

ANALYSIS OF BLOOD PRESSURE CHANGES IN PATIENTS UNDERGOING TOTAL HIP OR KNEE REPLACEMENT IN SPINAL AND GENERAL ANESTHESIA

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SUMMARY – The aim of this study was to analyze hemodynamic changes in hypertensive and normotensive patients undergoing total hip or knee replacement in spinal and general anesthesia. Eighty patients who underwent total hip or knee replacement surgery in the period between July 2010 and February 2011 at Sveti Duh University Hospital were retrospectively evaluated. Seventeen patients underwent the operation in general anesthesia and 63 patients in regional anesthesia. They were allocated into groups of normotensive (n=24) or hypertensive patients (n=56). The anthropologic and hematologic parameters of normotensive and hypertensive patients were compared, as well as their blood pressures immediately before and during the operation. Blood pressure immediately before anesthesia induction, the highest and the lowest intraoperative blood pressures were recorded. Blood pressure immediately before anesthesia induction was significantly higher in hypertensive patients who underwent the operation in regional anesthesia compared to normotensive patients (158.48 mm Hg vs. 144.71 mm Hg, $P<0.01$). The highest intraoperative systolic blood pressure was also significantly higher in hypertensive patients operated on in regional anesthesia compared to normotensive patients (161.20 mm Hg vs. 146.76 mm Hg, $P<0.01$). The difference between the highest and the lowest intraoperative systolic blood pressure was significantly greater in hypertensive patients undergoing the operation in regional anesthesia compared to normotensive patients (46.41 mm Hg vs. 35.88 mm Hg, $P<0.05$). The results presented in this paper indicate that the fluctuations of intraoperative blood pressure were greater and the highest intraoperative systolic blood pressure was higher in hypertensive compared to normotensive patients undergoing the operation in regional anesthesia. In our study, there were no significant differences in intraoperative blood pressure between hypertensive and normotensive patients who underwent the operation in general anesthesia.

Key words: *Total hip replacement; Total knee replacement; Arterial hypertension; Regional anesthesia; General anesthesia*

Introduction

Total hip replacement is one of the most common and successful orthopedic procedures today. Approximately 200 total hip replacements and 50 total knee replacements are performed yearly at Sveti Duh Uni-

versity Hospital in Zagreb, Croatia. These procedures are commonly performed in elderly patients with one or more comorbidities such as arterial hypertension, coronary heart disease, cerebrovascular insufficiency, diabetes mellitus, chronic obstructive pulmonary disease or chronic renal insufficiency, which increases both intraoperative and postoperative risk. Perioperative complications of the underlying diseases are common.

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Received July 27, 2011, accepted March 1, 2012

Some complications of total hip and knee replacement surgeries are common to all major surgical procedures, whereas others are procedure specific. Complications related to the extent of surgery include blood loss, infection and venous thromboembolism. However, the risk of venous thromboembolism is also procedure related, with patients undergoing hip and knee arthroplasty being the high risk group for this complication. Procedure specific complications include prosthetic joint infection, loosening of the prosthesis from the bone, dislocation of the prosthetic joint, periprosthetic fractures and the formation of periarticular calcifications¹.

Hypertension is the most common cardiovascular disease and the leading cause of coronary heart disease, cerebrovascular and renal diseases. More than a quarter of the world's adult population had hypertension in 2000². It has been identified as the leading risk factor for mortality, and is ranked third as a cause of disability-adjusted life-years³. The incidence of hypertension increases with age, which was shown in the Framingham Study⁴. The European Society of Cardiology (ESC) Guidelines provide recommendations for perioperative management of hypertensive patients. The presence of arterial hypertension is not considered an independent risk factor for cardiovascular complications in non-cardiac surgery. Patients with target organ damage as a consequence of hypertension should be identified and optimized preoperatively⁵.

