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A Comparative Analysis of Surgical and Conservative Management in Intra-Articular Condylar Fractures: A Retrospective Study

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Abstract: Background: Mandibular condylar fractures are among the most common fractures of the facial skeleton, and their surgical management remains a topic of considerable debate in maxillofacial trauma surgery. Numerous studies in the literature internationally have explored optimal treatment approaches, with a growing preference for open reduction and internal fixation (ORIF). While conservative treatment has traditionally been the standard for intra-articular fractures, recent research suggests that ORIF may also be appropriate for selected cases of these fractures. **Methods:** This study presents a 14-year review (2009–2023) of the authors' experience in the surgical management of intra-articular condylar fractures. Data were collected on surgical techniques, early and late complications, clinical and radiological outcomes, and comparisons with conservative treatment. **Results:** The analysis included evaluations of both short-term and long-term outcomes following ORIF, identifying specific scenarios where ORIF demonstrated advantages over conservative management. Clinical and radiographic assessments provided valuable insights into patient recovery and functional outcomes, while complication rates were documented for both treatment methods. **Conclusions:** Findings indicate that ORIF can be a beneficial treatment option for intra-articular condylar fractures in select patient groups, offering improved outcomes in cases where conservative treatment may be insufficient. However, conservative management remains a valid approach when surgical risks exceed potential benefits. This study adds to the ongoing discussion, supporting a tailored approach that considers individual patient factors when choosing between ORIF and conservative treatment.

Keywords: mandibular fracture; condylar fracture; trauma; internal fixation; malocclusion

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1. Introduction

Condylar fractures are widely reported in the literature as highly prevalent, accounting for approximately 27% of all fractures in the maxillofacial skeleton [1]. Road traffic accidents contribute to about 50% of condylar fractures, falls to 30%, and interpersonal violence to 20% [2]. The primary goal of treatment is to restore pre-traumatic masticatory function. A crucial aspect of achieving this goal is the re-establishment of pre-traumatic relationships between fractured segments, occlusion, and maxillofacial symmetry.

Mandibular condylar fractures are classified into three types: head fractures, neck fractures, and base fractures. The latter two, collectively referred to as extracapsular fractures, occur outside the joint capsule. Management of condylar fractures typically involves one of two approaches: conservative treatment (using closed reduction and immobilization) or surgical intervention (open reduction and internal fixation). In 2010, Loukota et al. proposed an anatomical classification of condylar head fractures, dividing

them into three types: Type A, involving the medial portion of the condylar head; Type B, affecting the lateral portion; and Type C, occurring near the attachment of the lateral capsule [3].

The functional outcomes of open reduction and internal fixation (ORIF) versus conservative management (CM) for mandibular condylar head fractures have been examined in several meta-analyses over the years [4–8]. Each approach has specific indications, contraindications, and distinct advantages and disadvantages. Unfortunately, many of these studies lacked detailed information about the level and side of the condylar head fracture or patient age, contributing to variability in treatment outcomes. The choice between open and closed reduction remains a contentious topic in maxillofacial surgery [9].

A review of the literature highlights the ongoing debate surrounding the optimal treatment for condylar fractures. According to some authors, such as Rozeboom [10], conservative management—being less invasive—may be appropriate for unilateral or minimally displaced fractures, as well as for dislocated condylar fractures with satisfactory occlusal relationships. This approach preserves normal occlusion with minimal complications, facilitates early jaw mobilization, and stabilizes occlusion using arch bars and elastics. However, it carries the risk of temporomandibular joint (TMJ) pain and may require prolonged maxillomandibular fixation (MMF). While initial functional recovery is often achieved with fewer complications, long-term issues such as reduced mouth opening, malocclusion, and deviation during jaw opening are frequently observed in non-surgical cases [11,12].

Nonetheless, conservative treatment has limitations, including patient discomfort and potential complications such as airway obstruction, impaired oral hygiene, speech difficulties, reduced nutrition leading to weight loss, and masticatory muscle atrophy due to disuse [13,14]. Advances in surgical techniques and materials, combined with the inconsistent outcomes associated with conservative management, have expanded the indications for open reduction surgery, even for intracapsular fractures [15,16]. Large-scale case series with postoperative follow-up remain scarce in the literature, as conservative approaches have historically been preferred for managing condylar fractures.

