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SYSTEMATIC-REVIEW

Temporo Mandibular Joint Disorders in Condylar Fracure Management (Systematic Review and Meta-analysis)

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Abstract

Introduction: **Condylar fractures represent about 10−40% of all mandibular fractures. Different management options are prescribed.**

Methods: **Four internet databases (Scopus, Web of Science, Cochrane Library, and PubMed) were searched for relevant published articles in the last five years from 2017 till May 17, 2022 without restrictions. We included all studies whether Cohort investigations, case investigations, or randomized clinical trials. All treatment options for mandible condylar fractures were included like ORIF, closed management, conservative management, osteosynthesis, and fixation with its combination. The assessed outcomes were maximum mouth opening (MMO), lateral excursion, occlusion deranged, pain assessed with the Visual Analogue Scale, complications, and condylar depth distance. Only we managed to perform a single-arm meta-analysis on the MMO after the ORIF procedures by using Open Meta-Analyst.**

Results: **The eligible studies were 17 studies with a total sample size of 1193 patients. The meta-analysis revealed that the mean effect of ORIF in MMO was 38.441 with a 95% confidence interval ranging from 35.188 to 41.695. ORIF showed better results compared to closed management regarding MMO, decreased protrusive and lateral excursive movements, and pain while ORIF was better than conservative management regarding occlusal derangement. In ORIF procedures, combination with disc repositioning revealed a significant positive in functional outcomes, Inter-maxillary Fixation with an occlusal splint usage was a more superior to open reduction in selected cases.**

Conclusion: **Several management types of mandibular condylar fractures exist, with various factors being taken into consideration while choosing a certain type for a certain patient.**

Keywords: TMJ disorders, Condylar fracture management

1. Introduction

The mandible is one of the commonest fractures (second following nasal bone). Compared to other mandibular anatomical locations, mandibular condyle fractures comprised 10−40% of all mandibular fractures.[1] Mandibular condyle fractures are divided into three categories based on the site of the fracture: condyle head fracture, condyle neck fracture, and subcondylar fracture.[2] Condylar fractures' proportion is lower in adults than in children. In children, it accounted for 40−67% of mandibular fractures.[3] Mandibular fractures' treatment involves an optimal environment for bony healing occurrence, such as suitable blood supply, immobilization, as well as fracture segments' proper alignment. Therefore, in order to allow for primary or secondary bone healing, decrease and fixation are required for the majority of fractures. An exception is a patient with a typical occlusion who has a unilateral subcondylar fracture.[4] Following mandibular condylar fracture treatment, the patient may experience complications including limited mouth opening, persistent pain, and functional loss, such as chewing, biting, yawning,

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as well as facial or trigeminal nerve's damage.[5] The temporomandibular joint (TMJ) may develop fibrous or bony ankylosis as a consequence of the mandibular condylar fracture, significantly impairing its functionality. If the fracture was not discovered, if the patient has severe mandibular condylar head comminuted fractures, if they are immobilized with an extended mandible, or if treatment is delayed, especially in young children, fibrous or bony ankylosis may develop.[6] It has been revealed that, for dislocated condylar process fractures in children and adolescents, both surgical and conservative management could obtain reasonable outcomes.[7] Meanwhile, many doctors prefer surgical treatment.[8] Throughout history, surgeons did not have a clear agreement on condylar fractures line of management.[9] Currently, there are various types of interventions in condylar fracture, and this systematic review aims to provide updated data about available interventions in the past few years.

2. Methods

To conduct our systematic review and meta-analysis, we were constrained by the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) criteria.[10]

2.1. Literature search

Four internet databases (Scopus, Web of Science, Cochrane Library, and PubMed) were searched for relevant published articles in the last five years from the beginning of 2017 till May 17, 2022 without any restrictions. We used the following search strategy: (‘temporomandibular joint’ OR temporomandibular OR TMJ OR ‘temporo-mandibular’ OR ‘temporo-mandibular’) AND (Fracture OR break OR accident OR broken OR Fractures).

