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ORIGINAL RESEARCH GENERAL ANESTHESIA

Impact of adductor canal block vs. femoral nerve block for postoperative analgesia in total knee arthroplasty

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ABSTRACT

Background: Patients undergoing Total Knee Arthroplasty (TKA) benefit from peripheral nerve blocks as a part of multi-modal analgesia. Femoral Nerve Block (FNB) and Adductor Nerve Block (ACB) are very common blocks used in postoperative analgesia. We compared the impact of the two nerve blocks on the postoperative analgesia in total knee arthroplasty under spinal anesthesia.

Method: This prospective double blind randomized controlled trial evaluated 60 patients, ASA PS I and II, randomized either to receive a single shot ACB (Group A, n = 30) or FNB (Group B, n = 30) for postoperative analgesia following TKA in reducing postoperative morphine consumption. Both groups also received infiltration of the local anesthetic by the operating surgeon. Total morphine consumption during first 24 h postoperatively, and pain scores at rest and on flexion of the knee joint at 6, 12, 18 and 24 h were recorded in both groups.

Results: Mean morphine consumption at 24 h in Group A and B was 3 mg and 2.75 mg respectively. There was no difference statistically (P = 0.994). Mean pain scores at rest and on knee flexion at specified intervals of 6, 12, 18 and 24 h were statistically not different. Time to initial ambulation in Group A and B was 238.3 and 406.6 min (P = 0.015), and it was significantly prolonged in Group B.

Conclusion: The results of this study conclude that adductor nerve block is an effective pain relief technique with comparable opioid sparing effect and with minimal quadriceps weakness and decreased time to early initial ambulation when compared to femoral nerve block, as a part of multimodal analgesia, in knee arthroplasty under spinal anesthesia. It offers good patient satisfaction and early ambulation.

Abbreviations: ACB: Adductor Nerve Block, FNB: Femoral Nerve Block, NRS: Numerical Rating Scale, PACU: Post Anesthesia Care Unit, PCA; Patient Controlled Analgesia, TKA: Total Knee Arthroplasty,

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INTRODUCTION

Total Knee Arthroplasty (TKA) is a common surgery done in the elderly and postoperative pain control is very challenging and involves a multidisciplinary approach

including surgeons, anesthesiologists, pain nurses and physiotherapists. Preoperative pain relief, especially in the elderly with multiple co-morbidities involves multimodal analgesia for earlier ambulation and recovery and also to reduce opioid consumption and opioid-related adverse effects.[1] Peripheral nerve blocks with local anesthesia are recommended for Total Hip Arthroplasty (THA) and Total Knee Arthroplasty to minimize perioperative complications which can translate to better clinical outcomes.[2] Quadriceps weakness due to Femoral Nerve Block (FNB) can be one limiting factor in using this technique with patients with a high risk of fall in comparison to Adductor canal Block (ACB).[3]

The primary objective of this study was to compare single shot FNB and ACB in reducing postoperative Patient Controlled Analgesia (PCA) morphine consumption in the first 24 h for pain relief. Other parameters like opioid-related side effects, time for early ambulation and patient satisfaction were also analyzed in this study.

METHODOLOGY

An Institutional Review Board approved study protocol and was implemented at King Hamad University Hospital, Kingdom of Bahrain as a prospective double-blinded randomized control trial. After obtaining written informed consent, using a computer-generated random table, the ASA I and II patients were randomized to receive either a single-shot Adductor block group (Group A) or a single-shot Femoral nerve block group (Group B). The inclusion criteria were patients undergoing primary TKA, age 40–80 years of either sex, the American Society of Anesthesiologists (ASA) Physical status classes I and II. The exclusion criteria were ASA physical status classes > III, history of allergy/contraindications to morphine, local anesthetics, nonsteroidal anti-inflammatory drugs, paracetamol, central neuraxial block and peripheral nerve blocks and patients who are receiving regular opioids.

