Improving Male Chin and Mandible Eesthetics

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KEYWORDS

• Mandibular implants • Chin implants • Genioplasty • CAD/CAM • Sexual dimorphism

KEY POINTS

- The chin and mandible are distinct in sexual dimorphism.
- Relative to the female, the male mandible has a longer ramus, more acute gonial angle, wider bigonial distance, and a more squared, projecting chin.
- Onlays of alloplastic material on the chin and mandible can augment skeletal contours to simulate the ideal masculine jawline.
- Appropriate evaluation, design, exposure, and surgical technique optimize surgical success.

Video content accompanies this article at http://www.plasticsurgery.theclinics.com.

INTRODUCTION

The skeleton is a vital determinant of facial attractiveness. The size and shape of the chin and mandible specifically contribute to this as they are fundamental to sexual dimorphism. In general, the male mandible has a longer ramus, more acute gonial angle, increased gonial width, and a more squared and projecting chin when compared with that of the female[1] (**Fig. 1**). Because of this, deficiencies in the chin and mandible can distract from the male esthetic. Therefore, augmentation of these skeletal deficiencies can simulate the ideal masculine jawline and improve overall facial esthetics. Onlay of alloplastic material as well as osteotomy with bone rearrangement are 2 proposed mechanisms to accomplish these goals. This article will focus on the evaluation, preoperative work-up, and surgical techniques to optimize results when undertaking mandibular skeletal augmentation in the male patient.

DISCUSSION

Evaluation

Physical examination

Physical examination is the most important element of preoperative assessment and planning. The first step in the evaluation process is to recognize facial asymmetry. Facial asymmetry is very common, even if it is subclinical.[2] Recognition of these specific asymmetries preoperatively is important to both the surgeon and the patient. They should be identified and discussed during the preoperative consultation so that the patient can anticipate asymmetry in the postoperative result. Preoperatively, these asymmetries belong to the patient. Postoperatively, if not identified before the surgery, they are attributed to the surgeon. Furthermore, as asymmetries become more severe, it is important to recognize that they are more complex than relative skeletal deficiencies or excesses. Rather, they reflect 3-dimensional differences that are most

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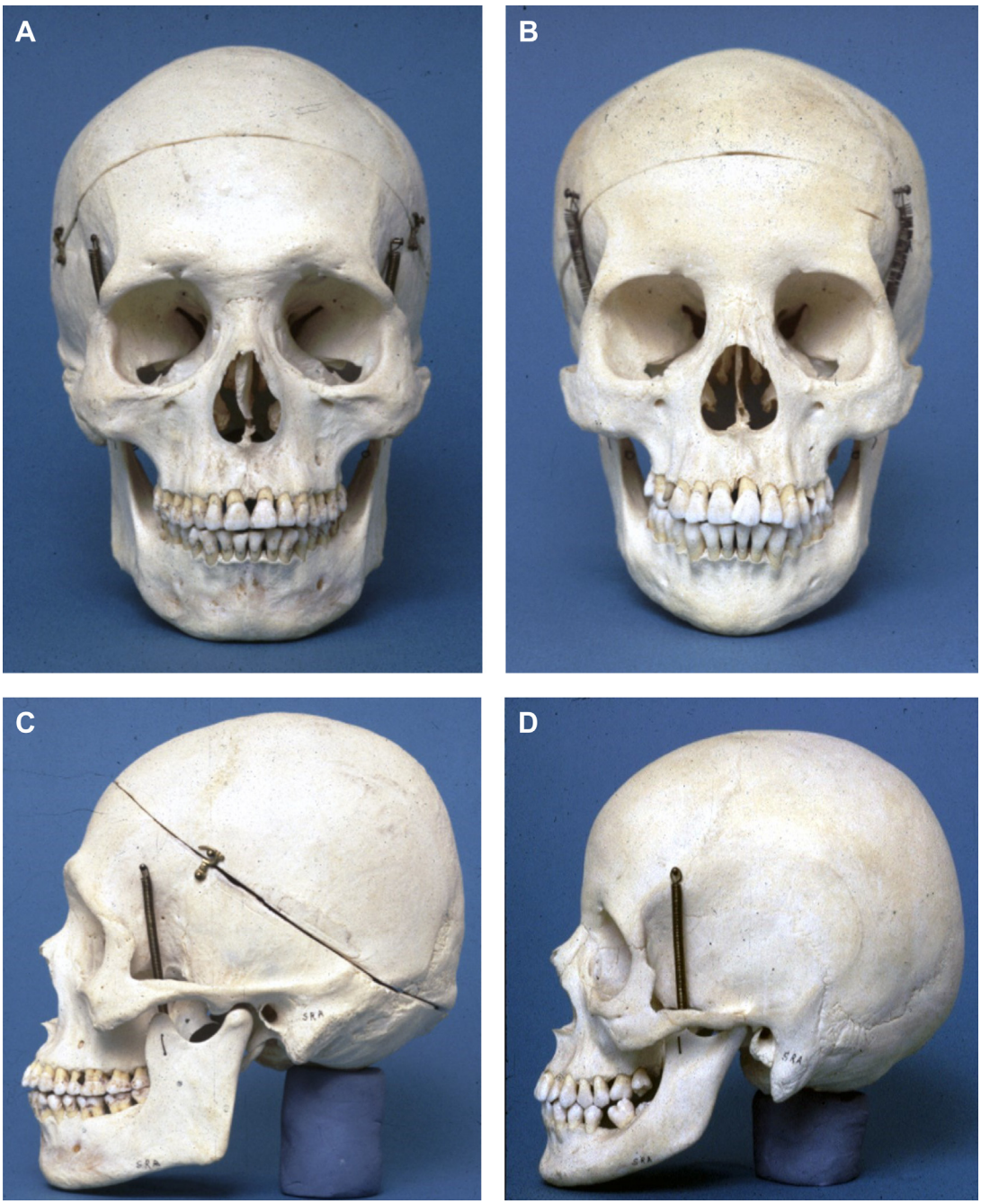

