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Impact of leg elevation added to a 15˚ left lateral incline on maternal hypotension and neonatal outcomes in cesarean section: A randomized clinical study

Sezaryen seksiyolarda 15˚ sol lateral eğime eklenen bacak elevasyonunun maternal hipotansiyon ve yenidoğan sonuçları üzerine etkisi: Randomize klinik çalışma

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Abstract

Aim: The supine position can cause maternofetal complications by exacerbating hypotension resulting from spinal anesthesia (SA). The aim of this study was to investigate and compare the effect of positioning the patient with a 15˚ left lateral incline and both positioning and elevating both legs on SA-induced hypotension.

Methods: This randomized clinical study was conducted on 200 pregnant women who underwent cesarean section in a university hospital between November 1, 2016 and April 15, 2017.

Pregnant women were separated into 2 groups as the 15˚ left lateral incline (Group 1) and the 15˚ left lateral incline and leg elevation group (Group 2). Mean arterial blood pressure (MAP) and heart rate (HR) values, ephedrine use, neonatal APGAR scores and umbilical cord vein blood gas analysis samples were compared at varying times. After administration of SA, MAP and HR were recorded at the second, fourth, sixth, eighth and tenth minutes until delivery of the infant, every five minutes after delivery until the 30th postpartum minute, and at the end of the surgery.

Results: Two and four minutes after the administration of SA and 20 minutes after delivery, mean HR values of group 2 were significantly higher than that of group 1 (P=0.002, P=0.005, P=0.006, respectively). MAP values were similar in both groups at all time points, however, a greater number of patients in group 1 had MAP <60 mmHg and HR <60 bpm at two and six minutes after the administration of SA.

Conclusion: Positioning the table at a 15˚ incline and leg elevation during caesarean section may provide maternofetal benefits by reducing the frequency of post-spinal hypotension in pregnant women.

Keywords: Pregnancy, Cesarean section, Spinal anesthesia, Hypotension

Öz

Amaç: Sırtüstü pozisyon, spinal anesteziden (SA) kaynaklanan hipotansiyonu arttırarak maternofetal komplikasyonlara neden olabilir. Bu çalışmanın amacı, SA uygulanan sezaryenlerde 15˚ sol lateral eğim ve bacak elevasyonu yöntemlerinin, SA'nın oluşturduğu hipotansiyon üzerine etkilerini araştırmaktır.

Yöntemler: Randomize klinik bu çalışma 1 Kasım 2016 ile 15 Nisan 2017 tarihleri arasında bir üniversite hastanesinde sezaryen uygulanan 200 gebede yapıldı.

Gebeler, 15˚ sol lateral eğim (grup 1) ve 15˚ sol lateral eğim + bacak elevasyon grubu (grup 2) olarak 2 gruba ayrıldı. Hastaların değişik zamanlardaki ortalama arter kan basıncı (OAB) ve kalp atım hızı (KAH) değerleri, efedrin kullanımları ile neonatal APGAR skorları ve umblikal kord veni kan gazı analiz örnekleri karşılaştırıldı. SA uygulamasından sonra OAB ve KAH değerleri, bebeğin doğumuna kadar 2, 4, 6, 8, 10. dakikalar ve doğumdan sonra her 5 dakikada bir kaydedildi. Benzer şekilde, bu değerler doğum sonrası 5, 10, 15, 20, 25, 30. dakikalar ve cerrahi bitiminde değerlendirildi.

Bulgular: SA uygulamasından 2-4 dakika sonra, KAH değerlerinin grup 2'de anlamlı derecede yüksek olduğu belirlendi (sırasıyla; P=0,002, P=0,005). OAB değerleri her iki grupta tüm zaman noktalarında benzer olup, doğumdan 20 dakika sonraki KAH değerleri grup 2'de yüksekti (P=0,006). Bebeğin doğumundan önce SA'den 2-6. dakikalar sonrasındaki, OAB <60 mmHg ve KAH <60 atım olan hasta sayısı grup 1'de daha fazla idi.

