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SYSTEMATIC REVIEW

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Comparison of operatively and nonoperatively treated isolated mason type II radial head fractures: a systematic review and meta-analysis

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Abstract

Background Radial head fractures are the most common bony injury of the elbow in adults. The current literature does not agree on whether isolated stable type II radial head fractures should be treated operatively or nonoperatively. This review aims to determine the preferred treatment for Mason type II radial head fractures and compare the outcomes of conservative and surgical treatment.

Methods Our study used PRISMA guidelines and conducted a thorough search of multiple electronic databases, including PubMed, Cochrane, Embase, Web of Science, CNKI, and Wanfang databases, initially identifying 545 relevant publications on surgical and conservative treatment of Mason type II radial head fractures. The final search date for this study is July 7, 2024.Through a comprehensive meta-analysis, we evaluated several outcomes, including functional scores (DASH, OES, and MEPS scores), clinical outcomes (elbow flexion, elbow extension deficit, elbow pronation, and elbow supination), and complication rate (total complications and elbow pain). The mean difference (MD) was compared for continuous outcomes, and the odds ratios (ORs) were compared for categorical outcomes.

Result A total of 271 patients from 4 studies met the inclusion criteria. Among them, 142 patients received surgical treatment and 129 patients received non-surgical treatment. The study found no statistically significant differences between surgical and non-surgical treatments in DASH, OES, MEPS, elbow flexion, elbow extension impairment, and elbow pain. Compared with surgical treatment, non-surgical treatment was associated with greater elbow pronation (OR = -3.10, 95% CI = [-4.96, -1.25], $P=0.55$, $I^2=0\%$) and a lower complication rate (OR = 5.54, 95% CI = [1.79, 17.14], $P=0.42$, $I^2=0\%$).

Conclusion Based on the current evidence, conservative management of isolated Mason II radial head fractures yields favorable therapeutic outcomes with a low incidence of complications.

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Keywords Radial head, Conservative, Operative, Meta-analysis

Introduction

Approximately one-third of elbow fractures in adults are radial head fractures [1–3]. The typical injury mechanism involves an axial load transmitted through an extended wrist and elbow to the lateral column, leading to different radial head fracture patterns based on forearm rotation [4]. The classification of radial head fractures follows the Mason system or its various modifications [5–10].In 1954, Mason initially identified type II fractures as marginal sector fractures with displacement [8]. This classification was further refined by Broberg and Morrey in 1986, who described these fractures as involving ≥ 30% of the articular surface with at least 2 mm displacement [5]. Hotchkiss, in 1997, added to the discourse by pointing out the significance of mechanical blockade in type II fractures, which is essential for informing treatment methods [6].

The consensus is that nonoperative management with early mobilization is sufficient for Mason type I fractures, as they do not present a mechanical block to forearm rotation [11–14]. On the other hand, for Mason type III fractures, especially those that are comminuted and beyond reconstruction, surgical approaches such as open reduction and internal fixation or arthroplasty are recommended [15–18]. For Mason type II radial head fractures without associated elbow dislocation or other fractures, the surgeon has not reached a consensus on the optimal treatment strategy. The choice between operative and nonoperative approaches remains particularly contentious when these fractures do not mechanically obstruct motion [19, 20]. In 2012, Kaas et al. [21]. conducted a systematic review which revealed that operative treatment had significantly better outcomes compared to nonoperative methods. However, the authors stated that the heterogeneity between the included studies prevented them from making definitive recommendations regarding treatment.

The study aims to address this gap by conducting the first meta-analysis comparing the functional outcomes and complications of surgical versus nonsurgical treatments for isolated Mason type II radial head fractures.

Methods

Study selection

The present study followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines for reporting systematic reviews and meta-analyses [22]. We registered the review protocol in the PROSPERO database (CRD42024540601) [23].The last search date was April 7, 2024, and the PubMed, the Cochrane Library, CNKI, Embase and Web of Science databases were searched. The search procedure is based on the following keywords: ("radial head" OR "Mason type II" OR "Mason II") AND ("Operative" OR "Open reduction and internal fixation" OR "ORIF") AND ("conservative" OR "nonoperative"). Initially, we screened the title and abstract of each article to assess eligibility. This was followed by a full-text review of articles that met the criteria. Additionally, we conducted a comprehensive examination of the references cited in the included articles to ensure completeness.

Inclusion and exclusion criteria

This study included only comparative studies of surgical and nonsurgical treatments for adult patients with Mason type II isolated radial head fractures. Case reports, Biomechanical cadaveric studies, anatomical descriptive studies, and review articles were excluded. Radial head fractures with dislocation were also excluded. There were no language restrictions. The surgical group was designated as the experimental group, while the nonsurgical group served as the control group. Measured outcomes included the Disability of the Arm, Shoulder and Hand (DASH) scores, Oxford Elbow Score (OES), Mayo Elbow Performance Score (MEPS), elbow flexion, elbow extension deficit, elbow pronation, elbow supination, total complications, and elbow pain.

