Original Article

ULTRASOUND GUIDED FEMORAL VS ADDUCTOR CANAL BLOCK FOR POST OPERATIVE ANALGESIA AND EARLY AMBULATION AFTER KNEE SURGERY

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Abstract

Background: In recent times, Adductor Canal Block is considered a valiant replacement to Femoral Nerve Block after knee surgeries, owing to the fact that there is no Motor Sparing in Adductor Canal Block and the analgesic effects post operatively are at par with that of the femoral nerve block. In this study, we put these 2 widely used blocks to test by giving a standard dose of local anaesthetics to patients undergoing all knee surgeries, dividing them randomly into 2 groups and giving one block per group and observing the motor function of quadriceps, and post operative analgesia in both the groups.

Materials and methods: This randomized controlled trial was conducted on 40 patients at tertiary care center for 18 months. They were divided into 2 groups consisting of 20 patients each.
Group 1 received ultrasound guided Femoral nerve block with 20 ml of 0.25% of Bupivacaine with 8 mg Dexamethasone.
Group 2 received ultrasound guided Adductor Canal block with 20 ml of 0.25% of Bupivacaine with 8 mg Dexamethasone.
All vitals and The Numerical Rating Scale for pain along with Pressure Biofeedback of Bilateral quadriceps muscle for strength (in mmHg) were recorded at rest and at every 2hrs for first 12 postoperative hours and every 4hrs for next 12 hours.

Results: Mean post-operative quadriceps pressure rate in adductor canal block receiving patient was higher than femoral block receiving patient 30 min afterwards and difference between them was statistically significant ($p < 0.05$). Mean post-operative pain score in adductor canal block receiving patient was lower than femoral block receiving patient, 8 hours onwards after surgery and difference between them was statistically significant ($p < 0.05$).

Conclusion: Adductor Canal Block provided a better postoperative analgesia comparable to Femoral Nerve Block. Adductor canal block is superior in providing early ambulation and early return of quadriceps motor function as compared with femoral nerve block. Thus, the ACB should speed mobilisation and aid rehabilitation, minimising immobilization-related problems such deep vein thrombosis and pulmonary emboli, decreasing hospital stays, and reducing falls during ambulation along with significant decrease in rate of Fall during ambulation.

Keywords: Bupivacaine, Dexamethasone, Femoral Nerve Block, Adductor Canal Block, Knee Surgery.

Introduction

Due Knee surgery is often used for the treatment of different conditions such as Meniscectomy, Meniscus Repair, Meniscus Transplant, Plica Removal, Lateral Release, Microfracture, ACL Reconstruction, Tendon Repair, Knee Replacements etc. which are some of the Common Knee surgeries performed. These surgeries are followed by moderate to severe postoperative pain that affects the normal recovery process, early ambulation and extended duration of hospital stay, causes patient dissatisfaction and a negative perception of hospital performance leading to increase in the health care utilization costs. Additionally acute and severe pain in the post operative period can also cause chronic pain after surgery. Unrelieved postoperative pain may lead to clinical and psychological changes that lower one's quality of life. [2] Thus, optimal pain relief is essential for functional recovery after knee surgeries.

Following knee surgery, achieving adequate analgesia while maintaining motor function became the main objective. Several painkillers operating at diverse places in the nervous system and through varied mechanisms are combined to provide multimodal analgesia.[3] Several Local analgesic procedures, including femoral nerve block, fascia iliaca, three in one block were employed to reduce pain during and after knee surgery (FNB). The postoperative pain response is influenced by the type and length of the surgical procedure as well as the patient's age. As a result, the anesthesiologist may choose the best analgesic regimen for every patient, both during and after surgery. [1]

Opioids have long been a mainstay in the post-op pain management of knee surgery. However, opioids' potentially harmful side effects such nausea, respiratory depression, and retention of urine limit their utilization in routine clinical practice. In recent years, procedures for localized analgesia have become increasingly common in the post-operative period. Ultrasound guided peripheral nerve blockade techniques have become the gold standard due to their increased efficacy, ease of performance, and safety.

