Epidural anesthesia versus general anesthesia in patients undergoing minimally invasive direct coronary artery bypass surgery

Minimal invazif koroner baypas cerrahisi yapılan hastalarda genel anesteziye karşı epidural anestezi

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ABSTRACT

Objective: Minimally invasive direct coronary artery bypass (MIDCAB) surgery in the awake patient with epidural anesthesia had been previously reported. However, there is no prospective randomized study comparing MIDCAB surgery with epidural anesthesia versus general anesthesia.

Methods: The study was conducted as a prospective and randomized study. Between January 2002 and May 2003, 76 patients were randomly assigned into either MIDCAB under general anesthesia (GA Group) or MIDCAB under epidural anesthesia (EA Group). The EA Group patients did not receive concomitant general anesthesia and they were conscious throughout the procedure. All patients had a left internal thoracic artery to left anterior descending coronary artery bypass using the same MIDCAB techniques. There were 42 patients in the GA Group and 34 patients in the EA Group. For statistical analysis, unpaired t-test for independent samples was used for comparison of continuous variables, and Pearson Chi-Square test was used for comparison of discrete variables.

Results: The demographic characteristics of the groups were similar. There was no mortality or major morbidity in both groups. The EA Group patients had lower arterial oxygen saturations (93.3±3.2% versus 97.4±1.3%, p<0.001) and higher partial carbon dioxide pressures (45.8±3.6 mmHg versus 41.5±2.5 mmHg, p<0.001), but these were not clinically significant. The EA Group patients had significantly less intensive care unit (ICU) (5.5±6.5 hours versus 18.2±4.8 hours, p<0.001) and hospital stay periods (31.4±20.7 hours versus 58.6±17.9 hours, p<0.001), as well as significantly less postoperative pain (visual analog score 1.06±0.6 versus 2.3±0.6, p<0.001) and blood loss (184.2±169.0 ml versus 371.7±315.3 ml, p<0.001). There was no any difference in regard to patient satisfaction after the procedure between the two groups. Long -term results were equally satisfactory in both groups.

Conclusions: It can be concluded that, similar surgical results can be achieved by MIDCAB surgery with general or epidural anesthesia. Although epidural anesthesia has no impact on the degree of patient satisfaction after the procedure, it yields significantly shorter ICU and hospital stay periods, which may result in more efficient use of hospital resources. *(Anadolu Kardiyol Derg 2009; 9: 54-8)*

Key words: Epidural anesthesia, general anesthesia, minimally invasive direct coronary artery bypass surgery

ÖZET

Amaç: Epidural anestezi ile uyanık hastada minimal invazif koroner baypas cerrahisi (MİDKAB) daha önce tanımlanmıştı. Fakat epidural anesteziyle yapılan MİDKAB ameliyatını genel anestezi ile kıyaslayan prospektif randomize bir çalışma yoktur.

Yöntemler: Çalışma prospektif ve randomize olarak yürütülmüştür. Ocak 2002 ile Mayıs 2003 arasında, 76 hasta rasgele ya genel anestezi ile MİDKAB yapılan gruba (GA Grup) ya da epidural anestezi ile MİDKAB yapılan gruba (EA Grup) alındı. Epidural anestezi grubundaki hastalar aynı anda genel anestezi almadılar ve ameliyat süresince bilinçliydiler. Bütün hastalarda aynı MİDKAB teknikleri kullanılarak sol internal torasik arter sol ön inen artere baypas edildi. Genel anestezi grubunda 42, EA grubunda ise 34 hasta vardı. İstatistiksel analiz, devamlı değişkenler için t-testleri ve ayrık değişkenler için Pearson Ki-Kare testleri kullanılarak gerçekleştirildi.

