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Systematic Review and Meta-analysis

Locking plate versus external fixation for type C distal radius fractures: A meta-analysis of randomized controlled trials

Dong Wang, Lei Shan, Jun-Lin Zhou*

Department of Orthopaedics, Beijing Chao-Yang Hospital, No. 8 Workers Stadium Road, Chaoyang District, 100020, Beijing, China

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ABSTRACT

Purpose: Distal radial fracture is one of the most common fractures. Up to now, locking plates (LP) and external fixation (EF) are two conventional surgical approaches to type C radius fracture. Which method is superior has not yet reached a consensus. We try to assess the clinical effectiveness of the two interventions by this meta-analysis.

Methods: We used network to search the PubMed, Embase, and Cochrane Medical Library of randomized controlled clinical trials about the type C distal radius fractures performed according to the search strategy mentioned in Cochrane Handbook 5.1.0 from Jan. 2005 to Jan. 2016. Patients in the experimental group were used LP, in the control group were included EF and other surgical approaches. Publication language was restricted to English. Studies that patient population and surgical indication did not define had been excluded. Studies must report at least one of the outcomes as follow: radial inclination, palmar tilt, ulnar variance, range of wrist flexion and extension, and range of wrist supination and pronation. The trials in which participants included children were excluded. We used Jadad study scores to appraise the study.

Results: Seven studies included 162 patients (LP group) and 190 patients (EF group). We compared the radial inclination, palmar tilt, ulnar variance, range of wrist flexion and extension, and range of wrist supination and pronation. The radial inclination were revealed a difference favoring LP over EF [WMD = 1.84, 95% *CI* (0.17, 3.50), $p = 0.03$] and the palmar tilt and ulnar variance was no significant difference between the two groups [(WMD = 3.61, 95% *CI* (0.00, 7.23), $p = 0.05$; WMD = 0.05, 95% *CI* (−0.99, 1.09), $p = 0.93$]. The functional activities of range of flexion and extension and range of supination and pronation between the two groups was no difference [WMD = 10.04, 95% *CI* (−6.88, 26.96), $p = 0.24$; WMD = 12.53, 95% *CI* (−9.99, 35.06), $p = 0.28$].

Conclusion: Locking plate and external fixation is feasible to heal radius type C fracture. We found the small difference between the two groups on imaging examination. The locking plate has the advantage on maintaining reduction, however no significant difference regarding outcomes has been found between the two groups.

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Introduction

Distal radial fracture is one of the most common fractures.[1] Fractures of the distal radius are account for an estimated 17% in all fractures diagnosed.[2] Because of the osteoporosis, most of fractures are obviously displaced and require surgery. Several surgical approaches have been advocated, and the decision-making was mainly based on fracture type and the general condition of the patient.[3]

The management methods of distal radius fractures have changed fundamentally over the previous two decades. Before that, casts or splints were universally used to immobilized, and the function activities of wrist was at least 6 weeks after immobilization. That method causes amyotrophy and the wrist function is hard to recover. The postoperative malformation is still existed as the immobilization was insecure. Then, along with the fixation tools developing, many varieties of highly sophisticated operative interventions come out. Several choices can be made for managing osteoporotic unstable fractures of distal radius. The fracture can be fixed by closed reduction with percutaneous Kirschner-wire or pins or external fixation (EF). The ability of fixation increased following

* Corresponding author.
E-mail address: 13240718193@163.com (J.-L. Zhou).
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the revolution of plate. The locking plates (LP) are better than common steel plate and dynamic compression plate in firmly hold the type C distal radius fracture block. Up to now, both EF and LP can be used for fixing the type C radius fracture.

