The efficacy of combined adductor canal block with local infiltration analgesia for pain control after total knee arthroplasty
A meta-analysis

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Abstract

Background: This meta-analysis aimed to evaluate the efficiency and safety of the combined adductor canal block (ACB) with local infiltration anesthesia (LIA) versus LIA alone for pain control after total knee arthroplasty (TKA).

Methods: We searched PubMed, Medline, Embase, Web of Science, the Cochrane Library and Google databases from inception to August 2017 to selected studies that comparing the combined ACB with LIA and LIA alone for pain control after TKA. Only randomized controlled trials (RCTs) were included. Outcomes included visual analogue scale (VAS) with rest or mobilization at 8 h, 24 h and 48 h, total morphine consumption at 6 h, 24 h and 48 h, distance walked at 24 h and 48 h and the length of hospital stay.

Results: Seven randomized controlled trial (RCTs) were finally included in this meta-analysis. The present meta-analysis indicated that, compared with LIA alone, combined ACB with LIA was associated with a reduction of VAS with rest at 24 h and 48 h and VAS with mobilization at 24 h. Additionally, combined ACB with LIA was associated with an increase of the distance walked at 24 h and a reduction of the length of hospital stay.

Conclusion: Combined ACB with LIA could significantly reduce pain scores and morphine consumption compared LIA alone after TKA. Further multimodal large sample RCTs are needed to identify the optimal drug of ACB and LIA.

Abbreviations: CI = confidence interval, NNH = number needed to harm. NRS = numerical rating scale, PRISMA = preferred reporting items for systematic reviews and meta-analyses, RCTs = randomized controlled trials, RR = risk ratio, SD = standard deviation, VAS = visual analogue scale, WMD = weighted mean differences.

Keywords: adductor canal block, local infiltration anesthesia, meta-analysis, total knee arthroplasty

1. Introduction

Total knee arthroplasty (TKA) has been shown as an efficacy operation in improving functional outcome and reliving pain for patients with knee osteoarthritis (OA) or rheumatoid arthritis (RA).[1,2] It has been estimated that TKA patients will reach 3.5 million by 2030.[3] However, appropriately 60% and 30% of patients experience severe pain and moderate pain respectively after TKA.[4] Various analgesia strategies have been implemented including patient-controlled anesthesia (PCA), local infiltration anesthesia (LIA), peripheral nerve block and epidural analgesia.[5,6]

Adductor canal block (ACB) is a new technique resulting in sensory blockade that can be easily visualized at the middle third of the thigh with use of ultrasonography.[7] It is a sufficient analgesic and gained popularity because of the small impact on the quadriceps muscle weakness. Thus, there was a low risk of postoperative falls. In addition, it could be implemented with a high success rate. LIA is considered an alternative choice for regional anesthesia.[8] The procedure can be performed without anaesthetists. Its simplicity and apparent safety gained popularity for pain control in orthopedic surgery. However, a short duration of action limits the clinical application. Therefore, combined ACB and peri-articular infiltration may improve and prolong analgesia. Whether the combined ACB and peri-articular infiltration provide superior analgesia compared peri-articular infiltration alone after TKA remains controversial.

Thus, we performed a meta-analysis from randomized controlled trial (RCTs) to evaluate the efficiency and safety of the combined ACB with LIA versus LIA alone for pain control after TKA.

2. Methods

This systematic review was reported according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines.[9]

3. Search strategy

We manually searched PubMed, Medline, Embase, Web of Science, the Cochrane Library and Google databases from inception to August 2017. The search strategies in Pubmed database was as follows: ((((((intra-articular infiltration) OR local infiltration) OR peri-articular infiltration) OR local

infiltration analgesia)) AND ACB)) AND (((((("Arthroplasty, Replacement, Knee" [Mesh]) OR TKR) OR TKA) OR total knee replacement) OR total knee arthroplasty). This meta-analysis collected data from published articles and thus no ethic approval was necessary for this article.

4. Inclusion criteria and exclusion criteria

1. Participants: Patients prepared for TKA.
2. Interventions: The intervention group received the combined ACB and LIA for pain control after TKA.
3. Comparisons: The control group received LIA alone for pain control after TKA.

4. Outcomes: visual analogue scale (VAS) with rest or mobilization at 8 h, 24 h and 48 h, total morphine consumption at 6 h, 24 h and 48 h, distance walked at 24 h and 48 h and the length of hospital stay.
5. Study design: RCTs were regarded as eligible in the study.

Non-RCTs, letters, editorial comments and combined ACB with LIA with other comparison were excluded in this meta-analysis.