Fig. 1. Female and male skull images obtained through the generosity of the Atkinson Skull Collection, University of the Pacific School of Dentistry, Webster Street, San Francisco, CA, USA. (*A*, *B*) demonstrate the frontal views of the male and female skulls, respectively. (*C*, *D*) demonstrate the lateral views of the male and female skulls, respectively. *(From* Yaremchuk MJ. Chapter 2: Evaluation and planning for facial implant surgery. In: Yaremchuk, MJ, ed. Atlas of Facial Implants, 2nd ed. Elsevier; 2020:13-22.)

easily conceptualized as twists of the facial skeleton.

In addition to facial asymmetry, the physical examination should make note of skin quality and prior surgical incisions and scars, as this may alter the surgical procedure. For example, if a prior intraoral incision was placed too close to the sulcus, the surgeon may choose to perform an external approach to the mandible to prevent future healing complications and subsequent implant contamination.

Finally, the examination should focus on the deficiencies of the mandible. Reviewing photographic images with the patient can be helpful when discussing esthetic concerns and goals. When assessing men from the frontal view, the ramus should extend to the level of the oral commissure, and the mandibular angle should project to the level of the lateral orbital rim. From the profile, the mandibular angle should approximate 130°, and the chin should at least project to a point approximately 3° behind a perpendicular line drawn straight down from the glabella.[3,4]

Imaging

Preoperative radiographic imaging is uncommon for pure esthetic surgery. However, it is helpful for facial skeletal surgery. Cephalometric x-rays are most often used for planning chin and mandibular augmentation surgery. These studies define skeletal dimensions and asymmetries as well as the thickness of the chin pad.

Computed tomographic (CT) evaluation provides the ability to view the skeleton in different planes and, through computer manipulation, in 3 dimensions. CT imaging provides digitized information that can be transferred to design software. Computer-aided designed and computer-aided manufactured (CAD/CAM) implants provide an increased level of refinement in both reconstructive and esthetic applications.[5] CAD/CAM can provide implants customized for the specific needs of the patient. The design process can also be conducted virtually.

Cone beam CT scans are available in many dental offices. They have the advantages of less expense and less radiation exposure to the patient.[6] However, because their field is limited and head positioning devices distort the soft tissue envelope, cone beam CT has a limited role in the CAD/CAM implant process.

Facial measurements

Because implant augmentation of the facial skeleton results in measurable changes in facial dimensions and proportions, it is intuitively appropriate to use facial measurements to evaluate the face and to guide surgery. Rather than neoclassical canons, however, facial anthropometrics and the objective data of sexual dimorphism guide the design of male chin and mandible augmentation.

