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Original Research Article

Comparative Study of Cardiovascular Morbidity with Ultrasound -Guided Combined Sciatic-Femoral Block and Unilateral Spinal Anaesthesia in High - Risk Patients Posted For Lower Limb Surgeries

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Abstract

Background & Aims: Unilateral spinal anaesthesia (USA) is known for its cardiovascular stability and used in high-risk patients for its safety profile. Ultrasound-guided combined sciatic femoral block (US CSFB) is an alternative to USA for lower limb surgeries. This prospective observational study, we compared cardiovascular morbidity of US CSFB and USA in high-risk patients undergoing lower limb surgeries.

Methods: After institutional ethics committee approval 80 ASA III, IV patients were enrolled. 40 in USA and 40 in CSFB group and heart rate, blood pressure, changes in SpO_2 and electrocardiography, requirement of vasopressors, fluid management were monitored.

Results: Hypotension incidence was 51% in USA group and 2.5% with CSFB group ($P < 0.001$). USA group showed maximum percentage fall from baseline SBP at 20th minute (-14.78% with P 0.001) and CSFB group showed no significant fall and better hemodynamic stability.

Conclusion: US CSFB provides better hemodynamic stability compared to USA in high risk patients undergoing lower limb surgeries.

Keywords: sciatic-femoral block, unilateral spinal anaesthesia, high-risk patients, cardiovascular morbidity.

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Introduction

Management of high - risk patients is always a challenging task for anaesthesiologists due to increased perioperative morbidity and mortality among them. Regional anaesthesia including spinal anaesthesia and peripheral nerve blocks is preferred for patients with multiple comorbidities because it reduces complications as compared to general anaesthesia (GA). [1, 2]

Unilateral spinal anaesthesia (USA) offers greater cardiovascular stability and fewer hemodynamic side effects than conventional spinal anaesthesia for lower limb surgeries. [3-5]

Peripheral nerve blocks provide cardiorespiratory stability, and prolonged analgesia with fewer side effects compared to the central neuraxial blockade. [6, 7] Combined sciatic-femoral block (CSFB) is one of the various nerve blocks administered for lower limb surgeries.

Ultrasound-guided sciatic–femoral nerve block (US CSFB) improves block quality, reduces the number of needle insertion attempts, administration time, local anaesthetic dose and speeds onset. [8, 9] While low dose spinal anaesthesia and USA have been studied in high - risk patients, few studies compare USA and CSFB. Hence, in this prospective observational study, we compared cardiovascular morbidity between US CSFB and USA in high - risk patients undergoing lower limb surgeries.

Methods

This prospective observational study (2020 - 2021) had institutional ethics committee approval (IEC/857/18) from a tertiary care center attached to a medical college and followed the Declaration of Helsinki.

Eighty consenting American Society of Anaesthesiologists (ASA) III and IV patients aged 18 to 90 years who were undergoing lower limb surgeries were enrolled. Forty patients received US CSFB were included in the CSFB group and 40 patients received USA were included in the USA group.

After preoperative evaluation, all relevant investigations including electrocardiogram (ECG), chest X-ray, 2D echocardiography etc, were noted. All patients received 2 ml/kg/hour of balanced salt solution during fasting. In the operation theatre, standard monitors were attached. All the patients were monitored with non-invasive blood pressure (NIBP) 5 lead ECG with leads II and V5 with ST segment analysis and pulse-oximeter (SpO_2). All patients received oxygen 2 L/min through nasal prongs.

A standard protocol for administration of US CSFB and USA was followed as per senior anaesthesiologist. For study purpose we observed baseline heart rate, systolic blood pressure (SBP), mean arterial pressure blood pressure (MAP), SpO_2 and volume of preloading intravenous fluid (IVF).

USA group patients received subarachnoid in block in lateral position with 1.2 ml (6mg) of 0.5% hyperbaric bupivacaine in L3-L4 space using 25-gauge Quincke needle. Patients were kept in lateral position for 10 minutes following block. In our study, unilateral spinal anaesthesia was defined as sensory block up to the T12 level with complete motor blockade and no contralateral sensory or motor block. In CSFB group, ultrasound guided (Samsung HS60) Femoral and sciatic nerve blocks were given using a mixture of 0.25% bupivacaine and 1% lignocaine with adrenaline (1:200,000) 15ml for the femoral and 25 ml for the sciatic nerve. Adequate US CSFB block was defined as sensory block in sciatic and femoral nerves distribution with immobility of the ankle and knee operated limb.