Quality assessment

Two authors (B.Z.Z. and H.Z.W.) evaluated the quality of the included studies using the Cochrane Reviewer's Handbook [24]. This study assessed the risk of bias in seven domains, which included random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias. Each criterion was assessed for a low, unclear, or high degree of bias. Non-randomized controlled trials were evaluated according to the Newcastle-Ottawa Scale (NOS), which mainly includes selection, comparison, and outcome [25]. Research scoring seven or more points was considered to be of high quality. The assessments of the included studies were conducted independently by two reviewers (B.Z.Z. and H.Z.W.), and any disagreements were resolved by consulting a third reviewer (J.L.Z.).

Data extraction

Two reviewers independently extracted relevant information from the included literature, including the first author, publication date, sample size, patient age and gender, dominant hand affected, and follow-up time. The outcome measures were the DASH score, OES, MEPS, elbow flexion, elbow extension deficit, elbow pronation, elbow supination, total complications, and elbow pain. When standard deviations were missing from studies, we attempted to contact the authors of articles by email to obtain relevant metrics. Medians and ranges were converted without means and SDs, as Wan et al. recommended [26]. Disagreements during the extraction process were resolved through consultation with a third investigator (J.L.Z.).

Statistical analysis

Data were analyzed using Review Manager (RevMan 5.4.1, Nordic Cochrane Center, Copenhagen, Denmark) for this meta-analysis. Mean difference (MD) with 95% confidence intervals (95% CI) was used for continuous data analysis, while odds ratios (OR) with 95% CI were used for dichotomous data analysis. To determine heterogeneity, we used the I^2 tests. If $I^2>50\%$ and $P<0.10$, it indicates high heterogeneity. In cases of significant heterogeneity, we applied random-effect models. Conversely, we used fixed-effect models when heterogeneity was low.

Result

Study selection

The PRISMA flow diagram (Fig. 1) illustrates the literature search and selection process. We identified 545 relevant articles by searching electronic databases. Four articles with 271 patients were selected for this meta-analysis, all of which compared the effect of surgical and nonoperative treatment of isolated mason type II radial head fractures [27–30].

Study characteristics

These studies included one randomized controlled trial [28], and three retrospective cohort studies [27, 29, 30], with 271 patients (115 males and 156 females), of which 142 underwent operative treatment and 129 with nonoperative treatment (Table 1).

Risk-of-bias assessment

The risk of bias items for each included study is shown in Fig. 2. Furthermore, the three retrospective cohort studies [27, 29, 30] were evaluated using the Newcastle-Ottawa Scale and were all rated as high quality, with scores ranging from 7 to 9, as shown in Table 2.

Functional outcomes

DASH

Postoperative DASH scores were reported in four studies [27–30] involving 142 patients who underwent surgical treatment; 129 patients received conservative treatment. The surgical and non-surgical groups had postoperative DASH scores of 12.6 and 12.5, respectively. There was no statistically significant difference between the two treatments (MD = -1.08, 95% CI = [-3.67, 1.51], $P=0.41$), with no heterogeneity ($P=0.58$, $I^2=0\%$). The forest plot of DASH scores is presented in Fig. 3.

OES

Postoperative OES scores were reported in two studies [27, 28] involving 54 patients who underwent surgical treatment; 41 patients received conservative treatment. The surgical and non-surgical groups had postoperative OES scores of 44.2 and 42.4, respectively. There was no statistically significant difference between the two treatments (MD=1.75, 95% CI = [-0.25, 3.75], $P=0.09$), with no heterogeneity ($P=0.66$, $I^2=0\%$). The forest plot of OES scores is presented in Fig. 4.

MEPS

Postoperative MEPS scores were reported in two studies [27–30] involving 142 patients who underwent surgical treatment; 129 patients received conservative treatment. The surgical and non-surgical groups had postoperative MEPS scores of 91.2 and 91, respectively. There was no statistically significant difference between the two treatments (MD = -2.12, 95% CI = [-11.33, 7.08], $P=0.65$), with high heterogeneity ($P=0.02$, $I^2=82\%$). The forest plot of MEPS scores is presented in Fig. 5.

Clinical outcomes

Flexion

Postoperative elbow flexion range were reported in three studies [27–29] involving 84 patients who underwent surgical treatment; 71 patients received conservative treatment. The surgical and non-surgical groups had postoperative flexion ranges of 134.8 and 132.7, respectively. There was no statistically significant difference between the two treatments (MD=0.16, 95% CI = [-5.26, 5.58], $P=0.95$), with high heterogeneity ($P=0.09$, $I^2=59\%$). The forest plot of flexion ranges is presented in Fig. 6.

