Ankle arthrodesis-Open versus arthroscopic in the Treatment of Ankle Arthritis: A meta-analysis

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Abstract

Background: This study intends in evaluating the comparsion between arthroscopic arthrodesis and open surgery for patients with ankle arthritis by performing a meta-analysis.

Methods: A literature search for this meta-analysis was conducted using four English databases (Pubmed, Embase, Medline and the Cochrane Library), up to August 2019. These included two prospective cohort study and 7 retrospective cohort studies, enrolling a total of 507 patients with ankle arthritis.

Result: For fusion rate, the pooled data showed significantly higher rate of fusion during the arthroscopic arthrodesis compared with open surgery (odds ratio 0.25, 95% CI 0.11 to 0.57, p = 0.0010). Regarding to the estimated blood loss, the pooled data showed significantly smaller blood losses during arthroscopic arthrodesis as compared with open surgery (WMD 52.04, 95% CI 14.14 to 89.94, p = 0.007). For tourniquet time, the pooled data showed smaller tourniquet time during arthroscopic arthrodesis compared with open surgery (WMD 22.68, 95% CI 1.92 to 43.43, p = 0.03). In the length of stay in the hospital, the pooled data showed less time of hospitalization for patients undergoing arthroscopic arthrodesis compared with open surgery (WMD 1.62, 95% CI 0.97 to 2.26, p < 0.00001). The pooled data showed better recovery for the patients who experienced arthroscopic arthrodesis as compared with open surgery at 1 year (WMD 14.73, 95% CI 6.66 to 22.80, p = 0.0003).

Conclusion: For patients with ankle arthritis, arthroscopic arthrodesis seems to be associated with a higher fusion rate, lesser amount of estimated blood loss, shorter tourniquet time, shorter length of hospitalization and better functional improvement at 1 year.

Background

The most frequently injured joint is the ankle joint because the it subsumes more force per square centimeter. Over 80% of ankle arthritis is post-traumatic. Disabling or even substantial functional impairment are the main symptoms of end-stage ankle arthritis.[2] It can alter the life quality of the patient dreadfully. Arthrodesis is always the ultimate option for patients when the conservative treatment fails.[1–3]

Arthrodesis, under open surgery, is the traditional option for ankle arthritis, chronic instability, and degenerative deformity. [4] Pain relief and functional improvement of a foot with ankle degeneration are highly recommended to treat ankle arthrodesis. However, it alters the biochemical performance and may cause foot pain, joint arthritis, and bone fracture.[5, 6] Arthroscopic arthrodesis is an advanced technique for treating ankle problems in the last decade. It became an available option since 1983. [7] It is reported that it is less invasive, and the patients suffer less pain after the surgery. However, it is time-consuming, and has controversial ankle fusion rate.[8] Moreover, the contraindication of the arthroscopic arthrodesis is the severe deformity. [9]

Choosing procedures between open surgery and arthroscopic arthrodesis for ankle arthritis is still controversial.[10] However, to our knowledge, only one systematic review and meta-analysis in the literature, comparing the outcomes of open and arthroscopic methods of ankle fusion is available but it did not extract the data of postoperative improvement.[10] This study intends in evaluating the fusion rate, the effectiveness, the complication, and the operative improvements by performing a systemic and meta-analysis that focuses all studies achieved to our criteria: comparative studies of arthroscopic arthrodesis and open surgery for patients with ankle arthritis.

Methods

Search Strategy

A literature search for this meta-analysis was conducted using four English databases (Pubmed, Embase, Medline and the Cochrane Library), up to August 2019. In order to maintain a high sensitivity in our research, we decided to include relevant Medical Subject Headings (MeSH), common keywords, and the comprehensive combination. No language restriction and no filters were set for the strategy. All the published relevant article bibliographies have been reviewed. 142 references were removed due to duplication and 186 references were imported to be an initial screening on the titles and the abstract.

Inclusion and Exclusion Requirement

Two examiners screened all the references including the titles and abstracts separately so that the eligibility criteria could be achieved. The irrelevant articles and non-full-text references are in the exclusion group. The inclusion criteria were as follows: (1) patients with ankle arthritis, include post-traumatic arthritis, osteoarthritis, and end-stage arthritis, or the patients with ankle instability are focused; (2) comparatives studies between open surgery of arthrodesis and arthroscope arthrodesis; (3) one or more outcomes of interest shown in the studies. Excluded studies were (1) not original articles and (2) pre-clinical studies.