Facial anthropometrics

Anthropometric data aid facial evaluation and surgical planning by describing normal facial measurements and relations. These data provide the average or "normal" dimensions of the face and its component features. Purely esthetic male chin and mandible surgery most often involves increasing the size and contour of these structures to provide a more masculine appearance. Facial implants must be appropriately sized, shaped, and positioned to be effective. Implants that are too small can result in a less masculinized result, whereas implants that are too large can create unnatural contours that relate poorly to other areas of the face and can ultimately upset facial balance.

Sexual dimorphism

On average, all facial measurements are greater in men than in women. In addition, the relationship between different facial measurements also differs in men and women. These differences are more pronounced in the lower third of the face. For example, the bigonial distance, the lower transverse facial dimension, has the greatest difference between the sexes. In other words, the lower one-third of men's faces tends to be absolutely and relatively wider than that of women.

Esthetic limitations of skeletal osteotomy and rearrangement

Sliding genioplasty and sagittal split osteotomy, which require skills in bone carpentry, can increase the contours of the deficient chin and mandible. However, because no bone is added after osteotomy and rearrangement, the structure remains deficient but in a different way. These deficiencies manifest as gaps at the osteotomy sites resulting in contour irregularities.[5] As a result, the chin often looks "stuck-on" after sliding genioplasty. Because occlusion guides the rearrangement after the sagittal split osteotomy, ramus height and angle width are often asymmetric. For these reasons, alloplastic implants are preferred for esthetic augmentation of the male chin and mandible.

Esthetic limitations of soft tissue augmentation

Soft tissue facial envelope augmentation with autologous fat or filler materials can camouflage underlying minor skeletal irregularities. Whereas augmenting the facial skeleton results in an increase in the projection of the skeleton, augmentation of the soft tissue volume results in an inflation of the soft tissue envelope and blunting of the contours of the skeleton.[7] Fundamentally, these modalities are antipodal in their visual effects. For example, if overly large implants were placed on the skeleton, the appearance would be too defined and ultimately, skeletal. However, excessive fat grafting placed in the soft tissue envelope would result in an increasingly spherical and otherwise amorphous shape.

Esthetic limitation of autogenous bone grafts

Autogenous bone has long been considered the standard material to restore or improve the craniofacial skeleton because it has the potential to be revascularized and assimilate into the facial skeleton. In time, it could be biologically indistinguishable from the adjacent native skeleton. These attributes make it ideal and the only material available to reliably reconstruct segmental load-bearing defects of the facial skeleton. When used as onlay grafts, however, these attributes lead to graft resorption and unreliable, asymmetric augmentation of the facial skeleton.[8]

Implant materials

Silicone rubber, porous polyethylene, and polyetheretherketone (PEEK) are the most commonly used alloplastic implant materials. Each material has advantages and disadvantages. Silicone rubber has a smooth surface and is relatively flexible making implant placement and removal beneath the soft tissue envelope easier. However, its lack of rigidity allows its shape to be distorted by soft tissue deforming forces and makes it feel less like actual bone. PEEK implants are extremely rigid making their placement difficult but tend to feel more like bone. Porous polyethylene implants have enough rigidity to resist soft tissue deforming forces but enough flexibility to facilitate placement. Its porous surface also allows superficial tissue integration avoiding the capsule formation intrinsic to smooth-surfaced implants. However, soft tissue tends to adhere to the porous surface making implant removal more difficult than the straightforward removal of smooth-surfaced implants (**Table 1**).

Indications and advantages of CAD/CAM implants

CAD/CAM provides added sophistication to facial implant surgery.[9] It provides 3-dimensional accuracy in implant design and manufacturing specific to the facial skeleton being addressed. This precision potentially minimizes or eliminates limitations intrinsic to the use of "off the shelf" implants and asymmetry of the facial skeleton. CAD/CAM implants are custom-made for the individual patient.

The precise fit of the CAD/CAM implant to the underlying skeletal contour makes for a more predictable result. A fundamental technical problem in placing bilateral implants in similar positions on opposite sides of the face. Remote, inconspicuous incisions routinely provide limited access and therefore limited exposure of the areas to be augmented. Furthermore, the surgeon never has the ability to see the position of both implants in a single view. CAD/CAM implants are made to augment precisely defined areas as well as register onto specific areas of the underlying skeleton, making implant positioning less problematic. They are also designed to avoid any gaps between the posterior surface of the implant and the anterior surface of the skeleton. Gaps are unavoidable when using "off the shelf" implants. These gaps add to the effective projection of the implant. For example, a 2 mm gap beneath a 3 mm implant will result in an unanticipated additive 5 mm in effective projection. An implant designed and manufactured to have its posterior surface mirror that of the underlying skeleton will avoid that unanticipated contour result.

