Treatment of Malocclusion and TMJ Dysfunction Secondary to Condylar Fractures

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ABSTRACT

Unfavorable sequelae from mandibular fractures includes malocclusion and temporomandibular joint dysfunction. The management of these complications is presented in this article and is largely based on the authors' experience. Cases that provide details on treatment methods are shown. Finally, an algorithm for treatment is suggested.

KEYWORDS: Mandibular condylar fracture, mandibular malunion, malocclusion, temporomandibular joint dysfunction

The editorial board of this journal asked us to write an article on the treatment of malunion of mandibular condylar fractures. In 1990 an article on this topic was published similarly entitled "Management of malunited mandibular condylar fractures."¹ When displaced condylar fractures are treated in a closed manner, we *expect* and *accept* a malunion, and we work for a functional neoarticulation that is in harmony with the occlusion. Studies have shown that the vast majority of patients with condylar fractures can be treated this way. Condylar malunion is not synonymous with malocclusion. Becking et al also recognized this.² Clearly, condylar fractures can be a cause of malocclusion, which is often followed by functional disorders such as mandibular hypomobility, pain, and masticatory dysfunction. Perhaps a more appropriate title for this article would be the treatment of malocclusion and temporomandibular joint (TMJ) dysfunction secondary to condylar fractures, regardless of whether a malunion is present.

Malocclusions secondary to condylar fractures occur for one of two reasons: no treatment or unsuccessful treatment of a condylar fracture. We occasionally see patients who never sought treatment for their fractures, and they come in later complaining of malocclusion and

functional disorders that may accompany it. Unsuccessful treatment may occur even with a good course of treatment because not all patients have the biological ability to adapt to their injury in a harmonious way.³ Commonly, the treatment has been inadequate with little instruction to the patient about care, poor follow-up, and noncompliance of the patient when engaged in functional rehabilitation. Most patients we have treated secondarily were initially treated in a closed manner, although some patients were treated by open surgery. Also, the largest number of patients with unsuccessful treatment in our experience had bilateral condylar fractures.

The incidence of malocclusion secondary to condylar fractures is not known, but it has been reported to occur in anywhere from 1.4⁴ to 13%⁵ of cases. Treatment of malocclusion has been varied. Depending on its severity, treatment options include functional rehabilitation, occlusal equilibration, removal of hyperoccluding teeth, orthodontics, prosthetic reconstruction of the dentition, orthognathic surgery, temporomandibular reconstruction, and combinations of these methods.^{1,2,6-11}

Similarly, many patients who present with malocclusion from untreated condylar fractures have associated mandibular hypomobility, and fewer patients have

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associated pain on opening their mouths and/or chewing. Often, the hypomobility is secondary to the pain that accompanied the original fracture, and the patient's self-induced avoidance of opening his or her mouth widely because of associated pain. Over time, opening becomes more difficult; stretching scar tissue, a consequence of soft tissue healing about a fracture or traumatized area, and associated muscles cause more pain, and mouth opening is subconsciously avoided.

This article presents our experience with the management of patients who present late with malocclusion and the often-associated hypomobility and (occasionally) pain secondary to untreated or ineffectively treated condylar fractures. The content is based on our combined experience of 75 years in the management of condylar injuries. This article does not discuss the management of patients with TMJ ankylosis secondary to condylar fractures.

MANAGEMENT OF PAIN ASSOCIATED WITH CONDYLAR FRACTURES

Pain is present in some patients with malocclusion secondary to condylar fracture, and it can arise from several sources. For instance, the malocclusion can be a traumatic one, where some of the teeth are prematurely contacting, excessively loading them in the axial and also possibly the lateral directions. Tooth pain from traumatic occlusion is relatively easy to diagnose and to manage by selectively grinding away the high places of teeth in hyperocclusion or making a bite splint to protect the teeth. Correction of the malocclusion should permanently eliminate this type of pain.

Commonly, the pain associated with condylar fractures is not severe and is located in the TMJ and/or muscles of mastication, usually the masseter and temporalis muscles on the affected side. The pain is generally present only on use of the jaw, especially during opening movements but occasionally when occluding the teeth. The pain is directly related to mobility of the mandible: Those with more pain tend to have less jaw movement than those with a wide jaw opening. The best way to manage the pain is to promote wide movement of the mandible.

