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Original Article

Anaesthesia Section

Postoperative Analgesia in Ultrasound-Guided 3-in-1 Block versus Fascia Illiaca Compartment Block in Adult Patients Undergoing Lower Limb Orthopaedic Surgeries under General Anaesthesia: A Randomised Clinical Study

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ABSTRACT

Introduction: Three-in-one block and Fascia Illiaca Compartment Block (FICB) are two peripheral nerve block techniques that target the femoral nerve, obturator nerve and lateral femoral cutaneous nerve in a single injection. Both nerve blocks are used to provide anaesthesia and analgesia to the lower limb for various surgical procedures. The use of ultrasonography in peripheral nerve blocks helps to visualise the nerve, needle, and the distribution of the drug in real-time. It, thus, shortens the time of onset of sensory block, decreases performance time, and lowers the required drug doses, and finally increases chances of a favourable outcome from the nerve block.

Aim: To compare the postoperative analgesic efficiency of ultrasound-guided 3-in-1 block with FICB in patients undergoing lower limb orthopaedic surgeries under General Anaesthesia (GA).

Materials and Methods: A randomised clinical study was conducted at a tertiary care hospital. One hundred and fifty patients were randomly allocated to two groups, 3-in-1 block group or FICB. Both groups received the respective blocks after surgery before extubation. Postoperatively, Visual Analog Scale (VAS) scores were evaluated hourly for first six hours and two hourly thereafter until rescue analgesia was instituted. Time period from giving the block to giving rescue analgesia was noted as duration of analgesia. Injection diclofenac 1.5 mg/kg Intravenous (i.v.) was given when VAS value reached ≥4.

Results: On analysis of 150 patients, divided into 3-in-1 block group (N=75) and FICB group (N=75); mean age: 53.29±8.69 years; the VAS scores at 2 to 18 hours, 20 hours, and 22 hours after performing the blocks were significantly less in the 3-in-1 block group compared to FICB group. Also, the mean time (hours) for first rescue analgesia in FICB group (3.49±0.53) was earlier compared with 3-in-1 block group (7.35±0.51).

Conclusion: A 3-in-1 block provides effective and prolonged postoperative analgesia in comparison to FICB.

Keywords: Nerve block, Rescue analgesia, Visual analog scale

INTRODUCTION

Postoperative pain control is critical to patient care after lower limb orthopaedic surgeries. It facilitates mobilisation and physiotherapy. Postoperative pain relief can be achieved by different methods including Non Steroidal Anti-Inflammatory Drugs (NSAIDS), neuraxial blockade, peripheral nerve blocks, infiltration and patient-controlled analgesia with opioids [1]. Three-in-one block provides analgesia after hip, femoral shaft, and knee surgery [2]. It uses a single injection to block the femoral, lateral femoral cutaneous, and obturator nerve simultaneously [3]. These three nerves provide major part of sensory supply to the lower extremity and allow for successful analgesia and anaesthesia to lower limb [4]. FICB captures two major nerves innervating lower extremities with anatomical safety and ease of procedure with a chance of blocking obturator nerve also [5]. It involves local infiltration anaesthesia under the fascia of the iliacus muscle and depends on the local aesthetics spread beneath the fascia to block the peripheral nerves [6]. Besides postoperative analgesia, both 3-in-1 block and FICB are used to provide analgesia for femur fractures and for closed reductions in the Emergency Department as well as facilitating positioning for performing central neuraxial blocks for surgeries [7].

Ultrasonography was first utilised to confirm the location of the needle and observe the spread of local anaesthetic, while performing peripheral nerve blocks [8]. Before that surface anatomy-based techniques, nerve stimulation, palpation of landmarks, fascial "clicks," paresthesias etc., were used to perform peripheral nerve blocks. However, ultrasound guidance provides a few advantages for nerve block. It allows visualisation of the local anatomy, the needle tip as it passes through structures and provides continuous visualisation of the local anaesthetic spread [9]. This helps the anaesthetists to a more informed guidance of the needle to the targeted nerve to avoid structures that might be damaged by the needle and to make appropriate manipulations of the needle to avoid damage to tissues as well as to ensure a proper spread of local anaesthetic agent [9]. Since then, ultrasound has been used in different peripheral nerve blocks owing to the precise performance of the procedure of block [10]. The efficacy of 3-in-1 femoral block and FICB in providing postoperative analgesia has been studied well individually.

