Disc Repositioning
Does it Really Work?

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KEYWORDS

• Disc repositioning • 3D quantitative findings • Surgical technique and possible pitfalls • Mitek mini anchor • Treatment alternatives • Lateral cephalometry • Clinical outcomes

KEY POINTS

- The effectiveness of temporomandibular joint (TMJ) disc repositioning is scarce.
- Further guidance for clinicians and patients regarding clinical and surgical options to better treat TMJ internal derangement are needed, especially regarding skeletal malocclusion that requires operative interventions.
- The lack of evidence that TMJ articular disc repositioning is an ineffective procedure points to a future when new TMJ biomarkers will support the technique effectiveness in better studies.
- As a sensitive technique with a wide learning curve, many surgeons have practiced TMJ articular disc repositioning with a large range of outcomes.

INTRODUCTION

Although limited, there is evidence to support the assumption that temporomandibular joint (TMJ) articular disc repositioning indeed works[1–5] and so far there is no evidence that TMJ articular disc repositioning does not work. Despite the controversy among professionals in private practice and academia, TMJ articular disc repositioning is a procedure based on (still limited) evidence; the opposition is based solely on clinical preference and influenced by the ability to perform it or not.

DISC REPOSITIONING AND LEVELS OF EVIDENCE

Evidence in health science can be classified in 6 distinct hierarchical levels according to the US Agency for Healthcare Research and Quality[6]: (1a) Meta-analysis of randomized, controlled trials, (1b) at least 1 randomized controlled trial, (2a) at least 1 well-designed controlled study without randomization, (2b) at least 1 other type of well-designed quasi-experimental study, (3) well-designed, nonexperimental descriptive studies such as comparative, correlation, and case-controlled studies; and (4) expert committee reports or opinions, or clinical experience of respected authorities, or both.

Specialized peered-reviewed journals are also a reasonable source of good scientific evidence. Although they have known limitations, a worldwide accepted metric to evaluate journals' strength is the impact factor, which is calculated by the Institute for Scientific Information[7] as the average number of times published papers are cited up to 2 years after publication. Dental literature has very distinct impact factor compared with the medical literature in most of the specialties. The impact factor of the *Journal of Oral and Maxillofacial Surgery*, *International Journal of Oral and Maxillofacial Surgery*, and *British Journal of Oral and Maxillofacial Surgery* in 2009 were 1.580, 1.444, and 1.327, respectively; the *New England*

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Journal of Medicine, the *Journal of the American Medical Association*, and *The Lancet* were 50.017, 31.171, and 17.457, respectively for the same period.

A recent study that listed the 100 most cited articles in dentistry[8] showed that, among them, only 6 papers that were published in the 2 journals of oral and maxillofacial surgery were included in the list (*Journal of Oral and Maxillofacial Surgery* and *International Journal of Oral and Maxillofacial Surgery*), whereas 41 papers that were published on the 3 journals of periodontology (*Journal of Clinical Periodontology*, *Journal of Periodontology*, and *Journal of Periodontal Research*) were included in the top 100 papers. It was concluded that, in dentistry, there is a predominance of clinical studies, particularly case series and narrative reviews/expert opinions, despite their low evidence level. It is also understandable that randomized, placebo-controlled, prospective clinical trials are not easily executed, mainly in oral surgery, either for ethical reasons or funding issues.[9] In this scenario, scientific evidence levels 2b and 3 should be considered as evidence enough to guide clinical protocols in oral and maxillofacial surgery. A quasi-experimental study is defined as a broad range of nonrandomized intervention studies, usually made when it is not logistically feasible or ethical to conduct a randomized, controlled trial.[10]

The current literature available on the effectiveness of open joint TMJ disc repositioning meets the "patient-oriented evidence that matters" (POEM) criterion. To meet POEM, readers should take advantage "from original research to clinical experience, remembering that each source of medical information is valuable since one learns which source is best for the specific information being sought."[11]

Two meta-analyses about the effectiveness of TMJ management concluded that operative interventions need further evidence for precise conclusions but pointed out some good results for open joint surgery.[3,12]

Mostly, Wolford and coworkers have addressed the outcomes of TMJ articular disc repositioning in several papers that could be classified according to the level of evidence 2b or 3, beside abstracts and expert opinions published by their group in many international scientific meetings held on all continents. The main focus of these studies were orthognathic surgery outcomes in patients with prior TMJ derangements and because of this, most of these studies evaluated patients who underwent TMJ disc repositioning and orthognathic surgery concomitantly.

Wolford and Cardenas in 1993[3] detailed described idiopathic condylar resorption, its possible etiologies and specific treatment options, and showed 12 successfully treated clinical cases of open joint TMJ articular disc repositioning with the aid of a titanium mini anchor used to hold the disc in place with artificial ligaments. All patients showed progressive condylar resorption before the procedure (average of 1.5 mm/y) with progressive steepening of the occlusal plane angle. Operative techniques included removal of the hyperplastic synovial tissue, repositioning of the articular discs, and double jaw surgery for mandibular advancement of 11 mm (range, 2–18 mm) and decrease of the occlusal plane angle an average of 8° (range, 5°–12°). At a postoperative follow-up average of 33 months (range, 18–68) no significant relapses were observed. In fact, 5 young patients (<16 years old) at the time of surgery showed a slight increase in condylar height (average, 0.4 mm; range −0.1 to 1.5).

Two years later, a retrospective clinical study assessed the outcomes of 105 patients who underwent TMJ disc repositioning.[2] At the longest follow-up (minimum of 1 year after surgery), there were no detectable condylar changes or mandibular positional changes. Visual analog scale assessment showed marked reduction of TMJ pain, facial pain, and headaches. TMJ noises, disability, and jaw function; in addition, diet also improved significantly. Interincisal opening improved slightly, whereas lateral excursive movements decreased.

Another retrospective clinical study design was used by Wolford and colleagues[1] in 2002 to evaluate all patients who had undergone concomitant orthognathic and TMJ surgery from 1991 through 1993. All patients who underwent unilateral or bilateral articular disc repositioning with concomitant mandibular ramus osteotomies or double jaw surgery and met the inclusion criteria were included in this study. They compared 70 patients in 3 groups according to mandibular movement: Group 1 had mandibular advancement, group 2 had mandibular setback, and group 3 had the mandibles remain at the original positions. One year after surgery, 20% of patients had pain and 60% reported complete relief of TMJ pain (before surgery, 80% had pain). Pain was assessed on a visual analog scale from 0 (no pain) to 10 (the worst pain imaginable). Severe pain was still present in 7% of the patients 1 year after surgery (before surgery, it was 53%). Concomitant TMJ and orthognathic surgery success based on a greater than 35 mm of maximal interincisal opening and a decrease in pain had an overall success rate of 91.4%.[1]

To our knowledge, there is no single experimental study that showed that articular disc repositioning does not work. No cohort, case-control, retrospective patient data review, single case report, or expert committee report or opinion has described unsuccessful outcomes after TMJ disc repositioning. A few expert opinions (the lowest level of evidence) has expressed against TMJ disc repositioning.[13–15]

ORTHOGNATHIC SURGERY IN THE PRESENCE OF DISC DISPLACEMENT AND CLINICAL OUTCOMES

Controversy surrounds the appropriate management of patients with preexisting internal derangement of the TMJ who need orthognathic surgery for correction of malocclusion and jaw deformities.[16] There are 2 significantly different philosophies; the first posits that orthognathic surgical procedures reduce or eliminate TMJ dysfunction and symptoms,[13,17–20] whereas the second posits that orthognathic surgery causes further harmful effects on the TMJ and thus worsens the symptoms and dysfunction postoperatively.[14,21,22] The second philosophy proposes appropriate operative management of the TMJ pathology in an initial separate operative procedure or concomitantly with the orthognathic surgery.[23]

Some authors[13,17–20] recommend that patients with coexisting TMJ dysfunction and skeletal facial deformities undergo orthodontic preparation followed by orthognathic surgery. For the small number of patients whose TMJ symptoms do not resolve and are too severe to permit orthodontic preparation for orthognathic surgery, TMJ surgery may be performed before orthognathic treatment. However, other studies[1–3,5,23–42] have shown that concomitant surgical correction of TMJ pathology and coexisting dentofacial deformities in a single operation provides high-quality treatment outcomes for most patients relative to function, esthetics, elimination, or significant reduction in pain, and improved patient satisfaction.

Preexisting TMJ pathology (symptomatic or not) that can cause unfavorable outcomes when only orthognathic surgery is performed include: articular disc dislocation, adolescent internal condylar resorption, condylar hyperplasia, osteochondroma, congenital deformities, reactive arthritis, connective tissue/autoimmune diseases, nonsalvageable joints, and others. All of these conditions can be associated with dentofacial deformities, TMJ pain, headaches, myofascial pain, TMJ dysfunction, and other problems.[23]

The most common TMJ pathology is anterior and/or medial displacement of the articular disc, which can initiate a cascade of events leading to arthritis and other TMJ-related symptoms.[23,43] Advancement of the mandible especially, in a counterclockwise direction, in a patient with displaced discs causes the discs to remain displaced as the condyles seek a superoposterior position in the fossa, potentially overloading the joints and causing instability in the long term.[23] Other authors have reported that patients with preoperative TMJ symptoms requiring large mandibular advancement seem to be at increased risk for condylar resorption[44,45]; thus, in these patients, a logical approach would be to return the disc to a normal anatomic and functional position. Concomitant treatment (when the discs are salvageable) may include articular disc repositioning and stabilization using the Mitek anchor (Mitek Surgical Products, Westwood, MA, USA) technique[1,2,23–29] and orthognathic surgery as indicated.[23]

Other factors that may contribute to skeletal relapse and condylar resorption include patient age and gender, a high mandibular plane angle, preoperative orthodontic treatment, bone healing, condylar positioning, neuromuscular adaptation, instability of segments, the degree of mandibular advancement performed, influence of operative technique, and time since onset.[5,16,46]

Several authors have described of TMJ condition that could be possible risk factors for skeletal relapse and condylar resorption after orthognathic surgery, including high mandibular plane angle, shortened posterior facial height, and small posterior/anterior facial height ratio.[16,46,47] However, these same characteristics are commonly seen in patients with TMJ pathology, and those authors apparently did not recognize that the patients who experienced postoperative relapse and condylar resorption likely had preoperative TMJ pathology. Schellhas and colleagues[48] investigated 100 patients clinically and radiographically by computed tomography, and high-field surface-coil MRI to identify risk factors for TMJ degeneration. In their study, 40 patients (52 joints) underwent an open arthroplasty procedure, in which the main surgical and pathologic findings included disc displacement, disc degeneration, and cartilage hypertrophy. TMJ internal derangement was posited to be the main cause of both acquired facial skeleton remodeling and unstable occlusion in patients with intact dentition and without previous mandibular fracture. Similar findings were described previously by Schellhas,[49] who concluded that internal derangement of the TMJ is an irreversible and generally progressive disorder.

