Secondary Treatment of Malocclusion/Malunion Secondary to Condylar Fractures

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Subcondylar and condylar fractures account for 29% to 32% of all mandible fractures seen in the United States. The treatment of these injuries, as noted elsewhere in this issue, continues to remain controversial. The results of open and closed treatment often leave the patient with less than desired mandibular function and occlusion. Complications associated with treatment of condylar and subcondylar fractures range widely in the oral and maxillofacial literature. Diagnostic errors, poor surgical technique, healing disorders, or complications may lead to the establishment of posttraumatic mandibular deformities. Nonunion, malunion/malocclusion, and/or facial asymmetry can be found early during the healing process or as long-term sequelae after the initial mandibular fracture repair. Although occasionally these problems are solved in a nonsurgical manner, reoperations play an important role in the management of these untoward outcomes.

In analyzing a patient’s condition it is also important to keep in mind the end point or goal of therapy (Box 1). The patient’s complaints and concerns are often multifactorial and guidance by the practitioner is essential. The factors that are most significant are also different for each patient. Some patients are happy to be able to open normally without pain, whereas other patients believe even the slightest malocclusion may be unacceptable. Secondary treatment of these injuries can be frustrating, but also rewarding. Clinicians need to focus treatment plans based on listening to patients and not focus on how a condyle may look on imaging. Ultimately success is based on patient function and satisfaction.

Splint therapy and physical therapy

A crucial step in the course of treatment of posttraumatic malocclusion is determining the presence or absence of temporomandibular disorder and/or myofascial pain. If there are no symptoms the patient should move toward evaluation for correction of the malocclusion. When signs and symptoms are present they should be addressed conservatively using splint therapy, masticatory complex rest, physical therapy, nonsteroidal inflammatory drugs, and muscle relaxants when indicated.

Splint therapy should be done with a stabilization splint that provides even bilateral contacts. There is no supporting evidence for anterior versus group function, particularly in this population. The splint should be worn by the patient continuously, and close follow-up should be provided for regular adjustments. These adjustments are necessary as the condylar process remodels to a stable articulation. Once the splint can be worn without change in occlusion then treatment is discussed for correction of the malocclusion.

Jaw exercises for increased range of motion should be promoted, which may also help if the patient has pain with function. Adjunctive physical therapy may be warranted by a physical therapist trained in TMD depending on the patient’s symptoms. Therapy should be geared toward improvement in mobility and pain. Thermal, transcutaneous electrical nerve
Box 1. Goals of therapy in late secondary treatment of mandibular condylar process fractures

- Obtain stable occlusion
- Restore interincisal opening
- Establish a full range of mandibular excursive movements
- Minimize deviation of the mandible
- Produce a pain-free masticatory complex at rest and during function
- Avoid internal derangement of the temporomandibular joint on the injured or the contralateral side
- Avoid the long-term complication of growth disturbance

stimulation unit, and dry needling may be used to treat the inflammation and pain. Exercise therapy and heat may be used for hypomobility.

If the patient’s symptoms resolve the practitioner and patient can be more assured that if the malocclusion is corrected, then the symptoms will likely improve. When the symptoms of TMD remain with the previously fractured condyle, one should consider a temporomandibular joint (TMJ) total joint prosthesis or concomitant open joint surgery with or without orthognathic surgery for correction of the malocclusion. If the patient develops symptoms in the joint not affected by the traumatic event, then the splint may be inappropriately loading that joint. If the patient’s symptoms resolve with splint therapy and the malocclusion is minor, the patient could be monitored for dental compensation without any treatment or with the use of orthodontic therapy.

Conservative treatment

The common types of malocclusion for condylar fractures depend on a unilateral versus bilateral condylar fractures. Posttraumatic malocclusion from a unilateral condylar process fracture with displacement likely results in a unilateral open bite of the contralateral side of the fracture with deviation on opening to the ipsilateral side. This is caused by the loss of mandibular ramus height and decreased posterior facial height on the ipsilateral side. This results in a clockwise or posterior rotation of the mandibular plane on the ipsilateral side of the fracture. The common malocclusion for a bilateral condylar fracture is an anterior open bite (AOB). This is caused by the loss of mandibular ramus height bilaterally causing clockwise or posterior rotation of the mandibular plane bilaterally. Both of these problems may cause significant problems for a patient. Their functional imbalance could lead to dysphonia, alteration in their anterior guidance, reduction in functional activity, pain, and poor aesthetics. As an oral and maxillofacial surgeon, one must determine if it is appropriate to perform surgical correction of the malocclusion. The answer must be discerned by the patient’s desire for surgery, what the goals of treatment are for the patient, and whether the issue can be corrected without surgery.

