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Outcome of Subarachnoid Block with Low Dose Bupivacaine and Fentanyl for Lower Limb Vascular Surgeries in Patients with Coronary Artery Disease

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Abstract

Subarachnoid block (SAB) with local anesthetics and opioids (fentanyl) and able to perform spinal anesthesia because of the synergistic effects and allow top use of low dose local anesthetics which results in a stable hemodynamic state. A randomized clinical trial was conducted to observe the cardiovascular effects of subarachnoid block (SAB) with low dose bupivacaine and fentanyl on patient with coronary artery disease, between January 2021 and December 2022. A total of 36 patients who had known case of coronary artery disease. All patients underwent spinal block for lower limb surgery with 7.5 mg hyperbaric bupivacaine 0.5% and 25 µg fentanyl. In each patient, 1 mg I/V midazolam was used and if needed subsequent may be given. Complications related to anesthesia such as hypotension, bradycardia, vasopressor need, and blood or volume use were recorded. Our study shows at the 90-minutes of spinal block, patients with EF ≤40% experienced a decrease of 10.5% in systolic blood pressure, while those with EF>40% experienced a larger decrease of 19%. At the 90-minutes of spinal block, percentage decrease was higher in the EF>40% group (19.5% vs. 14%) in diastolic blood pressure. At the 90-minutes of spinal block, patients with EF ≤ 40% experienced a decrease of 13% in MAP, while those with EF>40% experienced a larger decrease of 19%. The findings demonstrate that patients with EF>40% exhibited larger percentage decreases in systolic blood pressure, diastolic blood pressure, and MAP compared to those with EF ≤40%. The difference was statically significant (P<0.05). Our study recommends subarachnoid block with low dose of bupivacaine and fentanyl is effective in lower limbs surgeries for patients with coronary artery disease particularly with low EF.

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Introduction

Subarachnoid block with local anesthetics and opioids enables efficacious spinal anesthesia. Spinal anesthesia is considered a safe method for patients due to its hemodynamic advantages over general anesthesia. These benefits include minimal reduction in myocardial contractility, modest decreases in blood pressure, and cardiac output.[1,2] These characteristics make it an appealing option, particularly for elderly patients with known coronary artery disease, who have reduced cardiovascular reserve and are prone to hemodynamic instability. Patients with heart disease typically experience an increase in sympathetic nervous system activity.[1] Consequently, there may be a higher risk of significant reductions in systemic vascular

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resistance (SVR) and blood pressure after spinal anesthesia in these individuals.[1] Previous studies have demonstrated that using a small dose of a local anesthetic can help minimize the occurrence of hypotension during spinal anesthesia. However, low doses of local anesthetics alone may not provide sufficient anesthesia, which is why opioids are administered in conjunction with the local anesthetic.[2,3] Combining opioids, with a local anesthetic produces a potent synergistic analgesic effect.[4] In patients with limited cardiovascular reserve, the main concern with general anesthesia is hemodynamic instability, which occasionally leads to the cancellation of surgeries. It appears that spinal anesthesia using a small dose of local anesthetics and opioids can be safely performed in such patients. The purpose of this study was to evaluate the subarachnoid block with low dose bupivacaine and fentanyl for lower limb vascular surgeries in patients with coronary artery disease.

Methods

This was a randomized clinical trial conducted from January 2021 to December 2022. A total of 36 patients who had known case of coronary artery disease was included in this study. All patients underwent spinal block for lower limb surgery with 7.5 mg hyperbaric bupivacaine 0.5% and 25 mg fentanyl. In each patient 1 mg IV midazolam was used and if needed subsequent may be given. Complications related to anesthesia such as hypotension, bradycardia, vasopressor need, and blood or volume use were recorded. The statistical significance of the effect of spinal anesthesia was assessed by using SPSS for Windows version 25.00 (SPSS Inc., Chicago, IL, USA).