A lot of studies came to compare the difference of EF and LP. Some researches support the use of LP for the treatment of unstable distal radius fractures,[4] and some not.[5] Several randomized studies show no difference in long-term results after surgery with LP in comparison with percutaneous techniques.[6] The choice of the best option still remains controversial.[1]

Recently, some researchers have done the meta-analysis of randomized controlled clinical trials (RCTs) compared VLP (volar locking plate) with EF for the treatment of unstable distal radius fractures, but the result is worth discussing. There is a significant difference between type A and type C fracture. Type A fracture is extra-articular and it cannot influence the wrist articular surface and type C is wrist articular surface involved. Some type A fracture is stable and both EF and LP can get excellent outcomes. The proportion of type A and type C is not clear in the prior meta-analysis and the researches put all the types together to analysis. The results cannot be true. Moreover, additional studies have been reported since the earlier meta-analysis, which would make the present meta-analysis more precise and reliable. We conduct this meta-analysis based on all relevant RCTs to compare the LP with EF in the treatment of type C distal radius fractures in recent years. The outcomes we are interested in included radiological results and functional activities.

Methods

Search strategy

This study was all according to the PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analyses). We searched the PubMed, Embase, and Cochrane Medical Library of randomized controlled clinical trials about the type C distal radius fractures was performed according to the search strategy mentioned in Cochrane Handbook 5.1.0 from Jan. 2005 to Jan. 2016. The patients in the articles were older than 17 years. The following items were used: (distal radius or distal radial) and (type C fracture or type C fractures) and (EF or external fixator) and (locking plate or locked plate). The search performance was completed by two co-authors independently.

Eligibility criteria

All the randomized controlled clinical trials that compared (augmented) external fixation (EF) with locking plates (LP) in adult patients with type C distal radial fractures were considered. Publication language was restricted to English. Studies that patient population and the indication for surgery did not define were not included. The study must report at least one of the outcomes as follow: radial inclination, palmar tilt, ulnar variance, range of wrist flexion and extension, and range of wrist supination and pronation. The trials in which participants included children were excluded.

Study selection

Two co-authors independently screened the titles of articles previously described. Duplicates were removed. The irrelevant articles through screening the titles were eliminated. After that, to confirm the true article information we examined the abstracts of remaining articles. And then the final included articles were assessed by the full-text reading. Any disagreement was resolved by the discussion between two co-authors and if a consensus perspective could not be reached, a further decision was adjudicated by the third author.

Data extraction

The analysis data were extracted from final included studies by the two co-authors independently by using a data collection form. The data items included study type, number of patients, time of follow-up, interventions, fractures classification. The detailed information was obtained through the telephone or the e-mail contacting with the authors if the article did not provide.

Quality assessment

We evaluated the final included studies according to the "assessing the risk of bias" table of Cochrane Handbook for Systematic Reviews of Interventions version 5 and the Grading of Recommendations Assessment, Development and Evaluation (GRADE) system.

Statistics analysis

The software program RevMan5 was used for statistical analyses. We used Chi-square test to assess the between-study heterogeneity quantified through the I^2 statistic. 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. p value < 0.05 was considered to be statistically significant.

Results

Literature search and study characteristics

Seven articles[7–13] were eventually included. The characteristics of the included studies were summarized in Table 1 and the search process was shown in Fig. 1.

Study quality

All studies conducted the randomization. All the studies have complete follow-ups. All studies had reported the expected the outcomes completely.

Imaging examination results

Radial inclination

Data of radial inclination were pooled across the studies and the analysis revealed a difference favoring LP over EF at the final follow-up examination (Fig. 2, $p = 0.03$). The normal radial inclination is 20–25°, the mean radial inclination of LP group was 22.40, and the radial inclination of EF group was 20.44.

Palmar tilt

Analysis of palmar tilt compared with the LP group and EF group across 7 studies presented no significant difference (Fig. 3, $p = 0.05$). The normal palmar tilt is 10–15°, the mean palmar tilt of LP group was 6.03, and the radial inclination of EF group was 3.82. Although there is no difference between the two groups, the degree of palmar tilt of EF group is lower.

Ulnar variance

Data of ulnar variance were pooled across the studies and the analysis revealed no significant difference LP over EF at the final follow-up examination (Fig. 4, $p = 0.93$).

Table 1
The content of the included study.

