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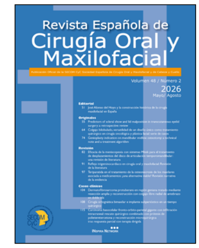

Original

Genioplasty indication on mandibular midline osteotomy: a technical note and a treatment algorithm

Mauricio Barreda[1-3], Josefina Bendersky[1,4], Francisca Moris[1] and Jaime de la Maza[1]*

[1]*Departamento de Cirugía y Traumatología Bucal y Maxilofacial. Universidad de Chile. Santiago, Chile.* [2]*Hospital Clínico San Borja Arriarán. Santiago, Chile.* [3]*Hospital del Salvador. Santiago, Chile.* [4]*Centro Cochrane Universidad de Chile. Santiago, Chile*

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ABSTRACT

Introduction: Mandibular midline osteotomy is an effective approach for correcting transverse maxillomandibular discrepancies in orthognathic surgery. When combined with bilateral sagittal split ramus osteotomy, it enables comprehensive three-dimensional correction. However, the indication of genioplasty in this context remains poorly standardized, with limited guidance on when and how it should be incorporated into surgical planning. This study proposes a decision-making algorithm to guide the indication and sequencing of genioplasty based on virtual surgical planning.

Methods: A decision-making algorithm was developed to determine the indication of genioplasty in patients undergoing mandibular midline osteotomy, integrating key variables derived from virtual surgical planning, including transverse expansion, sagittal chin displacement, and anticipated changes in lower facial symmetry. Three clinical cases are presented exclusively to illustrate the application of the algorithm across different clinical scenarios.

Results: The proposed algorithm stratifies patients into three decision pathways: 1) genioplasty indicated as part of the pre-established orthognathic plan, involving active sagittal or vertical repositioning of the chin; 2) genioplasty performed solely for stabilization of the chin segment, aimed at preventing midline widening after mandibular midline expansion; and 3) no indication for genioplasty in the absence of midline opening. Algorithm application during the virtual surgical planning phase allows prediction of chin position changes and facilitates a more precise, individualized surgical strategy.

Conclusions: The indication for genioplasty in mandibular midline osteotomy should be algorithm-driven rather than discretionary. The proposed framework provides a structured, reproducible approach to integrate chin management into orthognathic planning, optimizing lower facial symmetry and functional outcomes. The illustrative cases support its clinical applicability and highlight its potential role in standardizing decision-making in this complex surgical context.

Autor para correspondencia:

Correo electrónico: josefina.bendersky@uchile.cl (Josefina Bendersky).

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Indicación de genioplastia en osteotomía de línea media mandibular: nota técnica y algoritmo de tratamiento

Palabras clave:

Cirugía ortognática, osteotomía mandibular, mentoplastia, maloclusión, cirugía asistida por computadora, algoritmos.

R E S U M E N

Introducción: La osteotomía de línea media mandibular constituye una alternativa eficaz para la corrección de discrepancias transversales maxilomandibulares en cirugía ortognática. Cuando se combina con la osteotomía sagital bilateral de rama mandibular, permite una corrección tridimensional integral. Sin embargo, la indicación de genioplastia en este contexto permanece escasamente estandarizada, con limitada orientación respecto a cuándo y cómo debe incorporarse en la planificación quirúrgica. Este estudio propone un algoritmo de toma de decisiones para guiar la indicación y secuencia de la genioplastia basado en la planificación quirúrgica virtual.
Métodos: Se desarrolló un algoritmo de toma de decisiones para determinar la indicación de genioplastia en pacientes sometidos a osteotomía de línea media mandibular, integrando variables clave derivadas de la planificación quirúrgica virtual, incluyendo la magnitud de la expansión transversal, el desplazamiento sagital del mentón y los cambios esperados en la simetría del tercio inferior facial. Se presentan tres casos clínicos exclusivamente con el objetivo de ilustrar la aplicación del algoritmo en distintos escenarios clínicos.
Resultados: El algoritmo propuesto estratifica a los pacientes en tres vías de decisión: 1) genioplastia indicada como parte del plan ortognático preestablecido, con reposicionamiento activo sagital o vertical del mentón; 2) genioplastia realizada exclusivamente con fines de estabilización del segmento mentoniano, orientada a prevenir el ensanchamiento de la línea media tras la expansión mandibular; y 3) ausencia de indicación de genioplastia en casos sin apertura de la línea media. La aplicación del algoritmo durante la fase de planificación quirúrgica virtual permite anticipar los cambios en la posición del mentón y facilita una estrategia quirúrgica más precisa e individualizada.
Conclusiones: La indicación de genioplastia en el contexto de osteotomía de línea media mandibular debería estar guiada por un algoritmo más que depender de criterios discrecionales. El marco propuesto ofrece un enfoque estructurado y reproducible para integrar el manejo del mentón en la planificación ortognática, optimizando la simetría del tercio inferior facial y los resultados funcionales. Los casos ilustrativos respaldan su aplicabilidad clínica y destacan su potencial para estandarizar la toma de decisiones en este escenario quirúrgico.