An effective nerve block decreases opioid consumption and side effects, preserves motor power, and speeds mobilization. Motor strength preservation with proper analgesics is the ideal postoperative aim for orthopaedic surgeries to speed recovery, physical therapy, and hospital stays.

FNB reduces pain and hospital stay better than epidural or intravenous patient-controlled analgesia (PCA). [1-6] FNB-induced motor blockage increases fall risk by 2%. [7,8] FNB always weakens muscles and reduces pain.

In recent years, adductor canal blockade (ACB) has helped knee surgery patients manage postoperative pain. [9,11] The adductor canal may carry nerves other than the saphenous nerve, according to anatomical study. Medial retinacular, vastus medialis, medial femoral cutaneous, and articular branches of the obturator nerve are these nerves. [10–12] The sensory modifications affect the saphenous nerve-supplied regions and the medial and anterior knee, from the superior pole of the patella to the proximal tibia.[13] Ultrasonography makes the mid-thigh adductor canal block (ACB) a common and effective site of injection. [9,10] However, placebo-controlled trials [15-17] have demonstrated that the ACB's analgesic effect is equivalent to FNB's, suggesting that the ACB is as effective as FNB.

The aim of this study is to discuss the current two regional blocks, Femoral Nerve Block and Adductor Canal Block, available for post-operative analgesia and to determine early ambulation for knee surgeries such as total knee replacement, partial knee replacement, patellar surgeries, ligament repairs of knee etc, with the help of ultrasound and to use Numerical Rating Scale (NRS) for assessing pain and to use Pressure Biofeedback for measuring Quadriceps strength post operatively to compare, which block is superior in providing the same.

Methodology

A prospective, randomized, comparative, study was conducted after approval of institutional ethical committee. The study was conducted in the department of anesthesiology and critical care of Dr. D.Y. Patil Medical College, hospital and research Centre, Pimpri, Pune, India. The study was conducted for 18 months.

Forty patients of age of between 18 to 60 years during the study period with ASA I and II posted for elective orthopaedic knee surgery under spinal anesthesia and are hemodynamic stable are included in the study. Patients with previous known allergy to study drugs were excluded. We also excluded patients with major neurological, cardiac, respiratory, metabolic, renal, hepatic disease or with coagulation abnormalities. Patients informed of study objectives. Before participating in the trial, patients gave written agreement, which included all study material. 40 patients aged between 18-60 years posted for knee surgeries, were selected through a randomized process using envelop method into any of the two treatment groups. Based on the allocated treatment, patients received either ACB or FNB.

Group I - Femoral Nerve Block with 20 ml of 0.25% Bupivacaine plus Dexamethasone 8mg: 20 patients

Group II- Adductor Canal Block with 20ml of 0.25% Bupivacaine plus Dexamethasone 8 mg: 20 patients.

The day prior to surgery, a pre-anesthetic visit with evaluation of history and complaints were done. General and systemic cardiovascular, pulmonary, and central nervous system examinations were done. All routine investigations were noted. Detailed explanation about post operative pain, ambulation, its relief were explained to patient and relatives and NRS for pain assessment and Pressure Biofeedback for quadriceps strength in bilateral Lower Limb (in mmHg) were performed with patient and relatives. Patients were nil by mouth from midnight prior to surgery.

Preoperative pulse, non-invasive blood pressure, ECG, oxygen saturation, Pressure Biofeedback of quadriceps and NRS were noted in the proforma sheet. Peripheral venous access was established and intravenous (IV) fluids was given, preloading the patient with 500 ml of Ringer's lactate and Spinal Anaesthesia was performed prior to surgery with patient in sitting position, under all aseptic precautions, L3 –L4 intervertebral space was palpated, 26G Quincke's Babcock spinal needle was inserted and free flow of CSF obtained. After aspiration, appropriate amount of 0.5% bupivacaine is given as per the need of the patient.

