

### Endoscopic Surgery for Condylar Fractures

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**Type of Publication:** Original Research Paper

**Conflicts of Interest:** Nil

#### Abstract

This study was done to evaluate the role of endoscope in reduction of condylar/subcondylar fracture. It reviewed:

1) The history, 2) Anatomy, 3) Incidence 4) Etiology 5) Prevalence 6) Presentation 7) Diagnosis 8) Endoscopic Procedure. Many techniques have been described for the open reduction of condylar fractures but resulted in injury of the facial nerve or the creation of visible scars. The risk of facial nerve damage and visible scars can be reduced by minimally invasive techniques. In cases with moderate dislocation, a transoral approach is utilized to avoid damage of the facial nerve and visible scars. As endoscopic approach is a minimally invasive approach it could be used to prevent postoperative complications of open reduction.

**Keywords:** Mandibular condylar fractures, endoscope.

Abbreviations:

- MMF – Maxillomandibular fixation
- ORIF- Open reduction and internal fixation
- EORIF- Endoscopic open reduction and internal fixation
- M3 – Mandibular third molars

#### Introduction

Modern surgery attempts to minimize as much as possible the patient's somatic and psychological trauma. Minimally invasive surgery is a good way to achieve this objective; and is therefore of growing importance in nearly all surgical specialties. The basic methods of facial fracture repair include fracture exposure, reduction, and fixation. Traditionally, these repairs have been performed via an open surgical approach. In fact, in recent decades, increasingly wider exposures have been used to ensure accurate bony repositioning. However, recent experiences have suggested that the use of endoscopes, as in other minimally invasive procedures, may allow repair of facial fractures through smaller incisions with less-extensive exposure. Lower morbidity rates associated with smaller incisions and exposures made minimally invasive surgical techniques widely and rapidly acceptable. Using an endoscope, superior visibility in areas of limited exposure can be achieved through limited incisions. Fractures of the mandibular condyle are common and account for 9-45% of all mandibular

fractures<sup>1</sup>. Closed reduction is the method most widely employed for the treatment of dislocated condylar fractures<sup>2</sup>. Rehabilitation of temporomandibular joint function depends on anatomic reduction and altered condylar morphology which is difficult to achieve by the most widely used closed reduction method. Many techniques have been described for the open reduction of condylar fractures but resulted in injury of the facial nerve or the creation of visible scars<sup>3</sup>. The risk of facial nerve damage and visible scars can be reduced by minimally invasive techniques<sup>4</sup>. In cases with moderate dislocation, a transoral approach is utilized to avoid damage of the facial nerve and visible scars<sup>5</sup>. As endoscopic approach is a minimally invasive approach it could be used to prevent postoperative complications of open reduction. The purpose of this study is to evaluate the role of endoscope in reduction of condylar/subcondylar fracture.

### **Discussion**

Endoscopic sinus surgery was described in the 1970s and became the standard of care in the 1980s. Since then, the indications for endoscopic head and neck surgery have continued to expand, with applications in otology (middle ear endoscopy), skull base surgery (cerebrospinal fluid [CSF] leak management, optic nerve decompression, tumor resection), neck surgery (thyroid and parathyroid), and ophthalmologic surgery.

In facial cosmetic corrections, endoscopy was initially used for forehead rejuvenation. Now, endoscopic approaches replaced traditional open approaches, and many surgeons now use endoscopic techniques for midface rejuvenation. Maxillofacial surgery is not an exception and it employs minimally invasive surgical procedures for the treatment of temporomandibular joint diseases (arthroscopy of the TMJ)<sup>6</sup> and maxillofacial traumas. Within the field of maxillofacial traumas, the treatments by endoscopy of fractures of the mandible, of

the orbitozygomatic area and of the frontal sinus have been described<sup>7</sup>. Other applications of endoscopy are surgery of the salivary glands (sialoendoscopy) and surgery of the base of the skull.

