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The treatment of isolated Mason type II radial head fractures: a systematic review

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Background: Fractures of the radial head represent the most common bony injury of the elbow in adults. Radial head fractures are classified according to Mason or one of its classification modifications. Current literature does not indicate consensus on whether to treat isolated stable type II radial head fracture patterns with open reduction and internal fixation (ORIF) or nonoperatively, especially, when there is no mechanical block to motion.

Methods: We systematically reviewed the available literature searching electronic databases, that is, MEDLINE using the PubMed interface and Embase, for studies published between 2011 and 2020. The primary objective was to contrast the outcome scores of these 2 different study groups and the pitfalls accompanied with the 2 different approaches. The PRISMA guidelines were applied.

Results: The literature search left 11 studies for inclusion, all but 1 retrospective in design, comprising 319 patients. A total of 218 patients (68.3%) were treated with ORIF and 101 patients (31.7%) were treated nonoperatively. Our findings indicate that ORIF does not provide better results when compared to nonoperatively treated patients concerning functional outcome parameters. Treatment success, defined as excellent or good results according to the Mayo Elbow Performance Score or the Broberg and Morrey score, among the patients treated with ORIF was 90.9%; 7.1% were in need of subsequent surgery and 5.2% had radiologic osteoarthritic changes of the radial column. In addition, 95.1% of the nonoperative cohort were treated successfully, and osteoarthritis was present in 11.9%. Mean follow-up period of the ORIF and the nonoperative cohort was 73 and 39 months, respectively.

Conclusion: ORIF and nonoperative treatment of isolated Mason type II radial head fractures provide comparably satisfactory functional outcomes, without significant differences. Consideration of age, activity level and potential risks is recommended before making any treatment decision. Subsequent surgery rates were higher for patients treated with ORIF than for those treated nonoperatively and should be discussed. However, development of osteoarthritis of the radial column appears to be more likely after nonoperative treatment. The study pool remains limited, and implications of this review should be handled with caution.

Level of evidence: Level IV; Systematic Review

Keywords: Radial head fractures; Mason type II; isolated; ORIF; nonoperatively; outcome; systematic review

"Radial head fractures patterns comprise approximately one-third of all elbow fractures in adults."[4,6,18] The injury mechanism is typically composed of an axial load transmitted to the lateral column trough an extended wrist and elbow: depending on the forearm rotation, different radial head fracture patterns occur.[12]

Radial head fractures are classified according to Mason or one of its classification modifications.[2,15,17,23,24,28] Historically, Mason described type II fractures as marginal sector fractures with displacement back in 1954.[23] In 1986, Broberg and Morrey defined type II fractures as fractures

Institutional review board approval was not required for this systematic review.

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with ≥2 mm displacement comprising ≥30% of the articular surface.[2] Hotchkiss further noted the possibility of a mechanical blockade of type II fractures in 1997, which plays a key role in treatment.[15]

There is a general agreement that type I fractures without a mechanical block to forearm rotation can be successfully treated nonoperatively with early mobilization.[14,21,29,30] Until now, there is no consensus on whether to treat different type II radial head fracture patterns without elbow dislocation or concomitant fractures with open reduction and internal fixation (ORIF) or nonoperatively, especially when there is no mechanical block to motion.[22,27]

A systematic review performed by Kaas et al[19] and published in 2012 found the success rates of operative treatment to be significantly higher than the success rates of nonoperatively treated patients. However, the authors concluded that the studies included in their systematic review contained too many variables, concerning, for example, follow-up period or outcome scores to allow treatment recommendations.

We decided to perform an updated systematic review to gain a more current and less variable-troubled picture on isolated Mason type II radial head fractures, its treatment, outcomes, and associated complications.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were applied.[25]

Inclusion criteria

The following criteria for inclusion were defined preliminarily: (1) fractures classified as isolated Mason type II radial head fractures, (2) published between 2011 and 2020 in (3) English or (4) German language providing (5) sufficient outcome data, the Mayo Elbow Performance Score (MEPS) or the Broberg and Morrey score, treated with (6) open reduction and internal fixation (ORIF) or (7) nonoperatively. Moreover, the criteria were applied to the studies previously included in the systematic review by Kaas et al.[19]

Exclusion criteria

(1) Biomechanical cadaveric studies, (2) anatomic descriptive studies, (3) patients suffering Mason type 1, 3, or 4 fractures, studies approaching the fractures (4) arthroscopically or with (5) bone grafting, and patients with (6) concomitant fractures or (7) elbow dislocations were excluded.