If bony TMJ ankylosis is not present, the patient is started on exercises and physical therapeutic maneuvers to gain a normal range of opening (> 40 mm) measured at the incisal edges of the anterior teeth. Analgesics may be necessary in the beginning because if the patient stops opening at the point of pain, no gains will be made. If the patient makes no progress, a wide opening of the jaw (> 50 mm) by forced dilatation under general anesthesia is done to tear the adhesions, stretch the shortened and atrophic muscles, and give the patient a starting point for further exercises. It is not necessary to strip muscles or do coronoidotomies unless the hypo-

mobility has been present for an extremely long time. Myofibrosis is common after extended periods of hypomobility and does not respond well to less aggressive measures. Beginning immediately after forced dilatation under general anesthesia, the patient has to aggressively do jaw exercises, often with the aid of analgesics, to maintain the gains obtained with forced dilatation. A minimum of 3 months of exercises are required to maintain jaw opening throughout the healing process.

Patient discomfort subsides and becomes tolerable after a normal range of mandibular motion has been reached and maintained for 3 months. At this point, the associated malocclusion can be treated.

TREATMENT OF MALOCCLUSION SECONDARY TO CONDYLAR FRACTURES

Several myths regarding this topic must be dispelled. One untruth is that the mandibular condyle can "live" in only one position within the glenoid fossa. This myth has been nurtured by gnathologists, prosthodontists, orthodontists, and other dentists for more than 100 years. Evidence contrary to this view is provided by patients with fractures of the mandibular condyle that were successfully treated in a closed manner, and the condylar head healed in an abnormal position (malunion). A newly formed articulation occurs in this position without the condyle being in the center of the glenoid fossa. This new articulation is usually between the top of the condylar stump and the lowest curve of the articular eminence (Fig. 1). Other evidence comes from patients who have undergone chronic TMJ dislocation, and whose mandibular condyle becomes repositioned anterior to the articular eminence. Many patients function well with this condition for years and have no functional disorders as a result of the dislocation. Patients with teeth may complain of a malocclusion when it first occurs, but those without teeth may never do so. Occasionally dentures have been made to accommodate the new mandibular position caused by the dislocated condyles (Fig. 2).

Another myth is that a patient whose condyle has been subluxated or dislocated from the glenoid fossa for a period of time can (or should) have the condyle returned to the "proper" position within the fossa. This is difficult and may be impossible to do. Changes of the connective tissue occur within the TMJ when there is an altered location of the mandibular condyle, such as fibrous and/or osseous tissue filling the fossa.¹² Attempts to reposition the displaced condyle into the glenoid fossa are difficult and often fail, even when open surgery of the joint is done in concert with physically attempting to reposition the mandible (Fig. 3). In patients with chronic subluxation or dislocation, an attempt is made to reposition the mandible under general anesthesia. If that is not possible, we do mandibular ramus and/or Le Fort osteotomies to obtain the patients' normal occlusion,

Figure 1 Closed (left) and open (right) mouth tomograms of right temporomandibular joint 38 years after closed treatment of condylar fracture.

which does not change the position of the mandibular condyle. These patients can function extremely well even though their ability to protrude the jaw or go into lateral excursions may be lessened.

Even in the absence of a fracture, the mandibular condyle can form a very solid articulation in a different location that is functional and not associated with pain or dysfunction. It is this capability that is capitalized on

Figure 2 Patient who has had bilateral dislocation of the TMJs for years. (A) Panoramic radiograph shows condyles anterior to the articular eminences. (B) Lateral cephalogram shows maxillomandibular relationship. (C) Class I occlusion is shown. (Courtesy of Dr. James Wilson.)

when patients with condylar fractures are treated in a closed manner.

Another popular myth is that patients who present with malocclusion secondary to condylar fracture should have instead been managed with open treatment. The most important factor in the management of condylar fractures is *not* whether the patient was treated open or closed, but it is the quality of the functional rehabilitation of the mandible that occurs after open or closed treatment. This is the variable that gets very little attention. Most studies on condylar fractures reported in the literature mention nothing about the aftercare provided to the patients. All unilateral and most bilateral fractures of the mandibular condyle can be treated successfully by closed techniques if the patient is cooperative, the surgeon is motivated, and there are sufficient teeth to use as “handles” on the jaws for maintaining the normal occlusion, which correctly positions the jaw. One has to help facilitate the development of a stable new articulation by maintaining the normal occlusion and jaw position while the fibro-osseous changes are occurring in the TMJ.³ As mentioned previously, this will occur even

in patients who have no fracture and simply have their condyles positioned into a new position. It may be one of the reasons that functional appliances can be effective to anteriorly reposition a retrusive mandible.

