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REVIEW ARTICLE

Surgical Treatment of mandibular fractures: Review Article

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ABSTRACT

Mandibular fractures are common and usually the consequence of violent events. Depending on the direction, shape, displacement, and muscle forces operating on the fractured segments, these fractures are categorized as either favorable or unfavorable. Whereas unfavorable, noticeably displaced mandibular fractures require internal fixation, favorable mandibular fractures can be treated with closed reduction and maxillomandibular fixation, or with only functional therapy without any surgical intervention if there is minimal occlusion alteration that can be corrected by muscular actions. The most significant advancements in internal fixation methods for mandibular fractures stem from advances in technology. Previously, internal fixation was accomplished through interosseus wiring techniques, but these methods were rendered outdated with the introduction of contemporary mini plates and screws that offer rigid fixation and promote ideal fracture healing conditions. This method produces bone union, restores pre-injury occlusion, and usually eliminates the need for wire maxillomandibular immobilization in these unfavorable fractures, with the exception of the intraoperative restoration of occlusion. As a result, things will return to normal more quickly, safely, and comfortably.

Keywords: Mandibular fractures, Closed reduction,Fixation.

INTRODUCTION

One of the most common fractures that maxillofacial surgeons treat is a mandibular fracture. All of them affect the teeth and the occlusion, despite differences in position and/or severity [1-3]**.** For less complex mandibular injuries, the treatment paradigm still primarily relies on closed treatment; however, technological advancements have made it possible to reduce, stabilize, and fix even the most complex unfavorable mandibular fractures, providing patients with a level of predictability regarding their return to form and function that has never been seen before [4,5].

Closed versus open treatment of mandibular fractures.

Closed reduction techniques have been used for hundreds of years to treat mandibular fractures. where the broken segments are immobilized and osseous healing is permitted by the use of maxillomandibular fixation (MMF). It is important to balance the benefits of open versus closed reduction of mandibular fractures against the drawbacks. The location and features of the fracture as well as the adverse effects of the therapy are taken into account. Early mandibular mobilization can prevent undesirable outcomes such as reduced mouth opening or bony ankylosis. Early mobilization is beneficial in preventing potential ankylosis, particularly in patients who have condyle intracapsular fractures. When temporomandibular joint (TMJ) fractures occur, it is preferable to forego maxillomandibular fixation since postoperative physiotherapy can begin much earlier. Closed reduction has several benefits, including as convenience of use, shorter operating times, and protection of nearby structures. Maxillomandibular fixation has drawbacks such as making it difficult to see the reduced fracture immediately, requiring the patient to follow a liquid diet, and causing breathing and speaking issues. When treating fractures with closed reduction, the standard immobilization period has been six weeks. Juniper and Awty found that 80 percent of mandibular fractures treated with maxillomandibular fixation and open or closed reduction showed clinical union after four weeks [6]. They were able to demonstrate a relationship between the patient's age and the likelihood of an early fracture union. By four weeks, Armaratunga discovered that 75% of mandible fractures had reached clinical union. Children's fractures mended in two weeks, but many older patients' fractures required eight weeks to reach clinical union [7].

While maxillomandibular fixation has historically been seen as a benign treatment, there are potential serious complications. There is a great overview of the detrimental impacts of mandibular immobility on the masticatory system by Ellis [8]. Mandibular fractures that are closed reduced may have negative effects on the periarticular connective tissues, muscles, synovial joints, and bone. For many years, the orthopedic literature has identified the consequences of immobilization on bone as "disuse osteoporosis." Following joint immobilization, vascular distention, cortical and trabecular thinning, and enhanced osteoclastic activity have all been reported [9]. Not only does muscular atrophy occur in the musculature, but muscle length and function can also alter.

Rigid fixation

Applying fixation to sufficiently stabilize the fracture and allow for active use of the jaw during the healing period is known as rigid fixation in the mandible. The four AO/ASIF principles are

1. anatomical reduction
2. functionally stable fixation
3. atraumatic surgical technique
4. immediate active function.

While there are already a variety of osteosynthesis techniques available for treating mandibular fractures, the basics of plate application remain the same. An overview of the various types follows [9].

