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Original Article

Effect of saphenous nerve block for postoperative pain on knee surgery: a meta-analysis

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Abstract: Early post-operative mobilization is important both to reduce immobility-related complications and to get the best functional result following surgery on knee. We hypothesized that saphenous nerve block would reduce pain in this patient category compared with placebo injection. In this study, two reviewers independently searched the databases of PubMed, EMBASE, and Cochrane Library (last performed on 12 October, 2014) to retrieve eligible randomized controlled clinical trials. The primary outcomes were visual analog scale (VAS) pain scores within 24 hours after operation when at rest and at an active flexion of knee. Mean difference (MD) or odds ratio (OR) with 95% confidence intervals (CIs) was calculated for each end point. Subgroup analysis was calculated to evaluate potential sources of heterogeneity. Nine randomized controlled trials were retrieved and analyzed. We found that VAS pain scores at rest within postoperative 24 hours were significantly decreased in saphenous nerve block group than that in placebo group (MD = -0.79; 95% CI -1.35 to -0.22; P = 0.007), as well as VAS pain scores at an active flexion of knee within postoperative 24 hours (MD = -0.92; 95% CI -1.61 to -0.22; P = 0.010). In addition, compared to placebo injection group, saphenous nerve block resulted in significantly less morphine consumption during the first postoperative 24 hours (MD = -6.56; 95% CI -11.26 to -1.86; P = 0.006). To conclude, this meta-analysis suggests that saphenous nerve block has an advantage in pain relief both at an active flexion of knee and at rest after knee surgery. Further studies are still wanted to validate these conclusions

Keywords: Saphenous nerve block, post-operative pain, knee surgery

Introduction

Analgesia after knee surgery can be provided by multiple non-systemic non-opioid-based methods, including local anesthetic infiltration, peripheral nerve blockade, neuraxial procedures, and intra-articular injections. Relieving pain without compromising motor function is a challenge in early postoperative pain treatment. The saphenous nerve is the terminal sensory branch of the femoral nerve. It provides innervation to the skin overlying the medial, anteromedial, and posteromedial parts of the lower leg [1]. Saphenous nerve block has been tested and suggested for knee surgery in a few case studies [2-4]. Several recent randomized controlled trial (RCT) found that a saphenous nerve block reduced pain during knee flexion, and reduced morphine consumption during first 24 hours after meniscectomy [5, 6], and after total knee arthroplasty (TKA) [7-9]. It has been advocated as an alternative with perhaps less risk of motor weakness.

When an indwelling perineural catheter was placed in the adductor canal, a continuous saphenous nerve block was performed [10-12]. Adductor canal block (ACB) is a relatively new block with promising results reported in initial studies [5, 9]. It theoretically affects mainly sensory nerves. No convincing studies have been published that clearly indicate that nerves other than the saphenous nerve are blocked by an injection of local anesthetic in the adductor canal. Based on the new report of Andersen HL [13], what is called the adductor canal block is, in fact, equivalent to the midthigh saphenous nerve block.

Knee surgery is often related to quality of life, especially for total knee arthroplasty. For earlier

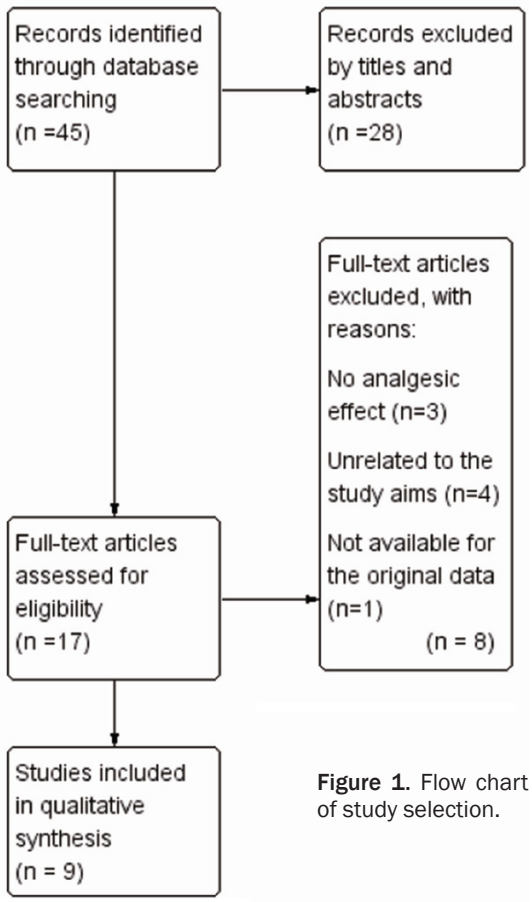

Figure 1. Flow chart of study selection.