2.2. Eligibility criteria

We included all studies whether they were randomized clinical investigations, cohort investigations or case-control investigations which were investigating the outcomes and complications of different management options in mandibular condylar fractures whether they were unilateral or bilateral and displaced or not. All age groups were eligible to be included. The exclusion criteria were studies included patients with pan-facial trauma, studies without sufficient follow-up periods (less than three months), animal investigations, case research, remarks, letters, abstracts from conferences, and reviews.

2.3. Search results screening

The results of searching databases were imported into EndNote X8.0.1.[11] The authors independently screened the titles and abstracts of resulted records. Then, the full texts of remained the studies were screened. In case of any conflicts, the final decision was made by discussion between the authors.

2.4. Data extraction

General data about the included studies were extracted like country, study design, population description, study duration, and follow-up periods. Also, baseline data of included patients were extracted regarding age, Sex, fracture side, and the selected intervention. Finally, the outcomes data were extracted like maximum mouth opening (MMO), lateral excursion, occlusion deranged, and pain assessed with the Visual Analogue Scale (VAS), complications, and condylar depth distance.

2.5. Quality assessment

In order to evaluate the case-control and cohort studies' quality, we utilized The Newcastle Ottawa Scale. It assesses three essential domains (study groups selection, comparability between them, and outcome or exposure ascertainment. However, in randomized control trials, we used Cochrane's risk of bias tool which evaluates seven essential domains including random allocation, allocation concealment, study's participants blinding, outcome assessors blinding, attrition bias, and any detected other bias.[12]

2.6. Qualitative synthesis and statistical analysis

As we included different treatment options in the treating of condylar fractures, it was difficult to perform meta-analyses as a limited number of studies were published for each specific management. Therefore, we qualitatively reviewed each included procedure like ORIF (Internal Fixation and Open Reduction), closed treating, conservative management, osteosynthesis, and fixation with its combination.

Only we managed to perform a single-arm meta-analysis of MMO after the ORIF procedure as it was reported in a sufficient number of studies. The single-arm meta-analysis was performed by Open Meta-Analyst by using the average of the studies’ values combined with the 95% Confidence Interval. Heterogeneity was estimated by the I squared test and the outcome was considered heterogeneous if

the I^2>50% and the *P*. value < 0.1 then. In the event that the heterogeneity was clear, a random effect model was then employed.

3. Results

3.1. Data collection

Initially, the systematic search revealed 1185 records. After duplicates removal, the remaining records were 767. A total of 633 entered the title/abstract screening, and 79 were suitable for the full texts one. In the end, a total of 17 articles[13–29] were included in the systematic review Fig. 1.

3.2. Studies' summaries & baseline characteristics

All the included studies were published between 2017 and 2022. Of the included studies, five were located in China, three in India, and two in Germany, and France, each. Other countries were Pakistan, Saudi Arabia, Turkey, the United

