Clinical Center of Vojvodina, Novi Sad, Emergency Center[1]
University of Novi Sad, Faculty of Medicine Novi Sad
Department of Anesthesia and Intensive Care[2]
Institute of Oncology of Vojvodina[3]
Emergency Center, Department of Emergency Neurology[4]

Original study
Originalni naučni rad
UDK 616.718.4-001.5-089.5:616.12-008.4
https://doi.org/10.2298/MPNS1808235G

PREDICTORS OF HYPOTENSION DURING SURGICAL MANAGEMENT OF FEMORAL FRACTURES IN SPINAL ANESTHESIA

PREDIKTORI HIPOTENZIJE TOKOM OPERATIVNOG ZBRINJAVANJA PRELOMA BUTNE KOSTI U SPINALNOJ ANESTEZIJI

Milica GOJKOVIĆ[1], Arsen UVELIN[1,2], Milanka TATIĆ[2,3], Vladimir VRSJAKOV[1], Dunja MIHAJLOVIĆ[1,2] and Aleksandra LUČIĆ PROKIN[4]

Summary

Introduction. Femoral fractures are the most common cause of morbidity and mortality in the elderly. The aim of this study was to establish the predictors of hypotension in the elderly patients with femoral fractures during surgery in spinal anesthesia. **Material and Methods.** This retrospective study included 454 patients and investigated the relationship between hypotension and predictive factors for the development of hypotension using binary logistic regression. A paired sample T-test for dependent variables was used to compare the mean arterial pressure before and after the surgical procedure. Three mean arterial pressure values were compared between subjects receiving bupivacaine and subjects who received levobupivacaine: preoperative, the lowest value during the surgery, and the mean arterial pressure at the end of the surgery. **Results.** The age of the subjects ranged from 20 to 93 years (mean = 71.56; standard deviation = 13.26, median = 74). The mean arterial pressure values during the preoperative evaluation (103.2 ± 14.7) were higher than the last mean arterial pressure during surgery (84.8 ± 13.6) and these differences were statistically significant ($p < 0.001$). The group of subjects who received levobupivacaine presented with higher values of median arterial pressure (73.99) than the group receiving bupivacaine (70.76). **Conclusion.** The predictors of hypotension during surgery of patients with femoral fractures in spinal anesthesia are elderly age and preoperative use of beta blockers.

Key words: Hypotension; Anesthesia, Spinal; Femoral Fractures; Orthopedic Procedures; Age Factors; Adrenergic beta-Antagonists; Risk Factors

Sažetak

Uvod. Prelomi butne kosti predstavljaju najčešći uzrok morbiditeta i mortaliteta bolesnika starijeg životnog doba. Cilj rada je utvrđivanje faktora koji imaju prediktivnu moć za nastanak hipotenzije tokom spinalne anestezije za operativno zbrinjavanje preloma butne kosti. **Materijal i metode.** Ispitivanje je sprovedeno po tipu retrospektivne studije, obuhvatilo je 454 bolesnika. Radi ispitivanja povezanosti hipotenzije i faktora koji imaju prediktivni značaj za nastanak hipotenzije primenjena je binarna logistička regresija. Poređenjem vrednosti srednjeg arterijskog pritiska na kraju operativnog zahvata sa inicijalnom vrednosti srednjeg arterijskog pritiska, u perioperativnoj evaluaciji primenjen je t-test za zavisne uzorke. Upoređivane su tri vrednosti srednjeg arterijskog pritiska: preoperativna vrednost, najniža vrednost tokom operativnog zahvata i vrednost srednjeg arterijskog pritiska na kraju operativnog zahvata, između grupe ispitanika koja je dobila bupivakain i grupe ispitanika koja je dobila levobupivakain. **Rezultati.** Starost ispitanika se kretela u opsegu od 20 do 93 godine (srednja vrednost = 71,56; standardna devijacija SD = 13,26; medijana = 74). Pokazano je da su vrednosti srednjeg arterijskog pritiska tokom preoperativne evaluacije (103,2 ± 14,7) više u odnosu na poslednju vrednost srednjeg arterijskog pritiska tokom operacije (84,8 ± 13,6) i ove razlike su statistički značajne ($p < 0.001$). Grupa ispitanika koja je primila levobupivakain imala je više vrednosti medijalnog srednjeg arterijskog pritiska 73,99 od grupe ispitanika koja je primila bupivakain (70, 76). **Zaključak.** Prediktori nastanka hipotenzije tokom operativnog zbrinjavanja preloma butne kosti u spinalnoj anesteziji su starost bolesnika i preoperativna upotreba beta blokatora.