Hemodynamic variables including heart rate, SBP, MAP, SpO2 were monitored every 5 minutes for 20 minutes, then every 10 minutes until surgery end. We recorded. Intraoperative bradycardia, tachycardia, hypotension, desaturation, ECG changes, vasopressors and IVF requirement, adverse events and treatment. Bradycardia was defined as heart rate <50 beats per minute and treated with atropine 0.5-1.5 mg intravenously. Tachycardia was defined as heart rate >20% of baseline. Hypotension was defined as SBP <20% of preoperative level. If SBP decreased >20% of baseline or < 90 mmHg, phenylephrine 10 micro grams (P10) in increments (maximum of 100 microgram) or ephedrine 6mg (E6) according to heart rate. Noradrenaline was started if patients unresponsive to both.

Considering the power of the study 80%, alpha error of 0.05, and incidence of hypotension in USA as 30% and that in CSFB as 5 %, we have calculated the sample size of 36 patients in each group, we have included 40 patients in each group with a 10% drop out rate. Descriptive statistics were used to summarize the baseline characteristics. All qualitative variables were presented as frequency and percentages and quantitative variables as mean and standard deviation. Based on the normality, either an independent t test or Mann -Whitney U test was used for intergroup comparison .Within group comparison of variable from base line to each time point, either paired t test or Wilcoxon signed rank test were used. For comparing incidence between groups chi - square test was used. A p <0.05 was significant. All data were entered in Microsoft Excel and analyzed using SPSS version 20.0

Results

Initially both groups had 40 patients.one patient in the USA group was excluded due to inadequate block. Demographic characteristics were comparable between groups (Table 1), except ASA classification which differed significantly (P 0.001).CSFB group had more ASA IV patients.

Table 1: Demographic data

Parameter	USA	CSFB	P value
Age(years)	61.33±11.43	58.15±12.12	0.234
Gender (M/F)	21(53.8%)/18(46.2%)	22(55%)/18(45%)	0.919
BMI (kg/m^2)	25.61±1.97	24.71±2.13	0.054
ASA			**0.001**
III	32(82.1%)	19(47.5%)	
IV	7(17.9%)	21(52.5%)	

Age and BMI are expressed as mean ±standard deviation. Sex and ASA status are represented as number (%). The P value of <0.05 is statistically significant. BMI-body mass index.

Patients in our study had multiple comorbidities making them high risk for surgeries. (Table 2)

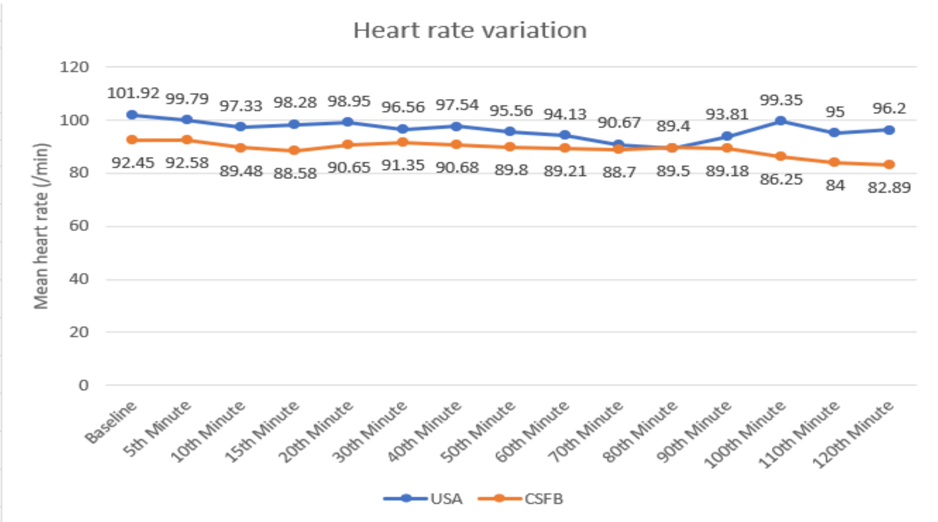
Table 2: Distribution of comorbidities among the study groups

