Turkish Journal of Geriatrics
2013; 16 (4) 414-420

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Geliş Tarihi: 20/03/2013
(Received)

Kabul Tarihi: 18/04/2013
(Accepted)

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RESEARCH

THE EFFECT OF SPINAL ANESTHESIA ON CARDIAC OUTPUT IN GERIATRIC PATIENTS

ABSTRACT

Introduction: In the elder population, anesthesia related morbidity and mortality rates are higher compared to young adults. In the present study, threfrequency of hypotension and changes in cardiac output related to spinal anesthesia among the geriatric patients were aimed to be investigated.

Materials and Method: The patients were divided into two groups: group 1 included patients between 65- 79 years of age, group 2 included patients 80 years and older. Systolic blood pressures, diastolic blood pressures and mean blood pressures of the patients were calculated. Heart rates, peripheral oxygen saturation, cardiac output and stroke volumes were determined. Cardiac output and stroke volumes were measured by echocardiography. Five hundred ml colloid fluid was given to all patients in the preoperative period. Following the infusion, systolic blood pressures, diastolic blood pressures, mean blood pressures, heart rates, peripheral oxygen saturation, cardiac output and stroke volume values of the patients were recorded just before patients underwent spinal anesthesia, and at 5, 10, 15 and 20 minutes following spinal anesthesia.

Results: There were no differences between the two groups regarding the demographic data. In group 2, the values of Systolic blood pressures, diastolic blood pressures and mean blood pressures were detected to be significantly lower at the 5th minute after spinal anesthesia. There were no differences between the two groups in cardiac output and stroke volume parameters.

Conclusion: We found that hypotension was more frequent in patients over the age of 80 than the patients between 65-79. The occurrence of hypotension in over the age of 80 was associated with the decrease in systemic vascular resistance rather than the decrease in cardiac output.

Key Words: Anesthesia, Spinal; Cardiac Output; Aged.

ARAŞTIRMA

GERİATRİK HASTALARDA SPİNAL ANESTEZİNİN KARDİAK OUTPUT ÜZERİNE ETKİSİ

ÖZ

Giriş: Yaşlı hasta popülasyonunda anestezi ile ilşkili mobiditeye ve mortalite hızları genç hastalara göre daha yüksektir. Bu çalışmada geriatrik hastalarda spinal anesteziye bağlı hipotansiyon ve kardiak outputdaki değişikliklerin sıklığının araştırılması amaçlanmıştır.

Gereç ve Yöntem: Hastalar iki gruba ayrıldı. Grup 1 65-79 yaş arasındaki hastaları içerirken, Grup 2 80 yaş ve üzeri hastaları içeriyordu. Hastaların sistolik kan basıncı, diyastolik kan basıncı ve ortalama kan basıncı değerleri hesaplandı. Kalp atım hızları, periferik oksijen saturasyonları, kardiak output ve stroke volümleri belirlendi. Kardiak output ve stroke volüm değerleri ekokardiografi ile ölçüldü. Preoperatif dönemde hastaların tümüne 500 ml kolloid sıvı verildi. İnfüzyon sonrası hastaların sistolik kan basıncı, diyastolik kan basıncı, ortalama kan basıncı, kalp atım hızları, periferik oksijen saturasyonları, kardiak output ve stroke volüm değerleri spinal anestezi uygulamadan hemen önce ve sonrası 5, 10,15 ve 20. dakikalarda kayıt edildi.

Bulgular: Demografik veriler açısından her iki grup arasında fark yoktu. Grup 2 'de sistolik kan basıncı, diyastolik kan basıncı ve ortalama kan basıncı değerlerinin spinal anestezi sonrası 5. dakikada anlamlı derecede düşük olduğu saptandı. Kardiak output ve stroke volüm değerleri açısından her iki grup arasında fark yoktu.

Sonuç: Seksen yaş üzeri hastalar da 65-79 yaş aralığındaki hastalara oranla hipotansiyonun daha sık oluştuğunu saptadık. 80 yaş üzeri hastalar da ortaya çıkan hipotansiyonsiyon kardiak outputun azalmasından çok sistemik vasküler dirençteki azalma ile ilişkilidir.

