Endovascular Repair of Abdominal Aortic Aneurysms in Patients with Mild Renal Insufficiency

Hafif Derecede Renal Disfonksiyonlu Hastalarda Abdominal Aorta Anevrizmalarının Endovasküler Tamiri

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ABSTRACT Objective: We aimed to analyze the results of elective endovascular aneurysm repair (EVAR) in patients with mild renal dysfunction. **Material and Methods:** Between April 2004 and August 2012, a total of 137 consecutive patients underwent elective EVAR, mostly under local anesthesia. We compared our results in the patients with normal renal functions (n=107), and the patients with preoperative mild renal dysfunction (serum creatinine 1.5-2 mg/dl, n=30). The operations were performed by the same group of vascular surgeons and radiologists, in a single institution. Preoperative, postoperative, and follow-up serum creatinine and creatinine clearance, demographic data, risk factors, hospital stay, morbidity and development of postoperative renal impairment were compared between the groups. **Results:** There was a significant difference between two groups for postoperative renal complications. Renal complications (5 patients) included contrast-induced acute renal failure in 4 patients in group II, and in one patient in group I. Those patients recovered with 2 or 3 dialysis sessions, without being dialysis-dependent permanently. Univariate and multivariate analyses indicated that presence of coronary artery disease, low ejection fraction, pre-existing renal dysfunction, use of larger volumes of contrast agent, and presence of a difficult anatomy (such as juxtarenal aneurysm, short landing zone) significantly increased the risk for postoperative serum creatinine increase, and pre-existing renal dysfunction, low ejection fraction and high volumes of contrast agent use increased the risk for dialysis. **Conclusion:** EVAR with intra-arterial contrast agents can be accomplished in patients with chronic renal insufficiency who do not require dialysis,with limited and acceptable morbidity and mortality. However, temporary dialysis and and a slight increase in serum creatinine levels should be expected. Our study showed that mild renal insufficiency, low ejection fraction, and high volumes of contrast agent use increased the risk for dialysis. Low ejection fraction, coronary artery disease, renal dysfunction and high volumes of contrast agent use are significant risk factors for postoperative increase in serum creatinine.

Key Words: Abdominal aortic aneurysm; endovascular stent graft; renal failure; dialysis

ÖZET Amaç: Hafif derecede renal disfonksiyonlu hastalarda abdominal aorta anevrizmalarının endovasküler tamiri (EVAR) sonuçlarımızı irdelemeyi amaçladık. **Gereç ve Yöntemler:** Nisan 2004-Ağustos 2012 tarihleri arasında ardışık 137 hastaya çoğunlukla lokal anestezi kullanmak sureti ile elektif EVAR tedavisi uygulandı. Normal renal fonksiyonlu hastalar ile (Grup I, n=107), preoperatif hafif derecede renal fonksiyon bozukluğu olan (Grup II, serum kreatinin 1,5-2 mg/dL, n=30) hastaların sonuçlarını kıyasladık. Operasyonlar aynı kurumdaki aynı cerrah ve radyoloji hekimlerince gerçekleştirildi. Preoperatif, postoperatif ve takip dönemindeki serum kreatinin ve kreatinin klerensleri kıyaslandı. Demografik veriler, risk faktörleri, hastanede kalış süresi, morbidite ve postoperatif renal yetmezlik kıyaslandı. **Bulgular:** Postoperatif renal komplikasyonlar bakımından iki grup arasında belirgin farklılık mevcuttu. Renal komplikasyon olarak (5 hasta) kontrastla indüklenen akut böbrek yetmezliği grup II'de 4 hastada, ve grup I'de 1 hastada gözlendi. Bu hastalar kalıcı olarak diyaliz bağımlısı olmadan, 2 veya 3 kez diyalize alınarak iyileştiler. Univaryans ve multivaryans analizler; koroner arter hastalığı varlığı, düşük ejeksiyon fraksiyonu, mevcut renal disfonksiyon, fazla miktarda kontrast kullanımı, zor anatomi (ör. jukstarenal anevrizma, kısa landing zone) gibi faktörlerin postoperatif dönemde serum kreatinin artışı riskini arttırdığını, mevcut renal disfonksiyon, düşük ejeksiyon fraksiyonu ve fazla miktarda kontrast kullanımının diyaliz riskini arttırdığını göstermiştir. **Sonuç:** Kontrast madde kullanılarak uygulanan EVAR, diyaliz gerektirmeyen renal disfonksiyonlu hastalarda da sınırlı ve kabul edilebilir bir mortalite ve morbidite ile uygulanabilirse de, geçici diyaliz ihtiyacı ve serum kreatininde artış beklenmelidir. Bizim çalışmamızda; mevcut renal disfonksiyon, düşük ejeksiyon fraksiyonu ve fazla miktarda kontrast kullanımının diyaliz riskini arttırdığı gözlenmiştir. Koroner arter hastalığı varlığı, düşük ejeksiyon fraksiyonu, mevcut renal disfonksiyon ve fazla miktarda kontrast kullanımı serum kreatininin artması için belirgin risk faktörüdür.