Implant development and design

CT scans are obtained and provide digital imaging and communications in medicine (DICOM) data, which is standard for handling, storing, printing, and transmitting information in medical imaging. These data are then used to create a 3-dimensional image, which is then used for virtual design sessions between surgeons and software engineers to create an implant. This technique is preferred by the authors because it allows millimeter precision of design. The computerized design is then used to manufacture an implant.

Critical in the design process is to recognize the patient's goals. It is useful for the patient to provide photographs of people who have their desired look. Digital manipulation of patient images can also be helpful. The patient should understand that these images are used as guides in the design process and not predictions of the surgical outcome. There is no algorithm that can translate a digitally created change in soft tissue to an implant design that will result in the outer contour

Table 1
Implant material characteristics

	Ease of Placement	Ease of Removal	Rigidity?	Deformed by Soft Tissues?
Silicone Rubber	Easy	Easy	No	Yes
PEEK	Difficult	Difficult	Yes	No
Porous Polyethylene	Moderate	Difficult	Yes	No

change, however. Effective communication between surgeon and patient is invaluable to the design process.

Because the native facial skeleton is not symmetric as previously discussed, implant augmentation will provide a relative symmetry. Chin implants should create symmetry relative to the midline structures—nasal radix, nasal septum, central incisors, and central lip elements. This symmetry should extend from mental foramen to mental foramen (**Fig. 2**).

Lateral to the mental foramen, mandible implants should relate to the width of the upper face. For example, the extent of lateral augmentation of the mandible angles should relate to the lateral orbital rims in the same way. Designing an implant for one side of the face and mirroring it to create an implant for the opposite side will create mandible symmetry only if the mandible and midface were symmetric before augmentation (**Fig. 3**).

Clinical experience has taught the senior author to control the design process. After voicing their goals and preferences, patient participation in the step-by-step design process has proved unrewarding.

Surgery

Preoperative

To optimize oral hygiene, the patient is requested to have a formal dental cleaning the week before surgery and to rinse with chlorhexidine mouthwash for the 3 days before surgery (Video 1). It is our preference to perform chin and mandibular augmentation under general anesthesia (nasotracheal intubation is ideal). This provides a panoramic view of the operative field. The airway is protected while the oral cavity can be optimally prepared. The entire face and oral cavity are prepared with an iodine solution after placement of a throat pack. The operative site is infiltrated with 1/200,000 epinephrine solution to provide hemostasis. Intravenous antibiotics are administered before the incision being made.

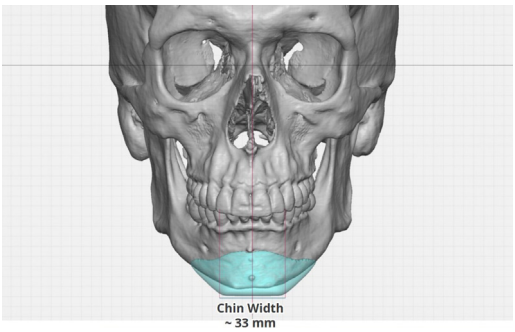

Fig. 2. Chin implant design demonstrates the symmetry relative to midline structures of the face.

Chin incision and dissection

The chin and the anterior mandible are accessed through a submental incision. The midline of the chin is marked on the pogonion as a reference point. Wide subperiosteal dissection is performed. The upper limit of the dissection is the origin of the mentalis muscle, preserving its origin on the bone (**Fig. 4**). Laterally, the mental foramen with its exiting nerve and the inferior border of the mandible body are exposed. Lateral dissection extends approximately 1 cm beyond the area of augmentation. The submental approach and extended dissection avoid damage to the mentalis muscle, allow visualization of the mental nerve, and provide a panoramic view of the complex and varying contours of the mandible to allow precise implant placement. The technique of intraoral placement of chin implants avoids a cutaneous scar but provides limited exposure to the menton and compromises the integrity of the mentalis muscle.