Intraoperatively, after connecting vital monitors, all patients received spinal anesthesia using a 25G spinal needle in the L3-L4 / L4-L5 interspace with a combination of 2.8 mL of 0.5% hyperbaric bupivacaine along with 25 mcg of fentanyl. As a part of multimodal analgesia, all patients received paracetamol 1 gm every 6th hour, dexamethasone 8 mg single dose, and diclofenac 75 mg infusion. intravenously. Before completion of the surgery, all patients received local infiltration analgesia infiltrated by the operating surgeon with 60 mL solution (10 mL of 0.5% Bupivacaine (25 mgs), 5 mg of morphine (0.5 mL) and 50 mL of normal saline). The surgeon injected entire amount of solution into the posterior capsule. In order to reduce the inter-individual technical bias, 2 dedicated consultant anesthesiologists did FNB and ACB respectively for all the study cases and they were blinded from postoperative follow-up.

Group A patients received ACB under ultrasound (SonoSite®) guidance after skin closure with 25 mL 0.5% bupivacaine at the mid-thigh level at the end of surgery. With the patient in the supine position, a linear transducer probe was placed centrally at the mid-thigh level to identify the femur. The probe was then slid medially to identify the femoral artery which lies in the adductor canal. The adductor canal is an anatomical intermuscular space on the medial side of the thigh. It extends proximally from the apex of the femoral triangle to the adductor hiatus distally. It is bounded anteromedially (roof) by the sartorius, laterally by the vastus medialis and posteriorly by the adductor longus and adductor magnus. In addition to the femoral artery, it contains the femoral vein, saphenous nerve, nerve to vastus medialis, and branches of the obturator nerve. Using a 22-gauge 50 mm needle (Insulated SonoPlex A Pajunk®) in an in-plane approach, the needle was advanced from lateral to medial side to lie just lateral or superficial to the femoral artery beneath the sartorius in the adductor canal. After negative aspiration for blood, normal saline was injected to observe the spread around the nerve. If no nerve was visible, then an injection was made to observe the spread around the femoral artery. After ensuring correct spread, a total of 25 mL of 0.5% bupivacaine was injected with frequent aspiration ensuring that there was no intravascular injection.

In Group B, a FNB was done after skin closure and dressing of the surgical wound. With the patient in the supine position, a high-frequency ultrasound probe was placed in the transverse plane at the midpoint of the inguinal crease to identify femoral vessels. The femoral nerve was identified lateral to the femoral artery as a triangular-shaped opaque structure. After obtaining the optimum image of the nerve, a 22-gauge 50 mm needle was inserted with an in-plane approach until the tip of the needle was in close proximity to the femoral nerve. Direct visualization of needle tip maintained by ultrasound while inserting the needle until the needle reaches close to the femoral nerve. A total of 25 mL 0.5% bupivacaine (125 mgs) was injected around the femoral nerve.

After surgery, the patients were kept in recovery for 1 hour and shifted to the ward for follow-up by an anesthesiologist and a pain nurse, who were blinded to the group the patient belonged to. As a part of multi-modal postoperative analgesia, PCA morphine was prepared at a concentration of 2 mg/mL programmed to a bolus dose of 1 mg, lockout interval of 5 min with a maximum 4 h limit of 30 mg. Postoperative monitoring was assessed on arrival at Post Anesthesia Care Unit (PACU), and in ward up to 24 h of surgery and patient pain score (Numerical

Rating Scale - NRS) at rest and flexion, opioid side effects like nausea, vomiting, sedation, patient time for initial ambulation and patient satisfaction were noted. Supplemental oxygen at a rate of 2 L/min via a nasal cannula for 24 h was also prescribed. The primary endpoint was the amount of morphine required in the first 24 h. Secondary endpoints were VAS scores at rest and flexion, side effects, time for initial ambulation and patient satisfaction.

Table 1: Patient characteristics and demographics

Parameter	Group A (n = 30)	Group B (n = 30)	P-value
Age (y)	64.4 ± 6.295	64.2 ± 5.378	0.895
Gender (Females)	21 (70)	21 (70)	1
ASA I	1 (3.3)	1 (3.3)	1
ASA II	29 (96.7)	29 (96.7)	1
Weight (kg)	89.88 ± 21.42	80.737 ± 13.691	0.054
Height (cm)	160 (151.75−168.5)	155 (150.37−162)	0.239
BMI (kg/m^2)	35 (28.87−40.25)	33.27 (28.8−35.32)	0.133

Data presented as n (%) or mean ± SD or median (Inter quartile range); P < 0.05 considered as significant

