

Functional Rehabilitation after Mandibular Fracture - A Systematic Review

Zygimantas Petronis, Nerija Spaicyte¹, Dovydas Sakalys, Gintaras Januzis

Department of Maxillofacial Surgery, Lithuanian University of Health Sciences, ¹Faculty of Odontology, Lithuanian University of Health Sciences, Kaunas, Lithuania

Abstract

Background: The objective of this study was to evaluate the efficiency of functional rehabilitation in terms of mouth opening, quality of life, healing process, occlusion and dysfunction, between different treatment methods, after condylar fractures, based on the current literature. **Methods:** Using the PRISMA guidelines in search of clinical trials published between 2011 and 2021, a literature analysis was performed. This search was conducted using the following Medical Subject Headings (MeSH) terms: rehabilitation OR mouth opening recovery OR function recovery AND mandibular fracture OR condylar fracture. **Results:** The literature search resulted in a total of 110 study articles, of which seven publications were used in the present review, according to a selection based on the pre-established eligibility criteria. The review showed that open reduction resulted in a better three-dimensional recovery of mandibular movements and revealed greater results regarding the absence of the symptoms after applied treatment. However, studies assessing closed reduction, especially performed with intermaxillary fixation screws (IMFS), revealed excellent results in terms of quality of life, mouth opening and occlusal parameters. **Discussion:** This systematic literature review showed that open reduction resulted in a better three-dimensional recovery of mandibular movements and showed greater results regarding the absence of symptoms. However, studies assessing CR, especially those performed with IMFS, revealed excellent results in terms of quality of life, mouth opening and occlusal parameters.

Keywords: Condylar fracture, mouth opening, quality of life, rehabilitation, treatment

INTRODUCTION

Mandibular fracture is the second-most common type of fracture in the craniofacial area.^[1] Conventionally, mandibular fractures are divided into five anatomic regions: symphysis/parasymphysis, body, angle/ramus region, coronoid process and condylar process.^[2] Condylar fractures are among the most common fractures in the maxillofacial region.^[3] These fractures have different causes such as interpersonal violence, traffic accidents, gunshot wounds, sports injuries, work accidents or falls.^[4]

General indications for closed reduction (CR) in mandibular fractures are paediatric fractures, coronoid process and condylar process fractures.^[5] The most appropriate choice generally is conservative treatment, unless certain specific conditions require an open reduction and internal fixation (ORIF), such as dislocated fracture, atrophic toothless mandible, poor osteogenesis, reduced healing potential, complex maxillofacial fractures, condylar displacement into middle cranial fossa,

lateral extracapsular displacement of the condyle and invasion by a foreign body (e.g., gunshot wound).^[6]

CR is a repositioning of fractured fragments by tooth-borne or bone-borne stabilisation without visualisation of the fracture line. This treatment continues until the hard callus is formed (4–6 weeks).^[7]

In open reduction, fracture segments are surgically approached, repositioned and fixed to their anatomical positions using rigid or semi-rigid fixation.^[7] The main purpose of this treatment is to improve immediate active function, get anatomical reduction and functionally stable fixation.^[8]

Address for correspondence: Dr. Nerija Spaicyte,
J. Vienozinskio G. 20, Raudondvaris, Lt-54119, Kaunas, Lithuania.
E-mail: nerijaspaicyte@gmail.com

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Disabilities requiring functional rehabilitation after condylar fracture include reduced mouth opening, chewing disorders and articulation disorders.^[9,10] All aforementioned symptoms play a significant role in negatively affecting patient’s quality of life.^[10] Therefore, clinicians should have a huge interest in making rehabilitation after mandibular fractures as efficient as possible.

As mentioned above, there are a couple of different methods for the treatment of condylar fractures.^[10,14-19] Thus, the efficiency of rehabilitation might vary between them. Since mandibular fractures significantly decrease quality of life, there is a need for a systematic review to gather evidence regarding the efficiency of rehabilitation after mandibular fractures to prepare the recommendations for possible further improvements in the management of condylar fractures.^[9]

The aim of this study was to evaluate the efficiency of functional rehabilitation, between different treatment methods, after condylar fractures.

METHODS

This systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO CRD42022326544) and was conducted and reported following international guidelines.^[11]

FOCUS QUESTION

The focus question was developed according to the population, intervention, comparison and outcome design [Table 1].