Anahtar Kelimeler: Abdominal aort anevrizması; endovasküler stent greft; böbrek yetmezliği; diyaliz

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Patients who are candidates for abdominal aortic surgery represent a group carrying a high risk of significant morbidity and mortality due to the nature of the surgery and associated comorbidities. Therefore, endovascular aneursym repair (EVAR) has become a very good alternative.[1,2] Despite the major advantages of EVAR over open repair, there are still some problems.[3,4] It requires intra-arterial administration of radiological contrast agents which can cause impaired renal function, leading to end-stage renal disease. The aim of this study was to review and analyze the results of our patients who had renal dysfunction and underwent EVAR under local anesthesia between 2004 and 2013.

MATERIAL AND METHODS

A total of 137 consecutive patients who underwent infrarenal EVAR between 2004 and 2013 were analyzed in this retrospective study. Over 9-year period, 137 patients underwent EVAR with use of intra-arterial contrast agents. Of those, 107 patients had normal renal functions (group 1), and 30 patients had pre-existing mild renal insufficiency with baseline a creatinine level 1.5-2.0 mg/dl (group 2, n=30). The exclusion criteria included chronic renal insufficiency requiring hemodialysis, symptomatic high-grade renal artery stenosis requiring renal angioplasty and stenting, and emergent cases. All patients received a detailed explanation of the procedure before surgery, and the study was approved by the Hospital's Review Board. For preoperative risk stratification, the patients were scored using American Society of Anesthesiologists (ASA) classification. All procedures were performed by the same team involving cardiovascular surgeons, interventional radiologists and anesthesiologists in a peripheral angiography suite.

Endovascular treatment was indicated for aneurysms greater than 5.5 cm in diameter. All diagnoses were made by computed tomography (CT) angiograms, and the preoperative measurements were made by the same team. All patients were evaluated by the anesthesia and cardiology departments for determining the risk status according to ASA. Patients at high risk, with severe cardiopulmonary disease, hostile abdomen, or other major comorbid conditions were offered treatment with two types of commercial endografts. The following stent grafts were used: Talent and Endurant (Medtronic, Santa Rosa, CA, USA; n=84), Excluder (W.L. Gore & Associates, Flagstaff, AZ, USA; n=53). Demographic data such as gender, age, patient status, risk factors, and body mass index were recorded and compared. Patient data were collected from the computer-based data system.

The patients were not allowed to have any oral intake 8 hours before the procedure. In the preoperative period, the drugs of the patients were continued except for antiaggregants. Premedication was administered with midazolam. A radial arterial line, two peripheral venous catheters (14 or 16 gauge), and a urinary Foley catheter were placed., A central venous catheter was used in all patients (jugular vein) routinely.

Routine precautions in patients with mild renal dysfunction included "staged contrast exposure" by operating the patient 10 days after the diagnostic CT, N-acetyl cysteine treatment, preoperative hydration, discontinuation of all nephrotoxic drugs, intraoperative administration of mannitol (0.5 g/kg intravenously), and use of a nonionic, low osmolar intra-arterial contrast agent (Optiray 350).