Table 2: Morphine consumption in initial 24 h

Morphine Consumption	Group A (n = 30)	Group B (n = 30)	P-value
at 6 h	1 (0−5)	2 (1−5)	0.111
at 12 h	2 (1−5)	2 (1−4)	0.691
at 18 h	2 (0.75−4)	2 (0−4)	0.558
at 24 h	0 (0−2)	0 (0−3)	0.867
Morphine PCA in 24 h	8 (3−12)	8 (2.75−14)	0.994

Data presented as median (Inter quartile range); P < 0.05 considered as significant

Statistical analysis:

The statistical analysis was carried out using SPSS software version 19. Quantitative measurements were summarized in terms of mean (standard deviation) / Median (Inter quartile range) and qualitative variables were expressed as frequency(percentages). The Shapiro-Wilk test was used to assess the normality of the data and to compare the mean differences between the two groups, for the normally distributed data student t-test was used, and for not normally distributed data Mann Whitney U test was done. The chi-square test was used to find the association between the two categorical variables. P = 0.05 was considered as significant.

3. RESULTS

Data analysis showed that the study Groups A and B were comparable on their characteristics like age, gender, ASA grade, weight, height and BMI. PCA Morphine consumption over 24 h in Group A and B were analyzed (Table 1). Mean morphine consumption at 24 h in Group A and B was 3 mg and 2.75 mg (P = 0.994) respectively (Table 2). It was found that the morphine consumption between Groups A and B at 0, 6, 12, 18 and 24 h were not statistically significant. Another variable was pain scores at rest and flexion at specified interval. At rest the mean pain scores were at 0, 6, 12, 18 and 24 h and Pain scores at flexion were at 0, 6, 12, 18 and 24 h, were not statistically different (Table 3). Opioid related adverse effects like nausea, vomiting and patient satisfaction score were also not statistically different (Table 4). Time to initial ambulation between Group A and B were 238.3 and 406.6 min respectively and it was statistically significant with P = 0.015.

4. DISCUSSION

Postoperative pain management in Total Knee Arthroplasty (TKA) is very challenging and involves multimodal analgesia including peripheral nerve blocks, neuraxial and intravenous opioids, paracetamol, non-steroidal anti-inflammatory drugs, and adjuvants like steroids (dexamethasone), anticonvulsants and anti-depressants. Various routes are utilized to enhance analgesia to

improve patient tolerance for early ambulation and further reduce morbidity and mortality. In modern day anesthesia practice, use of peripheral nerve blocks has become popular as an opioid-sparing technique.[4]

Many peripheral nerve blocks have been used in managing postoperative pain after TKA. But the most

Table 3: Visual Analog Scores at rest and flexion

Time after recovery	Pain score at rest			Pain score at flexion		
	Group A (n = 30)	Group B (n = 30)	P-value	Group A (n = 30)	Group B (n = 30)	P-value
0	27 (90)	26 (86.7)	0.95	27 (90)	26 (86.7)	0.95
1	1 (3.3)	1 (3.3)		1 (3.3)	1 (3.3)	
2	1 (3.3)	2 (6.7)		1 (3.3)	2 (6.7)	
3	1 (3.3)	1 (3.3)		1 (3.3)	1 (3.3)	
6 h	0 (0−2)	1 (0−2)	0.343	1 (0−2)	1 (0−3)	0.59
12 h	1 (0−1.25)	1 (0−2)	0.334	1 (1−3)	2 (1−3)	0.494
18 h	1 (0.75−2)	1 (0−2.25)	0.848	2 (1−3)	1 (1−3)	0.403
24 h	1 (0−2)	1 (0−2)	0.792	1.5 (1−3)	1 (0.75−3)	0.659

Data presented as n (%) for categorical variables or Median (IQR)

Table 4: Nausea, vomiting and patient satisfaction

Nausea/vomiting	Group A (n = 30)	Group B (n = 30)	P-value
Yes	1 (3.3)	1 (3.3)	1
at 6 h	1 (3.3)	1 (3.3)	1
at 12 h	1 (3.3)	0 (0)	1
at 18 h	1 (3.3)	0 (0)	1
at 24 h	0 (0)	0 (0)	
Patient satisfaction score	5 (4−5)	5 (4−5)	0.822

