Condylar Fracture Repair: Use of the Endoscope to Advance Traditional Treatment Philosophy

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Treatment of facial fractures has progressed significantly over the last 25 years largely because of the pioneer efforts of Paul Manson and Joseph Gruss. The systematic principles of wide exposure, visualized anatomic reduction, rigid internal fixation, and primary bone grafting of critical size defects—introduced by these surgeons—revolutionized the field of craniomaxillofacial surgery. The results achieved using their techniques far surpassed the outcomes of closed reduction and nonrigid fixation. Until recently, however, this standard of care was not applied to all areas of facial trauma; most notably omitted were the zygomatic arch and the mandibular condyle.

Closed treatment of mandibular fractures with maxillomandibular fixation (MMF) has a long and successful history, but it is not without significant morbidity. The best results have been achieved in skeletally immature children, where condylar remodeling often can restore condylar anatomy to near normal, even in the face of little or no fracture reduction. Despite almost miraculous condylar remodeling in children, the outcomes in adults have not been uniform, and a significant percentage suffers long-term aesthetic and functional problems [1–5]. Few studies exist comparing similar fractures treated by open versus closed methods. Most show equal or better outcomes after open treat-
ment despite the fact that more severely injured patients tended to undergo open treatment [6–15]. Patients treated with an open approach had better restoration of facial symmetry, faster recovery of jaw motion, and less chronic pain. The most important long-term complications of closed treatment are internal derangement and persistent malocclusion, the latter reported in up to 28% of patients [15–17].

The reluctance to use open reduction and internal fixation of condylar fractures stemmed from the belief that these injuries do well with closed treatment using MMF and because the open technique was challenging and associated with significant morbidity. All surgical approaches for the open treatment of condylar fractures require a facial incision, and nearly all will result in a perceptible scar [10], with up to 4% reporting an unsightly scar [7]. Close proximity of the facial nerve to the condyle compromises access to the fracture segment and makes the dissection tedious. Efforts to improve surgical access may result in either direct facial nerve injury or a traction injury during retraction. The risk of permanent facial nerve injury reported in 21 different series of open approaches, comprising 455 patients, averages 1%, while the risk of transient palsy ranges from 0% to 46% (mean 12%) [11,14,15,18–27]. An open intraoral approach, designed to circumvent these drawbacks, has been described, but it rarely is used because of very poor visualization and difficult hardware fixation [28].

The use of the endoscope to treat condylar injuries was a natural extension of minimally invasive techniques for managing craniomaxillofacial trauma. Most surgeons accept, on an intellectual level, that fracture reduction and rigid fixation with restoration of anatomy are laudable goals if that can be achieved without undue morbidity. Endoscopic assistance allows the surgeon to produce anatomic fracture alignment, and to avoid the negative sequelae of condylar malunion. The endoscopic approach described here has the potential to reduce morbidity by limiting scars, reducing the risk to the facial nerve, and eliminating the need for MMF, all while embracing the accepted advantages of anatomic reduction and rigid fixation. The decrease in morbidity associated with the endoscopic approach may expand the indications for reduction and rigid fixation in the future.

Regional anatomy and the effect of maxillomandibular fixation

Any displaced fracture of the condyle will have some degree of fragment overlap resulting in shortening of the posterior ramal height [29]. This is exacerbated by the normal resting tone of masticatory, suprathyroid, and infrahyoid musculature. As the fragments overlap, the mandible rotates such that there is premature posterior occlusal contact and an anterior open bite. In addition, this causes an unappealing loss of chin projection at the pogonion. Only with effort, as during chewing, are proper occlusion and chin position forcefully restored [30]. Furthermore, ramal shortening causes a decreased radius of mandibular rotation that is visible as ipsilateral jaw deviation during motion [29].

Attachments of the lateral pterygoid muscle usually place the condylar fragment into a flexed posture. This has been the case in 80% of adult condylar fractures in the authors’ experience. In addition, the lateral pterygoid often will cause inclination of the condylar head medially, further shortening the ramal height. This results in premature contact with the anterior wall of the glenoid fossa, limiting interincisal opening to initial hinge-type motion only. The additional 15 to 20 mm of opening available through translational movement never is achieved fully.