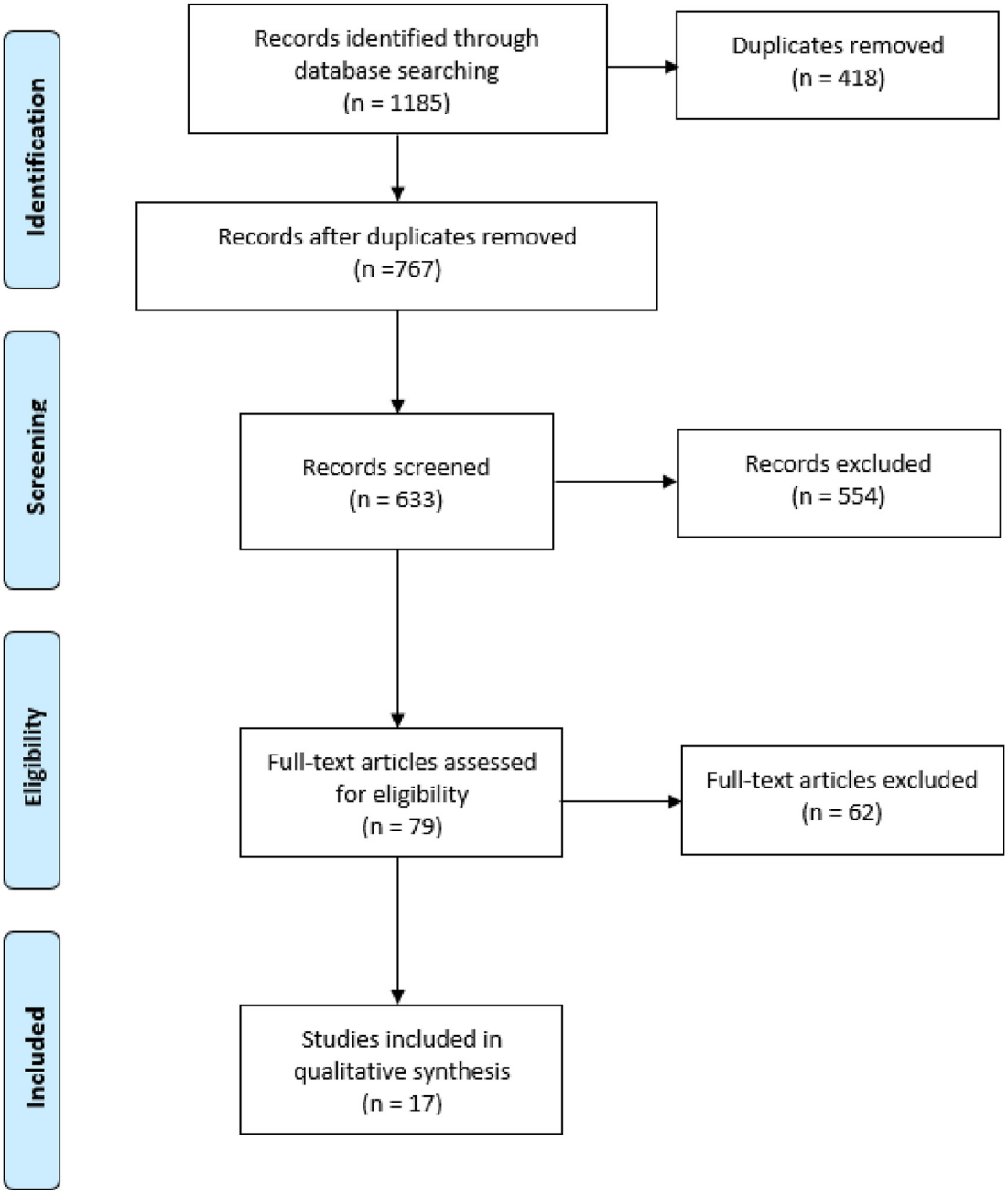

Fig. 1. PRISMA flow diagram.

Kingdom, and Ukraine. Most of the included studies were retrospective ($N = 11$), however, prospective studies, and RCTs were also included. The follow-up duration ranged from 3 months, up to 24 months (Tables 1 and 2).

3.3. Quality assessment

All included four RCTs[13–15,29] had high risks of allocation concealment, and participants' and personnel's blinding. Other domains showed low or unclear risks (Figs. 2 and 3).

Regarding the included cohort studies, one scored a total of five,[17] while the others scored 6 or 7. (https://aimj.researchcommons.org/cgi/editor.cgi?article=1839&window=additional_files&context=journal) Finally, regarding the case-control and prospective cohort, all studies scored 6, except **Madadian** *et al.*,[19] which scored a total of 7. (https://aimj.researchcommons.org/cgi/editor.cgi?article=1839&window=additional_files&context=journal).

3.4. Outcomes: open, closed, and function treatments

Asim *et al.*[13] reported the MMO (mm) as 36.39 ± 4.72 (open treatment), while 33.74 ± 4.72 (closed), while, with functional treatment, **Merlet** *et al.*[18] reported a mean of 45.22 following one year, and **Malinge** *et al.*[21] reported 44.31 ± 5.48. Regarding the lateral excursion (mm), **Asim** *et al.*[13] reported 0.48 ± 0.99 (open), while 1.09 ± 1.6 (closed). With closed treatment, in **Madadian** *et al.*[19] 119 patients had complications out of 177.

