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Management Strategies for Mandibular Fractures: A Prospective Study in Our Department

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Abstract **Original Research Article**

Introduction: The management of mandibular fractures aims to achieve rapid restoration of dental occlusion and masticatory function while minimizing complications. Bone healing largely depends on the therapeutic approach used. This study evaluates the treatment modalities adopted in the Department of Maxillofacial Surgery at Mohammed VI University Hospital in Marrakech. ***Materials and Methods:*** This was a four-month prospective study (April–August 2024) involving 200 patients treated for mandibular fractures. Medical, functional, orthopedic, and surgical treatments were analyzed using Microsoft Excel, along with the type of osteosynthesis material used and the complications encountered. ***Results:*** All patients received medical and functional treatment. Orthopedic management was performed in 32.8% of cases, mainly using IMF screws (83.7%). Surgical treatment was carried out in 80.14% of cases, with plate-and-screw osteosynthesis in 91.9%. The vestibular approach was used in 97% of surgical interventions. The main complications observed were labiomental hypoesthesia (25%), suture dehiscence (10%), and malocclusion (9%). ***Discussion:*** The findings are consistent with reports from developing countries. Conservative treatment remains indicated for simple fractures, whereas open reduction with internal fixation is considered the gold standard. However, the choice of treatment is often influenced by local constraints, particularly economic and logistical factors. ***Conclusion:*** The management of mandibular fractures systematically combines medical and functional treatment, with an appropriate choice between orthopedic or surgical approaches depending on fracture complexity. An individualized approach that takes into account the patient's socioeconomic context optimizes outcomes in maxillofacial trauma care.

Keywords: mandible, mandibular fracture, craniomaxillofacial trauma, facial trauma.

INTRODUCTION

The treatment of mandibular fractures aims to quickly restore occlusion and masticatory function while minimizing complications. Various therapeutic modalities are available, ranging from conservative and orthopedic treatment to open reduction with internal fixation, each adapted to the type and complexity of the fracture. The aim of our study is to describe the specific features of mandibular fracture management in the maxillofacial surgery department of the Mohammed VI University Hospital Center, highlighting the therapeutic choices, the osteosynthesis devices used, and the complications in this specific context.

MATERIALS AND METHODS

All patients with mandibular fractures treated at the maxillofacial and cosmetic surgery department of Ibn Tofail Hospital, part of Mohammed VI University Hospital in Marrakech, between April and August 2024 were analyzed prospectively.

The parameters studied included: medical, functional, and orthopedic treatment, using IMF screws or Erich's arch, surgical treatment, the type of approach used, the types of plates used, and any sequelae. Patients who were lost to follow-up were excluded from the study.

The topographical classification used to locate fractures followed that of Dingman and Natvig (1,2) (Fig. 1). Data were collected using a pre-established evaluation form.

The bibliographic analysis was based on the following databases: PubMed, EM-C Consult, NCBI, and Science Direct. The data were entered and analyzed using Microsoft Excel software. All data collection and analysis was carried out in accordance with ethical

principles, particularly with regard to confidentiality and the protection of patients' personal information.

THE RESULTS

The treatment of mandibular fractures in our training program is based on a strategy combining functional, orthopedic, and surgical approaches, adapted to the nature of the fractures, their topography, and the patient's clinical profile.

1. Functional and Medical Treatment:

Early functional treatment was initiated in all patients, including a liquid or soft diet, combined with oral hygiene care and active and passive rehabilitation in the postoperative phase.

Medical treatment was based on the administration of paracetamol-based analgesics, anti-inflammatory drugs, and anti-edema drugs (corticosteroids), as well as antibiotic therapy based on amoxicillin-clavulanic acid in cases of open fractures or associated wounds. Tetanus prophylaxis appropriate to the patient's vaccination status was also implemented, accompanied by rigorous oral hygiene, including gentle and regular brushing and mouthwashes.