The complex relationships of the temporomandibular articulation allow only minimal imperections. A malunited condyle alters these precise relationships, resulting in significant aberrations in joint dynamics that have a marked potential to produce late internal derangement. In addition, because of the bilateral interdependence of the craniomandibular articulation, the contralateral condyle sustains excessive biomechanical loads and similarly is predisposed to early degenerative changes [31].

Extended experience and careful analysis of closed treatment of condylar injuries using MMF have shown that fracture reduction rarely occurs. Instead, centric occlusion is forced through neuromuscular adaptation to the condylar malunion at the temporomandibular joint. Malunion often results in shortening of the posterior ramus because of interfragmentary overlap, abnormal orientation of the condylar fragment, and alteration of the temporomandibular joint biomechanics, all of which carry significant functional and aesthetic consequences.

When assessing the shortcomings of closed treatment, the significant independent morbidities associated with MMF often are overlooked because of the surgical simplicity of its application. The prolonged period of immobilization using MMF necessitates a lengthy postoperative regimen of muscular and occlusal rehabilitation to improve muscle function, condylar movement, and range of motion. Studies in rhesus monkeys have demonstrated loss of interincisal opening and maximal stimulated bite force after MMF [32,33]. Addition-
ally, comparisons of patients with condylar neck fractures randomized to open versus MMF treatment have demonstrated that patients after MMF have decreased range of motion necessitating long periods of physiotherapy to regain their premorbid function [7,15]. Many patients find MMF uncomfortable, and who have dementia or psychiatric diagnosis simply may not tolerate the procedure. It is difficult to maintain good oral hygiene with MMF; orthodontic treatment must be delayed during the period of MMF, and those who have seizure disorders or alcoholism are at risk for aspiration and death.

**Role of the endoscope—treatment indications**

The goals of condylar fracture treatment are: pain-free mouth opening with interincisal distance beyond 40 mm, good excursion of the jaw in all directions, restoration of preinjury occlusion, stable temporomandibular joints, and good symmetry [30]. In most circumstances, anatomic reduction and rigid fixation of the condyle are required to satisfy these objectives by restoring preinjury ramal height, upright posture of the condylar head, and complex anatomical relationships of the temporomandibular articulation.

Patients with condylar process fractures are selected for endoscopic-assisted reduction and fixation based on age, location of fracture, degree of comminution, direction of proximal fragment displacement, dislocation of condylar head, concomitant medical or surgical illness, and patient choice. Condylar fractures in prepubertal patients do not require anatomic reduction because of the great potential for rehabilitation through growth and remodeling. Fractures of the condylar head generally do not demonstrate significant loss of posterior ramal height and can be expected to do relatively well with traditional methods. Fractures that do not allow for the application of at least two holes of a 2.0 mm plate are likewise not amenable to endoscopic repair. Finally, open treatment is not advocated for nondisplaced, nondislocated fractures, as normal biomechanical relationships are unaltered.

**Preoperative planning**

**Fracture anatomy**

The endoscopic technique of condylar fracture repair relies on visual confirmation of fracture fragment reduction and sufficient length of the extra-capsular segment for the placement of fixation hardware. Endoscopic approaches by their very nature have a limited optical cavity, distorted perspective, and geometric constraints for instruments. Consequently, determination of the precise fracture geometry preoperatively is mandatory so that a decision can be reached whether an endoscopic approach is feasible. There are four specific fracture attributes that will help to make the decision: location, displacement, comminution, and relationship of the condylar head to the fossa.

**Fracture location**

Condylar fractures are classified as head (intracapsular), neck (below the head and above the sigmoid notch), and subcondylar [Fig. 1] [34]. Intracapsular fractures and high neck fractures are not treated using the endoscopic approach, because there is no possibility of applying fixation. In addition, surgical exposure may lead to devascularization of the condylar head. Fractures of the condylar neck are suitable for endoscopic treatment if sufficient bone stock is present proximally to accept two screws for miniplate fixation. Endoscopic repair of subcondylar fractures is generally the easiest.