Extension deficit

Postoperative elbow extension deficit range were reported in three studies [27–29] involving 84 patients who underwent surgical treatment; 71 patients received conservative treatment. The surgical and non-surgical groups had postoperative extension deficit ranges of 4.9 and 4.4, respectively. There was no statistically significant difference between the two treatments (MD=1.58, 95% CI = [-0.99, 4.16], $P=0.23$), with low heterogeneity ($P=0.31$, $I^2=15\%$). The forest plot of extension deficit ranges is presented in Fig. 7.

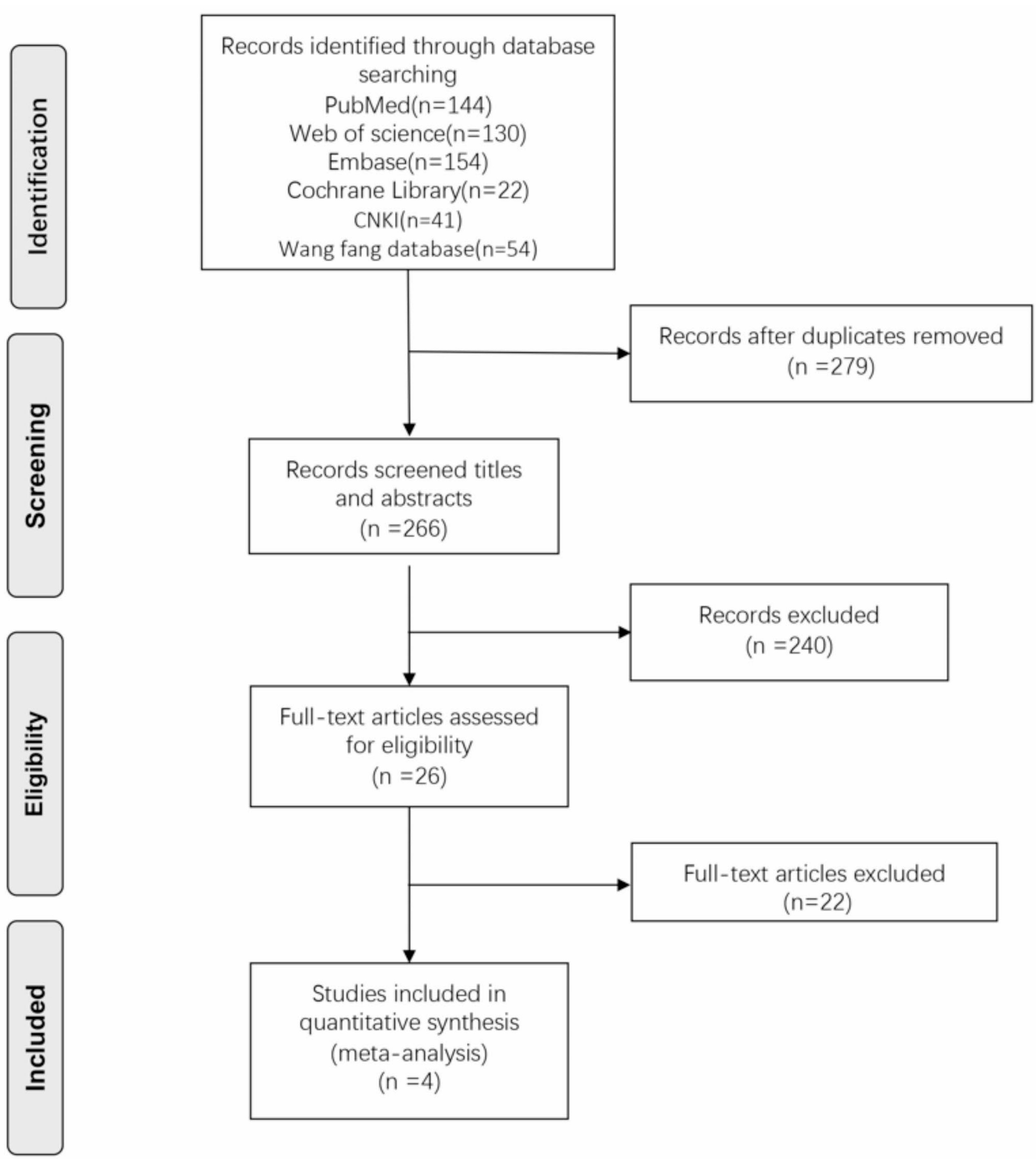

Fig. 1 Flow diagram of screening the included studies in the meta-analysis

Pronation

Postoperative elbow pronation range were reported in three studies [27–29] involving 84 patients who underwent surgical treatment; 71 patients received conservative treatment. The surgical and non-surgical groups had postoperative pronation ranges of 77.0 and 78.5, respectively. There was statistically significant difference between the two treatments (MD = -3.10, 95% CI = [-4.96, -1.25], P=0.001), with no heterogeneity (P=0.55, I^2=0%). The forest plot of pronation ranges is presented in Fig. 8.