Data presented as n (%) and Median (IQR)

popularly practiced blocks include femoral nerve block (FNB), adductor canal block (ACB), lumbar plexus block, fascia iliaca plane block and dual sub sartorial block.[5] Local infiltration analgesia (LIA) provides effective analgesia for the posterior compartment. Although FNB is the best choice for analgesia for TKA, combining FNB or ACB with LIA will consistently provide superior analgesia to both anterior and posterior knee compartments respectively and improve patient satisfaction, morphine consumption and reducing hospital length of stay.[6,7]

In addition to the sensory block, the femoral nerve block is associated mild quadriceps weakness which will impair early ambulation. Whereas, adductor canal block spares quadriceps muscle with reduction of in hospital patient fall, but at the same time comparable analgesia to FNB.[8,9] In our study, the pain scores at rest and during flexion were not statistically different between Groups A and B. It suggests that both femoral and adductor canal block are good choice to provide analgesia for TKA. LIA combined with FNB or ACB provides better posterior compartment analgesia during initial 6-8 h.[10-12]

Early ambulation and rehabilitation are vital in preventing postoperative complications following TKA and to reduce morbidity and mortality. Femoral nerve block-induced quadriceps weakness is an important factor in delaying early ambulation and delays physiotherapy, whereas, adductor canal block spares quadriceps and blocks saphenous nerve and nerve to vastus medialis muscles, hence avoids quadriceps weakness and buckling of knee.[13] Due to motor sparing effect of ACB, it is the preferred block in patients undergoing TKA to aid early ambulation with comparable analgesia to FNB. In our study, Group A patients ambulated earlier than Group B and it was found to be with statistically significant difference in initial ambulation after surgery. Time to initial ambulation was significantly delayed in FNB group attributable to quadriceps weakness. *Fujita et al.* also reported that ACB is associated with less knee buckling, better quadriceps strength and early ambulation in comparison to FNB.[14] It was also reported that 39% vs 11% near falls in FNB vs ACB group, but we did not report falls or near falls in our study.

In our study, the patients were prescribed PCA morphine as a rescue analgesia. Patients were also continued with other components of multi-modal analgesia like paracetamol, NSAIDs and ice bag applications. The PCA morphine usage was not statistically significant between 2 groups and this suggests that both femoral and adductor canal block reduces postoperative opioid usage. *Siddique et al.* also reported that both FNB and ACB augmented with infiltration between popliteal after and capsule of

the knee (iPACK) consumed same number of opioids for analgesia.[15]

According to PROcedure SPEcific Postoperative Pain ManagemenT (PROSPECT) Working Group recommendations, single shot ACB with LIA infiltration for postoperative analgesia following TKA. Further, they recommend against FNB (single shot / continuous) due to quadriceps and delayed initial ambulation.[4] Hence, ACB offers similar analgesic efficacy, opioid use with reduced time to early ambulation in comparison to FNB. This suggest that adductor canal block is a preferred technique of choice with minimal effect on motor function aiding early ambulation after TKA.

5. LIMITATIONS

Limitations of the study is as following. First, this is a single center trial, and patients recruited belonged to one center. Second, patients received single-shot nerve blocks in both groups and this had limited analgesic efficacy than continuous infusion. Third, the motor functions were not assessed objectively and the observation is done by time to initial ambulation supported by physiotherapist. Our results do not apply to revision, bilateral TKAs.

6. CONCLUSION

This study concludes that ACB with LIA is an effective pain relief technique with comparable opioid sparing effect, minimal quadriceps weakness and decreased time to early initial ambulation in comparison to FNB with LIA. As a part of multimodal analgesia, peripheral nerve blocks given as single shot injection as a part of multimodal analgesia is a good analgesic technique with good patient satisfaction and good clinical outcome.

7. Data availability

The numerical data generated during this research is available with the authors.

8. Funding

No industry or institutional funding was availed to complete this research.

9. Conflict of interest

The authors did not disclose any possible conflicts of interest.

10. Authors' contribution

SV: Concept, conduct of study and manuscript preparation and editing

MM, PN, SA: Conduct of study and manuscript preparation

SM: Concept and manuscript editing

PN: Concept, conduct of study and manuscript editing

SA: Concept, conduct of study and manuscript editing

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