Int J Clin Exp Med 2020;13(1):259-267
www.ijcem.com /ISSN:1940-5901/IJCEM0100586

*Original Article*

# Effects of ropivacaine and bupivacaine at equipotent doses on arrhythmia in epidural anaesthesia and analgesia

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Received August 5, 2019; Accepted December 3, 2019; Epub January 15, 2020; Published January 30, 2020

**Abstract:** Many studies have been carried out to investigate the effects of methods of inducing anaesthesia and anaesthetic drugs on arrhythmias, and several factors contributing to arrhythmias were identified. In this study, we investigated the effects of ropivacaine and bupivacaine at equipotent doses on arrhythmias in individuals under epidural anaesthesia and analgesia. Our randomized, double-blind study was carried out by using epidural ropivacaine (n=15) and bupivacaine (n=15) for total knee arthroplasty upon the approval by the Hospital Ethics Committee. Sensory block onset time, sensory and motor block levels and the two-segment regression time were recorded for the epidural anaesthesia condition; a PCA pump was used postoperatively for 24 hours, and local anaesthetic consumption, bolus number, VAS score, and evaluation results of the motor and sensory block were recorded for the analgesia condition. For the analysis of the cardiovascular effects, a Holter device was placed preoperatively for a 24-hour follow-up portion of the postoperative PCA infusion period, and the QTc, QTd and QTcd were examined by ECG measurements during the follow-up period. In addition, haemodynamic parameters in the peroperative and postoperative periods were recorded. In our study, the comparison of ropivacaine and bupivacaine at equipotent doses in individuals under epidural anaesthesia and analgesia showed that the effects were similar except for the effects on the motor block level. The motor block level was higher in the bupivacaine group during both epidural anaesthesia and epidural analgesia. No difference was observed between groups in terms of haemodynamic parameters in either period. In most of the previous studies, ropivacaine has been found to be less arrhythmogenic than bupivacaine. In a study by Pedigo and Scott, these two agents were shown to have similar effects on QT times. Similarly, in our study, there was no difference between groups in terms of the QTc, QTd, QTcd and ventricular ectopic beats. However, some parameters of the supraventricular ectopic beats were found to be higher in the ropivacaine group than in the bupivacaine group. Therefore, we believe that the effects of bupivacaine and ropivacaine on arrhythmias should be compared with additional studies with a wider scope.

**Keywords:** Arrhythmia, epidural anaesthesia, local anaesthetics

## Introduction

Arrhythmias are one of the most common problems encountered by anaesthetists. The administered anaesthetic agents, abnormal arterial blood gas and electrolyte values, practices such as endotracheal intubation resulting in catecholamine secretion, preexisting cardiac disease, surgical manipulation, interventions on the patient and other medicines used by the patient can be considered factors contributing to arrhythmias during anaesthesia. In many studies, it has been shown that anomalies in blood electrolyte levels, hypoxia and acidosis contribute to the occurrence of arrhythmias.

Prolonged QT dispersion is also known to be a key predictor of ventricular arrhythmias and sudden cardiac deaths. QT dispersion is the difference between the longest and shortest QT interval measured by a 12-lead ECG system. There have been various studies and there are ongoing studies on the possible factors affecting QT dispersion during general or regional anaesthesia. Bupivacaine and ropivacaine are commonly used as local anaesthetics (LAs),

**Table 1.** Demographic characteristics

| | Bupivacaine | Ropivacaine | P |
|---|---|---|---|
| Age (y) | 63.93 ± 6.75 | 65.13 ± 3.5 | 0.548 |
| Height (cm) | 162.87 ± 4.27 | 161.33 ± 5.42 | 0.412 |
| Weight (kg) | 77.2 ± 8.74 | 74.4 ± 12.13 | 0.477 |
| Duration of Surgery (min) | 154 ± 22.3 | 149.33 ± 20.86 | 0.595 |

and their effects on arrhythmias have been investigated through various clinical and animal studies [1-22].

In this study, we investigated the effects of epidurally administered 20 ml 0.75% ropivacaine and 0.5% bupivacaine on arrhythmias by assessing Holter monitor records.