Data Extraction and Quality Assessment

The following variables were extracted and double-checked by the reviewers Independent and quality assessment performed. Newcastle-Ottawa Scale (NOS) was used for assessing the risk of bias of observational studies. There are nine stars maximum in 3 domains (8 items): the selection of the study groups, the compatibility of the groups, and the ascertainment of the outcome of interest.[11] According to the scale, there are only low risk and high risk. Low risk was rated as one stars award, and high risk was estimated as no star award. Nine stars in a study was categorised as low risk of bias, Seven to eight stars in a review as a moderate risk of bias, Six or fewer stars in a study as high risk of bias. Two reviewers discussed if there was any disagreement needed to be resolved.[12] A third author was consulted when no agreement could be achieved. For baseline characteristics of the study participants,

age, sex ratio, body mass index (BMI), sample size and the lesion types were recorded as demographic and clinical characteristics. Regarding the information about interventions, the collected information about open surgery and arthroscopic arthrodesis were included in the ratio in each study. The adverse events and postoperative complication, the overall complication rate and the infection rates were recorded. For effective outcome, operation time, estimated blood loss, length of stay, Ankle Osteoarthritis Scale (AOS) score after surgery 12 and 24 months were abstracted[13] to compare the effectiveness of open arthrodesis and arthroscopic arthrodesis.

Statistical Analysis

For dichotomous variables (fusion rate, infection rate, overall complication rate), the odds ratio (OR) and weighted mean differences (WMDs) were calculated, respectively, and reported with 95% confidence intervals (CIs). [14, 15]The algorithms proposed by Hozo et al[1] were used when only the median, standard error, or range were reported in studies.

Assessing the statistical heterogeneity, the Chi-square test with significance set at $p < 0.10$ was used including the meta-analysis, and I^2 statistics quantified the heterogeneity. A fixed-effect model was applied for all variables with $I^2 < 50\%$. It means that there was no significant heterogeneity among the studies. All meta-analyses were directed by Review Manager Version 5.3 (RevMan, Copenhagen: The Nordic Cochrane Center, The Cochrane Collabortion, 2014). A two-tailed test of significance ($p < 0.05$) was used.[16]

Results

Study Characteristics

Table 1 shows the characteristics of 9 studies and their patients. Four of 9 studies were conducted in US, 1 in Canada, 1 in China, 1 in Denmark and 1 performed in UK. All the studies were published during the last 20 years from 1990 to 2019. These included two prospective cohort study and 7 retrospective cohort studies, enrolling a total of 507 patients with ankle arthritis. No randomized controlled trial was included. A total of 303 patients undertaken the arthroscopic arthrodesis and total of 214 patients undertaken the open surgical arthrodesis.

Using Newcastle-Ottawa scale, 2 analyses were rated at moderate risk of bias for study participation. 1 analysis was at high risk of bias. The graph demonstrates the summary and results of methodological quality assessment in Fig. 2.

Primary outcome

Fusion Rate

Seven studies presented fusion rate and the pooled data showed significantly higher rate of fusion during the arthroscopic arthrodesis compared with open surgery (odds ratio 0.25, 95% CI 0.11 to 0.57, p = 0.0010)in 128 of 167 patients. In addition, there was no significant heterogeneity between these two group.

Days to Union

Three studies assessed the days to union and there was no difference between arthroscopic and open surgery (WMD 1.62, 95% CI −5.97 to 59.08, p = 0.11) There was no significant heterogeneity among these three studies.

Surgical Outcomes

Operation Time

Four studies reported the operation time. The level of heterogeneity was low (Chi-square = 4.65, df = 3, I^2 = 35%, p = 0.20), the pooled data from four studies did not show notable difference between arthroscopic arthrodesis and open surgery (WMD 3.72, 95% CI −5.31, 12.76, p = 0.42)

Estimated Blood Loss

Two studies assessed the estimated blood loss during the surgery and the pooled data showed significantly smaller blood losses during arthroscopic arthrodesis as compared with open surgery (WMD 52.04, 95% CI 14.14 to 89.94, p = 0.007). In addition, there was no significant heterogeneity between two groups.

Tourniquet Time

Four studies presented tourniquet time and the pooled data showed remarkably smaller tourniquet time during arthroscopic arthrodesis compared with open surgery (WMD 22.68, 95% CI 1.92 to 43.43, p = 0.03). There was significant heterogeneity among these four studies.

Length of Stay

Six studies reported the length of stay in the hospital and the pooled data showed markedly less time of hospitalisation for patients undergoing arthroscopic arthrodesis compared with open surgery (WMD 1.62, 95% CI 0.97 to 2.26, p < 0.00001), with a low level of heterogeneity (Chi-square = 8.21, df = 4, I^2 = 51%, p = 0.08)

Complication

Overall Complication Rate

Eight studies assessed the overall complication rate and there was no difference between arthroscopic arthrodesis and open surgery (WMD 1.70, 95% CI 0.84 to 3.43, p = 0.14). There was no obvious heterogeneity among these eight studies.

Rate of infection

Seven studies, including 365 patients, reported the rate of infection and the pooled data showed no significant difference between patients who underwent arthroscopic arthrodesis and and those with open surgery (Odd Ratio 1.58, 95% CI 0.60 to 4.16, p = 0.36). There was no significant heterogeneity among these seven studies.

Functional Improvement

One Year Later

Two studies presented the postoperative recovery after 1 year with AOS score. The pooled data showed markedly better recovery for the patients who experienced arthroscopic arthrodesis as compared with open surgery (WMD 14.73, 95% CI 6.66 to 22.80, p = 0.0003) with a low heterogeneity (Chi-square 0.49, df = 1, p = 0.48, I^2 = 0%).

