



# Efficacy of Continuous Local Anaesthetic Infiltration at Sternal Incision Site in Patients Undergoing Open Heart Surgery

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## Abstract

**Background:** Most of the cardiac surgeries are performed through median sternotomy and associated with severe pain which if not relieved, leads to stress response with detrimental effects on major organ systems with increased postoperative morbidity and mortality.

**Materials and methods:** Eighty four patients (18 to 75 years), with modified Parsonnet score < 10 posted for cardiac surgery were included. Two multi holed, epidural catheters were placed by surgeon, one in sub-fascial plane just above sternum and another just below skin after sternal closure. Through each catheter, Group I patients received 0.25% levobupivacaine and Group II patients received 0.25% levobupivacaine and 2 mcg/ml of clonidine at 2 ml per hour in ICU via elastomeric pumps for patient controlled analgesia.

**Results:** The pain (VAS Score 24 hours) was significantly lower in Group II than Group I (2.7381 + 0.7005 vs 4.0238 + 0.8968). The total morphine requirement in 48 hours was significantly higher in Group I than Group II (11.2262 + 1.7455 vs 4.8714 + 2.4111mg). Duration of tracheal intubation and time for mobilisation were similar in both groups. Serum lactate and cortisol levels at 48 postoperative hours were significantly lower Group II than Group I (Lactate 1.39 + 0.613 vs 1.8 + 1.073; Cortisol 22.07 + 9.048 vs 30.73 + 15.666). Patient satisfaction scores in Group II were significantly higher than Group I (78.3095 + 8.4637 vs 72.5238 + 5.2277).

**Conclusion:** Clonidine as an adjuvant in levobupivacaine infusion at sternal wound site 23 significantly decreases postoperative pain in cardiac patients.

**Keywords:** Continuous infusion; levobupivacain; Clonidine; Median sternotomy

## Introduction

The International Association for the Study of Pain (IASP) defines pain as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. Most of the cardiac surgeries are performed through median sternotomy, it is associated with a significant amount of pain which patients describe as burning, aching or shooting unrelieved perioperative pain translates into uninhibited surgical stress response [1]. This may have detrimental effects on major organ systems which may lead to

substantial postoperative morbidity and adverse hemodynamic, metabolic, immunologic, and hemostatic alterations [2-4]. There may be intense pain after cardiac surgery. It originates from many sources, such as the incision site, from intraoperative tissue retraction and dissection, vascular cannulation sites, vein-harvesting sites and site of insertion of chest tubes [5]. Adequate pain relief is essential because it results in better patient comfort, decreased morbidity and reduced duration of stay in hospital and hence reduced costs. Patient satisfaction has a direct link to adequate pain relief. It is an essential element that influences clinical activity of Anaesthesiologists. Fast tracking in cardiac

