http://jmscr.igmpublication.org/home/
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v7i11.20

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

USG Guided Femoral Nerve Block versus Local Infiltration Analgesia for Post Operative Pain Relief in Knee Arthroscopy Surgeries

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Abstract
Background: *A good analgesic technique which is safe and easy to administer is an essential requirement in knee arthroscopy surgeries for early rehabilitation and faster recovery.*
Objectives: *1) Postoperative pain assessment by the Numeric Pain Rating Scale at 0/4/8/12 hrs. 2) Total analgesic requirement & time to first rescue in both groups.*
Methods: *110 patients were randomised to receive either USG guided FNB (n= 55) with 20ml of 0.375% ropivacaine or LIA (n=55) with a total solution of 20ml (15 ml of 0.375% ropivacaine with 30 mg ketorolac and 0.3mg epinephrine making a total volume of 20ml) with 15ml infiltrated intra articularly and 5 ml at the incision site along with the portal sites. Demographic data, NRS at 0,4,8 and 12 hrs, time to rescue analgesia, total analgesic requirement and quadriceps strength were recorded.*
Results: *Significant difference in pain scores at 12 hrs was observed (p = 0.01). An extremely significant difference was observed in the total analgesic requirement (p = 0.0004) with only 30 patients in LIA group requiring analgesia as compared to 47 in FNB group. Demographically the patients in both groups were similar. The quadriceps muscle strength was similar in both the groups.*
Interpretation & Conclusion: *The technique of LIA provides longer duration of analgesia with reduced supplementary analgesic requirement during the post-operative period.*
Keywords: *Analgesia, Femoral Nerve Block, Knee arthroscopy, Local Infiltration Analgesia, Pain, USG.*

Introduction

Knee arthroscopy comprises the majority of orthopaedic procedures.[1,2] The procedure is associated with a variable amount of postoperative pain, which is caused by irritation of free nerve endings of synovial tissue, anterior fat pad, and the joint capsule during surgical excision and resection.[3] Effective pain control allows for earlier ambulation and initiation of physiotherapy, which hastens recovery, reduces the length of stay in the hospital, and lowers the risk of postoperative complication.[4,5] Adequate pain relief reduces the surgical stress response, thereby reducing the patient's morbidity and improving postoperative recovery. Regional analgesia techniques provide successful analgesia after arthroscopy with rapid patient recovery and early mobilization.[6]

Femoral Nerve Block (FNB) has been widely used for the surgeries on the anterior thigh and knee, quadriceps tendon repair, and postoperative pain management after femur and knee surgery. An alternative approach which is becoming increasingly popular is the postoperative local infiltration analgesia (LIA) that comprises of intraarticular or periarticular infiltration or both of analgesic agents including local anaesthetics, opiates and non-steroidal anti-inflammatory drugs, which may be delivered directly to the sources of pain, reducing the risk of systemic side effects.[20,21]

There have been a lot of studies comparing these two techniques with varying results. This can be due to the difference in the various drug combinations used for Local Infiltration Analgesia in the studies. It can also be attributed to surgical technique an expertise of the operating surgeon.

Our primary aim was to provide an effective and safe technique to facilitate in making knee arthroscopy a day care procedure

A randomised comparative study was conducted to compare the use of a femoral nerve block (FNB) and local infiltration analgesia (LIA) in patients undergoing knee arthroscopy for evaluating the difference in the analgesic efficacy and safety profile of the two techniques in the post-operative period.

Three hypothesis were tested:

1) LIA would exhibit lower pain scores on NRS
2) LIA would have lesser analgesic consumption
3) LIA would be safer than FNB

Methodology

Study Design: The Prospective Interventional Randomised Comparative Study carried out in the Department of Anaesthesiology and Intensive Care at Safdarjung hospital and Vardhman Mahavir Medical College, New Delhi, a tertiary care centre, after obtaining clearance from the institutional ethical committee. The duration was 18 months.

