

## Awake off-pump coronary artery bypass grafting: our experiences of 14 cases

*Uyanık iken atan kalpte koroner arter bypass greftleme: 14 olgu deneyimimiz*

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**Background:** In this study, we defined our experiences on the feasibility and efficacy of high-thoracic epidural anesthesia + femoral block in 14 conscious patients undergoing off-pump coronary artery bypass grafting (OPCAB) with median sternotomy.

**Methods:** Fourteen conscious patients (8 males, 6 females; mean age: 57.6±9.4 years; range 48 to 67 years) with symptomatic coronary artery disease who were scheduled for OPCAB were included. An epidural catheter was inserted from the intervertebral spaces T<sub>1-2</sub> or T<sub>2-3</sub> one day prior to surgery. In the operating room, 5 mL of epidural solution (15 mL of lidocaine 2%, 2 mL of bicarbonate, fentanyl 100 µg and epinephrine 100 µg in 20 mL solution) was administered at five-minute intervals until the T<sub>1-8</sub> dermatome block was obtained. A femoral block was performed on the right and left lower limbs of the patients. The bolus doses of the epidural solution were repeated at 5 mL per hour. The patients were taken to the intensive care unit following the operation. The patients without any problems during the intensive care unit follow-up were taken to the ward.

**Results:** The mean surgical duration, length of intensive care unit stay, and duration of hospitalization were 112.7±25.9 minutes, 9.7±5.4 hours and 3.8±0.8 days, respectively. None of the patients suffered from pain during incision, sternotomy, and sternal retraction as well as throughout the operation. Hypotension was observed in two patients during the operation. The pleura were opened in two patients. General anesthesia was switched in four patients due to various reasons.

**Conclusion:** The combination of high-thoracic epidural anesthesia with femoral block may be an alternative to general anesthesia during OPCAB in selected patients.

**Keywords:** High-thoracic epidural anesthesia, femoral block; off-pump coronary artery bypass grafting.

**Amaç:** Bu çalışmada median sternotomi aracılığıyla atan kalpte koroner arter bypass greftleme (KABG) ile bilinci açık 14 hastada yüksek torasik epidural anestezi + femoral blok'un uygulanabilirliği ve etkinliği hakkındaki deneyimlerimiz tanımlandı.

**Çalışma planı:** Semptomatik koroner arter hastalığı olan bilinci açık 14 hastaya (8 erkek, 6 kadın; ort. yaş 57.6±9.4 yıl; dağılım 48-67 yıl) atan kalpte KABG cerrahisi planlandı. Hastalara ameliyattan bir gün önce T<sub>1-2</sub> veya T<sub>2-3</sub> intervertebral aralıktan epidural kateter takıldı. Ameliyat odasında kateterden 5'er mL epidural solüsyon (20 cc içinde 15 mL %2 lidokain, 2 mL bikarbonat, 100 µg fentanil ve 100 µg epinefrin) T<sub>1-8</sub> dermatom blokajı elde edilene kadar beş dakika aralıklarla yapıldı. Hastaların sağ ve sol alt ekstremitelerine femoral blok uygulandı. Ameliyat boyunca 5 mL/saat epidural solüsyon bolus şeklinde tekrarlandı. Hastalar ameliyat sonrasında yoğun bakım ünitesine alındı. Yoğun bakım ünitesi takibinde sorun olmayan hastalar servise alındı.

**Bulgular:** Ortalama ameliyat süresi, yoğun bakım ünitesinde kalış süresi ve hastanede kalış süresi sırasıyla, 112.7±25.9 dk., 9.7±5.4 saat ve 3.8±0.8 gün idi. Hastaların hiçbirinde insizyon, sternotomi ve sternal retraksiyon sırasında, yanı sıra ameliyat sürecinde ağrı olmadı. Ameliyat sırasında iki hastada hipotansiyon görüldü. İki hastada plevra açıldı. Dört hastada çeşitli nedenlerden dolayı genel anesteziye geçildi.

**Sonuç:** Yüksek torasik epidural anestezinin femoral blok ile kombinasyonu seçilmiş hastalarda atan kalpte KABG cerrahisinde genel anesteziye bir alternatif olabilir.

