

Protective Effect of Surgery Against Early Subtalar Arthrodesis in Displaced Intra-articular Calcaneal Fractures

A Meta-Analysis

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Abstract: The aim of this study is to determine whether surgery offers protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures.

Systematic review and meta-analysis: searches of electronic databases 1980 to August 2014, checking of reference lists, hand searching of journals, and contact with experts. Randomized controlled trials (RCTs) in which surgical treatment was compared with nonsurgical treatment of displaced intra-articular calcaneal fractures from 1980 to 2014. The modified Jadad scale was used for trial quality and effective data were pooled for meta-analysis. Study results related to early subtalar arthrodesis were extracted and risk assessment was combined with surgical treatment and nonsurgical treatment.

The primary analysis included 4 studies and 966 participants. The estimated overall risk ratio was 4.40 (95% confidence interval 2.67–7.39), indicating the incidence of early subtalar arthrodesis in nonsurgical group is 4.4 times the surgical group. The results showed that surgical treatment was superior to nonsurgical treatment in protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures ($Z = 5.600$, $P < 0.001$).

Surgery offers protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures.

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BACKGROUND

Displaced intra-articular calcaneal fractures are a serious injury, and the prognosis for patients, who are typically young, remains poor. Usually due to a fall from a height at work, the displaced intra-articular calcaneal fractures, affects primarily the subtalar joint. These fractures will heal if treated nonoperatively, but patients can be left with persistent deformity, incongruent joint surfaces, and loss of alignment. A 2 year recovery, with a stiff, painful, deformed foot that will not fit into

a normal shoe and osteoarthritis of the subtalar joint are common outcomes.^{1–2}

Orthopedic surgeons often fix these fractures internally to try to improve the final result. But controversy remains as to the optimal treatment of the injury, because both surgical and nonsurgical treatments have pros and cons. Outcomes from previous randomized controlled trials (RCTs) have varied. Some indicated^{3–6} that surgical treatments may be superior to nonsurgical treatment, while others found no significant differences between surgical and nonsurgical treatment.^{7–10} Of all the previous RCTs, Griffin et al¹⁰ recently report the results of a pragmatic, multicenter, comparing operative with nonoperative care of closed, displaced intra-articular calcaneal fractures 2 years after injury in the famous British Medical Journal. To the best of our knowledge, this is by far the highest impact factor report of RCTs focus on calcaneal fractures. This report aroused the interest of the majority of orthopedic surgeons, and a lot of rapid-responses were appeared in the www.bmj.com.¹¹ At the same time, an editorials of calcaneal fractures was also published, which gave a high evaluation of Griffin's study: surgery is no longer justified for most intra-articular displaced fractures.² However, in the end of this editorials, the author said that "Further meta-analysis may show that surgery offers protection against early subtalar arthrodesis in certain fracture subtypes. If so, then an eligible subgroup of patients might still consider surgery performed by a surgeon who does a high volume of calcaneal fracture fixations." So the aim of our study was to find out whether surgery offers protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures through meta-analysis of RCTs.

METHODS

Search Strategy

All published RCTs comparing surgical with nonsurgical treatments of displaced intra-articular calcaneal fractures were searched by 2 authors independently. Databases used for searching included Medline, BIOSIS, Cochrane library, and Google Scholar. The eligible time was from 1980 to August 2014. Only full-text articles published in English were included in this meta-analysis. Displaced intra-articular calcaneal fracture, displaced intra-articular fracture of the calcaneus, surgery, non-surgery, operation, nonoperation, RCTs, clinical controlled trials, controlled trials, and randomization were the key words used for searches.

Inclusion and Exclusion Criteria

Only RCTs compared surgical with nonsurgical methods for displaced intra-articular calcaneal fractures were taken into consideration. Studies with averaged follow-up less than 2 years were excluded. Studies whose follow-up rate less than 70% were excluded. Studies without effective reporting of primary

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results and inadequate data for meta-analysis were also excluded. In all the studies screened for the present meta-analysis, patients recruited were adults with a definite diagnosis and a written informed consent. The exclusion criteria included surgical contraindications, previous calcaneal abnormalities or injuries, co-existent foot injuries, extra-articular, and open fractures.⁵ Two orthopedic doctors independently screened titles of all articles obtained. The abstract potentially relevant to the topic was firstly reviewed; then a full text was referred to provide adequate data needed in this study. Discrepancies were resolved by consensus after discussion.

Data Extraction and Quality Evaluation

The effective data were pulled out from all eligible studies by 2 orthopedic doctors. Firstly, the data were extracted by one doctor to a previously prepared table. Then they were verified by the second one to confirm correctness. Disputes were resolved through consultation. A third senior orthopedic doctor may be consulted for opinions and advice if there is a need. The effective data refer to those applicable to meta-analysis and the information for general features of researches and participants.