Ključne reči: hipotenzija; spinalna anestezija; frakture butne kosti; ortopedske procedure; faktori starosti; beta blokatori; faktori rizika

Introduction

Femoral fractures are the most common cause of morbidity and mortality in elderly patients [1]. Surgical management of femoral fractures may be performed under general or neuraxial block anesthesia [2, 3]. The choice of anesthesia depends on patients' chronic diseases, previous anesthesiological complications and potential hemodynamic and respiratory problems. In regard to the accompanying comorbidities, spinal anesthesia may have advantages over general anesthesia. The advantages include lower incidence of respiratory and myocardial depression, better peripheral tissue perfusion due to the sympathetic blockade, decreased intra-operative bleeding and minimal coagulation disorders [4].

Corresponding Author: Prof. dr Arsen Uvelin, Klinički centar Vojvodine, Urgentni centar, 21000 Novi Sad, Hajduk Veljkova 1-7, E-mail: arsen.uvelin@mf.uns.ac.rs

Abbreviations
ASA – American Society of Anesthesiologists
SAP – systolic arterial pressure
DAP – diastolic arterial pressure
MAP – mean arterial pressure
SP – surgical procedure
MV – mean value

Hypotension is one of the most frequent adverse effects of spinal anesthesia and it may appear in up to one-third of patients undergoing surgery in spinal anesthesia [5]. Sympathetic blockade affects the cardiovascular system by decreasing the vein inflow and systemic vascular resistance [6]. When the level of analgesia overlaps the level of the fourth thoracic vertebra, it blocks cardioaccelerator fibers, causing pulse decrease and cardiac output reduction. Hypotension during spinal anesthesia represents a risk for brain and cardiac ischemia [7]. The elderly patients are more inclined to get hypotension due to difficult adaptation of the cardiovascular system to the changes in circulatory system [8].

Patients who consume alcohol are at higher risk for hypotension, due to neuropathy which is accompanying alcoholism and causes orthostatic hypotension. Patients undergoing urgent surgery present with higher incidence of surgical hypotension than patients who undergo elective surgery [9].

Material and Methods

This retrospective study included 454 patients with femoral fractures who underwent surgery at the Department of Anesthesia and Reanimation of the Emergency Center of the Clinical Center of Vojvodina in the period from 2014 – 2016.

The research was conducted with the approval of the Ethics Committee of the Clinical Center of Vojvodina.

There is little research on predictive factors of hypotension in elderly patients with femoral fractures during surgery in spinal anesthesia.

Medical history data as well as anesthesia cards were analyzed including patient age, sex, diagnosis, type of surgical procedure, preoperative status, American Society of Anesthesiologists (ASA) classification, accompanying comorbidity **(**ischemic heart disease, hypertension, diabetes, chronic obstructive lung disease), and chronic therapy. Arterial pressure was preoperatively examined in each patient by an internist.

The spinal anesthesia data included the type, dose of local anesthetic, duration of anesthesia and duration of surgery. Initially, noninvasive basal arterial pressure verified the systolic and diastolic pressure prior to spinal anesthesia and then every five minutes after spinal anesthesia. The anaes-

Table 1. Medical history data
Tabela 1. *Anamnestički podaci*

		Incidence/*Učestalost*	Percentage/*Procenat*
Diagnosis *Dijagnoza*	Fractura colli femoris	255	56.17
	Fractura daipahyseos femoris	25	5.51
	Fractura capitis femoris	37	8.15
	Fractura subtrochanterica femoris	137	30.18
Surgery *Operacija*	Hemialoarthroplastica coxae sec Moore	76	16.70
	Aloarthroplastica coxae cum proth.totalis	77	16.92
	Osteosynthesis cum cunei Gamma short	103	22.64
	Osteosynthesis cum cunei Gamma long	42	9.23
	Aloarthroplastica coxae partialis	37	8.13
	Osteosynthesis femoris	119	26.15
Accompanying diseases *Propratna oboljenja*	Hypertension arterialis/*Arterijska hipertenzija*	303	57.50
	Ischemic cardiac diseases/*Ishemijska bolest srca*	45	8.54
	Chronic obstructive lung diseases *Hronična opstruktivna bolest pluća*	34	6.45
	Diabetes mellitus type 2/*Dijabetes melitus tip II*	89	16.89
	Without accompanying disease *Bez propratnih oboljenja*	56	10.63
Chronic therapy *Hronična terapija*	Beta blocker/*Beta blokatori*	73	16.08
	Angiotensin converting enzyme inhibitors *Inhibitori angiotenzin konvertujućeg enzima*	34	7.49
	Calcium channel blockers *Blokatori kalcijumskih kanala*	13	2.86
	Other medications/*Druga terapija*	69	15.20
	No therapy/*Bez terapije*	265	58.37