The TMJs are the foundation for stable results in orthognathic surgical procedures; if the TMJs are not stable and healthy (pathologic), then orthognathic surgery outcomes may be unsatisfactory relative to function, esthetics, stability, and pain. Orthognathic surgery to correct dentofacial deformities requiring mandibular advancement cannot eliminate coexisting TMJ pathology, and those patients may have unsatisfactory outcomes.[16,21–23,50–54]

Clinical outcomes of TMJ surgery using Mitek mini anchor, including mandibular range of motion, chewing efficiency, pain levels, and disability has been assessed in several papers.[1,2,26,27] Mehra and Wolford[2] evaluated 88 patients with simultaneous TMJ disc repositioning using the Mitek mini anchor and orthognathic surgery and found that this technique provided significant decreases in TMJ pain, facial pain, headaches, TMJ noises, and disability, and significant improvements in jaw function and diet, along with stable occlusal and skeletal results.

Many studies used lateral cephalometry to monitor condylar changes after maxillomandibular advancement and the influence of articular disc repositioning (Figs. 1 and 2).[5] Condylar arthritic changes provide mandibular instability and can be detected through lateral cephalometric radiographs.[55] Cranial base superimposition in nongrowing patients can accurately detect condyle remodeling by monitoring mandibular position in a longitudinal basis.

Various methods and devices are currently used to diagnose internal derangement of the TMJ, including radiographic measures, such as arthrography and tomography, and methods that rely on the assessment of jaw movements. More recently, MRI has been used to evaluate the disk position. MRI has gained wide acceptance in evaluating the TMJ and shows a high diagnostic accuracy in determining the articular disk position related to the condyle and the articular eminence. Although arthrography and MRI of the TMJ have become standard in clinical practice and studies involving internal derangement, cephalometric radiography might also be available. Disk displacement has been reported to be associated with reduced posterior facial height, reduced mandibular length, and increased inclination of the mandible relative to the cranial reference planes in adolescents. However, some authors have reported that no cephalometric measurements can clearly distinguish persons with disk displacement of the TMJ from those with normal disk positions. If some characteristic findings from the cephalometric analyses suggest an association with the progression of internal derangement, this is an important implication for orthodontic treatment and patient education before treatment. In addition, this might further increase the diagnostic value of cephalometric radiographs.

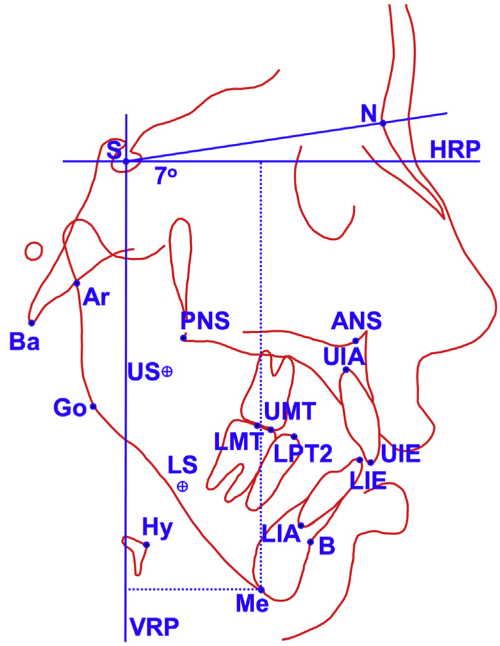

Fig. 1. Landmarks used for cephalometric assessment. The horizontal reference plane (HRP) is constructed at 7° to the SN plane. The vertical reference plane (VRP) is constructed perpendicular to the HRP, through the sella (S). The *dotted lines* indicate the method of measuring the menton (Me) relative to reference planes HRP and VRP. ANS, anterior nasal spine (a point posterior to the tip of the median, sharp bony process of the maxilla, on its superior surface, where the maxilla process first enlarges to a width of 5 mm). Ar, articulare; B, B point; Ba, basion; Go, gonion; Hy, hyoid; LIA, lower incisor apex; LIE, lower incisor edge; LMT, lower molar distal cusp tip; LPT2, lower premolar cusp tip; N, nasion; PNS, posterior nasal spine; S, sella turcica; UIA, upper incisor apex; UIE, upper incisor edge; UMT, upper molar mesial cusp tip; US, upper. (*From* Goncalves JR, Cassano DS, Wolford LM, et al. Postsurgical stability of counterclockwise maxillomandibula advancement surgery: affect of articular disc repositioning. J Oral Maxillofac Surg 2008;66(4):724–38; with permission.)

Goncalves and colleagues[5] reported a retrospective study evaluated the records of 72 patients who underwent maxillomandibular surgical advancement with counterclockwise rotation of the occlusal plane. The sample was divided into 3 groups to address the influence of TMJ health and articular disc surgical repositioning relative to postoperative stability. Group 1, with healthy TMJs, underwent double jaw surgery only. Group 2, with articular disc dislocation, underwent articular disc repositioning using the Mitek anchor technique concomitantly with orthognathic

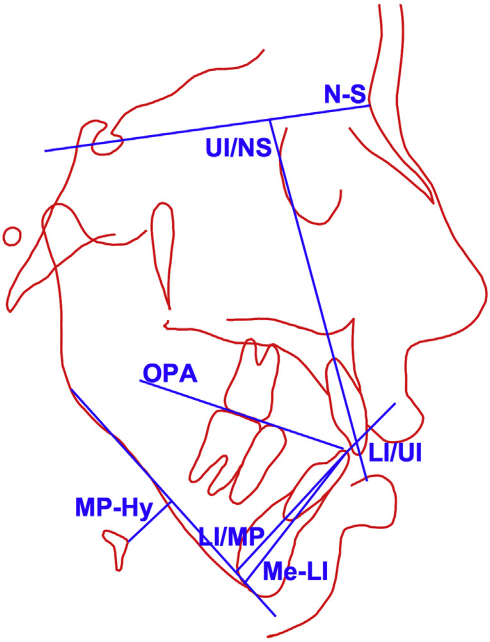

Fig. 2. Distances and planes used to define linear and angular measurements. Linear measurements include the distance from the hyoid to the mandibular plane (MP-Hy) measured on a perpendicular line from the MP; and the distance from the menton to the lower incisor edge (Me-LI). Angular measurements include the angle of the occlusion plane (OPA) to the nasium-sela (N-S line); the angle of the upper incisor to the N-S (UI/NS) line; the angle of the lower incisor to the mandibular plane (LI/MP); and the incisor angle (LI/UI). (*From* Goncalves JR, Cassano DS, Wolford LM, et al. Postsurgical stability of counterclockwise maxillomandibula advancement surgery: affect of articular disc repositioning. J Oral Maxillofac Surg 2008;66(4):724–38; with permission.)

surgery. Group 3, with articular disc dislocation, underwent orthognathic surgery only. Preoperative characteristics included high occlusal plane angle, maxillary and mandibular retrusion, and increased anterior facial height. All 3 patient groups had similar dentofacial deformities and underwent orthognathic operative procedures performed by the same surgeon in the same manner with rigid fixation. Each patient's lateral cephalograms were traced, digitized twice, and averaged to estimate surgical changes and postoperative stability. The maxillomandibular complex was advanced and rotated counterclockwise similarly in all 3 groups (**Fig. 3**). Postoperatively, the occlusal plane angle increased in G3 (37% relapse rate), but remained stable in G1 and G2. Postoperative mandibular changes in the horizontal direction demonstrated a significant relapse in G3 at the menton (28%), the B point (28%), and the lower incisor edge (34%; **Fig. 4**), but remained stable in G1 and G2. Maxillomandibular advancement with counterclockwise rotation of the occlusal plane is a stable procedure for patients with healthy TMJs and for patients undergoing simultaneous TMJ disc repositioning using the Mitek anchor technique. Those patients with preoperative TMJ articular disc displacement who underwent double jaw surgery and no TMJ intervention experienced significant relapse.

Surgical counterclockwise rotation of the maxillomandibular complex lengthens the functional moment arm (mandible), thereby increasing loading to the TMJs owing to stretch and tension of the suprahyoid muscles, periostium, skin, and other soft tissue elements. It may take several months for the soft tissues to adapt and reestablish a state of equilibrium.[56] Our previous studies[56–58] have shown that maxillomandibular advancement with counterclockwise rotation of the occlusal plane is a stable procedure in patients with healthy TMJs. Goncalves and colleagues[5] showed that the occlusal plane angle was stable postoperatively in patients with healthy TMJs and in articular discs repositioning concomitantly with orthognathic surgery patients, but the patients with articular disc dislocation who underwent only orthognathic surgery relapsed significantly (mean, 2.6°; range, −2.5° to 13.3°). The magnitude of clockwise rotation strongly indicates condylar resorption as the etiologic factor.