Two Years Later

Two studies assessed the postoperative recovery after 2 years using AOS scale and it reports that patients who underwent arthroscopic arthrodesis had no notable greater recovery than those who underwent open surgery (WMD 8.13, 95% CI –3.40 to 19.99, P = 0.48). In addition, there was no significant heterogeneity between these two groups (I^2 = 40%, P = 0.20).

Discussion

This study conducted a meta-analysis of comparative studies published since 1990 to compare the fusion rate, operative effectiveness, safety and the postoperative outcome evaluation between arthroscopic arthrodesis and open surgery with ankle arthritis. Although there are similar studies about the comparison between ankle arthrodesis and open surgery, this study included the most publications and reflects the latest surgical results, and focuses on the results of arthroscopic arthrodesis and open surgery for ankle arthritis. Considering issues of overcoming learning curve and insufficient evaluation,

the study results might be meaningful. This study evaluated the two procedures using 4 items: days to union, estimated blood loss, AOS scale at 12 and 24 months unlike the previous study. These items completed the evaluation from primary outcome to postoperative recovery. First, it was noted that there is no significant difference in days to union which is contradictory to the previous studies.[2] Patients who experienced arthroscopic arthrodesis did not have a shorter time to union than those who experienced an open surgery.

Regarding the rate of fusion, the meta-analysis showed that there was remarkable difference in statistics between arthroscopic arthrodesis and open surgery, and the data supports the most recent meta-analysis by Honnenahalli et al.[2] Patients who underwent arthroscopic arthrodesis has a higher fusion rate than those with open surgery. The soft tissue envelope under arthroscopic arthrodesis is disrupted to a minimum degree which protects major functions of soft tissues close to the surgical site. The bone healing cascade is activated rapidly, so the bone heals rapidly and the function improved in the early stage due to the minimum degree of soft-tissue envelope disruption [3, 17]. These theories may elucidate higher fusion rate for arthroscopic arthrodesis.

Additionally, the first to assess is the estimated blood loss data and the pooled data significantly favoured arthroscopic arthrodesis compared with open surgery. The data were pooled by O'Brien et al.[18] and Townshed et al. [3] Moreover, the tourniquet time is considerably shorter with arthroscopic arthrodesis during the operation. Although Meng et al.[19] mentioned longer operation time for arthroscopic arthrodesis; this study showed no significant differences in the operating time between these two procedures. There is only one relevant study mentioned in Meng et al.[19] but this pooled data extracted a larger sample size from different countries. Therefore, the risk of bias is minimised in the result. As a result, arthroscopic arthrodesis does not take longer time to complete.

Regarding the complications, it is reported that the patients who underwent arthroscopic arthrodesis may require removal of a screw for prominence, superficial infections, deep vein thromboses/pulmonary emboli, revision of fixation, stress fracture and deep infections after the surgery.[8] However, the study shows no significant difference between these two surgical procedures. It is reported that patients needed re-operation with similar complications in both groups. It explains why there was no remarkable difference in both groups due to similar postoperative radiological alignment[20]

Moreover, the postoperative improvements were studied with AOS score. The arthroscopic arthrodesis group showed significantly better scores at one year compared with open surgery groups.[21] However, no significant difference between both groups at 2 years was noted. Since less area was damaged during arthroscopic arthrodesis rather than open surgery, the tissues and functions recovers rapidly and in earlier-stage s as per Townshend et al. [3] Further study is needed to have a better understanding of the clinical picture of the finding, especially the education for patients to choose the best time point to reconstruct their ankle arthritis.[20] It is a new finding compared with the previous study. Thus, patients who underwent arthroscopic arthrodesis recovered in a shorter time but showed similar bone reconstruction in the long term compared with open surgery.

There are several limitations despite these findings. First, no randomized controlled trial (RCT) was reported. Higher risk of potential selection and reporting bias in an observational study compared with an RCT study. Second, a more extensive database is needed, especially the sample size and the number of countries. There are 4 out of 9 reviews from the US. It increases the risk of bias in a specific area. Third, nine studies reported different baseline characteristics between arthroscopic arthrodesis and open surgery. Thus, the comparability reduced in the reviews. Fourth, longer time follow-up is needed. 24 months follow-up cannot show long term effect or complication of the procedures.

Conclusion

In this study, arthroscopic arthrodesis seems to be associated with a higher fusion rate, lesser amount of estimated blood loss, shorter tourniquet time, shorter length of hospitalisation and better functional improvement at 1 year. Nevertheless, we need to interpret the results with caution, pool the RCT studies with larger sample size and do comparative studies in order to evaluate the efficiency of arthroscopic arthrodesis.

Declarations

Acknowledgements

Not applicable.

Authors' contributions

MTN and HQ designed the study and wrote the manuscript. PS and HH reviewed the risk of bias of studies and the language of the study. WH and ZX extracted the data from the studies. PJ interpreted the data result. LJ supervised the whole study. All authors read and approved the final manuscript.

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Availability of data and materials

All data and materials are contained within the manuscript.