ANESTHESIA

Local anesthesia was preferred. When general anesthesia was mandatory after the failure of local anesthesia, it was done in a standard fashion. General anesthesia was induced with fentanyl 0.7-2.0 mg/kg or sufentanil 0.2-0.6 mg/kg, followed by oxygenation and administration of etomidate 0.1-0.4 mg/kg. After loss of the lash reflex, patients were ventilated by mask with 100% O_2, and rocuronium in an intubation dose of 0.6 mg/kg was injected. After that, maintenance doses of etomidate were given, or the patient was ventilated with isoflurane. Anesthesia was maintained with a mixture of fentanyl, rocuronium and an oxygen – isoflurane mixture.

Intraoperative monitoring included continuous electrocardiogram, invasive arterial blood pressure, transcutaneous oxygen saturation, and urine output. Cefazolin sodium was administered intravenously (IV) for antibiotic prophylaxis in the operating room. Oxygen was supplied by nasal cannula, mask, or endotreacheal tube, when necessary. Local anesthesia was achieved using lidocaine 1% into the femoral cut-down site (maximum dose 4 mg/kg). Sedation was achieved by propofol, fentanyl or midazolam, when needed.

Procedure time, fluoroscopy time, the amount of contrast agent used were compared between two groups.

In the postoperative period, cardiac, respiratory and renal complications, intensive care unit stay times and endoleaks were compared between the groups. Renal failure was defined as need for temporary or permanent dialysis, or a increase in creatinine levels (any value more than 1.5 mg/dl). Dialysis indications were severe metabolic acidosis, severe hyperkalemia, and fluid overload which did not respond to diuretic treatment. Respiratory complications were defined as the occurrence of pneumonia, respiratory failure requiring pharmacologic intervention, or ventilatory support. Cardiac complications were defined as presence of precordial pain, electrocardiographical changes, increased cardiac enzymes, symptoms and signs of pulmonary congestion, and ventricular failure. Endoleaks were categorized as described by White et al.[3]

Charts, operative reports, and laboratory data were reviewed. In the initial postoperative period, serum creatinine levels were measured on postoperative days 1, 2 and 3. In patients with worsening renal function, daily serum creatinine measurements were made until renal functions healed or improved. In these patients, serum creatinine was also measured at postoperative office visit, on 10th day. Creatinine clearance indicated measure of glomerular filtration rate (GFR), and was calculated with the Cockroft formula: GFR _ (140 _ Age) _ Weight (kg)/(0.81 _ Serum creatinine [_mol/L]).

STATISTICAL ANALYSIS

In this study, descriptive statistics are showed as mean ± standard deviation (SD) for continuous variables. The distribution of continuous variables for normality was tested with Shapiro–Wilk test. Independent samples t test was performed for variables which were distributed normally. Continuity Correction Chi-Square test and Fisher's Exact Test were used for categoric variables, and were shown as frequency and percentage (%). Univariate binary logistic regression analysis was performed to find risk factors. The analyses were performed using SPSS software (Statistical Package for the Social Sciences, Version 20.0, SPSS Inc. Chicago, Illinois, USA). All p values were two-sided, and a p value of 0.05 or less was considered significant.

RESULTS

The mean age of the patients was 73.1 years. The demographics, and comorbidities in patients undergoing EVAR are summarized in Table 1. There were no significant differences in demographic data, except hyperlipidemia. Hyperlipidemia was more common in patients in group 1 (p=0.011).

Local anesthesia was preferred. Anesthetic conversion from local to general anesthesia was necessary only in 3 patients (2.3%). Anxiety (2 patients) and airway obstruction during the procedure was the causes for conversion to general anesthesia. Preoperative mean creatinine level was 0.99±0.21 mg/dl in group I and 1.73 ± 0.28 mg/dl in group II (p=0.0001). Transfusion of blood products was not required in any patients undergoing EVAR. There was not a statistically significant difference in procedure time, and contrast amount used between two groups. (p=0.143 and p=0.468, respectively). Perioperative features and postoperative intensive care unit and hospital stay times are summarized in Table 2. Intensive care unit stay and hospital stay times were significantly longer in group II (p=0.001). Overall 30-day mortality rate was 0.79%, with the one patient in group I. The cause of death was multi-organ failure triggered by pneumonia. The patient was a 85-year-old male

TABLE 1: Demographic data.