ambulation and initiation of physiotherapy, selecting an appropriate method of analgesia is necessary to hasten recovery. In this study we have aimed at demonstrating the effect of saphenous nerve block or ACB in knee surgery for less postoperative pain, analgesic requirements and more patient comfort.

Methods

Search strategy

We identified randomized controlled trials by electronically searching the databases: Pubmed, EMBASE, and Cochrane Library for reports published from 1 January 2000 to 25 October 2014. The following medical subject headings were included: saphenous nerve block, adductor canal block, infrapatellar block, subsartorial block, knee surgery, pain, analgesia, and randomized controlled trial. Alternative spellings were considered when searching. We removed duplicates that were identified in multiple database searches.

Inclusion criteria

Randomized controlled trials that compared the analgesic effect of saphenous nerve block and a sterile saline injection as sham group were included. Based on the fact that the ACB is equivalent to the mid-thigh saphenous nerve block, randomized controlled trials which compared the analgesic effect of ACB and saline injection were also included. We just included the studies written by English. The dosages and other details of anesthesia drug administration were not limited. Studies concerning knee arthroplasty, meniscectomy and cruciate ligament reconstruction were allowed.

Selection of studies

Two reviewers (Shuqing Jin, Xibing Ding) used the pre-specified criteria to screen for relevant titles, abstracts, and full papers. An article was removed if it did not meet the inclusion criteria. If these two reviewers reached different final selection decisions, a third reviewer (Quan Li) was consulted.

Data extraction

We extracted the following data from the included articles: First author; publishing date; number of patients; study design; description of interventions between saphenous nerve block (adductor canal block) and the placebo group; Visual analog scale (VAS) pain scores at rest and at an active flexion of knee which were evaluated within post-operative 24 hours; morphine consumption within first 24 hours, and incidence of nausea and vomiting. The definitions of the above indicators conformed to those of the original authors. As the primary outcomes, we defined the pain scores within postoperative 24 hours when at rest and at an active flexion of knee. Secondary outcomes were morphine usage during first postoperative 24 hours, and incidence of nausea and vomiting. The two reviewers (Shuqing Jin, Xibing Ding) who selected the appropriate studies also extracted the data and evaluated the risk of bias. An arbiter (Quan Li) was consulted to reconcile any disagreement.

Assessing the risk of bias

Methodological quality of each trials was assessed with the “risk of bias” tool recom-

Table 1. Characteristics of eligible trials

Article	Year of publication	Type of surgery	Number of patients	Saphenous nerve block group	Placebo injection group
Akkaya T	2008	Arthroscopic medial meniscectomy	40	Saphenous nerve block with 0.5% levobupivacaine	Saphenous nerve block with saline
Espelund M	2013	Arthroscopic anterior cruciate ligament reconstruction	49	Adductor canal blockade with ropivacaine 7.5 mg/m	Adductor canal blockade with 0.9% saline
Andersen HL	2013	Total knee arthroplasty	40	Saphenous nerve block with ropivacaine 7.5 mg/mL	Saphenous nerve block with saline
Jenstrup MT	2012	Total knee arthroplasty	71	Adductor-canal-block with intermittent 0.75% ropivacaine	Adductor-canal-block with intermittent saline
Jaeger P	2012	Total knee arthroplasty	41	Adductor canal block with 0.75% ropivacaine	Adductor canal block with saline
Hanson NA	2013	Arthroscopic medial meniscectomy	48	Adductor canal block with 0.5% ropivacaine	Sham subcutaneous injection of sterile saline
Grevstad U	2014	Total knee arthroplasty	49	Adductor canal block with 0.75% ropivacaine	Adductor canal block with isotonic saline
Hanson NA	2014	Total knee arthroplasty	76	Adductor canal block with 0.2% ropivacaine	Adductor canal block with nothing
Lundblad M	2011	Anterior cruciate ligament repair	62	Infrapatellar nerve block with levobupivacaine 5 mg/ml	Infrapatellar nerve block with saline