Anahtar Sözcükler: Spinal Anestezi; Kalp Debisi; Yaşlı.

INTRODUCTION

With the increase in quality of life and developments in medical technology, there has been an increase in the percentage of elders in the population. Older individuals constitute a growing part of population especially in developed countries; however, they may have a number of problems requiring surgical intervention. Autonomic dysfunction, and cardiac and respiratory diseases constitute the most frequent conditions concerning a great part of this population, which limits options for the kind of anesthesia used in surgery (1).

Spinal anesthesia (SA) is a commonly used technique. When compared to general anesthesia, SA is advantageous for preserving cognitive functions, decreasing the amount of intraoperative bleeding, having lesser risk of postoperative thromboembolism and providing effective postoperative analgesia, however it is unfavorable for those with hypotension, bradycardia and delayed mobilization (2-4). Hypotension is one of the most common complications of SA and this is thought to be due to decrease in cardiac output (CO). In recent years, various techniques have been developed to measure CO non-invasively. Measurement of suprasternal aortic blood flow, which was first described by Light in 1969, is a simple noninvasive method for detecting CO and one of its major advantages is that it can be applied in an awake patient (5). In the following years non-invasive CO calculation methods such as Doppler velocimetry of the descending aorta in, the Fick principle associated with applied to carbon dioxide partial rebreathing, and many non-invasive arterial pulse contour CO analysis have been developed (6) We measured the patients' CO and SV values with ecocardiography device non invasively.

In the literature, we found very few studies that reported on the changes in CO following SA in a geriatric patient population (7). In the present study, we aimed to evaluate the effect of age on frequency of hypotension and changes in cardiac output (CO) in the geriatric patient population after spinal anesthesia.

MATERIALS AND METHOD

The study was conducted at the Department of Anesthesiology and Reanimation of Medical Faculty of"Afyon Kocatepe University" and the local ethics committe approved the study protocol. The study included 40 patients over 65 years of age with an American Society of Anesthesiologists (ASA) score between 1 and 3, who were scheduled for elective orthopaedic surgery. Patients with a history of coronary artery disease, segmental wall motion abnormality and severe valvular heart disease on echocardiography, patients diagnosed with hypertension according to the guidelines of 2007 European Society of Cardiology patients diagnosed with hypertension (8), atrial fibrillation hypothyroidism and hyperthyroidism were excluded from the study.

Group 1 (elderly group) included twenty patients between 65 and 79 years of age, while Group 2 included twenty patients aged 80 and over. All patients were examined on the day before surgery and informed about the procedure; after that their consents were obtained. Eating and drinking were discontinued at 00.00 a.m. the night before surgery. All patients' gender, body mass index, smoking, drugs used, applied level of spinal anesthesia, dose of given local anesthetics, and concomitant disease of diabetes mellitus were recorded.

Body mass index (BMI) for both groups was calculated with the formula; body weight(kg)/height (m^2). Systolic blood pressures (SBP) and diastolic blood pressures (DBP) of the patients were measured via non-invasive arterial pressure monitorization. Patients mean blood pressure values were calculated with a formula of SBP/3 + 2DBP/3. Heart rates (HR) and peripheral oxygen saturation (SpO_2) were taken. Transthoracic assessment of CO and SV were performed with a 4 Mhz transducer of a (Sonos 5500®) echocardiography device. CO was calculated from the left ventricular outflow tract (LVOT). The diameter of the LVOT was taken as the distance between the bases of the aortic valve cups during systole, from the long parasternal view. The inner-edge-to-inner-edge measurement was chosen, with 3 determinations of the LVOT taken and then averaged. Continuous wave Doppler samples were then obtained in the LVOT from the apical 5 chamber view. The leading edge of 3 to 5 near consecutive Doppler velocity curves was traced and the average velocity time-integral (VTI) calculated through the software in the HP echocardiography device. All echocardiographic measurements were performed by one cardiologist. SV and CO were calculated using the formulae below:

SV = VTI X LVOT
CO= HR X SV = HR X VTI X LVOT. (9).

