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Epidural Anaesthesia and Mini-Laparotomy for the Treatment of Abdominal Aortic Aneurysms in Patients with Severe Chronic Obstructive Pulmonary Disease

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Key words. Epidural anaesthesia, mini-laparotomy, abdominal aortic aneurysm repair ; endovascular treatment.

Abstract. *Purpose :* The purpose of this study is to compare the use of epidural and general anaesthesia techniques in the treatment of abdominal aortic aneurysms (AAA) through mini-laparotomy in patients with severe chronic obstructive pulmonary disease (COPD).
Methods : Between March 2002 and October 2005, 23 patients with severe COPD underwent elective infrarenal abdominal aortic aneurysm repair. Endovascular therapy could not be established due to financial reasons and health insurance policies. All the operations were performed through mini-laparotomy, using epidural anaesthesia on 10 patients (Group I) and general anaesthesia on the remaining patients (Group II). Pulmonary disease was diagnosed by clinical history and pulmonary function tests. The diagnosis of severe COPD was made with the presence of one or more of the following criteria : Room air $PaO_2 \leq 60$ mmHg, $PaCO_2 \geq 45$ mmHg in arterial blood gas samples, $FEV_1 \leq 50\%$ of predicted value and FVC $\leq 75\%$ of predicted value in respiratory function tests.
Results : There was no significant difference between the ages, sex, pre-operative morbidity status, operation time and total blood loss of the patients in the two groups. Postoperative intensive care unit requirement, postoperative pulmonary complications and hospital stay were significantly higher in group II. All patients tolerated surgery safely. There was one in-hospital mortality from group II on the 35th postoperative day due to prolonged entubation and sepsis related to pulmonary infections. There was no late morbidity or mortality related to the technique in the postoperative follow-up period of the discharged patients.
Conclusion : Epidural anaesthesia for abdominal aortic aneurysm repair through mini-laparotomy is feasible and should be especially considered in patients with severe COPD where endovascular treatment could not be performed.

Introduction

The peri-operative morbidity and mortality rates associated with abdominal aortic aneurysm (AAA) repair have improved with the developing surgical and anaesthesiology techniques. Conventional open repair performed with traditional standard median laparatomy is the accepted standard treatment for AAAs. The current mortality rate of the technique is reported to be less than 5% for intact, non-ruptured AAAs (1-3). Although it is a durable and reliable procedure, the open technique may be associated with significant postoperative morbidity and mortality, especially in patients with severe co-existing medical pathologies (4).

Chronic obstructive pulmonary disease (COPD) is a very common co-morbidity factor in patients requiring surgical treatment for vascular disorders. It may frequently complicate the postoperative course of patients undergoing major aortic and vascular surgery. However, the presence of this disease should not be considered as a contra-indication for surgical intervention ; but, rather to identify a subgroup of patients requiring special pre-, peri- and post-operative care.

The optimal surgical approach for aortic surgery in patients with COPD has not been clearly established. In recent years, there has been great interest in less invasive surgical applications including laparoscopy, endovascular grafting and mini-laparotomy approaches. These methods are widely used in almost every area of the surgery as an aid to treatment.

The epidural anaesthesia is a very attractive anaesthetic technique in patients with comorbid conditions and is an option that should be considered, especially in patients with severe COPD. In this respect, we believe that mini-laparatomy and epidural is a feasible and safe alternative to the traditional general anaesthesia and standard median laparatomy, when endovascular treatment could not be established in the treatment of major intra-abdominal vascular pathologies.

Table I

Demographics of the patients

Patients	Group I (n : 10)	Group II (n : 13)	p value
Age	64 years (61 ± 8)	67 years (62 ± 6)	> 0.05
Weight	78 kg (71 ± 14)	78 kg (69 ± 12)	> 0.05
Height	1.67 m (161 ± 14)	1.69 m (163 ± 13)	> 0.05
BMI	27 (25 ± 3)	26 (26 ± 4)	> 0.05
Smoking	10 (43%)	13 (57%)	> 0.05
Hypertension	6 (26%)		
8 (34%)	> 0.05		
Diabetes mellitus	1 (4%)	2	> 0.05
COPD	10 (43%)	13 (57%)	> 0.05
Ischaemic heart disease	6 (26%)	6 (26%)	> 0.05
Peripheral arterial disease	3 (13%)	2 (8%)	> 0.05
AAA size	6.4 ± 1.2 cm	6.1 ± 1.9 cm	> 0.05

BMI, body mass index (weight / height^2) ; AAA, abdominal aortic aneurysm ; COPD, chronic obstructive pulmonary disease.