Subcondylar fractures of the mandible are frequent, their treatment being one of the most controversial aspects in maxillofacial surgery. The existence of this controversy is based in the positive and negative aspects of open reduction (preauricular, retromandibular and submandibular approaches) and closed reduction (intermaxillary fixation). Open and closed reductions have been the two kinds of treatment used to date<sup>8</sup>. Closed reduction, by definition, cannot achieve an anatomic reduction of the fracture and therefore, the function of the temporomandibular joint (TMJ) and its postsurgical rehabilitation will depend on the adaptation of the TMJ to its new modified condylar morphology. Possible complications are shortening of the ascending mandibular ramus, open bite, malocclusion, limited mouth opening, lateral mandibular deviation when opening the mouth, dislocation of the contralateral temporomandibular joint, condylar necrosis and ankylosis of the temporomandibular joint (med oral patrol oral cir buccal, open reduction can achieve an anatomic reduction of the fracture as it can be directly visualized, but there is a relatively high risk of injury to the facial nerve and undesired facial scars are produced<sup>9,10,11,12,13,14</sup>. Endoscopic treatment by transoral approach of subcondylar fractures of the mandible is a technique designed to combine the positive aspects of both conventional methods mentioned above<sup>15,16</sup>.

Until the present decade, conventional wisdom has suggested that closed reduction of mandibular condyle fractures along with some form of maxillomandibular fixation was the technique that provided the most favorable results. This widely held belief has been fostered by such 1950s statements as —complications

arising from fractures of the mandibular condyle are conspicuous by their absence. While cutting-edge research at the time, a review of the literature from which this —conventional wisdom was based has revealed completely different interpretations when scrutinized by today's standards. This was discussed at length in a review by a group<sup>17</sup>. While very specific indications for closed reduction of mandibular condyle fractures now remain, open reduction with rigid internal fixation (ORIF) has evolved as a popular and effective management because of recent comparisons reporting its superiority over closed reduction<sup>18</sup>. Many authors consider it the preferred technique for managing mandibular fractures categorized as subcondylar or low neck, offering the most favorable and predictable results<sup>17</sup>. As traditional ORIF of mandibular condyle fractures has gained popularity, so has the development of minimally invasive surgery. Minimally invasive surgery was initially developed by gynecologic and general surgeons for the treatment of benign tumors and cysts, as well as other minor surgical procedures that permitted management with endoscopic assistance through small incisions and portals<sup>19</sup>. Proponents of this surgical philosophy have suggested that its application for the management of mandibular condyle fractures will eliminate the need for —traditional access through very visible facial incisions and risking injury to the facial nerve through the use of —hidden incisions<sup>20</sup>. They also suggest that surgical technique than with traditional open approaches, with the added benefit of no greater risk to the facial nerve. But are the results the same? Are any benefits achieved? Or, are there risks or disadvantages of endoscope-assisted surgery that are not realized with traditional open approaches? The purpose of this study is to review the literature regarding the traditional approach and the endoscope-assisted approach to ORIF of mandibular condyle fractures, to

interpret the outcomes of these surgical procedures, and to then offer an objective opinion regarding the suitability of either.

The anatomy of the TMJ is well suited to its function. The articular eminence and the superior portion of the mandibular condyle are covered with fibrocartilage, while the articular disc is composed of dense collagenous connective tissue. The disc itself is without sensation, but the retrodiscal tissue, a loose areolar connective tissue, is well innervated. The jaw opens first by rotation of the condyle within the inferior joint space and then by translation of the condyle and disc in a downward and forward direction; thus, while rotation occurs in the inferior joint space, translation occurs in the superior joint space. Rotation alone allows approximately 20-24 mm of interincisal opening, which is the distance between incisal edges of the maxillary and mandibular incisors. Normal maximum interincisal opening meets or exceeds 40 mm, and to accomplish this, translation is necessary. The tooth-bearing facial skeleton, the dentition, and the TMJs together form an interdependent tripartite complex where disruption of any single part can result in marked difficulties in the others. As a corollary, considering all 3 parts in the reconstruction of an injury to any one part is necessary.

Unilateral fractures occur approximately 3 times more frequently than bilateral fractures do, but bilateral fractures are not uncommon. The frequency of these injuries does not seem to differ significantly from location to location<sup>21</sup>. The etiology of these injuries varies in accordance with both sociologic and age factors. In the Netherlands, for example, where bicycling is a common form of transportation, cycling accidents are the primary cause of condylar/subcondylar injuries. In large American cities, the most common etiology for the same injuries may be either motor vehicle accidents or interpersonal

violence, depending upon the characteristics of the city. In New York and San Francisco, for example, where population density is high and traffic is congested, interpersonal violence is far more common, while in the Midwest, where traffic moves faster and where land is available for all-terrain vehicle use, these fractures are more commonly a result of vehicular accidents. Among children, falls and playground and bicycle accidents are the usual causes of these injuries<sup>21</sup>.