2. Orthopedic Treatment:

In our study, orthopedic treatment was indicated in 32.8% of patients, either alone or while awaiting osteosynthesis. More specifically, 26 of the 200 patients treated in our department (13.2%) were treated solely with an orthopedic device, such as an Erich arch or IMF screws.

Table 1: Distribution according to the type of intermaxillary fixation used

Method	Number of patients	Percentage
Intermaxillary screws (IMF)	139	83.7%
Erich arch + steel wires	27	16.3%

This treatment has been favored in particular for patients with displaced subcondylar fractures causing dental articulation or mandibular kinetic disorders, with a blockage period limited to 15 days. It was also used in displaced single-focal fractures with favorable or unfavorable prognosis in cases of reducible dental articulation, alveolar-dental fractures, or in cases of associated instability, such as Lefort I fractures.

Apart from the contraindications for bimaxillary blocking seen in 16.8% of patients, 16.3% of patients benefited from ERICH metal arch blocking with 3/10 or 4/10 stainless steel interdental wires, while 83.7% benefited from IMF screw fixation. These results include cases treated with intermaxillary fixation as part of orthopedic treatment alone, in addition to surgical treatment, or while awaiting surgical treatment (Figure 1) and (Table 1).

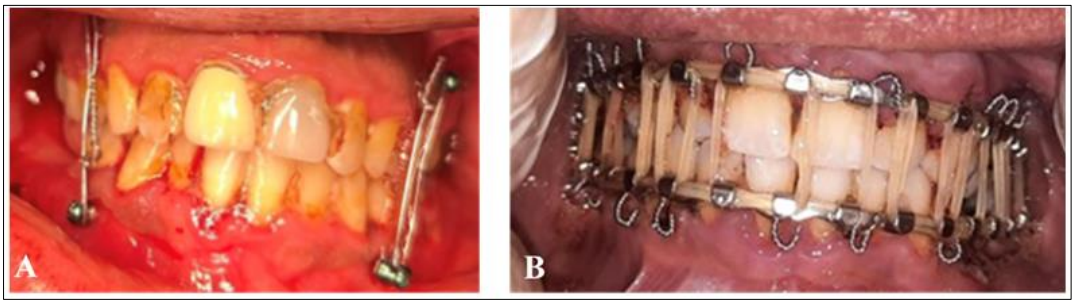

Figure 1: Images of different types of maxillomandibular fixation. A: Intermaxillary fixation with screws and rigid locking with stainless steel wire. B: Intermaxillary fixation with Erich's arch using stainless steel interdental wires and flexible locking with elastics

3. Surgical Treatment

Open reduction with screw plate osteosynthesis was performed in 80.14% of patients. Nasotracheal intubation was preferred, with the patient positioned in the supine position and with slight extension of the head.

The vestibular approach was preferred in 97% of patients, followed by the trans-scar approach in 1.8%, the trans-jugular approach in 0.9%, and Risdon's sub-angulo-mandibular approach in 0.9% (Figure 2) and (Table 2).

Table 2: Breakdown by type of approach adopted

Primary approach	Number of patients	Percentage
Endobuccal vestibular	155	97%
Trans-cicatricial incision	3	1.8%
Trans-jugal	1	0.9%
Risdon's sub-mandibular angle	1	0.9%

