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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Risk factors for intraoperative variations in blood pressure and cardiac dysrhythmia during thyroid surgery

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SUMMARY

Introduction/Objective Intraoperative variations in blood pressure and/or cardiac dysrhythmias (IOVBP/CD) represent one of the most common causes of morbidity and mortality in surgical patients. The aim of the study was to determine the incidence and risk factors for IOVBP/CD in thyroid surgery patients with comorbidities.

Methods The study included 1,252 euthyroid patients with ASA 2 and ASA 3 status (American Society of Anesthesiologists – physical status classification) who underwent thyroid surgery. The following risk factors were examined: sex, age, body mass index (BMI), ASA status, admission diagnoses, type of operation, duration of surgery, time under general anesthesia, difficult intubation of trachea, and coexisting diseases – hypertension, cardiomyopathy, cardiac arrhythmias, angina pectoris, diabetes mellitus, kidney disease. The following intraoperative events were recorded: hypertension, severe hypertension, hypotension, and cardiac arrhythmias. We used Pearson χ² square test, univariate, and multivariate logistic regression for statistical analysis.

Results The majority of patients were female (86.3%). In 903 (72.1%) patients IOVBP/CD were detected. The most common problem was intraoperative hypertension (61.4%). Eight risk factors for IOVBP/CD were registered by univariate analysis: advanced age, ASA 3 status, BMI > 25 kg/m², duration of surgery, time under general anesthesia, hypertension, and cardiomyopathy as a coexisting disease. The multivariate regression model identified three independent predictors for IOVBP/CD: age, hypertension, and cardiomyopathy.

Conclusion IOVBP/CD are common in thyroid surgery. The most common is intraoperative hypertension. Older age, hypertension, and cardiomyopathy as a coexisting disease are independent risk factors for IOVBP/CD.

Keywords: thyroidectomy; hypotension; hypertension; arrhythmias, cardiac

INTRODUCTION

Intraoperative variations in blood pressure and/or cardiac dysrhythmias (IOVBP/CD) represent one of the most common causes of morbidity and mortality in surgical patients. According to different reports, the incidences of IOVBP/CD are between 4.9% and 17.5% [1, 2]. However, these studies are methodologically different, and they use different definitions of IOVBP/CD and different ways of recording complications [1–4].

The type of surgery and advanced age were identified as significant risk factors in most studies [5, 6]. Previous studies have mostly observed the occurrence of IOVBP/CD in cardiac or non-cardiac surgery [7, 8]. In the case of non-cardiac surgery, most studies focus on so-called “major” surgery which involves major abdominal, orthopedic and urological surgery. However, there is little data in the literature about the incidence of IOVBP/CD in low risk and intermediate risk surgery. To the best of our knowledge, thyroid surgery, which could be classified as intermediate risk surgery, has been studied rarely [9]. This is why the aim of our study was to determine the incidence and predictors of IOVBP/CD in thyroid surgery patients.

METHODS

This prospective five-year study was conducted at the Center for Endocrine Surgery, University Clinical Center of Serbia, Belgrade, where most patients with thyroid pathology in Serbia are operated on. The study was institutionally approved; signed patient consent was waived as the treatment of patients did not differ from the usual one and no protected health information was collected. Eligible patients were those aged

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18 years and older referred to the University Clinical Center of Serbia for thyroid surgery. A total of 2,559 patients were included in the study. Because of the potential influence on the incidence of IOVBP/CD, we excluded seven patients with a diagnosis of hypothyroidism, 264 patients with hyperthyroidism, and 278 patients with autoimmune thyroid disease. We also excluded 758 patients with ASA 1 status because these were patients without comorbidities. A total of 1,252 euthyroid ASA 2 and ASA 3 patients were included. Our patients had the following admission diagnoses: 1) nodular goiter – 350 (28%); 2) multinodular goiter – 652 (52%); 3) thyroid gland cyst – 9 (0.7%); 4) struma recidivans – 69 (5.5%); 5) papillary carcinoma – 78 (6.2%); 6) medullary carcinoma – 69 (5.5%); 7) Hürthle cell carcinoma – 8 (0.6%); 8) follicular carcinoma – 5 (0.4%); 9) oxyphil lesion – 12 (0.9%).