Chemello and colleagues[56] and Satrom and colleagues[57] reported that mandibular advancement in double jaw surgery (with or without counterclockwise rotation) using rigid internal fixation with healthy TMJs is a stable procedure over the long term, with a mean anteroposterior relapse at point B of 6% regardless of the amount of surgical advancement performed. On the other hand, Wolford and colleagues[16] evaluated 25 consecutive patients (23 females and 2 males) with jaw deformities and displaced articular discs (confirmed by MRI) who were treated with orthognathic surgery only, including mandibular advancement, and stabilized with rigid fixation. The average postoperative relapse at point B was 36% of the mandibular advancement, and the average distance from the condyle to point B decreased by 34%, indicating condylar resorption. Six patients (24%) demonstrated significant postoperative condylar resorption (3–8 mm), resulting in class II anterior open bite malocclusion. The increased loading of the TMJs as a result of the mandibular advancement most likely stimulated the resorption process. New onset or aggravation of TMJ symptoms (eg, pain, TMJ dysfunction) occurred at an average of 14 months after surgery. At the completion of the study, 48% of patients required TMJ and repeat orthognathic surgery. Before surgery, 36% of the

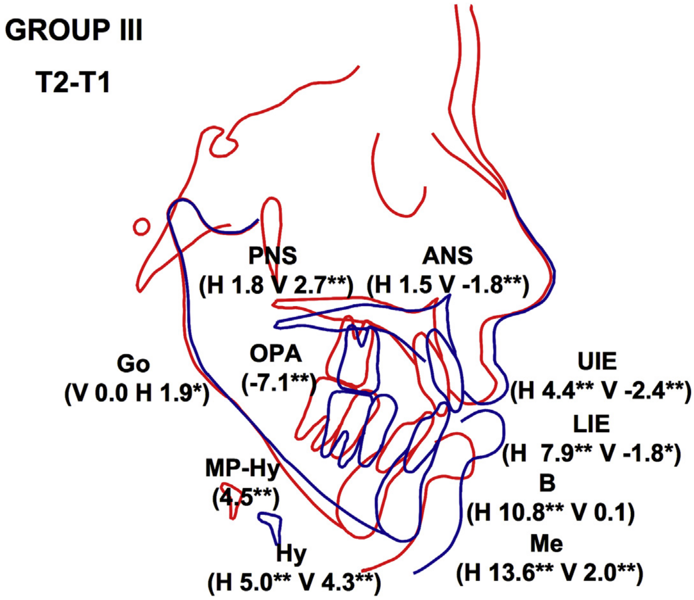

Fig. 3. Mean vertical and horizontal surgical changes (anterior nasal spine [ANS], posterior nasal spine [PNS], upper incisor edge [UIE], lower incisor edge [LIE], B point [B], menton [Me], gonion [Go], hyoid [Hy]), MP-Hy distance, and occlusion plane (OPA) for the 3 groups. The *red lines* indicate presurgery (T1); the *blue lines* indicate immediately postoperatively (T2). (*From* Goncalves JR, Cassano DS, Wolford LM, et al. Postsurgical stability of counterclockwise maxillomandibula advancement surgery: affect of articular disc repositioning. J Oral Maxillofac Surg 2008;66(4):724–38; with permission.)

patients complained of pain or discomfort, but at 2.2 years postoperatively, 84% of the patients reported a 75% increase in pain intensity compared with the preoperative pain. Only 4 of the 25 patients (16%) had a stable outcome without pain. This study clearly demonstrates the problems associated with performing orthognathic surgery only on patients with coexisting TMJ articular disc dislocations.

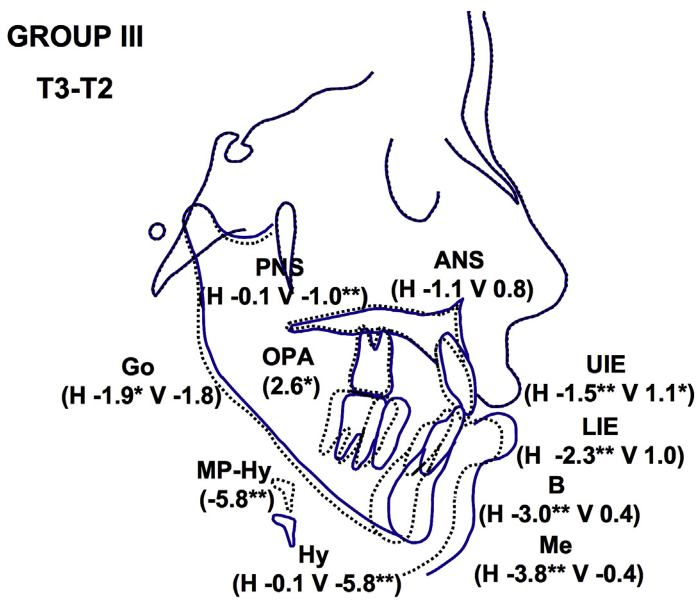

Fig. 4. Mean vertical and horizontal postoperative skeletal changes (anterior nasal spine [ANS], posterior nasal spine [PNS], upper incisor edge [UIE], lower incisor edge [LIE], B point [B], menton [Me], gonion [Go], hyoid [Hy]), MP-Hy distance, and OPA for the 3 groups. The *blue lines* indicate immediately postoperatively (T2); the *dashed lines* indicate long-term postoperatively (T3). (*From* Goncalves JR, Cassano DS, Wolford LM, et al. Postsurgical stability of counterclockwise maxillomandibula advancement surgery: affect of articular disc repositioning. J Oral Maxillofac Surg 2008;66(4):724–38; with permission.)

3-DIMENSIONAL QUANTITATIVE FINDINGS

Our group has studied 3-dimensional (3D) condylar changes after maxillomandibular surgical advancement with and without TMJ articular disc repositioning. We have used 3D quantitative assessment and cranial base voxel-wise automatic registration to compare immediately preoperatively (T1), immediately postoperatively (T2), and at least 11 months follow-up (T3). The first study[4] used iterative closest point rigid deformation to assess condylar changes immediate after surgery (T2–T1) and 1-year follow-up (T3–T2). Although it was not a randomized trial, all patients who met specific criteria were included in this retrospective study. We found that immediately after surgery, condylar displacements differ significantly between the 2 groups. Although patients with normal TMJ submitted to maxillomandibular advancement (MMA) have their condyles displaced up, backward, lateral, or medially (**Fig. 5**), patients with articular disc displacement submitted to maxillomandibular advancement with simultaneous articular disc repositioning (MMA-Drep) have their condyles moved down, forward, lateral, or medially (**Fig. 6**). One year after surgery, more than one half the patients in the 2 groups presented condylar resorptive changes of at least 1.5 mm and, interestingly, only the MMA-Drep patients showed bone apposition in localized condylar regions.

Articular disc repositioning seemed to promote a protective function that was demonstrated by limited condylar resorption at the anchor region and bone apposition at all other condylar surfaces being the lateral pole the most frequent region (**Fig. 7**). An ongoing study further compared the 2 groups mentioned (MMA × MMA-Drep), now with a surface correspondent analysis based on spherical harmonics (SPHARM-PDM; open-source, available at: http://www.nitrc.org/projects/spharm-pdm)[59,60] that allows correspondent surface measurements among 2 or more 3D volumes from the same patient. In this study, maxillomandibular stability was also addressed and it was concluded that patients with TMJ disc displacement submitted to maxillomandibular advancement and articular disc repositioning have the

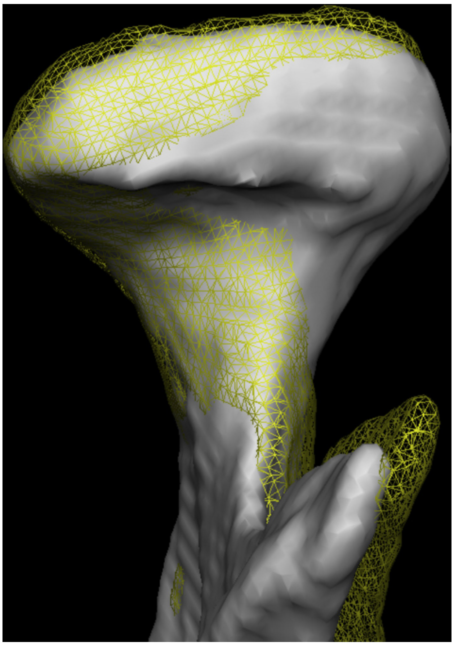

Fig. 5. Maxillomandibular advancement (MMA) group left condyle superimposition. Preoperatively (T1) solid 3-dimensional model in white and (T2) yellow in wiremesh overlay immediate postoperatively show condylar spatial change in upward, backward, and medial directions. (*From* Goncalves JR, Wolford LM, Cassano DS, et al. Temporomandibular joint condylar changes following maxillomandibular advancement and articular disc repositioning. J Oral Maxillofac Surg 2013;71(10):1759.e1–15; with permission.)

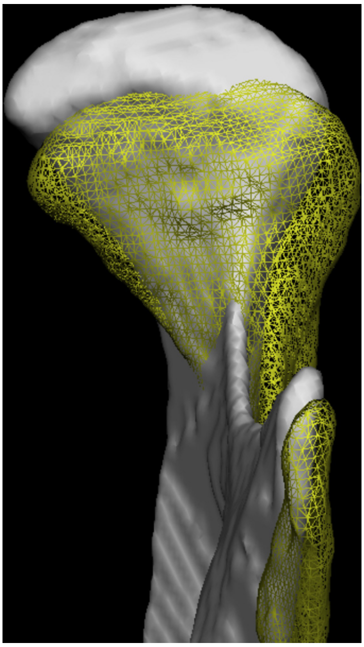

Fig. 6. Maxillomandibular advancement disc repositioning (MMA-Drep) group left condyle superimposition. Preoperatively (T1) solid 3-dimensional model in white and (T2) yellow in wiremesh overlay immediate postoperatively show condylar spatial change in downward, forward, and medial directions. (*From* Goncalves JR, Wolford LM, Cassano DS, et al. Temporomandibular joint condylar changes following maxillomandibular advancement and articular disc repositioning. J Oral Maxillofac Surg 2013;71(10):1759.e1–15; with permission.)