Sonuç: Masanın 15˚'lik bir eğimde konumlandırması ve bacakların elevasyonu, gebelerde postspinal hipotansiyon sıklığını azaltarak maternofetal faydalar sağlayabilir.

Anahtar kelimeler: Gebelik, Sezaryen, Spinal anestezi, Hipotansiyon

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Introduction

General or regional anesthesia administered during cesarean sections (CS) may affect maternofetal morbidity at varying rates. The necessity to provide safety for both the mother and the fetus increases the importance of anesthesia techniques preferred in these operations [1,2].

The administration of general anesthesia to pregnant women carries risks, such as difficult intubation and anesthesia-induced respiratory depression in the neonate, which reduce with regional anesthesia. Spinal anesthesia is more widely used due to easy administration and rapid onset of effect. The amount of anesthetic used is decreased, and it is not passed to the fetus. [3]. Nevertheless, with the occurrence of sympathetic block and peripheral venodilatation in spinal anesthesia, cardiac fluid reduces due to decreased venous return. Thus, hypotension is a frequent complication [4]. The incidence of hypotension following spinal anesthesia in pregnant women was reported as 7-80 % [5,6].

Hypotension may be exacerbated with the pressure of the uterus, which has grown during pregnancy, on Vena Cava Inferior in supine position. Therefore, the prevention of hypotension is of high importance. If it develops despite precautions, rapid treatment must be administered to protect uteroplacental perfusion and avoid fetal hypoxia [7].

In pregnant women receiving spinal anesthesia, in addition to fluid loading, oxygen support and vasoconstrictor administration, tilting the patient to the left while bandaging lower extremities or passive leg elevation may prevent the development of hypotension, and contribute to central circulation by rechanneling the blood pooled in lower extremities in supine position [8].

The aim of this study was to investigate SA-induced hypotension as well as vasoconstrictor use and compare the effects of positioning the patient with a 15˚ left lateral incline and leg elevation in addition to positioning on SA-induced hypotension and the neonate in cesarean section.

Materials and methods

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee, 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

This randomized clinical study was approved by the Scientific Research Ethics Committee of Kahramanmaras Sütcü Imam University (approval number-date: 215-27.07.2016) and included pregnant women who underwent caesarean section with spinal anesthesia between 1 November 2016 and 15 April 2017.

Informed consent was obtained from all the study participants pre-operatively. All patients (n=200) were between 18-45 years-of-age, more than or equal to 156 cm tall, more than 37 weeks pregnant and conformed to American Society of Anesthesiologists (ASA) risk score I-II. Patients with age <18 years or >45 years, ASA>II, multiple pregnancies, pregnancy-related diseases (pre-eclampsia-eclampsia, placental anomaly etc.), previous comorbid diseases, contra-indicative conditions for SA and those who refused were excluded from the study.

20 minutes before the operation, patients were admitted to the preoperative preparation room and non-invasive blood pressure (NIBP), heart rate (HR) and SpO_2 were monitored. 10 ml/kg Hartmann solution was administered intravenously; hemodynamic values were measured and recorded. Before the administration of spinal anesthesia, 200 patients were divided into two groups, with 100 patients in each group: Group 1 consisted of patients who were inclined 15^o to their left and Group 2 comprised patients whose both legs were elevated after inclination.

All patients were monitored with a 3-lead electrocardiogram (ECG) for HR, NIBP and SpO_2, and values were recorded. Following local sterilization with the patient in the sitting position, lumbar region was punctured at the L3-L4 level or the L4-L5 level with a 25G, 90 mm pencil point, spinal atraumatic needle (Egemen International, Turkey). After visualization of cerebral spinal fluid flow, 10 mg, 0.5% bupivacaine (Marcaine® Spinal Heavy 0.5% ampule, AstraZeneca, UK) was administered for spinal anesthesia.

