Systematic Review and Meta-Analysis

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Is dynamic locking plate superior than other implants for intracapsular hip fracture

A meta-analysis

Tao Li, MM, Qing-song Zhang, MM*

Abstract

Background: We studied the safety and efficacy of dynamic locking plate vs. other implants (cannulated cancellous screws [CCS] or sliding hip screw [SHS]) in patients undergoing intracapsular hip fracture (ICHF).

Methods: We searched Pubmed, Embase, Web of Science, Cochrane library and Google database from inception to March 25, 2018. We selected any studies comparing dynamic locking plate for treatment ICHF. Non-union rate, osteonecrosis rate, cutout rate, revision rate, the replacement rate, and Harris hip scores were the outcomes. Stata 12.0 was used for meta-analysis.

Results: Four studies involving 419 patients (143 patients in the dynamic locking plate group and 276 patients in the other implants group) were finally included. Compared with CCS or SHS, dynamic locking plate was associated with a reduction of nonunion rate, revision rate, replacement rate ($P < .05$). Furthermore, dynamic locking plate was also associated with an increase of the Harris hip scores ($P < .05$). There was no significant difference between the osteonecrosis rate and cutout rate ($P > .05$).

Conclusions: Current meta-analysis revealed that dynamic locking plate has a benefit role in improving postoperative clinical outcome than CCS or SHS in ICHF patients. Further high quality and large-scale randomized controlled trials (RCTs) are needed to further identify the efficacy of dynamic locking plate for ICHF.

Abbreviations: CCS = cannulated cancellous screws, CI = confidence interval; RR = risk ratio, ICHF = intracapsular hip fracture, RCTs = randomized controlled trials, SHS = sliding hip screw, WMD = weighted mean difference.

Keywords: dynamic locking plate, intracapsular hip fracture, meta-analysis

1. Introduction

Intracapsular hip fracture (ICHF) is a common fracture in elderly patients.[1,2] Improper treatment is associated with morbidity and mortality.[3] The prevalence of ICHF is increasing due to the aging population.[4] It is reported that hip fractures are wish to reach up to 6.26 million by the year 2050.[4]

Cannulated cancellous screws (CCS) and sliding hip screw (SHS) are the mainstream internal fixations for ICHF.[5] However, CCS and SHS were always lacked the ability to provide rotational and angular fracture fixation. Thus, the occurrence of osteonecrosis and nonunion is the main concern of internal fixation.[3] It is reported that the proportion of patients receiving secondary hip arthroplasty was 20% to 58%.[6–8] Administration with anatomic reduction and internal fixation is associated with a significantly reduction of the osteonecrosis and nonunion. Dynamic locking plate incorporates features of CCS and SHS.[9] Dynamic locking plate provided dynamic capacity and thus could prevent screws from backing out.

Parker et al[10] compared the occurrence of secondary fracture and complications at 2 years follow-up. Results showed that, compared with other implants, the complications related to the healing of the fracture are significantly decreased. However, whether dynamic locking plate is superior than other implants was not consistent. Moreover, some limitations exist in previous studies such as small sample size and were short of systematic analyses.

This meta-analysis aimed to assess the safety and efficacy of dynamic locking plate versus other implants (CCS or SHS) in patients undergoing ICHF.

2. Materials and methods

The current meta-analysis was performed according to the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions and was reported in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines. There was no registered protocol.

2.1. Literature search

We conducted a systematic search of 3 electronic databases (Pubmed, Embase, Web of Science, Cochrane library, and Google

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Department of Orthopedics, Puai Hospital Affiliated to Tongji Medical College of Huazhong University of Science and Technology, Wuhan, Hubei, China.

* Correspondence: Qing-song Zhang, Department of Orthopedics, Affiliated to Tongji Medical College of Huazhong University of Science and Technology, No.473 Hanzheng Street, Wuhan 430000, Hubei, China (e-mail: sci20170828@163.com).

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database) from their inception to March 2018. The search terms were as follows: (dynamic locking plate) and (fractures, hip or trochanteric fractures or fractures, trochanteric or intertrochanteric fractures or fractures, intertrochanteric or "hip fractures"[Mesh]). The reference lists of review were further searched for relevant trials. All data and analyses were based on previous ethically-approved studies, thus no ethical approval is required in this meta-analysis.

2.2. Inclusion and exclusion criteria

The trials were reviewed in which:

(1) the target population was consisted of ICHF patients;
(2) the intervention included dynamic locking plate for treatment of the ICHF patients;
(3) the comparison included alternative implants (CCS or SHS) for treatment of the ICHF patients;
(4) the outcomes were osteonecrosis, nonunion, revision surgery or other complications;
(5) randomized controlled trial (RCT) or non-RCTs were both included in this meta-analysis;
(6) length of follow-up should be more than 3 months.

Studies would be excluded: animal experiments, biomechanical study, combined with other treatment; patients with pathological fracture; and studies that did not include one of the outcomes.

2.3. Quality assessment

The quality assessment of studies was assessed by 2 reviewers (Tao Li and Qing-song Zhang) with the method recommended by Cochrane Collaboration. A total of 7 items were measured. Each item was assessed by 2 reviewers (Tao Li and Qing-song Zhang) and divergence was solved by discussion. Trials with high risk of bias for ≥1 key domains were considered to be at high risk of bias.

