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Saphenous nerve block versus femoral nerve block in enhanced recovery after knee replacement surgery under spinal anaesthesia

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Abstract

Background: Inadequate pain management after total knee replacement (TKR) prolongs recovery time and increases the risk of postoperative complications. Peripheral nerve fibres blockade has been used as a mode of analgesia after TKR. Femoral nerve block (FNB) is often used to provide postoperative analgesia after TKR. However, FNB causes quadriceps muscle weakness leading to delayed ambulation, patient discomfort and prolonged hospital stay. Nowadays, saphenous nerve block is a relatively new alternative being superior to FNB for providing pure blockage of sensory nerve fibres with preserving quadriceps muscle strength.

Results: Results of this study showed that leg raising test percentages were significantly higher in group S compared to group F (86.7% versus 43.3% respectively), whereas, time up and go (TUG) test values were significantly lower in group S compared to group F (Mean ±SD values were 22.47 ± 4.93 versus 44.6 ± 4.18 respectively with a *p*-value < 0.0001). Numerical rating score (NRS) for pain scoring was measured at 30 min after admission to PACU, 3, 6, 12 and 24hrs postoperatively showed no significant differences in both groups F & S (1;(0-2), 1;(1-2), 2;(1-2), 2;(1-2), 2;(2-2) versus 1;(0-2), 1;(1-2), 2;(1-3), 2;(1-2), 2;(2-3) respectively with a *p*-value 0.42, 0.1, 0.1, 0.49, 0.67). Also, both groups showed no significant difference in cumulative 1st 24hrs Nalbuphine consumption (Mean ±SD were 15.33 ± 7.3 for F group versus 14.33 ± 6.26 for S group with a *p*-value 0.57).

Conclusions: Despite the excellent analgesic effect of FNB, saphenous nerve block could be a favorable choice as a mode of analgesia after TKR, as it preserves quadriceps motor strength and promotes early mobilization compared to FNB.

Keywords: Total knee replacement (TKR), Femoral nerve block (FNB), Numerical rating score (NRS), Time Up and Go (TUG)

Background

Rapid recovery and ambulation in orthopedic surgeries are being favored following total joint replacements. Good coverage of analgesia along with preserving motor power has become the ideal postoperative target allowing rapid recovery, starting physical therapy shortly after the surgery and sooner discharge from the hospital (Sutton III et al., 2016).

Regarding the type of anaesthesia used to perform knee replacement surgeries, spinal anaesthesia was found to have more beneficial results than general anaesthesia. This is attributed to the physiological sequelae of blocking the sympathetic nerve fibres with minimal bleeding, more limb blood flow and earlier subsiding of pain. All of the previously mentioned, lead to less morbidity caused by thromboembolic and cardiopulmonary reasons, but as an adverse effect,

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decreased ability for early mobilization postoperatively caused by experiencing pain after fading of spinal anaesthesia (Memtsoudis et al., 2014).

A nerve block is optimum when aiming at the sensory nerves while preserving the motor power because it allows sooner mobility and rehabilitation, which is a desired result for patients having knee arthroplasty (Memtsoudis et al., 2018).

On comparing femoral nerve block with epidural or intravenous patient-controlled analgesia, it was found that femoral nerve block delivers better pain management, minimizes patient recovery and allows earlier hospital discharge. On the other hand, it is associated with an increased risk of falls due to minimizing quadriceps muscle power (Johnson et al., 2013).

The adductor canal lies at the level of the mid-thigh where the saphenous nerve is seen easily, enabling carrying out of saphenous nerve block, as it is considered as a relative substitute that delivers solid block for sensory nerve fibres with negligible impact on quadriceps muscle power (Liu et al., 2014).