Studies	Number (LP/EF)	Age (LP/EF)	Males (LP/EF)	Follow-up (month) (LP/EF)
Fakoor M 2015	39/55 (but the cases number in the table of the article: 14/37)	17–76/19–84	75.5% were male (the concrete data of each group is not clear)	12 (the concrete data of each group is not clear)
Gereli A 2010	16/14	49 ± 16/35 ± 10	11/11	26.1 ± 6.1/62.7 ± 16.8
Grewal R 2005	29/33	46 ± 2.7/45 ± 2.7	41%/64%	18 (6–24) (the concrete data of each group is not clear)
Jeudy J 2012	36/39	64.7 ± 3.7/64.6 ± 3.5	10/8	6/6
Roh YH 2015	36/38	54.4 ± 10.9/55.3 ± 11.2	16/14	12/12
Schmelzer-Schmied N 2009	15/15	50–70 (the concrete data of each group is not clear)	the concrete data of each group is not clear	38 ± 8/72 ± 12
Xu GG 2009	16/14	21–56/35–55	9/9	24/24

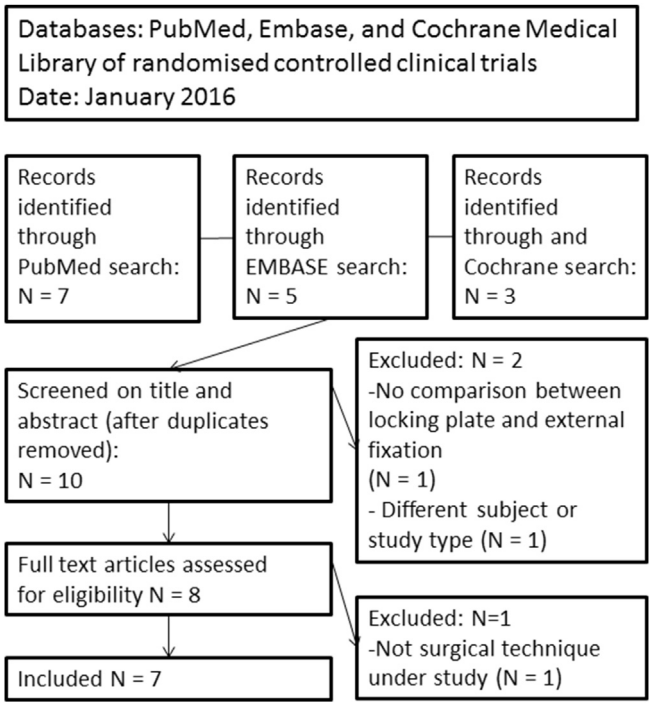

Fig. 1. The search process.

Functional activities

Range of flexion and extension

Analysis of range of flexion and extension compared with the LP group and EF group across 6 studies presented no significant difference (Fig. 5, $p = 0.24$).

Range of supination and pronation

Data of range of supination and pronation were pooled across the studies and the analysis revealed no significant difference LP over EF (Fig. 6, $p = 0.28$).

Discussion

In the past several years, the average age of the population was increasing and the prevalence of distal radius fractures was raised. The three dimensions can show a collapse of articular surface which means the loss of radial weight bearing region. The weight bearing regions can significant influence the function of the wrist. The newest theory explains the three columns of the distal radius segment. The middle column is the major weight bearing part. The degree of fracture comminuted can influence the integrality of lunar nest which is leading to loss of radial inclination, palmar tilt, and ulna variance. Less sclerotin in bone, the comminuted fracture is more easily to happen. This kind of osteoporotic fracture is hard to perform reduction and fixation.

In the past doctors faced the radius type C (AO/OTA type) fracture usually took a plaster or a splint to fixation. Because of the bad fixation, the fracture could not be stable. The motion of fracture influences healing. Then the function of the wrist was lost. The fixation of external fixation frame was stronger than plaster, so the stability of the fracture was improved. As so far, EF has been a traditional and important treatment of complex comminute fractures of distal radius. Even so, the recurrent displacements happened are also very high. Since development of the internal fixation, locking plate has been recommended apply in osteoporotic fracture. Locking plate can be locked by screw. The screw can fix the fracture fragment to the plate. When locking plate appeared, the displacements were sharply reducing. Although the locking plate has lot of advantages, it also has some drawbacks. The complications of LP include incision infection, nerve injury, vascular injury, reduction lost, plate rupture, and operation secondary fracture. And a screw cannot fix all the fracture fragments, some fragments would be dissociative. The discussion of the right surgical method between EF and LP has lasted over the last decade.