2.4. Data extraction

A specific extraction was performed by 2 reviewers to collect the following data from the included trials: patients' general characteristics (author and publication date), mean age and femoral patients, study and follow-up. Outcomes were abstracted and recorded on a pre-generated standard Microsoft Excel (Microsoft Corporation, Redmond, WA) file. There no any processes for obtaining and confirming data from investigators.

2.5. Statistical analysis

All of the data were analyzed by the software of Stata12.0 (Stata Corp., LP). Harris hip scores were expressed as weighted mean differences (WMDs) and 95% confidence intervals (CIs). Osteonecrosis, nonunion, revision surgery or other complications rate were presented as relative risk ratio (RR) with 95% CI. $P < .05$ was considered statistically significant. Heterogeneity was assessed with the I^2. If there was significant heterogeneity ($I^2 > 50\%$), we selected a random effects model to pool the data. Publication bias was visually inspecting assessed by funnel plots and Begg's test ($P > .05$ with no publication bias). We performed a sensitivity analysis when there was heterogeneity for primary outcome. One study was omitted in each turn in a comparison to figure out the potential source of heterogeneity. We did not perform subgroup analysis due to the limited number of the included studies.

3. Results

3.1. Literature characteristics

Figure 1 shows the flow diagram of included studies. First, we manually searched 451 potentially studies and no additional records were identified from other sources. After removing duplicates, we screened 322 papers. After reading the title and abstract of the 322 papers, 311 studies were excluded according the inclusion criteria. In the end, we included 4 clinical trials with 419 patients (143 patients in the dynamic locking plate group and 276 patients in the control group) in the meta-analysis.[11–14] The general characteristic of the included studies can be seen in Table 1. The mean age of the included patients ranged from 55.6 to 77.7 year. The duration of follow-up ranged from 12 months to 28.6 months.

3.2. Quality assessment

The risk bias summary and risk of bias graph of the included studies are summarized in Figure 2 and Figure 3 respectively. Only 1 study referred to the random sequence generation and thus the risk of bias was low risk of bias. Allocation concealment was low risk of bias in 1 study. Other risk of bias was all with unclear risk of bias.

4. Results of meta-analysis

4.1. Nonunion rate

Four studies[11–14] included nonunion rate. There was a little heterogeneity across the included 4 studies ($P = .217$, $I^2 = 32.6\%$). Compared with other treatment, dynamic locking plate was associated with a reduction of the nonunion rate (RR = 0.20, 95% CI 0.07–0.57, $P = .003$, Fig. 4).

4.2. Osteonecrosis rate

Four studies[11–14] totaling 419 patients included osteonecrosis rate. There was no heterogeneity between the studies ($P = .943$, $I^2 = 0.0\%$). Compared with other internal fixation, dynamic locking plate has no benefit on the osteonecrosis rate (RR = 1.71, 95% CI 0.64–4.62, $P = .287$, Fig. 5).

4.3. Cutout rate

Two studies[12,14] reported the cutout rate between dynamic locking plate versus other implants for ICHF patients. There was no heterogeneity between the studies ($P = .370$, $I^2 = 0.0\%$). There was no significant difference between dynamic locking plate and other internal fixation regarding the cutout rate (RR = 0.77, 95% CI 0.46–1.28, $P = .312$, Fig. 6).

4.4. Revision rate

All 4 studies[11–14] involving 419 hips included revision rate. The result showed dynamic locking plate was associated with a reduction of the revision rate (RR = 0.61, 95% CI 0.41–0.92, $P = .018$, Fig. 7).

4.5. The replacement rate

All 4 studies[11–14] give available data of the replacement rate. There was no heterogeneity between the included studies ($P = .510$, $I^2 = 0.0\%$). Compared with other treatment, dynamic locking plate was associated with a reduction of the replacement rate (RR = 0.37, 95% CI 0.17–0.84, $P = .018$, Fig. 8).

