ORIGINAL STUDY

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Surgical vs Non-surgical interventions for distal radius fractures: a quantitative analysis of Patient-Rated Wrist Evaluation measures

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Trials to assess differences in PRWE (Patient Related Wrist Evaluation) over time, for both surgical and non-surgical interventions post DRFs (distal radius fractures) are rare. The DASH (Disabilities of the Arm, Shoulder and Hand) questionnaire has been shown to be improved by a greater margin in the medium term for surgical interventions, than non surgical interventions. However, a study found that PRWE can be considered superior to the DASH questionnaire for DRFs, due to greater specificity to wrist pain and function. Conflicting data makes it difficult to determine surgical vs non-surgical superiority for DRF's over time with PRWE as a recovery metric. PubMed and Cochrane were searched for randomised controlled trials up to 31.8.23, reporting PRWE over 3, and 12 months. Data was extracted by 2 researchers. The differences in PRWE over time post surgical and non-surgical interventions was assessed using unpaired T testing. 1226 records were screened. 4 studies enrolling 817 participants met the eligibility criteria and were analysed. Significantly lower PRWE in surgical intervention has been identified at the 3 month mark ($p<0.001$). There was greater significant change in non-surgical intervention between months 3 and 12 ($p<0.001$). Change in PRWE over time may be a good indicator of functional outcomes in DRFs post surgical or non-surgical interventions. This could inform future clinical trial design and surgical decision-making. Further work is required to design even more user-friendly and digital patient-reported outcomes specifically for DRFs.

Keywords: DRF, surgery, PRWE, non-surgical.

INTRODUCTION

Distal radius fractures (DRFs) are treated via different modalities. Non-surgical modalities are more common in elderly patients, with evidence increasingly showing its 'non-inferiority' to surgical fixation[1]. However, operative treatment has been found to be more effective with greater effects on younger patients[2].

Common methods of quantifying function following an intervention are numerous, our research found two main measures: Disabilities of the Arm, Shoulder and Hand questionnaire score (DASH) and Patient Related Wrist Evaluation (PRWE). The PRWE was reported less frequently, despite its supposed superiority to the DASH[3].This superiority is attributed to greater specificity of the PRWE to DRFs, compared to the more general DASH. The PRWE is a questionnaire consisting of 15 items, used to score wrist related pain and disability in relation to function[4]. We believe that PRWE has potential to be used frequently.

The purpose of this study is to compare the current literature regarding the use of PRWE when comparing surgical and non-surgical interventions after a distal radius fracture, and to come to a quantitative conclusion to assess a difference in PRWE over time between the two domains of treatment, as a proxy for function.

METHODS AND MATERIALS

Protocol + Registration

The intention was to study DRFs and the functional outcomes or PROMS (patient reported outcomes) over time - specifically PRWE. We were comparing surgical and nonsurgical treatment modalities.

Our study has been registered via PROSPERO, CRD:42023459150[5].

Electronic Search

Systematic searches for randomised control trials (RCTs) reported in English were performed by different researchers via PubMed and Cochrane, encompassing: CT.gov, Embase, PubMed and ICTRP (Figure 1). This

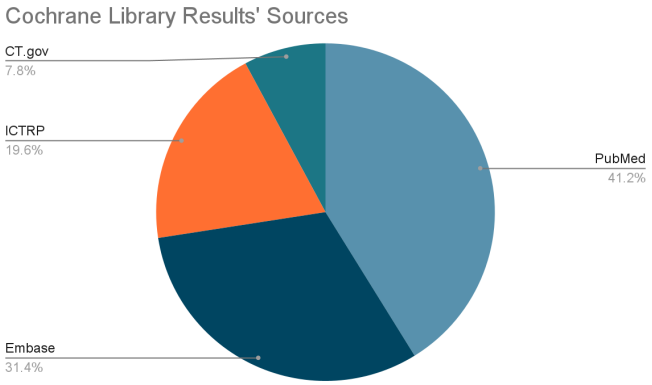

Figure 1. — Graphical representation of the location of results from the Cochrane search.