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surgery has led to adoption of multimodal analgesia, in order to maximize analgesia and limit the side-effects of any one particular method of pain relief. Various methods have been used for pain relief after cardiac surgery. They include intravenous opioids, NSAIDs, intrathecal and epidural techniques, nerve blocks and local anaesthetic infiltration [6]. Opioids are the commonest agents used for alleviating postoperative pain after cardiac surgery. They are usually delivered using either patient controlled analgesia or nurse controlled analgesia. However, opioids are notorious for causing sedation and respiratory depression, causing delayed tracheal extubation. They have other adverse effects such as nausea, vomiting, constipation and urinary retention. Limiting their use results in better adherence to fast-track discharge protocols [7]. Non-steroidal analgesics have been shown to be effective in reducing pain after median sternotomy [8]. However, they are sparingly used in patients after cardiac surgery. These groups of patients commonly have associated co-morbidities such as diabetes, hypertension and underlying nephropathy. Non-steroidal analgesics are known to cause renal dysfunction and bleeding tendencies. Cyclooxygenase-2 (COX-2) inhibitors possess analgesic (opioid-sparing) effects and lack deleterious effects on coagulation (in contrast with nonselective nonsteroidal anti-inflammatory drugs), because they spare the constitutive COX 1 system that confers protective effect. However, current evidence does not suggest that COX-2 inhibitors provide major advantages over traditional NSAIDs. Furthermore, potential links between this class of drugs and cardiovascular complications, sternal wound infections, and thromboembolic complications need to be fully evaluated [9]. Paracetamol infusion as an adjunct to opioids has shown equivocal results in treating postoperative pain after cardiac surgery [10]. Central neuraxial block using opioids and local anaesthetic infusions have proved to be efficacious in reducing postoperative pain after cardiac surgery [11]. Placement of needle and catheters in the presence of systemic anticoagulation requires strict vigilance. Other adverse effects associated with neuraxial blockade are hypotension, bradycardia, local site infection, catheter breakage etc. Continuous wound catheters have consistently demonstrated analgesic efficacy as evident by reduced opioid requirement and decreased pain scores after all types of surgery [12]. Studies of local anaesthetic infusion at the wound site after median sternotomy have produced variable results Paul F white and his colleagues demonstrated significantly reduced pain scores and earlier return of bowel sounds and removal of urinary catheter in patients receiving local infusion of 0.25% and 0.5% bupivacaine for 48 hours postoperatively after cardiac surgery [13]. The present study is designed to find the efficacy of local anaesthetic infusion at the wound site in reducing postoperative pain measured by the amount of rescue opioid required, its effect on duration of

tracheal intubation, patient mobilization, discharge from ICU, patient satisfaction, bio-chemical markers of stress response and development of chronic pain.

## Materials and Methods

This double-blinded, randomized, prospective study was carried out in the Department of Cardiothoracic and Vascular Surgery of a tertiary care hospital. After obtaining institutional ethics committee approval and written informed consent from the patients, 84 patients of age group 18 to 75 years posted for cardiac surgery via median sternotomy were included in the study. Patients with Modified Parsonnet Score > 10, known allergy to local anaesthetics, significant liver disease, severe renal dysfunction, any neurological dysfunction or insulin dependent diabetes mellitus or unable to comprehend Visual Analogue Scale were excluded from the study. Patients with active bacterial infection or those in whom the duration of postoperative positive pressure ventilation was more than 24 hours were also excluded from the study. All the patients underwent a thorough preoperative examination before surgery and all of them were explained meticulously regarding the procedure and were familiarised with the Visual Analogue Scale. After patient was shifted to operation theatre, five lead ECG, non-invasive blood pressure and saturation probe were attached. An arterial line was inserted in the left radial artery under local anesthesia and invasive arterial blood pressure monitoring commenced from then on. Induction of anaesthesia was done using intravenous injections of fentanyl (5- 10 mcg/kg), midazolam (0.05-0.1 mg/kg) and sleep dose of thiopentone sodium (0.5-1 mg/kg). Endotracheal intubation was facilitated using IV inj rocuronium (1 mg/kg). After securing the airway, the patient was adequately positioned and a central venous catheter was inserted in right internal jugular vein under strict aseptic precaution. Continuous monitoring included 5 lead ECG, pulse oximetry, capnography, invasive arterial blood pressure, central venous pressure, urine output, temperature. At the end of surgery, two epidural catheters were inserted at either end of sternotomy wound just after sternal closure with all aseptic precautions, by the surgeon. One catheter was placed in the sub-fascial plane just above the sternal wound after apposition of sternal wires. A second epidural catheter was placed just below the skin incision. The wound was closed and the patients were shifted to ICU. The patients were randomized into two groups by a computer generated randomization chart. Group I received 0.25% levobupivacaine at a rate of 2ml/ hour through each of the catheters. Group II received 0.25% levobupivacaine and 2 mcg/kg of clonidine at 2 ml per hour through each of the catheters. All the study drugs and syringes were prepared by a second anaesthesiologist blinded to study design. After shifting the patients to ICU, infusions were started after negative aspiration of blood and were delivered through the

