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Haemodynamic and respiratory response to the paravertebral injection of 0.5% ropivacaine and 0.5% bupivacaine**Grzegorz Hura¹, Hanna Misiulek², Adam Krakus¹, Jacek Karpe², Marek Grochla², Piotr Knapik²**¹ Department of Anaesthesia and Intensive Care, Bielsko-Biała, Poland² University Department of Anaesthesia, Medical University of Silesia, Zabrze, Poland**Abstract**

Background. Haemodynamic and respiratory function after the paravertebral injection of ropivacaine and bupivacaine has not been evaluated previously. The objective of the study was to determine whether there is a clinically significant impairment of circulation and respiration following thoracic paravertebral blockade and whether this potential impairment is different after ropivacaine or bupivacaine. **Material and methods.** 70 patients scheduled for mastectomy were randomized to receive a single injection of 0.4 ml/kg of 0.5% ropivacaine (n = 35) or 0.5% bupivacaine (n = 35) at the T4 level. Haemodynamic parameters and pulmonary function (evaluated by bedside spirometry) before and after the injection of the local anesthetic were analyzed. **Results.** Haemodynamic parameters did not change significantly from baseline values. The exception was diastolic blood pressure which increased after ropivacaine (from 77 ± 10 to 82 ± 12 mmHg, $P = 0.006$) and heart rate which decreased after bupivacaine (from 75 ± 12 to 71 ± 12 beats/min, $P = 0.014$). FVC and FEV₁ decreased similarly in both groups - FVC decreased from 2.19 ± 0.74 to 1.92 ± 0.67 L in ropivacaine group ($P < 0.05$) and from 2.20 ± 0.7 to 1.90 ± 0.70 L in bupivacaine group ($P < 0.001$), while FEV₁ decreased from 1.97 ± 0.61 L to 1.73 ± 0.56 L in ropivacaine group ($P < 0.05$) and from 1.97 ± 0.62 to 1.66 ± 0.62 L in bupivacaine group ($P < 0.001$). **Conclusions.** Paravertebral injection of equal concentrations of bupivacaine or ropivacaine combined with premedication has almost no influence on a circulatory system and produces comparable, not clinically significant impairment of pulmonary function. *Anestezjologia i Ratownictwo 2017; 11: 241-246.*

Keywords: paravertebral blockade, ropivacaine, bupivacaine, spirometry, mastectomy

Introduction

Thoracic paravertebral blockade (TPVB) could be performed in patients breathing spontaneously during the operation [1-4], however no comparison of different local anesthetics in this setting has been published so far in the medical literature.

There is a difference between ropivacaine and bupivacaine in cardiac toxicity. In addition, ropivacaine is known to result in a senso-motoric dissociation [5-7]. Therefore, more pronounced depression of the cardio-

vascular system and more profound motor blockade after bupivacaine could be expected.

Impairment of the motor function after TPVB involves predominantly intercostal muscles. Evaluation of this effect should be possible with the use of spirometry, because motor blockade might impair pulmonary function. This method of assessment has been previously used in clinical trials evaluating other techniques of regional anaesthesia like interscalene brachial plexus blockade [8,9] or thoracic epidural analgesia [10,11].

The purpose of this study was to determine whe-

ther there is a clinically significant impairment of the haemodynamic and respiratory function following thoracic paravertebral injection of the local anaesthetic and whether this potential impairment is different after equal concentrations and volumes of ropivacaine or bupivacaine. The results could be applied to patients undergoing paravertebral blockade and breathing spontaneously during surgery.

Material and methods

This prospective, single-blinded study included 70 patients with low preoperative risk (ASA I or II). All of them were scheduled to undergo elective modified radical mastectomy with axillary resection. Patients were randomized to receive a single injection of 0.5% ropivacaine ($n = 35$) or 0.5% bupivacaine ($n = 35$) at the T4 level as described by Eason and Wyatt [12]. The study was approved by the local ethics committee and each patient signed an informed consent.

Overall, haemodynamic data and oxygen saturation were collected in 69 patients as one patient from the bupivacaine group was excluded because of toxic reaction due to inadvertent intravascular injection of the local anaesthetic agent, which resolved uneventfully. Spirometry was performed in 66 patients, as the spirometry could not be performed in another four patients; one patient from the bupivacaine group developed vomiting while trying to sit after blockade, one patient (as already mentioned) developed toxic reaction to bupivacaine and there were technical problems in obtaining spirometry results in the other two patients (one from the ropivacaine group and one from the bupivacaine group).