The clinical presentation of condylar/subcondylar injuries may be either straightforward or quite subtle. An awareness of the mechanism of potential injury, as well as the specific signs and symptoms that should raise the index of suspicion is therefore helpful to the clinician. History, physical examination, and radiographic studies form the mainstays of diagnosis. Falls, blows to the contralateral face or ipsilateral preauricular area, or chin injuries should alert the examiner to the possibility of a condylar/subcondylar injury. Because of the U-shaped mandibular anatomy, patients thought to have a single mandibular fracture often have others. Also, the patient with a subcondylar fracture often has another mandibular fracture. Nevertheless, an isolated subcondylar or intracapsular fracture is quite possible<sup>21</sup>. Contusions over the chin or preauricular area, hemotympanum, and malocclusion are all potential signs of a condylar or subcondylar fracture. Less commonly, a facial nerve deficit may be associated with an injury to this area<sup>21</sup>. The examination must therefore include assessment of the patient's occlusion and facial nerve function. For all practitioners, and especially for the practitioner not trained in dental anatomy, ascertaining from patients whether or not they notice a change in their own occlusion may be helpful. Of course, such evaluations are not fail-safe because the presence of multiple fractures and/or injury to the inferior alveolar, lingual, and/or facial nerve

may skew patients' perception of their own clinical situation. Thus, all who intend to treat these types of injuries must become cognizant of normal mandibular range of motion parameters, as well as normal occlusal patterns and intraoral clues (eg, wear facets) that provide a guide to the patient's pre-morbid occlusion and functional relationships. In the patient with multiple fractures, obtaining dental study models may greatly facilitate treatment, while significantly decreasing intraoperative time<sup>21</sup>.

Plain radiography (most commonly) and CT scanning help to ascertain the location of the fracture, the degree and direction of displacement, and the presence or absence of associated injuries. All of this information is integral to developing an appropriate treatment plan for the patient. Panoramic radiography is a useful study. Properly taken, this modality allows examination of the entire mandible, TMJs, the maxilla, and the maxillary sinuses. Unfortunately, the equipment necessary to obtain radiographs is not available in every treatment facility. If panoramic radiography is unavailable, bilateral lateral oblique views of the mandible can allow the surgeon to view the condyles and subcondylar areas<sup>21</sup>. In 30° antero-postero (AP) skull radiography (ie, Towne view), the head is positioned so that the condyles and subcondylar area are not obscured by the base of the skull. By positioning the head and film in this manner, the condyles and subcondylar area are visualized. This view is particularly helpful for ascertaining the mediolateral position of the respective fractured segments, information not readily available from a panoramic view<sup>21</sup>. CT scanning in axial and coronal planes can yield much information about this area provided that the sections are sufficiently close to obtain images of the area and provided the practitioner is intimately familiar with the pertinent anatomy<sup>21</sup>. However, CT scanning is not the preferred imaging

modality for most mandible fractures, including those of the condyle. CT scanning does provide the most information about intracapsular fractures.

It is important when considering a particular intervention or management strategy that similar problems are being addressed under similar circumstances. This suggests that a uniform classification scheme or system of terminology and similar indications for therapy should exist. Unfortunately, when dealing with mandibular condyle injuries, a multitude of classification schemes and considerations for indications exist. Until a widely accepted classification system exists, it will remain difficult to make consistent decisions regarding management of condylar fractures. The first system attempting to categorize mandibular condyle injury was created without the aid of radiography. The initial categorization systems were largely anatomically or vector based noting a particular region involved and/or the direction and magnitude of displacement. As an example, in 1915, Brophy classified fractures of the —condyloid process by the location and direction of the fracture. These were —through the neck; from above and without; downward and inward; or reversed; from above and in front; backward and downward.<sup>22</sup>

**General requirements for endoscopic surgery include the following:** The ability to surgically obtain and maintain an optical cavity, to insert a fiberoptic endoscope, to maintain adequate hemostasis, to apply instrumentation.

**Advantages of endoscopic repair include the following:** More accurate fracture visualization, Small external incisions, Reduced soft tissue dissection, The potential for visualization around corners, possibility of reduced duration of hospital stays, Improved teaching opportunities (since the procedure can be visualized on a television monitor).

**Disadvantages of endoscopic repair include the following:** A current lack of dedicated instrumentation, moderate learning curve for the techniques, narrow field of view, limited ability for bimanual instrumentation without an assistant.