## Materials and methods

Our study, which was approved by the Hospital Ethics Committee, included 30 patients aged between 18 and 65 who agreed to undergo total knee arthroplasty (TKA) with epidural anaesthesia. The demographic characteristics of the patients in the ASA I-II risk group are presented in **Table 1**. Our study was a randomized and double-blind study. The patients were divided into two groups as follows: Group R: ropivacaine (n=15); Group B: bupivacaine (n=15).

Patients with a pre-existing cardiac disease, arrhythmias detected by ECG, drug use affecting the QT interval, an electrolyte imbalance, alcohol and smoking habits, DM, anomalies in routine biochemistry and haemogram results, infections and anatomical deformities in the lumbar region were excluded.

The preoperative and postoperative serum sodium, potassium, calcium, magnesium, urea, creatinine, blood sugar, haemoglobin and haematocrit values of patients were checked. Patients with anomalies in these levels were excluded from the study.

A 7 mL/kg 0.9% NaCl infusion was given to patients in the block room 30 minutes before the procedure. Standard monitoring in both groups consisted of non-invasive blood pressure systolic arterial pressure (SAP), diastolic arterial pressure (DAP), mean arterial pressure (MAP), heart beat rate (HBR) and oxygen saturation ($SpO_2$). Holter monitoring and QT interval measurements were carried out with a 12-lead ECG system (Cardiofax V Nihon Kohden Europe).

*Surgical period*

After the patients underwent testing in the preoperative period, they received midazolam sedation through separate vascular access.

Then, patients were placed in the recumbent position, and an epidural needle with the orifice directed cephalad was inserted in the midline through the L3-4 or L4-5 interspace. The epidural interspace was determined with the loss of resistance technique and saline. When the epidural interspace was reached, 3 ml of the drug was administered as a test dose. Following a 3-minute waiting period, during which the risk of a subarachnoid injection was eliminated, the remaining 17 ml was injected into the epidural interspace, which occurred after approximately 3-4 minutes. The doses administered for epidural anaesthesia are as follows: Group R: 0.75% ropivacaine, 20 ml; Group B: 0.5% bupivacaine, 20 ml.

Next, a 20 G epidural catheter was placed as it was moved forward approximately 3 cm in the cranial direction. After the external part of the catheter was properly fixed, the patient was placed in the supine position. Sensory block levels were checked every five minutes with a pinprick test. The surgical operation was initiated when the sensory block reached the T10 level. The patients were administered 3 L/min $O_2$ with a mask during the operation. The motor block was assessed using the Bromage scale. Sensory block onset time (SBOT), sensory block level (SBL), onset time of sensory block at the T10 level (OTSBT10), maximum sensory block level (MSBL) and motor block level at the onset time of the sensory block at the T10 level (MBL) were recorded. The patients were taken to the operating room after epidural anaesthesia.

The first follow-up was performed immediately after epidural anaesthesia was accepted, which was considered the $0^{th}$ minute. From the $0^{th}$ minute until the end of the operation, the SAP, DAP, HBR and $SpO_2$ values were recorded at the $15^{th}$, $30^{th}$, $60^{th}$ and $120^{th}$ minutes. The need for additional local anaesthetics (NELA) and the two dermatome regression times (RTs) during the operation were recorded.

During the operation, atropin 0.5 mg (i.v.) was administered when the HR was below 50/min,

and ephedrine 10 mg (i.v.) was administered when the MAP value was below 20% of the control value.

*Postoperative period*

Necessary information on PCA and PCA device use was provided to the patients at the preoperative visit. Upon termination of the surgery, the PCA device (Abbot Pain Management Provider) was connected to the epidural catheter, and PCA was administered via local anaesthetic infusion. The loading dose was not administered in the practice of PCA. The PCA device settings included a basal infusion rate of 4 ml/hr, a bolus dose of 2 ml and a lock-out time of 30 minutes. Concentrations in the groups: Group R: 3 mg/ml ropivacaine; Group B: 2 mg/ml bupivacaine.

For the postoperative follow-up of the patients, at the $0^{th}$, $1^{st}$, $2^{nd}$, $4^{th}$, $6^{th}$, $12^{th}$, and $24^{th}$ hours, the SAP, DAP, HR, $SpO_2$, SBL, MBL, local anaesthetic consumption (LAC), bolus number (BN), and visual analogue scale (VAS) values were monitored. In addition, when the VAS score was >4, diclofenac 75 mg (i.m.) was administered, and these instances were recorded.

