



The Intraoral Vertical Ramus Osteotomy

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Rebeka G. Silva

Abstract

The intraoral vertical ramus osteotomy (IVRO) has a distinct advantage over other TMJ surgeries; the joint capsule and intracapsular structures are preserved, and the surgery has a low complication rate. For selected patients with symptomatic anterior disc dislocation, the IVRO is a classic operation that can unload the joint as well as reposition it more favorably under the disc. The new condylar position can be characterized as an increase in the superior joint space dimension and a slightly more anterior angulation of the joint head. Patient selection is important, due to the need to maintain control over the occlusion through the use of maxillomandibular fixation for several weeks.

5.1 Introduction

The concept of joint preservation, including preservation of the (displaced) disc and synovium, is attractive to many surgeons who wish to take a more conservative surgical approach with selected TMD patients. One is tempted to be more conservative, perhaps, for the younger patient, with the idea that the condylotomy, also known as the intraoral vertical ramus osteotomy (IVRO), will keep the joint mechanism “virgin” and that the surgery will not close the door for later successful intracapsular surgery should the need arise. Similarly, older patients who may not be outstanding candidates for longer surgeries with higher bleeding risk may do well and get relief from painful opening with a condylotomy.

R. G. Silva (✉)

Oral and Maxillofacial Surgery, San Francisco VA Health Care System,
University of California San Francisco, San Francisco, CA, USA

Private Practice, Dental Implant and Oral Surgery of San Francisco, San Francisco, CA, USA
e-mail: rebeka.silva@va.gov

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Physiologic changes in disc position can produce changes in joint movement, joint noise, and pain if the patient is not able to adapt. A displaced disc that causes pain or limitation in maximum opening seems like a perfect candidate for repositioning and stabilization to the joint head, but why not bring the joint to the displaced disc instead? The net result is that the new joint position, guided by the surrounding muscular envelope, is similar to what is achieved through the use of an anterior repositioning splint. H. David Hall described the IVRO in 1975 as an alternative to the sagittal split osteotomy and the *extraoral* vertical ramus osteotomy for surgical treatment of mandibular prognathism [1]. In 1987 Hall reported on his series of patients who underwent IVRO for malocclusion after he modified his technique in 1977, and the modifications, which included a longer period of maxillomandibular fixation (MMF) and a less aggressive approach to stripping of the medial pterygoid muscle from the proximal segment, resolved some of the problems associated with the technique such as open bite and excessive condylar sag [2].

The idea that a fractured condylar neck could relieve TMD symptomatology is attributed by Hall to one of a few English surgeons in the late 1940s [3], although other sources point to a surgeon using the technique for correction of malocclusion as early as 1925 [4]. Early proponents created an osteotomy that was short and subcondylar, to mimic a subcondylar fracture. To decrease the incidence of inadvertent medial displacement or anterior displacement of the condylar head with respect to the eminence, the osteotomy orientation was changed to be more vertical, thus the change in name from “subcondylar osteotomy” to “intraoral vertical ramus osteotomy,” also known as the *modified condylotomy*. For the purposes of this chapter, we shall use the terms interchangeably as long as it is understood that the original condylotomy was a very different surgery from the present-day IVRO. Initially, a softly curved osteotomy was advocated, giving it a slight C-shape to avoid the lingula (Fig. 5.1a). Later, to reduce the incidence of inferior alveolar nerve injury, Hall proposed eliminating the curved cut in favor of a much straighter and easier cut through the ramus to create a butt joint between the proximal and distal segments, with or without lateral overlap of the proximal segment (Fig. 5.1b) [3, 5]. He recognized the value of the IVRO to increase the superior joint space through a controlled sag of the condylar head and through normalization of the joint-disc relationship. Today, we must credit Hall and his contemporaries for modernizing the IVRO technique for the selected TMD patients and for carefully quantifying the results of the surgery.