**Indications for Endoscopic Repair:** Indications for endoscopic repair are generally related to:- Fracture location, size, degree of comminution, the surgeon's abilities.

In a preliminary anatomic study, the reduction of osteotomized condylar processes was performed. Modified forehead lift instruments, special angulated condyle forceps, and a flexible fixator were used for repositioning the condylar segment under endoscopic vision. The cadaver studies served as a basis for further modification of the endoscopic plate application prototype. Later on various modifications made to facilitate the fracture reduction in better way with minimizing complications. The surgical material for the reduction of the fracture includes a 30-degree angulated and 4mm-thick optical retractor-dissector (Karl Storz®, Tuttlingen, Germany), a rhinoplasty aspirator-scraper, a transcutaneous device (straight drill for the opening of holes to place the screws and straight screwdriver), 1 mm-thick titanium miniplates with 4 holes and no bridge (Leibinger®) and 5-7 mm-long and 2 mm-thick screws (Leibinger®)<sup>8,40,41</sup>.

**Recent advancements:** With miniplate holder- The device consists of a 3.5mm endoscope (Fa. Wolf, Knittlingen, Germany) attached to a special channel for the application of 2.0 osteosynthesis plates (Synthes USA, Paoli, PA). A miniplate can be moved forward stepwise in this channel so that at each step the next plate hole is visible in the focus of the optical system. The curved tip of the endoscope is shaped like a periosteal elevator to enable preparation of the proximal fragment. At the tip of

the instrument is a standardized threaded hole to insert the transbuccal drill guide for drilling of the screw holes and placement of the osteosynthesis screws under visual control. Through additional channels, the field of vision of the endoscope can be flushed and suctioned<sup>42</sup>. With tissue dissector / posterior boarder retractor- The basic surgical armamentarium includes a 4-mm diameter straight endoscope with 30° optical tip angle illuminated by a xenon light source (7200B, Karl Storz, Tuttlingen, Germany) and a set of condylar fracture fixation system (Synthes, Paoli, PA). The endoscope could be incorporated into a specially designed tissue dissector or a modified posterior border retractor<sup>41</sup>.

Parameters selected for post operative evaluation of reduced condylar fracture. After surgery, the function of the mandible and the temporomandibular joint were assessed by measuring maximum mouth opening, mandibular deviation when opening the mouth, correct lateral moving of the mandible, existence of malocclusion and pain in the temporomandibular joint. Surgical techniques for reduction of condylar fractures follows basically either transoral or transbuccal approaches, depending upon dislocation of fracture segments either laterally or medially.

**Nondislocated Fractures & Laterally dislocated fractures<sup>43</sup>**:- An intraoral mucosal incision is designed from the ascending ramus down to the vestibular mucosa lateral to the lower first molar region. Subperiosteal dissection exposes the lateral part of the mandibular ramus, posterior border, sigmoid notch and the gonial angle. A sigmoid notch retractor and a modified posterior border retractor are then placed in their respective locations to provide access for the endoscope and the subsequent plate fixation. The endoscope is inserted intraorally through the subperiosteal pocket of the lateral ramus to verify the fracture line. The occlusion is then

wired together by intermaxillary fixation using arch bars. The nondislocated condylar segment is reduced using a combination of straight and angle periosteal elevators. A titanium compression miniplate (Catalog No. 443.460, Synthes) purposely designed for condylar fixation can be selected to adapt over the condylar segment and ramus. The transoral endoscope can provide good visibility of the fractured condylar segment and the lower part of the titanium plate. Under endoscopic guidance, fixation of the condylar segment is achieved with 2 or 3 titanium screws through a transbuccal route created by a 3-mm stab incision made on the ear fold below the pinna. Precise anatomical reduction of the condylar segment over the mandibular ramus is achieved using a modified nerve hook and a long periosteal elevator (Synthes). Final fixation to the mandibular ramus is then achieved with 2 or 3 titanium screws to the lower part of the plate transbuccally as described above, or transorally using a right angle screwdriver drill.

