Width-Controlling Fixation of Symphyseal/Parasymphyseal Fractures Associated With Bilateral Condylar Fractures With 2 2.0-mm Miniplates: A Retrospective Investigation of 45 Cases

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Purpose: Symphyseal and parasymphyseal fractures and bilateral condylar fractures represent a pattern that is quite challenging to manage. This study evaluated the treatment outcomes of a group of patients who underwent surgery using miniplate fixation for anterior mandibular fractures.

Materials and Methods: This retrospective case series study reviewed patients with bilateral condylar fractures and noncomminuted symphyseal and parasymphyseal fractures. The patients were surgically treated from 2008 to 2014 in the department of oral surgery. Evaluation of facial width control was considered the primary outcome variable, which consisted of clinical assessment and measurement of the lingual gap using computed tomography. Medical information was collected before surgery. Temporomandibular joint function and postoperative complications also were evaluated during follow-up. A paired sample *t* test was used for statistical analysis.

Results: Forty-five patients (37 male, 8 female; mean age, 34.8 ± 14.5 yr; range, 16 to 74 yr) were included in this study. Lingual gaps measured before surgery (3.38 ± 0.61 mm) and after surgery (0.64 ± 0.14 mm) were significantly different ($P < .001$). No patient was rated as "unsatisfactory" after esthetic evaluation of facial width.

Conclusion: For noncomminuted symphyseal and parasymphyseal fractures associated with bilateral condylar fractures, 2 2.0-mm miniplates with monocortical screws are stable and efficacious in controlling mandibular width when bilateral condylar fractures are anatomically reduced and stably fixated.

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Bilateral condylar fractures and symphyseal and parasymphyseal fractures represent a pattern that is quite challenging to manage. Treatment focuses on the restoration of the condylar position and mandibular width control. Inappropriate treatment can cause facial width increase, occlusion disorder, or limited mouth opening.[1-3]

The ideal fixation method for symphyseal and parasymphyseal fractures is still being debated. Many fixation methods have been mentioned in the literature, including mandibular reconstruction plates,[4] lag screws,[5-7] and 2.0-mm miniplates.[8,9] Determining which technique to use depends on the experience of the surgeons, availability of

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internal fixation, and other factors aside from documented outcomes.

This study aimed to evaluate outcomes in patients with symphyseal and parasymphyseal fractures associated with bilateral condylar fractures treated with 2 2.0-mm miniplates. The specific aims of the study were to measure lingual gaps and evaluate the effect of this width-controlling fixation on mandibular fractures.

Materials and Methods

CLINICAL SAMPLE

The authors designed and implemented a retrospective study to address the research purpose. The study population was composed of patients admitted to the Department of Oral and Maxillofacial Surgery, Peking University School and Hospital of Stomatology (Beijing, China) for evaluation and management of noncomminuted symphyseal and parasymphyseal fractures associated with bilateral condylar fractures from January 1, 2008 through December 31, 2014. Inclusion criteria were *1)* age older than 16 years; *2)* interval shorter than 4 weeks from the day of trauma to surgical intervention; *3)* open reduction of condylar fractures; *4)* linear (noncomminuted) fracture of the symphysis and parasymphysis region and the use of 2 2.0-mm miniplates for fixation; and *5)* regular follow-up for at least 3 months. Excluded patients were those who presented with edentulism in combination with midfacial fractures and with a bone defect or segmented bone in the symphysis and parasymphysis region. The hospital institutional review board approved this study (number PKUSSIRB-201520023).

VARIABLES

Evaluation of facial width was considered the primary variable, which consisted of imaging examination and clinical assessment. Lingual gaps between fragments in the anterior mandible were measured using computed tomography (CT). A slice with the maximum lingual gap was acquired in the axial images. The lingual gap was measured before and after surgery to evaluate fracture reduction. Facial width was esthetically evaluated through clinical examination according to the method proposed by Gerbino et al.[10] Patients were rated as "excellent" (pretraumatic appearance completely reestablished), "good" (presence of small defects and increased facial width, often noticeable only to the surgeon), or "unsatisfactory" (major defects and clear evidence of increased facial width, which should be corrected in a successive intervention).

Other study variables were mainly medical information before surgery, including demographic data (age and gender), type of condylar fracture, mechanism of injury, interval from the day of trauma to surgery, and maximum mouth opening. Variables related to follow-up included the evaluation of temporomandibular joint (TMJ) function and surgical complications. TMJ function was evaluated by examining mandibular motion, tenderness at rest or during movement, and clicking or crepitus of the TMJ. Postoperative complications included dehiscence of the incision, salivary fistula, palsy of the facial nerve, delayed or nonunion, plate fracture, and malocclusion.

SURGICAL TECHNIQUE

Titanium screws or wires were used for intracapsular fracture. One and two plates were used for neck and subcondylar fractures, respectively. Symphyseal and parasymphyseal fractures were reduced using an intraoral anterior degloving approach, allowing visualization of the lingual area of the fracture. Mandibular reduction forceps were used to close the fracture gap, especially in the lingual aspect. Intermaxillary fixation (IMF) was applied using arch bars or IMF screws before internal fixation. The fracture was fixed with 2 2.0-mm miniplates with 4 holes. The first plate was adapted and secured to the base of the mandible with 6 to 8 monocortical screws. The second plate was placed on the buccal surface of the mandibular cortex underneath the tooth roots. IMF was released, and occlusion was checked before closure. Light guiding elastics were used to help patients keep the proper occlusion for 1 to 2 weeks postoperatively. Then, patients were encouraged to use mouth-opening exercises.