All patients were given 500 ml colloid fluid, with an 18 gauge cannula, preoperatively. Following the SA, patients in both groups were given 4 ml/kg/h of 0.9% saline solution. The SBP, DBP, MBP, SpO_2, HR, CO and SV values were recorded again following the infusion. Then, using the standard technique of SA, a no. 22-gauge Quincke needle was introduced into the subarachnoid space at level of L3-L4 or L4-L5. After observing the free flow of cerebrospinal fluid, 10-15 mg of Heavy Marcaine® (Spinal Heavy, AstraZeneca, Sweden) was applied. Then the patients were placed in the supine position. The values of SBP, DBP, MBP, SpO_2, HR, CO and SV were recorded at 5, 10, 15 and 20 minutes following spinal anesthesia.

Hypotension was accepted as a twenty percent decrease in the SBP compared with the value obtained before fluid infusion. In case of hypotension, 5 mg of ephedrine was given intravenously, and the dose was repeated when the first application was not effective enough. Duration of the operation was accepted as the period between the beginning of the operation and the application of the last skin suture. All of the complications during the surgery following SA were recorded. The dermatome level of sensory blockade with a pinprick test bilaterally after injection of the local anesthetic was assessed by a blinded observer.

Statistical Analysis

Statistical Product and Services Solutions (SPSS) for Windows version 15.0 (SPSS Inc, Chicago, IL, USA) was used in this study for the statistical analysis. Student's t test was used for parametric data and the Mann-Whitney U-test was used for non-parametric data in evaluation of the patients' demographic data. A paired samples t-test was used to determine the difference between the two dependent variables. Analysis of variance was used to evaluate the variability of repeated measurements made at different time points, both within the group and between groups. Chi-square test was used for comparison of categorical variables. p value <0.05 was considered as statistically significant.

Results

Mean age of the patients in group 1 was 69.00±4.00, while in Group 2 it was 83.15±2.94. No statistically significant difference between the groups was determined regarding BMI, gender and ASA physical status. The maximum sensorial block level and duration of surgery did not differ between the groups. Patients medications, concomitant diabetes mellitus, smoking uses, applied level of spinal anesthesia used and dose of local anesthetic did not differ between the groups (Table 1).

In the evaluation of hemodynamic parameters, a significant decrease in SBP, MBP and DBP values were detected 5 minutes after SA in both age groups, with a greater decrease in Group 2. Recorded basal values of SBP, MBP and DBP in Group 1 were as follows; 127.2 mmHg, 90.1 mmHg and 71.5 mmHg, respectively. On the other hand, basal values of SBP, MBP and DBP in Group 2 were as follows; 125.3 mmHg, 89.1 mmHg and 71.1 mmHg, respectively. Fifth minute values of SBP, MBP and DBP in group 1 were as follows; 115.4 mmHg, 81.0 mmHg and 63.8 mmHg respectively. These values for Group 2 were 100.2 mmHg, 69.6 mmHg and 54.8 mmHg, respectively. The changes in the MBP of patients in both Groups are outlined in Figure 1. The rest of the SBP, MBP and DBP measurements (at 10th, 15th and 20th min.) obtained at different time points were similar. Hypotension occurred after spinal anesthesia in five patients. In Group 1, only one patient needed one dose of ephedrine at the fifth minute, while in Group 2, four patients needed one dose of ephedrine at the same time point. Cardiac output (CO) and SV values were similar at all measurements points in both groups (Figures 2,3).

Table 1— Demographic Data of the Patients in Group 1 and Group 2.