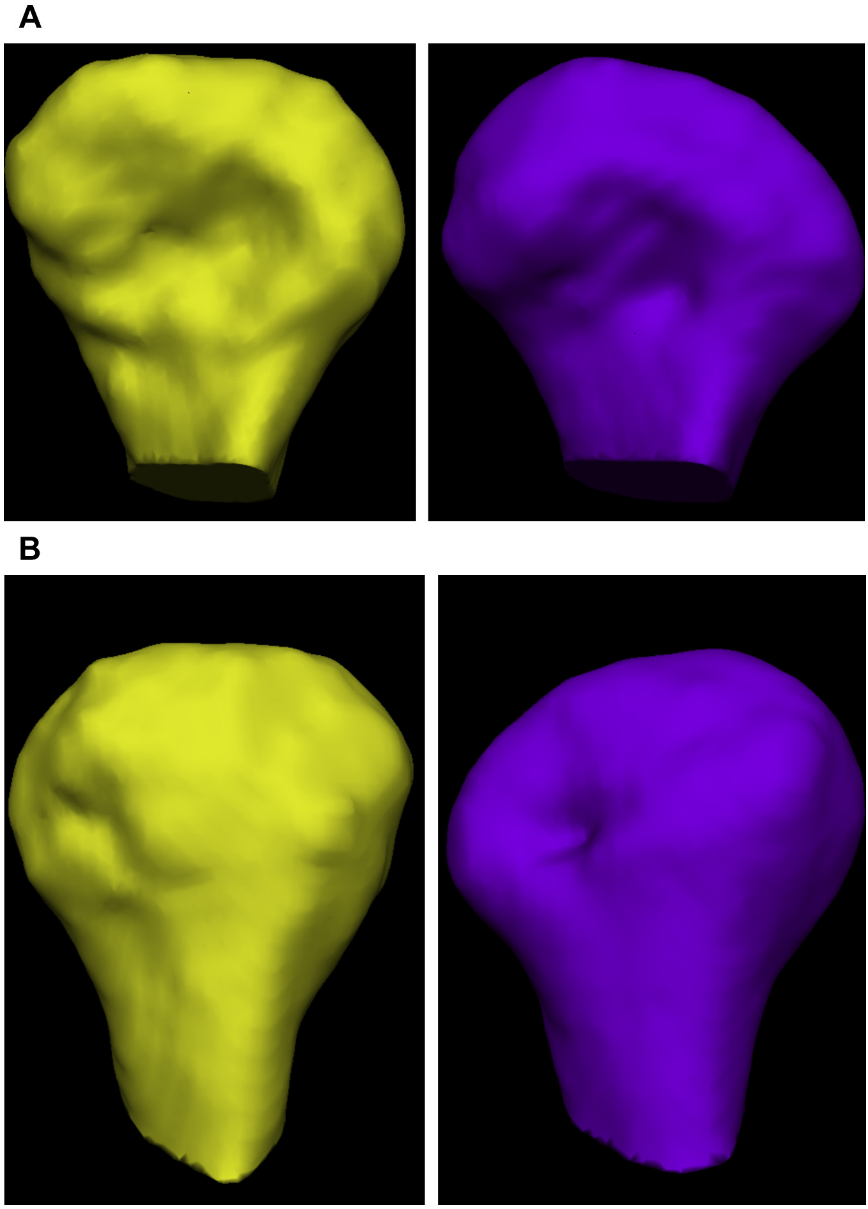

Fig. 7. (*A*) Maxillomandibular advancement disc repositioning (MMA-Drep) group left condyle anterior view. Immediately postoperative (T2) solid 3-dimensional (3D) model in yellow and (T3) 1-year follow-up in purple show condylar bone apposition in anterior, medial, and lateral surfaces. (*B*) MMA-Drep Group left condyle posterior view. Immediately postoperative (T2) solid 3D model in yellow and (T3) 1-year follow-up in purple show condylar bone apposition in posterior surface, and medial and lateral poles. Note bone resorption at the anchor region. (*Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

same stability as patients with normal TMJs submitted to maxillomandibular advancement only.

There are 3D quantitative analyses that have suggested that orthognathic surgery does not fix the TMJs and possibly will increase joint loading (observed even in patients with normal TMJs),[4] demonstrated by the significant reduction of TMJ space. This fact has been demonstrated before with plain radiographs,[61] cross-sectional computed tomography images,[62,63] and with 3D quantitative analysis,[4,64,65] showing that mandibular advancement promotes an upward, backward, and medial condyle displacement with likely change of the disc/condyle spatial relation. Individuals who received articular disc repositioning have their condyles moved in the opposite direction: Downward and forward to make room for the discs that preserved the overall condylar morphology.[4]

The relevance of 3D quantitative assessment with open-source software specifically designed for this purpose is the automatic algorithm used that dramatically decreases user interference and the possibility of unintentional bias.[59,66,67] This method also increases reliability because open source software can be freely evaluated over the Internet and the experiments can be replicated exactly the same way as initially presented in the literature, without the need for commercial software.

SURGICAL TECHNIQUE AND POSSIBLE PITFALLS

Annandale first described surgical repositioning of the displaced temporomandibular articular disc in 1887[68]; however, it was not until 1978 when Wilkes used arthrography to describe the anatomy, form, and function of the TMJ that disc repositioning became an accepted surgical technique.[69,70] Other surgeons, however, did not experience similar success, and this led to the development of modified techniques for disc repositioning surgery.[2,71–81] Some authors have proposed arthroscopic suturing techniques to reposition the disc.[82–86] Although various claims have been made, the reliability of an arthroscopic approach for predictably repositioning and stabilizing the disc in the TMJ has not been documented. The aim of this article was to evaluate our treatment outcomes with the use of the Mitek mini anchor in TMJ articular disc repositioning surgery.

Mitek Mini Anchor

Mitek anchors were originally developed for use in orthopedic surgery procedures such as rotator cuff repair, medial and lateral collateral ligament repair, bicep tendon reattachment, and other muscle, ligament, and tendon repair procedures.[2,87,88] Although available in various sizes, the Mitek mini anchor is the most adaptable Mitek anchor for TMJ disc stabilization. The successful use of the device for TMJ articular disc repositioning has been previously reported in the literature by Wolford and colleagues.[2,24,25,72] The United States Food and Drug Administration approves the use of the Mitek mini anchor specifically for use in the TMJ.

The Mitek mini anchor is cylindrical, measuring 1.8 mm in diameter and 5.0 mm in length. The body of the anchor is composed of titanium alloy (titanium 90%, aluminum 6%, vanadium 4%), and its arcs are composed of a nickel–titanium alloy (Nitinol), utilizing super elastic shape memory properties. An eyelet in the posterior aspect of the anchor allows placement of sutures that can function as artificial ligaments (Fig. 8).

Simultaneous surgical treatment would include repositioning the TMJ disc into a normal anatomic, functional position and stabilize it using the Mitek anchor (Mitek Surgical Products) technique[1–3,5,24–26,30] and then performing the indicated orthognathic surgery. The Mitek anchor technique uses a bone anchor that is placed into the lateral aspect of the posterior head of the condyle and the anchor will subsequently osseointegrate. Two 0-Ethibond sutures (Ethicon Inc., Somerville, NJ, USA) are attached to the anchor and are used as artificial ligaments to secure and stabilize the disc to the condylar head (Fig. 9).

High Success Rate with Disc Repositioning

Situations where the disc repositioning with the Mitek anchor has a high success rate:

1. Disc repositioning at the onset of displacement within 4 years of displacement provides the greatest predictability of outcome.
2. Adolescent internal condylar resorption patients who are treated within the first 4 years of disease onset.

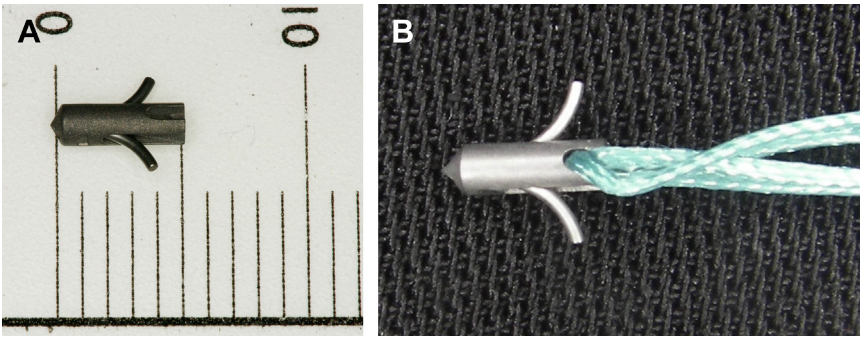

Fig. 8. (*A*) Body of the Mitek mini anchor is 1.8 × 5 mm and is composed of titanium alloy with wings of nickel titanium. (*B*) A doubled size 0 Ethibond suture has been passed through the eyelet of the Mitek mini anchor and these sutures function as artificial ligaments to stabilize the disc in the proper position.

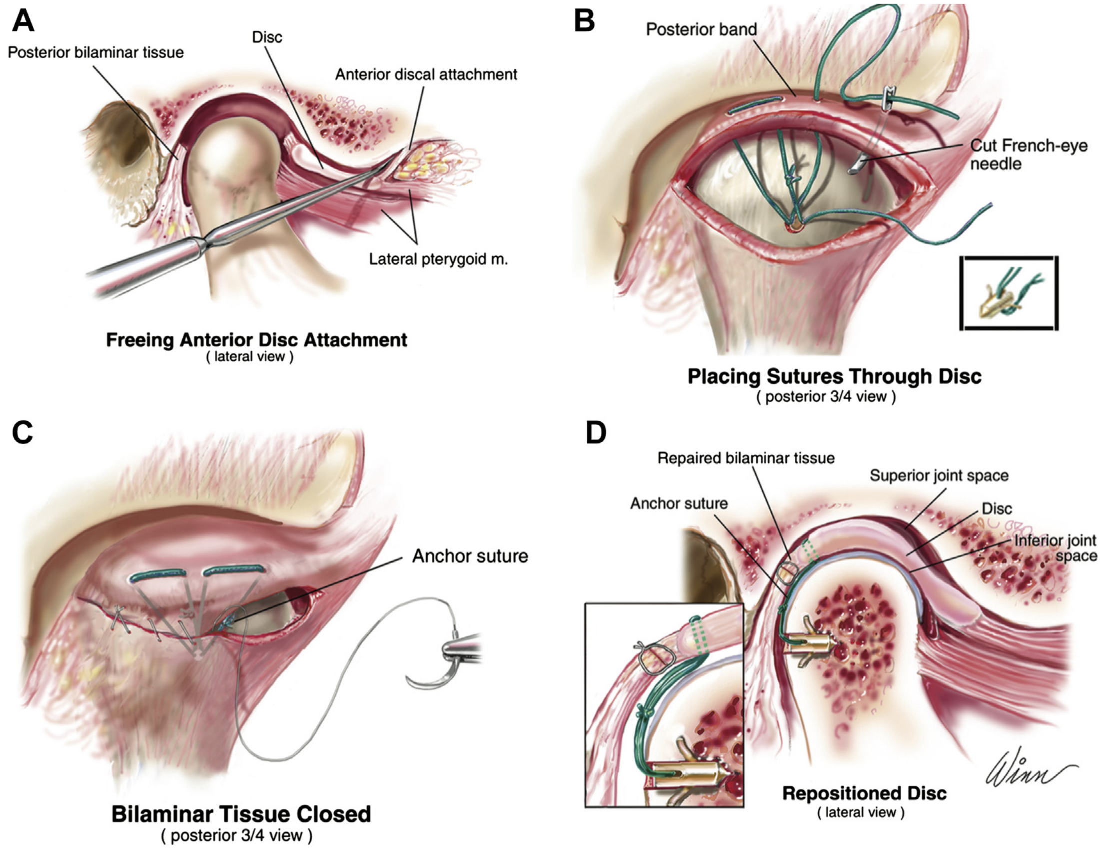

Fig. 9. (*A*) In the use of the Mitek anchor to stabilize the articular disc, the joint first is exposed and the excessive bilaminar tissue excised. To mobilize the disc, the anterior attachment of the disc to the articular eminence is released so the disc can be positioned over the condyle passively. (*B*, *C*) The Mitek Mini Anchor (insert) has an eyelet that will support two 0-Ethibond sutures that can function as artificial ligaments. The anchor is inserted into the posterior head of the condyle lateral to the mid-sagittal plane and 5 to 8 mm below the top. One suture is placed in a mattress fashion through the medial aspect of the posterior part of the posterior band. The other suture is placed more lateral through the posterior band. (*D*) Cross-sectional sagittal view shows the Mitek anchor positioned in the condyle with the artificial ligaments attached to the disc to stabilize it to the condylar head. (*Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