3.5. ORIF

Basha *et al.*[25] reported a mean MMO (mm) of 40 with ORIF, while **Merlet** *et al.*[18] found a mean of 41.29 after one year. For ORIF + SFS, **Kolk** *et al.*[28] found 47.93 ± 6.53, while with ORIF utilizing small-fragment positional screws, **Smolka** *et al.*[17] reported 41 ± 6. **Ceyar** *et al.*[14] revealed 37.41 ± 3.42 with ORIF with disc repositioning (at 3 months), and 22.5 ± 9.55 with ORIF without disc repositioning (at 3 months). Regarding the VAS score **Ceyar** *et al.*[14] reported 0.16 ± 0.38 with ORIF with disc repositioning (at 3 months), and 5.25 ± 2.34 with ORIF without disc repositioning (at 3 months). **Madadian** *et al.*[19] found complications in 59 out of 109 with ORIF, while 31 out of 72 in the conservative. **Kuntamukkula** *et al.*[16] found 31.27 ± 2.29 of maximal force (Mpa) with ORIF compared to 32.39 ± 2.86 with the control. In ORIF using small-fragment positional screws, the bone resorption was 0.9 ± 55 in 20 patients.[17] In ORIF with 1 or 2 minisuture anchors, 1 out of 21 had occlusion deranged.[22] In open reduction + mini plates, the paired sample *t*-test was 63.6±7.02.[23]

3.6. Meta-analysis

MMO was measured in mm in 6 studies. A single-arm meta-analysis was done to calculate the mean effect of ORIF different techniques on the MMO. Nine groups from six studies included 244 patients revealed that the mean effect is 38.441 with a 95% Confidence Interval ranging from 35.188 to 41.695.

4. Discussion

Based on our included studies' results, in high condylar fractures, ORIF with disc repositioning revealed a significant positive effect on TMJ function in the different outcomes, such as the MMO.[14] Meanwhile, IMF with an occlusal splint usage was a more superior to open reduction in selected cases.[23] Even though the Y-shaped plate and TCP showed insignificant differences in various outcomes, as MMO, surgeons preferred the Y-shaped plate over TCP because of its easy maneuverability, particularly in cases of fracture line location being upward towards the condylar neck.[29] Unilateral mandibular condylar fractures' open treatment showed better functional outcomes than the closed one, mainly regarding the MMO.[13] However, the ORIF group demonstrated better results than the closed group regarding reduced protrusive and lateral excursive movements, as well as TMJ pain; and in occlusal derangement in comparison to the conservative one. On the other hand, the ORIF group had worse outcomes, compared to both the closed and conservative groups, relating MMO.[19] It was said that closed reductions are less expensive for the patient and do not cause vascular envelope stress. On the other hand, it requires intact dentition or some kind of dental records and is connected to a considerable duration of immobility and mouth cavity closure. However, ORIF allows for direct visibility, the reduction of broken bone segments, and the restoration of the pre-injury occlusion without requiring full fixation of the mandible and maxilla. As a result, it enables shorter bony, quicker restoration to normal jaw function, improved feeding, and oral cleanliness.[4] Treatment of unilateral mandibular extra-capsular condylar fractures with ORIF demonstrated better clinical and functional outcomes when compared to the closed reduction in terms of occlusion, maximum inter-incisal opening, and lateral deviation during maximum inter-incisal opening and laterotrusion. This was the conclusion

Table 1. A table showing summary of included studies.

