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EFFECT OF ELASTIC WRAPPING OF LOWER LIMBS ON HEMODYNAMIC CHANGES AFTER SPINAL ANESTHESIA IN LOWER ABDOMINAL SURGERIES

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ABSTRACT
Background: Spinal anesthesia is preferred for lower abdominal surgeries due to its benefits, but it can cause post-spinal hypotension (PSH). This study examines the effect of elastic wrapping of lower limbs on hemodynamic changes post-spinal anesthesia.
Methods: This double-blinded, randomized control study involved 60 patients undergoing lower abdominal surgery under spinal anesthesia. Patients were divided into two groups: Group A (legs wrapped with crepe bandages) and Group B (no wrapping). Hemodynamic parameters were monitored, and the incidence of hypotension and tachycardia was recorded.
Results: Group A exhibited significantly higher systolic and diastolic blood pressures at various intervals post-spinal anesthesia compared to Group B. The mean arterial pressure was also higher in Group A. The incidence of hypotension and tachycardia was significantly lower in Group A, with reduced need for rescue vasopressors.
Conclusion: Elastic wrapping of the lower limbs significantly stabilizes hemodynamic parameters following spinal anesthesia, reducing the incidence of hypotension and tachycardia. This non-pharmacological method is simple, safe, and effective.

Keywords: Spinal anesthesia, post-spinal hypotension, elastic wrapping, hemodynamic stability, lower abdominal surgery.

INTRODUCTION
Spinal anesthesia has become the preferred choice for lower abdominal surgeries due to its numerous advantages, such as higher patient satisfaction, fewer adverse events (e.g., nausea, vomiting, and sore throat), rapid onset, reliability, dense motor block, avoidance of airway complications associated with general anesthesia, and better postoperative analgesia. Despite these benefits, the most prevalent and dangerous side effect is hypotension, making the prevention and management of post-spinal hypotension (PSH) crucial to avoid serious outcomes.[1,2]
Spinal anesthesia induces a sympathetic block of the pre-ganglionic fibers, leading to decreased systemic vascular resistance, blood pooling in the lower limbs, and reduced cardiac output. The severity of hypotension is proportional to the degree of block achieved.[3]

The primary strategies for managing PSH include fluid loading, pharmacological agents, and positioning protocols.[4] Administering crystalloid or colloid solutions prior to spinal anesthesia can reduce the incidence and severity of PSH. However, adequate intravascular volume expansion alone is often insufficient, particularly in the elderly, necessitating the use of vasopressors.[5]
Preloading with crystalloids, while preferable to no fluid regimen, still results in significant PSH. Colloid preloading may offer better outcomes, although recent randomized controlled trials have shown inconsistent results. The concept of fluid co-loading—initiating rapid fluid administration simultaneously with the spinal block—has been developed to address the limited efficacy of fluid preloading. Studies generally favor co-loading over preloading, especially with crystalloids.[6,7]
Vasopressors, including ephedrine, phenylephrine, and mephentermine, are commonly used in addition to fluids to prevent hypotension. However, these agents carry risks of side effects such as anaphylaxis, hypertension, tachyphylaxis, and cardiac dysrhythmias.[8]
Given the limitations and side effects of pharmacological interventions, non-pharmacological methods have been explored. Wrapping the lower limbs with elastic crepe bandages or compression stockings is a simple, safe, and effective way to manage PSH. This technique prevents blood pooling in the lower limbs, increasing venous return and thus improving hemodynamic stability.[9]
Elastic wrapping of the lower limbs has shown to significantly reduce the incidence of spinal hypotension. Studies indicate that even simple leg elevation can be effective. Elastic bandages prevent blood pooling due to sympatholysis, thereby increasing venous return and cardiac output.[5,8]
Foot compression, using devices like pneumatic compression devices (PCD) or crepe bandages (CB), offers a quick and efficient method to prevent hypotension associated with spinal anesthesia. These approaches not only have physiological benefits but also eliminate drug-related adverse effects.
Combining CB or PCD with preloading and left lateral tilt has been shown to reduce the incidence and severity of hypotension. Studies comparing the leg wrapping group with control groups have reported lower incidences of hypotension in the leg wrapping group.
In conclusion, while spinal anesthesia offers significant benefits for lower abdominal surgeries, managing its primary complication—hypotension—requires a multifaceted approach. Non-pharmacological interventions, such as elastic wrapping of the lower limbs, provide a promising, safe, and effective method to enhance hemodynamic stability and improve patient outcomes.