5. Study selection

Articles would be excluded from the present meta-analysis for case reports, conference abstract or review articles. Two
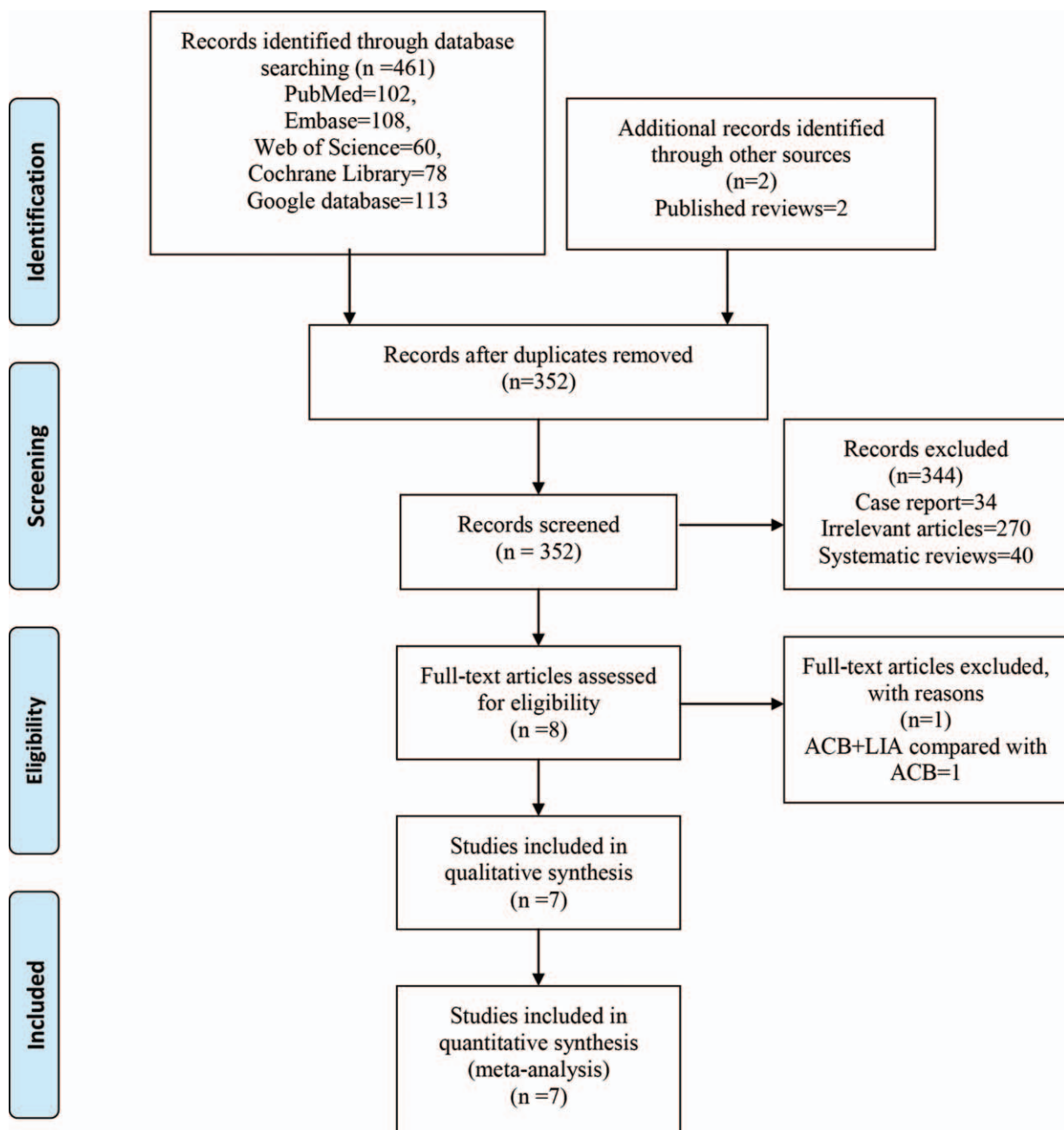

Figure 1. PRISMA flowchart for the included studies. PRISMA = preferred reporting items for systematic reviews and meta-analyses.

Table 1

The general characteristic of the included studies.

Study	Country	Control group		Intervention group		Concomitant pain management	Outcomes	Follow-up
		No of patients	Drugs and dose	No of patients	Preoperative			
Gudmundsdottir, 2017	India	34	102 ml of 200 mg ropivacaine, 30 mg ketorolac and 0.5 mg adrenaline	35	An ACB with 20 ml of 200 mg ropivacaine, 30 mg ketorolac and 0.5 mg adrenaline	acetaminophen, oxycodone and intravenous parecoxib	1,2,3,4,5,6,11	6 month
Gwam, 2017	India	45	30 mL of 0.25% bupivacaine, with 1:200,000 parts epinephrine, 8 mg of dexamethasone, 2 mg of morphine, and 30 mg of ketorolac were mixed in 50 mL	65	5 to 10 mL of 0.5% bupivacaine or 0.75% ropivacaine	NS	1,2,3,9,10,11	48 h
Zhou, 2017	China	20	100 ml ropivacaine 2 mg/ml with epinephrine 0.5 ml 1 mg/ml	20	30 ml of 0.375% of ropivacaine with 5 μg/ml epinephrine	oxycodone and acetaminophen	2,3,5,6,11,	3 month
Nader, 2016	Iran	20	ropivacaine 200 mg, morphine 4 mg, ketorolac 30 mg, clonidine 100 μg, and epinephrine 0.5 mg	20	10 mL of bupivacaine 0.25% with epinephrine 1:300,000	ketorolac and hydrocodone	2,3,4,6,7,8, 9,10	1 year
Andersen, 2013	Iran	20	100 ml of ropivacaine (2 mg/ml) and epinephrine (10 μg/ml)	20	An ACB with 15 mL boluses of ropivacaine (7.5 mg/mL) twice daily	Acetaminophen, morphine, PCA morphine	5,6,9,10,11	48 h
Perlas, 2013	USA	97	300 mg of ropivacaine (150 mL of 0.2% ropivacaine), 30 mg of ketorolac, and 0.6 mg of epinephrine	101	An ACB with 20 mL of 0.5% ropivacaine in addition to PI	Acetaminophen, celecoxib, opioids, PCA	1,3,5,6,11	7 days
Sawhney, 2016	USA	49	110 mL normal saline solution containing 300 mg ropivacaine, 10 mg morphine, and 30 mg ketorolac	50	An ACB with 30 mL of 0.5% ropivacaine in addition to intraoperative PI	Acetaminophen, celecoxib, gabapentin, hydromorphone PCA hydromorphone	1,2,3,5,8,11	48 h

