Volar locking plate versus external fixation in distal radius fractures: A meta-analysis

Giuseppe Maccagnano,[1,2] Giovanni Noia,[1] Giovanni Vicenti,[3] Marco Baglioni,[3] Maria Rosa Masciale,[3] Giuseppe Danilo Cassano,[3] Raffaele Vitiello,[4] Biagio Moretti,[3] Vito Pesce[1,2]

[1]Orthopedic and Trauma Unit, Department of Clinical and Experimental Medicine, Faculty of Medicine and Surgery, University of Foggia, Policlinico Riuniti di Foggia; [2]University of Foggia; [3]Orthopaedic and Trauma Unit, Department of Basic Medical Sciences, Neuroscience and Sense Organs, School of Medicine, University of Bari, AOU Consorziale Policlinico, Bari; [4]Fondazione Policlinico Universitario A. Gemelli IRCCS, Roma, Italy

Abstract

The purpose of this meta-analysis is to evaluate the efficacy of plate or external fixator treatments in distal radius fractures, based not only on clinical and radiographic parameters but on Health Related Quality of Life (HRQOL) parameters. The Preferred Reporting Items for Systematic Reviews and Metanalyses (PRISMA) guidelines were followed when conducting this systematic review. The Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) checklist was additionally consulted in order to ensure a high-quality methodological process, encompassing such elements as an 'a priori' design, independent reviews and comprehensive search. The literature search was carried out on PubMed, MEDLINE and Scopus. The search terms used were "Radius fracture AND osteosynthesis", "Wrist fracture AND external fixator" and "Wrist fracture AND plate". Two reviewers independently screened titles, abstracts and full texts. To determine inter-reviewer agreement, a k score was calculated after each screening state. Of the 5753 studies collected through the initial databases search, two studies were included in the final meta-analysis (125 treated with external fixator vs 132 with volar plate). There was a substantial inter-reviewer agreement as to the title (0.73; 95% confidence interval, 0.67-0.79) abstract (0.65; 95% CI, 0.46-0.83) and full-text screening stages (0.89; 95%CI, 0.67-1). The meta-analysis reported a mean difference equal to 0.00 (95%CI= -0.05 – 0.05), in accordance with I^2= 0% and p test for the heterogeneity value=0.089. This meta analysis confirms and quantifies that the two techniques are superimposable as regards the quality of life reported by patients at least one year of follow-up.

Introduction

Distal radius fractures are the most common types of fractures in pediatric and elderly populations. They account for roughly 25% of fractures in the pediatric population and up to 18% of all fractures within the elderly age group.[1,2] Data collected over the past 40 years has shown a overall increase in the prevalence of this injury.[3] The growing elderly population and the rising number of the active elderly are directly responsible for the increase observed in this age group.[4] Changes in the cultural dietary habit may be responsible for the altered bone metabolism, affecting the overall incidence of distal radius fractures.[5] Moreover, as the population ages and individuals strive to remain active, an increase of fractures caused by minor traumas has been observed.[6]

Distal radius fractures can be a significant cause of mortality and loss of independence in the elderly. Such decline is virtually defined by a worsened ability to prepare meals, perform heavy housekeeping, climb 10 stairs, go shopping and get out of a car.[7]

Multiple treatment options for patients with distal radius fractures are available, including closed reduction and cast immobilization, percutaneous K-wire fixation, volar or dorsal fixation plates (locking or non locking), bridge plating, use of an external fixator (EF), or a combination of those techniques. Over the past decade, a host of studies has attempted to discover and understand the factors which define treatment options and optimize outcomes in the active elderly patient affected by distal radius fracture. Unfortunately, treatments for those injuries are controversial.[8] For instance, even though clinical practice guidelines for distal radius fracture published by the American Academy of Orthopaedic Surgeons (AAOS) made 29 recommendations, none of them received a "strong" rating due to limit edevidence power.[9]

Most of the randomized trials and all meta-analyses focused on the comparison between external fixators and internal plate fixation, often with inconclusive results.[10,12]

Correspondence: Giovanni Noia, Department of Clinical and Experimental Medicine, Foggia University School of Medicine, AOU Policlinico Riuniti, Viale Luigi Pinto 1, 71222, Foggia, Italy.
Tel.: +39.3280238547.
E-mail: giovanni.noia@live.com

Key words: Wrist fracture, external fixattion, open reduction internal fixation (ORIF), clinical outcome, health-releated quality of life.

