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Internal *vs*. External Fixation for the Treatment of Closed Unstable Distal Radial Fractures in elderly: A Meta-Analysis of Clinical Trials

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Abstract

Background: Distal Radial Fractures (DRFs) in the elderly are common, and Open Reduction and Internal Fixation (ORIF) and External Fixation (EF) are the two main treatments. Our primary aim was to assess the clinical effectiveness of the two interventions in the elderly (≥ 65 years).

Methods: We performed a comprehensive search of PubMed, EMBASE and the Cochrane Library until February 31st, 2022. Studies were included if they investigated internal and external fixation for distal radial fractures in the elderly. The primary outcomes were Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient Rated Wrist Evaluation (PRWE) score, grip strength and complications, and secondary outcomes were functional and radiological assessments. Data were synthesized, and weighted mean difference with 95% Confidence Interval (CI) were calculated.

Results: Nine studies with a total of 569 patients in internal fixation groups and 576 patients in external fixation groups were included in the analysis. There were no significant differences in DASH score, PRWE score, grip strength, and incidence of total complications. No significant differences in functional assessment (including extension, flexion, pronation, supination, radial deviation, and ulnar deviation) were noted between two groups. As to radiological assessment, ORIF yielded significant better radial height, radial inclination and volar tilt, and less radial variance than patients in the EF group.

Conclusion: ORIF and EF produce similar results in the treatment of DRFs in the elderly, and minor objective radiological assessment did not result an impact on subjective function outcomes. These findings indicate that EF treatment might be more suitable for the treatment of DRFs in the elderly with respect to reducing postoperative complications and economic burden into medical cost.

Keywords: Distal radial fractures; Open reduction and internal fixation; External fixation; Elderly

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Introduction

As a result of the rapid development of medical technology and a longer life expectancy, the elderly have become the fastest growing subpopulation. Distal Radial Fractures (DRFs) are one of the most common fractures, accounting for up to 18% of all fractures in the elderly [1]. Moreover, DRFs are among the most common fractures in hospital emergency departments, and the incidence has increased over the past decades [2]. Several treatment modalities have been advocated, and clinical decision-making is mainly based on fracture type. The two most common treatments for DRFs are nonoperative External Fixation (EF), using closed reduction and cast immobilization, and operative Open Reduction Internal Fixation (ORIF). Operative treatment offers early clinical benefits, including better fracture realignment and earlier recovery of function, however, longer-term outcomes remain unclear. Until recently, surgical treatment for DRFs among the elderly population has not been proven to be superior to closed reduction and cast immobilization [3-5]. Therefore, the optimal management in elderly patients remains controversial.

Stable fractures can be treated with closed reduction and cast immobilization, and the early efficacy is satisfactory [6]. Many patients with displaced DRFs that were sufficiently reduced undergo non-surgical management of closed reduction and cast immobilization. For displaced and unstable fractures, closed reduction and cast immobilization cannot be maintained with external immobilization and additional fixation is recommended [7]. There has been a trend to manage DRFs in elderly patients with volar locking plate [8] and the rate of operative treatment in the elderly has gradually increased over the past few decades [9]. Previous studies supported early clinical benefits in patients undergoing surgery [3,4,10-12]. However, short- and mid-term clinical outcomes show no difference between those treated surgically and those treated non-surgically [3,4,10-12]. Clinical trials with multiple outcomes in the elderly population have shown that the best available evidence for operative versus nonoperative management of DRFs in the elderly was inconclusive, and the consensus statement has not been reached. Some studies have shown that ORIF yields better benefits than closed reduction and cast immobilization [13-15], while others have demonstrated similar outcomes [3,4,10-12,16,17].

Since the optimal management of DRFs in the elderly remains uncertain, we aimed to perform a systematic review and meta-analysis comparing the outcomes of operative and nonoperative management of DRFs in elderly patients (aged ≥ 65 years old).

Materials and Methods

Literature search strategy

This meta-analysis was conducted in accordance with PRISMA guidelines. PUMED, EMBASE, and Cochrane databases were searched until February 31st, 2022 using combinations of the following search terms: ((distal radius) OR (distal radial)) AND ((fracture) OR (fractures)) AND ((external fixation) OR (external fixator) OR (plate) OR (plating)) AND ((elderly) or (old)). The search performance was completed by two co-authors independently.

Eligibility criteria

Studies were selected for inclusion in the analysis based on the following criteria: (1) compared outcomes between nonsurgical and surgical treatment of DRFs; (2) Randomized Controlled Trial (RCT), comparative prospective, or retrospective study; (3) patients aged 65 years or older; and (4) reported quantitative clinical or radiological outcomes. Case reports, letters, review, comments, editorials, protocols and non-English publications were excluded. Articles that did not specify the type of conservative or surgical treatment were also excluded. Studies were identified by the search strategy by two co-authors independently. When there was uncertainty regarding eligibility, a third author was consulted.

