Condylar Displacement and Temporomandibular Joint Dysfunction Following Bilateral Sagittal Split Osteotomy and Rigid Fixation

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In this study changes in intercondylar width (ICW) and intercondylar angle (ICA) that occurred with rigid fixation after bilateral sagittal split osteotomy and mandibular advancement are documented and correlated with temporomandibular (TM) symptoms, magnitude of advancement, and mandibular shape. Even though individual changes occurred, there was no significant difference between the mean preoperative and postoperative ICA and ICW measurements. There was also no significant difference between the preoperative and postoperative incidence of TM pain or clicking. No correlation was found between the magnitude of advancement and the percent change in ICA or ICW, and the mandibular shape did not correlate to changes in ICW. This study suggests that screw osteosynthesis does not significantly change ICA or ICW. The fact that no significant increase in TM symptoms occurred indicates that the changes in condylar position that did occur were within the range of clinical adaptability of the patients.

Introduction

Rigid internal fixation is commonly used after bilateral sagittal split osteotomy (BSSO) of the mandible; however, there are few studies documenting its effects on condylar position. Tuinzing and Swart,1 studying dry mandibles, showed that intercondylar width decreased with a BSSO and mandibular setback and increased with an advancement. Freihofer,2 also using dry specimens, showed that condylar displacement tends to occur more frequently with screw fixation than with wire osteosynthesis.3 With clinical populations, concern exists that widely divergent ramus and large surgical movements will result in larger changes in intercondylar width and angle. Lateral oblique radiographs after sagittal splitting of the ramus have suggested that condylar displacement occurs more frequently with screw fixation than with wire osteosynthesis.3 In contrast, Spitzer4 found that screw fixation of sagittal split osteotomies caused no major malposition of the condyle, intercondylar width, and the angulation of the condylar long axis when measured on axial CT scans.

There is concern that if condylar position is changed, when rigid fixation is used with surgery, there will be an increase in temporomandibular symptoms. However, authors using rigid fixation have noted little or no change in TM symptoms in patients undergoing a BSSO.5,6 Moreover, several articles have reported no change in TM symptoms as a result of condylar displacement after ramus osteotomies.7-10 In contrast, Timmis et al11 found a significant reduction in the incidence of masticatory dysfunction with screw fixation after BSSO. The purpose of this study was to document changes in osteosynthesis after the sagittal split osteotomy. With clinical populations, concern exists that widely divergent ramus and large surgical movements will result in larger changes in intercondylar width and angle. Lateral oblique radiographs after sagittal splitting of the ramus have suggested that condylar displacement occurs more frequently with screw fixation than with wire osteosynthesis.3 In contrast, Spitzer4 found that screw fixation of sagittal split osteotomies caused no major malposition of the condyle, intercondylar width, and the angulation of the condylar long axis when measured on axial CT scans.

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intercondylar width and angle that occur with the bilateral sagittal split osteotomy and advancement of the mandible after stabilization with screw osteosynthesis. Changes in intercondylar width and angle were correlated with TM symptoms, mandibular shape, and magnitude of mandibular advancement.

**Materials and Methods**

Eighteen consecutive patients who underwent symmetrical mandibular advancements had submentovertex (SMV) radiographs made immediately preoperatively (T-1) and 6 to 12 months postoperatively (T-2). All patients were treated with BSSO and precision screw stabilization as described by Jeter et al. No concomitant maxillary procedures were performed. A standardized head position was used while obtaining the SMV radiographs on a Quint Sectograph-200 (Quint X-ray Co, Los Angeles). Three patients were eliminated from the study because exposure errors made identification of the landmarks unreliable, thus leaving 15 patients.

The outline of the condyles was traced on each T-1 and T-2 radiograph, and the medial and lateral poles were identified. A line through the long axis of each condyle was constructed, and the angle formed by intersection of the medial extensions of these lines was measured as the intercondylar angle (ICA) (Fig 1). The intercondylar width (ICW) was measured as the distance between the medial poles of the condyles. The ICA and ICW were recorded for each T-1 and T-2 radiograph.