Surgical treatment of condylar fractures remains a challenging endeavor, primarily due to anatomical complexities and the risk of facial nerve injury [17]. However, advancements in anatomical understanding and the development of innovative instruments and techniques have contributed to the growing preference for open reduction in managing condylar fractures in recent years.

When restoring skeletal continuity, reestablishing normal mandibular positioning, and achieving proper occlusal relationships, open reduction and rigid internal fixation of condylar fractures can return the condylar process to its pre-traumatic position or close to it. Regardless of the treatment modality employed, the primary objective remains achieving proper occlusion and facilitating early functional recovery [18]. According to the literature, condylar fractures with displacement exceeding 35–45° are generally considered for surgical treatment, particularly when ramus height is reduced by more than 5 mm [18,19].

Given the attention to condylar head fracture management in the literature, the present study aims to evaluate statistically significant differences (p value less than 0.05) between the different methods of treatment of fractures of the condylar head and, in particular, to study whether treatment using ORIF allows for better pain management and better restoration of functionality.

This analysis will evaluate cases of patients who were clinically assessed and treated in the Maxillofacial Surgery Department of Ancona Hospital from 2009 to 2023.

The null hypothesis of this study states that there is no notable variation in functional and clinical outcomes between surgical treatment through open reduction and internal fixation (ORIF) and non-surgical, conservative management for intra-articular fractures of the mandibular condyle.

2. Materials and Methods

The present study examined patients who presented to the Maxillofacial Surgery Department of Ancona Hospital with intra-articular (head) condylar fractures between 2009 and 2023. Ancona Hospital is the only maxillofacial surgery center in central-eastern Italy, serving an area with approximately 2 million inhabitants, with seasonal peaks due to summer coastal tourism, which justifies the increased number of cases evaluated. Retrospective data on all mandibular fractures were obtained from the operating theater database, the Ormaweb® surgery archiving program (Dedalus, Florence, Italy), and from an analysis of patient medical records.

To estimate a population of 387 patients with a 95% confidence level and a 5% margin of error, a sample size of approximately 193 patients is required.

The study focused specifically on patients with condylar head fractures from the larger group of mandibular fracture patients observed during the study period.

Inclusion criteria:

- Patients over 12 years of age;
- Fractures involving the condylar head, with or without associated fractures of the mandibular body or ramus;
- Fracture line located in the condylar head;
- Displacement of the condylar fragment ranging from 10° to 45° in the frontal or sagittal plane;
- Reduction in the height of the ascending ramus of the mandible by 2 mm or more.

Exclusion criteria:

- Condylar neck and subcondylar fractures;
- Complex multiple condylar fractures affecting various segments of the condylar process;
- Inadequate dentition for achieving normal occlusion;
- Edentulous patients;
- Patients ineligible for surgical procedures due to poor clinical condition;
- Fractures involving the midface region;
- Patients with a prior history of temporomandibular joint (TMJ) dysfunction.

Patients provided written informed consent detailing the procedures and potential complications associated with both surgery and intermaxillary fixation (IMF). This was required for all individuals undergoing either surgical or conservative treatment. Surgical decisions were made collaboratively by at least two experienced surgeons. Based on preoperative X-rays and CT scans, the cohort was divided into surgical and nonsurgical groups to determine the most appropriate treatment for the condylar head fracture. Patients were further categorized into three groups according to the type of treatment received: Group A, comprising patients who underwent surgical removal of the fractured fragments; Group B, consisting of patients treated with open reduction and internal fixation (ORIF); and Group C, encompassing patients who received nonsurgical functional therapy.