Once it is appreciated that the position of the mandibular condyle can rest in various positions yet maintain harmony with the occlusion, and that attempts to place the condyle into the “proper” position within the fossa often fail, treatment schemes can be developed for patients who present late with malocclusions that occur secondary to condylar fractures. Several variables are essential in determining the most appropriate treatment. The most important variable to consider is the degree of deformity of the mandibular ramus with its resultant malocclusion. If the mandibular ramus is severely shortened and multifragmented, and/or the patient has a marked malocclusion with the need for an extremely large movement of the mandible to obtain a good occlusion, TMJ reconstruction may be the preferred option (Fig. 4). If this is not the case, the most important variables are the presence of unilateral versus bilateral condylar fractures, the time

Figure 3 Patient whose temporomandibular joints (TMJs) were bilaterally dislocated for several weeks. (A) Anterior open-bite occlusion is seen at presentation. (B) Panoramic radiograph shows bilateral TMJ dislocation with the condyles anterior to the articular eminences. The patient was taken to surgery, and an attempt was made to reposition the mandibular condyles into their fossae. It was impossible to do so. Both right (C) and left (D) joints were opened.

Figure 3 (Continued) It was still impossible to position the condyles within their fossae. Right (E) and left (F) high condylectomies (G) were performed.

between injury and treatment of the malocclusion, and availability of a stable dentition. For the recommendations in the following sections, assume there is adequate dentition for the placement of arch bars and the use of elastics to maintain normal occlusion.

Temporomandibular Joint Reconstruction

In rare cases, the mandibular ramus may be deformed either by the initial trauma or by subsequent intervention. For instance, consider a patient who has had unsuccessful open reduction and internal fixation of a condylar fracture and possibly developed infection with bony resorption that resulted in severe malocclusion and will require a very large jaw movement to attain the pretrauma occlusion. This patient might be better managed with TMJ reconstruction. Similarly, patients who have intracapsular ankylosis and have a severe deformity may also benefit from reconstruction of the TMJ. Reconstruction of the TMJ not only provides a craniomandibular articulation but can give skeletal support to maintain the position of the mandible in its proper

occlusal position. The choice of TMJ reconstruction technique is at the discretion of the surgeon and might include autogenous or alloplastic materials. This article does not further discuss TMJ reconstruction because it is needed infrequently for malocclusions secondary to condylar process fractures, and TMJ reconstruction is a topic of its own.

Malocclusion Present Less Than 3 Months

Treating malocclusions secondary to condylar fractures in a delayed manner can be successfully performed with functional therapy out to 3 months. Considerable bony and soft tissue remodeling occurs about the TMJ in the first few months, and it is not complete for many months.^{12,13} There is little to lose and much to gain by treating these patients as if they had a fresh fracture (Figs. 5 and 6). In such cases, the patient undergoes a general anesthetic, and, if the mandible is hypomobile, forced dilatation (brisement) is performed to ensure an incisal opening under anesthesia of >50 mm. The widest opening possible is produced at surgery to help

Figure 3 (Continued) The disks were tied to the condylar stumps (H and I). The best occlusion that could be obtained during the surgery was still an anterior open bite (J). It was not possible to obtain a better occlusal relationship postoperatively using elastics. After several weeks of attempting to retrude the condyles into their fossae, a panoramic radiograph shows that the condyles are still positioned out of the fossae, opposite the articular eminences (K).

insure a stable incisal opening beyond 40 mm on completion of physical therapy and rehabilitation.