DATA SOURCE AND SEARCH STRATEGIES

An electronic search was performed in online database PubMed for the articles published between July 2011 and July 2021. This search was conducted using Medical Subject Headings (MeSH) terms. The following terms were used in the search strategy:

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{Subject AND Adjective}
{Subject: (rehabilitation [MeSH Terms] OR mouth
opening recovery OR function recovery)
AND
Adjective: (mandibular fracture OR condylar fracture)}
Full articles from these results were read for identifying
the studies meeting the eligibility criteria.
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Component	Description
Population (P)	Adult patients with condylar fractures
Intervention (I)	Treatment of condylar fracture
Comparison (C)	Comparison between different treatment methods
Outcome (O)	Rehabilitation effectiveness
Study design (S)	Controlled trials, retrospective studies
Focus question	How well do patients rehab after condylar fractures when different treatment methods are applied?

SELECTION OF STUDIES

In a first stage of data selection, the resulting publication’s abstracts were assessed for their eligibility accordingly to the inclusion and exclusion criteria. The search excluded paediatric patients because their treatment is different from adults due to anatomic factors such as facial and dental development and fewer complications are encountered after the healing.^[12]

The study selection process was done by three independent reviewers. They compared their results and resolved differences through discussion, consulting the fourth person when consensus could not be reached. The person was an experienced senior reviewer. Full-text articles were screened, and finally, reports were obtained for all the studies that were deemed eligible for inclusion in this article.

Inclusion criteria

- Studies written in English
- Studies regarding the information on mandibular fracture rehabilitation
- Patients older than 18 years
- Articles published in preceding 10 years (2011–2021)
- Human studies.

Exclusion criteria

- Previous mandibular fractures
- Pathological fractures
- *In vitro* and animal studies
- Case reports
- Systematic reviews.

Data extraction

Data were collected from the included full-text articles and set in the following fields:

- ‘Author, year’
- ‘Sample size’
- ‘Follow-up’
- ‘Treatment methods’
- ‘Type of evaluation’
- ‘Outcome’

Assessment of methodological quality

The quality of included study protocols was assessed after the study selection by investigating full-text articles. The Cochrane Collaboration’s two-part tool was used to assess the risk of bias across the studies, evaluating random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other biases.^[13]

SYNTHESIS OF RESULTS

A narrative synthesis of results was made. Data of interest were collected and put into a table in order which was described earlier. Meta-analysis was not performed due to high study heterogeneity.

RESULTS

Study selection

A total of 110 articles which were up to 10 years old were identified in the online search engine. Following the removal of duplicates and the review of article titles and abstracts, 18 articles were chosen. The present review uses seven articles meeting all the selection criteria, of which five are prospective and two are retrospective studies. The study selection process is illustrated in a flowchart in Figure 1.

Study characteristics

The most important information from each selected article is summarised in Table 2. All included studies involved a total of 425 patients, who were diagnosed with a condylar fracture. Included studies evaluated patients' maximal mouth opening (MMO),^[14-18] patients' quality of life^[10] and dysfunction index.^[19] The aetiology of trauma was mentioned as follows: traffic accidents, interpersonal altercations, sports injuries and falls.^[15,17,19] Other studies did not specify the causes. Injuries were treated by repositioning the mandible to its anatomical position conservatively or by osteosynthesis.

Methodological quality assessment of included studies

The Cochrane Collaboration's two-part tool^[13] was used to evaluate the risk of bias of included prospective studies [Figure 2]. The other three publications included retrospective data analysis of atypical design, and therefore, their quality could not be evaluated by standardised means.^[14,15] All the studies included were highly biased in evaluating 'blinding of personnel' and almost all studies did not describe the measures taken to ensure 'allocation concealment'. Even though all studies did not meet the 'personnel blinding'

condition, they are not considered to be of poor quality because the surgical interventions used in different groups are too different from each other to be concealed by the interventionist. It was also noted that studies did not indicate a conflict of interest between authors.

