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RESEARCH ARTICLE

ROLE OF INJ. ROPIVACAINE (0.2%) IN THORACIC EPIDURAL ANALGESIA FOR OFF- PUMP CORONARY ARTERY BY PASS GRAFTING SURGERY

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ABSTRACT

Background: Thoracic epidural anaesthesia (TEA) in coronary bypass surgery provides an excellent analgesia and helps in early recovery but the use of 0.2% Ropivacaine in TEA for off pump coronary artery bypass surgery (OPCAB) is not well documented in the literature.
Methods: After ethics committee approval, sixty patients were randomized into two groups. The General Anesthesia (GA) group (n=30) received Inj. Midazolam (0.1mg/kg) and Inj. Fentanyl (10mcg/kg) for induction. TEA was installed more than one hour before giving heparin at T5–T6 / T6-T7 level in GA+TEA group (n=30) and continuous infusion of 0.2% Ropivacaine @ 5-7 ml/hr intraoperatively was started and continued 24 hours in the postoperative period after extubation.
Results: TEA decreased heart rate (HR) but maintained arterial pressures and reduced the consumption of fentanyl and pancuronium significantly (P<0.001) as compared to GA group. In the postoperative period following extubation, heart rate, arterial pressures and CVP were maintained as pain control was superior in GA+TEA group. There was no neurological complication related to TEA.
Conclusions: We conclude that TEA using 0.2% Ropivacaine along with GA improves hemodynamics during and after OPCAB surgery, significantly reduces the intraoperative anaesthetic drug requirement and more effective in postoperative pain control.

INTRODUCTION

Thoracic epidural anaesthesia (TEA) has been introduced in cardiac surgery over the last decade. It is an attractive modality which provides both anesthesia and analgesia. Also the anaesthetic – analgesic effects of 0.2% epidural Ropivacaine in OPCAB have been proved in fewer studies, despite its widespread clinical use (**Kessler *et al.*, 2002; Achurin *et al.*, 2005; Bakhtiary *et al.*, 2007; Kirov *et al.*, 2011**). Therefore, we conducted prospective randomized clinical study to evaluate the potential benefits of continuous TEA using 0.2% Ropivacaine on hemodynamics, intraoperative requirement of narcotic drugs, muscle relaxants and postoperative analgesia in perioperative management of OPCAB surgery.

MATERIALS AND METHODS

After institutional ethics committee approval; this prospective, single centred, randomized controlled study comprised 60 patients divided into two groups group GA –General Anesthesia and Group GA+TEA – thoracic epidural and GA (n=30 each). After obtaining written informed consent, patients between 35 to 75 years age, undergoing elective coronary artery bypass grafting surgery, left ventricular EF >30%, prothrombin time >80%, platelet counts >1,00,000/ml, INR <1.5 and last dose of Tab. Clopidogrel intake >7 days before scheduled date of surgery were included. Patients requiring urgent or emergency procedure, unstable hemodynamics, significant valvular pathology and having general contraindications for epidural technique were excluded.

Patients in both the groups received pre-medication and cardiac drugs except ACE inhibitors. Baseline heart rate (HR), blood pressure (BP), electrocardiogram (lead II & V5 monitoring) was recorded. Radial artery cannulation for invasive BP monitoring and central venous cannulation for central venous pressure (CVP) monitoring were inserted under local anaesthesia. Patients in group GA were induced with Inj. Midazolam (0.1mg/kg), Inj. Fentanyl (10mcg/kg) and Inj. Rocuronium (1mg/kg) and maintained with oxygen-nitrous oxide- isoflurane (0.8 -1 MAC) mixture. Patient was kept on Intermittent Positive Pressure Ventilation to maintain an end tidal CO2 of 30-35 mm Hg. Patients in GA+TEA group had an epidural catheter inserted one hour prior to surgery. The catheter was inserted at T5-T6 or T6-7 level using 16 gauge Touhys needle, by midline approach in sitting position and