**Fracture displacement**

Displacement refers to the position of the condylar fragment relative to the ascending ramus. Fractures where the condylar segment is located medially are termed medial override, those where it is lateral, lateral override [Fig. 2]. The latter group forms the vast majority of adult condylar injuries treated at the authors’ centers. Displacement is an important variable guiding the initial approach to endoscopic treatment. Lateral override fractures are especially amenable to repair because of easier fragment visualization, manipulation, and hard-
ware fixation. In contrast, medial override injuries are more difficult to reduce endoscopically, as the telescoped ascending ramus obscures visual access to the lateral surface of the condylar fragment and greatly impairs manipulation because of physical obstruction. The authors simplify the treatment of medial override injuries by first reducing them to the lateral override category. Nondisplaced, nondislocated fractures signify the presence of sufficient periosteal support for stability and do not require open treatment.

**Fracture comminution**

Significant comminution is a relative contraindication to endoscopic repair as this technique relies largely on visualization of the fracture line for anatomic reduction and some degree of interfragmentary opposition for solid fixation. During reduction, the anterior and posterior borders of the fracture line are used as anatomic landmarks to assess accurate reduction. Commminated fractures often will have fracture fragments that involve the border and thereby obscure these landmarks. Microcomminution will obscure the interdigitation of small irregularities along the fracture line that ordinarily assist in precise reduction. Unfortunately, the visual limitations of endoscopy make reliable assessment of reduction deceptively challenging in the face of comminution.

A minor degree of comminution is not considered a contraindication.

**Condyle–fossa relationship**

Fractures associated with nondislocated condylar heads are the most favorable for endoscopic repair. A displaced condylar head without true dislocation usually can be relocated into anatomic position easily; however, those fractures with true dislocation of the condylar head are significantly more challenging.

**Radiographic imaging**

Accurate radiographic imaging is necessary to reliably assess the feasibility of endoscopic repair and to formulate a precise treatment strategy by identifying fracture location, direction of displacement, and degree of comminution [Fig. 3]. The accuracy of modern helical CT scans has surpassed panoramic tomography for detecting mandibular fractures. Using 1 mm collimated images (with a pitch of two) and 1 mm axial images reconstructed on every second image, in 2001, Wilson and colleagues compared helical CT scanning with panoramic tomography in detecting 73 mandibular fractures in 42 consecutive patients and correlated the results with known surgical findings. Helical CT scan detected 100% of the fractures, while panoramic tomography detected only 86%. In six missed frac-

![Fig. 2. Coronal (above) and three-dimensional (below) CT reconstructions of a patient who sustained bilateral condylar fractures. The fracture of the right condyle demonstrates lateral override, that of the left, medial override. Generally lateral override fractures are the easiest to approach endoscopically, whereas medial override injuries are first reduced to lateral override to facilitate repair.](image)
In one patient, the nature of a dental root fracture was seen better on panoramic tomography [35]. In the authors’ experience, fine cut axial computed tomography scans with three-dimensional reformatting provide the most precise illustration of these variables. The three-dimensional reformatting is not accurate for detecting fracture detail but rather used to aid in the visualization of the fracture, and forming a clear mental picture of what will be required for reduction.

Operative technique

Endoscopic equipment

At their centers, the authors use a 4 mm diameter 30° angle endoscope, a 4 mm endoscopic brow lift sheath (Isse Dissector Retractor, Karl Storz, Germany) that maintains the optical cavity, and a video system. Standard mandible fracture repair instruments are used in addition to the Subcondylar Ramus fixation set from Synthes (Paoli, Pennsylvania), which provides many specialized instruments facilitating the endoscopic technique.

Repair sequence

If present, extracondylar fractures are addressed first using standard open reduction and internal fixation techniques to restore an intact mandibular arch. The rigid arch is then helpful in manipulating fracture fragments to achieve adequate reduction. Injection at the intraoral incision site and along the lateral aspect of the ascending ramus with 1:200,000 epinephrine solution will decrease bleeding into the optical cavity.

Maxillomandibular fixation

If MMF was used for repair of an extracondylar fracture, it is removed. The use of tight wire maxillomandibular fixation will prevent distraction of the fracture and lock the displaced condyle in a malreduced position. The authors routinely employ rubber band anterior MMF that facilitates fracture repair by maintaining occlusion but permitting realignment of fracture fragments. Remember that the reduction of the fracture is a visual reduction and not based on occlusion.

