

Adductor canal block versus femoral nerve block for pain control after total knee arthroplasty A systematic review and Meta-analysis

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Abstract

Background: Femoral nerve block is a widely accepted nerve block method with evident reduction in consumption of opioid painkiller and minimization of the duration of hospital stay but may cause weakness of quadriceps muscle strength. Adductor canal block is another nerve block technique that attracts the attention of scientific community nowadays because of its possible superiority over Femoral nerve block regarding mobility and muscle strength.

Methods: This is a systematic review and meta-analysis of 33 studies, aiming to compare femoral nerve block with adductor canal block following total knee arthroplasty regarding pain control and mobilization.

Results: Adductor canal block showed better preservation of quadriceps muscle strength (MD = 0.28, 95% CI [0.11, 0.46], P = .002), and better mobilization up to 2 days postoperatively. However, no significant difference was found between the 2 interventions regarding pain control (MD = 0.06, 95% CI [-0.06, 0.17], P = .33) or opioid consumption (SMD = 0.08, 95% CI [-0.06, 0.22], P = .28) up to 2 days postoperatively. The better mobilization results of adductor canal block did not translate into a significant difference in the risk of falls or patients' satisfaction; however, adductor canal block patients had less mean length of hospital stay than the patients with femoral nerve block.

Conclusion: Both femoral nerve block and adductor canal block provide similar results regarding pain control and opioid consumption, however adductor canal block provides better preservation of quadriceps strength and mobilization, giving it more advantage over femoral nerve block.

Abbreviations: ACB = adductor canal block, CI = confidence interval, DVT = deep venous thrombosis, FNB = femoral nerve block, LOS = length of stay, MD: mean difference, MMT = manual muscle testing, NHLBI = National Heart, Lung, and Blood Institute, NIH = National Institute of Health, PNBs = peripheral nerve blocks, PRISMA = preferred reporting items for systematic review and meta-analysis, RR = risk ratio, SMD = standard mean difference, TKA = total knee arthroplasty, TUG = timed up and GO test, VAS = visual analog scale.

Keywords: adductor canal block, femoral nerve block, postoperative analgesia, total knee arthroplasty

1. Introduction

Total knee arthroplasty (TKA) is a popular and effective surgical intervention for the treatment of knee osteoarthritis.^[1] The number of TKA operations has prominently increased over the last decade to be the most frequent surgical operation done in the developed world.^[2] However, TKA is known to cause moderate to severe postoperative pain that delays the recovery

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

^a Faculty of Medicine, University of Khartoum, Khartoum, Sudan, ^b International Medical Research Association (IMedRA), ^c Faculty of Medicine, Menofia University, Shebin El kom, Menofia, Egypt, ^d Faculty of Medicine, South Valley University, Qena, Egypt, ^e Faculty of Medicine, University of Gezira, Wad Madani, Sudan, ^l Faculty of Medicine, Cairo University, Cairo, Egypt, ^e Faculty of Medicine, Al-Azhar University of Cairo, Cairo, Egypt, ^h Faculty of Medicine, Alexandria University, Alexandria, Egypt, ^l Faculty of Medicine, Beni Suef university, Egypt. process.^[3] The pain following TKA increases the patients' risk to various postoperative complications including infections, loosening of the joint, reflex sympathetic dystrophy and immobility-related complications as deep venous thrombosis (DVT).^[3,4]

Peripheral nerve blocks (PNBs) are analgesic techniques used after TKA primarily for pain control. In addition to pain reduction, nerve blocks significantly enhance recovery and

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reduce both hospital length of stay (LOS) and risk of re-admission.^[5] Femoral nerve block (FNB) is a widely accepted nerve block technique after TKA with high success rates in reduction of opioid consumption and minimization of the length of hospital stay.^[3,6] However, (FNB) may cause reduction of the quadriceps muscle strength impairing postoperative ambulation which increases the patients' risk of falls after the surgery.^[7,8] Adductor canal block (ACB) is another nerve block technique that attracts the attention of the scientific community nowadays because of its possible superiority over (FNB).^[9] Several studies have documented that (ACB) is better than (FNB) regarding postoperative quadriceps muscle strength preservation, postoperative ambulation and functional recovery without any alteration of pain control.[10-13] But on the contrary, 2 recent studies concluded that there is no statistically significant difference between ACB and FNB regarding the analgesic effect, quadriceps strength or functional recovery postoperatively.[14,15]

This systematic review aims to investigate the clinical efficacy of (ACB) compared to (FNB) and draw conclusions on whether or not ACB is superior to FNB regarding functional recovery without alteration of postoperative pain control following TKA.

2. Methods and Materials

We conducted this systematic review according to the Cochrane handbook for systematic reviews of interventions.^[16] Also, we reported this study using the preferred reporting items for systematic review and meta-analysis (PRISMA statement).^[17] This current review tests the hypothesis that patients with ACB will have better postoperative functional recovery, and muscle strength with–at least- same level of pain control as FNB. Ethical approval was not necessary for this study; because all data were obtained from previous published studies.

2.1. Search strategy

We searched PubMed, SCOPUS, web of science and Cochrane databases by using the keywords (Adductor canal block OR motor sparing knee blocks) AND (Femoral nerve block) AND (total knee arthroplasty OR total knee replacement) from conception till March 2021.

2.2. Eligibility criteria and study selection

We included only original papers (Randomized controlled trials or Cohort studies) which compare Adductor canal block with femoral nerve block in total knee arthroplasty patients and excluded any review, case report, systemic review, meta-analysis, or animal studies as well as studies with data that cannot be extracted. Reviewers independently screened the retrieved citations in 2 steps; title and abstract screening followed by full text screening.

2.3. Data extraction

Authors extracted the following data from the included studies:

- 1. Baseline characters of the studies' participants and summary of the included studies,
- 2. Study outcomes: pain control measured by visual analog scale (VAS) at rest and at motion—Quadriceps muscle strength (knee extensors strength) by Isometric measurement or manual muscle testing (MMT)–Mobilization after the operation measured by timed up and Go test and ambulation distance—the amount of Opioid consumption - length of hospital stay—Risk of falls - patient satisfaction.

2.4. Quality Assessment

We assessed the Quality of included trials using Cochrane Risk of Bias tool provided in Cochrane handbook for systematic reviews of interventions (version 5.1.0).^[16] The domains included were: (1) Random sequence generation (selection bias). (2) Allocation concealment (selection bias). (3) Blinding of participants and personnel (performance bias). (4) Outcomes assessment (detection bias). (5) Incomplete outcome data (attrition bias). (6) Other potential sources of bias. The reviewers judged the domains as: " low risk," "high risk," or " unclear". The quality assessment table used was provided in (part 2, chapter 2.5) of the same book.^[16] The quality of the included cohort studies was assessed by the quality assessment tool of the National Heart, Lung, and Blood Institute (NHLBI).^[18] We used the tool for observational cohort studies and cross-sectional studies. This tool is composed of 14 questions to assess the risk of bias and confounders. These questions were answered by "yes," "no," "cannot determine, " "not applicable," or "not reported" then each study was given a score to guide the overall rating of the quality as "good," "fair," or "poor" quality.

2.5. Data analysis

In the analysis, we presented the dichotomous data as risk ratio (RR) and continuous data as mean difference (MD) or standard mean difference (SMD), in a random-effects meta-analysis model using the inverse-variance method for continuous data and Mantel-Haenzel method for dichotomous data. Missing SD was calculated from standard error or 95% confidence interval (CI) according to Altman.^[19] In this analysis, we used review manager 5.3 for windows.

