Original Article

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Coronary Artery Bypass Surgery in "Awake" Patient: A Prospective Study

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Abstract

Background: Advances in cardiac surgery and anesthesia are meant to give better outcomes and faster recovery for the patients. As the rate of success of coronary bypass surgery has been standardized over the years, we are presently attempting to improve early recovery which directly helps in early rehabilitation.

Aim: To see the feasibility of awake cardiac surgery under epidural anesthesia. Single tertiary care medical center. Prospective, randomized, non-blinded clinical study. 10 patients scheduled for awake off-pump coronary artery bypass surgery.

Subjects and Methods: In selected 10 patients epidural catheter was inserted between C7-T3 inter-vertebral spaces 1 day prior to surgery. On the day of surgery, epidural anesthesia was given with bolus dose of 0.05 ml/cm of height of patient of 0.5% bupivacaine and 100 µg of fentanyl. After assessing the level of block, continuous infusion of 0.5% bupivacaine at 3 ml/h was started, and infusion rate was adjusted according to the requirement. Post-operative analgesia was maintained with continuous infusion of 0.125% bupivacaine 4-14 ml/h according to pain score. The epidural catheter was left *in-situ* for 48 h and removed.

Result: Thoracic epidural anesthesia (TEA) without intubation was used in 10 patients undergoing off-pump coronary artery bypass graft surgery, performed successfully through a median sternotomy. The mean surgical time was 113.5 min; average intravenous fluid infusion was 595 ml, one patient required nor-adrenaline infusion during surgery. The requirement of epidural infusion intra-operative and post-operative period was 20 ml and 276 ml, respectively. All patients had an uneventful post-operative course.

Conclusion: The study shows that awake cardiac surgery using only TEA without general anesthesia is feasible and safe.

Key words: Analgesic techniques, Awake surgery, Cardiac, Regional, Thoracic epidural anesthesia

INTRODUCTION

Surgical myocardial revascularization has undergone many changes from the way it was performed in the initial days. Though the initial focus was primarily on mortality and efficacy of the revascularization, the current focus is on the morbidity of the surgical procedure and the pattern of recovery of the patients in the post-operative period.

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Nevertheless, no new procedure and/or technique can ignore the primary aims of the surgery; and keeping this in mind, techniques can be developed, and advances be made to improve the overall result of the surgery. One such advance made is the use of latest anesthesiological techniques, thus facilitating faster recovery of patients by surgery performed under regional anesthesia in a totally conscious patient (conscious coronary artery bypass, CONCAB). Coronary arteries bypass grafting (CABG) in an "awake" patient without endotracheal general anesthesia with high thoracic epidural block was first performed in October 1998.[1] Regional anesthesia with the use of high thoracic epidural anesthesia (TEA) and post-operative analgesia in patients undergoing cardiac surgery leads to stress-response attenuation, improved perioperative analgesia, cardiac sympatholysis, and

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improved post-operative pulmonary function.[2-4] Therefore, it appears advantageous to combine the benefits of beating heart surgery with TEA, which enables CABG in the "awake" patient. Similar cases have been reported in the literature in an attempt to ameliorate the morbidity of the CABG procedure.[5-7] This study represents experience in first 10 patients who underwent this procedure.

SUBJECTS AND METHODS

After getting the approval from the ethics committee and informed consent from the patients, who were undergoing off-pump CABG, 10 cases had been selected for "awake CABG surgery." Inclusion criteria and exclusion criteria were defined in Tables 1 and 2, respectively.

During the pre-anesthetic visit, patients were explained about the procedure and its complication along with the routine clinical activity. The epidural catheter was inserted 1 day before surgery in all the patients. The procedure was done in the intensive care unit (ICU). Routine monitoring during epidural catheterization was done with electrocardiogram (ECG), non-invasive blood pressure, and pulse oximetry. Emergency drug tray (atropine, lidocaine, and ephedrine) was prepared and kept. A wide bore peripheral intravenous line was established with either 16 G or 14 G IV cannula. In sitting position, 20 G epidural catheter was inserted through an 18 G Touhy needle in a prominent inter-vertebral space between C7 and T3. Epidural space was identified by loss of resistance method. Only 3 cm of the catheter was kept inside the epidural space, and a sterile dressing was placed, taking care that the catheter was not kinked. The patients were pre-medicated with oral tablets of diazepam (5 mg) and ranitidine (150 mg) the night before surgery; and lorazepam (2 mg) and ranitidine (150 mg) 30 min before shifting to operation theater (OT).