DATA COLLECTION

CT scans were obtained before surgery and 3 to 5 days after surgery. Measurements of lingual gaps were repeated 3 times, and the mean value was used for statistical analysis. In addition, CT scans obtained at least 3 months postoperatively were used to evaluate bone union at the fracture site. The clinical examination of facial width was conducted by 2 of the authors (Y.Z. and J.A.).

Medical information before surgery was acquired by reviewing the medical history of the patients. TMJ function and postoperative complications were documented during follow-up.

STATISTICAL ANALYSIS

A paired sample t test was used to analyze the difference in lingual gaps measured before and after surgery.

Results

Forty-five patients (37 male, 8 female; mean age, 34.8 ± 14.5 yr; range, 16 to 74 yr) were included in this study. Descriptive statistics of the study population are presented in Table 1. A total of 26, 14, and 5

Table 1. DESCRIPTIVE STATISTICS OF STUDY POPULATION

Study Variables	Descriptive Statistics
Sample size, n	45
Gender, n (%)	
Male	37 (82.2)
Female	8 (17.8)
Age (yr), mean ± SD (range)	34.8 ± 14.5 (16-74)
Type of condylar fracture, n (%)	
Bilateral intracapsular fractures	26 (57.8)
Unilateral intracapsular fractures with contralateral neck and subcondylar fractures	14 (31.1)
Bilateral neck and subcondylar fractures	5 (11.1)
Etiology, n (%)	
Fall	22 (48.9)
Motor vehicle accidents	15 (33.3)
Others	8 (17.8)
Interval from day of trauma to surgery, mean ± SD (range)	9.6 ± 4.5 (3-20)
Maximum interincisal mouth opening (mm), mean ± SD (range)	17.7 ± 6.5 (3-28)

Abbreviation: SD, standard deviation.

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patients were diagnosed with bilateral intracapsular condylar fractures, unilateral intracapsular fractures with contralateral neck and subcondylar fractures, and bilateral neck and subcondylar fractures, respectively. The fractures resulted mainly from falls (48.9%), motor vehicle accidents (33.3%), and other causes (17.8%), such as bicycle accidents and violence. The average period from the day of the trauma to surgical intervention was 9.6 days. The average maximum interincisal mouth opening before surgery was 17.7 ± 6.5 mm (3 to 28 mm). All patients showed clinical findings, such as malocclusion, limited mouth opening, and widening of the lower face, before surgery.

EVALUATION OF FACIAL WIDTH

The lingual gap measurement at CT decreased significantly postoperatively compared with preoperatively ($P < .001$). During esthetic evaluation of facial width, 5 patients were rated as good, others were rated as excellent, and none were rated as unsatisfactory (Table 2).

EVALUATION OF TMJ FUNCTION

The average maximum interincisal mouth opening after surgery was 38.9 ± 3.2 mm (32.0 to 45.0 mm). No TMJ tenderness was detected at rest or during movement. Clicking on mouth opening was detected at the unilateral TMJ in 3 patients.

COMPLICATIONS

Wounds healed normally, except in 1 patient who had dehiscence of the mucosa at the mandibular symphysis, which was conservatively managed using local pressure and immobilization. Another patient had a salivary fistula that was conservatively managed with a compression dressing. Two patients developed transient palsy of the temporal branch of the facial nerve, which resolved spontaneously within 3 months.

CT scans obtained at follow-up depicted good bone union in symphyseal and parasymphyseal fractures. One patient developed plate fracture in the condylar fracture that occurred 10 weeks after treatment, resulting in an anterior open bite. Other patients had

Table 2. TREATMENT OUTCOME FOR WIDTH-CONTROLLING FIXATION

Lingual gap (mm)		Esthetic Evaluation		
Preoperative	Postoperative	Excellent	Good	Unsatisfactory
3.38 ± 0.61	0.64 ± 0.14	40	5	0