Data extraction

The analysis data were extracted from included studies that met the inclusion criteria. The data items included the name of the first author, year of publication, study type, number of participants, participants' age and gender, interventions, fractures classification, Disabilities of the Arm, Shoulder and Hand (DASH) score, Patient Rated Wrist Evaluation score (PRWE) score, grip strength and complications, functional assessment by ranges of wrist extension, flexion, pronation, and supination, and radial and ulnar deviation, and radiological assessments by radial height, radial inclination, ulnar variance and volar tilt.

Quality assessment

Quality assessment was performed for prospective studies by two independent co-authors using the Cochrane Risk of Bias Tool provided by the online software Cochrane Review Manager 5.4.

Data analysis

The primary outcomes included DASH score, PRWE score, grip strength and complications, while functional and radiological assessments were considered as secondary outcomes. Data were synthesized and analyzed using the software program RevMan 5.4. Heterogeneity among the studies was assessed by the Cochran Q and the I^2 statistics. If the values of I^2 were <30% which indicates low heterogeneity, we used the fixed effects model to pool data, otherwise the random effects model was used. Pooled standard differences in means of the outcomes with 95% Confidence Intervals (CIs) were calculated, and a two-sided value of P<0.05 was considered statistically significant.

Results

Study characteristics and quality assessments

A flow diagram of study selection is shown in Figure 1. Finally, 9 articles [3,4,10-12,15,18-20] were eventually included in the meta-analysis, and the characteristics of included studies are summarized in Table 1.

Quality assessments were performed for studies included in the meta-analysis (Table S1). All the studies have reported the expected the outcomes with complete follow-ups.

Primary endpoints

Seven studies reported DASH scores and were included in the analysis. Significant heterogeneity was detected when the data from these studies were pooled (I^2=53%), therefore, a random-effects model of analysis was used (Figure 2A). No significant difference in DASH scores between the ORIF and EF groups was noted (pooled standard difference in means = −0.20, 95% CI [−1.40, 1.00], P=0.74).

Three studies reported PRWE scores and were included in the analysis. Significant heterogeneity was detected when the data from these studies were pooled (I^2=70%), therefore, a random-effects model of analysis was used (Figure 2B). There was no significant difference in PRWE scores between the ORIF and EF groups (pooled standard difference in means = −2.95, 95% CI [−8.40, 2.50], P=0.29).

Six studies reported Grip strength and were included in the analysis. Significant heterogeneity was detected when the data from these studies were pooled (I^2=88%), therefore, a random-effects model of analysis was used (Figure 2C). Similarly, no significant difference in PRWE scores between the ORIF and EF groups was observed (pooled standard difference in means = 6.13, 95% CI [−2.88,

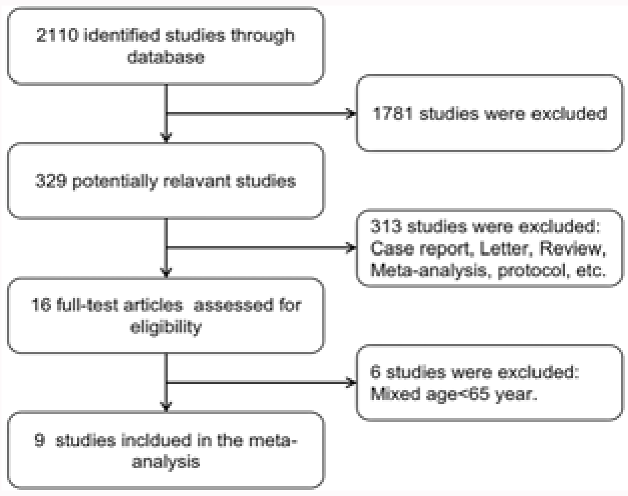

Figure 1: Flow diagram of study selection.

Table 1: Characteristics of the included studies.

First author, year	Study design	Age (years)	Male (%)	OTA classification	Treatment	Outcome measures	Follow-up (months)
Arora, 2009	Retrospective (n=114)	78.6 ± 5.8	36 (31.6)	A2, A3, C1,C2,C3	ORIF and EF	Range of motion, grip strength, DASH score, radiographic assessment, complications	57 (12-81)
Arora, 2011	RCT (n=73)	74.7 (65-89)	18 (24.7)	A2, A3, C1,C2,C3	ORIF and EF	Range of motion, grip strength, DASH score, radiographic assessment, complications	12
Bartl, 2014	RCT (n=185)	74.8 ± 6.9	21 (12.1)	C1,C2,C3	ORIF and EF	Range of motion, quality of life assessment (SF-36, EQ-5D), DASH score, radiographic assessment, complications	12
Chan, 2014	Retrospective (n=75)	73.5 ± 7.7	11 (14.7)	A, C	ORIF and EF	Range of motion, grip strength, DASH score, radiographic assessment	12
Egol, 2010	Retrospective (n=90)	74.5 ± 6.8	14 (15.6)	A, B, C	ORIF and EF	Range of motion, grip strength, DASH score, radiographic assessment, complications	12
Huang, 2020	Retrospective (n=69)	84 (80-97)	10 (14.5)	A2, A3, C1,C2,C3	ORIF and EF	Range of motion, radiographic assessment, complications	16.1 (12-22.8)
Lutz, 2014	Prospective (n=258)	74 ± 5	20 (7.8)	A, B, C	ORIF and EFI	PRWE score, radiographic assessment, complications	13.1 ± 9.3
Saving, 2019	RCT (n=122)	79 (70-98)	11 (9.0)	A2, A3, C1,C2,C3	ORIF and EF	PRWE score, DASH score, quality of life assessment (EQ-5D), grip strength, range of motion, radiographic assessment, complications	12
Tahir, 2020	RCT (n=159)	81 ± 2.6	126 (79.2)	A2, A3, C1,C2,C3	ORIF and EF	PRWE score, quality of life assessment (SF-12), DASH score, Mayo wrist score, grip strength, range of motion, radiographic assessment, complications	12