5.2 Indications and Patient Selection

The contemporary “modified” *modified condylotomy* technique has several clinical goals related to the reestablishment of a normal joint head-disc relationship: (1) to reduce joint pain, (2) to improve function, and (3) to possibly decrease risk of TMD progression from simple anteriorly displaced disc with reduction to anteriorly displaced disc without reduction to more serious degenerative joint

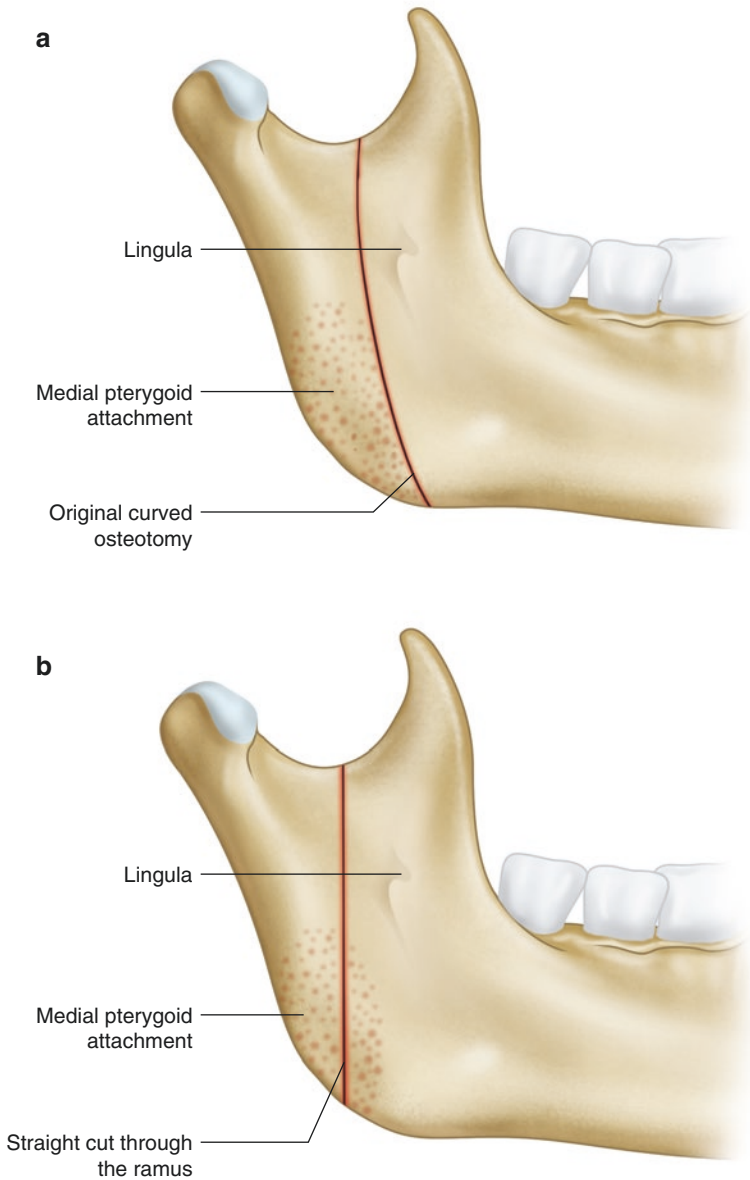


Fig. 5.1 The original osteotomy design featured a slight curve to avoid the lingula (a). The modified condylotomy is a straight cut to create a butt joint between the proximal and distal segments (b)

disease, should such disease progression be in the cards. The patients most likely to benefit from the IVRO surgery are those with a painful anteriorly displaced disc with reduction on opening and those who have acutely progressed to a non-reducing disc.

The occlusion must be controlled with MMF, or else an open bite will result. Thus, the IVRO candidate must have solid occlusion bilaterally, with teeth that have enough anatomy for good intercuspation. If the teeth are flattened due to bruxism, the surgeon will lose control of the occlusion and is advised to either create a splint to lock in the bite or select a different operation. Patients who have previously undergone a sagittal split osteotomy may be more difficult to osteotomize properly with an IVRO due to altered bone anatomy. The patient must be able to tolerate the MMF appliance for many weeks, whether a traditional arch bar is employed or an MMF device is stabilized to the bone with screws. The recommended period of MMF varies in the literature, but experience dictates that 3–4 weeks will be needed depending on the patient and perhaps his/her age, with many surgeons electing to maintain light guiding elastics for several weeks longer. Hall, in his 1996 paper, reported on his experience with reduction of postoperative MMF to 8–10 days but followed this up with guiding elastics for traction for 4½ weeks [5]. This modification, suggested by Bell et al. [6], along with the additional modifications of creating a butt joint and less stripping of the medial pterygoid muscle as previously described, resulted in 85% reduction of symptoms for patients with Wilkes stage II and early-stage III joints [5]. Prior to this technique modification, Hall reported a 72% reduction of symptoms with the older technique [7]. Based on his experience with hundreds of joints, Hall concluded that the IVRO could be offered to patients with early- and late-stage osteoarthritis as well as those with internal derangements, spanning the entire Wilkes classification.