The Femoral Nerve Block or The Adductor Canal Block were performed at the conclusion of the surgery by the anesthesiologist with 20ml of 0.25% Bupivacaine plus Dexamethasone 8mg in both groups of patients.

· The Femoral Nerve Block: - Patient in the supine position, the skin surrounding the femoral crease is disinfected, and the transducer is positioned to detect the femoral artery and nerve. After locating the femoral nerve, a skin wheel containing a local anaesthetic will be created approximately one centimeter from the transducer's lateral border. After the needle has been inserted in-plane in a lateral-to-medial direction, it is advanced towards the direction of the femoral nerve. After the needle tip has been moved, so that it is next to the nerve (either above, below, or laterally), and after careful aspiration, 1–2 mL of local anaesthetic is administered to confirm that the needle has been properly placed. The femoral nerve will be retracted away from the injection site if the injection is performed correctly. When it is absolutely necessary, more needle repositioning and injections were performed. Once the site of injection is confirmed, the remaining drug is given.

· The Adductor Canal Block: - The adductor canal block is usually given proximally, near the mid-thigh. The skin is disinfected, and the transducer is placed anteromedially between the middle and distal thirds of the thigh, or slightly lower. Probe follows femoral artery distally until it passes through the adductor hiatus and becomes popliteal artery. Needle is placed in-plane and moved toward the femoral artery in a lateral-to-medial position. As soon as the needle tip is seen anterior to the artery and after cautious aspiration, 1–2 mL of local anaesthetic is administered to confirm the correct injection location. When it does not appear that the local anaesthetic has distributed around the femoral artery, more needle repositioning and injections may be required. Once the site of injection is confirmed, the remaining drug is injected.

Vitals were checked and entered in the proforma sheet. Side effects like nausea, vomiting, restlessness, headache, pruritus, etc. were noted.

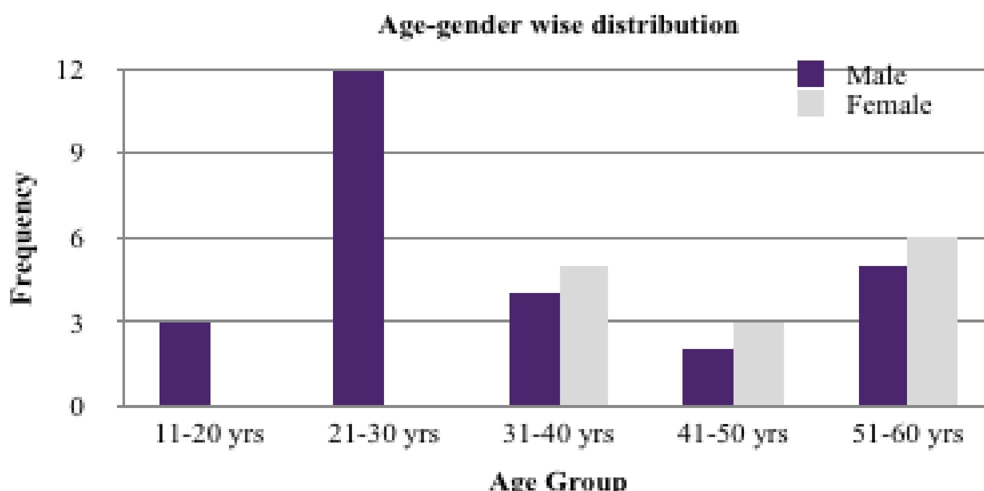
Post operatively the vitals were checked and entered in the proforma.

The Numerical Rating Scale along with Pressure Biofeedback of Bilateral quadriceps muscle were recorded at rest and at every 2hrs for first 12 postoperative hours and every 4hrs for next 12 hours. During the postoperative

phase, 50 mg of Inj Tramadol were to be administered on demand if the patient's pain score is greater than 5. Further rescue analgesics were to be administered if the patient's pain score is 5 or higher. The administration time of the rescue analgesic was recorded and maintained in the chart.