Chin implant positioning and closure

Marking the midline of the pogonion aids in symmetric implant placement. The midline can be marked with a marker, drill hole, or temporary screw. This is useful for implants of any design or material. When using “off the shelf” implants, it may be beneficial to contour prominences on the native mandible to allow better congruence

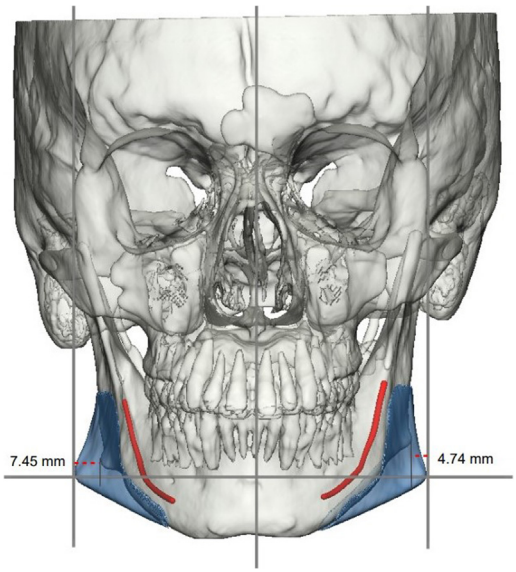

Fig. 3. Mandible implant design should relate to the respective upper face rather than just designing one side and mirroring that onto the contralateral side.

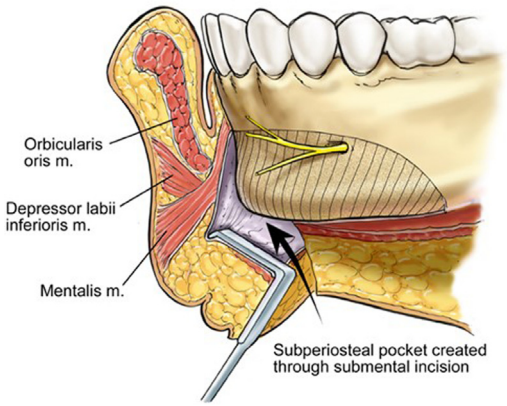

Fig. 4. The submental approach to the chin allows for wide exposure and preservation of the mentalis muscle. *(From* Yaremchuk MJ. Chapter 4: Principles and operative technique for facial skeletal augmentation. In: Yaremchuk, MJ, ed. Atlas of Facial Implants, 2nd ed. Elsevier; 2020:41-49; with permission).

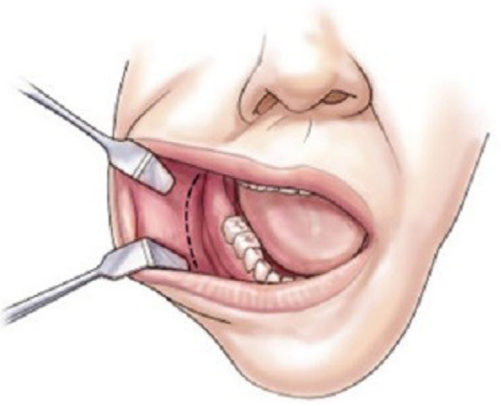

Fig. 5. The intraoral incision made to approach the mandible should be made off of the midline to assure an adequate mucosal cuff for secure coverage. *(From* Yaremchuk MJ. Chapter 4: Principles and operative technique for facial skeletal augmentation. In: Yaremchuk, MJ, ed. Atlas of Facial Implants, 2nd ed. Elsevier; 2020:41-49; with permission).

between the posterior surface of the implant and the mandible surface. Our preference is a two-piece porous polyethylene implant with registration tabs incorporated at the inferior border of the implant. Right and left portions of the implant are placed and positioned. The registration tab dictates lateral positioning. The connecting tab joins the 2 implant segments in the midline and also acts as a hinge to allow the implant to adjust to the unique inclination of the mandible border. It also allows the width of the implant to be varied as dictated by the space between the right and left segments. In most instances, there will be a small gap between the medial aspects of the implant halves, which is not clinically significant. Custom implants are designed for the contours of the chin and provide precise positioning, allowing for the advantages previously stated.

The implant is then fixed to the skeleton with titanium screws. This step helps to avoid any implant movement and to assure that the posterior surface of the implant is congruent with the anterior surface of the skeleton, avoiding undesirable gaps.

After hemostasis is achieved, the incision is closed in layers with reapproximation of the platysma muscle. Secure closure needs to be assured to prevent wound healing complications and subsequent implant exposure and contamination.