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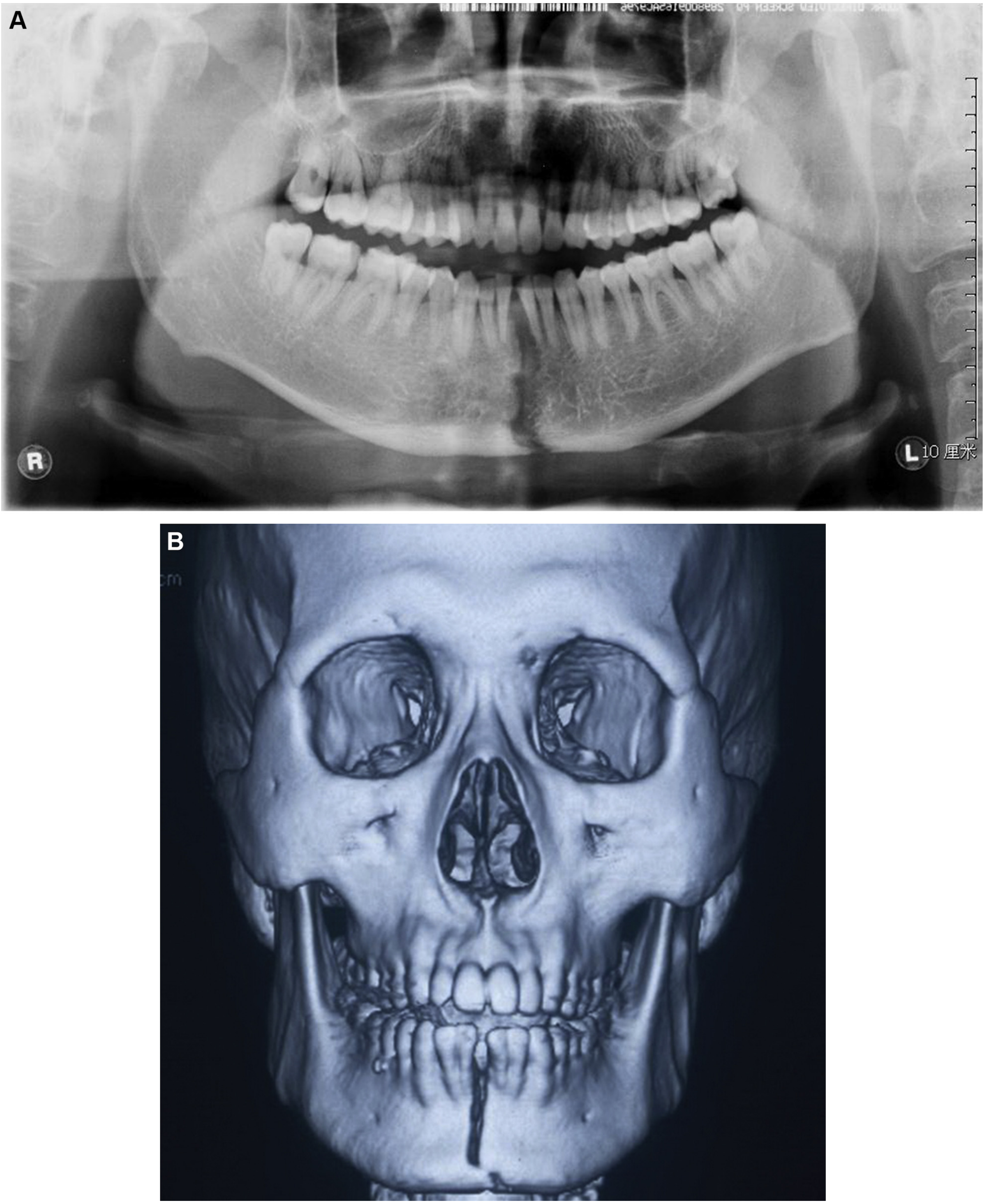

FIGURE 1. *A*, Panoramic radiograph of a patient diagnosed as having a symphyseal fracture associated with bilateral condylar fractures. *B*, Frontal view of preoperative 3-dimensional computed tomogram. **(Fig 1 continued on next page.)**

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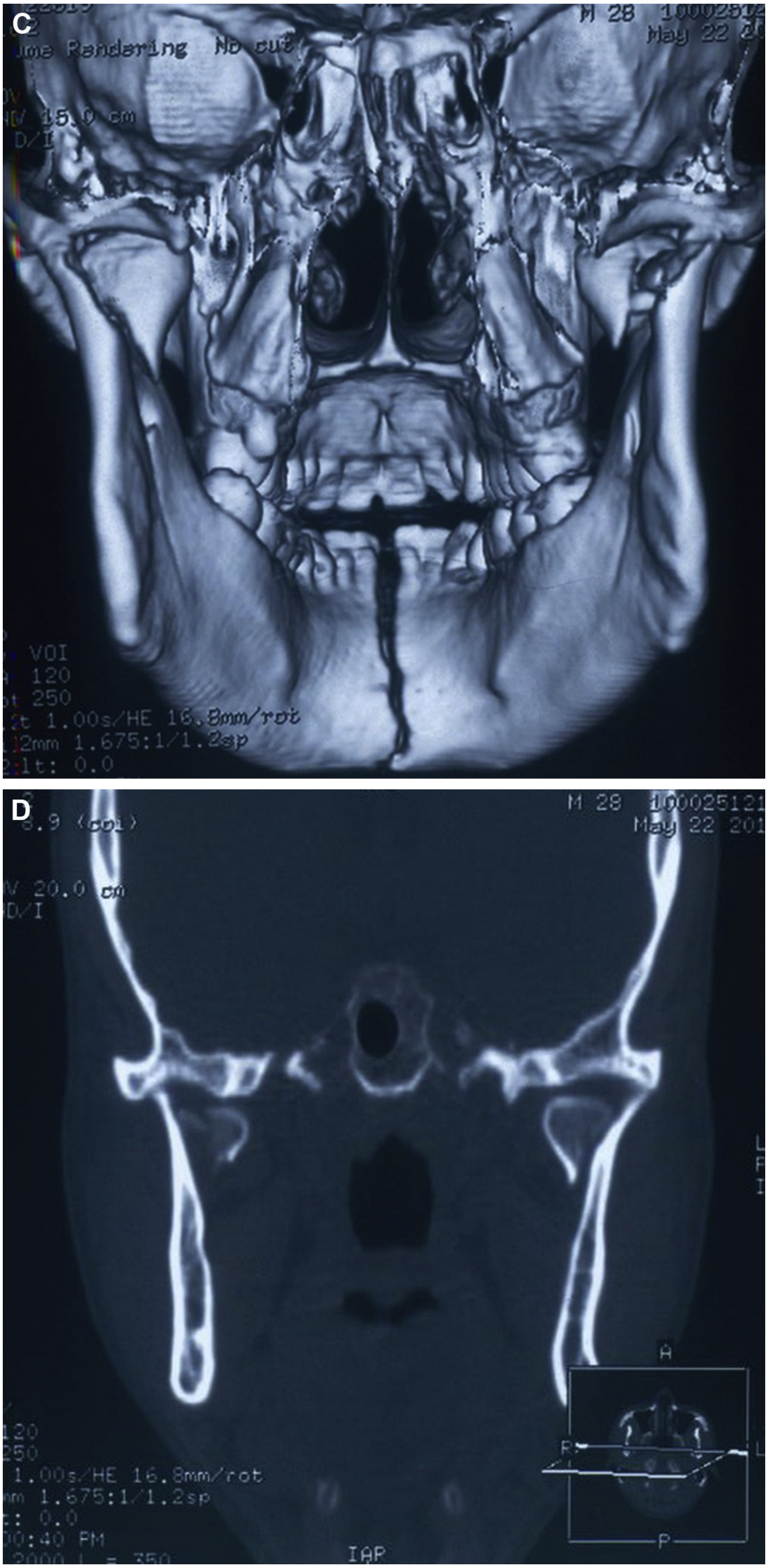