Side effects experienced by the patients during and after the operation were followed up and treated. Any cases of nausea or vomiting, bradycardia and hypotension observed during follow-up period were recorded. These side effects were treated with 10 mg metoclopramide (i.v.), atropin 0.5 mg (i.v.) and ephedrine 10 mg (i.v.), respectively.

*QT dispersion*

All the ECG systems were standard 12-lead systems, with a paper speed of 25 mm/sec. Each ECG signal was separately reviewed by two different cardiologists. In all derivations, the initial point of the QRS complex deflection from the isoelectric line and the return point of the T-wave to the isoelectric line were measured by people blinded to the clinical situation. The nadir between the T and U-waves was considered the end of the T-wave. T-waves that did not have an exact endpoint were excluded from the calculation. Patients for whom measurements could be made at 7 derivations, including at least 3 chest derivations, were included in the study. Bazett's formula was used for the correction of the QT interval according to speed.

$QTd = QTmax - QTmin$

$QTc = QT/RR_I$

$QTcd = QTcmax - QTcmin$

ECG measurements for QT were taken at $0^{th}$ and $30^{th}$ minutes during the operation and at the $0^{th}$ and $24^{th}$ hours after the operation.

A 12-lead Holter monitor (Rozinn) was placed on patients in the preoperative period for a 24-hour follow-up. The results were reviewed by a cardiologist blinded to the groups.

*Statistical analysis*

Student's t test was used to analyse the demographic data and serum values. The Mann-Whitney U test was used only to analyse height.

For the HR, SAP, DAP, MAP and QT times, repeated measures analysis of variance was used to determine whether there were any differences between groups and within groups in terms of time. When differences in terms of time were detected within groups, the Bonferroni test was administered to analyse the differences in the times.

Student's t test was used to compare the LAC, RT and onset time of the sensory block at the T10 dermatome. The Mann-Whitney U test was used to compare the SBOT, MBL, BN, VAS and Holter follow-up results. The Chi-squared test was used to compare the need for extra local anaesthetics, peroperative and postoperative side effects and treatments.

## Results

*Demographic characteristics, case characteristics*

There was no statistically significant difference between the two groups in terms of age, height, weight, sex, type of surgery and duration of surgery (P>0.05) (**Table 1**). All of the patients underwent total knee arthroplasty, and all of the patients included in the study were female.

There was no statistically significant difference between the two groups in terms of the preop-

**Table 2.** Mean arterial pressure

| MAP | Bupivacaine (mmHg) | Ropivacaine (mmHg) |
|---|---|---|
| Preop. | 109.53 ± 5.9 | 110.31 ± 6.46 |
| Preop. 0 min | 93.49 ± 20.48 | 93.95 ± 17.82 |
| Preop. 15 min | 87.16 ± 19.86 | 85.53 ± 13.1 |
| Preop. 30 min | 87.16 ± 13.19 | 87.71 ± 1.7 |
| Preop. 60 min | 88.16 ± 20.38 | 82.11 ± 13.34 |
| Preop. 120 min | 89.29 ± 17.24 | 82.15 ± 14.92 |
| Postop. 0th hour | 89.71 ± 13.75 | 81.44 ± 7.18 |
| Postop. 2nd hour | 82.78 ± 11.34 | 81.95 ± 8.13 |
| Postop. 4th hour | 81.11 ± 11.43 | 82.11 ± 8.75 |
| Postop. 6th hour | 83.04 ± 12.66 | 83.53 ± 8.82 |
| Postop. 12th hour | 84.49 ± 11.35 | 85.15 ± 6.53 |
| Postop. 24th hour | 87.47 ± 11.19 | 85.62 ± 7.07 |

