Review Article

Treatment Options of Maxillofacial Fractures in Iran: A Comprehensive Systematic Review

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ABSTRACT

Background: The aim of this study was to systematically review the literature on the treatment options of maxillofacial fractures in Iran, complementing a previous article regarding causes and the overall prevalence.

Methods: A systematic search of PubMed, Cochrane Library, Web of Science (WS) and Google Scholar (GS) electronic databases was conducted to identify the relevant articles published up to January 2023. Studies reporting the treatment option of maxillofacial fractures in Iran were included in the analysis. MOOSE guidelines were adopted for the current systematic review. No data or language restriction were applied. Risk of bias across the articles was assessed.

Results: This systematic review included 13 articles with a total of 19,147 treated patients for maxillofacial fractures. ORIF was the most common type of treatment, but complications occurred in approximately 5% of cases. Mandible fractures were not statistically more treated by ORIF than closed reduction or conservative treatment, and no type of treatment was considered statistically preferable depending on the anatomical region affected by Iranian maxillofacial surgeons. The included studies were considered to have a low risk of bias, but many were not clear in reporting cross-referenced data regarding the type of treatment, which could be considered a major flaw.

Conclusion: Overall, this study provides valuable insights into the types of treatment used for maxillofacial fractures by Iranian surgeons and highlights the importance of clear reporting of data in research articles.

KEYWORDS
Iran; Middle East; Maxillofacial Fractures; Prevalence; Systematic Review

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INTRODUCTION

Maxillofacial fractures are a common type of injury that is frequently encountered in the emergency department. These fractures most commonly result from falls, road traffic accidents, assaults, and sporting injuries [1–3]. The mandibular bone is the most frequently fractured facial bone, followed by the zygoma and maxilla [1]. The majority of mandibular fractures occur in young males aged 16-30 years [3,4].
The diagnosis of maxillofacial fractures is usually made based on

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the patient's history, clinical examination, and radiological investigations. In addition to identifying the location and extent of the fracture, radiological imaging can also help in determining whether any other structures have been affected, such as the dentition, airway, and cervical spine [5].

The management of maxillofacial fractures depends on the severity of the injury and the location of the fracture. Closed reduction with maxillomandibular fixation (MMF) is often used for the management of subcondylar fractures, while open reduction and internal fixation (ORIF) may be necessary for more complex fractures, such as those involving the zygoma or maxilla [1,6]. Treatment may also involve a combination of both open and closed reduction techniques. In cases where there is a significant delay between the injury and the repair, there is a higher risk of complications, such as infection and malunion [7].

Iran is a country with a high incidence of maxillofacial fractures, particularly due to road traffic accidents and interpersonal violence [8]. Therefore, it is important to evaluate the treatment options available in Iran to identify the most effective and efficient approaches to manage maxillofacial fractures.

The objective of this study was to conduct a systematic review of the literature to evaluate the various treatment options of maxillofacial fractures in Iran.

METHODS

Study design

This Systematic Review was conducted according to the recommendations from the Cochrane Group [9] and the book "Systematic reviews in health care: meta-analysis in context" [10]. A search protocol was specified in advance and registered at PROSPERO (International Prospective Register of Systematic Reviews) number CRD42023400498. This review was conducted according to MOOSE Reporting Guidelines for Meta-analyses of Observational Studies. This study complements a previous study on maxillofacial fractures in Iran Epidemiology.

Ethical approval

The present study was approved by the Research Ethics Committees of School of Dentistry – Mashhad University of Medical Sciences under the number IR.MUMS.DENTISTRY.REC.1401.111.

Focused question

We intended to perform an epidemiological study on maxillofacial fractures treatments besides the quality of Iranian studies through a risk of bias assessment. In summary, the main outcome is to perform a critical review of maxillofacial fractures in Iran, assessing treatment options in addition to the risk of bias and quality of studies.