Methods

The study is randomized, prospective, comparative study conducted from October 2019 to October 2021. Following the approval of the departmental ethical committee and written informed consent of the patients, 60 patients of American Society of Anesthesiologists (ASA) physical status I to II of both sexes, aged between 30 – 70yrs, underwent elective knee replacement surgeries under spinal anesthesia. Patients were allocated by computer generated randomized number into two equal groups of 30 patients each and received one of the following:

- Group F: patients received 15 ml of bupivacaine 0.5%.
- Group S: patients received 15 ml of bupivacaine 0.5%.

Exclusion criteria included patients having major spine deformities, clinically significant coagulopathy, skin infection at the injection site, allergy to local anesthetics, polytrauma patients having lower limb fractures, inability to visualize the femoral or saphenous nerves with ultrasound guidance, pre-existing myopathy or neuropathy on the operating limb, significant cognitive dysfunction and chronic analgesic abuser patients.

The primary outcome of the study is to compare the quadriceps muscle power and ambulation between the two groups in the first 24hrs postoperative. The secondary outcome is measuring postoperative pain score (measured at 30min after PACU admission, 3hrs, 6hrs, 12hrs and 24hrs postoperative) and the total postoperative opioid consumption over 24hrs postoperative.

Study interventions

- All patients were admitted on the day of surgery after fasting for 8 hrs. Intravenous access was established and lactated ringer solution will be infused and the patient received intravenous 0.05mg per kg midazolam as sedation. Monitors for non-invasive blood pressure, heart rate, electrocardiogram (ECG), and pulse oximetry (SpO_2) were used to monitor the perioperative vital parameters of patients. Spinal anesthesia was administered with 3ml of 0.5% heavy bupivacaine.
- After the end of the surgery, patients lied down supine with the ipsilateral limb externally rotated and abducted for performing either the femoral or saphenous nerve block. Blocks were performed by the most experienced doctor using a transportable Fugi M-Turbo ultrasound system with linear transducer using an echogenic needle of 22 G and 4 inches for optimal control and visibility.
- Under aseptic conditions, femoral block was carried out by placing the ultrasound probe on the femoral crease to visualize the femoral nerve & artery. After making sure of negative aspiration, the pre-decided volume of 15mL of 0.5% bupivacaine was injected around the femoral nerve to avoid in-advert intravascular injection. Dispersion of drug solution in tissue planes was observed and confirmed a successful block. A massage for 3 minutes was done to promote an equal drug distribution.
- As for saphenous nerve block, under complete aseptic precautions the ultrasound probe was placed on the medial aspect of the thigh, nearly at the point between the middle and distal third of the thigh. On visualizing the femoral artery, the probe was moved distally following the artery until it passed via the adductor hiatus becoming the popliteal artery. The saphenous nerve block was done by inserting the needle in-plane deep to the sartorius muscle till its tip became just anterior to the femoral artery. The pre-decided volume of 15mL of 0.5% bupivacaine was injected after negative aspiration.
- Patients were observed for complications either related to the nerve blockage e.g: hematomas or related to the bupivacaine injected e.g: hypotension, oxygen desaturation, bradycardia, nausea, vomiting or any other complications.
- Quadriceps muscle strength was assessed after regaining of motor power in the contralateral limb at 24hrs postoperatively by the ability of the patient to raise his leg straightened, simply done by asking the patient to extend the knee joint while fixating the thigh by the examiner. The motor power of

the quadriceps muscle was graded as follows: Grade 0- normal muscle power, Grade I-motor weakness, Grade II-complete motor paralysis (Ghodki et al., 2018).

- Patient's ambulation ability was assessed at the 24th hour postoperatively via time up and go (TUG) test. TUG is the time needed by the patient to get up from a chair, walk a distance of 3 meters and return to the sitting position in the chair. The time was measured in seconds ($\leq$ 10 sec indicates a normal mobility, 11-20 sec indicates good mobility without gait aid and 21- 30 sec stands for difficult mobility and a gait aid is needed. Patients were observed closely and allowed to use a 4-wheel walker as a walking aid during the test, to guard against fall (Chuan et al., 2019).
- Pain at rest in the postoperative period was evaluated after fading of spinal anaesthesia and regaining of sensation in the contralateral limb at (30min after PACU admission, 3hrs, 6hrs, 12hrs and 24hrs) in the first postoperative 24hrs via NRS for pain, where 0 indicated no pain and 10 indicated the worst pain. When NRS was $\geq$3, an injection of nalbuphine 10mg was given intravenously slowly over 10 min as a rescue analgesia.