2.6. Assessment of heterogeneity

The heterogeneity of the pooled data was assessed by I square and chi-square tests presented in the forest plots. The chi-square test measures the presence of significant heterogeneity. And the I-square test quantifies the size of the heterogeneity in the pooled data. Interpretation of the results followed the recommendations of the Cochrane handbook for systematic reviews and meta-analysis. The chi-square test was considered significant with a *P* value less than (.1) and the I-square test was interpreted as follows: ((0-40 %): might not be important; (30– 60%): may represent moderate heterogeneity; (50–90 %): may represent substantial heterogeneity).

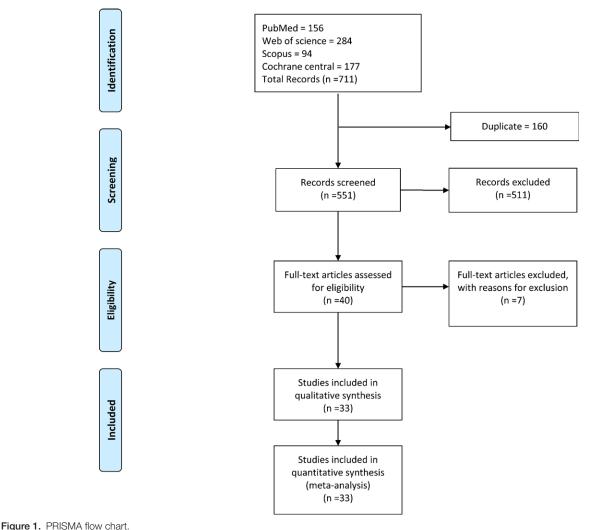
3. Results

3.1. Literature search

The literature search retrieved 711 citations. After title and abstract screening, 40 articles were selected. We evaluated the full text of the selected studies. Finally, 33 studies were eligible to be included in our review and quantitative analysis (PRISMA flow diagram; Fig. 1).

3.2. Characteristics of the included studies and quality assessment

The baseline characteristics of the studies' participants are shown in (Table 1) and the summary of all the included studies is present in (Supplementary table 1, http://links.lww.com/MD/G1000). A summary of the quality assessment for the included randomized trials is shown in (Fig. 2), All the included randomized controlled trials showed moderate to high quality. Eleven cohort studies^[24,25,27,28,34–38,40,41] were fair in quality according to NIH (national institute of health) quality assessment tool for Observational Cohort. One study^[42] had good quality. For more details and answers to all assessment questions in each study, see Supplementary table 2, http://links.lww.com/MD/H2.



3.3. Main outcomes of the study

A. Pain control measured by pain scores (VAS):

- i. Pain scores at 6-8 hours at rest
- The pooled effect estimate showed no statistically significant difference between the 2 techniques at 6-8 hours (MD = -0.06, 95% CI [-0.45, 0.33], P = .77). (Supplementary figure 1, http://links.lww.com/MD/H3) Pooled results were heterogeneous (P < .00001, $I^2 = 87\%$) and the detected heterogeneity could not be solved.
 - ii. Pain scores at 6-8 hours at motion
- The overall effect showed no statistically significant difference between the 2 interventions at motion (MD = -0.08, 95% CI [-0.47, 0.31], P = .70). (Supplementary figure 1, http://links.lww.com/MD/H3) Pooled results were heterogeneous (P < .0002, $I^2 = 80\%$) and the detected heterogeneity was best resolved after excluding Wang et al (P = .78, $I^2 = 0\%$) and the effect estimate remained nonsignificant (MD = 0.14, 95% CI [-0.03, 0.32], P < .11).
 - iii. Pain scores at 24 hours at rest.
- The pooled effect estimate showed no statistically significant difference between the 2 techniques at 24 hours postoperatively (MD = 0.01, 95% CI [-0.18, 0.19], P = .93). (Fig. 3). The pooled results were heterogeneous (P < .00001, $I^2 = 72\%$), and heterogeneity could not be solved.
 - iv. Pain score at 24 hours at motion.

- The pooled studies showed no significant difference between the 2 interventions at motion (MD = 0.09, 95% CI [-0.10, 0.29], P = .35). The pooled results were heterogeneous (P = .02, $I^2 = 51\%$) (Fig. 3). The detected heterogeneity could be solved by excluding Hegazy et al (P = .30, $I^2 = 15\%$) and the effect estimate remained nonsignificant (MD = 0.03, 95% CI [-0.12, 0.18], P = .69).
 - v. Pain score at 48 hours at rest.
- The pooled effect estimate showed no statistically significant difference between adductor canal and femoral nerve block (MD = 0.06, 95% CI [-0.06, 0.17], P = .33). The studies were homogenous (P = .90, $I^2 = 0\%$) (Supplementary figure 2, http://links.lww.com/MD/H4).
- vi. Pain score at 48 hours at motion.
- The pooled studies showed no statistically significant difference between adductor canal and femoral nerve block (MD = 0.00, 95% CI [-0.13, 0.13], P = .99) (Supplementary figure 2, http://links.lww.com/MD/ H4). The studies were heterogenous (P = .02, $I^2 = 54\%$) and the detected heterogeneity was best solved by excluding Wang et al (P = .26, $I^2 = 20\%$). Results remained nonsignificant (P = .42).
 - B. Quadriceps muscle strength:
 - i. Quadriceps muscle strength 6-8 hours postoperatively.
- Isometric measurement: ACB showed higher values of muscle strength over FNB on pooling means from included studies (MD = 2.15, 95% CI [0.38, 3.93], P = .02) (Fig. 4A).

Table 1 Baseline characters of the studies' participants.