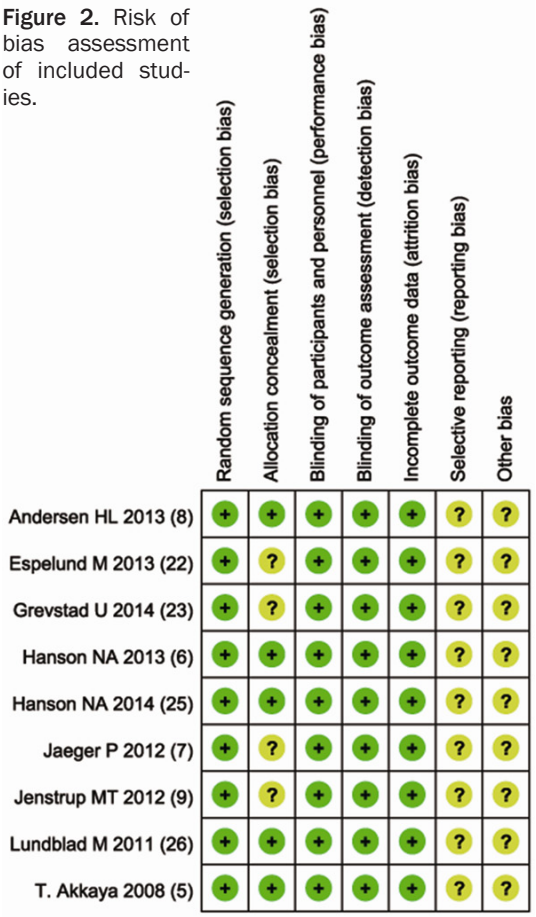

Figure 2. Risk of bias assessment of included studies.

mended by the Cochrane Handbook [14]. Seven items were assessed: "random sequence generation," "allocation concealment," "blinding of participants and personnel," "blinding of outcome assessment," "incomplete outcome data," "selective reporting," and "other bias." Two reviewers (Yao Tong, Hao Ren) evaluated the methodological quality of all articles. An arbiter (Quan Li) was consulted to reconcile any disagreements.

Statistical analysis

Review Manager Software (Revman 5.0, Cochrane Collaboration, Oxford, United Kingdom) was used for the meta-analysis. Heterogeneity among the studies was evaluated using the I^2 statistic and Chi Squared test. A fixed effects model was used if the heterogeneity test did not reveal a statistical significance (I^2 < 50%, P > 0.1). Otherwise, we adopted the random effects model. For the continuous variables in the studies included in this meta-analysis (VAS pain scores within postoperative 24 hours, and morphine usage within first postoperative 24 hours), used mean difference (MD) and 95% confidence interval (95% CI). For dichotomous variable (incidence of nausea and vomiting), we used the odds ratio (OR) and 95% CI. All tests of statistical significance were two-sided [15]. Sensitivity analysis was performed to explore the impact of an individual study by deleting one study each time, and examined by Stata software. Publication bias was visually examined by funnel plots.

Results

Search results

Initially, 45 records were identified through the PubMed, EMBASE, and Cochrane Library database. Of these, 17 potentially eligible articles, only 9 were found to fulfill the inclusion criteria [5-9, 22-25]. The remaining 8 articles [1, 16-21] were removed because the trails did not compare saphenous nerve block/ACB and saline injection, or did not compare the analgesic effect between two groups. 1 article was excluded because of the original data were not available from the authors [26]. Finally, 9 articles were included, a detailed explanation of the full electronic search strategy for Pubmed is shown in **Figure 1**.