**Anahtar sözcükler:** Yüksek torakal epidural anestezi, femoral blok; atan kalpte koroner arter bypass greftleme.



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Off-pump coronary artery bypass graft (OPCAB) surgery is widely performed in many heart centers. In our hospital, nearly all of the coronary artery bypass graft (CABG) surgeries, whether one or two grafts are used, are performed on a beating heart. In addition to general anesthesia, a combination of general and high thoracic epidural anesthesia (HTEA) or HTEA alone can be used for anesthesia in OPCAB surgery.<sup>[1,2]</sup>

Many intraoperative and postoperative benefits of TEA in cardiac surgery have been noted. For example, sympathectomy at the T<sub>1-5</sub> levels causes dilatation in the coronary arteries and internal thoracic artery (ITA) and increases the perfusion of these arteries. Furthermore, TEA provides ideal conditions for OPCAB surgery by decreasing the heart rate and arrhythmias that are observed during cardiac manipulations,<sup>[3,4]</sup> and it allows for the early mobilization of the patient and accelerates the recovery period by providing optimal postoperative pain control.<sup>[5,6]</sup>

This study outlines our experiences regarding the feasibility and efficacy of HTEA in conjunction with a femoral block in 14 conscious patients who underwent OPCAB surgery via a median sternotomy.

## PATIENTS AND METHODS

Between June 2007 and January 2008, awake OPCAB via a median sternotomy was performed on 14 patients (8 males, 6 females; mean age 57.6±9.4 years; range 48 to 67 years) with symptomatic coronary artery disease (CAD) at our hospital. The faculty ethics committee gave their approval for this study, and we also obtained written informed consent from each of the study participants.

Patients who refused general anesthesia, and those with chronic obstructive pulmonary disease (COPD) who might not have tolerated general anesthesia [forced expiratory volume in one second (FEV<sub>1</sub>) of between 30 and 50%], a history of transient ischemic attack and cerebral infarction, and significantly restricted (>70) stenosis of the left anterior descending (LAD) coronary artery, diagonal branches, or the right coronary artery (RCA) were excluded from the study along with those with a left ventricular ejection fraction (LVEF) of <40%, moderate or severe pulmonary hypertension, congestive heart failure, a previous history of cardiac surgery, clinically significant valvular disease, or catheter infections. In addition, patients who were uncooperative and those who were believed to have bleeding and coagulation disorders or difficult airways were also not included.

The administration was predicted to be completed within two and a half hours, and the administration of antiplatelet agents was discontinued at least seven days prior to the surgery. Furthermore, while still in the intensive care unit (ICU) one day prior to the surgery, an 18G epidural catheter (B. Braun Melsungen AG, Melsungen, Germany) was inserted at the T<sub>1-2</sub> or T<sub>2-3</sub> intervertebral space of each patient. If there was blood aspiration from the catheter, the surgery was to be postponed for 24 hours. In addition, the patients were premedicated with 0.07 mg/kg intramuscular midazolam one hour prior to entering the operating room.

The patients were given 5 mL of a solution consisting of 15 mL of lidocaine 2%, 2 mL of bicarbonate, 100 µg of fentanyl, and 100 µg of epinephrine in 20 mL was given at five-minute intervals until the T<sub>1-8</sub> dermatome block was applied. Using the nerve stimulation technique, a femoral block was achieved in the right or left extremity. Intra-arterial and central venous catheterization was done under local anesthesia. Repeat doses of the epidural solution (5 mL) were administered every hour, and oxygen was given to patients with a face mask at 4 L per minute throughout the operation.

