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ORIGINAL RESEARCH

A comparative study to compare the incidence of tourniquet induced hypertension in lower limb surgery under general anaesthesia in subcutaneous injection combined with sympathetic nerve blocks and femoral nerve blocks with peri-femoral artery block

[1]Dr. Deepak Bansal, [2]Dr. Kaushal Kumar Sahu, [3]Dr. Bimlesh Kumar Dhruv, [4]Dr. Navil Kumar Sharma

[1]Assistant Professor, [3]Senior Resident, [4]Associate Professor, Department of General Surgery, Chandulal Chandrakar Memorial Government Medical College, Bhilai, Chhattisgarh, India
[2]Associate Professor, Department of Anaesthesia, Chandulal Chandrakar Memorial Government Medical College, Bhilai, Chhattisgarh, India

Corresponding author
Dr. Navil kumar Sharma
Associate Professor, Department of General Surgery, Chandulal Chandrakar Memorial Government Medical College, Bhilai, Chhattisgarh, India
Email: navilsharma@gmail.com

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ABSTRACT

Background: TH (tourniquet-induced hypertension) is an unresolved issue prevalent globally including in India. To address this issue, various techniques have been explored including subcutaneous infiltration, peri-femoral artery blocks, and/or peripheral nerve blocks. **Aim:** The present study aimed to compare the incidence of tourniquet-induced hypertension during lower limb surgery under general anesthesia between subcutaneous infiltration and peri-femoral artery block combined with sciatic nerve blocks and femoral nerve block. The study also considered antihypertensive and intravenous fentanyl uses along with postoperative pain scores. **Methods:** The present study assessed 116 subjects who undergoing elective lower limb surgery. Subjects were divided into SI (subcutaneous infiltration) or P-FAB (peri-femoral artery block) groups. All subjects were given general anesthesia along with sciatic and femoral nerve blocks. TH was taken as a 30% rise in systolic blood pressure from baseline. The numerical rating scale was used to assess pain in the post-anesthetic care unit and at 4, 8, 12, and 24 hours after surgery. **Results:** The study results showed no significant difference in the TH incidence in SI and P-FAN groups, with p=1.00. Also, no significant difference was seen in intraoperative antihypertensive and fentanyl use, with p=0.994 and 0.457, respectively. There was no significant intergroup difference concerning all measured aspects, including incision sites and thigh, with p>0.05. **Conclusions:** The present study concludes that in subjects undergoing lower limb surgeries, the addition of peri-femoral artery block to general anesthesia with a sciatic and femoral nerve block to general anesthesia did not reduce the incidence of tourniquet-induced hypertension in comparison to subcutaneous infiltration.

Keywords: Anaesthesia, femoral artery, femoral nerve block, hypertension, nerve block, subcutaneous infiltration, tourniquets

INTRODUCTION

Tourniquets are commonly used in majority of the Orthopedic surgeries to reduce blood loss, especially in lower limb surgeries. However, a significant number of subjects are reported to have TH (tourniquet-induced hypertension) marked by intense pain, arterial blood pressure, increased heart rate, and elevated arterial SBP (systolic blood pressure). TH, when left unmanaged, tourniquet-induced hypertension can result in various complications.[1]

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TH is usually managed with antihypertensive agents and sedatives; however, these can cause various side effects such as vomiting, nausea, hypoxemia, drowsiness, and hypotension after tourniquet deflation. PNBs (peripheral nerve blocks) have been suggested as an alternative and various studies have reported their efficacy in the reduction of intraoperative TH. Additionally, multipleperipheral nerve blocks innervating both posterior and anterior thighs as combined SNB (sciatic nerve block) and FNB (femoral nerve block) have depicted high efficacy in TH reduction in comparison to single PNB during knee surgery, however, the effect remains incomplete.[2]

Literature data has suggested perivascular plexus presence regulating vasomotor function and blockage of the network which can reduce the TH incidence. It has been reported that a combination of saphenous and sciatic nerve blocks with FAB (femoral artery block)significantly decreases intraoperative TH compared with PNB alone. It also depicted the application and mechanism of FAB.[3]

However, it is not clear if the effect is from the block technique or the effect of the local anesthetic agent. Also, tourniquet inflation tolerance with subcutaneous local infiltration is also suggested.[4] The present study aimed to compare the efficacy of subcutaneous infiltration and peri-FAB (P-FAB) combined with SNB and FNB in decreasing the incidence of TH in two groups. The study also assessed intraoperative opioid and antihypertensive consumption and postoperative pain scores at the thigh and surgical sites.

