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Original Research

Volar Locking Plating Compared to Conservative Treatment in Distal Radius Fractures in Elderly Patients (>60 years old): A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Purpose: We performed a systematic review and meta-analysis to compare the efficacy of volar locking plating (VLP) to conservative treatment in distal radius fractures in patients aged >60 years old.
Methods: English articles were searched in electronic databases including MEDLINE, CENTRAL, Embase, Web of science, and ClinicalTrial.gov from inception to October 2020. Relevant article reference lists also were reviewed. Two reviewers independently screened and extracted data from trials comparing VLP to nonsurgical treatment in distal radial fractures in the elderly. Starting with 3052 citations, 5 trials (539 patients) met the inclusion criteria. The primary outcomes were disabilities of the arm, shoulder, and hand, and patient-rated wrist evaluation scores, grip strength, and range of motion.
Results: All trials of this random effect meta-analysis were at a moderate risk of bias due to the lack of blinding. Differences in the disabilities of the arm, shoulder, and hand score (mean difference [MD] −5,91; 95% confidence interval [CI], −8,83; −3,00), patient-rated wrist evaluation score (MD −9.07; 95% CI, −14.57, −3.57), and grip strength (MD 5,12; 95% CI, 0,59–9,65) were statistically significant and favored VLPs, however without reaching clinical significance. No effect was observed in terms of the range of motion and reoperation rates.
Conclusion: This review was not able to demonstrate any clinical benefit to the surgical treatment of distal radius fractures with VLP in patients aged >60 years old compared to nonsurgical treatment.
Type of study/level of evidence: Therapeutic I.

Distal radius fractures (DRFs), typically caused by a fall on an outstretched hand, are common in older people and the second most common fractures.[1] The best approach to treat DRFs in the elderly remains controversial.[2] Cast immobilization is the most common treatment for the majority of DRFs, as it stabilizes the fracture and allows the bone to heal. However, alignment often is lost rapidly in the elderly with osteoporosis.[3] Functional bracing, immobilization of the wrist in the neutral position, pronation, or supination are some of the several immobilization methods described.[4–6]

Internal fixation with a volar locking plate (VLP) was introduced with good clinical and radiological results,[7] thus becoming predominant in the surgical treatment of wrist fractures.[8–11] Patients aged >60 years old with unstable DRFs treated with a VLP had better grip strength, range of flexion, and radiologic outcome compared to Kirschner wiring.[8] Although it allows earlier motion, leading to an earlier return of function, the complication rate following volar plating can be as high as 22%[12] and a reoperation rate of 10.4%.[13] The most common complications associated with VLP include median nerve palsy, flexor tenosynovitis, extensor tenosynovitis, and tendon rupture.[14–16]

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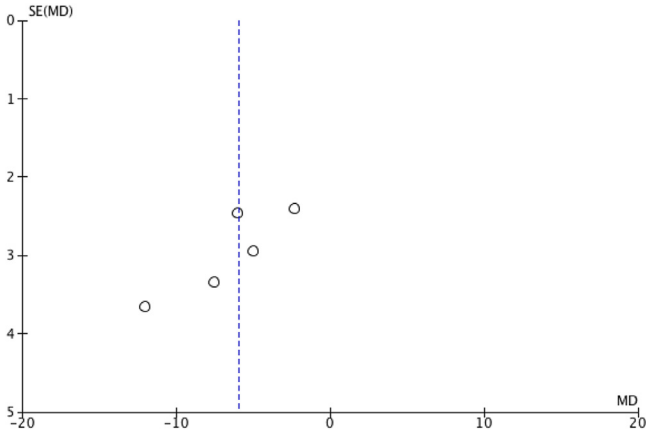

Figure 1. Funnel plot assessing publication bias for disabilities of the arm, shoulder, and hand score.

Surgical treatment with open reduction and internal fixation using VLP is widely prevalent despite the lack of evidence supporting its superiority over conservative treatment with closed reduction and plaster immobilization,[17] which historically was the mainstay of treatment in the elderly.[1] In this review, we aim to investigate whether the potential benefit of volar plating, namely earlier functional recovery, outweighs the risk of complications. It is worthwhile to determine the most effective treatment in older patients in the interest of the patients and society.[17,18] We aim to compare VLP to nonsurgical treatment in patients aged ≥60 years old with a DRF.

