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Condylar Resorption After Bicortical Screw Fixation of Mandibular Advancement

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Purpose: This study evaluated long-term condylar resorption after mandibular advancements stabilized with bicortical screws.

Patients and Methods: One hundred mandibular deficiency patients who underwent bilateral sagittal split osteotomies (BSSO) fixed with three bicortical screws per side, and who were followed for a minimum of 1 year with complete radiographic records, were evaluated. Preoperative panoramic radiographs were traced and superimposed as a best fit over long-term panoramic radiographs. Cephalometric tracings were available on all patients preoperatively, immediately after surgery, 6 to 8 weeks after surgery, and at long term after surgery. These tracings were used to show the amount of the initial advancement and any changes that occurred between 6 to 8 weeks and long term in those patients who exhibited 10% or greater changes in their condylar height. Preoperative temporomandibular joint signs and symptoms were recorded on all patients before surgery and at 6 months after surgery.

Results: There were 10 patients who had 10% or greater vertical change in their condyles; all changes were unilateral. Large advancement ($P > .009$) and preoperative temporomandibular joint symptoms ($P > .01$) statistically correlated with long-term postoperative condylar resorption. There was not a direct correlation between the amount of vertical change in the condyle and the amount of relapse. There was an improvement in temporomandibular joint symptoms for the group as a whole and in the group with condylar resorption.

Conclusions: Patients with large advancements and preoperative temporomandibular joint symptoms appear to be at risk for condylar resorption. These results are similar to those from other studies in which rigid fixation or miniplates were used for cases of mandibular advancement.

Immediate relapse after mandibular advancement with rigid fixation has been well documented.[1-6] Long-term relapse accompanied by progressive condylar resorption has not been studied to the same extent.[7-11] Condylar resorption leading to relapse was first reported in the early eighties.[12-14] Progressive condylar resorption has been defined as a change in shape of the condyle with loss of condylar height.[8,9,11] Its incidence has been reported to be between 2.3% and 7.7%, usually in patients treated by a bilateral sagittal split osteotomy (BSSO) to advance the mandible.[10,11,15] It has been seen with one- and two-jaw procedures in which the BSSO was stabilized with superior border wires, plates, or bicortical screws.[7-15]

Radiographic signs of condylar resorption are first noted at 6 months or more after surgery, with a range of 6 to 17 months.[8,9] Several theories offer reasons for its occurrence. Kerstens et al[15] suggested that jaw surgery stimulates the process by increasing load, disc displacement, and immobilization of an underlying dentofacial deformity. Arnett et al[16] suggested that mediolateral torquing or posterior positioning of the condyle after rigid fixation may be associated with condylar resorption and late relapse. Animal studies have shown that when posterior displacement of the condyle occurs, resorption of the posterior surface of the condyle and anterior surface of the postglenoid spine result.[17] This suggests that alterations in condylar position may induce remodeling changes within the temporomandibular joint (TMJ). Arnett et al[16] believed that this will lead to late relapse. Condylar

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resorption has been noted more frequently in women with high mandibular plane angles, preoperative temporomandibular dysfunction, large mandibular advancement, and distal segment counterclockwise rotation.[8,10,11,13,15]

Scheerlink et al[11] studied 103 patients who underwent mandibular advancements fixed by miniplates and noted a 20-fold increase in condylar resorption with advancements greater than 10 mm. It has been suggested that miniplates may not torque the condyles as much as bicortical screws.[18,19] In the study by Scheerlink et al,[11] there was a 7.7% incidence of late relapse due to condylar resorption.

Previous articles have evaluated long-term relapse and secondarily evaluated panoramic radiographs for evidence of condylar resorption. The purpose of this study was to evaluate the panoramic radiographs of a group of patients who underwent mandibular advancement with a BSSO fixed with three bicortical screws per side for condylar resorption and to assess what factors may have contributed to the problem. The severity of the condylar resorption was assessed to see what effect it had on stability of the case.