Exposure

An intraoral incision along the oblique line of the mandible is made. The endoscopic cavity is created by elevating the periosteum off the lateral aspect of the ascending ramus. The assistant may hold the endoscope while the surgeon uses the periosteal elevator and suction to continue the dissection proximally to reveal the condylar fragment. A common mistake is to inadvertently dissect under (or medial to) the proximal fragment. This occurs because of a failure to appreciate the degree of lateral override and coronal plane angulation of the proximal fragment. Once the proximal fragment is identified, the subperiosteal dissection continues on the lateral surface up to the joint capsule, or a sufficient distance to place the fixation hardware. Transcutaneous stab incisions for screw placement are made directly over the palpated fracture line at the posterior border of the mandible. Gentle, blunt hemostat dissection through the parotid gland and masseter muscle is performed to avoid injury to the facial nerve.

Reduction

To facilitate repair, medial override injuries are reduced initially into lateral override by placing a curved elevator medial to the proximal fragment while strongly distracting the fracture so as to allow the proximal fragment to be displaced to the lateral surface of the ascending ramus. If the fracture already is a lateral override, then interfragmentary realignment is achieved by distracting the distal segment through mechanical traction at the mandibular angle or placement of a 3 mm posterior occlusal spacer. The proximal segment can be reduced by bringing the condylar fragment out if its flexed position and applying medially directed pressure using a trocar inserted through the stab incisions. Removal of traction or posterior occlusal wedge then will permit the rubber band fixation to temporarily impact the fracture interfaces together and often maintain reduction while fixation is applied [Fig. 4].
Fixation

Screws are introduced through the transcutaneous trocar. A miniplate is fixated along the posterior border of the ascending ramus, taking advantage of its thick cortical bone and flat surface [see Fig. 4]. At least two screws are placed in each fracture segment to ensure solid fixation. Self-drilling screws have not been useful and often are a significant liability. Several authors have reported fracture of single miniplates; the authors advocate placement of two miniplates whenever possible.

In general, the fixation plate is attached to the condylar fragment first. This allows the plate to act as a handle to position the condylar fragment into reduction. After reduction is achieved, the screws are placed into the mandibular portion. Some groups have found that placing a plate near the sigmoid notch or anterior portion of the fracture first simplifies placement of the posterior border plate. Ultimately, each fracture will dictate the best approach. No matter the method, a meticulous inspection of the visual landmarks of anatomic reduction is imperative. The sigmoid notch and posterior border of the mandible must be visualized to ensure that reduction has occurred. If the reduction is not correct, then the distal screws should be removed and the condylar fragment repositioned. Following hardware placement, rubber band MMF is released and the mandible ranged in all excursions to ensure reproducible preinjury occlusion and stability of fixation.

Bailout

In a small number of attempted cases the endoscopic repair will not be possible because of inadequate proximal bone stock, excessive comminution, or inability to place fixation. In this circumstance, surgeons should resort to the method of condylar repair that they would use if the endoscopic technique was not available.

Postoperative regime

All patients leave the operating room without MMF and are kept on a soft diet for 6 weeks.

Results

The results depicted in the following sections represent the combined experience of the senior authors from three university medical centers: the Oregon Health and Science University Hospital Center, San Francisco General Hospital, and State University of New York Upstate Medical Center.

Fracture demographics

One hundred thirty-five patients were treated using primary endoscopic condylar fracture repair. The proportion of patients with bilateral, unilateral, and isolated fractures is shown in Fig. 5. Fractures involving bones other than the mandible were excluded; thus the term nonisolated fracture refers to involvement of the condyle and another mandibular site. In total, 150 condylar fractures were
attempted at primary endoscopic repair. Of those, 13 displayed medial override of the proximal fragment, and in eight fractures, the condylar head was dislocated completely out of the glenoid fossa.

Operative details

Of the 150 condylar fractures, plate fixation was achieved at primary endoscopic repair in 136 (91%) [Fig. 6]. In 27 patients presenting with bilateral condylar fractures, 13 had both sides repaired using the endoscopic approach. Fourteen had only one side treated endoscopically, as the bone stock in the proximal fragment on the contralateral side was deemed insufficient on preoperative CT images to achieve fixation.

In 75% of the fractures, the mean time required to accomplish endoscopic repair was less than 2 hours. The average duration for the last 30 cases was approximately 70 minutes.