All of the operations were performed by the same surgeon. Following the median sternotomy, the left internal mammary artery (LIMA) was skeletonized to decrease the risk of pneumothorax. Underwater drainage was conducted by immediately inserting thoracic drainage tubes in the patients for whom the pleura was opened. This was then closed using primary prolene sutures (Ethicon Inc., Somerville, NJ, USA). The saphenous vein was dissected by another surgeon. After the preparation of the LIMA, sternal retractors were inserted to reveal the heart. A Cor-Vasc system, produced by CoroNeo™ (CoroNéo Inc., Montreal, Quebec, Canada) was used to facilitate myocardial revascularization, and an intracoronary shunt was employed for the patients who underwent RCA anastomosis. This area was exposed by inserting the pericardial traction sutures in a manner which did not cause a pneumothorax. The LIMA-LAD anastomosis was completed first, and then the saphenous vein was anastomosed to the heart by placing a side clamp on the aorta. By removing the side clamp, distal anastomosis to the SVG was completed with the use of a hemostatic clamp. Next, heparin (150 IU/kg) was administered to the patients for anticoagulation, and the activated coagulation time (ACT) was maintained at >300 seconds. The heparin was neutralized with protamine at the end of the operation.

At the completion of the surgery, two mediastinal drainage tubes and two pacing wires to the right atrial appendix and the ventricle were inserted transiently. The sternum was then closed with a sternal steel wire after making sure that the bleeding was under control. The patients were taken to the ICU at the end of the operation.

The demographic data and preoperative characteristics of the patients are shown in Table 1. The blood pressures, pulses, and arterial blood gases of the patients were recorded during the preoperative period, after the administration of the epidural solution, after the incision, after the sternotomy, and at the end of the operation. A systolic pressure value of <80 mmHg was accepted as hypotension. Pain at the postoperative 6<sup>th</sup>, 12<sup>th</sup>, 24<sup>th</sup>, 48<sup>th</sup>, and 72<sup>nd</sup> hours was evaluated using a visual analog scale (VAS) in which 0 represented no pain and 10 signified the most severe pain. An isotonic solution containing 3 mg of morphine and 50 µg of fentanyl was given via the epidural catheter for postoperative analgesia, and this was left in place for three days.

Statistical analysis was performed using the SPSS version 12.0 for Windows (SPSS Inc., Chicago, IL, USA) software program. Descriptive statistics were expressed as mean ± standard deviation (SD), and repeated measurements were analyzed using analysis of variance (ANOVA). A value of  $p < 0.05$  was considered to be statistically significant.

## RESULTS

Off-pump CABG surgery under TEA was scheduled for 20 patients, but five patients refused the TEA, and one patient who was taking an antiplatelet agent was excluded from the study. Hence, ultimately 14 conscious patients with symptomatic CAD who

**Table 1. Demographic, preoperative, intraoperative and postoperative data of the patients**

	n	Mean±SD
Age (years)		57±9.3
Weight (kg)		77±5.8
Ejection fraction (%)		50±4.8
Chronic obstructive pulmonary disease	6	
Diabetes mellitus	4	
Chronic renal disease	2	
History of transient ischemic attack	3	
Length of the operation (minutes)		112±25.8
Time needed for LIMA removal (minutes)		9.9±1.3
Number of anastomoses		1.4±0.5

SD: Standard deviation; LIMA: left internal mammary artery.

underwent OPCAB surgery took part in the study. A median sternotomy was performed on all of the patients, who were slightly sedated. However, four patients had to be transitioned to general anesthesia, and they were also excluded from the study. This was necessary because of a persistent cough associated with a pneumothorax in the first and second patients, and the surgeon for the third patient made the decision to perform the operation on CPB because of the intramyocardial course of the LAD. In addition, general anesthesia was performed on the fourth patient because of incompatibility. Endotracheal intubation was used for the first three patients who needed general anesthesia, and a laryngeal mask airway was inserted in the fourth. The three intubated patients were extubated shortly after they were transferred to the ICU, whereas this took place in the operating room for the patient with the laryngeal mask airway. Additionally, a pneumothorax occurred in two patients following the median sternotomy. Furthermore, when the patients with opened pleurae became agitated during the period of repair, sedation with propofol was increased, and careful attention was given to ensure that spontaneous breathing occurred. The surgery was then completed without any problems after pleural repair. Electrocardiography (ECG) showed systemic hypotension without any signs of ischemia in two patients. Moreover, hypotension occurred during the RCA grafting in one patient and during the diagonal branches grafting in another. Next, the patients were placed in the Trendelenburg position, and the systemic arterial pressure returned to normal after the administration of 15 mg of ephedrine. Anxiety developed in the patients who had pericardial traction sutures that were needed to expose the region of the RCA, and they also developed hypotension and a pneumothorax. The perioperative and postoperative data of the patients is shown in Table 1. The length of ICU stay was 9.7±5.3 hours, the length of hospital stay was 3.8±0.8 days, and the mean number of anastomoses was 1.4±0.5. The details of the grafts of the patients are shown in Table 2,

