

Genioplasty

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Abstract

With increasing aesthetic awareness, in addition to the forehead, nose, and cheekbone prominence, the chin nowadays is seen as one of the most important parts of the facial skeleton. The size and location of these areas of the skeleton in relation to the skull base and their three-dimensional positional relationship to each other are essential and contribute the individuality of a human face. The position of the chin has a strong influence on the assessment of the facial harmony; its different types and forms dominate the appearance. Furthermore, the expression of the chin is equated with character traits and thus it is an important component of the profile forms. Genioplasty is a routine procedure for the correction of aesthetic and functional deformity of the chin region. It is therefore one of the contour-enhancing surgical methods.

Keywords

- ▶ genioplasty
- ▶ rhinoplasty
- ▶ facial profile
- ▶ orthognathic surgery

Phylogenetically, the chin is a relatively young anatomical structure specifically in human evolution; in the *Homo heidelbergensis*, there was no hint of such a structure.¹ Not until the Middle Ages did the chin receive attention both in the field of medicine and in aesthetics.

In Leonardo da Vinci's canon, he described the division of the face into an upper, middle, and lower third, including the chin, and he presumed that in an ideal case the proportion should be equal. He put forward the hypothesis that the proportions of the face are crucial for its harmony. Only far later have occlusion aspects of the chin and lower jaw been noticed, explaining how abnormalities may affect the lower and middle face, thus causing a disharmony of the whole face.² In 1865, Thomas Woolnoth concluded in his book, *The Study of a Human Face*, that compared with the concave or convex form, the straight facial profile was the most attractive one. Nowadays, the "receding chin," for example, is equated with weakness; the striking, prominent chin is associated with male attributes such as dominance and assertiveness.³ These features of attractiveness are gender specific and vary in their interpretation in different cultures.

In western society, a narrow and graceful chin is preferred for women, whereas the prominent and pronounced chin

associated with a greater height of the lower third of the face is favored for men.^{4,5} On "en face" images, a wider chin is considered more desirable for men and a delicate chin for women.⁶ A clearly defined "jawline" to distinguish the lower third of the face from the neck is aesthetically very important in antiaging therapy.⁷ This is also true for the "prejowl sulcus," which is a paramedian retraction of the edge of the lower jaw, playing a major role in the expression of marionette wrinkles.^{8,9}

Genioplasty with Osteotomies

Development

The first description of a genioplasty, which is now regarded as an extremely stable operation method, dates from 1934 by Aufrecht. The chin was built up with an osteochondral graft harvested in the course of a simultaneously performed rhinoplasty.¹⁰

In 1942, Hofer accomplished the first chin augmentation through an extraoral approach by using an advancement flap on a body donor. The chin projection was canceled with the saw, and after separation it remained stalked to the suprahyoid muscles, anterior digastric muscle, geniohyoid

muscle, and platysma muscle.¹¹ The fixation of the bone piece was performed with suture wires. Hofer achieved a feed possibility of 1 to 1.5 cm.¹²

The method of Hofer was modified by Obwegeser and Trauner in 1957. Through an intraoral approach, they led a straightforward displacement of the chin, with which they reached an aesthetically much more favorable outcome.^{13,14} Obwegeser indicated the adhering platysma muscle as a further disadvantage of the method of Hofer. This causes advancement of the neck relief anteriorly and unfavorably affects the aesthetics. Thus, Obwegeser preferred anterior displacement of the lower edge of the chin through an intraoral approach almost in the sense of a free graft, without the stalked platysma muscle.¹⁴

Bone grafts taken from ribs, jaw, and skull cap have often found application as an additional augmentation material. Long-term studies have shown a decreased bone resorption by using the sandwich-like storage of the bone graft.¹⁵

However, the world's most widely used method to enlarge the chin is chin implants inserted through an intraoral or extraoral approach. The most common materials for implants are polyethylene, methyl methacrylate, Teflon, and silicone.¹⁶

Classification and Indication

Precious²³ states that the lower part of the face assigns harmoniously during growth with the rest of the face if the hard and soft tissues of the lower face stay in balance. Depending on the size and position, a distinction is made between micrognathia and prognathia (→Fig. 1), and between prognathia (→Fig. 2) and retrognathia (→Fig. 3).

