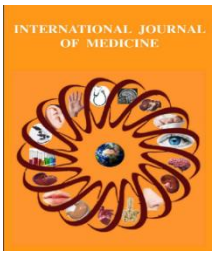

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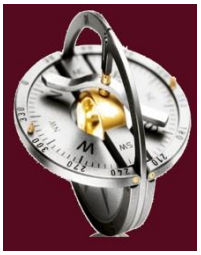

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Original Research

Elastic Leg Wrapping for Prevention of Post-Spinal Hypotension During Cesarean Section Under Spinal Anesthesia: A Prospective Randomized Comparative Study.

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Abstract

Background: Post-spinal hypotension is a frequent hemodynamic disturbance during cesarean section under spinal anesthesia. Sympathetic blockade, aortocaval compression and venous pooling reduce preload and can produce maternal symptoms and fetal compromise. Elastic leg wrapping is a simple mechanical intervention designed to limit lower-limb venous capacitance. *Objective:* To evaluate whether bilateral elastic leg wrapping prevents post-spinal hypotension and reduces rescue vasopressor requirement in parturients undergoing elective cesarean section under spinal anesthesia. *Methods:* This prospective randomized comparative study included 60 ASA physical status I-II term parturients scheduled for elective cesarean section. Participants were allocated into two equal groups. Group N received standard care without leg wrapping, while Group W underwent bilateral leg wrapping with elastic crepe bandage from ankle to mid-thigh before subarachnoid block. All patients received intrathecal 0.5% hyperbaric bupivacaine 2 ml with Ringer lactate co-loading. Hypotension was defined as a fall in systolic blood pressure greater than 20% from baseline and was treated with 6 mg intravenous mephentermine boluses. *Results:* Baseline age, weight, height and gestational age were comparable between groups. Hypotension occurred in 56.7% of patients without wrapping and 6.7% with wrapping. Rescue mephentermine requirement followed the same pattern, with 56.7% in Group N and 6.7% in Group W requiring treatment. Systolic blood pressure and mean arterial pressure were better maintained in the leg wrapping group across several intraoperative time points. No hypertension, bradycardia, nausea or vomiting was recorded. *Conclusion:* Elastic leg wrapping before spinal anesthesia is an inexpensive, non-pharmacological adjunct that reduces post-spinal hypotension and rescue vasopressor use during elective cesarean section.

Keywords: *Cesarean section; leg wrapping; spinal anesthesia; hypotension; mephentermine; vasopressor.*

Introduction

Spinal anesthesia is a preferred neuraxial technique for elective cesarean section because it provides dense sensory and motor block, avoids airway manipulation, limits fetal exposure to systemic anesthetic drugs and allows the mother to remain awake during delivery [1]. Despite these advantages, post-spinal hypotension continues to be one of the most important problems in obstetric anesthesia. The pregnant patient is especially vulnerable because sympathetic blockade produces arterial and venous dilatation, while the gravid uterus can impair venous return through aortocaval compression. The resulting fall in preload and systemic vascular resistance can produce nausea, vomiting, dizziness and reduced uteroplacental perfusion when not corrected promptly [2].

Several measures have been evaluated to prevent or treat spinal-induced hypotension during cesarean delivery. Fluid preloading and co-loading, phenylephrine or norepinephrine infusions, intermittent vasopressor boluses, uterine displacement and lower-limb compression have all been studied with varying results [2-4]. Current evidence supports proactive vasopressor use, yet drug-based strategies need reliable venous access, accurate dosing, close monitoring and consistent drug availability. They are also associated with clinically relevant effects such as bradycardia, tachycardia, hypertension or excessive hemodynamic fluctuation, depending on the agent and dosing method [2,10-14]. Therefore, low-risk adjuncts that reduce venous pooling remain useful in busy obstetric theatres.

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Mechanical methods are physiologically attractive because they target one central mechanism of post-spinal hypotension: redistribution of blood into the lower extremities after sympathetic blockade. Elastic leg wrapping, compression stockings and pneumatic compression devices increase external pressure on the lower limbs and shift venous blood centrally, thereby supporting preload without adding pharmacological exposure [5-9]. Earlier studies reported lower rates of hypotension after leg wrapping compared with no wrapping, and newer work has renewed interest in the technique as a low-cost option that can be combined with standard fluid and vasopressor rescue protocols [7,8].

However, the magnitude of benefit varies across institutions because wrapping technique, local anesthetic dose, fluid protocol, hypotension definition and rescue vasopressor practice differ. Local evidence is important before recommending routine use. The present study was conducted to evaluate the effectiveness of bilateral elastic leg wrapping for prevention of post-spinal hypotension in term parturients undergoing elective cesarean section under spinal anesthesia. The specific objectives were to compare the incidence of hypotension between wrapped and unwrapped groups and to assess the requirement for rescue intravenous mephentermine.