INTRODUCTION

Under the term dentofacial anomalies, we recognize skeletal and dental alterations affecting the facial skeleton. Among these, transverse anomalies are characterized by maxillary rotations and/or transverse compression or expansion of the jaws.

When maxillary and/or mandibular compressions are identified, early intervention through orthopedic treatments is both possible and advisable in order to prevent the need for surgical procedures. Nevertheless, in cases where early treatment is not performed or is insufficient, surgical intervention becomes necessary to improve transverse maxillomandibular relationships[1].

In patients who have completed growth and development and present with skeletal discrepancies, correction is achieved through a set of surgical procedures collectively known as orthognathic surgery, which repositions the craniofacial skeleton into a functionally and aesthetically appropriate position by means of craniofacial osteotomies[2].

By convention, transverse discrepancies between the jaws have traditionally been addressed through segmental osteotomies of the maxilla. However, this approach raises questions when the transverse anomaly is primarily mandibular in origin, or when the maxilla is responsible for the transverse discrepancy but presents no additional skeletal alteration, while sagittal or vertical correction of the mandible is still required. In such cases, mandibular midline osteotomy, in combination with bilateral sagittal split ramus osteotomy, has been developed as a surgical alternative for the correction of transverse discrepancies between the jaws[1].

The mandibular midline osteotomy, also referred to as symphyseal or median osteotomy, represents a valuable surgical option for managing maxillary or mandibular transverse discrepancies in the context of orthognathic surgery. This technique allows controlled separation of the hemimandibles through an interdental osteotomy between the central incisors, enabling transverse and sagittal adjustments according to virtual surgical planning. Currently, it is frequently combined with other procedures —such as bilateral sagittal split ramus osteotomy (BSSO) and genioplasty— enhancing its corrective potential across all three spatial planes and contributing to improve lower facial harmony[3]. The main indications include isolated transverse mandibular discrepancies, mandibular asymmetries with a normal maxillary base, and cases in which maxillary expansion or constriction is not advisable due to anatomic or dental limitations. Its execution requires precise digital planning, preservation of the mental neurovascular bundle, and careful handling of the lingual periosteum to maintain adequate segmental vascularization[4].

Several authors have described the mandibular midline osteotomy as an effective and stable option for addressing bimaxillary or isolated mandibular deformities. Ramanathan et al. reported its use in combination with genioplasty for correcting mandibular transverse deficiencies up to 4 mm, achieving stable postoperative outcomes with minimal complications[5]. Similarly, Olate et al. proposed a "one-step" surgical protocol integrating midline osteotomy, sagittal split osteotomy, and genioplasty, demonstrating predictable occlusal stability and long-term skeletal balance at three years of follow-up[4]. Collectively, the available evidence suggests that mandibular midline osteotomy, when performed with rigid fixation and accurate planning, provides reliable outcomes both for mandibular widening and constriction procedures.

Despite increasing interest in this surgical approach, current literature mainly focuses on technical execution and postoperative stability, with scarce attention to the decision-making process regarding concomitant genioplasty. To date, no studies have proposed an evidence-based algorithm or clinical guidelines defining when genioplasty should be indicated, modified, or avoided during mandibular midline osteotomies. The decision often relies on the surgeon's experience and subjective esthetic considerations, generating heterogeneity in surgical practice and potential variability in lower facial outcomes.

The aim of this technical note is to propose a structured decision-making approach for determining when to perform genioplasty in conjunction with mandibular midline osteotomy in orthognathic surgery. Additionally, three clinical cases are presented to illustrate the application of this algorithm and its impact on esthetic and functional outcomes. This proposal seeks to contribute to the standardization of lower facial management in orthognathic procedures involving mandibular midline osteotomy.

MATERIALS AND METHODS

Study design

A case series is presented with the aim of illustrating three surgical decision pathways regarding whether or not to perform genioplasty in mandibular midline osteotomy within the context of orthognathic surgery. Patients treated at Hospital San Borja Arriarán and Hospital del Salvador (Santiago, Chile) were included. No restrictions were applied regarding age, sex, or dentofacial diagnosis, provided that the primary indication was the presence of mandibular transverse discrepancy.

A preliminary surgical decision-making algorithm was developed to determine the need for genioplasty in patients undergoing mandibular midline osteotomy.

Inclusion and exclusion criteria

Inclusion:

- Patients undergoing orthognathic surgery who required mandibular midline osteotomy due to transverse discrepancy;
- Availability of complete clinical, photographic, and radiographic records.