Imaging examination results showed radial inclination of EF group worse. This explains that external fixation cannot maintain the position of radial styloid comparing locking plate. The radial styloid is proximally displaced, which makes the carpal articular surface of radius flat and the lateral interspace is increased. The

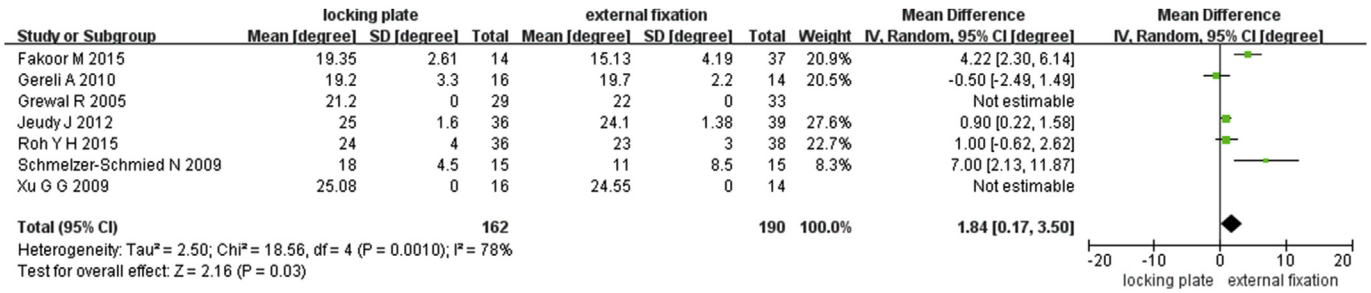

Fig. 2. The forest map of statistical analysis of radial inclination.

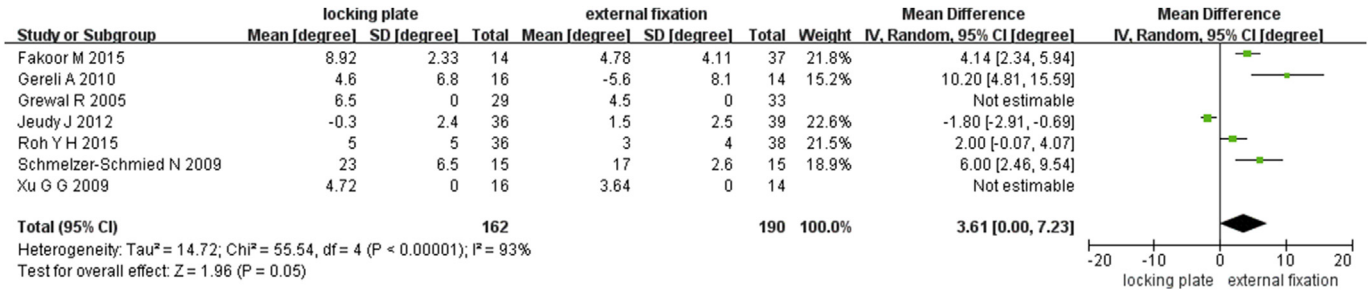

Fig. 3. The forest map of statistical analysis of palmar tilt.