Bulgular: Grupların demografik karakteristikleri benzerdi. Her iki grupta da mortalite veya büyük morbidite yoktu. Epidural anestezi grubundaki hastaların arteryel oksijen saturasyonu düşük (%93.3±3.2 ve %97.4±1.3, p<0.001) ve parsiyel karbondioksit basınçları yüksekti (45.8±3.6 mmHg ve 41.5±2.5 mmHg, p<0.001). Fakat bunlar klinik yönden önemli değildi. Epidural anestezi grubundaki hastalar önemli ölçüde daha az postoperatif ağrı (``visual analog score`` 1.06±0.6 ve 2.3±0.6, p<0.001) ve kanamanın (184.2±169.0 ml ve 371.7±315.3 ml , p<0.001) yanı sıra daha kısa yoğun bakım (5.5±6.5 saat ve 18.2±4.8

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saat, p<0.001) ve hastane kalış süresine (31.4±20.7 saat ve 58.6±17.9 saat, p<0.001) sahiptiler. Operasyondan sonra İki grup arasında tatmin açısından fark yoktu ve uzun dönem sonuçları eşit olarak tatminkardı.

Sonuç: Minimal invazif koroner baypas cerrahisinde benzer sonuçlar iki yöntemle de elde edilebilir. Epidural anestezinin ameliyattan sonra hasta memnuniyetinin düzeyine bir etkisi olmamasına rağmen yoğun bakım ve hastanede kalış süresini kısaltarak hastane kaynaklarının daha etkili kullanımına yaptığı olumlu etki göz ardı edilemez. *(Anadolu Kardiyol Derg 2009; 9: 54-8)*

Anahtar kelimeler: Epidural anestezi, genel anestezi, minimal invazif koroner baypas cerrahisi

Introduction

High thoracic epidural anesthesia as a sole anesthetic strategy enabled the performance of coronary artery bypass grafting (CABG) in a conscious patient without endotracheal general anesthesia in 1998 (1). This approach was used in several series of patients, demonstrating the safety and efficacy of this technique in selected patients (2-12).However, there is no prospective randomized trial comparing coronary bypass surgery under epidural anesthesia versus general anesthesia. It was previously suggested that, a further decrease in the invasiveness of the CABG surgery through epidural anesthesia could result in superior patient satisfaction (9).

The intention of this study is to compare the early results of minimally invasive direct coronary artery bypass (MIDCAB) surgery under general anesthesia versus epidural anesthesia with emphasis on subjective variables such as pain and patient satisfaction after the procedure.

Methods

The study was conducted as a prospective and randomized study. Patients who were referred for MIDCAB surgery, and who did not present contraindications to epidural catheter placement and consented for operation under epidural anesthesia; were randomized either to undergo operation under general endotracheal anesthesia (GA Group) or under epidural anesthesia (EA Group). Randomization of the patients was done by an anesthesiologist, who was not a principal investigator. All patients had a single left anterior descending (LAD) coronary artery stenosis or occlusion. Between January 2002 and May 2003, 76 patients were included in the study. Full informed written consent was obtained from each patient.

There were 42 patients in the GA Group with a mean age of 61±10 years (22 males, 20 females) and 34 patients in the EA Group with a mean age of 62±13 years (20 males, 14 females). Preoperative characteristics of the patients are depicted in Table 1.

Table 1. Preoperative characteristics of the patients

Parameters	GA Group (n=42)	EA Group (n=34)	p*
Diabetes, n(%)	11 (26.1)	9 (26.4)	NS
COPD, n(%)	12 (28.5)	9 (26.4)	NS
Hypertension, n(%)	21 (50)	18 (52.9)	NS
Smoking, n(%)	21 (50)	21 (61.7)	NS
Age over 70, n(%)	15 (35.7)	11 (34.7)	NS
Obesity, n(%)	2 (4.7)	0 (0)	NS

*- Pearson Chi-Square test

COPD - chronic obstructive pulmonary disease, EA - epidural anesthesia, GA- general anesthesia,NS - not significant

General anesthesia

General anesthesia group patients received standard endotracheal general anesthesia with midazolam for premedication, and fentanyl, propofol, and vecuronium for induction. Anesthetic maintenance was based on isoflurane in oxygen and air, and small boluses of fentanyl and propofol as needed. Appropriate doses of metoprolol were used for heart rate control. Patients were extubated in the intensive care unit (ICU), after confirmation of hemodynamic stability, normothermia and absence of surgical complications.