Ethics approval and consent to participate

Ethical approval is not necessary because it is a comment on previously published articles and does not involve the handing of any personal patient data.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Table

TABLE 1 Characteristics of the included studies

Author	Year	Country	Journal	Lesion Type	Procedure	Follow up	Sample size	Arthroscopic	Open	Age (A[a] vs O[b])	Male (A[a] vs O[b])	BMI (A[a] vs O[b])
Meng	2013	China	Chinese journal of reparative and reconstructive surgery	Ankle arthritis	Ankle fusion	12 months	30	14	16	Not available	Not available	Not available
O'Brien TS	1999	USA	Foot Ankle International	Post traumatic arthritis	Ankle fusion	NP	36	19	17	47.3 vs 44.6	9/19 vs 7/17	Not available
Nielsen KK	2008	Denmark	Foot and Ankle Surgery	Post traumatic arthritis	Ankle fusion	12 months	107	58	49	Not available	Not available	Not available
Townshed D	2013	Canada	Journal of Bone and Joint Surgery Am	Post traumatic/ primary OA	Ankle fusion	24 months	60	30	30	59.4 vs 54.7	11/30 vs 20/30	27.4 vs 29.6
Myerson	1990	USA	Clinical Orthopaedics and Related Research	Post traumatic arthritis	Ankle fusion	23 months	33	17	16	Not available	7/17 vs 7/16	Not available
Peterson	2010	USA	Journal of foot and Ankle Surgery	Ankle arthritis	Ankle fusion	6 months	10	10	10	56.2 vs 54.8	5/10 vs 6/10	37.36 vs 32.11
DeVries	2019	USA	Journal of Foot and Ankle Surgery	Ankle instability	Ankle fusion	24.2months	55	43	12	44.7 vs 39.5	16/43 vs 6/12	34.2 vs 33.1
Quayle	2016	UK	Foot and Ankle Surgery	Post traumatic arthritis	Ankle fusion	48 months	79	50	29	57 vs 61.9	37/50 vs 19/29	28.9 vs 28.0
Schmid	2017	Canada	Foot Ankle International	End-stage ankle arthritis	Ankle fusion	54 months	97	62	35	57.4 vs 57.11	39/62 vs 26/35	28.2 v 28.8