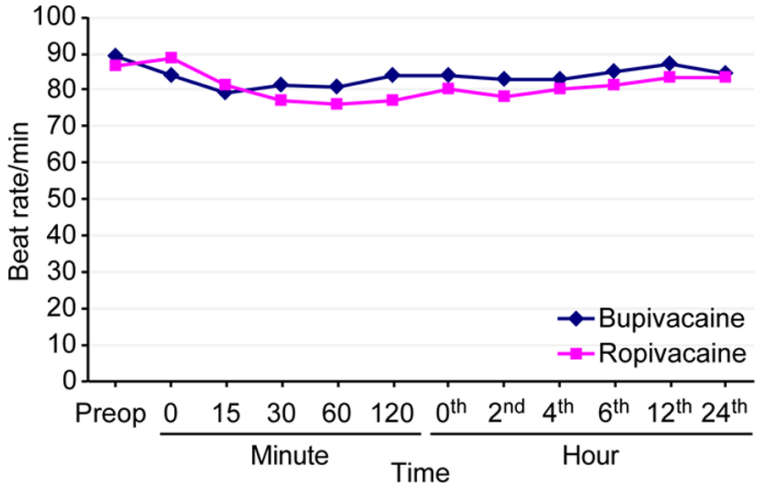


**Figure 1.** HBR values and time between groups. The analysis of the intragroup changes in the Qtc showed a statistically significant increase compared with the pre-operative 30 minute in bupivacaine group and at the postoperative 0 hour (P=0.018; P=0.02).

erative and postoperative serum sodium, potassium, calcium, magnesium, urea, creatinine, blood sugar, haemoglobin and haematocrit values of the patients (P>0.05).

*Haemodynamic parameters*

There was no significant difference between the groups in terms of the MAP values at different times (**Table 2**). The intragroup analyses showed a statistically significant decrease compared to the preoperative period at the pre-operative 15th and 30th minutes and all postoperative time points in the bupivacaine group and at all pre-operative and postoperative time points in the ropivacaine group (P< 0.05). However, there was no statistically significant difference in either group between the 0th minute and other time points after the epidural anaesthesia and between other pre-operative and postoperative time points (P>0.05).

In terms of the HBR values, there was no significant difference between the groups at any time point (**Figure 1** and **Table 5**). The intragroup analyses showed a statistically significant decrease only in the ropivacaine group in the HBR value at the pre-operative 60th minute compared with the preoperative value (P<0.05). However, there was no statistically significant difference in either group between the 0th minute and other time points after the epidural anaesthesia and between other pre-operative and postoperative time points (P>0.05).

In the $SpO_2$ values, no statistically significant difference was observed between or within groups between the preoperative value and the follow-up values (P>0.05).

There was no statistically significant difference between groups in terms of the development of hypotension and bradycardia as well as atropin and ephedrine requirements in the pre-operative period (P> 0.05).

*Holter monitor record analysis*

The follow-up results from the Holter monitor of the patients are presented in **Tables 3** and **4**. In terms of ventricular ectopic beats (VEB), the increases in the early ventricular ectopic (EVE) beats and total ventricular ectopic (ToVE) beats, especially in the ropivacaine group, are remarkable. However, these increases are not statistically significant (P>0.05) (**Tables 3** and **4**).

The analysis of the supraventricular ectopic beats (SVEB) from the Holter monitor of the patients in the follow-up period showed that

**Table 3.** Ventricular ectopic beats

| | Bupivacaine | | | | Ropivacaine | | | | P |
|---|---|---|---|---|---|---|---|---|---|
| | Mean ± Std | Median | Min | Max | Mean ± Std | Median | Min | Max | |
| Early VEB | 0.73 ± 1.39 | 0 | 0 | 4 | 48.67 ± 131.31 | 0 | 0 | 464 | 0.285 |
| Late VEB | 2.2 ± 4.43 | 0 | 0 | 15 | 18.6 ± 45.79 | 1 | 0 | 165 | 0.412 |
| Pairs | 0.2 ± 0.41 | 0 | 0 | 1 | 0.4 ± 0.74 | 0 | 0 | 2 | 0.683 |
| Beat in Run VEB | 0 ± 0 | 0 | 0 | 0 | 0.53 ± 1.25 | 0 | 0 | 4 | 0.367 |
| Total VEB | 3.13 ± 5.68 | 0 | 0 | 18 | 68.87 ± 177.78 | 5 | 0 | 635 | 0.233 |