Furthermore, the chin can deviate from the standard position in the sagittal, vertical, and in the transversal plane. Even within some malformation syndromes, micrognathia is obligatory or optional. These different forms are called *cranio-mandibulo-facial dysmorphism* and are summarized in this article.¹⁷⁻¹⁹

Some of the established classifications of geniodyplasias originated from Gattinger²⁰ and Brachvogel.²¹ Gattinger dis-

tinguishes a forward and a backward chin in the sagittal plane, a high and a low chin in the vertical plane, and the asymmetric forms of the chin in the transversal plane. He notes that it is in many cases a combination of two or all three groups.²⁰

Brachvogel²¹ states that the most aesthetic disorders of the chin region rather result directly or indirectly from incorrect positions of the entire lower or upper jaw in relation to the upper lip, as well as to the tongue with an induced hyperfunction of the perioral muscles. This results in a deformation of the alveolar process, misaligned teeth, and an impaired speech function. Counteracting these deformations, Precious and others call for an early functional genioplasty.^{3,22,23} According to Precious, the indications of a genioplasty include an incompetent lip closure, the open bite with the inlay of the tongue between the teeth and the strain of the mental soft tissue, which is needed to achieve a lip closure.²³ In general, indications of a genioplasty are corrections in the context of orthognathic surgery, reconstruction after trauma or tumor resection, and the aesthetic improvement of the profile curve.² Subject to the required shift directions, differentiated surgical techniques are recommended.²⁴

Operative Planning

The preoperative planning and diagnosis include a medical history, clinical examination, the model analysis, the evaluation of profile and en-face photographs, and the cephalometric analysis of the lateral X-ray.²⁵

Skeletal, dental, and soft tissue structures are reviewed and important information are determined such as the positional relationships of the jaw to the skull face, shape and size anomalies of the upper and lower jaw, the position of the teeth to each jaw base, and finally structure and growth direction of the facial skeleton.

Before carrying out an operational chin correction, the causes must exactly be clarified. Clinical investigation, radiographic diagnostic, and cephalometric analysis help in



Fig. 1 Micrognathia (a) and macrognathia (b) with normal occlusion.

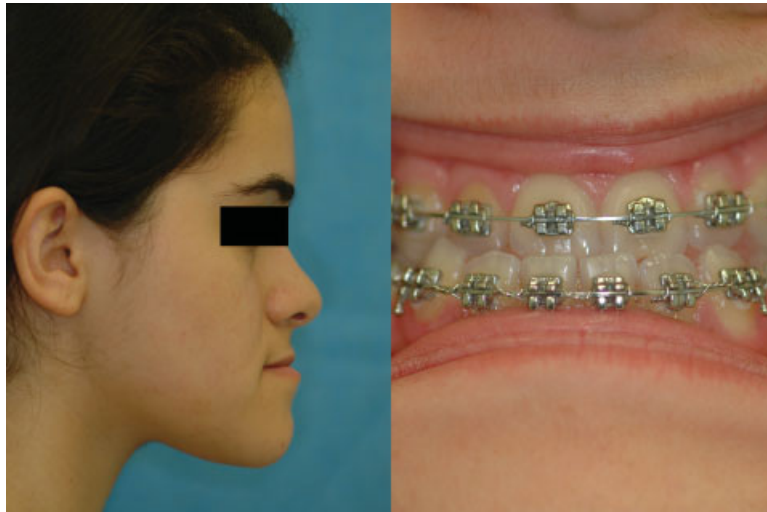


Fig. 2 Prognathia with class III malocclusion.



Fig. 3 Retrognathia with class II malocclusion.

making the decision whether the genioplasty as the sole operative action is sufficient to improve the facial profile or whether dysgnathic correction of the lower or upper jaw is necessary.^{26,27}

Cephalometry

The cephalometry is a crucial tool for the diagnosis and treatment planning in orthodontics. Based on preoperative analysis, the reasons for geniodyplasia can exactly be clarified.⁵³ Thus, an existing maxillary prognathism, alveolar protrusion and underdevelopment of the entire lower jaw, may be identified as the cause of a fleeing chin and even strengthening factor, respectively.²⁸