Table 1. — Search used for Pubmed

Terms (PubMed)
Surgical
Wrist
Functional score
Pain
VAS OR "Visual Analogue Scale"
NRS OR "Numerical Rating Scale"
PRWE OR "Patient Related Wrist Evaluation"
Ankle
Hip
Cuff
Knee
Final Search
(Surgical AND Wrist) AND (Functional Score*) AND ((Pain) OR (VAS OR "Visual Analogue Scale")) OR (NRS OR "Numerical Rating Scale") OR (PRWE OR "Patient Related Wrist Evaluation")) NOT (Ankle OR Hip OR Cuff OR Knee).

Table 2. — Search used for Cochrane

Operator	Term	Location
N/A	Surgical	Abstract
AND	Wrist	Title Abstract Keyword
AND	Functional Score	Title Abstract Keyword
AND	Pain	Title Abstract Keyword
AND	PRWE	Title Abstract Keyword

occurred on a single day (31st August 2023) and search terms were related to functional measures, surgery, DRFs/wrist and pain (Table 1, 2). There were no limits in relation to publication dates. All papers had to have their full texts available online, and prospective studies were excluded (Figure 2).

All studies that were included were RCTs with a followup of over 3 months and mention of PRWE across this timeframe; comparisons between surgical

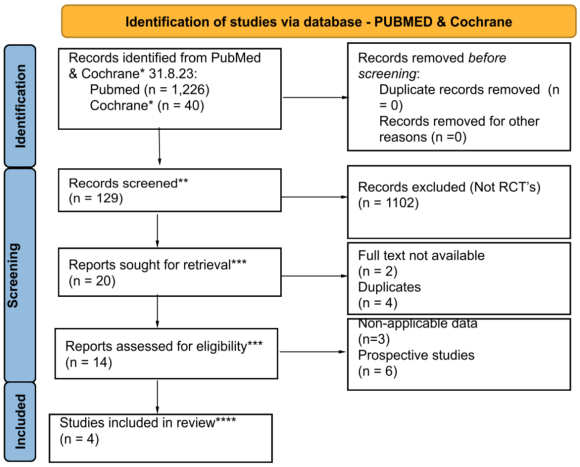

Figure 2. — PRISMA diagram depicting the numerical breakdown of our search and it's constituent stages.
**Cochrane acquired papers from CT.gov, ICTRP, PubMed & Embase; **Assessed for Surgical vs non-surgical intervention, wrist/distal radius, PRWE and follow-up of >3 months; ***Filtered and screened to assess for data regarding: PRWE, (SD and mean OR IQR and Median over time), Follow-up, N (surgical & nonsurgical), ****Chosen for PRWE data (with 3 and 12 month data points) with >3 month follow-up.*

and nonsurgical interventions and data at the 3 and 12 month marks (table 3). If papers had a reference to knees, ankles, hips or rotator cuff they were excluded. Our primary outcome was the PRWE score at 3 months and 12 months in patients with distal radius fractures

When extracting the data, we manually extracted mean and standard deviation data for the 3 and 12 month marks (Table 4). If this data was not available, we used median and interquartile range (IQR). All data was extracted into a spreadsheet.

We conducted a bias or quality assessment. Internal validity was assessed via the Revised Cochrane risk-of-bias tool for randomised trials (RoB 2) (figure 3,4)[6].

When analysing the data, we used weighted means to combine individual study data and used unpaired T testing to compare the different measures of effect. Results were formed into a table (figure 2). The data analysis was performed via R software. All actions were completed with reference to the PRISMA statement[7].

RESULTS

A total of 1266 studies were found through the electronic searches (figure 2). Of these, four studies met the eligibility criteria and were included in the systematic review (Table 4). The kappa agreement rate between the reviewers was 1.00.