Materials and Methods

Literature search

To identify eligible studies, a systematic review was performed in accordance with the Cochrane Handbook for Systematic Reviews of Interventions.[19] The protocol for this review was registered previously in PROSPERO (ID: CRD42021230245). Six literature databases were consulted from inception until October 19, 2020: MEDLINE (Ovid), EMBASE (Embase), Cochrane Central Register of Controlled Trials, Web of Science and Clinical Trials.gov. Randomized controlled trials (RCTs) were identified using validated filters[20] in MEDLINE, Embase ,and Web of Science and the search strategy was reviewed by an information specialist. Review articles' references were scanned to make sure that no relevant study was missed using the database search. Selected search terms included: "randomized controlled trials, RCTs, radius fracture, radius distal fracture, wrist fracture, forearm fracture, radial fracture, palmar plate, VLP, palmar locking plate, and internal fixation" (Appendix 1, available on the *Journal's* website at wwwjhsgo.org).

Inclusion and exclusion criteria

Level 1 evidence, prospective RCTs comparing VLPs to conservative treatment in DRFs in elderly patients (>60 years old) were included, regardless of language, year, or status of publication. Surgical treatment is limited to volar plating, whereas conservative treatment is defined as any nonsurgical treatment, such as closed reduction and cast immobilization. Animal or cadaver studies were excluded.

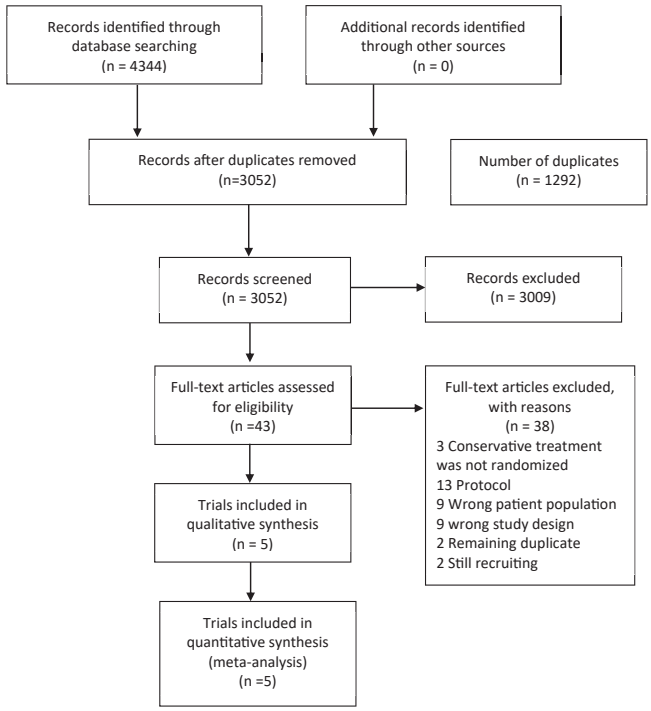

Figure 2. Study flow diagram.

Study selection

Two reviewers (R.M. and A.N.) independently performed all 3 steps of the selection process (screened titles, abstracts and full publications, eligibility and inclusion in meta-analysis). Both reviewers extracted data using a standardized, piloted data extraction form into a Microsoft Excel database (Microsoft Corp.). Disagreements were handled by an expert in the field (SP) (available upon request).

Methodological quality assessment

The risk of bias using the Cochrane Collaboration's Risk of Bias Tool for randomized trials 2[21] was assessed for every outcome and the senior author (SP) was consulted in case of disagreement. The risk of bias was recorded in review manager 5.4 (RevMan, The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Norway) and classified as low, unclear, or very high risk. It was attributed according to the worst assessed score for each item in the tool. To ensure good methodology, methods in each RCT (randomization, double-blinding, and follow-up) were reviewed. Of note, blinding surgeons is impossible, since they know which treatment is given.

Data and statistical analyses

For each trial, data extraction included study characteristics; demographics; individual treatment information; grip strength and functional outcomes, such as disabilities of arm, shoulder & hand score (DASH), patients-rated wrist evaluation score (PRWE); ranges of motion (palmar flexion, dorsal flexion, ulnar deviation, radial deviation, supination, and pronation); radiographic observations (malunion, volar tilt angle, radial inclination, ulnar variance, and stepoff); recurrence rate, reoperation rate, and adverse events, such as wound infection, volar plate infection, nerve or tendon injury, complex regional pain syndrome, and any other complication were

