Suprarenal Fixation is associated with Worse Midterm Renal Function after Endovascular Abdominal Aortic Aneurysm Repair, compared with Infrarenal Fixation.

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ARTICLE HIGHLIGHTS

Type of Research: Nonrandomized retrospective observational study

Key Findings: EVAR with a suprarenal fixation device is an independent predictor of midterm renal function decline. After propensity score matching, a comparison of renal outcomes in 87 pairs who underwent EVAR with supra-(SR) and infrarenal (IR) endograft fixation devices was performed. EVAR with SR endograft fixation is associated with worse outcomes for midterm renal function.

Take home Message: EVAR with suprarenal endograft fixation is an independent predictor of midterm renal function decline.

Table of Contents Summary

EVAR with suprarenal endograft fixation is associated with worse outcomes for midterm renal function in this retrospective observational study of 237 patients who underwent EVAR.

ABSTRACT

Introduction: Several reports have indicated that suprarenal fixation may impair renal function after endovascular abdominal aortic aneurysm repair (EVAR). However, most were short-term or at most, 1-year observational studies; therefore, the midterm effects on renal function remain unclear. This study aimed to identify predictors of midterm renal dysfunction after EVAR and compare renal outcomes in patients after EVAR with supra- and infrarenal fixation.

Methods: A total of 467 patients who underwent EVAR of nonruptured infrarenal abdominal aortic aneurysm (AAA) between 2007 and 2014 were reviewed in a prospectively collected database. Patients on hemodialysis at baseline were excluded. Among the remaining patients, those with 3-year laboratory testing were included in this study. Patients who developed acute kidney injury (AKI) were excluded from the late renal function estimation. Predictors of 3-year renal function decline were estimated using logistic regression analysis. In addition, patients undergoing EVAR with infra- (IR group) and suprarenal fixation devices (SR group) were propensity matched by age, sex, baseline renal function, baseline aneurysm diameter, comorbidities, smoking habits, and regular use of medicines that may act on kidney function. Changes in renal function after surgery were compared between the IR group and the SR group.

Results: During the study period, 237 patients (102 IRs and 135 SRs) were followed up with laboratory testing 3 years postsurgery. Logistic regression analysis revealed that the use of a suprarenal fixation device was independently predictive of a more than 20% decrease in the estimated glomerular filtration rate (eGFR) 3 years after EVAR (OR, 2.06; 95% CI, 1.18-3.58) [*p* =.011]. Eleven patients who developed AKI (1 IR and 10 SRs) were excluded from the subsequent analysis. After propensity score matching, 87 pairs were selected (mean age; 77.2 ± 6.3 years and 151 males (86.8%)). The mean follow-up duration was 5.5 ± 1.8 years. In the SR group, eGFR at 3 years after surgery decreased significantly more than that in the IR group (mean 17.8% vs 11.6%, respectively) [*p* =.034].

Conclusion: This study suggests that compared with EVAR with infrarenal endograft fixation, EVAR with suprarenal endograft fixation is associated with worse outcomes for midterm renal function.

INTRODUCTION

Endovascular aneurysm repair (EVAR) has become a standard treatment for abdominal aortic aneurysm (AAA) and has significantly improved short-term outcomes compared with open surgical repair (OSR).[1–3] However, this treatment involves several problems, such as higher rates of reintervention, sac enlargement and rupture, and late loss of the early survival benefit.[4–8] While an association between renal function decline (RFD) and mortality has been reported,[9] the long-term decline in renal function is more severe after EVAR than after OSR.[10]

Previous studies reported that suprarenal (SR) fixation increases the risk of post-EVAR renal impairment.[11–13] Although there are three meta-analyses comparing the effect of fixation type on renal function, two of them did not show a statistically significant difference between SR fixation and infrarenal (IR) fixation of endografts.[13–15] In addition, most of the included studies were short-term observational studies, and each included small numbers of patients with highly variable definitions of RFD. Thus, conclusions of previous meta-analyses should be treated with caution, and further study about the influence of SR fixation on renal outcomes, especially over longer periods, is needed.

