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

PREDIKTORI HIPOTENZIJE TOKOM OPERATIVNOG ZBRINJAVanja PRELOMA BUTNE KOSTI U SPINALNOJ ANESTEZIJI

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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 had higher values of mean 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

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].
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. Articular 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**

| Diagnosis Dijagnoza | Incidence/Učestalost | Percentage/Procenat |
|---------------------|----------------------|---------------------|
| 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 | Incidence/Učestalost | Percentage/Procenat |
|-------------------|----------------------|---------------------|
| 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 | Incidence/Učestalost | Percentage/Procenat |
|--------------------------------------------|----------------------|---------------------|
| 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 | Incidence/Učestalost | Percentage/Procenat |
|----------------------------------|----------------------|---------------------|
| Beta blocker/Beta blokatori | 73 | 16.08 |
| Angiotenin converting enzyme inhibitors/Inhibitori angiotenin 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 |
Ishemijska bolest srca
Arterijska hipertenzija
Dijabetes melitus tip II
Table 2. Association between medical history data and hypotension during surgery, multivariable logistic regression

| Accompanying diseases | OR/95% CI/LL/DG/UL/GG | p |
|-----------------------|------------------------|---|
| Arterial hypertensions/Arterijska hipertenzija | 1.04/1.00/1.04/0.037 | 0.78/0.52/1.18/0.238 |
| Ischemic cardiac diseases/Ishemijska bolest srca | 1.53/0.69/3.40/0.293 |
| Chronic obstructive lung disease | 1.07/0.47/2.46/0.865 |
| Hronična opstruktivna bolest pluća | 1.27/0.72/2.25/0.413 |
| Diabetes Mellitus type II/Dijabetes melitus tip II | 0.58/0.38/1.05/0.40 |

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

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 = 2.04, $p < 0.05$). The group of patients who re-
received 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 statistically 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. Vasodilatation 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 predictors 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 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].
Gulek et al. established that there was no significant statistical difference between the type of dosage of the local anesthetic (bupivacaine and levobupivacaine) 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 [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 levobupivacaine 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.

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