conventional bacterial filter present in the epidural kit. The infusions were delivered through an elastomeric pump set at 2ml/hour. There was no provision for bolus dose because such doses would not be effective and would increase the chance of local anaesthetic toxicity. The mechanism of this modality of analgesia is presumed to be by the action of cumulative dose of local anaesthetic on the nerves carrying afferent pain impulses from incision site. All the infusions were continued till 48 hours after shifting to the Intensive Care Unit. In the ICU, hemodynamic parameters including heart rate, invasive blood pressure, oxygen saturation, central venous pressure were monitored continuously for a period of 48 hours. Pain scores using Visual Analogue scale were noted at 6, 12, 24, 36 and 48 hours after surgery [14]. The patients who were on ventilator support at the time of recording of VAS, were asked to nod their head at the number on a scale of 1 to 10, which indicated the severity of their pain. Sedation score using Ramsay Sedation Scale were noted at 6, 12, 24, 36 and 48 hours after tracheal extubating [15]. Levels of blood glucose, lactate and cortisol were measured just after shifting the patient to ICU, at 24 hours and at 48 hours of stay in ICU. The time required for first rescue analgesic was noted. The patients were administered morphine at a dose of 0.05mg/kg intravenously, when the VAS score was more than or equal to 4. It was delivered

using a PCA pump. No background infusion was used to preclude accumulation of active metabolite Morphine 6 glucuronide. The lock out interval between the boluses was 30 minutes and a maximum of four doses were allowed over a period of 24 hours. Overall patient satisfaction as described on a 100-point scale with a score of 1 meaning very dissatisfied and 100 meaning fully satisfied. Incidence of chronic pain 3 months after surgery were noted. During discharge, the patients were asked to attend the Anaesthesia clinic at the end of three months. They were interrogated about any burning or shooting pain at the site of sternal wound.

## Result and Analysis

Out of 84 patient's one patient in group I and two patients in group II had sternal wound dehiscence. There was accidental catheter removal in one patient in group I. One patient was lost to follow up at the end of three months. There was no significant difference in between the two groups in terms of their age ( $p=0.44$ ), sex, modified Parsonnet score ( $p=0.18$ ), type of surgery, baseline parameters, aortic cross clamp times ( $p=0.25$ ) and cardiopulmonary bypass duration ( $p=0.52$ ). There were no significant arrhythmias or hypotension during 48 hours of infusion [16] (Figures 1 and 2) (Table 1).

*Table 1: Demographic Profile.*

Pre OP		Group 1 n =	Group 2 n = 2	Group1Mean± SD	Group2Mean± SD
Age		42	42	38.64 ± 15.62	41.12 ± 13.71
Sex	Male	25	23		
	Female	17	19		
Weight		42	41	50.36 ± 11.15	49.1 ± 8.29
Modified Personnet Score		42	42	8.33 ± 1.2	8.62 ± 0.62
Surgery	OPCAB	9	6		
	MVR	6	7		
	AVR	7	5		
	LA Myxoma	2	1		
	RA Myxoma	0	1		
	DVR	3	6		
	ASD	6	6		
	VSD	3	4		