Table 1
Characteristics of Included Trials

Study ID	Study Design	AO Classification	Initial No Participants		Woman		Age (SD or Range)		FU (mo)	Treatment (duration wear)	Physiotherapy
			VLP	C	VLP	NT	VLP	NT			
Arora 2011[28]	RCT	AC	36	37	28	27	75.9 (65–88)	77.4 (65–89)	12	Ca (5w)	+
Bartl 2014[27]	RCT	C	86*	81	77	76	75.3 (6.7)	74.4 (7.1)	12	Ca (6w)	+
Sirniö 2019[24]	RCT	AC	38	42†	37	39	62 (50–79)	64 (50–82)	24	Ca (6w)	−
Saving 2019[25]	RCT	AC	58	64‡	55	56	80 (70–90)	78 (70–98)	12	PS (4–5w)	−
Martinez-Mendez[26] 2017	RCT	C	50	47	39	37	67 (8)	70 (7)	24	Ca (4w)	+

VLP, volar locking plate; Ca, casting; PS, plaster splint; w, weeks; C, intraarticular fractures; AC, intra-articular and extra-articular fractures; NT, nonsurgical treatment. +, physiotherapy was prescribed; −, physiotherapy was not prescribed, even though indications for active mobilization were given. SD, standard deviation; FU, follow-up.

* Only 68 of 86 patients were evaluated at the 12-month follow-up.

† 16 patients underwent a delayed operation.

‡ Only 63 of 64 patients were assessed at the 12-month follow-up.

Table 2
Summary of Findings and Grading of Recommendations, Assessment, Development and Evaluations assessment

Quality of evidence								No of the participants		Effect	
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Publication bias	Overall quality of evidence	VLP	NT	Relative (CI 95%)	Absolute (CI 95%)
Functional outcomes (DASH score; follow-up 12–24 mo; measured with: DASH score (100); range of scores: 5,7–28; Better indicated by lower values)											
5	RCTs	Moderate*	Not serious	Not serious	Not serious	Not measurable	Moderate	268	271	−	−5.91 [−8.83, −3.00]
Functional outcomes (PRWE score; follow-up 12–24 mo; measured with: PRWE score (100); range of scores: 12,7–30; Better indicated by lower values)											
3	RCTs	Moderate*	Not serious	Not serious	Not serious	Not measurable	Moderate	144	148	−	−9,07 [−14.57, −3.57]
Functional outcomes (grip strength; follow-up 12–24 mo; measured with a dynamometer); range: 18,8–96; Better indicated by higher values)											
4	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	182	190	−	5,12 [0,59, 9,65]
Functional outcomes (Ulnar deviation; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
3	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	132	143	−	2,81 [1,07, 4,55]
Functional outcomes (Palmar flexion; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
4	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	182	190	−	2.88 [−4.72, 10.49]
Functional outcomes (Dorsal flexion; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
4	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	182	190	−	0.22 [−1.68, 2.12]
Functional outcomes (Radial deviation; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
3	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	132	143	−	−0.68 [−2.05, 0.69]
Functional outcomes (Supination; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
4	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	182	190	−	5.63 [−0.13, 11.38]
Functional outcomes (Pronation; follow-up 12–24 mo; measured with a goniometer); Better indicated by higher values)											
4	RCTs	Low -risk	Not serious	Not serious	Not serious	Not measurable	High	182	190	−	2.74 [−1.49, 6.97]

NT, nonsurgical treatment.

* Downgraded once since all studies were at a high risk of bias.

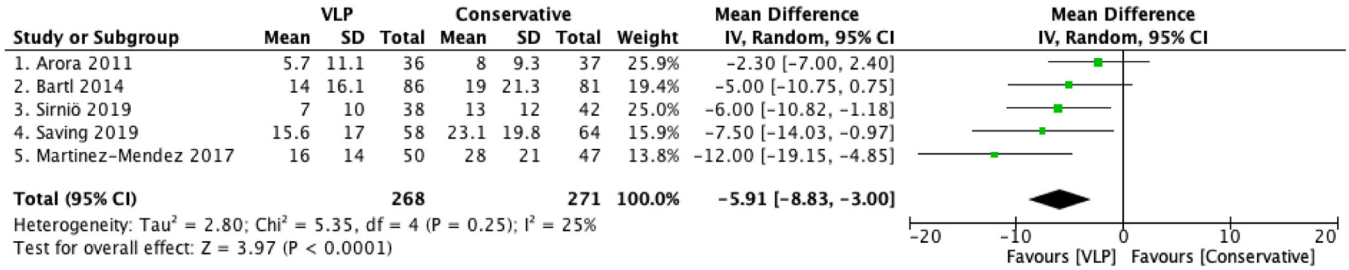

Figure 3. Forest plot comparing VLP and conservative treatment at 12 and 24 months of follow-up for the disabilities of the arm, shoulder, and hand score. CI, confidence interval; IV, inverse variance; Random, random effects; VLP, volar locking plate; conservative, conservative treatment.