MATERIALS AND METHODS

Study Area: The study was conducted in the Department of Anesthesiology, within the general surgery operation theatre.

Permission: Approval was obtained from the reference review board and the ethics committee.

Study Design: This hospital-based, double-blinded study was carried out from January 2022 to August 2022.

Study Universe: The study involved patients undergoing lower abdominal surgery under spinal anesthesia.

Eligibility Criteria:

Inclusion Criteria:
- Patients scheduled for lower abdominal surgery under spinal anesthesia.
- Patients who provided informed and written consent.
- Age between 20 and 60 years, of either sex.
- ASA grade I & II.

Exclusion Criteria:
- Patients with deranged coagulation profiles.

- Contraindications to spinal anesthesia, such as patient refusal, infection at the injection site, hypovolemia, and septicemia.
- History of varicose veins or deep vein thrombosis (DVT).
- History of allergic reactions to local anesthetics.
- Uncooperative patients.

Sample Size: With a 95% confidence interval and 80% power, a sample size of 30 cases per group was required to verify a minimum 46.66% difference in the incidence of hypotension between the two study groups.

Study Groups:
- **Group A (n=30):** Patients had their legs wrapped with a crepe bandage from the ankle to mid-thigh, applied tightly enough to feel firm but not painful, immediately before the administration of the subarachnoid block.
- **Group B (n=30):** Patients did not have their lower limbs wrapped but were covered immediately before the administration of the subarachnoid block.

Randomization: Randomization was achieved using the opaque sealed envelope method. A total of 60 envelopes (30 for each group) were prepared by an independent individual blinded to the study. Each patient drew one envelope and was assigned to the corresponding group.

Pre-Anesthetic Checkup: All patients were visited one day prior to surgery and informed about the anesthetic technique. The pre-anesthetic checkup included a review of medical and surgical history, general and physical examination, spine and airway examination, and vital parameters (blood pressure, pulse rate, respiratory rate). Routine investigations included:
- Hematological: Complete Blood Count.
- Biochemical: Random blood sugar, serum urea, serum creatinine, liver function tests (serum bilirubin, SGOT, SGPT), serum electrolytes (sodium, potassium, chloride).
- Electrocardiograph and chest X-ray.
- Coagulation profile: BT, CT, PT/INR.

Written informed consent was obtained after explaining the study protocol and procedures.
Procedure: Upon arrival in the operation theater, patients were identified, and their pre-anesthetic checkup and written consent were verified. Monitors (NIBP, SpO2, ECG) were attached, baseline vitals recorded, and IV access established with Ringer lactate started at 20 ml/kg/hr. The 60 patients were divided into two groups randomly.
In Group A (n=30), patients' lower limbs were wrapped and covered immediately before the subarachnoid block. In Group B (n=30), patients' lower limbs were not wrapped but were covered to ensure blinding before the administration of spinal anesthesia.

Leg Wrapping: A crepe bandage (15 cm width, 4 m stretched length) was applied from ankle to mid-thigh on both legs with the lower extremity raised at a 45-degree angle. The bandage was applied within 3 minutes by the same person to eliminate bias. Capillary pulsation in the toes was checked to avoid over-compression.
Under aseptic conditions, spinal anesthesia was performed using 15 mg (3 ml) of 0.5% hyperbaric bupivacaine with a 25G Quincke's needle in the L3-L4 interspace through the midline approach in the sitting position. Patients were then placed in a supine position.
Patients fasted for at least 6 hours and were premedicated with ranitidine 150 mg orally the night before and on the morning of surgery. Baseline vitals (HR, SBP, MAP, and SpO2) were recorded in the supine posture with a 15° left lateral tilt.

Hypotension Definition: A fall in systolic blood pressure to ≤90 mmHg or a >20% decrease from baseline MAP. Inj. mephentermine 6 mg was used as a rescue vasopressor for hypotension.

Outcome Analysis: Statistical analysis was performed using SPSS trial version 23.0 (IBM SPSS, US). Quantitative data were reported as mean ± standard deviation, and qualitative data as percentages. Incidence of hypotension and mephentermine requirement were analyzed using the Chi-square test, and serial hemodynamic measurements were analyzed by one-way ANOVA.