This study aimed to identify predictors of midterm renal dysfunction after EVAR and to compare renal outcomes in patients after EVAR with SR and IR fixation.

METHODS

Study population

Patients who underwent elective EVAR for an infrarenal AAA between June 2007 and December 2014 at our institution were reviewed. Of these, patients followed up with laboratory testing 3 years after surgery were included in this study. All patients provided written informed consent for their information to be recorded in a prospective collection database and met the inclusion criteria of the present study. The indication for repair was AAA ≥ 5 cm in diameter, a rapidly growing aneurysm (≥ 5 mm per 6 months), and saccular aneurysm. In principle, EVAR was applied to patients over 75 years of age or patients at high risk with OSR even under 75 years of age. Patients on hemodialysis at baseline, patients with ruptured or infected aneurysm, and patients requiring concomitant procedures to the renal artery, such as stenting, were excluded from this study. The institutional review board approved this study and the need for individual patient consent was waved since all data were obtained for routine clinical care.

Study and follow-up protocol

Patient baseline demographics, comorbidities, medications, serum creatinine, estimated glomerular filtration rate (eGFR), operative details, and outcomes were collected. All patients underwent a laboratory test and computed tomography angiography (CTA) with three-dimensional reconstruction before surgery. A standard follow-up protocol at 30 days, 3, 6 and 12 months after surgery and annually thereafter, was applied to the study cohort (Laboratory tests were applied as appropriate by the physician’s discretion). Patients underwent CTAs at 3, 6, and 12 months, and annually thereafter if renal function permitted. Outpatients with an eGFR less than 50 ml/min/1.73

m^2 were administered 200 ml of 0.9% saline 1 hour before CTA. Any antiplatelets was not added after EVAR in our institution.

Procedures

The following endografts were used in this study: 70 Zenith (COOK Medical, Bloomington, IN), 56 Endurant/Talent (Medtronic, Minneapolis, MN), 7 Incraft (Cordis Corp, Bridgewater, NJ) (these three endografts were defined as endografts with SR fixation), 87 Excluder (W.L. Gore and Associates, Flagstaff, AZ), 12 Powerlink (Endologix, Irvine, CA), and 1 Aorfix (Lombard Medical, Irvine, CA) (these three were defined as the endografts with IR fixation). All procedures were performed in a fully equipped operating room with the patients under regional or general anesthesia and with fluoroscopic guidance. Patients with eGFR less than 50 ml/min/1.73 m^2 were administered 0.9% saline at 1 ml/kg/hour 24 hours before EVAR. Metformin was discontinued 2 days before EVAR and was not restarted until 2 days after surgery. Perioperative administration of nonsteroidal anti-inflammatory drugs (NSAIDs) was avoided for patients with eGFR less than 50 ml/min/1.73 m^2.

Definitions

Preoperative coronary artery disease (CAD) was defined as an abnormal result on a coronary angiogram and a history of myocardial infarction or open or percutaneous coronary artery revascularization. Chronic obstructive pulmonary disease (COPD) was identified on pulmonary function studies or under active medication. Hypertension (HT), dyslipidemia (DL), and diabetes were identified in patients undergoing active medical treatment or diet modification. Cerebrovascular disease (CVD) was defined as a history of stroke, transient ischemic attack, or carotid intervention.

Diagnosis of acute kidney injury (AKI) was defined as an absolute increase in serum creatinine (Cr) of more than or equal to 0.3 mg/dl or a percent increase in serum Cr of more than or equal to 50% in the perioperative period according to the Acute Kidney Injury Network criteria (KDIGO; www.kdigo.org).

For the calculation of the estimated glomerular filtration rate (eGFR), the revised equation for the eGFR from serum Cr in Japan was used (eGFR (ml/min/1.73 m^2) = 194 x serum $Cre^{-1.094}$ x $Age^{-0.287}$ x 0.739 (if female)).[16]

The midterm RFD was defined as a percent decrease in eGFR at the 3-year follow-up of more than 20% compared with the baseline eGFR[17] or a newly introduced hemodialysis.