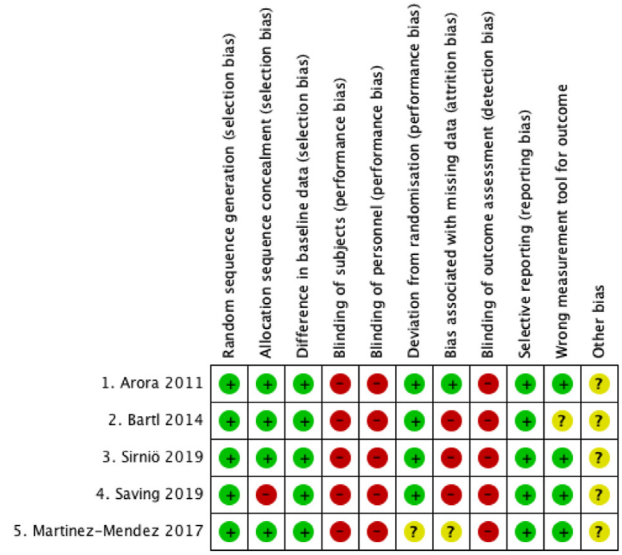

Figure 4. Summary of risk of bias for each study concerning the disabilities of the arm, shoulders, and hand score. A plus sign indicates low risk, minus sign, high risk, and question mark, unclear risk.

assessed. Statistical analysis was carried out using review manager 5.4. mean differences (MD) and standardized mean differences with 95% confidence intervals (CIs) were used to compare pooled continuous data. Complications, reoperations, and revisions were dichotomized, using the number of events collected in each study and presented in a table. Pooled dichotomous data (reoperation, recurrence) were expressed as a risk ratio (RR) with 95% CI.

The importance of each study was pondered using inverse-variance weighting and random effect (DerSimonian and Laird method) for meta-analysis.[22] A minimum of 3 studies was required for meta-analysis. The presence of statistical heterogeneity was assessed using the Higgins Score (heterogeneity I^2 statistic test) in each group and in every subgroup.[23] If substantial or considerable heterogeneity was identified, subgroup analysis would be used to investigate this heterogeneity. All subgroup analyses were defined a priori to evaluate known or potential sources of heterogeneity and are presented in Appendix 2 (available on the *Journal's* website at www.jhsgo.org). To assess the publication bias, funnel plots (see Fig. 1) were examined visually for asymmetry.

Results

Of the 3052 retrieved citations, we included 5 RCTs published between 2011 and 2019 enrolling 539 patients treated non-operatively or with VLP. All trials were conducted in Europe and patients' mean age >60 years. Figure 2 presents the flowchart of the study, and Table 1 the main characteristics of the included studies.[24–28] According to the GRADE framework, we rated the quality of evidence of functional scores as moderate and ranges of motion as high (Table 2).

Primary outcomes

The VLP group was associated with lower (better) DASH scores (MD −5.91; 95% CI, −8.83; −3.00; I^2 = 25%; 539 patients; 5 trials[24–28]; Fig. 3). All trials were at a moderate risk of bias due to the lack of blinding (Fig. 4).

The VLP group was associated with lower PRWE scores. The mean difference was statistically significant, and heterogeneity was classified as insignificant (MD −9.07; 95% CI, −14.57, −3.57; I^2 = 28%; 292 patients; 3 trials).[25,26,28] The risk of bias was judged to be moderate for all trials.

The VLP group was associated with better grip strength. The mean difference between both groups was statistically significant and heterogeneity was classified as substantial (MD 5,12 (95% CI, 0,59–9,65; I^2 = 73%; 372 patients; 4 trials).[24–26,28] The risk of bias was judged to be moderate for all trials.

Range of motion was not statistically significant, and heterogeneity was evaluated as considerable, for all directions and all subgroups. Detailed results are available in Appendix 2.

Subgroup analyses showed insignificant subgroup differences for all primary outcomes.

Secondary Outcomes

We presented radiographic measures, such as volar tilt angle, radial inclination, ulnar variance, and stepoff, as means with their standard deviation and *P* value (Table 3). Volar tilt angle and radial inclination seem to favor VLP being closer to the normal values, while radial inclination ulnar variance seems to be favoring nonsurgical treatment. Stepoff results were not statistically significant.