For all three groups, clinical and radiological parameters were assessed both preoperatively and during postoperative follow-up. These parameters included occlusal discrepancies indicated by improper intercuspation of the molars on both sides, mandibular mobility (opening, protrusion, and lateral excursion), presence of pain or clicking in the temporomandibular joint, complications (e.g., pathological scarring, infections, Frey syndrome, facial nerve deficiency, or the need for further surgery), maximum interincisal mouth opening, mandibular deviation during opening, and the height of the ascending ramus of the mandible.

Pain levels were evaluated using the Visual Analog Scale (VAS), capturing patient-reported pain before and after treatment for both surgical and conservative approaches. Measurements of maximum interincisal mouth opening and protrusion were taken using the incisal edges of the upper and lower anterior teeth. Lateral movements and mandibular deviations during opening were recorded relative to the dental midline, using a metallic

scale as a reference. The height of the ascending ramus was measured on CT scans, from the superior-most point of the condyle to the inferior-most point of the mandibular angle on the affected side. These measurements were taken preoperatively and at postoperative intervals of 3 days and 6 weeks for both treatment groups. Additionally, cone-beam CT scans were employed to assess and quantify condylar displacement in each case.

All parameters were evaluated preoperatively and reassessed at specific postoperative intervals: the third day, the first and second weeks, one month, and six months for surgically treated patients.

Statistical Analysis

Descriptive Statistics were used to summarize the demographic and clinical data. Confidence Intervals (CIs) were calculated for the differences in buccal opening. Univariate analyses were conducted using the *t*-test or Mann–Whitney test to compare the signed distances between the 3 groups analyzed. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed using IBM SPSS Version 25 (IBM Corp, Armonk, NY, USA).

3. Results

A total of 387 patients with mandibular condylar fractures were treated by the authors between January 2009 and December 2023. CT scans and X-ray analyses identified 177 patients with intracapsular condylar head fractures who met the inclusion and exclusion criteria. These 177 patients were contacted by phone and consented to participate in the post-treatment follow-up program. The authors meticulously recorded and documented all parameters outlined in the materials and methods section prior to the start of the study.

The average age of the patients was 37.9 years (±11 years). Of the total, 56 were female, with an average age of 43 years (±18 years), and 121 were male, with an average age of 32 years (±16 years). The average annual incidence of condylar head fractures was 11.8, with a peak of 21 fractures recorded in 2018. Approximately 80% of the patients resided in urban areas, while the remaining 20% lived in rural areas.

The leading causes of mandibular fractures were assault (42.2%), followed by accidental falls from standing height (27.9%), bicycle or scooter accidents (13%), falls from elevated heights (slightly over 2%), car accidents (just under 3%), sports-related injuries (5.1%), workplace accidents (5%), and falls down stairs (1.8%).

An analysis of the incidence of mandibular condylar fractures by gender (with females comprising 31.63% of the study group and males 68.37%) indicated that falls were significantly more common as a cause of fractures in females ($p < 0.02$), while assaults were significantly more common in males ($p < 0.03$).

The causes of injury vary significantly depending on the age and gender of the patients. Elderly individuals frequently experience head fractures due to assaults and falls, while children are more likely to sustain injuries from bicycle and scooter accidents. Although most trauma cases involve men, the leading causes of injury—assaults involving physical violence and falls—are similar for both sexes. Among the total patient cohort, 24 individuals sustained fractures in other parts of the body: 11 had rib fractures, 8 had fractures of the extremities, 2 had skull fractures, 3 had cervical spine fractures, and 1 suffered a sternal fracture.

Mandibular mobility during opening, lateral, and protrusive movements, temporomandibular joint (TMJ) pain, tenderness on direct palpation, facial edema, malocclusion, and abnormal mobility of dental elements.

In addition to these symptoms, several comorbidities were identified among the patients: arterial hypertension in 45 cases, type II diabetes mellitus in 24 cases, rheumatologic conditions in 11 cases, epilepsy in 8 cases, dementia in 5 cases, and orthostatic hypotension in another 5 cases. Notably, five patients presented with general health conditions that led the anesthetist to contraindicate surgical treatment. For these cases, a conser-

vative approach was chosen, incorporating early functional rehabilitation without rigid intermaxillary fixation.