Abbreviations: DASH: Disabilities of the Arm, Shoulder and Hand; EF: External Fixation; ORIF: Open Reduction and Internal Fixation; PRWE: Patient-Rated Wrist Evaluation; RCTs: Randomized Controlled Trials

15.14], P=0.18). These findings indicate that there were no significant differences in primary endpoints between ORIF and EF groups in the elderly, including DASH score, PRWE score and Grip strength.

Complications

All 9 studies reported incidence of complications and were included in the analysis. Significant heterogeneity was detected when the data from these studies were pooled (I^2=88%), therefore, a random-effects model of analysis was used (Figure 3). Consistently, no significant difference in the incidence of complications between the ORIF and EF groups was noted (P=0.59).

Secondary endpoints

Functional assessment: Data of functional assessment was pooled across the studies, including extension, flexion, pronation, supination, radial deviation, and ulnar deviation (Figure 4). As shown in Figure 4A, 7 studies reported the range of wrist extension and were included in the analysis. There was no significant heterogeneity (I^2=0%), therefore, a fixed-effects model of analysis was used and no significant difference was noted between the two groups (pooled standard difference in means = -1.29, 95% CI [−2.64, 0.07], P=0.06). As to range of wrist flexion, significant heterogeneity was detected (I^2=85%), and no significant difference was noted using a random-effects model of analysis (pooled standard difference in means = 0.23, 95% CI [−3.42, 3.88], P=0.90) (Figure 4B). Further, 7 studies reported pronation, and there was no significant heterogeneity (I^2=19%). Hence, a fixed-effects model of analysis was used and no significant difference was noted between the two groups (pooled standard difference in means = 0.05, 95% CI [−0.50, 0.61], P=0.86) (Figure 4C). With regard to supination, significant heterogeneity was detected (I^2=86%), and no significant difference was noted using a random-effects model of analysis (pooled standard difference in means = 1.56, 95% CI [−0.90, 4.01], P=0.21) (Figure 4D). Besides, 5 studies reported radial deviation and no significant heterogeneity was detected (I^2=19%). Therefore, a fixed-effects model of analysis was used and no significant difference was noted between the two groups (pooled standard difference in means = -0.50, 95% CI [−1.64, 0.64], P=0.39) (Figure 4E). As to ulnar deviation, significant heterogeneity was detected (I^2=43%), and no significant difference was noted using a random-effects model of analysis (pooled standard difference in means = 0.56, 95% CI [−1.36, 2.49], P=0.56) (Figure 4F). Taken together, these findings indicate that there were no significant differences in functional assessment between ORIF and EF groups in elderly.

Table S1: Quality assessment of the included studies.

First author, year	Total score
RCTs (Cochrane risk of bias tool)	
Arora, 2011	4
Bartl, 2014	5
Saving, 2019	5
Tahir, 2020	5
Retrospective and prospective studies (NOS)	
Arora, 2009	6
Chan, 2014	6
Egol, 2010	7
Huang, 2020	6
Lutz, 2014	4

