Effect of Wearing Compression Socks on Hypotension and the Amount of Ephedrine Administration after Spinal Anesthesia in Candidates for Cesarean Section

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ABSTRACT

Background and objectives: Due to the negative effects and risks of general anesthesia for the mother and fetus, spinal anesthesia has been the preferred method of anesthesia for cesarean section. Nevertheless, this method has its own disadvantages and side effects, which must be prevented or treated through effective approaches. This study evaluates the effect of wearing compression socks on degree of hypotension and ephedrine administration after spinal anesthesia in candidates for cesarean section.

Methods: In this clinical trial, 80 candidates for cesarean section were equally divided into an intervention group and a control group. Immediately after spinal anesthesia, the patients were worn compression socks from the tip of the toe fingers up to the knees. Blood pressure was measured and recorded just before spinal anesthesia and every 5 minutes after, for 30 minutes. The recorded data were analyzed by SPSS (version 19).

Results: The mean blood pressure recorded 5 minutes and 15 minutes after spinal anesthesia differed significantly between the two groups ($P<0.05$). Moreover, ephedrine was not administered for the patients in the intervention group in the first 5 minutes after spinal anesthesia.

Conclusion: Considering the positive effects of wearing compression socks on the anesthesia-induced hypotension and amount of ephedrine administration, this non-invasive method is highly recommended for cesarean section candidates who undergo spinal anesthesia.

KEYWORDS: Cesarean section, Spinal anesthesia, Hypotension

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INTRODUCTION

The rate of cesarean section (C-section) is increasing worldwide, particularly in developed countries [1]. This rate has increased from 6.7% in 1990 to 19.1% in 2014. According to the latest statistics, about one in every five pregnant women undergoes C-section [2]. Currently, C-section is one of the most common and major surgeries that can threaten the life of both the mother and the baby [3-6]. General and spinal anesthesia are the most commonly used anesthetic techniques for C-section candidates [7]. Many factors influence the anesthetic technique of choice for C-section, including urgency of surgery, mother's physical condition, physician's opinion and the mother's preference [8]. However, due to the risks of general anesthesia for both the mother and the fetus, the preferred anesthetic technique for C-section candidates has become spinal anesthesia [7]. In 2002, 95% of elective C-sections and 87% of emergency cases in the UK were subjected to spinal anesthesia. Spinal anesthesia is simpler and more effective than general anesthesia, and has less complications and mortality risk [9]. It also has some advantages over epidural anesthesia, such as fewer complications and less post-operative pain, thus reducing the need for morphine administration and increasing patient satisfaction [10, 11]. However, this method is invasive and not without undesirable complications, such as hypotension. Studies show that about 80% of women undergoing C-section via spinal anesthesia experience hypotension. It is believed that blockage of sympathetic nerves and vasodilatation of the arteries and arterioles, followed blood stasis in lower extremities may contribute to this issue [10, 12-17].

Since the severity and persistence of hypotension will lead to acidosis in the fetus, appropriate measures should be taken to prevent the onset or the continuation of hypotension in the mother during the process of anesthesia and C-section. Several pharmaceutical and non-pharmaceutical strategies have been introduced for preventing the spinal anesthesia-induced hypotension [18, 19]. Administration of colloidal fluid before surgery, injection of crystalloid fluid during surgery and administration of vasopressors are among the pharmaceutical methods, while use of bandages in lower extremities and alternating compression devices are among the non-pharmaceutical methods [20-23].

Sufficient hydration before spinal anesthesia is important for minimizing vascular dilation and the subsequent hypotension. However, excessive fluid intake may not be desirable for people with ischemic heart disease because of hematocrit dilution and subsequently, decreased oxygen supply to the heart muscle [24].

In the first few minutes after spinal anesthesia, administration of sympathomimetic drugs such as ephedrine (10-10 mg / dl) has proven to be effective, with positive inotropic effects in maintaining normal blood pressure [25]. Nevertheless, the administration of this drug is associated with side effects such as arrhythmia, supraventricular tachycardia and fetal acidosis. On the other hand, the concomitant use of this drug with a beta-adrenergic blocker may interfere with the effect of bronchodilator therapy and exacerbate the risk of hypertension, severe bradycardia and cardiac arrest [26, 27].

Various non-pharmaceutical techniques such as patient repositioning, using pneumatic devices, bandaging lower extremities and insertion of a wedge under the right hip or lumbar have been proposed to prevent hypotension while increasing cardiac output [22, 28, 29]. Considering the cost-effectiveness of non-pharmaceutical techniques and the positive impact of such techniques in lowering frequency of medication, in this study, we examined the effect of wearing compression socks on hypotension and the amount of ephedrine

administration after spinal anesthesia in patients undergoing C-section.