Epidural anesthesia

Epidural anesthesia group patients did not receive concomitant general anesthesia and they were conscious throughout the procedure. Midazolam was used for premedication. High thoracic epidural anesthesia was performed using previously described techniques (9). The objective of epidural anesthesia was to achieve somatosensory and motor block at the T1-T8 level. The upper permissible level of block was C6. No muscle-paralyzing agent or general anesthetic agent were used. Throughout the operation, patients spontaneously breathed nasal oxygen. The epidural catheter was removed few hours after the operation.

Anticoagulation

Aspirin was not discontinued in any patient. Anti-platelet drugs were discontinued 5 days prior to surgery. All patients received 1 mg/kg of heparin for anticoagulation, which was reversed with an appropriate dose of protamine at the termination of the procedure. The GA group patients received low-dose continuous heparin therapy, which was initiated when they arrive at the ICU and continued throughout the hospitalization period. All patients received clopidogrel and aspirin on hospital discharge.

Surgical technique

All operations were performed by the same surgeon. Cardiopulmonary bypass was not used. All patients had a left internal thoracic artery (LITA) to LAD artery bypass using the same MIDCAB techniques. In all patients, rib cage lifting (RCL) technique was used (13). In this technique, a 5 to 7 cm skin incision was made 2 cm to the left of the xyphoid process and 1 cm above and parallel to the *arcus costarum* (Fig. 1). The rib cage was mobilized from the left rectus muscle, and a longitudinal split was made on the sternum above the xyphoid process for a few cm, to facilitate the lifting of the rib cage. The split in the sternum was only a vertical line, and it was not curved towards the intercostal spaces. The rib cage was lifted upwards towards the left shoulder of the patient with a single Favaloro retractor, and both LITA take-down and LITA to LAD anastomosis were performed from within this exposure.

Data collection

Perioperative hemodynamic variables, postoperative blood loss, ICU and hospital stay durations, new onset atrial fibrillation, readmissions after hospital discharge in the first 2 postoperative months were recorded. Patients were followed-up by direct clinical examination or telephone contact at 6 months intervals thereafter, until February 2008.

Postoperative pain was assessed using a visual analog scale (VAS). Patients were asked to mark their perception of pain on a scale of 0 to 10, 0 indicating no pain and 10 indicating worst possible pain. The VAS for pain was obtained on an hourly basis for the first 6 postoperative hours, and then in every 4 hours, when applicable.

Visual analog scale for patient satisfaction was obtained on hospital discharge and at the second postoperative month. Patients were asked to mark their degree of satisfaction on a scale of 0 to 10, 0 indicating least satisfied and 10 indicating most satisfied.

Statistical analysis

Statistical analysis was computed using SPSS software v.10.0 (SPSS Inc, Chicago, Il). Values are expressed as mean±standard deviation. Unpaired t-test for independent samples was used for comparison of continuous variables, and Pearson Chi-Square test was used for comparison of discrete variables. P values smaller than 0.05 were considered statistically significant.

