

The Analgesic Efficacy of Local Anesthetics for the Incisional Administration following Port Access Heart Surgery: Bupivacaine versus Ropivacaine

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ABSTRACT

Background: To avoid large dose opioids, the authors investigated an alternative method for postoperative pain relief after Port Access cardiac surgery.

Methods: Out of 104 patients who underwent Port Access heart surgery, 78 patients who were extubated in the operating room were enrolled in the retrospective study. The standardized fast track cardiac anesthesia was used for all patients, and the catheter was placed in the surgical wound at the end of the operation. Analgesia was started with a bolus of bupivacaine (B group) or ropivacaine (R group) through the catheter and followed by continuous infusion of local anesthetic. The variables recorded were visual analogue scale (VAS) at extubation and during the first 24 hours, additional requirements of local anesthetic (LA), and opioid analgetic. Possible complications that could be connected with the catheter in the wound or with the administration of LA were recorded as well.

Results: There was no statistical difference between the R and B groups in mean pain score at extubation and in the first 24 hours. The groups were also comparable concerning the need for bolus application of the LA and opioid analgetic.

The microbiological analysis of 9 randomly chosen catheter tips from both groups was sterile.

Conclusion: Both local anesthetics, ropivacaine and bupivacaine, are equally effective for pain relief after Port Access cardiac surgery. The catheter in surgical incision and application of LA through it does not increase the risk for wound infection and does not interfere with wound healing.

INTRODUCTION

Unsuccessful postoperative pain management could increase postoperative complications and could be related to poor postoperative outcome [Deneuville 1993; Roberge 1998; Gust 1999; Scott 2001]. On the contrary, successful postoperative management has beneficial influence on postoperative recovery [Hopf 1997; Page 2001]. The high dose of opioid analgetics that has traditionally been used to alleviate postoperative pain can cause unwanted side effects such as

respiratory depression, vomiting, urine retention, and delayed early mobilization. To avoid these complications, other techniques for postoperative pain relief could be employed. It has been proven that a multimodal approach is the most effective [Khoury 1992; Rasmussen 1998; Vintar 2005]. With the combination of different drugs or methods for postoperative pain relief we can avoid unwanted side effects and provide good postoperative analgesia [Cheng 1998].

Due to a small surgical incision after endoscopic cardiac surgery using the Port Access system and video technology, incisional administration of local anesthetic (LA) and placement of catheter in the incision could be used for postoperative pain relief. The aim of the study was to compare the efficacy of ropivacaine with bupivacaine for postoperative pain relief when used for infiltration analgesia after endoscopic cardiac surgery.

METHODS

Patients and Procedures

One hundred four patients in a 2-year period underwent endoscopic cardiac surgery using the Port Access system and video technology. All patients extubated in the operating room within 15 minutes after the end of the procedures were enrolled in this retrospective study. They were operated because of mitral or tricuspid valve dysfunction, cardiac tumor removal, or atrium septal defect. All the procedures were performed by the same surgeon and the same anesthesiologist. For postoperative pain relief, all patients received a LA (ropivacaine or bupivacaine) through a catheter that was placed in the surgical incision. Patients were divided into the ropivacaine group (R group) or bupivacaine group (B group) on the basis of which LA they received. The groups were compared regarding the time to extubation, mean values of visual analogue score (VAS) at extubation and in the first 24 hours, and the need for additional bolus of LA or opioid analgetic.

Surgical Procedure

The operation was performed through a 2.5- to 3-cm long thoracotomy on the right side of the thorax, in the third or fourth intercostal space. The standard canulas of the Port Access system were inserted percutaneously using the Seldinger technique to establish cardiopulmonary bypass (CPB). The insertion of the venous canula in the inferior vena cava was performed by the surgeon through the femoral vein,

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Table 1. Criteria for Suitability for Extubation in the Operating Room*

Criteria	Suitability for Extubation
Hemodynamics	MAP 50-80 mmHg, heart rate 50-90 min ⁻¹ , dobutamin <5 µg kg ⁻¹ , no sign of myocardial ischemia†
Ventilation	Spontaneous breathing, respiratory rate 10-18 min ⁻¹ , TV ≥ 8 mL kg ⁻¹
Consciousness	Obey simple commands
Muscle strength	Lift the head and hold for 30 s
Body temperature	37.0°C < 36°C
VAS	< 3

*MAP indicates mean arterial pressure; TV, tidal volume; VAS, visual analogue scale.

