

The Implications of Local Anesthetic Volume in Adductor Canal Blockade: An
Integrative Review

Michaela Purcell, RN-BSN

Bryan College of Health Sciences

December 7, 2017

Michaela.purcell@bryanhealthcollege.edu

Abstract

Introduction: Maintaining patient safety is of utmost concern for anesthesia providers. The adductor canal block, a peripheral nerve block identified as a motor-sparing sensory block, may decrease fall risk and associated adverse outcomes seen in total knee arthroplasty patients following femoral nerve block. A large volume of local anesthetic administered in the adductor canal has been questioned due to concern about impaired quadriceps strength if volume extends beyond the adductor canal, causing an unintended femoral nerve block due to spread of local anesthetic into the femoral triangle.

Methods: A review of literature was performed on the following databases: PubMed, CINAHL Complete, and Cochrane Collection.

Results: A 20 ml volume provides approximately 95% of patients with pain control due to complete distal spread within the adductor canal while ensuring statistically insignificant motor blockade compared to femoral nerve block. Doses of 15 ml no longer provided statistically significant strength preservation 24-hours post-block suggesting volumes less than 20 ml should be avoided. Studies indicate that, although 30 ml volumes may cause proximal spread, the effect on quadriceps strength appears significantly less than that of the femoral nerve block.

Conclusions: Volumes of 20 to 30 ml are appropriate for adductor canal blockade.

Keywords: adductor canal, nerve block, total knee arthroplasty, volume, local anesthetic

Introduction

Maintaining patient safety and ensuring best patient outcomes is of utmost concern for anesthesia providers. According to the literature, patients undergoing total knee arthroplasty (TKA) experience significant early post-operative pain.¹ Adequate pain relief attenuates stress responses and long-term chronic pain complications while contributing to improved post-operative outcomes.²

The femoral nerve block (FNB) has traditionally been utilized in management of early post-operative pain, yet research has indicated a small (2%),^{3,4} yet clinically significant increased risk of post-operative falls due to a nearly 50% reduction in quadriceps muscle strength with FNB.⁵ The adductor canal nerve block (ACB), a peripheral nerve block that has been identified as a motor-sparing sensory block, may decrease fall risk and associated adverse outcomes seen in TKA patients with FNB.⁵ While the ACB provides only sensory block, it has also shown to provide pain relief comparable to the FNB when utilized in TKA patients.^{6,7}

A large volume of local anesthetic administered in the adductor canal has been questioned due to concern about impaired quadriceps muscle strength if volume extends beyond the adductor canal, leading to an unintended femoral nerve block caused by spread of local anesthetic into the femoral triangle. An ideal adductor canal volume would provide sufficient spread to all nerves within the adductor canal, including the obturator nerve in the distal part of the canal, while avoiding proximal spread into the femoral triangle, directly blocking the femoral nerve.⁸ Identification of the appropriate volume to utilize in the adductor canal may assist anesthesia providers in improving patient outcomes while minimizing the adverse effects of unintentional motor blockade.

Methods

The method used to obtain data included searches of the following online databases: PubMed, Cumulative Nursing & Allied Health Literature (CINAHL) Complete, and Cochrane Collection. Search results were limited to the English language and publication within the last ten years. The following search terms were utilized alone and in combination: adductor canal, nerve block, total knee arthroplasty, volume, and local anesthetic. Article reference lists were examined for additional articles of interest. Inclusion criteria consisted of systematic reviews, meta-analyses, and randomized controlled trials using human subjects with interventions evaluating the efficacy of ACB in patients undergoing TKA or in healthy volunteers when assessing adductor canal volume. Of the articles identified, eight met all inclusion criteria and were subsequently included in this literature review.