The modified Jadad scale was applied in methodological assessment.¹⁰ With an eight-item scale, it is aimed to evaluate randomization, blinding, withdrawals and dropouts, inclusion and exclusion criteria, adverse reactions, and statistical analysis (Table 1). The articles are scored between 0 (the lowest quality) and 8 (the highest quality). High quality is shown by scores of

4–8, meaning between good and excellent, while poor or low quality is expressed by scores of 0–3. Rigorous assessment was made by one orthopedic doctor before the verification of the other one.

It can be seen that the primary research results were in early subtalar arthrodesis among the surgical and nonsurgical treatment groups. And the secondary outcome was applied as a sensitivity analysis for the comparison of meta-analyses results among all RCTs.

Analysis of Statistics

I^2 statistics was applied in evaluated statistical heterogeneity. It is in accordance with Quality of Reporting of Meta-Analyses (QUOROM) guidelines.¹² It is used to express the percentage of the overall variation in research due to heterogeneity instead of by chance. I^2 can be counted based on basic results from a typical meta-analysis, when $I^2 = 100\% \times (Q - df)/Q$. In the above-mentioned formula, Q is Cochran heterogeneity statistic, while df is the degrees of freedom.¹³ There is substantial heterogeneity with $I^2 > 50\%$. In meta-analysis, a fixed-effects model was applied for effects with $P > 0.05$. In comparison, a random-effects model was used with $P \leq 0.05$. Dichotomous data were presented with the use of relative risk (RR) and continuous variables as the mean difference (MD), with 95% confidence interval (CI) for the both. Publication bias was evaluated based on Begg test and funnel plot, with $P < 0.10$ being of significance. Stata 11.0 (Stata corporation, college Station, TX) was conducted for the analysis of outcomes. It was considered as statistically relevant with P value of ≤ 0.05 .

RESULTS

Literature Retrieval

A total of 162 potentially relevant articles were identified. After reference to full texts, 4 published RCTs^{5,6,9,10} with a total of 966 patients met all inclusion criteria. Information on general characteristics of studies and participants was listed in Table 2.

Characteristics of the Included Studies

Total trial scores (Table 2) indicate that the quality of all the trials was good based on current rating system. All the 4 designs scored 6 or more,^{5,6,9,10} with maximum of 8.0 points.¹⁰ The good quality makes research results more convincing.

Overall Analysis

With regard to early subtalar arthrodesis in displaced intra-articular calcaneal fractures after treatment, outcome according to 4 RCTs^{5,6,9,10} showed that surgically treated patients had fewer early subtalar arthrodesis than the nonsurgically treated patients (RR 4.40, 95 % CI [2.62–7.39], $P < 0.001$) (Fig. 1). Funnel plot and Begg test ($Z = 1.020$, $P = 0.308$) showed that no significant publication bias was found in the studies (Fig. 2).

Sensitivity Analysis

The results of sensitivity analysis revealed, after excluding the study⁶ with lower quality, it did not affect the statistical significance of surgical treatment as protective factor for preventing early subtalar arthrodesis (I^2 , 37.7%; χ^2 , 4.820; P for heterogeneity, 0.186); hence, the meta-analytic association reported in this review for the factor of early subtalar arthrodesis was robust to the extent and the outcome was reliable.

TABLE 1. Modified Jadad Scale

Items	Response	Score
Was the study described as randomised?	Yes	+1
	No	0
Was the method of randomization appropriate?	Yes	+1
	No	0
	No described	-1
Was the study described as blinded? (double-blind with score 1; single-blind with score 0.5)	Yes	+1
	No	0
Was the method of blinding appropriate?	Yes	+1
	No	0
Was there a description of withdrawals and dropouts?	No described	-1
	Yes	+1
Was there a clear description of the inclusion/exclusion criteria?	No	0
	Yes	+1
Was the method used to assess adverse effects described?	No	0
	Yes	+1
Was the method of statistical analysis described?	No	0
	Yes	+1
	No	0

TABLE 2. The Basic Characteristics of These 4 Included Studies

First Author	Publication Year	Country	Early Subtalar Arthrodesis of Surgical Treatment Patients	Early Subtalar Arthrodesis of Nonsurgical Treatment Patients	Follow-Up	Jadad Score
Griffin	2014	UK	0/73	3/78	2 years	8
Agren	2013	Sweden	4/40	5/42	8–12 years	8
Howard	2003	Canada	5/161	24/148	2–8 years	6
Buckley	2002	Canada	7/218	37/206	2–8 years	6.5