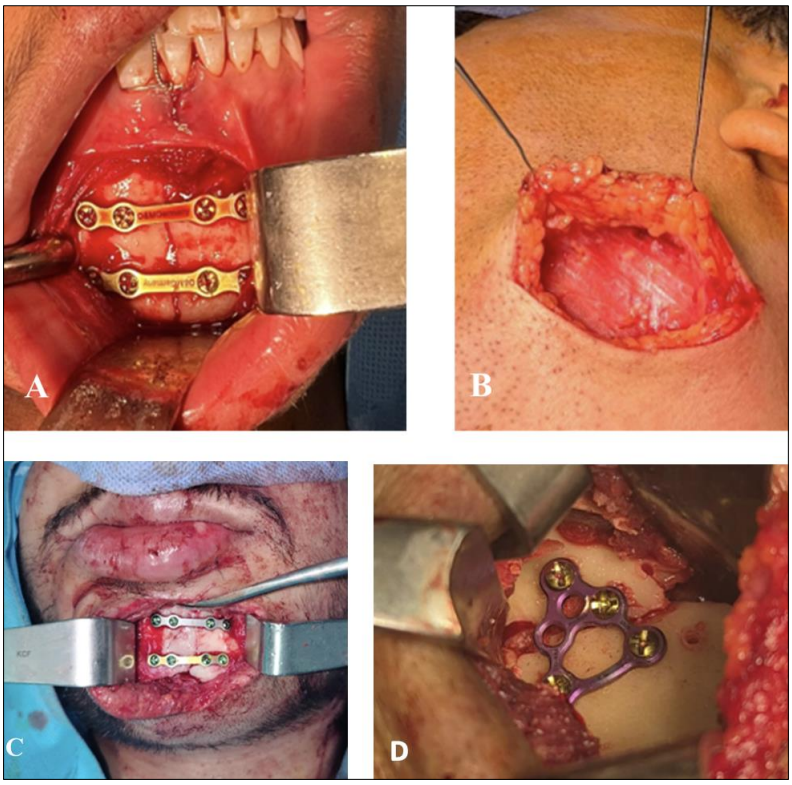

Figure 2: Images of different approaches. A: Vestibular approach with placement of two mini-plates for the treatment of a right parasymphyseal mandibular fracture. B: Risdon trans-cervical approach. C: Trans-scar approach with placement of two mini-plates for the treatment of a right parasymphyseal fracture. D: Trapezoidal plate for osteosynthesis of a dislocated lower condylar fracture

4. Osteosynthesis Equipment:

The most commonly used plate was a 1.0 mm semi-rigid titanium mini-plate without compression, combined with 7 mm self-drilling non-locking monocortical screws, used in 95.5% of cases. A 2.0 mm rigid maxi plate was used in two cases involving comminuted mandibular fractures, and a pediatric plate was used for a child (0.6 mm).

The choice of plates and screws was adapted to the location of the fractures, following Maxime Champy's ideal lines of bone tension and compression for osteosynthesis [3]. Mandibular angle fractures were treated with semi-rigid fixation using a 4-hole mini-plate on the external oblique crest. Mandibular body fractures were stabilized using a 4-hole mini-plate, or two plates (subapical and basilar) when the fracture crossed the mental foramen. For symphysis and parasymphysis fractures, two 4-hole mini-plates were placed at the subapical and basilar levels, due to the maximum torsional forces in this region [3]. Finally, 67% of mandibular angle fractures were associated with impacted, fractured, decayed, erupting, or reduction-impeding wisdom teeth, which required extraction during osteosynthesis (Table 3). Surgical intervention for condylar fractures was indicated in 1.8% of patients who presented with an unstable fracture or failure of orthopedic treatment.

Table 3: Breakdown by type of license plate adopted

Type of plate	Number of cases	Percentage	Main indication
Semi-rigid mini-plate (1.0 mm)	152	95,5%	Simple, parasymphyseal, angular fractures
Maxi rigid plate (2.0 mm)	3	1.8%	Comminuted fractures
Pediatric plate (0.6 mm)	2	0.9%	Children
Trapezoidal plate	3	1.8%	Low subcondylar fracture with dislocation

5. Postoperative Follow-Up:

A 7-day postoperative intermaxillary block was systematically applied, except in cases of contraindications (asthma, epilepsy, cognitive disorders, chronic alcoholism, etc.). Functional rehabilitation was initiated as soon as the block was removed.

Clinical and radiological follow-up was carried out according to the following schedule:

- **D1:** occlusal and scar check.
- **D7:** reassessment to decide whether to remove the splint or extend its use, with panoramic X-ray.