Literature Review

Background of Adductor Canal Block

The adductor canal, also known as Hunters canal,⁹ is a musculoaponeurotic tunnel extending from the apex of the femoral triangle to the adductor hiatus,¹⁰ containing the saphenous nerve, medial femoral cutaneous nerve, posterior branch of the obturator nerve, and vastus medialis nerve.^{9,10} With the exception of the nerve to vastus medialis, each of these nerves is exclusively sensory.⁹

Initially, the ACB was performed at the level of the distal thigh, distal to the quadriceps motor branch in an attempt to ensure blockade of the saphenous nerve.¹¹ It has since been identified by several sources that a mid-femoral block, with blockade proximal to the infra-patellar branching of the saphenous nerve, more reliably ensures

complete block of the knee.¹⁰⁻¹² When performing an ACB, the ultrasound probe is placed mid-thigh, approximately halfway between the superior anterior iliac spine and the patella.¹³ A transverse cross-sectional view of the femoral artery can be identified within the adductor canal, below the Sartorius muscle, just lateral to the artery and the Saphenous nerve; this is where local anesthetic is deposited.¹³

Motor nerve blockade after an ACB can be assessed by several different methods. These include: the validated Timed-Up-and-Go (TUG) test, Maximum Voluntary Isometric Contraction (MVIC) with dynamometer readings, Visual Analog Scale (VAS), and the 30-second chair sit test. The TUG test assesses ambulation ability, providing a numeric value for the number of seconds it takes a subject to get up from an ordinary armchair, walk 3-meters distance, turn, walk back to chair, and sit down. MVIC is used to assesses baseline quadriceps strength while subject is seated with knee flexed approximately 60-degrees and with both feet off the floor. Dynamometer is then used to assess maximum force of contraction that is held for three seconds. A mean value is determined after measuring the maximum force on three separate attempts. MVIC is then assessed at specific times post-block to calculate post-block percentage of pre-block value. The 30-second chair stand test assesses the number of times subject can stand and sit in 30 seconds. Effectiveness of ACB is generally assessed using the VAS, a pain scoring system that provides a numeric value ranging from zero millimeters, no pain, to 100 millimeters, the worst pain imaginable.¹³

Review of the Literature

Much variability exists in the literature regarding volume, dose, and type of local anesthetic used in ACB. In this review, five of the eight studies that met inclusion criteria

assess the effects of 30 ml of local anesthetic within the adductor canal^{7,12-15}, and five studies compare the effects of less than 30 ml of volume within the adductor canal^{6,8,11,14,15}. Two studies compared effects of both 30 ml and less than 30 ml^{14,15}. These techniques were assessed in either healthy volunteers or TKA patients. The study by Jenstrup et al.¹³ was the only study to examine an initial 30 ml block followed by 15 ml post-operative boluses through a continuous catheter, starting six hours post operatively. All other studies utilized a one time, single injection nerve block.

Jenstrup et al.,¹³ in a randomized trial in healthy volunteers, assessed 71 patients scheduled for TKA. The study assessed the effects of 30 ml of 0.75% ropivacaine within the adductor canal, followed by 15 ml of 0.75% Ropivacaine at 6-, 12-, 18-, and 24-hr post-operatively, compared to ACB placebo of 30 ml of isotonic saline, followed by 15 ml of 0.75% ropivacaine at 6-, 12-, 18-, and 24-hr post-operatively. Findings from this study indicated the ACB with an initial 30 ml ropivacaine injection significantly reduced 24-hr morphine consumption and pain score during 45-degree knee flexion, compared to placebo. However, 24-hr pain score at rest was not statistically different. Ambulation ability was assessed by the 24-hr validated TUG test. Results were significantly improved suggesting enhanced early ambulation with 30 ml of ropivacaine within the adductor canal compared to placebo. The failure to objectively assess motor strength of quadriceps with MVIC was a major limitation of this study.

Grevstad et al.⁷ also assessed the effects of ACB compared to FNB in patients scheduled for TKA. Study medication of 30 ml of 0.2% ropivacaine was administered by either FNB or ACB, and ambulation ability was assessed with 2-hr TUG test. Results of 2-hr TUG test in the ACB group took 32 seconds compared to 52 seconds in FNB.

