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Original Research

Impact of leg wrapping in combination with leg elevation on postspinal hypotension in subjects undergoing elective cesarean section under spinal anesthesia

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Abstract
Aim: This study aimed to compare the efficacy of lower extremity wrapping with elastic bandages in conjunction with leg elevation to leg elevation alone in terms of maternal systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and SaO2 in term mothers undergoing elective cesarean section (CS) with spinal anesthesia.
Material and Methods: A series of 62 term mothers aged between 20 and 45 years who were scheduled for elective CS under spinal anesthesia were enrolled in the study. Using sealed envelopes, participants were allocated to one of two study groups: the wrapping group (n=30) or the control group (n=32). All subjects received volume administration of lactated Ringer's solution of 10 mL/kg over the 15 min prior to the administration of the spinal block. Subjects allocated to the wrapping group received lower extremity wrapping with 10-cm Esmarch elastic bandages applied from the ankle to the mid-thigh immediately before the administration of the subarachnoid block. Following intrathecal injection, lower limbs were elevated 20° in subjects allocated to the wrapping group by tilting the foot-end of the operating table. Systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and SaO2 were monitored intraoperatively.
Results: Systolic, diastolic, and mean blood pressures were significantly higher in the wrapping group compared to the control subjects beginning from the 2nd minute of the intrathecal injection to the 20th-30th minute of the intrathecal injection. The median ephedrine dose was significantly higher in the control group than the wrapping group [15 (0-40) mg vs. 5 (0-30) mg, p=0.007]. Vomiting was also more frequent in control subjects compared to those receiving lower extremity wrapping and leg elevation (18% vs. 0%, p=0.024).
Discussion: Lower extremity wrapping in combination with leg elevation provides a better hemodynamic profile than volume administration alone in subjects undergoing elective CS under spinal anesthesia. Subjects receiving lower extremity wrapping and leg elevation require less vasopressors and experience less vomiting compared to subjects receiving only volume administration.

Keywords
Cesarean Section, Spinal Anesthesia, Hypotension

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Introduction

Spinal anesthesia is frequently employed in the anesthesia of healthy pregnant women undergoing elective cesarean section (CS). However, spinal anesthesia may cause hypotension in about 70% of the subjects undergoing CS depending on the presence of preoperative hypertension, age, the type of anesthesia used, and the weight of the newborn infant [1]. Increased sympathetic activity compared to the parasympathetic activity in addition to increased susceptibility to the effects of sympathetic block exposes pregnant women to increased vasodilatation [2]. Prolonged hypotension can not only lead to harmful effects in mothers but may also cause uteroplacental hypoperfusion.

Several measures have been introduced to prevent maternal hypotension occurring after spinal anesthesia for CS. Intravenous fluid therapy including crystalloid prehydration, administration of colloids, transcutaneous electrical nerve stimulation to augment sympathetic tone, and administration of vasopressors such as ephedrine and phenylephrine have been used to prevent maternal hypotension in subjects undergoing elective CS with spinal anesthesia [3-7]. These methods have been shown to improve maternal hemodynamics to some degree.

Wrapping the lower extremity with tight elastic bandages has also been studied for the prevention of maternal hypotension in subjects undergoing elective CS [8-10]. This technique theoretically improves autotransfusion from the lower extremity to the central veins. However, there are controversial results regarding the utility of lower extremity wrapping in subjects undergoing elective CS with spinal anesthesia.

This study aimed to compare the efficacy of lower extremity wrapping with elastic bandages in conjunction with leg elevation to leg elevation alone in terms of maternal systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and SaO2 in term mothers undergoing elective CS with spinal anesthesia.

Material and Methods

A series of 62 term mothers aged between 20 and 45 years who were scheduled for elective CS under spinal anesthesia were enrolled in the study. Written informed consent was obtained from all participants. The study was approved by the institutional review board and was conducted in accordance with the Declaration of Helsinki. Subjects with severe mental illness or retardation, preoperative hypovolemia, more than mild-degree valvular disease, and coagulation disorders were excluded from the study. Using sealed envelopes, participants were allocated to one of two study groups: the wrapping group (n=30) or the control group (n=32).