Spirometry measurements were obtained with the use of bedside equipment (SPIRO-31, Aspel, Poland). The mode of operation of this device is based on the difference of pressure in the Venturi valve. Basic spirometry parameters (forced vital capacity – FVC, forced expiratory volume in one second – FEV₁, peak expiratory flow – PEF) were performed in the evening before the operation, after the patients were admitted to the hospital (baseline). Subsequent measurements were taken 30 minutes after the paravertebral injection of the study drug. Spirometry was performed in the sitting position, at least three times and the best measurement was recorded according to the criteria of the European Respiratory Society [13,14].

Premedication with 7.5 mg of oral midazolam

(Dormicum®, F. Hoffmann-La Roche Ltd., Basel, Switzerland) was given 1 hour before the blockade. Immediately before the paravertebral injection, 1 µg/kg of fentanyl (Fentanyl, Polfa, Warsaw, Poland) and 1-2 mg of midazolam (Dormicum®, F. Hoffmann-La Roche Ltd., Basel, Switzerland) were administered intravenously. In addition all patients received 500 mL of crystalloid solution.

TPVB was performed at the T4 level as described by Eason and Wyatt using a 22-G spinal needle and a loss-of-resistance syringe (B. Braun, Melsungen, Germany) with the patients in the lateral position. After aspiration, 0.4 mL/kg (150 mg maximum) of ropivacaine 0.5% (Naropin, AstraZeneca, Sodertelje, Sweden) or bupivacaine 0.5% (Marcaine, AstraZeneca, Mont, France) was administered into the paravertebral space. A real body weight was calculated for subjects with BMI of 24 or less. For BMI > 24, upper values of “normal” weight for each patient were considered. Patients' weight ranged from 50 to 80 kg, therefore doses of local anaesthetic higher than 2 mg/kg could be avoided in all patients.

Subsequently the patient was returned to the supine position and the sensory blockade was assessed by ice-cold test. The surgical procedure was initiated 30 minutes following paravertebral injection to allow for recording of observations. After achieving adequate anaesthesia (T2 - T6 and full blockade of the armpit) spirometry was obtained in the sitting position.

Measurements were made before the blockade and 30 minutes after the blockade. Spirometry results at baseline and 30 minutes after paravertebral injection of the study drug were compared.

Further surgical procedure (radical mastectomy) was performed under light general anaesthesia with the use of the propofol infusion and supplemental fentanyl administration. The level of anaesthesia was titrated to achieve such a level, that the patients were not arousable on command but were able to breathe spontaneously and maintain satisfactory oxygenation throughout the procedure. The patients were not intubated and supplemental oxygen was administered via facemask.

A mean and standard deviation were used in the analysis of the data. T-test or Mann-Whitney's test and the Wilcoxon's test were applied in the comparison of the data, when appropriate. Statistica 6.0 statistical software was used. All findings with $P < 0.05$ were considered statistically significant.

Results

Patients in both study groups had similar demographic data (table I). No differences between the groups were also found in haemodynamic parameters and oxygen saturation before the blockade as well as 30 minutes after the injection of the local anaesthetics (table II). The only exception was found in diastolic blood pressure which increased after ropivacaine (from 77 ± 10 to 82 ± 12 mmHg, $P = 0.006$). No other significant differences were found regarding blood pressure values between both groups and in subgroups according to age.

Table I. Demographic data

Variable	Ropivacaine (n = 35)		Bupivacaine (n = 35)	
Age (yr)	56.9	± 13.1	58.6	± 13.1
Height (cm)	160.4	± 6.2	160.1	± 5.3
Weight (kg)	65.7	± 8.3	67.6	± 8.4
BMI (kg/m ²)	25.6	± 3.1	26.3	± 2.8

no significant differences between the groups

In the bupivacaine group, heart rate decreased from (from 75 ± 12 to 71 ± 12 beats/min, $P = 0.014$), while such difference was not detected in the ropivacaine group (74 ± 13 vs. 74 ± 10 beats/min, $P = 0.83$). It was revealed that older patients from the bupivacaine group (over 60 years old) were accountable for the decrease in heart rate. The difference in this subgroup (n = 16) was more pronounced (72 ± 12 vs. 65 ± 12 beats/min, $P = 0.012$) and was not present among younger patients (78 ± 13 vs. 75 ± 11 beats/min, $P = 0.27$). It was also found that in patients who received bupivacaine, the

decrease in heart rate values was related to patients' age (figure 1), with no such relation in the ropivacaine group (figure 2).