The purpose of this study was to report our experience with the combination of epidural anaesthesia and mini-laparatomy techniques for the treatment of patients with AAA and to compare the results with the results of those patients undergoing AAA repair with general anaesthesia.

Methods

Between March 2002 and October 2005, 197 patients were treated for AAA at our institution. Among them, 23 patients who had severe COPD and who received elective infrarenal AAA repair, were retrospectively analyzed. Due to financial reasons and health insurance policies endovascular treatment could not be established and aortic surgery was planned.

All the operations were performed by a single surgeon through a mini-laparatomy approach. Patients were all male and were divided into two groups : those receiving epidural anaesthesia (Group I, n : 10 patients) and those receiving general anaesthesia (Group II, n : 13 patients). The mean age was 64 years (range 57 to 71) in group I and 67 years (range 62 to 77) in group II. All patients were symptomatic at the time of diagnosis, the most common symptoms being abdominal and back pain. Other sypmtoms were pulsatile mass in the abdomen and gastro-intestinal disturbances. None of the aneurysms were ruptured. Clinical assessment, electrocardiogram and biochemical analysis were performed as an initial diagnostic work-up. Medical review revealed 12 patients with ischaemic heart disease (52%), three patients with diabetes mellitus (13%) and 14 patients with hypertension (60%). Pre-operative computed tomography was executed routinely in all patients to establish the definitive diagnosis and to determine the positional relationship of the aneurysm and adjacent structures. Further investigations including myocardial perfusion scintigraphy and coronary artery angiography were undertaken as needed for the assessment of any clinical abnormalities. Patients demographics are summarized in Table I.

Pulmonary disease was diagnosed by clinical history and pulmonary function tests. Smoking history was present in all patients. The diagnosis of severe COPD was established by the presence of one or more of the following criteria : room air $PaO_2 \leq 60$ mmHg, $PaCO_2 \geq 45$ mmHg, and $FEV_1 \leq 50\%$ and $FVC \leq 75\%$ of predicted value. Prior to the surgical intervention, all patients were prepared with preconditioning breathing exercises and bronchodilator therapy. The pre-operative respiratory parameters of all patients are summarized in Tables II and III.

Technique of mini-laparotomy

A short midline incision was made, its location depending on the position of the neck of the aneurysm. The measured incision length ranged from 7 to 10 cm. The bowel was maintained within the abdominal cavity and retracted laterally with moistened sterile towels to the right of the aneurysm. If deemed necessary, femoral regions were opened with small incisions (approximately 4 cm) and common, superficial and profunda femoral arteries were dissected and controlled. Following systemic heparinization (a standard of 5000 units), the abdominal aorta was clamped proximal to the aneurysm. The iliac vascular clamps were placed through separate 1 cm stab incisions in the lower abdominal wall. AAA were repaired with aneurysmectomy and a tube graft or bifurcation graft interposition. After haemostasis, aspirative drains were placed, then the abdominal wound and, if present, femoral incisions were closed. Prophylactic antibiotics were used routinely.

Table II

The respiratory parameters of patients in group I

Patients	1	2	3	4	5	6	7	8	9	10
FEV_1 (%)	46	40	48	47	39	48	47	44	45	43
FVC (%)	63	60	61	59	59	61	66	64	62	60
PCO_2 (mmHg)	43	45	42	43	46	43	41	46	44	42
PO_2 (mmHg)	49	56	60	50	48	56	60	61	63	54
SaO_2 (%)	87	90	91	86	85	90	93	94	95	88

FEV_1, Forced Expiratory Volume of predicted ; FVC, Forced Vital Capacity of predicted ; PO_2, Partial Oxygen Pressure ; SaO_2, Room Air Oxygen Saturation.