ACB = adductor canal block, NS = not stated, PCA = patient controlled anesthesia, PI = peri-articular infiltration anesthesia, VAS = visual analogue scale; 1, VAS with rest at 8 h; 2, VAS with rest at 24 h; 3, VAS with rest at 48 h; 4, VAS with mobilization at 8 h; 5, VAS with mobilization at 24 h; 6, VAS with mobilization at 48 h; 7, Total morphine consumption at 24 h; 8, Total morphine consumption at 72 h; 9, distance walked at 24 h; 10, distance walked at 48 h; 11, length of hospital stay.
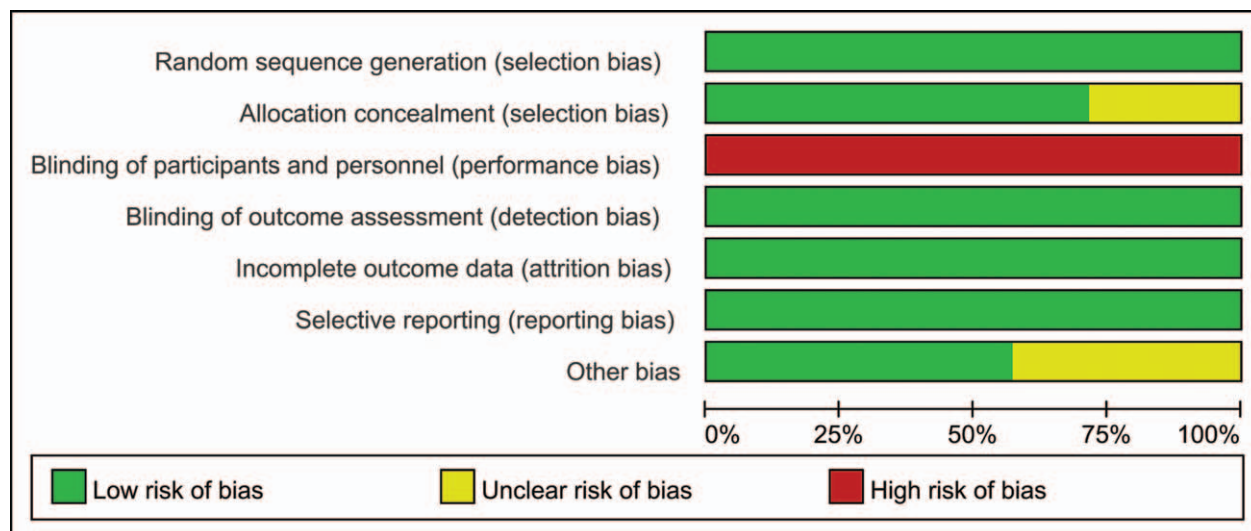

Figure 2. The risk of bias graph for the included studies.

reviewers independently scanned the abstracts of the potential articles identified by the above searches. Subsequently, the full text of the studies that met the inclusion criteria was screened, and a final decision was made. A senior author had the final decision in any case of disagreement regarding which studies to include.

6. Date extraction

The included studies were examined by 2 investigators and key data were extracted including first author name, samples size, published year, baseline characteristics, intervention of each groups and other outcome parameters. The primary outcomes were VAS with rest or mobilization at 8 h, 24 h and 48 h, total morphine consumption at 6 h, 24 h and 48 h, distance walked at 24 h and 48 h and the length of hospital stay.

7. Outcome measures and statistical analysis

Continuous outcomes (VAS with rest or mobilization at 8 h, 24 h, and 48 h, total morphine consumption at 6 h, 24 h and 48 h, distance walked at 24 h and 48 h and the length of hospital stay) were expressed as the weighted mean differences (WMD) with 95% CI. Statistical significance was set at $P < .05$ to summarize the findings across the trials. Variables in the meta-analysis were calculated using Stata software, version 12.0 (Stata Corp., College Station, TX). Statistical heterogeneity was evaluated using the chi-square test and the I^2 statistic. When there was no statistical evidence of heterogeneity ($I^2 < 50\%$, $P > .1$), a fixed-effects model was adopted; otherwise, a random-effects model was chosen. Publication bias was tested using funnel plots. Publication bias was visually assessed using funnel plots and was quantitatively assessed using the Begg test.

8. Results

8.1. Search results

In the initial search, a total of 386 studies were identified from the electronic databases (PubMed = 112, EMBASE = 108, Web of Science = 60, Cochrane Library = 50, Google database = 56). Then, all papers were input into Endnote X7 (Thomson Reuters Corp., USA) software for the removal of duplicate papers. A total of 308 papers were reviewed and 209 papers were removed according to the inclusion criteria at abstract and title levels. Additionally, 1 study was a duplicate publication so we only included the most recently published paper. Ultimately, 7 clinical studies with 596 patients (combined ACB with LIA group = 285, LIA group = 311) were included in the meta-analysis.[10–16] The flow diagram for the included studies can be seen in Figure 1.