- ***Compression plates***

Primary bone repair is more likely when compression plates are used because they create compression at the fracture site. Due to their construction, these plates can only be bent in two directions, and they cannot produce compression if they are not shaped correctly. Preventing compressive oblique fractures is crucial. Additionally, for them to produce uniform compression throughout the fracture line, bicortical screw engagement is necessary. Because of this, they must be positioned at the inferior border in order to prevent harm to the teeth's roots or inferior alveolar neurovascular structures and to offer efficient attachment. Nonetheless, it has been observed that fractures treated with compression plates have a higher frequency of complications [10].

- ***Reconstruction plates***

It is advised to use reconstruction plates to bridge continuity gaps and treat comminuted fractures. The screws that correspond to these stiff plates have a diameter of 2.3–3.0 mm. Three-dimensional contouring and adaptation of reconstruction plates to the underlying bone are possible [10].

- ***Locking reconstruction plates***

The titanium hollow-screw osteointegrated reconstruction plate (THORP) was first presented by Raveh *et al.* [11].By inserting an expansion screw into the bone screw's head, this technique creates stability between the screw and plate. The screw flanges expand as a result, locking them against the bone plate's hole wall. Eventually, Herford and Ellis discussed how mandibular surgery may be performed using a locking reconstruction bone plate/screw system [12].

By connecting the threads of the screw head with the threads in the reconstruction plate, this system (Lock-ing Reconstruction Plate, Synthes Maxillofacial, Paoli, PA) simplified the locking mechanism between the plate and the screw and did away with the necessity for expansion screws. Comparing locking plate/screw systems to traditional reconstruction plates reveals advantages. Compared to traditional plates, these plates allow for more stability and serve as internal fixators by locking the screw to the plate. It takes fewer screws to keep things stable. The main benefit of this kind of device is that it eliminates the need for the plate to make constant, close contact with the underlying bone. The plate and underlying bone will not be drawn toward one another when the screws tighten [13].

- ***Lag screw fixation***

Osteosynthesis for mandibular fractures can be achieved with lag screws. They require a minimum of two screws and perform effectively in oblique fractures. The lag screw fits passively in the outer bone segment's cortex and engages the opposing cortex. Either a genuine lag screw or overdrilling the proximal cortex can be used to achieve this. Of all the fixing procedures, this one produces the most stiffness by compressing the osseous segments. In order to prevent microfractures and spread the compressive pressures across a larger area, the proximal cortex should be countersunk. The symphyseal region of the mandible's structure, however, allows for the employment of lag screws in a different way; they can be inserted through the opposing cortices between the inferior teeth and the mental foramen. In order to avoid overriding between fractures, it is not recommended to obliquely treat them [14, 15].

- ***Miniplates***

Small plates having a screw diameter of 2.0 mm are commonly referred to as miniplates. It has been demonstrated that these plates work well for treating mandibular fractures. A superior border plate positioned at the point of peak stress may occasionally be sufficient for appropriate fixation in angular fractures, when a superior and inferior plate is normally needed. These plates have the benefit of being extremely low profile and sufficiently stable to eliminate the requirement for maxillomandibular fixation. There is less chance that they will be palpable, which lessens the requirement to remove the plate again later. Screws are usually positioned monocortically, however when they are positioned at the inferior border of the mandible, they might be positioned bicortically. Every osseous segment should have a minimum of two screws inserted. Compared to bigger plates, these plates require fewer soft-tissue reflections and smaller incisions. They can also be inserted via an intraoral technique, removing the need for an external face scar. Reconstruction plates are stiffer than these plates, hence treating comminuted fractures with them is not advised [16].

- ***Micro miniplates***

Typically, little pliable plates with a screw diameter of 1.0–1.5 mm are referred to as micro miniplates. Due to their failure to offer tight fixation and propensity for plate fracture during the healing phase, their application in mandibular surgery is limited [17]; When 1.3-mm micromini plates were utilized to provide osteosynthesis for mandibular fractures, a recent study reported a 30.4% complication rate. These plates, however, can function well in the midface since there are significantly fewer muscle forces there than there are on the mandible [18].