Eligibility criteria

Only maxillofacial fractures studies performed in Iranian soil were added. No language restriction was applied. Records that fulfilled the following items were considered: a) treatment options of maxillofacial fractures, b) studies performed in Iran; c) studies performed by at least one Iranian researcher.

Records including only results about: a) soft tissue trauma, b) studies performed outside Iran even partially, c) studies performed by Iranian foreigners, d) trauma not located on maxillofacial region were not considered, e) unpublished clinical trials, f) case reports, reviews, editorials, letters and comments, g) articles published before 2002.

Search strategy

The first hit was conducted online by two independent reviewers (SS and RG) in PubMed, Cochrane Library, WS and GS from inception until January of 2023. The following strategy was used: (Mandibular Fractures[MeSH Terms] OR Maxillary Fractures [MeSH Terms] OR Orbital Fractures[MeSH Terms] OR Zygomatic Fractures[MeSH Terms] OR Nose Fracture OR Facial Injuries[MeSH Terms] OR Maxillofacial Injuries[MeSH Terms]) AND Iran.

Because the search algorithm is different, an adaptation of the strategy was performed on GS: (mandibular maxillary orbital zygomatic nose +fractures "facial injuries" "maxillofacial injuries" +iran -"case report" -"systematic review" -meta-analysis -comments). Since it is possible to perform a bibliographic search according to the country of origin, Iran term was suppressed in WS search. A manual search was performed sought in the included articles.

Studies Selection

In the first screening procedure, titles and abstracts

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were screened by two independent reviewers (S.S. and R.G.). All articles considered eligible at the first screening procedure underwent a full-text evaluation. If disagreements arose during the two steps evaluation process, it was resolved by a third reviewer (S.S.). Studies that met the inclusion criteria or those with doubtful information either in the title or abstract were selected for full-text assessment in this review's second round. Reasons for rejection of studies were recorded for each report. Animal studies and comparative studies but with no relation to proposed theme were excluded, as so care reports and series, comments, letters, expert opinions, and reviews. Excluded studies on previous article were automatically not retrieved in this article. Only studies for which the full text was available were considered as eligible.

Data Extraction

The data from the selected articles was extracted by one researcher and the accuracy of the data extraction was verified by another researcher. The desired information included the names of the authors of the study, the year of publication of the articles, and the number of patients. Demographic data such as the age range of patients, the sex of the participants in the studies, as well as the causes of the fractures or other data were retrieved and crossed on treatment options whenever available.

Statistical analysis

T-Student was performed with RStudio. Shapiro-Wilkes test was used to assess if data deviate from a normal distribution. Results were considered significant only with a 95% confidence interval.

Risk of bias across studies

To assess the studies' quality, risk of bias was assessed according to MOOSE Reporting Guidelines [11]. Data were added to Microsoft Excel and a heat map was created using low and high risk. The queries of the included studies are briefly explained as follows:

a. Background: definition of the problem under study,
b. Search: reporting of the search strategy,
c. Methods: checklist section with appropriateness of quantitative summary of the data,
d. Results: reporting of results (charts, tables, sensitivity tests, subgroup analysis),
e. Discussion: publication bias, confounding and quality,
f. Conclusion: consideration of alternative explanations for observed results and appropriate generalizations of the conclusion.

Data collection process

The reviewers RG and SS separately submitted all eligible studies to a qualitative synthesis using an extraction data table, including mainly: type of treatment, age range, and anatomic region injured. Subsequently, extraction data table with the results of each included study were verified together to calibrate this process's validity and reliability.

RESULTS

Study selection

The first hit retrieved 536 records from databases. Excluded studies and reasons for refusal are shown in Table 1. A new flowchart was not added to avoid repetition with the first part of this systematic review. A total of 13 articles were included in the present systematic review [12–24].