Comorbidities	USA, (n=39) (%)	CSFB, (n=40) (%)
Uncontrolled hypertension	6(15.38%)	1 (2.50%)
Uncontrolled diabetes	13 (33.33%)	12 (30%)
Controlled hypertension	11 (28.21%)	8 (20%)
Controlled diabetes	5 (12.82%)	12 (30%)
Coronary Artery Disease	11 (28.21%)	6 (15%)

Chronic obstructive pulmonary disease	4 (10.26%)	4 (10%)
Chronic renal failure	5 (12.82%)	2 (5%)
Acute renal failure	5 (12.82%)	5 (12.50%)
Moderate reduction EF	3 (7.69%)	1 (2.50%)
Severe reduction EF	2 (5.13%)	5 (12.50%)
Cerebrovascular accidents	3 (7.69%)	3 (7.50%)
Addiction	2 (5.13%)	1 (2.50%)
AIDS	1 (2.56%)	1 (2.50%)
Epilepsy	2 (5.13%)	1 (2.50%)
Hyperthyroid	3 (7.69%)	0
Ectodermal dysplasia with bronchiectasis	0	1 (2.50%)
Decompensated liver disease	0	1 (2.50%)
Atrial fibrillation	0	2 (5%)

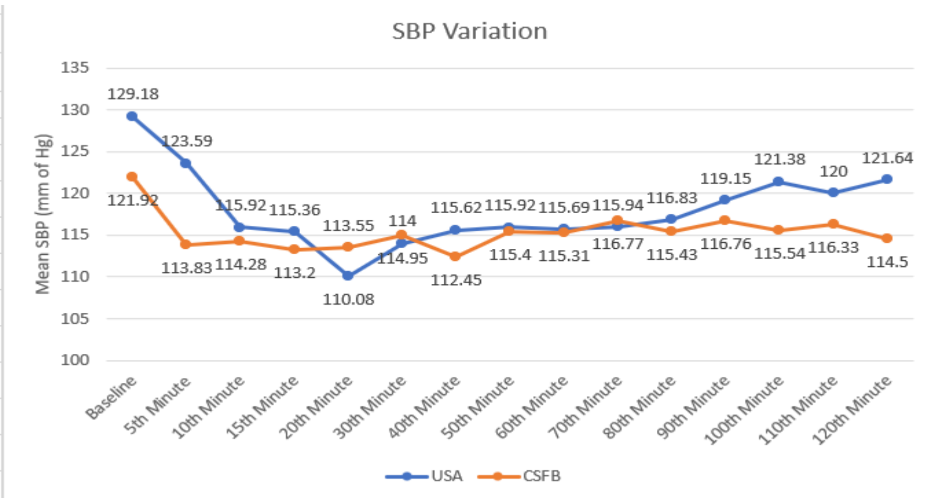
Table 2 shows percentage distribution of comorbidities in both groups. EF – ejection fraction, AIDS – acquired immunodeficiency syndrome.

Mean heart rate was higher in the USA group than in the CSFB group at all time points. (Graph 1) The difference was statistically significant at 15th and 20th minutes intraoperatively (P= 0.026 and 0.023), but clinically insignificant.



Graph 1: Mean heart rate between study groups

Graph 1 compares of mean heart rate between study groups at various time points.
The CSFB group showed less SBP variation than the USA group throughout intraoperative period. (Graph 2)



Graph 2: Mean SBP between study groups

Graph 2 shows compares mean systolic blood pressure between study groups at various time points. Table 3 shows the statistical significance of mean SBP changes from baseline and the percentage of variation.in the USA group, SBP fell significantly from baseline between 5th to 90th minutes. The maximum decrease at 20th minute (-14.78% with P 0.001).

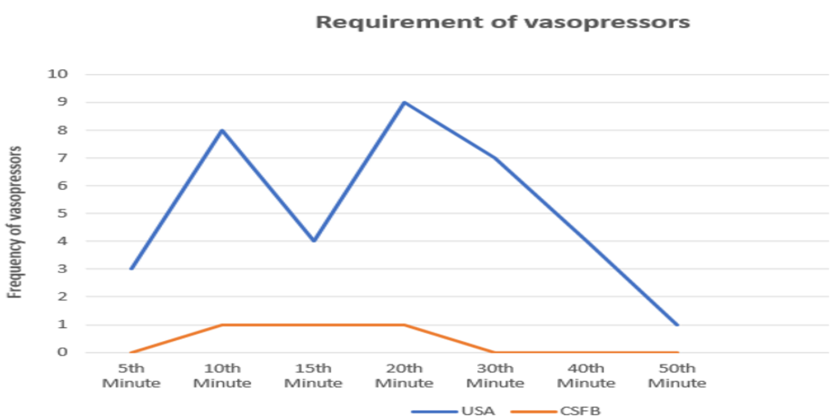
Table 3: SBP variation from baseline between study groups