Study ID	Year	Country	Study design	Population description	Study duration	Study center	Follow-up period
Asim *et al.*[13]	2019	Pakistan	RCT	Patients with moderately displaced and or deviated condylar neck or subcondylar fractures	2011–2015	Department of Oral and Maxillofacial Surgery, Armed Forces Institute of Dentistry, Pakistan Rawalpindi	6 months
Basha *et al.*,[25]	2020	Saudi Arabia	retrospective study	patients with condylar neck fracture	2014–2018	Aster Sanad Hospital, Exit 9, Al Hamra, Riyadh, Saudi Arabia, Oral & Maxillofacial Surgery.	6 months to 1 year
Merlet *et al.*[18]	2018	France	retrospective study	patients with condylar mandibular fracture with articular impact	2009–2015	NR	3 months to 6 years
Huang *et al.*,[27]	2020	China	retrospective study	individuals with mandibular condyle fractures in the sagittal plane	2014–2016	the School of Stomatology's Oral and Maxillofacial Trauma Center at Peking University	15 months
Kocaaslan *et al.*,[23]	2022	Turkey	retrospective study	patients with mandibular condyle fracture	2011–2016	The Marmara University School of Medicine's Department of Plastic, Reconstructive, and Aesthetic Surgery	6 months
Kolk *et al.*,[28]	2020	Germany	retrospective study	patients with condular head fracture	NR	NR	9 months to 6 years
Kumar *et al.*,[29]	2021	India	single-centre, prospective, double-arm, parallel-group	mandibular condylar fracture (MCF).	from January 21, 2019, through September 21, 2020		3 months
Kuntamukkula *et al.*,[16]	2018	India	prospective cohort study	isolated unilateral condylar fracture	2013–2015	Sri Sai college of Dental Surgery,	Sri Sai college of Dental Surgery,
Liu *et al.*,[20]	2019	China	retrospectively	sagittal fracture of the mandibular condyle (SFMC)	2014–2019	School and Hospital of Stomatology, Peking University, Department of Oral and Maxillofacial Surgery	(6 months from T0); T2, at the end of the follow-up (at least 1 year from T0).
Madadian *et al.*,[19]	2020	United Kingdom	retrospectively	mandibular condylar fractures	2005–2018	St. George's Hospital, Blackshaw Road, Tooting, London, Department of Oral and Maxillofacial Surgery	11 weeks

(*continued on next page*)

Table 1. (continued)

Study ID	Year	Country	Study design	Population description	Study duration	Study center	Follow-up period
Malinge *et al.*,[21]	2021	France	retrospectively	mandibular condylar fractures with an articular impact.	2002–2018	Nantes University Hospital (France)	Up to 24 months
Ren *et al.*,[26]	2020	China	retrospective	June 2015 to June 2017	June 2015 to June 2017	Shanghai Jiao Tong University School of Medicine, Shanghai Ninth People's Hospital	12 months
Shakya *et al.*,[22]	2021	China	prospective, non-controlled clinical trial	Patients with intra capsular condylar fractures and articular disc displacement	2018–2019	The West China Hospital of Dentistry	6.6 months
Skrypa *et al.*,[15]	2021	UKRAINE	Prospective study	patients with temporomandibular joint dysfunction after mandibular fractures	NR	Chernivtsi Regional Clinical Hospital's surgery dental department	6–12 months
Smolka *et al.*,[17]	2018	Germany	retrospective study	patients with mandibular condylar head fractures	2009–2016	NR	6 months
Ceyar *et al.*,[14]	2021	India	Prospective clinical trial	patients with high condylar fracture	NR	Department of Oral and Maxillofacial surgery	3 months
Xin *et al.*,[24]	2022	China	retrospective cohort	patients with sagittal fracture of mandibular condyle	2011–2021	The Ministry of Education, School, and Hospital of Stomatology's State Key Laboratory Breeding Base of Basic Stomatology Science and Key Laboratory of Oral Biomedicine	3 months

NR, Not reported.

Table 2. A table showing baseline characteristics of the included population.