**Table 2. Graft details**

	n
Grafts used	
Left internal mammary artery	10
Saphenous vein graft	4
Coronary arteries in which anastomosis was completed	
Left anterior descending coronary artery	10
Diagonal branches	2
Right coronary artery	2

**Table 3. Hemodynamic data**

	Preoperative	15 minutes after administering the epidural solution	At the time of incision	After the median sternotomy	At the end of surgery
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Systolic BP (mmHg)	139±14.7*	101±7.2**	112±3.5	116±3.7	107±5
Pulse (minutes)	84±6.1*	64±4.2	60±6.1	63±4.4	62±4.5

BP: Blood pressure; \* p<0.001; \*\* p<0.05; All values are given as mean ± standard deviation (SD). The preoperative values differed when compared with the other time periods.

and the intraoperative hemodynamic and respiratory data is shown in Tables 3 and 4. After the median sternotomy, the partial pressure for carbon dioxide (PaCO<sub>2</sub>) was higher but not at clinically significant levels. Tachycardia requiring a beta blocker did not develop and no signs of ischemia were observed via ECG.

Furthermore, there were no complications related to the operative and postoperative mortality, morbidity or postoperative VAS scores, and these results are shown in Table 5. During the postoperative period, the patients were questioned as to whether they were satisfied with the procedure, and most stated that they had experienced no pain and were satisfied. However, five said they even though they had experienced no pain, they still felt anxious during the OPCAB. Therefore, they did not want to recall the events.

## DISCUSSION

Karagöz et al.<sup>[7]</sup> was the first to perform OPCAB surgery using TEA alone in conscious patients, and this method has also been applied to multivascular bypass cases via a median sternotomy.<sup>[6]</sup>

Similar to other studies in the literature, we determined that HTEA alone can be used in OPCAB surgery for selected patients.

The benefits of awake OPCAB were reported by Karagöz et al.<sup>[7]</sup> In patients with severe COPD who are not candidates for general anesthesia,<sup>[8]</sup> the indication

for this method can be expanded, for example for patients with cerebral infarction. Over the past years, the efficacy of this method as it relates to postoperative neurocognitive function has been evaluated,<sup>[9,10]</sup> and it has been determined that general anesthesia may cause the deterioration of neurocognitive function in cases with a history of a cerebrovascular event. To be awake during surgery allows us to detect intraoperative changes in neurocognitive function immediately.

Furthermore, general anesthesia may increase the number of postoperative respiratory complications in cases with respiratory failure.<sup>[11]</sup> We identified the comorbidities in our patients prior to the operation, and none reported any operative or postoperative mortality or complications. However, some of our patients had previously had a bad experience with general anesthesia, and they refused it for this surgery.

Many anesthetists hesitate to use HTEA in cardiac surgery because of the risk of epidural hematoma development. In some studies the epidural catheter was inserted one hour before surgery,<sup>[12]</sup> but in others it was inserted one day prior to the operation.<sup>[11]</sup> In this study, we inserted the epidural catheters one day before the surgery was performed, which has the advantage of increasing the confidence interval (CI) regarding the risk of epidural hematoma. The disadvantage is that it extends the hospitalization time for the patient. However, since all of the patients in this study were taken to the surgical ward one day before the surgery, this may not have been a disadvantage.