Table 1 General characteristics of the included studies

Author and year	Country	study design	Treatment	Number	Age (years)	Male/female	Fracture to dominant side	Follow up (months)
Li 2023	China	RCS	Non-operative	58	37 (30–43)	22/36	36	27 (18–35)
			Operative	58	37 (29–50)	24/34	33	20 (17,30)
Mulders 2021	Netherlands	RCT	Non-operative	22	50.5 (43.3–54.3)	11/11	14	12
			Operative	23	50.0 (46.0–59.0)	9/14	10	
Glinski 2019	Germany	RCS	Non-operative	19	45.8 (18–64)	5/14	-	43.2 (9–16)
			Operative	31	42.6 (19–71)	19/12	-	
Yoon 2014	New Zealand	RCS	Non-operative	30	51 ± 17	9/21	14	36 ± 20.4
			Operative	30	39 ± 10	16/14	15	54 ± 21.6

RCS: Retrospective cohort study; RCT: randomized controlled trial.

Supination

Postoperative elbow supination range were reported in three studies [27–29] involving 84 patients who underwent surgical treatment; 71 patients received conservative treatment. The surgical and non-surgical groups had postoperative supination ranges of 76.9 and 77.3, respectively. There was no statistically significant difference between the two treatments (MD = -0.90, 95% CI = [-4.31, 2.50], P=0.60), with no heterogeneity (P=0.84, I^2=0%). The forest plot of supination ranges is presented in Fig. 9.

Total complications

Postoperative complication rates were reported in four studies [27–30] involving 142 patients who underwent surgical treatment; 129 patients received conservative treatment. In the surgical group, complications included elbow pain, wound infection, improper screw positioning, removal of the implants, heterotopic ossification, and hardware failure. In the non-surgical group, complications were primarily elbow pain and heterotopic ossification. The surgical and non-surgical groups had postoperative complication rates of 25% and 5.6%, respectively. There was statistically significant difference between the two treatments (MD=5.54, 95% CI = [1.79, 17.14], P=0.003), with no heterogeneity (P=0.42, I^2=0%). The forest plot of complication rates is presented in Fig. 10.

Elbow pain

Postoperative complication rates of postoperative elbow pain were reported in four studies [27–30] involving 142 patients who underwent surgical treatment; 129 patients received conservative treatment. The surgical and non-surgical groups had postoperative complication rates of postoperative elbow pain 4.2% and 6.9%, respectively. There was no statistically significant difference between the two treatments (MD=0.61, 95% CI = [0.22, 1.69], P=0.34), with no heterogeneity (P=0.89, I^2=0%). The forest plot of complication rates of postoperative elbow pain is presented in Fig. 11.

Discussion

The findings of this meta-analysis indicate no significant distinction between the two treatments in terms of the DASH, OES, MEPS, elbow flexion, elbow extension deficit, elbow supination and elbow pain. While our results showed a statistically significant difference favoring conservative treatment over operative treatment regarding elbow pronation (77 versus 78.5 degrees), this difference is small and unlikely to be clinically relevant. However, conservative treatment was superior in reducing the overall complication rate.

Our meta-analysis reveals no significant differences in functional outcomes between operative and conservative treatments as assessed by the DASH, OES, and MEPS scores. Specifically, average scores for conservative treatment were 12.5 for DASH, 42.4 for OES, and 91 for MEPS. These findings align with a systematic review by Lanzerath et al. [31], which reported a mean MEPS of 90.6 for the non-surgical cohort over a mean follow-up of 39 months, a mean Broberg and Morrey score of 94.4, and a 95.1% treatment success rate. In a prospective analysis by Duckworth et al. [32]. , 43 patients with non-operatively managed Mason II radial head fractures achieved excellent or good results in 96% of cases, evidenced by average scores of 6.1 on the DASH and 45.5 on the OES. Despite these generally positive outcomes, one patient did require surgery due to continued limitations in forearm rotation. Guzzini et al. [33]. demonstrated that 92.31% of 52 patients with Mason II radial head fractures, displaced 2 to 5 mm, achieved excellent outcomes as measured by the DASH score following conservative treatment; highly active athletes effectively regained mobility after two weeks of elbow immobilization without permanent stiffness. This suggests that satisfactory results can be obtained without surgical intervention. Our analysis revealed no significant differences between surgical and conservative treatments in elbow flexion,