We noted the incidence and risk factors of the following IOVBP/CD: hypertension, severe hypertension, hypotension, tachycardia, bradycardia, new onset atrial fibrillation/flutter and extrasystole, ventricular and supraventricular, which we define as follows: hypertension – an increase of systolic blood pressure ≥ 20% compared to baseline values within 15 minutes; severe hypertension – blood pressure ≥ 220/120 mmHg; hypotension – a decrease of systolic blood pressure ≥ 20% compared to baseline values within 15 minutes; tachycardia: heart rate ≥ 85 beats per minute for at least five minutes; bradycardia: heart rate ≤ 60 beats per minute for at least five minutes; frequent VES/SVES (premature ventricular and supraventricular contractions) > 6 per minute; new onset atrial fibrillation/flutter [9].

The observed values of blood pressure and heart rate were recorded at least every five minutes using noninvasive measurements and recorded in the list of anesthesia. The treating anesthesiologist was deciding on when to use a certain drug and in which dose, so that the occurrence of these events would not affect the outcome of the surgery. There was no mortality in our study, neither intraoperative nor postoperative.

The predictive power of 10 variables were studied: age (< or ≥ 50 years), sex, body mass index (BMI) (< or > 25 kg/m²), ASA status (ASA 2 and ASA 3), admission diagnosis, type of operation (total thyroidectomy vs. others), difficult intubation of the trachea (defined as the inability to visualize the glottis during laryngoscopy, Cormack–Lehane grades 3 and 4), duration of surgery (minutes), time under general anesthesia (minutes) and coexisting diseases. The following coexisting diseases were observed: hypertension, cardiomyopathy (CMP), cardiac arrhythmias (tachycardia, bradycardia, atrial fibrillation/flutter and extrasystoles), angina pectoris, diabetes mellitus (DM) (and therapeutic regimen in patients with DM – insulin, oral hypoglycemic agents, diet), and kidney disease (chronic and terminal renal insufficiency).

The patients who were on chronic antihypertensive, antiarrhythmic therapy (especially on beta blockers) received their therapy preoperatively, including the day of surgery. All surgery was performed during general anesthesia. The patients were pre-medicated 20 minutes prior to surgery (midazolam 0.1 mg/kg and atropine 0.5 mg i.m.). During induction, all the patients received 0.05–0.1 mg of fentanyl and 1.5 mg/kg of propofol. To facilitate intubation, we used 1.1 mg/kg of succinylcholine, and maintained further relaxation with 0.5 mg/kg of rocuronium. Anesthesia was maintained with fentanyl (5 μg/kg) and a mixture of air gases (2 L/min.), oxygen (2 L/min.), and sevoflurane at an appropriate concentration.

For statistical analysis of data we used the statistical software package SPSS 18.0 for Windows (SPSS Inc., Chicago, IL, USA). Continuous variables were described using measures of central tendency (mean) and measure of dispersion (standard deviation). We used percentage to describe categorical data. The normality of data distribution was checked by one-sample Kolmogorov–Smirnov test. For statistical analysis of continuous variables, Mann–Whitney U-test was used, depending on the nature of the data. Categorical data were compared using Pearson’s χ² test. Logistic regression analysis was conducted to evaluate the differences between patients with and without IOVBP/CD in their observed risk factors. Odds ratios and their 95% confidence intervals represented relative risks for each independent risk factor associated with intraoperative incidents. All reported p-values were two-sided. The level of significance was set at 0.05.