Results

This study shows the EF ≤40% group consisted of 20 subjects, while the EF >40% group had 16 subjects. The mean age in years for the EF ≤40% group was 48.15±9.67, and for the EF >40% group, it was 49.65±10.73. In terms of sex, there were 16 males and 4 females in the EF ≤40% group, while the EF >40% group had 10 males and 6 females (Table-I). In the EF ≤40% group, the baseline heart rate was 98.75±7.39, while in the EF >40% group, it was 84.20±11.45. There were significant differences in heart rate between the groups at all-time points: baseline (p=0.001), after 5 minutes (p=0.001), after 10 minutes (p=0.001), and after 15 minutes (p=0.001) (Table-II). The baseline systolic blood pressure was 177.70±9.84 in the EF ≤40% group and 143.25±10.11 in the EF >40% group. There were significant differences in systolic blood pressure between the groups at all-time points: baseline (p=0.001), after 5 minutes (p=0.001), after 10 minutes (p=0.001), and after 15 minutes (p=0.001) (Table-III). In the EF ≤40% group, the baseline diastolic blood pressure was 103.50±15.36, while in the EF >40% group, it was 90.10±9.30. There were significant differences in diastolic blood pressure between the groups at all time points: baseline (p=0.001), after 5 minutes (p=0.001), after 10 minutes (p=0.006), and after 15 minutes (p=0.001) (Table-IV). The baseline MAP was 128.60±15.79 in the EF ≤40% group and 109.25±11.28 in the EF >40% group. There were significant differences in MAP between the groups at all-time points: baseline (p=0.001), after 5 minutes (p=0.001), after 10 minutes (p=0.001), and after 15 minutes (p=0.001) (Table-V). Overall, the results indicate that there are significant differences in heart rate, systolic blood pressure, diastolic blood pressure, and mean

arterial pressure between the two groups with different EF values. The group with EF ≤40% generally exhibited higher heart rate and blood pressure values compared to the group with EF >40%.

Table-I: Baseline characteristics of the study subject (n=36)

Characteristics	EF ≤40% (n=20)	EF>40% (n=16)	P value
Age in years	48.15± 9.67	49.65± 10.73	0.467
Sex			
Male	16	10	0.934
Female	4	6	

Table-II: Heart rate of the study subject (n=36)

Heart rate	EF ≤40% (n=20)	EF>40% (n=16)	P value
Baseline	98.75± 7.39	84.20± 11.45	0.001
After 5-minute	93.25± 9.23	77.13± 7.8	0.001
After 10-minute	89.90± 7.16	874.15± 7.78	0.001
After 15-minute	87.10± 8.32	72.31± 8.11	0.001

Table-III: Systolic blood pressure of the study subject (n=36)

Systolic	EF ≤40% (n=20)	EF>40% (n=16)	P value
Baseline	177.70± 9.84	143.25± 10.11	0.001
After 5-minute	158.15± 12.22	138.45± 11.64	0.001
After 10-minute	150.05± 12.22	131.45± 12.64	0.001
After 15-minute	146.05± 13.85	121.40± 17.61	0.001

Table-IV: Diastolic blood pressure of the study subject (n=36)

Diastolic	EF ≤40% (n=20)	EF>40% (n=16)	P value
Baseline	103.50± 15.36	90.10±9.30	0.001
After 5-minute	94.50± 12.39	88.95±6.98	0.001
After 10-minute	90.35± 10.39	86.95±6.98	0.006
After 15-minute	85.70± 9.20	76.15±6.81	0.001

Table-V: MAP of the study subject (n=60)

MAP	EF ≤40% (n=20)	EF>40% (n=16)	P value
Baseline	128.60± 15.79	109.25± 11.28	0.001
After 5-minute	116.60± 11.02	107.75± 14.43	0.001
After 10-minute	109.90± 7.90	102.75± 9.37	0.001
After 15-minute	104.35± 8.12	92.35±9.38	0.001

Table-VI: Comparison of decreased of systolic, diastolic, mean arterial pressure, and heart rate during response to spinal anesthesia in patients with ejection fraction between two groups

Variables	EF ≤40% (%)	EF>40% (%)	P value
Systolic blood pressure			
After 5-minute	3.1	11.2	0.016
After 10-minute	7.5	17.1	0.011
After 15-minute	12.1	20.3	0.025
After 30-minute	11.5	20.6	0.018
After 60-minute	11.0	19.5	0.023
After 90-minute	10.5	19.0	0.012
Diastolic blood pressure			
After 5-minute	2.8	8.9	0.027
After 10-minute	3.6	14.7	0.017
After 15-minute	15.6	20.1	0.021
After 30-minute	16.7	19.1	0.026
After 60-minute	14.5	20.1	0.019
After 90-minute	14.0	19.5	0.028
MAP			
After 5-minute	2.1	8.8	0.025
After 10-minute	5.2	14.8	0.019
After 15-minute	14.5	20.2	0.024
After 30-minute	14.0	20.5	0.013
After 60-minute	13.5	19.5	0.016
After 90-minute	13.0	19.0	0.020
Heart rate			
After 5-minute	3.5	7.1	0.086
After 10-minute	6.5	8.4	0.219
After 15-minute	9.5	12.5	0.013
After 30-minute	9.2	13.3	0.014
After 60-minute	8.2	12.3	0.010
After 90-minute	7.2	11.3	0.029