Results of individual studies and synthesis of results study selection

Overall, a total of 19,147 treated patients were added to this study. The number of treatments is very different from overall patients (n=35,720). This can easily be explained as some articles have not reported the types of treatments of maxillofacial fractures. The distribution of the types of treatment on included articles is shown in Figure 1.
ORIF was the most common type of treatment

Table 1: Excluded articles and their reasons.

Reason	Reference
1. No treatment options studied	Dibaie et al[25]; Ebrahimi et al[26]; Farzan et al[27]; Ghaffari-Fam et al[28]; Ghorbani et al[29]; Hashemi and Beshkar[30]; Kadkhodaie[31]; Kashkooe et al[32]; Khojastepour et al[33]; Latifi[34]; Mehravaran et al[35]; Mesgarzadeh et al[36]; Mohammadi and Mohebbi[37]; Mosaddad et al[38]; Ramezanian et al[39]; Vahedi et al[40]; Yadollahi and Sahmeddini[41]; Zargar et al[42]

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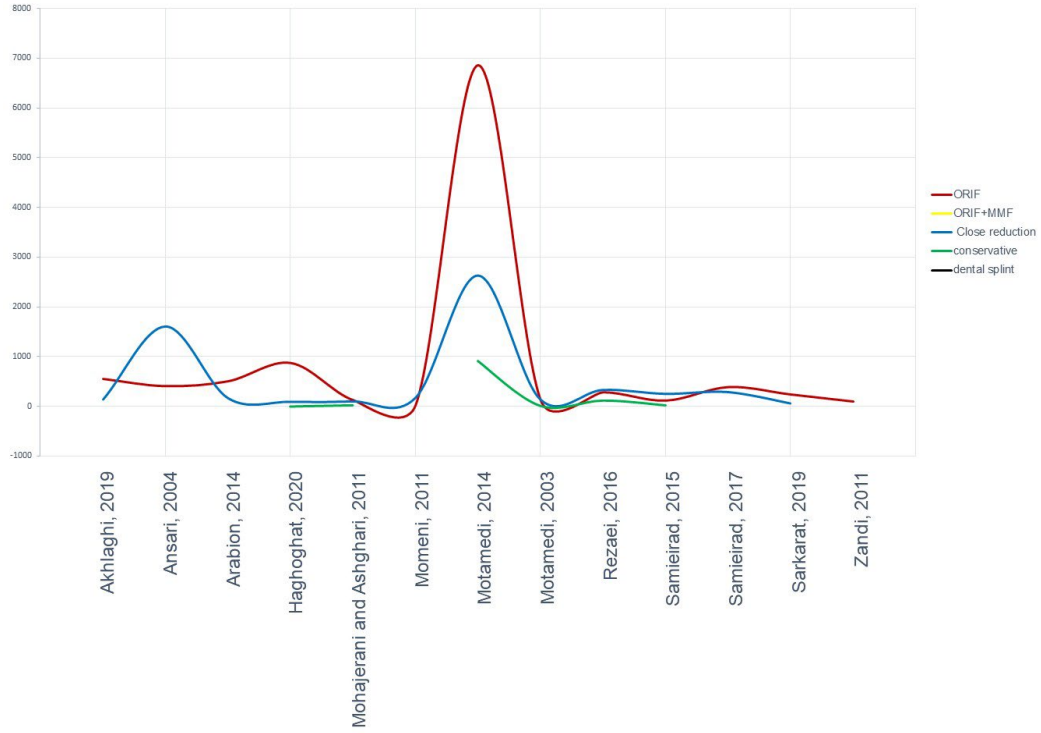

Figure 1: Distribution of types of treatment according to included articles.