Time point	USA (n=39)			CSFB (n=40)		
	Paired difference from baseline	Percentage of variation	P value	Paired difference from	Percentage of variation	P value
5th minute	5.59±2.12	-4.33%	**0.001**	8.09±1.82	-6.64%	0.203
10th minute	13.269±2.5	-10.26%	**0.001**	7.64±0.91	-6.27%	0.382
15th minute	13.82±2.70	-10.7%	**0.001**	8.72±0.97	-7.15%	0.091
20th minute	19.1±4.35	-14.78%	**0.001**	8.37±1.06	-6.87%	0.159
30th minute	15.18±3.43	-11.75%	**0.001**	6.97±1.82	-5.71%	0.946
40th minute	13.56±3.51	-10.49%	**0.001**	9.47±3.04	-7.77%	0.394
50th minute	13.26±2.87	-10.26%	**0.001**	6.52±1.54	-5.35%	0.834
60th minute	13.49±3.40	-10.44%	**0.001**	6.61±1.37	-5.42%	0.970
70th minute	13.24±3.35	-10.25%	**0.001**	5.15±1.45	-4.22%	0.906
80th minute	12.35±3.54	-9.56%	**0.001**	6.49±1.71	-5.3%	0.488
90th minute	10.03±3.39	-7.76%	**0.011**	5.16±2.34	-4.23%	0.672
100th minute	7.8±4.61	-6.03%	0.118	6.38±3.73	-5.23%	0.509
110th minute	9.18±6.57	-7.1%	0.081	5.59±5.08	-4.58%	0.315
120thminute	7.54±6.24	-5.84%	0.101	7.42±5.46	-6.08%	0.392

Mean SBP differences from baseline are expressed as mean ±standard deviation. The P value of <0.05 is statistically significant.

In CSFB group showed no statistically significant SBP decrease from baseline during surgery. In the USA group 20 of 39 patients had SBP fall >20% compared with20f 40 in the CSFB group. Hypotension incidence was found to be 51% in the USA group versus 2.5% in the CSFB group. This finding was statistically highly significant (P <0.001). MAP changes correlated with SBP in both groups. Preoperative T wave inversions were present in six patients in the USA group and three in the CSFB group. No new ST-T changes occurred intraoperatively. In the USA group, one patient developed atrial flutter and one had ventricular premature contractions (VPCs) 10 per minute. No desaturation occurred in either group. IVF requirement for preloading and the first two hours were comparable. Requirement of vasopressors was significantly higher in the USA group 19 versus 1 in CSFB group. (P <0.001). Sixteen USA group patients received phenylephrine 10 microgram for 33 total doses, while one CSFB group patient received three doses.

In USA group three patients required ephedrine 6mg and none in CSFB group required. Peak requirement of vasopressors was at 20th minute of blockade in USA group. Overall requirement of vasopressors was higher in USA group as compared to CSFB group (Graph 3). No others adverse events were observed intraoperatively.



Graph 3: Distribution of frequency of the requirement of vasopressors among the study groups

Discussion

We compared cardiovascular morbidity between US CSFB and USA in ASA III -IV patients undergoing lower limb surgeries. Cardiovascular morbidity was assessed by changes in heart rate SBP, MAP, and ECG, requirement of intravenous fluids, vasopressors, and adverse events.

Both groups had patients with multiple comorbidities, making them high risk for surgeries. Perioperative risk increases with higher ASA status. In the USA group (n = 39), 82% were ASA III and 18% were ASA IV. In the CSFB group (n=40), 47.5% patients were ASA III and 52.5% patients were ASA IV. Thus, the CSFB group had a higher proportion of ASA IV patients. In literature, several studies compared hemodynamic changes after USA and CSFB in ASA I and ASA II patients. [10, 11, 12] Few studies have evaluated with ASA III and IV patients receiving USA, [1, 13] and only case studies exist for ASA III and IV patients receiving CSFB. However, literature comparing USA and CSFB in high-risk patients is limited. Therefore, this prospective observational study, compared cardiovascular morbidity of US CSFB with USA in high-risk ASA III and IV patients undergoing lower limb surgeries.