Contributions: GM, study designer; GN, article writer; GV, article writer; MB, literature reviewer; MRM, literature reviewer; GDC, literature reviewer; RV, statistical analyzer; BM, final article reviewer; VP, study designer

Conflict of interest: The authors declare no conflicts of interest.

Funding: None.

Data availability: Readers are encouraged to contact the authors for details about the study population.

Received for publication: 20 March 2021.
Accepted for publication: 27 March 2021.

Orthopedic Reviews 2021;13:9147
doi:10.4081/or.2021.9147

First introduced by Orbay in 2000, volar locking plates (VLP) have become increasingly popular for treating distal radius fractures in recent years.[13,14] VLP provide biomechanical stability, enable the fixation of comminuted and osteoporotic bone and promote early return to activities of daily life.[15,16] However, there are more than 40% of complication rates reported,[17] such as extensor and flexor tendon injuries, prominent screw, improper plate position and insufficient reduction,[18] leading to the hardware removal as well as to increasing risks and costs. However, plate removal has been reported even if there were no symptoms with frequency, after bony healing, and it varies from 0 to 100% depending on the surgeon, institution or country.[19,20]

The external fixator is a traditional and important treatment for complex fractures of distal radius. External fixation is a valuable approach for wrist fracture treatment, with the advantages of being minimally-invasive, allowing mobilization of the joint and providing early stability of the fracture with acceptable results.[21] However, recurrent displacements occurred in more than

half of the cases and the complication rate for this technique is 20-35%.[22,23]

It is useful to take into account some parameters in order to compare clinical outcomes: the Disabilities of Arm Shoulder and Hand (DASH) and radiographic values, such as radial height, volar tilt and ulnar variance. Due to the lack of supremacy of one of the two devices in terms of function, we have decided to take into account the Health-Related Quality of Life (HRQOL) parameters. Even though HRQOL parameters have drawn increased attention recently, they have not been considered yet.

The purpose of this meta-analysis is to evaluate the efficacy of plate or external fixator treatments in distal radius fractures, based not only on clinical and radiographic parameters but - most importantly - on HRQOL parameters.

Materials and Methods

The Preferred Reporting Items for Systematic Reviews and Metanalyses (PRISMA) guidelines were followed when conducting this systematic review.[24]

The Revised Assessment of Multiple Systematic Reviews (R-AMSTAR) checklist was additionally consulted in order to ensure a high-quality methodological process, encompassing such elements as an 'a priori' design, independent reviews and comprehensive search.

Search strategy

The literature search was carried out on PubMed, MEDLINE and Scopus and was completed on April 09, 2019. The search terms used were "Radius fracture AND osteosynthesis", "Wrist fracture AND external fixator" and "Wrist fracture AND plate". On the one hand, the inclusion criteria in the research were: human studies, all levels of evidence, studies in which the HRQOL (SF-12, SF-36 and EQ-5D) was present, patients treated with plate or external fixator, articles written in English. On the other hand, the exclusion criteria were: cadaver studies, studies without HRQOL outcome, other systematic reviews.

Table 1. Scores for prognostic and diagnostic studies.

High quality study	<1 Flaw
Moderate quality study	≥1 and <2 Flaws
Low quality study	≥2 and <3 Flaws
Very low quality study	≥ 3 Flaws

Table 2. Scores for randomized and observational studies.

High quality study	<2 Flaw
Moderate quality study	≥2 and <4 Flaws
Low quality study	≥4 and <6 Flaws
Very low quality study	≥6 Flaws

Study reviewers

Two reviewers (M.R.M. and G.D.C.) independently screened titles, abstracts and full texts of the studies to be included in the review.

Discrepancies between the reviews were thoroughly examined to the full text screen to avoid inadvertent exclusion. At this stage, potential discrepancies have been overcome by consensus debate mediated by a third senior reviewer (M.B.).