**Table 4.** Supraventricular ectopic beats

| | Bupivacaine | | | | Ropivacaine | | | | P |
|---|---|---|---|---|---|---|---|---|---|
| | Mean ± Std | Median | Min | Max | Mean ± Std | Median | Min | Max | |
| Single SVEB | 16.13 ± 42.1 | 3 | 0 | 167 | 89.4 ± 134.6 | 42 | 0 | 495 | 0.001 |
| Pairs | 3.87 ± 11.1 | 0 | 0 | 43 | 1.9 ± 2.49 | 1 | 0 | 9 | 0.202 |
| Total Run SVEB | 1.2 ± 3.3 | 0 | 0 | 13 | 1.67 ± 2.3 | 1 | 0 | 9 | 0.098 |
| Beat in Run SVEB | 5.8 ± 13.47 | 0 | 0 | 52 | 26.8 ± 83.02 | 3 | 0 | 325 | 0.285 |
| Total SVEB | 28.37 ± 76.81 | 9 | 0 | 305 | 120 ± 156.2 | 53 | 0 | 507 | 0.001 |

**Table 5.** QTc

| | Bupivacaine (msec) | Ropivacaine (msec) | P |
|---|---|---|---|
| QTc-0 min | 403.20 ± 30.9 | 406.18 ± 33.2 | 0.485 |
| QTc-30 min | 440.82 ± 41.33 | 442.49 ± 47.75 | 0.464 |
| QTc-Postop. 0$^{th}$ hour | 434.67 ± 32.86 | 442.99 ± 31.83 | 0.477 |
| QTc-Postop. 24$^{th}$ hour | 428.07 ± 31.12 | 409.05 ± 40.41 | 0.372 |

**Table 6.** Patients with a QTc interval of more than 440 msec

| | B (number of patients) | R (number of patients) | P |
|---|---|---|---|
| QTc-0 min | 2 | 3 | 0.624 |
| QTc-30 min | 8 | 9 | 0.713 |
| QTc-Postop. 0$^{th}$ hour | 7 | 7 | 1 |
| QTc-Postop. 24$^{th}$ hour | 6 | 3 | 0.232 |

there was an increase in single supraventricular ectopic (SinSVE) beats and total supraventricular ectopic (ToSVE) beats in the ropivacaine group. This increase was statistically significant (P<0.005) (**Table 4**).

*QT analysis*

There was no statistically significant difference between the groups in the QT and QTc measurements (P>0.05).

The analysis of the intragroup changes in the QTc showed a statistically significant increase compared with the pre-operative 0$^{th}$ minute at the pre-operative 30$^{th}$ minute in the bupivacaine group and at the postoperative 0$^{th}$ hour in the ropivacaine group (P=0.018; P=0.02). As a QTc interval of more than 440 msec is known to be indicative of arrhythmias, the QTc intervals of more than 440 msec in both groups were compared, and no difference was found between them (P>0.05) (**Table 6**).

There was no statistically significant difference between and within groups in terms of the QTd intervals (P>0.05) (**Table 7**).

There was no statistically significant difference between and within groups in terms of the QTcd intervals (P>0.05) (**Table 8**).

## Discussion

In our study, the effects of ropivacaine and bupivacaine at equipotent doses on the incidence of arrhythmias in patients under epidural anaesthesia and analgesia were compared, and the QTc, QTd and QTcd intervals were found to be affected to a similar extent in both groups, with no difference. According to the follow-up results from the Holter monitor, single and total supraventricular ectopic beats in the ropivacaine group are significantly higher than those in the bupivacaine group. The maximum number of "beats in run", one of the supraventricular ectopic beats, was 325 and 52 in the ropivacaine and bupivacaine groups, respective-

**Table 7.** QTd

| | Bupivacaine (msec) | Ropivacaine (msec) | P |
|---|---|---|---|
| QTd-0 min | 33.33 ± 11.75 | 40.67 ± 12.8 | 0.221 |
| QTd-30 min | 33.33 ± 12.91 | 37.33 ± 12.23 | 0.223 |
| QTd-Postop. 0$^{th}$ hour | 37.33 ± 13.34 | 34.67 ± 9.15 | 0.221 |
| QTd-Postop. 24$^{th}$ hour | 27.33 ± 8.84 | 36 ± 12.42 | 0.231 |

**Table 8.** QTcd

| | Bupivacaine (msec) | Ropivacaine (msec) | P |
|---|---|---|---|
| QTcd-0 min | 39.35 ± 15.65 | 48.23 ± 13.65 | 0.17 |
| QTcd-30 min | 38.63 ± 16.19 | 42.27 ± 15.89 | 0.174 |
| QTcd-Postop. 0$^{th}$ hour | 43.96 ± 15.72 | 39.55 ± 9.92 | 0.17 |
| QTcd-Postop. 24$^{th}$ hour | 32.38 ± 10.5 | 42.18 ± 14.53 | 0.201 |

ly. There was no difference between the groups in terms of the "beats in run". The maximum number of total ventricular ectopic beats in the ropivacaine and bupivacaine groups were 635 and 18, respectively. There was no difference between the groups in terms of ventricular ectopic beats. We attribute the statistical insignificance in the differences in the Holter monitor results to the small number of patients in our study. We believe that there might be statistically significant differences in future studies involving more patients.