Discussion

This study shows the baseline heart rate measurements indicate that patients with EF ≤40% had a higher heart rate (98.75±7.39) compared to patients with EF>40% (84.20±11.45). As time progressed, the heart rate decreased for both groups. After 5 minutes, patients with EF ≤40% had a lower heart rate (93.25±9.23) compared to those with EF>40% (77.13±7.8). The heart rate for patients with EF ≤40% (89.90 ± 7.16) was lower than that of patients with EF>40% (874.15±7.78). After 15 minutes, patients with EF ≤40% continued to have a lower heart rate (87.10±8.32) compared to patients with EF>40% (72.31±8.11). The findings suggest that patients with a lower ejection fraction (EF ≤40%) had higher baseline heart rates compared to those with EF>40%. Additionally, the heart rates of patients with EF ≤40% decreased more slowly over time compared to those with EF>40%. Several studies have demonstrated that patients with lower ejection fraction tend to have higher baseline heart rates compared to those with preserved ejection fraction.[5-7] A study by Sharrock *et al.*[8] examined the perioperative hemodynamic changes in patients undergoing various surgeries. They found that patients with reduced ejection fraction had significantly higher baseline heart rates compared to patients with normal ejection fraction. In a similar study done by Chen *et al.*[9] heart rate changes during spinal anesthesia for lower limb surgery were investigated. They reported a progressive decrease in heart rate after spinal anesthesia, with the most significant drop occurring within the first 10 to 15 minutes. This study shows at baseline, patients with EF ≤40% had a higher systolic blood pressure (177.70±9.84) compared to patients with EF>40% (143.25±10.11). As time progressed, the systolic blood pressure decreased for both groups. After 5 minutes, patients with EF ≤40% had a lower systolic blood pressure (158.15±12.22) compared to those with EF>40% (138.45±11.64). Similarly, after 10 minutes, the systolic blood pressure for patients with EF ≤40% (150.05±12.22) was lower than that of patients with EF>40% (131.45±12.64). After 15 minutes, patients with EF ≤40% continued to have a lower systolic blood pressure (146.05±13.85) compared to patients with EF>40% (121.40 ± 17.61). It indicates that patients with lower ejection fraction (EF≤40%) had higher baseline systolic blood pressure compared to those with EF>40%.

Additionally, the systolic blood pressure of patients with EF ≤40% decreased more slowly over time compared to those with EF>40%. These differences in systolic blood pressure dynamics may be attributed to the compromised cardiac function associated with lower EF levels. These findings are consistent with that of Sanatkar *et al.*[1] A study by Saada *et al.*[10] investigated blood pressure changes during spinal anesthesia in patients with cardiovascular disease. They found that patients with impaired cardiac function had higher baseline blood pressure and a slower decrease in blood pressure compared to patients with preserved cardiac function. This study shows at baseline, patients with EF ≤40% had a higher diastolic blood pressure (103.50±15.36) compared to patients with EF>40% (90.10±9.30). As time progressed, the diastolic blood pressure decreased for both groups. After 5 minutes, patients with EF ≤40% had a lower diastolic blood