3. No significant intracapsular inflammation, especially in the bilaminar tissues.
4. No history of connective tissue autoimmune diseases, such as rheumatoid arthritis, juvenile idiopathic arthritis, psoriatic arthritis, Sjögren syndrome, scleroderma, lupus, or ankylosing spondylitis.
5. Good remaining anatomy of the disc.
6. Reducing discs provide betters outcomes compared with nonreducing discs.
7. No other joint involvement.
8. No recurrent gastrointestinal, urinary, or respiratory tract problems.
9. No history of sexually transmitted diseases.

Successful surgical technique is the result of careful observation of details through a sequence of steps that have paramount importance. This section describes TMJ articular disc repositioning with all anatomic and surgical sequences that have proven to be effective and safe. Furthermore, it highlights possible mistakes that commonly affect outcomes.

Description of Procedure

A precise surgical intervention is paramount to obtain predictable outcomes; we present a detailed, step-by-step guide for a successful disc repositioning surgery.

Step 1

The patient is taken to the operating room and nasoendotracheal intubation is performed by the anesthesiologist. This is important, because it aids in the sterility of the field by allowing the surgeon to isolate the mouth of the patient using a tegaderm or ioband. It also helps in manipulating the patient's

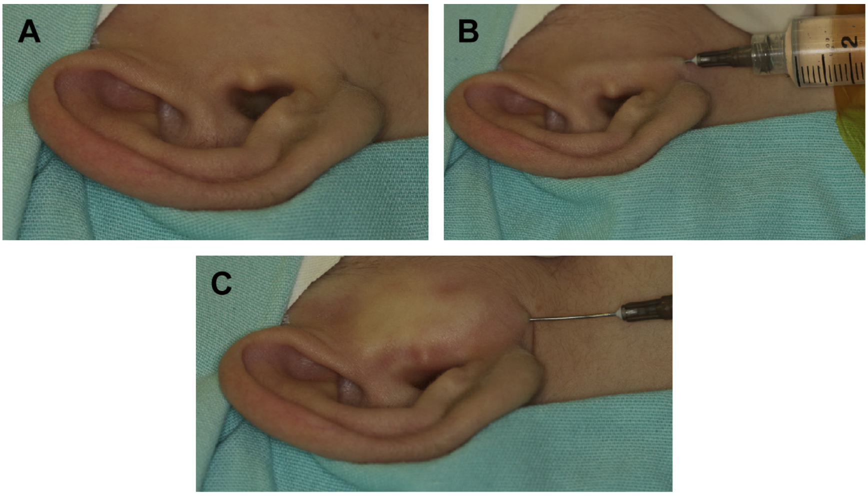

Fig. 10. (*A–C*) Preauricular site is injected with 5 mL of 1% lidocaine 1:100,000 epinephrine in a subcutaneous plane.

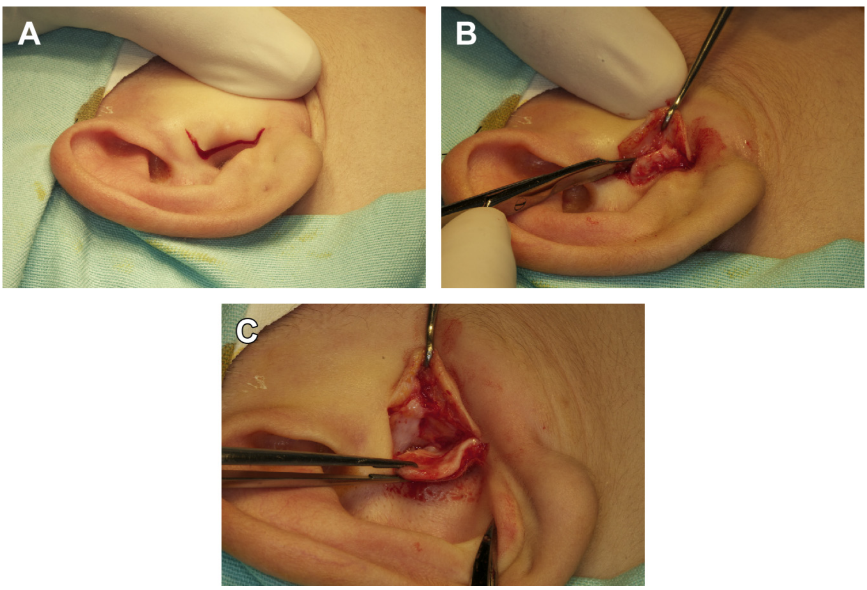

Fig. 11. (*A*) Modified endaural incision with #15 blade. (*B*) Sharp dissection with fine Iris scissors. (*C*) Tragal cartilage isolated 12 to 15 mm to the subcutaneous tissue.

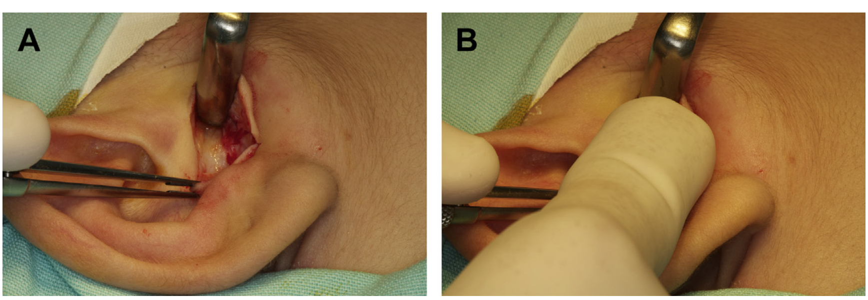

Fig. 12. (*A*) Long pickup holding the tragal cartilage backward and the small retractor showing the zygomatic area. (*B*) Digital manipulation to identify the zygomatic arch and to feel the condylar head.

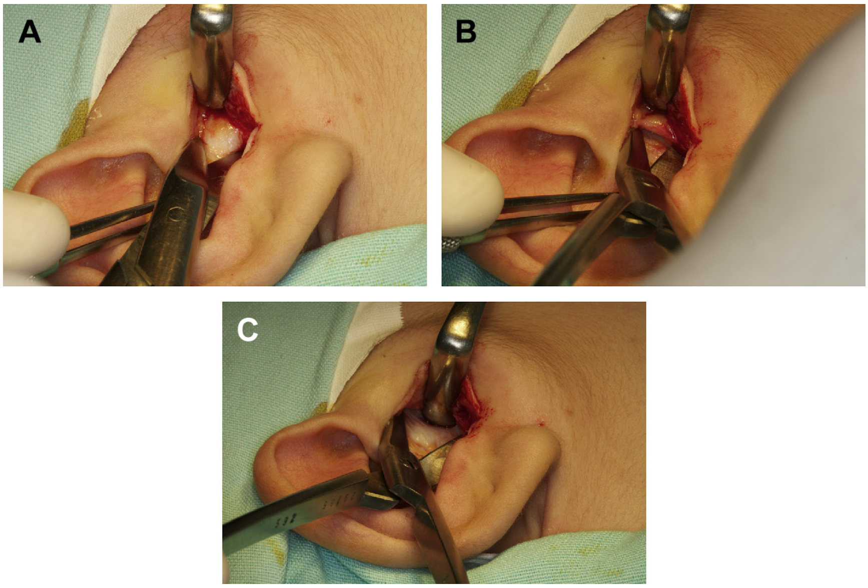

Fig. 13. (*A*) Sharp dissection with Dean scissors perpendicular to the arch 8 mm in front of the tragal cartilage. (*B*) Blunt dissection carried to the temporalis muscle fascia, below the fat tissue. (*C*) Blunt dissection is extended anteriorly to expose the articular eminence.

mouth while maintaining sterility and it permits the assessment of the occlusion during surgery.

Step 2

Bilateral preauricular sites are injected with 5 mL of 1% lidocaine 1:100,000 epinephrine in a subcutaneous plane (Fig. 10).

Possible Pitfalls: If you do not inject lidocaine, you will have more bleeding during the endaural incision and dissection of the subcutaneous plane.

Step 3

With a #15 blade, a modified short endaural incision is made with extension of 5 mm anterosuperiorly and 3 mm anteroinferiorly. Sharp dissection with fine Iris scissors is carried from tragal cartilage down approximately 12 to 15 mm to the subcutaneous tissue (Fig. 11). The prearicular approach is also preferred by some surgeons.

Possible Pitfalls: If you do not make the correct extension of endaural incision, you will not have a good surgical field to work in the TMJ; if you do not pay attention in the tragal cartilage during the sharp dissection, you can damage the cartilage, increasing the risk of perforating the external auditory meatus. The preauricular approach results in a more visible scar.

Step 4

Digital manipulation is done to identify the zygomatic arch and the condyle into the fossa when the mandible is moved laterally (Fig. 12).

Possible Pitfalls: If you do not do digital manipulation to identify the zygomatic arch you can incise in the wrong place, and potentially injure the frontal branch of cranial nerve VII or the external auditory canal.

Step 5

At this level, on top of the zygomatic arch, 8 mm in front of the tragal cartilage, blunt dissection is made with Dean scissors, perpendicular to the arch, carried to the temporal muscle fascia, below of the fat tissue. The dissection is extended anteriorly to expose the articular eminence (Fig. 13).