In the OT, patients were connected to the monitor; femoral artery cannulation and Swan-Ganz catheter insertion were done under local anesthesia. Correct placement of the epidural catheter was tested with bolus dose of 2 ml of 0.2% lidocaine with 1:2,00,000 adrenaline. Criteria followed for correct placement were: (1) No rise in heart rate more than 10 beats/min, (2) No rise in systolic blood pressure more than 15 mmHg, and (3) No sign and symptom of the subarachnoid block. We have used 2 ml of test dose which contains 40 mg of lidocaine and 10 μg of adrenaline which is sufficient to recognize the inadvertently placement of the catheter in intravascular or subarachnoid space.[8] After successful test dose, epidural anesthesia was given with bolus dose of total 10 ml of 0.5% bupivacaine (which is 0.05 ml/cm of height of patient[9]) and 100 μg of fentanyl. This combination was given over 15 min through a syringe pump. The level of the block was checked for T1-T6 dermatome by the loss of pinprick and temperature sensation. The surgical skin incision was mid-manubrial which was well below the sternal notch thus avoiding the overlap of cervical dermatomes on the upper thoracic dermatomes. If the patient perceives any pain during skin incision, the surgeon may infiltrate local anesthesia. After assessing the level of block continuous infusion of 0.5% bupivacaine at 3 ml/h was started, and the dose was adjusted according to the requirement. Oxygen was administered through Hudson's mask. The patients' ECG, respiratory rate, pulse oximetry, rectal temperature, arterial pressure, and pulmonary artery pressure were monitored. Arterial blood gases were sampled every 2 h and were found to be satisfactory (Tables 3 and 4). The patients' limbs were strapped to prevent accidental movement during surgery.

Table 1: Inclusion criteria of patients

1	Willing to sign written informed consent document
2	Patients scheduled for elective off-pump coronary artery bypass grafting surgery
3	Stable angina
4	Left ventricular ejection fraction >50%
5	Prothrombin time (INR) <1.5
6	Partial thromboplastin time <45 s
7	Platelet counts >100,000/ml
8	Antiplatelet therapy stopped for 1 week

INR: International normalized ratio

Table 2: Exclusion criteria of patients

1	Emergency operation
2	Known coagulation disorders or recent thrombolytic therapy
3	Unstable angina
4	Heart block
5	Acute myocardial infarction within the previous 7 days
6	Clinically significant associated valvular disease
7	Significant left main disease (LM >50%)
8	Patient on IABP or on ventilator
9	Known neuraxial pathology
10	Infection at the site of epidural catheter insertion
11	Patients participating in other clinical studies
12	Difficult airway

Table 3: Hemodynamic parameter

Parameter	Before TEA	30 min after TEA	2 h after TEA	4 h after TEA	12 h after TEA	24 h after TEA
Heart rate	85.71	63.42	63.14	75.28	77	74.14
ABP-systolic	154	129.85	120.85	129	138.57	135.57
ABP-diastolic	75.57	68	62.14	67.85	73.28	69.71
ABP-mean	105.14	91.14	83.71	92.28	98.14	90
PAP-systolic	26.28	32.57	27.42	31.71	31.85	28.42
PAP-diastolic	14.14	15.85	12.28	16.85	15.57	17
PAP-Mean	18.85	22.85	17.42	21.71	21.85	19

TEA: Thoracic epidural anesthesia, ABP: Arterial blood pressure, PAP: Pulmonary artery pressure