- **M1, M3, M6, M12:** monitoring of consolidation, occlusion, and mandibular function.

Immediate Complications

In our series, no major immediate postoperative complications were observed. However, early, late, and secondary functional complications were noted during postoperative follow-up.

Early Complications

Early complications, occurring within the first 15 days post-operatively, were dominated by: Suture loosening, occurring in 10% of cases, requiring simple outpatient repair. Exposure of osteosynthesis material was reported in 1.47% of cases, mainly in angular fractures in edentulous patients. Infection of the material was observed in 4.5% of cases, requiring antibiotic therapy, local washing, and in some cases, removal of the material. Persistent edema beyond the first postoperative week affected 12% of patients. Persistent moderate pain was noted in 8% of cases, requiring prolonged analgesic treatment.

Late Complications

Late complications, occurring more than one month after surgery, included: Dislodgement of osteosynthesis material in 1.4% of cases, occurring mainly in edentulous patients with angular fractures, requiring hospitalization for removal of the material (Figure 3). Persistent labio-mental hypoesthesia was noted in 25% of cases, treated with vitamin therapy (vitamins B1 and B6). Dysesthesia of the inferior alveolar nerve was reported in 5% of patients, with a favorable outcome in most cases. No cases of temporomandibular joint (TMJ) ankylosis were recorded in our series.

Figure 3: Image showing removal of osteosynthesis material with exposure of a plate through the oral mucosa at 40 days post-op

Secondary Functional Complications:

In terms of function, the observed sequelae included:
Limited mouth opening in 12% of cases, requiring functional rehabilitation.

Malocclusions were reported in 9% of cases. Two patients required repeat surgery with orthodontic follow-up (Figure 4). Among these, 12 cases of malocclusion were specifically associated with orthopedic treatment alone (i.e., 12 cases out of the 26 patients who received only this type of treatment). These were distributed as follows:

o Anterior open bite: 25%
o Premature molar contact: 50%
o Crossbite: 25%

Clinical improvement was observed in most patients after compliance with medical and functional treatment.

It should be noted that these complications were more frequent in patients with condylar fractures (40.3%) and angular fractures (39.7%).

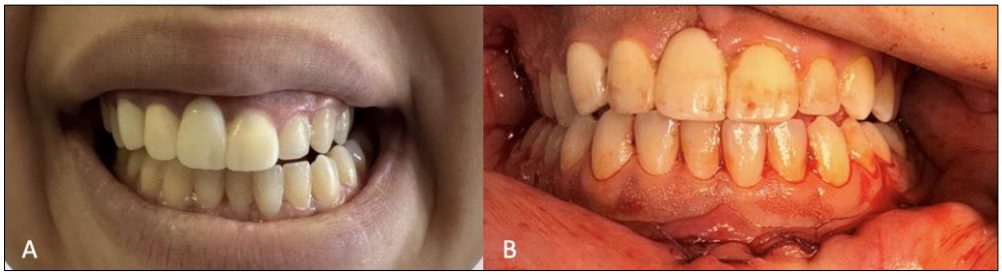

Figure 4: A: Image showing dental articulation disorder in a patient treated with osteosynthesis at 20 days post-op. B: Intraoperative image of dental articulation after surgical revision

DISCUSSION

Post-traumatic mandibular fractures are a major challenge in maxillofacial trauma, particularly in developing countries, where various socioeconomic and environmental factors influence their frequency and management [4]. At the Mohammed VI University Hospital in Marrakech, the epidemiology and treatment modalities of these fractures reflect the typical characteristics observed in these contexts.

Patient comfort and rapid restoration of occlusal function and anatomical form are now priority objectives in the treatment of mandibular fractures [1-6].