Statistical analysis

Statistical presentation and analysis of the present study was conducted using the mean, standard Deviation, median, independent-samples *t*-test, Chi-square (X^2) test and Mann-Whitney U test by (SPSS 22.0 for windows).

Level of significance: >0.05 Non significant <0.05* Significant <0.001** Highly significant

Sample size

Using STATA program, setting alpha error at 5% and power at 90%, results from previous study showed that 13% of femoral nerve block group had Grade 0 (completely normal) muscle power at 12 hours compared to 57% of saphenous nerve block group (Ghodki et al., 2018). Based on this, the needed sample is 27 cases per group and with taking in account 10% dropout rate, the needed sample is 30 cases per group (60 cases totally).

Results

Demographic data

Groups were compared regarding their demographic data (in terms of age, BMI, sex and ASA physical status classification) and there were no statistically significant differences between the two groups (*p*-value > 0.05) Table 1.

Quadriceps muscle weakness grading

Patients in the two groups were compared for their ability to raise their leg straightened with assessment of quadriceps muscle weakness and a significant statistical difference (*p*-value was 0.0019) existed between the two groups Table 2.

TUG test

Patients in both groups showed a statistically significant difference (*p*-value $\leq$ 0.001) as regarding TUG test Table 3.

Postoperative pain

The two groups were compared as regard pain in postoperative period. NRS was used to estimate pain at regular interval (30 min after PACU admission, 3hr, 6hr, 12hr & 24hr postoperative). Results showed no statistically significant difference between both groups (Fig 1 & Table 4).

Table 1 Comparison between the two groups as regard demographic data

Demographic data	Group F (*n*=30)	Group S (*n*=30)	T/ X^2	*p*-value
Age (years)	59.3 ± 6.7	59.78 ± 6.3	0.3	0.77
BMI (kg/m^2)	28.7 ± 4.4	30.3 ± 10.5	0.79	0.44
Sex (male)	16 (53%)	18 (60%)	X^2=0.3	0.6
(female)	14 (47%)	12 (40%)		
ASA (I)	16 (53%)	19 (63%)	X^2=0.6	0.4
(II)	14 (47%)	11 (37%)		

Data expressed as mean ± SD proportion, T = student *t* test and X2= Chi-square

Table 2 Comparison between the two groups as regarding quadriceps muscle weakness

Quadriceps muscle weakness grades	Group F (*n*=30)	Group S (*n*=30)	X^2	*p*-value
Grade 0	13 (43.3%)	26 (86.7%)	12.6	0.0019
Grade I	6 (20%)	2 (6.7%)		
Grade II	11 (36.7%)	2 (6.7%)		

Data expressed as proportion, X2= Chi-square

Table 3 Comparison between the two groups as regarding TUG test

	Group F (*n*=30)	Group S (*n*=30)	*t*	*p*-value
TUG test (seconds)	44.6 ± 4.18	22.47 ± 4.93	18.7	**< 0.001**