All subjects received volume administration of lactated Ringer's solution at 10 mL/kg over the 15 min prior to the administration of the spinal block. Subjects allocated to the wrapping group received lower extremity wrapping with 10-cm Esmarch elastic bandages applied from the ankle to the mid-thigh immediately before the administration of the subarachnoid block. Each leg was wrapped in turn and the presence of adequate capillary pulsation in the toes was confirmed to ensure that arterial pressure had not been exceeded. Leg wrapping was completed within 3 min. Lower extremities were lifted at an angle of 45° during the application of the Esmarch elastic bandages.

All intrathecal injections were performed by the same anesthesiologist while the patient was sitting with legs extended on the horizontal operating table. A standard of 12 mg of hyperbaric 0.5% bupivacaine was injected through a 25-gauge Quincke-type spinal needle at the L3-4 interspace using the midline approach. Following intrathecal injection, lower limbs were elevated 20° in subjects allocated to the wrapping group by tilting the foot-end of the operating table. Systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate, and SaO2 were monitored non-invasively using the same dedicated intraoperative monitoring system at baseline (prior to fluid infusion), immediately after intrathecal injection, at 2-min intervals for the first 10 min subsequent to intrathecal injection, and every 5 min thereafter until completion of surgery. Elastic bandages were removed slowly within 5 min following the surgery.

Primary outcome

The difference in intraoperative hemodynamic measurements between the groups was the primary outcome measure of this study. Intraoperative ephedrine and atropine requirements and intraoperative nausea and vomiting were the secondary outcome measures.

Statistical analysis

All analyses were performed with SPSS 21 (IBM Corp., Armonk, NY, USA). To check the normality of the data, the Shapiro-Wilk test was used. Data are presented as mean±standard deviation and median (minimum-maximum) for continuous variables and as frequency and percentage for categorical variables. Normally distributed variables were analyzed using Student's t-test. Non-normally distributed variables were analyzed with the Mann-Whitney U test. Pearson's chi-square test was used for comparison of the categorical variables. Two-tailed p-values of less than 0.05 were considered statistically significant.

Results

A total of 62 term mothers undergoing elective CS with spinal anesthesia were enrolled in the study (mean age: 28.5±5.1 years). The groups were similar with respect to age, ASA class, anesthetic agent dose, and level of spinal block. The values of the study subjects are presented in Table 1. Systolic blood pressure was significantly higher in the wrapping group

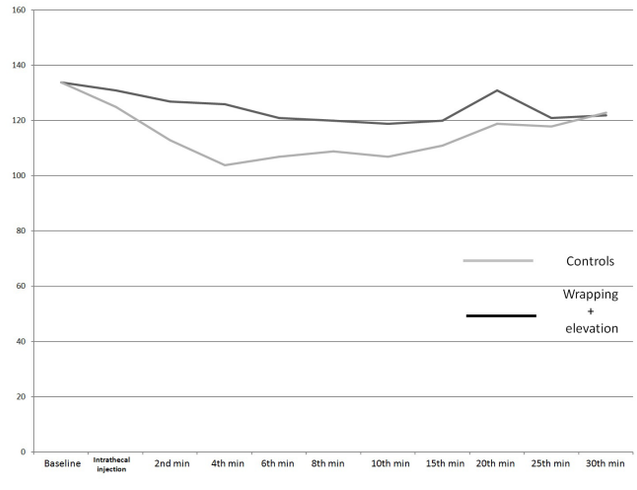

Figure 1. Intraoperative change in systolic blood pressure in subjects receiving leg wrapping + leg elevation and in controls

Table 1. Clinical features of the study groups

	Bandage	Controls	p
Age , years	27.96 ± 3.66	29.81 ± 5.34	0.120
ASA class			
I	29 (96.7%)	31 (96.9%)	0.738
II	1 (3.3%)	1 (3.1%)	
ASA class			
I	29 (96.7%)	31 (96.9%)	0.738
II	1 (3.3%)	1 (3.1%)	
Median ephedrine dose, mg	5 (0-30)	15 (0-40)	0.007
Atropine requirement, n (%)	1 (3.3%)	3 (9.4%)	0.139
Nausea, n (%)	13 (43.3%)	20 (62.5%)	0.203
Vomiting, n (%)	0 (0%)	6 (18.8%)	0.024
Tremors, n (%)	1 (3.3%)	0 (0%)	0.484
Anesthetic dose (mg), n (%)	10.91±1.02	11.34±1.26	0.136
Block level			
T2, n (%)	1 (3.3%)	0 (0 %)	0.470
T4, n (%)	6 (20%)	10 (33.3%)	
T6, n (%)	18 (60%)	17 (56.7%)	
T8, n (%)	5 (16.7%)	3 (10.0 %)	

Data are presented as mean±standard deviation or as median (maximum-minimum) values for continuous variables. ASA: American Society of Anesthesiologists.