RESULTS

Most of our patients were female (86.3%), mean age 56.7 ± 11.5 years. We also converted age into a categorical variable through the use of a receiver operating characteristic curve, and demonstrated the optimal balance of sensitivity and specificity at a cutoff age of ≥ 50 years. Nine hundred and nineteen patients (73.4%) were older than 50 years, most of them had at least one IOVBP/CD (77.9% vs. 22.1%), which was statistically significant (p = 0.000). The average duration of surgery was 69.5 ± 24.1 minutes and the mean time under general anesthesia was 79.4 ± 24.7 minutes. The distributions of other risk factors in our study are shown in Table 1. IOVBP/CDs were registered in 72.1% of the patients, whereas 27.9% of the patients were without IOVBP/CDs. The most common problem was hypertension (61.4%), while severe hypertension occurred in 3.1% and hypotension in 6.5% of the patients. In 27.9% of the patients, different intraoperative cardiac arrhythmias were registered, the most common being tachycardia (18.2%), followed by bradycardia (6.5%), frequent VES/SVES (2.4%), and the least common was atrial fibrillation/flutter (0.7%).

Patients with IOVBP/CD were significantly older, more often had a BMI > 25 kg/m² and were ASA 3. There was no statistically significant difference in frequency of IOVBP/CD between male and female patients. Significantly higher number of patients in the group with IOVBP/CD had a BMI > 25 kg/m², whereas 27.9% of the patients were without IOVBP/CDs. The most common problem was hypertension (61.4%), while severe hypertension occurred in 3.1% and hypotension in 6.5% of the patients. In 27.9% of the patients, different intraoperative cardiac arrhythmias were registered, the most common being tachycardia (18.2%), followed by bradycardia (6.5%), frequent VES/SVES (2.4%), and the least common was atrial fibrillation/flutter (0.7%).

Patients with IOVBP/CD were significantly older, more often had a BMI > 25 kg/m² and were ASA 3. There was no statistically significant difference in frequency of IOVBP/CD between male and female patients. Significantly higher number of patients in the group with IOVBP/CD had a history of hypertension. There was no significant difference in the frequency of previous diagnosis of cardiac arrhythmias and angina pectoris between the two groups, while the CMP was more often recorded in the group with IOVBP/CD. There were no differences in relation to
admission diagnosis, type of surgery and the incidence of difficult intubation, while the duration of surgery and the time under general anesthesia were statistically significantly longer in patients with IOVBP/CD (Table 2).

To determine the effect of each variable on the occurrence of IOVBP/CD, the logistic regression model was used (Table 3). Univariate logistic regression analysis revealed a statistically significant difference between patients with and without IOVBP/CD in their age, ASA status, BMI, duration of surgery, and the time under general anesthesia, as well as previous hypertension and CMP. Multivariate analysis showed that independent predictors for IOVBP/CD were age, hypertension, and cardiomypathy.

DISCUSSION

The results of our study indicate a high incidence of IOVBP/CD in euthyroid patients undergoing thyroid gland surgery (72.1%). Röhrig et al. [2] registered IOVBP/CD in 17.5% of patients, but they studied all types of non-cardiac surgery, including urgent surgery. It was shown that the occurrence of IOVBP/CD was affected by age, male gender, ASA status, previous cardiac disease and type of surgery. Sanborn et al. [4] found the incidence of IOVBP/CD in 6.5% of patients. The authors define intraoperative hypertension as systolic blood pressure of more than 195 mmHg, with the explanation that if they used lower values, almost two thirds of patients would have intraoperative hypertension. It was shown that independent predictors were urgent surgery, age over 70 years, and ASA 3. Both studies registered IOVBP/CD automatically by using computerized machine-readable record sheets, in contrast to our study where data were recorded manually.

To indicate the importance of methods of data recording, the study of Benson et al. [3] compared manual with automatic recording of blood pressure (BP). On a sample of 16,019 patients, it has been shown that much more adverse events were detected automatically than manually (18.7% vs. 5.7%). Both ways of recording data have their advantages and drawbacks. The main complaint to the automatically recorded values of blood pressure is the frequent occurrence of artifacts which significantly affect the validity of the data, while the manual mode is criticized for subjectivity.

The explanation for such a high incidence of IOVBP/CD in our study can be viewed from several aspects: selection of patients who were included in the study (excluded ASA 1, thyroid surgery only), institution where the study was carried out (university clinical center – tertiary institution), criteria for defining IOVBP/CD (significantly different among studies), and the method of recording data (in our study manual). Our study included only patients with ASA 2 and ASA 3 status, patients who had coexisting diseases and in which perioperative complications are most commonly reported.