The reoperation RR between both groups was not statistically significant. Heterogeneity was evaluated as moderate (RR, 1.67; 95% CI, 0.53, 5.24; I^2 = 43%; 372 patients, 4 trials).[24–26,28] Subgroup analyses showed insignificant intergroups differences. Adverse events could not be analyzed because of a large heterogeneity between studies.

Discussion

In this review, the elderly patients (defined as >60 years old) treated with VLP achieved statistically better functional results (DASH and PRWE score) and better grip strength than patients with nonsurgical treatment, without reaching clinical significance based on the minimal clinically important difference (MCID).

Table 3
Radiographic Results

Radiographic outcome	N° of studies	VLP		Conservative treatment		*P* value
		Mean (SD)	N	Mean (SD)	N	
Volar tilt angle (°)	5	3.75 (7.84)	248	−5.59 (14.34)	246	<.001
Radial inclination (°)	5	20.46 (5.71)	248	16.01 (7.44)	246	<.001
Ulnar variance (mm)	5	1.24 (2.32)	248	2.03 (2.38)	246	.0002
Stepoff (mm)	2[17,19]	0.32 (0.83)	86	0.82 (2.36)	84	.0616

Normal range of volar tilt (10°–25°), radial inclination (21°–25°), ulnar variance (2.5 mm), stepoff (<1–2mm).[22]

These findings support some of the conclusions of other systematic reviews, while these reviews assessed a different clinical question and used different inclusion criteria.

Fu et al[29] conducted a systematic review to evaluate the effects of VLPs compared to nonsurgical treatment in DRFs in the elderly. The population differed from this review since the investigators included late-aged adults (>50 years old), as well as observational and retrospective studies. The DASH score effect estimate was not statistically significant between treatments and grip strength estimate favored the nonsurgical group. This difference probably is due to the larger heterogeneity of the included studies. The inclusion of younger patients in the review also can explain this difference.[30]

A systematic review conducted by Chen et al[31] on the safety and efficacy of operative versus conservative management of DRFs in elderly patients does not support that operative management can provide better clinical outcomes. Grip strength was not statistically different between the groups, and a significant difference was noted when comparing DASH scores between different surgical treatments. They also suggested that VLPs resulted in the highest rate of major complications requiring surgery and that the nonsurgical treatment had the lowest rate of complications in all categories. The investigators included a wide variety of trials (RCT and retrospective) with a large heterogeneity and different surgical treatments preventing comparisons with this review.

An older systematic review[32] on outcomes and complications after treating unstable DRFs in the elderly suggested that despite worse radiographic outcomes associated with the conservative treatment, functional results were not different from patients treated surgically. In this study, we observed a better radiologic result with the VLP, and patients with VLP have better functional scores. However, the number of included patients is too low to achieve enough power to demonstrate a solid link between the radiologic aspect and the functional result.

Another review evaluated all RCT comparing any surgical to nonsurgical treatment and suggested that nonsurgical treatment still may be the preferred option for patients aged >60 years old with a DRF due to lack of evidence showing a decrease in complications with other treatment options, and that the minor functional differences did not reach MCID for DASH and PRWE scores.[33] The impact on subjective functional outcomes and quality of life remains uncertain.[34] The main difference with this review is the inclusion of lower-quality RCTs with mixed surgical treatment arms, that can hire the potential benefit of VLPs. A more recent review conducted by Stephens et al[35] showed similar conclusions to ours. However, aiming to compare VLP to nonsurgical treatment in the elderly, they included a randomized clinical trial evaluating patients from 18–75 years old,[36] that we chose not to include since it differed from our target population.

We also observed a statistically significant difference in functional scores that do not reach the MCID for DASH and PRWE scores. We can explain this partially with the inclusion on lower-quality RCTs with small sample sizes. Higher quality RCT specifically dedicated to this question, with greater sample size, and with age subgroup randomization blocks (≥60, ≥70, and ≥80 years old) will help to answer the question and prevent heterogeneity.

Our review aimed to compare specifically VLP to nonsurgical treatment in patients aged >60 years old with level 1 evidence. The rigorous method used provides the best actual evidence. The main limitation is a substantial to considerable heterogeneity between groups for the grip strength and range of motion. The length of follow-up varied depending on the measured outcome and the trials, which could have affected the measure of association. Although we performed our systematic review according to high methodological standards, the results are limited by the quality of trials included. None of the studies had blinded their participants, personnel, investigators, or outcome assessment to the assigned intervention group. We could not perform subgroup analyses related to sex, an important variable to assessing bone quality in the elderly.

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