Abbreviations: NOS: Newcastle-Ottawa Scale; RCTs: Randomized Controlled Trials

Radiological assessment: Data of radiological assessment was

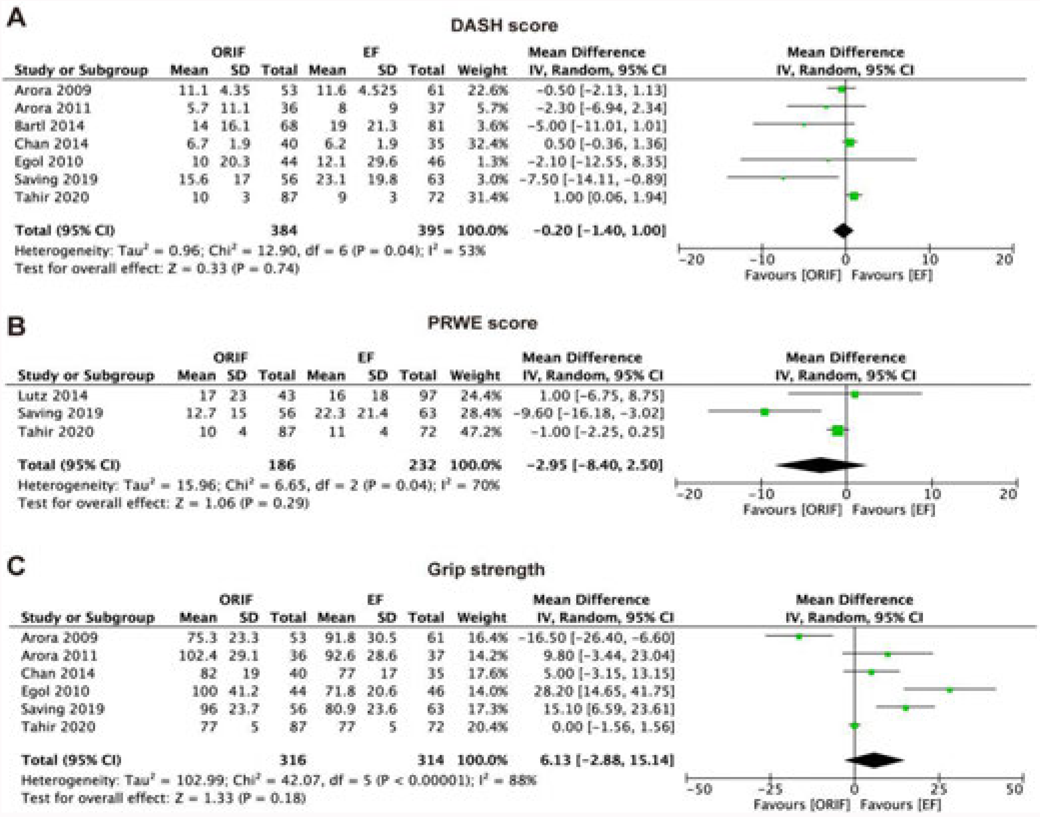

Figure 2: The forest map of statistical analysis of DASH score, PRWE score and Grip strength in ORIF and EF groups. (A) Forest map of statistical analysis of DASH score. (B) Forest map of statistical analysis of PRWE score. (C) Forest map of statistical analysis of Grip strength.
Abbreviations: CI: Confidence Interval; DASH: Disability of the Arm, Shoulder and Hand; EF: EXTERNAL FIXATION; ORIF: Open Reduction and Internal Fixation; PRWE: Patient Rated Wrist Evaluation score.

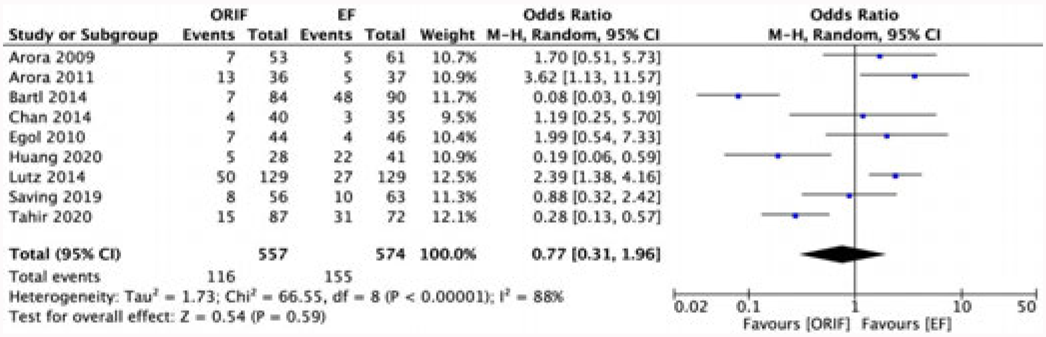

Figure 3: The forest map of statistical analysis of incidence of total complications in ORIF and EF groups. **Abbreviations:** CI: Confidence Interval; EF: External Fixation; ORIF: Open Reduction and Internal Fixation.

pooled across the studies, including radial height, inclination, ulnar variances and volar tilt (Figure 5). As shown in Figure 5A, 3 studies reported radial height and were included in the analysis. Significant heterogeneity was noted (I^2=44%), therefore, a random-effects model of analysis was used and there was a significant difference favoring ORIF over EF (pooled standard difference in means = 1.49, 95% CI [0.72, 2.27], P<0.001). As to radial inclination, all 9 studies were included and significant heterogeneity was detected (I^2=85%). Hence, a random-effects model of analysis was used, a significant difference favoring ORIF over EF was noted (pooled standard difference in means = 3.25, 95% CI [2.07, 4.43], P<0.001) (Figure 5B). Further, 8 studies reported pronation, and significant heterogeneity was noted (I^2=68%). Therefore, a random-effects model of analysis was used and a significant difference was observed between the two groups (pooled standard difference in means = -1.63, 95% CI [−2.07, -1.19], P<0.001) (Figure 5C). With regard to volar tilt, significant heterogeneity was detected (I^2=97%), and there was a significant difference between the two groups using a random-effects model of analysis (pooled standard difference in means = 8.21, 95% CI [2.43, 13.99], P<0.001) (Figure 5D). Taken together, these findings indicate that ORIF yielded significant better radial height, radial inclination and volar tilt, and less radial variance than patients in the EF group in elderly.