Inclusion Criteria

All patients of either sex with American Society of Anaesthesiologists (ASA) physical status Grade I and Grade II, aged 18yr-60yr, undergoing elective unilateral knee arthroscopy will be eligible for inclusion in the study.

Exclusion Criteria

The following patients shall be excluded from the ambit of the study:-

1) Previous knee surgery or pre-existing joint disease
2) Contraindications to regional anaesthesia or allergy to study medications
3) Failed spinal anaesthesia

Randomisation

A total of 110 patients were randomly allocated to two groups of 55 each by block randomisation with the allocation concealed in sealed envelopes which were opened just before the start of anaesthesia.

GROUP F (n=55) – Femoral nerve block

GROUP L (n=55) – Local infiltration analgesia

Anaesthesia Technique

After the patient was shifted to the operation theatre, non-invasive monitors, including electrocardiography, non-invasive blood pressure and pulse oximetry, were established. An intravenous access with a wide bore cannula was secured. After sedation with intravenous midazolam 1mg, oxygen via mask was applied.

Thereafter, the patient was given subarachnoid block in lateral position, with the operative limb in dependent position. The block was performed with 2.5ml of 0.5% hyperbaric bupivacaine and 10 mcg fentanyl.

At the end of surgery, patient was randomly allocated to either group F or group L.

The patients in the Group F received FNB under ultrasound guidance by the investigator. With the patient in the supine position, the skin over the femoral crease was disinfected and the transducer positioned to identify the femoral artery, immediately lateral to the vessel, and deep to the fascia iliaca is the femoral nerve, which is typically hyperechoic and roughly triangular or oval in shape. Once the femoral nerve was identified, a skin wheal of local anaesthetic was made on the lateral aspect of the thigh 1 cm away

from the lateral edge of the transducer. The needle was inserted in-plane in a lateral-to-medial orientation and advanced toward the femoral nerve. A needle passage through the fascia iliaca is often felt as a "pop" sensation. Once the needle tip was witnessed adjacent (either above, below, or lateral) to the nerve, and after careful aspiration, 1 to 2 mL of local anaesthetic was injected to confirm the proper needle placement. After confirmation of needle position 20ml of 0.375% ropivacaine was injected.

The patients in Group L will received LIA, with 15ml of 0.375% ropivacaine combined with 30mg ketorolac and 0.3mg epinephrine making the total volume to 20ml. 15ml of this drug was infiltrated into the knee joint, the operative field including the posterior capsule, and 5ml infiltrated along the incision sites including the portal and tendon harvest site. The injection was administered 10 min before the tourniquet release by the operating surgeon. This drug mixture was administered by the operating surgeon himself.

Outcomes and Rescue

Primary Outcome

Assessment of Post Operative Pain: Postoperative pain was assessed 0/4/8/12 hours by the Numeric Pain Rating Scale (NRS) on a scale of 1 to 10. The patient was assessed initially at 4 hourly intervals.

Secondary Outcome

Assessment of Quadriceps Function: The strength of quadriceps muscle was evaluated as the ability or inability to extend the operated knee against gravity with the hip passively flexed at 45^0 compared with contralateral limb at 24 and 48 hours after surgery.

Other Outcomes

1) Time to first rescue analgesia
2) Total amount of analgesic required.
3) Any untoward effects of the procedure were noted and treated appropriately.

Any adverse events, including, paraesthesia, hematoma, residual numbness and motor weakness were recorded.

Rescue Analgesia

If at any time post operatively, the patient had NRS score of more than 4, patient was given intravenous paracetamol 1gm and if even after this the NRS score did not decrease, the patient was administered intravenous tramadol 50mg.

Statistical Analysis and Methods

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by the Kolmogorov-Smirnov test. If the normality was rejected then the non-parametric test was used.