- ***Bioresorbable plates***

Different quantities of poly-dioxanone (PDS), polyglycolic acid, and polylactic acid are used to make bioresorbable plates. A poly-L-lactic acid (PLLA) plate has been demonstrated to break at 50% of the yield strength needed to break a miniplate [19]. These plates can cause symptoms akin to those of a foreign body as well as inflammation. However, Laughlin *et al.*'s investigation shown that, in terms of healing the fracture with bone union and function restoration, resorbable plates perform equally well to titanium 2-mm plates [20].

- ***Three-dimensional miniplates***

The idea behind these miniplates is that three-dimensional stability can be produced by using bone screws to fasten a geometrically closed quadrangular plate. The smallest structural element of a three-dimensional plate is a square stone or an open cube. Clinical outcomes and biomechanical analyses in one study have demonstated that 3-D plates are stable enough to be used in the osteosynthesis of mandibular fractures without causing significant problems. The plate's slender 1.0 mm connecting arms enable simple, distortion-free adaption to the bone. Good blood flow to the bone is made possible by the open spaces between the arms [21].

General principles

- ***Surgical technique***

The placement of intermaxillary fixation occurs before a fracture is reduced. This makes it possible to use the occlusion to help with the fracture's anatomical reduction. The recommended approach combines maxillomandibular fixation with full-arch bars. During physical therapy, the arch bars offer a means of using elastic bands to sustain the occlusion after surgery. Following surgery, the arch bars are often taken out four weeks later. The fracture site determines the surgical strategy. One may use a transoral, vestibular, or transfacial method. Although a face approach increases the risk of injury to the facial nerve and leaves a scar on the skin, it offers great access. With the exception of condyle fractures, most fractures are readily accessible via a transoral incision. Sufficient access for fracture reduction and fixation implantation is provided via a subperiosteal dissection performed using a periosteal elevator. The mental nerve, which is located in the mental foramen close to the apices of the premolar teeth, should be protected against harm. The nerve can be freed if more exposure is required by lightly slicing the periosteum surrounding the nerve. When modifying the bone plate, bone-reducing forceps can frequently be used to lessen the fracture. Additionally, it creates interfragmentary compression, which increases the likelihood of primary bone repair. During the healing process, the smallest bone plate that will offer sufficient stability under functional loads is selected. It is necessary to use two screws at least on each side of the fracture. For the treatment of comminuted fractures or continuity defects, larger, more robust plates are needed. After the fixation is applied, the intermaxillary fixation that helped reduce the fractures during plating is removed. It is suggested to follow miniplate fixation for at least three weeks with a soft diet. Regaining pre-injury function, particularly maximal mouth opening, during the postoperative phase is crucial and should be achieved with intensive physiotherapy [12].

- ***Teeth in the line of fracture***

If the right antimicrobial therapy and fastening methods are applied, the majority of teeth that are in danger of breaking can be saved. Teeth that inhibit reduction of the fractures, partially erupted third molars with pericoronitis, teeth that are abnormally movable, broken tooth roots, exposed root surfaces in their entirety, or an excessive delay from the moment of fracture to treatment are all indications for extraction of teeth in the fracture line [22, 23].

- ***Antibiotics and mandible fractures***

Zallen and Curry [24] found that when patients did not get antibiotic therapy, mandibular fractures were linked to a 50% infection risk. For those who got antibiotics, the infection rate dropped to 6%.

Surgical Treatment by Fracture Site

- ***Body***

When dealing with closed mandibular body fractures that are either minimally displaced or nondisplaced, the term maxillomandibular fixation (MMF) is frequently employed. This is particularly true in cases where the fracture is isolated and reducible and the dentition is adequate. However, the results of this strategy include prolonged immobility and challenges with intraoral cleaning. In order to avoid the difficulty of dental wiring, some patients especially the elderly may discover that open reduction, internal fixation (ORIF) is preferred. In fact, larger displaced mandibular body fractures will usually require ORIF for proper anatomical reduction. To obtain exposure, a lateral gingivobuccal sulcus incision is made; in certain circumstances, an extraoral submandibular (Risdon) approach may be employed. Usually, two smaller plates are utilized for fixing; one is placed on the inferior border and the other somewhat above to protect the dental roots. The latter plate serves as a tension band. One large plate is used along the inferior border. Ellis found that utilizing two miniplates was associated with higher postoperative complications than using a single, stronger plate after examining 682 individuals who underwent ORIF for symphyseal or body fractures. Among these were noninfectious wound dehiscence and the need to take out the patient's exposed hardware [25].