MATERIALS AND METHODS

The present single-center, double-blind, randomized controlledstudy was aimed to compare the efficacy of subcutaneous infiltration and peri-FAB (P-FAB) combined with SNB and FNB in decreasing the incidence of TH in two groups. The study also assessed intraoperative opioid and antihypertensive consumption and postoperative pain scores at the thigh and surgical sites.The study was done atDepartment of General Surgery and Anaesthesia,ChandulalChandrakarMemorial Government Medical College, Bhilai Chhattisgarh. Verbal and written informed consent were taken from all the subjects before study participation.

The study included subjects undergoing lower limb surgeries with thigh tourniquet inflation times>90 minutes, subjects aged 18-65 years, in ASA (American Society of Anesthesiologists) physical status I or II, and weight of >50 kg. The exclusion criteria for the study were subjects that were not willing to participate, contraindications to regional anesthesia or study medication, known drug allergies, difficult airway, uncontrolled hypertension, persistent opioid use, risk of local anesthesia toxicity, and subjects not willing to participate.

A total of 116 subjects were divided into 2 groups as SI group (control group) which was given subcutaneous infiltration with FNB and SNB and the experimental group P-FAB with FNB and SNB. Each group was given premedication with 1 mg intravenous midazolam and 25 µg fentanyl before PNB. Anesthesiologists with >5 years' experience in ultrasound-guided PNB performed the FNB and SNB using a 100-mm nerve stimulation needle. All subjects underwent injection of 20 mL of 0.25% bupivacaine with popliteal SNB and ultrasound-guided using a high-frequency linear transducer. In FNB, the inguinal crease was accessed on the operated site, and an ultrasound transducer was placed along the inguinal ligament for the identification of femoral vessels and nerves. Utilizing the in-plane technique, the block needle was advanced till the tip was placed under fascia iliaca, and 20 mL of 0.25% bupivacaine was injected in 5 mL doses with intermittent negative aspiration.

In the P-FAB group, the block needle was advanced in the plane from the lateral to the anteromedial aspect of the femoral artery. Following negative aspiration, 8 mL of 1% lidocaine with epinephrine (0.005 mg/mL) was injected. The needle was withdrawn slightly and was advanced to the posterolateral aspect of the femoral artery. Following negative aspiration, 7 mL of 1% lidocaine with epinephrine 0.005 mg/mL was injected to attain adequate 7 mL of 1% lidocaine with epinephrine 0.005 mg/mL was injected. In the SI group, a subcutaneous injection of 15 mL of 1% lidocaine with epinephrine (0.005 mg/mL) was administered in the subinguinal area using ultrasound guidance following FNB.

During surgery, general anesthesia was given to all the subjects, and 0.5mg/kg ketamine and 1-2mg/kg intravenous propofol were used as induction agents followed by the insertion of a laryngeal mask airway. Sevoflurane was used for anesthesia maintenance with a target minimum alveolar concentration of 1.3 in an oxygen-air mixture. For prophylaxis of PONV (postoperative nausea and vomiting), 8mg ondansetron and 10 mg dexamethasone were given intravenously 30 minutes before completion of surgery. A thigh tourniquet was applied to all the subjects at a pressure setting of 250-320 mmHg based on the preference of the surgeon. The laryngeal mask was removed at surgery end once the subjects were responsive and awake.

TH was defined as a 30% SBP increase during intraoperative tourniquet inflation. Baseline SBP was assessed before tourniquet inflation and vital signs were assessed every 5 minutes. In the case of TH, 0.2mg intravenous nicardipine was given followed by 25 µgintravenous fentanyl after three dosages of nicardipine. All subjects underwent routine anesthetic care after the completion of surgery.

The primary objective of the study was intraoperative TH incidence as a 30% increase in SBP above baseline at any time point during the procedure.

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Secondary outcomes were intravenous nicardipine and fentanyl use along with NRS pain scores at the thigh and surgical site (0–10, where 0 = no pain and 10 = the worst imaginable pain) in the post-anesthetic care unit (PACU) at 4, 8, 12, and 24 h postoperatively. Other parameters assessed were cold sensation tests, prolonged sensorimotor blockade assessed through manual tests for quadriceps muscle strength, the incidence of nerve injury,PONV and dizziness scores by NRS (0–100) at PACU and on postoperative day (POD)1, and thigh circumference (preoperatively, at PACU, and 12 and 24 h postoperatively).