	Group 1	Group 2	P
BMI, kg/m²	27.63±1.04	28.40±2.53	0.28
Sex Male/Female	10/10	9/11	0.75
Active smoking, %	2(%5)	1(%2.5)	0.54
Diabetes Mellitus, %	4(%10)	6(%15)	0.46
Drug usage			
Statin, %	4(%10)	5(%12.5)	0.70
Inhaler, %	6(%15)	8(%20)	0.50
NSAID, %	4(%10)	6(%15)	0.46
ASA score			
1/2/3	3/12/5	2/11/7	0.74
Maximum Blockade level	Th 10 (Th 5-10)	Th 10(Th 4-10)	0.39
Local anestetic dosage, mg	13.12±1.79	13.25±1.64	0.50
Spinal Anesthesia Level L3-L4/L4-L5,	12/8	14/6	0.50
Operation duration, minute	122.15±20.40	122.25±20.55	0.98
Hearts Rates (minute)			
5th	74.30±8.44	71.40±6.80	0.25
10th	75.65±8.68	74.20±7.74	0.44
15th	76.20±7.50	74.50±7.40	0.97
20th	75.65±8.44	73.65±6.70	0.29

Data are represented as Mean ± Standard Deviation (SD) otherwise indicated. ASA, American Society of Anestheiologic score; BMI, Body mass index; Th, thoracic;

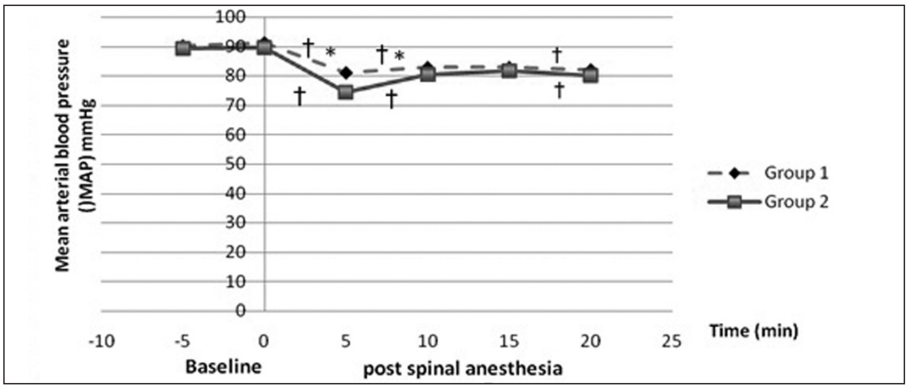

Figure 1— Changes in the MBP of the patients.

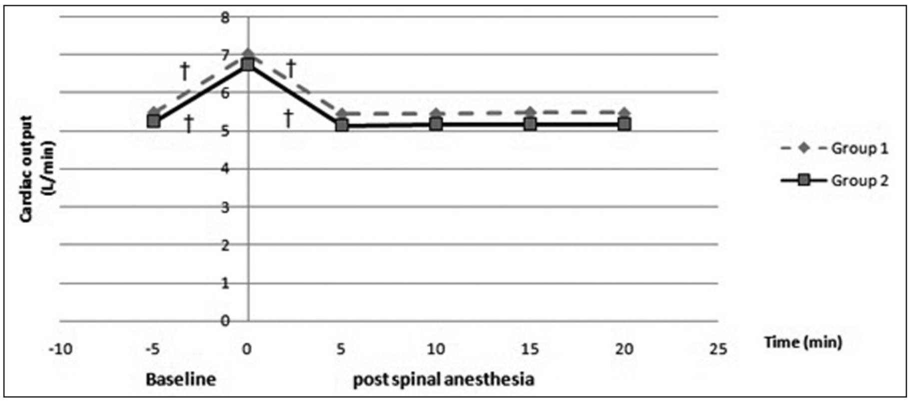

Figure 2— Cardiac Output values.

There were no differences in the heart rates and SpO_2 values of patients either within groups or between groups ($p>0.05$) (Figure 4). No additional complications were noted apart from hypotension.

DISCUSSION

This study demonstrated that after SA, hypotension may be seen more frequently in patients 80 years of age or older, compared to patients in the 65 to 79 age range. However SV and CO were not significantly affected by spinal anesthesia in either the elderly (65-79) or age 80 and older groups. Spinal anesthesia induced hypotension may be due to decrease in systemic vascular resistance (SVR) and it may be more prominent in those aged 80 and above.

Geriatric patients in the community have many compromising physiological characteristics and also much comorbidity that threaten life. These comorbidities may directly affect decisions about type of anesthesia, as they may cause serious complications. In particular, in the presence of respiratory problems regional anesthesia is preferred by most anesthetists because of its important advantages. Spinal anesthesia is a commonly used central block method, which is well-known by clinicians and easy to apply. However, SA has predictable side effects.