Study ID	Groups	No of patients	Age (yr)	Male (%)	Body mass index	Duration of surgery (min)
ahmy et al 2020.[20]	ACB	40	59.5 ± 4.6	14	24.4 ± 4.6	100.1±2.9
	FNB	40	60.1 ± 1.1	13	23.5 ± 2.9	100.4 ± 3.1
(ac maz et al 2021. ^[21]	ACB	43	64.4 ± 1.7	20	-	_
	FNB	43	66.0 ± 1.4	25	-	_
aegar et al 2013 ^[22]	ACB	23	70 ± 8	21.7	-	82 ± 20
0	FNB	27	66 ± 9	51.8	-	75 ± 15
im et al 2013 ^[23]	ACB	46	68 ± 9.4		29.9 ± 6.4	_
	FNB	47	67.6 ± 11.3			_
Ikassabany et al 2016 ^[11]	ACB	31	63±8		$\begin{array}{c} 30.3\pm5.8\\ 31\pm5\\ 32\pm6\\ 26.12\pm3.6\\ 25.67\pm2.88\\ 31.29\pm75\\ 31.48\pm71\\ -\\ -\\ -\\ 29\pm5.9\\ 31.3\pm5.9\\ -\\ -\\ -\\ 33\pm6\\ 33\pm7\\ 30\pm5\\ 29\pm5\\ 27.2\pm10.14\\ -\\ -\\ -\\ 29.54\pm5.46\\ 30.52\pm5.3\\ 31.5\pm6\\ \end{array}$	-
	FNB	31	65 ± 8			-
an et al 2018 ^[13]	ACB	100	64.2 ± 7.5			71.5 ± 8.1
	FNB	100	63.5 ± 6.7			72.6±8.1
udwigson et al 2015 ^[24]	ACB	148	64.09±112			-
	FNB	149	64.74 ± 112			_
eo et al 2017 ^[25]	ACB	19	72.2 ± 5.3	$\begin{array}{cccccccccccccccccccccccccccccccccccc$		_
	FNB	24	74.3 ± 6.81		_	
/eissman et al 2016 ^[26]	ACB	24	86.67 ± 11	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	60 ± 18.5	
leissinan et al 2010 ¹²⁴						
lament at al 2019[27]	FNB	21	67.3±8.89			56.67 ± 11.1
lement et al 2018 ^[27]	ACB	118	65.5 ± 9.3			-
	FNB	146	66.8 ± 9.4			-
ludumbai et al 2013 ^[28]	ACB	66	65 ± 9			105±18
	FNB	102	66 ± 10			105 ± 27
lachi et al 2015 ^[29]	ACB	39	67±8			113 ± 32
	FNB	41	66 ± 7			115 ± 21
oh et al 2017 ^[30]	ACB	50	64.3 ± 17.7	-	27.2 ± 10.14	-
	FNB	50				-
revstad et al 2014 ^[31]	ACB	25	65.33 ± 28.88		-	71.6 ± 23.7
	FNB	25	63.33 ± 31.11		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	81 ± 45.92
hah et al 2014 ^[32]	ACB	48	68.31 ± 7.56	27.1	29.54 ± 5.46	68.85 ± 4.57
	FNB	50	65.94 ± 7.22	28	30.52 ± 5.3	68.30 ± 4.42
larcinici et al 2016 ^[12]	ACB	49	67 ± 8	39	31.5 ± 6	-
	FNB	49	67 ± 8	37	31.7 ± 5.4	_
im et al 2019 ^[15]	ACB	15	63 ± 7	33	26.6 ± 4.3	_
	FNB	15	65 ± 8			_
legazy et al 2014 ^[33]	ACB	53	62 ± 12			_
	FNB	54	63 ± 11			-
atterson et al 2015 ^[34]	ACB	35	65.7 ± 8.9			_
	FNB	41	65 ± 13.3			_
ludumbai et al 2015 ^[35]	ACB	48	66.7 ± 13.3			_
	FNB	46	67.3±20			_
hacher et al 2017 ^[36]	ACB	150	67.3 ± 20 68.4 ± 31.1			_
	FNB	129	68.8 ± 28.9			—
assmussen et al 2014 ^[37]	ACB	23	63.3 ± 11.9	20		_
	FNB	23		20	34 ± 16.3 32.7 ± 10.4	-
habban; at al 0017 ^[38]			62 ± 11.9			—
hobhani et al 2017 ^[38]	ACB	22	64.3 ± 7.4	36.4	35.7 ± 9.6	=
1	FNB	23	68.7 ± 6.7	39.1	33.3 ± 7.4	-
lemtsoudis et al 2014 ^[39]	ACB	30	-	-	-	-
	FNB	29	-	-	-	-
rennan et al 2018 ^[40]	ACB	141	73.21+0.55	-	30.58 ± 0.46	-
	FNB	104	72.28+0.78	-	31.47 + 0.57	-
olarinwa et al 2018 ^[41]	ACB	791	—	-	-	-
	FNB	834	-	-	-	-
rdon et al 2015 ^[42]	ACB	45	64.86	31.1	-	93.31
	FNB	45	67.71	31.1	-	90.29
et al 2016 ^[43]	ACB	24	62.3 ± 6.5	46	-	77.6 ± 8.2
	FNB	27	61.4 ± 6.8	48	-	76.6 ± 8.4
hang wei et al 2014 ^[44]	ACB	30	63.7 ± 5.8	25	-	98.4 ± 10.3
-	FNB	30	61.9 ± 6.7	36	-	97.1 ± 8.2
ukreja et al 2019 ^[45]	ACB	45	63.4	46.5	31.4	_
	FNB	45	65.4	46.3	32.3	_
orys et al 2019 ^[10]	ACB	43	67.33 ± 2.59	18.6	31.56 ± 1.85	_
5150 0t ui 2010	FNB	43	68.8 ± 2.37	19	30.8 ± 1.92	_
huan et al 2019 ^[14]	ACB	42 75	66.66 ± 10.37	53	30.8 ± 1.92 32.3 ± 4.37	_ 91 ± 18.51
IIIIIII EL AI ZUI 9000						
Vana at al 0000[46]	FNB	76	68±7.4	49 50	33.46 ± 7.03	96±31.11
Vang et al 2020 ^[46]	FTB	31	61.77 ± 3.66	50	-	87.77±6.55
	ACB	32	61.67 ± 4.49	53	_	84.20 ± 6.10

ACB = adductor canal block, FNB = femoral nerve block, FTB = femoral triangle block.





The pooled studies were heterogeneous (P = .0003, $I^2 = .88\%$).

MMT: Pooled results showed that the ACB group has higher values of muscle strength (MD = 0.73, 95% CI [0.43, 1.02], P < .00001) (Fig. 4A). The pooled studies were homogenous (P = .21, $I^2 = 34\%$).

ii. Quadriceps muscle strength 1 day postoperatively.

- **Isometric measurement:** pooled studies showed no statistically significant difference between the 2 interventions (MD = 0.20, 95% CI [-0.01, 0.41], P = .06) (Fig. 4B). The pooled studies were homogeneous (P = .87, $I^2 = 0\%$).
- **MMT:** Pooled results showed that the ACB group has higher mean values of muscle strength (MD = 0.54, 95% CI [0.30, 0.78], P < .0001) (Fig. 4B). The pooled studies were heterogonous (P = .07, $I^2 = 49\%$).
- iii. Quadriceps muscle strength 2 days postoperatively.
- **Isometric measurement:** pooled studies showed no statistically significant difference between the 2 interventions (MD = 0.05, 95% CI [-0.18, 0.28], *P* = .66) (Supplementary figure 3, http://links.lww.com/MD/H5). The pooled studies were homogeneous (*P* = .39, *I*² = 0%).
- **MMT:** Pooled results showed that the ACB group has significantly higher mean values of muscle strength (MD = 0.28, 95% CI [0.11, 0.46], P = .002) (Supplementary figure 3, http://links.lww.com/MD/H5). The pooled studies were homogenous (P = .12, $I^2 = 45\%$).
 - C. Mobilization after the operation
 - i. Mobilization by ambulation and walking distance at 24 hours.
- The pooled mean difference showed that ACB significantly increases walking distance at 24 hours compared to femoral nerve block (MD = 46.32, 95% CI [13.77, 78.87], P = .005) (Supplementary figure 4, http://links.lww. com/MD/H6). The pooled studies were heterogeneous (P < .00001, $I^2 = 99\%$) and the detected heterogeneity could not be solved by excluding a study.
 - ii. Mobilization by ambulation and walking distance at 48 hours.
- The pooled mean difference showed that ACB significantly increases the walking distance at 48 hours compared to FNB (MD = 17.97, 95% CI [3.08, 32.86], P = .02). The pooled studies were heterogeneous (P = .002, $I^2 = 68\%$) (Supplementary figure 4, http://links.lww.com/MD/H6).
- iii. Mobilization by **timed up and GO test (TUG) at 24 hours**. The pooled mean difference showed that ACB technique significantly decreases the test duration at 24 hours compared to FNB (SMD = -0.92, 95% CI [-1.47, -0.36], P = .001) (Fig. 5). The pooled studies were heterogeneous (P < .00001, $I^2 = 93\%$). The detected heterogeneity could not be solved by excluding single study.
- iv. Mobilization by **timed up and GO test** (**TUG**) at 48 hours. The pooled mean difference showed that ACB technique significantly decreases the test duration at 48 hours compared to FNB (SMD = -0.41, 95% CI [-0.62, -0.20], P = .003) (Fig. 5). The pooled studies were heterogeneous (P = .04, $I^2 = 49\%$). The detected heterogeneity could be solved by excluding Seo et al (P = .57, $I^2 = 0\%$) and the effect estimate would remain significant (P = .002).
- v. Mobilization by timed up and GO test (TUG) at 72 hours.
- The pooled mean difference showed no statistically significant difference between the 2 interventions at 72 hours (SMD = -0.53, 95% CI [-1.47, 0.40], P = .26) (Fig. 5). The pooled studies were heterogeneous (P < .00001, $I^2 = 90\%$). The detected heterogeneity could be solved by excluding Seo et al ($I^2 = 0\%$) and the effect estimate would remain nonsignificant (P = .80) D. Opioid consumption