Baseline MVIC was compared to 2-hr MVIC, revealing a 193% increase in ACB group compared to a 15% increase in the FNB group ($P < 0.0001$). Pain was assessed with the VAS 2-hr post-operatively during 45-degree passive knee flexion, resulting in mean VAS score of 20 mm compared to baseline of 66 mm in the ACB group. The 2-hr VAS was 23 mm compared to baseline of 65 mm in the FNB group. Results suggest ACB provides statistically significant increase in quadriceps muscle strength with comparable pain relief during 2-hr knee flexion compared to FNB.⁷ Limitations to the study included the use of a high four-wheeled walker to perform the TUG test, which is usually performed without assistance.

Jaeger et al.⁵ assessed the effect of 30 ml of 0.1% ropivacaine with contralateral placebo of 30 ml of saline in 12 healthy subjects, comparing study medication and placebo in ACB and FNB. On study day one, individuals received either an ACB or FNB with placebo of the opposite block in the contralateral leg. On study day two, 72-hr later, subjects received placebo in contralateral leg with study medication ACB or FNB in the opposite leg. Mobilization was assessed with 1-hr and 6-hr TUG tests. All subjects who received the ACB were able to mobilize post-block, but of the FNB group, only six out of 11 could perform the 1-hr and 6-hr TUG tests.

The 30-second chair stand test time was reduced in FNB compared to ACB ($P=0.007$ and $P=0.02$ at 1-hr and 6-hr, respectively). When assessing quadriceps strength, mean MVIC at 0.5 to 6-hr was 92% of baseline compared to 51% of baseline in FNB. It is important to note the results are significantly different in this study due to being performed in healthy volunteers compared to surgical TKA patients utilized in the Jenstrup et al.¹³ and Grevstad et al.⁷ studies above. Results indicated reduced quadriceps

muscle strength in both ACB and FNB; however, ACB reduction was only 8% compared to 49% in FNB.⁵ Limitations of this study included the lack of breakdown of MVIC at specific hours and time to perform TUG tests, making it difficult to assess results.

Another study by Jaeger et al.¹⁴ assessed 26 healthy volunteers, comparing the effects of 30 ml of 0.1% ropivacaine to 10 ml of 0.1% ropivacaine within the adductor canal. All subjects could be mobilized and perform the 2-hr and 4-hr TUG tests with bilateral ACBs, resulting in minimal change between pre- and post- block scores. As assessed by MVIC, quadriceps strength between the two volumes did not differ at 2-hr, 3-hr, or 4-hr post-block even though two individuals in each group experienced a less than 25% decline in quadriceps strength.

The only difference between volumes was found in the modified 30-second chair stand test at 2-hr post-block, with a mean decrease of three in the 10 ml group and six in the 30 ml group ($P=0.02$). At 4-hr, this was no longer statistically significant. Every subject was able to mobilize without gait aides even with bilateral ACBs. Subjects completed the TUG test with scores similar to pre-block scores, which calls into question the clinical relevance of a 25% reduction in quadriceps strength.

A strength difference between volumes was never more than 10%, which is equivalent to side-to-side differences commonly seen in healthy individuals.¹⁴ Although there was minimal functional difference between 10 ml and 30 ml of volume within the adductor canal, duration of block may be affected. At 6-hr post-block, there was block resolution in seven of 26 limbs for 10 ml ACB, and resolution of only two of 26 limbs for 30 ml ACB. Limitations to this study include the modifications made to these validated

tests allowing performance of modified tests during bilateral adductor canal blocks. These modifications had the potential to affect study outcomes.

Grevstad et al.¹⁵ studied 20 health volunteers, assessing the effects of five separate nerve block injections over three days, with a one to two day interval between injections. Study medication within the ACB included 10, 20, and 30 ml of 1% lidocaine, 20 ml of saline (placebo), and FNB with 20 ml of 1% lidocaine. MVIC was used to assess quadriceps muscle strength. No statistically significant difference in quadriceps muscle strength was noted between the 10 ml (95% of baseline), 20 ml (99% of baseline), and 30 ml (92% of baseline) compared to the significant impairment in the FNB (18% of baseline).