To prevent hypothermia, the room temperature was kept at 22°C, intravenous (IV) fluids (ringer lactate solution IP) were given through on line warmer, and a warming blanket was used to keep the patient warm. After sternotomy, the surgeon carefully harvested the left internal mammary artery (LIMA), using an extrapleural dissection technique without opening the left pleura and radial artery through a vertical incision in the forearm. The lungs and pleura moved less toward the surgeon during harvesting of LIMA as compared to controlled ventilation. Therefore, extrapleural dissection was easier than normal. Heparin injection was administered to keep the activated clotting time around 300 s. In the case of single vessel disease, the LIMA was anastomosed to left anterior descending. In triple and double vessel disease, the LIMA and radial artery were anastomosed together, as a Y-graft. Anastomoses were performed by the standard beating heart technique. Epicardial stability was achieved using octopus 3 tissue stabilizers (Medtronic Inc, Minneapolis, MN). After the anastomosis, protamine was administered to neutralize the heparin. As both the pleurae were intact, only 2 mediastinal chest tubes were placed. The sternum was approximated with 6 steel-wire-sutures and incisions were closed in layers. The patients were hemodynamically stable throughout the procedure (Table 5). Their mean arterial pressure was maintained >70 mmHg with IV fluids (ringer lactate IP), lowering the head end of operation table and infusion of a vasopressor such as ephedrine and nor-adrenaline. During the whole procedure, patients were verbally communicating and listening to the music of their choice.

At the end of the surgery, patients were shifted to the ICU, and post-operative analgesia was maintained with continuous infusion of 0.125% bupivacaine 4 ml/h. Opioids were knowingly avoided in epidural infusions as they cause sedation. The pain relief was assessed by VAS scale. The infusion rate was adjusted depending on the patient's condition. If the patient complains of inadequate pain relief (VAS>4), the rate will be modified providing it had been constant for at least 30 min. Each dose adjustment will consist of 4 mL top-up dose followed by a 2 mL/h increase in infusion rate up to a maximum of 14 mL/h. The rate of epidural infusion will be decreased if the patient complains of paresthesia in dermatome C8 or higher, weakness in upper limbs or the patient is pain-free (VAS<4). The epidural catheter was left *in-situ* for 48 h and removed before the patient was shifted out of ICU; subsequent analgesia was obtained by oral analgesics.

Post-operative monitoring was consist of ECG with automatic ST segment analysis, intra-arterial blood pressure, pulmonary artery pressure, SpO_2, arterial blood gas analysis every 6 h, creatine phosphokinase (CPK-MB), and troponin-T (Trop-T) 6 and 12 h after surgery.

RESULTS

The demographic profile (Table 6) shows all the patients were male, mean age was 54 years, weight 65 kg, 5 of them had single vessel disease, 3 had double vessels, and 2 had triple vessel disease. Their ejection fraction was more than 56%, 4 patients had regional wall motion abnormalities, and 2 had a history of myocardial infraction. 4 patients were actively smoking, 3 patients were alcoholic, 3 patients were diabetic, 2 had renal dysfunction with serum creatinine more than 1.5 mg/dl, 7 patients had treated high arterial pressure, and 2 had the chronic obstructive pulmonary disease.

Desired level of the block from T1 to T6 dermatomes were achieved in 7.1 (4-11) min after infusion of bolus

Table 4: Respiratory parameter

Parameters	Before TEA	30 min after TEA	2 h after TEA	4 h after TEA	12 h after TEA	24 h after TEA
Respiratory rate	17.28	13.71	15.57	18	22	21.71
SpO_2	95	100	100	97.91	97.58	97.57
PaO_2	77.65	167.78	122.08	143.94	126.35	132.07
$PaCO_2$	34.47	43.74	40.7	42.52	39.04	39.91
pH	7.42	7.28	7.28	7.31	7.35	7.39

TEA: Thoracic epidural anesthesia, SpO_2: Peripheral oxygen saturation, PaO_2: Partial pressure of oxygen in arterial blood, $PaCO_2$: Partial pressure of carbon dioxide in arterial blood

Table 5: Result

Complications	Mean	Range (SDEV)
Surgical time (minutes)	113.5	85-145 (20.031)
Time of onset of block (min)	7.1	4-11 (2.071)
Amount of ringer lactate (ml)	595	350-1200 (245.407)
Intraoperative 0.5% bupivacaine (ml)	20	15-28 (4.335)
Post-operative 0.125% bupivacaine (ml)	276	230-350 (30.724)
Ephedrine bolus used		Two case
Nor-adrenaline infusion used		One case

Table 6: Demographic characteristics

Patient variable	Mean	STDEV
Age (y)	54.2	7.763
Sex M:F	10:0	
Weight	65.2	6.413
EF%	56.94	9.745
No of graft	1.7	0.853
	Frequency (%)	
Smoker	40	
Alcoholic	30	
Hypertension	70	
Previous MI	20	
RWMA	40	
Diabetes	30	
COPD	20	
Renal disease	20	