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confirmed by loss of resistance to saline technique. The epidural was considered failure when the insertion required more than 2 attempts or more than once the bloody tap occurred. The catheter tip was positioned at the level of T4. In the event of 'bloody tap', a higher level was attempted for epidural placement. A test dose of 2 cc of 2% Inj. Lignocaine through the epidural catheter was administered for confirmation. All the catheters were inserted by the same operator. Before induction, epidural block was established by 8-10 ml of Inj. Ropivacaine (0.2%). The block assessment was done 20 mins later by using loss of temperature sensation to cold bilaterally at the midclavicular line with ether swab. Successful block was defined as block over T1 to T8 dermatomes. If required, block was extended with 2 ml of 0.2% Ropivacaine. Failure to obtain such a block was considered as failure of epidural technique and the patient was transferred to only GA group. Epidural catheter was removed after 24 hours of extubation, ensuring 4 hours heparin free interval, as per institutional protocol.

General anaesthesia was then induced and maintained similar to GA group. As soon as the patient was hemodynamically stable, the epidural infusion of 0.2% Ropivacaine was started @ 5-7 ml/hr and kept throughout the surgery. All patients included in the study were operated with median sternotomy surgical approach. Unfractionated Heparin 200 IU /kg was given 3 minutes before starting anastomosis for all patients and at least 1 hour after epidural catheter placement to accomplish an activated clotting time (ACT) of 250- 350 seconds and antagonized using Inj. Protamine 1 mg for each 100 IU of Heparin after completion of anastomosis to return the ACT to baseline or less than 120 seconds.

We defined certain acceptable limits to optimize individual patient management as follows:

- Hypotension (systolic BP <20% of baseline or SBP < 90 mm Hg) was treated with volume or vasopressors or inotropes, depending on the CVP levels.
- Hypertension (systolic BP>20% of baseline) was treated with Inj. Propofol (0.25-1mg/kg), a volatile agent or Glyceryl trinitrate.
- Tachycardia (HR >100 beats/min) was treated with beta – adrenergic blocker.
- Bradycardia (HR <40 beats/min) was treated with atropine.

Hemodynamic measurements like Heart Rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP) and CVP were recorded from induction till patient was extubated and then every four hourly till 24 hours after extubation. Blood sugar levels (BSL) were checked every 2 hours both intraoperatively and postoperatively. Intraoperative and postoperative requirement of Fentanyl and Pancuronium were recorded. Postoperatively, patient was shifted to ICCU and ventilation was continued with same parameters. The patients were extubated by fast track extubation technique i.e. within 6 hours postoperatively. After extubation the level of sedation was evaluated by the attending physician by means of the Ramsay Sedation Scale (RSS) score 1-6. Before surgery, the patients were familiarized with Visual Analog Scale to assess their pain. (0= no pain to 10 = maximum imaginable pain) In the Group GA, after extubation, the pain relief was given by Inj. Paracetamol 15 mg/kg IV six hourly and inj. tramadol 50 mg IV if required. In the GA+TEA group, the epidural infusion was commenced as soon as the patient was hemodynamically stable after shifting in the ICU & continued till 24 hours in the postoperative period. After extubation, the rate of infusion was titrated according to clinical need. If the patients reported pain score $\geq$ 4 on VAS, epidural rate was increased in increments of 1 ml/hr every 2 hours. The rate was decreased if there was paraesthesia in dermatome C8 or higher in a painless patient. Motor monitoring was performed for upper limb to assess the complications of epidural technique, if any. It was graded according to Epidural Anaesthesia Scoring Scale for Arm Movements (ESSAM). Rescue analgesia in the GA + TEA group was Inj. Tramadol 50 mg IV.

Statistical analysis

The group size was calculated to find a 20% difference between mean arterial blood pressure in both groups during surgery with a power of 80% and beta as 0.2. All data presented as mean $\pm$ SD and analyzed using SPSS 16 software. P value <0.05 was considered significant.