Search strategy

MEDLINE using the PubMed interface and EMBASE were searched for clinical studies using the MeSH terms *radial head*, *fracture*, *Mason type II*, *isolated*, *ORIF*, and *conservative* as key words. The search was completed on June 25, 2020.

Study selection

The studies identified were independently scanned by 2 reviewers (F.L. and T.L.). At this stage, the titles and abstracts were assessed for eligibility. Full texts of the records, which outlived this process, were analyzed. Full texts' reference lists were additionally analyzed and searched for further articles, regardless of the publication date. This procedure is illustrated in the PRISMA-adapted flow diagram (Fig. 1). Disagreement was resolved by consensus decision including a third reviewer (L.P.M.). Additionally, the studies included in the systematic review of Kaas et al,[19] which was published in 2011, were evaluated. However, only 3 of the 9 studies included in the systematic review of Kaas et al were eligible for inclusion because of insufficient follow-up/outcome data in 3 cases, no separately described results for each Mason type in 2 cases, and an arthroscopic approach in 1 case.

By this means, a total of 11 studies were suitable for inclusion.

Data extraction

The data of these 11 studies were extracted into prefabricated tables. The level of evidence was graded for each article included. Patients treated with ORIF were compared to patients treated conservatively. The primary objective was to contrast the outcome scores of these 2 different study groups. Type II adaptions of the original Mason classification were treated as Mason type II fractures, as previously handled in the review of Kaas et al.[19]

Statistics

Treatment success was statistically compared between the ORIF cohort and the nonoperative cohort using the chi-square test. The level of significance was defined as a P value of $<.05$ (SPSS; IBM, Armonk, NY, USA).

Results

Study selection

The initial search covered 191 publications published between 2011 and 2020. All but 1 study included were retrospective in design (level of evidence: IV), only the study of Prokop et al[26] was prospective. Removal of duplicates and exclusion of abstracts not fitting the inclusion criteria left 27 full texts for eligibility assessment. Nineteen were excluded. Reasons are outlined in the PRISMA-adapted flow diagram (Fig. 1). Eight publications were suitable for inclusion.[3,5,11,16,26,31-33] The studies included in the systematic review of Kaas et al[19] were supposed to be added; however, 6 of them were excluded because of reasons outlined in the PRISMA-adapted flow diagram. Three studies were suitable for inclusion.[9,10,20] Therefore, we included 11 studies.