A summary of the included studies are presented in Tables 3, 4, 5 and 6. The overall population included 817 patients (416 in the nonoperative group and 401 in the operative group).

Table 3. — Summary of included papers

References	Origin and year of publication	Surgical Intervention	Surgical group N	Nonsurgical Intervention	Nonsurgical group N	Available PRWE Data	Data forms
CROSSFIRE Study Group[8]	Australia and New Zealand, 2021	open reduction and internal fixation using a volar-locking plate (VLP)	79	Nonsurgical treatment was closed reduction and cast immobilisation (CR)	85	3 months, 12 months	Mean, SD
Costa ML, Achten J, Ooms A, Png ME, Cook JA, Lamb SE et al.[9]	United Kingdom, 2022	manipulation and surgical fixation with K-wires plus cast	245	Manipulation and moulded cast	255	Baseline, 3 months, 6 months, 12 months	Mean, SD
Selles CA, Mulders MAM, Winkelhagen J, van Eerten PV, Goslings JC, Schep NWL et al.[10]	The Netherlands,2021	volar plate fixation	44	cast immobilisation	46	6 weeks, 3 months, 6 months, 12 months	Median, IQR
Wilcke MK, Abbaszadegan H, Adolphson PY[11]	Sweden, 2011	volar locked plating	33	bridging external fixation	30	3 months, 6 months, 12 months	Median, IQR

Table 4. —All PRWE data extracted from the included papers

Author(s)		Non-operative (N = 85) - CR		Operative (N=79) - VLP		
		Mean	SD	Mean	SD	P
(CROSSFIRE) Study Group[8]	3 months	37.1	22.3	28.1	23.1	N/A
	12 months	21.5	24.3	19.8	21.1	N/A
Author(s)		Non-operative (N = 255)		Operative (N=245)		
		Mean	SD	Mean	SD	P
Costa ML, Achten J, Ooms A, Png ME, Cook JA, Lamb SE et al.[9]	Baseline	84.3	13.3	81.91	14.52	N/A
	3 months	42.08	23.85	41.56	24.77	0.82
	6 months	28.35	23.35	27.56	22.33	0.87
	12 months	21.16	23.09	20.69	22.33	0.87
Author(s)		Non-operative (N = 46)		Operative (N=44)		
		median	IQR	median	IQR	P
Selles CA, Mulders MAM, Winkelhagen J, van Eerten PV, Goslings JC, Schep NWL et al.[10]	6 weeks	58	(49-76)	39	(22-60)	<0.001
	3 months	40	(15-62)	21	(7-49)	0.002
	6 months	24	(9-51)	9	(3-18)	0.002
	12 months	12	(3-28)	5	(0-12)	0.01
Author(s)		Non-operative (N = 30)		Operative (N=33)		
		median	IQR	median	IQR	P
Wilcke MK, Abbaszadegan H, Adolphson PY[11]	3 months	31	(23-29)	14	(8-20)	<0.001
	6 months	17	(11-22)	9	(5-14)	0.02
	12 months	15	(9-12)	11	(6-16)	0.3

The included papers were assessed in 5 domains: randomisation process; deviations from intended interventions; missing outcome data; measurement of the outcome and selection of the reported result – there was then a final overall judgement (Figure 3,4). Each domain was scored on a scale of: low, some concerns

Figure 3 - RoB 2 diagram to test for internal validity, 'Px' where x is a number between 1-4 represent the different papers included in the study.: P1(8), P2(9), P3(10), P4(11). D1 represents the randomisation process, D2 represents deviations from the intended interventions; D3 represents missing outcome data; D4 represents measurements of the outcome data; D5 represents selection of the reported result.