Discussion

This meta-analysis compared outcomes of surgical and nonsurgical management of DRFs in persons 65 years of age or older

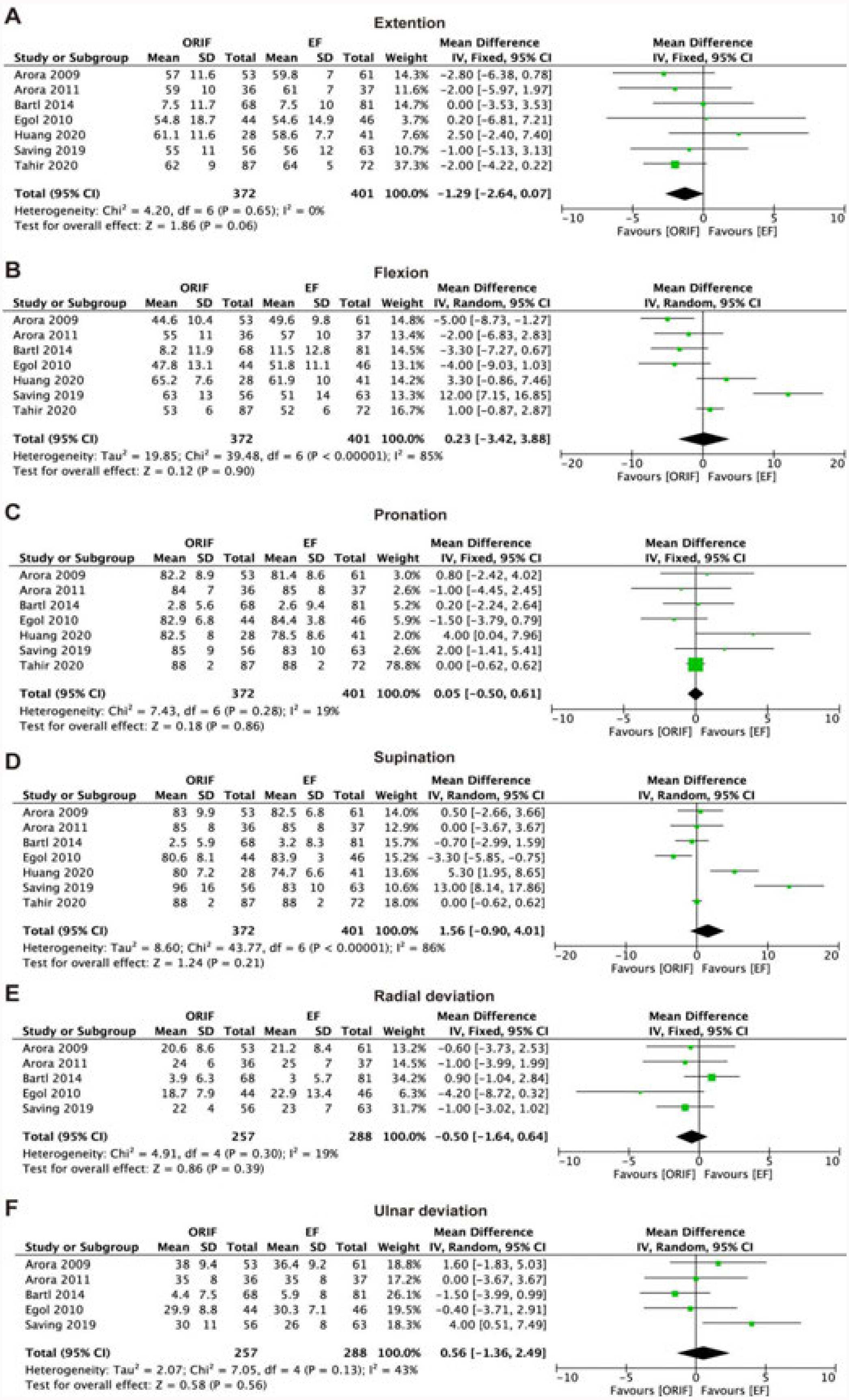

Figure 4: The forest map of statistical analysis of functional assessment in ORIF and EF groups. (A) Forest map of statistical analysis of range of wrist extension. (B) Forest map of statistical analysis of range of wrist flexion. (C) Forest map of statistical analysis of pronation. (D) Forest map of statistical analysis of supination. (E) Forest map of statistical analysis of radial deviation. (F) Forest map of statistical analysis of ulnar deviation. **Abbreviations:** CI: Confidence Interval; EF: External Fixation; ORIF: Open Reduction and Internal Fixation.