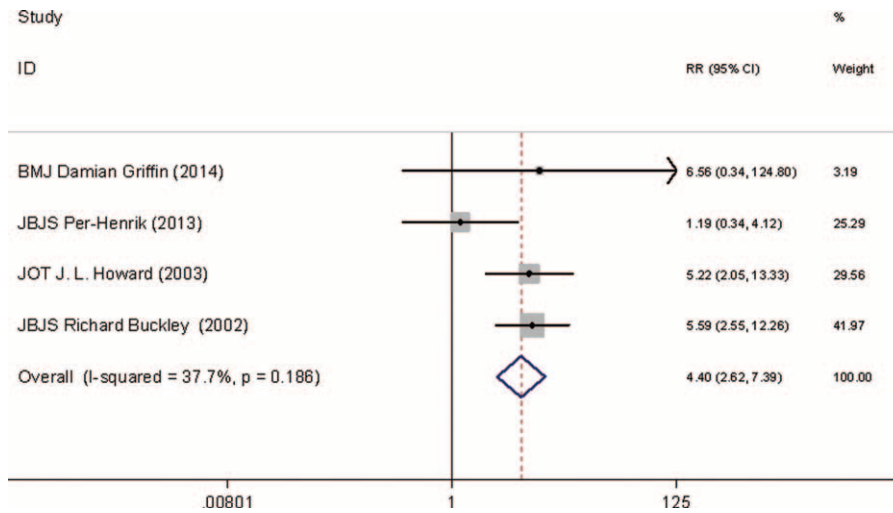


FIGURE 1. Changes in early subtalar arthrodesis after surgical and nonsurgical treatment.

DISCUSSION

Results of our meta-analysis confirmed that in displaced intra-articular calcaneal fractures treatment, surgery can effectively protect against early subtalar arthrodesis. To our best knowledge, this was the first meta-analysis about whether surgery offers protection against early subtalar arthrodesis in

displaced intra-articular calcaneal fractures. It solved the questions in the above Editorials of BMJ.² And it also reminds that surgery for displaced intra-articular calcaneal fractures is still necessary.

There was several meta-analysis on whether displaced intra-articular calcaneal fractures should be given surgical treatment or not.^{14,15} However, most of those meta-analysis on RCTs paid their attention to recovery of the Böhler angle, calcaneal height and width, be able to resume preinjury work and high risk of surgical complications. And the conclusions were basically like this: surgery can effectively restore the anatomical structures of the calcaneus and lead to better functional recovery, but there is a high risk of complications. Only Bruce and Sutherland¹⁶ pointed that “though it reported a greater risk of major complications after surgery, subtalar arthrodesis for the development of subtalar arthritis was significantly greater after conservative treatment.” This problem was secondly pointed in the Editorials of BMJ.² For the above reason, we made a meta-analysis, which was special for whether surgery offers protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures.

In order to answer the questions correctly, we excluded a considerable of RCTs, which was low quality for the aim of our study.^{17–20} Early subtalar arthrodesis in displaced intra-articular calcaneal fractures was mainly happened 2 years later, so the RCTs with a follow-up less than 2 years were excluded.^{18–20}

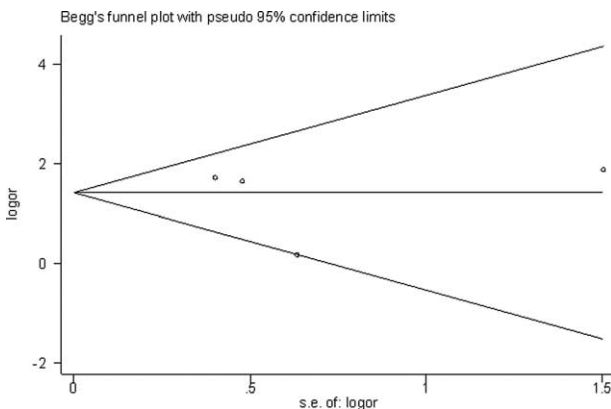


FIGURE 2. Begg funnel plot for publication bias.

Ibrahim et al¹⁷ did a RCT of conservative versus operative treatment on displaced intra-articular calcaneal fractures for 15-year follow-up. However, of 56 patients enrolled in the study 15 years ago, only 26 was able to be finish the follow-up 15 years later. Because of the high lost rate (53.6%) of follow-up in this study, it was also excluded from our meta-analysis. Although only 4 RCTs were included in this study, all of them have a Jadad scale scores more than 6, with maximum of 8.0 points. Meanwhile it contained 966 patients met all inclusion criteria. The sample was big enough and had good quality, which makes research results more convincing.

The limitations of this study were lack of compared in conventional items between surgical and nonsurgical treatment, such as recovery of the Böhler angle and so on. However, we think that the comparison of conventional items has little effect on the core idea of this paper. So, there was no need to do a lot of repetitive, no innovative work.

CONCLUSIONS

In summary, our meta-analyses confirm that surgery offers protection against early subtalar arthrodesis in displaced intra-articular calcaneal fractures. It reminds us that surgical treatment for displaced intra-articular calcaneal fractures is still necessary.

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