Patients and Methods

One hundred mandibular deficiency patients who underwent a BSSO with fixation using three bicortical screws per side, and who were followed for a minimum of 1 year with complete radiographic records, were evaluated. The osteotomy was completed and stabilized as described by Van Sickels and Jeter.[20] The proximal segment was manually repositioned and stabilized to the distal segment with a clamp. The occlusion was checked after placement of the screws, and the patients were allowed to function with elastic traction. In advancements of greater than 7 mm as measured at pogonion, anterior suspension wires were placed, and the patients were allowed to function with elastic traction between the suspension wires. Cases were included if there was a small proximal fragment fracture that was stabilized with a plate, providing that there was enough overlap of the proximal and distal segments to allow for placement of three bicortical screws. No cases with maxillary surgery were included; however, 44 cases had genioplasties in addition to their mandibular advancement.

Radiographs included cephalograms obtained within 6 weeks before surgery, within 4 days after surgery, 6 to 8 weeks after surgery, and 1 to 5 years after surgery. Panoramic radiographs were obtained within 6 weeks before surgery and 1 to 5 years after surgery. All radiographs were taken on the same machine.

To assess initial movement, presurgical cephalograms and initial postoperative cephalograms were traced, and the changes at B point were noted. Preoperative and long-term panoramic radiographs were also evaluated. Long-term postoperative panoramic radiographs were obtained an average of 3 years after surgery. Those radiographs that showed morphologic condylar changes were traced. The tracings of the radiographs were superimposed as a best fit of the sigmoid notch, posterior border of the ramus, and the gonial angle. A horizontal line was drawn at the narrowest part of the condyle on the preoperative tracing. All tracings were reviewed by a second investigator checking for accuracy of this horizontal line. A vertical line perpendicular to the horizontal line was then drawn to the superior aspect of the condyle (Fig 1). Vertical changes of less than 10% were attributed to normal remodeling. Those cases with greater than 10% change were further subdivided into three groups, 10% to 19% (group 1), 20% to 29% (group 2), and greater than 30% loss of vertical height (group 3) (Fig 2).

In the group of patients showing vertical changes, the panoramic radiographs taken 24 hours postoperatively were compared with the preoperative and long-term radiographs and analyzed for changes that may have occurred because of condylar rotation

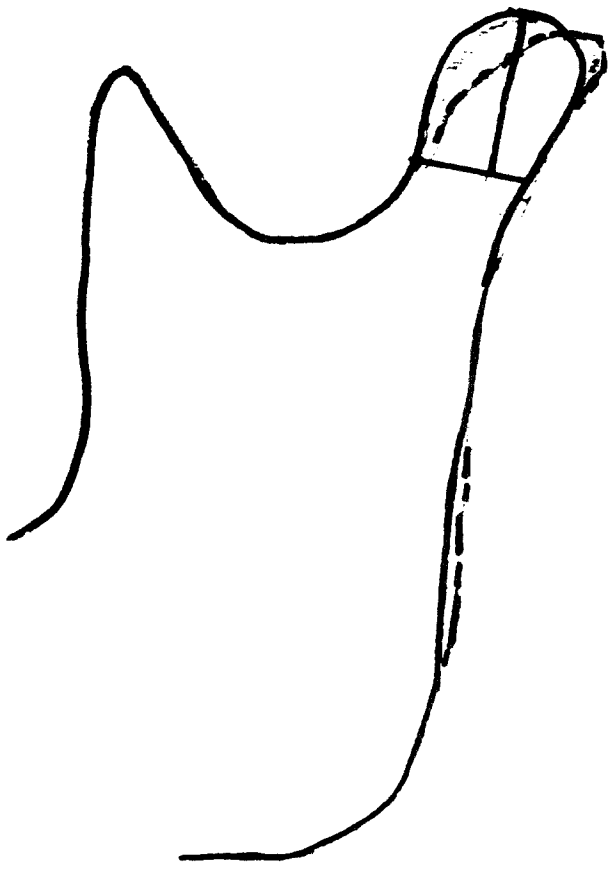

FIGURE 1. Example of superimposed tracings of preoperative and long-term radiographs.

