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Application of Angular Measurements in the Correction of the Asymmetric Chin

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Osseous genioplasty is an important surgical option for the correction of true chin asymmetry or to disguise a mandibular asymmetry when a mandibular ramus osteotomy is not indicated.[1-5] Linear measurements are traditionally obtained in genioplasty planning to guide the amount of surgical repositioning of the chin, especially in cases of chin midline shifts.[1,2,4] However, for asymmetries in which there is a cant of the chin's inferior border, rotation of the osteotomized bone segment is usually necessary to level it; therefore angular measurements might be preferred over linear measurements to measure the rotational movement accurately. Nevertheless, to date, the importance of angular measurement in genioplasty planning has never been studied.

We have been using angular measurements to assess chin cant or to calculate the amount of rotation necessary to correct chin asymmetry for the past 5 years, with very good outcomes. We have been combining both linear and angular measurements when chin midline shifts are associated with chin cant or vertical asymmetries.

In this article, we will show how angular measurements are important in chin asymmetry treatment planning; we will also discuss the advantages of this planning strategy over the traditional evaluation. The application of angular measurements will be shown in 2 treatment phases: clinical examination and surgical treatment.

Clinical Examination

CHIN ASYMMETRY CORRECTION WITH ISOLATED GENIOPLASTY

The first step in properly assessing chin asymmetry is establishing the correct treatment reference plane. Usually, patients with asymmetry tilt their heads, disguising their chin asymmetry. To avoid misdiagnosis, the position of the head might need to be oriented by the surgeon. The bipupilar plane is a good anatomic reference for establishing the treatment plane in some situations, but in cases of orbital vertical dystopia, we use the cranial vault as a reference.[2,4-6]

The second step is to mark the facial midline. The labial philtrum can be used as a good reference for determining the facial midline. After that step, the chin midline is traced perpendicularly to the inferior border, and the angle between the chin and facial midline is measured (Fig 1). A patient photograph is the best tool for performing angle measurement because it is easier to assess the angle precisely on a bi-dimensional plane.

Once the chin cant angulation has been determined, it is also necessary to evaluate and quantify the chin midline shift.

Taking into account that the horizontal chin osteotomy is performed at a mean height of 15 mm relative to the inferior border,[1] the intersection point between the planned osteotomy line and the chin midline is defined. This point is the rotational central point of the chin, and the distance between this point and the facial midline is measured (Fig 1). In this situation, because the measurement is linear, it is imperative that the measurement be performed on the patient during the examination.

To correct a chin asymmetry, angular measurement guides the correction of inferior border cant asymmetries, whereas linear measurement is used to correct the chin midline shift.

CHIN ASYMMETRY CORRECTION WITH GENIOPLASTY COMBINED WITH BIMAXILLARY SURGERY

When bimaxillary osteotomy is intended, it is supposed that the occlusal plane cant and dental midline shifts will be corrected; therefore genioplasty planning should assess only the intrinsic asymmetry of the chin. The patient's head must be tilted so that the occlusal plane is parallel to the ground. The angulation between the chin midline and a line perpendicular to the inferior occlusal plane crossing the inferior dental midline must be measured (Fig 2).

In addition, the chin midline shift must be measured relative to the inferior dental midline and not relative to the facial midline.

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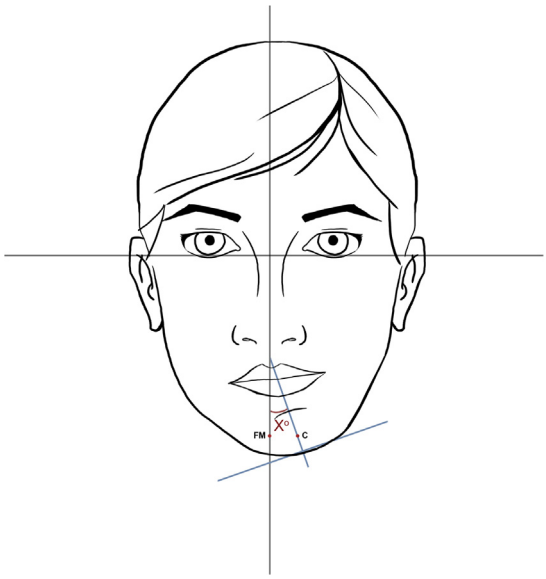

FIGURE 1. Clinical examination. After orientation of the head position, the angle between the facial midline and the chin midline (x°) is measured. The distance between the central point of the chin (C) and the facial midline (FM) is also measured.