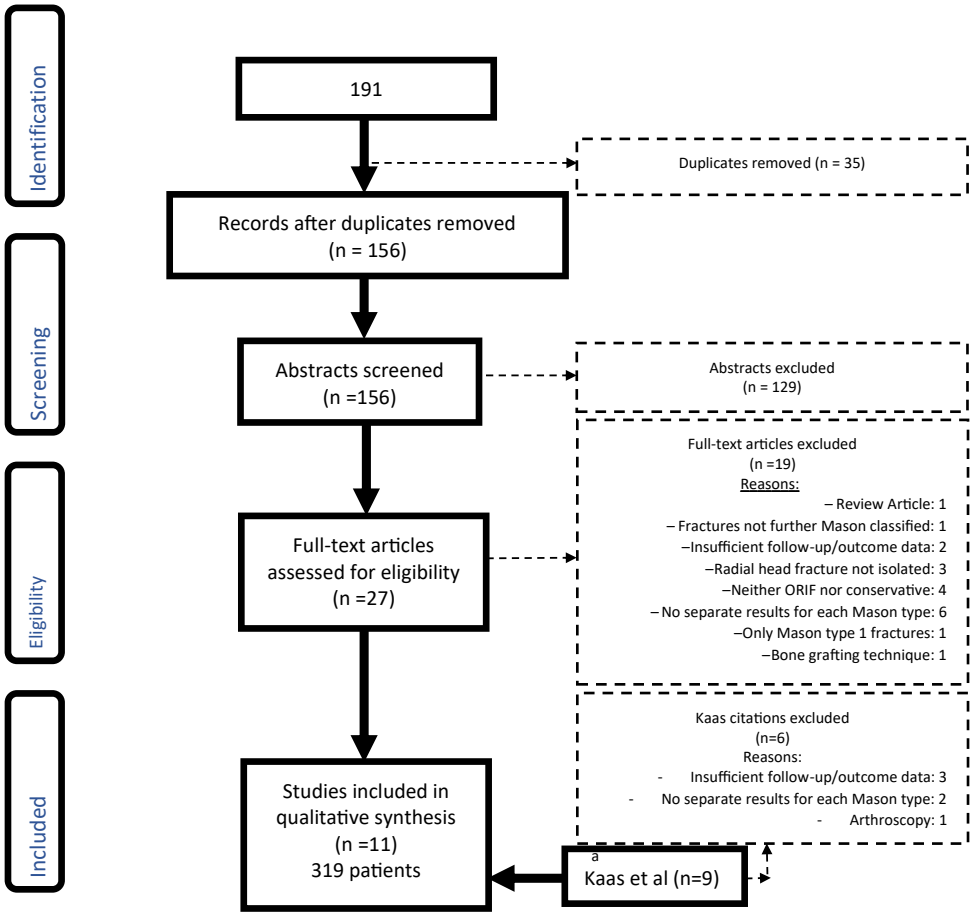

Figure 1 Study flow chart. *ORIF*, open reduction and internal fixation.

Study characteristics

The characteristics of the studies included are shown in Table I. The study cohort of the publications included was divided into 2 groups: ORIF and nonoperative treatment. Altogether, 218 patients (68.3%) were treated with ORIF and 101 patients (31.7%) were treated nonoperatively. Among the 218 patients treated with ORIF, the mean age was 40 years, mean follow-up was 73 months, and 59.4% of the patients treated were male. The exact radial head fixation method was available for 182 ORIF patients: 130 (71.4%) were treated with screws only, 31 (17%) with biodegradable pins, 10 (5.5%) with K-wires, 7 (3.8%) with screws and plate, and 4 (2.2%) with plates only. Among the 101 patients treated without surgical intervention, the mean age was 38 years, follow-up was 39 months, and the male proportion was 44.5%.

Functional outcomes

MEPS was reported in 134 patients treated with ORIF and in 101 conservatively treated patients and is shown in Table II and juxtaposed in Figure 2. The average MEPS of the ORIF cohort was 88.9 points, whereas the average MEPS of the nonoperative cohort was 90.6 points. Broberg and Morrey score was reported in 100 ORIF patients and in 52 conservatively treated patients. ORIF patients scored 94.6 points on average, and the nonoperative cohort scored 94.4 points on average. Excellent or good results concerning the MEPS or, in case publications did not provide the MEPS, the Broberg and Morrey score were rated as successful treatment as previously handled by Kaas et al[19] and Zwingmann et al.[34] The study by Von Glinski et al[31] only provided the average MEPS but no further information on the patients' individual MEPS (excellent, good, fair, or poor). Consequently, success rates of 187 ORIF patients and 82 conservative patients were extracted. Overall, 170 of the available 187 ORIF patients (90.9%) were treated successfully. Further, 78 of the available 82 conservative patients (95.1%) were treated successfully. Statistical analysis showed no significant difference between patients treated with ORIF and patients treated nonoperatively concerning treatment success ($P = .236$).

Table I Summary of the studies included

Treatment / First author (year)	Included patients (n)	Mean age, yr (range)	Mean FU, mo (range)	Gender, % male	Excluded patients (n)
ORIF					
Chwedczuk et al[3] (2016)	6	39 (21-75)*	34 (14-58)*	60.3*	57
Demiroglu et al[5] (2016)	23	35 (24-53)	26 (18-40)	60.0	0
Ertürer et al[9] (2010)	21	36 (25-58)	31 (11-80)	66.7	0
Givissis et al[10] (2008)	9	33 (19-47)	81 (36-136)	77.8	11
Iacobellis et al[16] (2012)	25	49 (26-71)	45 (12-95)	40.0	7
Lindenhovius et al[20] (2009)	16	39 (17-54)	264 (168-360)	56.3	0
Prokop et al[26] (2002)	22	44 (24-70)	41 (12-62)	54.5	13
Von Glinski et al[31] (2019)	31	43 (19-71)	46 (3-132)	61.3	0
Yoon et al[32] (2014)	30	39	54	53.3	0
Zarattini et al[33] (2012)	35	40	125	71.4	24
Total	**218**	**40**	**73**	**59.4**	
Nonoperative					
Guzzini et al[11] (2017)	52	28 (13-48)	36 (24-60)	59.6	0
Von Glinski et al[31] (2019)	19	46 (18-64)	53 (12-144)	26.3	0
Yoon et al[32] (2014)	30	51	36	30	0
Total	**101**	**38**	**39**	**44.5**	

ORIF, open reduction and internal fixation; *FU*, follow-up.
* Applies to the whole study population.