MATERIALS AND METHODS

This clinical trial (registration number: IRCT2015083018553N2) was approved by the ethics committee of the Alborz University of Medical Sciences (code: ABZUMS.REC.1394.4.6). Subjects consisted of 80 candidates for C-section in a hospital affiliated to the Alborz University of Medical Sciences, Iran. Sampling was done through convenience sampling from April to September 2015, and informed consent was taken from all subjects. Inclusion criteria included: no history of cardiovascular disease, no history of hypertension, no history of eclampsia/preeclampsia, using a specific protocol for fluid therapy in the pre-operative stage and having a normal body mass index (BMI> 40) in the 12^{th} week of pregnancy. Obesity is the most important risk factor for post-spinal hypotension [30]. The subjects were able to withdraw from the study at any stage.

Data were collected using a demographic questionnaire and a checklist for recording blood pressure and the amount and frequency of ephedrine administration. Blood pressure was measured using a digital calibrated sphygmomanometer (Model M6, Omron, Japan). Baseline values of blood pressure and heart rate were recorded while lying down and just before spinal anesthesia. Then, the subjects were randomly assigned to an intervention (N=40) and a control (N=40) group. We applied the single-blind method so that the recorder was unaware of the subjects groups. Based on the recommendations of anesthesiologists, in the intervention group, immediately after spinal anesthesia, compression socks were worn by lifting the patient's legs (approximately 15 degrees). The legs were restored to supine position with head angle of 10 degrees. No intervention was done for the subjects in the control group. However, for ethical reasons, a pair of compression socks was also given to the control group subjects at the end of the study. The used compression socks were thigh-high socks (Pak Saman Co., Iran) available in large and extra-large sizes. Size measurement was done based on a pilot study conducted on the mean size of the patients' feet while under C-section. Blood pressure was measured 5, 10, 15, 20, 25, 30, 35 and 40 minutes after spinal anesthesia, by using the digital calibrated sphygmomanometer.

The frequency of ephedrine (5mg) administration, 5, 10, 15, 20, 25, 30, 35 and 40 minutes following spinal anesthesia was recorded for each patient. The surgeries were performed by two surgeons using the same surgical technique and for a same duration. Spinal anesthesia was performed with the same needle size and type and by the same anesthetist at a certain level of sensory block, according to a specific protocol for fluid therapy. Cases requiring more than one injection of the anesthetic drug or Methergine administration, as well as those with unusual bleeding during surgery were excluded from the study.

The recorded data on each checklist were entered into SPSS (version 19). Analysis of data was done using the T-test, Mann-Whitney U test and chi-squared test.

RESULTS

The demographic characteristics, surgical history and baseline blood pressure levels did not differ significantly between the two groups (Tables 1 and 2). Considering the normality of data based on the Kolmogorov-Smirnov test, comparison of variables was made using the t-test and Chi-square test.

Table 1. Demographic characteristics of the C-section candidates in the two study groups

Parameter	Intervention group (N=40)				Control group (N=40)				P-value
	Mean	SD	Max	Min	Mean	SD	Max	Min	
Age (years)	31.2	6.15	44	21	29.50	3.36	37	23	0.28
Weight (Kg)	83.15	7.83	93	63	85.9	5.66	98	75	0.21
Duration of surgery (minutes)	38	4.7	48	37	39	6.1	49	36	0.49

Table 2. Medical history and blood pressure level of C-section candidates in the two study groups

Parameter	Intervention group Number (%)		Control group Number (%)		P-value
	Yes	No	Yes	No	
History of surgery	70 (28)	30 (12)	70 (28)	30 (12)	>0.05
History of spinal anesthesia	55 (22)	45 (18)	60 (24)	40 (16)	0.82
History of general anesthesia	15 (6)	84 (34)	20 (8)	80 (32)	0.77
History of C-section	60 (24)	40 (16)	60 (24)	40 (16)	>0.05

Five minutes and 15 minutes after anesthesia, the mean blood pressure differed significantly between the intervention group and the control group (Table 3). In the intervention group, there was a significant difference between the mean blood pressure level before and after spinal anesthesia. However, since this decrease in blood pressure was less than 20% of the baseline value, it was considered normal from the medical perspective and did not require ephedrine administration. Ten minutes after anesthesia in the intervention group, the blood pressure decreased by more than 20% of the baseline value and therefore, a number of patients received ephedrine. After 15 minutes, the blood pressure drop was observed in other cases in the intervention group, and ephedrine was administrated again. In contrast, the subjects in the control group experienced the drop in the blood pressure (>20%) 5 minutes after spinal anesthesia. Therefore, a large number of patients received ephedrine at minutes 5 and 10. However, a relative increase in the blood pressure of control subjects was noted 15 minutes after the spinal anesthesia. Twenty minutes after the spinal anesthesia, the blood pressure level remained almost stable in both groups.