RESULTS

We found no significant differences among the groups regarding demographic data including age, sex, weight, duration of surgery and mechanical ventilation. (Table 1) Comparison of baseline hemodynamic parameters did not reveal any significant difference between groups. (Table 2) The insertion of the thoracic epidural catheter was successful in all patients.

DISCUSSION

Coronary artery bypass grafting (CABG) is one of the most common cardiosurgical interventions. In many institutions, CABG is performed without cardiopulmonary bypass (CPB), a modification which is commonly referred to as off-pump coronary artery bypass grafting (OPCAB). The off-pump technique enables coronary revascularization on the beating heart, thereby reducing the risk of complications associated with CPB. However, OPCAB may lead to hemodynamic alterations, postoperative pain and respiratory dysfunction, requiring thorough monitoring and perioperative care (**Chassot *et al.*, 2004; Cheng and Bainbridge, 2006; Scott *et al.*, 2005; Ngaage, 2003**). Thus the anaesthesia management during CABG becomes utmost important. The principles of anaesthetic management are providing maximum cardiac protection by use of cardio-protective anaesthetic techniques, maintaining hemodynamic stability, enabling surgical exposure within limits of acceptable hemodynamics and providing excellent postoperative analgesia.The addition of regional anaesthesia to general anaesthesia is an improvement in quality of recovery for patients undergoing CABG. Thoracic epidural analgesia (TEA) was among the first anaesthetic techniques described for CABG (**Clowes *et al.*, 1954**).

Till date, various combinations of local anaesthetics and opioid have been used in the thoracic epidural during CABG. But only few studies have used Inj. Ropivacaine in OPCAB surgery (**Kessler *et al.*, 2002; Achurin *et al.*, 2005; Bakhtiary *et al.*, 2007**) The concentrations used were different in all these studies. A dose-finding study (**Scott *et al.*, 1995**) with 0.1%, 0.2% and 0.3% Ropivacaine demonstrated that 0.2% Ropivacaine provided the best balance between analgesia and motor block. Etches and colleagues (**Etches *et al.*, 1997**) found that epidural infusion of 0.2% Ropivacaine @ 10-14 ml/hr reduced PCA morphine requirements and significant motor block in at least 30% of patients with little effect on pain scores after lower abdominal surgery. Hence we used 0.2% Ropivacaine epidurally during OPCAB to assess its effects on perioperative hemodynamics, quality of pain control and intraoperative anaesthetic drug requirement. In the anesthetized patient, the major determinant of heart rate is the balance of the sympathetic and parasympathetic activity. High regional anaesthesia, including the upper five thoracic segments (T1-T5), blocks the cardiac afferent and efferent sympathetic fibers, resulting in loss of the chronotropic and inotropic drive to the myocardium (**Bakhtiary *et al.*, 2007**).

Using epidural anaesthesia with 0.2% Ropivacaine only, in combination with general anesthesia a, we observed decreased heart rates throughout the surgical procedure (Table 2) and in postoperative period (Table 3) with maintenance of mean SBP, DBP and MAP. Hemodynamic values during LIMA harvest revealed no significant changes between groups. While the hemodynamic changes during distal anastomosis to anteriorly located coronary artery (LAD) can be related to moderate heart dislocation and compression, for maintenance of an optimum surgical exposure and a relatively stable operative field. The most expressed hemodynamic changes are observed at a stage of shunting of coronary arteries located on back surface of heart-the right coronary and circumflex arteries. The basic mechanism is decrease in preload due to mechanical compression of the right heart chambers and as consequence reduced preload of left ventricle, leading to decreased cardiac output. The measures to prevent myocardial ischemia at this stage of operation include maintenance of relative bradycardia and normal MAP.