The most common complication seen after SA is hypotension (10). As known, the main elements constituting blood pressure are CO and vascular resistance. Due to the sympathetic blockade that may occur after SA, arterial, arteriolar and venous vasodilatation occurs, resulting in a decrease in SVR and venous return. CO decreases as a result of the decline in venous return due to the peripheral pooling of blood (11). The decrease in both CO and SVR contribute to the development of hypotension but it is not clear which factor is more effecti-

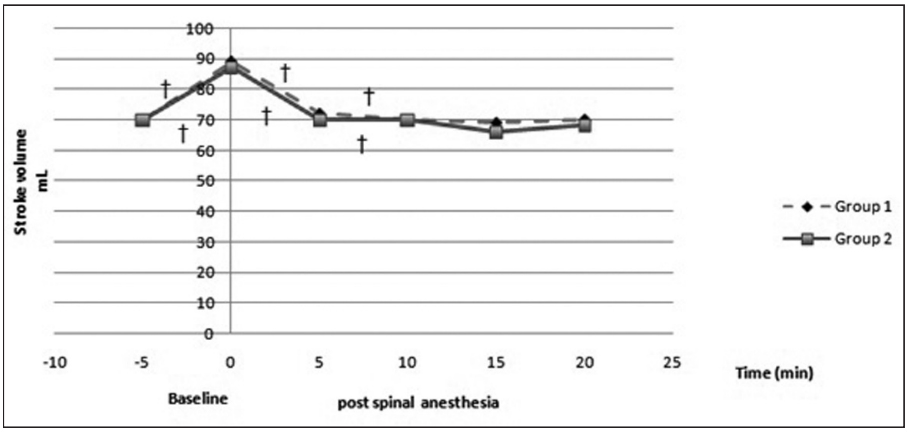

Figure 3— Stroke volume valuer of the patients.

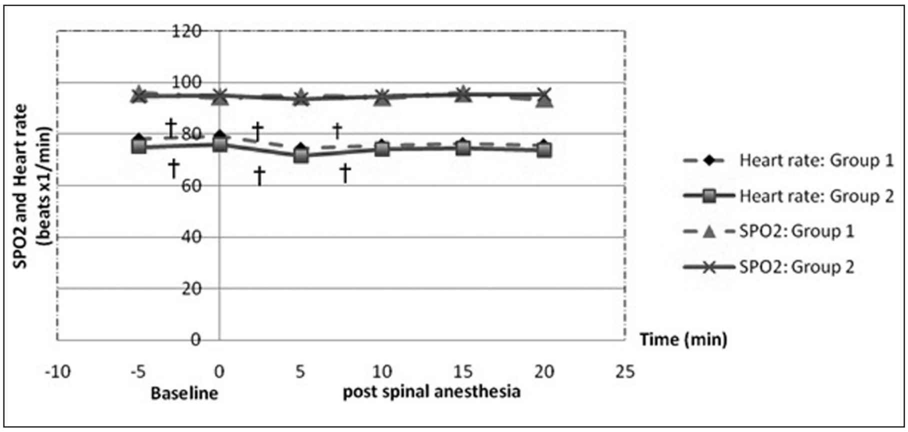

Figure 4— SPO_2 and heart rate values of the patients.

ve. In the present study, we aimed to find out which one of CO and SVR contributes more to the development of hypotension after SA, in two different geriatric age groups.