†Change in ST segment.

and the insertion of the second venous canula in the superior vena cava was performed by the anesthesiologist through the right jugular vein. The arterial canula was inserted by the surgeon through the femoral artery after full heparinization with heparin (300 IU/kg¹). During CPB patients were cooled to 29°C, and cold-blood anterograde cardioplegia was employed for heart protection. Before discontinuation from CPB the patients were rewarmed to 37°C.

Anesthetic Protocol

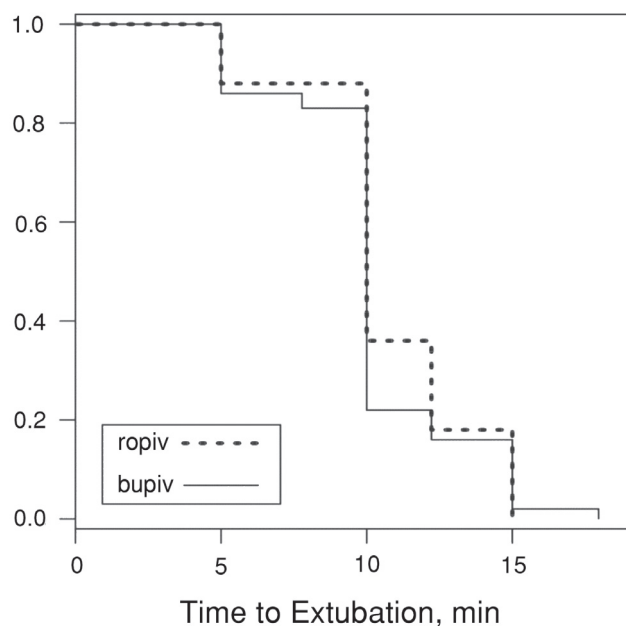
On the day of the operation, patients were premedicated with fluzepam 5 mg. To start the anesthesia fentanyl (3-5 µg kg⁻¹), etomidat (0.3 mg kg⁻¹), and the muscle relaxant vecuronium (0.1 mg kg⁻¹) were used. The patients were intubated with double lumen tubes to enable 1-lung ventilation during the procedure. For maintaining the anesthesia we used a continuous infusion of ultra-short acting opioid remifentanyl (0.2-0.3 µg kg⁻¹ min⁻¹) and sevoflurane (1.0%-1.2%) and a continuous infusion of propofol (3-4 mg kg⁻¹ h⁻¹) during CPB.

Standard hemodynamic monitoring for Port Access cardiac surgery was performed. It consists of 5-lead electrocardiogram, pulse oximetry, invasive blood pressure measurement in both the left and right radial artery, and central venous pressure. A Swan-Ganz catheter was inserted in the case of pulmonary hypertension. Transesophageal echocardiography (TEE) was used with all patients.

If the patients fulfilled the extubation criteria, they were extubated at the end of the procedure while still in the operating room. Otherwise they were reintubated with a single lumen tube and transferred to the intensive care unit (ICU). The extubation criteria are listed in Table 1.

Postoperative Analgesia

At the end of the operation, before closing the surgical wound, a multihole epidural catheter (Portex clear G 18 epidural catheter with 3 lateral eyes; Smith's Medical, Kent, UK) was placed between the muscles alongside the wound through



Kaplan-Meier curve: time to tracheal extubation. Log rank test: $P = .574$. Ropiv indicates ropivacaine; bupiv, bupivacaine.

a Touchy needle inserted at a distance of 4 to 5 cm from the wound in the vicinity of the intercostal nerve. The catheter was tunneled 4 to 5 cm subcutaneously, sutured, and firmly secured to the skin with sterile transparent dressing. A bolus of LA 10 mL 0.75% of ropivacaine or 10 mL 0.5% of bupivacaine was applied through the catheter. All other wounds on the thorax and in the groin, which were caused by catheters, canulas, and drain, were infiltrated with 10 mL of LA as well. When the patients were admitted to the ICU, a catheter was connected to the pump by use of an antiseptic technique, which provides the continuous infusion of 5 mL h⁻¹ of 0.15% ropivacaine or 5 mL h⁻¹ 0.15% bupivacaine. In the ICU the analgesia was supplemented with metamizol 1.25 g on a regular basis. The intensity of pain was evaluated and recorded immediately after the extubation and over the next 24 hours every 4 hours using the VAS (0 = no pain, 10 = worst pain imaginable).