With the patient under general anesthesia, if the mandible can be readily positioned into a normal occlusal relationship with the maxilla, arch bars are secured to the teeth. The patient undergoes the usual 3-month rehabilitation process that would be used for a fresh fracture (Table 1). As few elastics as necessary are placed to allow the patient to bite into a proper occlusion because the goal is to allow a full range of mandibular function while the proper occlusal position is maintained when the patient closes. The addition of skeletal wires around the arch bars might be considered to help minimize dentoalveolar changes that can occur with elastic traction (eruption of teeth).³ A minimum of 3 months of rehabilitation is required while mature fibro-osseous and soft tissue changes are occurring about the TMJ, which provides a stable new articulation. It may take longer

and not be as successful when treating bilateral fractures because the biomechanics of mandibular position are much more disturbed with loss of both temporomandibular articulations.³

If the mandible cannot be easily manipulated into the proper occlusion with the patient under a state of general anesthesia, or can only be done so with force, the surgery is abandoned and the patient is treated as described in the next section.

Malocclusion Present More Than 3 Months

With long-standing malocclusions or those where the patient is under general anesthesia and the mandible cannot be easily manipulated into a normal occlusion with the maxilla, the ability to obtain a satisfactory outcome using closed methods is less than when the fractures are fresh and the normal occlusion is

Figure 3 (Continued) A lateral cephalogram (L) shows the anterior open-bite malrelationship of the jaws. A Le Fort I osteotomy and advancement genioplasty (M) were performed to obtain a normal occlusion (N). The patient had good mandibular function even though his condyles remained out of the fossae (O).

Figure 4 Patient who had open treatment for bilateral condyle and ramus fractures and subsequently had resorption, leading to severe malocclusion and facial deformity. Panoramic radiograph (A) and lateral cephalogram (B) show the loss of bone and facial deformity from loss of posterior support of the mandible. It is doubtful that conventional osteotomies would be able to reconstruct a functional articulation and provide support to maintain a good occlusion. Partial or total joint replacement would be a better option. (Courtesy of Professor Yi Zhang.)

easily obtainable. In these instances, we create a stable craniomandibular articulation and good mandibular function to be followed later with orthognathic surgery.

There are patients who present with post-traumatic malocclusions secondary to condylar process fractures that have excellent, full range mandibular motion. These patients can be planned and treated as a standard

Figure 5 Patient with right unilateral condylar fracture that went untreated for 11 weeks. Frontal (A) and open-mouth (B) photographs demonstrated slight deviation of the mandible to the right and good mobility of mandible. Her occlusion (C–E) showed premature contact on the right posterior, deviation of the mandible to the right, and slight open bite on the left. The panoramic radiograph showed a high condyle fracture on the right (F).

Figure 5 (Continued) She was taken to surgery and when under a general anesthetic, her mandible deviated to the right (G). However, it was easy to reposition it into a normal occlusion (H). Arch bars were applied, and she was treated as a fresh condyle fracture patient, with a class II elastic on the right side (I), allowing her to close into a proper occlusal relationship (J). She was weaned from the elastic over a 6-week course, at which time her occlusion was normal. Frontal (K) and open-mouth (L) photographs taken 3 years later show she has good facial symmetry but some deviation to the right on opening. Her occlusion (M–O) remained stable.

Figure 5 (Continued) A panoramic radiograph shows the malunion of the condylar fragment, which now articulates with the articular eminence (P). A lateral cephalogram shows a normal maxillomandibular relationship (Q). A P-A cephalogram (R) shows no facial asymmetry.

orthognathic surgery case. For unilateral condylar fractures, this will usually be a sagittal split osteotomy of the mandibular ramus on the side of the fracture. A more predictable result can be obtained by doing an osteotomy on both sides of the mandible even though only one condylar fracture is involved (Fig. 7). Although it has been reported and it is tempting to perform an osteotomy only on the side of the injury,^{1,2,8} in some cases the mandible wanders back to the side of the fracture during the postoperative period even though the mandible passively rotated into the proper position during surgery. We usually perform the sagittal ramus osteotomy on the side of the injury, and complete the separation of the proximal and distal segments. We then manipulate the occlusal segment of the mandible to see how passively it rotates into occlusion with the maxilla. If the move is not extremely passive, a sagittal or vertical ramus osteotomy is done on the other side. Becking et al have also reported using bilateral osteotomies in some patients

with unilateral fractures of the mandibular condyle, but do not state why or how a determination was made that it should be done.²

If a patient has bilateral condylar fractures and presents with an anterior open bite, the choice of whether to perform mandibular or maxillary surgery depends on the position of the lower dental midline. If the lower dental midline is off to one side, the open bite is closed using bilateral sagittal split osteotomies. Studies have shown that open-bite closure by sagittal ramus osteotomies is stable.¹⁴⁻¹⁹ If the anterior open bite is symmetrical with the lower dental midline coincident with the upper dental midline, either bilateral sagittal ramus osteotomies or a Le Fort I maxillary osteotomy with posterior impaction can be done. The latter is our first choice when appropriate because it does not require manipulation of the mandibular rami, where the condylar malunions are located.