Study ID	Sample size	Dropped patients	Sex		Intervention
			Male	Female	
Asim *et al.*[13]	80	14	59	7	open ttt = 40 closed ttt = 40
Basha *et al.*,[25]	10	0	10	0	ORIF = 10
Merlet *et al.*[18]	83	0	58	25	ORIF, Functional ttt
Huang *et al.*,[27]	44	0	30	14	Internal fixation with screws
Kocaaslan *et al.*,[23]	24	0	NR		IMF only = 8, IMF + splint = 11, open reduction + mini plates = 5
Kolk *et al.*,[28]	80	0	47	33	CR-MMF = 26 ORIF + SFS = 54
Kumar *et al.*,[29]	20	0	19	1	Trapezoidal Condylar Plate, Y-Shaped Plate
Kuntamukkula *et al.*,[16]	30	0	18	12	Operated (ORIF) Control
Liu *et al.*,[20]	20	0	10	10	displaced disc status as complete reduction (DCR), incomplete reduction (DICR), non-fractured (NF)
Madadian *et al.*,[19]	358	0	NR	NR	Conservative, closed, ORIF
Malinge *et al.*,[21]	108	0	59	49	Functional treatment
Ren *et al.*,[26]	56	0	36	20	Surgical, conservative
Shakya *et al.*,[22]	21	0	16	5	ORIF with 1 minisuture anchor = 14, and with 2 minisuture anchor = 17
Smolka *et al.*,[17]	48	0	31	17	ORIF using small-fragment positional screws
Ceyar *et al.*,[14]	24	0	18	6	ORIF with disc repositioning ORIF without disc repositioning
Xin *et al.*,[24]	95	0	64	31	resorbable-screw osteosynthesis titanium-screw osteosynthesis

NR, Not reported.