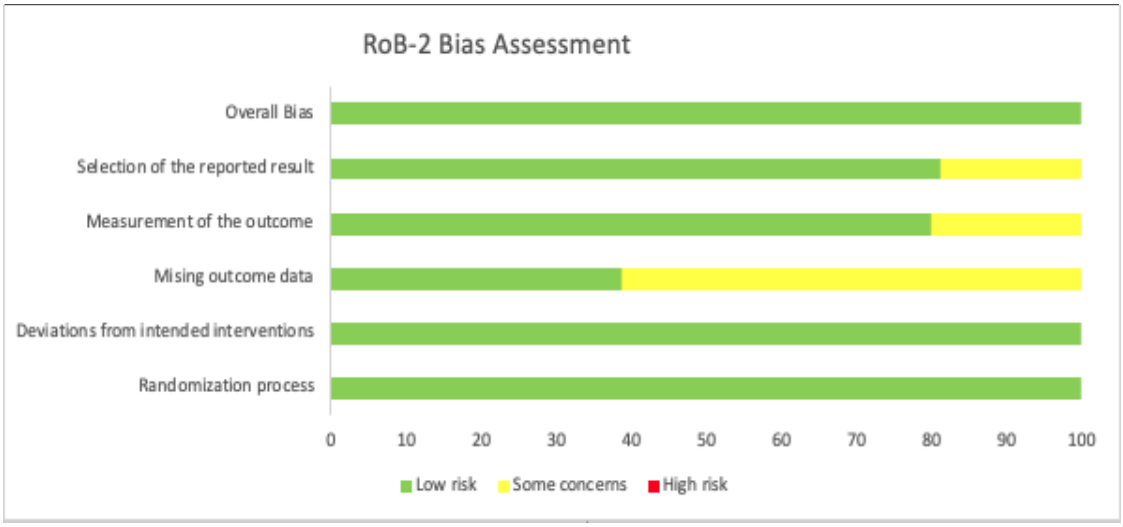

Figure 4. — RoB 2 diagrammatic representation.
Shows the % of studies that have low, medium and high risk of bias in each of the 5 domains.

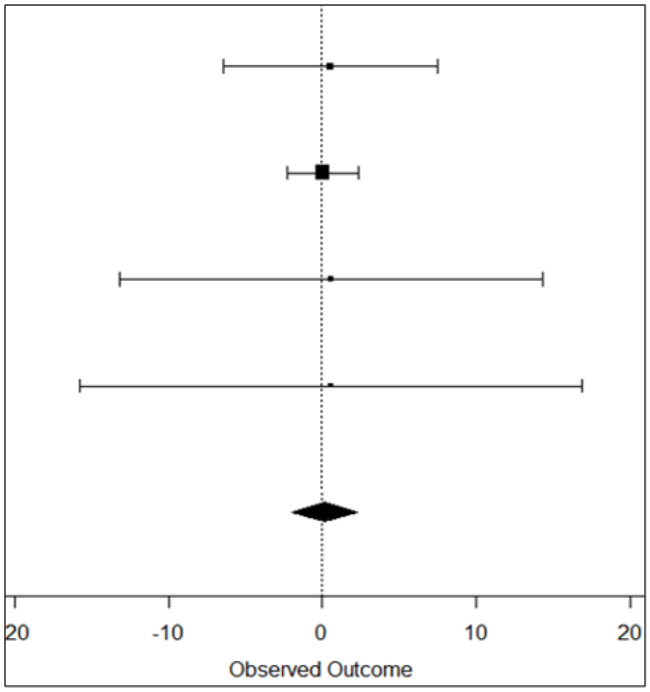

Figure 5. — Forest plot summarising the outcome of nonsurgical vs surgical interventions after 3 months.

and high, by the RoB-2 algorithm.[6] They were then assessed and scored by both researchers respectively and independently and then compared. We extracted the bias assessment table as a bar chart (Figure 4).