- ***Symphysis/Parasymphysis***

The most common cause of anterior mandibular fractures is a posteriorly directed force, which is frequently observed in auto accidents. Concomitant mandibular fractures and C-spine injuries arising from neck hyperextension should always be taken into consideration due to the strength of the bone in this location of the jaw. The standard course of treatment for symphyseal and parasymphyseal fractures is open reduction with internal fixation; closed therapy is nevertheless a recognized alternative in some cases with simple, nondisplaced fractures. To reveal the fracture, a lower gingivobuccal sulcus incision and dissection to the inferior border of the jaw are performed. But the surgeon in this area needs to carefully dissect the area around the mental nerve in order to position the inferior plate below the mental foramen. Two miniplates are usually sufficient and produce equal results, as previously mentioned, albeit with higher postoperative complications [26].

A pair of lag screws used to cross the fracture line can be another reasonably priced rigid fixing technique. However, if proper bone-to-bone contact is not made, these long screws may shear the fracture pieces and cause malocclusion. It can be difficult to install them correctly as well. Because of this, some people think that this process requires a greater level of skill and experience and is very technique-sensitive (Figure 1) [26].

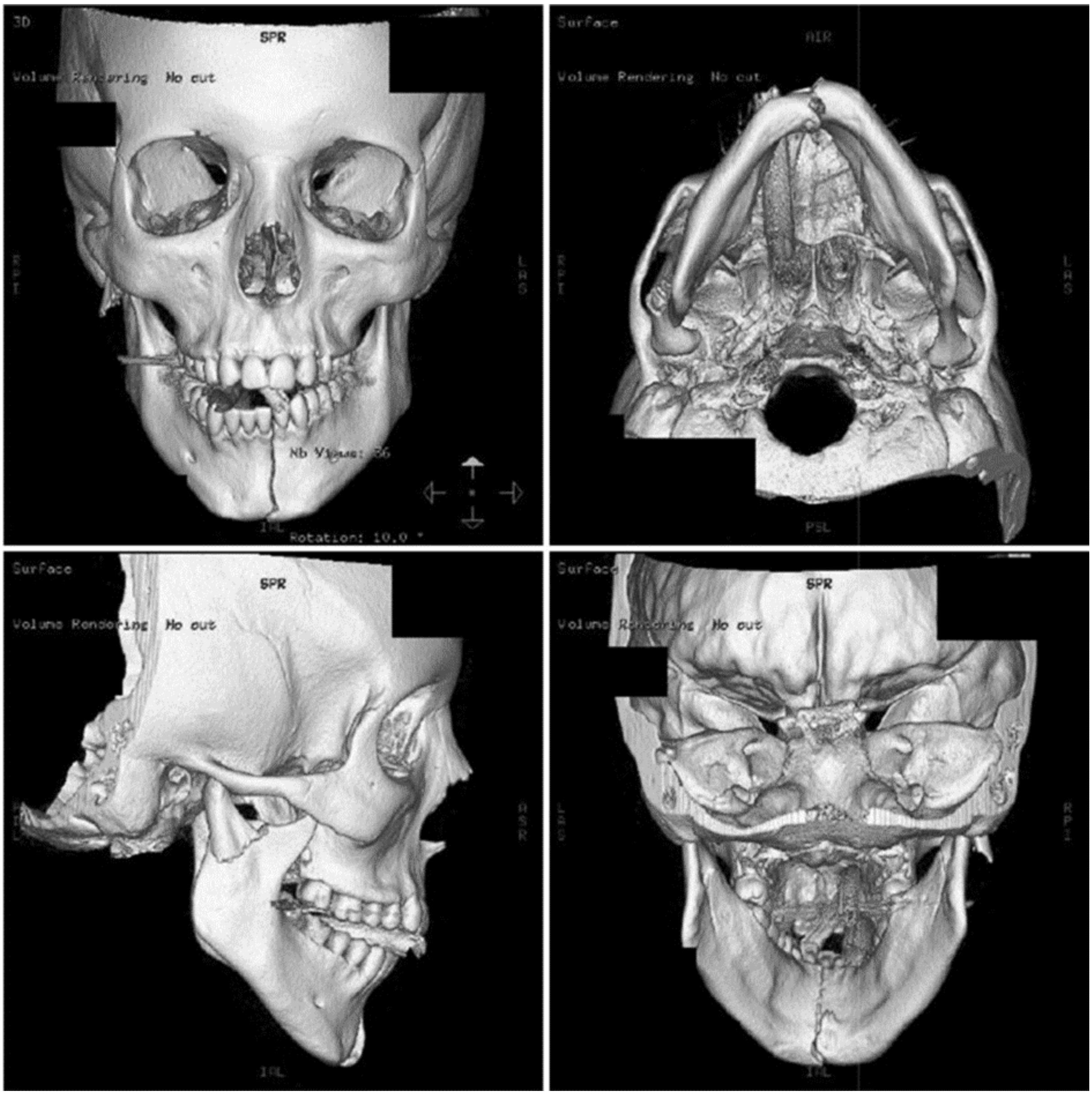

Figure (1): Displaced symphyseal and right subcondylar fractures [27].

- ***Angle***

Interpersonal violence-related mandibular fractures typically result in angular fractures; frequent fractures in this region are mainly thought to be caused by impacted third teeth and the reduced cross-sectional area of the mandible. Furthermore, of all mandibular fractures, mandibular angle fractures are the most technically difficult and have the highest rate of sequelae [28, 29].

It is important to take into account the several powerful muscles in the anatomical region that are capable of producing significant forces in different directions. Champy therefore showed that, when the forces of these muscles are considered, absolute rigid fixation is not necessary. Individuals with nondisplaced or mildly displaced fractures with normal occlusion may benefit from attentive