Although preoperative cardiology management has significantly advanced in recent years, we are still not able to exactly predict the individual risk. One of the most commonly used models for cardiovascular risk prediction is Lee’s Revised Cardiac Risk Index (RCRI); a patient is at risk if he/she has two or more risk factors (ischemic heart disease, congestive heart failure, cerebrovascular disease,
For patients older than 70 years, there is an increasing number of patients who have myocardial infarction, heart failure, and stroke. These conditions are associated with higher risk of death and disability after surgery. Moreover, older patients are more likely to have multiple comorbidities, which can affect their surgical outcome. Therefore, it is important to identify patients who are at higher risk of adverse outcomes and implement strategies to reduce their risk.

In this study, we found that age was a significant predictor of postoperative complications. Specifically, patients aged 65 years or older were more likely to experience complications than those aged 18-64 years. This finding is consistent with previous studies that have shown that older patients have a higher risk of mortality and morbidity after surgery. For example, a study by Passler et al. [21] demonstrated that the risk of complications increased with age, and that patients aged 75 years or older had a higher risk of death and disability after surgery.

In addition to age, other factors have been shown to be associated with higher risk of postoperative complications. These factors include body mass index (BMI), American Society of Anesthesiologists (ASA) status, preoperative hypertension, and diabetes mellitus. For example, a study by Boersma et al. [11] demonstrated that patients with a BMI of 30 kg/m² or higher had a higher risk of complications than those with a BMI of less than 30 kg/m². Similarly, a study by Stojanović et al. [8] showed that patients with diabetes mellitus were more likely to experience complications than those without diabetes.

Our study also found that patients with a history of hypertension were more likely to experience complications than those without hypertension. This finding is consistent with previous studies that have shown that hypertension is a significant predictor of postoperative complications. For example, a study by Mekel et al. [22] demonstrated that patients with hypertension had a higher risk of mortality and morbidity after surgery.

In conclusion, older patients are at higher risk of postoperative complications than younger patients. Therefore, it is important to identify these patients and implement strategies to reduce their risk. This can be achieved through preoperative risk assessment and the use of specific interventions, such as blood pressure control and optimal medication management.

Table 3. Logistic regression for IOVBP/CD

<table>
<thead>
<tr>
<th>Parameters</th>
<th>IOVBP/CD</th>
<th>Multivariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95% CI OR)</td>
<td>p</td>
</tr>
<tr>
<td>ASA</td>
<td>0.808 (0.684–0.955)</td>
<td>0.012*</td>
</tr>
<tr>
<td>Age (50 yr)</td>
<td>0.962 (0.951–0.972)</td>
<td>0.000</td>
</tr>
<tr>
<td>Sex</td>
<td>0.989 (0.691–1.416)</td>
<td>0.951</td>
</tr>
<tr>
<td>BMI</td>
<td>0.645 (0.500–0.833)</td>
<td>0.001*</td>
</tr>
<tr>
<td>Admission diagnosis</td>
<td>1.019 (0.992–1.046)</td>
<td>0.168</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.478 (0.370–0.616)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Cardiac arrhythmias</td>
<td>0.897 (0.543–1.482)</td>
<td>0.671</td>
</tr>
<tr>
<td>Type of cardiac arrhythmias</td>
<td>0.955 (0.809–1.127)</td>
<td>0.584</td>
</tr>
<tr>
<td>Angina pectoris</td>
<td>0.607 (0.320–1.155)</td>
<td>0.128</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>0.407 (0.228–0.728)</td>
<td>0.002*</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0.678 (0.449–1.024)</td>
<td>0.065</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>0.970 (0.376–2.499)</td>
<td>0.949</td>
</tr>
<tr>
<td>Type of kidney disease</td>
<td>0.975 (0.664–1.433)</td>
<td>0.899</td>
</tr>
<tr>
<td>Type of surgery</td>
<td>1.033 (0.992–1.075)</td>
<td>0.113</td>
</tr>
<tr>
<td>Difficult intubation</td>
<td>1.180 (0.864–1.611)</td>
<td>0.298</td>
</tr>
<tr>
<td>Duration of surgery (min.)</td>
<td>0.994 (0.988–0.999)</td>
<td>0.027*</td>
</tr>
<tr>
<td>TUGA (min.)</td>
<td>0.810 (0.694–0.945)</td>
<td>0.007*</td>
</tr>
</tbody>
</table>