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Both angular and linear measurements will be used in the genioplasty to correct the intrinsic chin deformity. Bimaxillary surgery will correct the occlusal cant and dental midline shifts.

Surgical Treatment

Once the angular and linear measurements are taken during the clinical examination, the surgeon should transfer these data for the surgical procedure.

1) The incision and chin exposure are performed in the usual way.
2) Once the chin is exposed, 3 vertical lines are marked perpendicular to the inferior occlusal plane. These lines are created by means of corticotomies, with a sagittal saw (Fig 3A).
3) An angled line is marked, creating the same angle previously obtained during the clinical examination, crossing the central vertical line on the level of the planned horizontal chin osteotomy. To create the desired angle, a surgical protractor can be used, or a template with the same angle can be manufactured beforehand (Fig 3A).
4) A horizontal osteotomy is performed perpendicular to the 3 initial vertical lines, on the side where the resection is planned.

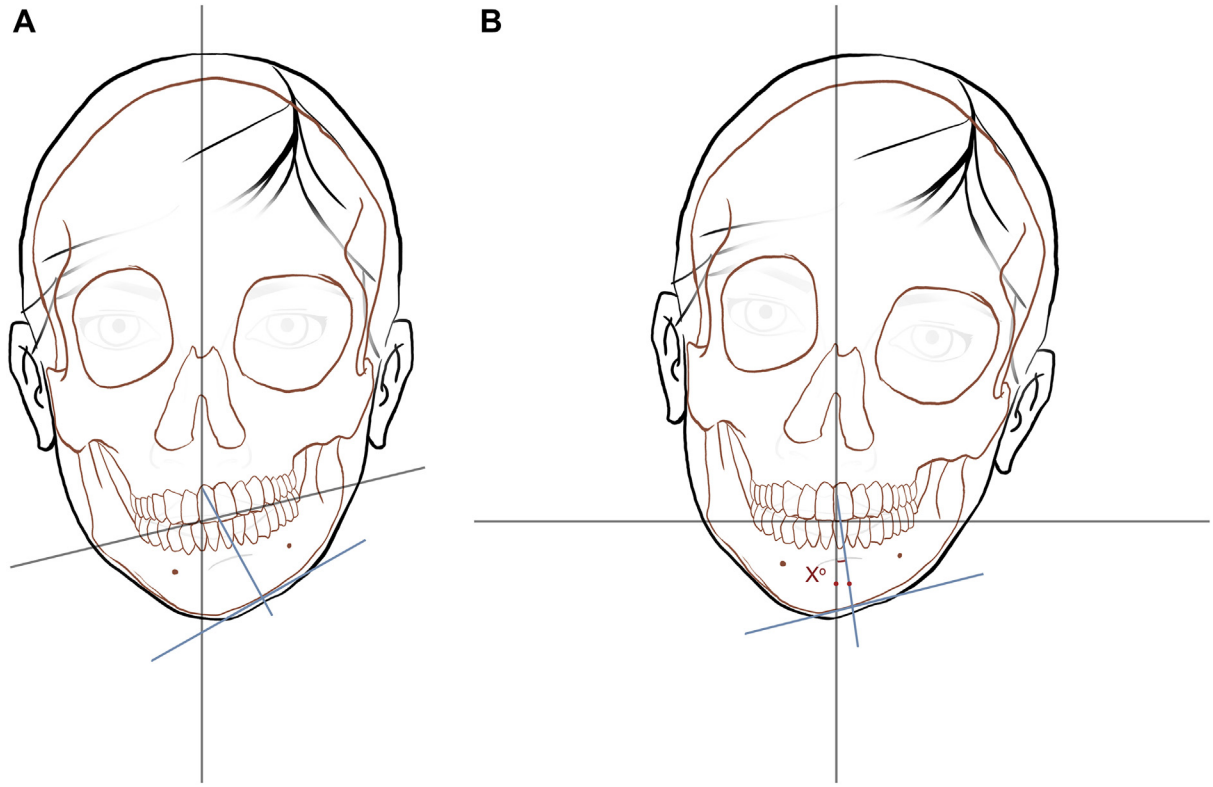

FIGURE 2. Orientation of head when bimaxillary surgery is intended to be performed simultaneously with genioplasty. *A*, Initial presentation of facial asymmetry. *B*, Oriented head position. The head of the patient is tilted, so the occlusal plane is parallel to the ground. The angle between the chin midline and a vertical line crossing the dental midline is measured. In addition, the distance between the central point of the chin and the vertical line is measured. (x°, angle between facial midline and chin midline.)

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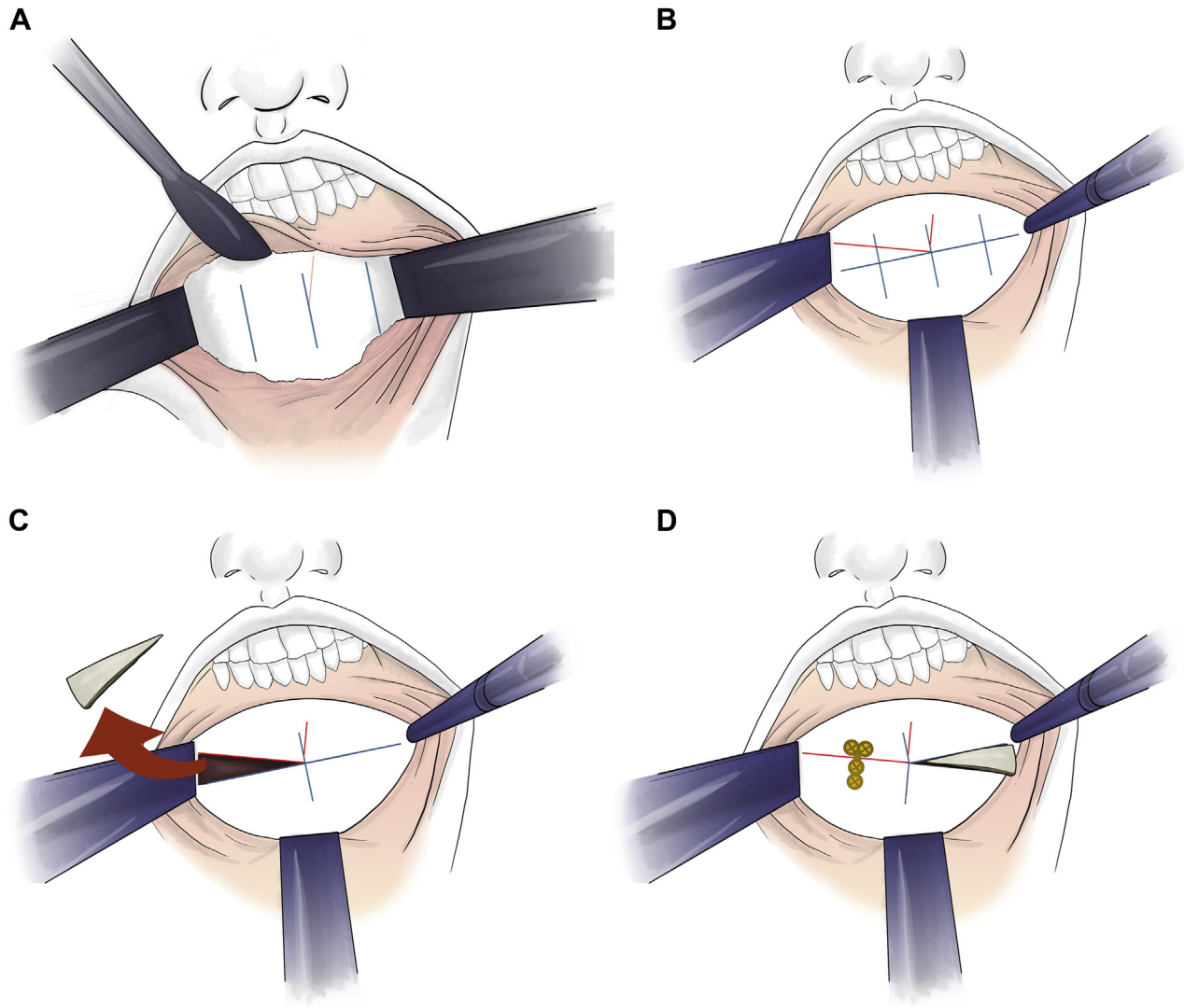