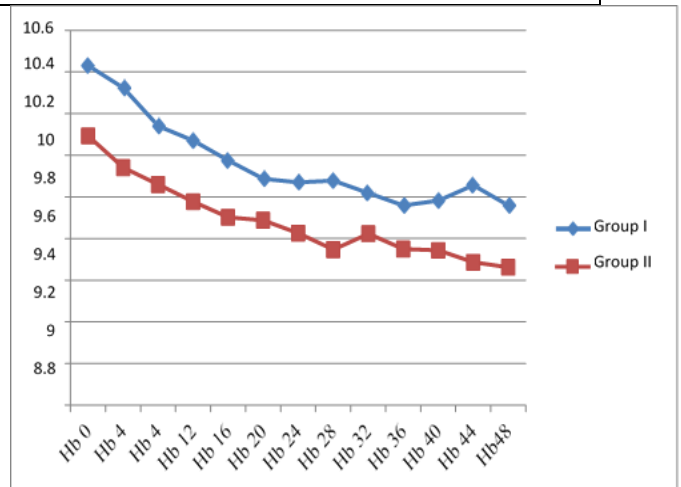
	On Pump CABG	0	1		
	Ebsteins Anomaly	0	1		
	DCRV	1	1		
	Pericardiectomy	0	1		
ACxcl Time §	42	41	37.7 ± 31.94	46.6 ± 37.51	
CPB Time ¶	42	42	50.38 ± 39.35	56.24 ± 42.95	
Baseline HR <sup>x</sup>	42	42	88.71 ± 21.5	99 ± 14.92	
Baseline MAP <sup>s</sup>	42	42	93.29 + 15.8	107.74 + 16.89	
Baseline SpO2	42	42	98.19 + 1.27	97.26 + 1.38	
Baseline RR <sup>~</sup>	42	42	16.76 ± 2.65	20.29 ± 2.89	
§ Aortic Cross Clamp Time; ¶ Cardiopulmonary Bypass ; <sup>x</sup> Heart Rate ; <sup>s</sup> Mean Arterial Pressure ; <sup>~</sup> Respiratory Rate					

**Table 2:** Total postoperative morphine requirement (in mg).

	Group	Mean	Std Dev	Minimum	Maximum	Median	p-value
<b>DOSE MORPHINE</b>	<b>Group I</b>	11.2262	1.7455	8.0000	15.0000	11.0000	<0.0001
	<b>Group II</b>	4.8714	2.4111	0.0000	10.0000	5.0000	
Total dose of Morphine required in 48 hours ( in mg)							

Pain scores were significantly less in group II as compared to group I during the postoperative 6 hours ( $3.5 \pm 0.9$  vs  $5.3 \pm 1.6$ ,  $p < 0.0001$ ), 12 hours ( $3.4 \pm 0.63$  vs  $4.8 \pm 0.9$ ,  $p < 0.0001$ ) and 24 hours ( $2.7 \pm 0.7$  vs  $4 \pm 0.8$ ,  $p < 0.0001$ ). Thenceforth the intensity of pain as measured by VAS decreased and was found to be similar between the two groups (Figure 3) (Table 2).

The total dose of morphine required 48 hours postoperatively was significantly less in group II as compared to group I ( $4.87 \pm 2.4$  vs  $11.23 \pm 1.74$  mg,  $p < 0.0001$ ). There was no statistical difference in the duration of tracheal intubation between the two groups ( $9.76 \pm 3.55$  vs  $11.26 \pm 4.76$  hours,  $p = 0.089$ ). The time for first mobilization with assistance was also comparable in the two groups ( $23.55 \pm 7.48$  vs  $22.17 \pm 6.17$  hours,  $p = 0.37$ ).



**Figure 1:** Heart rate variation in the postoperative period.

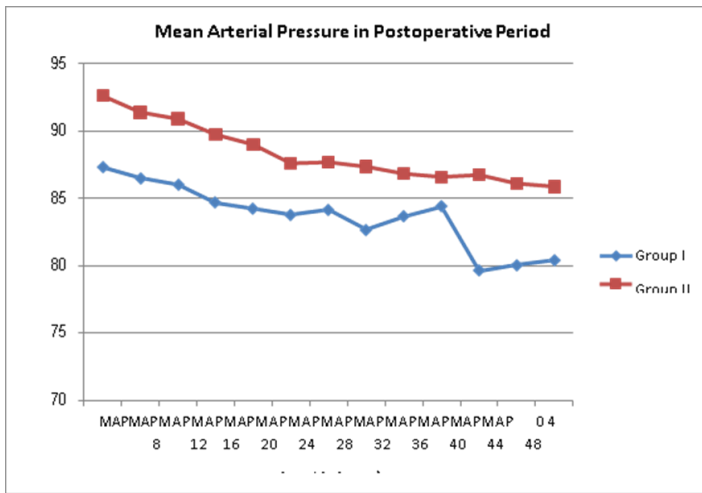


Figure 2: Mean arterial pressure variation in postoperative period.

