Timing of tourniquet release in knee arthroplasty: meta-analysis of randomized, controlled trials
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CRD summary
This review assessed whether timing of tourniquet release in knee arthroplasty affects peri-operative blood loss and risk of early post-operative complications. The authors concluded that early release increases peri-operative blood loss, but is associated with a lower risk of a complication requiring reoperation. Given the significant variability and methodological limitations of the included studies, the reliability of the authors' conclusions is unclear.

Authors' objectives
To assess whether timing of tourniquet release in knee arthroplasty affects peri-operative blood loss and risk of early post-operative complications.

Searching
MEDLINE and PubMed (1966 to 2005), EMBASE (1980 to 2005), the Cochrane CENTRAL Register (2006), Trials Central and Current Controlled Trials were searched. In addition, the references of relevant articles were checked and experts in the field were contacted. Searches were not restricted by language and search terms were reported.

Study selection
Study designs of evaluations included in the review
Randomised controlled trials (RCTs) were eligible for inclusion.

Specific interventions included in the review
Studies comparing tourniquet release before wound closure (early release) to achieve haemostasis and after wound closure (late release) were eligible for inclusion. The included studies also identified treatment with or without chemical thromboprophylaxis with aspirin, warfarin or low molecular weight heparin.

Participants included in the review
Studies of patients undergoing primary knee replacement (arthroplasty) with tourniquet control were eligible for inclusion. The included studies identified patients undergoing primary knee arthroplasty with uncemented, hybrid or cemented knee replacements, and unicompartmental knee replacements in addition to total knee replacements.

Outcomes assessed in the review
Studies measuring blood loss and/or reporting post-operative complications as the primary outcomes were eligible for inclusion. The included studies reported the following primary outcomes: post-operative, total measured or calculated blood loss; prevalence of early complications (within first 6 weeks post operation); fall in haemoglobin levels; presence of symptomatic deep vein thrombosis; minor wound complications; and wound complications requiring reoperation. Secondary outcomes included volume of blood transfused, operative time and tourniquet time.

How were decisions on the relevance of primary studies made?
Two reviewers independently screened studies for relevance, with any disagreements resolved through discussion.

Assessment of study quality
Two reviewers independently assessed validity on the basis of items such as allocation concealment, blinding, attrition levels and selective reporting of outcomes. The quality of reporting was also assessed, according to the Consolidated Standards of Reporting Trials (CONSORT) checklist. Any disagreements were resolved through discussion.

Data extraction
Two reviewers independently extracted the data from the included studies, with any disagreements resolved through consensus. Data were extracted on each outcome, ultimately to calculate the weighted mean differences (WMDs) for...
continuous data and risk differences (RDs) for dichotomous data, along with 95% confidence intervals (CIs). The authors of included studies were contacted for missing data, when necessary.

**Methods of synthesis**

How were the studies combined?  
RDs were pooled using a fixed-effect model, with studies weighted according to the Mantel-Haenszel method. WMDs were pooled using a fixed-effect or random-effects model (DerSimonian and Laird) where appropriate. Continuous data were weighted using the inverse variance method.

How were differences between studies investigated?  
Statistical heterogeneity was assessed using the chi-squared and I-squared tests. Clinical heterogeneity was investigated through subgroup analyses assessing the differences between total measured blood loss in replacements with and without cement, the total measured blood loss in patients not receiving chemical thromboprophylaxis, and the decrease in haemoglobin in patients without peri-operative blood transfusion. Sensitivity analyses were also carried out to assess methodological heterogeneity by removing studies with inadequate reporting and those without predefined complications.

**Results of the review**

Eleven RCTs (872 participants with 893 procedures: 458 early release and 435 late release) were included in the review.

The included RCTs met between 7 and 17 of the 22 CONSORT criteria. The methodological quality of the RCTs was poor, with only 2 studies reporting adequate concealment of allocation and only one using blinding. Publication bias was not assessed because of the small number of included studies. Sample sizes were between 25 and 50 for both early- and late-release groups.

Pooled WMDs from 5 studies, in which total blood loss had been measured ‘properly’ as defined by review authors (n=382), showed statistically significant differences in total measured blood loss, with higher levels in the early-release groups (228.7 mL, 95% CI: 168.3, 289.1, p<0.00001). Three studies measuring calculated blood loss, calculated on the basis of the maximum decrease in haemoglobin concentration, (n=251), reported a statistically significant difference with greater loss in the early-release groups (WMD 320.7 mL, 95% CI: 204.3, 437.1, p<0.00001). However, when pooling 8 studies (n=675) there were no significant differences between groups for measured post-operative blood loss or decrease in haemoglobin levels. Other outcomes were reported.

Seven studies reported data on early post-operative complications (n=580). There were statistically significant increases in risk of regional complications (RD 7%, 95% CI: 2, 12, p=0.006) and risk of reoperation (RD 3%, 95% CI: 0.1, 5, p=0.04) in the late-release group. There were no significant differences between groups for minor wound complications or presence of symptomatic deep vein thrombosis.

Subgroup and sensitivity analyses did not significantly alter the outcomes of interest. There was significant clinical heterogeneity between type of knee replacement, additional prophylaxis and drainage procedures. There was also significant methodological heterogeneity.

**Authors’ conclusions**

Compared with late release, early release of the tourniquet with primary knee arthroplasty increases peri-operative blood loss, but reduces the risk of a complication requiring reoperation. Large well-conducted studies are needed to further assess the risk of early post-operative complications associated with late tourniquet release in knee arthroplasty.

**CRD commentary**

The review question was clear and was supported by appropriate inclusion criteria relating to the participants, interventions, outcomes, comparator and study designs. Relevant literature searches were conducted using electronic databases and other appropriate sources. In addition, the references of relevant articles were checked and experts in the field contacted. Searches were not restricted by language, and attempts were made to minimise the potential for publication bias, although this was not investigated. Validity was assessed using appropriate criteria, and attempts were
made to minimise errors and bias at each stage of the review process. Appropriate methods were used to pool the results and investigate heterogeneity. Despite some analysis of heterogeneity, however, the pooling of studies with significant clinical and methodological differences might not have been appropriate, and the number of studies included and sample sizes were small. The quality of the included studies was poor. Given the limitations mentioned, the reliability of the authors’ conclusions is unclear.

**Implications of the review for practice and research**

Practice: The authors did not state any implications for practice.

Research: The authors stated that further research using large, well-conducted randomised studies is required.

**Bibliographic details**


**Indexing Status**

Subject indexing assigned by NLM

**MeSH**

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.