

# Comparison of Upper Thoracic Epidural Analgesia versus Low Thoracic Epidural Analgesia in Off-Pump Coronary Artery Bypass Graft for Perioperative Pain Management and Fast Tracking

## Abstract

**Background:** Upper thoracic epidural analgesia (TEA) is compared with lower thoracic epidural analgesia for the perioperative pain management and fast tracking in patients undergoing off pump coronary artery bypass grafting (OPCAB) surgery for the intraoperative hemodynamic, quality of analgesia, incentive spirometry, time to awakening & extubation and intensive care unit (ICU) duration. **Materials and Methods:** A prospective, randomized comparative clinical study was conducted with total of 60 patients randomized to either Group U: Upper TEA ( $n = 30$ ) or Group L: Lower TEA ( $n = 30$ ). Visual analog scale (VAS) was recorded in both the groups during rest and deep breathing at the various time intervals postextubation. Both the groups were also compared for intraoperative hemodynamics, incentive spirometry, time to awakening, and extubation and ICU duration. Statistical analysis was performed using the independent Student's *t*-test. A value of  $P < 0.05$  was considered statistically significant. **Results:** Postextubation VAS score at rest and deep breathing at 0, 3, 6, 12, 24, 36, and 48 h were statistically significant in both groups ( $P \leq 0.05$ ). Incentive spirometry, time to awakening and extubation and duration of ICU stay were also statistically significant ( $P \leq 0.05$ ) between the groups. **Conclusion:** Lower thoracic epidural was better than upper thoracic epidural in perioperative pain management and fast tracking in OPCAB surgery.

**Keywords:** Lower thoracic epidural, OPCAB surgery, upper thoracic epidural

## Introduction

Thoracic epidural anaesthesia followed by postoperative epidural analgesia is increasingly being used for abdominal, major vascular, and cardiothoracic surgery. The objective of thoracic block is not solely to block noxious afferent stimuli from the surgical site but also to impart a bilateral selective thoracic sympathectomy. Poststernotomy pain is a complication of cardiac surgery.<sup>[1]</sup> Poorly controlled pain is associated with sympathetic nervous system activation and increased hormonal response to stress which may contribute to the multiple postoperative adverse events, including myocardial ischemia, cardiac arrhythmias, hypercoagulability, pulmonary complications, and increased rates of delirium and wound infection.<sup>[2-5]</sup> Pain may be associated with many surgical interventions, including incision, saphenous vein removal, pericardiotomy or chest tube insertion, intraoperative dissection

and retraction of tissue, among others.<sup>[6]</sup> These investigators found that maximal pain intensity was highest on the first postoperative day and lowest on the third postoperative day.

In patients who undergo coronary artery bypass grafting (CABG), iatrogenic injuries to the pleura and the harvesting of the left internal thoracic artery (ITA) necessitate the placement of chest tubes through a subxiphoid or intercostal approach to prevent hemothorax or pneumothorax after surgery. Irritation of the pleura and intercostal nerves by friction from the chest tubes can cause postoperative pain and pulmonary morbidities.<sup>[1-3,7]</sup> Specifically, pain associated with chest tubes can diminish pulmonary functions because of hypoventilation and atelectasis, particularly in high-risk CABG patients who have pulmonary disease.<sup>[8,9]</sup>

It is seen that sternotomy pain is moderate and that cause due to intercoastal and pericardial drains are more severe. Thus, our study has

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focused on lower thoracic epidural which can effectively provide analgesia to intercostal and pericardial drain pain.

The aim of this study was to assess the impact of dorsal lower thoracic epidural fentanyl with bupivacaine on perioperative analgesia and hemodynamics in successfully fast-tracking surgery as compared with upper thoracic epidural with General Anaesthesia in patients subjected to off-pump CABG.

## Materials and Methods

After approval from the ethical committee and obtaining written informed consent from the patients, 60 patients were enrolled prospectively in the study.

Exclusion criteria are urgent surgery, active ischemia or unstable angina, acute myocardial infarction in the last 3 months, prior cardiac surgery, left ventricular ejection fraction <0.4, permanent pacemaker, preoperative need for inotropic agents, severe pulmonary hypertension (>100 mmHg), uncontrolled diabetes, serum creatinine >1.5 mg/dL, impaired liver functions, chronic atrial fibrillation, and moderate to severe valvular disorders. Exclusion factors are coagulopathy, platelet count <100,000/mL, and patient refusal to participate.