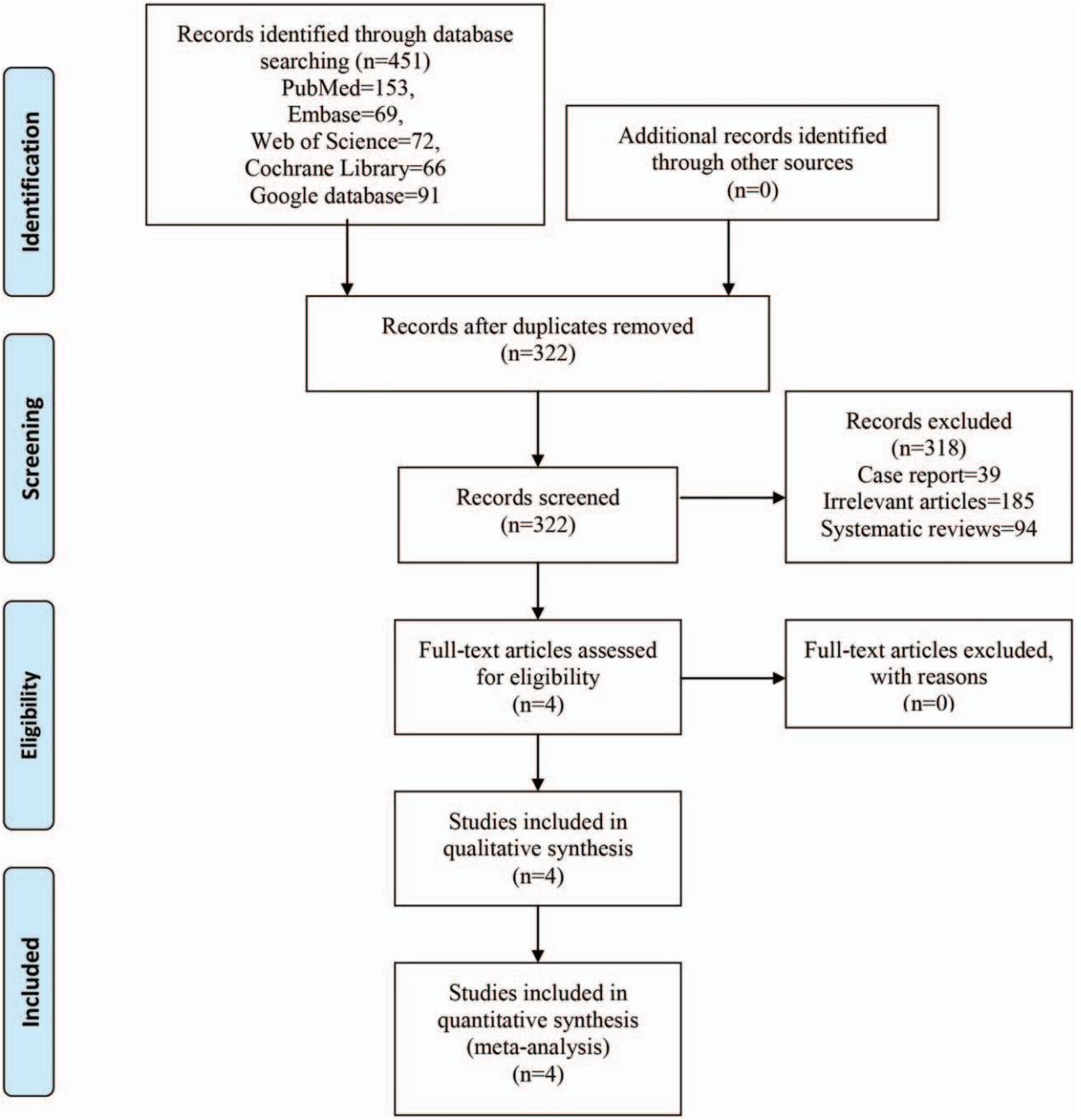

Figure 1. PRISMA flowchart for the included studies.

Table 1

The general characteristic of the included studies.

Author	Cases (Targon FN/Co)	Mean ge (year, Targon FN/Co)	Female patients (Targon FN/Co)	Intervention	Con	Outcomes	Follow-up	Study
Eschler 2014	27/25	NS	NS	Targon FN	SHS	1,2,3,4,5	15.5 months	PCS
Griffin 2014	51/123	66.5/67.4	NS	Targon FN	CCS	1,2,3,5	12 months	RCT
Thein 2014	31/47	50.9/55.6	41.9/66	Targon FN	CCS	1,2,5,6	28.6 months	PCS
Warschawski 2016	34/81	66.8/77.7	50/24.7	Targon FN	CCS	1,2,3,4,6	19 months	PCS

1, nonunion rate, 2, osteonecrosis rate; 3, cutout rate; 4, revision rate, 5, the replacement rate; 6, Harris hip scores.
CCS = cannulated cancellous screws, Co = control, PCS = prospective controlled trials, RCT = randomized controlled trials, SHS = sliding hip screw.

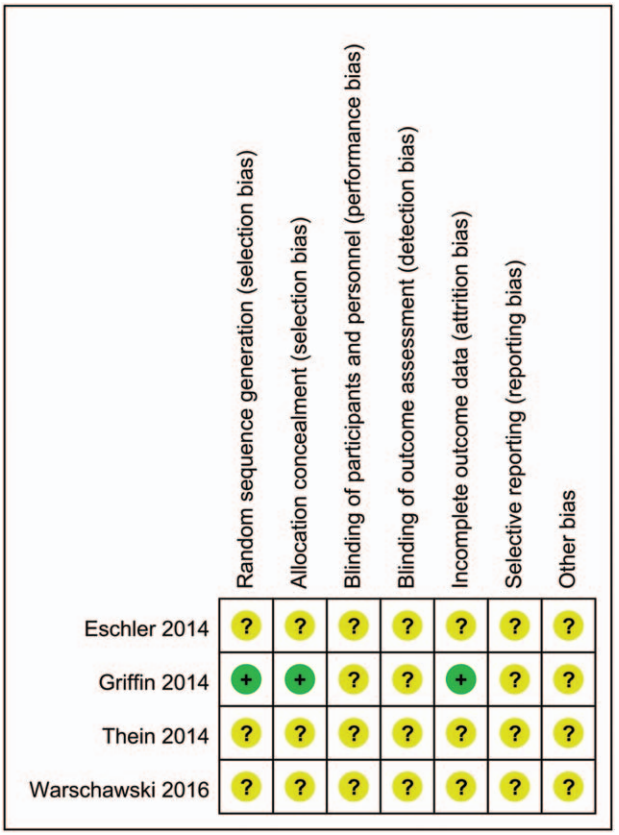

Figure 2. The risk of bias summary for the included studies.