Grevstad et al.¹⁵ also assessed maximum voluntary electromyography (EMG) activity from the vastus medialis, which was assessed over a five-second period with EMG electrodes placed on the vastus medialis muscle.¹⁵ The nerve to the vastus medialis has been identified as the only nerve within the adductor canal that provides sensory and motor supply.^{9,15} Mean value was used to calculate post-block percentage of pre-block value.¹⁵ The decline in EMG seen after 20 ml ACB and 30 ml ACB was similar to the decline seen with the FNB, indicating volumes of both 20 and 30 ml resulted in vastus medialis EMG decline comparable to that of FNB. Statistically significant EMG response in the vastus medialis was only seen in 10 ml ACB volume compared to all other volumes, indicating 10 ml volume had minimal effect on vastus medialis. Based on EMG response over vastus medialis, only 35% of subjects had affected vastus medialis after 10 ml ACB, whereas 84% of subjects were affected with 20 ml ACB, and 100% were affected with 30 ml ACB.

Study results indicate a positive correlation exists between local anesthetic volume within the adductor canal and effect on vastus medialis muscle even though strength reduction was shown to be insignificant on functional outcome as measured by MVIC. Of significance to this study, was evidence that only an 8% reduction in quadriceps muscle strength exists following an ACB with 30 ml of 1% Lidocaine.¹⁵

Kim et al.⁶ studied 93 subjects receiving TKA, assessing the effect of 15 ml of 0.5% bupivacaine with 5 mcg/ml of epinephrine for ACB to 30 ml of 0.25% bupivacaine with 5 mcg/ml of epinephrine for FNB. Quadriceps muscle strength was assessed with handheld dynamometer pre-operatively and at 6 to 8-, 24-, and 48-hrs post-operatively. Mean strength during knee extension was significantly higher for ACB versus FNB at 6 to 8-hour post-operatively ($P < 0.0001$). Mean strength at 24- and 48-hr was no longer statistically significant, indicating strength preservation for 15 ml ACB with 0.5% bupivacaine with 5mcg/ml of epinephrine is no longer significant 24-hr post-block.

Kwofie et al.¹¹ assessed 15 ml of 3% Chloroprocaine in ACB versus FNB in 16 healthy volunteers. MVIC during 45-degree knee extension was assessed at 30- and 60- minutes post-block. MVIC for ACB was preserved at 95.1% and 98.8% of baseline, respectively. This was statistically significant ($P < 0.0001$) compared to FNB, which was 11.1% and 41.2%, respectively. Although no studies directly compare the MVIC of 15 ml to 30 ml within the adductor canal, the MVIC of 15 ml was only slightly better than that of the 30 ml volume (92% at 0.5 to 6-hr) seen by Jaeger et al.⁵ who studied ACB with 0.1% ropivacaine and 92% seen by Grevsted et al.¹⁵ who studied ACB with 30 ml of 1% lidocaine within the adductor canal.

Jaeger et al.⁸ performed an assessment on 40 healthy volunteers to determine the minimal effective volume of local anesthetic needed to fill the adductor canal distally in at least 95% of volunteers (ED95), while avoiding proximal spread. MRI imaging was performed to assess spread within the adductor canal. Based on this study, the volume that provided distal spread without proximal spread was 10 ml. The volume closest to ED95 was 20 ml. Results suggest a volume of 20 ml is needed to ensure complete distal spread even though proximal spread occurs.⁸

Although lower mean quadriceps strength was observed in most subjects with proximal spread to the femoral triangle, volumes of 10, 15, and 20 ml were not statistically different as assessed by 1-hr MVIC testing.⁸ Twelve of the subjects with proximal spread to the femoral triangle displayed no statistically significant decrease in quadriceps strength with a median MVIC of 96% at 1-hr.⁸ This was also comparable to the study by Kwofie et al.,¹¹ with MVIC of 95.1% at 30-minutes and 98.8% at 60-minutes; both studies were performed in healthy volunteers.