Four studies included data to perform the systematic review and meta analysis for PRWE score at 3 months, measured using a 15-item questionnaire. The mean PRWE differed significantly between nonsurgical and surgical groups (40.03 ± 23.34 vs 34.38 ± 23.83, respectively; $p < 0.001$) (table 7). When considering the effect size, overall pooled Cohen's D estimate showed no significant difference in PRWE between nonsurgical and surgical interventions at 3 months ($D = 0.12$, 95% CI = -2.04 to 2.28, $p = 0.91$), with no important heterogeneity ($I^2 = 0\%$, $p = 0.99$) (figure 5).

Four studies included data to perform the systematic review and meta analysis for PRWE score at 12 months, measured using a 15-item questionnaire. The mean PRWE did not differ significantly between nonsurgical and surgical groups (18.85 ± 21.33 vs 18.00 ± 19.39, respectively; $p = 0.55$) (table 7). When considering the effect size, the overall pooled Cohen's D estimate

Table 5. — Summary of extracted data at 3 months, after all data is converted to a homogenous form

	Nonsurgical Group			Surgical Group				
Study	Mean	SD	Total	Mean	SD	Total	Normalised Weight	Effect Size (Cohen's D) 95% CI
Lawson A et al. 2021	37.10	22.3	85	28.1	23.10	79	0.124	0.56 [-6.38, 7.50]
Costa ML et al. 2022	42.08	23.85	255	41.56	24.77	245	0.331	0.02 [-3.70, 3.75]
Selles CA et al. 2021	40	34.81	46	21	31.11	44	0.033	0.57 [-13.12, 14.27]
Wilcke MK et al. 2011	31	4.44	30	14	8.89	33	0.512	0.57 [-15.67, 16.82]
Total (95% CI)			416			401	1.00	0.12 [-2.04, 2.28]
Heterogeneity: $Tau^2 = 0\%$, df = 3 (P = 0.99) , $I^2 = 0\%$, $H^2 = 1.00$. Test for overall effect: z = 0.11 (P = 0.91)								

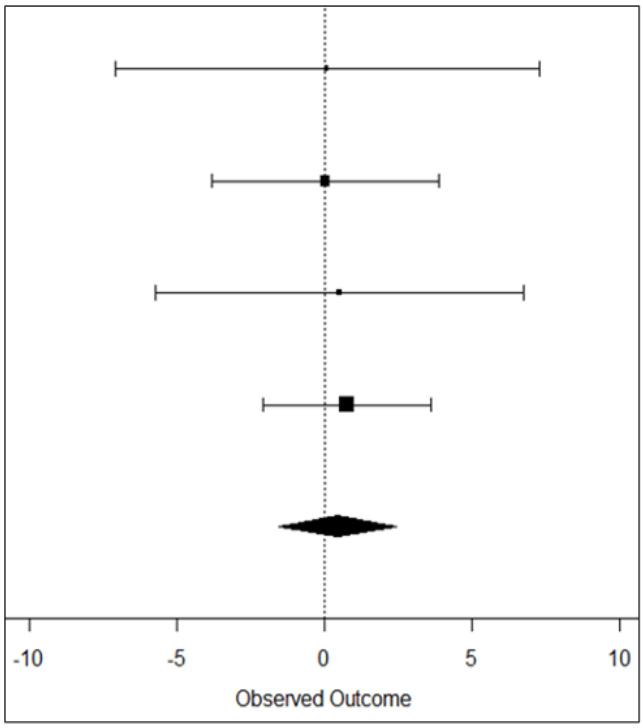

Figure 6. — Forest plot summarising the outcome of nonsurgical vs surgical interventions after 12 months.

showed no significant difference in PRWE between nonsurgical and surgical interventions at 12 months (D = 0.12, 95% CI = -2.04 to 2.28, p = 0.9103), with no important heterogeneity ($I^2 = 0\%$, p = 0.99) (figure 6).