	Group I (normal renal function) (n=107 patients 78%)	Group II (renal dysfunction) (n=30 patients 21.8%)	p
Female gender	38 (35.5%)	13 (43.3%)	0,569
Age	78 ± 5.2	72 ± 9.3	0.002
ASA III	44 (41%)	17 (56.6%)	0,191
ASA IV	18 (16.8%)	8 (26.6%)	0.341
Smoking	74 (69.1%)	17 (56.6%)	0.288
Hypertension	83 (77.5%)	21 (70%)	0.538
COPD	43 (40.1%)	9 (30%)	0.422
Diabetes mellitus	36 (33.6%)	11 (36.6%)	0.486
Hyperlipidemia	39 (36.4%)	4 (13.3%)	0.029
Body mass index	26 ± 2.3	25 ± 3.1	0.108
Peripheral arterial disease	21 (19.6%)	8 (26.6%)	0.561
Coronary artery disease	28 (26.1%)	11 (36.6%)	0.370
Low ejection fraction (below 35%)	32 (29.9%)	12 (40%)	0.409
Difficult anatomy	12 (11.2%)	4 (13.3%)	0.752
Preoperative creatinine level (mg/dl)	0.99±0.21	1.73 ± 0.28	0.00001

ASA: American Society of Anesthesiologists, COPD: Chronic obstructive pulmonary disease.

TABLE 2: Operation details and postoperative period.

	Group I (Normal renal function)	Group II (Renal dysfunction)	p
Operation time	153 ± 18.3 mins	157 ± 11.2 mins	0.143
Floroscopy time	33 ± 3.5 min	31.2 ± 2.4 min	0.002
Contrast	167 ± 54 ml	158 ± 61 ml	0.468
ICU stay time	1.4 ± 0.6 days	3.7 ± 1.8 days	<0.001
Hospital stay time	3.2 ± 1.1 days	5.6 ± 1.3 days	<0.001

ICU: Intensive care unit.

with ASA IV status. Cardiac complications were observed in four patients (3 in normal renal function group, 1 in renal dysfunction group) and included myocardial infarction, atrial fibrillation in two patients and congestive heart failure. Pulmonary complications included decompensation of pre-existing chronic obstructive pulmonary disease (COPD) requiring ventilatory support in two patients, pneumonia and pleural effusion. Renal complications (5 patients) included contrast-induced acute renal failure in 4 patients in group II, and one patient in group I. Those patients recovered after 2 or 3 dialysis sessions without being dialysis-dependent permanently. One patient with compensated renal failure became dialysis dependent (in renal dysfunction group, Group II). There was one patient in group I who required temporary dialysis. This patient had a juxtarenal aneurysm, and needed internal iliac artery coil embolization. Postoperative complications requiring for dialysis were significantly higher in group II (p=0.0001). Operative details, mortality and renal complications in the postoperative period are summarized in Tables 2 and 3. Serum creatinine levels increased in 10 patients when compared to the preoperative levels (7 patients in group II, and 3 patients in group I, p=0.001). In all these patients, the amount of contrast used was more than 200 ml. Mean serum creatinine levels in postoperative 1st, 3rd and 10th days were 1.14±0.2, 1.17±0.18 and 1.18±0.21 mg/dl, respectively in group I (p=0.001). Mean serum creatinine levels in postoperative 1st, 3rd and 10th

TABLE 3: Mortality and renal complications in the postoperative period.

	Group I		Group II		
Variables	**n=107**	**%**	**n=30**	**%**	**p**
Mortality	0	1	3.3	n.s	
Temporary dialysis	1	0.9	4	16.6	p=0.0001
Permanent dialysis	0	1	3.3	n.s	
Increase in creatinine level	3	2.8	7	23.3	p=0.0001

n.s = not significant.

days in group II were 1.96±0.46, 2.04±0.63 and 1.93±0.74 mg/dl, respectively in group II. Mean creatinine clearance levels are shown in Figure 1.