FIGURE 3. *A*, Three vertical lines and one angulated line with the desired angle are marked. *B*, An osteotomy is created perpendicular to the vertical lines, and another one is created perpendicular to the angulated line. *C*, The osteotomy continues on the other side, and after completion of the osteotomy, a wedge of resected bone is removed and the segment is rotated. *D*, The resected bone is transplanted to the other side, and the segment undergoes fixation.

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5) Another osteotomy is performed perpendicular to the marked angled line on the same side. This osteotomy will allow bone wedge resection to be performed at the desired angle (Fig 3B).
6) The osteotomy can now be completed on the other side after the horizontal osteotomy, perpendicular to the vertical lines.
7) Once the chin bone segment is mobilized, it is rotated until the marked angled line is parallel to the central vertical line of the bone distal segment. This step ensures that the segment is rotated as planned (Fig 3C).
8) After the rotation, the chin is lateralized according to the measurement that was obtained during the clinical examination by use of the linear measurements.
9) The resected bone segment is transplanted to the gap on the other side of the genioplasty and undergoes fixation. It is necessary to reverse the side of the graft so that it fits anatomically on the gap (Fig 3D).

Case 1

A 40-year-old female patient was complaining about facial asymmetry that developed during her adolescence. She denied worsening of the deformity since then. She had already undergone a genioplasty, performed by another surgeon, to disguise a maxillomandibular asymmetry, but the operation resulted in a limited esthetic outcome.

By means of clinical and image evaluations, an untreated condylar hyperplasia was diagnosed on the

left, which resulted in a severe facial asymmetry. On the basis of the patient's history, it was believed that the condylar hyperplasia was not active at that time.

Bimaxillary osteotomy was planned to correct the occlusal plane cant and, thus, achieve correction of the facial asymmetry. In the postoperative period, residual chin asymmetry was noted because of partial occlusal cant correction. A second procedure was planned to correct the chin asymmetry by means of an osseous genioplasty (Fig 4). The asymmetry was corrected with 8° of counterclockwise rotation relative to the frontal plane and 4 mm of lateralization (Fig 5).

The patient was seen at follow-up over a period of 4 years, showing symmetry and esthetic improvement (Fig 6).

Case 2

A 25-year-old male patient with a hemifacial microsomia affecting the left side of the face sought surgical