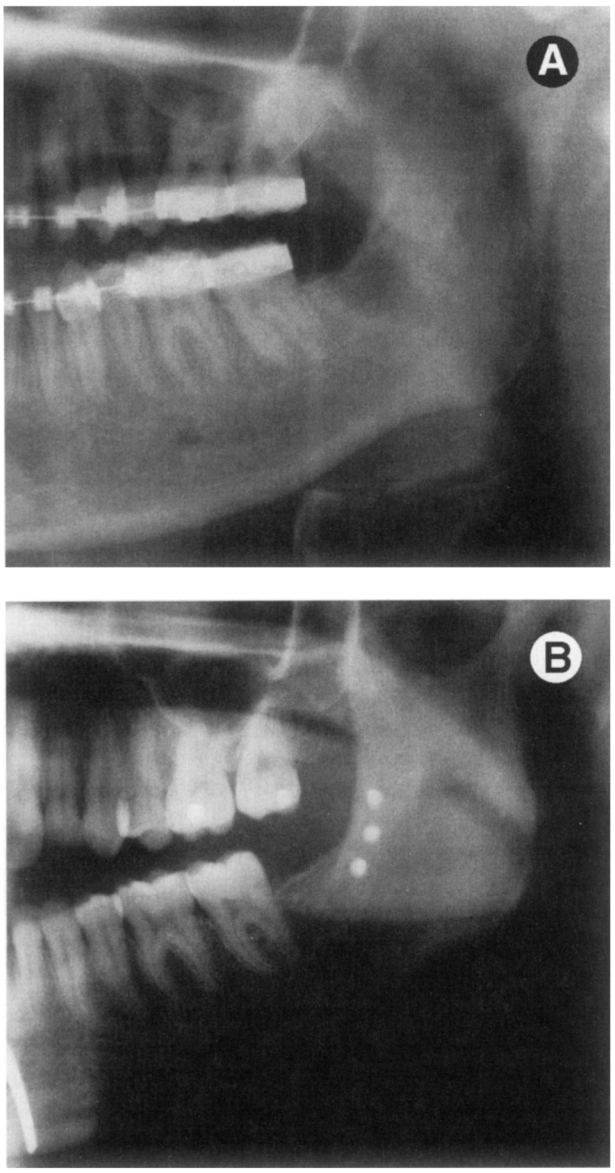

FIGURE 2. *A*, Preoperative and *B*, 5-year postoperative panoramic radiographs of a patient with greater than 30% of original condylar height.

during the surgery. Cephalometric tracings of 6- to 8-week postoperative radiographs and those from long-term follow-up were done on all cases in which there were morphologic condylar changes of 10% or greater.

Preoperative TMJ signs (pain and preauricular or endaural tenderness on palpation, clicking or popping) and symptoms were recorded on all patients at 2 to 5 weeks before surgery and at 6 months after surgery. Also, panoramic radiographs were examined preoperatively and long term after surgery for signs of arthrosis.

Cases with 10% or greater morphologic condylar change were evaluated for magnitude of advancement, sex, and preoperative TMJ symptoms. Data were analyzed using Student's *t*-test and a χ^2 analysis.

Results

Before surgery, 13% of the 100 patients had joint tenderness, 39% had clicking, popping/joint sounds, and 7% had both. After surgery, 21 of those who had clicking, popping/joint sounds had improved (noise no longer present). Eight of the 13 with joint tenderness improved (absence of tenderness). Ten patients who had no preoperative symptoms developed joint tenderness or joint sounds.