There was no accidental coverage of renal arteries. In 6 patients, suprarenal fixation was needed. Intensive care unit and hospital stay times were significantly shorter in group I (p=0.034) There was no conversion to open surgery. Access-related complications were observed in one patient in group I, and one in group II (one groin hematoma and one groin infection). None of these access sites required surgery. Postoperative pain management was handled by use of non-steroidal anti-inflammatory drugs, paracetamol, or opioids, when needed. Postoperative pain management was not different between the groups.

Type I endoleak was observed in four patients (2.7%). Three type I endoleaks were observed in group I with challenging aneurysm morphologies, short landing zones and angulated necks. The solution for type I endoleaks were maintained by endovascular procedures. There were 18 type II endoleaks in group I, and 5 in group II. There was one type III endoleak in group I.

Univariate analysis did not indicate peripheral arterial disease, hypertension, smoking, chronic obstructive pulmonary disease or diabetes mellitus as significant risk factors for worsening renal insufficiency or death. Univariate analysis indicated that presence of coronary artery disease, low ejection fraction, preexisting renal dysfunction, use of larger volumes of contrast agent, difficult anatomy (such as juxtarenal aneursym, short landing zone) significantly increased the risk for increased postoperative serum creatinine (p=0.001). Chronic renal insufficiency, low ejection fraction and increased contrast agent increased the risk for dialysis (p<0.05). When chronic renal insufficiency value increased 1 unit, the risk of dialysis increased 5.2 units (95 C.I.% 4.7_5.4) (p=0.08), and the risk of rise in creatinine levels increased 4.7 units (95 C.I.% 4.4_5) (p=0.04). When low ejection fraction value increased 1 unit, the risk of dialysis increased 4.2 units (95 C.I.% 3.8_4.4) (p<0.001), and the risk of rise in creatinine levels increased 7.1 units (95 C.I.% 6.6_7.3) (p<0.001). When contrast agent value increased 1 unit, the risk of dialysis increased 2.2 units (95 C.I.% 28_2.5) (p<0.001), and the risk of rise in creatinine levels increased 3.1 units (95 C.I.% 2.7_3.3) (p<0.001). Table 4 shows the summary of the risk factors.

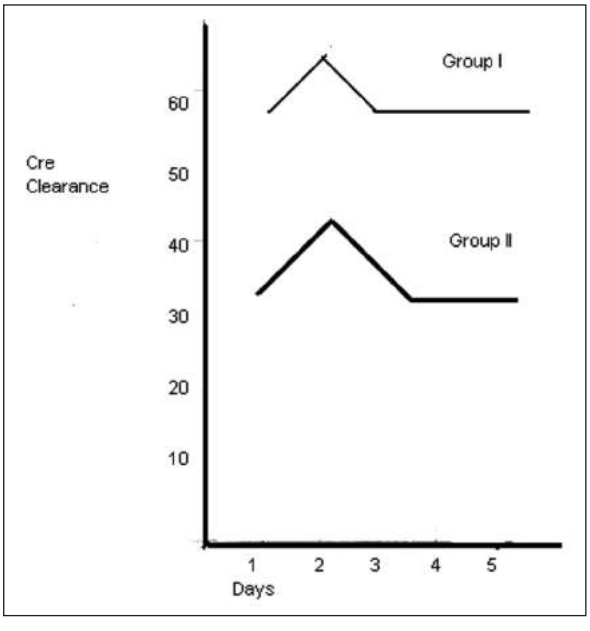

FIGURE 1: Postoperative creatinine clearance levels.

TABLE 4: Univariate risk analysis.