(55.09%). Data from type of treatment can be considered normally distributed (w=0.85699, *P*=0.2176). Other types of treatment are shown in Figure 2. Nose, condylar and alveolar fractures were mostly treated by closed reduction with posterior support (unclear number of cases) [14,16,17,24]. Nose fractures are usually open treated in cases of skin wound [24]. Some zygomatic bone and arch fractures were stabilized with direct wiring (n=220), some of them with hook reduction technique [17,24]. Others were submitted to Giilie´s approach without any internal fixation (n=10) [24]. Naso-frontal fractures were unusually treated with open reduction and wiring or mini-plates (n=12) [17] despite others authors considered this type of fracture need ORIF in all cases [16]. Circumzygomatic or frontozygomatic suspension using arch bars were performed in 228 cases but with the aid of acrylic splints or dentures only in seven [17]. Around one fifth of zygomatic fractures were treated conservatively [16]. Dental splinting were very common in dentoalveolar fractures [16].

Complications have occurred in approximately 5% of cases [22], including infection, asymmetry and malocclusion. The types of treatment were crossed with other data in seven articles, all of them with anatomical region of the fractures [12,14,16,17,22–24]. Despite data were not available clearly in all these studies [17]. One article has associated patients requiring tracheostomy in four cases, all of them due to gunshot [22]. Only one article has crosses the type of treatment with age range [14]. Patients under 16-59 years underwent ORIF more than age groups. No article has crossed the type of treatment with other data such as gravity of case, hospitalization stay, or etiology.

Mandible fractures were not statistically more treated by ORIF than close reduction (t=0.30921, df=4.2795, *P*=0.7716) or conservative treatment (t=1.0232, df=3.0526, *P*=0.3803). Same can be seen on other anatomical regions comparing ORIF to close reduction (t=0.61674, df=4.6654, *P*=0.5662) or conservative treatment (t=1.0182, df=4.2428, *P*=0.3631). No type of treatment was considered as statistically preferable depending on anatomic region affected by Iranian maxillofacial surgeons.

Risk of bias

The risk of bias across studies is expressed in Figure 3. No additional analyses were pre-specified and made. According to prespecified protocol, included studies can be considered in low risk of bias (*P*=0.8695). Despite considered low risk of bias, majority of included articles were not clear in reporting data

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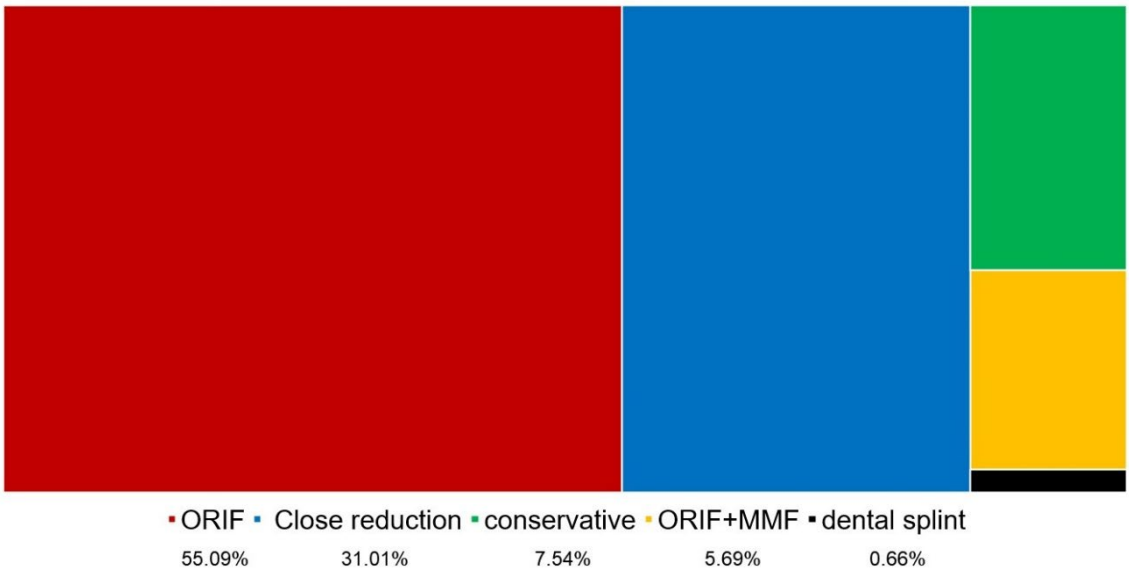

Figure 2: Types of treatment of maxillofacial fractures in Iran.