The sample of the included studies ranged from 20 to 101. The dose of ACB ranged from 10 ml to 30 ml. The drug for LIA included ropivacaine and bupivacaine. The follow-up ranged from 48 h to 6 months. The general characteristics of the included studies can be seen in Table 1.

8.2. Quality assessment

The quality assessment of the included studies is summarized in Figures 2 and 3. All of the included studies describe the random sequence generation procedure; 2 studies did not describe the allocation concealment. Blinding of the participants and personnel were all with high risk of bias. Three studies did not

describe the sample calculation and thus identified as unclear risk of bias. The overall kappa value regarding the evaluation of the risk of bias of included RCTs was 0.763, indicating that the agreement between the 2 reviewers was acceptable.

9. Results of the meta-analysis

9.1. VAS with rest at 8 h, 24 h and 48 h

Postoperative VAS scores with rest at 8 h were reported in 5 studies,[10–12,14,15] and the pooled results indicated that combined ACB with LIA has no beneficial for reducing VAS scores with rest at 8 h (WMD = −4.63, 95% CI −16.07, 6.82, $P = .428$, Fig. 4).

Postoperative VAS scores with rest at 24 h were available in 7 studies.[10–16] The meta-analysis results indicated, compared with LIA alone, ACB combined with LIA was associated with a reduction of the VAS scores with rest at 24 h (WMD = −7.42, 95% CI −14.32, −0.53, $P = .035$, Fig. 4).

Postoperative VAS scores with rest at 24 h were available in 6 studies.[10–12,14–16] Pooled results indicated that, compared with LIA alone, combined ACB with LIA was associated with a reduction of VAS scores with rest at 48 h (WMD = −4.72, 95% CI −8.71, −0.72, $P = .021$, Fig. 4).

Figure 3. The risk of bias summary for the included studies.

9.2. VAS with mobilization at 8h, 24h and 48h

Pooled results indicated that there was no significant difference between the ACB combined LIA versus LIA alone in terms of the VAS scores with mobilization at 8h, 24h and 48h ($P=.769$, $P=.825$ and $P=.224$ respectively, Fig. 5).

9.3. Total morphine consumption at 6h, 24h and 48h

Total morphine consumption at 6h were reported in 3 studies,[10,14,15] and the pooled results indicated that combined ACB with LIA was associated with a reduction of total morphine consumption at 6h than LIA alone group (WMD=−9.36, 95% CI −16.57, −2.15, $P=.011$, Fig. 6).

Total morphine consumption at 24h were available in 5 studies.[10–12,14,15] The meta-analysis results indicated, compared with LIA alone, ACB combined with LIA was associated with a reduction of the total morphine consumption at 24h (WMD=− 7.75, 95% CI −11.02, −4.48, $P=.000$, Fig. 6).

Total morphine consumption at 48h were available in 6 studies.[10–12,14–16] Pooled results indicated that there was no significant difference between the total morphine consumption at 48h between ACB combined LIA group and LIA alone group (WMD=−3.54, 95% CI −7.44, 0.36, $P=0.076$, Fig. 6).

9.4. Distance walked at 24h and 48h

Distance walked at 24h were reported in 3 studies,[13,15,16] and the pooled results indicated that combined ACB with LIA was associated with an increase of distance walked at 24h than LIA alone group (WMD=7.23, 95% CI 0.91, 13.56, $P=.025$, Fig. 7).

Distance walked at 48h were available in 3 studies.[13,15,16] The meta-analysis results indicated that there was no significant difference between the distance walked at 48h between combined ACB with LIA group with LIA alone group (WMD=1.28, 95% CI −4.71, 7.27, $P=.676$, Fig. 7) Figure 8.
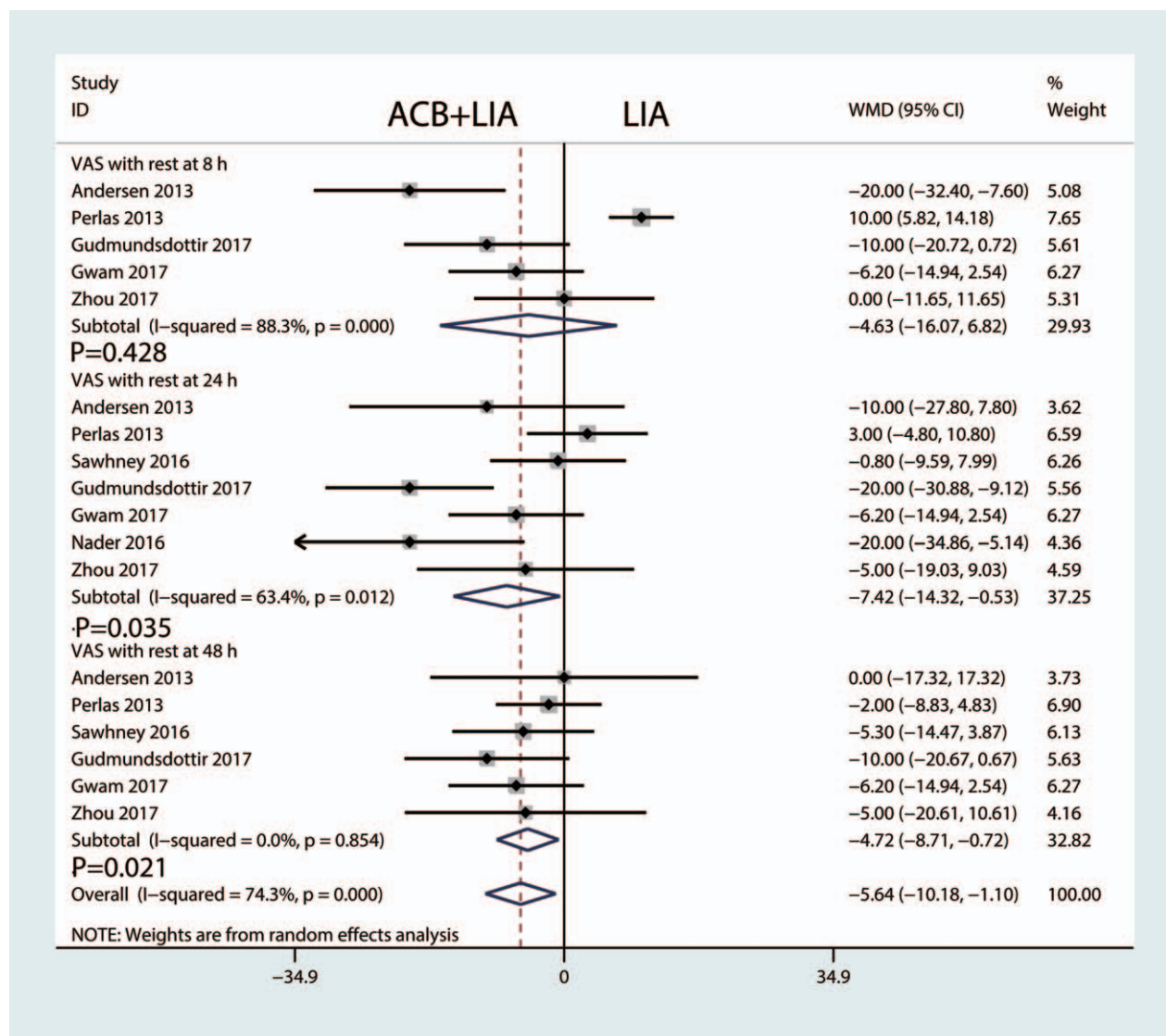