 - i. At 24 Hours.
- The pooled effect estimate showed no statistically significant difference between the 2 intervention groups (SMD = -0.01, 95% CI [-0.28, 0.25], P = .93) (Fig. 6). Pooled results were heterogeneous (P < .00001, $I^2 = 85\%$) and the detected heterogeneity could be best solved by excluding klement et al 2019 (P = .08, $I^2 = 37\%$). The pooled results would remain nonsignificant.
 - ii. At 48 Hours.

		ACB			FNB			Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% Cl
1.6.1 Pain Score at rest									
borys 2019	3.8	0.897609	43	3	0.88711	42	5.1%	0.89 [0.44, 1.33]	
Elkassabany et al 2016	4.33	2.22	31	4	1.48	31	4.7%	0.17 [-0.33, 0.67]	
fahmy 2020	3.6	3	40	3.3	2.3	40	5.2%	0.11 [-0.33, 0.55]	
Jaegar et al 2013	1.78	1.677	22	1.15	1.58	26	4.3%	0.38 [-0.19, 0.95]	
Kac maz 2021	2.5	0.14	40	2.6	0.14	40	5.1%	-0.71 [-1.16, -0.25]	
kim et al 2014	3.1	3.2	46	2.8	2.3	47	5.4%	0.11 [-0.30, 0.51]	
Klement et al 2019	3.7	2	118	4.8	2.2	146	6.4%	-0.52 [-0.77, -0.27]	
Kukreja 2019	4.18	2.64	43	4	2.35	43	5.3%	0.07 [-0.35, 0.49]	
Li et al 2016	2.6	1.5	24	2.8	1.6	27	4.4%	-0.13 [-0.68, 0.42]	
Lim et al 2019	0.67	1.48	15	0.67	1.48	15	3.5%	0.00 [-0.72, 0.72]	
Machi et al 2015	4.628	1.823	39	3.572	2.604	41	5.1%	0.46 [0.02, 0.91]	
Mementsoudis et al 2014	2.81	2.42	59	2.47	2.42	59	5.7%	0.14 [-0.22, 0.50]	 +
Mudumbai et al 2013	4	3	66	3	3	102	6.0%	0.33 [0.02, 0.64]	
Patterson et al 2014	2.67	1.48	23	2.67	1.48	41	4.7%	0.00 [-0.51, 0.51]	
Shah et al 2014	2.458	0.354	48	2.58	0.309	50	5.4%	-0.36 [-0.76, 0.03]	
Tan et al 2018	3.26	0.36	100	3.2	0.3	100	6.2%	0.18 [-0.10, 0.46]	
thobhani et al 2017	2.67	3.7	22	3.67	5.2	23	4.2%	-0.22 [-0.80, 0.37]	
Wang 2020	2.666667	0.77842	30	3.333333	0.77842	30	4.5%	-0.85 [-1.38, -0.32]	
wiessman et al 2016	1.67	2.22	21	1.5	2.22	21	4.1%	0.08 [-0.53, 0.68]	
Zhang wei et al 2014	3.67	1.48	30	3.67	0.75	30	4.7%	0.00 [-0.51, 0.51]	
Subtotal (95% CI)			860			954	100.0%	0.01 [-0.18, 0.19]	•
Heterogeneity: Tau ² = 0.12;			< 0.00	001); I² = 72	:%				
Test for overall effect: Z = 0.1	09 (P = 0.93))							
1.6.2 pain score at motion									
fahmy 2020	4.3	2.3	40	4	1.5	40	9.5%	0.15 [-0.29, 0.59]	
Hegazy et al 2014	5.5	1.2	53	4.75	0.9	54	10.6%	0.70 [0.31, 1.09]	
Jaegar et al 2013	3.8	2.08	22	3.4	2.36	26	7.1%	0.18 [-0.39, 0.74]	
Lim et al 2019	5.67	2.96	15	5.3	3.7	15	5.2%	0.11 [-0.61, 0.82]	
Machi et al 2015	4	2	39	4	2	41	9.5%	0.00 [-0.44, 0.44]	
Mementsoudis et al 2014	3.8	2.6	59	2.82	2.46	59	11.2%	0.38 [0.02, 0.75]	
Shah et al 2014	3.27	0.341	48	3.4	0.335	50	10.4%	-0.38 [-0.78, 0.02]	
Tan et al 2018	3.9	0.4	100	3.85	0.45	100	13.5%	0.12 [-0.16, 0.39]	
wang 2020	3.33	1.55	30	3.67	0.77	30	8.1%	-0.27 [-0.78, 0.23]	
wiessman et al 2016	4.3	2.96	21	4.2	1.85	21	6.6%	0.04 [-0.57, 0.64]	
Zhang wei et al 2014 Subtotal (95% Cl)	5.25	0.9	30 457	5.4	0.9	30 466	8.2% 100.0%	-0.16 [-0.67, 0.34] 0.09 [-0.10, 0.29]	
Heterogeneity: Tau ² = 0.05;	Chi ² = 20.54	l. df = 10 (P	= 0.02); I² = 51%					-
Test for overall effect: Z = 0.9			,						
									-1 -0.5 0 0.5 1
									Favours [experimental] Favours [control]

Figure 3. Pain Score at 24 hours.

The pooled effect estimate showed no statistically significant difference between the 2 intervention groups (SMD = 0.08, 95% CI [-0.06, 0.22], P = .28) (Fig. 6). Pooled results were homogenous (P = .13, $I^2 = 32\%$).

iii. Total opioid consumption.

- Results showed no statistically significant difference between the 2 intervention groups (SMD = 0.61, 95% CI [-0.19, 1.41], P = .14) (Fig. 6). Pooled results were heterogenous (P < .00001, $I^2 = 96\%$) and it could not be solved.
 - E. Recovery After the operation:
 - i. Length of hospital stay.
- Pooled results showed that ACB was associated with significantly lower period of hospital stay when compared to FNB (MD = -0.25, 95% CI [-0.48, -0.02], P = .04) (Supplementary figure 5, http://links.lww.com/MD/H7). Pooled results were heterogeneous (P < .00001, $I^2 = 92\%$) and the detected heterogeneity could not be solved by excluding any study.

ii. Risk of falls

The pooled results showed no statistically significant difference between ACB and FNB regarding the risk of postoperative falls (MD = 1.09, 95% CI [0.77, 1.53], P = .64) (Supplementary figure 6, http://links.lww.com/MD/H8). Pooled results were heterogeneous (P = .03, $I^2 = 67\%$) and the detected heterogeneity could be solved by excluding Bolarina et al ($I^2 = 18\%$). And the effect estimate would remain nonsignificant.

iii. Mean patient satisfaction

The pooled results showed no statistically significant difference between ACB and FNB (MD = 0.08, 95% CI [-0.06, 0.22], P = .28) regarding the patients' satisfaction (Supplementary figure 7, http://links.lww.com/MD/H9). Pooled results were homogeneous (P = .21, $I^2 = 27\%$).