Complications

Among the 218 patients treated with ORIF, one study including 6 patients did not provide individual complications. The remaining 212 patients were in need of a subsequent operative treatment in 15 cases (7.1%), as shown in Table III. Common causes were arthrolysis in 6 cases and intra-articular screw removal in 5 cases. Of the patients treated operatively, 12.3% had complications not requiring further operative treatment, among them osteoarthritis, heterotopic ossification, screw failure, superficial infection, nerve palsy, and ankylosis. In the conservative group, no patient needed subsequent surgical treatment; however, 13.9% had complications, the most common being osteoarthritis. In addition, 5.2% of the patients treated with ORIF had signs of osteoarthritis compared with 11.9% of the patients treated nonoperatively.

Discussion

Fractures of the radial head cover approximately one-third of all fractures of the elbow; however, the optimal treatment protocol remains debatable for isolated Mason type II fractures.[22,27]

In 2012, Kaas et al[19] published a previous systematic review dealing with Mason type II fractures without associated fractures or diagnosed elbow dislocations. They included 9 retrospective studies involving 224 patients and defined successful treatment as an excellent or good result according to the Broberg and Morrey score, Mayo Elbow Performance Score, or Radin score.[19] They found successful treatment to be significantly higher in patients treated with ORIF (93%) than nonoperatively (80%); however, they could not draw firm conclusions because of the heterogeneity of the publications included.

In our current systematic review, the inclusion and exclusion criteria only allowed to include 3 of the 9 studies previously analyzed by Kaas et al.[19] The reasons were insufficient follow-up or outcome data in 3 cases, the incomplete provision of results for each Mason fracture type in 2 cases, and an arthroscopic approach in 1 case. Consequently, 11 studies were left for inclusion.

Many authors postulate that a mechanical block to forearm rotation is the only clear indication for ORIF in isolated Mason type II fractures without elbow dislocation and a fracture displacement of more than 2 mm but less than or equal to 5 mm.[7,20,27] Zarattini et al[33] treated 35 patients with a mechanical block to joint movement with ORIF. After a mean follow-up period of 125 months, the mean Broberg and Morrey score was 95.1 points, with 32 patients scoring excellent, 2 patients scoring good, and 1 patient scoring fair. One patient needed subsequent surgery because of an intra-articular screw removal. However, if no mechanical block to forearm rotation is present, the treatment indication remains debatable.[22,27]

This systematic review provides the hypothesis that both, ORIF and conservative treatment can equally provide satisfactory outcomes for isolated Mason type II fractures on the basis of a synthesis of more homogenous study protocols than previously available.

Contrary to the publication of Kaas et al,[19] our findings indicate that the ORIF cohort is not even statistically

Table II Summary of the functional outcome scores

Treatment / First author (year)	Patients (n)	Outcome good-excellent	Mean MEPS	Mean Broberg and Morrey score	Mean DASH/qDASH score (range)
ORIF					
Chwedczuk et al[3] (2016)	6	6/6	NA	99 points (6 excellent)	qDASH: 1.2 points
Demiroglu et al[5] (2016)	23	23/23	95.9 (90-100) points (23 excellent)	NA	qDASH: 1.38 (0-9.1) points
Ertürer et al[9] (2010)	21	19/21	NA	93.4 (73-100) points (13 excellent, 6 good, 2 fair)	NA
Givissis et al[10] (2008)	9	8/9	90.5 (20-100) points (8 excellent, 1 poor)	NA	NA
Iacobellis et al[16] (2012)	25	25/25	98.4 (85-100) points (23 excellent, 2 good)	NA	DASH: 6.8 (0-38.8) points
Lindenhovius et al[20] (2009)	16	13/16	89 (55-100) points (9 excellent, 4 good, 2 fair, 1 poor)	91 (62-100) points (7 excellent, 6 good, 3 fair)	DASH: 12 (0-52) points
Prokop et al[26] (2002)	22	21/22	NA	96.5 (67-100) points (20 excellent, 1 good, 1 poor)	NA
von Glinski et al[31] (2019)	31	NA	78.4 (65-95) points	NA	DASH: 35.9 (22-100) points
Yoon et al[32] (2014)	30	21/30	86 (80-90) points (11 excellent, 10 good, 9 fair)	NA	qDASH: 7 (4-10) points
Zarattini et al[33] (2012)	35	34/35	NA	95.1 points (32 excellent, 2 good, 1 fair)	DASH: 2.8 points
Total		**170/187**	**88.9**	**94.6**	
Nonoperative					
Guzzini et al[11] (2017)	52	50/52	94.5 (65-100) points (42 excellent, 8 good, 2 fair)	94.4 (64-100) points (40 excellent, 9 good, 3 fair)	DASH: 12.4 (0-46) points
Von Glinski et al[31] (2019)	19	NA	75.9 (60-95) points	NA	DASH: 32.3 (25-95) points
Yoon et al[32] (2014)	30	28/30	93 (89-97) points (19 excellent, 9 good, 2 fair)	NA	qDASH: 6 (2-11) points
Total		**78/82**	**90.6**	**94.4**	

ORIF, open reduction and internal fixation; *NA*, not available; *MEPS*, Mayo Elbow Performance Score; *DASH*, Disabilities of the Arm, Shoulder, and Hand; *qDASH*, Quick DASH.

superior to the nonoperatively treated patients, concerning functional outcome parameters.