The patients were then immediately given the supine position and the operating table was adjusted to a 15º left lateral incline using a Digital Inclinometer® for patients in Group 1. In addition to positioning, the legs of patients in Group 2 were elevated with a standard 25 cm-high cushion positioned below the legs. After the administration of spinal anesthesia, the sensory motor block level was evaluated with the pinprick test from the mid-clavicular line, and as the block reached T4 level, the surgical team was notified so they could begin the operation. The time taken for the sensory block to reach T4 level was recorded.

Mean arterial pressure (MAP) and HR were measured and recorded immediately after the administration of spinal anesthesia and at the second, fourth, sixth, eighth, tenth minutes of the surgical procedure until delivery of the infant. Following delivery, the operating table and legs were brought to the neutral position. The above-mentioned values were recorded every five minutes. The placenta was sent for venous blood gas analysis immediately after the delivery. The Apgar scores of the neonate were recorded at the first and fifth minutes post-delivery.

MAP falling below 60 mmHg during surgery was considered severe hypotension and 10 mg ephedrine was administered to these patients. The amount of vasopressor used and total operating time was recorded for each patient.

Statistical analysis

The power of this study, obtained with comparing the findings of the two groups, was determined as 0.93. Statistical Package for the Social Sciences (SPSS) 22.0 software was used for statistical analysis of the data. Descriptive statistics were presented as number (n), percentage (%), and mean (standard deviation) (SD). Conformity of the data to normal distribution was assessed with the Kolmogorov Smirnov test. The Independent Samples t-test was used in comparing the data of the groups, and Chi-square and Fisher's exact tests were utilized in the comparison of categorical data. A value of $P<0.05$ was considered statistically significant.

Results

There was no statistically significant difference between the groups with respect to age, height, weight, body mass index (BMI) and gestational week (P=0.658, P=0.098, P=0.888, P=0.489, P=0.117, respectively) (Table 1). The number of ASA I and ASA II patients in Groups 1 and 2 were 65, 35 and 77 and 23, respectively. The time sensory block took to reach the T4 dermatome level after the administration of spinal anesthesia was 4.81 (1.01) minutes in group 1 and 4.82 (0.72) minutes in group 2. Total operating times were 41.74 (8.63) and 42.81 (9.06) minutes in groups 1 and 2, respectively. The two groups were similar with regards to these two parameters (P=0.936, P=0.394, respectively).

The HR and MAP values of groups 1 and 2 were compared preoperatively, before, immediately after and two, four, six, eight, ten minutes following the administration of spinal anesthesia and immediately after the delivery of the infant. The HR values at two and four minutes after spinal anesthesia were significantly higher in group 2, and that at the tenth minute was significantly higher in group 1 (P=0.002, P=0.005, P=0.014, respectively). With respect to MAP values, there was no statistically significant difference between the groups at any point in time (Table 2). The changes in the MAP and HR rates in both groups before delivery are shown in Figure 1.

After neutralization of position and delivery, the above-mentioned values were measured every five minutes until the 30th minute and at the end of the surgery

With the equalization of the position of the patients after delivery of the infant, these values were recorded at 5, 10, 15, 20, 25, 30th minutes and at the end of surgery. The HR values were significantly high in group 2 at 20 minutes after delivery (P=0.006) and no difference was found at any other time. The MAP values were similar in both groups at all periods in time (Table 3).

For better interpretation of the parameters, the HR and MAP values at the defined times before delivery of the infant were evaluated as <60 and >60. Accordingly, although no statistically significant difference was determined between the groups with respect to HR and MAP values at all the time points, there was a greater number of patients with MAP <60 mmHg in group 1 at two minutes after the administration of SA (P=0.043). HRs of 6 patients in group 1 were <60 bpm at six minutes following SA, and all patients in group 2 had HR >60 bpm (P=0.007).