Qualitative analysis

Quality of life

One study compared the quality of life of patients in the treatment of fractures of temporomandibular joint (TMJ) using intermaxillary fixation (IF) by individual mandibular splints or elastics on intermaxillary fixation screws (IMFS).^[10] Survey results showed that within 6 weeks of treatment, 91% of patients treated with IMFS for intermaxillary fixation have been able to observe normal daily activities. Only 59% of patients treated with IF using individual dentate splints had the same feeling of well-being as before. The study concluded that patients with mandibular joint fracture who were treated with IMFS experienced less social exclusion, less eating discomfort and a better quality of life than patients treated with maxillomandibular fixation with individual mandibular splints.^[10]

Mouth opening recovery

Five included publications have analysed the recovery of the mouth with different methods of treatment of mandibular fractures.^[14-18] Two of these were retrospective data analyses.^[14,15] Both studies evaluated the recovery of the mouth opening after fractures of TMJ. Patients in their 20s were found to have a MMO bigger as much as 3.2 mm on average, compared to patients of 40 years of age. The study concludes that patients with severely dislocated fractures or patients with multiple mandibular fractures tend not to recover

Table 2: Data of interest

Study ID	Authors	Publication year	Number of patients	Follow-up	Treatment method	Main outcome rehabilitation evaluation type
1	Niezen <i>et al.</i> ^[14]	2015	142	3, 6, 13, 26 and 52 weeks	Closed treatment. Rigid IF was not used (<i>n</i> =142)	Mouth opening
2	Rozeboom <i>et al.</i> ^[15]	2018	74	5-7 days and 3, 6 and 12 weeks	Open treatment (<i>n</i> =14) Closed treatment (<i>n</i> =60)	Mouth opening, function
3	Shiju <i>et al.</i> ^[16]	2015	50	1 st and 2 nd day, 1 st , 2 nd and 6 th week and 6 months	Open reduction followed by elastic MMF for 1 or 2 weeks (<i>n</i> =25) Closed management with rigid MMF using Erich's arch bar for 2 weeks followed by guiding elastics for 1 or 2 weeks (<i>n</i> =25)	Mouth opening
4	Sforza <i>et al.</i> ^[17]	2011	21	Range, 6-66 months	Open reduction, rigid internal fixation and functional treatment (<i>n</i> =9) Closed reduction and functional treatment (<i>n</i> =12)	Mouth opening
5	Guo <i>et al.</i> ^[18]	2016	13	6 months	Open reduction and internal fixation based on CAD technology, and three-dimensional interface	Mouth opening
6	van den Bergh <i>et al.</i> ^[10]	2015	50	1, 3, 6 weeks	IMFS (<i>n</i> =24) Arch bar (<i>n</i> =26)	Quality of life
7	Kokemueller <i>et al.</i> ^[19]	2012	75	8-12 weeks, 1 year	Closed treatment (<i>n</i> =44) Endoscope-assisted transoral open reduction and internal fixation (<i>n</i> =31)	Dysfunction index

MMF: Maxillomandibular fixation, CAD: Computer-aided design, IMF(IF): Intermaxillary fixation