Orthopedic surgeries can be performed using a number of different anesthetic techniques. Hu *et al.* performed a meta-analysis to evaluate relative efficacy of regional and general anesthesia in patients undergoing total hip or knee replacement. Results showed that regional anesthesia reduced the operating time, the need for transfusion and the incidence of thromboembolic disease (deep vein thrombosis and pulmonary embolism). Regional anesthesia therefore seems to improve the outcome of patients undergoing total hip or knee replacement⁶.

The aim of this retrospective study was to analyze blood pressure values immediately before and during total hip or knee replacement surgery in relation to the preoperative diagnosis of hypertension.

Patients and Methods

Data on 80 patients having undergone total hip or total knee replacement surgery at Sveti Duh University Hospital, Zagreb, from July 2010 to February 2011, were retrospectively evaluated. Fifty-four patients underwent total hip replacement, 12 of them in general and 42 in regional anesthesia. Of the 26 patients having undergone total knee replacement, 5 were operated on under general and 21 under regional anesthesia.

Patient age, sex, height and weight expressed as body mass index (BMI), preoperative American Society of Anesthesiologists (ASA) status, preoperative blood pressure, hemoglobin, hematocrit and platelet count, as well as the type of surgical procedure and anesthesia were recorded. Blood pressure immediately before the induction of anesthesia, alongside the highest and the lowest intraoperative blood pressures were also recorded.

The ASA Physical Status classification system consists of six categories. ASA I patients are considered to be normal and healthy. ASA II patients have a mild to moderate systemic disease without any functional limitations. ASA III patients have a severe systemic disease that limits their activity, but is not incapacitating. ASA IV patients have a severe systemic disease that limits their activity and is a constant threat to life. ASA V patients are moribund and are not expected to survive more than 24 hours regardless of whether they undergo a surgical procedure or not. ASA VI are clinically dead patients artificially maintained for harvesting the organs. If the surgery is an emergency, the physical status classification is followed by "E" (for emergency)⁷.

For surgical procedures performed in regional anesthesia, spinal anesthesia was used. Spinal anesthesia was performed with the patient in sitting position of L3/L4 or L4/L5 intervertebral space utilizing 22-26 gauge Quincke needles. Patients were administered 15 mg of isobaric levobupivacaine (0.5% Chirocaine). On the evening before the surgery, patients were sedated with midazolam 7.5 mg or diazepam 5 mg *per os*, whilst on the day of the surgery no premedication was given. On the day of the surgery, patients also received their antihypertensive therapy, unless their blood pressure was 20% or more below their usual values.

Table 1. Anthropologic and hematologic parameters in hypertensive and normotensive patients

	Normotensive patients (n=24)	Hypertensive patients (n=56)	<i>P</i>
Age (years)	65.96±10.12	69.00±7.79	0.149
Body mass index	29.82±4.27	30.12±5.23	0.799
Hemoglobin (g/L)	140.71±15.05	138.82±13.23	0.576
Hematocrit	0.42±0.04	0.40±0.04	0.253
Platelets (x10 ⁹ /L)	226.92±46.47	239.66±57.83	0.343

Values are mean ± SD.

For the induction of general anesthesia, intravenous anesthetics etomidate, propofol and thiopental were used. Anesthesia was maintained with inhalational anesthetics isoflurane or sevoflurane in nitrous oxide and oxygen mixture. Fentanyl and sufentanil were used as opioid analgesics, while vecuronium was used for muscular relaxation.

Standard intraoperative monitoring included continuous ECG, peripheral oxygen saturation monitoring with a pulse oximeter and noninvasive blood pressure measurements. Blood pressure was measured every 5 minutes with an automatic cuff. In general anesthesia, expiratory CO₂ (capnography), concentration of oxygen and volatile agents in inspiratory and expiratory gas mixture as well as parameters of ventilation (airway pressures and minute ventilation) were all monitored.