Although there are a few studies comparing the efficacy of these two blocks, the outcomes were varied. Some studies found 3-in-1 block superior than FICB and vice-a-versa, whereas some found no differences between the two blocks at all [10-16]. Moreover, these studies used smaller sample sizes and did not strictly target assessment of postoperative analgesic efficacy of the two blocks.

Hence, this study was proposed to compare the postoperative analgesic efficiency of ultrasound guided 3-in-1 block with FICB in patients undergoing lower limb orthopaedic surgeries under GA. The primary outcome measures were time till rescue analgesia and VAS scores till first rescue analgesia. The haemodynamic variability in the first 30 minutes of performing the blocks was the secondary outcome measure.

MATERIALS AND METHODS

This randomised clinical study was conducted in the Department of Anaesthesiology, Atal Bihari Vajpayee Institute of Medical Sciences and Dr Ram Manohar Lohia Hospital, New Delhi, India from November 2018 to March 2020. Institutional Ethics Committee (IEC) approval was obtained before starting the study. {F.No.TP(MD/MS) (6/2018)/IEC/PGIMER/RMLH}.

Inclusion criteria: The patients of age 18-60 either sex who came for elective lower limb orthopaedic surgeries belonging to American Society of Anaesthesiologists (ASA) grade I and II [17] were included in the study.

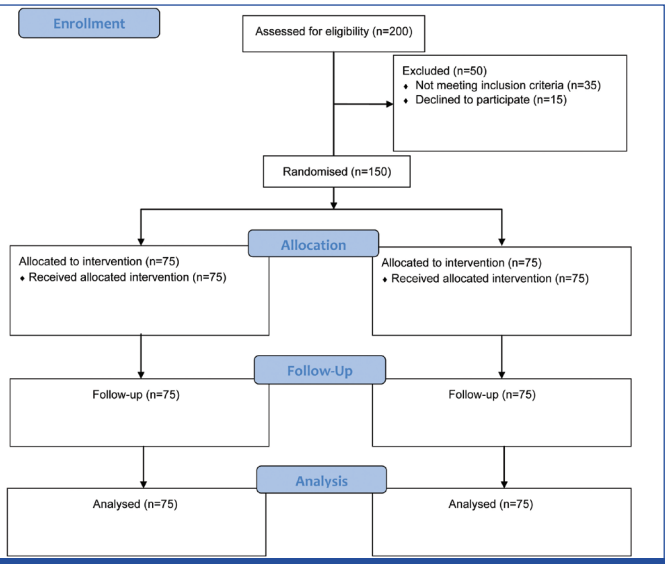
Exclusion criteria: Patients with infection over skin puncture site, coagulation disorders, allergies to local anaesthetic agents, pre-existing neurological deficits were excluded from the study.

Sample size calculation: It was based on duration of analgesia in two groups. A study using a similar protocol observed significant difference between the two groups in the mean Visual Analog Scale (VAS) (at rest) at six hours after surgery [10]. Taking those values as reference, the minimum required sample size with 80% power of study and 5% level of significance was 74 patients in each study group.

Study Procedure

After a full preoperative evaluation, the enrolled patients were explained about the nerve block in the preanaesthesia clinic and again on the day of the surgery. All patients were fasted overnight and received Tablet Ranitidine 150 mg and Tablet Alprazolam 0.25 mg at night and morning before surgery. After written informed consent of the patient, patient was bought to operation theatre, an 18-gauge intravenous line was established and standard ASA monitors were attached and baseline vitals were recorded. General anaesthesia was induced using propofol 2 mg/kg and fentanyl 1.5 mcg/kg. After induction Vecuronium 0.2 mg/kg was given. Intubation was done 3 minutes after giving vecuronium. Maintenance was achieved with a mixture of oxygen, nitrous oxide, and sevoflurane. Vecuronium top-up doses were used if indicated.

All patients received either 3-in-1 block or FICB based on the computer-generated random number table. All haemodynamic parameters were monitored every 5 minutes for the next 30 minutes. After 30 minutes of giving the block, anaesthesia was reversed with injection neostigmine 0.05 mg/kg+Glycopyrrolate 0.01 mg/kg [Table/Fig-1].



[Table/Fig-1]: CONSORT flow diagram.

Technique of ultrasound guided 3-in-1 block: Patient was positioned supine with thighs slightly abducted. Under asepsis, the high frequency (6-10 MHz) linear ultrasound probe was placed 1 cm distal to the inguinal ligament on the side of the affected hip to identify the femoral vessels and nerve in cross-section. The nerve was identified as a hyperechoic structure approximately 1 cm lateral to the pulsatile artery and centered on the ultrasound screen at a depth of 3-4 for optimal viewing. A 21-gauge spinal needle was applied 2 cm lateral to the ultrasound probe to puncture the skin at a 45° angle in plane to the probe from lateral to medial direction. The needle was directly visualised by ultrasound throughout the procedure to ensure that vascular puncture was avoided and that spread of local anaesthetic was administered in the correct facial plane. After aspiration, injection was given with 40 mL of 0.25% bupivacaine. Immediately after the injection, manual pressure was given for 5 minutes 1 cm below the injection site.