5.3 The Counterargument

It has been argued that the ideal method of treating internal derangement should focus on the reduction of inflammation through various techniques, including decreased loading, gentle physiotherapy, anti-inflammatory medication, and restoration of normal synovial fluid through lavage. Instead, the IVRO focuses on the alteration of anatomy within the joint apparatus. The fact that a large number of adults have occult or relatively asymptomatic disc displacement speaks to the temporomandibular joint's marvelous ability to adapt to changes in the joint-disc anatomic relationship. It can also not be denied that arthrocentesis and nonsurgical arthroscopy have shown very good outcomes in comfort and maximum incisal opening, often without altering the disc position at all [8, 9]. In his commentary on the utility of the IVRO to treat TMJ conditions, Israel points out that surgeons should ask themselves which is the real problem to be corrected. Is the problem a mal-relationship of the condyle to the disc, or is it the pathologic molecular and microscopic changes that arise from overloading, parafunctional habits or trauma, which caused the mal-relationship in the first place [10]? The surgeon who focuses on modifying the physical condyle-disc relationship without understanding or addressing the true reasons for the pathology risks poor outcomes, relapse, and/or the need for additional surgery.

5.4 Basic Technique

Anesthesia preparations:

- General, nasotracheal intubation, stabilize tube.
- Neuromuscular blockade for ease of jaw opening.
- IV prophylactic antibiotic and steroids.

Soft tissue:

- Place throat pack and prep mouth with chlorhexidine rinse.
- Apply MMF system of choice, with the understanding that maintenance of fixation followed by guiding elastics will be needed for many weeks.
- Bite block to the contralateral side.
- Infiltration of local anesthesia with epinephrine to the buccal vestibule.
- Identify external oblique ridge and ascending ramus.
- Incision through mucosa with blade or Bovie, lateral to the external oblique ridge, as for sagittal split osteotomy, leaving a good 2–3 mm cuff of unattached gingiva lateral to the attached gingiva so that closure of the incision is facilitated. A more laterally-based incision than described may heal with a scar band that creates a food trap. Carry incision through submucosa, muscle, and periosteum, and laterally retract the flap to expose the ramus of the mandible, taking care to develop an atraumatic soft tissue envelope.
- Smoothly dissect all periosteum off the lateral ramus, so that the sigmoid notch, posterior ramus, and inferior border can be visualized.

Osteotomy:

- Helpful instruments include a set of lighted Bauer retractors (Fig. 5.2) to visualize the sigmoid notch and the antegonial notch; the Levasseur-Merrill retractor (Fig. 5.3) to retract the masseteric sling, stabilize the ramus during the osteotomy, and allow for proper A-P positioning of the oscillating saw blade; and a curved freer or other ramus measuring instrument to check the trajectory/position of the osteotomy and determine if the cut is full thickness.
- Place a lighted Bauer retractor in the sigmoid notch. Using an IVRO oscillating saw with a fan-shaped blade big enough to fully penetrate the ramus, create the superior half of the osteotomy from the mid-ramus to the sigmoid notch, taking care to be posterior to the antilingula. The cut should be approximately 7–10 mm from the posterior border of the ramus. IVRO blades come in two sizes, 12 mm cutting edge × 7.0 mm cutting depth and the longer 11.5 mm cutting edge × 12.0 mm cutting depth (Fig. 5.4). The longer blade should be used with care as it may cause injury to medial soft tissues as it penetrates through the bone.
- The Levasseur-Merrill retractor is very helpful to position the oscillating saw blade, because it wraps around the posterior border of the mandible. When cutting with the oscillating saw, support the retractor with the nondominant hand to pull the mandible forward, and rest the oscillating saw against the retractor's "shelf" (Fig. 5.5). This maneuver will position the saw blade cut, 7–10 mm