FIGURE 1 (cont'd). *C*, Posterior view of preoperative 3-dimensional computed tomogram showing a fracture gap in the lingual aspect. *D*, Preoperative coronal computed tomogram showing bilateral condyles that were diagnosed as intracapsular fractures. **(Fig 1 continued on next page.)**

FIGURE 1 (cont'd). *E*, Preoperative axial computed tomogram showing linear fracture in the symphysis with lateral displacement of the fragment and a lingual gap of 3.51 mm.

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good occlusion, and no crossbite from widening of the mandible was found.

REPORT OF TYPICAL CASE

A 28-year-old man with multiple mandibular fractures resulting from a high fall was included in the present study. Mouth opening before surgery was 20 mm with an anterior open bite. A 2-mm gap between the lower central incisors was detected before surgery. Preoperative CT and panoramic radiography (Fig 1) showed that the linear fracture of the symphysis was accompanied by lateral displacement of the fracture. The condylar fracture was diagnosed as bilateral intracapsular fractures, which were reduced using a preauricular approach and fixed using a 16.0-mm bicortical screw. The articular disc was reduced and sutured to the bilaminar zone. The symphyseal fracture was reduced through an intraoral approach and fixed using 2 2.0-mm miniplates with 4 holes and 6.0-mm screws. One plate was placed at the mandibular base, whereas the other was placed on the buccal surface of the mandibular cortex underneath the tooth roots. Postoperative CT scan and panoramic radiograph (Fig 2) showed that anatomic reduction was achieved, and the lingual gap of the mandible was closed. Light guiding elastics were used for 1 week after surgery, and the patient was encouraged to use mouth-opening exercises. During follow-up at 3 months, the mouth opening was 37 mm, with good occlusion, a satisfactory facial appearance, and no clicking in the TMJ. CT scan and panoramic radiograph (Fig 3) obtained after 3 months showed good fracture healing.

Discussion

In this retrospective study, the authors evaluated treatment outcomes of patients with symphyseal and parasymphyseal fractures associated with bilateral condylar fractures, which were managed through open reduction, and 2 2.0-mm miniplates were used for anterior mandibular fixation. Results showed that the fracture gap in the lingual aspect was efficaciously closed during surgery. All patients received a rating of good or excellent at clinical assessment of facial width restoration.