Technique of ultrasound guided fascia iliaca compartment block: With the patient in supine position, under asepsis a high frequency (6-10 MHZ) linear ultrasound probe was placed in transverse orientation on the thigh just inferior to inguinal ligament at the junction of medial two-third and lateral one-third of the distance from anterior superior iliac spine to pubic tubercle, to identify the femoral artery and the iliacus muscle lateral to it, covered by the fascia illiaca. A 21 gauge spinal needle was inserted from lateral to medial direction in plane to the ultrasound beam. The needle was advanced until the tip is placed underneath the fascia illiaca. After a negative aspiration, injection was given with 40 mL of 0.25% bupivacaine.

Haemodynamic variables viz., heart rate, systolic and diastolic blood pressures, mean arterial pressure, and oxygen saturation was measured every 5 minutes till 30 minutes from giving the block. VAS scores were evaluated every hourly for first 10 hours and 2 hourly thereafter until rescue analgesia was instituted. Time period from giving the block to giving rescue analgesia was noted as duration of analgesia. Side-effects if any, were recorded at the same intervals. Injection diclofenac 1.5 mg/kg IV given when VAS value reached ≥4.

This was a single-blinded study wherein the observer analysing the outcome parameters such as haemodynamic variables, VAS scores and time till rescue analgesia was blinded to the details of the patients as well as the blocks given. Thus, observer bias was minimalised.

STATISTICAL ANALYSIS

Categorical variables were presented in number and percentage (%) and continuous variables was presented as mean±SD and median. Normality of data was tested by Kolmogorov-Smirnov test. If the normality is rejected, then non parametric test was used. Quantitative variables were compared using unpaired t-test/Mann-Whitney Test (when the data sets are not normally distributed) between the two groups. Qualitative variables were compared using Chi-square test/Fisher's-exact test. A p-value of <0.05 was considered statistically significant. The data was entered in Microsoft excel spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

RESULTS

Both the groups were comparable in age, age distribution, height, weight, sex, and operative procedures [Table/Fig-2]. Haemodynamic parameters following the blocks were also comparable. Significant difference was seen in Diastolic Blood Pressure (DBP) (mmHg) after 5 minutes, after 10 minutes, after 20 minutes, after 30 minutes between the two groups (p-value <0.05) [Table/Fig-3] and in Mean Blood Pressure (mmHg) after 5 minutes, after 10 minutes, after 30 minutes [Table/Fig-3].

No significant difference was seen in VAS after 1 hour, after 24 hours [Table/Fig-4]. Significantly less VAS scores were seen in 3-in-1 block group than in FICB group after 2 hours, after 3 hours, after 4 hours, after 5 hours, after 6 hours, after 7 hours, after 8 hours, after 9 hours, after 10 hours, after 12 hours, after 14 hours, after 16 hours, after 18 hours, after 20 hours and after 22 hours (p-value <0.05). The mean time for first rescue analgesia in FICB group was earlier (3.49 hours) compared with 3-in-1 block group (7.35 hours) [Table/Fig-5].

DISCUSSION

Major lower limb surgery is often painful and requires aggressive management. Lower limb peripheral nerve blocks have been in use

Variables	3 in 1 block	FICB	p-value
Age (years)			
≤30	3	4	0.212
31-40	5	2	
41-50	19	11	
>50	48	58	
Mean (SD) (years)	52.88±8.58	53.69±8.83	53.29±8.69
Gender			
Male	33	37	0.513
Female	42	38	
Height (cm)	156.47±7.67	156.97±6.45	0.508
Weight (kg)	70.23±4.71	71.15±5.75	0.155
Operative procedure			
ORIF with IMIL nail	1	0	0.33
THR	19	14	
TKR	55	61	

[Table/Fig-2]: Demographic data.
SD: Standard deviation; cm: Centimetres; kg: Kilograms; ORIF with IMIL nail: Open reduction internal fixation with intramedullary interlocking nail; THR: Total hip replacement; TKR: Total knee replacement