The basis of the diagnostic evaluation of lateral cephalograms is the precise definition of cephalometric reference points. They determine reproducibility and validity for fur-

ther metric analysis methods.²⁹ Special care has to be taken to locate the A-point, the anterior and posterior nasal spine, and the apex point of the lower incisors.³⁰ Even so random errors may occur due to variability of sharpness, optical density, and complexity of X-rays. Troulis et al showed a standard error of 1.14 mm in the evaluation of an X-ray image.³¹ The most important points and measures

Surgical Method

Genioplasty with osteotomies is usually done under general anesthesia. Through a lingual tumescent anesthesia, the soft tissue is pushed aside and blood flow of the sublingual vein and artery is minimized. In addition, an infiltration at the edge of the mandible along the planned end of the saw cut, anterior to the facial artery and vein and in the oral vestibule,

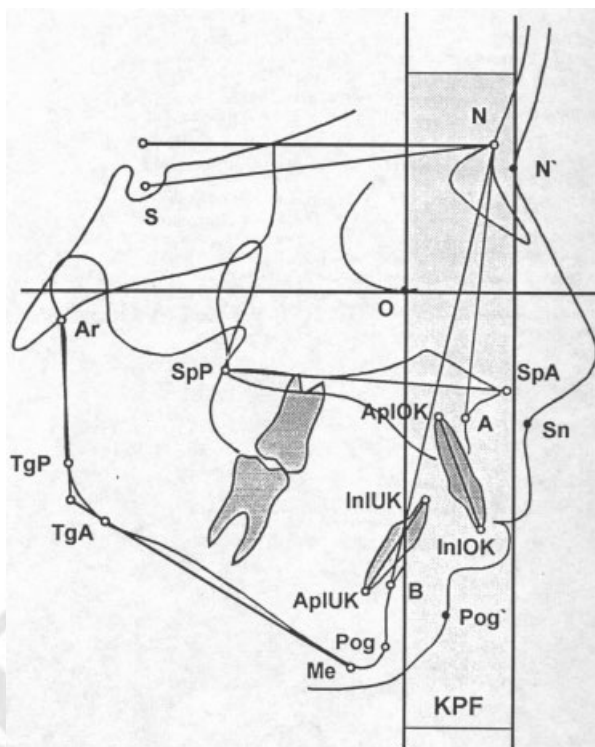


Fig. 4 Cephalometry landmarks for the analysis by genioplasty.⁵³

is made. Gingival margin incisions reduce scar formation and minimize the risk of local infection of the wound as well as wound dehiscence.

A subperiosteal preparation to push the mucosa aside is followed by the exposition of the mental nerve on both sides. For preservation of the nerve during osteotomy, the periosteum is slit directly above the foramen mentalis with a No. 11 scalpel. Now, the nerve is carefully dissected from the periosteum with a blunt dissecting scissor above the incision line, so there is no tension on it.

After the mentalis muscle has been cut, the soft tissue is dissected subperiosteally up to 4 to 5 mm to the edge of the mandible to avoid a “dropping chin,” which is the subsequent lowering of the soft tissues. The osteotomy line is marked with a Lindemann cutter. Also, the center line of the lower jaw is marked by a vertical line. The horizontal osteotomy holds at least 5 mm away from the mental foramen and 10 mm from the apex of the teeth.

The osteotomies can be performed with rotary instruments, an oscillating saw, or by Piezosurgery device. All three variants may be used in the same surgical procedure for individual sections of the operation, whereas the Piezosurgery is the preferred method in the vicinity of nerve and vascular bundles. The advantages of the oscillating saw are the short duration of the osteotomy and the minimum gap of the osteotomy. However, neighboring structures are threatened by the nonselective cutting.

With a fine chisel of 4 to 6 mm, the osteotomy is then completed with the help of the pre-sawed gap and external digital palpation of the edge of the mandible. In an additional osteotomy to reduce the height, two saw cuts are made in a

planned distance, first the caudal line and then the cranial line (► **Fig. 8**). If displacement in the sagittal direction is being performed simultaneously, the osteotomy may not be parallel. In an anterior displacement, the saw cuts must converge and in return the lines should diverge in a posterior displacement. A wedge-shaped osteotomy should follow to prevent formation of a step at the edge of the mandible.