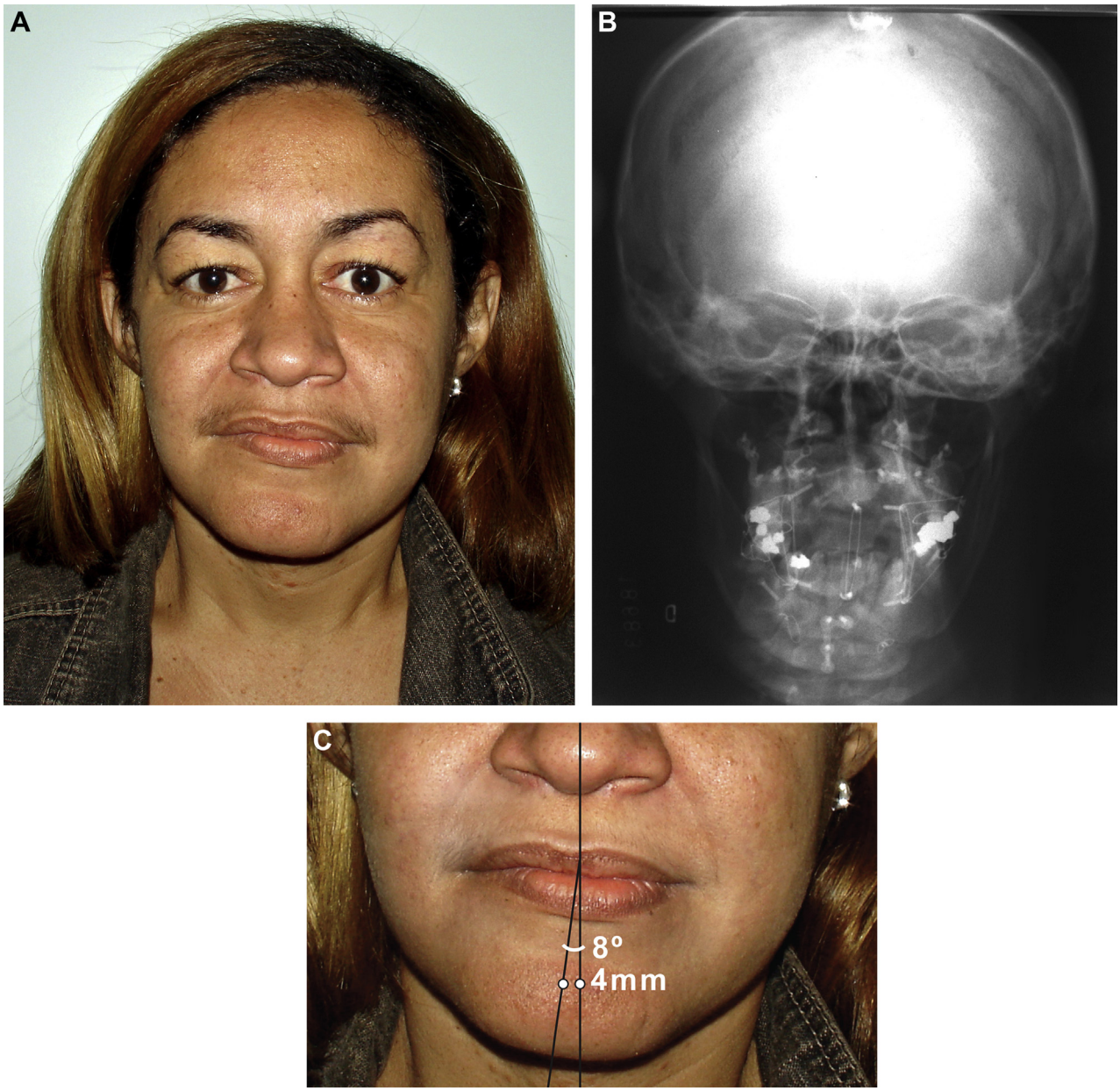

FIGURE 4. *A*, Presurgical frontal presentation. *B*, Posteroanterior cephalometric radiograph after bimaxillary surgery and before genioplasty. The fixation material in the chin was placed by another surgeon before the bimaxillary surgery in a first attempt to correct chin asymmetry. *C*, Planning with the use of angular and linear measurements. An 8° angle was measured between the facial midline and chin midline. The distance between the facial midline and the central point of the chin (the point of intersection of the planned horizontal osteotomy and the chin midline) measured 4 mm.