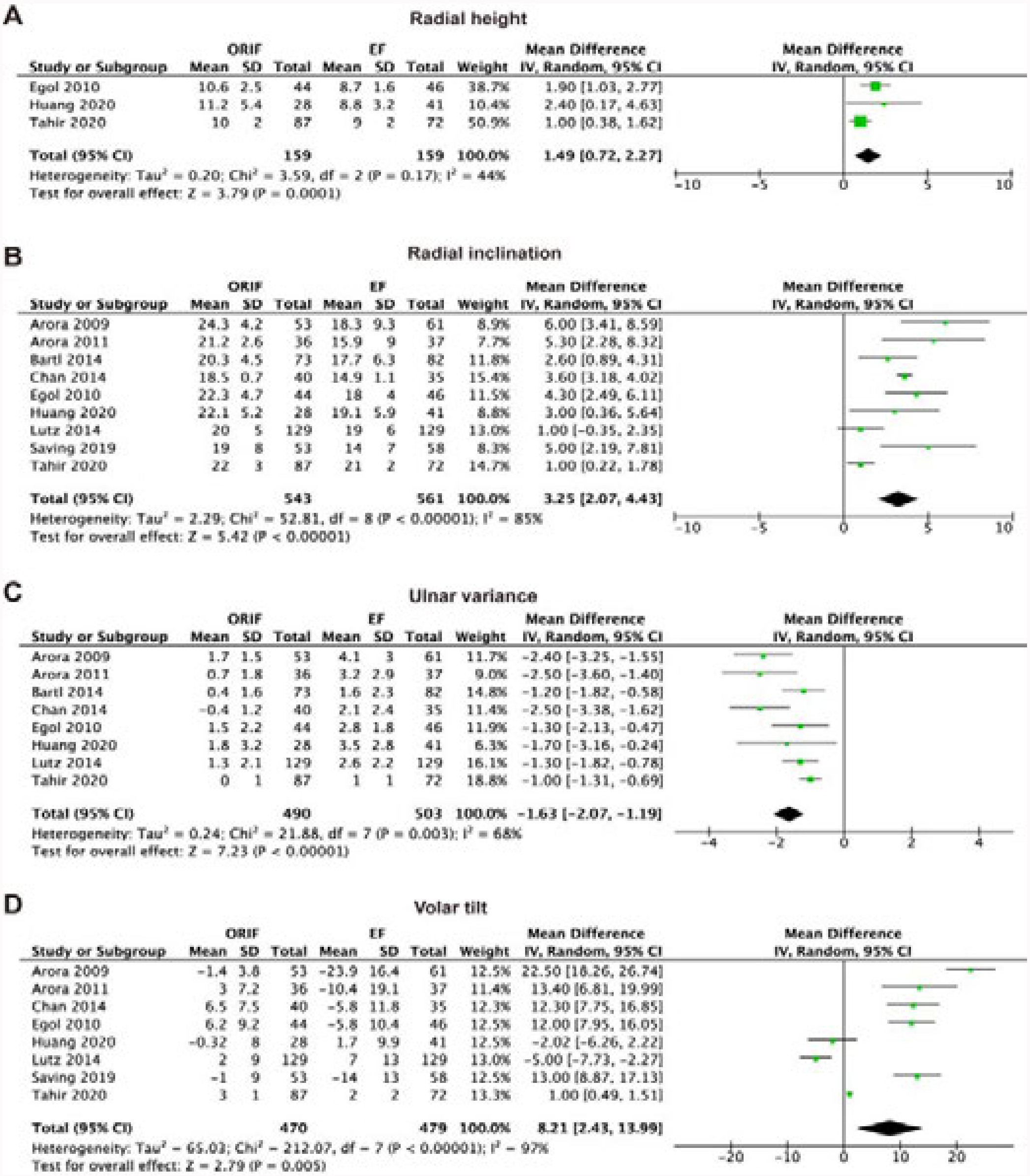

Figure 5: The forest map of statistical analysis of radiological assessment in ORIF and EF groups. (A) Forest map of statistical analysis of radial height. (B) Forest map of statistical analysis of radial inclination. (C) Forest map of statistical analysis of ulnar variance. (D) Forest map of statistical analysis of supination. (E) Forest map of statistical analysis of radial deviation. (F) Forest map of statistical analysis of volar tilt.
Abbreviations: CI: Confidence Interval; EF: External Fixation; ORIF: Open Reduction and Internal Fixation.

and assessed the clinical benefits and complications on ORIF and EF for DRFs. And the results indicated that both types of management lead to similar results with respect to DASH, PRWE scores, grip strength, complications and functional assessments, although ORIF yielded significant better radial height, radial inclination and volar tilt, and less radial variance. Of note, these results of radiological assessment should not be interpreted that surgery for DRFs in the elderly is necessary, considering the increasing life expectancy and low functional demands in the elderly. Therefore, EF treatment might be more suitable for the treatment of DRFs in the elderly with respect to reducing postoperative complications and economic burden into medical cost.

Over the past decades, locking plate system was one of technical advances which has been made in the treatment of unstable DRFs in osteoporotic patients. Since the fixed angle construction does not affect blood supply to the bones and does not require good bone quality to provide stability, ORIF produces good clinical results in elderly patients with an unstable distal radial fracture and has been increasingly utilized. Although the enthusiasm for anatomical reduction has driven the push for ORIF, there is no clear evidence that this is necessary for satisfactory outcomes [21,22]. The uncertainty about the long-term relevance of different degrees of extra-articular malunion is unlikely to be resolved in the near future [23].