Statistical tests were applied as follows-

1) Quantitative variables were compared using the Unpaired t-test/Mann-Whitney Test (when the data sets were not normally distributed) between the two groups.
2) Qualitative variables were compared using Chi-Square test /Fisher's exact test.

A p value of <0.05 has been considered statistically significant.

The data was entered in MS Excel spreadsheet and analysis were done using the latest SPSS software.

Results

A total of 110 patients were enrolled and were divided into group F (FNB) and group L (LIA), with 55 patients in each group. Majority of the patients belonged to the age group of 15 to 55 years, with the maximum number falling in the age group of 15-25 years in both the groups, shown in Table 1.Most of the patients were male and constituted 76.36% of the total number (Table 2). The demographic profile was similar in both groups, with no significant statistical difference. The duration of surgery is variable in both the groups but it is not statistically significant (Table 3). The mean tourniquet time in group F is 56.67 ± 13.99 and in group L is 51.4 ± 15.1, shown in Table 4.

1. **Age Distribution**

AGE	GROUP F	GROUP L	TOTAL
15-25	23 (41.82%)	26 (47.27%)	49 (44.55%)
26-35	22 (40.00%)	18 (32.73%)	40 (36.36%)
36-45	8 (14.55%)	8 (14.55%)	16 (14.55%)
46-55	2 (3.64%)	3 (5.45%)	5 (4.55%)

2. **Gender**

SEX	GROUP F	GROUP L	TOTAL	P VALUE
FEMALE	10 (18.18%)	16 (29.09%)	26 (23.64%)	0.178
MALE	45 (81.82%)	39 (70.91%)	84 (76.36%)	
TOTAL	55 (100.00%)	55 (100.00%)	110 (100.00%)	

3. **Duration of Surgery**

SAMPLE SIZE	GROUP F	GROUP L	P VALUE
	55	55	
MEAN	71.02	64.84	0.012
STANDARD DEVIATION	18.62	23.29	
MEDIAN	67	60	
MIN-MAX	40-120	30-150	

4. **Tourniquet Time**

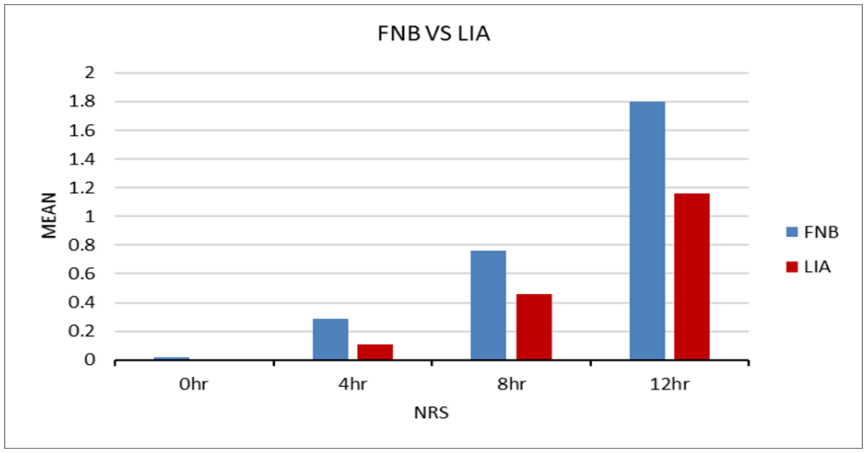
SAMPLE SIZE	GROUP F	GROUP L	P VALUE
	55	55	
MEAN	56.67	51.4	0.012
STANDARD DEVIATION	13.99	15.1	
MEDIAN	55	47	
MIN-MAX	30-90	25-90	

The NRS values at 0hr, 4hr and 8hr are statistically insignificant while comparing both groups. However, the mean NRS at 12hr has a significant statistical difference, with a p-value of 0.01, while comparing both the groups. This shows that LIA is better than FNB for post-operative pain at 12 hours i.e. it provides longer pain relief. (Table 5)

