Acute Kidney Injury After Endovascular Repair of Abdominal Aortic Aneurysm

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ABSTRACT

Introduction: The aim of this study is to determine the prevalence of acute kidney injury after endovascular repair of an abdominal aortic aneurysm and examine the risk factors.

Patients and Methods: Patients who underwent endovascular repair of abdominal aortic aneurysms between November 2013 and March 2019 were examined retrospectively. We have excluded the patients who had ruptured abdominal aortic aneurysms and were undergoing emergency repair and those who underwent endovascular procedures, such as renal or iliac stenting, in addition to endovascular repair. Other than procedural exclusion criteria, patients dependent on dialysis, those having acute kidney injury and those with missing data were not included in the study. The acute kidney injury was diagnosed in patients according to Kidney Disease: Improving Global Outcomes definition.

Results: Out of 185 patients who underwent elective endovascular repair of abdominal aortic aneurysms, 167 patients were included in this study. There was no in-hospital mortality or requirement of reintervention. An acute kidney injury developed in 23 (13.8%) patients and 6 (3.3%) of these patients needed hemodialysis. The preoperative renal functions of patients who needed hemodialysis after the endovascular repair were significantly impaired than those who did not need hemodialysis [p< 0.001; CI (25.79-61.62)].

Conclusion: With new acute kidney injury definitions, the frequency of endovascular aneurysm repair-related acute kidney injury is much higher than expected. If acute kidney damage has developed after an endovascular repair, it is permanent and patients should be closely monitored for renal function.

Key Words: Renal failure; endovascular procedures; abdominal aortic aneurysms; acute renal injury

Endovasküler Abdominal Aorta Anevrizma Onarımı Sonrası Akut Böbrek Hasarının Değerlendirilmesi

ÖZET

Giriş: Bu çalışmanın amacı, endovasküler abdominal aort anevrizması onarımı sonrası akut böbrek hasarı prevalansını belirlemek ve risk faktörlerini incelemektir.

Hastalar ve Yöntem: Kasım 2013-Mart 2019 tarihleri arasında abdominal aort anevrizması nedeniyle endovasküler onarım yapılan hastalar geriye dönük olarak incelendi. Acil onarım yapılan rüptüre abdominal aort anevrizmaları ve endovasküler onarımın yanı sıra renal veya iliyak çıplak stentleme gibi endovasküler işlemler uygulanan hastalar çalışma dışı bırakıldı. İşlemsel kısıtlamalar hariç; diyalize bağımlı ve akut böbrek hasarı olan hastalar ve veri eksikliği olan hastalar çalışmaya dahil edilmedi. Akut böbrek hasarı tanısı böbrek hastalığına; global sonuçlar iyileştirilmesi tanımına göre konuldu.

Bulgular: Yüz seksen beş hastaya abdominal aort anevrizmaları için elektif olarak endovasküler onarım yapılmış ve 167 hasta çalışmaya dahil edilmiştir. Hastane içi mortalite veya yeniden girişim olmamıştır. Yirmi üç (%13.8) hastada akut böbrek hasarı gelişmiş ve bu hastaların 6 (%3.3)'sında hemodiyaliz gerekmiştir. Endovasküler onarım sonrası hemodiyalize ihtiyaç duyan hastaların ameliyat öncesi böbrek fonksiyonları, hemodiyalize ihtiyaç duymayanlara göre anlamlı derecede bozuk saptanmıştır [p< 0.001; CI (25.79-61.62)].

Sonuç: Yeni akut böbrek hasarı tanımları ile endovasküler anevrizma onarımına bağlı akut böbrek hasarı sıklığı beklenenden çok daha yüksektir. Endovasküler onarımdan sonra akut böbrek hasarı geliştiyse, kalıcıdır ve hastalar böbrek fonksiyonu açısından yakından izlenmelidir.

Anahtar Kelimeler: Böbrek yetmezliği; endovasküler prosedürler; abdominal aort anevrizmaları; akut böbrek hasarı

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INTRODUCTION

Abdominal aortic aneurysm (AAA) is a vascular condition that leads to the risk of a life-threatening rupture. According to the autopsy studies, the rate of occurrence of AAA is in the range of 0.5% to 3.2%[1]. Traditionally, the treatment of an AAA is performed with an open surgical repair (OSR) through a large abdominal incision. As an alternative to OSR, an endovascular aneurysm repair (EVAR) has been put into practice, especially with technical developments, and has become the preferred treatment method in eligible patients[2,3]. Due to the minimally invasive nature, EVAR has better recovery and early term results compared to OR[4].

However, acute renal failure caused by the use of contrast agents, ischemia, and embolism is one of the complications that need attention while performing an EVAR[5,6]. When describing acute kidney injury (AKI), a broad spectrum ranging from slight increases in the parameters of a renal function test to a renal replacement therapy is taken into consideration. The occurrence of AKI after surgical procedures causes a significant increase in the mortality and morbidity rates and the cost associated with hospital stay[7].