Exclusion:

- Insufficient clinical records or absence of diagnostic imaging.

Preoperative planning

All cases were planned using virtual surgical planning, following a standardized sequence:

1. Determination of maxillary position;
2. Three-dimensional assessment of mandibular width and precise measurement of the transverse discrepancy;
3. Analysis of central incisor roots to define a safe symphyseal osteotomy line;
4. Planning of maxillomandibular movements (sagittal, vertical, and rotational);
5. Evaluation of mandibular segment separation, which was a determining factor in the indication for genioplasty.

Surgical sequence

All procedures followed a reproducible surgical workflow, with specific adjustments when genioplasty was required. All patients underwent surgery under general anesthesia with nasotracheal intubation in the supine position. The surgical sequence was as follows:

1. Le Fort I osteotomy.
2. Placement of the intermediate splint and temporary wire intermaxillary fixation.
3. Fixation of the maxilla with rigid osteosynthesis plates and screws (2.0 system) at the anterior and lateral buttresses.
4. Genioplasty (when indicated).
5. Removal of temporary intermaxillary fixation and the intermediate splint;
6. Bilateral sagittal split ramus osteotomy.
7. Placement of the final splint and temporary wire intermaxillary fixation.
8. Orthodontic archwire sectioning in cases requiring separation of the mandibular segments.
9. Mandibular midline osteotomy between the central incisors.
10. Repositioning of the final splint.
11. Rigid osteosynthesis of the midline osteotomy using a straight 2.0 plate with monocortical screws.
12. Bilateral condylar repositioning and fixation of the proximal and distal segments of the sagittal split ramus osteotomy using plates and screws (2.0 system).
13. Rigid fixation of the genioplasty (when performed) using an X-shaped 2.0 plate with mono- and bicortical screws.
14. Release of intermaxillary fixation and verification of final occlusion.

Orthodontic management

All three patients received pre- and postoperative orthodontic treatment. When required, the segmented mandibular arch was temporarily stabilized with light-cured resin until initial consolidation, followed by reinstatement of a continuous archwire.