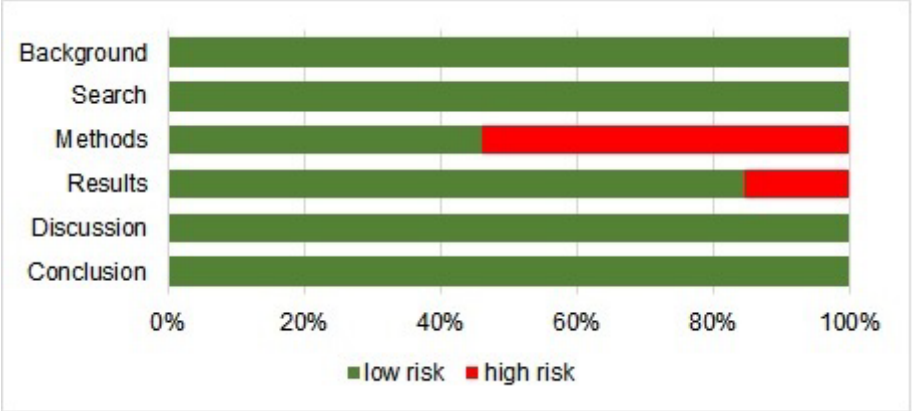

Figure 3: Risk of bias of the included articles on MOOSE guideline.

cross-references regarding type of treatment. This can be considered a major flaw of these articles.

DISCUSSION

Maxillofacial fractures refer to fractures or breaks in the bones of the face and jaw, which can result from a variety of causes, such as vehicular accidents, falls, sports-related injuries, or assaults. These fractures can be classified into several types based on the location of the fracture, including mandible fractures, maxilla fractures, zygomatic complex fractures, and nasal fractures. The incidence of maxillofacial fractures varies widely based on geographic location, age, gender, and lifestyle factors [40]. In Iran, for instance, studies have shown that maxillofacial fractures are more common among young men involved in traffic accidents, while in Western countries, elderly individuals are more likely to suffer from maxillofacial fractures due to falls [37].

The treatment of maxillofacial fractures is important to restore normal facial structure and function, prevent further complications, and improve the patient's quality of life. Over the years, there have been various treatment options for maxillofacial fractures, including closed reduction, open reduction with internal fixation (ORIF), and external fixation. Closed reduction involves the manipulation of the fractured bones to bring them back into proper alignment without requiring surgery. ORIF, on the other hand, involves the use of plates, screws, and

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wires to stabilize the fracture fragments and allow for proper healing. External fixation, meanwhile, uses metal pins that are placed outside the body to hold the fractured bones in place [43,44].

The use of ORIF in facial fracture management has been found to be effective in various studies. ORIF have been shown to be an effective treatment for ZMC and mandibular fractures, and compared to closed reduction, ORIF was associated with shorter hospital stay, faster return to normal activities, and better aesthetic results [43–45].

However, despite the benefits of ORIF, there are also potential risks and complications associated with this treatment approach. These include infection, hardware failure, malocclusion, nerve injury, and wound dehiscence. In addition, ORIF may not be suitable for certain types of fractures, such as comminuted fractures with extensive soft tissue damage or fractures that are too close to vital structures. In these cases, a closed approach or external fixation may be a more appropriate treatment option [44,46].