## Methodology

### *Anaesthetic technique*

All patients were pre medicated with appropriate doses of tablet Alprazolam night and morning before surgery.

In both the groups an epidural catheter was inserted 12 h before induction of GA, with the patient in the sitting position, using an 18-G needle, in the epidural space between the T3 and T4 spines using loss of resistance in high thoracic epidural and between T10 and T11 in low thoracic epidural. Epidural activated with loading dose of 0.1 mL/kg of 0.125% bupivacaine with 1 µg/kg of fentanyl over 20 min before induction of anaesthesia and correct placement of epidural catheter was confirmed by pin prick method followed by infusion of 0.125% bupivacaine and fentanyl 1 µg/mL at 0.1 mL/kg/h continued postoperatively till second day.

Under standard ASA and invasive arterial monitoring, all patients received general anaesthesia with balanced anaesthesia technique using Propofol (1–2 mg/kg), Midazolam (0.05–0.1 mg/kg), Fentanyl (4–5 µg/kg), and Vecuronium (0.1 mg/kg).

After endotracheal intubation, mechanical ventilation was initiated in all patients with SIMV-VC mode with tidal volume of 6–8 ml/kg, initial respiratory rate of 12/min, titrated accordingly to maintain etCO<sub>2</sub> of 30–35 mmHg and I: E ratio of 1:2.

Anesthesia was maintained with Isoflurane 0.5–1% with oxygen and air. Intravenous fluids were titrated according to the central venous pressure and urine output.

The surgical steps were standardized. Median sternotomy was performed, and heparin 200 IU/kg was given intravenously to get activated clotting time of about 250–300 s. Intravenous infusion of 2 g of magnesium sulfate was infused. The left internal mammary artery was harvested in all patients. A mechanical suction stabilizer was used to facilitate the surgery.

## Parameters recorded

1. Pulmonary function test – incentive Spirometry was recorded postoperatively at frequent intervals till 48 h postoperatively after extubation
2. *Intraoperative parameters*: HR, MAP were recorded at baseline, after skin incision, 2 min after sternotomy, and after closure of the sternum. Anesthesia duration, incidence of dysrhythmia, total doses of fentanyl (µg/kg), atropine, b-blocker, inotropes, and/or vasodilator were recorded
3. *Intensive care unit (ICU) parameters*: Time to awakening, time to extubation, ICU stay, and VAS score at rest and deep breathing were recorded. Rescue analgesia was achieved by top-up doses of intravenous fentanyl (1 µg/kg) when VAS score was >4. VAS was recorded at 0, 3, 6, 12, 24, 36, and 48 h of extubation. If any patient experience breakthrough pain then second rescue analgesia of Inj. Paracetamol 1 g IV was administered. The patient was discharged from the ICU when he or she has fulfilled the criteria of discharge. Epidural catheter was removed on the second day after surgery according to ASRA guideline. Any incidence of complications was recorded

## Statistical analysis

Statistical analysis was done with openepi software. Continuous variables were presented as mean and standard deviation. Categorical variables were presented as percentages. Continuous variables were compared using the unpaired *t*-test, and categorical variables were compared using the Chi-square test. Statistical significance was set at a two-tailed probability level < 0.05.

## Results

Demographic and baseline variables, duration of surgery, inotrope score [Table 1 and Figure 1] and intraoperative hemodynamic parameters [Table 2a and 2b & Figure 1] were comparable among the groups. Intraoperative use of Inj. Fentanyl IV was statistically significant between the groups [Table 1].

Postoperative data such as VAS score at rest and deep breathing, incentive spirometry, rescue analgesia required, time to awakening, and extubation and ICU stay were also statistically significant between the groups [Tables 3a-c, 4 and 5].

The primary outcome as depicted in the Figures 2a-c, 3, 4a and 4b shows an overall improvement in the postoperative data such as VAS score at rest and deep breathing, incentive

**Table 1: Distribution of cases with respect to age, weight, height, duration of surgery and intraoperative total fentanyl required and inotrope score**

	Mean±SD		P
	Group U n=30	Group L n=30	
Age (years)	46.67±5.44	46.37±3.79	0.8051
Height (cm)	154.1±6.89	153.87±8.61	0.9094
Weight (kg)	65.57±8.90	64.33±9.65	0.6069
Duration of surgery	321.2±39.77	322.2±38.43	0.9214
Total intraoperative IV fentanyl required	301.67±53.31	401.67±52.9	<0.0000001
Intraoperative inotrope score	5.23±1.43	5.01±0.13	0.233881