METHODOLOGY

Study design and setting: This prospective randomized comparative study was conducted in the Department of Anaesthesiology, Gandhi Medical College and Hospital, Secunderabad, Telangana, from September 2022 to September 2024. Institutional Ethics Committee approval was obtained before recruitment, Written informed consent was obtained from all participants. The study assessed a simple mechanical intervention previously described in obstetric neuraxial anesthesia literature [5-9].

Study population: Sixty full-term pregnant women scheduled for elective lower segment cesarean section under spinal anesthesia were included. Eligible participants were term parturients aged approximately 20-35 years, with singleton pregnancy, gestational age greater than 37 weeks and ASA physical status I or II. Patients refusing participation, patients with deep vein thrombosis, superficial thrombophlebitis, twin pregnancy, polyhydramnios, oligohydramnios, BMI greater than 35 kg/m2, allergy to local anesthetics, coagulation abnormality or spinal deformity were excluded.

Group allocation and intervention: Participants were allocated into two equal groups of 30 each. Group N received standard intraoperative care without leg wrapping; the lower limbs were covered with drapes only. Group W received bilateral elastic crepe bandage wrapping immediately before subarachnoid block. A 15 cm wide, 4 m long crepe bandage was applied from ankle to mid-thigh on each leg while the lower limb was elevated to approximately 45 degrees. The same person performed wrapping in about 3 minutes to reduce technique-related variation, and both groups had legs covered with drapes before intraoperative monitoring by the recording anesthesiologist.

Anaesthetic technique and monitoring: In the operating room, standard monitors were attached, including electrocardiography, non-invasive blood pressure and pulse oximetry. Baseline hemodynamic values were recorded. Intravenous access was secured with 18G cannulae and Ringer lactate co-loading was given at 10 ml/kg/hour. Spinal anesthesia was administered in the sitting position at the L3-L4 or L4-L5 interspace through a midline approach using a 23G Quincke needle. All patients received 2 ml of 0.5% hyperbaric bupivacaine intrathecally. After delivery, oxytocin 10 IU was administered as slow intravenous infusion.

Outcome definitions and statistical analysis: Systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate were recorded after spinal anesthesia, every 3 minutes until delivery and every 5 minutes thereafter until the end of surgery. Hypotension was defined as a systolic blood pressure fall greater than 20% from baseline and was treated by increasing crystalloid administration and giving intravenous mephentermine 6 mg boluses until recovery. Data were analyzed with SPSS version 15.0. Continuous variables were expressed as mean with standard deviation and compared using unpaired Student's t-test. Categorical variables were compared using chi-square test or Fisher's exact test. A p value less than 0.05 was considered statistically significant.

Results

A total of 60 term parturients undergoing elective cesarean section under spinal anesthesia were analyzed, with 30 patients in Group N and 30 patients in Group W. The two groups were comparable for baseline demographic and obstetric variables. Mean age was 26.23 +/- 4.27 years in Group N and 26.03 +/- 4.34 years in Group W. Mean weight, height and gestational age were also similar, with no statistically significant difference between groups (Table 1).

Table 1. Baseline demographic and obstetric characteristics

Variable	Category or statistic	Group N	Group W	p value
Age group	20-24 years	11 (36.6%)	13 (43.3%)	
Age group	25-29 years	14 (46.7%)	10 (33.3%)	
Age group	30-35 years	5 (16.7%)	7 (23.4%)	
Age	Mean +/- SD, years	26.23 +/- 4.27	26.03 +/- 4.34	0.858
Weight	Mean +/- SD, kg	72.83 +/- 13.14	72.37 +/- 8.43	0.871
Height	Mean +/- SD, cm	151.80 +/- 4.82	151.63 +/- 6.21	0.908
Gestational age	Mean +/- SD, weeks	38.63 +/- 1.27	38.97 +/- 1.22	0.304

Heart rate increased after spinal anesthesia in both groups and remained statistically comparable at all measured time points. Although Group N showed a higher mean heart rate at 3 minutes, the difference narrowly missed statistical significance. This pattern indicates that leg wrapping did not produce clinically relevant tachycardia or bradycardia (Table 2).