	Dialysis				Rise in serum creatinine level			
			95%CI for OR				95%CI for OR	
Risk factors	p value	OR	Lower	Upper	p value	OR	Lower	Upper
Low EF (below 35%)	<0.001	4.2	3.8	4.4	<0.001	7.1	6.6	7.3
Contrast agent	<0.001	2.2	2	2.5	0.002	3.1	2.7	3.3
Coronary artery disease	0.40	1.8	1.5	2.1	0.002	2.3	1.3	2.5
Peripheral arterial disease	0.60	1.7	1.5	1.9	0.7	0.9	0.7	1.1
Renal dysfunction	0.03	5.2	4.7	5.4	0.04	4.7	4.4	5
Smoking	0.40	2.1	1.8	2.4	0.5	1.5	1.3	1.8
COPD	0.50	1.4	1.2	1.6	0.7	1.8	1.5	2
Pre- and postoperative hypotension	0.08	1.9	1.7	2.2	0.07	2.4	2.2	2.7
Diabetes mellitus	0.60	1.8	1.6	2	0.8	1.6	1.3	2
Anatomic difficulties (juxtarenal aneursyms)	0.06	2.7	2.4	2.9	0.001	5	4.6	5.3

OR: Odds ratio, CI: Confidence interval, EF: Ejection fraction, COPD: Chronic obstructive pulmonary disease.

Mean follow up period was 28.3 ± 11 months. In that period, 3 patients became dialysis-dependent. In the follow up period, CT angiogram with contrast agent was not used in patients with renal dysfunction. Doppler ultrasonography and CT without contrast were the primary choices in patients with renal dysfunction.

DISCUSSION

Abdominal aortic aneurys is a life-threatening condition, and a successful outcome depends on many factors, including surgical and anesthetic expertise, adequate hospital facilities to deal effectively with complications (e.g. cardiology, critical care and renal support), and general cooperation between different specialties for perioperative management. Just as in all fields of surgery, developments have occurred in the direction of minimally invasive techniques to reduce mortality, morbidity, and discomfort to patients. In vascular surgery, this direction has been embodied by the development of EVAR.

Over the past decade EVAR with intra-arterial contrast agents has become an established method for aortoiliac aneurysm repair. It requires intra-arterial administration of radiological contrast agents, which can cause impaired renal function leading to end-stage renal disease. Chronic renal insufficiency is a relative contraindication for use of intra-arterial contrast agents, and is thought to further increase the risks of EVAR. Another patient population at increased risk for perioperative complications after open or endovascular repair are those with preoperative renal insufficiency. Although recent studies have shown that progressive renal dysfunction may develop in patients after EVAR, data are conflicting about the effect of EVAR on renal function.[4,5] The incidence of worsening renal function in patients undergoing an open aneurysm repair with normal preoperative renal function is below 6%, and two- to threefold increases may be seen in patients with preexisting chronic renal insufficiency.[4] Some reports showed that mortality in patients undergoing EVAR with preexisting chronic renal insufficiency was significantly higher when compared to patients without renal problems.[6] On the contrary, some reports demonstrate that with perioperative precautions, including adequate intravenous hydration, use of low osmolar contrast agents, avoidance of nephrotoxic drugs, and use of mannitol to promote diuresis, risk for worsening of renal failure was low, and not significantly increased in patients with preexisting chronic renal insufficiency when compared to the patients with normal renal function.[4] In our study, renal dysfunction was found as a major risk factor for worsening of renal failure even if mortality and morbidity rates were comparable with patients with normal renal functions. Some authors

reported their experience in 116 patients at high risk undergoing EVAR. Twenty-six of their patients with preexisting chronic renal insufficiency received mean intra-arterial contrast volume of 155 ml during EVAR, and a transient increase in serum creatinine developed postoperatively in only one patient.[7] In our study, serum creatinine levels increased in seven patients, which may be attributed to comorbid factors and larger amount of contrast volume used.