Table 2. Association between medical history data and hypotension during surgery, multivariable logistic regression
Tabela 2. *Povezanost anamnestičkih podataka i hipotenzije tokom operacije, multivarijatna logistička regres*ija

		OR/OV/ KŠ	95% CI/*IP* LL/*DG*	UL/*GG*	p
	Age/*Godine*	1.02	1.00	1.04	0.037
	ASAC/*KAUA*	0.78	0.52	1.18	0.238
Accompanying diseases *Propratna oboljenja*	Arterial hypertension/*Arterijska hipertenzija*	1.04	0.64	1.70	0.881
	Ischemic cardiac diseases/*Ishemijska bolest srca*	1.53	0.69	3.40	0.293
	Chronic obstructive lung disease *Hronična opstruktivna bolest pluća*	1.07	0.47	2.46	0.865
	Diabetes Mellitus type II/*Dijabetes melitus tip II*	1.27	0.72	2.25	0.413
Chronic therapy *Hronična terapija*	Beta blockers/*Beta blokatori*	3.16	1.42	7.01	0.005
	Angiotensin converting enzyme inhibitors *Inhibitori angiotenzin konvertujućeg enzima*	1.23	0.49	3.14	0.659
	Calcium channel blockers/*Blokatori kalcijumskih kanala*	0.65	0.16	2.63	0.543
Diagnosis *Dijagnoze*	Fractura colli femoris	0.73	0.43	1.21	0.222
	Fractura diapahyseos femoris	1.22	0.38	3.93	0.735
Surgery *Operacija*	Hemialoarthroplastica coxae sec Moore	1.05	0.52	2.09	0.899
	Aloarthroplastica coxae cum proth.totalis	1.14	0.58	2.24	0.709
	Osteosynthesis cum cunei Gamma short	0.59	0.34	1.05	0.074
	Osteosynthesis cum cunei Gamma long	0.91	0.40	2.05	0.818

Legend: OR – odds ratio. 95%; CI – confidence interval for OR; LL – lower level of confidence interval; UL – upper level of the confidence interval; ASAC – American Society of Anesthesiologists Classification; p - difference between measurements
Legenda: *OV - odnos verovatnoće (KŠ – količnik šansi), IP – intervali poverenja za OV; DG – donja granica intervala poverenja. GG – gornja granica intervala poverenja; KAUA - Klasifikacija Američkog udruženja anesteziologa, p – nivo razlika među merenjima*

thetic card included the systolic arterial pressure (SAP) and diastolic arterial pressure (DAP) in order to verify values of arterial pressure with a precision of up to 5 mmHg. Mean arterial pressure (MAP) was calculated based on the formula DAP + (SAP-DAP)/3. Hypotension was defined as the drop of the arterial pressure by 20% under basal conditions.

The integral part of the data analysis was the quantity of crystalloid and colloid solutions, and vasoactive medications that were used in patients with hypotension after spinal anesthesia. Data about blood loss during surgery and the quantity of blood products that were applied in the aim of compensation (resuspended erythrocytes and freshly frozen plasma) were also analyzed.

In order to examine the connection between hypotension during surgery and medical history data, binary logistic regression was applied. The criterion variable was the value of arterial blood pressure prior to surgery, whereas the predictor variables included age, ASA, accompanying diseases, chronic therapy, diagnosis, and type of surgery.

T-test for dependent variables was applied in order to compare the last MAP at the end of surgery with the initial, preoperative MAP. Three mean pressure values were compared in the group that received bupivacaine and the group that received levobupivacaine prior to surgery, at the end of surgery, and the lowest pressure during the procedure, as well as three T-tests for independent samples.

Results

The age of patients ranged from 20 to 93 years (mean age = 71.56; SD = 13.26; median = 74). There were more female than male patients (283; 62.3%). Detailed medical history data are presented in **Table 1**. The duration of surgical procedure (SP) was from 25 to 240 minutes, whereas the average duration was 67.9 minutes. During the SP, 62 patients (13.65%) received an erythrocyte transfusion, whereas the average amount of erythrocytes was 395.9 rml (SD = 56.8).