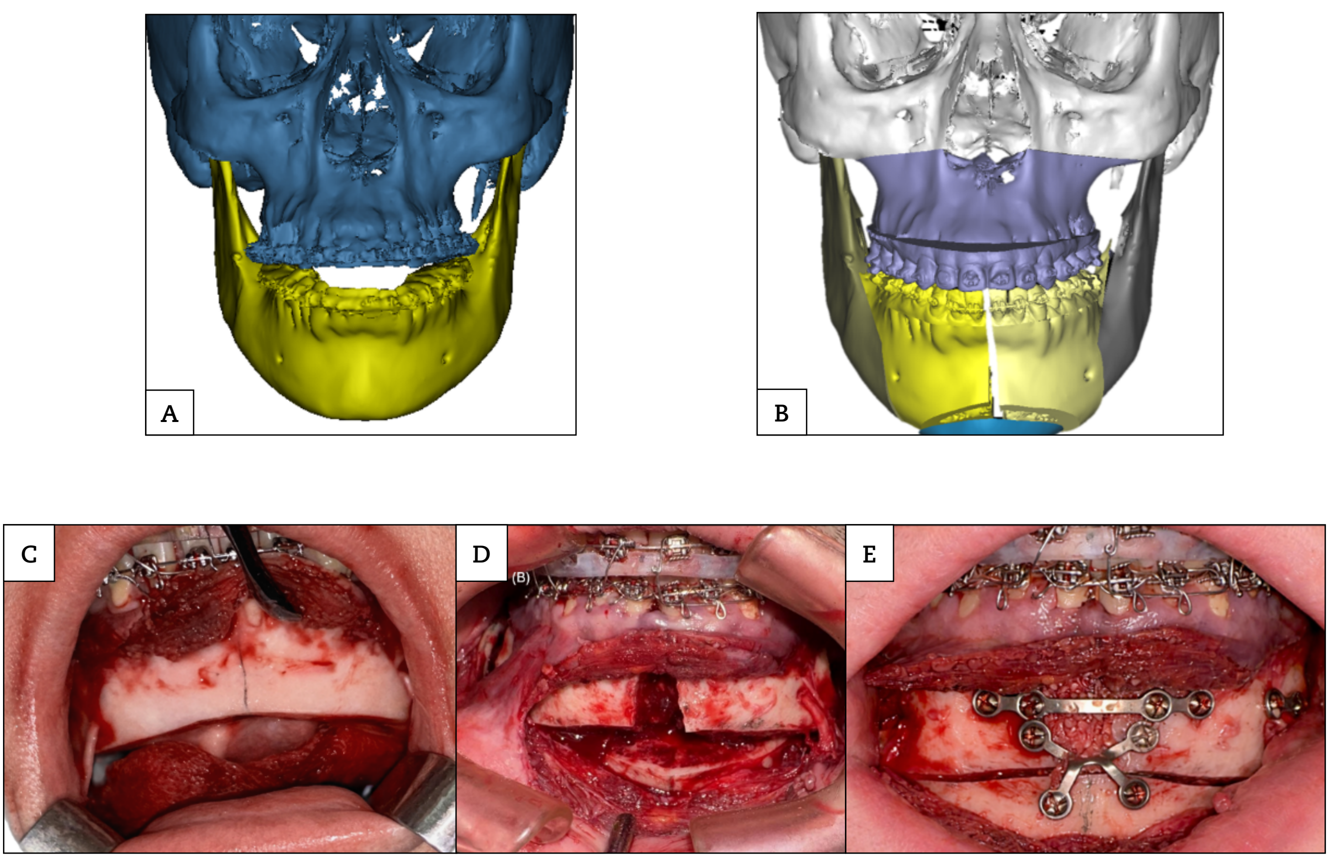
RESULTS

Case 1. Requires genioplasty based on prior orthognathic planning

A 53-year-old female patient diagnosed with vertical Class III dentofacial deformity was included. A triple orthognathic procedure was planned and performed. This comprised a 4-mm maxillary advancement, a 2-mm posterior maxillary impaction, and an advancement genioplasty of 8 mm combined with a 3-mm vertical elevation. In addition, a midline mandibular osteotomy was carried out, achieving a 6-mm compressive reduction at the basilar border. Fixation of the midline osteotomy was achieved with a straight plate, while an X-shaped plate was used for stabilization of the advancement genioplasty. There were no complications during surgery (Figure 1). Postoperative stability of the chin segment was assessed clinically during a follow-up period of 1.5 years, with no evidence of relapse or displacement.

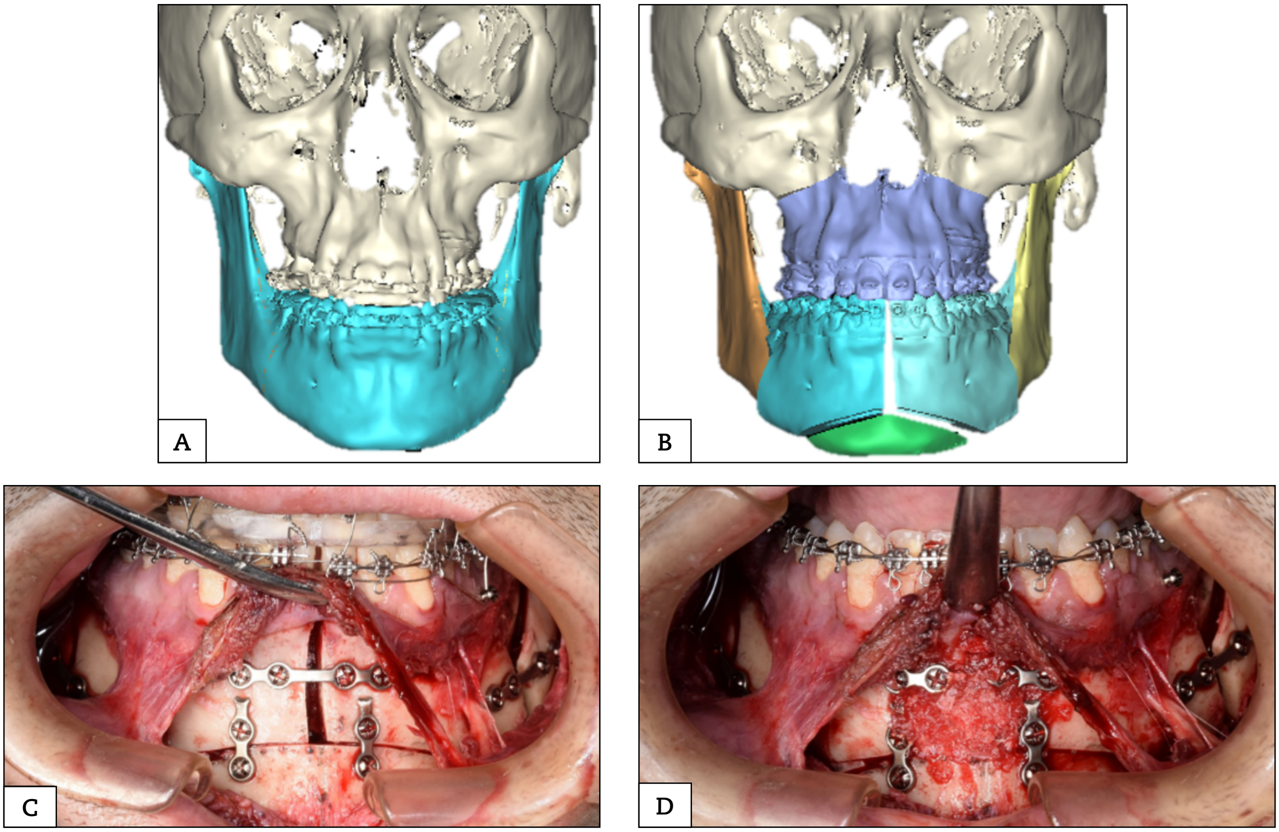
Case 2. Requires genioplasty due to widening at the midline