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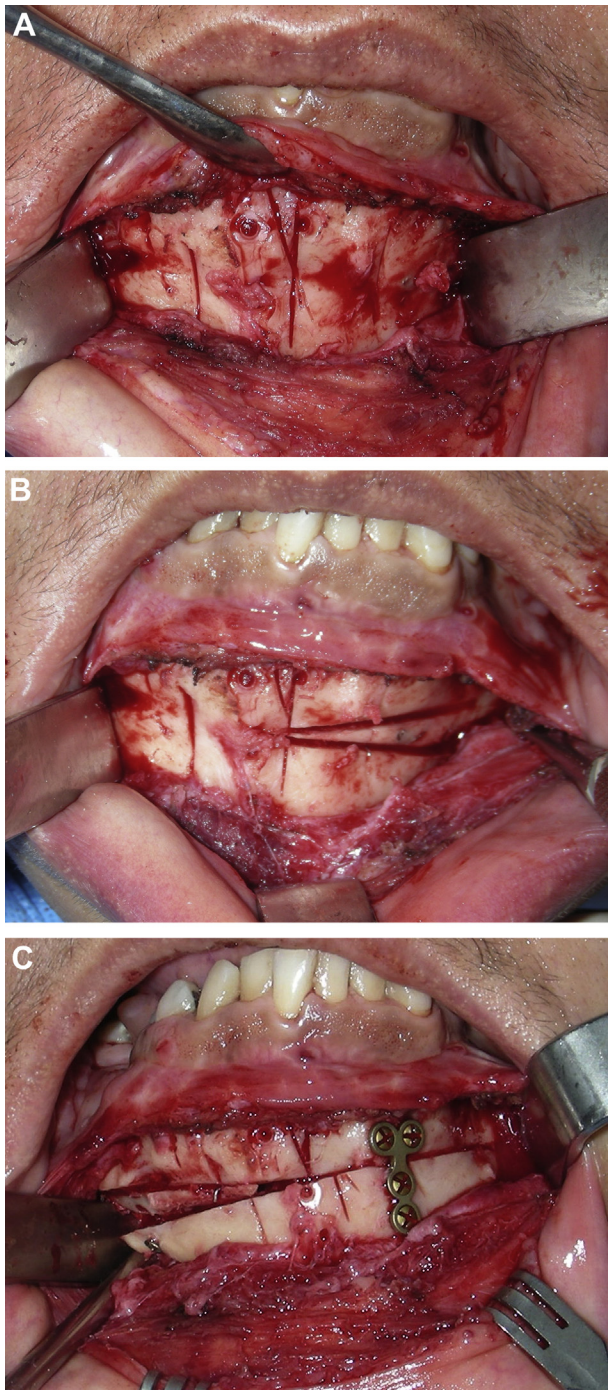

FIGURE 5. Asymmetric chin correction. *A*, Marked reference lines. *B*, The bone wedge resection was performed at an 8° angle. *C*, After resection and completion of the osteotomy on the other side, the chin was rotated and the bone graft was transplanted. In addition, the chin was lateralized 4 mm to the left.

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correction of the deformity. After presurgical orthodontics, bimaxillary osteotomy was planned to level the occlusal cant, correct the dental midlines, and correct the sagittal deformity. On the left side of the face, mandibular advancement and temporomandibular joint reconstruction were planned, with a patient-fitted total joint prosthesis.

To assess the dysmorphology of the chin, the occlusal plane was leveled to the ground during the clinical examination, and an angle of 4° between the chin midline and inferior dental midline was noted. In addition, there was a 2-mm chin midline shift to the right.

After temporomandibular joint reconstruction and bimaxillary surgery, the chin asymmetry was corrected by use of the presented technique. There were no complications related to the genioplasty. The patient was seen at follow-up over a period of 7 months and presented with satisfactory symmetry (Fig 7).

Discussion

Planning for vertical and rotational chin asymmetries traditionally uses linear measurements to determine the height difference between the 2 sides of the chin. It is recommended that the height from the canine or commissure to the inferior border of the symphysis should be measured on both sides and the difference between these measurements should be used to guide the amount of vertical repositioning of the chin.[1,2,4] For instance, if 1 side is 4 mm higher than the other, it is resected by 4 mm on the higher side or it can be elongated by 4 mm on the shorter one.

However, linear measurements have 2 major drawbacks. The first is that correction of a symphysis inferior border cant requires a wedge-shaped segment resection that does not have homogeneous thickness over all its extent. Although linear measurement can be used to determine how much is necessary to resect at the canine level, the height of bone resection can differ throughout along its extent.

The second drawback is associated with genioplasty planning aimed at mandible asymmetry camouflage when ramus osteotomy is not intended. In such cases there is no true vertical asymmetry of the chin. Instead, chin asymmetry is actually caused by the ramus and by body asymmetry. The vertical linear measurements between both sides will show no difference, but the chin is rotated because of the occlusal and mandibular cant. In such a case, only angular measurements will allow for correction of the canted chin. The angle formed between the chin midline and the facial midline must be measured and used in the resection of a wedge segment; that will allow for inferior border leveling.