Table 1. Patient Demogaphic Data

	GA	GA+TEA	P value
Age (years)	59.23 + 9.73	59.86 + 8.95	0.93
Weight (kg)	64.16 + 7.27	65.23 + 7.77	0.94
Sex (M/F)	27/3 (90%/10%)	25/5(83%/17%)	0.48
Duration of Surgery (hrs)	4.50 (4.07-4.69)	4.50 (4.39-5.00)	0.16
Duration of mechanical ventilation (hrs)	5.00 (4.53-5.00)	5.00 (4.53-5.00)	1

Table 2. Hemodynamic parameters before extubation

		HR(beats/min)		SBP (mm Hg)		DBP (mm Hg)		MAP (mm Hg)		CVP(cm of H2O)	
Event	Grp	Mean ± SD	P	Mean± SD	P	Mean ± SD	P	Mean ± SD	P	Mean ± SD	P
Baseline	GA	66.23± 4.11	0.34	112± 5.11	0.20	62.93± 6.51	0.67	84.16 ± 8.09	0.83	11.40 ± 1.30	0.46
	GA+ TEA	65.23± 3.95		110 ± 4.54		62.33 ± 4.42		83.76 ± 6.19		10.03 ± 1.65	
Post Induc- tion	GA	77.66± 7.80	0.028	110 ± 8.18	0.64	65.50 ± 8.51	0.60	80.43 ± 7.72	0.70	10.50 ± 1.14	0.00
	GA+ TEA	73.03± 8.12		109 ± 8.63		66.60 ± 7.44		81.17 ± 7.00		9.40 ± 1.59	
Sterno- Tomy	GA	73.66± 7.44	0.23	121 ± 5.32	0.13	70.20 ± 7.18	0.02	87.10 ± 5.63	0.77	11.73 ± 1.86	0.23
	GA+ TEA	71.03± 9.55		115±19.41		73.77 ± 4.07		87.60 ± 7.22		11.10 ± 2.20	
Anterior anastomosis	GA	75.50 ± 6.14	0.000	113 ± 8.21	0.66	65.33 ± 7.17	0.26	81.27 ± 7.28	0.53	11.00 ± 1.26	0.45
	GA+ TEA	67.26 ± 8.53		112 ± 5.41		67.07 ± 4.36		82.20 ± 3.58		10.73 ± 1.46	
Posterior Anastomosis	GA	76.60±10.88	0.002	110 ± 8.51	0.88	61.73 ± 7.86	0.27	77.87 ± 7.81	0.57	9.83 ± 1.15	0.75
	GA+ TEA	67.03± 12.4		109 ± 7.21		80.33 ± 9.83		78.80 ± 4.52		9.97 ± 1.92	
	GA+ TEA	68.56 ± 13.0		108 ± 6.32		64.33 ± 4.74		79.00 ± 4.45		9.47 ± 1.76	
	GA+ TEA	64.00 ± 9.05		112 ± 8.65		64.87 ± 6.89		80.73 ± 5.57		10.43 ± 1.55	
Closure	GA	67.36 ± 7.94	0.030	116±10.61	0.76	68.13 ± 8.84	0.01	84.40 ± 7.21	0.03	9.80 ± 1.61	0.14
	GA+ TEA	62.96 ± 6.89		116±12.85		62.63 ± 6.50		80.43 ± 6.68		9.17 ± 1.70	
In ICU till extubation	GA	67.30 ± 11.5	0.41	111 ± 8.39	0.14	68.23 ± 7.09	0.03	82.83 ± 6.80	0.02	10.60 ± 2.33	0.00
	GA+ TEA	65.23 ± 7.46		108 ± 7.42		64.87 ± 4.11		79.57 ± 3.57		10.93 ± 1.76	
Extubation	GA	82.93 ± 15.4	0.04	123±13.74	0.00	70.55 ± 2.25	0.42	88.31 ± 12.3	0.71	10.72 ± 2.00	0.26
	GA+ TEA	75.00 ± 13.8		115 ± 6.81		73.17± 12.52		87.21 ± 10.1		10.07 ± 2.37	

