bony segment starting from the previous resection margin to the mandibular angle or chin, in a single piece. At the same time, over-resected bone was reconstructed using a previously mentioned three-dimensional printing method. Even after this revision surgery, some patients were still displeased with the irregular contour (3 patients, 15 percent of this subtype). In these cases, a face-lifting technique added a final touch to restoring the smooth contour.

Patient Satisfaction Questionnaire

A self-evaluated questionnaire of patient's subjective satisfaction after the primary operation was distributed. The self-evaluation was based on a scale from 1 to 5 (1 = poor, 2 = disappointing, 3 = satisfactory, 4 = good and 5 = excellent). Six months after the revision procedure, each patient was asked again to self-assess his or her satisfaction on the same scale.

Results

Of the total of 184 patients, 12.0 percent were male, and the remaining 88.0 percent were female. The mean age was 26.9 years old (range 19 ~ 48). Ninety-five percent of the subjects visited our clinic for revision surgery after the first operation at other clinics. Patients who had undergone only primary mandibuloplasties included 97.3 percent, and 2.7 percent of the patients had already undergone a secondary mandibuloplasty. No patient had undergone three or more previous mandibuloplasties.

Causes of Reoperation

Table 1 outlines the number and percentage of the patients in each dissatisfaction type. In total, 145 patients (78.8 percent) accounted for dissatisfaction type I. The percentages of patients falling under each subcategory—under-resection of the mandibular angle, under-corrected mandibular tubercle and parasymphysis and overall unsatisfactory outcomes on both mandibular angle and chin—were 10.9, 46.7 and 21.2 percent, respectively. On the other hand, the number of patients classified into dissatisfaction type II totaled 39 patients (21.2 percent). More specifically, each subcategory of type II—over-resection of the mandibular angle, over-resection of the mandibular tubercle and parasymphysis and overall irregular mandibular surface—was responsible for 4.9, 4.3 and 12.0 percent, respectively.

Fig. 1 A three-dimensional remodeling of the previously over-resected mandible. (*Left*) A three-dimensionally printed mandible before the revision surgery. (*Right*) Bone cement fixated to the mandible model

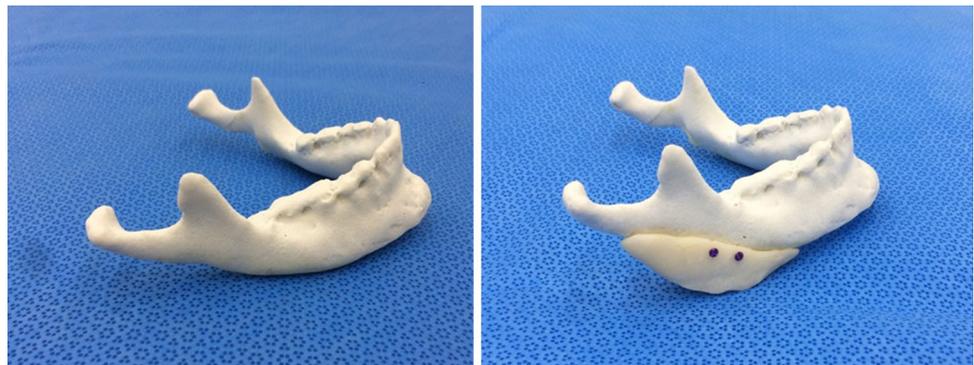


Table 1 The number and percentage of the patients in each dissatisfaction type

<i>Type I Lack of overall slender frontal facial contour</i>	
(a) Under-resection of the mandibular angle	20 (10.9%)
(b) Under-corrected mandibular tubercle and parasymphysis	86 (46.7%)
(c) Overall dissatisfactory outcome on both mandibular angle and chin	39 (21.2%)
<i>Type II Unnatural and asymmetrical overall facial look due to over- or inaccurate resection of the bone</i>	
(a) Over-resection of the mandibular angle	9 (4.9%)
(b) Over-resection of the mandibular tubercle and parasymphysis	8 (4.3%)
(c) Overall irregular mandibular surface	22 (12.0%)

Self-satisfaction Evaluation

Table 2 demonstrates the mean patient self-evaluation score of overall satisfaction after the primary operation and after revision surgery. First, of the patients categorized into type I, those undergoing revision surgeries due to under-corrected mandibular tubercle and parasymphysis showed the most remarkable improvement after reoperation—from 2.3 to 4.0. Patients subject to overall unsatisfactory outcomes on both mandibular angle and chin responded with the highest satisfaction score after the revision surgery with a mean score of 4.4. Meanwhile, additional resection of the mandibular angle failed to yield an enhanced outcome—2.8 after primary operation and 3.1 after revision surgery.