The results of our study show that closed reduction was the preferred treatment method for patients who were either under 15 or over 60 years of age. Interestingly, these findings are consistent with the results of previous studies [14], [16], [47]. Due to the fact that children have a high ability to create new bone tissue,

In addition, the results of our systematic review also revealed that the choice of treatment plan for facial fractures depends on the location of the fracture. For example, nasal and mandibular subcondylar fractures were found to be more effectively treated using a closed approach. This aligns with established scientific protocols for facial fracture management, which aim to attain optimal functional and aesthetic results with minimal scars and complications related to motor or sensory nerves [48–52]. On the other hand, ZMC and mandibular body fractures were typically treated with ORIF surgery, which has gained popularity globally for the management of facial fractures and treatment of mandibular fractures [53]. This treatment approach, particularly in Iran [14], is preferred by surgeons over ORIF due to its stable and accurate anatomical reduction of fragments and the absence of IMF, allowing for immediate functional recovery. As a result, this treatment method may potentially reduce both the bone healing and recovery period [14].

Furthermore, our study found that ORIF is a more effective treatment option for maxillofacial fractures when compared to conservative management. The benefits of ORIF include the restoration of facial contours, functional occlusion, prevention of malocclusion, and early return to work or daily activities [25]. These findings are consistent with those of other studies that have shown that ORIF is a safe and effective treatment option for maxillofacial fractures, with a low rate of complications and high success rate [26,27].

It is important to note that the choice of treatment plan for maxillofacial fractures should be tailored to the individual patient's needs and characteristics. For instance, children have a high ability to create new bone tissue, and using ORIF surgery to fix bone fractures may raise the risk of harming tooth buds and causing uneven growth. Thus, closed reduction may be a better treatment option for this age group [47,54]. On the other hand, older patients have reduced ability to heal and may have underlying health issues, making ORIF treatment more complicated [55,56]. As a result, individuals who are either very young or very old may benefit more from closed reduction treatment plans.

In terms of the specific techniques used for ORIF surgery, our study found that mini-plates and screws were the most commonly used methods for stabilizing fractures of the maxillofacial region. This finding is consistent with those of other studies that have reported high success rates with the use of mini-plates and screws in maxillofacial fracture management [28,29]. However, the choice of technique also depends on the type and location of the fracture. For example, rigid fixation is recommended for fractures of the mandible, while semi-rigid fixation is recommended for fractures of the zygoma [30].

In terms of the timing of surgery, our study found that early intervention (within 7-10 days of the fracture) is generally preferred for the treatment of maxillofacial fractures. This is because early intervention can lead to better functional and aesthetic outcomes, as well as a reduced risk of complications such as infection and nonunion [31]. However, the timing of surgery should also take into consideration the patient's general health status, as well as any associated injuries or comorbidities.

Finally, it is important to note that the management of maxillofacial fractures requires a multidisciplinary approach involving the collaboration of maxillofacial

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surgeons, oral and maxillofacial radiologists, anesthesiologists, and other medical and dental specialists. This is because maxillofacial fractures often involve complex anatomical structures, and the treatment plan should take into consideration not only the fracture itself but also any associated injuries, comorbidities, and functional and aesthetic considerations. In addition, patient education and follow-up care are also important components of the management of maxillofacial fractures, as they can help reduce the complications associated with maxillofacial fractures [57,58].

CONCLUSION

This study analyzed data from 19,147 treated patients with maxillofacial fractures. ORIF was the most common type of treatment, and data from the type of treatment can be considered normally distributed. Complications occurred in approximately 5% of cases, including infection, asymmetry, and malocclusion. The decision to use ORIF versus closed reduction for treating bone fractures may depend on a patient's age and overall health status, as young patients may have a higher risk of tooth bud damage with ORIF and older patients may have more complications with the surgery. Therefore, closed reduction may be a more suitable option for these age groups. However, data on the type of treatment cross-referenced with other data such as the gravity of the case or hospitalization stay were not available in the majority of the included articles, which can be considered a major flaw. The risk of bias across studies was low according to the pre-specified protocol.

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COMPETING INTERESTS

Authors declare that they have no conflicts of interest to disclose.

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