Table 2. Heart rate changes during the intraoperative period

Time point	Group N, mean +/- SD	Group W, mean +/- SD	p value
Baseline	82.17 +/- 5.83	82.70 +/- 5.21	0.710
After spinal anesthesia	83.87 +/- 5.51	86.23 +/- 5.42	0.086
3 min	93.57 +/- 7.27	89.97 +/- 6.69	0.051
6 min	103.57 +/- 19.27	103.93 +/- 11.98	0.929
12 min	97.67 +/- 16.84	104.30 +/- 12.81	0.091
15 min	86.83 +/- 10.78	89.77 +/- 9.66	0.271
20 min	82.63 +/- 13.23	88.00 +/- 7.99	0.062
25 min	85.50 +/- 8.94	88.87 +/- 10.90	0.196
30 min	85.20 +/- 8.28	85.47 +/- 7.59	0.897
35 min	84.53 +/- 8.08	85.07 +/- 5.82	0.770
40 min	83.63 +/- 7.24	83.47 +/- 4.86	0.917
45 min	82.53 +/- 5.54	79.87 +/- 6.70	0.098
50 min	83.50 +/- 4.93	81.17 +/- 7.19	0.148

Systolic blood pressure decreased after spinal anesthesia in both groups; however, Group W maintained higher systolic values during the early and mid-intraoperative period. Significant differences favoring the leg wrapping group were observed at 6, 12, 15, 20, 25, 30, 35, 40 and 45 minutes (Table 3).

Table 3. Systolic blood pressure changes during the intraoperative period

Time point	Group N, mean +/- SD	Group W, mean +/- SD	p value
Baseline	125.53 +/- 11.07	122.50 +/- 5.15	0.179
After spinal anesthesia	114.80 +/- 5.85	115.03 +/- 5.93	0.878
3 min	106.43 +/- 8.44	108.93 +/- 5.80	0.186
6 min	95.23 +/- 7.91	100.20 +/- 8.24	0.021
12 min	97.77 +/- 10.27	104.97 +/- 11.76	0.014
15 min	107.27 +/- 8.62	112.30 +/- 9.80	0.039
20 min	108.87 +/- 6.45	116.73 +/- 8.59	<0.001
25 min	114.93 +/- 6.70	119.00 +/- 6.83	0.023
30 min	112.37 +/- 6.13	117.67 +/- 7.56	0.004
35 min	114.37 +/- 3.68	118.50 +/- 5.42	0.001
40 min	113.93 +/- 4.33	118.10 +/- 4.19	0.001
45 min	114.07 +/- 5.19	118.63 +/- 3.86	<0.001
50 min	115.97 +/- 3.89	117.30 +/- 4.39	0.218

Diastolic blood pressure showed smaller between-group differences. Most time points were statistically comparable, but Group W had a significantly higher diastolic pressure at 50 minutes. The overall trend supported better late diastolic pressure preservation in the wrapped group without hypertension (Table 4).

Table 4. Diastolic blood pressure changes during the intraoperative period

Time point	Group N, mean +/- SD	Group W, mean +/- SD	p value
Baseline	69.93 +/- 7.20	69.63 +/- 6.91	0.869
After spinal anesthesia	64.53 +/- 6.91	66.73 +/- 6.40	0.206
3 min	59.53 +/- 5.93	61.73 +/- 6.80	0.187
6 min	57.20 +/- 5.21	58.67 +/- 6.16	0.323
12 min	53.93 +/- 6.69	56.13 +/- 5.92	0.183
15 min	51.73 +/- 6.94	54.60 +/- 5.78	0.087
20 min	53.20 +/- 7.27	53.73 +/- 7.29	0.778
25 min	57.33 +/- 7.37	56.93 +/- 6.36	0.823
30 min	55.27 +/- 6.16	58.13 +/- 6.37	0.081
35 min	60.23 +/- 7.43	61.57 +/- 6.02	0.448
40 min	63.53 +/- 5.55	64.13 +/- 7.77	0.732
45 min	64.80 +/- 5.97	65.67 +/- 5.07	0.547
50 min	64.80 +/- 5.97	68.87 +/- 6.23	0.012

Mean arterial pressure was better preserved in Group W during the period when post-spinal sympathetic blockade is expected to have its strongest hemodynamic effect. Statistically significant differences favoring Group W were recorded at 6, 12, 15, 20, 30 and 50 minutes (Table 5).

Table 5. Mean arterial pressure changes during the intraoperative period

Time point	Group N, mean +/- SD	Group W, mean +/- SD	p value
Baseline	88.46 +/- 5.65	87.26 +/- 5.06	0.392
After spinal anesthesia	81.29 +/- 4.77	82.83 +/- 4.74	0.215
3 min	75.15 +/- 4.73	77.47 +/- 4.48	0.057
6 min	69.88 +/- 4.36	72.51 +/- 5.06	0.035
12 min	68.54 +/- 5.03	72.41 +/- 4.13	0.002
15 min	70.24 +/- 4.66	73.83 +/- 3.86	0.002
20 min	71.75 +/- 5.21	74.73 +/- 4.88	0.026
25 min	76.54 +/- 6.05	77.63 +/- 5.05	0.450
30 min	74.30 +/- 5.13	77.98 +/- 4.96	0.007
35 min	78.28 +/- 5.28	80.55 +/- 4.28	0.073
40 min	80.34 +/- 4.16	82.13 +/- 5.39	0.154
45 min	81.22 +/- 4.73	83.31 +/- 3.29	0.052
50 min	81.86 +/- 4.34	85.01 +/- 4.26	0.006

The incidence of post-spinal hypotension was significantly lower in Group W. Seventeen patients in Group N developed hypotension compared with only two patients in Group W. Rescue vasopressor requirement showed the same reduction. Among patients who required mephentermine, most required only one 6 mg bolus; the distribution of bolus number among treated patients was not statistically different (Table 6).