Δ PRWE between Nonsurgical and Surgical groups

It is worth noting that there was a significant change ($p < 0.001$) in PRWE between the 3 and 12 month timepoints (figure 7) between nonsurgical ($\Delta = -21.18$) and surgical groups ($\Delta = -16.38$).

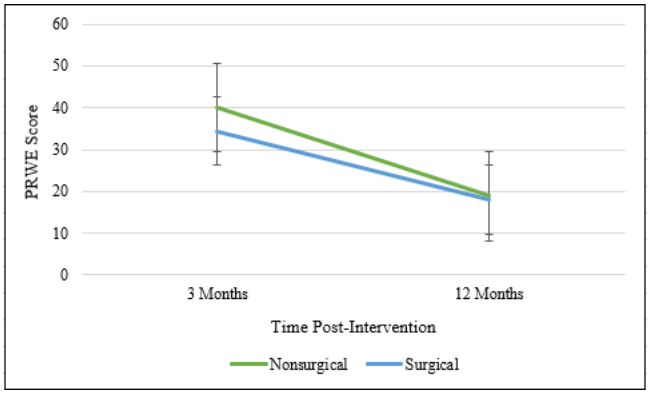

Figure 7. — Change in PRWE between 3 and 12 months depicted graphically.

Publication bias was not evaluated, since only four articles were included in this systematic review and meta-analysis.

DISCUSSION

The evidence in this study is derived from 4 peer-reviewed and published randomised control trials, comparing PRWE measures for surgical and non surgical intervention in patients with DRF's. This review attempted to quantitatively analyse and assess differences in PRWE, irrespective of sex, age and demographic factors. The studies analysed came from Australia and New Zealand[8], the UK[9], the Netherlands[10], and Sweden[11]. Selected studies covered a large geographical area. All papers followed an intention-to-treat analysis in relation to PRWE.

The CROSSFIRE Study Group's paper was an RCT and parallel observational study[8], consisting of 300 participants. The study itself focussed on 460 patients

Table 6. — Summary of extracted data at 12 months, after all data is converted to a homogenous form

	Nonsurgical Group			Surgical Group				
Study	Mean	SD	Total	Mean	SD	Total	Normalised Weight	Effect Size (Cohen's D) 95% CI
Lawson A et al. 2021	21.50	24.30	85	19.80	21.10	79	0.0813	0.07 [-6.91, 7.06]
Costa ML et al. 2022	21.16	23.09	255	20.69	22.33	245	0.2477	0.02 [-3.70, 3.75]
Selles CA et al. 2021	12	18.52	46	5	8.88	44	0.1105	0.48 [-5.56, 6.53]
Wilcke MK et al. 2011	15	2.22	30	11	7.40	33	0.5605	0.73 [-2.03, 3.49]
Total (95% CI)			416			401	1.00	0.45 [-1.55, 2.44]
Heterogeneity: $Tau^2 = 0\%$, df = 3 (P = 0.99) , $I^2 = 0\%$, $H^2 = 1.00$. Test for overall effect: z = 0.44 (P = 0.66)								

Table 7. — Unpaired U-test of PRWE at 3 and 12 months respectively, between operative and nonoperative interventions

	Mean ± S.D		P Value
	Nonoperative (N = 416)	Operative (N = 401)	
3 months PRWE	40.03 ± 23.34	34.38 ± 23.83	<0.001
12 months PRWE	18.85 ± 21.33	18.00 ± 19.39	0.55
Δ PRWE	-21.18	-16.38	<0.001

that were 60 years old and over. It encompassed 19 centres across Australia and New Zealand and had PRWE as one of the primary outcomes. Its conclusion of VLP (Volar plate) fixation offering no clinically important advantage over closer reduction at the 12 month mark was echoed in our own results, as surgical and non-surgical interventions had no significant difference at the 12 month mark, and further supported in a paper out of Sweden and a meta analysis out of China[12,13]. A concern, however, was that the CROSSFIRE Study Group's Paper was at a self proclaimed potential risk of sampling bias as local surgical teams may not have offered participation for all eligible patients. Overall, this study was deemed to have a low risk of bias by both researchers and as such, we were happy to include it.