The data gathered were statistically analyzed using SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk. NY, USA) for assessment of descriptive measures, Student t-test, ANOVA (analysis of variance), Fisher's exact test, Mann-Whitney U test, and Chi-square test. The results were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered.

RESULTS

The present single-center, double-blind, randomized controlledstudy was aimed to compare the efficacy of subcutaneous infiltration and peri-FAB (P-FAB) combined with SNB and FNB in decreasing the incidence of TH in two groups. The study also assessed intraoperative opioid and antihypertensive consumption and postoperative pain scores at the thigh and surgical sites. The present study assessed 116 subjects who had to undergo elective lower limb surgery. Subjects were divided into SI (subcutaneous infiltration) or P-FAB (peri-femoral artery block) groups. The mean age of the study subjects in the SI and P-FAB group was 50.35±16.36 and 53±15.79 years, mean BMI was 24.46±3.73 and 25.10±3.83 years. There were 32 males and 22 females in SI and 34 males and 20 females in the P-FAB group. In the SI group, 24 and 28 subjects were from ASA I and II, and in P-FAB, 16 and 38 subjects respectively. Surgery of the ankle and foot was done in 34 and 20 subjects from SI and 32 and 22 subjects from the P-FAB group respectively. Preoperative NRD scores were 0 in both groups. Hypertension was reported in 14 and 22 subjects from the SI and P-FAB group respectively. Mean surgical time was 190.87±65.96 and 185±100.79 minutes in SI and P-FAB groups and the mean tourniquet pressure was 296.1±20.01 and 301.09±12.49mmHg in SI and P-FAB groups respectively (Table 1).

On assessing the incidence of tourniquet-induced hypertension, it was reported in 28 subjects from the SI group and 28 subjects from the P-FAB group respectively which was statistically non-significant with p=1.00. Preoperative non-hypertension was seen in 16 and 14 subjects from SI and P-FAB groups respectively depicting statistical non-significance with p=0.819. Preoperative hypertension was seen in 12 subjects from SI and 14 subjects from the P-FAB group which was statistically non-significant with p=0.596 (Table 2).

It was seen that for a description of antihypertensive and opioid use in two groups of study subjects, fentanyl was used in 22 subjects from SI and 16 subjects from the P-FAB group which was non-significant with p=0.391. The time of fentanyl use was 0-30 mins in no subject from either group, 35-60 mins in 6 subjects from SI group, 65-90 mins in 10 and 8 subjects from SI and p-FAB group, 95-129 mins in 2 and 4 subjects from SI and p-FAB group, and 125-50 mins in 6 and 4subjects from SI and p-FAB group with p=1.00 showing non-significant difference in both the groups at all the times. Maximum dose of fentanyl in SI and P-FAB group was 0.63 and 1.00 (p=1.00). Nicardipine was used in 12 subjects each from SI and P-FAB groups respectively. Time of Nicardipine use was non-significant in two groups with p=0.09. 0.115, and 0.48 at 35-60, 65-90, and 90-120 minutes respectively. However, a significantly higher number of subjects in the P-FAB group used nicardipine compared to the SI group at 125-150 minutes with p=0.02. Total nicardipine use was 0.6 mg in both groups (Table 3).

The study results showed that for postoperative parameters in two groups of study subjects nerve complication incidence was not seen in any study subject from either group. Mean thigh circumference in the two groups was comparable at preoperative, PACU, 12, and 24 hours with p=0.805, 0.642, 0.811, and 0.945 respectively. Mean dizziness scores at PACU and on day 1 were non-significant with p=0.937 and 0.151 respectively in the two groups. Mean PONV, NRS, and mean thigh pain NRS were 0 in both groups at all the assessed time intervals (Table 4).