Table 3. Hemodynamic parameters after extubation

		HR (beats/m)	SBP (mm Hg)	DBP (mm Hg)	MAP (mm Hg)	CVP(cm of H2O)
Time	Group	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
0 min	GA	84.07 ± 6.70	119.13 ± 15.8	75.20 ± 0.54	89.90 ± 11.6	11.33 ± 1.18
	GA+TEA	75.67 ± 5.62	112.27 ± 5.56	63.33 ± 5.37	79.63 ± 3.75	10.30 ± 1.73
4 hours	GA	82.97 ±7.71	120.60 ± 14.8	79.27 ± 3.89	92.97 ± 13.6	10.07 ± 1.28
	GA+TEA	72.60 ± 6.69	112.47 ± 5.66	66.50 ± 5.18	81.83 ± 4.29	8.93 ± 1.48
8 hours	GA	82.87 ± 8.58	109.97 ± 14.0	68.80 ± 9.88	82.50 ± 10.2	11.33 ± 1.65
	GA+TEA	77.07 ±7.77	108.27 ± 7.20	61.67 ± 4.00	77.20 ± 4.37	10.03 ± 2.27
12 hours	GA	79.10 ± 7.93	118.17 ± 7.17	74.37 ± 9.89	88.97 ± 7.53	11.53 ± 1.57
	GA+TEA	73.67 ± 7.24	104.73 ± 7.97	67.37 ± 8.97	79.87 ± 6.05	9.43 ± 1.41
16 hours	GA	81.33±10.80	111.17 ± 6.06	70.27 ± 6.44	83.90 ± 3.74	11.13 ± 1.55
	GA+TEA	74.97 ± 7.31	109.53 ± 4.06	63.63 ± 5.40	79.07 ± 3.49	10.03 ± 2.14
20 hours	GA	76.97 ± 6.33	108.80 ± 5.90	68.80 ± 6.67	82.13 ± 4.83	11.13 ± 1.14
	GA+TEA	72.73 ± 8.13	110.70 ± 5.16	63.43 ± 4.03	79.20 ± 2.80	10.07 ± 1.78
24 hours	GA	80.77 ± 9.60	116.57 ± 6.83	72.47 ± 7.28	87.17 ± 5.63	10.83 ± 1.23
	GA+TEA	69.50 ± 6.88	107.23 ± 5.89	63.77 ± 2.76	78.17 ± 2.44	10.33 ± 1.58

Table 4. Comparison of VAS score

	TEA+GA group	GA Group	p value
At Rest (post extubation)	4.29 ±0.53	4.87±0.87	<0.001
4hrs	4.03±0.7	4.71±0.5	<0.001
8hrs	3.10±0.9	4.10±0.9	<0.001
12hrs	3.15±0.7	4.47±0.7	<0.001
16 hrs	2.85±0.5	4.30±0.2	<0.001
20hrs	2.21±0.6	3.32±0.5	<0.001
24hrs	1.81±0.5	3.25±0.7	<0.001

Table 5. Intraoperative drug requirement

Requirement	Group GA	Group GA+TEA	P value
Fentanyl(mcg)	1410.83 ± 251	1188.43 ± 162.65	0.0001
Pancuronium(mg)	14.63 ± 2.48	12.76 ± 1.95	0.002

The reduction in heart rate can be due to action through a decrease of β-receptor stimulation, but an increased vagal activity by TEA cannot be excluded. Similar results were found in studies by **Bakhtiary *et al.* (2007) and Kirov *et al.* (2011)**. During the intraoperative period, changes in the mean SBP, DBP and MAP (Table 2) with GA+TEA were not significantly different than with GA alone. This can be due to minor cardiac effects seen in beta blocked patients thereby reduced degree of vasodilation owing to a low sympathetic tone. One possible explanation is also that patients in the GA+TEA group remained capable of constriction of capacitance vessels in the remaining unblocked lower body segments (**Baron *et al.*, 1988**), thereby increasing the mean arterial pressure intraoperatively. As 0.2% Ropivacaine alone does not show beneficial effect in hemodynamics intraoperatively as compared to GA, this implies that it is less effective in controlling the stress response of surgical procedure in our study. In the pre-extubation period, from hemostasis onwards (Table 2), SBP showed minimal fluctuations in GA+TEA group as compared to GA group. Possible explanation is adequate pain relief provided by TEA which prevented the rise in SBP in GA+TEA group.