Patients were allocated into groups according to the type of anesthesia (general or spinal) and according to the preoperative presence of hypertension. The European Society of Hypertension and European Society of Cardiology Guidelines⁸ were used for evaluation of hypertension. Patients were considered normotensive if their preoperative systolic blood pressure was ≤139 mm Hg and their preoperative diastolic blood pressure was ≤89 mm Hg. Patients were considered hypertensive if their preoperative systolic blood pressure was ≥140 mm Hg or their preoperative diastolic blood pressure was ≥90 mm Hg.

Statistical analysis

Quantitative variables were analyzed for the normality of distribution using the Kolmogorov-Smirnov test. Group comparisons were performed using Stu-

dent's t-test. Statistical significance was defined as a *P* value less than 0.05. Statistical analyses were performed with the IBM SPSS Statistics v. 19.0.0 software.

Results

A total of 80 patients underwent total hip or knee replacement, 32 (40%) of them male and 48 (60%) female. Their average age was 68 years. Patients at the age of 70 or older made up 48% of all patients and more than 80% of patients were 60 or over. There were no significant differences in age, BMI, hemoglobin, hematocrit and platelet count between the hypertensive (n=24) and normotensive (n=56) patients (Table 1).

Sixty-three patients underwent surgery using spinal and 17 patients using general anesthesia. Because of the possible influence of the type of anesthesia on intraoperative blood pressure, data on the patients who underwent the operation under general anesthesia were presented and analyzed separately from data on the patients who underwent the operation under spinal anesthesia.

There were no significant differences in blood pressure immediately before and during the surgery between the normotensive and hypertensive patients operated on under general anesthesia. This may have been due to the small sample size (n=17) (Table 2).

In patients undergoing the operation in regional anesthesia, blood pressure immediately before anesthesia induction was significantly higher in hypertensive (n=46) compared to normotensive (n=17) patients (*P*<0.01). Also, the highest intraoperative systolic blood pressure was significantly higher in

Table 2. Blood pressure (BP) in patients undergoing operation in general anesthesia

	Normotensive patients (n=7)	Hypertensive patients (n=10)	P
Systolic BP immediately before anesthesia induction (mm Hg)	150.00±29.44	155.50±10.12	0.589
Diastolic BP immediately before anesthesia induction (mm Hg)	84.29±17.18	83.50±10.55	0.908
The lowest intraoperative systolic BP (mm Hg)	114.29±9.76	121.00±19.12	0.409
The lowest intraoperative diastolic BP (mm Hg)	58.57±13.45	67.50±6.35	0.085
The highest intraoperative systolic BP (mm Hg)	167.14±22.89	168.50±20.28	0.899
The highest intraoperative diastolic BP (mm Hg)	92.86±16.04	93.00±13.37	0.984
Difference between the highest and the lowest intraoperative systolic BP (mm Hg)	52.86±19.76	47.50±18.45	0.575

Values are mean ± SD.

hypertensive patients ($P<0.01$) (Table 3). The difference between the highest and the lowest intraoperative systolic blood pressure was significantly greater in hypertensive compared to normotensive patients who underwent the surgery using regional anesthesia ($P<0.05$) (Fig. 1).

Discussion

The main finding of the present study was that both blood pressure fluctuations were greater and the highest intraoperative systolic blood pressure was higher in hypertensive compared to normotensive patients undergoing the operation in regional anesthesia. There were no significant differences in BMI or other demographic characteristics between hypertensive and

normotensive patients. However, most other studies found the prevalence of hypertension to increase proportionally to BMI⁹⁻¹¹.

Hypertension is the leading cause of death and disability in most Western societies and the most frequent abnormality in surgical patients. Mild to moderate hypertension (systolic blood pressure <180 mm Hg, diastolic blood pressure <110 mm Hg) is not independently responsible for perioperative cardiac complications. However, intraoperative hemodynamic instability, especially when target organ damage is present, is associated with perioperative cardiac complications^{12,13}. It is recommended that intraoperative blood pressure be maintained within 20% of the best estimate of preoperative blood pressure, especially in hypertensive patients.