[a]Arthroscopic arthordesis

[b]Open Surgery

Figures

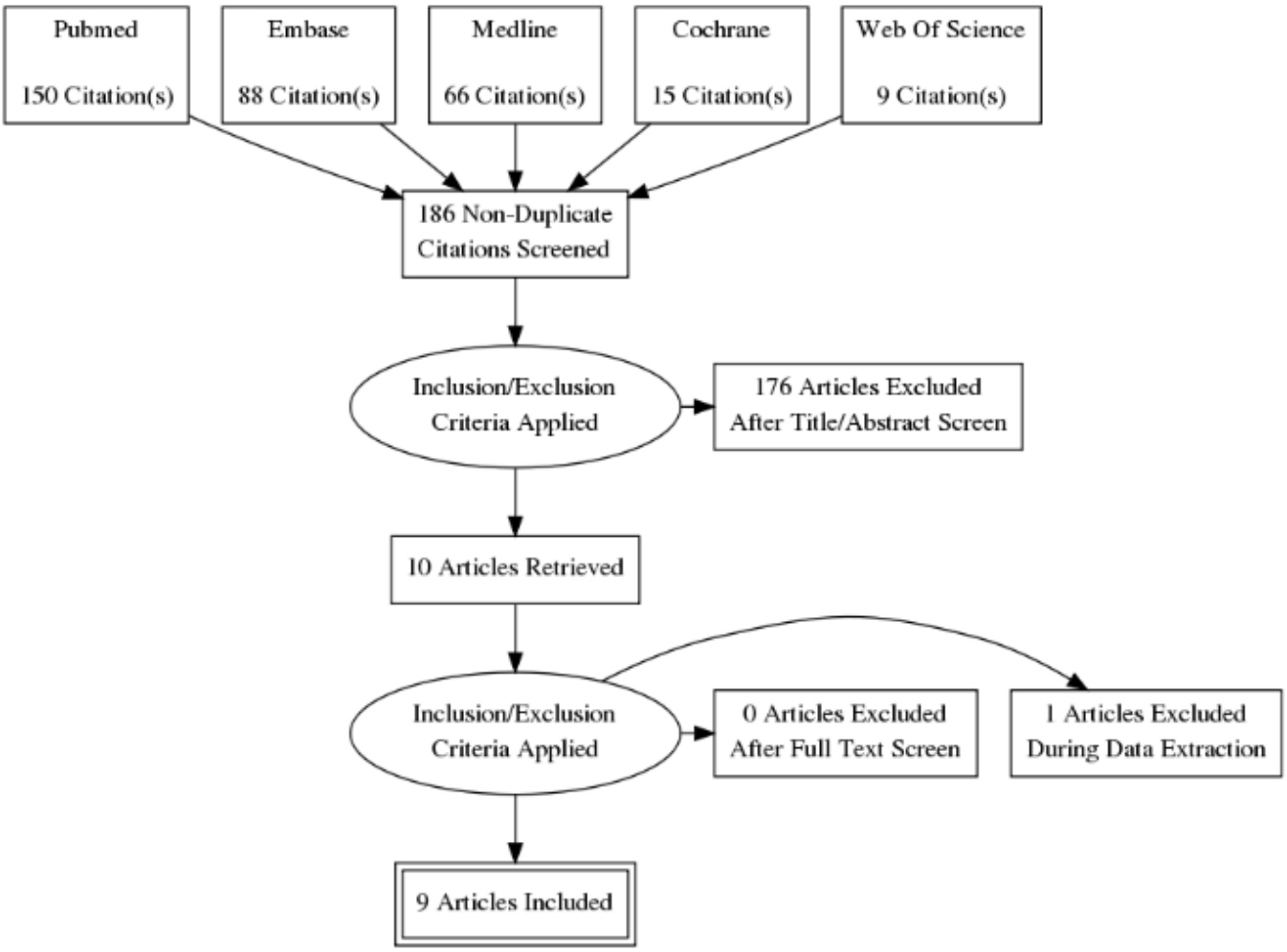

Figure 1

Study selection process

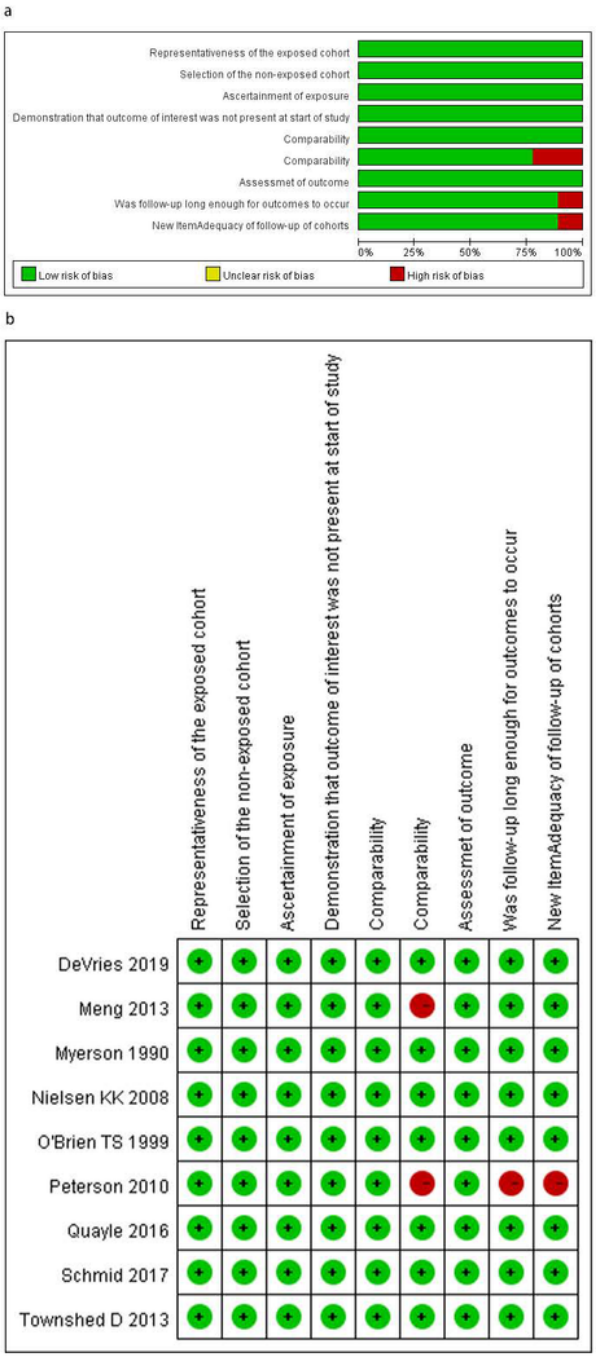

Figure 2

Quality assessment of the meta-analysis. a Risk of bias

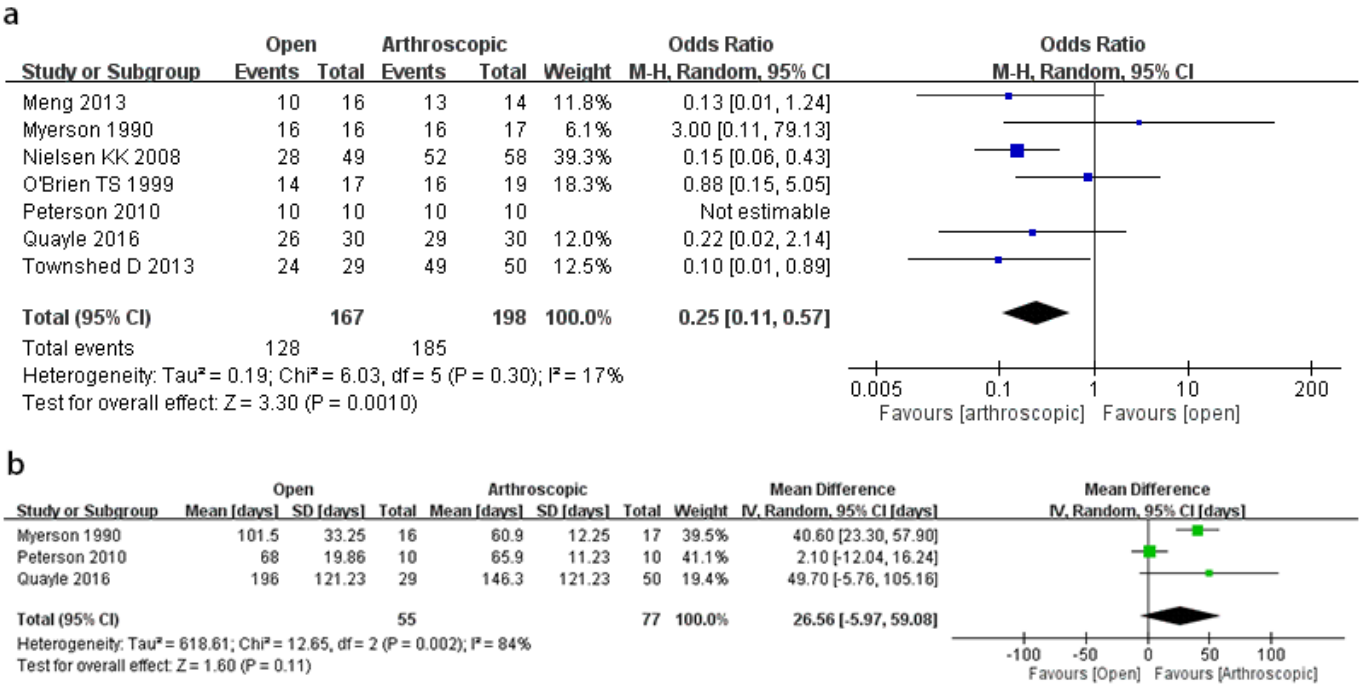