In the postoperative period following extubation, GA+TEA showed significant decrease in SBP, DBP and MAP (Table 3) due to adequate pain relief and partly due to arterial and venous vasodilation. Our results are in accordance with other studies that demonstrate decreased heart rate and cardiac index but the effect on systemic vascular resistance, central venous pressure and MAP remains controversial (**Greitz *et al.*, 1983; Otton and Wilson, 1966**). The use of plain 0.2% Ropivacaine in this study as an epidural infusion in the postoperative period showed that the median VAS score for pain was always recorded below 4, a small figure compared with that expected after other types of major surgery. (Table 4) This suggests that pain was well controlled for most patients. This monotherapy with 0.2% Ropivacaine seemed to be comparable to other studies (**Achurin *et al.*, 2005; Kirov *et al.*, 2011**) where VAS was maintained well below 2 at rest and 3 during cough with the use of combined ropivacaine and opioid.

In the present study, the analgesic effect of epidural administration of 0.2% Ropivacaine reduced the requirements of intravenously administered Fentanyl (P = 0.001) and Pancuronium (P = 0.002) for general anaesthesia. (Table 5) Similar results were found by **Kirov *et al.* (2011)** with 50% reduction in fentanyl requirement with TEA. Among patients receiving epidural Inj. Ropivacaine @ 5-7 ml/hr the median spread of sensory blockade at all times was from atleast T1 (upper limit of cephalad spread) to T8 (lower limit of caudal spread). The level of motor block was checked at frequent intervals with assessment of hand grip, wrist and elbow flexion; according to the ESSAM score. (**Abd Elrazek *et al.*, 1999**) Six patients complained of paraesthesia in dermatomes T1 and C8 in whom paraesthesia subsided on reducing the infusion rate. There were no major neurovascular complications related to TEA in our study. In studies by **Liem *et al.* (1992) and Kirno *et al.* (1994)** the epidural catheter was

placed more than 12 hours before surgery in an attempt to decrease the risk of epidural hematoma in patients posted for CABG. There are clinical disadvantages with the technique described in these studies e.g., manpower issues (anaesthesiologists, nurse anaesthetists) for catheter insertion the day before surgery, increased preoperative monitoring and consequently increased costs. **Olivier *et al.* (2005)** inserted the thoracic epidural catheters in 30 patients immediately before induction with no neurological complications noted. Similar results were found by **Kundu *et al.* (2008) and Caputo *et al.* (2011)**.

In OPCAB surgery, the need for heparinization is reduced to half the dose as that used for on pump CABG, making the use of epidural anaesthesia a more attractive approach. When epidural analgesia is conducted under strict protocols with appropriate neurologic monitoring and the presence of normal clinical history and coagulation studies, the potential for permanent neurologic damage from an epidural hematoma is judged to be acceptably low. The important factors minimizing this risk are presence of normal coagulation system prior to insertion and removal of the catheter, avoidance of repeated attempts, postponing surgery in the presence of bloody tap and close neurological surveillance. There was no evidence of any adverse reactions or side effects in the form of anaphylaxis, skin rashes, bronchospasm or severe haemodynamic changes during the study. The main limitation of the study was that it was not blinded. Although it is recognized that lack of masking can affect the assessment of clinical parameters, all patients were managed according to strict protocols and data were collected in a consistent manner throughout.

Conclusion

Thoracic epidural anaesthesia using 0.2% Ropivacaine is safe during coronary revascularization on beating heart; improves hemodynamic control, reduces the intraoperative anaesthetic drug requirement and provides effective postoperative analgesia.

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