Results

1. *Bar diagram showing age and gender wise distribution of study sample*

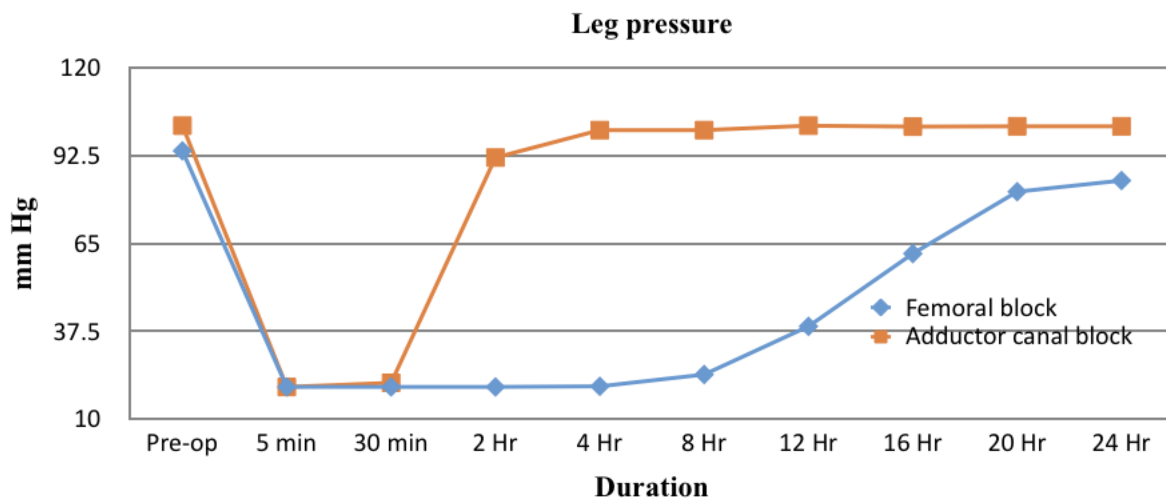


Mean age of 40 study sample was 38.63 years (standard deviation – 13.86 years), with the highest 60 years and lowest 18 years. There was 26 (65%) male and 14 (35%) female in the study while 12 (30) % samples were from 21-30 years age group followed by 11 (27.5%) subjects in 51-60 years age group.

2. *post-operative quadriceps pressure in operated leg among study subjects*

Group Statistics							
Group		N	Mean	Std. Deviation	Std. Error Mean	P value
Pre-operative	Femoral block	20.00	94.00	18.24	4.08	0.165
	Adductor canal block	20.00	101.90	17.06	3.82	
5 min	Femoral block	20.00	20.00	.000a	0.00	0.051
	Adductor canal block	20.00	20.00	.000a	0.00	
30 min	Femoral block	20.00	20.00	0.00	0.00	**0.00**
	Adductor canal block	20.00	21.30	2.77	0.62	
2 Hr	Femoral block	20.00	20.00	0.00	0.00	**0.00**