Most often, patients present with malocclusion and a restricted range of mandibular motion. Orthognathic surgery is not recommended on patients with mandibular hypomobility. This not only makes intraoral surgery difficult, it also worsens these patients' hypomobility by adding the cicatricial effects of a surgical wound.²⁰ Postsurgical physical therapy for these patients is also difficult because of their discomfort from surgery. Instead, the malocclusion is ignored for the time being and physical therapeutic exercises are started to increase the range of mandibular motion before doing corrective jaw surgery.

The surgeon should carefully explain and supervise appropriate exercises to obtain a good range of mandibular motion (Table 2). The goal should be at least a 40 mm opening between the incisor teeth and 6 to 8 mm of lateral excursions. The patient will have

lessened excursions away from the side of a unilateral condylar fracture and a diminished ability for protrusive movement with bilateral fractures. Good mandibular motion within a normal range is the goal. Once mandibular motion is pain free, within a normal range, and stable, one can correct the malocclusion.

DISCUSSION

As in previous publications on treatment of malocclusion secondary to condylar fractures,^{1,2,8,11} we believe the malocclusion is better treated in the majority of cases by orthognathic surgical procedures than by TMJ reconstruction when ankylosis is not present. This is contrary to an old dictum to "operate the defect," but orthognathic surgery is chosen because of its predictability. Orthognathic surgery provides a predictable

Figure 6 Patient with malocclusion 12 weeks after no treatment for bilateral subcondylar fractures. (A) Patient has good mobility of the mandible but anterior open-bite malocclusion (B and C).

Figure 6 (Continued) The panoramic (D) and lateral cephalometric radiographs (E) show the anterior open-bite and low subcondylar fractures. Orthodontic appliances were secured to the dentition, and elastics were used to produce a normal bite relationship (F). The photograph of the occlusion is 8 days after beginning elastic therapy. A panoramic radiograph taken 2 weeks after the beginning of treatment (G) shows that the bite is closed and the condyles are in a reasonable position within the fossae. Records taken 13 months after treatment showed the patient maintained good mandibular mobility (H).

outcome for dentofacial deformity patients or patients with post-traumatic malocclusion. This is not true for the predictability of TMJ reconstructive procedures in the treatment of post-traumatic malocclusion, especially autogenous reconstructions.

There may be patients for whom TMJ reconstruction is necessary, but this is rare. If the mandibular ramus is not acceptable for an osteotomy because of multifragmentation, TMJ reconstruction is a better alternative. A decision must then be made whether the reconstruction will be performed with autogenous

tissues—such as the posterior segment of the mandibular ramus and attached condyle, a rib, or similar graft—or whether TMJ reconstruction with an alloplastic material would be more beneficial. A factor that might cause selection of an alloplast for reconstruction is in a patient with a very severe malocclusion, part of which was preexistent (pretrauma). This requires a large move of the mandible, comparable to what is necessary in a patient treated late for early-onset TMJ ankylosis. In such cases, alloplastic total TMJ reconstruction may provide a more secure result because it

Figure 6 (Continued) A normal occlusion was obtained (I and J). Six years after treatment, the patient showed good facial symmetry (K) and good mandibular mobility (L).

can provide a stable articulation against the large force required to obtain and maintain the new position of the mandible.

Some recommend open reduction of the malunited or nonunited condylar fragment if closed treatment does not provide a good outcome. This suggestion is based on the thought that TMJ reconstruction using the patient's own condyle will provide good articulation and stable occlusion. This sounds reasonable, but there are implicating factors to consider. First, one has to question why closed treatment is ineffective. Closed treatment of condylar fractures depends on the quality of rehabilitation, which is often inadequately managed by the surgeon or poorly cooperated with by the patient. In such cases, one has to question whether open treatment would be the best option for the patient.