Ten patients had 10% or greater vertical change in their condyles. All cases were unilateral; 8 of the 10 cases with resorption had preoperative temporomandibular symptoms. Several showed change in condylar morphology on the opposite side, which did not result in 10% vertical change. Six of these had 10% to 19% resorption, three had between 20% and 29% resorption, and one had greater than 30% resorption. When the 24-hour postoperative panoramic radiographs were compared with the preoperative radiographs, there were no differences with respect to sagittal rotation of the proximal segment that could account for the vertical changes. All surgeries were done by two senior surgeons. There was no association between the surgeons involved and the incidence of condylar resorption.

The relationship between TMJ symptoms and condylar resorption was significant ($P > .01$). Five of the eight cases had resolution of TMJ symptoms postoperatively. Two had secondary TMJ surgery, one at 1 year and the second at 2 years postoperatively. One patient had no change in her TMJ symptoms after surgery.

Nineteen patients had variations in the shape of their condyles before surgery. After surgery, there were 29 patients. Most of these changes were subtle changes in morphology. None resulted in significant changes in condylar height.

The average age of all of the patients undergoing surgery was 27.6 years (range, 13 to 55). The age of those who had condylar resorption was 23.7 years. The difference in age between the groups was not statistically significant.

The average advancement for the whole group was 6.53 ± 1.8 mm at B point; the average advancement of those having condylar resorption was 7.75 ± 2.1 mm at B point. For those without condylar resorption, the average advancement was 6.38 ± 1.7 mm at B point. This was significant at $P > .009$. The cephalometric radiographs from 6 to 8 weeks after surgery to long term after surgery for the resorption group were compared. In group 1, B point relapsed 1, 3, 0.5, 2, 1, and 4 mm, respectively, during this period. In group 2, B point relapsed 3, 2, and 0.5 mm, respectively. In

group 3 (1 patient), B point relapsed 8 mm. The amount of vertical resorption did not directly correlate with the amount of relapse seen between 6 to 8 weeks and long term. In all but the patient from group 3, orthodontics was used successfully to manage occlusal discrepancies. The latter patient ended up with 4 mm overjet (Fig 3). She did not have a second orthognathic surgical procedure.

Thirty men and 70 women were involved in the study. Two men and eight women had resorption. The difference between men and women undergoing resorption was not statistically significant.

Skeletal suspension wires were used routinely on patients with larger advancements. There were six patients with skeletal wires who had resorption and four without wires who had it. There was no significant difference in condylar resorption in those who did or did not have skeletal wires used. There also was no significant difference in mandibular plane angle in those who had condylar resorption and those who did not.

Discussion

This study was retrospective in design; hence, it has several of the pitfalls that occur with retrospective studies. All of the data on preoperative and postoperative TMJ signs were collected on standardized forms, but the examiners were not calibrated. The data were consistent with other studies that showed improvement in TMJ symptoms after mandibular advancement surgery.[21-23] In a recent study by Feinerman and Piecuch[23] comparing wire osteosynthesis and miniplates to stabilize mandibular advancements, they showed that masticatory muscle pain and TMJ clicking improved with rigid fixation and worsened with nonrigid fixation. What is interesting is that TMJ signs improved both for the whole group and for the group with condylar resorption. Positive preoperative TMJ symptoms and large advancements correlated with condylar resorption and late relapse. There was not a direct correlation between large advancements and condylar resorption, suggesting that several factors play a role in this phenomenon. Additionally, the method used of examining panoramic radiographs, although used in multiple other studies, has inherent flaws. There was no correlation between improvement in symptoms and condylar resorption.