Table 1 shows detailed characteristics of eligible trials, and **Figure 2** shows "risk of bias" assessment results. Methodological quality of eligible trials was moderate, and all of the included RCTs had a low risk of bias. A total of 476 patients were included in the data synthesis; In 7 studies patients were randomly assigned to receive either saphenous nerve block with ropivacaine or isotonic saline. In the article reported by Akkaya T et al and Lundblad M et al. 10 ml of 0.5% levobupivacaine was injected to perform the block group. The dose of analgesics varied among trials. Among the 9 included studies, the types of surgeries were total knee arthroplasty, meniscectomy and anterior cruciate ligament reconstruction.

Primary end points

Saphenous nerve block versus placebo injection on the analgesic efficacy: The trials assessed pain intensity using the VAS. There was statistically significant difference in pain scores at rest within postoperative 24 hours

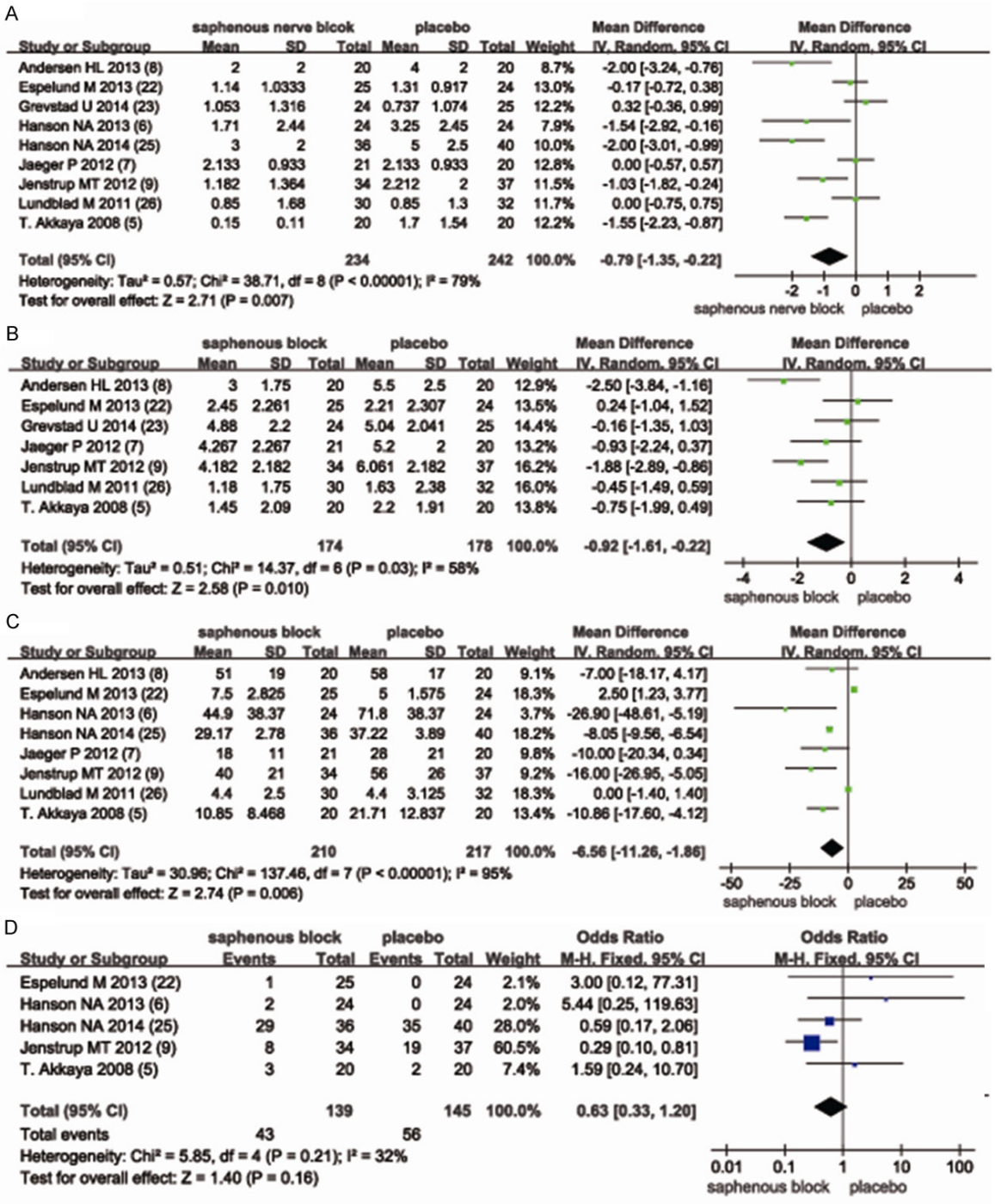

Figure 3. Meta-analysis results of saphenous nerve block compared with placebo injection. A. VAS pain scores at rest within postoperative 24 hours; B. VAS pain scores at an active flexion of knee within postoperative 24 hours; C. Total morphine consumption within first postoperative 24 hours; D. Incidence of nausea and vomiting.

(MD -0.79; 95%CI: -1.35 to -0.22; P = 0.007; **Figure 3A**). There was also significant difference in VAS pain scores at an active flexion of knee between the block group and placebo group within postoperative 24 hours (MD -0.92; 95%CI: -1.61 to -0.22; P = 0.010; **Figure 3B**).

Secondary end points

Compared to placebo group, saphenous nerve block resulted in significantly less morphine consumption within first postoperative 24 hours (MD -6.56; 95% CI: -11.26 to -1.86; *P* =

Table 2. Results of subgroup analysis

	No. of trials	Mean Difference/Odds Ratio (95% CI)	Interaction P
VAS pain scores at rest			
Type of surgeries			
Total knee arthroplasty subgroup	5	MD = -0.85; 95% CI -1.74 to 0.04; P = 0.06	0.86
Meniscectomy or cruciate ligament reconstruction subgroup	4	MD = -0.74; 95% CI -1.57 to 0.09; P = 0.08	
Method of blocks			
Continuous nerve catheter subgroup	3	MD = -1.57; 95% CI -2.26 to -0.88; P < 0.00001	0.01