observation, a soft diet, and/or a short course of treatment. A single plate along the oblique ridge, two lateral border plates, or a matrix-type miniplate on the lateral border are some of the ways to stabilize Angle fractures, but due to the tendency for proximal segment displacement, the majority of Angle fractures are managed with a modified ORIF technique via an intraorally vestibular incision (Figure 2). The most common method is intraoral procedure using a vestibular incision. In an article that was published in 2010, Ellis looked at 185 people who had angle fractures during a 12-year period and were treated with either MMF for five to six weeks, ORIF with one miniplate, or ORIF with two miniplates. The least complicated, least time-consuming, and least complicated technique was to do the procedure using a single mini-plate approach along the external oblique ridge [28]. Only the third process, nevertheless, produced a strict fixation.

Surgical complications were less likely when the single miniplate was positioned on the transbuccal (lateral surface of the jaw) rather than the external oblique ridge. In contrast to using traditional miniplates, it was found Since utilizing geometric miniplates reduced the likelihood of complications following surgery [30]. There are very few cases of bilateral mandibular angle fractures for which transoral rigid and nonrigid fixation using 2.0-mm miniplates has been documented [31].

Figure (2): Postoperative angle fracture repaired with a ladder miniplate [28].

- ***Condyle***

Mandibular condyle fractures account for 25 to 35 percent of all mandibular fractures. Preauricular pain, malocclusion, or chin deviation with mandibular opening and closing are the patient's presentation symptoms. Premature contact of the posterior teeth is a characteristic of anterior open-bite deformity in patients with bilateral condylar fractures. These fractures frequently coexist with symphysis/parasymphysis fractures, and a history of trauma to the symphyseal region may also be present. It is important to distinguish between intracapsular fractures, which involve breaks in the condyle itself, and extracapsular fractures, which involve breaks in the condylar neck. This is because intracapsular fractures have a higher risk of ankylosis because of their location within the temporomandibular joint (TMJ) [32, 33].