These objectives depend on rapid consolidation, which in turn is determined by the stability of the fixation [6]. Several treatment options are available, starting with a strict liquid diet with gradual thickening and passive and active rehabilitation, orthopedic treatment with intermaxillary fixation, open reduction with internal fixation, and closed treatment with external fixation using Kushner pins, etc [6].

Fracture involving the mandibular dentate portion is considered an open fracture. The risk of infection is very high in our patients, who generally have poor oral hygiene. This prescription is accompanied by analgesics, anti-edema drugs, and functional treatment. The latter consisted of a liquid diet that was gradually thickened to reduce any stress on the bones, combined with mouthwashes and active and passive rehabilitation.

Conservative treatment is recommended for isolated fractures without displacement where the dental articulation is preserved [1-6]. It is the treatment of choice for condylar fractures, especially capital fractures, high subcondylar fractures, and coronoid process fractures. Arguments in favor of this treatment are based on studies that have demonstrated similar results to invasive treatment [7, 8], and that it avoids the complications of osteosynthesis, particularly damage to the facial nerve, unsightly scars, and the risk of ankylosis, especially in children [8, 9].

Orthopedic treatment is based on maxillomandibular fixation using Erich arch bars with stainless steel wires or elastics, hybrid arch bars, intermaxillary fixation screws, circummandibular and piriform wiring, and orthodontic brackets with hooks [1-6]. It is indicated in the following cases, subject to the patient's consent: low subcondylar fractures with little or no displacement for a period not exceeding 15 days, favorable unfragmented unifocal mandibular fractures, and alveolodental fractures. The latter two require prolonged immobilization for 45 days [6].

Maxillomandibular arch bars, although effective, have several major disadvantages [5]. They are time-consuming to place and can cause gingival damage during fixation [6]. Furthermore, studies have reported significant difficulty in maintaining oral hygiene during their use. [5-10]. To address these limitations, the technique of intermaxillary fixation using self-tapping screws was introduced in the 1980s as a more modern alternative [5]. It involves inserting 4 to 8 screws into the maxilla and mandible, placed at the junction of the attached and free mucosa. This method offers several advantages: it significantly reduces operating time, decreases the risk of gingival lesions, and facilitates oral hygiene compared to traditional arch bars [5].

Nevertheless, the use of screws for intermaxillary fixation can be associated with certain complications related to the placement technique. These include screw fracture during insertion, screw loosening, and iatrogenic damage to the tooth roots, which can lead to tooth loss or the formation of bone sequesters around the screw placement sites [11]. However, in our study, no complications related to the use of IMF were recorded, which justifies its preferred adoption.

In countries such as the United Arab Emirates, Nigeria, Jordan, Egypt, and Iran [12, 13], orthopedic treatment alone using maxillomandibular blockage (MMB) remains common practice. In contrast, in more developed countries, surgical management without the use of JMB has become the norm [14- 16]. While the choice of treatment depends in part on the preferences of surgeons, it is mainly influenced by the material resources available. In many developing countries, financial constraints limit access to surgical treatment [14]. In our series, surgical treatment is considered the gold standard when indicated, reflecting our efforts to make this approach accessible to all categories. This choice is also motivated by the high probability of non-compliance with orthopedic treatment in our patients, who often have a history of risky behavior (assaults, fights, alcohol and tobacco use, etc. etc.), making them more likely to disregard the requirements of orthopedic treatment, thus increasing the risk of premature release of the intermaxillary block and the onset of subsequent complications.

In this context, open reduction with semi-rigid fixation is the preferred method for unstable mandibular fractures, particularly for displaced bifocal fractures with unfavorable lines associated with dental articulation disorders, trifocal or comminuted fractures, fractures occurring on atrophic bone, and cases where intermaxillary fixation is contraindicated [2-6].

Internal fixation by osteosynthesis using semi-rigid monocortical mini-plates, based on the load-sharing engineering principles popularized by Champy, is the most widely used method in our training, and is mainly indicated for simple fractures with acceptable bone stock [3-17]. On the other hand, lockable reconstruction plates, such as the maxi-plates used in our study, are load-bearing fixation devices specifically recommended for complex fractures, comminuted fractures, and severely

atrophied mandibles. This approach is supported by several studies, notably that of B. Pickrell *et al*., [6], and also corresponds to the strategy adopted in our department.