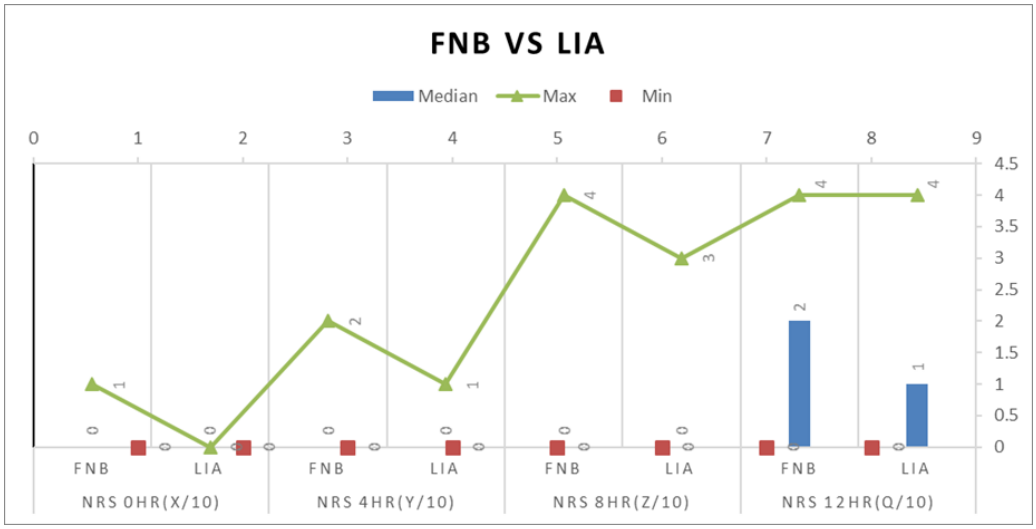
5. **NRS**

NRS	GROUP F	GROUP L	P VALUE
	MEAN ± SD	MEAN ± SD	
0	0.02 ± 0.13	0 ± 0	0.317
4	0.29 ± 0.69	0.11 ± 0.31	0.299
8	0.76 ± 1.02	0.46 ± 0.79	0.114
12	1.8 ± 1.32	1.16 ± 1.07	0.01

Comparison of Mean NRS Values



Comparison of Min-Max and Median Values

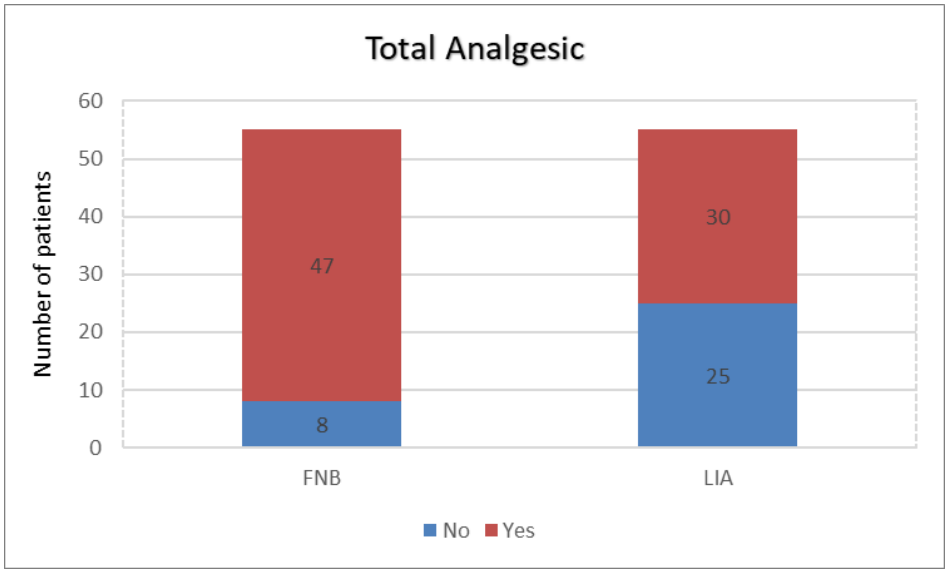


47 patients in the group F and 30 patients in the group L required rescue analgesia. The patients who required rescue analgesia are being compared according to the time of first analgesic requirement termed as the time to rescue. The mean time to rescue analgesia in Group F (FNB) is 13.25 hrs, which is not statistically different (p-value 0.995) from Group L (LIA) which has a mean of 13.26 hrs. (Table 6)