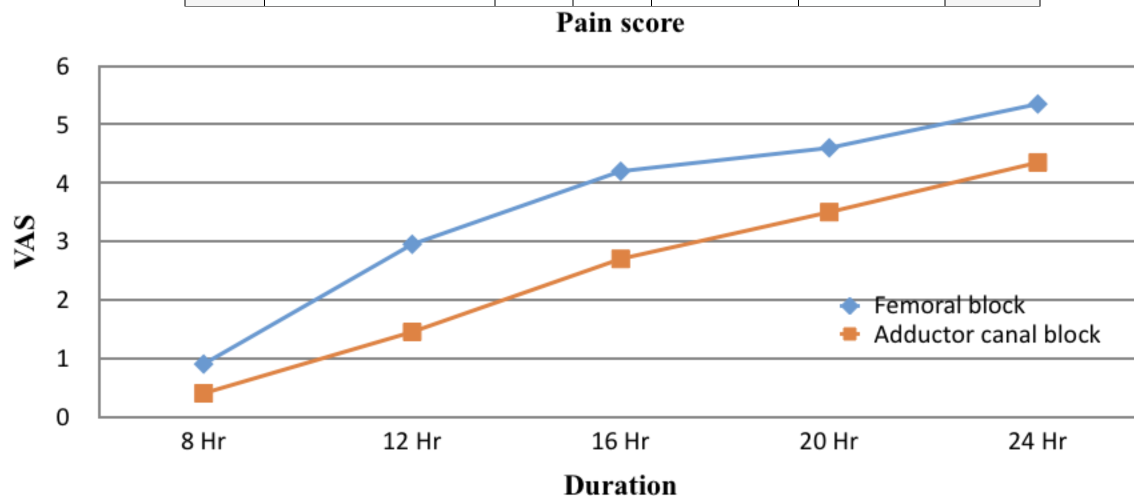
	Adductor canal block	20.00	91.90	14.15	3.16	
4 Hr	Femoral block	20.00	20.20	0.62	0.14	**0.00**
	Adductor canal block	20.00	100.50	17.03	3.81	
8 Hr	Femoral block	20.00	23.90	4.23	0.95	**0.00**
	Adductor canal block	20.00	100.50	17.03	3.81	
12 Hr	Femoral block	20.00	39.00	11.81	2.64	**0.00**
	Adductor canal block	20.00	101.90	17.06	3.82	
16 Hr	Femoral block	20.00	61.80	14.75	3.30	**0.00**
	Adductor canal block	20.00	101.60	17.10	3.82	
20 Hr	Femoral block	20.00	81.20	16.59	3.71	**0.00**
	Adductor canal block	20.00	101.70	16.89	3.78	
24 Hr	Femoral block	20.00	84.70	16.77	3.75	**0.003**
	Adductor canal block	20.00	101.70	17.07	3.82	



Mean post-operative quadriceps pressure rate in adductor canal block receiving patient was higher than femoral block receiving patient 30 min afterwards and difference between them was statistically significant ($p < 0.05$).

3. *Post-operative pain score among study subjects*

Group Statistics						
Group		N	Mean	Std. Deviation	Std. Error Mean	P value
8 Hr	Femoral block	20.00	0.90	0.31	0.07	**0.001**
	Adductor canal block	20.00	0.40	0.50	0.11	
12 Hr	Femoral block	20.00	2.95	0.69	0.15	**0.00**
	Adductor canal block	20.00	1.45	1.28	0.29	
16 Hr	Femoral block	20.00	4.20	0.41	0.09	**0.00**
	Adductor canal block	20.00	2.70	1.56	0.35	
20 Hr	Femoral block	20.00	4.60	0.60	0.13	**0.001**
	Adductor canal block	20.00	3.50	1.19	0.27	
24 Hr	Femoral block	20.00	5.35	0.49	0.11	**0.00**
	Adductor canal block	20.00	4.35	0.88	0.20	



Mean post-operative pain score in adductor canal block receiving patient was lower than femoral block receiving patient, 8 hours onwards after surgery and difference between them was statistically significant ($p < 0.05$)

Discussion

Postoperative analgesia, introduced by Henrik Kehlet in 1997, promotes early mobilisation and rehabilitation to improve recovery and reduce postoperative morbidity. FNB is a widely used analgesic treatment for postoperative pain control in patients having knee and below- knee surgery, however because it induces quadriceps muscular weakness, the patient's risk of falling increases, impeding early rehabilitation. [21-23] Consequently, with FNB, there is always a trade-off between effective pain reduction and muscle strength. In the context of day surgery, the motor-sparing impact of block becomes significant. In ACB, as opposed to FNB, the saphenous branch is blocked, making it primarily a sensory block. [24,25] The adductor canal is the intermuscular space that can be found in the middle of the thigh, between the adductor longus, sartorius, and vastus medialis muscles. It is made up of only two branches of the femoral nerve: the exclusively cutaneous saphenous nerve and the vastus medialis nerve. As a result, ACB is quickly becoming the primary regional anaesthetic for the management of postoperative pain associated with knee arthroplasty in many orthopaedic institutions.