The paper out of the UK was a multicentre RCT[9], consisting of 500 patients. The ages of those involved in the study was 16 and above, with the study being powered towards its primary outcome of PRWE at 12 months - its secondary outcome was PRWE data at 3 and 6 months. Just as with the CROSSFIRE Study Group's study, no significant differences were found between the surgical and nonsurgical interventions (K-wire and a moulded cast respectively, with both groups involving manipulation of the DRF) at 3 months (p=0.82), 6 months (p=0.87) or 12 months (p=0.87). This study, however, lost about 20% of its patients to followup and as such has relatively narrow confidence intervals, but after analysis of the study by both researchers, it was deemed to have a low risk of bias overall. This paper was published in 2022 and was therefore considered to be up to date with the current data.

Wilcke MK et Al's paper was an RCT based in Sweden involving 63 patients under the age of 70[11]. There were two groups: surgical (volar locked plating, n=33) and non surgical (bridging external fixation n=30). They found that, at 3 months (p=<0.001) and 6 months (p=0.02), the operative group had significantly lower PRWE scores and no significant differences were found at the 12 month mark (p=0.3). This trend was also evident in the overall results from our study. The major limitation of this study is that the authors proclaimed that they feel their study may have been underpowered and as such did question if there was a significant difference at the 12 month mark too. After their retrospective power analysis. They found that 70-110 patients would be needed per group to make the 12 month PRWE differences – this would have required at least a 100% increase in sample size. This paper was still included in the overall analysis as the results were still considered valid by both researchers and Wilcke MK et Al

Selles, C.A et Al's paper was also a multicenter RCT[10]. It enrolled patients between the ages of 18 to 75 on the prerequisite that the DRF was, both,

'acceptably reduced' and intra-articular. What qualified as 'acceptably reduced' wasn't defined. This paper, unlike the others, found that there were better functional outcomes at the 12 month mark for operative treatment when compared to nonoperative treatment. This trend was also found at the 6 week (p=0.001), 3 week (p=0.03), 6 month (p=0.007) and 12 month (p=0.02) marks. This was also found when comparing Operative interventions with the 28.2% of nonoperative situations that needed subsequent surgery with p=<0.001, p=0.02, p=0.02 at 6 week, 3 month and 6 month points respectively. For the non operative group that had subsequent surgery, the differences in PRWE at 12 months were not significantly different to those that just had operative treatment. This was noted when analysis was undertaken and we decided that wasn't relevant for our study and as such, didn't include the nonoperative group that had subsequent surgery in our analysis.

We have considered the limitations of our study. Although our search encompassed 4 databases, we still could have missed some relevant articles relevant to our search. Given that the data in these studies were non-homogeneous, with two papers reporting mean and standard deviation and two reporting median and interquartile range, we had to assume that all studies had normally distributed data. The variation in quality and inherent bias has also been considered. The small sample size could also be a limitation, but the large number of participants overall does help to offset this. This meant that we couldn't assess publication bias. We do acknowledge the different types of surgical interventions, and if there were more viable papers, we would've stratified by type of intervention. Also, as patients were being treated, blinding was not completely possible for both the surgeons and participants. Importantly, each paper attempted to blind the two aforementioned group stakeholders where possible and ensured that statisticians were blinded. Overall, our results should be interpreted cautiously, considering the methodological limitations and limited number of studies available but our results should be supported with large scale, well designed prospective studies involving PRWE as a primary outcome.

To the best of our knowledge, this meta-analysis is the first to analyse the differences in PRWE at the 3 and 12 month marks between surgical and non surgical interventions post DRF. Based on: the PRISMA guidelines, protocol registration on PROSPERO and the Cochrane Collaboration Handbook's recommendations, transparency in the methodology for assessing and reporting the evidence was ensured.