Between 2020 and 2021, five patients with condylar head fractures who were otherwise surgical candidates tested positive for SARS-CoV-2. Due to their clinical condition—including challenges in assessing occlusion caused by oral intubation and their compromised health requiring intensive care unit (ICU) hospitalization—surgical treatment was deemed inappropriate. Instead, the focus was placed on immediate functional and physiotherapeutic restoration of mastication and mandibular mobility.

In the 177 cases analyzed, preoperative CT scans revealed an average reduction in the height of the mandibular ascending ramus of approximately 2.9 mm (range: 2 mm to 3.7 mm). Surgical treatment was performed on 95 patients with condylar head fractures, distributed as follows: Group A included 32 patients who underwent surgical removal of fractured fragments; Group B comprised 63 patients treated with open reduction and internal fixation (ORIF); and Group C included 82 patients who received non-surgical functional treatment. Within Group C, 43 patients underwent rigid intermaxillary fixation for an average duration of 4 weeks, while 39 patients were treated with physiotherapy/rehabilitation therapy without surgery or IMF.

The primary surgical approach for condylar head fractures involved preauricular pretragal access in 62 cases and preauricular retrotragal access in 33 cases. Rigid fixation was achieved using titanium plate and screw systems (Stryker, Kalamazoo, MI, USA), while rigid intermaxillary fixation was secured with transosseous screws from the Stryker Hybrid System (Stryker, MI, USA). Postoperative functional rehabilitation was provided to all patients in Groups A and B.

In Group C, which did not undergo surgery, 43 patients maintained rigid intermaxillary fixation for an average duration of 22.5 days (95% CI: 14.2–29.7 days), while 39 patients immediately commenced rehabilitation or physiotherapy (Table 1).

Table 1. Subdivision of patients into groups based on the type of surgical or conservative treatment performed.

Treatement	Number of Patients	Study Groups	Type of Treatment	Number of Patients
Surgical treatment	95	GROUP A	Surgical removal of fractured fragment	32
		GROUP B	Open reduction and internal fixation	63
Non-surgical treatment	82	GROUP C	Rigid intermaxillary fixation	43
			Isolated physiotherapy/rehabilitation therapy	39

A total of 23 patients presented with bilateral condylar fractures, accounting for 46 individual fractures. In some cases, patients in Groups A and B required intermaxillary fixation (IMF) for 7 to 40 days to correct and stabilize occlusion or to manage contralateral fractures treated non-surgically. Post-treatment, temporomandibular joint (TMJ) function was assessed objectively through measurements of mouth opening, lateral excursion, and protrusion, as well as subjectively through patient-reported experiences of pain and difficulty eating.

Treatment successfully restored occlusion in all patients in Groups B and C. However, outcomes in Group A were less favorable, with one patient developing an anterior open bite that required subsequent orthognathic surgery. This case involved a young patient who specifically requested corrective surgery. Normal mouth opening was achieved post-treatment in all groups, except for five patients in Group C who developed TMJ ankylosis. These patients had been in a coma due to severe head trauma, which delayed timely functional rehabilitation. Lateral excursion outcomes were similarly satisfactory across all groups.

In terms of specific measurements, Group A exhibited an average preoperative mouth opening of 34.4 mm, which increased to 41.3 mm at six months post-treatment. Group B

improved from an average of 34.8 mm preoperatively to 42.9 mm post-treatment, while Group C improved from 32.6 mm preoperatively to 39.4 mm post-treatment (excluding patients with coma-related TMJ ankylosis, the ideal average for Group C was 41.21 mm). The mean increase in mouth opening at six months was 6.9 mm for Group A, 8.1 mm for Group B, and 6.8 mm for Group C, with no statistically significant differences observed between the groups.

Regarding pain management, Group A achieved the best outcomes, with only 2 of 32 patients (6.25%) reporting persistent postoperative pain ($p = 0.04$). In comparison, 5 of 63 patients (7.92%) in Group B and 9 of 82 patients (10.97%) in Group C reported ongoing pain (Table 2).