The mandibles were categorized based on their shape. Lines from the center of the condylar neck to the midline of the anterior border of the symphysis were constructed on each T-1 SMV (Fig 2). The angle formed by the intersection of these lines, the condyle-symphysis angle (CSA), was used to divide the mandibles in "U" and "V" shapes. A U-shape was defined as an angle >80 degrees and a V-shape as an angle of <70 degrees. These parameters provided groups composed of the most narrow versus the most broad-shaped mandibles.

The magnitude of mandibular advancement was determined by cephalometric analysis. The amount of horizontal movement of pogonion between T-1 and T-2 was recorded as the amount of advancement. The cephalometric and SMV tracings were performed by one researcher to assure consistency, and all measurements were made to the nearest 0.5 mm.

TM dysfunction was evaluated by history and physical examination. Each patient was questioned at T-1 and T-2 regarding TM or facial pain. Objective evaluations of TMJ clicking, crepitus, and range of motion were also performed. Statistical analysis was accomplished with a Student's *t* test (two-tailed), Pearson's correlation coefficient, and Fisher's exact test. A 95% confidence level was accepted as significant.

**Results**

The ICA had a T-1 mean of 124.5° (SD = 18.23°) and a T-2 mean of 126.5° (SD = 23.7°). The ICA mean percent difference between T-1 and T-2 was...
1.24° (range, −12.6° to 20.75°). In nine patients the angles increased, in four the angles decreased, and in two it remained unchanged.

When the ICW was examined, the T-1 mean was 88.83 mm (SD = 5.4 mm), and the T-2 mean was 88.73 mm (SD = 6.04 mm). The ICW mean percent difference between T-1 and T-2 was −0.16 mm (range, −4.6 mm to 4.8 mm). In five patients the ICW increased, and in eight the ICW decreased. Two patients remained unchanged. The mean mandibular advancement was 6.33 mm (range, 5 to 11 mm). Analysis of the data showed no significant difference between T-1 and T-2 in both the ICA (P = .48) and ICW (P = .86) measurements. No correlation between the magnitude of advancement and the mean percent change in ICA (P = .79) or ICW (P = .64) was identified. There was also no correlation between mean percent change in ICA and mean percent change in ICW (P = .07).

The CSA of the T-1 radiographs ranged from 64 to 82.5 degrees. Three mandibles were categorized as U-shaped (CSA >80 degrees) and four as V-shaped (CSA <70 degrees). The others fell between these values and were not separately evaluated. Between T-1 and T-2, none of the U-shaped and one of the V-shaped mandibles showed an increase in ICW. For the same time interval, two of the U-shaped and three of the V-shaped mandibles ICW decreased. There was no significant difference (P = .67) in the number of V- and U-shaped mandibles that showed increases or decreases in ICW.

When examining TM dysfunction, three patients had TM pain at T-1; one of these resolved at T-2, leaving two patients with TM pain postoperatively. Objective examination revealed that four patients had a click at T-1. Followup examination at T-2 showed that three patients’ clicks had resolved, one was unchanged, and two new asymptomatic clicks had developed. All of the patients had maximum openings of >40 mm, with no deviation. Analysis of the data showed no significant difference between T-1 and T-2 in the numbers of patients experiencing TM pain (P = .5) nor clicking (P = .5).

**Discussion**

The results of this study show that precision screw osteosynthesis of BSSO does not significantly change ICA or ICW from preoperative values when compared with postoperative measurements at 6 to 12 months. Even though changes were noted, they were not statistically significant. The fact that no significant increase in TMJ symptoms occurred during the same time frame indicates that the changes in condylar position were not clinically significant.

Some authors have suggested that as the mandible is set back the condylar width will decrease and, conversely, as the mandible is advanced the width will increase. Freihofe found larger condylar displacements with screw fixation of sagittal ramus osteotomies of dry specimens than with wire fixation. From our study it is evident that clinical changes in ICW and ICA do not conform to a simple geometric model. Even though all the cases were advancements, both increases and decreases in ICA and ICW were noted. A geometric model of mandibular advancement also implies that larger advancements should result in larger changes in ICW and ICA. However, no correlation between the percent change in either of these measurements and the magnitude of advancement was noted.