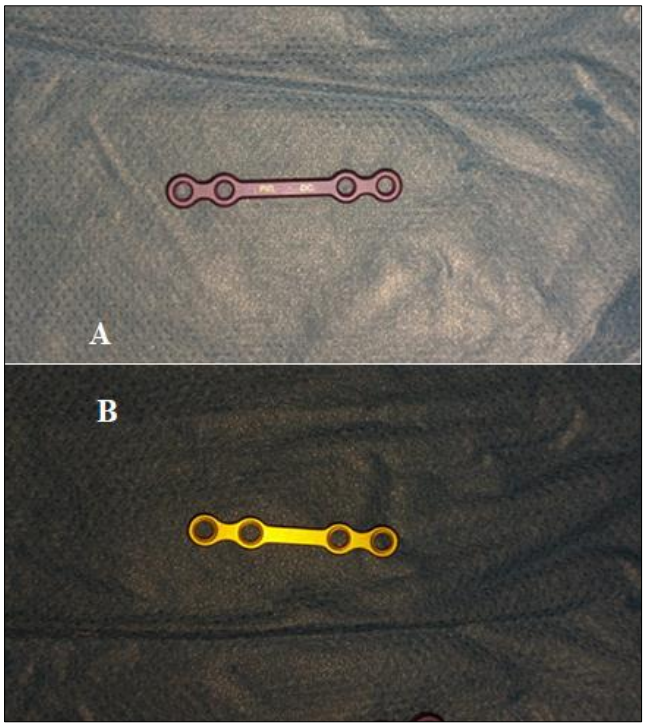

Figure 5: Different types of plates used. A: Rigid straight plate with 4 holes. B: Semi-rigid straight pediatric plate with 4 holes.

In 1978, Champy *et al*., established the basis for mandibular fracture fixation by identifying regions of the mandible where the use of monocortical plates allows for stable fixation [17]. These areas correspond to regions subjected to torsional forces at the symphysis, tensile forces on the alveolar line, and compressive forces on the basilar line [17]. According to their observations, torsional forces reach their maximum in the region between the two canines during mastication, justifying the use of two parallel fixation plates, one on the basilar edge and the other on the subapical line, for symphyseal and parasymphyseal fractures [17]. For fractures of the horizontal ramus, a mini-plate placed on the subapical line is generally sufficient, except in cases of fractures crossing the mental foramen, where two plates are preferable [6]. (Figure 5). For mandibular angle fractures, a single mini-plate is placed on the external oblique line, corresponding to the upper retromolar region [3-18]. For the pediatric population, the authors recommend basilar reduction with the placement of a pediatric plate (Figure 5) so as not to reach the germs of the permanent teeth with cervical, endo-buccal, or mixed approaches, with the advantage of removing the osteosynthesis material from the third postoperative month onwards [19, 20]. For the time being, resorbable plates are not entirely satisfactory due to the significant inflammatory reaction they induce.

The vestibular approach is the most commonly used in our approach and the most frequently recommended for surgical access, as it leaves no skin scarring and preserves the marginal branch of the facial nerve [1-17]. This approach requires limited subperiosteal dissection to prevent devascularization of the fracture site, while taking care to protect the mental nerve. For mandibular angle fractures, this approach is often combined with a transjugal approach [18].

In cases of severely displaced or comminuted fractures, a transcutaneous approach may be considered, including Risdon's subangulomandibular approach, the retromandibular approach, or the trans-scar approach [6-21]. These approaches allow direct access to the fracture site, facilitating reduction and fixation, especially in cases of comminuted or atrophied fractures, while taking into account anatomical and functional specificities, namely the terminal branches of the facial nerve [18].