A 30-year-old male patient diagnosed with vertical Class III dentofacial deformity was included. A triple orthognathic procedure was planned and performed. This comprised an 8-mm maxillary advancement and a 3-mm anterior maxillary impaction. In addition, a midline mandibular osteotomy was carried out, achieving a 4-mm expansive modification at the basilar border. In this case, genioplasty was performed solely to maintain the position of the chin segment following the midline osteotomy, with no associated movements. A straight plate was used to stabilize the midline osteotomy, and an additional straight plate cut in half was placed bilaterally on both sides of the genioplasty segment to enhance its stability, given that no sagittal advancement was performed. There were no intraoperative complications (Figure 2). Clinical follow-up at 1 year confirmed stable positioning of the chin segment with no signs of displacement.



A: preoperative three-dimensional model; B: virtual surgical planning; C: intraoperative marking of osteotomy lines; D: mandibular midline osteotomy with segment separation for transverse widening; E: reduction and stabilization of the segments using osteosynthesis plates. Genioplasty is performed according to the initial surgical plan for sagittal chin repositioning, independent of midline expansion.

Figure 1. Virtual planning and intraoperative sequence of mandibular midline osteotomy with repositioning genioplasty.



A: preoperative three-dimensional model; B: virtual surgical planning showing mandibular segmentation and planned movements; C: intraoperative reduction and fixation of mandibular midline osteotomy and genioplasty using osteosynthesis plates, with genioplasty performed to preserve chin position and enhance segment control; D: bone graft applied in midline osteotomy.

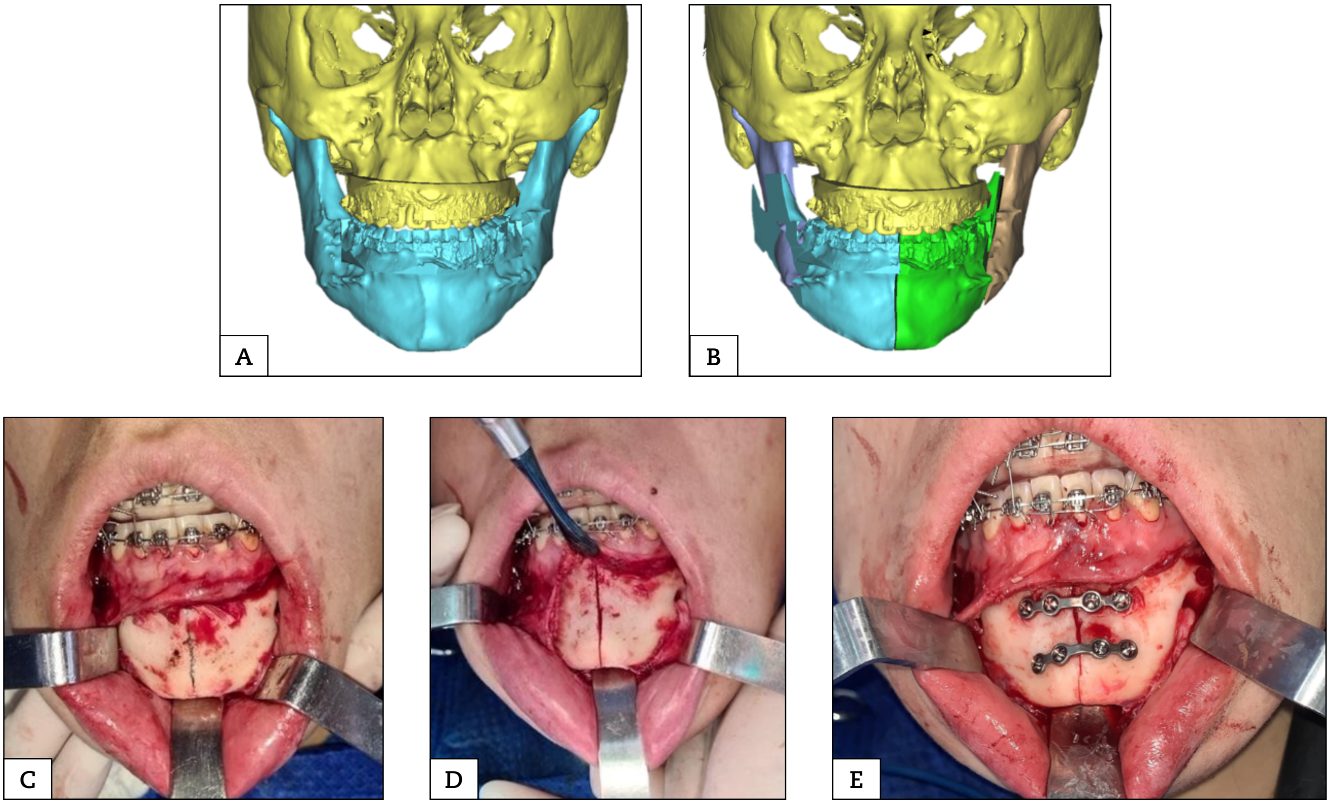
Figure 2. Virtual planning and intraoperative sequence of mandibular midline osteotomy with transverse expansion and stabilizing genioplasty.