4.6. Harris hip scores

Only 2 studies[11,13] including 124 patients reported the HSS. Results showed that dynamic locking plate was associated with an increase of the Harris hip scores (WMD = −9.09, 95% CI −17.97 to −0.21, Fig. 9).

4.7. Sensitivity analysis, publication bias

Sensitivity analysis and publication bias can be seen in Supplement S1 and Supplement S2, http://links.lww.com/MD/C634 respectively. Pooled results indicated that the result was relatively stable and no publication bias existed in current included studies.

5. Discussion

5.1. Summary of evidence

This meta-analysis aimed to compare dynamic locking plate versus other treatment for ICHF patients. Our meta-analysis found that

(1) compared with other implants, dynamic locking plate significantly reduced the nonunion rate, revision rate, replacement rate;
(2) dynamic locking plate further improved Harris hip scores than other implants.

5.2. Comparison with other meta-analysis

Only 1 relevant meta-analysis about this topic has been published.[15] Although the main finding of our meta-analysis was consistent with previous meta-analyses, differences between ours and the previous ones should be noted. First, previous meta-analysis did not comprise Harris hip score between these two methods. In comparison, our current meta-analysis included 4 trials and found that dynamic locking plate further improved Harris hip scores than other implants.

5.3. Implications for Clinical Practice

ICHF always result from low energy falls and now is a prevalent injury in the elderly population and major cause of morbidity and mortality. Cancellous screws and dynamic hip screw were 2 alternatives for treatment of ICHF.

Parker et al[16] conducted a meta-analysis involving 5269 patients and found that, based on available evidence, the optimal choice implant for ICHF was unclear. For revision rate, Bhandari et al[17] revealed that SHS was superior than other implants for treatment ICHF. For intertrochanteric fracture, Barwar et al[18] found that dynamic locking plate allows sound bone healing, however, it should be interpreted with caution because only a prospective study with a large sample size would allow definitive conclusion. Another biomechanical experimental indicated that dynamic locking plate provided superior mechanical stability than other implants.[18,19] Brandt et al[20] further revealed that Targon FN enhances the mechanical strength of reconstructions in unstable/displaced ICHFs. Escheler et al[11] reported that complications in SHS group occurred earlier than in the dynamic locking plate group. The selection of younger and healthier patients for Targon FN

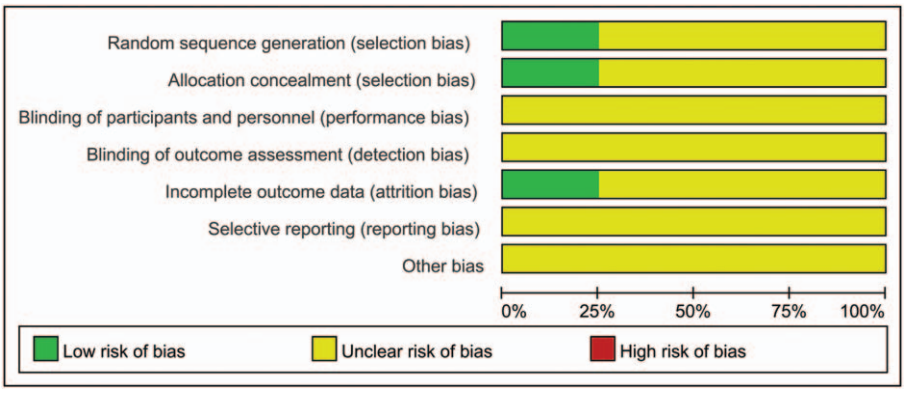

Figure 3. The risk of bias graph for the included studies.