Possible Pitfalls: Visualizing the superficial layer of the deep temporal fascia is key in protecting the facial nerve.

Step 6

With a #9 periosteal elevator, the lateral rim of the glenoid fossa is demarcated (Fig. 14).

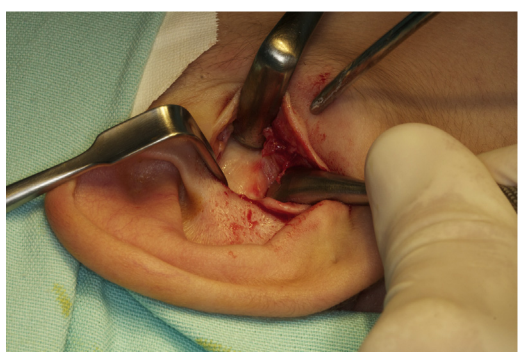

Fig. 14. Lateral rim of the glenoid fossa is demarcated.

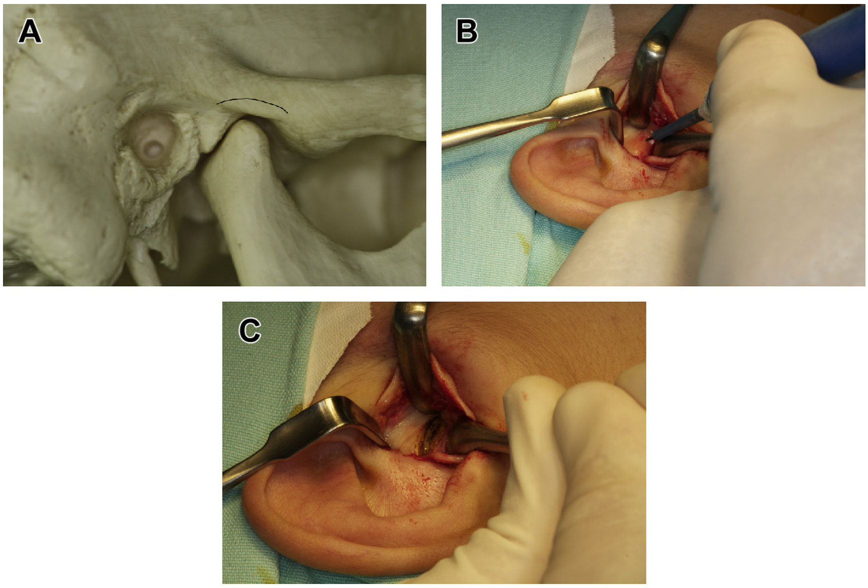

Fig. 15. (*A*) Extension of the C incision in the zygomatic arch. (*B*, *C*) Using Bovie electrocautery, a circular linear incision is performed on top of the arch, following the shape of the glenoid fossa.

Possible Pitfalls: This marking helps in delineating and identifying the condyle and protects the TMJ before the incision over the zygomatic arch.

Step 7

Using Bovie electrocautery, a curved linear incision is performed on top of the arch, following the shape of the glenoid fossa (**Fig. 15**).

Possible Pitfalls: The incision has to stay on bone on top of the arch to prevent inadvertent damage to the disc and fibrocartilage of the superior joint space.

Step 8

With a periosteal elevator, the fossa tissues are reflected inferiorly and laterally to expose inner capsule of the TMJ (**Fig. 16**).

Possible Pitfalls: If you do not reflect tissues to expose the inner capsule, you will have difficulty entering the superior joint space.

Step 9

Approximately 3 mL of 1% lidocaine 1:100,000 epinephrine is injected into the superior joint space to hydraulically displace the disc inferiorly. You can observe the mandible moving forward (**Fig. 17**).

Possible Pitfalls: This step hydraulically displaces the disc inferiorly and makes the access to the superior joint space safer.

Step 10

The lateral capsular attachments are incised superficially with a #15 blade 45° from inferior to superior aspect. The superior joint space is entered superficially with a freer elevator (**Fig. 18**).

Possible Pitfalls: The angulation of the blade is important in protecting the articular disc and the use of a freer elevator prevents scuffing and scratching of the fibrocartilage at the fossa, decreasing the risk of adhesions.

Step 11

Using Dean scissors, the lateral capsular attachments are cut along the margin of the glenoid fossa and articular eminence (**Fig. 19**).

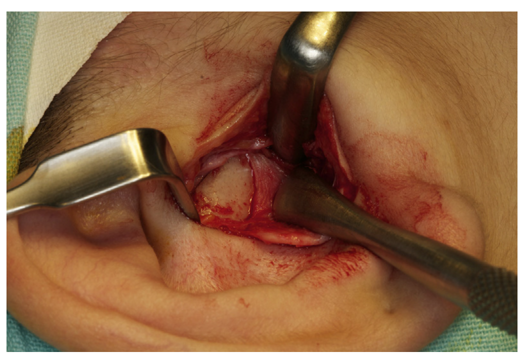

Fig. 16. With a periosteal elevator, the fossa tissues are reflected inferiorly and laterally to expose to the lateral capsule of the temporomandibular joint.

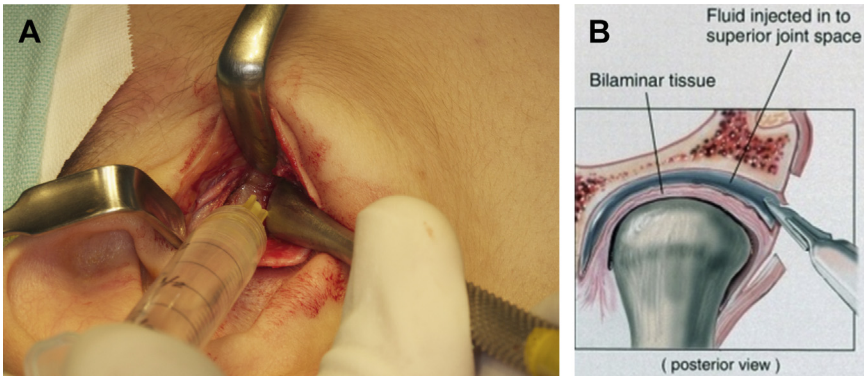

Fig. 17. (*A*) Lidocaine 1:100,000 epinephrine is injected into the superior joint space. (*B*) Anesthetic hydraulically displace the disc inferiorly to make an incision in the capsule securely. ([*B*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

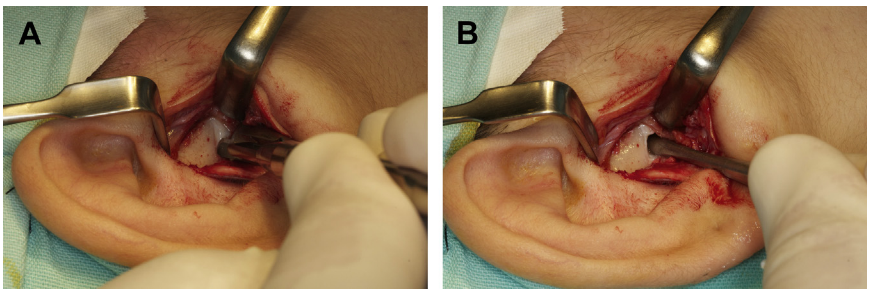

Fig. 18. (*A*) The lateral capsular attachments are incised with a #15 blade. (*B*) The superior joint space is entered with a freer elevator.

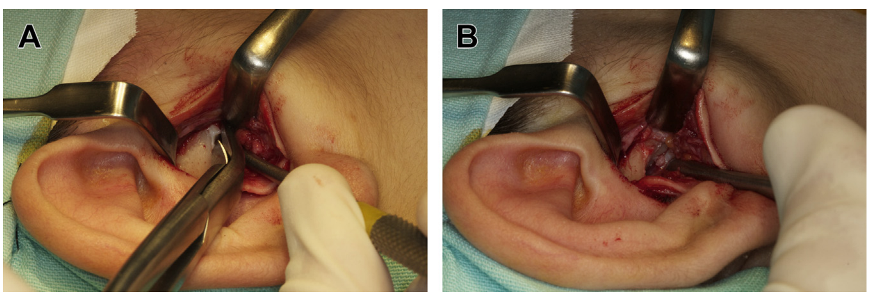

Fig. 19. (*A*, *B*) The lateral capsular attachments are dissect with Dean scissors countering the glenoid fossa beyond the articular eminence.

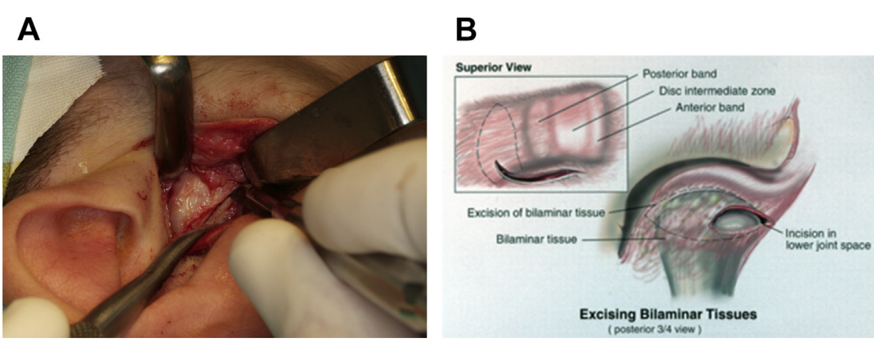

Fig. 20. (*A*, *B*) Using a #15 blade the lateral capsule is incised 10 mm below the lateral pole of the condyle from posterosuperior to inferoanterior aspect. ([*B*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

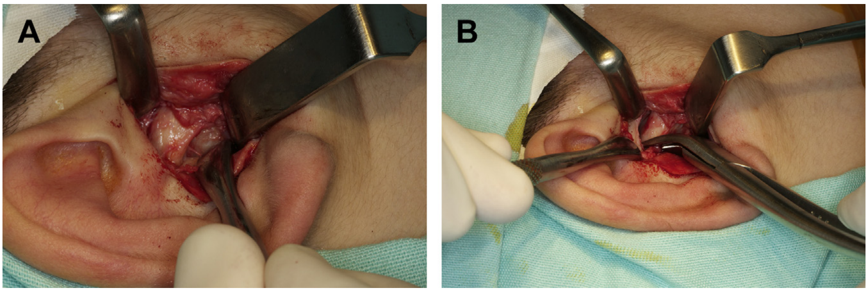

Fig. 21. (*A*) Using a #9 periosteal elevator, the condyle is dissected inferiorly. (*B*) Using the Dean scissors, the bilaminar tissue is cut around the posterior aspect of the condyle.