Mandible incision and dissection

A generous intraoral mucosal incision is made to expose the ramus and body of the mandible. It is made at least 1 cm above the sulcus on its labial side (**Fig. 5**). The anterior ramus, angle, and body of the mandible are freed from their soft tissues in the subperiosteal plane. It is important to free both the inferior and posterior borders of the mandible of soft-tissue attachments to allow for accurate implant placement. The use of a J stripper can help facilitate this dissection.

Freeing of the inferior border inevitably violates the pterygomasseteric sling. Care should be taken not to divide the sling as this results in postoperative elevation of the masseter muscle and mid ramus bulging with mastication.[10]

Mandible implant positioning and closure

To assure its desired position and to apply it to the surface of the mandible without gaps, the implant is fixed to the underlying skeleton with titanium screws. A long-guarded drill facilitates screw hole drilling. With vigorous retraction, implant fixation can be done through the intraoral incision without the need for transcutaneous trocar placement. Clamping the implant to the mandible maintains its position during screw fixation. It is important to avoid damage to the inferior alveolar nerve during screw fixation. The nerve usually resides in the center of the ramus.

After hemostasis is appropriate, the wound is irrigated (antibiotic irrigation is a rational adjunct to decrease bacterial contamination in this operation performed through intraoral access). The incision is closed in 2 layers with absorbable sutures. Care is taken to evert the mucosal edges. A small suction drain is placed. We prefer one with a trocar, which allows the skin exit site to be located behind the ear lobule. An elastic tape external compression dressing is used to help apply the

soft tissues to the implant and avoid hematoma/seroma formation.

Postoperative care

After surgery, patients spend the night in the surgery center or hospital for monitoring and pain management. The drains are removed on the morning after surgery assuming output is appropriate. They are given an oral prophylactic antibiotic for the first week after surgery as well as an oral narcotic and Tylenol for pain management. They are encouraged to sleep with their head of bed elevated and apply ice liberally for the first 48 to 72 hours after surgery to help reduce swelling. Regarding the intraoral incisions, chlorhexidine mouth rinse is performed 3 times per day for the first week postoperatively. The postoperative diet should include liquids only for the first 2 days after surgery and then advance to soft foods for the next 5 days. They are seen in clinic 1 week after surgery at which time their chin sutures are removed, and their diet is advanced as long as the intraoral incisions are healing well.

Unfavorable Outcomes

Like all other surgeries, esthetic augmentation of the male chin and mandible is not without its possible complications. Generally, specific unfavorable outcomes include infection, hematoma, sensory and motor disturbance, as well as disruption of the pterygomasseteric sling.

In our published series, the infection rate was 2.4% for mandible implant surgery.[11,12] No isolated chin surgeries have suffered infection in the senior author's hands, most likely related to the avoidance of intraoral contamination with the use of submental access. Recognition of and treatment of implant infections must be swift. Antibiotics can suppress implant infections but cannot cure them because of the presence of biofilm formation. Infection ultimately requires implant removal. In the senior author's greater than 25-year experience of facial implants, there have not been any late (greater than 3 months postoperatively) infections without secondary contamination from another procedure such as dental cleaning or filler placement, for example.

Although motor disturbances can be troublesome for patients in the postoperative period, they are temporary. They result most likely from retraction neurapraxia or from merely elevating the soft tissues during dissection. The motor nerves are protected as long as one remains in the subperiosteal plane. Temporary sensory disturbance may also result from intraoperative retraction of the mental nerve, which should always be identified before and after implant placement. Knowledge of the nerve location in the ramus prevents its damage during mandible implant screw fixation. The images provided for CAD/CAM implant design can also provide the precise location of the nerve and its location relative to the implant.

CLINICAL EXAMPLES

Case 1

A 26-year-old man who desired a more masculine chin and mandible. His main esthetic concerns