Therefore, especially in recent years, the identification of AKI and determination of risk factors and preventive measures have become major concerns. The aim of this study is to determine the prevalence of AKI after EVAR in our center and to examine the risk factors.

PATIENTS and METHODS

Patients who underwent EVAR for an AAA between November 2013 and March 2019 were examined, retrospectively. Hostile anatomies in all patients were suitable for EVAR, and only elective repairs were included in the study. The ethics committee of our institute has approved this retrospective study (2018.6/8-109). We have excluded the patients undergoing emergency repair due to ruptured AAAs and those who underwent endovascular procedures, such as renal or iliac bare stenting, in addition to EVAR. Besides procedural exclusion criteria, dialysis-dependent and AKI patients and those with missing data were also not included in the study.

A nonionic low osmolar contrast agent (Iohexol, OmnipaqueTM) was used in all patients. Before and after the procedure, hydration was adjusted considering the fluid volume of the patient, and oral N-acetyl cysteine (1200 mg/day) was started one day before the procedure. The AKI diagnosis was made based on Kidney Disease: Improving Global Outcomes (KDIGO) definition, which states that an increase in serum creatinine level above 0.3 mg/dL within 48 hours or an increase in serum creatinine level more than 1.5 times over basal creatinine values within 1 week is evaluated as acute renal failure.

Statistical Analysis

The data were analyzed using SPSS version 20 (SPSS, Chicago, IL, USA). The distribution of continuous variables was evaluated using the Kolmogorov-Smirnov test. While descriptive analyzes were presented, number and percentage values were used. Forcategorical variables, the X^2 test or the Fisher exact test was used as appropriate. A comparison of the data of patients with and without acute renal failure was made using the Mann-Whitney U test. The Wilcoxon test was used to monitor the change in glomerular filtration rate before and after the procedure. Logistic regression analysis was performed to evaluate the factors in the investigation of the causes of acute renal failure; $p< 0.05$ was considered statistically significant.

RESULTS

Between 2013 and 2019, 185 patients underwent elective EVAR due to AAA, out of which 167 patients were included in this study and their data were examined for the presence of AKI. There was no in-hospital mortality and none of the patients required conversion to OSR. Endoleak was not detected in any of the patients on digital subtraction angiography after the procedure or CT angiography before discharge.

AKI had developed in 23 (13.8%) patients according to the KDIGO criteria. Six (3.3%) of these patients needed hemodialysis. There was no difference between patients with and without AKI when compared with age, sex, ejection fraction, diabetes, pre-procedure renal function, and amount of contrast agent used in the procedure (Table 1).

Moreover, no relationship was observed in the multivariable analysis for AKI with factors that increase the risk of kidney failure, such as age, gender, diabetes, serum albumin level, C-reactive protein level, ejection fraction of patients, pre-procedure renal functions, and contrast agent use (Table 2).

According to the definition of AKI, renal functions at the 3rd month after EVAR were significantly more impaired than before the procedure ($p= 0.004$, $z= 2.89$). Also, preoperative renal functions of patients who needed hemodialysis after EVAR were significantly impaired than those who did not need hemodialysis [$p< 0.001$; CI (25.79-61.62)].

DISCUSSION

EVAR is a less invasive procedure with lower perioperative mortality and morbidity than open surgery in the treatment of AAA. Although during EVAR, patients are exposed to lesser perioperative bleeding and no aortic clamping, the development of AKI is significantly observed after the procedure[8]. The rate of incidence of AKI varies from 3% to 19% in patients who underwent endovascular repair, and this broad range of values has been linked to the differences in the definition of AKI used

Table 1. Preoperative baseline characteristics and postoperative parameters of AAA patients

	All patients	Non-AKI (n= 144)	AKI (n= 23)	p
Age (years)	67.8 ± 9.7	69 (18-87)	70 (47-81)	0.747
Male sex (n, %)	165 (89.2)	128 (88.9)	20 (87)	0.729
Diabetes mellitus (n, %)	44 (24)	34 (23.9)	5 (21.7)	0.817
EF (%)	65 (20-65)	65 (20-65)	65 (20-65)	0.824
Baseline SCr (mg/dL)	0.99 (0.4-4.12)	0.97 (0.4-4.12)	1.07 (0.51-2.3)	0.234
Baseline eGFR (mL/min/1.73 m²)	78 (15-135)	78 (15-131)	74 (23-110)	0.299
Albumin (g/L)	4 (1-4.9)	3.98 (1-4.9)	4.05 (2.1-4.6)	0.279
Total protein (g/dL)	7.2 (3-8.6)	7.1 (3-8.6)	7.315 (6.34-8.3)	0.111
Uric acid (mg/dL)	6.2 ± 1.8	6.3 (3-10.9)	6.6 (4-9.1)	0.516
CRP (mg/L)	1.02 (0.3-28.9)	1.06 (0.34-28.34)	0.64 (0.34-20.1)	0.569
Hemoglobin (g/dL)	12.96 ± 1.86	13.1 ± 1.87	13.11 ± 1.83	0.976
Contrast media (cc)	90 (45-240)	90 (45-240)	90 (60-230)	0.761
eGFR (1st week) (mL/min/1.73 m²)	74 (13-126)	80 (14-126)	39 (13-81)	< 0.001
eGFR (3rd month) (mL/min/1.73 m²)	66.47 ± 24.81	70 (13-122)	50 (18-108)	0.02

EF: Ejection fraction, SCr: Serum creatinine, eGFR: Estimated glomerular filtration rate, CRP: C-reactive protein, AKI: Acute kidney injury.