No differences were found between the groups in baseline spirometry. Paravertebral blockade and injection of opioid significantly impaired spirometry results in both groups. FVC decreased from 2.19 ± 0.74 to 1.92 ± 0.67 l in the ropivacaine group ($P < 0.05$) and from 2.20 ± 0.70 to 1.90 ± 0.70 l in the bupivacaine group ($P < 0.001$). FEV₁ decreased from 1.97 ± 0.61 to 1.73 ± 0.56 l in the ropivacaine group ($P < 0.05$) and from 1.97 ± 0.62 to 1.66 ± 0.62 l in the bupivacaine group ($P < 0.001$). PEF decreased from 4.75 ± 1.18 to 4.19 ± 0.98 L/s in patients who received ropivacaine ($P < .001$) and from 4.37 ± 1.14 L/s to 3.75 ± 1.18 in patients who received bupivacaine ($P < 0.01$). The degree of spirometry impairment was similar after ropivacaine and bupivacaine (figure 3). No differences were found in the mean respiratory rate before and after the blockade in both study groups.

Discussion

Haemodynamic parameters and oxygen saturation values were similar in both groups during the entire perioperative period and the analysis revealed only two (not clinically important) details. In the bupivacaine group heart rate decreased 30 minutes after the blockade, while such finding was not observed in the ropivacaine group. In addition, 30 minutes after the blockade diastolic blood pressure was significantly higher in the ropivacaine group.

Both observations can result from the systemic effect of the local anaesthetics, which are redistributed

Table II. Haemodynamic data and oxygen saturation

Variable	Time	Ropivacaine			Bupivacaine		
		n			n		
Heart rate (beats/min.)	Before the block	35	74	± 12.6	35	75	± 12
	After the block	35	74	± 10.2	34	71	± 12
Systolic blood pressure (mm Hg)	Before the block	35	128	± 20	35	134	± 22
	After the block	35	132	± 23	34	134	± 26
Diastolic blood pressure (mm Hg)	Before the block	35	77	± 10	35	78	± 10
	After the block	35	82	± 12	34	*77	± 9
Mean blood pressure (mm Hg)	Before the block	35	94	± 12	35	97	± 12
	After the block	35	99	± 14	34	96	± 13
Oxygen saturation (%)	Before the block	35	97	± 2	35	96	± 3
	After the block	35	98	± 2	34	98	± 2

*p < 0.05

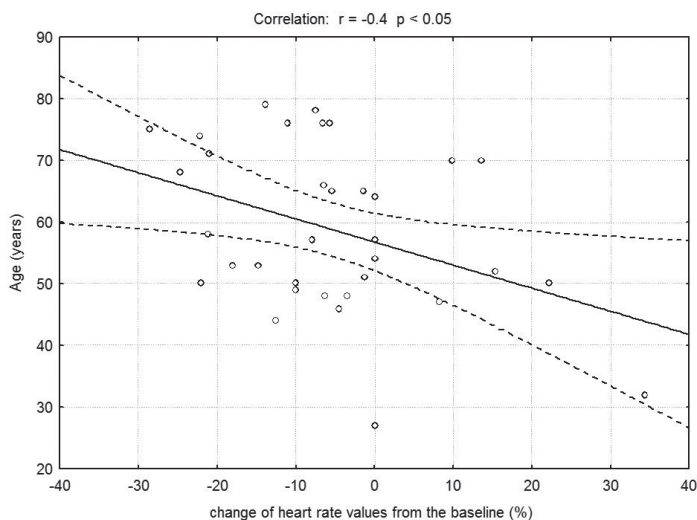


Figure 1. Correlation of the patients' age with the change in heart rate after the blockade in the bupivacaine group