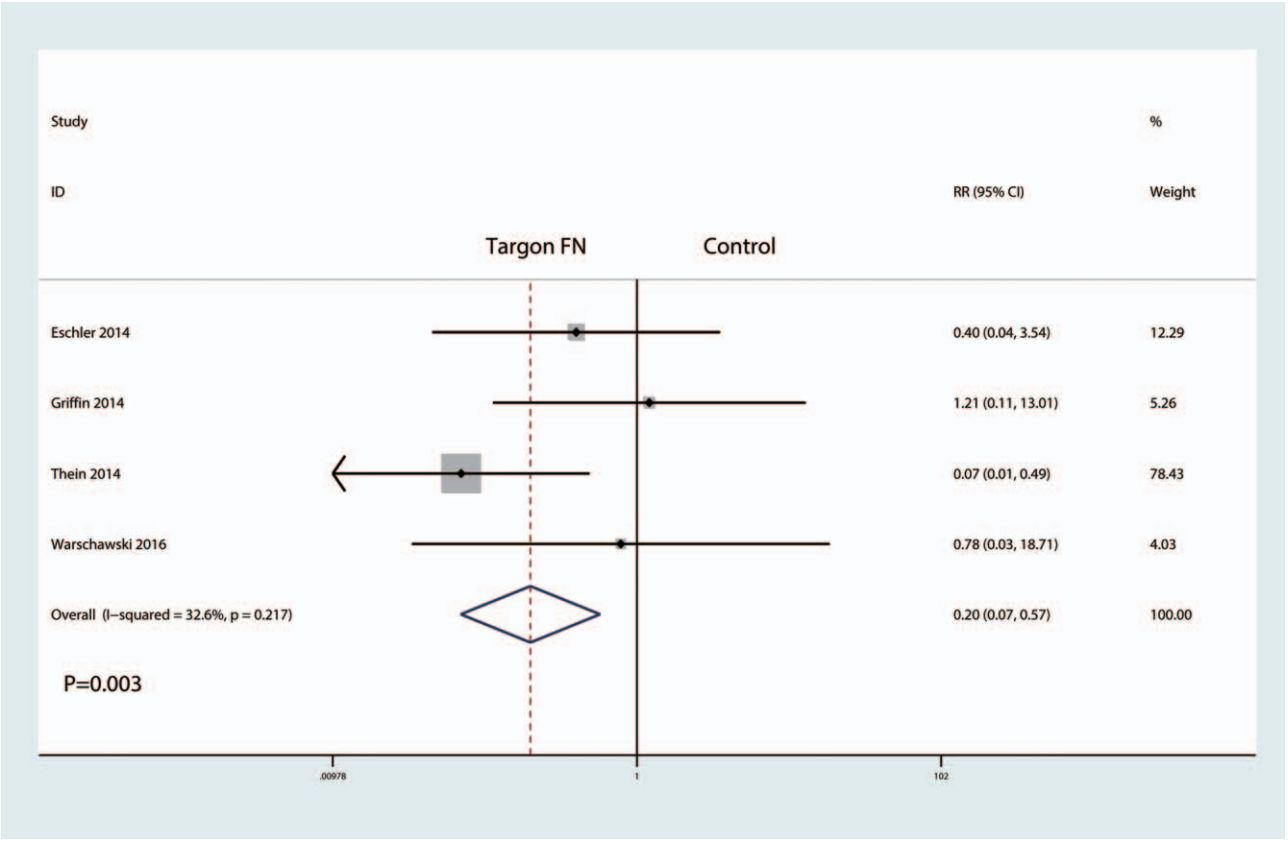

Figure 4. Forest plot comparing the nonunion rate between the 2 groups.

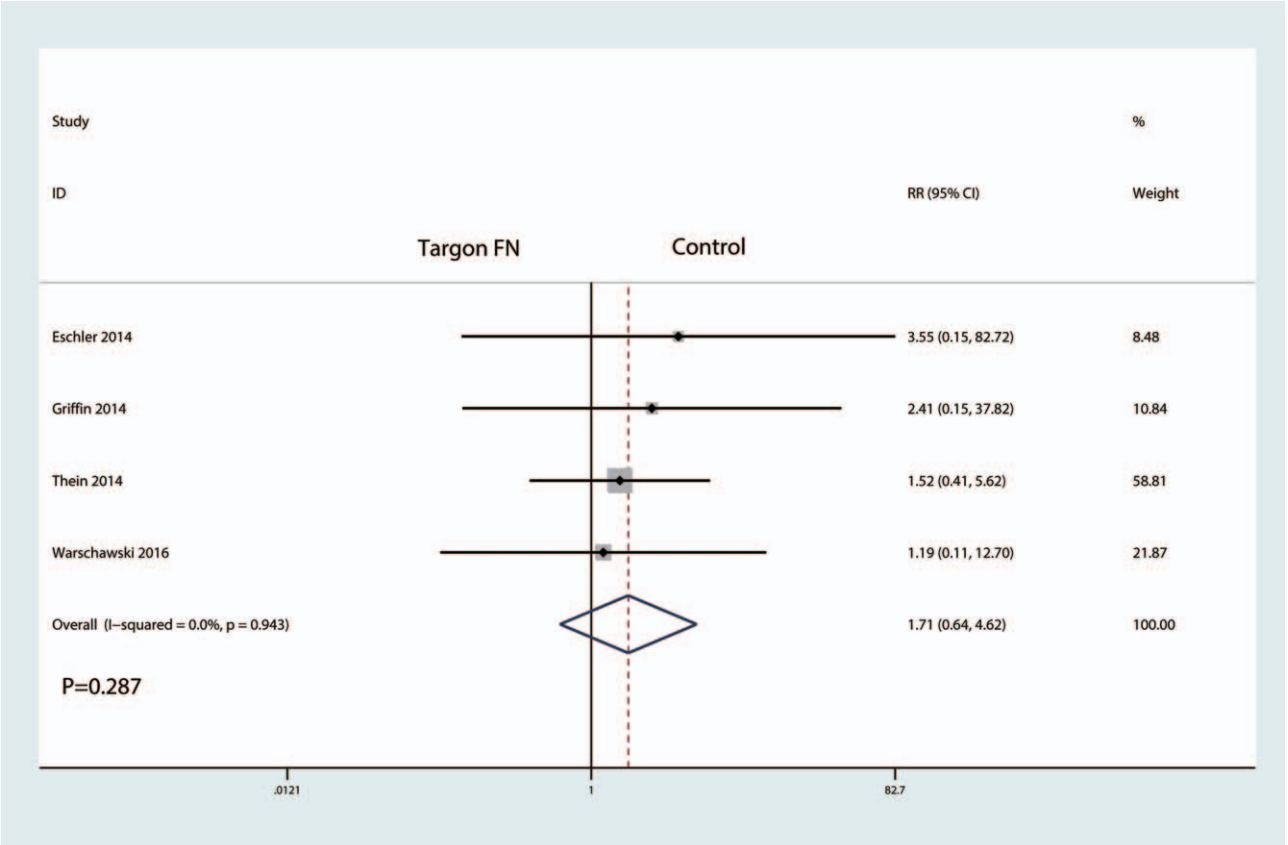

Figure 5. Forest plot comparing osteonecrosis rate.