Open treatment of a malunited condylar process is much more difficult than open treatment of a fresh fracture. The displaced fragment has to be separated from the mandible to which it is now fused. Depending on the time between the initial injury and the treatment of the malocclusion, the fragment may be impossible to position within the glenoid fossa for the reasons stated previously. After a few weeks of the condyle being out of the fossa, making room for it within the fossa becomes an extremely difficult maneuver; it may require open-joint surgery. This means that the vascular supply to the condylar fragment can be in jeopardy. Because of the remodeling process that is occurring, the bone may be soft and not have the integrity to adequately retain bone screws. This can result in screw loosening and loss of fixation, which does occur occasionally after open reductions and internal fixations performed on acute

Figure 6 (Continued) The patient also showed a stable occlusion (M–O). Open- and closed-mouth tomograms of the temporomandibular joints exhibited good range of motion (P and Q).

fractures.²¹ Thus, it is not prudent to perform open surgery unless done during the first weeks of an injury, and the decision to do so would be the same as it would be for a fresh fracture.

A consideration in selecting orthognathic surgery for treating post-traumatic malocclusions is the time between the injury and when the patient presents with malocclusion. A basic requirement of orthognathic surgery is that the temporomandibular articulation must be stable. If corrective jaw surgery is undertaken before the time when a stable articulation is reestablished, there may be difficulty at surgery in

Table 1 Rehabilitative Physical Therapy

- Arch bars or orthodontic appliances (with hooks) are attached to teeth
- Two or three small elastics hold teeth in occlusion while sleeping
- Elastics are removed on awakening; full jaw is used during day
 - Jaw levering if needed
 - 40+ mm incisal opening within 7 to 10 days
- Regimen continued 3+ months (until joint and occlusion are stable)

positioning the condyle. The articulation may feel “doughy” or “soft” at this time, and it can be difficult to obtain a stable condylar position. Another potential problem with occlusal correction before a stable articulation has been reestablished is that postsurgical

stability can be compromised. If the condyle continues remodeling after surgery, the occlusion can change. Approximately 2 or 3 weeks after fracture of the condylar process, the condyle and articular fossa begin a remodeling phase that lasts for several months.^{12,13}

Figure 7 Patient with malocclusion secondary to untreated condylar process fracture that occurred several years before on the left side. Frontal photograph (A) shows slight deviation of chin to the left. Photograph taken from below the face (B) shows loss of ramus height on the left side. There was hyperocclusion on the left and an open bite on the right (C). The panoramic radiograph (D) shows the malunited condylar fracture on the left and an open bite on the right. The open-mouth panoramic radiograph (E) demonstrates that the malunited condyle has good mobility. The lateral cephalogram (F) shows the maxillary occlusal plane to be level, but there is a cant of the mandibular occlusal plane.

Figure 7 (Continued) The patient underwent presurgical orthodontic therapy to coordinate the arches. A vertical ramus osteotomy was performed on the right side (G), and a sagittal ramus osteotomy was performed on the left side (H). Eight months later, the patient had good facial symmetry (I), good mobility of the mandible (with deviation to the left on opening) (J), and a stable occlusion (K). The panoramic radiograph (L) demonstrates that the left condyle maintained its malrelationship with the glenoid fossa.

Figure 7 (Continued) The lateral (M) and P-A cephalograms (N) demonstrate that the mandibular occlusal plane has been leveled, but a discrepancy remains in the vertical position of the gonial angles secondary to loss of posterior vertical dimension on the left.

Table 2 Goals of Rehabilitative Physical Therapy

- Wide, pain-free opening of mouth (beyond 40 mm at incisors)
- Good occlusion
- Good facial and jaw symmetry

It is believed that occlusal correction should not be done while this process is still active. Becking et al had stable results in their patients who underwent orthognathic surgery for malocclusion secondary to condylar fractures when treated at least 9 months after their initial condylar fracture treatment.² We have no data on when it is safe to perform orthognathic surgery for these patients before that time frame. It may seem prudent to wait until imaging shows signs of cortication of the articular surfaces and malocclusion is no longer progressing before undertaking occlusal correction. However, with adequate functional therapy that includes maintenance of the occlusion and good mandibular mobility, one can perform orthognathic surgery early, even before stable articulation has been reestablished. The functional therapy will create a stable condylar position while the osteotomy is healing.

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