In the present systematic review, the ORIF cohort had an average MEPS of 88.9 points and an average Broberg and Morrey score of 94.6 points, and treatment was successful in 90.9% after a mean follow-up of 73 months.

On the other hand, the nonoperative cohort, consisting of 3 studies and followed up after 39 months on average, was evaluated with an average MEPS of 90.6 points and an average Broberg and Morrey score of 94.4 points, and the treatment was successful in 95.1%. Guzzini et al[11] reported functional outcome for 52 patients with 2-5 mm displaced isolated Mason type II fractures. Immobilization comprised a long arm cast for 2 weeks with the elbow in 90° flexion and the forearm in neutral rotation and was followed by active and passive elbow and forearm movement. Von Glinski et al[31] described nonoperative treatment of 19 isolated Mason type II fractures with 2-5 mm displacement. Patients were immobilized for 3-5 days and subsequently mobilized unrestricted. Yoon et al[32] treated 30 isolated 2-5-mm displaced fractures conservatively and encouraged patients to begin active motion exercises within 1 week after injury. In this study, noticeably, the mean MEPS of the patients treated nonoperatively was significantly higher, statistically. A margin of approximately 20 points (75.9-94.5 points) among the conservative cohort concerning

Treatment / First author (year)	Mean MEPS	Mean BM score
ORIF		
Chwedczuk et al[3] (2016)	-	99
Demiroglu et al[5] (2016)	95.9	-
Ertürer et al[9] (2010)	-	93.4
Givissis et al[10] (2008)	90.5	-
Iacobellis et al[16] (2012)	98.4	-
Lindenhovius et al[20] (2009)	89	91
Prokop et al[26] (2002)	-	96.5
von Glinski et al[31] (2019)	78.4	-
Yoon et al[32] (2014)	86	-
Zarattini et al[33] (2012)	-	95.1
Nonoperative		
Guzzini et al[11] (2017)	94.5	94.4
von Glinski et al[31] (2019)	75.9	-
Yoon et al[32] (2019)	93	-

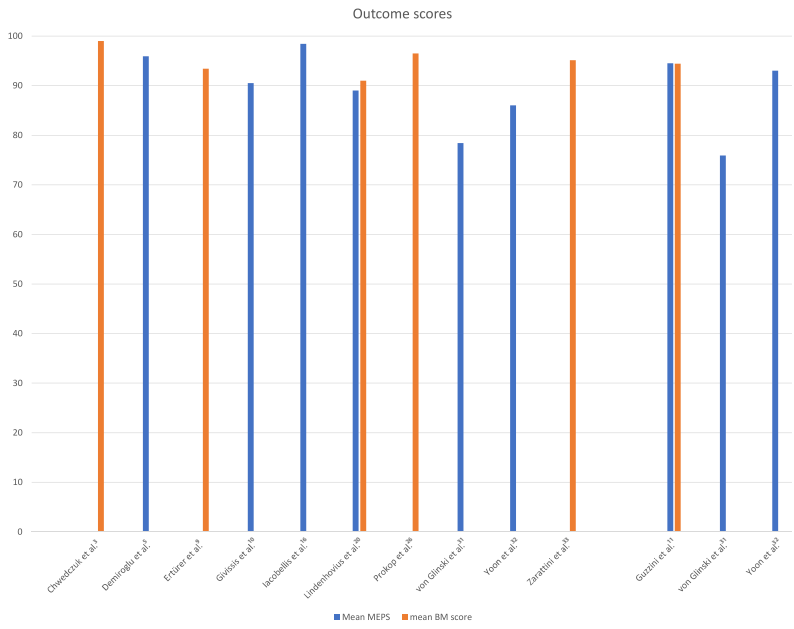

Figure 2 Graphic comparison of the functional outcome scores. *MEPS*, Mayo Elbow Performance Score; *BM*, Broberg and Morrey score.

mean outcome scores of the 3 separate studies included may be noted.