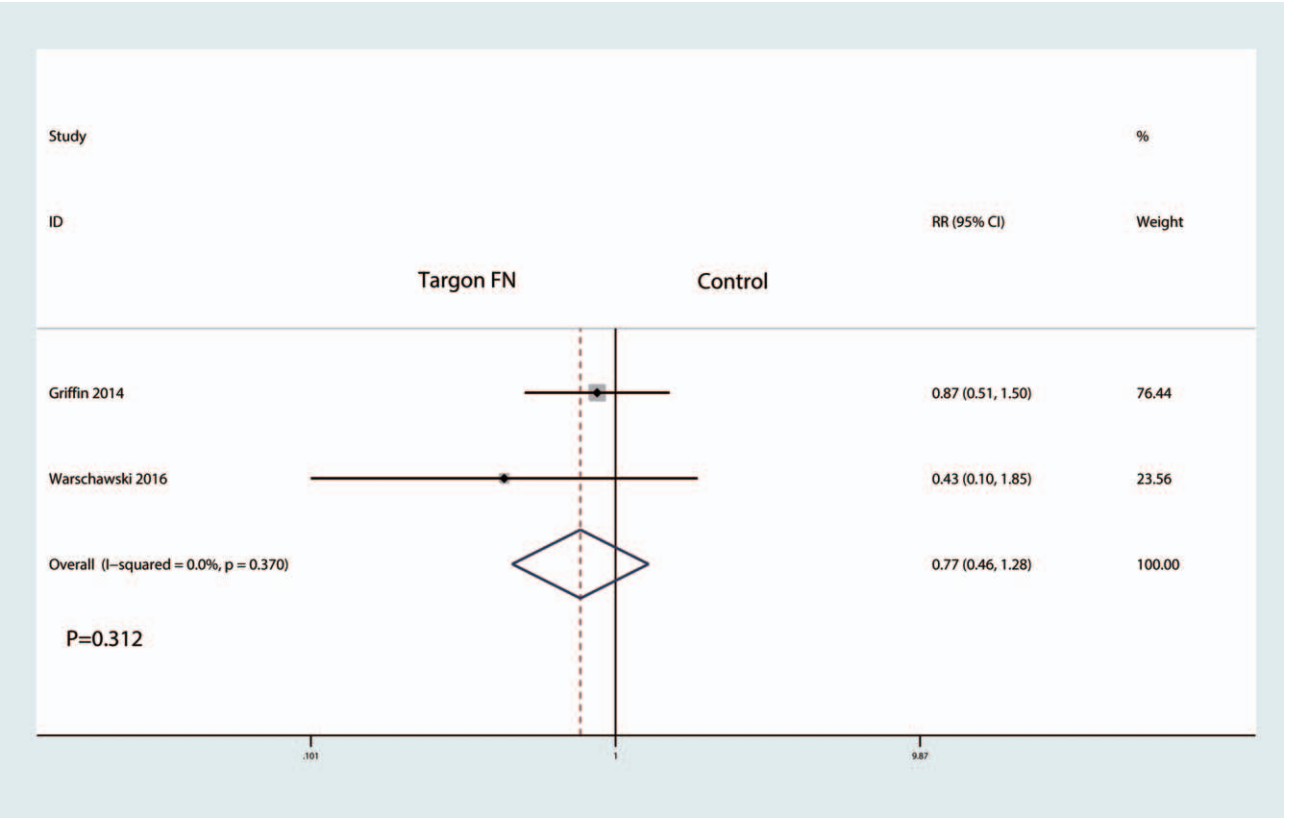

Figure 6. Forest plot comparing cutout rate.