Despite the popularity of ORIF, most displaced DRFs are initially managed with closed reduction and subsequent orthosis [24]. EF is a clinically used method for the treatment of DRFs, with the advantages of convenient operation, low cost, minimal trauma, and greatly reducing the pain of the elderly patients. Because of the low functional requirements of elderly patients, there is little difference in the efficacy satisfaction between ORIF and EF treatment of DRFs.

Therefore, EF remains a preferred treatment option in most cases. However, the optimal method for DRFs remains to be determined.

Clinical practice guidelines for the treatment of DRFs provide little guidance on ORIF *vs.* EF [25-27]. Subsequent guidelines made recommendations based primarily on evidence from several RCTs [3,4,11,18]. Some guidelines made a strong recommendation for operative treatment in adults and a weak recommendation for operative treatment in patients aged 65 years [26]. In contrast, British guidelines made no recommendation for patients aged 65 years and recommended closed reduction and cast immobilization as the primary treatment option after careful consideration of patient characteristics [27]. In our meta-analysis, the primary outcomes, including DASH score, PRWE score and grip strength, showed no significant differences in patients treated with ORIF compared with those treated with EF. Similar results were also found in the secondary outcomes such as extension, flexion, pronation, supination, radial deviation, and ulnar deviation. Moreover, ORIF treatment yielded significantly better radial height, radial inclination and volar tilt.

As various approaches appear to be equally effective, there is no general consensus on the optimal technique for closure to reduce DRFs. In addition, the reduction technique does not appear to affect the outcomes. Patient characteristics and preferences, fracture type, local expertise, and resources can influence treatment choices. Therefore, there are sufficient arguments to support that surgeons should continue to use the techniques for which they have been trained and perform best at institutions in local facilities. There is insufficient evidence on the benefit of routine repeat or preoperative reduction in DRF patients. Future prospective randomized studies are warranted to investigate the need for repeat or preoperative reductions in radiological or surgical outcomes and patient comfort.

The question about whether ORIF or EF treatment more beneficial is of current clinical interest and importance; of the 9 studies included in our review, 3 were published in 2019 or 2020. Given this emerging evidence, an up-to-date synthesis of evidence can provide evidence as a basis for shared decision-making and clinical practice guidelines. However, limitations of the present study should be noted: (1) the sample size of the included studies is relatively small, and our study was limited by the number of RCTs available in the literature. Since we were unable to include data from ongoing, unpublished RCTs [28,29], a large-scale randomized controlled trial is still needed for verification; (2) due to the limited number of relevant studies, the observation index data of the included literature are not fully reported; (3) some of the included literatures did not use blinding and allocation concealment, so there are methodological deficiencies.

To sum up, ORIF and EF have similar results in the treatment of DRFs in the elderly, and minor objective radiological assessment did not result an impact on subjective function outcomes. These findings suggest that EF management can be a valid treatment option for DRFs in elderly patients. However, they should not be interpreted as a replacement for ORIF, as operations should still be performed where there are surgical indications. But when there are no definitive surgical indications, EF management can avoid postoperative complications and reduces medical costs.