Figure 4. Forest plot comparing VAS scores with rest at 8h, 24h and 48h. VAS = visual analogue scale.
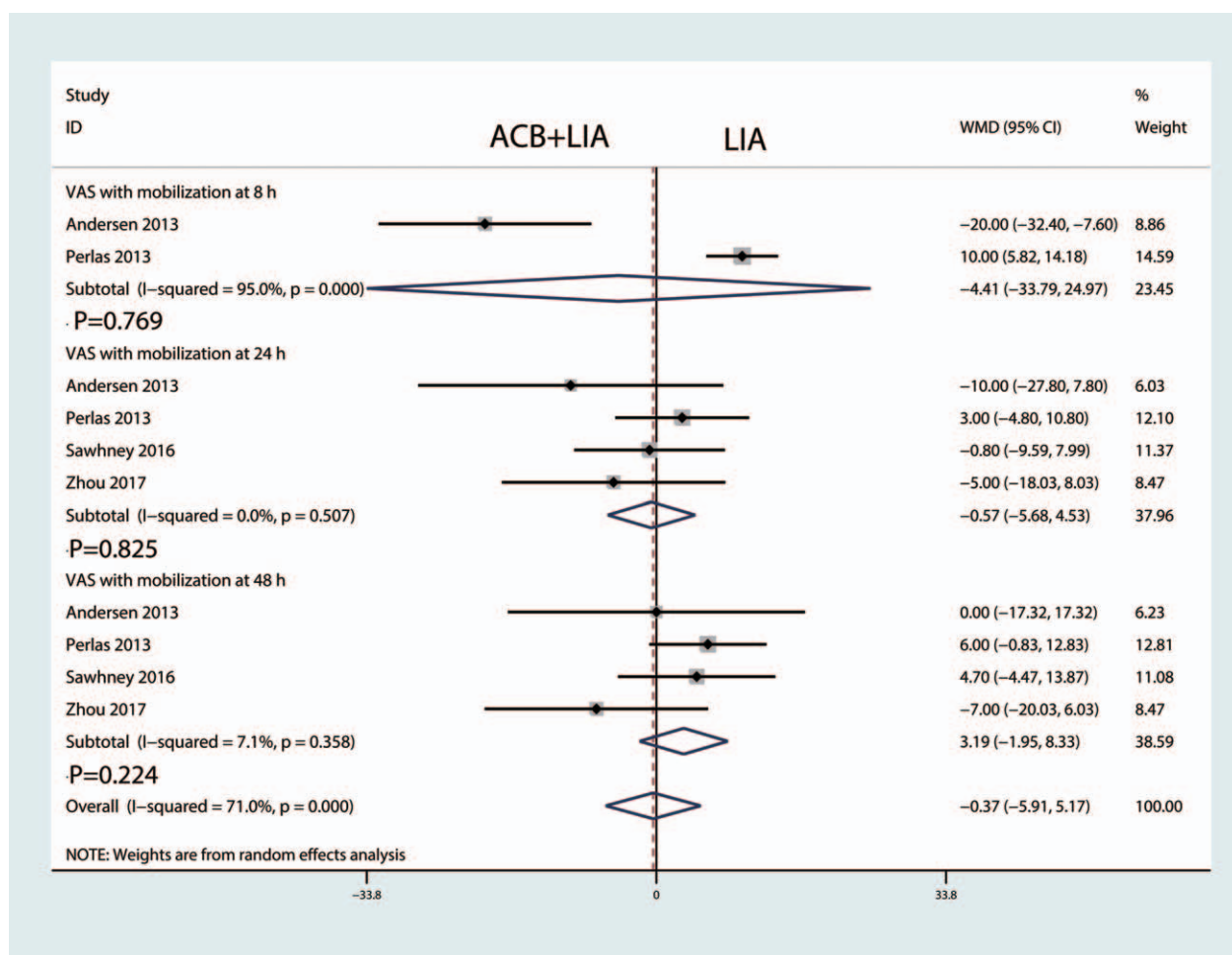
Figure 5. Forest plot comparing VAS scores with mobilization at 8 h, 24 h and 48 h. VAS = visual analogue scale.