Table 1: Demographic data of two groups of study subjects

S. No	Characteristics	SI Group (n=54)	P-FAB group (n=54)
1.	**Mean age (years)**	50.35±16.36	53±15.79
2.	**Height (cm)**	162.80±9.19	165.04±7.00
3.	**Weight (kg)**	64.95±10.53	67.81±12.57
4.	**BMI (kg/m2)**	24.46±3.73	25.10±3.83
5.	**Gender**		
a)	Males	32	34
b)	Females	22	20
6.	**ASA physical status I/II**	24/28	16/38
7.	**Surgery (ankle/foot)**	34/20	32/22

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8.	**Preoperative hypertension (n)**	14	22
9.	**Preoperative pain scores (NRS)**	0	0
10.	**Mean surgical time**	190.87±65.96	185±100.79
11.	**Mean tourniquet pressure (mmHg)**	296.1±20.01	301.09±12.49

Table 2: Tourniquet-induced hypertension subgroup analysis

S. No	Parameters	SI Group (n=54)	P-FAB group (n=54)	p-value
1.	**TH incidence**	28	28	1.00
2.	**Preoperative non-hypertension**	16	14	0.819
3.	**Preoperative hypertension**	12	14	0.596

Table 3: Description of antihypertensive and opioid use in two groups of study subjects

S. No	Parameters	SI Group (n=54)	P-FAB group (n=54)	p-value
1.	**Fentanyl use incidence**	22	16	0.391
a)	**Time of use (min)**			
i.	0-30	0	0	-
ii.	35-60	6	0	0.239
iii.	65-90	10	8	1.00
iv.	95-120	2	16	0.805
v.	125-150	6	4	1.00
b)	**Total fentanyl dose (µg)**	0, 0.73	0, 0.100	0.457
2.	**Nicardipine use incidence**	12	12	1.00
a)	**Time of use**			
i.	0-30	0	0	-
ii.	35-60	18	6	0.09
iii.	65-90	16	26	0.115
iv.	95-120	14	14	0.48
v.	125-150	0	10	**0.02**
b)	**Total nicardipine use (mg)**	0, 0.6	0, 0.6	0.990

Table 4: Postoperative parameters intwo groups of study subjects

S. No	Postoperative complications	SI Group (n=54)	P-FAB group (n=54)	p-value
1.	**Nerve complication incidence**	0	0	-
2.	**Mean thigh circumference (cm)**			
a)	Preoperative	43.69±5.62	43.35±4.3	0.805
b)	At PACU	44.31±5.05	45.15±7.79	0.642
c)	12 hours	43.89±5.29	43.57±4.33	0.811
d)	24 hours	43.5±5.17	43.59±4.16	0.945
3.	**Mean dizziness scores**			
a)	At PACU	0	0	0.937
b)	Day 1	0	0	0.151
4.	**Mean PONV scores**			
a)	At PACU	0	0	-
b)	Day 1	0	0	-
5.	**NRS (surgical site pain)**			
a)	At PACU	0	0	-
b)	4 hours	0	0	-
c)	8 hours	0	0	-
d)	12 hours	0	0	-
e)	24 hours	0	0	-
6.	**Mean thigh pain NRS**			
a)	At PACU	0	0	-
b)	4 hours	0	0	-
c)	8 hours	0	0	-
d)	12 hours	0	0	-
e)	24 hours	0	0	-

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DISCUSSION

The present study assessed 116 subjects who had to undergo elective lower limb surgery. Subjects were divided into SI (subcutaneous infiltration) or P-FAB (peri-femoral artery block) groups. The mean age of the study subjects in the SI and P-FAB group was 50.35±16.36 and 53±15.79 years, mean BMI was 24.46±3.73 and 25.10±3.83 years. There were 32 males and 22 females in SI and 34 males and 20 females in the P-FAB group. In the SI group, 24 and 28 subjects were from ASA I and II, and in P-FAB, 16 and 38 subjects respectively. Surgery of the ankle and foot was done in 34 and 20 subjects from SI and 32 and 22 subjects from the P-FAB group respectively. Preoperative NRD scores were 0 in both groups. Hypertension was reported in 14 and 22 subjects from the SI and P-FAB group respectively. Mean surgical time was 190.87±65.96 and 185±100.79 minutes in SI and P-FAB groups and mean tourniquet pressure was 296.1±20.01 and 301.09±12.49mmHg in SI and P-FAB groups respectively. These data were comparable to the previous studies of

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CONCLUSIONS

The present study, considering its limitations, concludes that in subjects undergoing lower limb surgeries, the addition of peri-femoral artery block to general anesthesia with a sciatic and femoral nerve block to general anesthesia did not reduce the incidence of tourniquet-induced hypertension in comparison to subcutaneous infiltration.

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