Overall, the outcomes of revision operation in dissatisfaction type II patients were less dramatic. In the case, for which over-resection of the mandibular angle was the issue, the self-satisfaction score after revision surgery was 3.4, an insignificant improvement from 3.2, the score after primary operation. Moreover, patients whose chief complaints were over-resected mandibular tubercle and parasymphysis and overall irregular mandibular surface claimed no improvement after reoperation, as the figure dropped down from 3.3 to 3.2 and 3.4 to 3.0, respectively.

Complications

Patients were evaluated in the clinic on postoperative day 1, 2 weeks, 3 months and 6 months after the revision

surgery. Immediate and delayed postoperative complications were noted. During the observation period, the presence of any complications was evaluated. One patient noted paresthesias of the lip and chin, and two patients noted dental paresthesias, all lasting longer than 6 months. Contracture of the mentalis muscle and excessive scarring of the soft tissue on the chin was found in a total of twelve patients. In this case, we primarily administered Botulinum toxin or triamcinolone, and the symptoms resolved in ten patients; in another two patients, we had to surgically excise the excessive scar tissue underlying the chin skin. Two patients suspicious of inflammatory or infective signs were given antibiotics, and the symptoms subsided without any surgical intervention. Finally, bone cement placed in the chin was removed in two patients due to dissatisfaction with the shape of the chin.

Cases

Case 1

A 34-year-old female 2 years after underwent bilateral mandibular angle resection and genioplasty at another clinic. She complained of over-resection of both mandibular angles and a long face with protruded maxilla. We reconstructed the mandibular angles with bone cement and performed orthognathic surgery including a 2-mm setback of maxilla (Fig. 2).

Table 2 The mean patient self-evaluation score of overall satisfaction after primary operation and revision surgery

	After primary operation	After revision surgery
<i>Type I Lack of overall slender frontal facial contour</i>		
(a) Under-resection of the mandibular angle	2.8	3.1
(b) Under-corrected mandibular tubercle and parasymphysis	2.3	4.0
(c) Overall dissatisfactory outcome on both mandibular angle and chin	2.5	4.4
<i>Type II Unnatural and asymmetrical overall facial look due to over- or inaccurate resection of the bone</i>		
(a) Over-resection of the mandibular angle	3.2	3.4
(b) Over-resection of the mandibular tubercle and parasymphysis	3.3	3.2
(c) Overall irregular mandibular surface	3.4	3.0

Case 2

A 25-year-old female with a history of genioplasty and two times of bilateral mandibular angle resection at another clinic 18 months ago complained of over-resection of both mandibular angles. We reconstructed the mandibular angles with bone (Fig. 3).

Case 3

A 39-year-old female who underwent bilateral mandibular angle resection 3 years ago, genioplasty using a silicone implant 2 years ago and submental liposuction 1 year ago at another clinic complained of an unnatural jaw line and soft tissue sagging of the chin. We lengthened the chin with a sliding genioplasty after removing the chin implant and reconstructed the mandibular angles with bone (Fig. 4).

Case 4

A 48-year-old female who underwent bilateral mandibular angle resection and genioplasty using a silicone implant 20 years ago had a short chin with sagging of soft tissue and discontinuous jaw line due to under-resection of parasymphysis and tubercle. We lengthened the chin with a sliding genioplasty after removing the chin implant and resected the entire jaw line to make a smooth curve. We performed a facelift simultaneously to correct soft tissue sagging (Fig. 5).

Discussion

There are several factors responsible for an aesthetically slender chin, including the angle of the mandibular lower border, width of the chin and the length-to-width ratio of

the chin [7, 8]. An ideally slender chin can be realized as the angle stiffens, the width narrows down, and the ratio increases. A slender look, however, does not necessarily represent a natural look. In other words, even a very slender face may look natural, and conversely, even a less slender face may seem unnatural. An unnatural appearance may be attributable to discontinuity of the line or presence of soft tissue depression. If too much bone is resected at the mandibular angle, a line along the lower mandibular angle may lose its natural curvature, and moreover, there may be a depressed area. And this could possibly lead to overall unnatural facial contour.