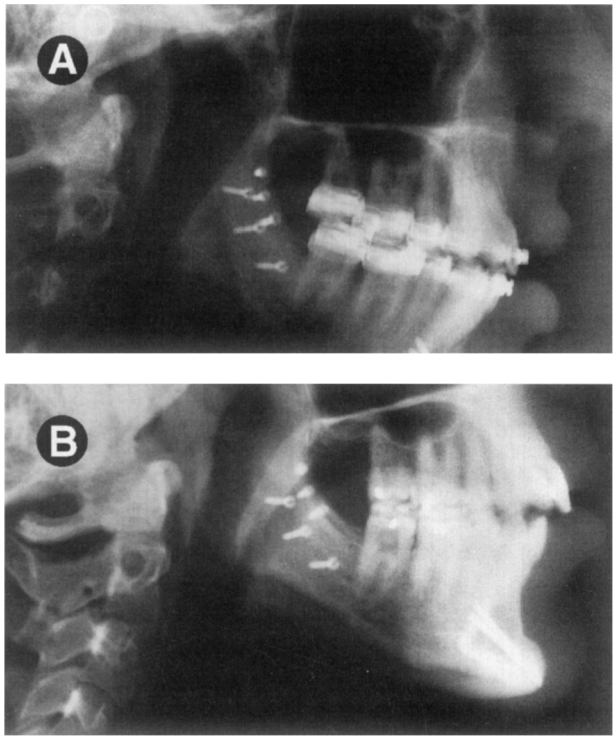

FIGURE 3. *A*, Six-week and *B*, 5-year postoperative cephalograms. An increase in overjet is noted on the 5-year film.

Several authors have suggested there are variations in joint anatomy in different dentofacial deformities and that changes in position and force subsequent to surgery will have an effect on the condyles.[15,24] One would reasonably expect that with changes in load on the condyles there would be a certain number of condyles that would show morphologic changes after surgery that represented adaptation. Our data support this contention in that there was an increase in the number of cases in which the condyle did not have a "normal" shape (from 19 to 29). However, there were 10 cases where the changes were considered beyond morphologic adaptation. Habets et al[25,26] have suggested that if there is a difference of more than 6% in the vertical dimension between the two sides on the panoramic radiograph, then condylar asymmetry exists. Moore et al[10] thought that the point where condylar remodeling stops and condylar resorption begins is an arbitrary one. Using Habet et al's studies, they believed that 6% change was within the margin of remodeling; beyond that it represented resorption. We chose 10% change. Similar to the study by Scheerlinck et al,[11] large advancements had a greater incidence of condylar resorption. Their incidence was 7.7%; ours was 10%. Eight of their patients had relapse at B point of 35% to 120%. In seven of them, the patient had a Class I occlusion on one or both sides. They believed clinical examination alone would not have shown that relapse had occurred. In our 10 cases, only the patient in the category of 30% or greater had late relapse of such a magnitude that it resulted in an unacceptable occlusion. However, in contrast to their study, the amount of vertical change did not directly correlate with the amount of relapse

seen between 6 and 8 weeks and in the long-term cephalometric radiographs.

Several authors have suggested that women have a higher incidence of condylar resorption than men.[8-11,15,16] Statistically, this was not borne out in our study. More women than men had surgery, and more women had resorption. Because TMJ symptoms are a cofactor for risk of resorption, and joint symptoms occur more often in women, there is probably a trend for women to have a greater incidence of condylar resorption.

Skeletal suspension wires were used on patients who had large advancements. Skeletal wires have been shown to minimize early relapse, presumably by decreasing the load on the osteotomy site.[5,6] Large advancements were shown to result in condylar resorption, and skeletal suspension wires did not help. None of the patients were placed in fixation after surgery. Alternative strategies should be used to decrease the load on the condyles in susceptible patients to prevent resorption.

The mandibular plane angle did not correlate statistically with condylar resorption. Kerstens et al[15] thought that high-angle cases were at greater risk. Our sample was limited only to mandibular advancements; no maxillary surgeries were included. It may be that high-angle cases are more susceptible to condylar resorption. Alternatively, cases that need maxillary surgery might fall into the category of larger advancements.

There was no difference statistically in the length of follow-up between those patients who had condylar resorption and those that did not; however, all of the patients who had condylar resorption were followed-up for 2 years or greater.

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