Fig. 5.2 Set of Bauer retractors capable of accepting a fiber-optic light cord. Within the surgical wound, one Bauer engages the sigmoid notch, and the opposite one engages the antegonial notch, giving excellent visibility. Each Bauer has a slightly curved blade and is approximately 19–20 cm in overall length



Fig. 5.3 The Levasseur-Merrill retractor can accept a fiber-optic light cord, and the handle has a finger rest allowing the surgeon to pull up on the retractor to stabilize the mandible. The hooked end engages the posterior border of the mandible, providing visibility during surgery



Fig. 5.4 Close-up view of a long sharp, fan-shaped oscillating saw blade for IVRO. The blade has a 12 mm long cutting edge and a 12 mm cutting depth

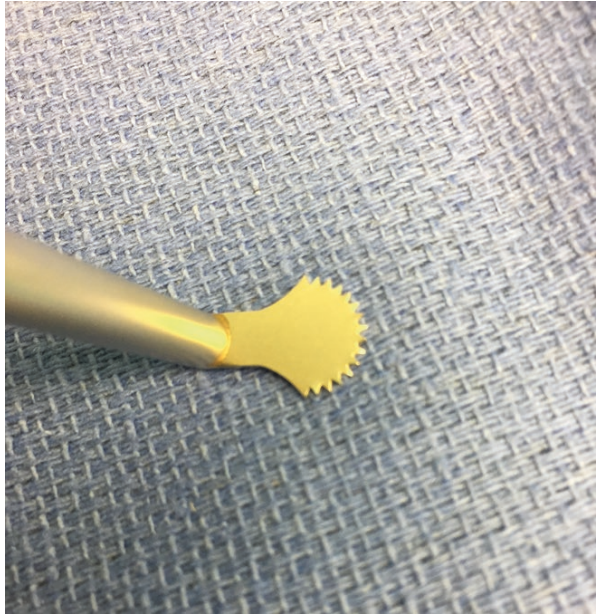
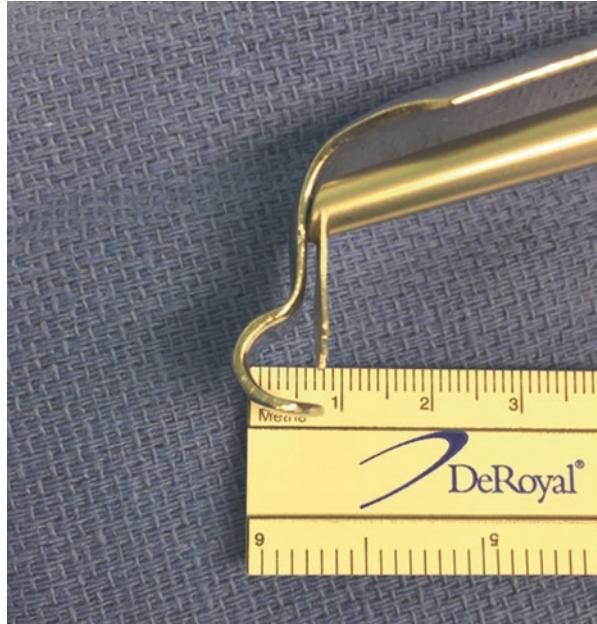