**Table 2a: Distribution of cases with respect to fluctuation of intraoperative heart rate from the baseline**

Fluctuation of intraoperative heart rate from the baseline (%)	Group U n=30		Group L n=30		P
	Intraoperative heart rate mean±SD	Fluctuation from baseline (%), mean±SD	Intraoperative heart rate mean±SD	Fluctuation from baseline (%), mean±SD	
Baseline	77.93±7.89	-	80.73±7.99	-	
At induction	69.73±6.98	10.26±7.06	73.1±8.07	8.77±12.13	0.5632
Skin incision	73.13±6.03	5.72±7.55	75.9±9.85	5.23±14.50	0.8702
During sternotomy	75.03±6.24	3.03±10.52	76.83±8.88	3.79±15.68	0.8263
2 min after sternotomy	74.83±5.05	3.13±10.52	78.4±7.34	1.83±14.33	0.6902
Sternal closure	76.37±6.01	1.37±9.29	78.9±8.47	1.44±13.86	0.9817

**Table 2b: Distribution of cases with respect to fluctuation of intraoperative Mean Blood Pressure from baseline**

Fluctuation of intraoperative mean blood pressure from baseline (%)	Group U n=30		Group L n=30		P
	Intraoperative heart rate mean±SD	Fluctuation from baseline (%) mean±SD	Intraoperative heart rate mean±SD	Fluctuation from baseline (%) mean±SD	
Baseline	97.24±8.8178	-	101.43±9.34	-	
At Induction	83.59±6.28	13.76±5.63	89.18±6.62	11.72±6.63	0.2040
Skin incision	85.69±5.94	11.37±8.16	91.21±7.68	9.67±7.92	0.4162
During Sternotomy	86.81±4.89	10.11±8.62	91.52±5.33	9.09±9.28	0.6608
2 min after sternotomy	85.41±6.46	11.51±10.03	90.83±6.67	9.86±9.23	0.5099
Sternal closure	91.86±3.71	4.93±7.68	95.56±4.05	5.16±8.08	0.9104

**Table 3a: Distribution of cases with respect to VAS score at rest after extubation**

VAS score at rest after extubation (x/10) (h)	Mean±SD		P
	Group U n=30	Group L n=30	
0 (extubation)	2.4±0.77	1.23±0.43	<0.0000001
3	2.43±0.86	1.5±0.68	0.00001991
6	2.47±1.04	1.43±0.73	0.00003524
12	2.37±1.03	1.3±0.53	0.000004529
24	1.93±0.64	1.27±0.45	0.00002179
36	2±0.69	1.3±0.47	0.00002405
48	1.9±0.66	1.27±0.45	0.00006193

spirometry, time to awakening and extubation and ICU stay in Group L, which was statistically significant as compared to group U. There were no complications reported in either of the groups.

## Discussion

In the current era of fast tracking in cardiac surgery, optimal perioperative pain management plays a vital role. In the

present study, both groups had VAS  $\leq 4$ , which signified optimal pain management, facilitating in fast tracking with significant ventilator duration, and ICU stay in group L as compared with Group U. Effective pain management also resulted in better pulmonary rehabilitation with an acceptable incentive spirometry in both the groups. Better dynamic pain scores (VAS during deep breathing  $\leq 4$ ) in both the groups had facilitated with better physiotherapy cooperation, earlier extubation preventing postoperative pulmonary complications. In our study, VAS score both at rest and deep breathing was significantly higher on first postoperative day in group U as compared with Group L. After removal of intercoastal drain tube on second postoperative day VAS score decreased drastically in both groups but it was still significantly higher in Group U as compared with Group L. Also, requirement of rescue analgesia was higher in Group U as compared to Group L. Time to awakening, time to extubation and duration of ICU stay was significantly prolonged in Group U as compared with Group L.