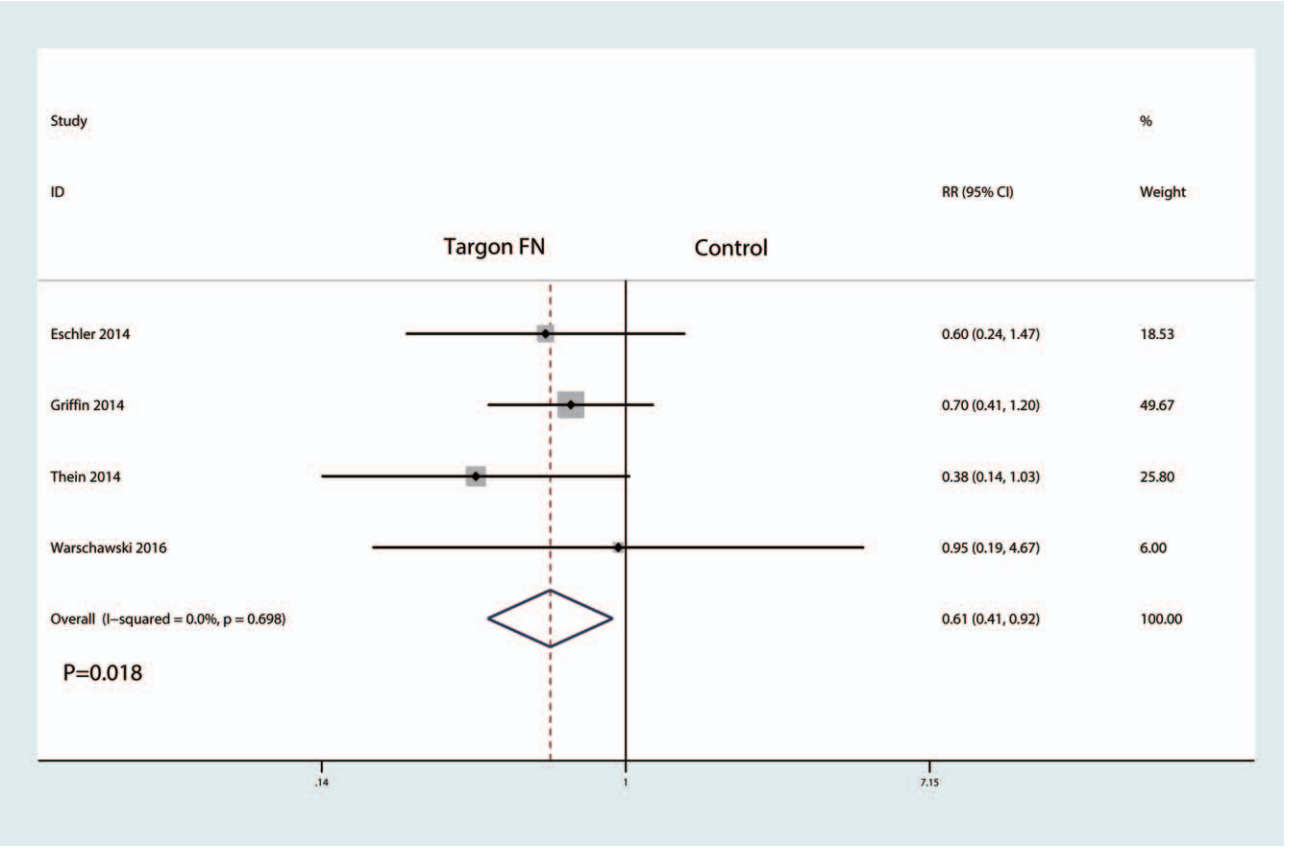

Figure 7. Forest plot comparing revision rate.

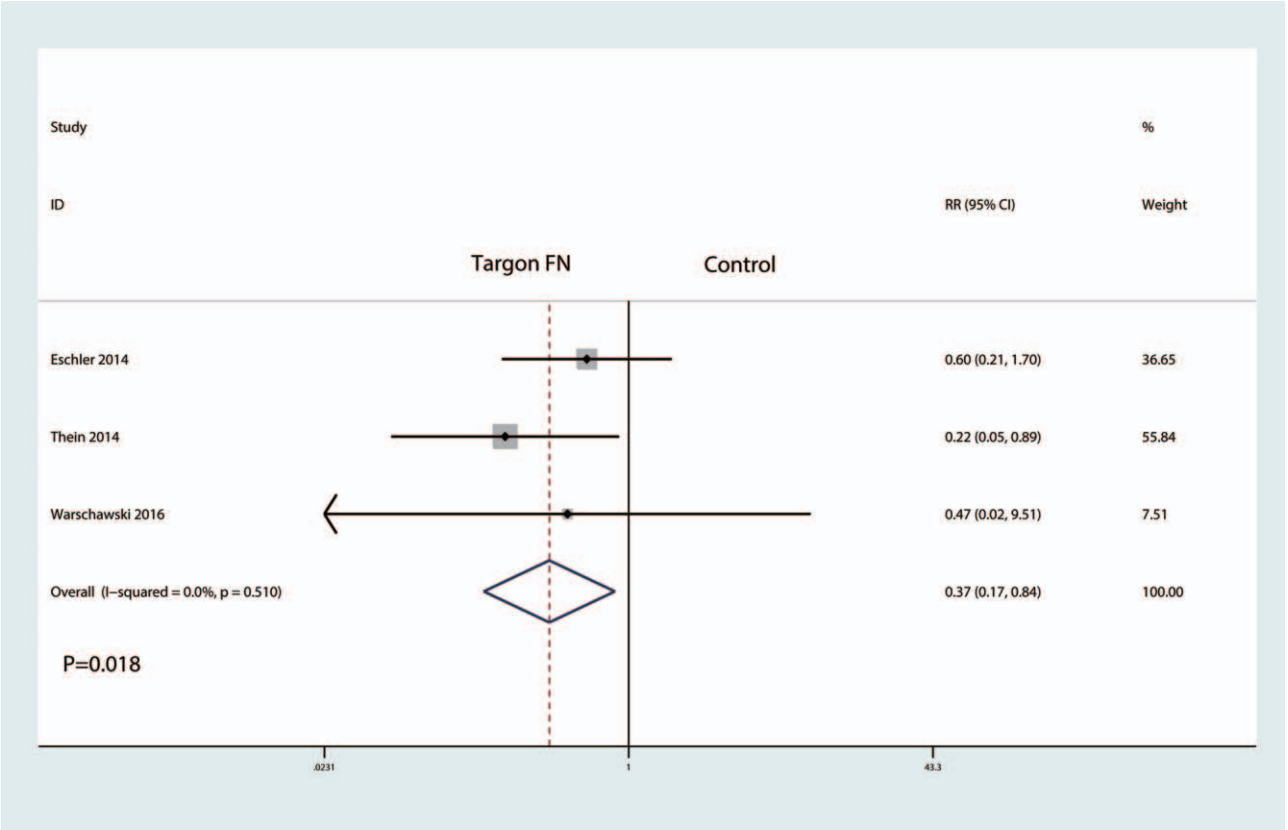

Figure 8. Forest plot that comparing the replacement rate.