Heart rate (bpm)	3-in-1 block (n=75)	FICB (n=75)	p-value
Baseline	77.09±8.45	78.48±8.9	0.402
After 5 minutes	75.68±6.59	76.03±7.01	0.947
After 10 minutes	75.68±6.05	76.4±7.31	0.481
After 20 minutes	75.92±6.77	75.97±7.01	0.901
After 30 minutes	76.21±6.7	76.35±7.08	0.833
Systolic blood pressure (mmHg)			
Baseline	124.88±6.39	124.08±6.23	0.518
After 5 minutes	125.68±5.62	123.68±7.01	0.06
After 10 minutes	124.03±7.06	123.31±6.35	0.632
After 20 minutes	122.53±7.13	122.99±6.19	0.859
After 30 minutes	122.83±6.94	122.32±6.75	0.627
Diastolic blood pressure (mmHg)			
Baseline	72.99±6.99	72.35±6.68	0.715
After 5 minutes	73.63±6.99	69.97±5.65	**0.001**
After 10 minutes	71.84±5.16	69.47±4.95	**0.006**
After 20 minutes	70.48±5.05	69.19±5.57	**0.044**
After 30 minutes	72.93±7.06	68.32±5.2	**<0.0001**
Mean blood pressure (mmHg)			
Baseline	90.01±5.83	90±5.63	0.957
After 5 minutes	90.6±5.98	87.54±5.63	0.002
After 10 minutes	88.99±5	87.11±4.91	0.049
After 20 minutes	87.52±4.75	86.76±5.28	0.344
After 30 minutes	89.13±5.07	86.09±5.22	0.0004

[Table/Fig-3]: Comparative analysis of the clinical parameters of all participants at baseline and variable time intervals after giving the block.

Time after (hours) block	Mean VAS scores		p-value
	3-in-1 Block	FICB	
1	0	0	1
2	0	1.49 ±0.5	**<0.0001**
3	0	2.57 ±0.5	**<0.0001**
4	1.43±0.5	3.53±0.5	**<0.0001**
5	1.84±0.49	3.99±0.12	**<0.0001**
6	2.17±0.38	4.03±0.16	**<0.0001**
7	2.99±0.2	4.28±0.45	**<0.0001**
8	3.63±0.49	5±0	**<0.0001**
9	4.04±0.2	5±0	**<0.0001**
10	4.39±0.49	5.03±0.16	**<0.0001**
12	4.95±0.28	5.21±0.41	**<0.0001**
14	5.11±0.35	5.71±0.46	**<0.0001**
16	5.4±0.49	5.97±0.16	**<0.0001**
18	5.83±0.38	6±0	**0.0002**
20	5.92±0.27	6±0	**0.012**
22	5.95±0.23	6±0	**0.043**
24	5.97±0.16	6±0	0.155

[Table/Fig-4]: Mean visual analogue scale scores at different time intervals.

Variable	3-in-1 Block	FICB	p-value
First rescue analgesia time (hours)	7.35±0.51	3.49±0.53	**<0.0001**

[Table/Fig-5]: Comparison of first rescue analgesia time.

as a safe and effective method for providing postoperative analgesia in these surgeries. Among the various nerve blocks, 3-in-1 block and FICB are commonly used for anaesthesia and analgesia in hip replacement. Peripheral nerve blocks avoid the complications and adverse effects of spinal anaesthesia and intravenous opioid analgesia, provide excellent analgesia, and also reduce postoperative inflammatory response. Therefore, it is important to evaluate the effect of different peripheral nerve blocks on other lower limb surgeries as well. This randomised clinical study aimed to compare 3-in-1 block (n=75) and FICB (n=75) for providing postoperative analgesia in patients undergoing lower limb orthopaedic surgeries under general anaesthesia.

The pain score, as measured by VAS score, was 0 after one hour of anaesthesia, in both the groups. However, with increasing time (upto 22 hours), patients with 3-in-1 femoral block reported significantly less pain as compared to FICB. Thereafter, at 24 hours, VAS score though less in 3-in-1 femoral block, became statistically comparable in comparison to FICB.