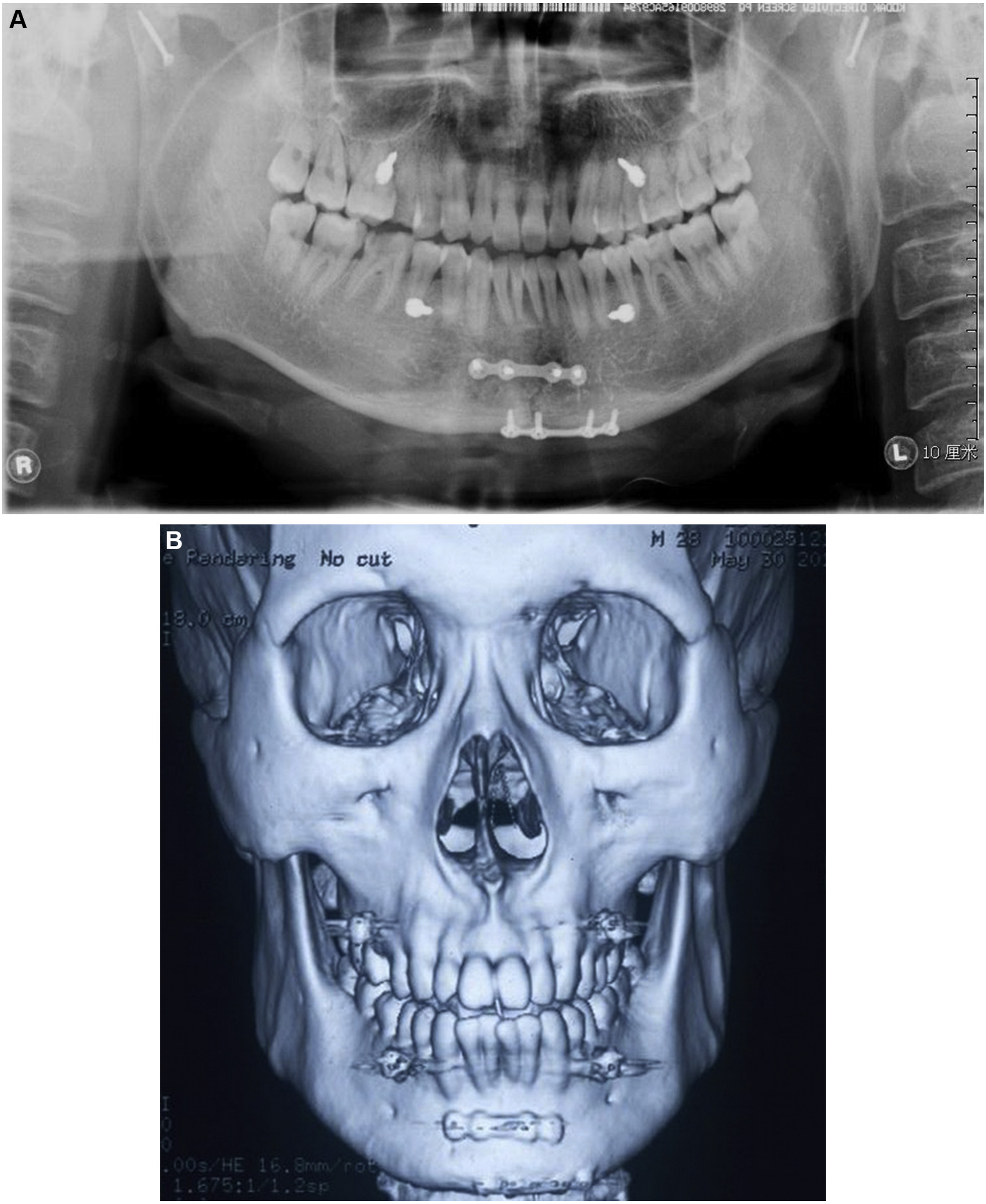

FIGURE 2. *A*, Panoramic radiograph obtained immediately after surgery showing that the fractures were anatomically reduced. *B*, Frontal view of postoperative 3-dimensional computed tomogram. **(Fig 2 continued on next page.)**

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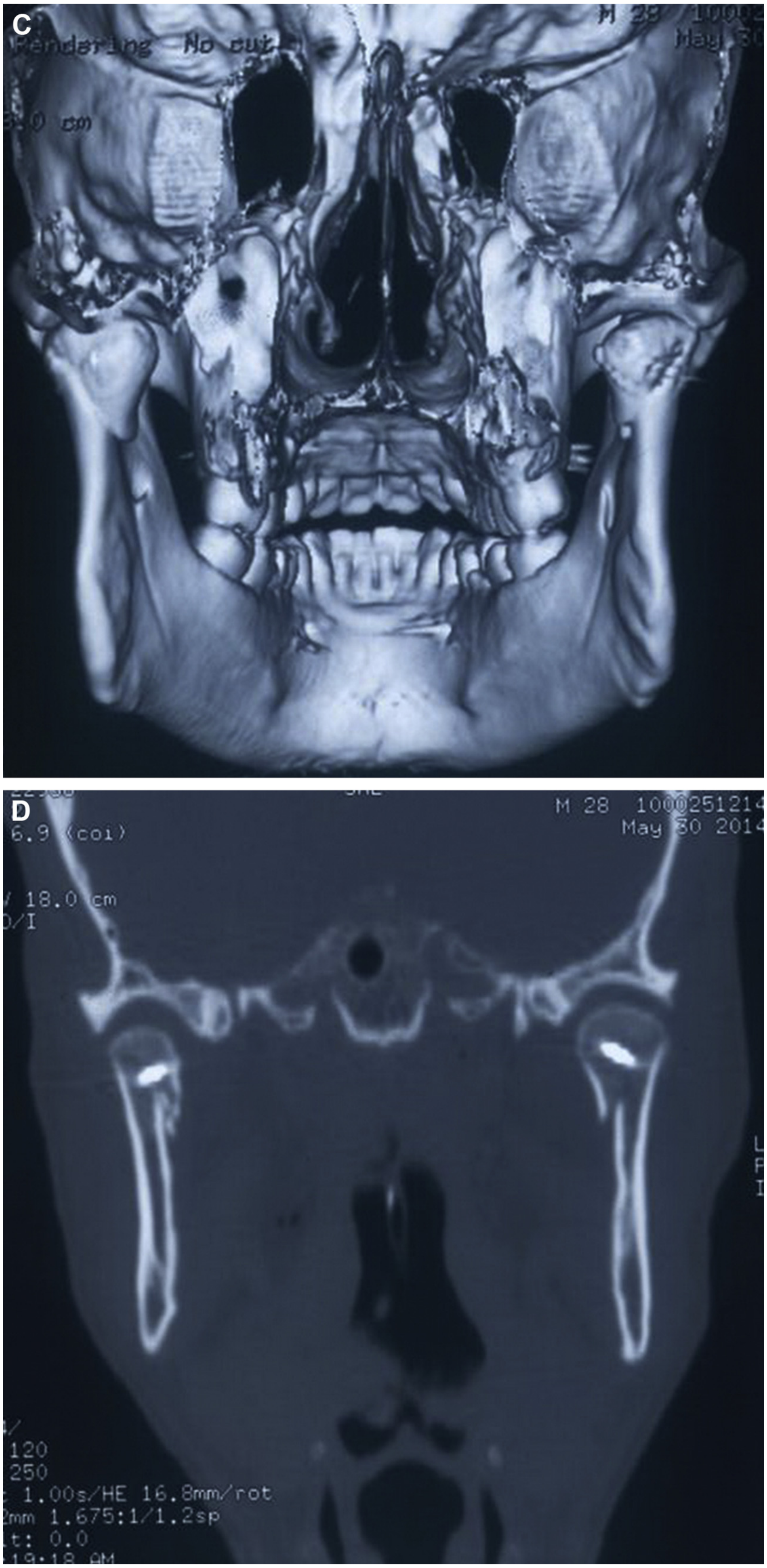

FIGURE 2 (cont'd). *C*, Posterior view of postoperative 3-dimensional computed tomogram showing the closed fracture gap in the lingual aspect. *D*, Postoperative coronal computed tomogram showing that the bilateral condylar fractures were anatomically reduced. **(Fig 2 continued on next page.)**

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FIGURE 2 (cont'd). *E*, The lingual gap measured on the postoperative axial computed tomogram was 0.45 mm.