Single injection subgroup	6	MD = -0.41; 95% CI -1.00 to 0.19; P = 0.18	
VAS pain scores at an active flexion of knee			
Type of surgeries			
Total knee arthroplasty subgroup	4	MD = -1.36, 95% CI -2.35 to 0.37; P = 0.007	0.10
Meniscectomy or cruciate ligament reconstruction subgroup	3	MD = -0.35, 95% CI -1.02 to 0.33; P = 0.31	
Method of blocks			
Continuous nerve catheter subgroup	2	MD = -2.11; 95% CI -2.92 to -1.30; P < 0.00001	0.0006
Single injection subgroup	5	MD = -0.41, 95% CI -0.94 to 0.13; P = 0.14	
Morphine consumption			
Types of surgeries			
Total knee arthroplasty subgroup	4	MD = -8.21, 95% CI -9.68 to -6.75; P < 0.00001	0.003
Meniscectomy or cruciate ligament reconstruction subgroup	4	MD = -1.87, 95% CI -5.81 to 2.08; P = 0.35	
Method of blocks			
Continuous nerve catheter subgroup	3	MD = -8.22; 95% CI -9.96 to -6.48; P < 0.00001	0.01
Single injection subgroup	5	MD = -2.87; 95% CI -6.79 to 1.06; P = 0.15	

0.006; **Figure 3C**). However, there was no significant difference in number of patients who has a history of nausea and vomiting. (OR 0.63, 95% CI: 0.33 to 1.20; *P* = 0.16; **Figure 3D**).

Subgroup analysis

The results of subgroup analysis are presented in the **Table 2**. Exploratory subgroup analysis showed statistically significant difference in VAS pain scores at rest within postoperative 24 hours, neither in the total knee arthroplasty subgroup (MD = -0.85; 95% CI -1.74 to 0.04; P = 0.06) nor in the meniscectomy and cruciate ligament reconstruction subgroup (MD = -0.74; 95% CI -1.57 to 0.09; P = 0.08). VAS pain scores at an active flexion of knee were significantly decreased for saphenous nerve block compared with placebo in the total knee arthroplasty subgroup (MD = -1.36, 95% CI -2.35 to 0.37; P = 0.007). And in the meniscectomy and cruciate ligament reconstruction subgroup, no difference was found (MD = -0.35, 95% CI -1.02 to 0.33; P = 0.31) for pain scores at an active flexion of knee. The reduction of morphine consumption within postoperative 24 hours is marked in the total knee arthroplasty subgroup (MD = -8.21, 95% CI -9.68 to -6.75; P < 0.00001), rather than in the meniscectomy and cruciate ligament reconstruction subgroup (MD = -1.87, 95% CI -5.81 to 2.08; P = 0.35).