The excellent functional results after conservative treatment are supported by satisfactory outcome scores, which were reported for similar fractures in various other case series not included in this systematic review as they did not provide one of the demanded outcome scores.[1,8] It is also remarkable that only approximately 40% of the patients treated with ORIF but approximately 55% of the patients treated nonoperatively were female.

Aside from outcome scores, the occurrence of complications was evaluated. A subsequent operative treatment rate of 7.1% among patients treated with ORIF should be discussed, given that the conservative cohort needed none. However, the overall complication rates were similar (12.3%, ORIF vs. 13.9%, nonoperative).

This trend is shown in the study by Yoon et al,[32] which compared isolated Mason type II fractures treated nonoperatively (n = 30) with those treated with ORIF (n = 30). They found that complications predominate in the operative group: 33.3% of the patients treated with ORIF had complications (8 heterotopic ossification, 2 screw failure), this was countered by a 6.7% complication rate for patients treated nonoperatively (1 heterotopic ossification, 1 complex regional pain syndrome). Nevertheless, the follow-up period of those treated with ORIF (54 months) compared to the follow-up period of those treated nonoperatively (36 months) might be a confounder in this study.

Complications include radiographic appearance of osteoarthritic changes of the radial column. Despite the longer follow-up period of patients treated with ORIF, the rate of osteoarthritic changes was more than 100% higher in the nonoperative group: Among the patients treated nonoperatively, 11.9% had signs of osteoarthritis, in contrast, osteoarthritic changes were only visible in 5.9% of patients treated with ORIF. The average follow-up of 3-6 years is rather short, and long-term studies are required. However, based on these figures, ORIF might be recommended for young, active patients with high physical demands. This finding is in accordance with long-term follow-up publications not included in this systematic review: in the study of Akesson et al,[1] 28 of 34 patients showed degenerative changes radiographically after nonoperative treatment and a mean follow-up period of 19 years (range 41-43). Herbertsson et al[13] published a long-term study on 100 simple Mason type II and III fractures. Although the prevalence of degenerative changes in the injured elbows amounted to 76% after a mean follow-up of 19 years, 77% showed no clinical symptoms. Therefore, radiologic osteoarthritic changes do not necessarily imply clinical consequences.

Furthermore, the treatment of concomitant instabilities must be considered. For instance, Von Glinski et al[31] compared 31 patients treated with ORIF with 19 patients treated nonoperatively. Although mean outcome scores were similar and subsequent surgery was necessary in 10 patients treated with ORIF, concerning persistent instabilities, the authors found significantly more instabilities in the nonoperative group (n = 5) than in the ORIF cohort (n = 1).

Limitations of this systematic review include the retrospective design of all but 1 of the studies included,

Table III Summary of the complications

Treatment / First author (year)	Patients, n	Subsequent operative treatment	Complications not requiring further reoperation: no. and cause
ORIF			
Chwedczuk et al[3] (2016)	6	NA	NA
Demiroglu et al[5] (2016)	23	0	0
Ertürer et al[9] (2010)	21	0	1 OA
Givissis et al[10] (2008)	9	1 soft tissue release and HO removal (flexion contracture)	1 superficial infection (resolved)
Iacobellis et al[16] (2012)	25	0	1 HO
Lindenhovius et al[20] (2009)	16	1 irrigation, debridement, and parenteral antibiotics (deep infection)	1 superficial infection
		2 intra-articular screws	2 OA (2 grade 1)*
			1 transient posterior interosseous nerve palsy
Prokop et al[26] (2002)	22	0	1 ankylosis
Von Glinski et al[31] (2019)	31	2 intra-articular screws	6 OA
		6 arthrolysis	
		2 implant removals	
Yoon et al[32] (2014)	30	0	8 HO
			2 screw failures
Zarattini et al[33] (2012)	35	1 intra-articular screw	2 OA (2 grade 1)*
Total	**212**	**7.1%**	**12.3%**
Nonoperative			
Guzzini et al[11] (2017)	52	0	6 OA
Von Glinski et al[31] (2019)	19	0	6 OA
Yoon et al[32] (2014)	30	0	1 complex regional pain sydrome
			1 HO
Total	**101**	**0%**	**13.9%**

ORIF, open reduction and internal fixation; *NA*, not available; *HO*, heterotopic ossification; *OA*, osteoarthritis.
* According to the Broberg and Morrey score.

the lack of prospective randomized controlled studies comparing therapies, and the divergence of follow-up period among the ORIF cohort (73 months) and the nonoperative cohort (39 months). Particularly, the study of Von Glinski et al[31] should be viewed with caution as it did not provide the individual patient's MEPS. Concerning the nonoperative patient data, this limitation effects approximately 20% (19 of 101) and could potentially imply a distortion of the functional outcome scores. Chwedczuk et al[3] only provided age, follow-up, and gender, applying to the whole study population (n = 63); however, only 6 patients were suitable for inclusion. Therefore, the provided values are at most an approximation. Nevertheless, this systematic review provides an updated survey of the current literature and may shift attention to issues rather missed out until now.