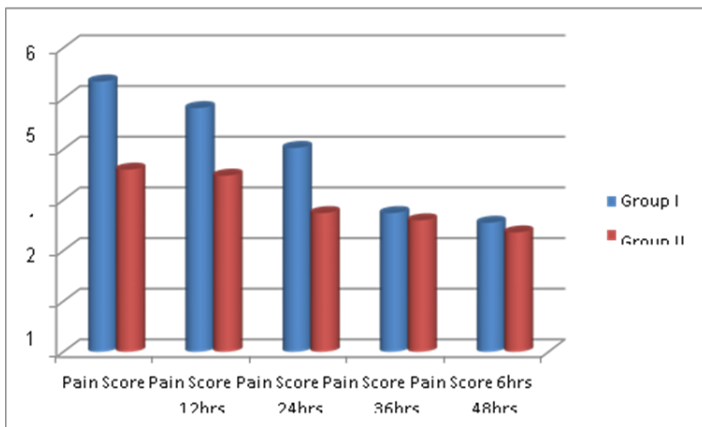


Figure 3: Pain Scores in the postoperative period.

The bio chemical markers for stress response at the end of 48 hours were significantly lower in group II than in group I. Serum lactate was  $1.79 \pm 0.7$  mmol/L in group I vs  $1.38 \pm 0.61$  in group II ( $p=0.034$ ). Serum cortisol in group I was  $30.7310 \pm 15.6662\mu\text{g/dl}$  vs  $22.07 \pm 9.04$  ( $p=0.003$ ) (Figure 4).

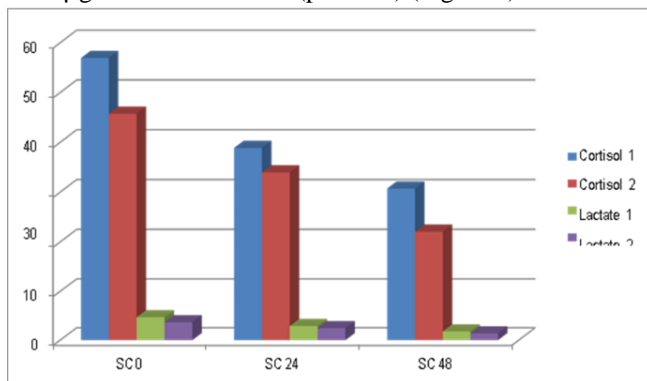


Figure 4: Serum biochemical markers (Cortisol and Lactate) in postoperative period.

The patient satisfaction score was found to be significantly higher in group II than in group I ( $78.3 \pm 8.46$  vs  $72.52 \pm 5.220$ ,  $p=0.0003$ ). One patient in group I was lost to follow up. Two ( $n=41$ ) patients developed chronic pain in group I (7.14%) whereas 3/42 (7.32%) patients developed chronic pain in group II. None of the patients had 2 catheter breakage, wound dehiscence or sternal wound infection requiring re-exploration.