Conclusions

Evidence suggests the adductor canal block is an alternative peripheral nerve block that may be utilized when attempting to minimize quadriceps motor weakness associated with femoral nerve block. The adductor canal block is comparable to femoral nerve block in postoperative pain control and opioid consumption.^{6,7,13} The goal of the adductor canal block is to provide distal spread of local anesthetic within the adductor canal while avoiding proximal spread to the femoral triangle.^{8,14}

Based on the MVIC results of several studies within this literature review^{5,7,14,15} and the volume finding study by Jaeger et al.,⁸ a volume of 20 ml will ideally provide

95% of patients with pain control due to complete distal spread within the adductor canal while ensuring statistically insignificant motor blockade when compared to femoral nerve block. Doses of 15 ml no longer provided statistically significant pain control preservation 24-hours post-block suggesting volumes less than 20 ml should be avoided.

Although 30 ml volumes cause proximal spread of local anesthetic affecting the nerve to vastus medialis, the only sensory-motor nerve within the adductor canal, the weakness does not appear to have a statistically significant effect on functional outcomes or ambulation ability when compared with 20 ml ACB volumes.^{8,14,15} Studies also indicate that, although 30 ml volumes may cause proximal spread, the effect on quadriceps strength appears to be significantly less than the femoral nerve block,¹⁵ suggesting volumes of 20 to 30 ml are appropriate for adductor canal blockade.

References

1. Fischer HB, Simanski CJ, Sharp C, et al. A procedure-specific systematic review and consensus recommendations for postoperative analgesia following total knee arthroplasty. *Anaesthesia*. 2008;63(10):1105-1123.
2. Kehlet H, Jensen TS, Woolf CJ. Persistent postsurgical pain: Risk factors and prevention. *Lancet*. 2006;367 North American Edition(9522):1618-1625.
3. Atkinson HD, Hamid I, Gupte CM, et al. Postoperative fall after the use of the 3-in-1 femoral nerve block for knee surgery: A report of four cases. *J Orthop Surgery* (10225536). 2008;16(3):381-384.

4. Kandasami M, Kinninmonth AW, Sarungi M, Baines J, Scott NB. Femoral nerve block for total knee replacement - A word of caution. *Knee*. 2009;16(2):98-100. doi: 10.1016/j.knee.2008.10.007.
5. Jæger P, Nielsen ZJ, Henningsen MH, Hilsted KL, Mathiesen O, Dahl JB. Adductor canal block versus femoral nerve block and quadriceps strength: A randomized, double-blind, placebo-controlled, crossover study in healthy volunteers. *Anesthesiology*. 2013;118(2):409-415. doi: 10.1097/ALN.0b013e318279fa0b.
6. Kim DH, Lin Y, Goytizolo EA, et al. Adductor canal block versus femoral nerve block for total knee arthroplasty: A prospective, randomized, controlled trial. *Anesthesiology*. 2014;120(3):540-550. doi: 10.1097/ALN.000000000000119.
7. Grevstad U, Mathiesen O, Valentiner LS, Jaeger P, Hilsted KL, Dahl JB. Effect of adductor canal block versus femoral nerve block on quadriceps strength, mobilization, and pain after total knee arthroplasty: A randomized, blinded study. *Regional Anesth Pain Med*. 2015;40(1):3-10. doi: 10.1097/AAP.000000000000169.
8. Jæger P, Jenstrup MT, Lund J, et al. Optimal volume of local anaesthetic for adductor canal block: Using the continual reassessment method to estimate ED95. *Br J Anaesth*. 2015;115(6):920-926. doi: 10.1093/bja/aev362.
9. Lund J, Jenstrup MT, Jaeger P, Sørensen AM, Dahl JB. Continuous adductor-canal-blockade for adjuvant post-operative analgesia after major knee surgery: Preliminary results. *Acta Anaesthesiol Scand*. 2011;55(1):14-19. doi: 10.1111/j.1399-6576.2010.02333.x.