RESULTS

Distribution of Cases According to Age and Sex

The age distribution showed no significant difference between the groups (p=0.104). The mean age in Group A was 42.03 ± 13.563 years, while in Group B it was 36.27 ± 13.462 years. The majority of patients in Group A were in the 51-60 age range (36.67%), whereas in Group B, the 21-30 age range had the most patients (23.33%). The sex distribution was also comparable between the groups, with 66.67% males and 33.33% females in Group A, and 70.00% males and 30.00% females in Group B (p=1.000).

Baseline Vital Parameters

The baseline vital parameters, including systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), SpO2, and respiratory rate (RR), were similar between the groups. No significant differences were observed, indicating that the groups were comparable at baseline.

Intraoperative Hemodynamic Changes

Systolic Blood Pressure (SBP): Significant differences in SBP were observed between the groups from 4 to 10 minutes post-spinal anesthesia, with Group A showing higher SBP compared to Group B. At 4 minutes, SBP was 115.47 ± 9.63 mmHg in Group A and 106.93 ± 11.19 mmHg in Group B (p=0.002). At 6 minutes, SBP was 114.13 ± 10.77 mmHg in Group A and 102.90 ± 10.79 mmHg in Group B (p=0.000).

Diastolic Blood Pressure (DBP): Group A had significantly higher DBP from 4 to 10 minutes post-spinal anesthesia compared to Group B. At 4 minutes, DBP was 71.67 ± 6.036 mmHg in Group A and 67.50 ± 7.851 mmHg in Group B (p=0.025). At 6 minutes, DBP was 70.83 ± 6.670 mmHg in Group A and 65.57 ± 8.419 mmHg in Group B (p=0.009).

Mean Arterial Pressure (MAP): Significant differences in MAP were observed between the groups from 4 to 10 minutes post-spinal anesthesia. At 4 minutes, MAP was 86.27 ± 6.297 mmHg in Group A and 80.57 ± 8.492 mmHg in Group B (p=0.005). At 6 minutes, MAP was 85.30 ± 6.655 mmHg in Group A and 78.00 ± 8.534 mmHg in Group B (p=0.000).

Heart Rate (HR): Significant differences in HR were observed between the groups from 4 to 10 minutes post-spinal anesthesia, with Group B showing higher HR compared to Group A. At 4 minutes, HR was 78.37 ± 10.529 bpm in Group A and 90.03 ± 10.972 bpm in Group B (p=0.000).

Side Effects

Group B experienced significantly higher incidences of hypotension and tachycardia compared to Group A. Hypotension occurred in 56.67% of patients in Group B and 10.00% in Group A (p<0.001). Tachycardia was observed in 30.00% of patients in Group B and 6.67% in Group A (p=0.045).
In conclusion, elastic wrapping of the lower limbs significantly mitigated the hemodynamic changes post-spinal anesthesia, reducing the incidence of hypotension and tachycardia during lower abdominal surgeries.

First dose of vasopressure

The number of the cases required vasopressure were 8 (26.67%) in the group B at 6 min followed by 4 (13.33%) & 2 (6.67%.) in 4 min & 8 min respectively as compared to 2 cases in group A at 10 min only p-values is (p=<0.001S)

Total dose of vasopressure.

The Maximum total dose of 12 mg was needed in 40.00% of cases in the group B as compared to no cases in group A . p-values (<0.001S), where as 6mg was needed in 2 cases (6.67%) in each group.

Table 1: Distribution of Cases According to Age

Age Range	Group A (n=30)	Group B (n=30)	p-value
	No	%	No
≤20	2	6.67	4
21-30	6	20.00	7
31-40	8	26.67	7
41-50	3	10.00	6
51-60	11	36.67	6
Total	30	100.00	30
Mean ± SD	**42.03 ± 13.563**	**36.27 ± 13.462**	

Table 2: Comparison of Baseline Vital Parameters Between Groups

Parameter	Group A (n=30)	Group B (n=30)	p-value
	Mean ± SD	Mean ± SD	
SBP	128.00 ± 8.570	128.20 ± 8.248	0.927NS
DBP	80.47 ± 5.964	79.13 ± 7.109	0.434NS
MAP	96.30 ± 5.814	95.67 ± 8.147	0.730NS
Heart Rate	75.77 ± 5.606	77.97 ± 7.029	0.185NS
SpO2	99.47 ± 1.137	99.70 ± 0.837	0.369NS
Respiratory Rate	14.73 ± 0.691	14.37 ± 0.809	0.064NS