Table 2. Analysis of the results obtained between outcomes and distant complications in each of the 3 groups of patients.

Study Groups	Results				Complications			
	Restoration of Occlusion	*p* Value	Average Mouth Opening	*p* Value	Distant Post-Treatment Pain	*p* Value	Permanent Postoperative Sequelae	*p* Value
GROUP A	86%	0.09	41.3 mm	0.13	6.25%	0.04	9.37%	0.05
GROUP B	100%	0.11	42.9 mm	0.08	7.92%	0.14	7.94%	0.05
GROUP C	100%	0.10	39.4 mm	0.15	10.97%	0.11	-	-

There were statistically significant surgical complications in Groups A and B (although none were present in Group C). In 3 out of 32 patients (9.37%) in Group A permanent deficits directly induced by the surgical procedure were documented; in particular, two patients with Frey's syndrome and one with permanent deficit of facial nerve temporal branch. In Group B, out of a total of 63 patients, three patients reported Frey's syndrome and two with permanent deficit of facial nerve temporal branch.

4. Discussion

There is ongoing debate about the optimal treatment approach for condylar head fractures. The epidemiological data presented in this study confirm that trauma to the chin often results in mandibular condylar process fractures through an indirect mechanism. Patients with these fractures frequently exhibit skin injuries in the chin area, with approximately one-third of cases involving condylar head fractures. The epidemiology of these fractures has remained consistent over recent decades, with assaults and falls being the primary causes, consistent with findings from previous studies [1,19,20]. While the causes of injury may vary by region, falls remain the leading cause of fractures globally.

In 2005, Loukota et al. categorized mandibular condylar fractures into three types: condylar head (diacapitular) fractures, neck fractures, and base fractures, with the latter two often referred to as extracapsular fractures [21]. Additionally, Kozakiewicz et al. further subdivided condylar neck fractures into high- and low-neck fractures based on the anterior border of the condylar head [20,22]. The location and severity of fractures are critical factors influencing treatment choices and functional outcomes, as highlighted by Ying et al. and Boffano et al. [23,24]. Generally, non-displaced intracapsular condylar fractures are managed conservatively, whereas displaced or dislocated fractures often require surgical intervention (Khelemsky et al.) [25]. Tailoring treatment to patient-specific factors, such as age, fracture type, and overall health, is essential.

Despite the prevalence of condylar fractures, there is no consensus on whether surgery should be considered the gold standard, unlike for other facial fractures [5]. In cases where the fractured condylar head is too small for open reduction and internal fixation (ORIF), fragment removal is often recommended, as suggested by Chakranarayan and Mukherjee [26]. Bilateral condylar fractures, in particular, tend to result in more severe functional impairments, as noted by Gupta et al. [27]. Singh et al. found that ORIF provided

superior outcomes for bilateral fractures across both subjective and objective measures [28]. However, ORIF is generally not recommended for children under 12 years of age, as it may interfere with mandibular growth [29].

Meta-analyses on this topic have often failed to account for critical variables, such as fracture level, side, and patient age, introducing potential biases. To address this gap, the authors excluded patients under 12 years of age and focused on comparing ORIF and conservative management (CM) for unilateral and bilateral mandibular intracapsular condylar fractures. This paper reflects the authors' experience in treating condylar head fractures, a topic of considerable interest in maxillofacial surgery [30,31]. A range of treatments, including CM, ORIF, and fragment removal [32,33], were employed in this study. The primary goals of treatment remain the restoration of occlusion and the optimization of TMJ function.

Restoration of occlusion is a straightforward and measurable objective, even though patients may initially perceive their bite as abnormal due to dental trauma, such as crown fractures or avulsions. However, assessing TMJ function can be challenging, as pre-trauma joint sounds or pain may not have been documented and could be unrelated to the fracture. Patients with preexisting TMJ dysfunction or other risk factors may be more likely to develop TMJ issues following a condylar fracture [10].