Among nine trials, Andersen HL et al, Hanson NA and Jenstrup MT et al used a continuous nerve catheter to complete the block, and single injection was used in the other studies. Subgroup analysis showed that in continuous nerve catheter subgroup, VAS pain scores at rest (MD = -1.57; 95% CI -2.26 to -0.88; P < 0.00001), VAS pain scores at an active flexion of knee (MD = -2.11; 95% CI -2.92 to -1.30; P < 0.00001), and morphine consumption (MD = -8.22; 95% CI -9.96 to -6.48; P < 0.00001) within first operative 24 hours are significantly decreased for saphenous nerve block. In single injection subgroup, none of these indicators showed statistically significant difference for saphenous nerve block group versus placebo group.

Sensitivity analysis

We performed sensitivity analysis of 4 end points (Figure S4A-D). No individual study which significantly affected the result or heterogeneity was found in the sensitivity analyses of VAS pain scores at rest and at an active flexion of knee within postoperative 24 hours (Figure

S4A, 4B). Sensitivity analysis of total morphine consumption within first 24 hours revealed that the study by Espelund M et al. [22] was the source heterogeneity, but the study did no effect on the results (Figure S4C). Sensitivity analysis of incidence of nausea and vomiting revealed that the trial reported by Hanson NA et al. [25] was the source heterogeneity, but the trial did not significantly affect the pooled result (Figure S4D).

Publication bias

Begger's funnel plot for publication bias (Figure S5A-D) suggested that there was neither evidence of publication bias in VAS pain scores at rest within postoperative 24 hours (P = 0.754, Figure S5A), nor active flexion of knee (P = 0.764, Figure S5B). No evidence of publication bias for morphine usage (P = 1.000, Figure S5C) and for incidence of nausea and vomiting (P = 1.000, Figure S5D) were found.

Discussion

The aim of this meta-analysis which included 9 RCTs and 476 patients was to evaluate the analgesic effect of the saphenous nerve block compared with isotonic saline injection. Our results showed that saphenous nerve block significantly lower VAS pain scores within 24 hours at movement and at rest compared with placebo group, and reduced total morphine consumption within first postoperative 24 hours. But it didn't reduce the incidence of nausea and vomiting. The results of subgroup analysis showed that the analgesic effect of saphenous nerve block is much more significant when using continuous nerve catheter than using single injection technology. In addition, VAS pain scores at an active flexion of knee and morphine consumption within first postoperative 24 hours are statistically marked in total knee arthroplasty surgery, instead of meniscectomy or cruciate ligament reconstruction surgery subgroup.

Akkaya T et al. [5] first reported utilizing saphenous nerve block for pain after arthroscopic medial meniscectomy. In his report, tramadol consumption through IV PCA was statistically significantly lower in saphenous block group than in saline injection group, and pain during walking measured within 24 hours was significantly different with better results in block group. But there was no correlation within both groups regarding the rate of complications. Hanson NA et al. [6] showed similar results in their study.

The results of Espelund M and colleagues' study [22] demonstrated no significant additional analgesic effects of ACB after arthroscopic anterior cruciate ligament reconstruction, neither within 24 hours postoperatively when patients were standing, nor at rest. Further, the need for additional anesthetics during first 24 hours postoperatively was not significantly different in groups.

Jenstrup MT [9], Jager P [7] and Grevstad U [23] et al. evaluated the effect of ACB on pain during an active flexion of knee and at rest in patients after TKA, compared with saline injection. All of them found a significant reduction in pain scores during an active flexion of knee, and Grevstad U also found a significant decrease of VAS pain scores at rest at 45 min after the first block. Andersen HL and colleagues [8] suggested that VAS pain scores during movement on the day of surgery were significantly lower in the saphenous nerve block group as well as pain at rest, after total knee arthroplasty. In Jenstrup MT's and Hanson NA's [25] study, morphine consumption within first 24 hours was significantly reduced in the ACB group compared that in the placebo group.