CONCLUSION

Lower PRWE at 3 months in the surgical group is indicative of better short-term improvement hence may be the advised therapeutic modality in those who require a quicker return to normal function. However, greater Δ PRWE between 3-12 months in nonoperative group is indicative of better medium-term improvement. Nonetheless there is need for more high-quality randomised clinical trials investigating surgical and nonsurgical interventions, which most importantly establish a PRWE score pre-treatment (i.e. a baseline). Future studies should include more patients, have longer follow-up times, and perform subgroup analyses regarding age, severity and type of treatment of DRF.

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Conflict of interest: None declared.

Ethical approval: Not required.

REFERENCES

1. Cooper AM, Wood TR, Scholten II DJ, Carroll EA. Nonsurgical Management of Distal Radius Fractures in the Elderly: Approaches, Risks and Limitations. *Orthop Res Rev*. 2022;14:287-292
2. Ochen Y, Peek J, van der Velde D, et al. Operative vs Nonoperative Treatment of Distal Radius Fractures in Adults: A Systematic Review and Meta-analysis. *JAMA Netw Open.* 2020;3(4):e203497.
3. Gupta S, Halai M, Al-Maiyah M, Muller S. Which measure should be used to assess the patient's functional outcome after distal radius fracture? Acta Orthop Belg. 2014 Mar;80(1):116-8.
4. MacDermid JC. Development of a scale for patient rating of wrist pain and disability. J Hand Ther. 1996 Apr-Jun;9(2):178-83
5. Srikar Reddy Namireddy, Saran Gill. Surgical vs Nonsurgical interventions for distal radius fractures: a quantitative analysis of PRWE measures. PROSPERO 2023 CRD42023459150 Available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD4202345915. Accessed 8 September 2023.
6. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et Al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ* 2019; 366: l4898.
7. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JPA et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009; 339: b2700.
8. The Combined Randomised and Observational Study of Surgery for Fractures in the Distal Radius in the Elderly (CROSSFIRE) Study Group. Surgical Plating vs Closed Reduction for Fractures in the Distal Radius in Older Patients: A Randomized Clinical Trial. *JAMA Surg.* 2021;156(3):229-237
9. Costa ML, Achten J, Ooms A, Png ME, Cook JA, Lamb SE et al. Surgical fixation with K-wires versus casting in adults with fracture of distal radius: DRAFFT2 multicentre randomised clinical trial. BMJ. 2022 Jan 19;376:e068041. doi: 10.1136/bmj-2021-068041. Erratum in: BMJ. 2022 Feb 17;376:o423. Erratum in: BMJ. 2022 Mar 4;376:o580.

10. Selles CA, Mulders MAM, Winkelhagen J, van Eerten PV, Goslings JC, Schep NWL et Al. Volar Plate Fixation Versus Cast Immobilization in Acceptably Reduced Intra-Articular Distal Radial Fractures: A Randomized Controlled Trial. J Bone Joint Surg Am. 2021 Nov 3;103(21):1963-1969.
11. Wilcke MK, Abbaszadegan H, Adolphson PY. Wrist function recovers more rapidly after volar locked plating than after external fixation but the outcomes are similar after 1 year. Acta Orthop. 2011 Feb;82(1):76-81.
12. Sirniö K, Leppilahti J, Ohtonen P, Flinkkilä T. Early palmar plate fixation of distal radius fractures may benefit patients aged 50 years or older: a randomized trial comparing 2 different treatment protocols. Acta Orthop. 2019 Apr;90(2):123-128.
13. Chen Y, Chen X, Li Z, Yan H, Zhou F, Gao W. Safety and Efficacy of Operative Versus Nonsurgical Management of Distal Radius Fractures in Elderly Patients: A Systematic Review and Meta-analysis. J Hand Surg Am. 2016 Mar;41(3):404-13.