Fig. 5.5 The Levasseur-Merrill retractor provides a platform to position the oscillating saw blade at an A-P position, approximately 7–8 mm from the posterior border of the mandible



from the true posterior border of the ramus. Use the oscillating saw blade in a continuous sawing manner; the blade cuts best when one moves and rotates the blade against the bone, using the fan-shaped blade at an angle to start and continue the cut. Once the bony cut is well defined from the mid-ramus to the sigmoid notch, proceed straight down to the inferior half of the osteotomy, finishing at or near the angle of the mandible. For best visibility, remove the Bauer from the sigmoid notch, and place the opposite Bauer in the antegonial notch. Many surgeons aim to bring the inferior half of the cut slightly anterior to the angle of the mandible. The reasons for this are twofold: by curving the osteotomy anteriorly as one approaches the inferior border of the mandible, the free (proximal) segment is less likely to end in a sharp pointy bony tip. In addition, the proximal segment remains attached to a portion of the medial pterygoid muscle on the medial side. Refine the saw cut to ensure that the osteotomy is full thickness from top to bottom. In patients with a small mandible, there may not be enough room for both a Levasseur-Merrill retractor and a Bauer retractor at the sigmoid notch. In that case, a modified curved freer or a ramus-measuring instrument that is marked at 7–10 mm can be used to engage the posterior mandible, and the IVRO saw can be positioned with the aid of a dental or laryngeal mirror. Some surgeons prefer not to use the Levasseur-Merrill retractor as its placement requires the stripping of a portion of the periosteum from the posterior border of the mandible. Lighted retractors or a lighted suction tip is essential as visibility is notoriously poor.

- If there is a pointy tip of bone at the angle of the mandible after the osteotomy is completed, trim it with a round bur or rongeur.
- Grasp the loose proximal segment with a bone clamp, and tug to verify that the condyle is free to move, rotate, and sag slightly.
- Many surgeons advocate a “butt-end” relationship between the proximal and distal halves of the ramus osteotomy so that the principal component of proximal bone movement is inferior. Others, fearing that the proximal segment may slip onto the medial side of the ramus, try to create a “lap joint,” where the proximal bone laterally overlaps the distal segment by a small amount (Fig. 5.6a, b). If this is desired, one should gently strip a small portion of the medial pterygoid muscle off the proximal segment to allow for this overlap. The medial pterygoid detachment should be the minimum required to permit a passive, lateral position of the proximal segment (Fig. 5.7). In some cases, to prevent torquing of the ipsilateral condyle, it is necessary to bur away a thin strip of the bone from the proximal segment, along the medial aspect of the entire length of the cut edge. This morticing will allow the proximal segment to lie nicely against the lateral aspect of the distal segment, minimizing twisting of the bone. The proximal bone segment that will not stay lateral or butt end with respect to the distal segment may need to be stabilized with a suture through a small hole drilled through the inferior end of the proximal osteotomy and sutured to the lateral periosteal envelope (Fig. 5.8).

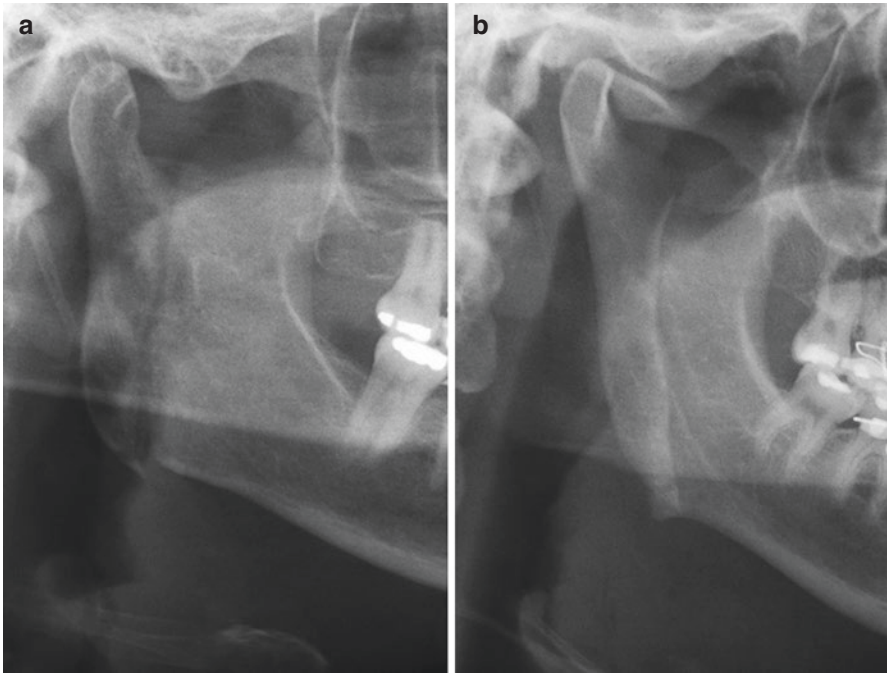
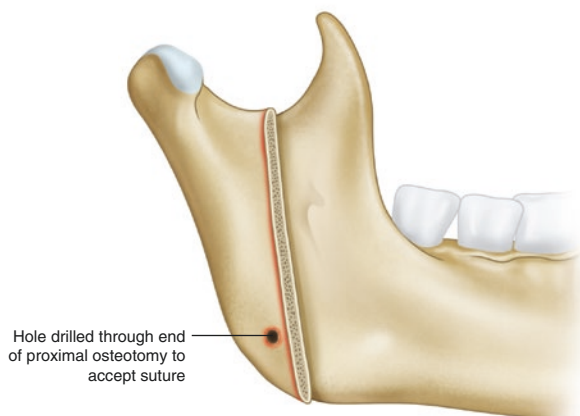