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Symphyseal and parasymphyseal fractures and bilateral condylar fractures are among the most common types of mandibular fractures.[11] When a force is applied along the symphysis and parasymphysis region of the mandible, compressive strain develops along the buccal aspect, whereas tensile strain develops along the lingual aspect.[12] The result would be a fracture that begins in the lingual region and spreads toward the buccal aspect. Therefore, closure of the lingual gap was chosen as the main criterion to evaluate the efficiency of the surgery. In addition, the force applied in the symphysis region is distributed along the arch of the mandible to the bilateral condyle. Stress concentration occurs in the condylar region, and fractures occur. The level of condylar fracture varies with the degree of mouth opening. When the mouth is opened, the fractures tend to be located more in the condylar neck or condylar head region, whereas when the mouth is closed, fractures localize in the subcondylar area.[13] In the present study, the most common fracture type was the condylar head fracture.

Symphyseal and parasymphyseal fractures can result in loss of mandibular continuity. The symphyseal region tends to move posteriorly, and the rami tend to flare laterally, when pulled by genioglossus and geniohyoid muscles. Complications arise when symphyseal and parasymphyseal fractures are combined with bilateral condylar fractures, which can result in loss of restriction to the mandible from the condylar capsule and lateral pterygoid muscle. Posterior support through TMJ articulation is no longer available. The lateral mandibular fragments become "free" and are pulled upward and laterally by the masseter and temporalis muscles. In such cases, the imbalance in muscle dynamics might lead to lingual gap formation, increased lateral splaying of mandibular angles, and increased facial width.[1]

Miloro[14] pointed out that if condylar fractures undergo closed treatment, then very stable fixation must be applied across the reduced mandibular symphysis to maintain the transverse dimension of the mandible. The most stable fixation involved applying a reconstruction plate across the symphysis or 2 well-placed lag screws if the fracture was linear. If condylar fractures were managed by open surgery, then the symphysis fracture could be treated as an

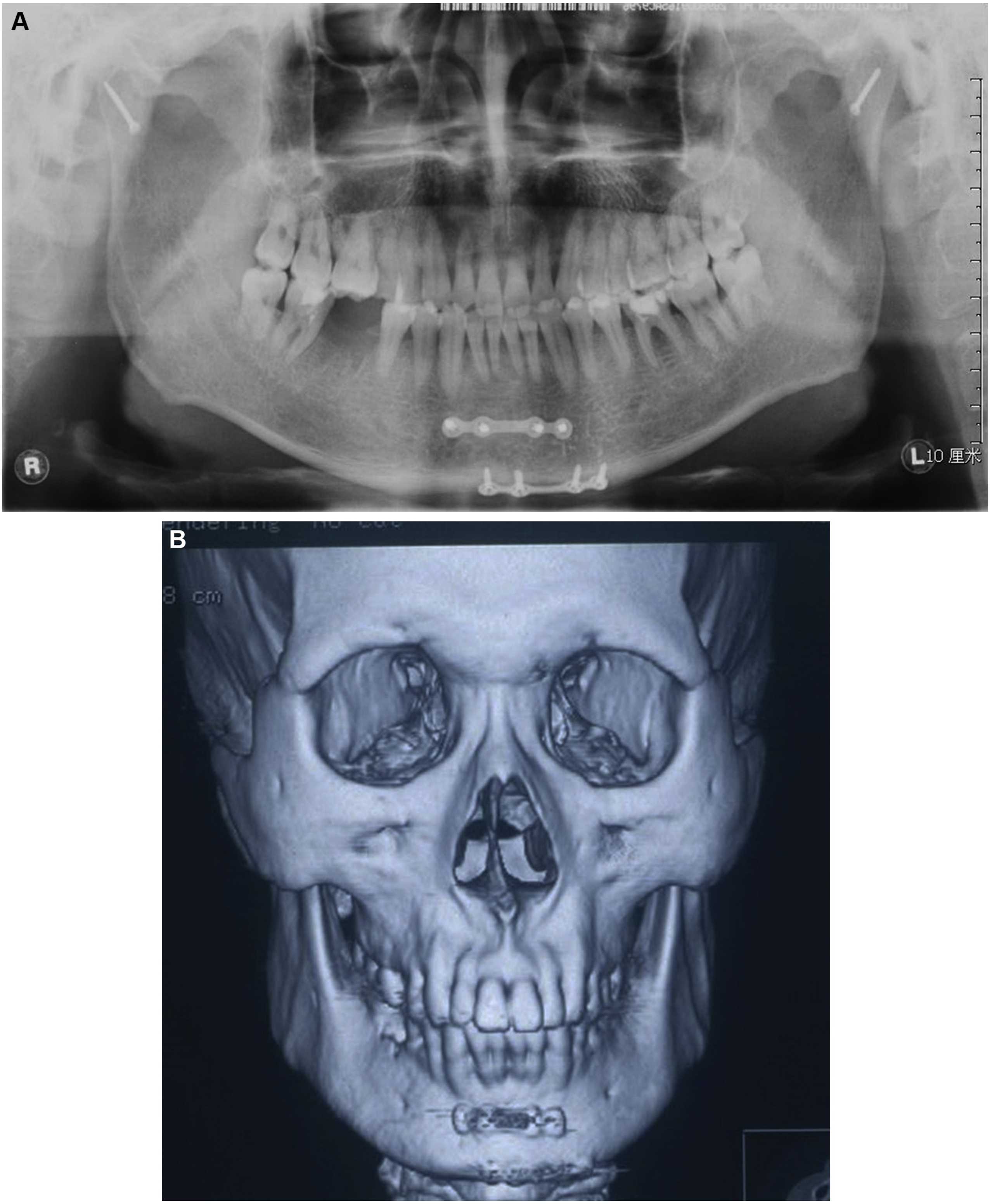

FIGURE 3. *A*, Panoramic radiograph obtained 3 months after the operation. *B*, Frontal view of 3-dimensional computed tomogram obtained 3 months after the operation. **(Fig 3 continued on next page.)**