4. Discussion

The pooled results of the studies included in this meta-analysis showed that both ACB and FNB exhibit equal pain control and opioid consumption after 24 and 48 hours of total knee arthroplasty operation both in rest and in motion; however, ACB showed superiority to FNB regarding quadriceps muscle strength up to 2 days postoperation specially when assessing the muscle strength using manual muscle testing. ACB also showed better mobilization results than FNB up to 2 days postoperation but equal results after 3 days, the better mobilization results did not translate into any difference in the risk of falls or patients' satisfaction about the procedure.

Total Knee arthroplasty is a successful surgical procedure with excellent long-term survival rates.^[47–49] The main aim of patients undergoing TKA is to alleviate pain and improve their functional mobility, thus no leniency is allowed in handling such aspect of the patient complaint.^[50] Besides suffering and discomfort, severe unrelieved postoperative pain delays rehabilitation and lengthens the hospital-stay period, and may lead to persistent postsurgical pain.^[51] Previous studies reported poor management and a higher percentage of patients with severe pain after TKA procedure.^[52,53] Almost 44–57% of the patients who have undergone the surgery are

		ACB			FNB			Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
1.12.1 Isometric Kgf									
kim et al 2014	7.3	5.4	46	2.2	3.8	47	27.3%	5.10 [3.20, 7.00]	$ \longrightarrow$
Mementsoudis et al 2014	2.86	3.55	59	2.45	3.31	59	33.2%	0.41 [-0.83, 1.65]	
Tan et al 2018	5.03	0.65	100	3.44	0.41	100	39.5%	1.59 [1.44, 1.74]	•
Subtotal (95% CI)			205			206	100.0%	2.15 [0.38, 3.93]	
Heterogeneity: Tau ² = 2.08; Test for overall effect: Z = 2			lf = 2 (P	= 0.0003); I² = 88%	0			
1.12.2 MMT									
Koh et al 2017	3.2	1.1	50	2.5	0.8	50	33.7%	0.70 [0.32, 1.08]	
Li et al 2016	3.34	0.88	24	2.5	1.7	27	13.4%	0.84 [0.11, 1.57]	-
Mementsoudis et al 2014	1.61	1.59	59	1.33	1.45	59	20.9%	0.28 [-0.27, 0.83]	- +
Wang 2020	3.67	0.78	30	2.666667	0.77842	30	32.0%	1.00 [0.61, 1.40]	
Subtotal (95% CI)			163			166	100.0%	0.73 [0.43, 1.02]	◆
Heterogeneity: Tau ² = 0.03; Test for overall effect: Z = 4		,	`	= 0.21); l²	= 34%				
									-4 -2 0 2 4
(B) 24 hours post	topera		•		END			Moon Difforence	Favours [FNB] Favours [ACB]
Study or Subgroup 1.13.1 Isometric KgF	Mear	ACB 1 SI	D Tota	l Mean			/eight l	Mean Difference V, Random, 95% Cl -0.10 [-1.77, 1.57]	Favours [FNB] Favours [ACB] Mean Difference IV, Random, 95% Cl
Study or Subgroup	Mear 3.9	ACB 1 SI	2 4	Mean 6 4		<u>otal V</u> 47 59			Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014	Mear 3.9	ACB 1 SI 9 4.:	2 40 3 5	Mean 6 4 9 5.08 0 6.43	SD T 4 4.06 0.79	47 59 100	/eight 1.6%	V, Random, 95% Cl -0.10 [-1.77, 1.57]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0	Mear 3.9 6.64 0; Chi² =	ACB SI ACB A: ACB A: ACB ACB ACB ACB ACB ACB ACB ACB	2 4 2 4 8 5 4 10 20 df = 2	Mean 6 4 9 5.08 0 6.43 6	SD T 4 4.06 0.79	47 59 100 206 1	/eight 1.6% 2.2% 96.2%	V, Random, 95% CI -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0 Test for overall effect: Z = 1.13.2 MMT	Mear 3.{ 6.6 ² 0; Chi ² = 1.87 (P	ACB 5 3.66 4 0.74 5 0.29, = 0.06	D Tota 2 44 8 55 4 100 209 df = 2 (I Mean 6 4 9 5.08 0 6.43 9 7.08 9 7.08 9 8.13	SD T 4 4.06 0.79); ² = 0%	47 59 100 206 1	Veight I 1.6% 2.2% 96.2% 00.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.00 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016	Mear 3.5 6.6- 0; Chi² = 1.87 (P	ACB SI 3 4.: 5 3.66 4 0.74 : 0.29, = 0.06 3 0.74	D Tota 2 44 3 55 4 100 209 df = 2 (3) 4 3	$\begin{array}{c c} I & Mean \\ \hline 6 & 4 \\ 9 & 5.08 \\ 0 & 6.43 \\ \hline P = 0.87 \\ 1 & 2.7 \\ \end{array}$	SD T 4 4.06 0.79 ; I ² = 0%	47 59 100 206 1	Veight 1 1.6% 2.2% 96.2% 90.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.01 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017	Mear 3.9 6.64 0; Chi ² = 1.87 (P	ACB 3 SI 3 4.3 5 3.6 4 0.7 • 0.29, = 0.06 3 0.7 1	2 41 2 41 8 55 4 100 209 df = 2 6 3) 4 3 1 5	$\begin{array}{c cccc} I & Mean \\ \hline 6 & 4 \\ 9 & 5.08 \\ 0 & 6.43 \\ \hline 7 \\ P = 0.87 \\ \hline 1 & 2.7 \\ 0 & 3.5 \\ \end{array}$	SD T 4 4.06 0.79 5; I ² = 0%	47 59 100 206 1 31 50	Veight 1 1.6% 2.2% 96.2% 00.0% 17.9% 14.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.00 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016	Mear 3.9 6.64 0; Chi ² = 1.87 (P	ACB 3 SI 3 4.3 5 3.64 4 0.74 • 0.29, = 0.06 3 0.74 1 3 1.0	2 41 2 41 3 55 4 100 209 df = 2 6 3) 4 3 1 51 7 2	I Mean 5 4 9 5.08 0 6.43 5 9 1 2.7 0 3.5 4 3.94	SD T 4 4.06 0.79 ; I ² = 0%	47 59 100 206 1 31 50 27	Veight 1 1.6% 2.2% 96.2% 90.