Recent research by Elkassabany et al., 2016 and Bolarinwa et al., 2018 reveal that ACB is superior to FNB for quicker pain alleviation, quadriceps strength, earlier ambulation, and greater average distance walking during physical therapy.

In the current study, we compare the effect of FNB and ACB in post-operative analgesia, their duration, the effect of quadriceps muscles and early ambulation.

A total of 40 patients who were undergoing knee surgery were included in the study in which 20 patients were given Femoral nerve block for postoperative analgesia and 20 patients with Adductor canal block.

DEMOGRAPHIC PROFILE:

The 40 study sample's mean age was 38.63 years (standard deviation – 13.86 years), with the highest 60 years and lowest 18 years. The study included 26 (65%) men and 14 (35%) women, 12 (30%) of whom were 21-30 years old and 11 (27.5%) were 51-60 years old.

Among 40 patients, ACL repair & patellar fracture were most common surgeries performed among study subjects (10 subject each) followed by surgery for PCL repair in 6 subjects.

POST-OPERATIVE QUADRICEPS PRESSURE:

Post-operative quadriceps pressures were measured in both the groups at 5 minutes, 30 minutes, then at 2 hour, 4 hour, 8 hour, 12 hour, 16 hour, 20 hour & 24 hour. Mean post- operative quadriceps pressure rate in adductor canal block receiving patient was higher than femoral block receiving patient 30 min afterwards and difference between them was statistically significant ($p < 0.05$).

Our study results were in line with the previous conducted studies:

In 2018, **Ghodki et al.,** (18) revealed that the Straight leg test in patients with ACB had less quadriceps muscular weakness than those with FNB. The disparity was really significant. Assessment of quadriceps muscular strength with the timed up and go test on POD1 revealed that 26 patients in the ACB group were able to perform the test and none were at risk of falling, but only 18 patients in the FNB group were able to execute the test and 6 were at risk of falling. This change was statistically noteworthy (P 0.01). On POD2, all patients in both groups successfully completed the test without the possibility of falling.

In 2017, **Seo et al**. (25) used manual muscle testing (MMT) to directly quantify quadriceps strength. On postoperative days 1, 2, and 3, ACB patients had considerably stronger strength than FNB patients.

In 2017, **Kuang M-j et al.** (13) found that the ACB group had considerably better quadriceps muscular strength measured by maximum voluntary isometric contraction (MVIC) using a handheld dynamometer at 24 hours than the FNB 291 group (MD=75.65, 95%CI: [28.49, 122.81], P=0.002).

ACB maintained quadriceps muscular strength better than FNB in 2016, according to Li et al. (14) In 2016, **Xing-qi Zhao et al.** (26) found that ACB patients had equivalent or better quadriceps strength and mobilisation than FNB patients at 6–8, 24, or 48 h postoperatively.

In 2013, **Jaeger et al.** (8) discovered that the ACB improved early ambulation in comparison to FNB and preserved quadriceps muscular strength in a trial involving 11 healthy participants. According to that study, following ACB but 49% after FNB, the quadriceps muscular strength (measured as the mean quadriceps maximum involuntary isometric contraction, or MVIC) declined from baseline by 8%. (13)

ACB did not affect quadriceps strength or balance in 2013, according to **Kwofie et al.** (9) Quadriceps strength and balance decreased after FNB (95.1% ±17.1% vs 11.1% ±14.0%; $P < 0.0001$) and baseline (97.0% ±10.8% vs 91.8% ±9.6%; $P = 0.17$). A 15 mL bolus of 3% chloroprocaine reduced quadriceps isometric contraction by 11% at 60 min after ACB block in one leg and 95% with FNB in the contralateral leg in healthy volunteers.