Equilibration

Dental equilibration can be completed through occlusal adjustments. Two studies that looked at using occlusal adjustment for closure of an AOB found a mean closure of open bite anteriorly by an average of 2.28 mm and another by 2.38 mm. There was 33.3% relapse among the patients of the first study. This procedure can also cause the risk of dentin hypersensitivity depending on the amount of reduction along with future occlusal wear leading to dentin exposure. One study found resolution of the dentin hypersensitivity by the fifth month. There is little literature in support of this course of treatment and its use should be weighed heavily against other treatment options. However, for minor malocclusions, this treatment option could be considered.

Orthodontic correction of bilateral condylar process fractures

The long-time accepted treatment of a skeletal open bite has been orthodontics followed by orthognathic surgery. Because bilateral condylar process fractures create a skeletal AOB, surgery is the best option. In certain instances, the patient may be averse to undergoing surgical correction of this problem or their AOB may be minimal. After a minimum of 6 months of monitoring, any condylar resorption should be considered stable. With the use of orthodontics alone to close an AOB the relapse rates are high. At 10-year follow-up after correction of patients with an AOB, an open bite of 3 mm or more was found in more than 35% of patients. Other studies have looked at the use of skeletal anchorage devices for orthodontic closure of AOB, and there are even several case reports of closure of an AOB in patients with previous condylar fractures. These devices are able to intrude the lower molars by 3 to 5 mm. There are several case reports of using mini-implants for maxillary molar intrusion. In one study they showed a range of intrusion of the maxillary molars by 1.5 mm to 3.3 mm (mean, 1.9 mm) with closure at the incisors of 3 mm to 4.5 mm. Although these results are promising it has been shown that long-term stability is low and many studies do not have long-term follow-up. Most studies advocate for a postretention period of at least 4 months before removal of the anchorage devices. Others advocate for excessive intrusion to account for relapse. It should also be taken into account that for these bodily movements of the posterior dentition, a long treatment period is required. The use of these devices may

Fig. 1 TMJ concepts total joint prosthesis.
prove to be a viable treatment option in the population of patients with posttraumatic open bites, but further scientific investigation is warranted.

Arthroplasty/Total joint replacement

In open and closed treatment of condylar fractures, postoperative malocclusion can occur. Reductions in ramus height and those with dislocated fractures are prone to functional disorders of TMJ but also occlusal disorders. Soft tissue injury of the joint can occur at the time of condylar fracture and can involve hemarthrosis and disk displacement. Also, injury of the temporomandibular disk at the time of fracture can be responsible for disk degeneration. After injury, the TMJ may incur secondary osteoarthrosis (arthritis), aseptic necrosis, bifid deformity of the condyle, fibrous ankylosis, or osseous ankylosis. Also, condylar head fractures are more prone to lead to postoperative ankylosis of the TMJ.

Fig. 2 Preoperative computed tomography demonstrating position of a 52-year-old woman 12 weeks after undiagnosed right mandibular condylar process fracture resulting in loss of right mandibular vertical ramus height and left posterior open bite malocclusion.

Fig. 3 Preoperative VSP evaluating feasibility of performing only a reosteotomy of the right condylar process. This demonstrated the amount of remodeling that had already taken place at the fracture site and the inability of the contralateral left condylar/fossa to accommodate this method of treatment. The red areas over the left condylar head demonstrate the interferences this would result in.
Significant variations in tolerating occlusal disturbance vary among individuals. Occlusal disorders can involve working or nonworking side interferences, premature contact, or the lack of contact in an area of the dentition. Patients should be interviewed regarding subjective symptoms, such as TMJ pain, limitation to daily activities, and alleviating and aggravating factors. The clinical examination involves palpation of the masticatory muscles for pain, measuring the maximum interincisal opening, lateral excursive movements, protrusive movement, joint sounds, and occlusal evaluation. In fibrous ankylosis the involved condyle only demonstrates rotational movement with a maximum opening of less than 20 mm with deviation to the affected side with no translational. In bony ankylosis the patient’s range of motion is further limited to 5 mm to 7 mm. This clinical information in conjunction with imaging, such as computed tomography and/or MRI, can help aid in diagnosis.