TUG (time up and go) test

Data expressed as mean ± SD, *t* = student t test

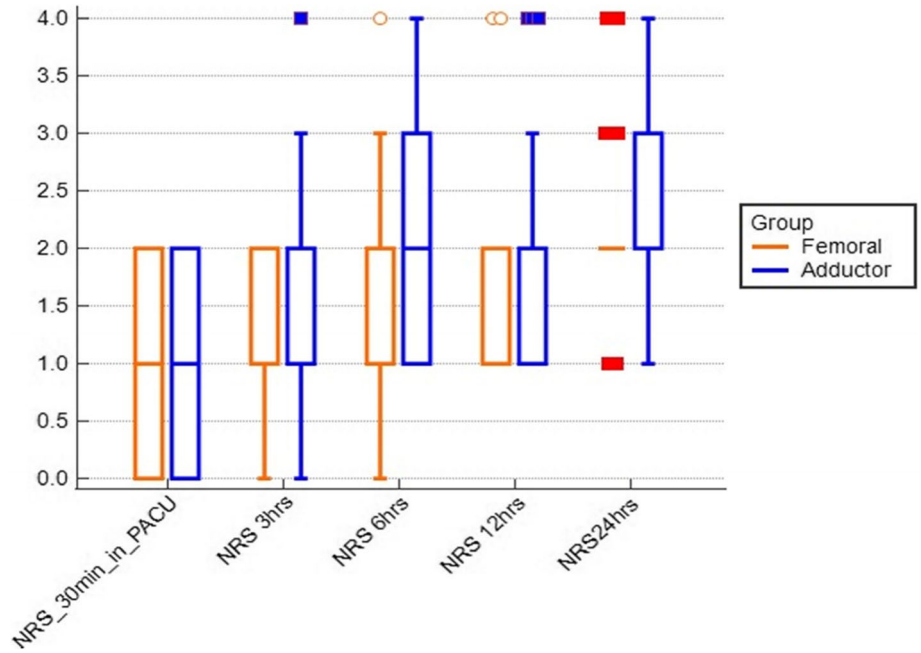

Fig. 1 Box and whisker between groups as regard Numerical Rating Score

Table 4 Comparison between groups as regard numerical rating scale

Numerical Rating Score	Group F (*n*=30)	Group S (*n*=30)	Mann-Whitney test	
			z	*p*-value
30min after admission to PACU	1 (0-2)	1 (0-2)	0.8	0.42
3hr	1 (1-2)	1 (1-2)	1.6	0.1
6hr	2 (1-2)	2 (1-3)	1.58	0.1
12hr	2 (1-2)	2 (1-2)	0.7	0.49
24hr	2 (2-2)	2 (2-3)	0.43	0.67

Data expressed as Median (IQR): Inter quartile range, z=Mann-Whitney test

Table 5 Comparison between groups as regard total dose of nalbuphine consumption

	Group F (*n*=30)	Group S (*n*=30)	*t*-test	*p*-value
Postoperative nalbuphine consumption (mg)	15.33 ± 7.3	14.33 ±6.26	0.57	0.57

Data expressed as mean ± SD, T = student t test

Nalbuphine consumption in the first 24 hours

No statistically significant difference was found between both groups regarding total dosage of Nalbuphine consumption in the first postoperative 24hr (*p*-value was 0.57) Table 5.

Discussion

Comparison of straight leg raising showed superiority of S group over F group with a *p*-value=0.001 and comparison of mean ± SD values of TUG test showed lower values for S group compared to F group (*p*-value<0.001). While, comparison of the median values of NRS pain score of FNB and saphenous nerve block showed that there was no significant difference between them both (*p*-values >0.05%). Total dosage of nalbuphine consumption in the first 24hrs postoperative showed no significant difference between both groups (*p*-value=0.57).

In agreement with our results, Tan *et al.,* reported that patients receiving ACB (adductor canal block) preserved quadriceps motor power compared to those receiving FNB. VAS pain scores at rest and during movements were found to be equivalent in both patient groups. However, VAS for lateral knee pain showed higher scoring in ACB over FNB group but still, range of movement of knee joint overall was remarkably greater in ACB group than FNB group (Tan et al., 2018).

Ghodki *et al.,* estimated that the analgesic potency of both FNB and ACB were similar by assessing NRS pain score and total narcotics consumption for 48 hours postoperatively following ACL repair surgery. But, ACB was superior to FNB for preserving quadriceps muscle power that was evaluated by straight leg raise and TUG (time up and go) test (Ghodki et al., 2018).