Transfusion of blood plasma was received by 4 patients (0.08%), and the average blood plasma volume was 217.5 ml (SD = 56.8).

Table 2 presents results of multivariable logistic regression analysis and the model was statistically significant (($\chi 2$ (15) = 26.45, $p < 0.05$). The results suggested that the patients had higher values of MAP during the pre-operative evaluation (mean value (MV) = 103.2; SD = 14.7) in relation to the last value of MAP during surgery (MV = 84.8; SD = 13.6) and these differences were statistically significant ($p < 0.001$). Detailed medical history data are represented in **Table 3**.

The MAP measured upon surgery was by 10% (or more) lower than MAP in the pre-operative evaluation of 305 (66.4%) examined subjects, and by 20% (or more) lower in 204 (44.4%) of examined patients. The gathered results showed that the differences were present only in case of the lowest values of the mean pressure during the SP (t (425) = 2.04, $p < 0.05$). The group of patients who re-

Table 3. Descriptive statistics for mean arterial pressure (MAP)
Tabela 3. *Deskriptivna statistika za srednji arterijski pritisak (SAP)*

	MAP – preoperatively (1) *SAP – preoperativno (1)*	MAP – at the end SP (2) *SAP - na kraju OZ (2)*	MAP – the lowest during SP (3) *SAP – najniži tokom OZ*
Min/*Min*	50.00	40.00	40.00
Max/*Max*	163.33	120.00	113.33
MV/*MV*	103.24	84.82	72.73
SD/*SD*	14.6	13.60	13.61
Sk/*Sk*	0.365	0.062	0.245
Ku/*Ku*	1.575	-0.184	-0.265
p/*p*	1 > 2 (p < 0.001), 1 > 3 (p < 0.001), 2 > 3 (p < 0.001)		

Legend**:** Min – minimum, Max – maximum, MV- mean value, SD – standard deviation, Sk – declivity, Ku – flattening, p - difference between measurements

Legenda: Min – minimum, Max – maksimum, MV – srednja vrednost, SD – standardna devijacija, Sk – zakošenost, Ku – spljoštenost, p – nivo razlika među merenjima, OZ – operativni zahvat

ceived levobupivacaine (MV= 73.99) presented with somewhat higher values of MAP in regard to the group who received bupivacaine (70.76). Detailed medical history data are represented in the **Table 4**.

Column N refers to the number of respondents per group. There were 337 patients in the Marcaine group, and 92 patients in the Chirocaine group.

The two last columns present Skjunis (symmetrical distribution measure) and Kurtosis (statistical measure that describes the tailedness of the probability distribution of the real valued random variable) are important characteristics for the implementation of certain statistical analyses and in all cases they were in the range of acceptable values of ± 2.00.

Examined subjects who had hypotension during surgery received a greater quantity of solution (MV= 1631.2; SD = 637.9) from those without hypotension during surgery (MV= 1344.4; SD = 489.1) and these differences were statistically significant ($t(301.1) = -5.14$, $p < 0.001$). Of the overall number of 454 patients, 122 (26.6%) received neosynephrine during the SP. The average dosage of neosynephrine was 157.7 micrograms (SD = 130.7). On average, the group of examinees who received neosynephrine was older (MV= 73.53; SD = 11.92) from the group who did not receive neosynephrine (MV = 70.83; SD = 11.12) and these differences were stastically significant ($t(244.6) = -2.04$, $p < 0.005$).

Discussion

Femur fractures are most common in elderly women. The average age of the patients in this retrospective study was 71.5 years, and almost two-thirds were women. The average age of the patients with fractures of the upper femur in the European literature is a bit higher, over 80 years [10].

During spinal anesthesia, hypotension occurs due to the blockage of sympathetic fibers. Vasodilation of the post-arterioles decreases the circulatory volume and the venous inflow into the heart. Dagnino et al. established that due to the degenerative-dystrophic changes that influence the blood vessels, the older patients are more likely to experience hemodynamic changes during spinal anesthesia. Elderly patients have less functional reserve to cope with hemodynamic changes during spinal anesthesia [11].