Determination of inter-reviewer agreement. To determine inter-reviewer agreement, a k score was calculated after each screening state. A k>0.6 was considered as substantial agreement, a k between 0.21 and 0.6 was considered as moderate agreement, and a k<0.2 was considered as slight agreement.

Assessment of study quality

The Grading Quality of Evidence and Strength of Recommendations criteria,[25] processed by Grade Working Group and included in "AAOS Guideline and Systematic Review Processes v2.0"[26] was used to assess the quality of each study included. There are several checklists to determine the quality of randomized, prognostic, diagnostic and observational studies. All of them consists of six questions, three additional questions for observational studies and randomized studies. For prognostic and diagnostic studies, the scores are shown in Table 1 while in Table 2 the scores for the randomized and observational studies are shown.

Data abstraction

The two reviewers (M.R.M. and G.D.C.) independently collected data from the included studies, inserting them into predetermined tables. The following data, when available, were collected from each article: primary author, year of publication, study design, level of evidence, number of patients, patient demographics (*i.e.,* sex,

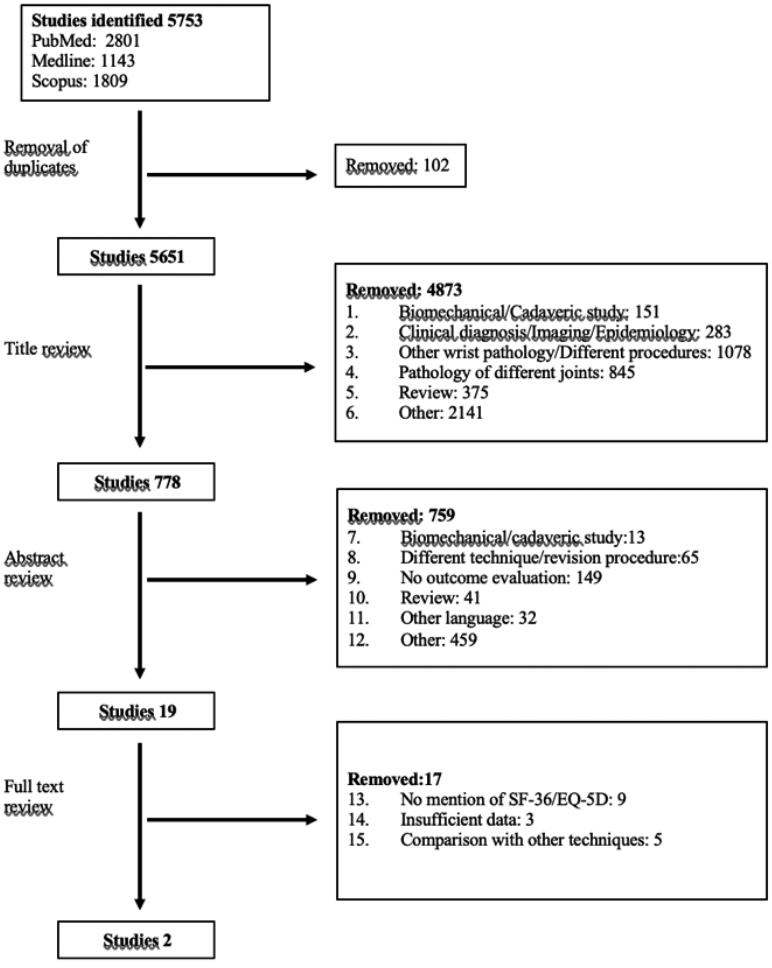

Figure 1. Flowchart of studies selection.

age, etc) and technique of performed surgery. Outcomes measures such as SF-36, EQ-5D, SF-12 and complications were also collected for each study, where reported.[27-30]

Statistical analysis

The values of the EQ-5D score were extracted at least 1 year after the surgery. When studies did not report a standard deviation, it was calculated from the standard error, using the Cochrane method.[31]

The weighted mean differences (WMDs) with 95%CI were calculated for the continuous outcomes of each study. The mean difference was not standardized because each outcome of interest was assessed separately, and the unit of measurement was the same across studies for the specified outcomes.