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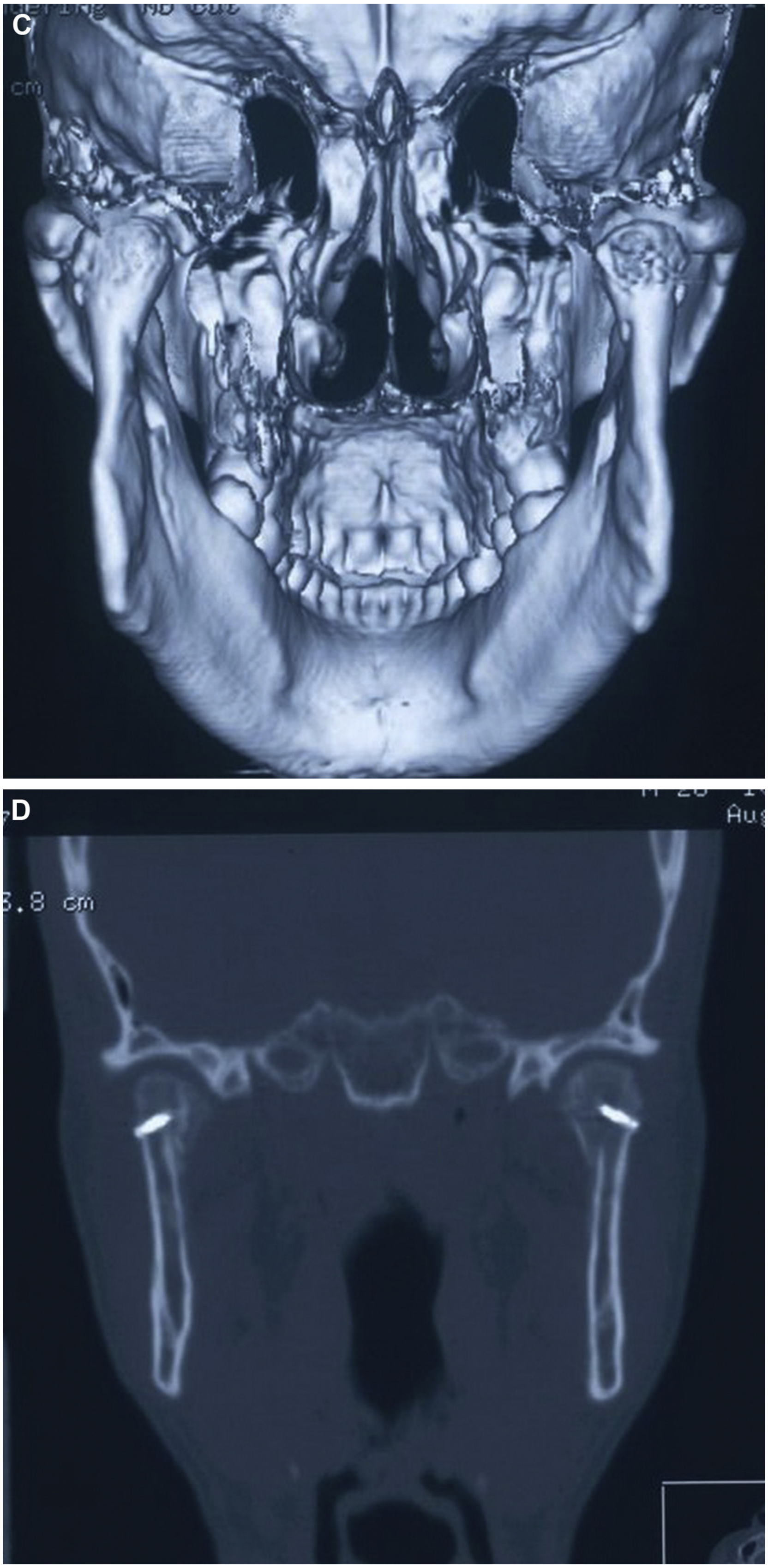

FIGURE 3 (cont'd). *C*, Posterior view of 3-dimensional computed tomogram obtained 3 months after the operation. *D*, Postoperative coronal computed tomogram at follow-up showing good bone union in the bilateral condyles. **(Fig 3 continued on next page.)**