The perioperative use of epidural analgesia has profound inhibitory effects on the body's response to surgery,

**Table 3b: Distribution of cases with respect to VAS score at deep breathing after extubation**

VAS score at deep breathing after extubation (x/10) (h)	Mean±SD		P
	Group U n=30	Group L n=30	
0 (extubation)	3.33±0.99	2.03±0.49	<0.0000001
3	3.5±0.86	2.4±0.67	0.000000810
6	3.53±1.07	2.33±0.76	0.000005458
12	3.33±1.06	2.23±0.68	0.00001220
24	2.87±0.68	2.1±0.55	0.00001065
36	2.8±0.81	2.07±0.58	0.0001738
48	2.73±0.74	2.07±0.52	0.0001836

**Table 3c: Distribution of cases with respect to incentive spirometry after extubation**

Incentive Spirometry after extubation (xballs) (h)	Mean±SD		P
	Group U n=30	Group L n=30	
0 (extubation)	1.21±0.62	1.83±0.38	0.00001831
3	1.07±0.67	1.73±0.43	0.00002882
6	1.07±0.67	1.83±0.36	0.000000989
12	1.23±0.65	1.83±0.36	0.00004343
24	1.47±0.51	1.88±0.22	0.0001575
36	1.52±0.5	1.88±0.22	0.0006404
48	1.55±0.5	1.92±0.19	0.0003621

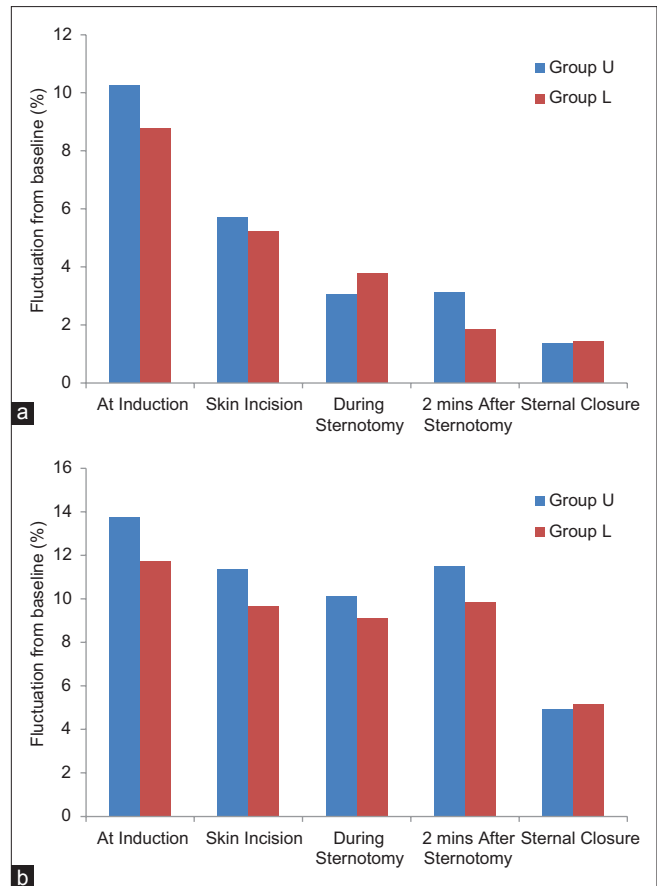
**Table 4: Distribution of cases with respect to rescue analgesia required**

Rescue analgesia (No. of cases) (h)	Group U n=30 (%)	Group L n=30 (%)	P
0 (extubation)	11 (36)	0 (0)	0.0002
3	16 (53)	3 (10)	0.0003
6	16 (53)	2 (6)	0.0001
12	13 (43)	1 (3)	0.0002
24	5 (16)	0 (0)	0.0195
36	5 (16)	0 (0)	0.0195
48	3 (10)	0 (0)	0.0756

**Table 5: Distribution of cases with respect to time to awakening, time to extubation**

	Mean±SD		P
	Group U n=30	Group L n=30	
Time to awakening (min)	93.3±23.51	81.33±14.21	0.02029
Time to extubation (min)	146.73±24.73	130.67±14.9	0.003479
Duration of ICU stay (min)	5227.2±0.49	4507.2±0.35	0.00002811

improving a variety of postoperative morbidity parameters, and improves surgical outcome.<sup>[10]</sup> A meta-analysis on “role of epidural analgesia in surgical practice”<sup>[11]</sup> observed improvement in the surgical outcome through beneficial effects on perioperative pulmonary function, blunting surgical stress response, and improved analgesia. A meta-analysis of 15 trials enrolling 1,178 patients who