If the VAS pain score was greater than 3, and the pain had the maximum intensity in the area of the catheter, a bolus of 5 mL 0.5% ropivacaine or 5 mL 0.5% bupivacaine was given through the catheter. If the pain originated somewhere else, however, a bolus of opioid analgetic—piritramid (3 mg)—was administered in the vein. The number of boluses of LA and piritramid were recorded. The catheter was removed by the surgeon on the third or fourth postoperative day. In case of any sign of wound infection, the tip of the catheter was sent for microbiological analysis. In addition, we randomly chose 10 catheter tips and sent them for microbiological analysis.

Statistical Analysis

Statistical analysis was performed using unpaired t test to analyze parametric data, and a χ^2 test was used to compare

Table 2. Demographic Data, Type of Procedure, and Time to Extubation*

	Ropivacaine Group (n = 41)	Bupivacaine Group (n = 37)	P
Age, y	59.6 (13.2)	59.5 (11.1)	.964
Sex, m/f (%)	15/26 (37%/63%)	18/19 (49%/51%)	.282
ASA 3 and 4	26 (63%)	23 (62%)	.909
Time to extubation, min	10.4 (2.9)	10.8 (2.8)	.522
MVR/PMV + PTV	15 (36.5%)	14 (37.8%)	.93
MVR/PMV	22 (53.6%)	20 (54%)	.98
Other	22 (53.6%)	3 (0.8)	.81

*Results are presented as mean values (\pm SD) or percentage. ASA indicates American Society of Anesthesiologists' patient classifications; MVR, mitral valve replacement; PVM, plastic of mitral valve; PVT, plastic of tricuspid valve.

Table 3. Pain Scores and Requirements for Additional Analgesia*

	Ropivacaine Group (n = 41)	Bupivacaine Group (n = 37)	P
VAS at extubation	0.83 (9.92)	1.08 (1.46)	.743
VAS in the first 24 h	2.97 (1.6)	2.54 (1.3)	.464
Boluses of LA, n	2.1 (1.13)	2.1 (1.6)	.957
Boluses of piritramid, n	1.6 (1.28)	2.1 (1.2)	.106

*Results are mean values (\pm SD). VAS indicates visual analogue scale; LA, local anesthetic.

dichotomous data. A P value $< .05$ was considered to indicate statistically significant differences. Results are expressed as mean values \pm standard deviation or as percentage.

RESULTS

Out of 104 patients, 78 patients extubated in the operating room were enrolled in the study. Forty-one patients received ropivacaine (R group), and 37 patients received bupivacaine (B group). Twenty-six patients were excluded because they were not extubated in the operating room but later in the ICU.

Demographic data, type of the procedures, and time to extubation are summarized in Table 2.

No statistical difference was found in the average time to tracheal extubation (Figure).

The VAS score at extubation was statistically comparable in both groups. The mean VAS score in the first 24 hours was less than 3 in both groups. There was also no statistical difference found between the groups regarding the need for additional bolus of LA or piritramid (Table 3).

Two catheters fell out when the nurses were changing the drapes. In 1 patient, the catheter was cut when removal was attempted, and the tip of the catheter was left in the wound. With the patient's consent, the remains were left in the place without intervention. The wound healed completely and uneventfully and as of the time of this writing it has caused no trouble.

No catheter tips were sent to microbiological analysis because of wound infection. The microbiological analysis of

9 randomly chosen catheter tips was sterile. The *Staphylococcus epidermidis* was isolated from 1 tip, which we ascribed to contamination at the time of removal.

DISCUSSION

Our study shows that both types of LA are suitable for post-operative pain relief using incisional administration through a catheter in the surgical wound. The mean VAS scores at extubation and in the first 24 hours are almost identical in both groups. More importantly, mean VAS was less than 1 at extubation and less than 3 in the first 24 hours.