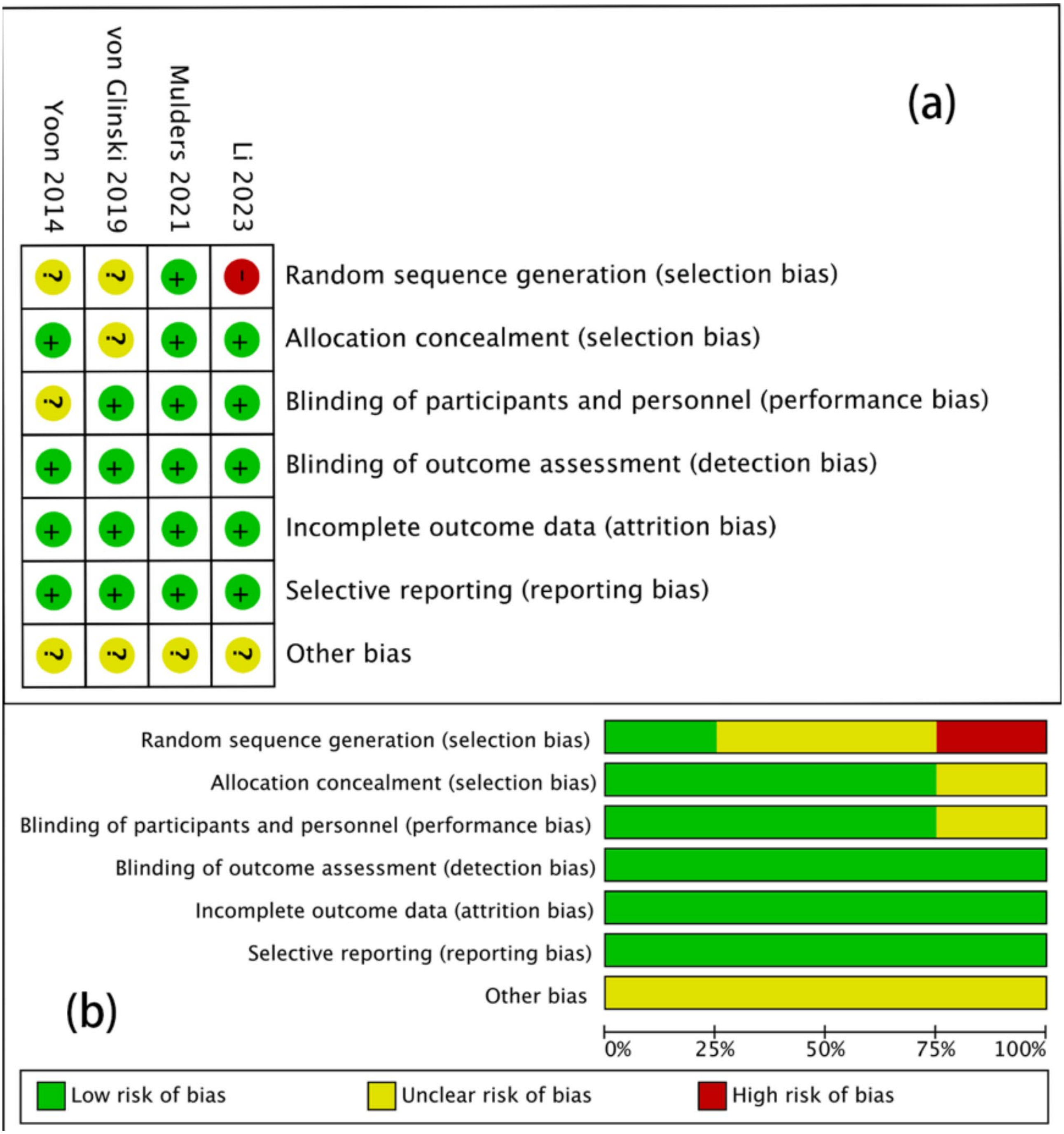

Fig. 2 Review authors' judgments about each risk of bias item for each included study. (a) Risk of bias summary; (b) risk of bias graph presented as percentages

extension deficit, and supination. Although a statistically significant difference was detected in elbow pronation, the minor difference in magnitude (77 versus 78.5 degrees) suggests it is not likely clinically meaningful. Additionally, the study showed that conservative treatment was more effective than surgical approaches in improving elbow joint pronation, a finding consistent with those reported by Mulders et al. [28]. The prognosis of radial head fractures is affected by several factors, including the patient's age and socioeconomic status, the type and comminution of the fracture, and the choice of management—whether operative or conservative [18, 34–36]. While it has traditionally been thought that surgical fixation is necessary for Mason type II fractures with displacements of 2 mm or greater, recent studies

Table 2 Quality assessment for the nine cohort studies according to Newcastle-Ottawa scale

Study	Year	S				C		E			Total score
		S1	S2	S3	S4	C1	C2	E1	E2	E3	
Li	2023	★	★	★	★	★	★	★	★	★	9
Glinski	2019	★	★	★	★	★	-	★	★	★	8
Yoon	2014	★	★	★	★	★	★	★	★	★	9

S selection, C comparability, E exposure. S1 representativeness of the exposed cohort, S2 selection of the nonexposed cohort, S3 ascertainment of exposure, S4 demonstration that outcome of interest was not present at start of study, C1 comparability of controls for the most important factor, C2 comparability of controls for a second important factor. E1 assessment of outcome, E2 was follow-up long enough for outcomes to occur, E3 adequacy of follow-up of cohorts.

have shown that these displacements do not inevitably lead to poor outcomes in non-operative settings [37].