When approaching patients who seek revision mandibuloplasties, we should differentiate their exact desires, whether it is a slender chin or natural contour. For patients longing for a slender chin, we should take into considerations the above-mentioned factors. On the other hand, for patients who desire a more natural contour, we should aim at regaining the continuity of the natural lines by eliminating the step-offs or depressed areas.

We previously demonstrated the effect of reducing the chin width for creating a slender chin [5]. Besides reducing the width, lengthening the chin is also very helpful. As the chin length increases, the lower mandibular border angle gets stiffened, and as a result, the length-to-width ratio of the chin increases [5, 7–9].

The main objective of the mandibular angle resection does not lie in volume reduction. Obviously, volume reduction is one of the important considerations to make; however, simple volume reduction without regard to factors associated with a slender chin could result in soft tissue sagging or depression, and hence an unnatural overall face. The amount of resected bone is not proportional to the degree of slenderness; rather, it is more related to the soft tissue problem including sagging and contracture [10, 11]. As a result, it is crucial not to unnecessarily over-resect the

Fig. 2 A 34-year-old female with a previous history of bilateral mandibular angle resection and advancement genioplasty at outside hospital 2 years ago. (Above) Frontal and right lateral 45° photographs and three-dimensional CT images. (Below) Same photographs and CT images 1 year after revision orthognathic surgery with maxillary setback of 2 mm



Fig. 3 A 25-year-old female with a history of two times bilateral mandibular angle resection at an outside hospital approximately one and a half years ago. (Above) Frontal and right lateral 45° photographs and three-dimensional CT images. (Below) Same photographs and CT images one year after revision surgery using bone cement



Fig. 4 A 39-year-old female with a history of unspecified mandible surgery, augmentation genioplasty using an implant and chin fat grafting each 3, 2 and 1 years ago, respectively. (Above) Frontal and right lateral 45° photographs and three-dimensional CT images. (Below) Same photographs and CT images 1 year after revision surgery in which previously inserted implant was removed and replaced with a bone cement and sliding genioplasty



Fig. 5 A 48-year-old female with a history of bilateral mandibular angle resection and augmentation genioplasty using an implant. (Above) Frontal and right lateral 45° photographs and three-dimensional CT images. (Below) Same photographs and CT images 1 year after revision surgery in which the previously inserted implant was removed and sliding genioplasty and face-lifting technique were used



bone. Corticotomy, if excessive, may also interrupt the continuity of the surface and induce an unnatural depression.

Overall, it is hard to bring about a successful outcome in bony reconstruction. In most revision surgeries, soft tissue has already undergone extensive contracture and scarring

and adapted to the underlying bone. Therefore, even if the structure is reconstructed to the original state, the soft tissue can hardly recover its previous properties, and the overall reconstructive result may not be as satisfactory as anticipated. Furthermore, because muscle insertion sites have changed, unless autologous bone is to be used, reconstruction may not be optimally performed at all. In conclusion, it is critical to avoid over-correction during the primary operation [12, 13].

Over-reconstruction of the chin may also yield an unexpected outcome. Patients often want to go back to their previous appearance after the revision surgery. In this case, patients may request the removal of the new artificial implant. Once again, this highlights the need for a detailed preoperative discussion with the patient. Patients seeking for revision surgery generally have a higher standard of expectation than the usual patients. It is almost obligatory to carry out a thorough preoperative planning and consultation by directly involving the patient. Moreover, if possible, it is advisory to help create realistic expectations before the surgery. As always informed consent is of paramount importance, explanation of possible consequences of revision should precede the actual surgery.

Table 2 outlines the mean patient self-evaluation score of overall satisfaction after primary operation and revision surgery. In general, the satisfaction score improved after revision surgery. However, the score decreased in dissatisfaction type IIb and IIc. The study lacked the evaluation of statistical significance of these findings, and this should be pointed out as one of the study's drawbacks.

Conclusion

To realize a natural appearance with mandibular contouring, it is important not only to carefully consider the ratio and shape essential for an optimal slender facial contour, but also to minimize unnecessary resection of the bone. In this paper, we have suggested a classification system for surgical indications of revision mandibuloplasty and correction techniques. This classification system is believed to be useful for those managing patients in need of revision mandibuloplasty.

Compliance with Ethical Standards

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

Ethical Approval This article does not contain any studies with animals performed by any of the authors. Abiding by the Declaration of Helsinki, this study did not violate human rights.

Informed Consent This study acquired informed consents of the patients whose photographs are included in the article.

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