Conservative therapies previously discussed, such as physical therapy and splint therapy, are initiated and ongoing monitoring is used to evaluate the patient’s progress. Splint therapy also is used as a diagnostic aid to determine the stability of the condylar ramus unit.

A gap arthroplasty is a surgical option in this patient population. An osteotomy is created inferior to the posttraumatic altered condyle to allow free movement of the mandible and improve range of motion. Autogenous or alloplastic interpositional materials can be used to decrease the risk of reankylosis. Autogenous materials include temporalis muscle/fascia, fat, dermis, and auricular cartilage. Silicone, acrylic, polyethylene, metals, and ceramic have been described as possible alloplastic interpositional materials. Material migration, foreign body reaction, and fragmentation may occur with alloplastic materials. After the resection of the condyle, the mandible is mobilized to determine if adequate range of motion has been achieved. If inadequate mandibular movement is present further dissection of the temporalis/coronoidectomy, masseter, and medial pterygoid musculature can be considered. The temporomandibular disk can also be inspected during this procedure for pathology and if present can be corrected.

Because of the created bony gap often the vertical height of the ramus is further decreased. This can result in a worsening malocclusion. A consideration to help stabilize the vertical dimension is joint reconstruction. The two most widely discussed joint reconstruction options include TMJ prosthesis/total joint reconstruction (alloplast) and autogenous methods, such as costochondral graft or a ramus osteotomy.

Markowitz and coworkers described the possibility of reconstructing the mandibular condyle by performing a ramus osteotomy and sliding the proximal segment superiorly into the articular fossa. This approach has the benefit of being autogenous without donor site morbidity. The costochondral graft has the benefit of being biologically compatible with growth potential. Nelson and Buttrum discussed that the biologic

![Image](Proximal Segment Overlap Analysis - LSSO and Right Condylectomy / Repositioning)

**Fig. 4** Preoperative VSP evaluating feasibility of performing a left mandibular sagittal split osteotomy (LSSO) with concurrent reosteotomy of the right condylar process fracture. This again revealed the significant "gap" that would result at the right side without bony contact.
reconstruction of the adult TMJ is preferable to alloplastic reconstructions because just as in the growing child, the adult articulation must adapt to the demands of the functional matrix. However, the growth is unpredictable and this graft option in comparison with a prosthesis has the added disadvantage of resorption, reankylosis, and donor site morbidity. A further disadvantage is that an immobilization period is usually necessary until consolidation and functional stability of the grafts has taken place.21

A TMJ prosthesis (Fig. 1) has the advantages of no donor site morbidity, early/immediate return to function, and consistent condyle and fossa anatomy. Disadvantages of alloplastic joint replacement include higher cost and hardware failure.16 All patients undergoing gap arthroplasty or joint reconstruction run the risk of potential injury to the facial nerve, Frey syndrome, and parotid gland injury. The postoperative use of arch bars/elastics to help guide the patient into reproducible occlusion should be considered. Physical therapy is an important adjunct to ensure the improvement of function and decrease in discomfort. Physical therapy is an important adjunct to ensure the improvement of function and decrease in discomfort. Use of tongue blades or Therabite (Atos Medical, Inc, West Allis,
WI) for opening should be considered in the early postoperative period to prevent decreased maximal incisal opening caused by scar tissue formation. As in management of patients with TMD, a surgical plan that includes total joint replacement should be considered as the last option when other procedures do not achieve the desired goals. Counseling the patient about all potential risks is crucial before surgery.

Orthodontics and orthognathic surgery

Once it has been determined that a malocclusion or malunion is too significant to be treated by occlusal equilibration or orthodontic therapy alone, one must consider the surgical options for these patients. Philosophically speaking, combining orthodontic therapy with orthognathic surgery to correct malocclusion provides the most ideal result. However, if ideal occlusion exists on articulated models one can consider proceeding without orthodontics. Combining orthodontics with surgery allows for correction of major malocclusions as long as the posttrauma condyles are functional, and within the fossae.