The mean amount of ephedrine used after spinal anesthesia was 5.20 (8.10) mg (36% of patients) in group 1 and 6.20 (9.40) mg (40% of patients) in group 2, which were statistically similar (P=0.421).

PH and lactate values of umbilical vein blood gases obtained immediately after delivery were 7.31 (0.05), 1.90 (0.87) mmol/l and 7.32 (0.04), 1.77 (0.62) mmol/l in groups 1 and 2, respectively, with no significant difference (P=0.059, P=0.214).

Apgar scores of neonates in Groups 1 and 2 were 8.56 (1.26), 8.73 (1.01) at the first minute and 9.61 (0.85), 9.54 (0.59) at the fifth minute, respectively. There was no statistically significant difference between the groups (P=0.294, P=0.501, respectively).

Table 1: The demographic data of the patients

	Group 1 Mean (SD)	Group 2 Mean (SD)	t	*P*-value
Age (y)	29.73 (5.53)	29.37 (5.95)	0.443	0.658
Height (cm)	162.73 (4.61)	161.72 (3.95)	1.663	0.098
Weight (kg)	78.36 (12.85)	78.62 (13.19)	0.141	0.888
BMI (kg/m^2)	29.59 (4.71)	30.06 (4.95)	0.693	0.489
Gestational week	38.42 (0.67)	38.27 (0.66)	1.575	0.117

Independent samples t test, α: 0.05

Table 2: Comparison of HR and MAP values at birth

	Group 1 Mean (SD)	Group 2 Mean (SD)	t	*P*-value
HR pre-op	96.54 (13.57)	94.90 (13.98)	0.842	0.401
HR before spinal	97.10 (13.40)	99.88 (18.53)	1.216	0.226
HR after spinal	96.35 (18.33)	99.16 (18.17)	1.089	0.277
HR second minute	88.93 (21.98)	98.11 (19.65)	3.114	0.002*
HR fourth minute	86.60 (21.28)	94.95 (18.00)	2.884	0.005*
HR sixth minute	87.71 (21.03)	90.75 (17.39)	0.884	0.378
HR eighth minute	93.04 (17.14)	86.77 (15.00)	1.484	0.143
HR tenth minute	96.25 (13.67)	81.38 (14.30)	2.652	0.014*
HR baby birth	92.41 (15.75)	92.09 (15.56)	0.145	0.885
MAP (mmHg)	Mean (SD)	Mean (SD)	t	*P*-value
MAP pre-op	91.24 (14.54)	90.48 (15.58)	0,357	0.722
MAP before spinal	101.69 (14.16)	102.38 (13.04)	0,358	0.720
MAP after spinal	86.15(17.71)	88.17 (17.70)	0,807	0.421
MAP second minute	76.71 (18.60)	79.29 (18.05)	0,996	0.321
MAP fourth minute	77.73 (18.52)	78.00 (16.27)	0,105	0.916
MAP sixth minute	79.05 (17.95)	76.78 (15.20)	0,768	0.444
MAP eighth minute	78.30 (11.86)	81.03 (15.73)	0,739	0.463
MAP tenth minute	80.33 (10.91)	80.77 (15.83)	0,079	0.937
MAP baby birth	87.16 (13.47)	85.64 (13.71)	0,791	0.430

Independent samples t test, α: 0.05, * the difference was statistically significant, HR: heart rate, MAP: mean arterial pressure

Table 3: Comparison of HR and MAP values according to groups after the time of baby emergence