Lingually, the separated mandibular edge remains stalked to the muscles, being well fed via the lingual periosteum and the terminal branches of the lingual artery. Once freed, the edge may be shifted according to the profile planning and fixed with miniplates and screws. In cases of smaller displacements, a single miniplate, also known as “X-plate,” is sufficient for central fixation, whereas in larger displacements two microplates should be additionally attached in the paramedian region of the mandible. On principle in large osteotomies, it is recommended to perform a fixation on both sides to keep the postoperative situation stable and avoid any tilting. After displacement and plate fixation, the bony steps may be smoothed with a drill or filled using xenogenic or alloplastic augmentation material, such as Bio-Oss or Cerasorb M.

Autogenic bone from the mandibular angle region, optionally in combination with xenogenic or alloplastic bone substitute materials, is used for major bone reconstructions such as great vertical chin advancement in the short face syndrome. At the end of any bony genioplasty, the two portions of the mentalis muscle should be reunited with a deep suture, followed by a subsequent saliva-proof wound closure and a pressure bandage.

The different forms of chin anomalies are discussed in the following paras.

Micrognathia

The surgical correction is performed by an anterior displacement to restore the harmony of the face. Through an intraoral approach, the osteotomy is performed with a saw. This is followed by the repositioning of the lower segment anteriorly with osteosynthesis plates and screws (► **Fig. 5**).

Macrognathia

Here, the surgical technique differs only in that after the osteotomy the caudal chin segment is shifted posteriorly and repositioned with plates and screws (► **Figs. 6 and 7**).

Chin Height Correction

In addition to the displacement of the chin to anterior or posterior, there is the possibility of reduction or prolongation of the chin height.

If a reduction of the chin height should be achieved, the horizontal osteotomy is performed at two locations—generally with a distance of ~5 mm cranial to the foramina of the mental nerve bilaterally, and then parallel to this further caudally. After removing the osteotomized bone fragment, the caudal segment of the chin is being repositioned with plates and screws (► **Figs. 8 and 9**).

For planned extension of the chin height, the position of the chin has to be reevaluated after the osteotomy. To achieve



Fig. 5 Pre- and postoperative pictures 4 months after chin advancement.

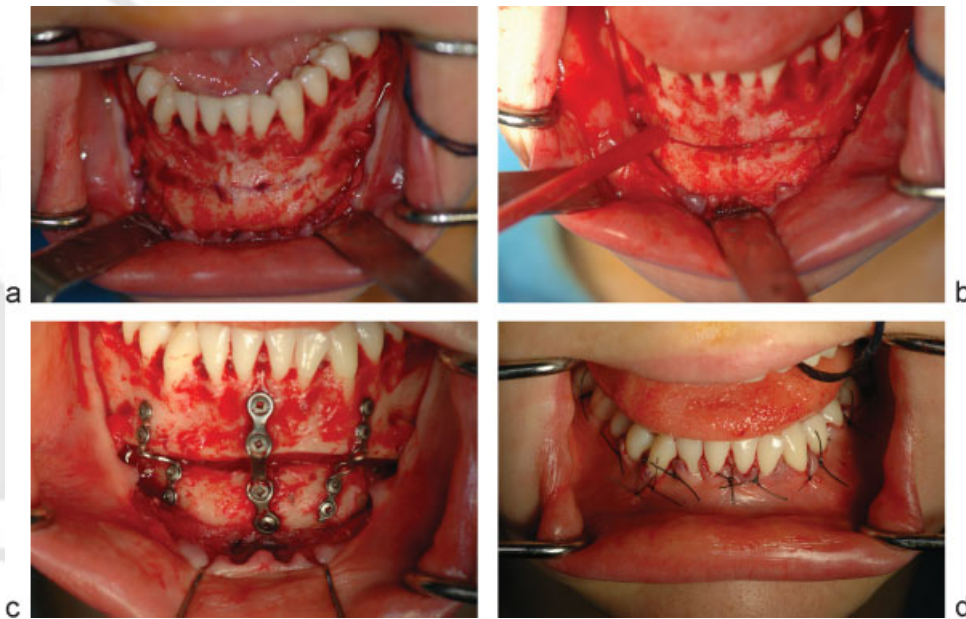


Fig. 6 (a-d) Intraoperative photographs of chin reduction in macrognathia.