Possible Pitfalls: Failure to adequately dissect the capsular attachments at the glenoid fossa will cause limited visibility and greater difficulty in mobilizing the articular disc.

Step 12

Using a #15 blade, the lateral capsule is incised just above the lateral pole of the condyle from posterosuperior to inferoanterior (**Fig. 20**). The incision is made at this level to maintain and maximize soft tissue attachment and vascularity to the condyle.

Possible Pitfalls: Care must be taken to minimize damage to the fibrocartilage of the fossa and condylar head, as well as the disc, because injury to these structures can promote the formation of adhesions and degenerative changes postoperatively.

Step 13

Using a periosteal elevator, the condyle is retracted inferiorly to create a space to insert the Dean scissors and cut the bilaminar tissue around the posterior aspect of the condyle until the medial wall of the fossa is reached (**Fig. 21**).

Possible Pitfalls: If a piece of the retrodiscal tissue is not removed, there will not be adequate space to reduce the articular disc and the condyle may be displaced forward. Also, access and visibility will be limited.

Step 14

In cases of anterior displacement, it is often necessary to free the disc anteriorly where the ligament attaches from the anterior band of the disc to the anterior slope of the articular eminence; sometimes, it is necessary to release the medial attachments as well.

Possible Pitfalls: The anterior release is critical to passively reposition the disc. Sometimes, a medial release is also necessary.

Step 15

Using a Mitek drill bit (2.1 mm diameter) with a built-in stop, a 2×10-mm hole is made in the posterior head of the condyle. The position of the anchor may vary slightly from case to case, but is generally positioned 8 to 10 mm below the superior aspect of the condyle, and just lateral to the midsagittal plane. It is not necessary to strip soft tissue from the posterior condyle for hole preparation, and generally the hole is drilled through the periosteum to maximize soft tissue attachment and blood supply to the condyle.

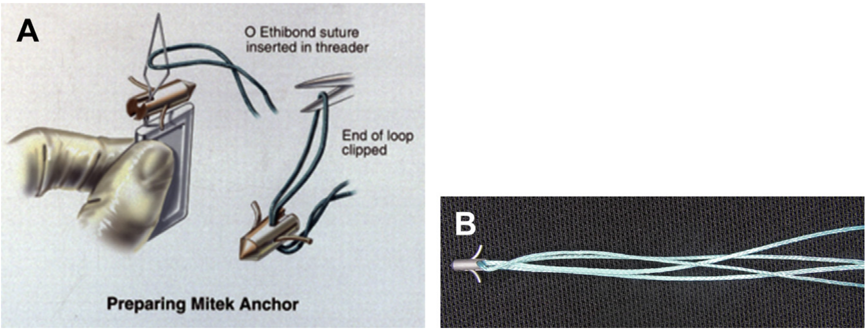

Fig. 22. (*A*, *B*) A doubled size 0 Ethibond suture has been passed through the eyelet of the Mitek mini anchor, and the loop is cut, thereby yielding 2 separate strands of suture material. ([*A*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

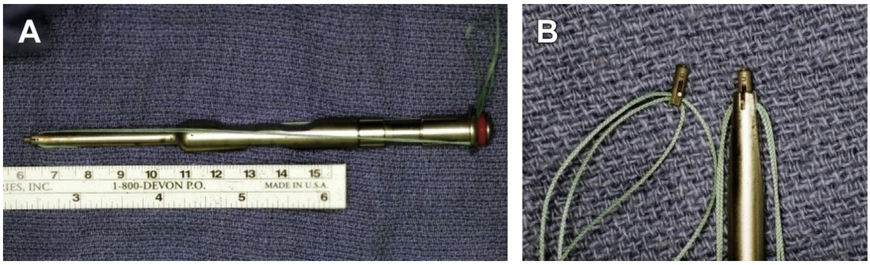

Fig. 23. (*A*, *B*) The anchor is then loaded onto an inserting device used to place the anchor in the condyle.

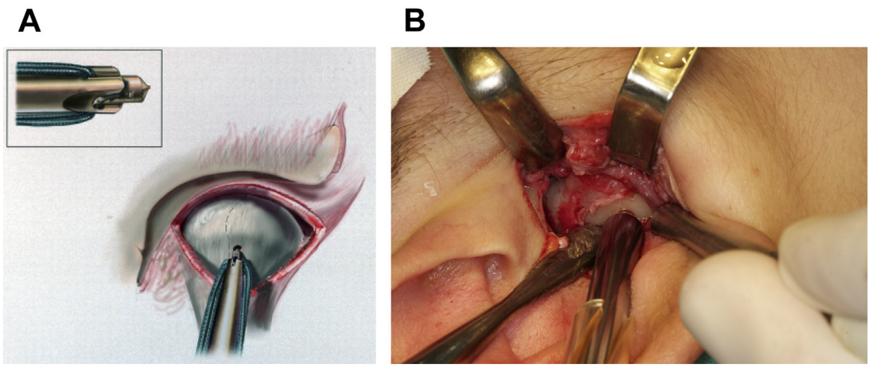

Fig. 24. (*A*, *B*) The 1.8-mm titanium Mitek anchor is then placed into the prepared hole. ([*A*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

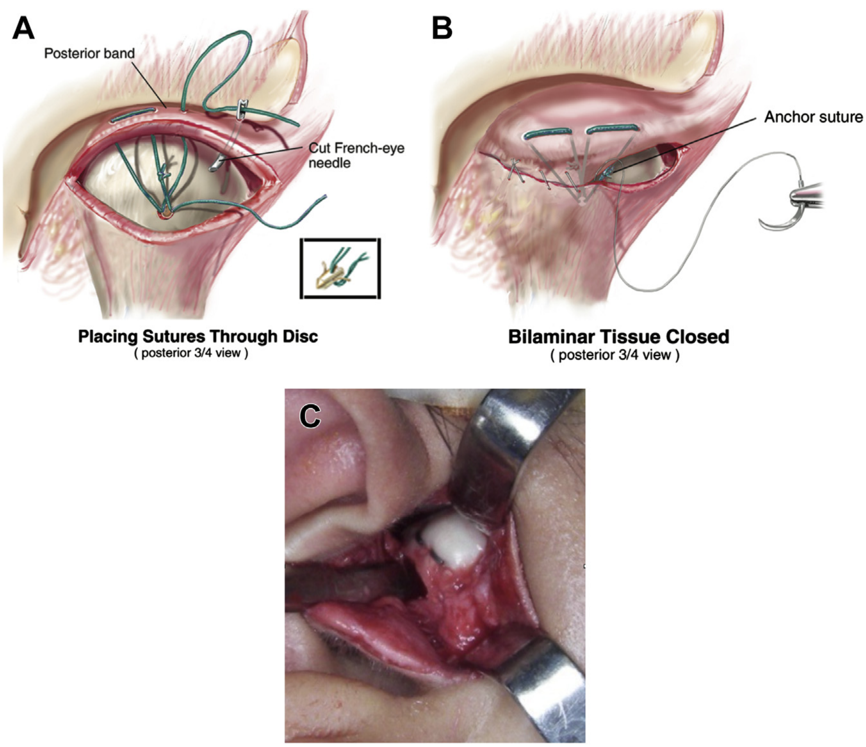

Fig. 25. (*A–C*) The anchor is inserted into the posterior head of the condyle lateral to the mid sagittal plane and 5 to 8 mm below the top. One suture is placed in a mattress fashion through the medial aspect of the posterior part of the posterior band. The other suture is placed more lateral through the posterior band. These sutures function as artificial ligaments to stabilize the disc in the proper position. ([*A*, *B*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

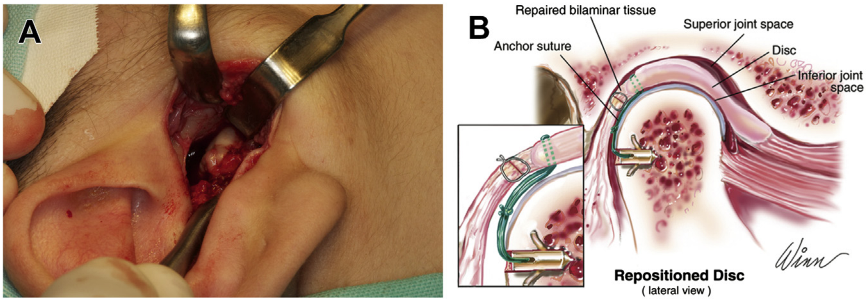

Fig. 26. (*A*) Disc is well-secured in new optimal position. (*B*) Cross-sectional sagittal view shows the Mitek anchor positioned in the condyle with the artificial ligaments attached to the disc to stabilize it to the condylar head. ([*B*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

Possible Pitfalls: The position of the anchor can be modified to suit the type of reduction necessary.

Step 16

Before placing the implant, 1 size 0 polyester or other nonresorbable braided suture is doubled and threaded through the eyelet of the anchor (**Fig. 22**). The suture loop is then cut, thereby making 2 separate strands, and the anchor is placed into an inserting device (**Fig. 23**).

Possible Pitfalls: If you do not use a threader you will have difficulty to inserting the 0 Ethibond into the eyelet of the anchor.

Step 17

The 1.8-mm titanium Mitek anchor is then placed into the prepared hole using a special delivery device, and using hand pressure, the trigger is advanced, delivering the anchor below the cortical bone level into the softer medullary bone of the condyle (**Fig. 24**).

Possible Pitfalls: Failure to place the anchor into an inserting device with the permanent suture into the eyelet of the anchor will cause difficulty during the insertion of the anchor inside the hole and can break the wings.

Step 18

Using an 8-mm modified French-eye needle, the 2 sutures are then attached to the disc in a mattress or running fashion from the posteromedial to posterolateral aspect of the disc to reposition it in correct position on top of the condylar head (**Fig. 25**). The sutures are securely tightened and positioned with a double knot and 3 simple knots (**Fig. 26**). The condyle is manipulated in various directions noting the disc and condylar unit moved harmoniously and the disc well-secured in its new, optimal position.

Possible Pitfalls: The use of a double knot or a surgeon's knot is necessary to secure the suture as close as possible to the condylar head and stabilize the anchor.