Fig. 5.6 A passive butt-end relationship is created between the proximal and distal portions of the IVRO osteotomy (**a**). The proximal portion of the osteotomy is lateral to the distal segments and overlapping it (**b**)

Fig. 5.7 The proximal portion of the right IVRO osteotomy lies lateral to the distal portion of the osteotomy in this PA cephalometric image



Fig. 5.8 A suture placed through the drilled hole can be sutured to the lateral periosteal envelope to stabilize the proximal portion of the osteotomy if it does not remain butt end or lateral to the distal portion of the osteotomy



Finish:

- Irrigation of wound
- Tight wound closure with polyglactin suture
- Removal of the throat pack
- Application of strong maxillomandibular fixation (MMF) using wires or elastics
- Head wrap and ice pack for swelling

Postoperative course:

- Tight MMF is needed for the first 3–4 weeks, with the longer period advised for bilateral cases. This is followed by up to 4 weeks of progressively lighter-guiding elastics to assist the patient with finding his/her occlusion and to discourage chewing. Toward the end of the guiding elastic period, the patient may briefly remove elastics and initiate gentle range of motion exercises. Food with slightly firmer texture may also be started.
- After release of fixation and removal of the arch bar devices, physical therapy is strongly encouraged to restore normal range of motion and jaw strength. Physical therapy may be supplemented by at-home jaw exercises consisting of jaw opening repetitions and stretch-and-hold sequences.

5.5 Results

The separation of the proximal segment containing the condyle, from the distal segment containing the dentition, may serve as a stress breaker, permitting “unloading” of the synovial tissues. Many authors have shown excellent, long-lasting improvement in function and comfort following IVRO for internal derangement [11–16]. Indeed, our own informal review of patient satisfaction among patients with internal derangement who underwent a surgical procedure demonstrated that the patient

cohort with the highest level of satisfaction is the IVRO group within the first few years after surgery (unpublished data). The prospective study published in 2000 by Hall, Navarro, and Gibbs showed that at 1 year following IVRO, there was a statistically significant improvement in most measures of pain and that results at 3 years were essentially unchanged [11]. A progression from a displaced disc with reduction to displaced disc without reduction, even for those with Wilkes IV and V, was not observed. The IVRO has also been employed in cases of TMJ degenerative joint disease. Tasanen and Lamberg in 1974 and Tasanen and Jokinen in 1981 reported on patient cohorts with radiographically documented cases of osteoarthritis and found high patient satisfaction and functional status to be quite good [17, 18].