EF: Ejection fraction, MI: Myocardial infraction, RWMA: Regional wall motion abnormality, COPD: Chronic obstructive pulmonary disease

dose. Midline sternotomy and harvesting of internal mammary arteries were successful in all patients; no visible pneumothoraces were seen. Mean operative time was 113.5 min (85-145), number of bypasses was 1.7 (1-3) grafts. 2 out of 10 patients needed ephedrine bolus of 15 mg, and 1 patient needed an infusion of nor-adrenaline (0.02 μg/kg/min) to maintain mean arterial pressure above 70 mmHg. Total amount of IV fluid (ringer lactate) required during the intraoperative period was 595 ml (350-1200). Intraoperatively, the amount of 0.5% bupivacaine and fentanyl including both bolus and infusion dose was 20 ml (15-28), and postoperatively in the ICU 0.125% bupivacaine was of 276 ml (230-350) (Table 5).

Perioperative ECG monitoring with automatic ST segment analysis displayed no signs of myocardial ischemia. The levels of cardiac enzymes CPK-MB and Trop-T were normal (6 and 12 h after surgery). The patients were satisfied with their experience of this anesthetic technique and surgery. There was no major complication found in post-operative period (Table 7). They were discharged on the 5th post-operative day.

DISCUSSION

TEA is used in the post-operative period for alleviating the pain after cardiac surgery. Routinely, the surgery is done with general anesthesia. However, TEA provides excellent conditions for off-pump coronary artery bypass, by causing both coronary artery and systemic artery dilatation. This dilates the LIMA as well as improves collateral blood flow to the heart.[10,11] The hemodynamic condition remains stable during the manipulations of the heart, especially since the hypotensive and myocardial depressive effects of general anesthesia are absent.[12,13] In the case of breathing difficulty, hypoxia, or hypercapnea, a continuous positive pressure ventilation (CPAP) can be administered through a CPAP mask that can be connected to the circle absorber through a Y-connector. The end tidal $C0_2$ probe can be connected to this Y-connector.[12] unlike routine cardiac surgery, the negative pleural pressure is maintained. Thus, it facilitates the extrapleural dissection of the LIMA. There is always a theoretical danger of accidental opening of the pleura leading to pneumothorax and further lung collapse. However, usually the pleural perforation is small; hence, an intercostals chest tube needs to be inserted immediately and connected to continuous low suction through underwater seal to avoid this theoretical danger. The anesthesiologist should also be ready for endotracheal intubation if required. The danger of pleural perforation occurs during LIMA dissection and rarely during sternotomy itself. Deep pericardial stay sutures may be used, but thinner suture material must be used, and only a superficial bite must be taken to prevent the pleura and lung from being damaged. Analgesia after the surgery is good and systemic painkillers are not needed.[14] the patients' pain-free condition improves respiratory movements. Many other complications, which may be secondary to chest wall splinting, were avoided using this method. The risk of epidural hematoma formation in cardiac surgery patients was found to be much less than that of the overall population receiving epidural analgesia.[15] As general anesthesia and mechanical ventilation are totally avoided and excellent pain relief is achieved, the recovery is faster, and hospitalization is shortened.[5] In the right subsets of patients, it is very beneficial. Patients need to be co-operative and consenting for this technique. As patient comfort and co-operation is maximal due to the earlier mentioned advantageous factors, a better effort to recovery and also better patient satisfaction has been found. Long-term studies are thus needed for this procedure to be used as a standard approach. The various advantages offered by this procedure may allow awake CABG (i.e., CONCAB) to compete with interventional catheter-based techniques.

Table 7: Post-operative complications

Complications	No. of cases	Percentage
Intubation	Nil	
ECG changes	2	20
Arrhythmia	1 had ventricular ectopic subsided with amiodarone	10
ST changes	1 (elevated in all leads may be due to pericardial reaction)	10
Trop-T (+ve)	Nil	
Stroke	Nil	
Death	Nil	

ECG: Electrocardiogram, Trop-T: Troponin-T

CONCLUSION

10 patients were subjected to awake coronary artery bypass surgery with the use of TEA. Anesthesia and surgical techniques were modified to make it successful. In today's scenario many people, who are coming for CABG surgery, are not interested to be awake during surgery. It needs more effort to educate the patients about the procedure. The study shows that awake cardiac surgery using only TEA is feasible.

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