Table 3: Comparison of SBP Between Groups

Time (min)	Group A (n=30)	Group B (n=30)	p-value
	Mean ± SD	Mean ± SD	
0	125.53 ± 7.57	126.27 ± 6.69	0.692NS
2	120.47 ± 8.99	117.60 ± 8.75	0.216NS
4	115.47 ± 9.63	106.93 ± 11.19	0.002S
6	114.13 ± 10.77	102.90 ± 10.79	0.000S
8	110.97 ± 9.31	104.90 ± 11.66	0.03S
10	110.62 ± 8.58	105.20 ± 10.04	0.028S
15	109.77 ± 8.41	108.67 ± 10.05	0.647NS
20	117.00 ± 7.12	118.77 ± 8.58	0.388NS
25	116.57 ± 6.58	117.87 ± 8.57	0.513NS
30	117.53 ± 8.54	120.60 ± 8.76	0.175NS
35	117.03 ± 6.32	120.43 ± 7.36	0.060NS
40	118.87 ± 9.20	121.83 ± 7.02	0.166NS
45	118.64 ± 6.32	119.53 ± 7.11	0.617NS
50	118.92 ± 8.65	121.10 ± 8.33	0.345NS
55	118.36 ± 7.05	121.65 ± 7.97	0.151NS
60	121.39 ± 7.78	122.14 ± 6.71	0.775NS
65	119.41 ± 8.98	122.27 ± 5.61	0.355NS
70	117.55 ± 9.45	119.83 ± 5.78	0.600NS

75	117.71 ± 6.37	118.67 ± 5.03	0.826NS
80	124.00 ± 7.70	114.50 ± 0.71	0.176NS

Table 4: Comparison of DBP Between Groups

Time (min)	Group A (n=30)	Group B (n=30)	p-value
	Mean ± SD	Mean ± SD	
0	77.13 ± 7.089	78.67 ± 6.138	0.374NS
2	74.30 ± 6.675	73.20 ± 7.199	0.542NS
4	71.67 ± 6.036	67.50 ± 7.851	0.025S
6	70.83 ± 6.670	65.57 ± 8.419	0.009S
8	69.76 ± 4.958	65.00 ± 7.834	0.007S
10	69.63 ± 6.505	65.93 ± 6.782	0.03S
15	68.97 ± 5.792	67.50 ± 6.312	0.352NS
20	70.50 ± 5.569	72.90 ± 5.505	0.099NS
25	71.57 ± 7.749	74.47 ± 7.080	0.136NS
30	71.73 ± 7.524	72.80 ± 6.025	0.547NS
35	70.00 ± 6.998	72.37 ± 5.417	0.148NS
40	70.77 ± 7.214	72.43 ± 4.987	0.302NS
45	74.14 ± 6.317	74.67 ± 5.701	0.741NS

50	71.23 ± 6.055	73.69 ± 5.399	0.117NS
55	79.09 ± 6.248	76.30 ± 7.009	0.167NS
60	75.59 ± 6.801	73.93 ± 6.878	0.506NS
65	72.88 ± 6.811	75.09 ± 6.363	0.402NS
70	70.55 ± 4.298	74.33 ± 4.761	0.115NS
75	71.86 ± 4.845	71.67 ± 2.887	0.952NS
80	70.50 ± 3.786	71.50 ± 7.778	0.832NS