Fig. 7 (a, b) Pre- and postoperative pictures 3 days after chin reduction.

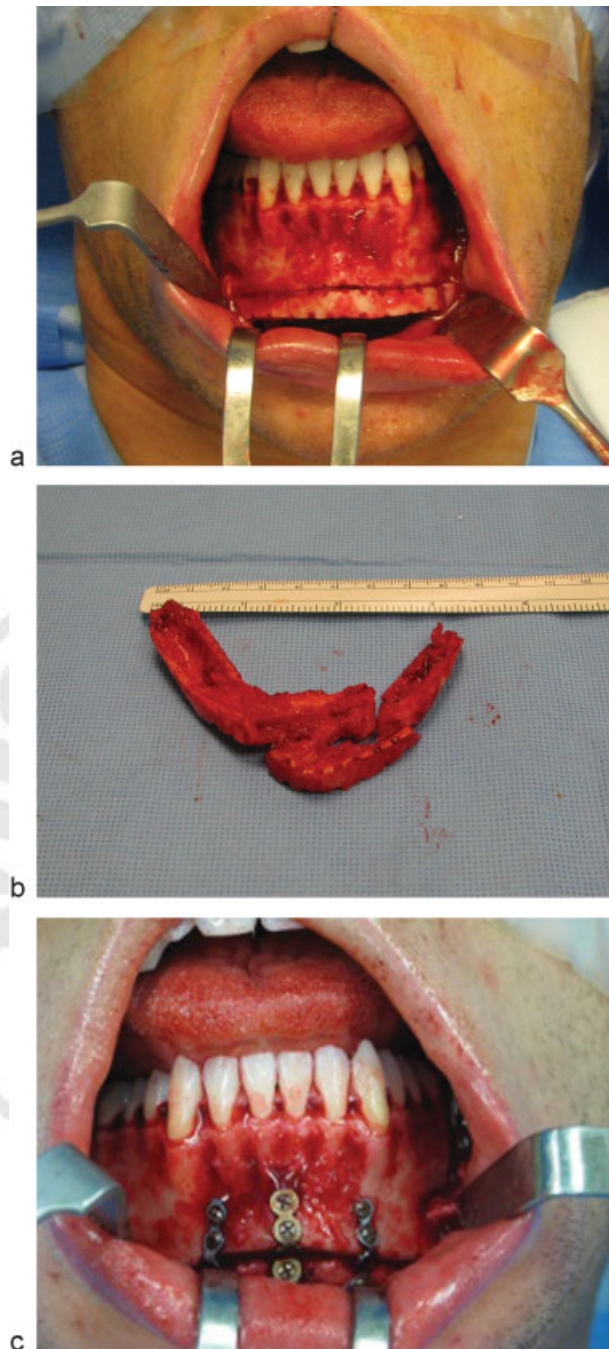


Fig. 8 (a–c) Sagittal and vertical chin reduction.

the desired vertical distance from the caudal chin segment to the cranial mandibula, the caudal segment usually has to be fixed with 3 mini plates and 12 screws: one miniplate has to be located centrally in the mandibular midline and two bilaterally.

The resulting gap between the caudal and cranial bone segment is now filled with bone substitute materials, preferably mixed with autologous blood and bone. This mixture acts to the new bone formation as a placeholder, and ensures stability in the chin area (►Figs. 10 and 11).

Genioplasty Implants

Most chin corrections can be performed three-dimensionally using the aforementioned methods of osteotomies. The posterior or anterior advancement of the chin, the reduction of the chin height by osteotomy, or the enlarging of the chin for the “short face syndrome” are generally treated this way.^{32,33} In some situations, however, as in individual forming of evident hypoplastic chin or in padding of marionette lines to reduce sagging cheeks, a pure onlay plastic using facial implants may be indicated. The most common materials used for chin implants are Silastic (hardened silicone), Gore-Tex, and Medpor. Thus, an upcoming facelift can be postponed for several years.

Initially, the procedure starts with an opening by a stepped incision far labially, followed by a transection of the mentalis muscle more cranially. A subperiosteal pocket below and distal to the mental foramen with optional extension to the angle of the jaw should be prepared. Once inserted, the implant should be fixed with two titanium screws to secure it against slipping. Alternatively, it is fixed within an extraorally dissected pocket, placing sutures to the periosteum. Finally, a multilayered wound closure is performed, initially with adaptation of the mentalis muscle and subsequently followed by saliva-proof sutures for closure (►Fig. 12).