Data analysis

All statistical analyses were performed using SPSS statistical software, version 24 (IBM Corp., Armonk, NY). For comparisons, categorical variables were analyzed using a chi-square test or Fisher's exact test, as appropriate. Continuous variables were analyzed using Student's *t*-test or the Mann-Whitney test, as appropriate. Logistic regression analysis was applied for univariate and multivariate analyses of risk factors of the midterm RFD.

Patients undergoing EVAR with IR fixation devices were matched to patients undergoing EVAR with SR fixation devices according to their propensity scores, which were estimated using the following covariates: age, sex, baseline renal function, baseline aneurysm diameter, comorbidities, smoking habits, regular use of medicines that may act on kidney function, and the number of times contrast-enhanced CT scans were performed. After the matching, 87 pairs were selected and compared. All p values were two-sided, with $p < 0.05$ regarded as indicative of statistical significance.

RESULTS

Patient characteristics and general outcomes

A total of 467 patients who underwent EVAR for infrarenal AAAs were identified during the study period. Of these, 237 patients were included in this study (11 patients were excluded due to undergoing hemodialysis at baseline, one was due to a concomitant renal stenting during EVAR, 5 were due to repair with only aortic extenders, and 213 were excluded due to a lack of laboratory data at 3 years after surgery). Of the 213 patients excluded due to a lack of data, 32 patients died within 3 years. 5 patients of them developed RFD (>20% decrease in eGFR compared with baseline eGFR) while living, and all 5 patients underwent EVAR with an SR fixation device. In the excluded patient cohort, there were 115 patients (54.0%) in the SR group, and 98 patients (46.0%) in the IR group, respectively and the proportion of fixation types was similar to the study cohort (p = .53). In terms of the baseline renal function, there was no significant differences between the study cohort and the excluded patient cohort in serum Cr (1.00 ±

0.37 mg/dl vs 0.97 ± 0.44 mg/dl, p = .45) and eGFR (60.0 ± 18.1 ml/min/1.73 m^2 vs 61.2 ± 20.5 ml/min/1.73 m^2, p = .52) **Table 1** shows the demographics and characteristics of the study cohorts. The mean follow-up duration was 5.2 ± 1.8 years.

Risk factors of midterm renal function decline

99 (41.8%) of 237 patients (102 IRs and 135 SRs) developed the midterm RFDs. Of those, 33 patients were in IR group and 66 were in SR group, respectively. We examined the predictors of a >20% decrease in eGFR 3 years after surgery in the overall cohort of included patients. Univariate analysis revealed that SR fixation (odds ratio [OR]: 2.00; 95% confidence interval [CI]:1.17 to 3.41) [p = 0.011] and AKI (OR: 4.00; 95% CI: 1.03 to 15.5) [p = 0.045] were the predictors for RFD 3 years postoperatively. Sex, age, patient comorbidities, baseline aneurysm diameter, and baseline renal function did not show significant associations with the midterm RFD. In addition, SR fixation was the unique independent predictor of midterm RFD by multivariate analysis (**Table 2**).

Renal outcomes

Eleven patients developed AKIs perioperatively. AKI occurred significantly more frequently in the SR group than in the IR group [p = 0.026] (**Table 3**). Patients who developed AKI were excluded before the propensity score matching in order to accurately compare renal function changes between the two groups in the chronic phase. Four patients (two patients in each group) received newly introduced hemodialysis within three years after surgery. According to the results of risk factor analysis, we compared the impact of fixation type on the midterm outcomes of renal function. In the original (unmatched) cohort, male sex and a larger amount of contrast medium were significantly more prevalent in patients in the SR group. The demographics of the patients matched with propensity scores are shown in **Table 3**; 87 patients in each group were matched. In this matched cohort, previously reported risk factors of RFD after EVAR, such as the baseline renal function or the number of times contrast medium was applied, were similar in both the IR group and the SR group. Age, other comorbidities, smoking habits, and regularly used medicines were also comparable between the two fixation types in the matched cohort.