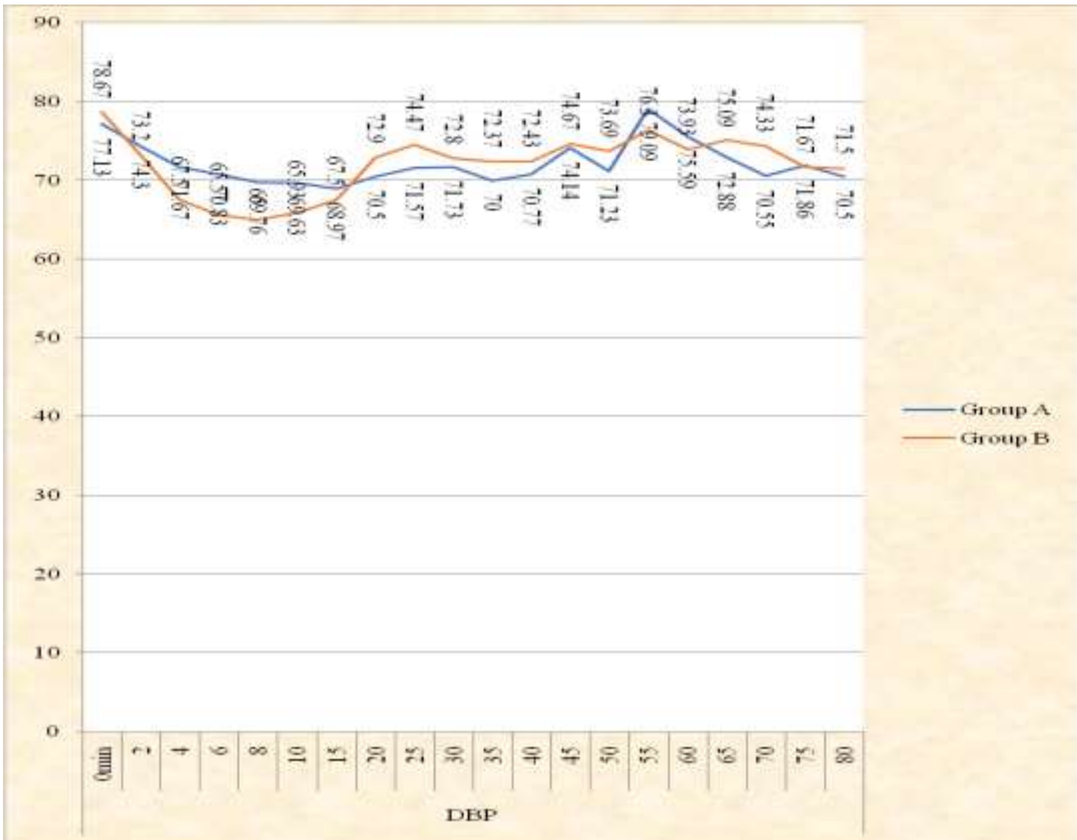


Table 5: Comparison of Side Effects Between Groups

	Group A		Group B		p-values
	No	%	No	%	
Hypotension	3	10.00	17	56.67	<0.001S
Nausea	1	3.33	6	20.00	0.108NS
Tachycardia	2	6.67	9	30.00	0.045S
Vomiting	0	0	4	13.33	0.121NS

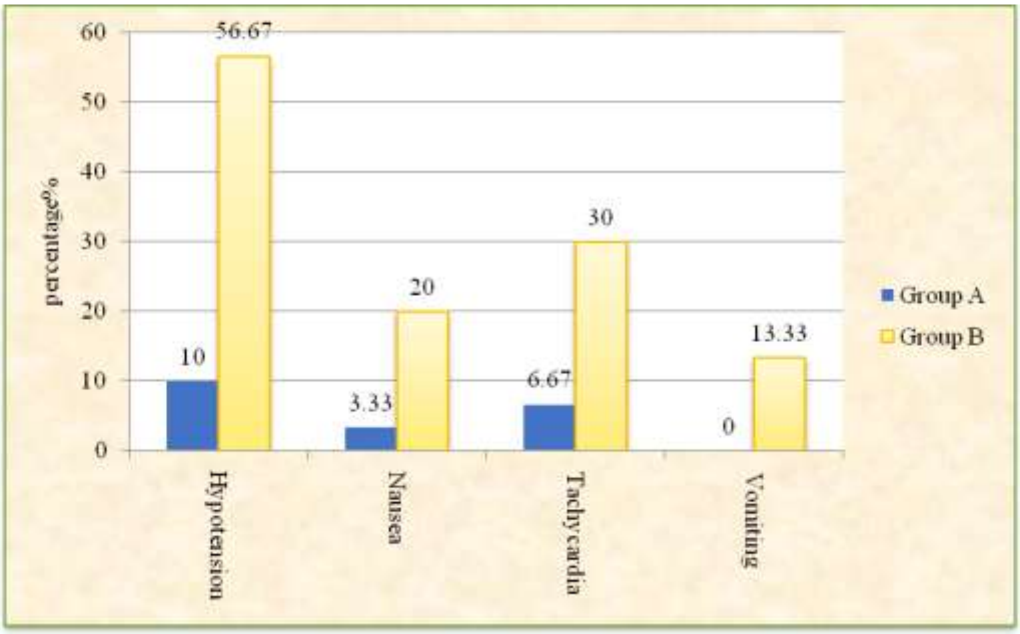


Table No. 6: Comparison of time interval of requirement of First dose of vasopressure

