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Releasing of Tourniquet Before Wound Closure or not in Total Knee Arthroplasty: A Meta-Analysis of Randomized Controlled Trials

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ABSTRACT

The purpose of this study is to examine our hypothesis that releasing tourniquet intraoperatively before wound closure is better than releasing postoperatively after wound closure and bandaging. We carried out a systematic review using meta-analysis of selected randomized controlled trials comparing tourniquet releasing before and after wound closure in TKA. The results showed that tourniquet releasing before wound closure significantly increased the total blood loss ($P < 0.00001$), calculated blood loss ($P < 0.0001$) as well as postoperative blood loss ($P = 0.007$). However, it decreased the risk of both minor ($P = 0.0007$) and major complications ($P = 0.05$). The available evidence indicated that releasing tourniquet before wound closure for hemostasis increased perioperative blood loss, nevertheless, the risk of complications decreased significantly.

TKA is a successful procedure for reducing pain and restoring function in cases with severe rheumatoid arthritis and osteoarthritis. Although the use of pneumatic tourniquet is still highly debatable [1], considering the fact of providing more clear visualization, less intraoperative bleeding thus ensuring better cementation, it has become a common procedure and is widely used during TKA. However, whether releasing tourniquet before wound closure remains disputed. Various studies referring to this issue, including randomized controlled trials (RCTs), retrospective studies and systematic review have been previously reported, while, no final conclusion has been drawn. The latest meta-analysis concentrating on the timing of tourniquet releasing in TKA was published in April 2007 by Rama et al, who drew the conclusion that early tourniquet releasing increased the blood loss accomplished with primary knee arthroplasty. However, tourniquet releasing after wound closure could increase the risk of early postoperative complications requiring another operation [2]. Well-conducted larger studies are needed to further explore the risk of early postoperative complications associated with late tourniquet releasing. However, since then many RCTs have been conducted, it is necessary to engage a new meta-analysis containing these latest RCTs to recognize the debate. We therefore conducted a study of all available RCTs comparing tourniquet releasing before and after wound closure in TKA to evaluate the efficacy of this aspect of the procedure.

Methods

We followed the methodological guidelines outlined by the Cochrane Collaboration (Oxford, United Kingdom) [3] during conducting this meta-analysis. These findings were reported according to the recommendations outlined in the Quality of Reporting of Meta-Analyses (QUOROM) statement [4].

Inclusion and Exclusion Criteria

We identified literature that met the following inclusion criteria: (1) randomized controlled trials, (2) comparison of tourniquet releasing before (release before) and after (release after) wound closure during TKA surgery. (3) Outcome measurements should include at least one of these parameters (total blood loss, minor and major complications). Exclusion criteria were: unpublished data, proceedings of meetings, non-randomized controlled trials, different tourniquet application strategy.

Literature Search

Two independent reviewers (Pengfei Zan and Yong Yang) carried out a systematic computerized search of electronic data-bases including the Cochrane Central Register of Controlled Trials, PubMed, Ovid MEDLINE and EMBASE. In addition, we also searched the Internet search engine "Google". The key words used for the search included: "total knee replacement", "total knee arthroplasty", "TKR", "TKA" and "tourniquet release". The search was not restricted to the language of reports.

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Article Selection and Validity Assessment

We included randomized controlled trials comparing tourniquet releasing before wound closure or not during TKA. Retrospective or prospective studies were excluded. The volume of blood loss and incidence of complications were regarded as primary outcomes. By scanning the title of each study we could filter those inappropriate articles. Afterwards, we independently reviewed abstracts of the remained studies and selected those that were potentially relevant to our study. Bibliographies of each study were reviewed for any additional studies. We then critically appraised and identified the studies that were appropriate in our analysis. All disagreements were settled by discussion.

Data Extraction

Outcome data from individual study were extracted independently by Pengfei Zan and Yong Yang and checked by a third author against the original information to avoid anthropic mistakes. Whenever necessary, we contacted the authors of the studies for the missing data and additional information. One German article [5] was translated by a Germanic doctor. For any disaccord, we reached a consensus by discussion. Data extracted included publication information; participant demographics; sample size; cement or cementless; method of anesthesia; tourniquet time and operative time; usage of the drainage and the time removed; blood loss measures, including the intraoperative blood loss, postoperative blood loss, total measured blood loss, and calculated blood loss; incidence of complications (including minor complications and major complications); decrease in hemoglobin; the number of transfused patients, and amount of blood transfusion; a straight-leg raise; knee flexion; pain scores. The calculated blood loss was obtained by the method proposed by Gross [6]. With this method, the estimated blood volume was calculated based on height and weight of the patient, using a correction factor for gender. Based on the data extracted from the included studies, we defined the complication as a minor or major one according to whether a second operation was needed. Wound complications such as erythema, marginal necrosis, cellulitis, superficial infection, oozing, significant leg swelling, and DVT, which could be healed through conservative treatment and did not require another operation were defined as minor complications. Wound dehiscence, active hemorrhage, hematoma or deep infection that required drainage or debridement or revision, knee stiffness which need a second operation under anesthesia were defined as major complications.