9.5. Length of hospital stay

Length of hospital were reported in 4 studies,[11,12,14,15] and the pooled results indicated that, compared with LIA alone, ACB combined with LIA was associated with a reduction of the length of hospital stay by 0.46 days (WMD = −0.46, 95% CI −0.53, −0.38, P = .000, Fig. 7).

9.6. Subgroup analysis

We performed a subgroup analysis according to the quality of the studies and the continuous ACB. Results can be seen in Table 2. Final results indicated that combined ACB with LIA was associated with a reduction of VAS with rest at 8 h, 24 h and 48 h at any subgroup.

10. Discussion

This systematic review and meta-analysis aimed to assess the effects of combined ACB with LIA versus LIA alone for pain control in patients following primary TKA. The final results indicated that treatment with combined ACB with LIA was associated with lower pain scores with rest at 24 h and 48 h postoperatively. In addition, combined ACB with LIA decreased the total morphine consumption at 6 h and 24 h and the length of hospital stay. After a comprehensive search of multiple electronic databases, a total of 7 studies were included in this meta-analysis.

A major strength of the current meta-analysis was the statistical rigor with which the outcomes were calculated.

The pooled results indicated that ACB combined LIA was associated with a less pain scores at 24 h and 48 h after TKA, which was equivalent on a 110-point VAS to 7.42 points at 24 h and 4.72 points at 48 h. Ma et al[17] conducted a meta-analysis about the combined ACB with periarticular infiltration versus periarticular infiltration for analgesia after TKA. The results of their meta-analysis revealed that combined ACB with periarticular infiltration may not associate with a reduction in analgesia when compared to periarticular infiltration alone in the early postoperative period after TKA. With respect to VAS scores with mobilization at 8 h, 24 h and, 48 h, there was no significant difference between combined ACB with LIA and LIA alone group. However, Zhou et al [12] revealed that combined ACB with LIA was associated with a reduction of VAS with mobilization at 24 h and 48 h than LIA alone group.

Furthermore, combined ACB with LIA associated with a reduction of total morphine consumption at 6 h (WMD = −9.36, 95% CI −16.57, −2.15, P = .011) and 24 h (WMD = −7.75, 95% CI −11.02, −4.48, P = .000). Sawhney et al[16] found that the combination of ACB with LIA provided better pain relief and reduce total morphine consumption compared with LIA alone. Gudmundsdottir et al[10] indicated that no benefit of ACB added to a single-dose LIA compared with LIA alone on pain and total morphine consumption.
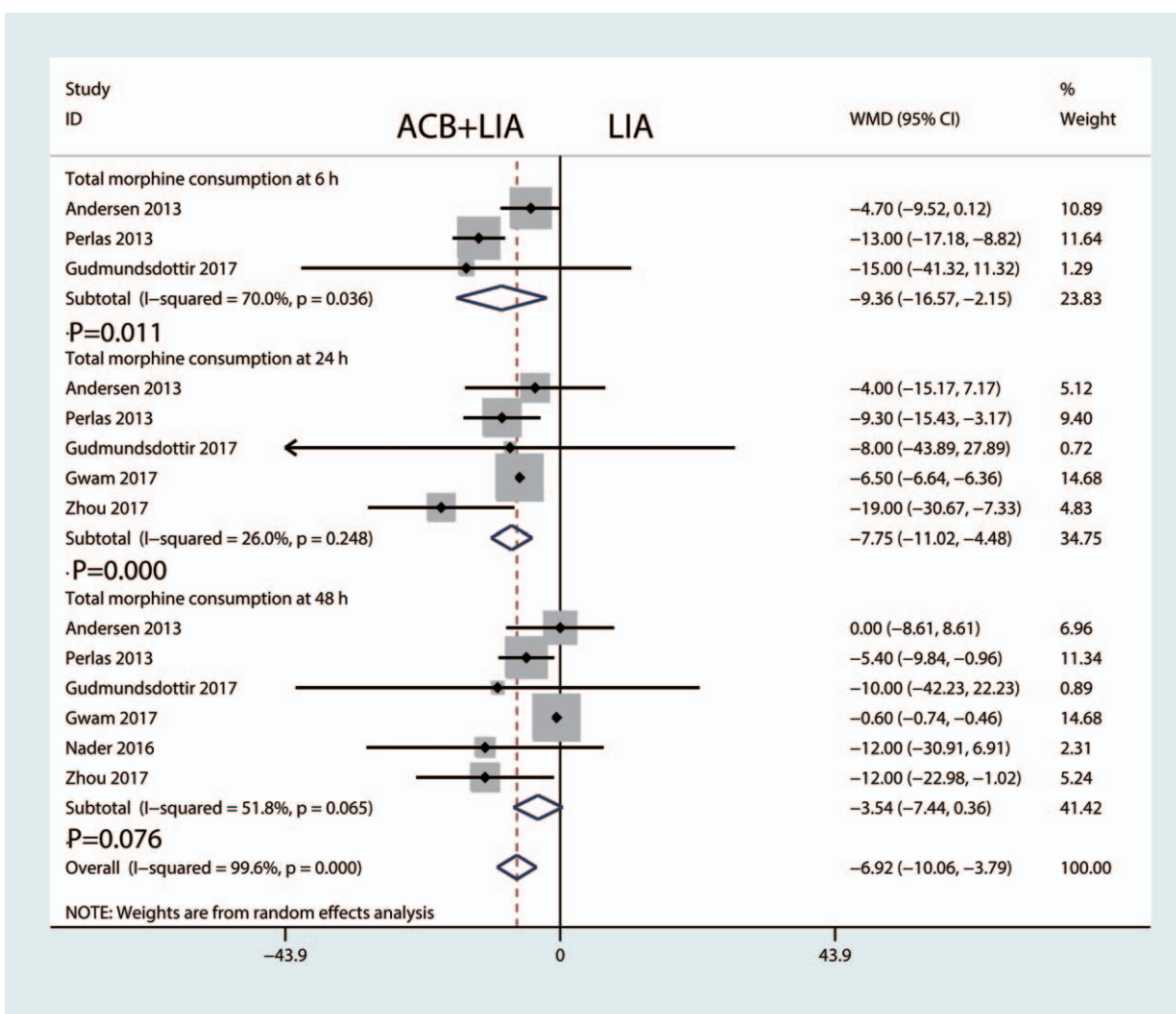
Figure 6. Forest plot comparing the total morphine consumption at 6h, 24h and 48h.