Time interval of First dose of vasopressure	Group A		Group B		p-values
	No	%	No	%	
4 min	0	0.00	4	13.33	<0.001S
6 min	0	0.00	8	26.67	
8 min	0	0.00	2	6.67	
10 min	2	6.67	0	0.00	

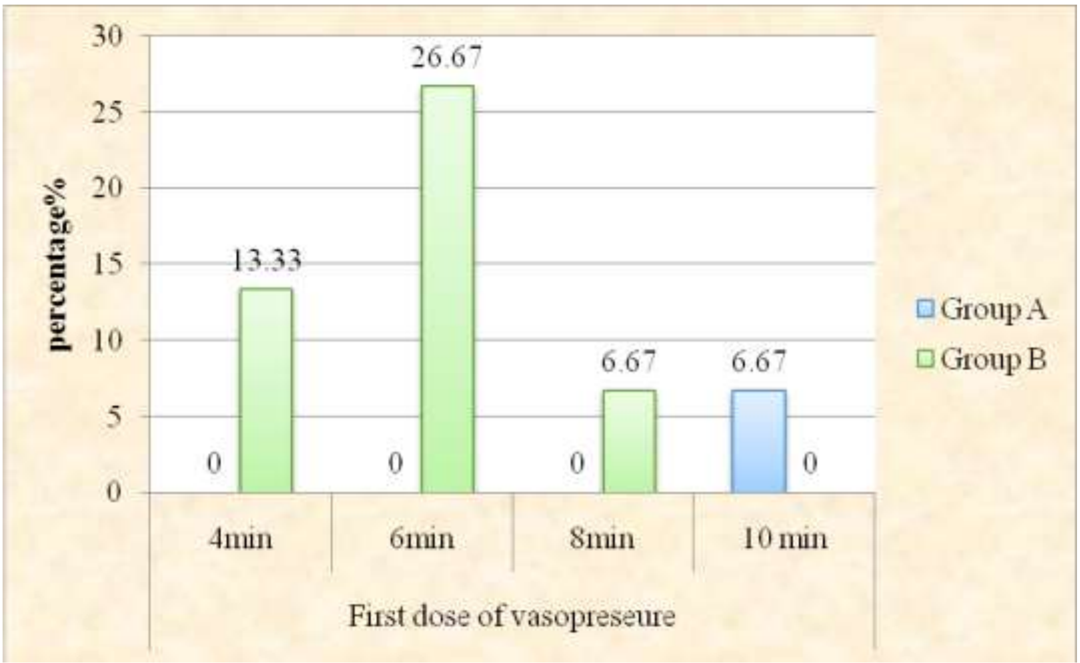
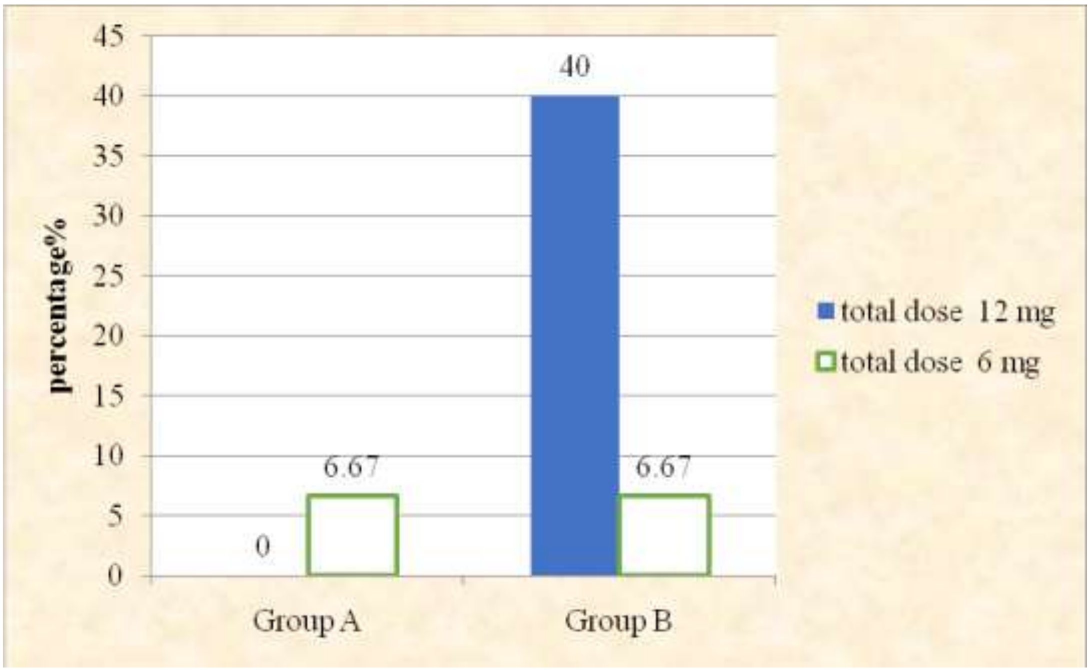