	Group 1 Mean (SD)	Group 2 Mean (SD)	t	*P*-value
HR fifth minute	96.41 (16.30)	98.15 (15.42)	0.775	0.439
HR tenth minute	95.97 (14.36)	97.01 (15.58)	0.491	0.624
HR fifteenth minute	95.58 (13.32)	98.01 (15.52)	1.186	0.237
HR twentieth minute	94.30 (13.32)	100.03 (14.64)	2.801	0.006*
HR twenty-fifth minute	94.52 (13.62)	96.52 (15.54)	0.874	0.383
HR thirtieth minute	93.04 (13.37)	94.79 (14.91)	0.685	0.495
HR surgical end	89.00 (12.58)	91.44 (14.19)	1.287	0.200
MAP (mmHg)	Mean (SD)	Mean (SD)	t	*P*-value
MAP fifth minute	85.08 (12.82)	83.00 (14.33)	1.082	0.281
MAP tenth minute	83.40 (12.02)	83.84 (14.04)	0.238	0.812
MAP fifteenth minute	83.00 (11.88)	80.41 (13.06)	1.463	0.145
MAP twentieth minute	81.54 (11.47)	81.39 (13.25)	0.087	0.931
MAP twenty-fifth minute	83.77 (10.88)	83.51 (12.84)	0.140	0.889
MAP thirtieth minute	85.02 (10.17)	84.66 (10.75)	0.191	0.849
MAP surgical end	90.87 (11.22)	88.34 (11.44)	1.579	0.116

Independent samples t test, α: 0.05, * the difference was statistically significant, HR: heart rate, MAP: mean arterial pressure

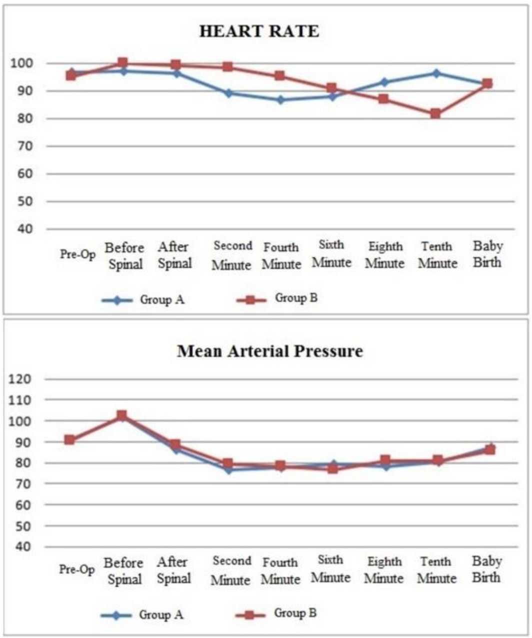

Figure 1: The changes in the mean arterial pressure and heart rates before delivery

Discussion

In this study examining the effects of positioning with a 15º left lateral incline and leg elevation in addition to positioning on the neonate and SA-induced maternal hypotension in caesarean section, HR values were found significantly high at the second and fourth minutes following SA administration in leg elevation patients. MAP values were similar at all time points before and after delivery, and HR values 20 minutes after delivery was significantly higher in the leg elevation group. More patients in the positioning only group were observed to have MAP <60 and HR <60 two and six minutes after the administration of SA.

SA administered during caesarean section has various benefits for both the mother and the infant, beginning with decreased hemorrhage rate compared to general anesthesia. This can be associated with reduced venous return and a drop in central venous pressure following vasodilatation, which develops as a result of sympathetic blockage [9,10]. However, venous pooling and reduction in vascular resistance due to sympathetic blockage, along with the sensory block effect of local anesthetics can lead to severe hypotension. The incidence of hypotension in spinal anesthesia is reported as 83% [11]. Hypotension can be exacerbated by dehydration, pressure exerted on the uterus by Vena Cava Inferior in the supine position and vagal activation during the operation. Although this effect is desired in some situations, various complications may develop as severity increases. Numerous studies have been conducted for the prevention of deep hypotension in patients who were administered regional anesthesia. In a study by Singh et al. [12], the effect of tying the legs on hemodynamic changes was evaluated in cesarean section performed with spinal anesthesia. The frequency of hypotension was reported as 10% in the group with tied legs and 43.3% in the group with untied legs. MAP values were recorded at the fourth, sixth, eighth minutes post-SA administration and statistically significantly higher in the group with tied legs. It was concluded that tying the legs could prevent post-spinal anesthetic hypotension by increasing cardiac output through cardiac venous return. In another study, pregnant patients' legs were elevated by 30 cm after spinal anesthesia administration and its effect on post-spinal anesthetic hypotension was compared with a control group. Leg elevation was found to significantly lower SA-induced hypotension [13].