**Table 4. Respiratory data**

	Preoperative	After the incision	After the median sternotomy	At the end of the surgery
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
PaO <sub>2</sub> (mmHg)	82±6.7	85±5.1	89±11.7	87±8.8
PaCO <sub>2</sub> (mmHg)	39±1.7	40±1.9	40±2.9*	40±1.8
SpO <sub>2</sub> (%)	96±0.8	96±0.7	96±1.1	96±1.2

SD: Standard deviation; \* p<0.001; When compared with the other time periods, the levels were significantly higher after the median sternotomy.

**Table 5. Postoperative visual analog scale scores**

	At rest	On coughing
	Mean±SD	Mean±SD
6 <sup>th</sup> hour	3.3±0.7	3.8±0.8
12 <sup>th</sup> hour	2.9±0.7	3.4±0.5
24 <sup>th</sup> hour	2.4±0.5	2.8±0.6
48 <sup>th</sup> hour	1.6±0.7	2.7±0.5
72 <sup>th</sup> hour	1.4±0.5	2.1±0.6

SD: Standard deviation.

Median sternotomies should start at the patient's inspiration and continue through the midline to reduce the possibility of pneumothorax. If the skeletonization method is used for LIMA harvesting, a reduction in the number of pneumothoraces usually occurs. Unfortunately, in our cases, none of the pneumothoraces occurred during LIMA harvesting. We used a deep pericardial traction suture to expose the RCA, but this method can still result in a pneumothorax.<sup>[13]</sup>

In this study, hypotension developed in two patients. It was found in one during diagonal anastomosis and the other during RCA anastomosis. This is unique in that although a decrease in arterial blood pressure to 50 mmHg can be tolerated during OPCAB, it can cause serious problems such as anxiety, agitation, and respiratory distress by disturbing the cerebral perfusion in spontaneously breathing patients.<sup>[14]</sup> However, the advantage of being conscious during the beating heart surgery is that the patient can be monitored through patient interaction. Hence, a drop in the blood pressure to critical levels, which would disturb the cerebral perfusion, is not likely in patients under general anesthesia, and to our knowledge has not been previously reported in the literature.<sup>[15]</sup> Four of our patients had to be transitioned to general anesthesia, and in a study by Noiseux et al.,<sup>[16]</sup> this was carried out in two of their patients. One had severe hemodynamic instability during the distal anastomosis of the LAD resulting from an EF of <30%, and the continuous epidural infusion of fentanyl led to superficial respiration in the other. The LVEF of the patients was good, and those with a low EF were not included in their study. Drugs were administered as intermittent boluses to minimize hemodynamic instability and respiratory depression risk.

Awake OPCAB requires excellent patient cooperation. During the operation, the patients who developed a pneumothorax and hypotension and those whose heart was elevated to enable the insertion of the traction sutures to expose the area of the RCA. Furthermore, the transition to general anesthesia

occurred in one patient in the study because his arms and legs were constantly moving, and he was not responding to commands.

Some of our patients experienced anxiety during the OPCAB procedure, and Liang et al.<sup>[17]</sup> determined that because awake OPCAB patients remain conscious, it is inevitable that tension and anxiety levels will have a corresponding increase in the patient's stress levels; thus, they were not in favor of keeping the patient's conscious. However, we believe that providing deep sedation with a low dose of propofol infusion without causing respiratory failure from the start of the surgery is a much better option.

One of the advantages of epidural analgesia is that it provides good pain control in the postoperative period, and the pain scores of our patients during rest and coughing were quite low. This technique was also employed when two grafts were used, and the number of grafts does not seem to be a limiting factor for awake OPCAB if enough cardiac output can be provided during the manipulation of the heart.

As previously mentioned, although this study revealed the effectiveness of epidural anesthesia alone in OPCAB surgery, we think it is best when it is performed in conjunction with HTEA under deep sedation or when it is combined with general anesthesia. By doing this, not only are the disadvantages of OPCAB avoided, but the patient can benefit from the advantages of both general and epidural anesthesia.

One important limitation of our study was that it involved a small population. Thus, our findings must be supported by larger series as well as future controlled blind studies.

### Conclusion

The combination of TEA and a femoral block can be an important alternative to general anesthesia in selected patients during awake OPCAB if the problems that are associated with this surgery can be overcome. If this occurs, we believe that satisfactory results can be achieved.

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