In our research, predictors of hypotension during spinal anesthesia for femoral fracture surgical treatment were the age and chronic therapy by beta blockers prior to the surgery. Similar results were reported by Oliveira et al. who pointed out the age over 45 years and female sex are predicators of hypotension during spinal anesthesia; however, these were not just patients with femoral fractures [9]. Beta blockers reduce the sympathetic system activity and decrease the myocardial oxygen consumption. These medications have an impact on the myocardium and decrease the intensity of myocardial activity, the arterial blood pressure and the heart rate. There is no data in the literature showing that chronic treatment with beta blockers may be a predictor of hypotension during spinal anesthesia. This can be interpreted as an indication that generally patients who take beta blockers have slower heart rate; drop of systemic vascular resistance occurs as an effect of blocking the sympathetic nervous system, so they cannot adequately react to increase the heart rate, but experience an intensive drop of the heart rate and arterial pressure.

Our research has established that the examined subjects who received levobupivacaine for spinal anesthesia intraoperatively presented with slightly higher average arterial pressure. Luck JF et al. suggested that levobupivacaine used for spinal anesthesia in the elderly caused lower decrease of arterial blood pressure than bupivacaine [12]. It was also established that the group of patients who received levobupivacaine showed higher average arterial pressure in comparison to those who received bupivacaine. Glaser et al. failed to prove that there was a difference in intraoperative values of arterial pressure between the patients in spinal anesthesia who received levobupivacaine versus those who received racemic bupivacaine. However, in this research, the group of patients was very heterogeneous regarding the age, from 18 to 85 years [13].

Table 4. Descriptive indicators for Medial pressure versus a group of drugs
Tabela 4. *Deskriptivni pokazatelji za medijalni pritisak u odnosu na grupu lekova*

	Group/*Grupa*	N/*Broj*	MV/*SV*	SD/*SD*	Min/*Min*	Max/*Maks*	Sk/*Sk*	Ku/*Ku*
MAP preoperatively *Medijalni pritisak preoperativno*	Marcaine	333	103.01	15.31	70.0	163.33	0.45	1.12
	Chirocaine	92	104.60	12.38	80.0	146.67	0.89	1.57
MAP - at the end of SP *MP na kraju OZ*	Marcaine	337	84.46	12.92	40.0	120.0	-0.01	0.00
	Chirocaine	92	87.27	15.52	50.0	120.0	-0.61	0.50
MAP - the lowest during SP *MP najniži tokom OZ*	Marcaine	335	70.76	13.22	40.0	113.33	-0.22	0.26
	Chirocaine	92	73.99	14.18	45.0	110.0	0.44	0.49

Legend: Min – minimum, Max – maximum, MV- mean value, SD – standard deviation, MAP – medial arterial pressure, SK – declivity, Ku – flattening, p - level of difference between measurements

Legenda*: Min – minimum, Maks – maksimum, SV – srednja vrednost, SD – standardna devijacija, MP – medijalni pritisak, OZ – operativni zahvat, SK – zakošenost, Ku – spljoštenost, p - nivo razlika među merenjima*

Gulek et al. established that there was no significant statistical difference between the type or dosage of the local anesthetic (bupivacaine and levopubivacaine) and arterial hypotension during spinal anesthesia in elderly patients [14]. By comparing the preoperative values of average arterial pressure and the values at the end of the SP, it was proved that the patients have higher preoperative MAP in relation to the last value of MAP during surgery. In our research, in more than 44% of examined patients MAP was lower by 20% or more in relation to the preoperative MAP.

Hartmann et al. found that patients who consumed alcohol were at three times higher risk for arterial hypotension. Due to alcoholic neuropathy, the sympathetic nervous system is being attacked, causing orthostatic dysregulation [15].

Patients prone to hypotension during spinal anesthesia received a higher initial and maintenance dose of neosynephrine during the surgical procedure. In our patients, almost one-third received 150 micrograms of phenylephrine for hypotension during the surgery.

Mitra et al. established that application of crystalloid solutions was efficient prior to the surgery in the aim of preventing hypotension. In their research they proved that it was more efficient to apply phenylephrine than ephedrine in the treatment of hypotension in spinal anesthesia [16].

Our research also recognized that it was efficient to use crystalloid and colloid solutions in the aim of filling intravascular volume in the treatment of hypotension in spinal anesthesia. If inadequate therapy response was obtained in regard to correction of volume, neosynephrine was used in the treatment of hypotension.