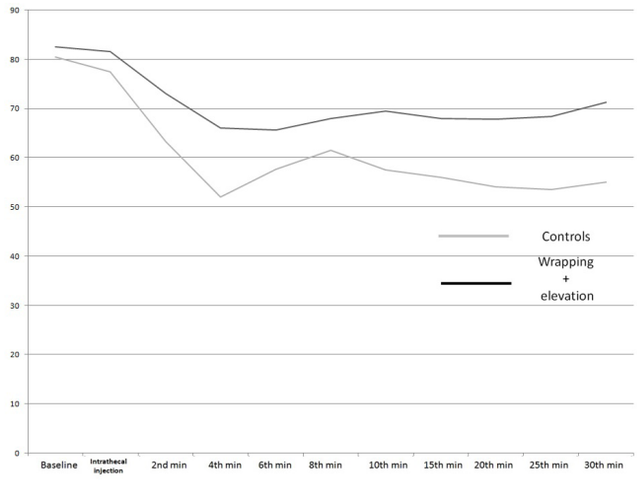

Figure 2. Intraoperative change in diastolic blood pressure in subjects receiving leg wrapping + leg elevation and in controls

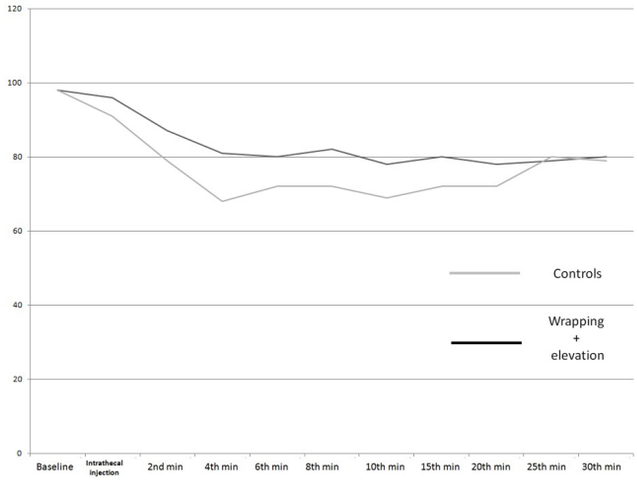

Figure 3. Intraoperative change in mean blood pressure in subjects receiving leg wrapping + leg elevation and in controls

compared to the control subjects beginning from the 2nd minute of the intrathecal injection to the 20th minute of the intrathecal injection (Figure 1). Diastolic blood pressure was also significantly higher in the wrapping group compared to the control subjects beginning from the 2nd minute of the intrathecal injection to the 30th minute of the intrathecal injection (Figure 2). Consistent with systolic and diastolic blood pressure, mean blood pressure was significantly higher in the wrapping group compared to the control subjects beginning from the 2nd minute of the intrathecal injection to the 20th minute of the intrathecal injection (Figure 3). There were no significant differences between the groups in terms of heart rate or SaO_2 in any of the recordings.

The median ephedrine dose was significantly higher in the control group than the wrapping group [15 (0-40) mg vs. 5 (0-30) mg, p=0.007]. Atropine requirement was similar among the groups. There were no significant differences in the rate of intraoperative nausea and tremor. However, vomiting was more frequent in control subjects compared to those receiving lower extremity wrapping (18% vs. 0%, p=0.024).

Discussion

The present study hypothesized that lower extremity wrapping with elastic bandages in combination with leg elevation would provide better intra- and postoperative hemodynamic profiles compared to leg elevation alone in subjects undergoing elective CS with spinal anesthesia. Our findings demonstrate that lower extremity wrapping in combination with leg elevation provides significant hemodynamic improvement in subjects undergoing elective CS with spinal anesthesia. Subjects receiving wrapping and leg elevation required less vasopressors compared to controls. Moreover, subjects receiving wrapping and leg elevation experienced less vomiting during the surgery compared to subjects not receiving wrapping and leg elevation. Hypotension occurring following the intrathecal injection of the anesthetic agents in subjects undergoing elective CS is the major drawback of spinal anesthesia in this patient group. The reduction in blood pressure not only exposes the mother to the detrimental effects of hypotension but also leads to placental hypoperfusion, which may cause fetal acidosis and in severe cases fetal bradycardia and cardiovascular collapse. Reduced arterial and venous tonus resulting from the sympathetic block is the main cause of the hypotension occurring after spinal anesthesia. Moreover, increased sensitivity to local anesthetics in pregnant women leads to a more extensive spinal block compared to non-pregnant women.