Also the requirement for bolus of LA and opioid analgesic is statistically not different between groups. A small surgical wound with endoscopic cardiac procedures offers the opportunity to choose this alternative method for post-operative pain management. LA blocks the conduction of the impulses along the intercostal nerve, and continuous infusion of LA through the catheter additionally prolongs the analgesia also in the postoperative period, as long as the catheter is in place. The main benefit of this type of analgesia is that at the end of the procedures we can stop the opioid analgesic and the patients are awake and spontaneously breathing so they could be extubated while still in the operating room immediately at the end of the operation.

Seventy-five percent of the patients in our study group were extubated within 15 minutes after the end of the operation, and the intensity of pain at the end of the operation was low in both groups.

Even though it is well known that lower concentrations of bupivacaine in serum cause unwanted cardiovascular and central nervous side effects in comparison with ropivacaine, we did not notice any side effects that could be related to the administration of LA. To avoid administration of the LA into the vessel by accident we undertook all methods of precaution. Before the first administration of the bolus by the surgeon, he carefully checked the position of the catheter by aspiration with syringe.

We chose a concentration 0.15% and a rate of administration of 5 mL h⁻¹ not to exceed the maximum day dose of LA. According to 2 studies where they used higher concentration of LA, its concentration in the serum was still within the normal ranges and we could safely use higher rates and concentrations in our study [White 2003; Dowling 2003]. But the exact dose that is the most efficacious but still safe has to be established.

Of course, analgesia through catheter in the wound solely is not adequate to control pain after endoscopic cardiac procedures, because patients feel pain also in other parts of the body that are connected to the intubation, insertion of the canulas, and catheters. That is why we add the nonsteroidal antiinflammatory drug metamizol. It has been confirmed that nonsteroidal antiinflammatory drugs also have an opioid sparing effect [Hynninen 2000]. Metamizol is a safe drug because it does not have influence on blood coagulation or gastric secretion, and short usage of this drug does not cause agranulocytosis. If after these 2 different methods for postoperative pain relief the patients still felt pain, they were given an opioid analgetic on request. We preserved the multimodal approach for postoperative pain management, which has been proven also to be most efficient for other types of surgery.

At the ward, the patients were instructed to administer the bolus of LA by themselves through patient control analgesia pumps when they felt pain in the area where the catheter had been placed. The boluses can also be given before the respiratory physiotherapy, making the rehabilitation faster. After 3 days, the catheter was removed by the surgeon, and thereafter per oral analgetic was sufficient.

The group of patients not extubated in the operating room had the same method for postoperative pain relief.

In our study we have also proven that a catheter in the surgical wound does not have unwanted side effects on the wound healing and does not cause infection. At the daily dressing changing, we paid especially careful attention to discover any sign of inflammation or infection that could be related to the catheter in the wound. No catheter was removed because of signs of infection, and 9 randomly chosen catheters tips sent to the microbiological analysis were sterile. The *Staphylococcus epidermidis* was isolated from 1, but because there was no sign of wound or systemic infection we considered that as contamination when the catheter had been removed. Also, the studies dealing with the problem of correlation between wound infection and catheter in the surgical incision did not prove the fear of infection [Deneuve 1993; Hopf 1997; Fredman 2000; Klein 2000]. One study even indicates that bupivacaine might have an antimicrobial effect [Rosenberg 1985].

The use of a catheter in the surgical wound does not demand any additional skills and knowledge from the nursing staff. They have to pay attention when changing dressing not to remove or cut it by accident.

Analgesia management has become extremely important with the introduction of minimally invasive cardiac surgery and the development of fast-track postoperative recovery [Wilmore 2002; Gersak 2005; Kehlet 2005]. Less invasive surgical techniques require less invasive anesthetic techniques. Analgesia with the administration of the LA through the catheter in the surgical incision is just 1 of the less invasive methods for postoperative pain management. Use of paravertebral block and insertion of the catheter in the paravertebral space, the method that is already standard in thoracic surgery, might also be an alternative for cardiac procedures performed through thoracotomy, but further studies are necessary to evaluate this technique also in cardiac surgery.

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