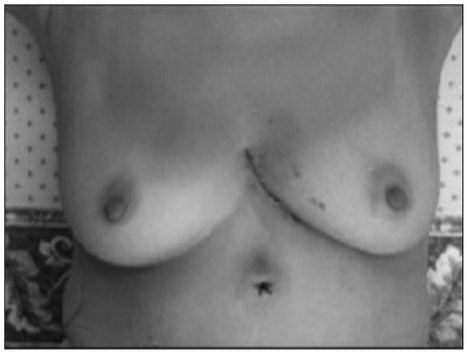

Figure 1. Skin incision in rib cage lifting technique

Results

The demographic and preoperative characteristics of the groups were similar (Table 1). There was no mortality or major morbidity in both groups. Results are depicted in Table 2. The duration of the operations was similar in both groups. Both group of patients had stable perioperative hemodynamics, with a marked decrease in the heart rate in the EA Group (66.5±8.4 / min vs. 82.1±11.3 / min, p<0.001). The EA Group patients had lower arterial oxygen saturations and higher partial carbon dioxide pressures (p<0.001 for both), but these were not clinically significant. Left pleural cavity was opened in 17 patients (50%) in the EA group and 13 patients (30.9%) in the GA group (p>0.05). There was no conversion to general anesthesia in the EA group, and no conversion to full sternotomy or cardiopulmonary bypass in either group. Mean time to extubation at the ICU in the GA group was 0.9±.2 hrs. The EA Group patients had significantly less intensive care unit (ICU) stay (5.5±6.5 hrs vs. 18.2±4.8 hrs, p<0.001) and hospital stay (31.4±20.7 hrs vs. 58.6±17.9 hrs, p<0.001) durations, as well as significantly less postoperative pain (VAS for pain 1.06±.6 vs. 2.3±.6, p<0.001) and blood loss (184.2±169 ml vs. 371.7±315.3 ml, p<0.01). No patient in either group received blood transfusion. Nine patients in the EA group were discharged from the hospital on the afternoon of their operation.

One patient in the GA group presented with new onset atrial fibrillation (p>0.05). Both the EA and GA group patients were equally satisfied from their operation at the time of hospital discharge (VAS for satisfaction 8.2±1.1 vs. 7.7±1.3, p>0.05), as well as at the second postoperative month (VAS for satisfaction 8.9±.9 vs. 8.9±.9, p>0.05). No patient was re-hospitalized at the first two postoperative months from cardiac causes and all patients were symptom free.

Table 2. Intra- and postoperative data of patients

Variable	GA Group (n=42)	EA Group (n=34)	p*
Duration of operation, min	91.7±23.6	89.5±17.8	NS
Intensive care unit stay, hours	18.2±4.8	5.5±6.5	<0.001
Hospital stay, hours	58.6±17.9	31.4±20.7	<0.001
Arterial blood pressure, systolic, mmHg	95.8±21.0	100±24.7	NS
Heart rate, beats/min	82.1±11.3	66.5±8.4	<0.001
Arterial oxygen saturation, %	97.4±1.3	93.3±3.2	<0.001
PCO2, mmHg	41.5±2.5	45.8±3.6	<0.001
Postoperative blood loss, ml	371.7±315.3	184.2±169.0	<0.001
VAS-pain (0=no pain, 10=worst pain), points	2.3±0.6	1.06±0.6	<0.001
VAS-patient satisfaction at discharge (0=least satisfied, 10=most satisfied), points	7.7±1.3	8.2±1.1	NS
VAS-patient satisfaction at 2 months (0=least satisfied, 10=most satisfied), points	8.9±0.9	8.9±0.9	NS

Values are expressed as mean ± standard deviation

* - independent samples t test

EA - epidural anesthesia, GA- general anesthesia, NS -not significant, PCO2 - peak partial carbon dioxide tension in arterial blood, VAS - visual analog score

Long term follow-up

Follow-up was 100% complete in both groups. Patients were followed-up for a mean of 4.9±0.4 years in the EA group and 4.8±0.4 years in the GA group (p>0.05). There were no late deaths in both groups of patients. A total of 7 patients presented with recurrent angina and underwent control coronary angiography (3 in EA group and 4 in GA group, p>0.05) with patent grafts in all. Amongst these, 2 patients in the EA group and 1 patient in the GA group underwent percutaneous coronary interventions (p>0.05).

Discussion

This study revealed that, epidural anesthesia had no impact on the degree of patient satisfaction after MIDCAB surgery, but yielded significantly shorter ICU and hospital stay periods, which may result in more efficient use of hospital resources.