Table 3. Mean blood pressure level of subjects at different time intervals following spinal anesthesia

Blood pressure	Intervention group (N=40)		Control group (N=40)		P-value
	Mean	**SD**	**Mean**	**SD**	
Before anesthesia	123.2	9.1	122.6	10.7	0.789
5 min after anesthesia	115.15	13.7	99.55	9.6	<0.001
P -value	**<0.001**		**<0.001**		
5 min after anesthesia	115.15	13.7	99.55	9.6	<0.001

10 min after anesthesia	102.6	12.66	98.85	10.9	0.202
P -value	**<0.001**		**0.789**		
10 min after anesthesia	102.6	12.66	98.85	10.9	0.202
15 min after anesthesia	112.35	9.73	105.55	8.7	0.004
P -value	**<0.001**		**0.005**		
15 min after anesthesia	112.35	9.73	105.55	8.7	0.004
20 min after anesthesia	113.45	8.8	109.30	4.8	0.029
P -value	**0.288**		**0.014**		
20 min after anesthesia	113.45	8.8	109.30	4.8	0.029
25 min after anesthesia	111.10	8.7	110.70	5.8	0.321
P -value	**0.017**		**0.240**		
25 min after anesthesia	111.10	8.7	110.70	5.8	0.321
30 min after anesthesia	111.15	8.6	11.5	5.2	0.654
P -value	**0.959**		**0.254**		
30 min after anesthesia	111.15	8.6	11.5	5.2	0.654
35 min after anesthesia	110.40	6.8	110.85	5.4	0.746
P -value	**0.466**		**0.473**		
35 min after anesthesia	110.40	6.8	110.85	5.4	0.746
40 min after anesthesia	111.85	7.1	11.05	6.1	0.655
P -value	**0.052**		**0.705**		

The pattern of ephedrine administration in the first 15 minutes (5, 10, 15 minutes) after anesthesia differed significantly between the study groups. No ephedrine was administrated during the first 5 minutes, while 18 patients in the control group received ephedrine due to hypotension. Moreover, 10 and 15 minutes after anesthesia, the patients in the intervention group received less amount of ephedrine compared to the subjects in the control group (Table 4). All patients in the control group received ephedrine, while nearly 50% of patients in the intervention group received ephedrine.

Table 4. Comparison of the frequency of ephedrine administration between the intervention and control groups (5, 10 and 15 minutes after the spinal anesthesia)

	Intervention group			Control group			
Time (min)	5	10	15	5	10	15	P-Value
Number of patients receiving ephedrine	0	16 (40%)	2 (5%)	18 (45%)	18 (45%)	4 (10%)	0.003*

Number of patients not receiving ephedrine	22 (55%)	0	<0.001**

*Mann-Whitney test

** Chi-squared test

DISCUSSION

The results showed that the mean blood pressure of C-section candidates in both groups differed significantly at different times after spinal anesthesia. In other words, hypotension was more common in the control group. In line with this finding, in a study by Adsumelli et al. on the effect of an alternating compression device on hypotension, 52% of the patients in the intervention group and more than 90% of the patients in the control group experienced hypotension of more than 20% [31]. In another study, bandaging of lower extremities in 60 patients undergoing C-section decreased incidents of blood pressure drop, 4, 6 and 8 minutes after spinal anesthesia, compared to a control group [29]. Our findings are also in line with findings of a study on the use of bandages for lower extremities for preventing hypotension following epidural anesthesia in candidates for C-section [32]. Nahed et al. also reported the effectiveness of bandaging and lifting the legs in preventing hypotension in candidates undergoing C-section via spinal anesthesia [33].

One of the most effective and commonly used drugs for prevention of anesthesia-induced hypotension is ephedrine. In our study, all patients in the control group received high doses of ephedrine multiple times, indicating the severity of hypotension in these cases. In the intervention group, ephedrine was not administrated during the first 5 minutes, while 18 patients in the control group received ephedrine due to hypotension. After 10 minutes, only 5 patients in the intervention group received ephedrine, while 18 patients in the control group received ephedrine. Fifteen minutes after anesthesia, two patients in the intervention group and four in the control group received ephedrine again. These results elucidate that the frequency and dose of ephedrine administration were significantly higher in the control group. In the intervention group, ephedrine was administrated only twice and to approximately half of the patients after spinal anesthesia. This shows the effectiveness of the intervention method in lowering incidence of anesthesia-induced hypotension. These findings are in line with the results of some other studies [29, 31-33].

Similar to our study, Jabalameli et al. also showed that ephedrine administration along with bandaging of lower extremities can be effective in preventing hypotension in women undergoing C-section via spinal anesthesia [34]. Furthermore, Das et al. demonstrated that bandaging of lower extremities before spinal anesthesia lowers the amount of phenylephrine required for the treatment of anesthesia-induced hypotension in C-section candidates [35].

CONCLUSION

We showed that wearing compression socks is a non-invasive, effective and economical method for preventing anesthesia-induced hypotension, which also reduces the need for ephedrine administration. Therefore, it is recommended to use this safe and effective method for all patients undergoing spinal anesthesia.

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