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.01 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.3 4.5 4.5 3.67	ACB 3 SI 3 3.64 4 0.74 5 3.64 4 0.74 5 0.29, = 0.06 3 0.74 1 0.7 3 1.0 3 1.0 3 1.0 7 0.7	D Tota 2 44 8 55 4 100 209 df = 2 (3) 4 3 1 55 7 24 5 55 7 3	I Mean 6 4 9 5.08 0 6.43 5 6 1 2.7 0 3.5 4 3.94 9 2.57 0 3.33	SD T 4 4.06 0.79); I ² = 0% 0.74 1.4 1.5 1.15 0.77	47 59 100 206 1 31 50 27 59 30	Veight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% Cl) Heterogeneity: Tau ² = 0.01 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 2.8 3.66 2.65	ACB 3 0.29, 3 0.74 3 0.74	D Tota 2 44 8 53 4 100 209 df = 2 0 5) 4 3 1 50 7 20 5) 4 3 1 50 7 20 5) 7 20 5) 7 20 50 7 30 4 2	$\begin{array}{c cccc} & & & & & \\ \hline & & & & \\ \hline & & & & \\ \hline & & & &$	SD T 4 4.06 0.79 ; l ² = 0% 0.74 1.4 1.5 1.15 0.77 1.48	47 59 100 206 1 31 50 27 59 30 21	Veight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.01 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wiessman et al 2016 Zhang wei et al 2014	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 2.8 3.66 2.65	ACB 3 SI 3 3.64 4 0.74 5 3.64 4 0.74 5 0.29, = 0.06 3 0.74 1 0.7 3 1.0 3 1.0 3 1.0 7 0.7	D Tota 2 44 8 53 4 100 209 df = 2 0 5) 4 3 1 50 7 20 5) 4 3 1 50 7 20 5) 7 20 5) 7 20 50 7 30 4 2	I Mean 6 4 9 5.08 0 6.43 7 3.5 1 2.77 0 3.54 9 2.577 0 3.331 1 2.233	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.74 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30	Veight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38] 1.00 [0.63, 1.37]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% Cl) Heterogeneity: Tau ² = 0.01 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 4.8 2.8 3.66 2.66 3.33 5; Chi ² =	ACB 1 SI 2 4.1 5 3.64 4 0.7 4 0.29, = 0.06 3 0.7 1 3 1.00 7 0.7 3 0.7 1 1.07 3 1.00 7 0.7 3 0.7 1 1.07	$\begin{array}{cccc} D & Tota \\ 2 & 4i \\ 3 & 5i \\ 4 & 10i \\ 20i \\ df = 2 \\ i \\ 4 & 3i \\ 7 & 2i \\ 7 & 3i \\ 4 & 2i \\ 4 & 3i \\ 244 \\ 244 \\ 0, df = 6 \end{array}$	I Mean 6 4 9 5.08 9 5.08 0 6.43 7 3.5 4 3.94 9 2.57 0 3.33 1 2 2 2.33	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.79 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30 21 30 248 1	Jeight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4% 16.7% 17.0% 17.9% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016 Zhang wei et al 2014 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 4.8 2.8 3.66 2.66 3.33 5; Chi ² =	ACB 1 SI 2 4.1 5 3.64 4 0.7 4 0.29, = 0.06 3 0.7 1 3 1.00 7 0.7 3 0.7 1 1.07 3 1.00 7 0.7 3 0.7 1 1.07	$\begin{array}{cccc} D & Tota \\ 2 & 4i \\ 3 & 5i \\ 4 & 10i \\ 20i \\ df = 2 \\ i \\ 4 & 3i \\ 7 & 2i \\ 7 & 3i \\ 4 & 2i \\ 4 & 3i \\ 244 \\ 244 \\ 0, df = 6 \end{array}$	I Mean 6 4 9 5.08 9 5.08 0 6.43 7 3.5 4 3.94 9 2.57 0 3.33 1 2 2 2.33	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.79 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30 21 30 248 1	Jeight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4% 16.7% 17.0% 17.9% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38] 1.00 [0.63, 1.37]	Mean Difference
Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016 Zhang wei et al 2014 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 4.8 2.8 3.66 2.66 3.33 5; Chi ² =	ACB 1 SI 2 4.1 5 3.64 4 0.7 4 0.29, = 0.06 3 0.7 1 3 1.00 7 0.7 3 0.7 1 1.07 3 1.00 7 0.7 3 0.7 1 1.07	$\begin{array}{cccc} D & Tota \\ 2 & 4i \\ 3 & 5i \\ 4 & 10i \\ 20i \\ df = 2 \\ i \\ 4 & 3i \\ 7 & 2i \\ 7 & 3i \\ 4 & 2i \\ 4 & 3i \\ 244 \\ 244 \\ 0, df = 6 \end{array}$	I Mean 6 4 9 5.08 9 5.08 0 6.43 7 3.5 4 3.94 9 2.57 0 3.33 1 2 2 2.33	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.79 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30 21 30 248 1	Jeight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4% 16.7% 17.0% 17.9% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38] 1.00 [0.63, 1.37]	Mean Difference
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Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016 Zhang wei et al 2014 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 4.8 2.8 3.66 2.66 3.33 5; Chi ² =	ACB 1 SI 2 4.1 5 3.64 4 0.7 4 0.29, = 0.06 3 0.7 1 3 1.00 7 0.7 3 0.7 1 1.07 3 1.00 7 0.7 3 0.7 1 1.07	$\begin{array}{cccc} D & Tota \\ 2 & 4i \\ 3 & 5i \\ 4 & 10i \\ 20i \\ df = 2 \\ i \\ 4 & 3i \\ 7 & 2i \\ 7 & 3i \\ 4 & 2i \\ 4 & 3i \\ 244 \\ 244 \\ 0, df = 6 \end{array}$	I Mean 6 4 9 5.08 9 5.08 0 6.43 7 3.5 4 3.94 9 2.57 0 3.33 1 2 2 2.33	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.79 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30 21 30 248 1	Jeight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4% 16.7% 17.0% 17.9% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38] 1.00 [0.63, 1.37]	Mean Difference
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Study or Subgroup 1.13.1 Isometric KgF kim et al 2014 Mementsoudis et al 2014 Tan et al 2018 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0 Test for overall effect: Z = 1.13.2 MMT Elkassabany et al 2016 Koh et al 2017 Li et al 2016 Mementsoudis et al 2014 wang 2020 wiessman et al 2016 Zhang wei et al 2014 Subtotal (95% CI) Heterogeneity: Tau ² = 0.0	Mear 3.9 6.64 0; Chi ² = 1.87 (P 4.1 4.2 4.8 2.8 3.66 2.66 3.33 5; Chi ² =	ACB 1 SI 2 4.1 5 3.64 4 0.7 4 0.29, = 0.06 3 0.7 1 3 1.00 7 0.7 3 0.7 1 1.07 3 1.00 7 0.7 3 0.7 1 1.07	$\begin{array}{cccc} D & Tota \\ 2 & 4i \\ 3 & 5i \\ 4 & 10i \\ 20i \\ df = 2 & 0i \\ 3i \\ 4 & 3i \\ 7 & 2i \\ 7 & 3i \\ 4 & 2i \\ 4 & 3i \\ 244 \\ 244 \\ 244 \\ 0, df = 6 $	I Mean 6 4 9 5.08 9 5.08 0 6.43 7 3.5 4 3.94 9 2.57 0 3.33 1 2 2 2.33	$\begin{array}{c} \text{SD} \text{T}, \\ 4 \\ 4.06 \\ 0.79 \\ 0.79 \\ 0.79 \\ 0.79 \\ 1.4 \\ 1.5 \\ 1.15 \\ 0.77 \\ 1.48 \\ 0.74 \\ 0.74 \\ \end{array}$	47 59 100 206 1 31 50 27 59 30 21 30 21 30 248 1	Jeight I 1.6% 2.2% 96.2% 00.0% 17.9% 14.0% 8.4% 16.7% 17.0% 8.4% 16.7% 17.0% 17.9% 17.0%	V, Random, 95% Cl -0.10 [-1.77, 1.57] -0.08 [-1.48, 1.32] 0.21 [-0.00, 0.42] 0.20 [-0.01, 0.41] 0.30 [-0.07, 0.67] 0.60 [0.12, 1.08] 0.86 [0.15, 1.57] 0.23 [-0.17, 0.63] 0.34 [-0.05, 0.73] 0.67 [-0.04, 1.38] 1.00 [0.63, 1.37]	Mean Difference