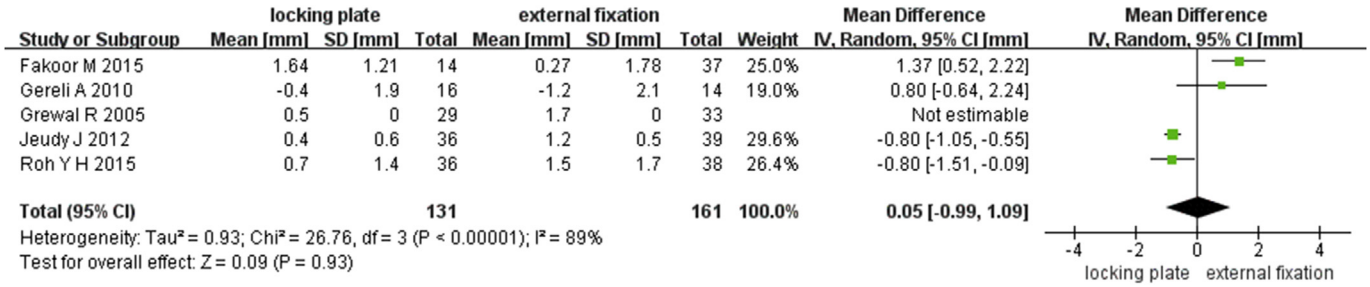

Fig. 4. The forest map of statistical analysis of ulnar variance.

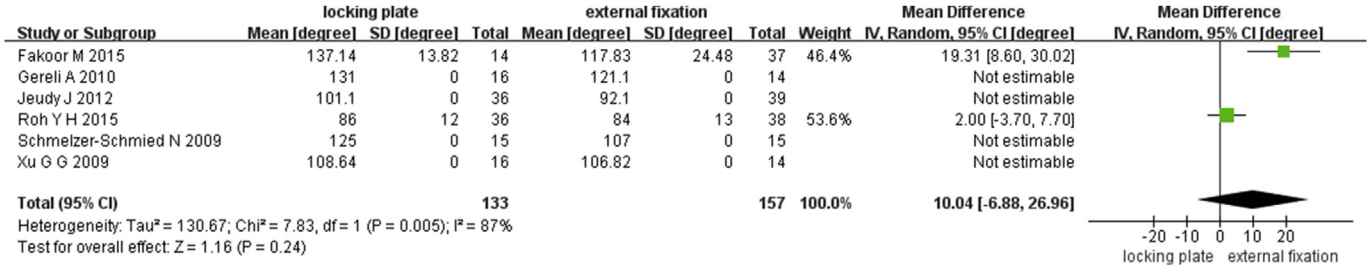

Fig. 5. The forest map of statistical analysis of range of flexion and extension.

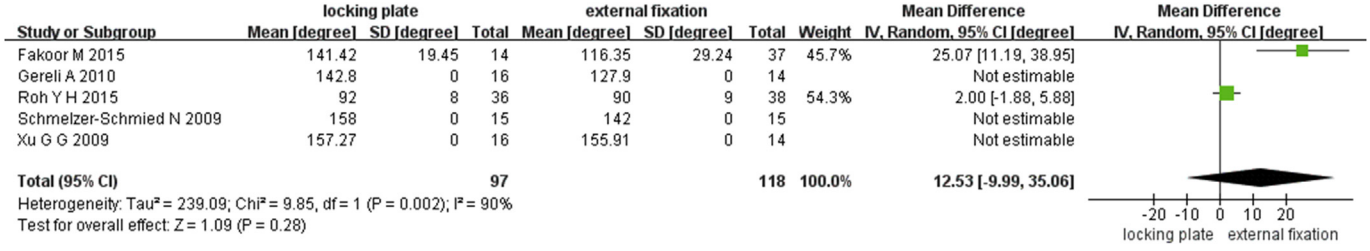

Fig. 6. The forest map of statistical analysis of range of supination and pronation.

ulnar deviation of wrist is not stable. Because the *p* value is 0.03, the difference between the two groups is not remarkable. In clinical this difference cannot make the obvious badness. The palmar tilt and ulnar variance is no significant difference but the *p*-value is close to the critical value. Locking plate is better than external fixation in maintaining reduction to a certain extent.

The functional activities or outcomes between LP group and EF group are not significant different, even some advantages in maintaining reduction on imaging examination of LP group were found. Finally, both locking plate and external fixation are feasible to radius type C fracture.

In conclusion, both locking plate fixation and external fixation are feasible management for radius type C fracture. Although locking plate fixation has the advantage on maintaining reduction and imaging examination of the involved wrist did not reveal significant difference between the two surgical approaches.

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