6. Time to Rescue Analgesia

	FNB	LIA	P VALUE
MEAN ± SD	13.25 ± 5.68	13.26 ± 5.18	0.995

The total analgesic requirement in both the groups showed a significant statistical difference with a p-value of 0.0004, implying that LIA reduces the consumption of a rescue analgesic in the post-operative period.



The Quadriceps muscle strength was also tested at 24 hrs and 48 hrs in the post-operative period. Both the groups showed similar strength with no history of falls. No other side effects were observed.

Discussion

In our study, we have compared the analgesic efficacy of ultrasound-guided Femoral Nerve Block with Local Infiltration Analgesia in patients undergoing knee arthroscopy surgeries. The study was carried out in a single tertiary care centre. In our knowledge, this study is the first one to compare the two techniques on Indian patients. The findings are logical, plausible, and consistent with expectations. There are several limitations to our study, particularly concerning clinical importance. We adopted a rigorous inclusion and exclusion criteria which attributed to the small sample size. The observational nature of our study is susceptible to bias and confounding despite randomization.

All the patients gave consent to be a part of the study and were discharged on the next day of surgery.

The significant findings of the study are: -

1. Lower pain scores on NRS 12 hours after surgery in the Local infiltration group when compared to Femoral nerve block group
2. The total analgesic requirement was significantly lower in the LIA group

The confounding variables such as time duration of surgery, gender, age and tourniquet time have been well matched in the final analysis. The Anaesthesiologist administering the block remained the same in all the cases. Similarly, the surgical team who gave the LIA was also the same in all the cases.

Local Infiltration Analgesia is the concept of surgical wound and site infiltration with local anaesthetics.[9,10]

The volume of the injectate can vary from 50ml to 200ml for surgical anaesthesia.[12-19]

We have used a lower volume i.e. 20 ml, as our purpose was to provide post-operative analgesia and to decrease the amount of LA, minimising the chances of toxicity. The solution for LIA contained a local anaesthetic combined with epinephrine and ketorolac in our study as well as in six other studies.[12-15,17,20] In one trial, an antibiotic was also added to the solution.[21]

The addition of epinephrine in the injectate results in a delayed washout of the local anaesthetic resulting in a high and long-lasting local concentration of the anaesthetic and a low systemic level of the drug.

Ropivacaine is a racemic mixture[22]and has been observed that ropivacaine has a lower incidence of a motor blockade than bupivacaine.[23,24] This particular property has led to a decrease in the falls associated with the use of bupivacaine in femoral nerve blocks. And hence we have preferred this drug over bupivacaine.

Recently, there has been some concern over the fact that local anaesthetics are chondrotoxic.[24] But it has been shown that the effect on cartilage is dose and time-dependent cytotoxic effects[25]. Sola et al. have compared the in vivo chondrotoxic effect after a single injection of different concentrations of solutions, namely, saline, bupivacaine, ropivacaine, triamcinolone, and a mixture of these agents in the knee joint of rats. It was seen that only an injection with low dose ropivacaine did not lead to chondrotoxicity.[25]

The mean tourniquet time in group F was 56.67 minutes with a standard deviation of 13.99 minutes. Group L showed a statistically similar mean tourniquet time of 51.4 minutes and a standard deviation of 15.1 minutes. This implies that our study was not influenced by the tourniquet time.