Park et al. found excellent resolution of TMD symptoms in patients who underwent IVRO instead of sagittal split osteotomy (SSO) with rigid fixation for “surgery-first” orthognathic surgery [19]. In the surgery-first approach, orthognathic surgery is carried out without the typical presurgical orthodontic preparation. While the opportunity for rigid fixation is afforded by the sagittal split osteotomy to stabilize the mandibular bony segments, the authors opine that the technique can torque the joints and lead to worsening of TMJ symptoms in those with preexisting TMD. Their finding that the IVRO allows for a natural and comfortable joint position is consistent with other investigators. Ueki reported that 88% of patients who underwent IVRO with or without Le Fort I osteotomy reported fewer or no TMJ symptoms as opposed to 66.7% of patients who underwent sagittal split osteotomy with or without a Le Fort I osteotomy [20]. The author’s experience, consistent with above, is that unfavorable condylar seating or torquing during the application of fixation screws or plates in sagittal split osteotomy cases may occasionally cause new-onset TMJ internal derangement or worsening of preexisting TMJ dysfunction. These observations suggest that the surgeon should carefully consider the choice and method of fixation technique when planning sagittal split osteotomy, instead of IVRO, for the surgical correction of malocclusion. This is of particular importance in patients with preoperative intracapsular TMJ symptoms, because the relationship of the condylar head, the disc, and the fossa is hard to control.

5.6 Complications

Reoperation rates for IVRO have been reported to be low. Yamauchi and his group observed that out of 638 IVROs performed on 319 patients (all bilateral cases) for either mandibular prognathism or TMD, the condylar head was dislocated anterior to the articular eminence unilaterally in only 8 patients, or 1.25% [21]. One patient had the condyle repositioned in a closed manner under local anesthesia, and four patients underwent open reduction. Three patients did not have any intervention as they were symptom-free, and condylar head remodeling was noted over the 12-month follow-up period. Therefore, the reoperation rate for this large series of IVRO patients was less than 1%. Hall and Werther showed that in a group of 184 consecutive patients with 299 operated joints, less than 5% of joints underwent reoperation. All joints that were reoperated had an MRI-proven

displaced disc, and the majority of those had lost most or all of the increased joint space achieved by the initial surgery [22]. Other authors have also had similar observations and have shown that the maintenance of the increased superior joint space following IVRO is positively associated with improved long-term outcomes, including relief of pain [23–25]. Thus, the observation of loss of joint space is predictive of a poor outcome, probably due to the recurrence of heavy joint loading leading to intra-articular soft tissue injury and the elaboration of mediators of inflammation [22].

It has been shown that approximately 70–79% of joints with anteriorly displaced discs with reduction have that relationship corrected with IVRO [13, 16]. Among the IVRO cases that required reoperation, Hall found that a strong risk factor was the loss of the reduced disc relationship after it had been achieved with IVRO [22]. Some authors report a higher rate of poor outcomes following bilateral IVRO [24], and that has been this author's experience as well (unpublished data).

Infection rates are classically low and generally only occur if a hematoma within the wound is allowed to develop and persist. For this reason, a compressive wrap around the jaw is a good idea for the early postoperative period. The incidence of numbness of the inferior alveolar nerve distribution with IVRO is much less than with sagittal split osteotomy. Chen et al. reported a 9% rate in the early postoperative period with improvement down to 2% at 6 months or more [26]. Al-Bishri et al. found a 7.5% rate of neurosensory disturbance after IVRO using a questionnaire [27]. Takazakura et al., testing with a trigeminal somatosensory evoked potential, showed that none of his IVRO patients had hypoesthesia 3 months after surgery [28]. Through accurate positioning of the osteotomy at no more than 10 mm anterior to the posterior border of the ramus, and by carefully overlapping the segments versus creating a butt-end relationship between the proximal and distal segments, the rate of inferior alveolar nerve injury can be significantly minimized. If one uses the antilingula as a landmark during surgery, the osteotomy should be at least 5 mm posterior to it to reliably avoid the inferior alveolar nerve, per Aziz's anatomic study [29].

5.7 Conclusion

The literature appears to support the utilization of the IVRO for selected patients with anteriorly displaced discs with reduction and anteriorly displaced discs with acute nonreduction status. Some surgeons have achieved good results in patients with joints demonstrating the full gamut of osteoarthritic changes, but total joint replacement may be a better long-term option in this group of patients. However, patients with multiple medical comorbidities who have failed conservative measures and for whom a lower-risk, shorter operation is desired may benefit from IVRO. The surgeon is cautioned to control the occlusion during the healing period and to carefully select patients who can tolerate extended weeks of MMF.

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