With the advent of off-pump CABG, various technologies have emerged in an attempt to facilitate the operation. Amongst these, high thoracic epidural anesthesia is an important tool; which yields cardiac sympathectomy resulting in vasodilatation of coronary and internal thoracic arteries, and bradycardia without hemodynamic compromise (14, 15). Other advantages include, attenuation of stress response, a favorable oxygen supply/demand ratio for the myocardium, balancing the procoagulant activity observed after off-pump surgery and effective pain control (14-19). These advantages outweigh the most dreaded complication of epidural hematoma formation, which is estimated to be as low as 1 in 150.000 (20). This had led to the utilization of high thoracic epidural anesthesia in patients undergoing CABG with or without general anesthesia (1-12, 21-23).

One of the major drawbacks of off-pump CABG is an increased procoagulant activity observed after the procedure, in part due to increased plasma levels of plasminogen activator inhibitor type 1 (24). It has been documented previously that, epidural anesthesia decreases the plasma plasminogen activator inhibitor type 1 activity (19), thus yielding a fibrinolytic effect, which counterbalances the procoagulant activity observed after off-pump CABG. Depending on this protective effect of epidural anesthesia, EA group patients did not receive heparin therapy immediately after surgery, which may explain the difference in postoperative blood loss between the two groups.

Occurrence of pneumothorax in a spontaneously breathing conscious patient with an open chest had been a major concern by some authors (25). However, with increased experience in performing CABG in the conscious patients without endotracheal general anesthesia, it had become apparent that, single lung diaphragmatic respiration is tolerated quite well by the majority of patients, given that the pleura is widely open (9). Airflow through a small opening in the pleura causes tension in the pleural cavity, which results in respiratory distress and mediastinal shift. However, when the pleura is widely opened, tension is relieved without any respiratory or hemodynamic consequence. Hence, the size of the opening in the pleura determines the consequences of pneumothorax, rather than occurrence of pneumothorax per se.

The RCL method (13), is used in this study, and as it appears to us it is as a facile way to perform MIDCAB to the LAD coronary artery. One of the major advantages of this approach is the wide exposure gained by lifting the rib cage upwards, thus enabling control over the entire length of the LAD. Also, as there is no intercostal nerve traction, the operation is relatively painless, even without an epidural catheter; which may explain the lack of difference in the level of patient satisfaction between the two groups presented in this study. Although EA group patients experienced significantly less pain compared to GA group patients, this was not translated into the extent of patient satisfaction after the procedure.

In our previous experience, we had observed that, elimination of general anesthesia in CABG enabled very early and effective mobilization of the patients, without imposing health risks (9). Others shared this observation as well (5, 7). The application of this strategy to MIDCAB surgery, which is a low-risk procedure even in the presence of serious comorbidities (26, 27), led to the minimization of ICU and hospital stay durations of the patients in the EA group. Although ICU and hospital stay periods of the GA group patients were relatively short, a further decrease in these periods was achieved through epidural anesthesia. Twenty-four patients in the EA group stayed in the ICU less than 8 hours and 10 of these patients - for less than an hour. This effective early mobilization of the patients after MIDCAB surgery has led to the discharge of carefully selected 9 patients, on the same day of their surgery, who met the same day discharge criteria, which was previously reported (9).

Limitation of the study

Relatively small number of patients in the study groups may constitute a limitation regarding the conclusions of the study.

Conclusion

The results of this study imply that, similar surgical results can be achieved by MIDCAB surgery with general or epidural anesthesia. It was previously reported that, significant cost reduction and improved resource utilization can be achieved by utilization of minimally invasive techniques in CABG (28). It can be concluded that, further improvements may be achieved in MIDCAB surgery under epidural anesthesia, by providing more efficient use of hospital resources through shorter ICU and hospital length of stay, without compromising the quality of the operation.

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