Step 19

The surgical site is then profusely irrigated and the lateral capsule is sutured back into position.

Possible Pitfalls: If you do not irrigate the surgical site with saline solution, you will increase the risk of infection. If you do not suture the lateral capsule, you will not stabilize the disc laterally and it will take longer to heal the joint.

Step 20

A layered closure of the incision is completed with 4–0 Polydioxanone (PDS) for the deep tissue of temporomandibular fascia (**Fig. 27**) and to approximate the subcutaneous tissue of the endaural incision (**Fig. 28**). The skin is closed in a subcuticular fashion (**Fig. 29**).

CLINICAL CASE

A 19-year-old woman presented with bilateral TMJ anteriorly displaced articular discs (confirmed by MRI). Intermediate zone criteria is the location of the intermediate zone of the disk in relation to the condyle and the articular eminence. Using this criterion, we can observe articular disc displacement (**Fig. 30**). She had vertical excess

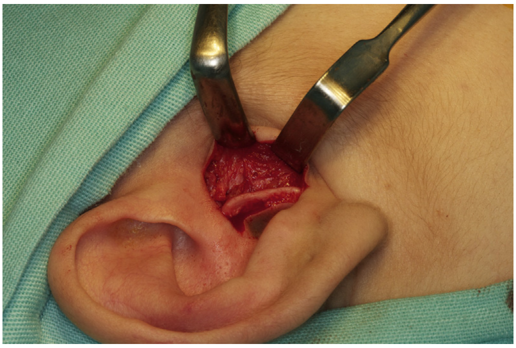

Fig. 27. A layered closure of the incision is completed with 4–0 PDS for the deep tissue of temporomandibular fascia.

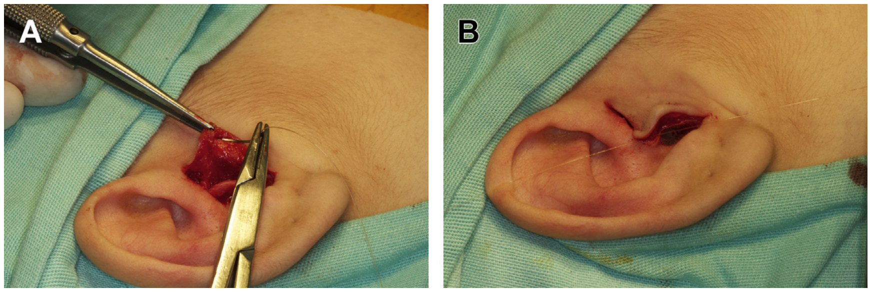

Fig. 28. (*A*, *B*) Approximation of the subcutaneous tissue of the endaural incision.

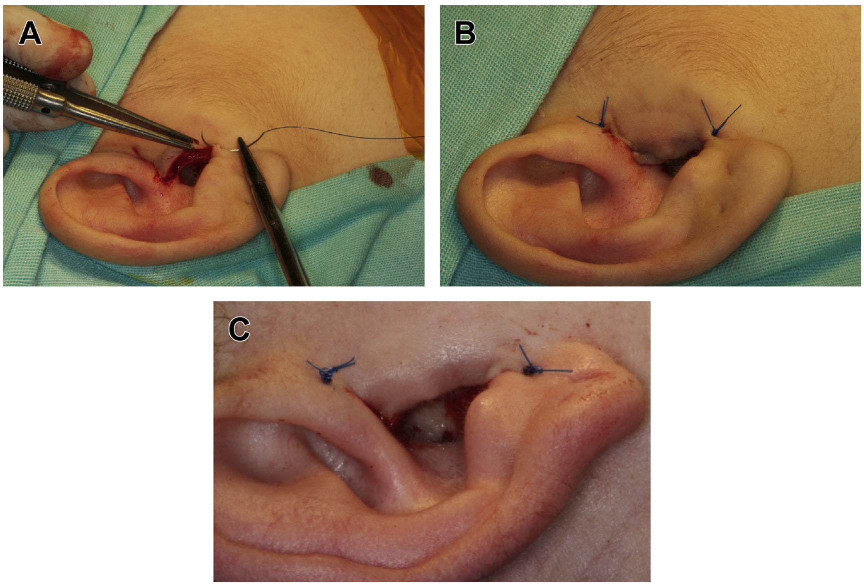

Fig. 29. (*A*–*C*) To close the skin, 5–0 Prolene is used in a subcuticular fashion.

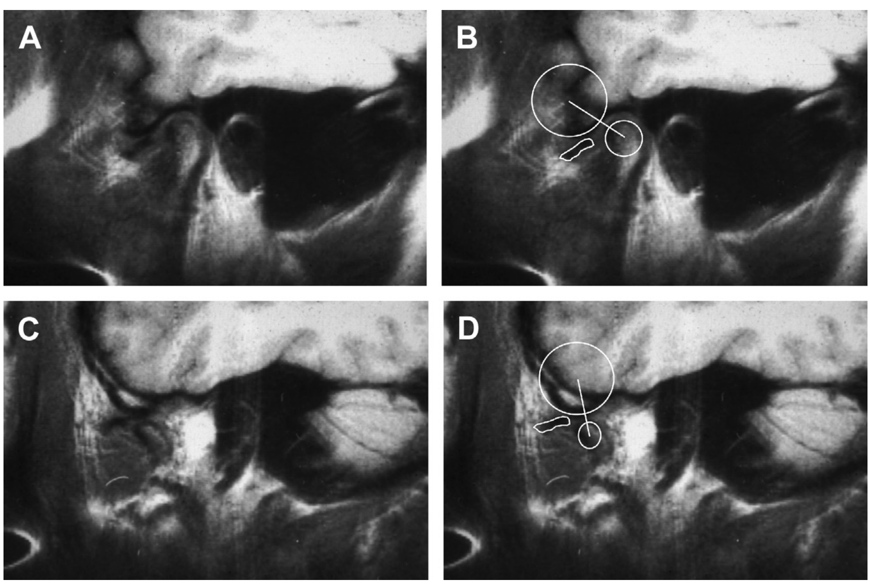

Fig. 30. (*A*, *B*) MRI of a temporomandibular joint showing a significantly anterior displaced articular disc using Intermediate Zone (IZ) criteria. (*C*, *D*) On opening, the disc remains anteriorly displaced and nonreducing with degenerative changes using IZ criteria. (*Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

of maxilla, lip incompetence, facial asymmetry, mandible retruded, high occlusal plane angle, and class II skeletal and occlusal dentofacial deformity (**Figs. 31** and **32**). She complained of moderate to severe TMJ pain, headaches, and myofascial pain, as well as clicking in the TMJs and difficulty eating. After orthodontic preparation, surgery was performed in a single operation, including bilateral TMJ disc repositioning with Mitek anchors, bilateral mandibular ramus sagittal split osteotomies and multiple maxillary osteotomies for maxillomandibular counterclockwise advancement at the pogonion. At 2 years postoperatively, the patient demonstrated good stability, esthetics, symmetry, smile, and occlusion with elimination of TMJ pain, headaches, myofascial pain, and TMJ noise, as well as improved jaw function and facial esthetics.

Fig. 31. (*A*, *C*) This 19-year-old woman presented with bilateral articular disc displacement and temporomandibular joint (TMJ) dysfunction. The mandible is significantly retruded, with a high occlusal plane angle and associated facial morphology. (*B*, *D*) The same patient 2 years after undergoing bilateral TMJ articular disc repositioning with Mitek mini anchors and simultaneous double jaw orthognathic surgery. (*Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

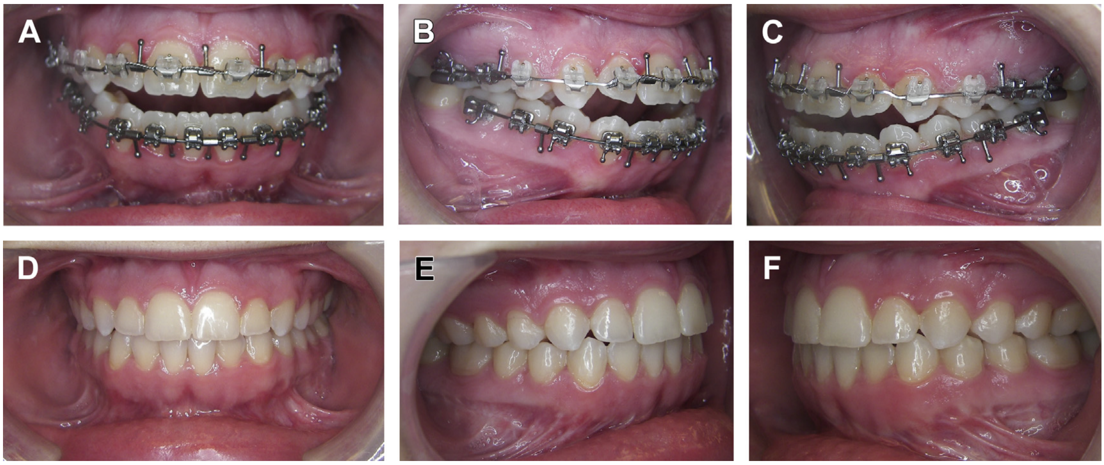

Fig. 32. (*A–C*) Preoperative occlusion demonstrating an anterior open bite and class II occlusal relationship. (*D–F*) The occlusion remained stable 2 years postoperatively. ([*B*] *Courtesy of* Larry M. Wolford, DMD, Dallas, TX.)

SUMMARY

Scientific evidence with regard to the effectiveness of TMJ disc repositioning remains scarce and needs further efforts to guide clinicians and patients among the clinical and surgical options to better treat TMJ internal derangement, mainly when associated with skeletal malocclusion that requires surgical interventions. Although scarce, we have reviewed several papers that showed outcomes after TMJ articular disc repositioning. These studies were undertaken with lateral cephalometric radiographs, tomograms, cone-beam computed tomography, MRIs, and visual analog scale assessments for reported pain and function. The lack of evidence that TMJ articular disc repositioning is an ineffective procedure points to a future when new TMJ biomarkers will support the technique effectiveness in more rigorously controlled studies.

Because this is a sensitive technique with a wide learning curve, many surgeons have practiced TMJ articular disc repositioning with a large range of outcomes. In this article, we have reviewed all the main steps for a successful surgery and the most frequent pitfalls that can compromise the procedure. Adequate training is important for achieving the best results possible.

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