Statistical Analysis

The results were collected using the method of variance-weighted. The presence of heterogeneity were tested using the standard chi-square test (with a level of significant of $P = 0.1$) and the I^2 statistic [7].

An I^2 statistic value of >50% indicated substantial heterogeneity. Random-effects analysis [8] was used for comparing trials with heterogeneity, otherwise fixed-effects analysis [9] was used. The mean difference or relative risk was calculated for all outcomes. If the standard deviation of a mean was not reported in a study, it was calculated by the range with use of the methods proposed by Hozo et al [10]. The meta-analysis was carried out using the RevMan 5.2 software (Cochrane Collaboration, Oxford, United Kingdom).

Results

Identified Trials

A flow chart of the studies was shown in Fig. 1. Of the 1594 studies identified by the primary search, 1574 studies were excluded based on the inclusion/exclusion criteria, leaving nineteen potentially relevant studies. This was further reduced to sixteen after critical appraisal of the full articles, eliminating three non-randomized controlled trials [11–13]. Table 1 shows the included studies with their contributions to the data pool [5,14–28].

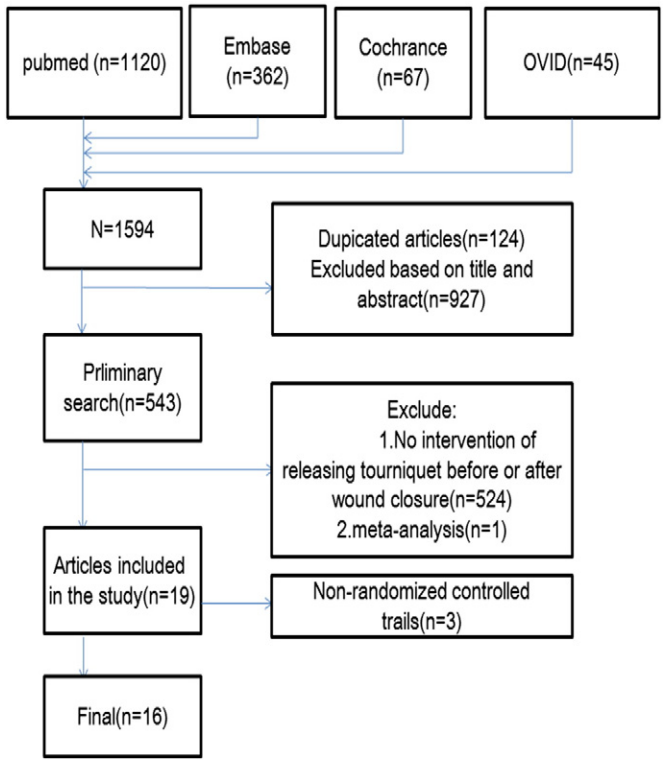

Fig. 1. Fow chart of the studies identified in the meta-analysis.

Outcome Analysis

Blood Loss

A total of 8 studies [14,16–20,22,23] including 608 knees were included for analysis of the total measured blood loss and showed significantly more blood loss in the knees with tourniquet releasing before wound closure (Fig. 2) (mean difference = 184.19 ml; 95% confidence interval = 134.43 to 233.95; $P < 0.00001$). In four studies [5,19,21,24], the calculated blood loss proposed by Gross [6], also showed significantly more blood loss (Fig. 3) (mean difference = 268.86 ml; 95% confidence interval = 143.77 to 393.96; $P < 0.0001$). In addition, we found six studies [5,20,21,25–27] in which the postoperative blood loss was measured properly showed significant difference between the two groups (Fig. 4) (mean difference = 89.56 ml; 95% confidence interval = 24.88 to 154.23; $P = 0.007$). However, four studies [5,16,20,27] in which the decrease in hemoglobin (HB) reported showed no significant difference (Fig. 5) (mean difference = 0.43; 95% confidence interval = −2.63 to 3.50; $P = 0.78$).

Complications

Based on the available data, ten studies [5,14–18,20,24,25,27] involved complications including minor complications and major complications. From Figs. 6 and 7, we could draw the conclusion that tourniquet releasing after wound closure increased the risk of both minor complications (odds ratio = 0.39; 95% confidence interval = 0.23 to 0.67; $P = 0.0007$) and major complications (odds ratio = 0.32; 95% confidence interval = 0.10 to 1.00; $P = 0.05$). With four available studies [5,16,17,20], we also conducted a subgroup analysis regarding DVT, which was which was confirmed by phlebography in clinical suspected patients. Fig. 8 showed no significant difference between