Conclusion

Both ORIF and nonoperative treatment of isolated Mason type II radial head fractures provide comparably satisfactory outcomes. No statistically significant differences concerning treatment success among patients treated with ORIF or nonoperatively were observed. Treatment decision requires individual consideration of age, activity level, and potential risks. Higher rates of subsequent operative treatment among patients treated with ORIF should be discussed. However, osteoarthritis of the radial column appears to be more likely after nonoperative treatment. The study pool remains limited, and implications of this review should be handled with caution as prospective randomized controlled trials are lacking as of this writing.

Disclaimer

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References

1. Akesson T, Herbertsson P, Josefsson PO, Hasserius R, Besjakov J, Karlsson MK. Primary nonoperative treatment of moderately displaced two-part fractures of the radial head. J Bone Joint Surg Am 2006;88:1909-14. https://doi.org/10.2106/JBJS.E.01052
2. Broberg MA, Morrey BF. Results of delayed excision of the radial head after fracture. J Bone Joint Surg Am 1986;68:669-74.
3. Chwedczuk B, Piekarczyk P, Kwiatkowski K, Piątkowski K. Surgical treatment of radial head fractures: outcomes and complications. Ortop Traumatol Rehabil 2016;18:435-44. https://doi.org/10.5604/15093492.1224617
4. Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. Injury 2006;37:691-7. https://doi.org/10.1016/j.injury.2006.04.130
5. Demiroglu M, Ozturk K, Baydar M, Kumbuloglu OF, Sencan A, Aykut S, et al. Results of screw fixation in Mason type II radial head fractures. SpringerPlus 2016;5:545. https://doi.org/10.1186/s40064-016-2189-2
6. Duckworth AD, Clement ND, Jenkins PJ, Aitken SA, Court-Brown CM, McQueen MM. The epidemiology of radial head and neck fractures. J Hand Surg 2012;37:112-9. https://doi.org/10.1016/j.jhsa.2011.09.034
7. Duckworth AD, McQueen MM, Ring D. Fractures of the radial head. Bone Joint J 2013;95-B:151-9. https://doi.org/10.1302/0301-620X.95B2.29877
8. Duckworth AD, Wickramasinghe NR, Clement ND, Court-Brown CM, McQueen MM. Long-term outcomes of isolated stable radial head fractures. J Bone Joint Surg 2014;96:1716-23. https://doi.org/10.2106/JBJS.M.01354
9. Ertürer E, Seçkin F, Akman S, Toker S, Sari S, Oztürk I. The results of open reduction and screw or K-wire fixation for isolated type II radial head fractures. Acta Orthop Traumatol Turc 2010;44:20-6. https://doi.org/10.3944/AOTT.2010.2234
10. Givissis PK, Symeonidis PD, Ditsios KT, Dionellis PS, Christodoulou AG. Late results of absorbable pin fixation in the treatment of radial head fractures. Clin Orthop 2008;466:1217-24. https://doi.org/10.1007/s11999-008-0134-6
11. Guzzini M, Vadalà A, Agrò A, Di Sanzo V, Pironi D, Redler A, et al. Nonsurgical treatment of Mason type II radial head fractures in athletes. A retrospective study. Il G Chir 2017;37:200-5. https://doi.org/10.11138/gchir/2016.37.5.200
12. Harrison JWK, Chitre A, Lammin K, Warner JG, Hodgson SP. Radial head fractures in adults. Curr Orthop 2007;21:59-64. https://doi.org/10.1016/j.cuor.2006.10.003
13. Herbertsson P, Josefsson PO, Hasserius R, Karlsson C, Besjakov J, Karlsson M. Uncomplicated Mason type-II and III fractures of the radial head and neck in adults. A long-term follow-up study. J Bone Joint Surg Am 2004;86:569-74. https://doi.org/10.2106/00004623-200403000-00016
14. Herbertsson P, Josefsson PO, Hasserius R, Karlsson C, Besjakov J, Karlsson MK. Displaced Mason type I fractures of the radial head and neck in adults: a fifteen- to thirty-three-year follow-up study. J Shoulder Elbow Surg 2005;14:73-7. https://doi.org/10.1016/j.jse.2004.07.001
15. Hotchkiss RN. Displaced fractures of the radial head: internal fixation or excision? J Am Acad Orthop Surg 1997;5:1-10.