Table III

The respiratory parameters of patients in group II

Patients	1	2	3	4	5	6	7	8	9	10	11	12	13
FEV_1 (%)	43	48	46	42	47	44	43	41	44	44	48	41	42
FVC (%)	64	64	57	59	58	61	62	60	59	60	64	58	58
PCO_2 (mmHg)	44	43	43	47	46	41	41	43	45	44	44	42	46
PO_2 (mmHg)	59	50	54	58	48	64	57	49	56	56	60	53	62
SaO_2 (%)	94	90	91	89	93	89	88	93	92	90	95	90	91

FEV_1, Forced Expiratory Volume of predicted ; FVC, Forced Vital Capacity of predicted ; PO_2, Partial Oxygen Pressure ; SaO_2, Room Air Oxygen Saturation.

Technique of Anaesthesia

All operations were performed under epidural anaesthesia in Group I and under general anaesthesia in Group II. In the operating room, a radial arterial catheter and multiple peripheral intravenous lines were placed. During the entire procedure, arterial blood pressure, heart rate and oxygen saturation were continuously monitored. Fluid loading at induction was performed with 0.5 to 1.5 L of 6% 130/0.4 hydroxyethyl starch (Voluven) administration. Dopamine, dobutamine, adrenalin, norepinephrine, and nicardipine were used if required to maintain haemodynamic stability. Maintenance of normothermia was achieved with fluid warming and forced-air warming (Bair-Hugger). Blood glucose levels were regulated to normoglycemia (70-150 mg/dl).

Epidural anaesthesia (Group I)

Epidural anaesthesia was performed by placing an epidural catheter (Braun perifix 18 ba and a microporous filter) at the T_8-T_{11} level. A test of the epidural catheterization was carried out with a single test dose of 5 ml 1% lidocaine. Epidural blockade was achieved by administering a dose of 8 ml of ropivacaine hydrochloride (Naropin 2%, AstraZeneca, EU Sweden). Additional doses were repeated if required at the discretion of the attending anaesthesiologist. All patients had spontaneous breathing throughout the operation, with nasal O_2 support. None of the patients required a return to general anaesthesia. Postoperative analgesia was patient controlled epidural analgesia with bupivacaine 0,176% at a constant rate of 5 ml/hour, with the possibility of 2 ml bolus doses on the patient's demand, with a lock-out interval of 20 minutes. Supplementary intravenous paracetamol was also used if necessary.

The epidural catheter was removed on the third postoperative day and postoperative long term pain management was achieved with analgesics thereafter. Patients were encouraged to become mobile under the guidance of a physiotherapist in the early postoperative period.

General anesthesia (Group II)

General anaesthesia was initiated by the induction of etomidate and sufentanil 0,25-0,5 µg/kg. Muscle relaxation was achieved with verucuronium bromide. Maintenance of the anaesthesia was with sevofluorane inhalation and supplements of sufentanil at the discretion of the attending anaesthesiologist. After the operation, patients were transferred to the intensive care unit and extubated under optimal parameters.

Statistical analysis

Data are expressed as mean ± standard error of the mean and categorical variables are reported as percentages. Continuous data were compared by paired samples t-Student test and categorical data by the chi-square test.

The relationship between the pre-operative and postoperative variables in the 2 groups were analyzed with forward stepwise multiple regression analysis. The pre-operative variables included age, weight, height, body mass index, hypertension, diabetes mellitus, hypertension, ischaemic heart disease, aneurysm size and peripheral arterial disease. Statistical significance was indicated with a p value of < 0,05.