Yu B et al., compared VAS scores after Femoral Nerve Block (FNB) and FICB for hip replacement in 60 elderly patients and found that the mean VAS score (at rest) at 6 hours after surgery was significantly lower in FICB group ($p<0.05$) [10]. However, in both groups, the mean VAS score at rest (<1) and that during activity (<1.5) indicated that patients experienced only slight pain. In 2018, Shukla U et al., also measured mean VAS score in femoral nerve block and FICB at different time intervals, on patients undergoing surgery for femur fractures [11]. At the time of application of block patient did not have any pain due to the persistent effect of sub-arachnoid block. At no time interval any significant difference was reported between the groups. Another study by Kanadli H et al., compared VAS scores and total analgesic consumption after FNB and FICB in 100 patients undergoing total knee replacement [12]. The study found out that analgesic consumption at 30 minutes and upto 6 hours postoperatively was lower in FNB group, however it was lower in the FICB group from the 6th to 24th hours. Total analgesic consumption in FICB group was less compared to FNB group. The VAS level at the 24th hour was lower in the FICB group. Corroborating with the VAS score, the time to first rescue analgesia (hours) was significantly more in 3-in-1 femoral as compared to FICB (7 hours vs 3 hours, $p<0.0001$).

The present study findings are in line with those by Temelkovska-Stevanovska M et al., who reported a statistically significant difference in the time of the first additionally introduced analgesic agent between FNB and FICB (after 12.58 hours for the FNB versus 11.98 hours for FICB group) [13]. In contrast to the index study, Shukla U et al., noted no significant difference in time (in hours) to "first requirement" of analgesic in FNB group and FICB group (8.24±1.880 vs 8.09±1.869) [11]. Even Pandya M and Jhanwar S observed that the mean time for first demand of rescue analgesic was (duration of analgesia) comparable among the two groups (12.97±3.06 hours in FICB group and 11.93±3.02 hours in three in one group) [18]. But in contrast to these studies, in the present study,

VAS scores were significantly less and the time till rescue analgesia was prolonged in 3-in-1 block group compared to FICB group. The reasons could be a larger sample size in the present study, and that the blocks were performed in patients undergoing surgery under GA, after the surgery before extubation, thus, focussing purely on the postoperative analgesic efficacy of the two blocks.

In the present study, median heart rate (bpm), systolic blood pressure (mmHg) in both groups were comparable with no statistically significant difference between them (p-value >0.05). The DBP and MAP was comparable among the two groups at baseline but they were significantly lower in FICB group than 3-in-1 block group (p<0.05). However, there were no episodes of hypotension which needed separate management.

Some of the previous studies also compared haemodynamic parameters at different time interval after 3-in-1 block and FICB in lower limb surgeries. One such study by Shukla U et al., compared heart rate and MAP at different time intervals and found that heart rates in FNB group and FICB group were comparable at all times [11]. Deniz S et al., also found no statistically significant difference between the groups based on MAP and HR [14]. The studies which compared 3-in-1 femoral block and FICB for providing postoperative analgesia in patients undergoing lower limb surgeries provided limited information about changes in haemodynamic effects.

The advantage of 3-in-1 block is that it uses a single injection to block femoral, lateral femoral cutaneous and obturator nerves which constitute the major sensory supply of lower extremity facilitating effective perioperative anaesthesia and analgesia in lower limb surgeries. This block can also result in anaesthesia sparing to the obturator nerve and lateral femoral cutaneous nerve, thereby leading to increased dissatisfaction among patients [18]. Whereas, FICB was introduced as a safer alternative to 3 in 1 block in children [15]. Placed more laterally in the inguinal region FICB captures the three major sensory nerves supplying lower extremity simultaneously reducing chances of arterial puncture as well as nerve damage [16].

Limitation(s)

It is a single centre study. It did not include other age groups like children and very elderly patients. This study also did not include surgeries done in an emergency. The blocks were given in patients under general anaesthesia, and not in awake patients.

CONCLUSION(S)

Both 3-in-1 block and FICB are used to provide postoperative analgesia to patients undergoing lower limb orthopaedic surgeries. FICB is a fascial plane block whereas 3-in-1 block specifically targets three major nerves of the lower limb, viz., femoral nerve, lateral femoral cutaneous nerve and obturator nerve. The authors compared ultrasound guided 3-in-1 block with FICB in adult patients undergoing lower limb orthopaedic surgeries under general anaesthesia with comparable demographic characteristics. The present study concluded that 3-in-1 block provides better postoperative analgesia than FICB in terms of reduced VAS pain scores and prolonged duration of analgesia. The mean time to postoperative rescue analgesia was significantly lower in FICB group as compared to 3-in-1 block group. As regards to the haemodynamic variables, there was a slight reduction in diastolic as well as mean blood pressure in FICB group which was clinically insignificant. There were no statistically significant haemodynamic changes in the 3-in-1 block group. There were no clinically significant complications in either of the study group. To sum up, the FICB and the 3-in-1 block, both are effective methods of postoperative analgesia following lower limb surgeries but 3-in-1 block provides better and prolonged analgesia.

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