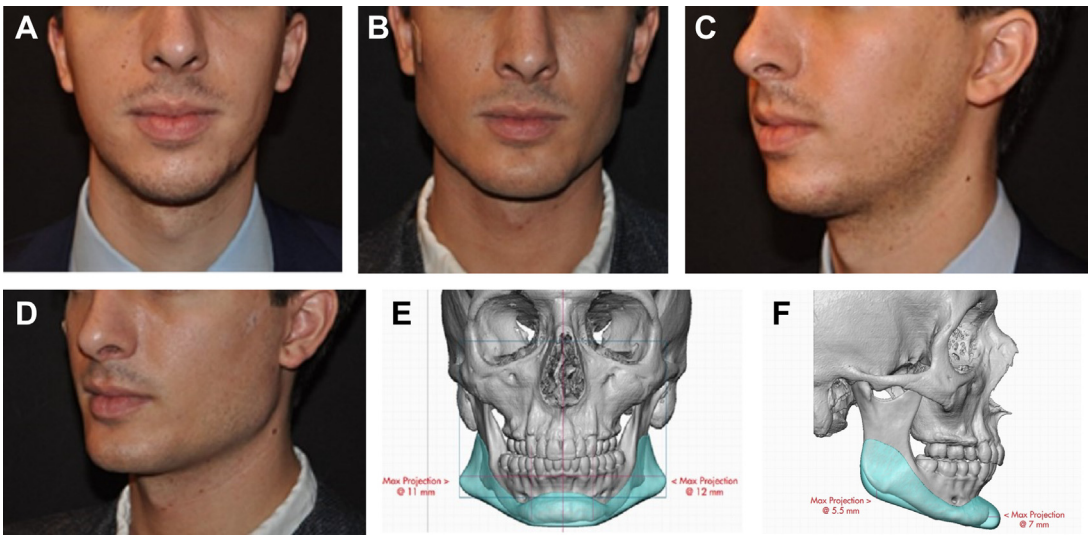

Fig. 6. Clinical case number 1 demonstrates a 26-year-old man who underwent chin and mandible implant augmentation with CAD/CAM implants. His design allowed for increased mandibular angle projection, ramus height, and chin projection per his esthetic goals of a more masculinized look.

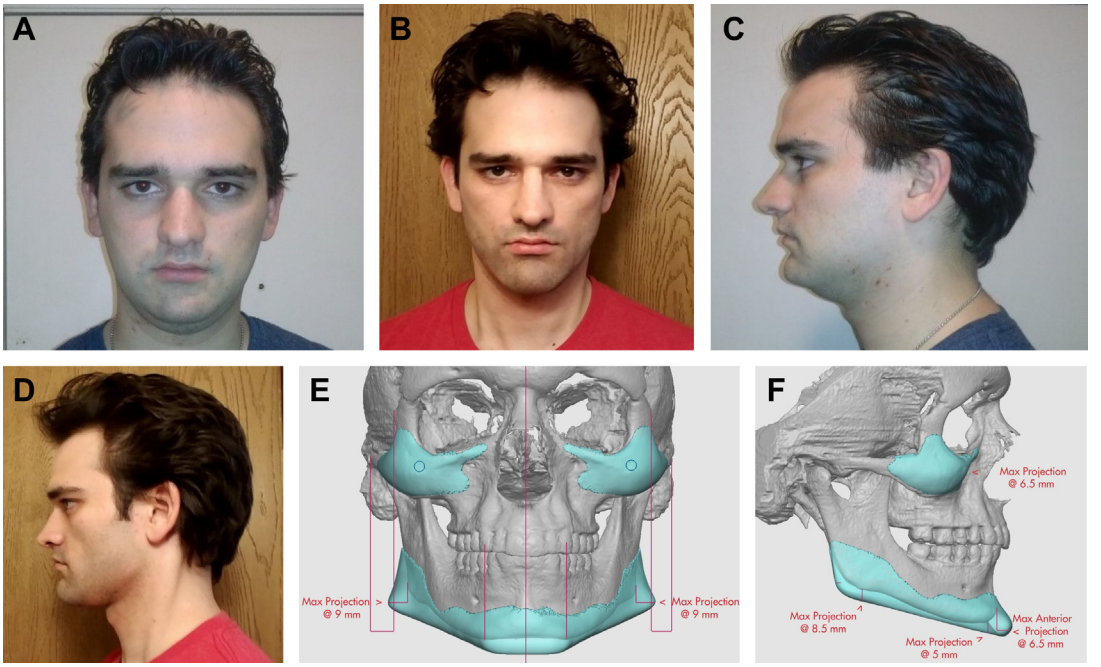

Fig. 7. Clinical case number 2 demonstrates a 28-year-old man who underwent chin and mandible implant augmentation with CAD/CAM implants. His design allowed for increased mandibular angle and chin projection per his esthetic goals of a more masculinized look.

included a lack of mandibular angle definition and a weak chin (**Fig. 6**A, C). Chin and mandible implants were designed with the aid of CAD/CAM to accomplish the goals of increasing angle projection and ramus height as well as giving a stronger and more projected chin (**Fig. 6**E, F). Four years after surgery, the patient was pleased with his result (**Fig. 6**B, D). Of note, after having chin and mandible implant surgery, he also underwent midface augmentation with malar implants, which is also seen in his postoperative photographs.