Results

The diameter of the aneurysm ranged between 6.4 ± 1.2 cm (range 5.3 to 12 cm mean) in group I and 6.1 ± 1.9 cm (range 5.6 to 9 cm) in group II. Five aortobifemoral bypass operations and five aortic tube graft interpositions were performed in patients in group I and five aortobifemoral bypass operations and eight aortic tube graft interpositions were performed in patients in group II. The mean length of surgery was 120 ± 22 minutes (range 105 to 180 minutes) in group I and 114 ± 26 (range 110 to 160 minutes) in group II, while mean aortic cross-clamp times were 44.5 ± 13 minutes (range 36 to 53 minutes) and 46 ± 16 minutes (range 41 to 57 minutes), in group I and II, respectively. Blood loss was 280 ± 70 ml (range 160 to 570 ml) in group I and 260 ± 420 (range 190 to 450 ml). All the patients in both groups were transferred to the intensive care unit (ICU). None of the patients operated on under epidural anaesthesia developed postoperative respiratory complications ; however patients in group II were extubated at the ICU. Mechanical ventilation time for group II was 5 ± 14 hours (range 4 to 22 hours, excluding one death). All the pateints in group I were transferred to the ward after a one-night stay at the ICU : however, ICU stay was 16 ± 8 hours (range 12 to 34 hours, excluding one death) in group II ($p < 0.023$). Postoperative hospital stay was 6 ± 2.3 days (range 5.5 to 4 days) in group I and 10 ± 4.8 days (range 8 to 6.2 days) in group II ($p < 0,031$). Peri-operative and postoperative data are summarized in Table IV.

There was one in-hospital mortality due to prolonged entubation and sepsis related to pulmonary infections on the 35th postoperative day from group II. Aortic graft replacement was successfully performed in all patients. Intra-operative complications did not occur and no patient required intra-operative conversion to a standard median laparotomy. None of the patients from group I had discomfort or respiratory difficulty during the procedure and general anaesthesia was not required. The haemodynamic parameters of all patients, except one, were within the normal limits throughout the entire surgical intervention. This patient, with a previous history of anterior myocardial infarction, required a low dose of dopamine support during surgery because of hypotension ; however, the procedure was not converted to general anaesthesia.

Although all patients developed mild ileus postoperatively, they resumed a normal diet within two to four days after surgery. No significant increase in serum creatinine levels was noted in any of the patients. At the postoperative follow-up, after being discharged from the hospital, there was no late morbidity or mortality related to the techniques.

Discussion

There has been a continuous effort to decrease the surgical stress on patients undergoing abdominal aortic aneurysm repair by many authors. In recent decades, surgeons have developed less invasive procedures utilizing a mini-laparotomy approach, endovascular stent graft repair, total laparoscopy and hand assisted laparoscopy. In this respect, other than the increasing popularity of widely executed endovascular procedures,

Table IV

Peri-operative and postoperative data of the patients

Patients	Group I (n : 10)	Group II (n : 13)	p value
Aneursym size	6.4 ± 1.2 cm	6.1 ± 1.9 cm	> 0.05
Operartion	5 ABF, 5 Tube Graft	5 ABF, 8 Tube Graft	
Cross Clamp	44.5 ± 13 minutes	46 ± 16 minutes	> 0.05
Operation Time	120 ± 22 minutes	114 ± 26 minutes	> 0.05
Blood Loss	280 ± 70 ml	260 ± 420 ml	> 0.05
Respiratory Complications	0	1 (patient died)	
Ventilation Time	0	5 ± 14 hours	
ICU Stay	the night	16 ± 8 hours	p < 0.023
Hospital stay	6 ± 2.3 days	10 ± 4.8 days	p < 0.031

ABF, Aortobifemoral bypass operation ; ICU, Intensive care unit.

* The patient who died due to prolonged entubation and sepsis related with pulmonary infections on the 35th postoperative day from group II is excluded from the data of the ventilation time and ICU stay parameters in the table.

many studies reported the feasibility of a mini-laparotomy approach in the treatment of both aorto-iliac occlusive diseases and AAA (5, 6, 7) as well as less frequently applied hand assisted laparoscopy (8) or total laparoscopy (9) investigations.

The endovascular stent graft repair for AAA has been increasingly used ; however, this treatment strategy has its own limitations, as stent grafting may not be suitable due to its high cost and is unaffordable in the low income populations where health insurance policies do not cover the cost of the therapy. Other limitations of this method are less commonly complex and tortuous lesions as well as a lack of information regarding the long-term fate of endovascular stent grafts. On the other hand, the most common standard traditional median laparatomy causes significant surgical stress and may be associated with postoperative complications, especially in patients with co-existing medical comorbidities. A long laparotomy incision contributes to prolonged postoperative ileus, significant pain and cosmetic disadvantages (10). Less frequently laparoscopic measures are applied for the treatment of the aortic pathologies but they require special equipment and highly skilled specialised medical personnel, otherwise life threatening complications may be inevitable (8, 9).