Table No. 7: Comparison of total dose of vasopressure required.

Total Dose	Group A		Group B		
	No	%	No	%	p-values
12 mg	0	0.00	12	40.00	<0.001S
6 mg	2	6.67	2	6.67	0.605NS



DISCUSSION

Spinal anesthesia is a widely favored method for lower abdominal surgeries due to its numerous benefits, including higher patient satisfaction, fewer adverse events, rapid onset, and effective postoperative analgesia. However, one of its major complications is post-spinal hypotension (PSH), primarily caused by the sympathetic block leading to decreased systemic vascular resistance, blood pooling in the lower limbs, and reduced cardiac output. This study aimed to investigate the effect of elastic wrapping of lower limbs on hemodynamic changes following spinal anesthesia.[10]

Our study revealed that elastic wrapping of the lower limbs significantly mitigates the hemodynamic changes associated with spinal anesthesia. The results showed that patients in Group A, who had their lower limbs wrapped, exhibited higher systolic blood pressure (SBP) and diastolic blood pressure (DBP) at various intervals post-spinal anesthesia compared to Group B, who did not have their lower limbs wrapped. The mean arterial pressure (MAP) was also significantly higher in Group A during the critical initial minutes following spinal anesthesia.[11]

These findings align with previous studies indicating that non-pharmacological interventions, such as elastic wrapping, can effectively prevent PSH. The physiological basis for this effect lies in the prevention of blood pooling in the lower limbs, which increases venous return and cardiac output, thereby stabilizing blood pressure.[12]

The use of vasopressors like ephedrine, phenylephrine, and mephentermine is a common pharmacological strategy to manage PSH. However, these agents are associated with adverse effects, including hypertension, tachyphylaxis, and cardiac dysrhythmias. Our study demonstrated that elastic wrapping significantly reduced the need for vasopressors, as indicated by the lower incidence of hypotension and the reduced requirement for rescue vasopressors in Group A.[13]

Furthermore, the incidence of side effects such as hypotension and tachycardia was significantly lower in the group that received elastic wrapping. This suggests that elastic wrapping not only provides hemodynamic stability but also improves the overall safety profile of spinal anesthesia by reducing the need for pharmacological interventions and their associated risks.[14]

The effectiveness of elastic wrapping as a simple, non-invasive, and cost-effective method to manage PSH is particularly relevant in settings where access to pharmacological agents may be limited or where their use is contraindicated. The technique's ease of implementation and the absence of significant adverse effects make it a valuable addition to the perioperative management of patients undergoing spinal anesthesia.

In summary, the findings of this study support the use of elastic wrapping of the lower limbs as an effective strategy to prevent PSH in patients undergoing lower abdominal surgeries under spinal anesthesia. By improving hemodynamic stability and reducing the incidence of hypotension and tachycardia, this non-pharmacological intervention enhances patient safety and outcomes.

CONCLUSION

Elastic wrapping of the lower limbs significantly mitigates the hemodynamic changes following spinal anesthesia in lower abdominal surgeries. This technique effectively reduces the incidence of hypotension and tachycardia, minimizes the need for vasopressors, and provides a simple, safe, and cost-effective method to improve patient outcomes.

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