Iskander et al compared the efficacy of femoral nerve block with intraarticular injection with ropivacaine for ACL repair surgeries and concluded that femoral nerve provides superior analgesia.[26] In their study, they found that the VAS scores in the recovery and during rehabilitation were higher in the intraarticular group with a p-value of <0.001. This is in contrast to the findings of Iamaroon et al, where they found that the post-operative analgesic effects of FNB (20 ml of 0.25% bupivacaine) and Intraarticular infiltration (15 ml of 0.25% into the knee joint and 5 ml along the incision sites

including the portal sites) were comparable with a p-value of >0.05.[27] This corroborates with a study by Kristensen et al, where they have compared LIA with FNB and found no significant differences in the pain scores at any follow-up point in their study.[28] Mehdi et al in their study, concluded that the pain control was effective in patients who received extra or intra articular infiltration with bupivacaine and that FNB has no significant advantage.[29] They also suggested performing ACL surgeries on day care basis with the use of intraarticular infiltration for post-operative pain relief. However, Mayr et al also conducted a study in which they found out that the pain scores were similar in pre-operative intra articular anaesthesia and femoralis 3 in 1 block groups.[30] They found post-operative intra articular anaesthesia to be less satisfactory. This difference might be due to the fact that they have used femoralis 3 in 1 block instead of FNB. In our study, we have found that the NRS values between the two groups are similar at 0, 4 and 8 hours after the surgery, but the NRS values are significantly different at 12 hours with a p-value of 0.01. This shows that LIA provides a longer pain relief than FNB in ACL surgeries, minimizing the need for supplementary analgesia. This also shows that 0.375% of ropivacaine is effective as higher concentrations, thereby reducing the probability of chondrotoxicity in any patient as has been hypothesized in some lab studies.

In our study, the mean time to rescue analgesia between the two groups was similar in duration. Although, we observed a considerable difference (p-value = 0.0004) in the analgesic requirement in the two groups. A total of 47 patients in the group F and 30 patients in the group L required rescue analgesia postoperatively in our study. This difference is highly significant and gives LIA an edge over FNB in the pain management regimes for ACL surgeries. Iamaroon et al too observed a similar time to first morphine requirement in both groups.[27] Mehdi et al in their study observed no such difference in the total analgesic requirement.[29] These findings were also repeated in the study done by Kristensen et al, where they found no significant difference between the two groups.[28] Iskander et al had a different result altogether, with reduced analgesic consumption and a longer time to rescue analgesia in FNB group (20ml of 1% ropivacaine) than LIA (20ml of 1% ropivacaine).[26] This difference might be attributed to the fact that patients received 2gm propacetamol and 100 mg ketoprofen during the first 24 hours after surgery, which was not the case in our study.

The quadriceps muscle strength was evaluated as the ability or inability to extend the operated knee against gravity with the hip passively flexed at 45^0 compared with the contralateral limb at 24 hours and 48 hours after surgery. We observed no difference between the two groups at the pre-specified time interval. FNB did not affect the Quadriceps strength in any of the patients as was observed in some studies.[31] Iamaroon et al found reduced quadriceps muscle strength in the FNB group at 24 hours after the surgery but at 36 hours both groups had good ability to extend the knee.[27] This can be due to the use of bupivacaine in their study, which causes motor weakness along with sensory weakness. No other study has compared the difference in the two groups after knee arthroscopy surgeries.

Both techniques are safe and provide adequate analgesia. However, we can suggest that:-

1. LIA has a prolonged analgesic affect postoperatively with reduced analgesic requirement when compared with FNB.
2. LIA decreases the requirement of supplementary analgesia in the postoperative period when compared with FNB.
3. LIA is easy to administer & a less time-consuming technique.

There is a need for further study on the topic as there is only a handful of literature comparing both groups in knee arthroscopy surgeries, our study is a step in comparing the two techniques in a tertiary care centre in a developing country.

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