In our study, the surgical group had comparable scores with an average DASH of 12.6, OES of 44.2, and MEPS of 91.2. Lanzerath et al. [31] corroborated these results in their study focused on Mason II radial head fractures, reporting similar functional scores and treatment success rates in patients treated with operative treatment. Zarattini et al. [38]. observed excellent long-term outcomes in patients with isolated Mason Type II radial head fractures, reporting an average DASH score of 2.81 and a Broberg and Morrey score of 95.09 over an average follow-up period of 125 months post-ORIF, with only a single case of postoperative osteoarthritis. In contrast, Khalfayan et al. [39]. compared nonoperative treatment with operative treatment in patients with Mason Type II radial head fractures, finding that more patients in the operative group had good or excellent MEPS outcomes. The systematic review by Kaas et al. [21]. specifically focused on Mason Type II radial head fractures and suggested that surgical treatments are more successful than non-surgical approaches for this fracture type. However, this evidence is less convincing due to the heterogeneity and lower quality of the retrospective studies included. Thus, the choice between conservative and surgical treatment remains contested, hindered by a lack of definitive, high-quality evidence. Surgical treatment often leads to favorable functional outcomes, yet conservative management is still a practical alternative, mainly when there is no substantial displacement or instability. Some studies have suggested that the primary indication for opting for operative treatment in isolated Mason type II fractures is the presence of a mechanical block to forearm rotation [6, 20, 34, 35, 40–43].

Our results showed that surgical treatment had a higher complication rate than conservative treatment, with the most common complications in the surgical group including wound infection, improper screw positioning, removal of implants, heterotopic ossification, and hardware failure. In contrast, the conservative treatment group primarily experienced complications such as heterotopic ossification and elbow pain. However, there was no significant difference in the incidence of elbow pain at the final follow-up between the two treatments. In a systematic review, Lanzerath et al. [31]. reported total complication rates for surgical and conservative treatment at 12.3% and 13.9%, respectively. This is inconsistent with our findings, which showed complication rates of 25% for surgical treatment and 5.6% for conservative treatment. While the short-term complications are important to consider, the long-term outcomes, particularly in terms of degenerative changes in the elbow, also play a crucial role in evaluating the effectiveness of different treatment approaches for Mason II radial head fractures. In