Asymmetric dysmorphology of the mandible often occurs in cases of mandibular hemihyperplasia, hemifacial microsomia, and temporomandibular ankylosis. In most cases, however, facial asymmetry is caused by spatial disturbances in the position of the jaws.[7] Genioplasty can be performed to correct a mandible dysmorphology or to correct a mandibular asymmetry when jaw

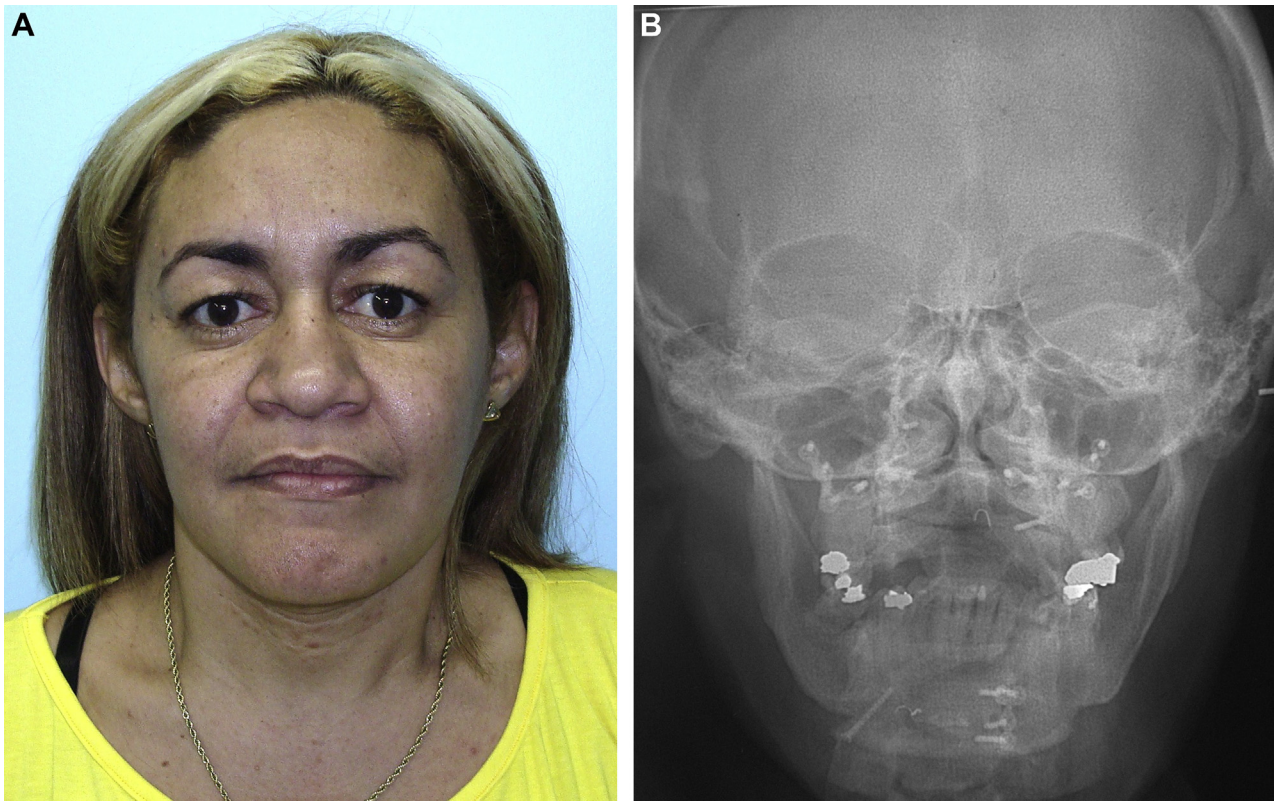

FIGURE 6. *A*, Frontal presentation 5 years after surgery. *B*, Posteroanterior cephalometric radiograph after genioplasty.

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osteotomy is not intended. In case 1, a previous bimaxillary osteotomy did not totally correct the mandibular occlusal cant, and thus the patient maintained mandibular asymmetry. Using linear measurements would have been useless because there would have been no height difference between the chin sides. Only angular measurement shows how much rotation is necessary to level the inferior border of the symphysis. In case 2, bimaxillary osteotomy was performed to level the occlusal plane and to correct dental midlines, and the genioplasty was performed only to correct the mandibular dysmorphology in the chin region.