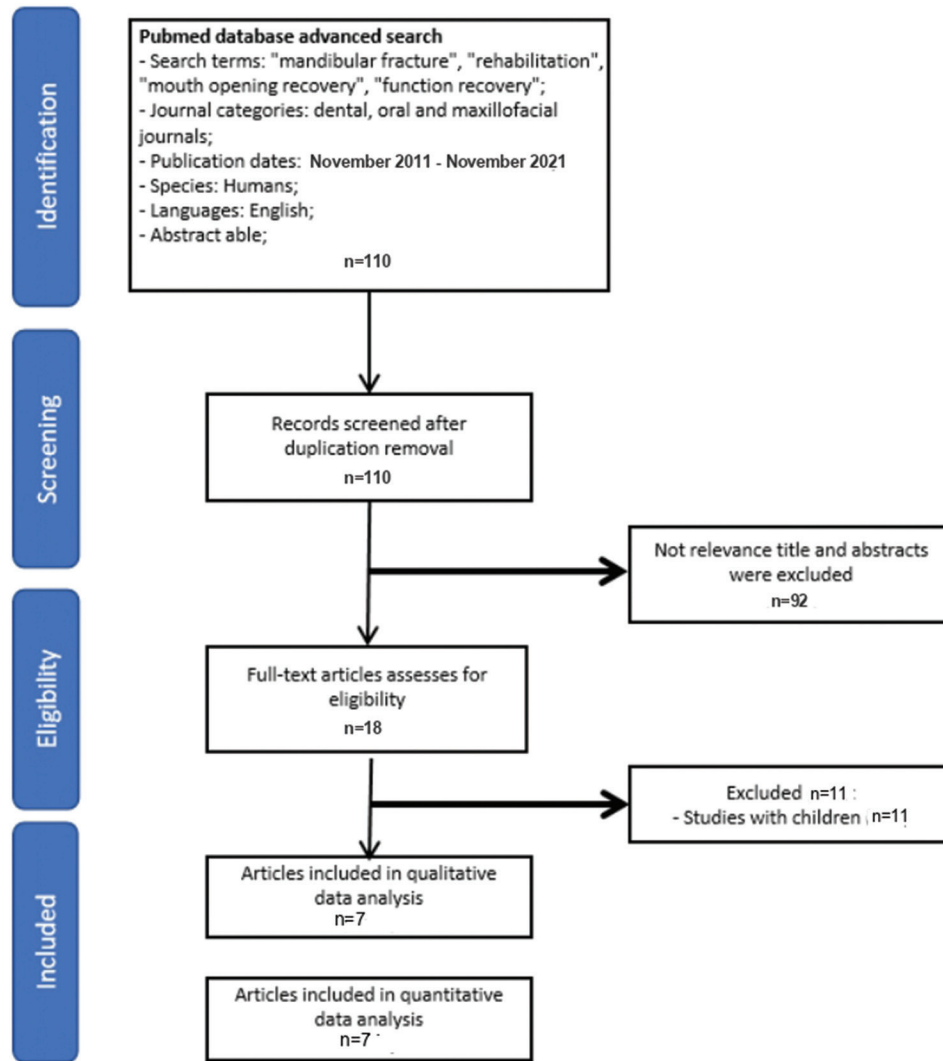


Figure 1: PRISMA selection criteria flowchart

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants (performance bias)	Blinding of personnel (performance bias)	Blinding of outcome assessor (selection bias)	Selective Reporting (reporting bias)	Other bias
Shiju M. et al. 2015	●	?	●	●	?	?	?
Sforza C. et al 2011	●	?	●	●	?	?	?
Guo S. et al. 2015	●	?	●	●	?	?	?
van den Bergh, B. et al. 2015	●	?	●	●	?	?	?
Kokemueller H. et al. 2012	?	?	●	●	?	?	?

Figure 2: Risk of bias

maximal pre-injury mouth opening.^[14] Results from another study showed that physiotherapy applied to patients during rehabilitation after a mandibular fracture had no significant effect on MMO recovery.^[15]

The three remaining studies included prospective evaluations of patient mouth opening.^[16-18] One of the studies compared three-dimensional recovery of mandibular movements

after open reduction and fixation with metal plates versus manual CR in unilateral condylar fractures. Better results were observed in those who had undergone metal plate osteosynthesis.^[17] However, in another study which also compared the aforementioned treatment methods, no significant difference was observed in the rehabilitation of mandibular movements.^[16] The third prospective study included was investigating the application of computer-aided planning to osteosynthesis surgery of mandibular condyle fracture. Results showed that 6 months after operation, the average MMO recovery of patients was 43 mm. Despite the excellent results, the small sample size and the absence of a control group do not demonstrate reliably greater efficiency of this treatment method than conventional osteosynthesis.^[18]

Assessment of Asymmetric Helkimo Dysfunction Score, Clinical Dysfunction Index, Anamnestic Dysfunction Index and Index for Occlusion and Articulation Disturbance
 One of included studies compared two different treatment methods for mandibular condylar fractures: endoscopic surgery

(ENDO) versus conservative, nonsurgical treatment (CONS).^[19] The Asymmetric Helkimo Dysfunction Score was used. At follow-up of 8–12 weeks, score was lower in the CONS group; furthermore, during later follow-up checkups, better results were seen in the ENDO group; however, results did not differ statistically significantly. In conclusion, both treatment methods were effective.

After 8–12 weeks of follow-up, the CONS group of patients had a lower Clinical Dysfunction Index than the ENDO group patients; however, after 1 year, 57% of patients in the ENDO group had no symptoms left, whereas only 10% of the CONS group patients had no symptoms.