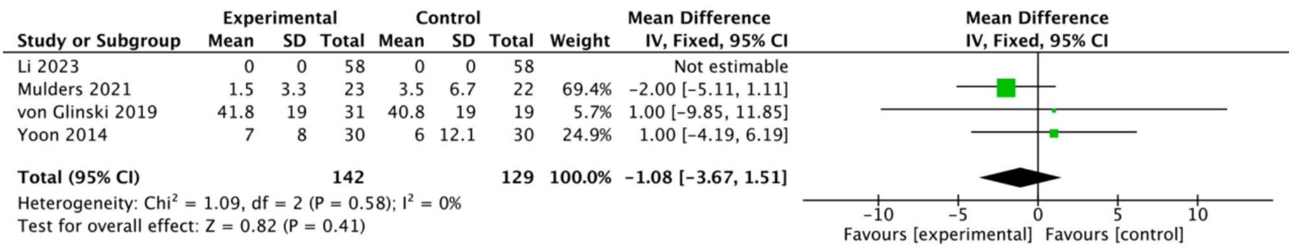

Fig. 3 DASH

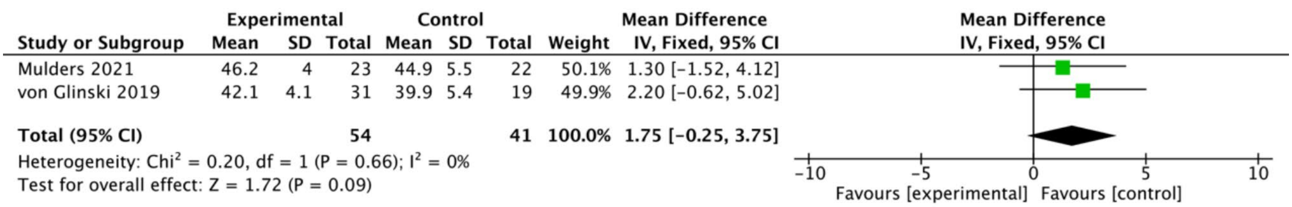

Fig. 4 OES

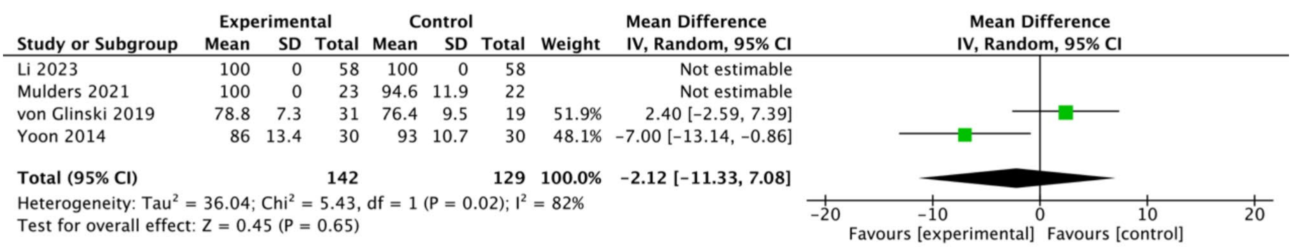

Fig. 5 MEPS

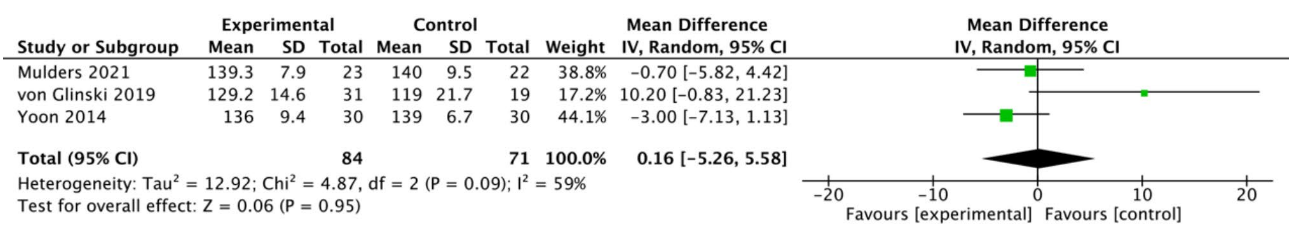

Fig. 6 Elbow flexion

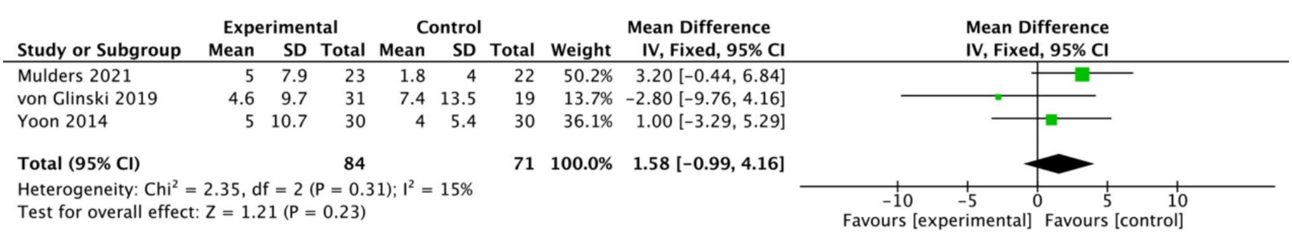

Fig. 7 Elbow extension deficit

their retrospective analysis, Akesson et al. [40]. reported that 82% of conservatively treated patients with Mason II radial head fractures experienced degenerative changes in their injured elbows, compared to only 21% in uninjured elbows. Nonetheless, these patients reported satisfactory functional outcomes and did not suffer from elbow discomfort. In a long-term study by Herbertsson et al. [44]. , 100 patients with Mason II and III-type fractures underwent surgical or conservative treatment. Nineteen years later, radiological examinations revealed