Patients who do not have malocclusion can usually be put on a soft diet under close supervision in place of MMF. However, there are several therapeutic options available if malocclusion is present, ranging from direct approach or endoscopic procedures to closed reduction, MMF, and ORIF. A more cautious approach is necessary, according to earlier research, since conservative care yielded occlusal and functional results that were comparable to those of individuals receiving ORIF. Additionally, it is believed that an open technique carries an increased risk of the broken segment devascularizing and leaving noticeable external scars [34]. Damage to the facial nerve is another known risk associated with ORIF; however, most cases seem to be temporary, with full recovery taking place in less than six months [35].On the other hand, proponents of ORIF claim that the open approach improves occlusion, posterior ramus height restoration, and pain control. Additionally, it has been found that individuals with condylar injuries may experience discomfort, arthritis, malocclusion, TMJ dysfunction, facial asymmetry, and ankylosis as long-term effects of closed therapy. Compared to a closed therapy, ORIF resulted in superior A 2015 meta-analysis by Al-Moraissi and Ellis uncovered functional clinical outcomes such protrusion, MIO, and the absence of chin deviation [35].The authors also noted improvements in occlusion and reduction of postoperative discomfort in patients who got open therapy [36]. The management of these fractures, according to some authorities, should ultimately depend on the surgeon's skill and comfort level as well as whether they think open surgery or closed surgery will better achieve the therapeutic goals, even though objective outcome metrics do seem to change with treatment option [34].

Bilateral subcondylar fractures provide a different kind of issue since they are associated with higher rates of sequelae, including up to 5% malocclusion rates. These patients have less structural support due to their lack of cranio-mandibular articulations, which makes conservative rehabilitation more difficult [36, 37]. Treating at least one of the fractures with ORIF to restore posterior facial height may be the best course of action to minimize rates of discomfort and malocclusion, even if there have been instances of these fractures being managed conservatively with ORIF. Other indications of ORIF include open fractures, the displacement of a fragmented fragment into the middle cerebral fossa, and the presence of a foreign body at the fracture site [38, 39].

Special Considerations

- ***Atrophic Mandible Fractures***

Because of the reduced bone volume resulting from the resorption of alveolar bone brought on by tooth loss, the atrophic mandible is more vulnerable to fractures. Elderly people without teeth are most likely to suffer from atrophic fractures. Patients with atrophic mandibles have a 4–20% higher risk of nonunion due to the decreased bone stock and inadequate blood supply. Due to their lack of teeth and the corresponding small-cross sectional area of their jaw, these patients are not suitable candidates for some standard fracture immobilization treatments, specifically MMF. Since a large number of these individuals are medically incapable, it is reasonable to infer that no treatment is required for these fractures. For patients undergoing intervention, details of both closed and open therapy have been provided [38].

Bruce and Ellis [39] found that closed treatment had higher rates of delayed or fibrous union than ORIF (25% vs. 12.6%) in a study of 104 consecutive edentulous fractures. Closed treatment patients also had worsening aesthetics, increased morbidity and length of impairment, and decreased jaw function. When ORIF is paired with quick bone grafting, it can show promising outcomes in patients who are stable enough medically to be placed under general anesthesia. Bone grafting can assist stabilize the fracture, promote osseous union, add weight to boost the possibility of prosthetic reconstruction by enlarging the alveolus, and prevent pathologic fracture because the atrophic mandible has a limited blood supply [38].

- ***Pediatric fractures***

The developing mandible and the presence of deciduous teeth complicate the management of pediatric fractures. Youngsters are typically less tolerant of MMF. For the treatment of pediatric mandibular fractures, an acrylic splint may be useful. Without MMF, this can be used to enable early postoperative physiotherapy in order to prevent growth problems and/or ankylosis, which are more prevalent in juvenile patients [40].For children under the age of twelve, closed procedures should be used to treat condylar process fractures. Asymmetry in the face and delayed growth are possible outcomes of damage to the condylar growth center. Five years after nonsurgical treatment of their fractures, Dalhlstrom*et al*. saw satisfactory restitution of the TMJ and no development abnormalities in fourteen children [41].Early research on animals revealed that when condyle fractures were treated with closed reduction, mandibular growth and symmetry were not significantly compromised. In his comparison of three fracture repair techniques, Boyne saw no differences in the outcomes of Rhesus monkeys treated with internal fixation (wire), MMF, or no therapy at all [42].

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