Table 2. Risk factors of postoperative AKI following EVAR

		(95% CI)		
	OR	Lower	Upper	p
Contrast media	0.992	0.975	0.316	1.008
Age	0.98	0.935	0.398	1.027
Diabetes mellitus	0.807	0.238	0.73	2.732
Sex	1.02	0.201	0.981	5.168
Ejection fraction	1.03	0.964	0.387	1.1
Baseline SCr	1.767	0.745	0.196	4.188
Albumin	1.623	0.445	0.463	5.921
C-reactive protein	1.022	0.871	0.79	1.2

SCr: Serum creatinine, OR: Odds ratio.

in several studies[3]. In addition, in most studies, the diagnosis of AKI was simply calculated by an increase in serum creatinine level observed within the first 24-48 hours or a decrease in creatinine clearance. Especially in studies using recent AKI definitions, the rates of incidence of AKI after EVAR were observed to be higher, and it was emphasized that AKI is a more serious complication[9]. In our study, the recent AKI definition of KDIGO was used, and the incidence rate of AKI after EVAR was found to be 13.8%. This rate is similar to the data found in the literature. Also, it has been observed that hemodialysis was required in 3.3% of the patients.

In addition to the increase in mortality and morbidity rates of hospital stay also increases for patients who develop AKI after EVAR[7]. Therefore, determining the factors that can contribute to the development of AKI after EVAR and taking necessary precautions have become important in patients undergoing the intervention. Moreover, due to the contrast-induced nephropathy experienced after percutaneous coronary interventions, the amount of contrast agent used is considered as a risk factor in the development of AKI after endovascular procedures.

Injecting a contrast agent directly near the renal artery ostium for imaging during EVAR results in a) decrease in vaso-

dilation due to local prostaglandin and nitric oxide, b) direct toxic effects on tubular cells due to free radicals, c) increase in intratubular pressure associated with diuresis induced by the contrast agent, and d) increase in urine viscosity and tubular obstruction, resulting in the development of medullary ischemia and nephropathy[3].

Contrary to expectations, in studies related to kidney damage developed after EVAR, no relation was found between the amount of contrast agent and AKI[9]. In our study, the amount of contrast agent used in patients with and without AKI was similar, and the role of contrast agent in kidney injury physiopathogenesis has not been observed.

In EVAR-related AKI, the GFR, which is an indicator of renal function, is another important factor to be considered before the procedure. However, there is no consensus in the literature about whether preoperative renal functions have an effect on the development of AKI after the EVAR procedure. Saratzis et al. reported that patients with AKI had impaired kidney function before the procedure compared to patients without AKI, but in multivariate analyzes, pre-procedure kidney function was not seen as an independent risk factor[9]. However, another similar study reported that pre-procedure renal function was not related to its progression in post-procedure chronic kidney disease staging[10]. Therefore, there is a contradiction in the literature about the relationship between pre-procedure renal functions and post-procedure AKI. In our study, no relation was found between pre-procedure renal functions and EVAR-related AKI. However, it was observed that the patients who needed hemodialysis in the first week after EVAR had impaired kidney function before the procedure. Therefore, it is necessary to be prepared for post-procedure renal replacement therapies, especially in patients with pre-procedure renal dysfunction. In addition, the data in the 3-month follow-up shows that the renal functions of patients with AKI continue poorly and may become chronic compared to patients without AKI.

During the EVAR procedure, microembolics from the vascular wall due to catheter and wire manipulations have been accused of AKI physiopathogenesis, but there is no evidence related to microembolics or infarction in the control imaging methods confirming this relationship in the literature[9,11]. Another hypothesis in EVAR-related AKI physiopathology is the ischemic process that occurs in the lower extremities due to the use of large sheaths. In a standard EVAR procedure, the lack of lower limb circulation for at least 45-60 minutes, and subsequent release of myoglobin and inflammatory mediators due to reperfusion may lead to kidney injury[12].

This study has few limitations because of its observational, retrospective nature. Moreover, there is lack of long-term results that cannot be examined because of insufficient data.

In conclusion, the EVAR procedure has become a frequently used method in the present treatment of AAAs. Currently, with the use of new AKI definitions, the frequency of EVAR-related AKI is much higher than expected. If acute kidney damage has developed after EVAR, it is permanent and patients should be closely monitored for renal function.

Ethics Committee Approval: University of Health Sciences, Kartal Kosuyolu High Speciality Training and Research Hospital Non-Invansive Clinical Research Ethics Committee has approved this retrospective study (2018.6/8-109).

Informed Consent: This is retrospective study, we could not obtain written informed consent from the participants.

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