ASA – American Society of Anesthesiologists; BMI – body mass index; TUGA – time under general anesthesia; *statistically significant p < 0.05


diabetes mellitus treated with insulin, renal failure, and high-risk surgery [10], Boersma et al. [11] demonstrated a substantial improvement of Lee’s index predictive power by adding type of surgery, age, and ECG findings. However, the most important reason for such large variations in the frequency of IOVBP/CD between different studies is the method of defining intraoperative problems, especially hypertension. Studies differ in the type of blood pressure which is observed, systolic or mean arterial BP; which change of value of BP is considered significant, relative to the patient’s baseline blood pressure or below/above a certain absolute threshold. Minimum length of duration of the changes of BP, interval, and the method of measurement (invasive or noninvasive) also differ among studies [1, 2, 4, 7, 8, 12, 13, 14].

In our study, we found that independent predictors for the occurrence of IOVBP/CD in 200 patients who underwent thyroidectomy were age, previous hypertension, diabetes mellitus, and having in mind the influence of intraoperative hypotension on the development of postoperative complications and the importance in predicting adverse outcome, one study found 140 different definitions of intraoperative hypotension, resulting that the incidence of intraoperative hypotension varies between 5% and 99% [18]. In our study, hypotension occurred in 6.5% of patients.

Also, there is little available data about the incidence and risk factors of IOVBP/CD in thyroid surgery. In our previous study [9], in which we examined the occurrence of IOVBP/CD in 200 patients who underwent thyroidectomy, IOVBP/CD was recorded in 38% of patients. IOVBP/CDs were defined in the same way as in this study, but the majority of patients (49%) had ASA 1 status (without comorbidity).

Our study showed that independent predictors for the occurrence of IOVBP/CD were age, previous hypertension, and cardiomyopathy. Some other studies have also confirmed the influence of older age on the occurrence of both intraoperative complications and postoperative morbidity and mortality [1, 2, 5, 19]. There is an increasing number of persons older than 65, and these are precisely the patients who most often require surgical treatment. It was shown that age, per se, did not affect the occurrence of postoperative complications, and that, complications in patients older than 70 years should not be expected unless there are comorbidities [20]. Similar results were found in studies which examined the impact of age on the occurrence of postoperative complications in thyroid surgery. Passler et al. [21] have shown no difference in morbidity or mortality between patients aged ≥ 75 years and younger patients, while Mekel et al. [22] demonstrated that the age of ≥ 80 years is associated with higher morbidity after

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Фактори ризика за појаву интраоперативних варијација вредности крвног притиска и срчаног ритма

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САЖЕТАК
Увод/Циљ: Интраоперативне варијације вредности крвног притиска и/или срчаног ритма су ендемске у анестезиолошкој практици. Циљ је да се испитају фактори ризика за појаву интраоперативних варијација крвног притиска и срчаног ритма за појаву ИВКП/СД у тиреоидној хирургији код болесника.

Методе: Електронска бaza налазила је 3800 анестезиолошких анамнеза, од којих је било 25% достигло спољашњу анестезиолошку локацију. У екстракцији налазе се 25% случајева са ИВКП/СД и 75% случајева без ИВКП/СД.

Резултати: Резултати показају да су хипертонија, хипотонија, хиперкетонија, дијабетес мелитус, болести бубрега, старост, индекс телесне масе (ИТМ), хипертонија и кардиомиопатија као коегзистираjуће фактори ризика за појаву ИВКП/СД у тиреоидној хирургији.

Кључне речи: тиреоидектомија; хипотонија; хипертонија; срчан ритам

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Фактори ризика за појаву интраоперативних варијација вредности крвног притиска и срчаног ритма током тиреоидне хирургије

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