Zhao *et al.,* demonstrated that quadriceps muscle power was higher in ACB than FNB group. They also

found that VAS pain scores are similar in both groups apart from pain 2hrs postoperative (during rest) and pain at 12 hours postoperative (during activity) being lower in ACB group. Two patients in FNB manifested a DVT (deep venous thrombosis), while none did in ACB group (Zhao et al., 2017).

In a similar study conducted by FAiAz *et al.,* they assessed analgesic efficacy using VAS pain score and total diclofenac dose consumption while they measured quadriceps strength using the Medical Research Council grading for muscle power. They concluded that FNB was superior to ACB regarding postoperative analgesic quality, however, ACB was the best option overall attributed to quadriceps muscle weakness caused by FNB (AF, 2019).

In controversy to our results, Chuan *et al.,* in their study where TKA patients received either continuous ACB or continuous FNB by infusing 0.2% ropivacaine via a catheter using pump infusions. They found that VAS pain scores, total opioid consumption and TUG test values showed no significant differences between the two groups. So, they concluded that both FNB and ACB were even regarding quality of analgesia and quadriceps strength. Differences between their results and our study results may be due to using ropivacaine in lower concentrations (Chuan et al., 2019).

Song and his colleagues performed a study where both patient groups were compared for quality of analgesia and ambulation ability. They found that NRS pain score and total morphia consumption were higher in ACB whereas, no significant differences were detected in quadriceps power and TUG test values in both groups. Difference regarding analgesia may be due to the fact that in their study, periarticular infiltration was done using a mixture of ropivacaine, ketorolac, morphia and adrenaline. Whereas, difference regarding motor power may be because FNB injection site was done 5 cm proximal to the apex of femoral triangle, so the muscular branches supplying the quadriceps muscle were spared distally (Song et al., 2020).

Similarly, Macrinici *et al.,* in their study estimated that TUG test values were higher in FNB while, MVIC (Maximal voluntary isometric contraction) was lower in FNB compared to ACB. However, VAS pain scores and 6-minutes walking test values showed no significant differences between both patient groups. However, in their study they used 30ml of 0.375% bupivacaine while we used 15ml of 0.5% of the same drug and added to both nerve blocks, they performed intraoperatively local anaesthetic infiltration of the posterior capsule (Macrinici et al., 2017).

Conclusions

In our study we compared saphenous nerve block to femoral nerve block using high concentrations of local anesthetics in providing analgesia in knee surgeries along with preserving motor power. It was concluded from the results that both blocks were almost similar regarding their analgesic properties, and moreover, saphenous nerve block was proved to be better in preserving motor power and allowing ambulation even with the higher concentrations of local anesthetics, providing a better overall modality for postoperative analgesia in knee surgeries.

Abbreviations

ASA: American Society of Anesthesiologists.; FNB: Femoral nerve block; ACB: Adductor canal block; TKR: Total knee replacement; TKA: Total knee arthroplasty; TUG: Time up and go; VAS: Visual analogue score; NRS: Numerical rating score; MVIC: Maximal voluntary isometric contraction.

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Authors' contributions

AM designed the study, revised literature, performed the analysis, followed the patients, assessed the motor power, measured the pain score along with time for rescue analgesia and wrote the manuscript. AS designed the study, performed the analysis, wrote and critically revised the manuscript. EM revised literature performed the analysis and critically reviewed the manuscript. MM and AH revised literature, followed the patients, collected the data, performed the analysis and critically reviewed the manuscript. All authors approved the final version of the manuscript.

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Availability of data and materials

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

Declarations

Ethics approval and consent to participate

Approval of research ethical committee of Faculty of Medicine, Ain-Shams University was obtained (code number: FMASU M D 208/2019) and written informed consent was obtained from patients after description of the procedure and its potential complications.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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