Another issue in patients undergoing EVAR is contrast nephropathy. Patients with chronic renal insufficiency, particularly in association with diabetic nephropathy and dehydration, are increasingly susceptible to the deleterious effects of intra-arterial contrast agents. In our study, despite precautions taken in the perioperative period (using an automated volume controllable power injector for contrast delivery and trying to use minimum amount of contrast agent and diluting the contrast up to 30%), using contrast agent more than 200 ml (usually as a result of repeated angiograms due to anatomically challenging cases such as short landing zones, internal iliac artery coiling, endoleak controls) was a risk factor in increased serum creatinine levels and postoperative dialysis. The patients with renal dysfunction underwent EVAR at least 10 days after CT scanning. Adequate intravenous hydration, use of N-acetyl cysteine (600 mg orally twice daily), using local anesthesia, avoidance of nephrotoxic drugs, avoidance of perioperative hypotension, and use of mannitol when required were the other precautions. In our series, our strategy was waiting for 10 days between the diagnostic CT angiogram and the procedure. We may comment that we might have get better results in preventing the increase in serum creatinine if we did the same "staging" strategy especially in patients who needed internal iliac artery coil embolizations. In our series, renal complications (5 patients) included contrast-induced acute renal failure in 4 patients in group II, and one patient in group I. These patients recovered with 2 or 3 dialysissessions without being dialysis-dependent permanently. One patient with compensated renal failure became dialysis dependent (in renal dysfunction group, group II). There was one patient in group I who required temporary dialysis. This patient had a juxtarenal aneurysm, and needed internal iliac artery coil embolization. The need of a prolonged floroscopy time and increased contrast amount were the major risk factors for dialysis. In the follow up period, 3 patients became dialysis-dependent which may be attributed to the progressive nature of the chronic compensated renal disease.

It is well recognized that renal dysfunction is common in patients with heart failure, and it is a poor prognostic factor.[8-12] Chronic heart failure (CHF) is caused by loss of ventricular function and by various adaptational responses, including neurohormonal activation, peripheral vasoconstriction, and salt and water retention.[8] A large number of clinical, hemodynamic, biochemical, and electrophysiological factors have now been identified that are related to prognosis in patients with CHF.[11] In routine clinical practice, left ventricular ejection fraction carries an independent prognostic value.[8-10] It was also demonstrated that renal hemodynamic reserve is already impaired in patients with asymptomatic left ventricular dysfunction In our study, patients with low ejection fraction had a significant tendency for having impaired renal functions. Other preexisting comorbid conditions, including smoking, COPD, hypertension, and diabetes mellitus did not have any adverse effects on worsening renal functions.

Another important factor is the choice of anesthesia. It is well known that anesthesia and surgical stress have a significant effects on renal functions and body fluid regulation in both direct and indirect ways. Inhalation anesthetics generally reduce glomerular filtration and urine output. Volatile anesthetics in general cause a decrease in glomerular filtration rate likely caused by a decrease in renal perfusion pressure either by decreasing systemic vascular resistance (eg, isoflurane or sevoflurane) or cardiac output (eg, halothane). This decrease in glomerular filtration rate is exacerbated by hypovolemia and the release of catecholamines and antidiuretic hormone as a response topainful stimulation during surgery.[11] Positive-

pressure ventilation used during general anesthesia can decrease cardiac output, renal blood flow, and glomerular filtration rate. Decreased cardiac output leads to a release of catecholamines, rennin, and angiotensin II, with the activation of the sympathoadrenal system, and resultant decrease in renal blood flow.[12] Although the only proven direct toxic effect is fluoride-related toxicity of methoxyflurane, it may be speculated that local or regional anesthesia may be a safer way for preventing renal dysfunction. In our study, the vast majority of the patients were treated with endovascular stent grafts under local anesthesia. In addition to many advantages we believe that "local anesthesia first" is a good alternative in preserving renal functions by both avoiding anesthetic drugs and mechanical ventilation.

Our study shows that EVAR can be accomplished in patients with mild renal insufficiency, with acceptable morbidity and mortality. Presence of coronary artery disease, low ejection fraction, preexisting renal dysfunction, use of larger volumes of contrast agent, difficult anatomy (such as juxtarenal aneursym, short landing zone), significantly increased risk for increased postoperative serum creatinine. Chronic renal insufficiency, low ejection fraction and increased contrast agent use increased the risk for dialysis. Preacautions are mandatory for minimizing the renal complications in patients with mild renal insufficiency.

Conflict of Interest

Authors declared no conflict of interest or financial support.

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