Case 3. Genioplasty is not required, as there is no midline widening

22-year-old female patient with a diagnosis of Class II dentofacial deformity and anterior open bite was included, presenting with relapse following prior orthognathic surgery. Mandibular orthognathic surgery was planned and performed using bilateral sagittal split osteotomy (BSSO) and mandibular osteotomy, without concomitant genioplasty. In this case, the mandibular midline osteotomy was performed in a compressive mode —that is, with approximation rather than separation of the mandibular segments— and therefore did not generate an intermental gap between the hemimandibles. As no gap was created, no widening of the chin segment was anticipated, and consequently the rationale for performing a stabilizing genioplasty was absent. This distinguishes Case 3 from Case 2, in which an expansive midline osteotomy with segment separation necessitated genioplasty to prevent chin widening. Planned pogonion movements secondary to BSSO were 3 mm anteriorly and 1.7 mm superiorly, with no transverse change. The mandibular midline osteotomy was stabilized using two straight plates, one placed in the tension zone and the other towards the compression zone (Figure 3). The patient was followed clinically for 3 years, with no evidence of skeletal relapse or segment instability.

Algorithm

An algorithm for the indication and sequencing of genioplasty in the setting of midline mandibular osteotomy during orthognathic surgery was developed and applied. The indication for genioplasty is determined exclusively during the virtual surgical planning phase, based on the anticipated skeletal movements and their impact on chin position and symmetry. When the virtual plan identifies the need for genioplasty —which may be indicated for chin advancement, vertical repositioning, or correction of chin cant— the procedure is planned as an initial surgical step prior to performing the mandibular midline osteotomy. Conversely, when genioplasty is not required according to the primary orthognathic plan, the algorithm differentiates between two scenarios based on the nature of the midline osteotomy: 1) when the midline osteotomy is expansive and generates an intermental gap between the mandibular segments, genioplasty is incorporated before the midline osteotomy solely to preserve the position of the chin segment and prevent widening of the mental region secondary to segment separation; and 2) when the midline osteotomy does not generate an intermental gap —as in compressive or minimal-displacement osteotomies— no chin widening is anticipated, and therefore genioplasty is not indicated. The key determinant



A: preoperative three-dimensional model; B: virtual surgical planning showing mandibular segmentation and planned movements; C: intraoperative marking of the osteotomy line at the mandibular symphysis; D: mandibular midline osteotomy; E: reduction and fixation of the mandibular segments using osteosynthesis plates.

Figure 3. Virtual planning and intraoperative sequence of mandibular midline osteotomy. No genioplasty is required.

of this decision is not the mere presence of a midline osteotomy, but specifically whether that osteotomy will produce a gap between the hemimandibles that would otherwise result in undesired widening of the mental region. The three clinical cases presented in this technical note exemplify each of these decision pathways, illustrating the practical application of the algorithm (Figure 4).