Figure 3

Forest plot and meta-analysis of a the fusion rate; and b days to union

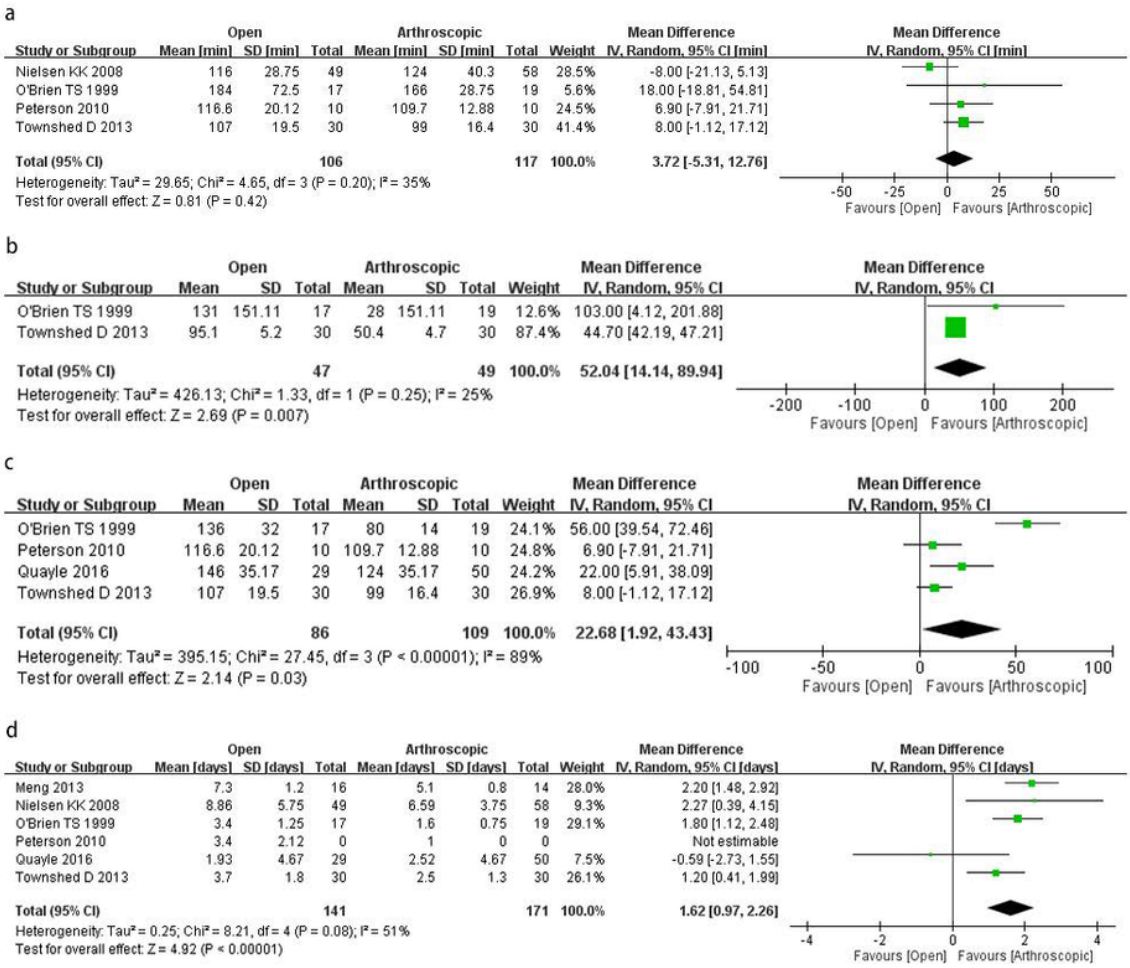

Figure 4

Forest plot and meta-analysis of a operation time; b estimated blood loss; c tourniquet time; and d length of stay