Additionally, combined ACB with LIA was associated with an increase of the distance walked at 24h. Sawhney et al[16] suggested that when ACB is combined with LIA, analgesia is improved because of the ability to provide local anesthetic to the anterior, medial, lateral, and posterior aspects of the knee, potentially providing more complete analgesia compared with using LIA individually. Perlas et al[15] reported that combined ACB with LIA provided early ambulation and a higher incidence of home discharge.

Table 2

Subgroup analysis for the VAS with rest at 8h, 24h and 48h.

Variables	Studies(n)	Patients(n)	P value	Weighted mean difference (95% CI)	Heterogeneity P value (I²)	Model	Subgroup difference
				Incidence			
VAS at 8h							
CACB	2	226	.000	−3.59 (−10.57, −2.16)	.800, 0.0	Fixed	0.003
High quality	3	163	.009	−7.66 (−13.42, −1.89)	.006, 82.5	Random	
VAS at 24h							
CACB	3	251	.010	−10.23 (−15.46, −5.00)	.031, 65.7	Random	0.015
High quality	4	180	.010	−9.50 (−16.76, −2.25)	.000, 92.4	Random	
VAS at 48h							
CACB	3	208	.000	−2.71 (−3.55, −1.87)	.000, 85.7	Random	0.006
High quality	3	300	.002	−3.13 (−7.85, −5.69)	.000, 72.9	Random	

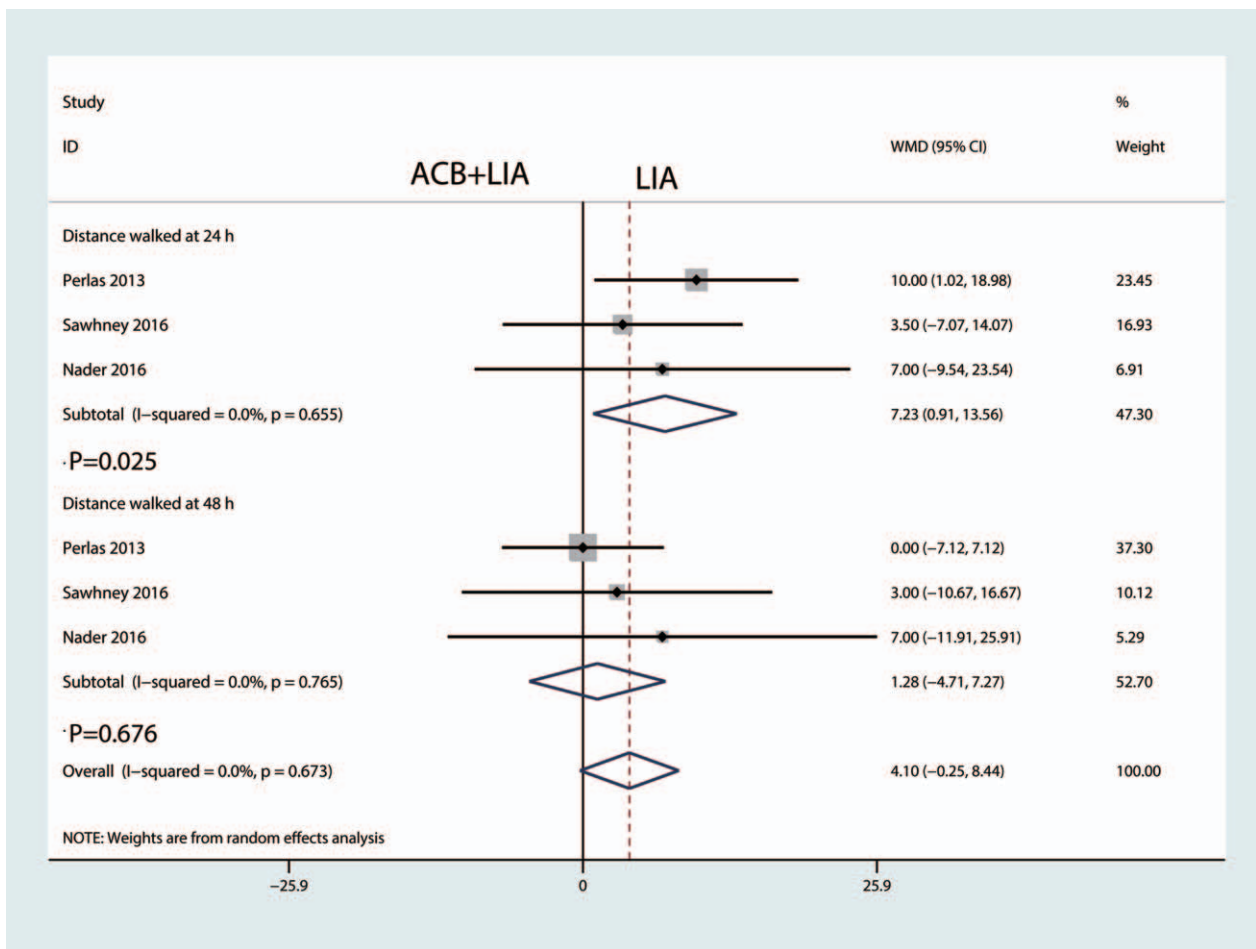CACB = continuous adductor canal block, VAS = visual analogue scale.