DISCUSSION

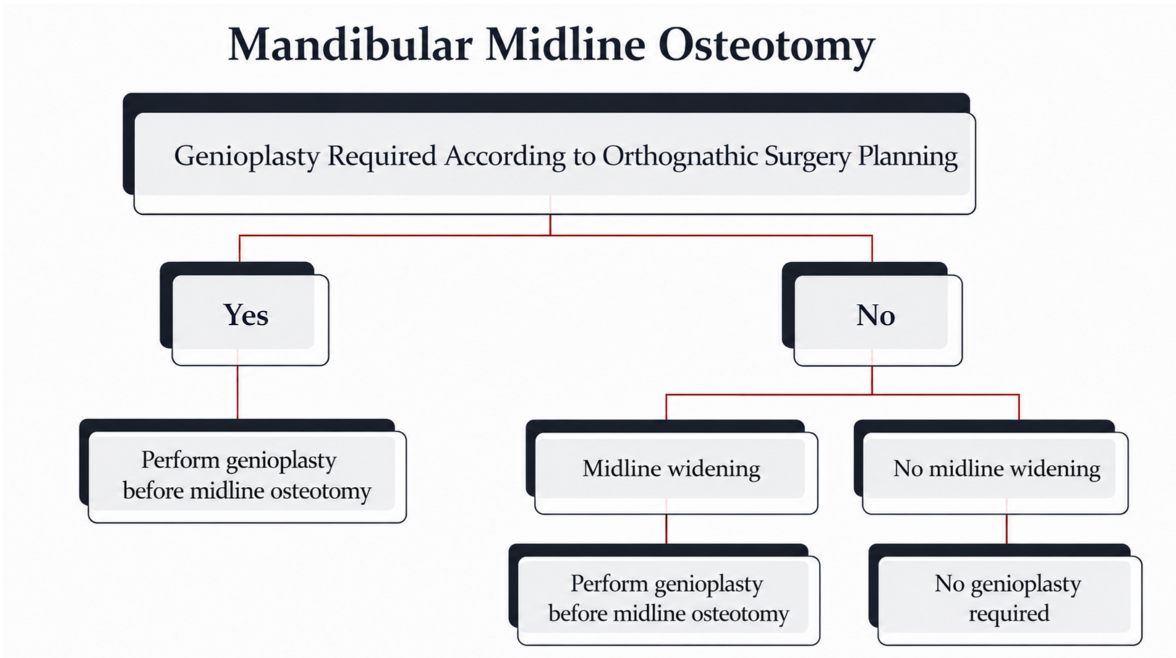
This technical note presents a structured algorithm to support surgical decision-making regarding genioplasty in the context of mandibular midline osteotomy. Unlike approaches based primarily on intraoperative judgment or subjective aesthetic criteria, the proposed framework anchors the indication and sequencing of genioplasty to objective variables derived from virtual surgical planning, enabling a more systematic and individualized evaluation of chin position and lower facial symmetry prior to surgery.

The three clinical cases illustrate how the proposed algorithm translates into distinct surgical strategies rather than a uniform indication for genioplasty. In one scenario, genioplasty was required to actively modify sagittal chin position in accordance with the planned skeletal movements. In a second case, genioplasty was performed without altering chin position, serving a stabilizing role to preserve the spatial relationship of the mental segment during midline osteotomy, avoiding transverse widening of the chin; and a third case in which genioplasty was omitted, as the transverse expansion generated by the midline osteotomy itself did not result in any additional clinically relevant increase in lower facial width.

Originally described as a midline mandibulotomy for surgical access to intraoral tumors by Roux in 1829, the technique evolved over time toward its modern applications. In the context of orthognathic surgery, the first description of mandibular midline osteotomy for transverse correction was reported by Bell in 1976[3,6,7]. This technique allows separation of the mandible at the level of the symphysis, creating independent right and left segments[4].

Several authors have reported predictable skeletal and occlusal outcomes following mandibular midline osteotomy when performed with rigid fixation and accurate planning. However, while the technical execution and postoperative stability of this procedure have been widely described, the literature provides limited guidance on the management of the chin segment during transverse mandibular correction. Consequently, decisions regarding adjunctive genioplasty are often based on individual surgeon preference, which may contribute to variability in lower facial outcomes.

A critical technical aspect in mandibular midline osteotomy is the management of occlusal positioning during mandibular segmentation. Interocclusal surgical splints constitute a fundamental tool in orthognathic surgery, as they allow accurate



This diagram illustrates the proposed algorithm to guide the indication and surgical sequencing of genioplasty in the context of mandibular midline osteotomy during orthognathic surgery. The decision is initially based on virtual surgical planning. When genioplasty is indicated as part of the orthognathic plan (e.g., for sagittal, vertical, or asymmetry correction), it is performed as the first surgical step. If genioplasty is not initially required, the algorithm differentiates according to the presence or absence of midline widening. In cases involving midline expansion, genioplasty is performed at the beginning of the procedure to facilitate segment control and preserve chin position. Conversely, when no midline widening is observed following mandibular midline osteotomy, genioplasty is not indicated.

Figure 4. Decision-making algorithm for genioplasty in mandibular midline osteotomy.

intraoperative transfer of the planned occlusion and contribute to maxillomandibular stability during the early phase of skeletal consolidation[8,9]. In our protocol, the final splint is positioned after completion of the bilateral sagittal split ramus osteotomy; however, it is not rigidly engaged at this stage, as passive seating is not expected prior to transverse correction. In this context, prior segmentation of the mandibular orthodontic arch should be considered when vertical movements are planned or when a clinically relevant transverse correction is anticipated, as in cases of limited transverse displacement without vertical components this step may not be required. When indicated, orthodontic archwire sectioning allows effective mobilization of the bony segments during surgery and facilitates the creation of an adequate intersegmental space, as previously described by Ramanathan et al. This approach enhances surgical predictability and stability by preventing intraoperative blockages or mechanical interferences during transverse manipulation. Following the mandibular midline osteotomy, transverse separation or approximation of the hemimandibles enables precise adaptation to the final splint, at which point definitive fixation is achieved.