A particular factor in mandibular angle fractures is the condition of the third molar. The presence of this tooth, especially when it is partially impacted or erupting, increases the risk of fractures, as reported by Shuai Xu *et al*., [22]. In our practice, we have opted to extract impacted wisdom teeth when they interfere with reduction, when they are fractured or impacted in the fracture site, or when they are infected [6-22]. These extractions are usually performed at the end of osteosynthesis to minimize complications.

In our study, patients with comminuted fractures, significant displacement, or considerable

damage to adjacent soft tissue were treated extraorally using 2.0 mm rigid compression plates.

The management of condylar fractures remains an area of considerable controversy [7]. In general, the optimal treatment strategy varies depending on the location of the fracture and may include approaches ranging from a liquid diet to maxillomandibular blockage to osteosynthesis with plates. In 1983, Zide and Kent proposed a set of widely recognized indications for open reduction osteosynthesis in the treatment of condylar fractures, which we also adopt in our approach. Absolute indications include: displacement of the condyle into the middle cranial fossa, inability to achieve satisfactory reduction with maxillomandibular blockage, lateral extracapsular displacement of the condyle, and the presence of a foreign body in the temporomandibular joint (TMJ) [23].

It should be noted that, in cases of associated subcondylar or coronal fractures, the duration of bimaxillary locking did not exceed 5 to 7 days. Patients will then be checked at 1 month with a panoramic dental X-ray to ensure proper consolidation before unblocking if orthopedic treatment is required and to initiate rehabilitation, assess mouth opening, and check the position of the osteosynthesis material. Then at 3 months to assess the progress of mouth opening, the patient's adherence to physiotherapy, the presence of sequelae, and finally the condition of the scar. In addition, S. Lambert *et al*., recommend intermaxillary immobilization for 3 to 4 weeks in cases of bilateral condylar fracture, followed by functional treatment beginning with median protraction [24].

Persistent labio-mental hypoesthesia was observed in 25% of patients. This complication is mainly related to the anatomical location of the fracture at the horizontal branch. It most often occurs during the placement of bicortical screws in the posterior region of the body or mandibular angle via an intraoral approach with transbuccal instrumentation. These injuries are generally due to limited visibility, insufficient access, or imperfect knowledge of the local anatomy [25].

Compared to surgical treatment, orthopedic treatment showed a significantly more favorable complication profile in our series, although this comparison is not entirely objective due to differences in indications and the unequal number of patients between the two modalities.

Thus, in our series, malocclusion was observed in 3% of cases, reflecting satisfactory occlusal control despite an often-conservative approach. This illustrates the value of functional modalities that are well adapted to the nature of the fractures. However, it may result from delayed reduction, particularly in subcondylar fractures, highlighting the importance of early reduction to restore good dental articulation.

These data confirm that, when carefully selected, orthopedic treatment can be an effective and low-morbidity therapeutic alternative, particularly in simple or low-displacement fractures. This finding is consistent with the results of Seiji Nakamura *et al*., in Japan, where the most common complications, such as malocclusion (3%) or infection (1%), remained mainly related to surgical treatment [50]. Similarly, the study by Anyanechi and Saheeb in Nigeria [51], highlights that open reduction with rigid internal fixation was associated with the highest overall complication rate (20.7%), with malocclusion again being the most common complication.

We believe that these complications could have been avoided if patients had attended their postoperative appointments and followed postoperative instructions carefully.

Conclusion

Changes in the incidence and profile of maxillofacial fractures over the years have shown that there is a need to focus on preventive measures aimed at improving patients' quality of life. It is therefore necessary to ensure strict compliance with traffic rules, organize prevention campaigns and improve road safety, organize prevention programs to minimize assaults, improve protection during sports activities, and legislate on the wearing of protective helmets for workers. This will facilitate access to specialized care. These measures are essential for reducing incidence, limiting complications, and improving functional prognosis.

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