Appropriate evaluation of mounted models or analysis of digital virtual treatment plan via systems, such as Suresmile (OraMetrix, Inc, Richardson, TX) or 3D systems, gives the best idea of the potential benefits and pitfalls of combined surgical and orthodontic case planning. With the advent of computed tomography scanning, 3D imaging and virtual surgical planning (VSP) have gained a foothold in orthognathic surgery. VSP is rapidly replacing traditional model surgery in many parts of the country and the world. It allows the ability to show the patient what can be accomplished before beginning any actual treatment. In the event of a unilateral fracture malunion, previous authors have suggested unilateral mandibular osteotomies to correct the malocclusion, whereas if there was a bilateral condylar fracture with resulting functioning condyles but a developed AOB, Le Fort maxillary surgery may be the best option. The use of VSP allows one to perform osteotomies in 3D and assess how this will impact the occlusion in a much more precise manner than traditional model surgery (Figs. 2–6). The ability to view segment movement and bone position change in multiple planes is unparalleled. In a retrospective study 21 patients with posttraumatic malocclusion caused by condylar process fractures, orthognathic surgery was used to successfully restore proper occlusion. Group I with 15 patients was treated with unilateral or bilateral mandibular ramus osteotomies for asymmetric malocclusion. In group II six patients were treated with either a Le Fort I osteotomy (n = 5) or bilateral ramus osteotomies (n = 1) for AOB.

The timing of surgery should be at least 6 months after the initial injury because the risk of remobilizing a malunion within the first 6 months after the failed initial surgery compromises the result. The benefit of Le Fort osteotomy for treatment of
the open bite deformity lies in not having to manipulate the condyles in this patient pool. This is similar to how we manage patients with TMD internal derangement or those with idiopathic condylar resorption. Any time we can avoid operating on the lower jaw we decrease the risk of redeveloping or reactivating pain or altered function. However, in cases where the patient has an asymmetry of the mandible as a result of the fracture, obviously mandibular surgery is indicated. Review of the literature supports the use of either unilateral or bilateral ramus osteotomies. We have found that clinically, even in cases of a unilateral fracture, the use of bilateral sagittal ramus surgery provides a better result. Additionally, the use of the sagittal split osteotomy with rigid fixation has the benefit of earlier function thus preventing risk of long-term trismus.

Case report

A.L. is a 52-year-old woman status post bilateral subcondylar and symphysis mandible fracture in November 2009. The patient was treated at another facility with 8 weeks of maxillo-mandibular fixation. After release of fixation the patient had a significant malocclusion with pain and condylar deformity (Fig. 7). She was referred to us at that time. Late in 2010, the patient underwent a revision arthroplasty and plication procedure to reconstruct a stable left TMJ. The patient gained stability and did well using an oral orthodontic splint. Despite a stable and functional joint, the patient was still concerned about the significant posttraumatic malocclusion and had orthodontic treatment followed by maxillary and mandibular orthognathic surgery (Fig. 8). The patient was followed for 2 years after surgery and has a stable and repeatable occlusion with no pain and good range of motion.

Treatment protocol

Developing a protocol for dealing in this patient population is helpful for the surgeon when evaluating and managing these patients after their initial trauma and treatment. We hope to propose a logical treatment regimen for patients with minor malocclusions and those with significant malunions (Fig. 9). This decision tree is an initial guide in considering management decisions to best achieve treatment goals.

Summary

The patient who presents with the sequela of malocclusion or malunion after suffering subcondylar or condylar fractures has the right to expect that clinicians can provide solutions for their dilemma. Treatments can be simple or complicated depending on the severity of the problem. The ultimate goal is to restore function and occlusion, in a pain-free manner, as close to the preinjury architecture as possible. As technology advances, the tools that can be applied to these situations also advance and expand. In our literature search for this article we came upon a paper that was written in 1945 that stated “it is inevitable that there would be disappointment with the
outcome of the treatment for the fractured mandible.” Clinicians have come so far since that time and are continuing to develop better treatment protocols for patients. The focus also has to remain on listening to the patient’s goals and desires and not allow treatment plans to be solely guided by radiograph findings and the inherent desire as surgeons to “fix” things.

References