Another technical consideration in mandibular midline osteotomy is the management of the intersegmental gap created during transverse mandibular expansion. The need for bone grafting in this region remains a matter of surgical judgment and largely depends on the magnitude of the transverse expansion and the resulting basal separation between the mandibular segments. Currently, there is a lack of studies specifically addressing bone grafting indications in the context of mandibular midline osteotomy; therefore, most clinical recommendations are extrapolated from evidence related to other orthognathic procedures, where bone grafting has been recommended in situations such as: 1) maxillary and mandibular advancements of more than 5 mm and 8 mm, respectively; 2) inferior repositioning of the maxilla and chin of 5 mm; and 3) the presence of intraoperative palpable osteotomy gaps at the BSSO and chin osteotomy sites[2].

In cases of limited expansion, when adequate cortical contact between the hemimandibles is maintained and stable rigid fixation is achieved, spontaneous bone healing may occur without the need for grafting. Conversely, when larger gaps are generated, the absence of bony contact may compromise stability and increase the theoretical risk of delayed union or the development of a contour irregularity or bony defect along the mandibular basal border. In such situations, the use of bone graft —either in block or particulate form— can be considered to enhance bone healing, provide structural support to the basal border, and reduce mechanical stress on the fixation system. Therefore, the decision to place a bone graft should be individualized and primarily guided by the magnitude of the transverse and/or vertical movement, the morphology of the resulting defect, and the stability achieved with rigid fixation.

A number of potential complications associated with surgical mandibular midline widening have been described in the literature, including condylar torquing, midline diastema formation, difficulties in controlling the bigonial width, lingual flaring of the mandibular arch, and the risk of vascular compromise when multiple mandibular osteotomies are performed[5]. These considerations have traditionally limited the widespread use of surgical midline widening procedures.

Among the previously described factors, transverse changes in mandibular width are particularly relevant, as they represent one of the most important determinants of the postoperative appearance of the lower facial profile[10]. This factor should be carefully considered during virtual surgical planning, as it may influence the execution of the surgical plan, either through the performance of mandibular angle osteotomies to reduce its volume or by modifying the design of the genioplasty to compensate and achieve a more harmonious result.

Another relevant consideration is the surgical sequence. Traditionally, orthognathic surgery is performed following a maxilla-first sequence, as this approach facilitates the intraoperative transfer of the surgical plan using an intermediate splint. However, in certain clinical scenarios it may be necessary to adopt a mandible-first sequence due to other surgical determinants independent of the transverse mandibular correction[11]. In these cases, transferring the surgical plan using conventional splints alone becomes highly complex and difficult to reproduce. In this context, customization of the maxillary surgery through the use of patient-specific titanium plates becomes practically indispensable to accurately transfer the final position of the maxilla.

This study has some limitations that should be acknowledged. The small sample size is inherent to the design of a technical note, in which cases were selected exclusively to illustrate each decision pathway of the proposed algorithm rather than to achieve statistical power. The descriptive, non-comparative design precludes the establishment of causal inferences or generalization of findings. Postoperative stability was assessed through clinical follow-up rather than standardized radiographic or tomographic evaluation, which may limit the precision of skeletal outcome reporting. Additionally, the surgical outcomes may be subject to variability associated with virtual planning protocols and the experience of the surgical team. The follow-up period also differed across cases, which should be considered when interpreting the results. Despite these limitations, the main strength of this report is the proposal of a structured, reproducible decision-making algorithm applicable to a variety of clinical scenarios involving mandibular midline osteotomy and genioplasty. The inclusion of three distinct clinical cases representing each decision pathway, combined with a detailed technical description, enhances the clinical utility of the framework and its potential for reproducibility in other surgical settings.

CONCLUSIONS

Midline mandibular osteotomy is a valuable surgical option for the management of maxillary or mandibular transverse discrepancies in the context of orthognathic surgery. Careful surgical planning is essential to determine both the indication for and the optimal timing of genioplasty. Orthodontic arch segmentation should be considered when interincisal vertical changes or mild dental compression are anticipated. Additionally, bone grafting may be indicated to manage the mandibular midline osteotomy gap. An inherent effect of this technique is a potential increase in intergonial distance; therefore, patients should be appropriately informed, and mandibular contouring may be considered when necessary.

Ethical considerations

Patient management complied with institutional ethical principles and the Declaration of Helsinki. All patients provided informed consent for the academic use of their clinical records. The study was approved by the Ethics Committee of the Servicio de Salud Metropolitano Central on April 16, 2026.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to the publication of this work.

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