eGFR changes were also compared in the matched cohort. The changes in eGFR from baseline in patients who underwent EVAR were -4.7 ± 7.6 ml/min/1.73 m^2 in the IR group vs -5.9 ± 8.6 ml/min/1.73 m^2 in the SR group at 12 months (p =.55); -6.8 ± 8.3 ml/min/1.73 m^2 vs -8.4 ± 11.6 ml/min/1.73 m^2 at 24 months (p =.48); and -7.3 ± 10.3 ml/min/1.73 m^2 vs -11.2 ± 14.1 ml/min/1.73 m^2 at 36 months (p =.037). RFD was analyzed by calculating the % decrease in eGFR at each time point compared with the baseline (preoperative) eGFR. The % decrease in eGFR in the SR group gradually increased year by year and reached a statistical difference at 3 years after surgery compared with the IR group (mean 17.8% vs 11.6%, respectively) [p =.034] (**Figure 1**).

DISCUSSION

This study demonstrated that compared with infrarenal endograft fixation, suprarenal endograft fixation is the unique predictor of RFD after EVAR and significantly associated with midterm renal function decline.

Although some reports focused on the change in renal function after EVAR, the definition of renal dysfunction varies between studies.[13] For example, the definition of renal dysfunction was a simple increase in serum Cr in some studies, and others defined RFD as a decrease in eGFR. In addition, the rate of change in either the Cr or eGFR value also varies. Because AKI is defined by the Acute Kidney Injury Network criteria (KDIGO; www.kdigo.org) and the definition is therefore clear, most of the predictor analysis of renal deterioration after EVAR focused on 30-day renal dysfunction. However, in the chronic stage, there is little evidence of the extent to which renal function deterioration after surgery affects patients' prognosis. In particular, Cr values do not reflect accurate kidney function, and defining an increase in serum Cr as renal function impairment in the chronic stage seems to be problematic.

Some studies have been similar to this study in terms of using eGFR for kidney function evaluation. Unlike those studies, we used the Japanese equation for the estimation of GFR, whose accuracy has been proven in a large population study.[16]

In this study, we identified that SR fixation is the unique predictor of midterm RFD. Furthermore, to minimize the influence of factors that might impact renal outcomes, the patients' backgrounds were adjusted using propensity score matching, followed by comparison of the midterm renal outcomes between the IR group and the

SR group. This result demonstrated that renal function was significantly more impaired in the SR group than in the IR group.

There are several reports on SR versus IR stent grafts and renal outcomes. One systematic review and meta-analyses on this topic found adverse effects of SR fixation on renal function.[13] On the other hand, others did not identify significant differences.[14,15] Meta-analyses on this topic have considerable problems with their methods. Since the definitions of RFD were different in each study, it is impossible to review them as one. Another problem is that the time points of the renal outcomes were quite different in each study. In addition, most of their study periods were short. The authors concluded that the adverse effect of SR fixation on renal outcomes disappeared when sophisticated statistical modeling was performed to account for study heterogeneity.[15]

A few studies investigated the effects of SR fixation on mid- to long-term renal outcomes after EVAR.[18,19] However, study populations were small, and further data are needed. In addition, the definition of renal deterioration in the chronic stage is not clear. For example, there is little evidence indicating whether a 20% reduction in eGFR, which was the definition of RFD in this study, will lead to a worse result in the future.