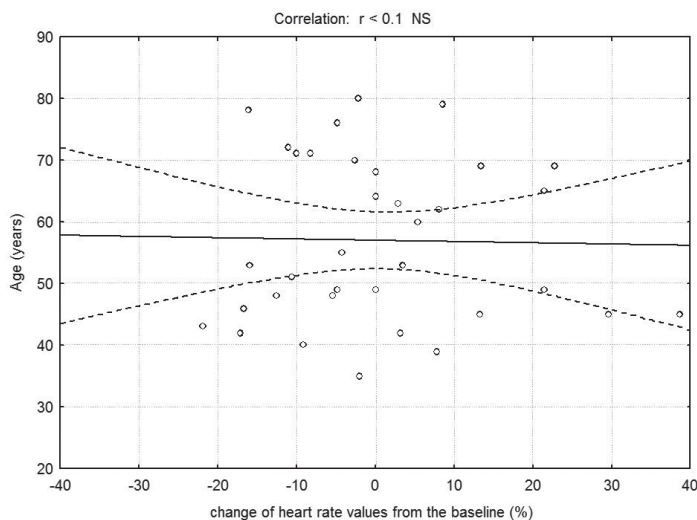


Figure 2. Lack of correlation of the patients' age with the change in heart rate after the blockade in the ropivacaine group

from the paravertebral space to the circulatory system. Decrease in heart rate after bupivacaine may be easily explained, as this agent has already been demonstrated to cause bradycardia [15,16]. Moreover, only the older patients (over 60 years old) in the bupivacaine group developed a clinically and statistically significant reduction of the heart rate.

The increase in diastolic blood pressure after paravertebral injection of the study drugs is more difficult to explain. One can speculate, that it may be linked to

the fact that ropivacaine causes constriction of blood vessels when applied in small concentrations [17], but it could also be a matter of coincidence only.

In our study bedside spirometry was used as an indicator of pulmonary function. It was already proved that TPVB may decrease respiratory function [18-20], but there are no trials comparing the degree of spirometry impairment caused by different local anaesthetic agents. A number of studies have demonstrated no decrease in FVC and FEV₁ values following epidural

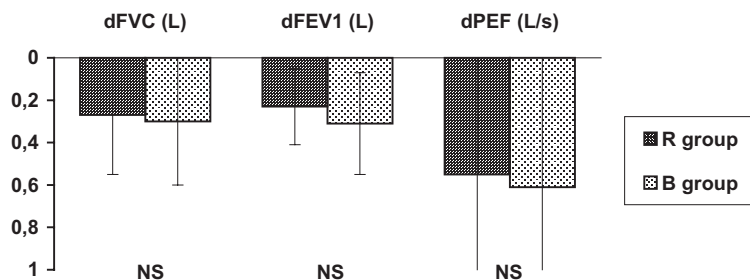


Figure 3. Statistically not significant decrease in spirometry results after TPVB: dFVC, dFEV₁ and dPEF are the differences between the spirometry values before and after the injection of local anaesthetic into the paravertebral space

anesthesia [21-23]. Why might this occur with unilateral PVB and not after bilateral epidural anesthesia? One can suspect that the influence of unilateral paravertebral blockade can be less pronounced than the one of bilateral epidural blockade, however our study design (namely the injection of low-dose midazolam and fentanyl) may be responsible for a different scenario. As there was no control group receiving only midazolam and fentanyl, it is possible that all changes in spirometry results were due to sedation rather than paravertebral blockade. Nevertheless, decrease in spirometry results was fully comparable between the study groups.

The trial therefore has some limitations. The use of sedation before the blockade in our trial can be a matter of discussion. In our opinion paravertebral injection should be preceded by sedation. Despite using infiltration analgesia, application of the blockade could be quite painful, especially in case of technical problems with the identification of paravertebral space [24]. For this reason also the other authors were using midazolam (1-3 mg IV) and fentanyl (50-150 µg IV) directly before TPVB [25].

We feel, that the results of our study are clinically important as TPVB is becoming increasingly popular for surgical anaesthesia. It has been proposed for day case breast augmentation - the whole procedure was

performed without general anaesthesia in 100 patients [26]. In comparison to general anaesthesia TVPB is known to be associated with less postoperative pain, less nausea and vomiting and greater patients' satisfaction [27].

In our previous study, we were able to prove that both ropivacaine and bupivacaine provided satisfactory conditions for mastectomy, with ropivacaine being slightly superior to bupivacaine [28]. In this paper, we are able to conclude that paravertebral injection of equal concentrations of bupivacaine or ropivacaine combined with premedication has almost no influence on a circulatory system and produces comparable, not clinically significant impairment of pulmonary function.

Conflict of interest

None

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