Table 3. Blood pressure (BP) in patients undergoing operation in regional anesthesia

	Normotensive patients (n=17)	Hypertensive patients (n=46)	P
Systolic BP immediately before anesthesia induction (mm Hg)	144.71±14.73	158.48±17.73	0.006
Diastolic BP immediately before anesthesia induction (mm Hg)	82.35±11.06	88.15±13.10	0.110
The lowest intraoperative systolic BP (mm Hg)	110.88±13.72	114.78±18.56	0.433
The lowest intraoperative diastolic BP (mm Hg)	61.76±11.31	63.59±11.96	0.588
The highest intraoperative systolic BP (mm Hg)	146.76±14.57	161.20±19.36	0.007
The highest intraoperative diastolic BP (mm Hg)	86.18±10.83	91.30±11.62	0.119
Difference between the highest and the lowest intraoperative systolic BP	35.88±12.02	46.41±19.28	0.040

Values are mean ± SD.

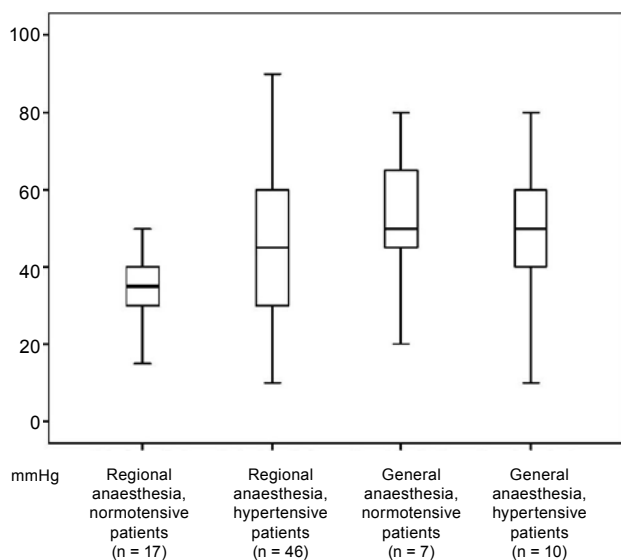


Fig. 1. Differences between the highest and the lowest intraoperative systolic blood pressures in normotensive and hypertensive patients operated on under regional and general anaesthesia (a line within the box is the median value; the upper and lower limits of the box represent the 25th and 75th percentile).

In our study, there were no significant differences in intraoperative blood pressure between hypertensive and normotensive patients who underwent the operation in general anaesthesia. Goldman and Caldera investigated the risks of general anaesthesia for elective surgical procedures in patients who had a history of hypertension. They did not find significant differences in the mean intraoperative blood pressures between patients with normal and elevated blood pressures preoperatively¹⁴. Prys-Roberts *et al.* found that patients with untreated or poorly regulated hypertension had greater fluctuations of intraoperative blood pressure when compared to normotensive patients¹⁵. Due to the small number of patients operated on under general anaesthesia in the present study, it is not possible to make such conclusions about intraoperative blood pressure changes in hypertensive patients undergoing total hip or knee arthroplasty in general anaesthesia. The difference in intraoperative blood pressures between spinal and general anaesthesia should be further investigated within prospective studies.

Blood pressure immediately before the induction of anaesthesia and the highest intraoperative systolic blood pressure were significantly higher in hyper-

tensive when compared to normotensive patients undergoing the operation in regional anaesthesia. Also, the difference between the highest and the lowest intraoperative systolic blood pressure was significantly greater in hypertensive patients compared to normotensive ones. This is consistent with the study by Šakić *et al.*, who compared hemodynamic responses of hypertensive and normotensive patients undergoing transurethral resection of the prostate in spinal anaesthesia¹⁶. Total hip and knee replacement is often performed in elderly patients with comorbidities other than hypertension, which increases the perioperative risk. Blood pressure regulation is an important part of the preoperative preparation and optimization of these patients.