In their study on rabbits in 1977, Aberg et al. [3] found that when local anaesthetics were administered in the form of intravenous infusion, they had less toxicity than S-bupivacaine R or racemic bupivacaine. Later, studies also showed that the S form of the anaesthetic was less toxic [4, 5]. Based on the results of studies carried out on this topic, ropivacaine was produced as the 99.5% pure S isomer of bupivacaine.

In a study on pigs under anaesthesia, Reiz compared intracoronarily administered bupivacaine, ropivacaine and lidocaine at equipotent doses. The toxicity rates of these three local anaesthetics in terms of electrophysiological cardiotoxicity were found to be 15, 6.7 and 1, respectively. This study concluded that ropivacaine is 70% safer than bupivacaine in terms of the electrophysiology results [6].

Bupivacaine and ropivacaine differ in their effects concerning the mechanisms responsible for the cardiotoxicity of local anaesthetics. Bupivacaine was found to have larger effects than ropivacaine on potassium channels [4, 7], sodium channels [4, 8] and the inhibitory function of mitochondrial energy metabolism [4, 8]. The inhibitory effect of ropivacaine on cardiac potassium channels is seven times less than that of bupivacaine [8].

Most of the bupivacaine-related toxic reactions are known to be due to high bupivacaine concentrations in the plasma. Cases of morbidity and mortality have been reported even at small doses. In a study, Hotverd demonstrated that bupivacaine at a level of 2000 ng/ml plasma prolonged transmission time and had a negative inotropic effect. The arrhythmias observed in that study were found to have developed through the reentry mechanism [9].

In animal experiments, ropivacaine was found to have a smaller inhibitory effect on Purkinje fibres and ventricular transmission than bupivacaine [5, 10]. Furthermore, ropivacaine was found to play a smaller role than bupivacaine in the development of AV blocks, AV dissociation and ventricular arrhythmias [8, 11]. Similarly, bupivacaine was found to pose a higher risk for QRS enlargement, ventricular tachycardia and ventricular fibrillation than ropivacaine [4, 12].

In a study of 12 volunteers, Knudsen administered local anaesthetics in the form of 10 mg/min intravenous infusion to investigate the acute toxicity of ropivacaine and bupivacaine. In this study, the bupivacaine group was found to have a longer QRS time than the ropivacaine group [12].

In a study on dogs under anaesthesia, Groban compared the levels of risk caused by lidocaine, bupivacaine, levobupivacaine and ropivacaine for ventricular arrhythmias after programmed electric stimulation or spontaneous arrythmias. There was no difference between the groups in terms of ventricular tachycardia and ventricular fibrillation after programmed electric stimulation or spontaneous arrythmias. However, while there was no difference between lidocaine and ropivacaine in terms of the ventricular extrasystoles after programmed electric stimulation, and the increase in the number of ventricular extrasystoles due to bupivacaine and levobupivacaine was significantly

higher than the increase caused by lidocaine [14].

A general review of the lethal effects of local anaesthetics in animal experiments reveals that lethal effects occur [8] due to respiratory depression and pump failure without arrhythmias following the administration of lidocaine, due to fatal ventricular tachycardia and fibrillation without hypoxia and acidosis following the administration of bupivacaine, and due to both mechanisms following the administration of ropivacaine and levobupivacaine.

Studies have shown that the onset time of the adverse effects of bupivacaine on the cardiovascular system and central nervous system is longer than that of the adverse effects of ropivacaine. Moreover, the number of cardiac arrests that occurred after the administration of bupivacaine requiring cardiopulmonary resuscitation is less than that due to ropivacaine [5, 8, 13, 16-18].

In our study, the follow-up results from the Holter monitor demonstrated the following.