16. Iacobellis C, Visentin A, Aldegheri R. Open reduction and internal fixation of radial head fractures. Musculoskelet Surg 2012;96:81-6. https://doi.org/10.1007/s12306-012-0186-3
17. Johnston GW. A follow-up of one hundred cases of fracture of the head of the radius with a review of the literature. Ulster Med J 1962;31:51-6.
18. Kaas L, van Riet RP, Vroemen JPAM, Eygendaal D. The epidemiology of radial head fractures. J Shoulder Elbow Surg 2010;19:520-3. https://doi.org/10.1016/j.jse.2009.10.015
19. Kaas L, Struijs PAA, Ring D, van Dijk CN, Eygendaal D. Treatment of Mason type II radial head fractures without associated fractures or elbow dislocation: a systematic review. J Hand Surg 2012;37:1416-21. https://doi.org/10.1016/j.jhsa.2012.03.042
20. Lindenhovius ALC, Felsch Q, Ring D, Kloen P. The long-term outcome of open reduction and internal fixation of stable displaced isolated partial articular fractures of the radial head. J Trauma 2009;67:143-6. https://doi.org/10.1097/TA.0b013e31818234d6
21. Liow RYL, Cregan A, Nanda R, Montgomery RJ. Early mobilisation for minimally displaced radial head fractures is desirable: a prospective randomised study of two protocols. Injury 2002;33:801-6. https://doi.org/10.1016/S0020-1383(02)00164-X
22. Martin DP, Wilt ZT, Cantlon MB, Wang ML. Controversies surrounding the management of the isolated type-II radial-head fracture. JBJS Rev 2017;5:e3. https://doi.org/10.2106/JBJS.RVW.17.00010
23. Mason ML. Some observations on fractures of the head of the radius with a review of one hundred cases. Br J Surg 1954;42:123-32.
24. McKee MD, Jupiter JB. A contemporary approach to the management of complex fractures of the distal humerus and their sequelae. Hand Clin 1994;10:479-94.
25. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. Int J Surg 2010;8:336-41. https://doi.org/10.1016/j.ijsu.2010.02.007
26. Prokop A, Jubel A, Helling HJ, Udomkaewkanjana C, Brochhagen HG, Rehm KE. [New biodegradable polylactide implants (Polypin-C) in therapy for radial head fractures]. Chirurg 2002;73:997-1004. https://doi.org/10.1007/s00104-002-0545-y [in German].
27. van Riet R, van den Bekerom M, Van Tongel A, Spross C, Barco R, Watts A. Radial head fractures. Shoulder Elb 2020;12:212-23. https://doi.org/10.1177/1758573219876921
28. van Riet RP, Morrey BF. Documentation of associated injuries occurring with radial head fracture. Clin Orthop 2008;466:130-4. https://doi.org/10.1007/s11999-007-0064-8
29. Struijs PAA, Smit G, Steller EP. Radial head fractures: effectiveness of conservative treatment versus surgical intervention. Arch Orthop Trauma Surg 2007;127:125-30. https://doi.org/10.1007/s00402-006-0240-4
30. Unsworth-White J, Koka R, Churchill M, D'Arcy JC, James SE. The non-operative management of radial head fractures: a randomized trial of three treatments. Injury 1994;25:165-7.
31. Von Glinski A, Rausch V, Königshausen M, Dudda M, Schildhauer TA, Seybold D, et al. Instabilität nach operativer und konservativer Versorgung von isolierten Mason-II-Frakturen. Unfallchirurg 2019;122:219-24. https://doi.org/10.1007/s00113-018-0504-9
32. Yoon A, King GJW, Grewal R. Is ORIF superior to nonoperative treatment in isolated displaced partial articular fractures of the radial head? Clin Orthop 2014;472:2105-12. https://doi.org/10.1007/s11999-014-3541-x
33. Zarattini G, Galli S, Marchese M, Mascio LD, Pazzaglia UE. The surgical treatment of isolated Mason type 2 fractures of the radial head in adults: comparison between radial head resection and open reduction and internal fixation. J Orthop Trauma 2012;26:229-35. https://doi.org/10.1097/BOT.0b013e318220a227
34. Zwingmann J, Welzel M, Dovi-Akue D, Schmal H, Südkamp NP, Strohm PC. Clinical results after different operative treatment methods of radial head and neck fractures: a systematic review and meta-analysis of clinical outcome. Injury 2013;44:1540-50. https://doi.org/10.1016/j.injury.2013.04.003