Figure 7. Forest plot of distance walked at 24 h and 48 h between the two groups.
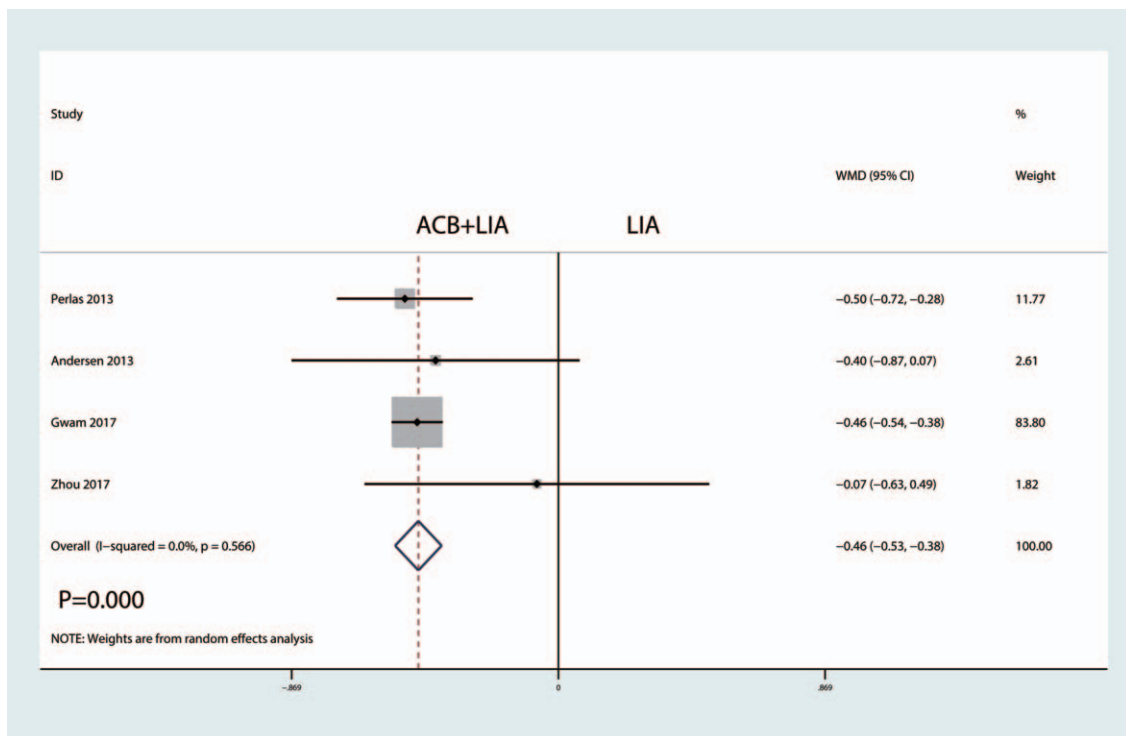

Figure 8. Forest plots comparing the length of hospital stay between the two groups.

There were a total of 5 limitations in the current meta-analysis: Only seven RCTs were included in the study, all of them were recently published, however, the sample size was relatively small; Postoperative knee functional is an important parameter, due to the insufficiency of relevant data, we cannot perform a meta-analysis; Methodological weakness in RCTs should be considered when analyzing the results; Duration of follow up is relatively short which leads to underestimate complications; Publication bias may existed due to the limited number of the included studies.

In conclusion, immediate analgesic efficacy and opioid-sparing effects were obtained with the administration of combined ACB with local infiltration analgesia in TKA patients. Additionally, ACB combined with local infiltration analgesia was associated with a reduction of the length of hospital stay. The number of the included studies and the quality of the studies were limited and thus need for more studies to identify.

Author contributions

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Software: Yanan Li.
Visualization: Yixuan Zhang.
Writing – original draft: Yixuan Zhang.

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