Figure 4. Quadriceps muscle strength: (A) at 6-8 hours postoperatively. (B) at 1 day postoperatively.

woken up by pain during the first 3 days after TKA.^[53] The developed sleep deprivation reduces pain threshold generating a vicious cycle and causing dissatisfaction in about 19% of the patients undergoing TKA.^[54,55] Therefore, sleep disturbance and persistent postoperative pain appear to be crucial predictors of persistent functional limitations at 1 and 3 months after TKA.^[54,56]

Our nonsuperiority results between both modalities of anesthesia in TKA in terms of pain control and opioid consumption are in line with the results of many other studies.^[14,15,57,58] A recent meta-analysis showed an equivalent effect of ACB and FNB in patients with TKA.^[59] Lim et al found that the perioperative morphine consumption and pain scores at 1, 24, and 48 hours postoperatively were similar between the groups.^[15] Likewise, both Kim et al and Jaeger et al showed that pain scores and opioid consumption were similar in both ACB and FNB groups.^[22,23] Moreover, the superiority of ACB over FNB in terms of mobility and muscle strength is also consistent with the results reported in previous trials.^[11,31,60] ACB is proposed to have a quadriceps-sparing effect, as it blocks distally to where most of the motor fibers of the femoral nerve branch off.^[61] Both Jaeger et al and Kwofie et al showed preservation of quadriceps strength with ACB as opposed to FNB.^[8,62] Jaeger et al reported quadriceps strength of 52% of the baseline value in patients with continuous ACB and 18% only in patients with continuous FNB.^[22]

		ACB			FNB			Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
1.9.1 24 hours									
Chuan 2019	40.66667	19.65295	75	46.66667	24.18204	76	9.6%	-0.27 [-0.59, 0.05]	
Elkassabany et al 2016	65.33333	38.08219	31	70.33333	38.85937	31	9.2%	-0.13 [-0.63, 0.37]	
fahmy 2020	5.9	1.2	40	11.1	2.4	40	8.8%	-2.71 [-3.33, -2.10]	
Hegazy et al 2014	5.2	0.7	53	10.3	3.5	54	9.3%	-2.00 [-2.46, -1.53]	
Jaegar et al 2013	37	22	23	39	16	27	9.0%	-0.10 [-0.66, 0.45]	_ _
Liet al 2016	75.52632	12.89474	24	81.84211	14.21053	27	9.0%	-0.46 [-1.01, 0.10]	
Lim et al 2019	78.83333	63.46856	15	84.96667	40.8129	15	8.5%	-0.11 [-0.83, 0.60]	-
Machi et al 2015	54.6798	32.4165	39	69.82759	29.51863	41	9.3%	-0.48 [-0.93, -0.04]	
Macrinici et al 2017	35	31.33339	49	48	31.33339	49	9.4%	-0.41 [-0.81, -0.01]	
seo et al 2017	38.8	3.99	19	42.1	3.6	24	8.8%	-0.86 [-1.49, -0.23]	
Shah et al 2014	51.81	7.93	48	180	68.44	50	9.1%	-2.58 [-3.13, -2.04]	_ _
Subtotal (95% CI)			416			434	100.0%	-0.92 [-1.47, -0.36]	◆
Heterogeneity: Tau ² = 0.81 Test for overall effect: Z = 3			(P < 0	00001); I² =	93%				
1.9.2 48 Hours									
Chuan 2019	39.33333	19.65295	75	44	21.15928	76	21.8%	-0.23 [-0.55, 0.09]	
Elkassabany et al 2016	46	33.41906	31	46	30.31031	31	9.0%	0.00 [-0.50, 0.50]	-+-
fahmy 2020	4.8	0.8	40	5.2	0.8	40	11.3%	-0.50 [-0.94, -0.05]	
Hegazy et al 2014	4.2	0.9	53	4.5	0.8	54	15.3%	-0.35 [-0.73, 0.03]	
Lietal 2016	51.05263	13.68421	24	62.63158	14.47368	27	6.8%	-0.81 [-1.38, -0.23]	_ —
Lim et al 2019	62.66667	23.22819	15	67.63333	33.28828	15	4.3%	-0.17 [-0.89, 0.55]	+ <u>-</u> -
Machi et al 2015	45.5665	24.17019	39	49.38424	26.96413	41	11.6%	-0.15 [-0.59, 0.29]	
Macrinici et al 2017	34	31.33339	49	44	29.59264	49	14.0%	-0.33 [-0.72, 0.07]	
seo et al 2017	34.1	3.2	19	40.4	4.72	24		Not estimable	
wiessman et al 2016 Subtotal (95% CI)	53.33333	33.33333	21 347	70.5	25.92593	21	5.8% 100.0%	-0.56 [-1.18, 0.05] - 0.32 [-0.47, -0.17]	
		7.46.00		17 001		554	100.0%	-0.52 [-0.47, -0.17]	•
Heterogeneity: Tau ² = 0.00 Test for overall effect: Z = 4			= 0.57);	1~= 0%					
1.9.3 72 Hours									
Li et al 2016	30	13.15789		33.42105		27	25.4%	-0.25 [-0.80, 0.31]	
Machi et al 2015	41.00985	20.47358	39	36.82266	15.04315	41	26.3%	0.23 [-0.21, 0.67]	- =
seo et al 2017	29.2	2.7	19	37.09	3.8	24	23.3%	-2.30 [-3.09, -1.51]	_
wiessman et al 2016 Subtotal (95% CI)	51	20.74074	21 103	50.66667	24.44444	21 113	25.0% 100.0%	0.01 [-0.59, 0.62] -0.53 [-1.47, 0.40]	
Heterogeneity: Tau ² = 0.81 Test for overall effect: Z = 1	•			001); I² = 90)%				
									-4 -2 0 2 4
									-4 -2 0 2 4 Favours [ACB] Favours [FNB]
re 5. Mobilization by tin	nod un an	d GO tost	THG						

Figure 5. Mobilization by timed up and GO test TUG.

Regarding the risk of falls, we found no statistical difference between both interventions in the meta-analysis model. nevertheless, Kwofie et al (using the Berg Balance Scale) demonstrated a higher incidence of quadriceps muscle weakness and risk of falls after administration of FNB.^[62] Elkassabany et al used the Tinetti Scale for gait and balance to report a higher incidence of falls in the FNB group after 48 hours.^[11] The weakness of quadriceps with FNB was also demonstrated by Thacher et al who reported a statistically significant difference in episodes of near fall (knee-buckling) in about 13% of patients with FNB vs 2% with ACB during physiotherapy.^[36]

Despite all the aforementioned advantages of the 2 peripheral nerve blockade techniques being investigated in this study, various limitations and disadvantages may exist. Patients undergoing peripheral nerve blockades carry the risk for a possible nerve injury during the procedure, in addition to possible local and systemic toxicities from the large volume of local anesthetic used in the procedure.^[63,64] Despite its advantage in preservation of muscle strength postoperatively, ACB carries an increased risk for neuropathy, myositis, and infection due to perioperative injection of local anesthetic in the adductor canal close to the operative site, in addition to ischemia resulting from possible tourniquet compression.^[65] Another major challenge in the use of ultra-sound guided peripheral nerve blockade techniques, is the requirement of a highly skilled physician to perform the procedure specifically in cases of smaller and deeper nerves, or in individuals with higher body mass index, edematous tissues or subcutaneous emphysema, which are known conditions that limit the visualization by the ultra-sound and consequently make the nerve blockade difficult. $^{\rm [63,64]}$

The knowledge from this study is a statistical confirmation of the previously reported literature that points out the superiority of ACB over FNB in preservation of muscle strength postoperatively, with both the techniques being equally effective in pain control. Physicians can use this piece of knowledge to make evidence based decisions on which peripheral nerve block modality to use with different types of patients undergoing TKA, bearing in mind that pain is a complex multi-dimensional perception that is influenced by several factors above and beyond the pain control method being applied on the patient. These factors include but are not limited to the patient gender, age, length of hospital stay in addition to the familial, psychological, social and cultural variables.^[66,67]

5. Strengths and Limitations

The main strength point of the current systematic review is the high number of included studies in the analysis compared to previous systematic reviews.^[59,68] The available data from the included studies allowed for assessment of different outcomes at various time points enriching the analysis.