Table 6. Incidence of hypotension and rescue vasopressor requirement

Outcome	Group N	Group W	p value
Hypotension present	17 (56.7%)	2 (6.7%)	<0.001
Hypotension absent	13 (43.3%)	28 (93.3%)	<0.001
Rescue vasopressor required	17 (56.7%)	2 (6.7%)	<0.001
Rescue vasopressor not required	13 (43.3%)	28 (93.3%)	<0.001
One mephentermine bolus among treated patients	16/17 (94.1%)	2/2 (100.0%)	0.724
Two mephentermine boluses among treated patients	1/17 (5.9%)	0/2 (0.0%)	0.724

No episode of hypertension or bradycardia was documented in either group. No intraoperative nausea or vomiting was reported. Overall, the results show that bilateral elastic leg wrapping was associated with improved hemodynamic stability and a marked reduction in rescue mephentermine use during elective cesarean section under spinal anesthesia.

Discussion

The present study showed that bilateral elastic leg wrapping before spinal anesthesia markedly reduced post-spinal hypotension during elective cesarean section. Hypotension occurred in 56.7% of patients without wrapping and in 6.7% of patients with wrapping, producing a 50 percentage point absolute reduction. Rescue mephentermine requirement was reduced in the same proportion. These findings are clinically meaningful because the greatest risk period after subarachnoid block is the early intraoperative phase, when sympathetic blockade and lower-limb venous pooling reduce preload.

The observed hemodynamic profile is consistent with the physiological basis of lower-limb compression. Spinal anesthesia reduces sympathetic tone, increases venous capacitance and allows redistribution of central blood volume to the lower extremities. External compression with elastic crepe bandage counteracts this shift and supports venous return. Earlier randomized work by Bhagwanjee et al. and Rout et al. demonstrated that leg wrapping decreases post-spinal hypotension compared with no compression [5,6]. Bagle et al. similarly reported lower hypotension and vasopressor requirement in cesarean patients receiving elastic leg wrapping [7].

Our results are also supported by contemporary evidence. Sundararajan et al. reported that both leg wrapping and norepinephrine infusion reduced post-spinal hypotension compared with placebo during elective cesarean delivery [8]. Bjornestad et al. compared leg wrapping with phenylephrine in regional anesthesia for cesarean section and showed that mechanical compression remains a relevant strategy in obstetric anesthesia [9]. Systematic reviews and network meta-analyses have placed leg compression among effective non-pharmacological methods, although vasopressors remain central to modern prophylaxis and rescue treatment [3,4,10].

Vasopressors such as phenylephrine and norepinephrine provide reliable blood pressure control, but their use requires careful dosing and monitoring. Phenylephrine is well studied but can produce reflex bradycardia and lower cardiac output, whereas norepinephrine has been investigated to preserve heart rate and cardiac output while maintaining arterial pressure [10-14]. In many routine settings, especially where infusion pumps or ready-to-use vasopressors are limited, leg wrapping offers a low-cost adjunct rather than a replacement for rescue therapy.

The absence of bradycardia, hypertension, nausea and vomiting in this cohort suggests good tolerability. The main practical advantage is simplicity: the intervention uses inexpensive crepe bandages, needs minimal preparation and can be incorporated before spinal anesthesia. Standardization of bandage width, wrapping extent and application force remains important for reproducibility.

Limitations

This study had a single-centre design and a modest sample size, limiting external generalizability. Blinding was incomplete because the intervention was visible before draping. Neonatal outcomes, umbilical cord blood gas values, maternal satisfaction and postoperative lower-limb comfort were not analyzed. Bandage pressure was not measured objectively, so compression intensity varied within usual clinical practice.

Conclusion

Bilateral elastic leg wrapping before spinal anesthesia reduced post-spinal hypotension and rescue mephentermine requirement in term parturients undergoing elective cesarean section. The technique preserved systolic blood pressure and mean arterial pressure during clinically important intraoperative intervals without observed bradycardia, hypertension, nausea or vomiting. As an inexpensive, non-pharmacological and easily reproducible method, leg wrapping is a useful adjunct to standard monitoring, crystalloid co-loading and vasopressor rescue. It is especially relevant in obstetric theatres where infusion pumps or continuous prophylactic vasopressor protocols are difficult to implement. Larger multicentre trials with neonatal acid-base outcomes and standardized compression pressure can further define its routine role.

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