References

1. Johnell O, Kanis JA. An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int. 2006;17:1726-33.
2. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. Hand Clin. 2012;28:113-25.
3. Arora R, Lutz M, Deml C, Krappinger D, Haug L, Gabl M. A prospective randomized trial comparing nonoperative treatment with volar locking plate fixation for displaced and unstable distal radial fractures in patients sixty-five years of age and older. J Bone Joint Surg Am. 2011;93:2146-53.
4. Bartl C, Stengel D, Bruckner T, Gebhard F, Group OS. The treatment of displaced intra-articular distal radius fractures in elderly patients. Dtsch Arztebl Int. 2014;111:779-87.
5. Ju JH, Jin GZ, Li GX, Hu HY, Hou RX. Comparison of treatment outcomes between nonsurgical and surgical treatment of distal radius fracture in elderly: A systematic review and meta-analysis. Langenbecks Arch Surg. 2015;400:767-79.
6. McQueen MM, Hajducka C, Court-Brown CM. Redisplaced unstable fractures of the distal radius: a prospective randomised comparison of four methods of treatment. J Bone Joint Surg Br. 1996;78:404-9.
7. McQueen MM, MacLaren A, Chalmers J. The value of remanipulating Colles' fractures. J Bone Joint Surg Br. 1986;68:232-3.
8. Hung LP, Leung YF, Ip WY, Lee YL. Is locking plate fixation a better option than casting for distal radius fracture in elderly people? Hong Kong Med J. 2015;21:407-10.
9. Huetteman HE, Shauver MJ, Malay S, Chung TT, Chung KC. Variation in the treatment of distal radius fractures in the United States: 2010 to 2015. Plast Reconstr Surg. 2019;143:159-67.
10. Egol KA, Walsh M, Romo-Cardoso S, Dorsky S, Paksima N. Distal radial fractures in the elderly: Operative compared with nonoperative treatment. J Bone Joint Surg Am. 2010;92:1851-7.
11. Chan YH, Foo TL, Yeo CJ, Chew WY. Comparison between cast immobilization versus volar locking plate fixation of distal radius fractures in active elderly patients, the Asian perspective. Hand Surg. 2014;19:19-23.
12. Arora R, Gabl M, Gschwentner M, Deml C, Krappinger D, Lutz M. A comparative study of clinical and radiologic outcomes of unstable colles type distal radius fractures in patients older than 70 years: Nonoperative treatment versus volar locking plating. J Orthop Trauma. 2009;23:237-42.
13. Tomaszuk M, Kiryluk J, Tomaszuk A, Popko J. Evaluation of treatment of low-energy distal radial fractures in postmenopausal women. Ortop Traumatol Rehabil. 2017;19:55-65.
14. Mulders MAM, Walenkamp MMJ, van Dieren S, Goslings JC, Schep NWL, Collaborators VT. Volar plate fixation versus plaster immobilization in acceptably reduced extra-articular distal radial fractures: A multicenter randomized controlled trial. J Bone Joint Surg Am. 2019;101:787-96.
15. Saving J, Severin Wahlgren S, Olsson K, Enocson A, Ponzer S, Skoldenberg O, et al. Nonoperative treatment compared with volar locking plate fixation for dorsally displaced distal radial fractures in the elderly: A randomized controlled trial. J Bone Joint Surg Am. 2019;101:961-9.
16. Testa G, Vescio A, Di Masi P, Bruno G, Sessa G, Pavone V. Comparison between surgical and conservative treatment for distal radius fractures in patients over 65 years. J Funct Morphol Kinesiol. 2019;4:26.
17. Larouche J, Pike J, Slobogean GP, Guy P, Broekhuyse H, O'Brien P, et al. Determinants of functional outcome in distal radius fractures in high-functioning patients older than 55 years. J Orthop Trauma. 2016;30:445-9.
18. Lutz K, Yeoh KM, MacDermid JC, Symonette C, Grewal R. Complications associated with operative versus nonsurgical treatment of distal radius fractures in patients aged 65 years and older. J Hand Surg Am. 2014;39:1280-86.
19. Tahir M, Khan Zimri F, Ahmed N, Rakhio Jamali A, Mehboob G, Watson KR, et al. Plaster immobilization versus anterior plating for dorsally displaced distal radial fractures in elderly patients in Pakistan. J Hand Surg Eur Vol. 2021;46:647-53.
20. Huang YY, Lin TY, Chen CH, Chou YC, Su CY. Surgical outcomes of

elderly patients aged more than 80 years with distal radius fracture: Comparison of external fixation and locking plate. BMC Musculoskelet Disord. 2020;21:91.

21. Downing ND, Karantana A. A revolution in the management of fractures of the distal radius? J Bone Joint Surg Br. 2008;90:1271-5.
22. Forward DP, Davis TR, Sithole JS. Do young patients with malunited fractures of the distal radius inevitably develop symptomatic post-traumatic osteoarthritis? J Bone Joint Surg Br. 2008;90:629-37.
23. Karantana A, Davis TR. Extra-articular fractures of the distal radius-- A European view point. Hand Clin. 2012;28:145-50.
24. Schermann H, Kadar A, Dolkart O, Atlan F, Rosenblatt Y, Pritsch T. Repeated closed reduction attempts of distal radius fractures in the emergency department. Arch Orthop Trauma Surg. 2018;138:591-6.
25. Members of the Writing, Review, and Voting Panels of the AUC on the Treatment of Distal Radius Fractures; Watters WC, Sanders JO, Murray J, Patel N. The American Academy of Orthopaedic Surgeons appropriate use criteria on the treatment of distal radius fractures. J Bone Joint Surg Am. 2014;96:160-1.
26. Nylenna M, Fronsdal KB, Kvernmo HD, Hove L, Husby T, Rokkum M, et al. Treatment of distal radial fractures in adults. Oslo, Norway: Knowledge Centre for the Health Services at The Norwegian Institute of Public Health (NIPH); 2013 Feb. Report from Norwegian Knowledge Centre for the Health Services (NOKC) No. 03-2013. 2013.
27. Ibrahim T, Aldahamsheh OMS, Hegazy A, Ghomrawi HMK. Applicability of the AAOS appropriate-use criteria for distal radius fractures in surgical practice. Int Orthop. 2018;42:197-202.
28. Pedersen J, Mortensen SO, Rolfing JD, Thorninger R. A protocol for a single-center, single-blinded randomized-controlled trial investigating volar plating versus conservative treatment of unstable distal radius fractures in patients older than 65 years. BMC Musculoskelet Disord. 2019;20:309.
29. Hevonkorpi TP, Launonen AP, Raittio L, Luokkala T, Kukkonen J, Reito A, et al. Nordic Innovative Trial to Evaluate OsteoPorotic Fractures (NITEP-group): Non-operative treatment versus surgery with volar locking plate in the treatment of distal radius fracture in patients aged 65 and over - a study protocol for a prospective, randomized controlled trial. BMC Musculoskelet Disord. 2018;19:106.