An inverse-variance random-effects model was used. Forest plots were used to determine if there was variable specific efficacy heterogeneity. The I^2 test was used to assess heterogeneity based on the thresholds reported in the Cochrane Handbook for Systematic Reviews of Interventions: 0%-40% might not be important, 30%-60% may represent moderate heterogeneity, 50%-90% may represent substantial heterogeneity, and 75%-100% may represent considerable heterogeneity. P-value<0.05 was considered statistically significant for heterogeneity.

It was not possible to assess potential publication bias because of the limited number of studies included; furthermore, any quality sub-analysis was assessed for the same reason.

Results and Discussion

The PubMed, MEDLINE and Scopus database searches provided a total of 5753 studies for potential inclusion in the review (Figure 1).[32,33]

After adjusting for duplicates, 5651 studies remained. Of these, 5632 studies were discarded after reading titles and reviewing abstracts.

The full text of the remaining nineteen studies was examined in greater detail. Of these, seventeen studies did not meet the inclusion criteria, in particular three studies were excluded because of insufficient data and no response from the corresponding author to the request for missing data,[34-36] in nine studies was no mention of SF-36 or EQ-5D although five studies reported HRQoL scores on patients treated with other technique, they did not make a direct comparison between the two techniques,[37-41] thus they were excluded.

Two studies passed the inclusion and exclusion criteria for use in this review (Figure 1).

There was a substantial inter-reviewer agreement as to the title (0.73; 95% confidence interval, 0.67-0.79) abstract (0.65; 95% CI, 0.46-0.83) and full-text screening stages (0.89; 95%CI, 0.67-1).

The two studies were published between 2016 and 2019. The one by Mellstrand Navarro C. at al.[32] is level of evidence I and the one by Saving *et al.*[33] is level of evidence II.

The demographics of patients in the 2 studies are reported in Table 3.

The meta-analysis reported a mean difference equal to 0.00 (95%CI= -0.05 – 0.05), in accordance with I^2= 0% and p test for the heterogeneity value=0.089 (Figure 2).

The two studies included 132 patients undergoing open reduction and internal fixation with plate and screws and 125 patients surgical treatment with external fixator (Table 4).

Complications

Reoperation occurred in 23 patients treated with EF and in 26 patients treated with VLP. In VLP group the major cause of reoperation was the removal of plate (18), while in the EF group the major cause of reoperation was revision with plate for loss of reduction (11), 5 of these have removed the plate. The most common complication after VLP was a transient disfunction of median nerve which was reported by 25 patients. The most frequent complication in the EF group was wound infection which occurred in 14 patients. The complete list of complications reported by the two included studies is shown in the Table 5.

Table 3. Demographics of the patients included in the two studies.

Author	Title	Year	Nation	N. of patients VLP	Mean age VLP (range)	Gender M/F VLP	N. of patients EF	Mean age EF (range)	Gender M/F EF	Follow-up (months)
Mellstrand Navarro C. *et al.*	Volar locking plate or external fixation with optional addition of K-wires for dorsally displaced distal radius fractures: a randomized controlled study	2016	Sweden	70	63 (50-74)	7/63	69	63 (50-74)	5/64	12
Saving J. *et al.*	External fixation versus volar locking plate for unstable dorsally displaced distal radius fractures – a 3-year follow-up of a randomized controlled study	2019	Sweden	62 (50-74)	63	7/55	56 (50-74)	63	2/54	36

Table 4. Results of the evaluation of patients included in the 2 studies.

Author	PRWE VLP	PRWE EF	DASH VLP	DASH EF	EQ-5D VLP	EQ-5D EF	Level of evidence	Quality
Mellstrand Navarro C. *et al.*	13±9	14±7	11±7	13±8	0.85±1	0.89±1	I	High
Saving J. *et al.*	6.1±9.1	6.6±12	5.4±7.2	7±9.9	0.92±0.13	0.92±0.13	II	Moderate

Discussion

Distal radius fracture management in elderly patients remains without consensus regarding the appropriate treatment or anticipated outcome.

Multiple treatment options for patients with distal radius fractures are available. This systematic review mainly focuses on the HRQoL's difference between EF and volar locking plate for the treatment of distal radius fracture in the elderly at one year follow up.