The retrospective nature of this study introduces potential biases, as the collecting author occasionally had to interpret fracture classifications due to missing imaging data. Many patients were excluded due to insufficient documentation or missed follow-up appointments. Functional outcomes depended heavily on patient compliance and understanding, a key factor given the lack of universal treatment guidelines in the literature [34]. Additionally, some patients were unable to provide a comprehensive history of their treatment.

The findings of this study align with those of a prospective study by Hlawitschka et al. [16], both demonstrating significant differences in pain levels, measured using the Visual Analog Scale (VAS), between surgical and nonsurgical groups. Weiss et al. [18] reported radiographic anatomical reductions in the condylar head in 87.5% of the surgical (ORIF) group compared to 25% in the conservative group. Similarly, Boffano et al. [19] observed higher rates of anatomical alignment in operative cases. This study found that by six weeks postoperatively, the surgical group achieved satisfactory anatomical restoration and symmetry of the ascending ramus height.

Comparing outcomes from three treatment methods performed by the same surgical team within a relatively short timeframe allowed the authors to draw useful conclusions, despite a modest sample size of 177 patients. Occlusion was restored in Groups B and C, although damaged teeth occasionally required additional interventions. In Group A, one patient required orthognathic surgery for correction. No significant differences were observed between groups in maximal mouth opening or lateral excursion.

Pain control outcomes favored Group A, where only 2 of 32 patients (6.25%) experienced post-treatment pain—an interesting finding, considering that 6–12% of the general population reports TMJ pain [35,36]. Surgical complications were common in Groups A and B, though most were temporary. Patients often attributed these complications to the surgery rather than the trauma itself, despite the known risks associated with general anesthesia and hospitalization. Notably, no cases of bleeding or infection were encountered in this study.

Shakya et al. [37] found no differences in protrusive and lateral excursive movements between surgical and conservative treatments. In contrast, Vincent et al. [36] reported higher rates of malocclusion in conservatively managed patients. Menon [9] found no significant differences in occlusion outcomes between ORIF and closed reduction with maxillomandibular fixation. Ying et al. [16] also observed statistically significant differences in VAS pain scores ($p = 0.03$), with lower pain levels in the operative group (2.9) compared to the conservative group (13.5).

The null hypothesis of this study is that there is no significant difference in functional and clinical outcomes between surgical treatment using open reduction and internal fixation

(ORIF) and conservative treatment in intra-articular fractures of the mandibular condyle. The first null hypothesis of the study was partially rejected, as statistically significant differences between the two groups were observed only in relation to distant post-treatment pain and permanent postoperative sequelae. However, no significant differences were found regarding mouth opening and occlusion.

The present study is limited by its relatively small sample size and the variability introduced by having multiple surgeons perform the procedures instead of a single surgeon. All surgeons involved in the present study are considered experts in the treatment of condylar fractures. Despite these limitations, the study recommended surgical management over conservative approaches for moderately displaced condylar fractures. However, further research with larger sample sizes and procedures ideally conducted by the same surgeon would provide even more valuable insights for drawing definitive conclusions.

5. Conclusions

Fractures of the mandibular condyle head are more prevalent than previously recognized, accounting for over one-third of all condylar process fractures. While surgical intervention may introduce complications, conservative treatment has proven effective in carefully selected cases, particularly when the risks of surgery outweigh its potential clinical benefits. Conservative management is typically recommended for cases involving incomplete, compound, or minimally displaced fractures, as well as for pediatric patients under 12 years of age. However, recent advancements in surgical techniques offer distinct advantages, such as accelerated functional recovery, improved anatomical alignment, and enhanced patient comfort. For complex fractures with significant fragmentation, fragment removal through open techniques remains the preferred approach to prevent substantial functional impairment. In most cases, open reduction and internal fixation (ORIF) is the preferred method, as it facilitates optimal recovery and precise fracture alignment, thereby improving the patient's quality of life. ORIF is particularly recommended for single-fragment fractures with minimal mandibular ramus height loss. Looking ahead, prospective studies with rigorous control of confounding factors are essential to further refine clinical guidelines and standardize protocols for conservative treatment, fostering more consistent and effective outcomes.

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