In cases of condylar fracture with medially dislocated condyle, an intraoral reduction is considered very difficult or virtually impossible. A preauricular incision with temporal extension provides the best access for reducing the medially dislocated condyle. With the zygomatic arch and glenoid fossa exposed by subperiosteal dissection, the displaced condylar segment can be mobilized back to the glenoid fossa with a pair of manipulation forceps. Reduction of the fracture is facilitated by forceful mouth opening to allow the fractured condylar head to be relocated into the fossa. One titanium compression miniplate (Catalog No. 443.450, Synthes) is selected to adapt over the condylar segment and fixation is achieved with 2 or 3 titanium screws. The endoscope is inserted intraorally and manipulated to ascend cranially in order to visualize the fractured condylar neck and the lower part of the titanium plate. Precise anatomical reduction can be

achieved by pulling down the plate attached to the condylar segment using a modified nerve hook (Synthes). Further stabilization is facilitated with a long periosteal elevator, angle elevator and modified posterior border retractor. A 3-mm stab incision is made on the skin fold below the ear pinna for access by a transbuccal trocar. Final fixation to the mandibular ramus is achieved with 2 titanium screws to the lower part of the plate through a transbuccal route. A right angle screwdriver drill can be used to apply these screws below the fracture line if available.

Endoscopically-assisted transoral approach treatment of subcondylar fractures of the mandible is included within the concept of minimally invasive surgical procedures. Within the field of maxillofacial surgery, arthroscopy of the temporomandibular joint is another example of minimally invasive surgery<sup>6</sup>. Arthroscopy is less traumatic because it uses very small incisions and minimizes the damage that exposure to the open air and manipulation may produce in the inner tissue. The risks of complications related to the surgical wound such as bleeding, infection or dehiscence, are notably reduced<sup>7</sup>. Regarding subcondylar fractures of the mandible, this technique is becoming more popular, but is still far from being in general use. This technique combines the positive aspects of the open and close reduction<sup>7,10</sup>. This treatment leaves no facial scars and the risk of injury to the facial nerve is minimum<sup>7,10</sup>. It provides a direct view of the fracture, thus allowing anatomic reduction and a sufficient stable fixation. Concerning fixation, it must be considered that miniplates provide a semi-rigid fixation, and when added to the fact that we are dealing with fractures of the mandibular condyle (where there are two directions of mandibular forces<sup>57</sup>; then the optimal number of miniplates is two: one parallel to the condylar axis and the second parallel to the semi lunar notch axis<sup>58,59</sup>.

The main limitations for this kind of treatment derive from the difficulty of the surgical technique itself: the need to invest in the equipment and in instruments; the learning process to master the endoscope presents a very slow learning curve. As a result, the time of surgery for the first operations is longer than that of a traditional closed or open reduction<sup>5,10,15</sup>.

Larger samples of patients can be found in the published literature<sup>16</sup>: Lee et al. in 1998, studied 20 patients involving 22 subcondylar fractures; Chen et al. in 1999, studied a sample of 8 patients; Schön et al. in 2002 9 who compared the transoral to the submandibular approach, both endoscopically assisted, and concluded that the risk of involvement of the facial nerve and the time of surgery were higher in the submandibular approach; Schön et al. in 2003 10, studied 8 patients with a follow-up period of 18 months; Kellman et al. in 2003 59 studied a sample of 9 patients. All the above-mentioned studies produced very favorable results, both from the functional and aesthetic aspects. Endoscopically-assisted transoral approach is mainly indicated for subcondylar fractures with lateral displacement<sup>9,10</sup>, although it can also be used in fractures with medial displacement<sup>10</sup>. However, this technique has still not been adopted as the routine technique due to its higher technical difficulty compared to extraoral approaches, which provide better visibility<sup>9</sup>. For non-displaced subcondylar fractures, where occlusion is not affected, and with good mandibular mobility and little pain, treatment by observation for 7 to 10 days or by intermaxillary fixation is preferred. Fractures of the condylar head and intracapsular fractures must be treated by intermaxillary fixation<sup>16</sup>. The use of angulated drills and screwdrivers facilitates the transoral management of these type of fractures, without needing to use a transbuccal instrument, (used in our patients)<sup>9,10</sup>. The main difficulty in using and popularizing this technique is

its learning curve and the availability of the specific surgical instruments required<sup>60</sup>.

### Conclusion

Nevertheless, after reviewing the various articles published over the last few years, it is believed that with exception of absolute indication of closed treatment used in children, there are still no rules and/or norms defined for treating condylar fractures. The decision about the choice of the type of treatment must always take into consideration some of the factors, such as the patients' general health status, type of fracture, diagnostic precision, and mainly the capability, experience and skill of the surgeons in this type of lesion.

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