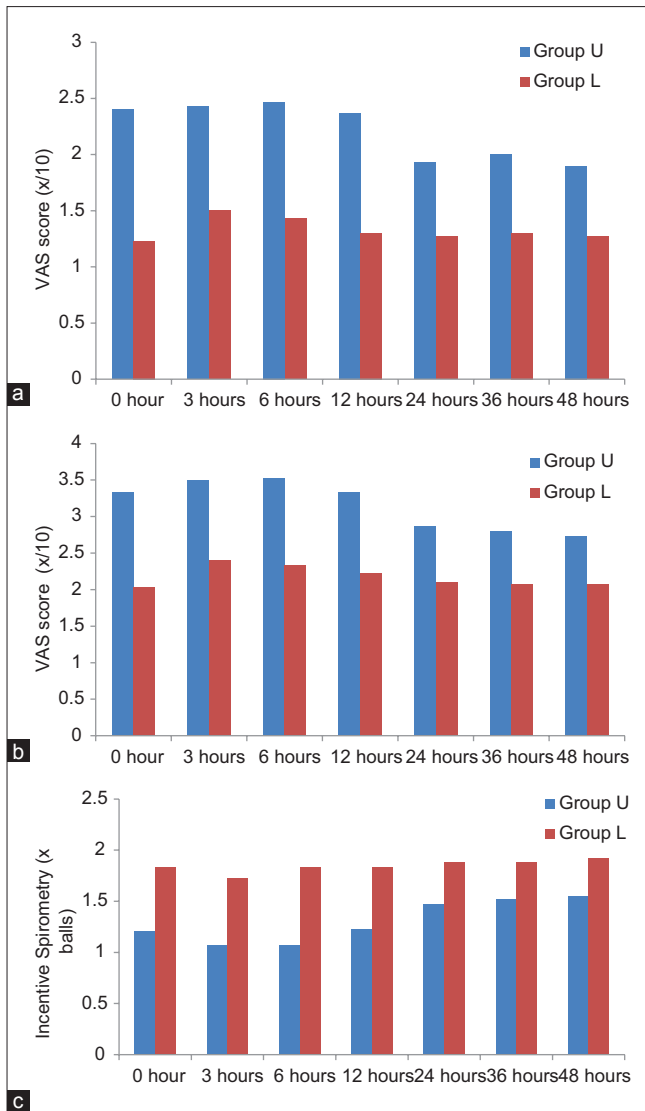


**Figure 1: (a) Distribution of cases with respect to fluctuation of intraoperative heart rate from the baseline. (b) Distribution of cases with respect to fluctuation of intraoperative mean blood pressure from baseline**

were randomized to either GA or GA combined with TEA in patients undergoing CABG on CPB demonstrate that TEA + GA patients had a reduced incidence of dysrhythmias, pain, pulmonary complications, and ventilation times without any effect on the incidence of PMI or mortality.<sup>[12]</sup> Royse *et al.* in their study showed better analgesia, associated with physiotherapy cooperation, earlier extubation, and less psychological disorders.<sup>[13]</sup>

To our knowledge, very few studies have been done comparing upper versus lower thoracic epidural analgesia for cardiac surgery cases.

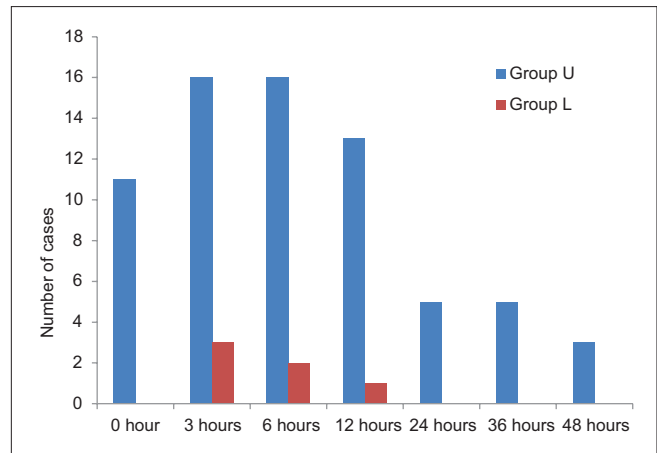
Mehta *et al.*<sup>[14]</sup> in their study of epidural analgesia in high-risk cardiac surgical patients has shown that cardiac surgery is associated with high morbidity and mortality in patients with renal, hepatic or pulmonary dysfunction, advanced age, and morbid obesity. Thoracic epidural analgesia is associated with decreased morbidity in these patients. Thoracic epidural analgesia in cardiac surgery is associated with haemodynamic stability, decreased catecholamine response, good pulmonary function, early extubation, and discharge from ICU. It is an important component of fast tracking in cardiac surgery as well. The