Clinical outcome was assessed in the selected articles using different rating scales such as PRWE, DASH and shown in Table 4. We focus, as already mentioned on Quality of Life and in particular on EQ-5D score. The analysis highlights no statistical difference between ORIF or EF at the final follow up. The statistical analysis is shown in Figure 2.

The complications reported by the two treatments are almost overlapping: 53 (42.4%) for patients treated with FE and 55 (41.7%) for patients treated with ORIF. The need for a surgical revision was 18.4% (23 patients) in the EF group and 19.7% (26 patients) in the ORIF group. The population size was not large enough to make any statistical inferences regarding complications.

The strenghts of this study are based on rigorous application of PRISMA and R-AMSTAR guidelines, ensuring that the highest methodological quality of review was performed. Broad search terms and multiple databases were used to ensure that the literature included in this study was as much comprehensive as possible. In addition, the k statistic was used to verify that relevant studies were not being eliminated due to chance. The AAOS criteria were used to determine which strong recommendations could be made based on the quality of the studies. Since the tests results for patients' quality of life are closely linked to age and gender, the included studies are homogeneous for sex and age, thus enabling the exclusion of any bias linked to these characteristics.

One of the great limitations of this meta-analysis is that depite their good quality, the included studies are limited in the number. This is due to the fact that there are just few studies that compare the two techniques, some of them report incomplete data on outcomes and other do not take HRQOL parameters into account.

Another limitation is that the follow-ups reported by the two studies are not homogeneous and one of the included papers did not report the standard deviation for which it was necessary to calculate it.

Other limitations due to the smallness of sample and the characteristics of the included studies are the impossibility of sub-analysis based on the quality of the study, the impossibility of calculating the differences in the score between t0 and the end of follow-up and the impossibility to do the funnel plot.

Thus, conclusions must not be taken as absolute, but rather they must be framed within the tenets of evidence-based medicine including a shared decision-making process with the patient encopassing their specific characteristics and surgeon experience.

Table 5. Complete list of complication reported in the 2 studies included.

	External fixator (n=125)	Volar locking plate (n=132)
Secondary plating owing to fracture redisplacement	11	4
Plate extraction		
Tenosynovitis	5	14
Complex regional pain syndrome	0	1
Other	0	3
Fasciotomy owing to compartment syndrome	0	1
Carpal tunnel release	3	2
Debridement owing to deep infection	2	0
Scar correction	2	0
Tendon transfer owing to extensor tendon rupture	0	1
Transient disfunction of median nerve		
< 1 year	17	19
> 1 year	0	7
Superficial wound infection	11	0
CRPS	2	3
Total	53	55

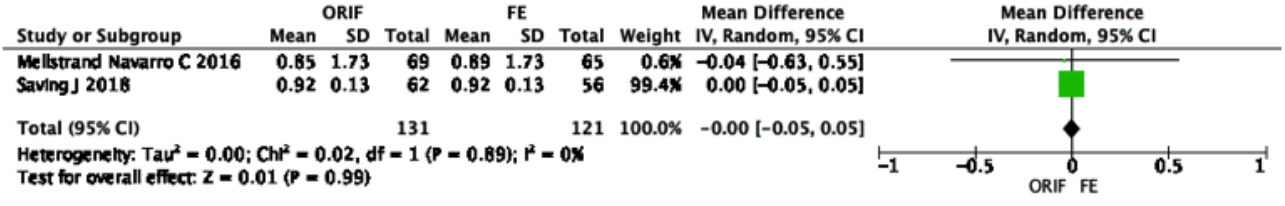

Figure 2. Forest plot of mean difference.

Conclusions

Analyzing the study results we did not find any significant statistical differences in terms of the quality of life in patients treated with external fixation and in those treated with plate and screws. According to literature we can confirm that there is no difference in terms of functional results at least one year follow-up between external fixator and plate. The number of post-surgery complications is also comparable for the two techniques. Therefore, as already stated, the choice of the device has to consider the patient's age, the type of fracture, the skin conditions, the patient's pathologies and the surgeon's skills. Although no strong conclusions can be drawn due to the limitations reported. Further high quality studies are needed underling the psychological view and quality of life in order to draw stronger conclusions.

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