Case 2

A 28-year-old man who desired a more masculine chin and mandible. His main esthetic concerns included a lack of mandibular angle definition and chin projection (**Fig. 7**A, C). In addition to midface implants, chin and mandibular implants were designed with the aid of CAD/CAM to allow for increased angle and chin projection (**Fig. 7**E, F). Two years after surgery, he was pleased with his result (**Fig. 7**B, D). Of note, he also underwent rhinoplasty at the time of his implant placement.

SUMMARY

The male mandible differs from that of the female in distinct, anatomic ways. These differences play a role in male facial esthetics and can be enhanced by chin and mandible augmentation. Critical components of these procedures include patient evaluation, imaging, preoperative planning, surgery, and postoperative care. If this entire process can be completed in a thoughtful, skillful manner, desirable surgical outcomes can be achieved consistently while minimizing complications.

CLINICS CARE POINTS

- The mandible and chin play a vital role in male esthetics as they contribute to sexual dimorphism.
- The male mandible usually has a longer ramus, more acute gonial angle, wider bigonial distance, and a more squared and projecting chin compared with that of the female.
- Augmentation of the chin and mandible can provide a more esthetic and masculinized appearance.
- Although the chin and mandible can be augmented with osteotomies with bone arrangement and soft tissue augmentation, the authors prefer alloplastic implant augmentation as other methods have undesired downsides.

- CAD/CAM alloplastic implants offer advantages such as balancing natural asymmetries, providing for a more precise surgical placement, and an overall more predictable result compared to "off the shelf" implants.
- When designing CAD/CAM implants for the chin and mandible, they should relate to the upper face structures to provide overall facial balance.
- Surgical placement of alloplastic chin and mandible implants can have predictable and successful outcomes if key surgical maneuvers are applied to the operation.
- Surgical complications such as infection, motor and sensory nerve disturbances, and disruption of the pterygomasseteric sling are associated with implant augmentation of the chin and mandible but can be mitigated with careful patient selection, surgical planning, and precise surgical execution.

DISCLOSURE

The authors have nothing to disclose.

SUPPLEMENTARY DATA

Supplementary data related to this article can be found online at https://doi.org/10.1016/j.cps.2021.12.004.

REFERENCES

1. Fan Y, Penington A, Kilpatrick N, et al. Quantification of mandibular sexual dimorphism during adolescence. J Anat 2019;234(5):709–17.
2. Thiesen G, Gribel BF, Freitas MP. Facial asymmetry: a current review. Dental Press J Orthod 2015;20(6):110–25.
3. Mommaerts MY. The ideal male jaw angle–an Internet survey. J Craniomaxillofac Surg 2016;44(4):381–91.
4. Farkas LGHT, Katic MJ. Anthropometry of the head and face. 2nd edition. New York: Raven Press; 1994.
5. Lee JH, Kaban LB, Yaremchuk MJ. Refining post-orthognathic surgery facial contour with computer-designed/computer-manufactured alloplastic implants. Plast Reconstr Surg 2018;142(3):747–55.
6. Venkatesh E, Elluru SV. Cone beam computed tomography: basics and applications in dentistry. J Istanb Univ Fac Dent 2017;51(3 Suppl 1):S102–21.
7. Yaremchuk MJ. Commentary on: the role of microfat grafting in facial contouring. Aesthet Surg J 2015;35(7):772–3.
8. Pierard-Franchimont C, Goffin V, Pierard GE. Modulation of human stratum corneum properties by salicylic acid and all-trans-retinoic acid. Skin Pharmacol Appl Skin Physiol 1998;11(4–5):266–72.
9. Wagner M, Gander T, Blumer M, et al. [CAD/CAM revolution in craniofacial reconstruction]. Praxis (Bern 1994) 2019;108(5):321–8.
10. Thomas MA, Yaremchuk MJ. Masseter muscle reattachment after mandibular angle surgery. Aesthet Surg J 2009;29(6):473–6.
11. Straughan DM, Yaremchuk MJ. Changing mandible contour using computer designed/computer manufactured (CAD/CAM) alloplastic implants. Aesthet Surg J 2021;41(10):NP1265–75.
12. Yaremchuk MJ, Chang CS, Dayan E, et al. Atlas of facial implants. 2nd edition. Elsevier; 2020.