After 8–12 weeks of follow-up, about a quarter of patients in both groups had no symptoms when evaluating the Anamnestic Dysfunction Index. However, the majority in the CONS group still felt moderate or even severe symptoms. At follow-up of 1 year, 70% of the ENDO group of patients felt no symptoms, in comparison only 29% of patients felt no symptoms in the CONS group.

When evaluating the index for occlusion and articulation disturbance, ENDO showed better results in both follow-up periods. After the whole follow-up period, more patients with occlusal disorders were seen in the CONS group.

According to the results of an analysed prospective study, endoscopically treated mandibular condylar fractures showed better results, authors also state that the endoscopic approach will probably be used more and more when treating mandibular condylar fractures.

DISCUSSION

This systematic literature review showed that open reduction resulted in a better three-dimensional recovery of mandibular movements^[17] and showed greater results regarding the absence of symptoms.^[19] However, studies assessing CR, especially those performed with IMFS,^[10] revealed excellent results in terms of quality of life, mouth opening and occlusal parameters.

A literature review was done by Kommers *et al.*^[20] in 2013 concluded that no study had a patient-centred approach, assessing the effect of mandibular injury and treatment on the patient's quality of life. Our included study analysed CR with individual splints or with IMFS. It was found that patients having mandibular condyle fractures treated with IMFS experienced less social isolation and difficulty with eating. The plausible explanation for that is a shorter duration of surgery, less pain and favourable occlusal results compared to the use of arch bars.^[13] However, another prospective study by Omeje *et al.*^[21] in 2014 indicates that there is no significant statistical difference between open and CR groups regarding the overall quality of life. It however does not include the closed treatment with IMFS, which according to our reviewed study of van den Bergh *et al.*^[10] showed great results, therefore, there is the credibility of insufficient evaluation and there is a need for further investigation.

Notwithstanding the type of therapy, clinical treatment aims at re-establishment of occlusal contacts and functional restoration of TMJs (mouth opening >40 mm and minimal lateral deviation at maximum MO). According to a meta-analysis performed by Xiaodong Han *et al.*^[22] in 2019, open reduction provides better clinical outcomes including MMO for moderately displaced unilateral mandibular condyle fractures compared with closed treatment. One of our reviewed articles shows better results of MMO made with ORIF as well,^[17] and another one argues that no significant difference was found.^[16] In the second one,^[16] it is noticeable that despite the MMO, changes had been seen in mouth deviation and occlusal discrepancies which are more superior in ORIF as compared to CR. In one study, the effectiveness of computer-aided design (CAD) technology in pre-operative surgical treatment planning was investigated and it turned out this new pre-operative design procedure might facilitate and upgrade open treatment and contribute to the improvement of restoring functions of the mandible.^[18] Regardless of great outcomes of ORIF, there is still a considerable number of nerve injuries reported using this technique. In the investigation with CAD technology, two out of 13 cases experienced the temporal branch of the facial nerve injury due to excessive pull during the operation. In the study by Schenkel *et al.*^[23] in 2016, over 45% suffered from purely post-operative hypoaesthesia without pre-existing post-traumatic IAN injury. Fortunately, literature shows a high potential for recovery after disturbed nerve continuity with published recovery rates between 33% and 100%, and it mostly depends on the age of the patient as well as the location of the fracture.^[18,24] When assessing dysfunction indexes, endoscopic surgery showed better results than conservative non-surgical treatment.^[19] Endoscope-assisted surgery allows miniplate fixation through an intraoral incision, and it has advantages such as time-saving, invisible scars and low risk of facial nerve damage. However, there is a need for intensive training and handling of specialised instruments in endoscopic techniques.

In conclusion, both open and closed treatment methods are proven to be efficient with a slight superiority of open reduction considering MMO. However, it does not prove the advantage in all cases and treatment methods should be chosen according to the indications. Adjuvant measures such as CAD technology should be considered to improve the rehabilitation of mandibular fractures as it facilitates surgical treatment. The modification of traditional open reduction surgery to endoscopic assisted is associated with lower morbidity and should as well as be considered to improve the traditional approach. When it comes to closed treatment, usual CR with splints replaced by IMFS has also shown great results in terms of functional rehabilitation. Further investigation must be performed to prove the benefits of these methods.

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Conflicts of interest

There are no conflicts of interest.

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