The advantages of a chin implant are the less invasive procedure with quicker healing and less risk to the teeth and nerves. Some of the drawbacks are the higher risk for infection and migration and the limitations for vertical augmentation.

Discussion

The Bony Relapse

Considering postoperative changes in patients after sagittal augmentation and vertical reduction, the results vary.³⁴ The recurrence rate concerning the relative mandibular length was 0.14 mm on average; changes in the vertical dimension reflected in the mandibular plane showed an average deviation of 0.87 degrees. Talebzadeh and Pogrel³⁵ also confirm that 12 months after augmenting genioplasty, there was no significant recurrence. The biggest recurrence was only 0.38 mm.³⁵

Taking into account that the determination of reference points used for investigations includes an error of at least 1 mm, postoperative bone or soft tissue differences of less than 1 mm have no operational, technical, clinical, or aesthetic relevance.² Therefore, the bony stalked genioplasty may be regarded as a precisely plannable and safely predictable process, provided there is stable fixation and proper reattachment of soft tissues. There is no reason to expect significant bone resorption, according to the literature.³⁶ Minimal changes in the bony pogonion may be interpreted as the result of an increased postoperative muscle train, which surgically calls for compensation by a slight over-correction of shortening.³⁷



Fig. 9 (a–d) Pre- and postoperative pictures 6 months after sagittal and vertical reduction.

Soft Tissue Changes

Another important consideration in planning a genioplasty is the anticipated impact on the soft tissue. In our own study on 21 patients, analyzing radiographs in the sagittal plane by means of point XIX (lower lip to E line), the soft tissue followed the hard tissue by an average of 72%³⁸ (► **Fig. 13**). McDonnell et al reported a forward displacement of the soft tissue pogonion of 75% on average,³⁹ and Wegener noted that soft tissue displacement of the chin region is less than 25% relating to the bony structures.⁴⁰ More or less comparable results were published by Steinhäuser and Paulus,⁴¹ Joss et al,⁴² and Segner and Hölte.⁴³ Park et al also found that the soft tissue followed the hard tissue in 97%.⁴⁴ These and other investigations of genioplasty patients made it evident that the effect of the soft tissue on the facial profile and the position of the lower lip is linked to its thickness and to the degree of horizontal and vertical displacements.^{35,45,46}

Complications

Owing to a very low complication rate, the genioplasty is considered one of the most successful operational activities in

the aesthetic plastic surgery.⁴⁷ It is estimated that 90 to 95% of patients are satisfied with the postoperative result.⁴⁸

In a study on 200 patients who underwent genioplasty in isolation or combined with other surgical procedures, Richard et al⁴⁹ described only six complications.

Fractures, atypical osteotomies, bleeding, soft tissue damage, or nerve injuries are among possible intraoperative complications.⁵⁰ Postoperative complications include sensory loss, hematoma, infection, secondary dislocations, bone necrosis, ptosis of the chin, deficient ossification, dental lesions, periodontal lesions, and irregular contours of the lower jaw.⁴⁹

Combining Genioplasty with Nose Jobs

The significance of the chin is often underestimated in assessing the facial aesthetics. One rather focuses on the nose, the eyes, and the lips, which occupy a more central position in the face. This condition is even more serious when the chin or the lower jaw is underdeveloped and thus the nose is more expressed. Many of those patients only seek consultation for a rhinoplasty, whereas in reality an additional chin