10. Vora MU, Nicholas TA, Kassel CA, Grant SA. Adductor canal block for knee surgical procedures: Review article. *J Clin Anesth*. 2016;35:295-303. doi: S0952-8180(16)30693-6 [pii].
11. Kwofie MK, Shastri UD, Gadsden JC, et al. The effects of ultrasound-guided adductor canal block versus femoral nerve block on quadriceps strength and fall risk: A blinded, randomized trial of volunteers. *Regional Anesth Pain Med*. 2013;38(4):321-325. doi: 10.1097/AAP.0b013e318295df80.
12. Jæger P, Zaric D, Fomsgaard JS, et al. Adductor canal block versus femoral nerve block for analgesia after total knee arthroplasty: A randomized, double-blind study. *Regional Anesth Pain Med*. 2013;38(6):526-532. doi: 10.1097/AAP.0000000000000015.
13. Jenstrup MT, Jaeger P, Lund J, et al. Effects of adductor-canal-blockade on pain and ambulation after total knee arthroplasty: A randomized study. *Acta Anaesthesiol Scand*. 2012;56(3):357-364. doi: 10.1111/j.1399-6576.2011.02621.x.
14. Jæger P, Koscielniak-Nielsen Z, Hilsted KL, Fabritius ML, Dahl JB. Adductor canal block with 10 mL versus 30 mL local anesthetics and quadriceps strength: A paired, blinded, randomized study in healthy volunteers. *Regional Anesth Pain Med*. 2015;40(5):553-558. doi: 10.1097/AAP.0000000000000298.
15. Grevstad U, Jaeger P, Sorensen JK, et al. The effect of local anesthetic volume within the adductor canal on quadriceps femoris function evaluated by electromyography: A randomized, observer- and subject-blinded, placebo-controlled study in volunteers. *Anesth Analg*. 2016;123(2):493-500. doi: 10.1213/ANE.0000000000001310 [doi].

Table 1

Evidence Source	Sample/evidence level	Supplemental Anesthesia technique	Intervention/comparison	Findings
Jenstrup et al, ¹³ 2012	N= 71 Prospective, parallel, double-blind, placebo-controlled RCT Age 50-85 ASA 1, 2, 3 BMI 18-35 kg/m ² Scheduled for TKA	Spinal anesthesia (2 ml 0.5% hyperbaric bupivacaine)	ACB with 0.75% ropivacaine (30 ml of study med injected) followed by additional 15 ml of 0.75% Ropivacaine at 6, 12, 18 & 24 h post-op vs. ACB with placebo (isotonic saline 30 ml injected) followed by 15 ml isotonic saline at 6, 12, 18 & 24-h post-op	Total morphine consumption from 0-24 h post-op was significantly reduced with ropivacaine, 40 mg +/- 21 vs. 56 +/- 25 mg (P= 0.006). Control group performed 24-h TUG test faster than placebo (36+/- 17 vs. 50+/- 29 seconds, respectively (P =0.03). Pain scores lower during 45-degree knee flexion with Ropivacaine group (P= 0.01).
Kim et al, ⁶ 2014	N= 93 Prospective, double-blind, RCT Age 18-90 ASA 1, 2, 3 Scheduled for elective unilateral TKA	CSE (2.5 ml 0.5% bupivacaine + epidural PCA 10 mcg/mL hydromorphone & 0.06% bupivacaine)	USG ACB with 15 ml 0.5% bupivacaine & 5 mcg/ml epinephrine vs. USG FNB with 30 ml 0.25% bupivacaine with 5mcg/ml epinephrine	Outcomes were non-inferior (ACB was not weaker than FNB nor higher pain scores or increased opioid use)
Kwofie et al, ¹¹ 2013	N= 16 Randomized, blinded trial of volunteers ASA 1 or 2	None	USG ACB 15 ml of 3% Chloroprocaine vs. USG FNB 15 ml 3% Chloroprocaine	MVIC utilized to assess knee extension, which was preserved in ACB at 95.1% +/- 17.1% at 30-min vs.