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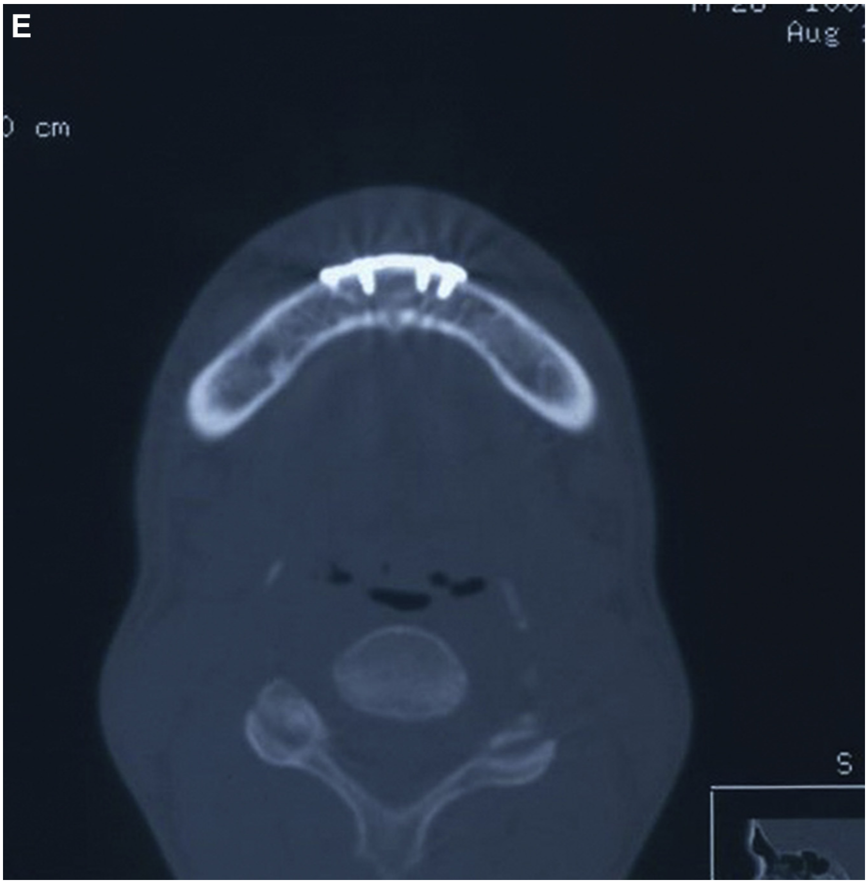

FIGURE 3 (cont'd). *E*, Postoperative axial computed tomogram at follow-up showing good bone union in the symphysis.

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isolated fracture regardless of the technique chosen by the surgeon.

The authors propose that condylar fractures should undergo surgical treatment to reposition the condyles to their original physiologic position and restore the normal relation between the disc and the condyle. A stable posterior base was provided to treat the anterior fracture once the fracture at the 2 joints had been well restored. In addition, attachment of the lateral pterygoid muscle was re-established during surgery. The lateral pterygoid muscle could produce anteromedial tension to the bilateral condyles, which would be beneficial to close the lingual gap and control the mandibular width.[15] In the present study, all condylar fractures were managed by open reduction and acquired stable fixation. Three patients were found to have clicking at the unilateral TMJ after surgery. Determining whether the joint disorder was associated with surgery was difficult owing to the lack of preoperative clinical examinations of TMJ signs. Two patients developed transient palsy of the temporal branch of the facial nerve, which was related to the preauricular approach for intracapsular fractures. However, no permanent facial nerve injury occurred, indicating that the technique was safe for facial nerves. One patient developed a salivary fistula after surgery, and the incidence (2.2%; 1 of 45) was a little higher than previously reported.[16] Meticulous closure of the access in layers was necessary to prevent the formation of a salivary fistula if the parotid gland was exposed during surgery.

Narrowing of the widened mandibular transverse dimension must be strongly emphasized when treating symphyseal and parasymphyseal fractures. The granulation and bone stubble between the fractured surfaces must be cleaned carefully to achieve anatomic reduction. When a bone defect or comminuted fracture is absent, mandibular reduction forceps are applied to close the fracture gap, especially in the lingual aspect. IMF is mandatory before reduction and fixation. The biomechanical environment of this location deserves special mention. Bone is subject to tension at the lower border and compression at the alveolar side of the mandible, which is different from fractures in the body or angle of the mandible.[17] Small shear forces are found in this mandibular region, but torsion moments are greater than in other regions.[18] The mechanical behavior of the fixations should be evaluated properly based on these considerations. The reconstruction plate is recommended for comminuted fractures or fractures with bone defects.[4] Miniplates or lag screws are commonly used in noncomminuted fractures.

Lag screw fixation demands more technical sensitivity, which is believed to provide absolute rigid fixation.[14] The main advantages of miniplates are their ease of adaptability and easy accomplishment by novice surgeons.[9] Several studies have evaluated the clinical outcomes between miniplates and lag screws. A randomized prospective study conducted by Agnihotri et al[19] indicated that patients with fixation by lag screws had greater clinical stability than those with fixation by 2 2.0-mm miniplates. However, no meaningful differences were found in occlusal or osseous healing outcomes between patients treated with lag screws and those treated with plates in the study by Ellis.[20]

In 2 in vitro studies, lag screws behaved better mechanically than 2 miniplates.[21,22] However, experiments in vitro could not completely simulate the function of the complex biomechanical state of the mandible. Therefore, one must be very careful when applying treatment recommendations from laboratory studies to the patient. Furthermore, bite forces are considerably decreased after fracture treatment[23]; thus, using such rigid systems might not be necessary for fracture fixation during the healing period.

In this study, the fracture gap in the lingual aspect was measured, which was a relatively objective method to evaluate the effect of 2 2.0-mm miniplates for width-controlling fixation. Inherent bias could be present in the clinical assessment of esthetics. A more objective evaluation method, such as 3-dimensional surface acquisition technology,[24] could be used in a prospective study.

In conclusion, for noncomminuted symphyseal and parasymphyseal fractures associated with bilateral condylar fractures, 2 2.0-mm miniplates with monocortical screws are stable and efficacious for controlling mandibular width when bilateral condylar fractures are anatomically reduced and stably fixated.

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