Hip and knee arthroplasty are commonly performed in spinal or epidural anaesthesia because of the favorable effect of neuraxial block on hemodynamics. Hemodynamic changes, such as lower arterial blood pressure, lower central venous and peripheral venous pressure, seem to explain the lower intraoperative blood loss and reduced transfusion requirements in patients undergoing surgery in regional anaesthesia¹⁷⁻¹⁹. In our study, the highest intraoperative systolic blood pressure was significantly higher in hypertensive patients compared to normotensive patients operated on in spinal anaesthesia. This can lead to greater perioperative blood loss in hypertensive patients, influencing the outcome as well as the cost of the procedure. Although we did not compare perioperative blood loss and requirements for blood transfusion between hypertensive and normotensive patients, Đurasek *et al.* performed a prospective study that included 80 patients who underwent total knee replacement. They showed that hypertensive patients had a statistically greater perioperative blood loss, but did not receive more blood transfusion²⁰.

Conclusion

The results presented in this paper indicate that patients undergoing total hip and knee arthroplasty under regional anaesthesia have intraoperative blood pressure fluctuations that are greater in hypertensive compared to normotensive patients. The hemodynamic changes described could adversely affect the outcome of high risk patients. This emphasizes the

importance of preoperative evaluation and optimization of these patients. In our study, there were no significant differences in intraoperative blood pressure between hypertensive and normotensive patients who underwent the operation in general anesthesia.

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Sažetak

ANALIZA PROMJENA ARTERIJSKOG TLAKA KOD UGRADNJE ZGLOBNIH ENDOPROTEZA U SPINALNOJ I OPĆOJ ANESTEZIJI

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U ovom radu su analizirane hemodinamske promjene u hipertenzivnih i normotenzivnih bolesnika tijekom operacija ugradnje totalnih endoproteza kuka i koljena u općoj i regionalnoj anesteziji. Retrospektivno su analizirani podatci 80 bolesnika kojima je od srpnja 2010. do veljače 2011. u Kliničkoj bolnici Sveti Duh ugrađena totalna endoproteza kuka ili koljena. Sedamnaest bolesnika operirano je u općoj anesteziji, a 63 u regionalnoj. Njih 24 je svrstano u skupinu normotenzivnih, a 56 u skupinu hipertenzivnih bolesnika. Uspoređivani su njihovi antropološki i hematološki pokazatelji, kao i intraoperacijsko kretanje tlaka. Zabilježen je njihov arterijski tlak neposredno prije uvida u anesteziju, te najviši i najniži tlak tijekom zahvata. Arterijski tlak neposredno prije uvida u anesteziju bio je statistički značajno viši u hipertenzivnih bolesnika operiranih u regionalnoj anesteziji u odnosu na normotenzivne (158,48 mm Hg prema 144,71 mm Hg, $P<0,01$). Također najviši intraoperacijski sistolički tlak bio je statistički značajno viši u hipertenzivnih bolesnika operiranih u regionalnoj anesteziji u odnosu na normotenzivne (161,20 mm Hg prema 146,76 mm Hg, $P<0,01$). Razlika između najvišeg i najnižeg intraoperacijskog sistoličkog tlaka bila je statistički značajno viša u hipertenzivnih bolesnika operiranih u regionalnoj anesteziji u odnosu na normotenzivne (46,41 mm Hg prema 35,88 mm Hg, $P<0,05$). Rezultati izneseni u ovom radu govore u prilog tome da su kolebanja intraoperacijskog tlaka veća, te da je najviši intraoperacijski sistolički tlak viši u hipertenzivnih u odnosu na normotenzivne bolesnike operirane u regionalnoj anesteziji. Nisu pronađene statistički značajne razlike intraoperacijskog tlaka između hipertenzivnih i normotenzivnih bolesnika operiranih u općoj anesteziji.

Ključne riječi: *Totalna endoproteza kuka; Totalna endoproteza koljena; Arterijska hipertenzija; Regionalna anestezija; Opća anestezija*