In rotational correction of the chin, the fulcrum point can be placed at the extreme ends of the bone segment or at its center.[1] We believe that when the fulcrum point is placed in 1 of the extremities of the segment, there is a trend toward loose control of the vertical dimension of the chin. In the presented technique, we placed the fulcrum point at the center of the segment, and thus there is correction of the rotational asymmetry without any vertical change. While 1 side is elongated, the other is shortened, without any change in the central vertical dimension of the chin. Moreover, this technique also allows for accurate vertical changes if they are desired. After rotation, if vertical reduction is intended, another slice of bone with the appropriate height can be resected. In the same manner, if elongation is planned, after transplantation and fixation of the bone wedge graft to the distal segment, the chin segment–graft complex can be repositioned inferiorly and another graft can be used to fill the gap.

Over the past 5 years, we have used the described technique with good outcomes. The only complication we have observed to date occurred in 1 patient with a contour irregularity in the inferior border of the mandible. In this patient, when the graft was reversed to adapt to the other side, the extremity of the graft resulted in lateral over-contouring. Currently, we advocate recontouring the graft until it is certain that no irregularities exist on the inferior border of the mandible.

Today, in the digital planning era, treatment simulation can virtually correct asymmetric deformities 3-dimensionally with linear and rotational movements, and by use of computer-aided design/computer-aided manufacturing technology, a surgical splint can be manufactured to place the chin in the planned position.[8] Although this technology is promising, it is not yet available to most of the surgeons around the world. The use of angular measurements is a simple, cost-effective, and safe method for properly correcting a chin asymmetry

FIGURE 7. *A*, Presurgical frontal presentation. *B*, To assess the true dysmorphology of the chin, the inferior occlusal plane was made level to the ground and the angle between the chin midline and the inferior dental midline was assessed. *C*, Frontal presentation 3 months after surgery. *D*, Preoperative computed tomography scan. **(Fig 7 continued on next page.)**

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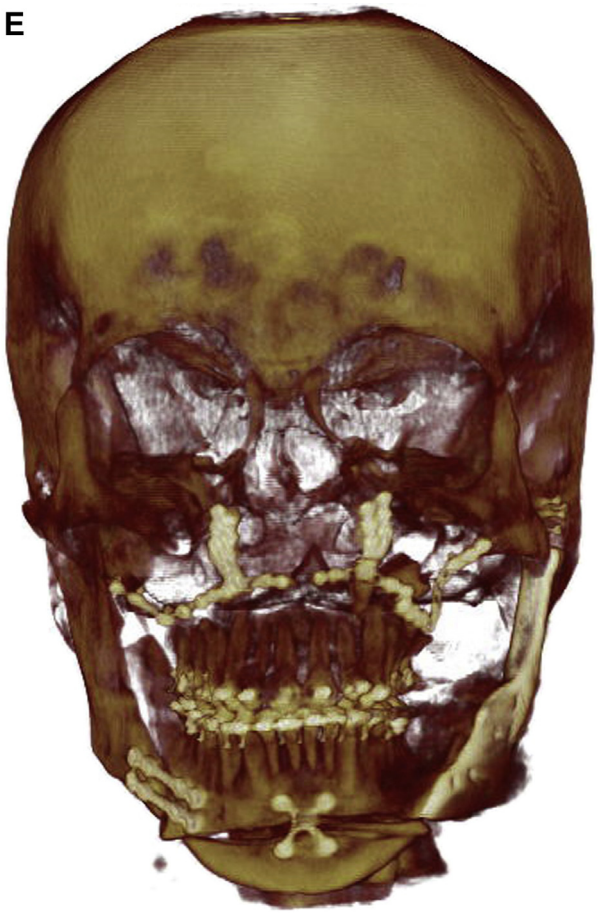

FIGURE 7 (cont'd). *E,* Postoperative computed tomography scan.

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with an inferior border cant without using any advanced technology, and thus it can be applied worldwide.

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