Several preventative measures have been investigated in previous studies to overcome the hypotension occurring with spinal block. Intravenous fluid administration before spinal anesthesia is one of the most studied strategies aiming to prevent hypotension. Despite questionable efficacy, a recent survey on the management of spinal-induced hypotension in subjects scheduled for cesarean delivery revealed that fluid management is still popular in obstetric anesthesia [1]. However, a recent Cochrane review indicated that crystalloids alone may be insufficient to prevent hypotension during spinal anesthesia [11]. On the other hand, several studies have shown that fewer women receiving colloids experience hypotension

compared to those receiving crystalloids.

Autotransfusion by leg elevation or compression of the leg has also been subject to several studies investigating preventative measures against spinal hypotension. An early study revealed that 16% to 20% of the blood volume is accumulated in the legs during the spinal blockade [12]. The volume of the blood pooled in the legs is estimated to be 150 mL [13]. There are also studies demonstrating increased vascular distensibility of the calf vessels during spinal anesthesia [14]. This evidence led to the conduction of studies investigating the impact of passive leg elevation and leg compression techniques on blood pressure and heart rate in subjects undergoing CS with spinal anesthesia. One of the earliest reports documenting the efficacy of leg elevation was written by Assali and Prystowsky. These authors showed in their study on subjects undergoing CS with spinal anesthesia that leg elevation by 90° or exclusion of the legs from the systemic circulation by cuffs could prevent hypotension related to spinal blockade [15]. Pernoll et al. reported that simultaneous elevation of the legs to the straight-up position and left uterine displacement was the most efficient method to prevent hypotension [16]. However, some authors asserted that the volume subject to autotransfusion is limited and thus cannot provide a remarkable change in blood pressure [17].

Compression of the legs has also provided conflicting results. James et al. studied the impact of inflatable boots covering the legs from the toes to the upper part of the thighs in 83 women undergoing CS with spinal anesthesia [18]. They reported that inflatable boots did not add any benefit to standard care in prevention of spinal hypotension. Opposite results were derived from the study of Goudie et al., in which the authors used inflatable splints to prevent hypotension during spinal anesthesia. They reported that hypotension was less common and less severe in subjects receiving inflatable splints; moreover, the incidence of hypotension was significantly lower in splint-treated patients compared to controls [19]. Rout et al. used Esmarch bandages for lower extremity wrapping and found that lower extremity wrapping in combination with 30° leg elevation provided a fivefold reduction in the likelihood of postspinal hypotension compared to leg elevation alone [8]. Similar to the findings of Rout et al., Bhagwanjee et al. showed in subjects undergoing CS with spinal anesthesia that lower extremity wrapping immediately after spinal injection resulted in reduced incidence of hypotension and vasopressor agent requirement compared to conventional care [17]. Similarly to the findings of the earlier trials, the study by van Bogaert reported reduced incidence of postspinal hypotension with lower extremity wrapping compared to leg elevation alone in subjects undergoing elective CS [9].

Consistent with the previous data reported by Rout et al. [8], we found that lower extremity wrapping in combination with leg elevation provides favorable hemodynamic profile, less vasopressor requirement, and less vomiting in subjects undergoing elective CS under spinal anesthesia. Our results indicate that autotransfusion obtained with the implementation of leg wrapping and leg elevation is likely sufficient to prevent spinal hypotension. In contrast to the study of Rout et al., we did not enroll a group of subjects receiving only leg elevation; thus, we cannot comment on whether leg elevation itself could also prove successful in prevention of spinal hypotension. This can be regarded as a major limitation of this study. Nevertheless, we suggest that leg wrapping along with leg elevation can prevent the development of hypotension in subjects undergoing elective CS under spinal anesthesia.

Conclusion

Our findings indicate that lower extremity wrapping in combination with leg elevation provides a better hemodynamic profile than volume administration alone in subjects undergoing elective CS under spinal anesthesia. Subjects receiving lower extremity wrapping and leg elevation required less vasopressors and experienced less vomiting compared to subjects receiving only volume administration. These findings indicate that the combination of lower extremity wrapping with leg elevation may improve the hemodynamic profile and prevent spinal hypotension in elective CS.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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