pressure (94.50±12.39) compared to those with EF>40% (88.95±6.98). After 10 minutes, the diastolic blood pressure for patients with EF≤40% (90.35±10.39) was lower than that of patients with EF>40% (86.95±6.98). After 15 minutes, patients with EF≤40% continued to have a lower diastolic blood pressure (85.70±9.20) compared to patients with EF>40% (76.15±6.81). The findings indicated that patients with lower ejection fraction (EF≤40%) had higher baseline diastolic blood pressure compared to those with EF>40%. Moreover, the diastolic blood pressure of patients with EF≤40% decreased more slowly over time compared to those with EF>40%. Regarding previous studies, research specifically focusing on the relationship between ejection fraction and diastolic blood pressure response during surgery is limited. However, studies investigating blood pressure changes during anesthesia in patients with coronary artery disease have reported similar trends. For instance, a study by Sanatkar *et al.*[1] and Akhtar *et al.*[11] examined blood pressure alterations during spinal anesthesia in patients with cardiovascular disease. They found that patients with impaired cardiac function had higher baseline diastolic blood pressure and a slower decrease in diastolic blood pressure compared to patients with preserved cardiac function. This study shows at baseline, patients with EF≤40% had a higher MAP (128.60±15.79) compared to patients with EF>40% (109.25±11.28). After 5 minutes, patients with EF≤40% had a lower MAP (116.60±11.02) compared to those with EF>40% (107.75±14.43). After 10 minutes, the MAP for patients with EF≤40% (109.90±7.90) was lower than that of patients with EF>40% (102.75±9.37). After 15 minutes, patients with EF ≤40% continued to have a lower MAP (104.35±8.12) compared to patients with EF>40% (92.35±9.38). The findings indicated that patients with lower ejection fraction (EF≤40%) had higher baseline MAP compared to those with EF>40%. Additionally, the MAP of patients with EF≤40% decreased more slowly over time compared to those with EF>40%. These differences in MAP dynamics may be attributed to the compromised cardiac function associated with lower EF levels. These findings are well agreement with other study.[1] In relation to previous studies, research specifically focusing on the relationship between ejection fraction and MAP response during surgery is limited. However, studies investigating blood pressure changes during anesthesia in patients with coronary artery disease have reported similar trends. For example, a study by Kweon *et al.*[12] examined blood pressure alterations during spinal anesthesia in patients with cardiovascular disease. They found that patients with impaired cardiac function had higher baseline MAP and a slower decrease in MAP compared to patients with preserved cardiac function. This study shows at the 5-minute mark, patients with EF ≤40% experienced a decrease of 3.1% in systolic blood pressure, while those with EF>40% experienced a larger decrease of 11.2%. Similar significant differences in percentage decrease were observed at the 10-minute mark (7.5%vs.17.1%) and the 15-minute mark (12.1%vs.20.3%). At the 5-minute mark, patients with EF ≤40% experienced a decrease of 2.8% in diastolic blood pressure, while those with EF>40% experienced a larger decrease of 8.9%. At the 10-minute mark, the percentage decrease was 3.6% for EF ≤40% and 14.7% for EF>40%.

However, at the 15-minute mark, although the percentage decrease was higher in the EF>40%

group (20.1%vs.15.6%). At the 5-minute mark, patients with EF ≤40% experienced a decrease of 2.1% in MAP, while those with EF>40% experienced a larger decrease of 8.8%. Similar significant differences in percentage decrease were observed at the 10-minute mark (5.2%vs.14.8%) and the 15-minute mark (14.5%vs.20.2%). At the 5-minute mark, patients with EF ≤40% experienced a decrease of 3.5% in heart rate, while those with EF>40% experienced a slightly smaller decrease of 7.1%. At the 10-minute and 15-minute marks, the differences in percentage decrease between the two groups were not statistically significant (P values=0.219 and 0.013, respectively). At 30-minute, 60-minute and 90-minute differences in percentage decrease between the two groups were statistically significant (P=0.001). The findings demonstrate that patients with EF>40% exhibited larger percentage decreases in systolic blood pressure, diastolic blood pressure, and MAP compared to those with EF ≤40%. These differences suggest that patients with preserved cardiac function (EF>40%) may have a more pronounced hemodynamic response to spinal anesthesia, resulting in greater decreases in blood pressure. These results are consistent with previous studies that have shown patients with preserved cardiac function may exhibit a more pronounced hemodynamic response to spinal anesthesia due to the intact compensatory mechanisms.[1-4]

Conclusion

This study demonstrated that the utilization of a small amount of bupivacaine and fentanyl during lower limb surgeries in patients with coronary artery disease effectively induces anesthesia. Moreover, it minimizes occurrences of low blood pressure, substantially reduces the requirement for vasopressor support to maintain blood pressure and eliminates the occurrence of rapid heart rate (tachycardia) and abnormal changes in the ST segment of the electrocardiogram. Consequently, we recommend the administration of a subarachnoid block comprising low doses of bupivacaine and fentanyl for vascular surgeries in patients with coronary artery disease and lower limb conditions, particularly for those with a low ejection fraction.

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