Several explanations for these findings are plausible. Increases in ICW seen with BSSO and advancement in dry mandibles implies that the fragments are in close apposition along their entire interface after rigid fixation. Realistically, this does not occur. In spite of contouring of the proximal and distal segments, gaps between the segments may be present with both advancements and setbacks. With advancements the gaps frequently occur in the anterior aspect of the osteotomy, and with setbacks the gaps tend to occur in the posterior aspect (Fig 3, A and B). An important aspect of the surgical technique used in this study was placement of a stabilizing clamp on the proximal and distal segments prior to screw osteosynthesis. Depending on bony contact and how the clamp is placed, the proximal segment may be influenced by this procedure. As both widening and narrowing of the intercondylar width and angle occurred, clamp placement and subsequent screw osteosynthesis probably have more of an influence on condylar displacement than the direction or amount of surgical movement. The same reasoning concerning clamp and screw placement may explain why there was no difference in the numbers of U- and V-shaped mandibles that increased in ICW. Concerns that a V-shaped mandible would have more divergent rami and therefore produce larger increases in ICW when advanced, compared to a U-shaped mandible, appear unfounded.

Although the amount of surgical change and mandibular shape are of academic interest, a more important question is that of TM symptoms. With condylar movements do you increase TM symptoms, and to what extent are patients able to adapt to these changes? In this study, the ICA changes ranged from decreases of 12.6 degrees to increases of 20.75 degrees, and the ICW changes ranged from decreases of 4.6 mm to increases of 4.8 mm. It appears that these changes were within the adaptive
range of these patients, as no increase in the incidence of TMJ symptoms occurred. These findings are consistent with previous reports of no increase in TM symptoms with rigid screw fixation after BSSO.\textsuperscript{5,6,11}

To better understand the relationship between condylar displacements and adaptability, changes in TM symptoms in individual patients should be correlated with changes in condylar position. In our study two patients who developed asymptomatic clicks had small changes in ICA, one increasing 1 degree and the other 2 degrees. Likewise, the ICW changed slightly in these patients, with both having decreases of only 0.5 mm. In another patient both the TM/facial pain and click resolved postoperatively; the ICA increased 7 degrees and the ICW decreased 0.5 mm. In another patient the TM/facial pain persisted postoperatively, but the click resolved; the ICA increased 20.75 degrees, the largest increase in the sample, and the ICW decreased 4 mm. One patient with an asymptomatic click had resolution of the click and no change in ICW or ICA. It should be noted that all these patients exhibited adequate range of motion without deviation. No definite conclusions can be made based on these patients. Perhaps some condylar movements are more favorable than others. For example, anterior rotation of the lateral pole may be more favorable than the opposite situation. In addition, there are probably variations in adaptability between patients. A larger sample may help answer the questions concerning condylar displacement and adaptability.

Our findings are similar to those of Spitzer et al.,\textsuperscript{4} who showed that screw fixation of BSSO produced no major malpositioning of the condyle. In a similar fashion, they evaluated intercondylar width and the angulation of the condylar long axis from axial CT projections immediately before and shortly after surgery.

To what extent normalization of condylar position by bony remodeling may have influenced our results can not be evaluated because postoperative radiographs were made at only one time interval. Radiographic evidence of bony remodeling following ramus procedures has been documented.\textsuperscript{13-16}
Evaluation of patients at both shorter and longer postoperative periods may have shown changes in condylar position with time.

References

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Discussion

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The relation between change of intercondylar angle (IC/A) and intercondylar width (IC/W) after a sagittal split osteotomy and the function of the temporomandibular joint (TMJ) postoperatively seems difficult to evaluate with a sample of only 15 patients. The statement that the mandibular advancement was 5 to 11 mm is, in my opinion, insufficient. It is also necessary to consider the deformation preoperatively, because the deformity itself and the direction of mandibular advancement (clockwise, counterclockwise, or parallel) appear very important when the TMJ function is concerned.1

It would have been beneficial if the change of the condylar fragment in the sagittal plane had been measured together with the change of ICA and ICW. Upward rotational movement of this fragment results in a change of relation between condyle, disc, and eminence, which certainly has influence on the TMJ function.2

The relation between the TMJ function and maxillofacial deformities is an interesting subject, and investigations should be encouraged to find some relationships between them. It is worthwhile to know when to recommend osteotomies for TMJ disorders and when to refrain from corrective surgery. A survey of a larger group of patients might provide some answers.

References