The early and late ventricular ectopic beats were higher in the ropivacaine group than in the bupivacaine group. However, this difference was statistically insignificant. It should be noted, however, that one patient in the ropivacaine group had a “beat in run”, which is a multiple pairing, four times, which indicates a risk for ventricular tachycardia. However, this patient had no cardiac symptoms.

The single and total supraventricular ectopic beats were significantly higher in the ropivacaine group than in the bupivacaine group. The maximum number of “beats in run” was 325 in the ropivacaine group and 52 in the bupivacaine group. There was no statistically significant difference between groups in terms of the “beats in run”, which shows that both anaesthetics are associated with a risk for tachycardia.

The aforementioned studies show that ropivacaine has a smaller arrhythmic effect than bupivacaine does. Only in the study by Groban et al. [14], there was no difference between ropivacaine and bupivacaine in terms of ventricular arrhythmias. The results of our study are similar to those in Groban’s study. It should also be noted that differences between species must be taken into consideration [8]. In other words, studies on animals must be supported with those on humans. In most of the studies, these two local anaesthetics were compared at equal concentrations, but their anaesthetic levels are not equipotent at equal concentrations. Upon a general review of the Holter monitor results in our study, we believe that ropivacaine and bupivacaine at equipotent doses should be compared with additional studies with a wider scope.

In a study on pigs, following an intraarterial injection of 5.33 mg ropivacaine and 4 mg bupivacaine, Pedigo found that the QRS intervals were longer by 75% and 155% after the administration of ropivacaine and bupivacaine, respectively, which was a significant difference. For the change in the QT intervals, they were longer by 18% and 20% after the administration of ropivacaine and bupivacaine, respectively. When ropivacaine and bupivacaine were compared in terms of the prolongation of the QT intervals and effective refractory period, no statistically significant difference was found between the two groups [19].

In the comparison of ropivacaine and bupivacaine intravenously administered to volunteers, Scott found that ropivacaine had a higher toxicity threshold. The dose at which central nervous system symptoms emerged was 124 mg for ropivacaine and 99 mg for bupivacaine. At these doses, both local anaesthetics had cardiovascular effects, such as an increase in heart rate and blood pressure, a decrease in stroke volume and ejection fraction, and prolongation of the PR and QTc intervals. There was no difference between the groups in terms of these changes [20].

In our study, there was no significant difference between the groups in terms of the QTc, QTd and QTcd intervals, which is consistent with the results in studies by Scott et al. [20] and Pedigo et al. [19]. Within each group, there was prolongation of the QTc intervals. Additionally, there was no statistically significant difference between the groups, in terms of the QTc values over 440 msec, which constitutes the threshold of significance. Therefore, we think additional studies with a wider scope should be carried out to compare ropivacaine and bupivacaine at equipotent doses.

Regarding the effects of ropivacaine and bupivacaine on the haemodynamic parameters under epidural anaesthesia, in the comparison by Cederholm et al. [21] between 0.75% ropivacaine and 0.5% bupivacaine and the comparison by Wood and Rubin [22] between 1% ropivacaine and 0.75% bupivacaine, no difference was found between the groups in terms of changes in heart rate and blood pressure. In our study, the pre-operative and postoperative follow-up results for blood pressure revealed no significant difference between groups. Within each group, however, there was a significant decrease in values at all time points compared with those recorded in the preoperative period. We attribute this decrease to the fact that we administered Dormicum for sedation in patients once they were taken to the block room, causing epidural anaesthesia to take effect (pre-operative $0^{th}$ minute follow-up was taken after the anaesthetic was injected, the catheter was fixed, and the patient was placed in a supine position). In our study, there was no significant difference between the groups in terms of heart rate in the re-operative and post-operative periods. The follow-up results for heart rate and blood pressure in our study are consistent with those in the aforementioned studies.

## Conclusion

As stated by Mather in the article "Are modern local anaesthetics safe?", new local anaesthetics seem to be safer than bupivacaine. The author concluded the article by claiming: "but this does not mean they are completely safe".

Taking into consideration the results in our study and the evaluation by Mather, we believe that studies of a wider scope are necessary to compare ropivacaine and bupivacaine.

## Acknowledgements

Thanks to AJE for English revision.

## Disclosure of conflict of interest

None.

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