Imbelloni LE et al compared USA (6mg of 0.5% bupivacaine) and CSFB in 60 ASA I, II patients [12] and reported no hypotension or bradycardia. In our study, bradycardia was absent in both groups. SBP did not decrease significantly from baseline in the CSFB group but fell significantly in the USA group. The possible explanation could be, in USA group, although we limited the spread of the spinal drug and its effect to one limb and expecting the increased venous capacity in affected side is compensated by a reflex vasoconstriction of the non-blocked areas. This compensation may be impaired in ASA III and IV patients with multiple comorbidities compared to ASA I, II patients.

In the USA group, SBP decreased significantly from baseline from 5 to 90 minute, with maximal reduction at the 20th minute (14.78% , P = 0.001). In USA group 20 patients versus one patient in the CSFB group showed a > 20% reduction from baseline. The incidence of hypotension was 51% in the USA group and 2.5% in the CSFB group (P <0.001). This may be due to reduced physiological hemodynamic reserve and impaired cardiovascular compensation in high-risk patients contributing to decreased cardiac output and blood pressure after spinal anaesthesia. [14-17] Thus, early detection and rapid correction of hemodynamic changes are critical in high-risk patients.

In the CSFB group, maximal SBP decrease from baseline was -7.7 % (P 0.394) at the 40th minute with no statistical significance. Multiple studies and case reports have documented stable hemodynamic stability with CSFB. [6, 10-12]

This may be attributed to CSFB being a peripheral nerve block, producing vasodilation limited to blocked dermatomes. This finding is clinically relevant for managing high risk patients with multiple comorbidities undergoing lower limb surgeries.

Lairez et al evaluated cardiovascular effects of low-dose spinal anaesthesia in elderly patients using echocardiography [18] and reported the incidence of spinal anaesthesia induced hypotension (66%) increases with age. Even with low doses (i.e., 7.5 mg of bupivacaine), spinal anaesthesia induced hypotension remains common in older patients due to impaired myocardial relaxation and reduced systolic function, decreasing cardiac output and systemic vascular resistance.

Ali L et al evaluated the safety of USA in elderly patients with cardiac failure (mean age of 80 years n = 20, ASA III and IV) undergoing major lower limb surgery using 7.5 mg of bupivacaine. [1]Hypotension incidence was 75%. The higher incidence compared to our study could be attributed to older age, higher bupivacaine dose, and cardiac failure in all patients.

No episodes of bradycardia occurred in either group in our study. Similarly, Imbelloni et al and Fanelli et al reported no bradycardia with USA and CSFB in ASA I, II [11, 12]

Hypotension after spinal anaesthesia is managed with vasopressors or intravenous fluids. However fluid overload increases the risk of pulmonary edema in patients with myocardial dysfunction or renal failure. Therefore, vasopressors were the preferred modality. The requirement of vasopressors was significantly higher in the USA group than in the CSFB group (48 % vs 2.5%; P <0.001).Ali L et al reported higher vasopressors use (70%) compared to our study. [1]

No significant ECG changes occurred intraoperatively except in two USA group patients. These patients developed flutter waves and VPCs, respectively, with metabolic acidosis on ABG. The ECG changes resolved after correcting acidosis. Yazigi A et al compared the frequency of myocardial ischemia in lower limb surgeries under general anaesthesia versus CSFB. [19] The number of ischemic episodes and number of patients affected were lower with CSFB. Consistent with this no significant ECG changes occurred in any CSFB group patient in our study.

In our study, group allocation was decided by the attending anaesthesiologist based on patient characteristics and surgery to ensure patient safety, which may introduce selection bias. As this was an observational study, future randomized controlled trials are warranted to validate these findings.

Conclusion

From our study, we conclude that both USA and US CSFB are effective anaesthetic techniques for lower limb surgeries. Our study demonstrated better hemodynamic stability with lower vasopressor requirement in the CSFB group than in the USA group in ASA III and IV patients. Therefore, ultrasound - guided combined sciatic- femoral block is recommended for high-risk patients undergoing lower limb surgeries who are prone to hemodynamic instability.

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