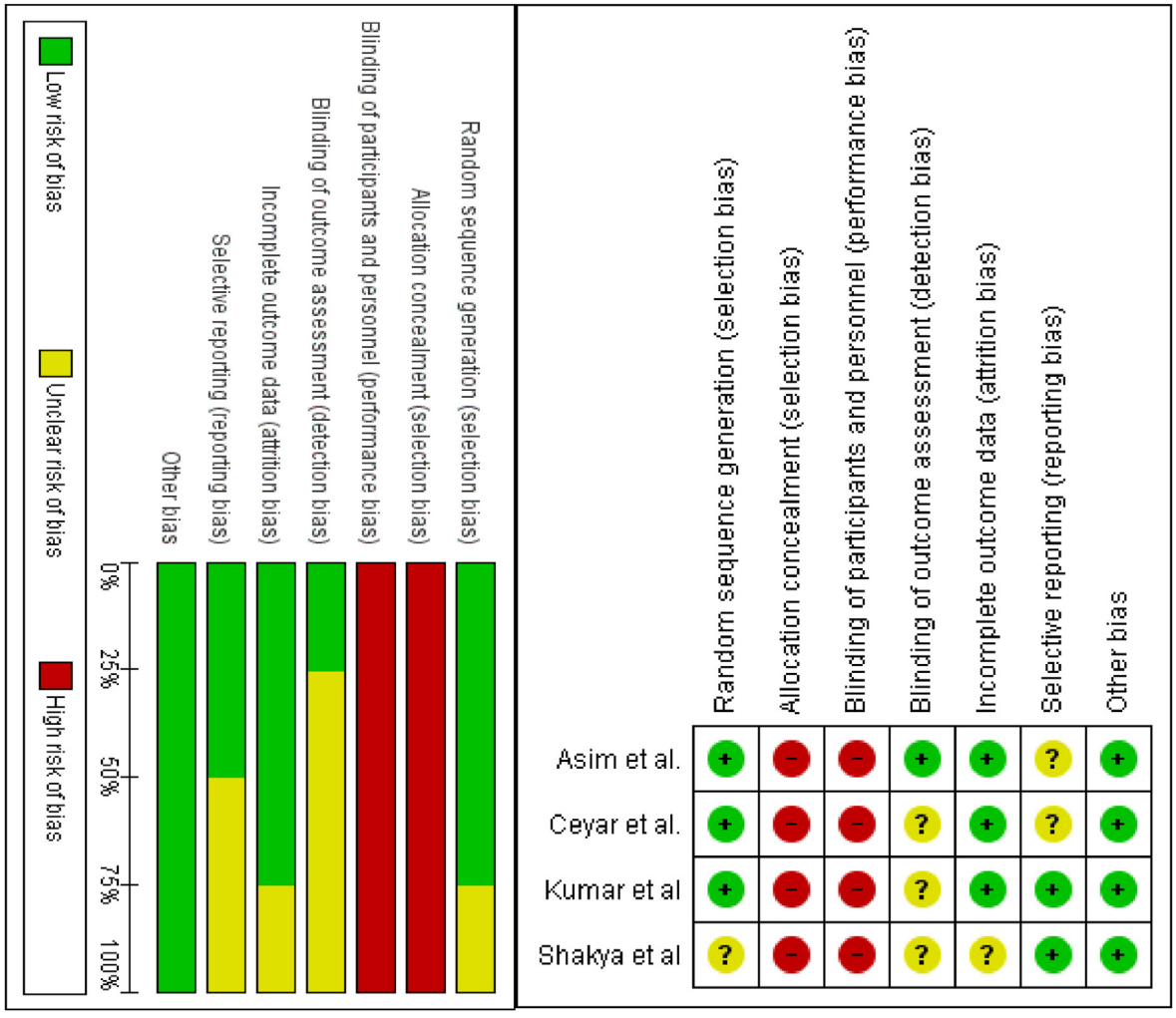

Fig. 2. Risk of bias graph.

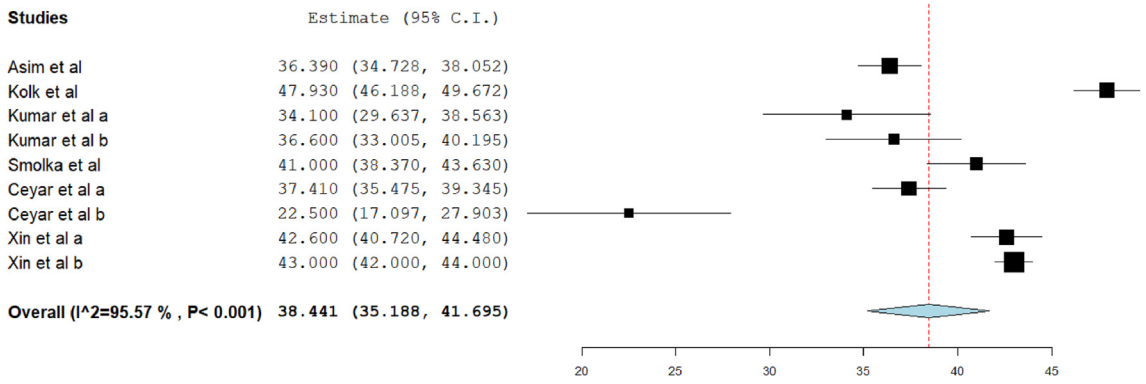

Fig. 3. Forest plot show the mean impact of ORIF different techniques on the MMO.

of a previous meta-analysis comparing open with closed reductions. Meanwhile, no significant variation was found between them regarding protrusion and TMJ pain.[30] However, cross-sectional research of 12,303 patients found that ORIF had increased risks of a lengthier hospital stay, higher overall medical costs, and hematoma formation compared to close reduction, but a decreased risk of wound infections.[31] IMF is one of the logical choices for people who are more likely to have problems from ORIF. IMF may not be the best choice for long-term results, however, since there is a significant overlap between this at-risk group for problems and the at-risk group for noncompliance.[4] The various options for treatment are determined by the clinical symptoms and diagnostic results of the fracture, such as unilateral or bilateral fracture, displacement, dislocation, size, and position of the condylar segment, dental malocclusion, mandibular dysfunction, and the patient's readiness for surgical intervention. The patient's age, general health, and the surgeon's expertise are additional crucial elements influencing the ultimate decision.[32] Future RCTs with large sample sizes and data eligible for meta-analysis are highly recommended to obtain more conclusive conclusions about the preferred intervention in different selected cases. The strengths include our strict following of the PRISMA guidelines, and the inclusion of various intervention types. On the other hand, the limitations include the small sample size, and that the majority of included studies were retrospective ones.

4.1. Conclusion

Several management types of mandibular condylar fractures exist, with various factors being taken into consideration while choosing a certain type for a certain patient. high condylar fractures, ORIF with disc repositioning revealed a significant positive effect on TMJ function while IMF with an occlusal splint usage was a more superior to open reduction in selected cases.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of Interest

There are no conflicts of interest.

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