### Discussion

Pain after cardiac surgery remains a challenge for cardiac anaesthesiologists. Postoperative pain is an important concern after cardiac surgery because it is associated with adverse hemodynamic changes which may be detrimental in these patients. Undertreated severe pain may have physiological consequences increasing the stress response to surgery, seen as a cascade of endocrine-metabolic and inflammatory events that ultimately may contribute to organ dysfunction, morbidity, increased hospital stays and mortality. The pain often causes the patient to remain immobile, thus becoming vulnerable to deep venous thrombosis, pulmonary atelectasis, and muscle wasting and urinary retention. Besides, restlessness caused by severe pain may contribute to postoperative hypoxemia. The peripheral neural activation, together with central neuroplastic changes, associated with postoperative pain may in some patients continue into a chronic pain state [17-19]. Also, unrelieved pain after cardiac surgery is associated with major organ dysfunction. Patients undergoing surgery are usually petrified of postoperative pain and it is listed as one of the main concerns of the patients before surgery [20]. Pain is neglected in the postoperative period especially because of inadequate reporting and recording. There are reservations about administering pain medication especially opioids because of fear of development of physical dependence, tolerance and side-effects. Pain after cardiac surgery may be multifactorial in origin. The commonest cause's incisions, intraoperative tissue retraction and dissection, multiple intravascular cannulations and chest tube insertion sites. The most excruciating pain is felt on the first two postoperative days. The intensity of pain decreases as the distance from the operation increases [21]. The nature of pain also changes from sharp localized pain to dull osteo-articular pain. Efficacy of a continuous wound catheters delivering local anaesthetics has been documented in different group of surgical patients [22]. Similar studies conducted in cardiac surgery, have shown variable results. The results of our study are in accordance to those of Paul F White and his colleagues who used continuous infusion of 0.25% and 0.5% of bupivacaine and found decreased pain scores and better patient satisfaction scores in the postoperative period. They did not find any significant decrease in the duration of tracheal intubation and ICU stay [13]. Their study on 37 patients undergoing cardiac surgery. They used a continuous infusion of

ropivacaine for a period of 4 days and reported a persistently low pain scores (0-3), faster recovery time and lesser duration of hospital stay [23]. In a similar study conducted a series of intercostal blocks along with continuous infusion of presternal 0.25% bupivacaine was used. They showed lower morphine consumption over 48 hours ( $8.6 \pm 0.94$  vs  $18.83 \pm 3.4$  mg,  $p < 0.02$ ), earlier time for extubation and better respiratory parameters [24]. Levobupivacaine is L enantiomer of upivacaine with better safety profile. The effect of parasternal block and local anesthetic infiltration with levobupivacaine after cardiac surgery with desflurane was evaluated. Patients in the levobupivacaine group used significantly less morphine in the first 4 h after surgery ( $20.8 \pm 6.2$  mg versus  $33.2 \pm 10.9$  mg in the placebo group;  $P = 0.013$ ); they also had better oxygenation at the time of extubation. The incidence of chronic pain was found to be similar in the two groups. Petsikas and his colleagues found that unrelieved pain after cardiac surgery may lead to chronic post sternotomy pain in as high as 30% of cases [25,26]. In the present study it was found to be around 8% which is significantly less. However, since this was studied as a secondary outcome measure, larger population groups need to be considered to establish the actual reduction in incidence of chronic pain. Thus, in this study we found that the intensity of pain was significantly lower in patients receiving levobupivacaine plus clonidine ( $p < 0.0001$ ) which led to a significantly lower requirement of morphine ( $p < 0.0001$ ) required in postoperative period. These patients also had lower levels of biochemical markers of stress as evident by significantly lower lactate ( $p = 0.034$ ) and cortisol levels ( $p < 0.0003$ ). Also, they were more satisfied with their postoperative care ( $p < 0.0003$ ). However, the duration of tracheal intubation and time required for first mobilization with assistance were similar in both groups. One limitation of the study was not being able to measure blood levobupivacaine levels as high performance liquid chromatography for estimation was not available.

## Conclusion

Subcutaneous and subfascial infiltration of 0.25% levobupivacaine and  $2 \mu\text{g}/\text{ml}$  of clonidine produced lesser pain scores, decreased postoperative opioid requirements, decreased surgical stress response and led to better patient satisfaction in cardiac surgical patients. Clonidine was found to have analgesic sparing effects when combined with levobupivacaine. It is a simple method which can be easily used and is not associated with any adverse effect.

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