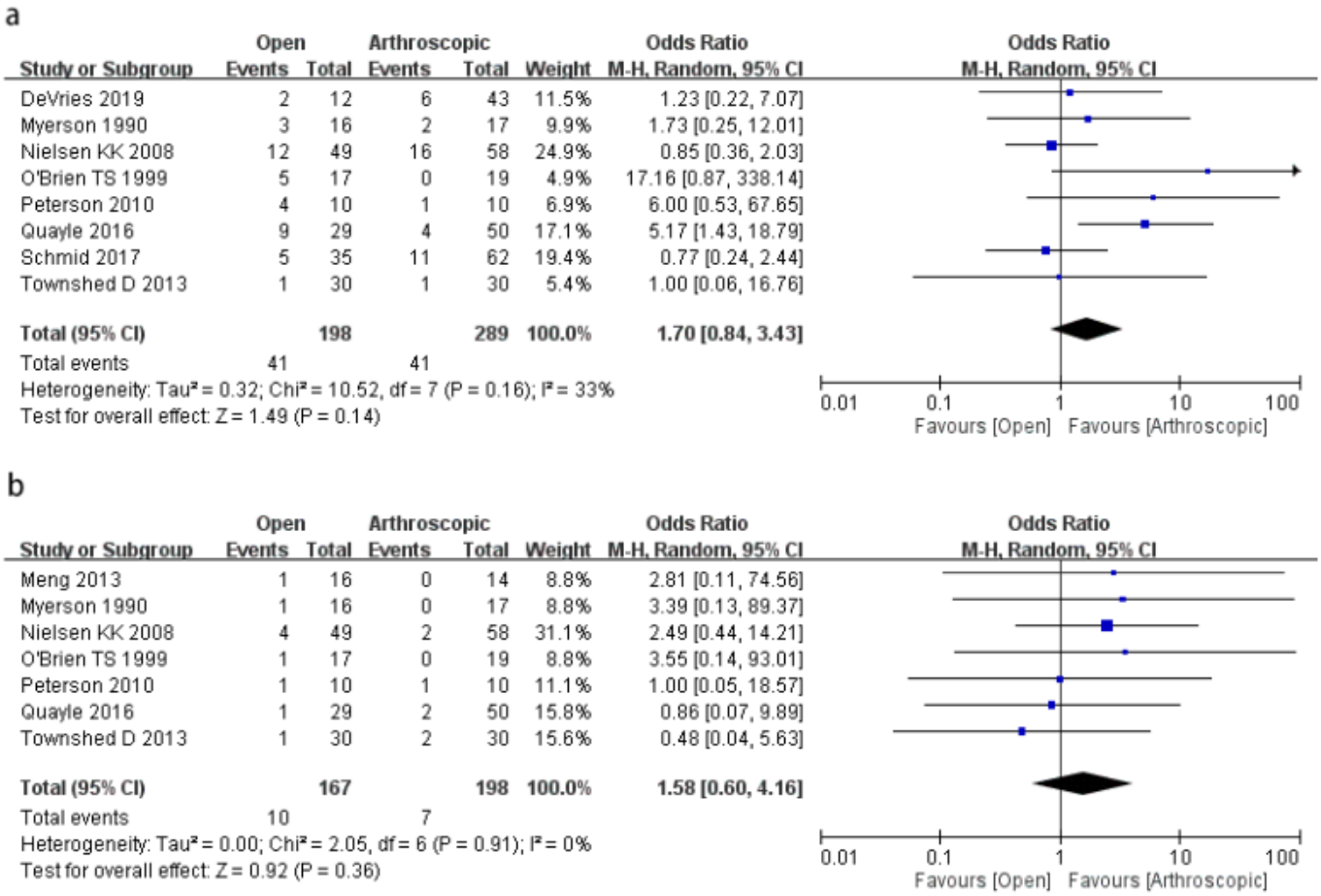

Figure 5

Forrest plot and meta-analysis of a overall compliation rate; and b infectious rate