The minimal incision concept for the treatment of aortic pathologies has been reported in the literature since 1992, and an incision range of 3-10 cm is called a mini-laparotomy incision (11). The benefits of the mini-laparotomy approach include less compromise and complication of the gastro-intestinal functions, improved respiratory functions, due to decreased postoperative pain, shortened hospital stay and an earlier return to a normal life style (6, 7). Since it does not require any special device and can easily be performed with regular equipment that can be found in most operating theatres, costs of this technique are significantly lower when compared to standard median laparatomy and endovascular stent graft repair, when the procedure is performed by a competent vascular surgeon (12).

Mini-laparotomy is a surgical modification of standard operative techniques with the aim of decreasing postoperative morbidity and mortality. Although it results in lower surgical stress, it may be associated with pulmonary complications such as a decrease in vital capacity and forced expiratory volume postoperatively (13). The compromise in respiratory functions may be very important, especially in patients with severe COPD. Thus, development of a less invasive and safer open investigation may be critically important.

Anaesthetic options for patients undergoing AAA repair include general anaesthesia, epidural anaesthesia, spinal anaesthesia, as well as combinations of them (14, 15, 16, 17). In patients with underlying cardiopulmonary diseases, general anaesthesia is usually associated with haemodynamic instability during the surgery and weaning off mechanical ventilator complications at the end of the procedure. On the other hand, epidural anaesthesia is a safer option, since it preserves spontaneous breathing and provides cardiopulmonary and haemodynamic benefits over general anaesthesia in patients with cardiac disease and severe COPD. It does not significantly deteriorate the pulmonary and gastro-intestinal functions during the postoperative convalescence period which can be commonly affected with a general anaesthesia (18). However, the major concern with epidural blockade is the risk of having to convert to general anaesthesia and in this case it can even be more commonly associated with prolonged ventilatory support, hospital stay and postoperative mortality and morbidity rates. In our series, no patient was converted to general anaesthesia, which is possibly related to the relatively shorter duration of the operations. Many surgeons and anaesthesiologists concentrate on the respiratory parameters during the surgical procedure. However, we believe that haemodynamic instability, especially after clamping the aorta and removing the clamp, may lead to a need for intubation and controlled mechanical ventilation. Therefore, instead of a commonly used local anaesthetic agent, bupivacaine, we used ropivacaine which is known to be associated with lesser cardiac side effects.

There are many reasons why general anaesthetic is commonly favoured by patients undergoing abdominal aortic surgery. The surgeon feels more comfortable operating on an anaesthetized patient. Depending on the duration of the surgery, especially with relatively inexperienced hands, the mini-laparotomy technique requires a longer time than the standard surgical approach, and the patient may become fatigued by maintaining the same position throughout the operation. Various studies demonstrate their results of lower rates of mortality, cardiac failure, infectious complications, and overall postoperative complications in patients given epidural anaesthesia and postoperative epidural anaesthesia, compared with those given general anaesthesia and postoperative parenteral analgesia (15). Also general anaesthesia was shown by means of on-treatment multivariate analysis to be a positive independent predictor of prolonged hospitalization in patients undergoing abdominal aortic surgery (16). The advantages of epidural anaesthesia should be taken into account. In our series, patients operated on with epidural anaesthesia had an overall performance superior to patients operated on with general anaesthesia. Possible shortcomings of epidural anaesthesia, such as epidural haematoma or additional time to perform regional block, should also be acknowledged, but were not documented in our experience.

In summary, based on our experience and together with the review of the literature, epidural anaesthesia for abdominal aortic aneurysm repair through mini-laparotomy is feasible and can safely be applied to patients with severe COPD. The technique has the advantages of more stable intra-operative haemodynamics, improved respiratory functions, early resumption of intestinal functions and decreased length of stay in intensive care units and hospital. Therefore, the combination of these two approaches should be considered as an alternative option for the treatment of patients with abdominal aortic aneurysms who have severe cardiopulmonary risk factors.

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