**Figure 2:** (a) Distribution of cases with respect to VAS score at rest after extubation. (b) Distribution of cases with respect to VAS score at deep breathing after extubation. (c) Distribution of cases with respect to incentive spirometry after extubation

risk of epidural hematoma secondary to anticoagulation or residual effects of antiplatelet drug can be reduced by taking standard precautions. They concluded thoracic epidural analgesia in high risk cardiac surgery might decrease pulmonary, cardiovascular or renal complications, provide excellent analgesia and allow early extubation. In our study VAS score was  $\leq 4$  in both groups, but analgesia was better controlled with Group L as compared to Group U. Also, we reported shorter duration of time to awakening and extubation and duration of ICU stay in Group L which are important component of fast tracking. None of the subjects have any complication both intraoperatively and postoperatively.

Stenger *et al.*<sup>[15]</sup> in his study of High thoracic epidural analgesia as an adjunct to general anesthesia was associated with better outcome in low-to-moderate risk



**Figure 3:** Distribution of cases with respect to rescue analgesia required

cardiac surgery patients has shown that addition of high thoracic epidural analgesia (HTEA) to general anesthesia in cardiac surgery patients enhance the fast-track and improvement in outcome. In our study fast tracking was better in Group L as compared with Group U in comparison to time to awakening and extubation and ICU stay.

Mehta *et al.*<sup>[14]</sup> has shown that thoracic epidural analgesia in cardiac surgery is associated with haemodynamic stability. In our study, intraoperative fluctuation of heart rate and mean blood pressure from baseline were within the define limits ( $\leq 20\%$  from baseline) in both groups. Intraoperative inotrope scores were also compared.

Our results are consistent with the hypothesis that lower thoracic epidural is better in perioperative pain management and also helps in early fast tracking as compared to upper thoracic epidural.

### Conclusion

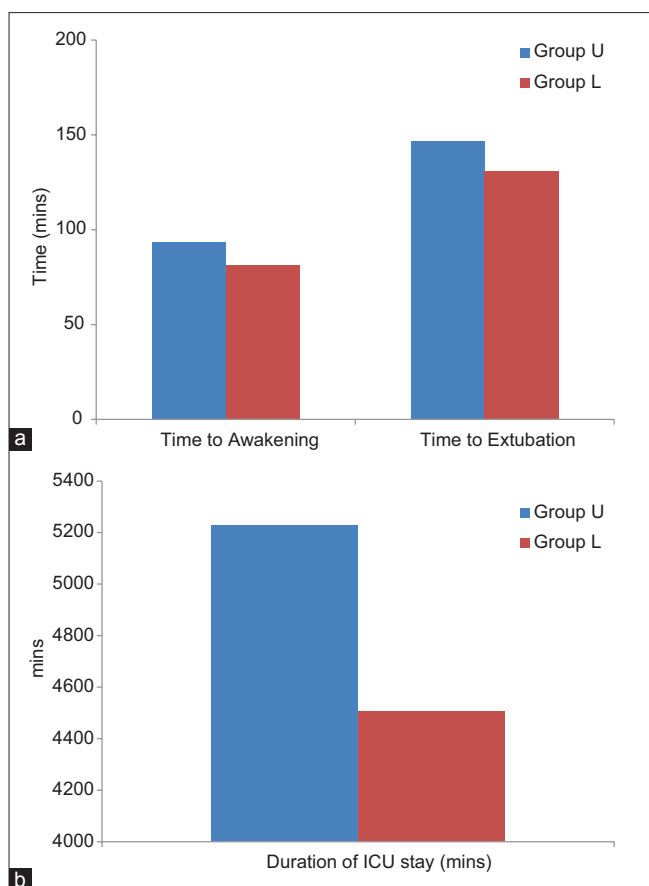
Lower thoracic epidural group was found to have lower VAS score and early fast tracking as compared to upper thoracic epidural in off-pump coronary artery bypass graft surgery. However, fast tracking was possible in both groups, but it was significantly better in lower thoracic epidural group as compared with upper thoracic epidural group.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.



**Figure 4: (a) Distribution of cases with respect to time to awakening and extubation. (b) Distribution of cases with respect to duration of ICU stay**

### Conflicts of interest

This manuscript had been nominated for Janak Mehta Award presentation in IACTA 2019.

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