However, Heterogeneity of the pooled data in different outcomes is a major limitation to this study; this heterogeneity may be explained by the variations in ACB protocols (continuous infusion or single shot) and the different types of anesthesia used in the TKA operation (general or spinal) among the included studies. Variations among patients in pain tolerance may be another source of heterogeneity.^[69]

		ACB			FNB		:	Std. Mean Difference	Std. Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
1.15.1 at 24 h									
Ardon et al 2016	74.96	37.23	45	72.4	62.34	45	6.4%	0.05 [-0.36, 0.46]	
Chuan 2019	63.33	52.9	75	66	46.85	76	6.9%	-0.05 [-0.37, 0.27]	
Elkassabany et al 2016	65	37	31	62	32.6	31	6.0%	0.08 [-0.41, 0.58]	
Hegazy et al 2014	26	21.2	53	25.3	20.5	54	6.6%	0.03 [-0.35, 0.41]	_ _ _
Jaegar et al 2013	22	9	22	20.0	20.0	26	5.6%	0.00 [-0.57, 0.57]	
kim et al 2014	50.3	30.8	46	50.4	33.1	47	6.5%	-0.00 [-0.41, 0.40]	
Klement et al 2019	20	14.8	118	42.8	21.6	146	7.1%	-1.20 [-1.47, -0.94]	-
Kukreja 2019	75.54	49.81	43	68.78	55.08	41	6.4%	0.13 [-0.30, 0.56]	
Lim et al 2019	21	43.01	15	20	12	15	4.9%	0.08 [-0.63, 0.80]	
Machietal 2015	9.9	7.4	39	11.18	10.37	41	4.3% 6.3%	-0.14 [-0.58, 0.30]	
Mudumbai et al 2013	9.9 69	39	- 59 66	64	45	102	0.3% 6.9%	0.12 [-0.19, 0.43]	
	1.5	3.6	48	1.3	4.9	46	0.9% 6.5%	• • •	
Mudumbani 2016			48					0.05 [-0.36, 0.45]	
Patterson et al 2014	6.03	3.7		7.03	3.78	41	5.9%	-0.26 [-0.78, 0.25]	
Rassmussen et al 2014	78.2	42.2	23	94.6	48.5	22	5.5%	-0.36 [-0.94, 0.23]	
Thacher et al 2017	73.4	40.03	150	59.8	40.03	129	7.2%	0.34 [0.10, 0.58]	
thobhani et al 2017	88.67	38.5	22	47.67	28.1	23	5.3%	1.20 [0.56, 1.84]	
Subtotal (95% CI)			819			885	100.0%	-0.01 [-0.28, 0.25]	–
Heterogeneity: Tau² = 0.24 Test for overall effect: Z = 0			(P < 0.0)0001); I² =	85%				
1.15.2 at 48 h									
Ardon et al 2016	28.19	17.69	45	31.84	23.09	45	8.4%	-0.18 [-0.59, 0.24]	
Chuan 2019	63.33	52.9	75	66.33	47.6	76	11.7%	-0.06 [-0.38, 0.26]	
Elkassabany et al 2016	57.3	43	31	51.67	37	31	6.4%	0.14 [-0.36, 0.64]	_
Hegazy et al 2014	21.2	15.3	53	18.4	11.5	54	9.4%	0.21 [-0.17, 0.59]	
kim et al 2014	60.7	32.3	46	62.8	39.1	47	8.6%	-0.06 [-0.46, 0.35]	
Kukreja 2019	55.5	32.3	43	44.47	22.26	41	7.9%	0.39 [-0.04, 0.82]	
Lim et al 2019	41	22	15	39	29	15	3.5%	0.08 [-0.64, 0.79]	
Machi et al 2015	8.9	5.1	29	9.92	3.66	41	6.8%	-0.23 [-0.71, 0.24]	
Mudumbai et al 2013	51.2	31	66	53	38	102		-0.05 [-0.36, 0.26]	
Rassmussen et al 2014	73	48.8	23	67.4	31.8	22	5.0%	0.13 [-0.45, 0.72]	
Thacher et al 2017	45	33.7	150	41.8	33.7	129	15.8%	0.09 [-0.14, 0.33]	 _
thobhani et al 2017	40 147.67	58.5	22	96.33	38.5	23	4.4%	1.02 [0.40, 1.65]	
Subtotal (95% CI)	147.07	30.3	598	90.55	30.0	626	4.4 %	0.08 [-0.06, 0.22]	▲ · ·
Heterogeneity: Tau ² = 0.02	- Chi2 - 10 01	0 df = 11/F		N- 12 - 000		020	100.070	0.00[-0.00, 0.22]	The second secon
Heterogeneity: Tau== 0.02 Test for overall effect: Z = 1			r = 0.13	5), 1" = 32%					
1.15.5 total consumption									
borys 2019	20	1.154701	43	13.75	0.877971	42	12.3%	6.03 [5.01, 7.05]	
Kac maz 2021	23.75	7.82	40	21.5	0.24	40	14.7%	0.40 [-0.04, 0.85]	⊢
Li et al 2016	37.9	20.6	24	38.3	22.6	27	14.3%	-0.02 [-0.57, 0.53]	
seo et al 2017	145.5	42.7	19	171	33.3	24	14.1%	-0.66 [-1.28, -0.04]	
Tan et al 2018	34.25	22.35	100	32.5	20.95	100	15.1%	0.08 [-0.20, 0.36]	- + -
Thacher et al 2017		106.6575	150		106.6575	129	15.2%	0.11 [-0.13, 0.34]	+ -
Wang 2020	12.66667		30			30	14.4%	-0.88 [-1.41, -0.35]	_ _
Subtotal (95% CI)			406				100.0%	0.61 [-0.19, 1.41]	
Heterogeneity: Tau ² = 1.08	•	• •	° < 0.00	0001); I² = 9	6%				
Test for overall effect: Z = 1									
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i est for overall effect: Z = 1								_	
i est for overall effect: 2 = 1								_	-2 -1 0 1 2 Favours [ACB] Favours [FNB]

6. Conclusion

ACB has the advantage of preserving the quadriceps muscle strength and better mobilization after the operation over the FNB, but both the interventions are equal regarding pain control and opioid consumption.

Author contributions

AA: idea conception, search strategy, screening and extraction conflict resolution and study supervision. EAH, MMM, HAA, EAI, MAH: Screening, data extraction, and writing. AKE, YHA, AAA, ASA: Statistical analysis, manuscript writing and study revision. All authors reviewed the manuscript and approved it for publication.

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