Our study has pointed out the predictors of hypotension in surgical management of femoral fractures in spinal anesthesia - the patient's age and taking beta blockers. It showed that levobupivacaine caused lower degree of hypotension than bupivacaine. Thus, we suggest special preparation before and during spinal anesthesia in elderly patients, and potential reduction of beta blockers immediately prior to surgery.

The main drawback of our study is its retrospective design. A prospective study should check whether levopubivacaine causes lower degree of hypotension than racemic bupivacaine in elderly patients with femoral fractures treated in spinal anesthesia, and it may represent a better choice in geriatric population.

Conclusion

Predictors of hypotension during surgery of patients with femoral fractures in spinal anesthesia are elderly age and preoperative use of beta blockers.

References

1. Grubor P, Asotić M, Grubor M. Method of choice in the treatment of femoral neck fractures in subjects aged over 65. Acta Medica Medianae. 2010;49(3):5-10.

2. Vidić G, Milenković S, Golubović Z, Stojanović S, Antić Z, Antić Z. Treatment of periprosthetic femoral fractures with self-dynamisable internal fixator. Acta Medica Medianae. 2017;56(3):31-7.

3. Mladenović M. The role of surgical procedures in prevention and therapy of hip osteoarthrosis caused by morphological changes of th femoral neck [dissertation]. Niš: University of Niš, Facuty of Medicine; 2017.

4. Janković D. Spinal anesthesia. In: Janković D. Regional nerve blocks and infiltration therapy of pain. Oxford: Blackwell Publishing; 2004. p. 272-85.

5. Carpenter RL, Caplan RA, Brown DL, Stephenson C, Wu R. Incidence and risk factors for side effects of spinal anesthesia. Anesthesiology. 1992;76(6):906-16.

6. Klasen J, Junger A, Hartmann B, Benson M, Jost A, Banzhaf A, et al. Differing incidences of relevant hypotension with combined spinal-epidural anesthesia and spinal anesthesia. Anesth Analg. 2003;96(5):1491-5.

7. Casati A, Fanelli G, Aldegheri G, Colnaghi E, Casaletti E, Cedrati V, et al. Frequency of hypotension during conventional or asymmetric hyperbaric spinal block. Reg Anesth Pain Med. 1999;24(3):214-9.

8. Tarkkila P, Isola J. A regression model for identifying patients at high risk of hypotension, bradicardia and nausea during spinal anesthesia. Acta Anaesthesiol Scand. 1992;36(6):554-8.

9. Oliveira Filho GR, Garcia JHS, Goldschimidt R, Dal Mago AJ, Cordeiro MA, Ceccato F. Predictors of early hypotension during spinal anesthesia. Rev Bras Anestesiol. 2001;51(4):298-304.

10. Herrera R, De Andres J, Etan L, Olivas FJ, Martinez-Mir I, Steinfeldt T. Hemodynamic impact of isobaric levobupivacaine versus hyperbaric bupivacaine for subarachnoid anesthesia in patients aged 65 and older undergoing hip surgery. BMC Anesthesiol. 2014;14:97.

11. Dagnino J, Prys-Roberts C. Studies of anaesthesia in relation to hypertension. VI: cardiovascular responses to extradural blockade of treated and untreated hypertensive patients. Br J Anaesth. 1984;56(10):1065-73.

12. Luck JF, Fettes PD, Wildsmith JA. Spinal anaesthesia for elective surgery a comparison of hyperbaric solution of racemic bupivacaine, levobupivacaine. Br J Anesth. 2008;101(5):705-10.

13. Glaser C, Marhofer P, Zimpfer G, Heinz MT, Sitzwohl C, Kapral S, et al. Levobupivacaine versus racemic bupivacaine for spinal anesthesia. Anesth Analg. 2002;94(1):194-8.

14. Gulec D, Karsli B, Ertugrul F, Bigat Z, Kayacan N. Intrathecal bupivacaine or levobupivacaine: which should be used for elderly patients? J Int Med Res. 2014;42(2):376-85.

15. Hartmann B, Junger A, Klasen J, Benson M, Jost A, Banzhaf A, at 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.

16. Mitra JK, Roy J, Bhattacharyya P, Yunus M, Lyngdoh NM. Changing trends in the management of hypotension following spinal anesthesia in cesarean section. J Postgrad Med. 2013; 59(2):121-6.

Rad je primljen 9. V 2018.
Recenziran 21. VI 2018.
Prihvaćen za štampu 22. VI 2018.
BIBLID.0025-8105:(2018):LXXI:7-8:235-240.