According to the results of the present study, hypotension after SA occurs more frequently in patients aged 80 or over than in elderly ones. In both groups of geriatric patients, CO and SV were not significantly affected after SA. Cardiac pulse rates were also measured during echocardiographic examination (CO and SV) and, after spinal anesthesia, there were no significant differences between cardiac pulse rates in both groups at 5th, 10th, 15th and 20 th minutes of study. Chronic diseases and the use of a variety of drugs may increase the risk of hypotension during spinal anesthesia in elderly individuals. Diabetes mellitus is one of the chronic diseases which are frequent in the elderly, and significant hypotension during spinal anesthesia can be seen in these patient depending on autonomic nervous system dysfunction(12), In our study there was no difference in the percentage of diabetic patients and chronic medications used by patients. Hypotension was not seen in patients with diabetes mellitus. Development of hypotension after SA in patients aged 80 or over may be due to changes in SVR (13). Minville et al. measured cerebral blood flow after SA and compared patients under 60 years of age with the patients over 60 years of age in their study. They found that hypotension occurred more frequently in the geriatric age group, although the maximum sensorial block levels were similar in both groups (14). In the present study hypotension occurred more frequently in the older age since the maximum sensorial block levels were similar. The dosage of local anesthetics and application intervals have also been shown to be effective in development of hypotension after SA (15). In our study, those factors were standard in both groups.

Today, preloading before SA with infusion of intravenous fluid is the most common method to avoid SA induced hypotension. In previous studies that used crystalloids and colloids for preloading, the results showed that colloids were more effective (16,17). To prevent hypotension, we also applied colloid infusion before SA in the present study.

In their study that evaluated the efficacy of hydration before anesthesia for preventing hypotension due to SA in elderly patients, Buggy et al. used intravenous ephedrine when hypotension occurred (18). We also applied 5 mg of IV ephedrine in the present study; only one patient required ephedrine in Group 1 while 4 patients in Group 2 needed it.

After SA a decline in CO occurs; however, preloading before SA prevents the increase of the decline (19). We believe that the reason there was no significant change in CO after SA in our study was the preloading with colloids. In their study with patients aged 80 or older, Nakasuji et al. reported a significant decrease in SVR but no significant changes in CO in patients who developed hypotension after SA. They concluded that SA-induced hypotension was due to the decrease in SVR (19). Similarly, we observed that there was no difference between CO levels measured before and 5 minutes after SA in patients over 80 years of age who developed hypotension.

Evaluation of CO and SV by transthoracic echocardiography (ECG) is a non-invasive, simple, cheap and applicable method in an awake patient with spontaneous respiration. Measurement of CO with this method is not continuous, as in other methods, and can be applied at regular intervals (20). McLean et al. reported that measurement of CO and SV with transthoracic ECG correlated with the thermodilution method (21). In their study on cardiac functions after unilateral SA, Donatti et al. used this method to evaluate CO (9). Although non invasive estimation of SV and CO is a limitation and Fick method is accepted as the golden standard for those parameters, we also used transthoracic ECG to determine CO and SV non-invasively in the present study. In another study assessing CO and SV after SA, measurements of CO and SV were made once per minute (22); however, we performed these measurements once every 5 minutes. This may be a limitation of our study. Other limitations for the present study include the small number of patients and not to measure central venous pressure (CVP). If CVP had been measured, SVR ccould be calculated by using the formula SVR=MAP-CVP/CO.

In conclusion, hypotension related to spinal anesthesia occurs more frequently in patients aged 80 and over than in patients aged 65 to 79. We believe that the hypotension in the older group (Group 2) is related to the decrease in vascular resistance rather than the decrease in CO. In elderly patients (Group 1), preloading with colloids before SA can prevent hypotension related to SA.