In our study, which was similar to the above-mentioned study in terms of leg elevation, MAP values between the two groups were found similar. This could be due to the use of lower elevation, 25 cm, in this present study, which was not increased to avoid difficulty in manipulation of the surgeon by the surgical team. Unlike the previous study, we did not include a control group with supine positioning, which could be another reason for the lack of significant difference between MAP values of the two groups. The reason we did not include a supine, neutral position group is that we always tilt the operation table to the left to reduce the pressure on Vena Cava Inferior and never prefer the supine position in pregnant women during caesarean section.

A review of the literature showed that no tilt angles were specifically reported by the studies. Left lateral inclines at different angles can create different aortocaval pressures in pregnant patients and it has been reported that non-invasive arterial pressure, cardiac output, stroke volume and systemic vascular resistance are least affected in patients in a 15º left inclined position [14]. As cardiac output was found to increase by more than 5% in the 15º left inclined position and higher angles have not provided patient comfort and safety, this angle was selected in the current study.

Although no significant difference was determined between the two groups with respect to MAP values at all the time points, a more detailed subgroup analysis showed that two minutes after spinal anesthesia, a greater number of patients in Group 1 had MAP <60 mmHg. Similarly, HR values of <60 bpm at two and six minutes post-SA were detected in more patients in group 1, whose legs were not elevated. As a primary outcome of this study, our data shows that leg elevation has positive effects on hemodynamics in the early stage after spinal anesthesia with insignificant effects.

In prophylaxis and treatment of maternal hypotension, the use of vasopressors and crystalloid-colloid fluids is important along with physical maneuvers that increase venous return. Different effects have been reported on central venous pressure, heart rate, systemic vascular resistance for each method used [15]. In studies that have investigated the effect of non-invasive manipulations on maternal hypotension, both leg elevation and tying the legs reduce the use of vasopressors [12,13]. We found no significant differences between the two groups in terms of ephedrine use, which can be attributed to reasons previously discussed, such as not preferring the supine position and tilting the patients in both groups, thereby preventing a significant hemodynamic difference between the groups.

Maternal hypotension that can develop due to decreased systemic arterial pressure, which decreases increased uterine perfusion pressure, can cause a reduction in uterine blood flow and impairment in fetal oxygenation. Fetal metabolic acidosis is reported at high rates in spinal anesthesia-administered cases, which is consequential of hypotension and related use of high doses of ephedrine [16].

With the aim of determining maternal hypotension and its possible fetal effects, the umbilical vein blood gas pH and lactate values obtained immediately after birth were evaluated together with the first and fifth minute Apgar scores, which yielded similar results in both groups. This result was not surprising as the pregnant patients operated on and the infants had no previously known pathology and the manipulations did not cause any differences between the groups with respect to evident hemodynamic changes or the use of ephedrine.

Limitations

Limitations of the study include that the sitting position was preferred during the administration of SA even though fewer hemodynamic changes have been reported in pregnant women when SA is administered in the left lateral position [17]. Several pregnancy-associated changes in the vertebral anatomy, the presence of lumbar lordosis, and more importantly, the severe discomfort formed in the lateral position in pregnant women played a role in this preference.

Conclusion

The methods of positioning the operating table at a 15º incline and leg elevation, applied on their own or together, to pregnant women receiving spinal anesthesia, insignificantly reduced the frequency and depth of SA-induced maternal hypotension. It could provide maternofetal benefits with respect to less use of vasopressors. Furthermore, despite all these positive effects, appropriate conditions must be provided with preoperative fluid resuscitation and pharmacological support during the operation together with these methods for pregnant women undergoing caesarean section, and necessary interventions must not be delayed.

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