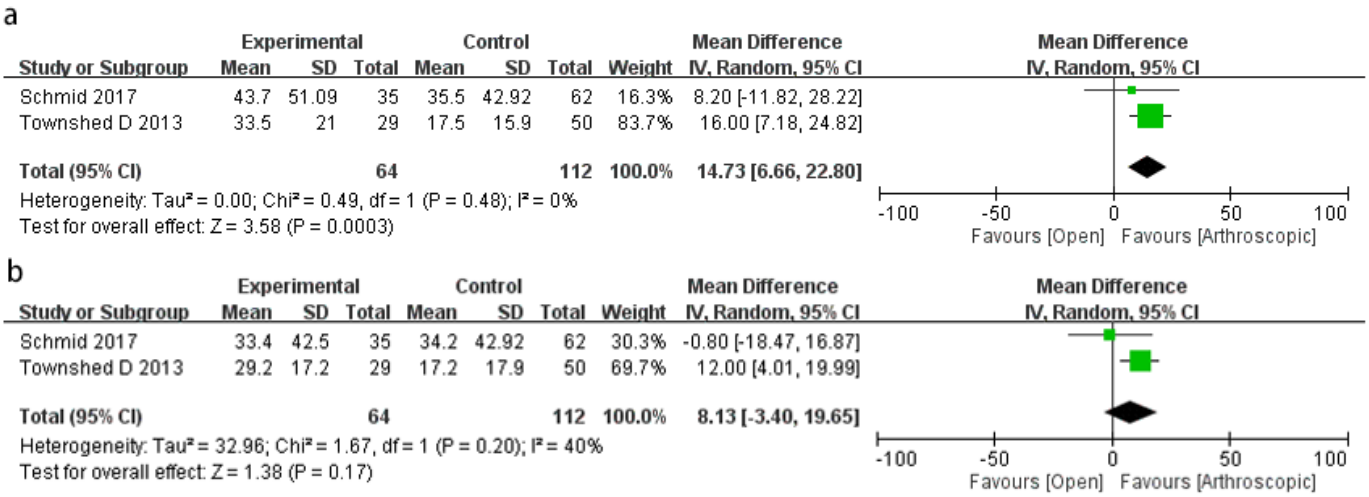

Figure 6

Forrest plot and meta-analysis of AOS score at a 1 year; and b 2 years

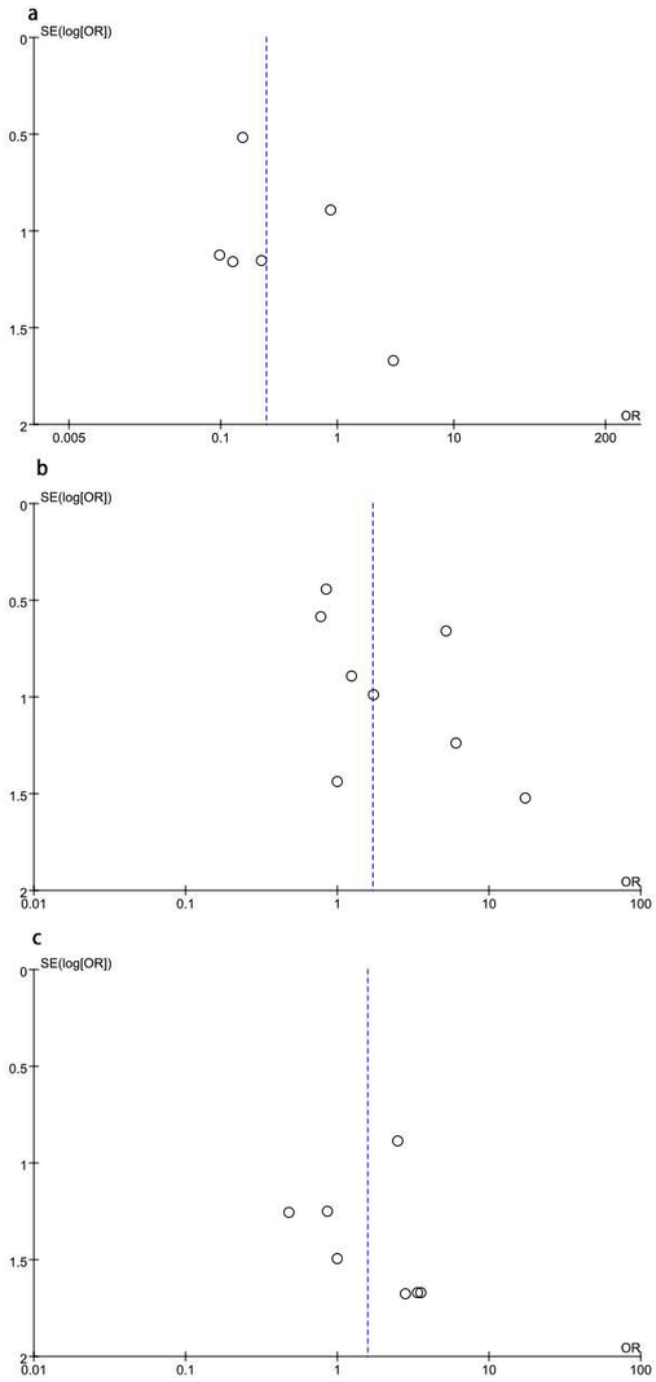

Figure 7

Funnel plot of publish bias in a fusion rate; b overall complication; and c infectious rate

Supplementary Files

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- PRISMA2009checklist.pdf