	BMI < 30 kg/m ² Healthy male volunteers receiving ACB in one leg with FNB in contralateral leg			FNB 11.1% +/- 14.1% and 98.8% +/- 15.5% at 60-min vs. FNB 11.4% +/- 14% and 41.2% +/- 34.3%. FNB significantly decreased c/t ACB (P< 0.0001). Low volume LA (15 ml) in the adductor canal provides significantly greater motor sparing compared to FNB at both 30- and 60- minutes post-block.
Jaeger et al, ⁸ 2015	N= 40 Prospective, blinded dose-finding study Age 18-30 years ASA 1 BMI 18-25 kg/m ² Healthy young men	None	USG ACB with 5 ml of 1% lidocaine vs. USG ACB with 10 ml of 1% lidocaine vs. USG ACB with 15 ml of 1% lidocaine vs. USG ACB with 20 ml of 1% lidocaine vs. USG ACB with 25 ml of 1% lidocaine vs. USG ACB of 30ml of 1% lidocaine (25- & 30-ml volumes, not tested)	Dose with the greatest distal spread without proximal spread was the 10 ml. Dose closest to ED95, needed to fill the adductor canal distally was 20 ml (Indicating volumes > 20 ml are not required for distal spread in ACB).
Grevstad et al, ⁷ 2015	N= 50 Randomized, single-center, blinded, placebo-controlled trial Age 30-85 ASA 1,2,3	Spinal anesthesia: 10-15 mg bupivacaine 0.5% Pre-op meds: 400 mg oral celecoxib,	USG ACB 30 ml 0.2% ropivacaine & 30 ml saline USG FNB vs. USG FNB 30 ml 0.2% ropivacaine & 30 ml saline USG ACB.	MVIC was significantly higher 2-h post block in the ACB group 193% compared to 16% in the FNB group (P<0.0001).

	BMI 18-40 kg/m ² Scheduled for elective unilateral TKA	acetaminophen 1 g, gabapentin 600mg		T120 TUG test: 32 seconds c/t 52 s in FNB. (2 patients (8%) in ACB and 2 (8%) in FNB were unable to perform baseline d/t pain). At T120, all patients in ACB group could perform tests but seven (28%) in the FNB could not perform the test). No significant difference was found in pain between the two groups at rest or during tests.
Jaeger et al, ⁵ 2013	N= 12 Prospective, double-blind, placebo-controlled RCT Age 18-30 ASA 1 BMI 18-25 kg/m ² Healthy young male volunteers	None	All subjects received both ACB and FNB during 2-days of study (72 hours apart). Day 1: ACB with <u>30 ml of 0.1% ropivacaine</u> and FNB with 30 ml of isotonic saline or FNB with 30 ml of 0.1% ropivacaine and ACB 30 ml isotonic saline. Day 2: Received reverse of what was received on day 1.	Quad strength mean reduction from baseline was 8% with ACB compared to 49% with FNB. (ACB with 30 ml of 0.1% ropivacaine still have an 8% reduction in quad strength). Mean quad ACB MVIC was 92% of baseline compared with 51% in FNB.

Jaeger et al, ¹⁴ 2015	N= 26 Paired, blinded, RCT Age 18-30 ASA 1 BMI 18-25 kg/m ² Healthy male volunteers	None	Bilateral USG ACB with <u>10 ml of 0.1% ropivacaine</u> vs. USG ACB with <u>30 ml of 0.1 % ropivacaine</u>	Quadriceps strength between the two volumes did not differ significantly at any predefined time points (2, 3, or 4 hours post-block). The only difference between volumes was found in the modified 30-second chair stand test at 2-h post-block.
Grevstad et al, ¹⁵ 2016	N= 20 Randomized, observer- and subject- blinded, placebo-controlled study Age > 18 ASA 1 BMI 18-30 kg/m ² Healthy male volunteers	None	Subjects received 5-single-injection nerve blocks over 3 separate days with 1-2 day interval between injections (ACB with <u>10 ml, 20 ml, 30 ml of 1% lidocaine</u>) and FNB with 20 ml of 1% lidocaine, and placebo <u>ACB with 20 ml of saline</u> .	A small decline (8%) in quad muscle strength was found after an ACB with 30 ml of LA. No statistically significant differences in quad femoris muscle strength (via MVIC) were noted between the 10 ml (95%), 20 ml (99%) 30 ml (92%), and placebo compared to the FNB, which had a significant impairment of quad strength (18% baseline).

Table. Matrix of Randomized Controlled Trials Reviewed.

CSE: combined spinal epidural anesthetic, USG: ultrasound guided, ACB: adductor canal block, FNB: femoral nerve block