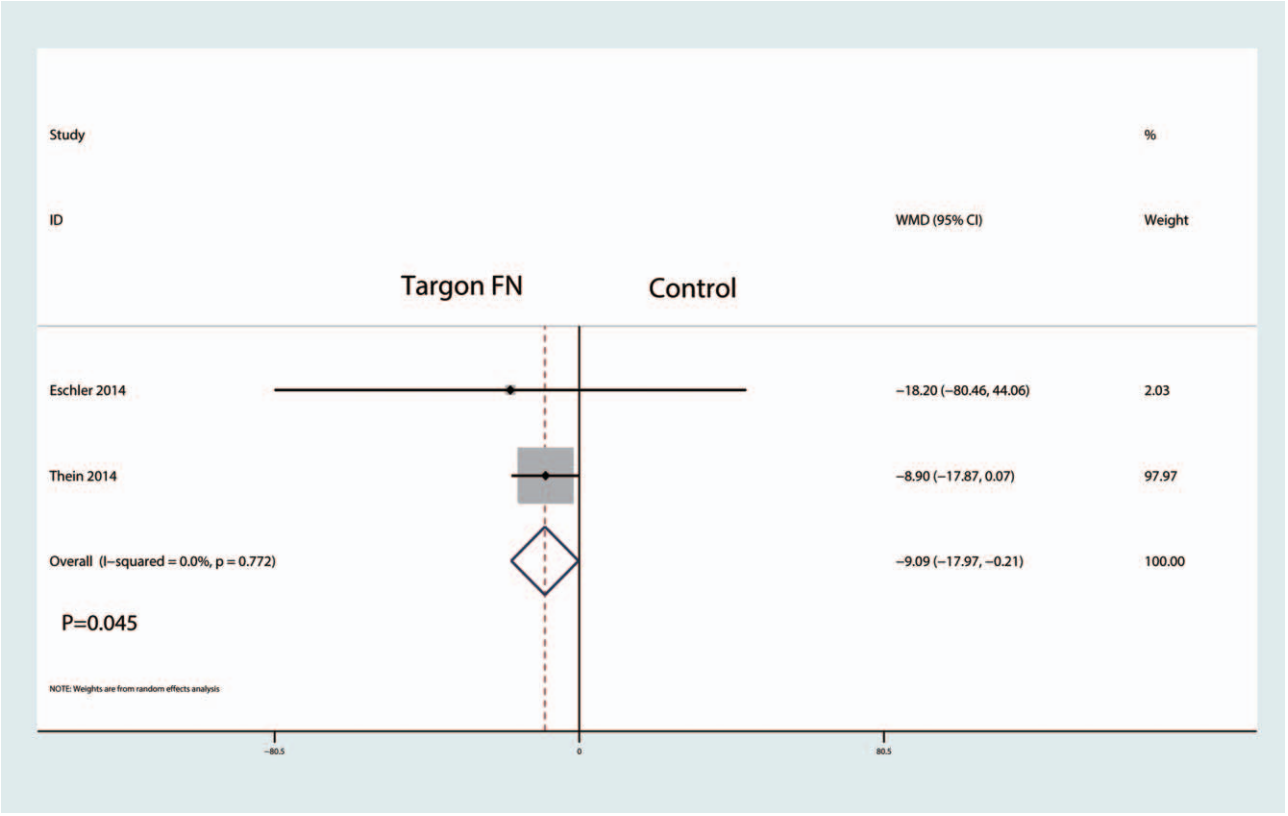

Figure 9. Forest plot that comparing the Harris hip scores.

treatment may have skewed complication rates in favour of the Targon FN group. And Targon FN may be suitable for both ICHF and extracapsular hip fracture

5.4. Strengths and Limitations

A major strength of current meta-analysis was that we systematically searched the electronic databases and calculated the relevant outcomes with strictly statistically method. Another strength of current meta-analysis was that we systematically compared relevant clinical outcomes.

There were a total of 5 limitations in this meta-analysis:

(1) A total of 4 clinical studies were finally included in this meta-analysis and the relative small sample size will affect the final outcomes;
(2) Only 2 studies refer to the Harris hip scores and cutout rate and thus this outcome need for more studies to identify;
(3) We did not perform subgroup analysis due to the limited number of the included studies and thus future studies should be focused on dynamic locking plate for the clinical outcomes for different age, sex, and fracture classification patients;
(4) The duration of follow-up was relative short and thus longer follow-up was need to identify any omitted complications;
(5) We included non-RCTs and thus exist selection bias for the final outcomes.

6. Conclusions

Compared with HSS or SHS, dynamic locking plate has a beneficial role in reducing the nonunion, revision and replacement rates in ICHF patients. We only included 4 relevant studies and thus more high-quality RCTs are needed in future to further confirm the efficacy of dynamic locking plate for ICHF.

Author contributions

Investigation: Tao Li.
Supervision: Qing-song Zhang.
Validation: Qing-song Zhang.

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