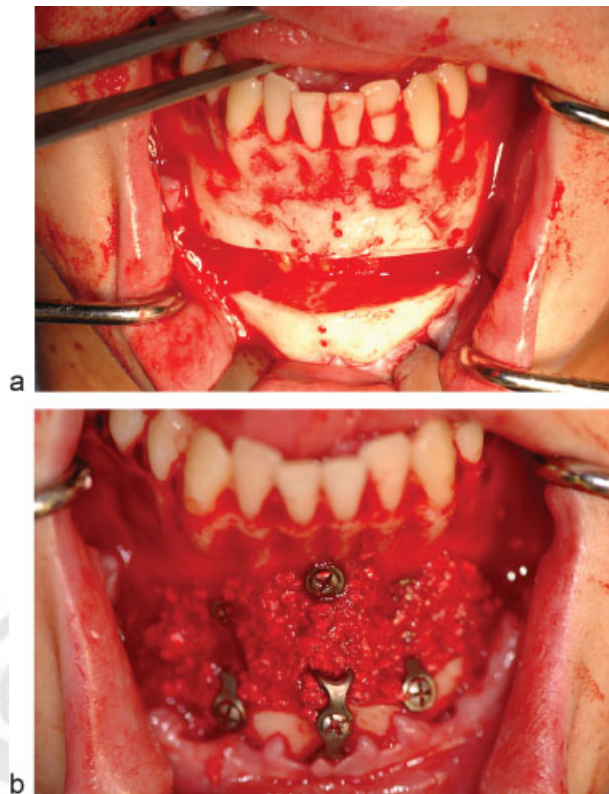


Fig. 10 (a, b) Chin advancement and vertical augmentation.

correction is needed to achieve a harmonious profile.^{51,52} Even of many advantages the simultaneous correction of chin and nose has not yet been fully established in facial plastic surgery (► **Fig. 14**).

Conclusion

Taking into account the social development that leads to an ever greater emphasis on aesthetic components in medicine, the surgical procedure of genioplasty is becoming more and more popular. Although implants may be indicated in selected cases of chin augmentation, surgical chin corrections by osteotomy open up numerous possibilities of three-dimensional variation of the chin. Reduction of the height or posterior displacement is possible only in this way.

The displacement of the chin must be planned accurately as part of an in-depth profile analysis. For the facial proportions and the entire aesthetics of the face, the chin carries an essential importance. Thus, to achieve an optimal aesthetic result, chin corrections are not debated in isolation anymore. More often, the correction of the chin is integrated in the treatment of complex profile correction in cases of dysgnathia.

Through the use of modern rigid osteosynthesis materials such as mini- or microplates and screws, the pull of the suprahyoid muscles can now be compensated securely. This ensures a lasting and stable fragment positioning.



Fig. 11 (a, b) Pre- and postoperative pictures 7 days after chin advancement and vertical augmentation.

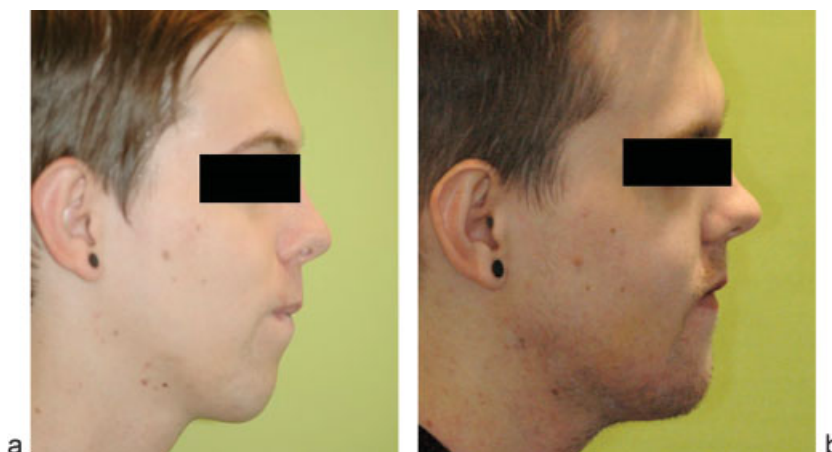


Fig. 12 (a, b) Chin augmentation with Medpor implant.



Fig. 13 (a, b) Soft tissue displacement of the chin region after chin advancement.



Fig. 14 (a, b) Pre- and postoperative pictures after simultaneous rhinoplasty and genioplasty.

Considering the results, the autologous genioplasty characterizes a straightforward and lasting stable method, with reduced complications, for the harmonization of facial aesthetics, which could be performed as a sole procedure or in combination with dysgnathia corrections.

It could be shown that the genioplasty, with implementation of stalked soft tissue, stable fixation with lag screws or miniplates, and reattachment of the soft tissue of the chin region, leads to stable bony contours enabling predictable results.

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