Whether ACB is equivalent to saphenous block in the present study is controversial. A letter from Egeler C et al. [27] stated the midthigh approach to the ACB also blocks the obturator branches traversing the distal part of the adductor canal to go on and supply the posteromedial aspect of the knee. Japer P et al. [21] reported that the ACB theoretically affects mainly sensory nerves. The only motor nerve traversing the adductor canal is the nerve to the vastus medialis. Thiel [4] used dissection photoimages to visualize and describe the adductor canal and its contents, showing only the saphenous nerve is described as lying in the adductor canal [28]. The up-to-date letter from Andersen HL et al. [13] definitely stated the so-called ACB was equivalent to the midthigh saphenous nerve block. Selectively block saphenous nerve at mid-thigh level and ACB were treated equally in the present study.

This meta-analysis is characterized by several limitations that should be noted. Firstly, sample size in this study was 338 which seemed rela-

tively small. Secondly, various anesthesia methods were used in different trials. General anesthesia was performed in the study of Espelund M, Jager P, and Hanson NA. Spinal anesthesia was performed in Andersen HL and Jenstrup MT's study. Grevstad U used a standardized multimodal analgesic regimen. Thus different anesthesia methods and anesthetic may affected the postoperative pain scores.

In summary, saphenous nerve block is a promising option when used as an additional analgesic technique for patients in pain after knee surgery, especially for TKA surgery with continuous nerve catheter. Extensive, large, randomized, double-blind, multicenter, controlled clinical trials that compared saphenous nerve block and placebo will be better to confirm these findings.

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Disclosure of conflict of interest

None.

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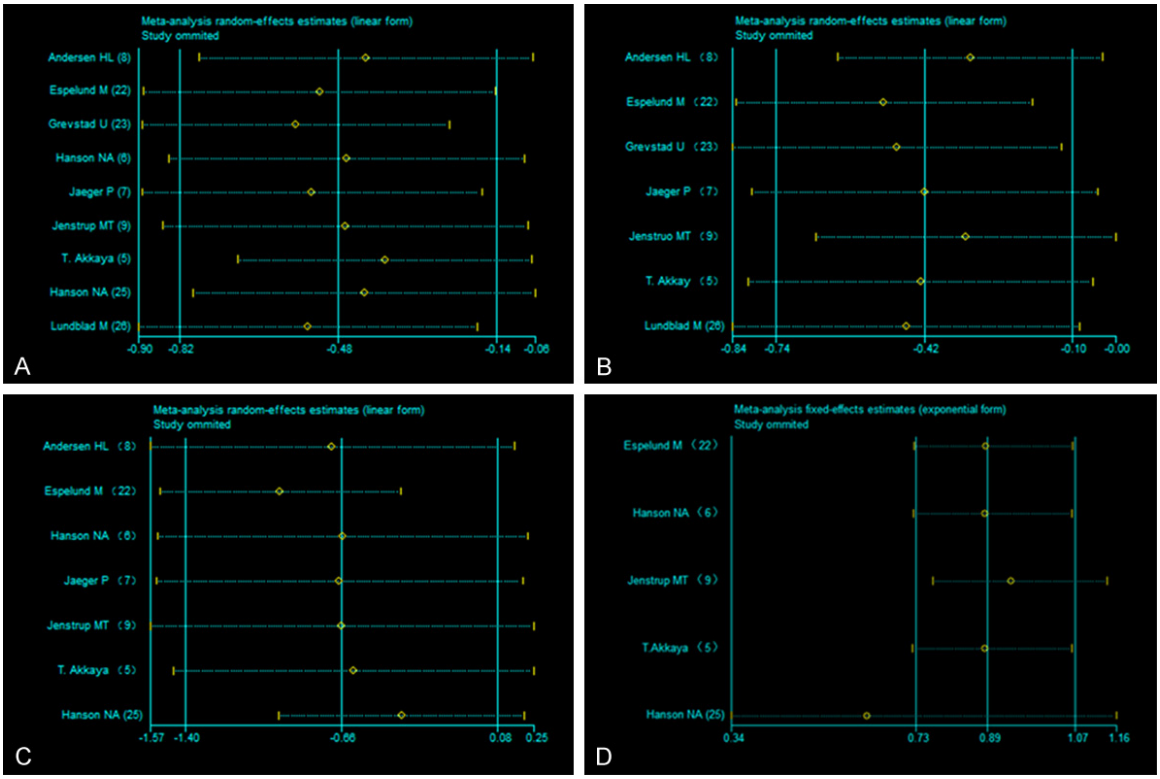