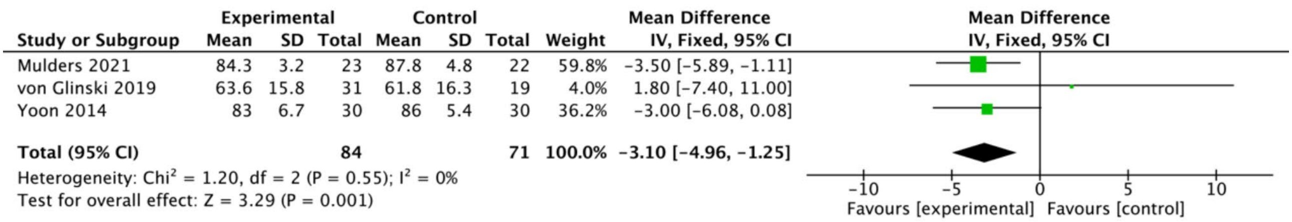

Fig. 8 Elbow pronation

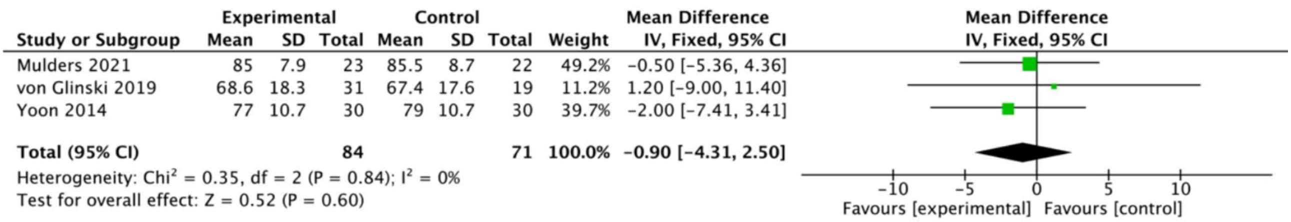

Fig. 9 Elbow supination

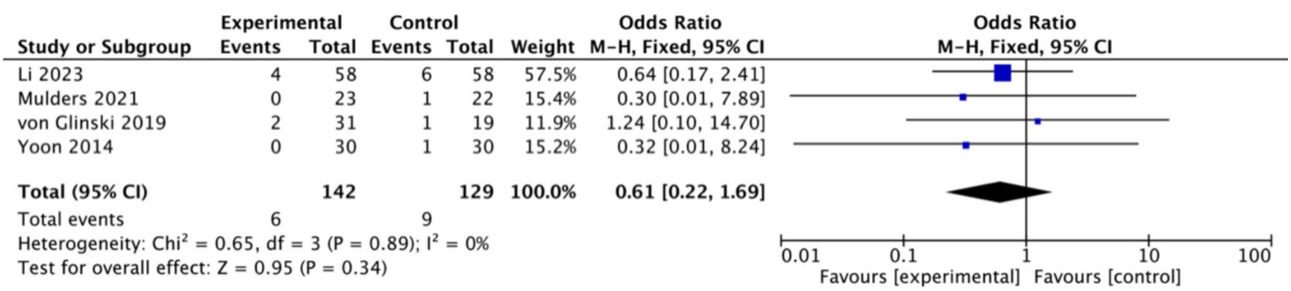

Fig. 10 Total complications

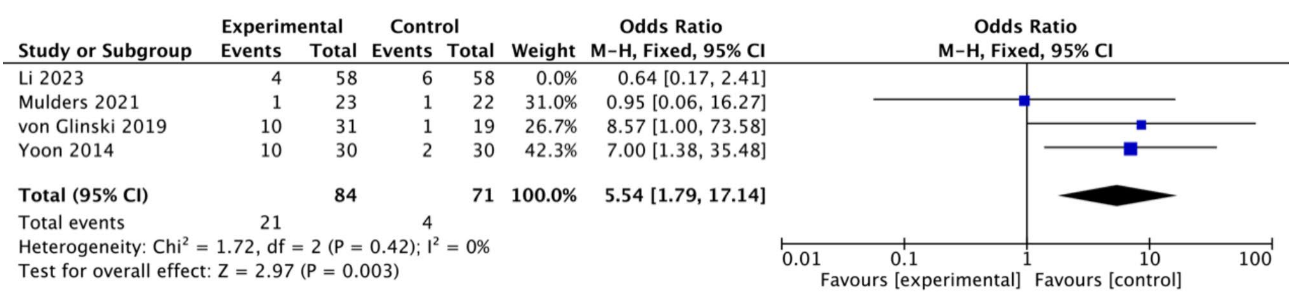

Fig. 11 Elbow pain

that 76% of the elbows had degenerative changes, though clinical symptoms were absent in 77% of these cases. The study concluded that radiological signs of degeneration in the elbow do not necessarily correlate with pain or restricted movement. Some retrospective studies have reported favorable outcomes with surgical intervention for displaced partial radial head fractures [38, 39, 45, 46]. Lindenhovius et al. [41]. observed minor degenerative changes in only 2 of 16 patients with operatively managed Mason type II radial head fractures after a follow-up period averaging 22 years. Lanzerath et al. [31]. found that osteoarthritis developed post-treatment in 11.9% of patients treated non-surgically, in contrast to 5.9% who received surgical intervention. Our findings suggest that while surgical treatment is associated with a higher complication rate in the short term, it may offer better long-term outcomes for patients with Mason Type II radial head fractures, particularly in reducing the risk of degenerative changes in the elbow. This indicates that surgical intervention could be preferable in younger, more active patients who have higher functional demands and are at risk for long-term joint degeneration.

Our meta-analysis also had some limitations. First, our study only included one RCT and did not include more randomized controlled studies of higher methodological quality. The quality and quantity of the studies included in our analysis impose limitations on the potential value of our meta-analysis. The level of available evidence will limit the value of the statistical analysis performed. This study suggests the need for conducting randomized controlled trials in a multicenter setting to obtain more definitive conclusions. Second, the meta-analysis included studies with varying length follow-up periods, which introduces a potential source of heterogeneity. These factors may impact the reliability and stability of the conclusions drawn from our meta-analysis.

Conclusion

Based on the current evidence, conservative management of isolated Mason II radial head fractures yields favorable therapeutic outcomes with a low incidence of complications.

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Author contributions

All authors contributed to the study's conception and design. Material preparation, data collection, and analysis were performed by Binzhi Zhao and Hanzhou Wang. The first draft of the manuscript was written by Binzhi Zhao and Hanzhou Wang. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval

Ethics approval was not required for this systematic review.

Informed consent

As this was a systematic review, data from individual participants was not obtained and will not be published.

Competing interests

The authors declare no competing interests.

Conflict of interest

The author declare that they have no potential conflict of interest.

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