Outcomes

Bailout procedure

Fourteen of 150 attempted endoscopic fracture repairs were aborted. The bailout procedure used in nine fractures was MMF. In these nine fractures, fracture reduction was achieved, but plate fixation was not possible because of the short condylar pole. Despite endoscopic fracture reduction and postoperative MMF, follow-up radiographs revealed loss of fracture reduction in all cases. Traditional open reduction and internal fixation techniques were used as the bailout procedure in the other five aborted endoscopic fractures. These were found to be exceptionally challenging surgical repairs, with persisting malreduction found in two fractures treated with traditional ORIF following aborted endoscopic procedures.

Radiographic fracture reduction

Plate fixation was achieved at primary endoscopic repair in 136 of 150 condylar fractures. Malreduction in 6 of these 136 condylar fractures, however, was found on early postoperative CT imaging. Four malreduced fractures were revised using secondary endoscopic procedures with successful correction of the malreduction. The other two malreductions were judged as minor and acceptable.

Hardware failure (broken plate) with late loss of reduction occurred in two of the remaining 130 primarily fixated condylar fractures; no secondary procedures were performed.

Mandibular function

Postoperative dental occlusion and interincisal jaw opening were documented in 102 patients. Mal-
occlusion was found in 3 of 102 patients. Interincisal jaw opening exceeded 35 mm in 96% of patients (98/102).

**Aesthetic appearance**

Scarring from endoscopic access portals was minimal in all cases. Facial height, chin projection, and a symmetrical appearance of the jaw line were restored in cases where fracture reduction was achieved successfully.

**Soft tissue complications**

There were no permanent facial nerve palsies. Two temporary palsies (one full and one involving the frontal branch only) occurred; both resolved completely and spontaneously. One soft tissue abscess was identified at a trocar portal and was treated uneventfully by incisional drainage.

**Summary**

This compilation of a series of 150 attempts at endoscopic condylar fracture repair represents the early evolving experience from three centers. The comprehensive data presented delineate the advantages and potential pitfalls with this newly introduced technique. Analysis of the early results shows a high rate (9%) of bailout. Does this represent a failure of the technique? Critical scrutiny of the data suggests not. Specifically, a review of CT images of the 14 fractures where plate fixation could not be achieved by the endoscopic technique suggests that these belong to a subgroup of proximal injuries that are predictably difficult to manage regardless of the surgical method. These data confirm this notion, as bailout to traditional techniques showed successful anatomic repair in only 2 of the 14 aborted cases attempted initially using the endoscope.

The incidence of bailout procedures can be reduced by careful analysis of CT images and subsequent exclusion of these proximal injuries. When endoscopic repair is used selectively to treat injuries that have been shown to be amenable to this approach, it can be expected to reliably produce anatomic reduction in 94% (128/136) of cases. Only 6 of 136 primarily endoscopically fixated fractures went on to malreduction. Four of those 6 were salvaged with successful secondary endoscopic procedure. Plate fracture accounted for 6 of 136 primarily endoscopically fixated condylar fractures. The substantial advantages of anatomic reduction have been delineated. Restoration of premorbid ramal height, upright posture of the condylar head, and complex temporomandibular joint relationships results in an aesthetic chin projection and occlusion, adequate interincisal opening (96% of patients had opening greater than 35 mm). Additionally, the technique prevents the late sequelae of internal derangement. Furthermore, the drawbacks of open reduction had been avoided. No patients sustained significant facial scarring, and there were no cases of permanent facial nerve palsy and only two cases of temporary facial nerve palsy.

The endoscopic approach is technically demanding, and the initial operative times are long. Following a period of adjustment, however, the authors have found the time required approximates that of transcutaneous open methods. In this series, the last 30 cases took an average of 70 minutes. The skills needed for condylar repair are also increasingly essential to complete various other facial plastic surgery procedures, and many instructional courses already have been organized. Furthermore, the development of specialized endoscopic instruments facilitates repair.

In the treatment of condylar injuries, the endoscope is not only an aid; it alters the treatment philosophy, from the conservative MMF to anatomic repair. Each surgeon will have to decide on his or her indications for endoscopic repair, and indeed this may depend heavily on his or her experience and patient preference. The authors feel that anatomic reduction and fixation are the best way to restore preinjury facial aesthetics and mandibular motion dynamics and to prevent late sequelae of internal derangement. Thus, the authors strongly advocate endoscopic repair of adult condylar neck and subcondylar fractures that demonstrate displacement or dislocation. The authors look forward to future advancements of this and other endoscopic techniques.

**References**