Figure S4. Sensitivity analysis of each end point. A. VAS pain scores at rest within postoperative 24 hours; B. VAS pain scores at an active flexion of knee within postoperative 24 hours; C. Total morphine consumption within first postoperative 24 hours; D. Incidence of nausea and vomiting.

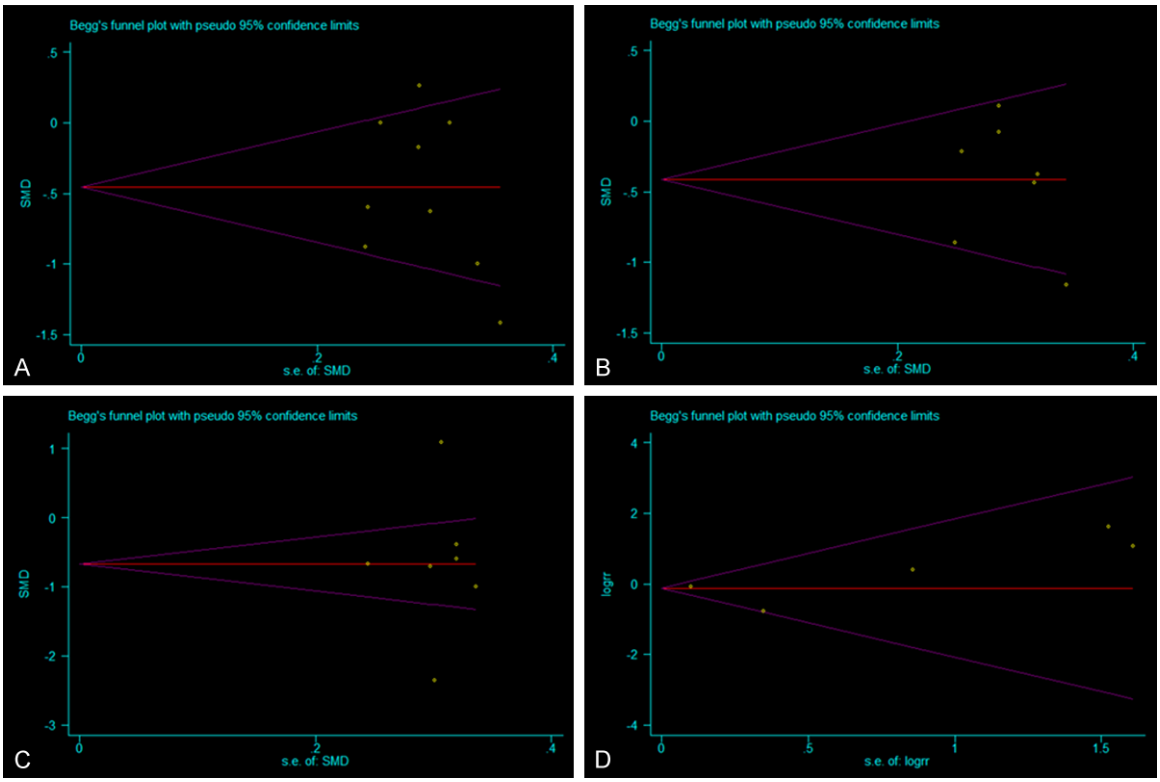

Figure S5. Begg's funnel plots for publication bias. A. VAS pain scores at rest within postoperative 24 hours; B. VAS pain scores at an active flexion of knee within postoperative 24 hours; C. Total morphine consumption within first postoperative 24 hours; D. Incidence of nausea and vomiting.