REFERENCES

1. Çelik JB, Topal A ,Erol A, Güven S, Kara İ. A comparasion of recovery characteristics of sevoflurane and propfol-remifentanil anesthesia in geriatriric patients. Turkish Journal of Geriatrics 2011;14(3)208-13.
2. Critchley LA. Hypotension, subarachnoid block and the elderly patient. Anaesthesia 1996;51(12):1139-43. (PMID:9038450).
3. Rooke GA, Freund PR, Jacobson AF. Hemodynamic response and change in organ blood volume during spinal anesthesia in elderly men with cardiac disease. Anesth Analg 1997;85(1):99-105. (PMID:9212130).
4. Critchley LA, Stuart JC, Short TG, Gin T. Haemodynamic effects of subarachnoid block in elderly patients. Br J Anaesth 1994;73(4):464-70. (PMID:7755705).
5. Light LH. Non-injurious ultrasonic technique for observing flow in the human aorta. Nature 1969;224(5224):1119-21. (PMID:5353728).
6. Cholley BP, Payen D. Noninvasive techniques for measurements of cardiac output. Curr Opin Crit Care 2005;11(5):424-9.(PMID:16175028).
7. Meyhoff CS, Hesselbjerg L, Koscielniak-Nielsen Z, Rasmussen LS. Biphasic cardiac output changes during onset of spinal anaesthesia in elderly patients. Eur J Anaesthesiol 2007;24(9):770-5. (PMID:17462120).
8. Mancia G, De Backer G,Dominiczak A, et al. ESH/ESC 2007 Guidelines for the management of arterial hypertension. Rev Esp Cardiol 2007;60(9):968.e1-94. (PMID:17915153).
9. Donati A, Mercuri G, Iuorio S, et al. Haemodynamic modifications after unilateral subarachnoid anaesthesia evaluated with transthoracic echocardiography. Minerva Anestesiol 2005;71(3):75-81. (PMID:15714183).
10. Hartmann B, Junger A, Klasen J, et al. The incidence and risk factors for hypotension after spinal anesthesia induction: an analysis with automated data collection. Anesth Analg 2002;94(6):1521-9. (PMID:12032019).
11. Kayhan Z. Santral Bloklar Spinal Epidural Anestezi, In: Kayhan Z (Ed). Klinik Anestezi. 3th Edition, Logos Yayıncılık, Ankara, Turkey 2004, pp 552-89.
12. McAnulty GR, Robertshaw HJ, Hall GM. Anaesthetic management of patients with diabetes mellitus. Br J Anaesth 2000;85(1):80-90. (PMID:10927997).
13. Nishikawa K, Yamakage M, Omote K, Namiki A. Prophylactic IM small-dose phenylephrine blunts spinal anesthesia-induced hypotensive response during surgical repair of hip fracture in the elderly. Anesth Analg 2002;95(3):751-6. (PMID:12198065).

14. Minville V, Asehnoune K, Salau S, et al. The effects of spinal anesthesia on cerebral blood flow in the very elderly. Anesth Analg 2009;108(4):1291-4. (PMID:19299802).
15. Stienstra R, Greene NM. Factors affecting the subarachnoid spread of local anesthetic solutions. Reg Anesth 1991;16(1):1-6. (PMID:2007097).
16. Marhofer P, Faryniak B, Oismüller C, Koinig H, Kapral S, Mayer N. Cardiovascular effects of 6% hetastarch and lactated Ringer's solution during spinal anesthesia. Reg Anesth Pain Med 1999;24(5):399-404. (PMID:10499749).
17. Baraka AS, Taha SK, Ghabach MB, Sibaii AA, Nader AM. Intravascular administration of polymerized gelatin versus isotonic saline for prevention of spinal-induced hypotension. Anesth Analg 1994;78(2):301-5. (PMID:8311283).
18. Buggy D, Higgins P, Moran C, O'Brien D, O'Donovan F, McCarroll M. Prevention of spinal anesthesia-induced hypotension in the elderly: comparison between preanesthetic administration of crystalloids, colloids, and no prehydration. Anesth Analg 1997;84(1):106-10. (PMID:8989009).
19. Nakasuji M, Suh SH, Nomura M, et al. Hypotension from spinal anesthesia in patients aged greater than 80 years is due to a decrease in systemic vascular resistance. J Clin Anesth 2012;24(3):201-6. (PMID:22537572).
20. Michard F. Stroke volume variation: from applied physiology to improved outcomes. Crit Care Med 2011;39(2):402-3. (PMID:21248521)
21. McLean AS, Needham A, Stewart D, Parkin R. Estimation of cardiac output by noninvasive echocardiographic techniques in the critically ill subject. Anaesth Intensive Care 1997;25(3):250-4. (PMID:9209605).
22. Teoh WH, Sia AT. Colloid preload versus coload for spinal anesthesia for cesarean delivery: the effects on maternal cardiac output. Anesth Analg 2009;108(5):1592-8. (PMID:19372341).