In 2011, **Charous et al.** (27) showed an 80% loss in quadriceps muscular strength with FNB with basal infusion or repeated hourly bolus doses in healthy volunteers. A perineural catheter injected 30 ml of ropivacaine (0.1%) over 6 h. (14)

POST-OPERTAIVE PAIN SCORE:

The severity of pain was evaluated using the NRS scoring technique in the postoperative phase. The NRS score was recorded (0=no pain, 10=worst possible pain) till patient requested for rescue analgesia. Mean post-operative pain score in adductor canal block receiving patient was lower than femoral block receiving patient, 8 hours onwards after surgery and difference between them was statistically significant ($p < 0.05$)

In contrary to our study, many studies showed no significant indifferences between the two groups in pain score.

In 2019, **Kukreja et al.,** (28) conducted a study of Comparison of Adductor Canal Block and Femoral Nerve Block After Primary Total Knee Arthroplasty. In 2018, **Ghodki et al.,** conducted study on both blocks for arthroscopic Anterior Cruciate ligament Reconstruction. Both the studies demonstrated no significant difference VAS /NRS pain scores among patients undergoing AC block in comparison to patients undergoing FN block. However, unlike the current study, both the studies involved a dose 20 mL 0.5% ropivacaine and **Ghodki et al.,** (18) was limited to ACLR.

In 2014**, Chisholm et al** (29) published the results of a study they did in 2014 that compared the effectiveness of both blocks in providing adequate pain control after anterior cruciate ligament reconstruction. They reported that there was no significant difference between the two groups in terms of pain score or the use of opioids within the first twenty-four hours after surgery. In contrast to our study, the participants in this one was limited to patients who had undergone anterior cruciate ligament reconstruction.

According to research conducted by **Kim et al** (19) in 2014, when comparing adductor canal block and femoral nerve block for Total Knee Arthroplasty(TKA), no statistically significant difference was seen in pain levels at 24 and 48 hours post-anesthesia. Our research, however, is not limited to TKA alone.

Memtsoudis et al. (30) compared adductor canal and femoral nerve blocks for analgesia following total knee replacement in 2014. Patients reported similar overall pain levels at rest and during exercise. This study only included total knee replacement; however, the present study covers any knee surgery.

In 2012, **Jenstrup et al**., (11) found that the ACB reduced pain and ambulation after TKA more than placebo. The study used 30 ml of 0.75% ropivacaine and did not measure strength. Proximal distribution of this massive local anaesthetic could weaken quadriceps. ACB and FNB were directly compared using 20 ml of 0.25% bupivacaine.

POST-OPERATIVE FALLS:

In the current study, no falls were noted. However, it has to be noted that in our institute, post operative ambulation after knee surgeries are done on Post Operative day 2. It is presumed that improved strength facilitates progress through physical therapy, and that the relative preservation of motor strength by ACB correlated with improved ability to ambulate.

No patients in the ACB group were noted to be weak on POD 1. However, given the small sample size of this study (n = 40), it would be difficult to assess fall risk reduction.

In 2017, **Thacher et al.** (31) retrospectively compared adductor canal block to femoral nerve block in total knee arthroplasty. The FNB group had one fall, while the ACB group had none. In 2020, **Armanious et al.** (20) found that the ACB group had less falls (2 patients (5%) than the FNB group (9 patients (22.5%)). (p = 0.023). Our results differ from theirs since we ambulate POD 2 and have a different demographic and more men (65% and 35%).

Conclusion

1. Adductor Canal Block provided a better postoperative analgesia comparable to Femoral Nerve Block.

2. Adductor canal block is superior in providing early ambulation and early return of quadriceps motor function as compared with femoral nerve block.

3. Thus, the ACB should speed mobilisation and aid rehabilitation, minimising immobilization-related problems such deep vein thrombosis and pulmonary emboli, decreasing hospital stays, and reducing falls during ambulation along with significant decrease in rate of Fall during ambulation.

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