Although direct association between AKI and RFD at 3 years was not detected in this study, the lack of an independent association must have been due to the use of a less-powered analysis. There was an apparent difference in the incidence of AKI between the IR group and the SR group. Therefore, patients who developed AKI were excluded from the comparison of late renal function between the two groups

Several mechanisms that cause renal function deterioration after EVAR with SR fixation have been implicated. First, microembolization may occur during endovascular manipulations and cause localized ischemia of the renal parenchyma.[20] Second, the difference in patient selection may cause a difference in renal deterioration. Shorter neck length, increased angulation, and larger diameter are generally more common in patients treated with SR grafts. Fairman et al. indicated that this anatomical hostility increases the rate of renal complications.[21] However, other studies have suggested that complicated necks do not result in adverse outcomes.[22] Only one factor for baseline aneurysm diameter was incorporated in this study, and that factor was not associated with renal outcome. Other morphological factors were not incorporated in this study. Third, functional renal artery stenosis may be caused by transrenal stent struts.[23] However, others have shown no deleterious effect on renal artery morphology and function.[24] Fourth, contrast medium, which has a toxic effect on tubular cells,[25] is administered intraoperatively and repeatedly in serial CTAs during follow-up. Gray DE et al. reported that it is not the type of endograft fixation, but repeated administration of contrast medium that causes renal function deterioration.[17] In contrast, the number of times contrast-enhanced CT scans were administered was not associated with the midterm RFD in this study. However, we do not have accurate information on how many times patients were exposed to contrast medium use during this study period because patients in Japan can easily access any hospital and are able to undergo examinations with contrast medium. Thus, the insufficient information on contrast medium exposure may have some impact on the study results.

There are several limitations of this study. First, this is a nonrandomized retrospective observational study. Obviously, there are numerous selection biases in the indication for the endograft choice, particularly owing to anatomical factors. Patients treated with SR endografts appear to have shorter neck anatomy, and this more hostile morphology may contribute to a higher rate of RFD. We have not incorporated these factors into the analyses in this study. Only baseline aneurysm diameter was incorporated, and there was no statistical significance. Second, the loss to follow-up with laboratory testing at three years after surgery was high. Only half of the patients who underwent EVAR during the study period were analyzed, which may have influenced the study results. Third, we did not have sufficient information on the number of times of contrast exposure as described above. Fourth, we do not have information about the number of patients regularly using NSAIDs or other drugs that may affect kidney function. The negative effects of routine use of ACEIs/ARBs or diuretics on short-term renal outcomes are frequently discussed, and we incorporated these factors into the analysis. However, we did not have any information on additional medicines, such as NSAIDs, and this factor may have affected the outcomes. Fifth, the equation for estimated GFR used in this study is different from the equation used in other countries. However, the accuracy of this equation had been confirmed by epidemiological study, and is now widely used in Japan. Since the eGFR value in this study accurately reflects the actual GFR, it can be considered to be the same as the eGFR value by the equation used in other countries.

CONCLUSIONS

This study demonstrates that EVAR with SR endograft fixation is an independent predictor of midterm RFD. Furthermore, risk-adjusted comparisons using propensity score matching revealed that midterm renal function was significantly impaired in the SR group compared with the IR group.

CONFLICT OF INTEREST

None.

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Table 1. Patient demographics and characteristics.

	n = 237
Follow-up duration, years, median (IQR)	5.1 (4.0, 6.4)
Age, years, mean (SD)	77.0 (6.3)
Male, n (%)	207 (87.3%)
HT, n (%)	182 (76.8%)
DL, n (%)	100 (42.2%)
DM, n (%)	22 (9.3%)
CAD, n (%)	74 (31.2%)
CVD, n (%)	37 (15.6%)
COPD, n (%)	124 (52.3%)
Baseline serum Cr, mg/dl, mean (SD)	1.00 (0.37)
Baseline eGFR, ml/min/1.73 m^2, mean (SD)	60.0 (18.1)
ARB or ACEI, n (%)	118 (49.8%)
Diuretic, n (%)	28 (11.8%)
Antiplatelet, n (%)	98 (41.4%)
Statin, n (%)	97 (40.9%)
ß-blocker, n (%)	48 (20.3%)
CCB, n (%)	134 (56.5%)
Current smoker, n (%)	35 (14.8%)
Aneurysm diameter, mm, mean (SD)	52.7 (9.6)

Intraoperative contrast medium, ml, mean (SD)	97.8 (46.1)
Suprarenal fixation, n (%)	135 (57.0%)
Acute kidney injury, n (%)	11 (4.6%)

HT: hypertension, DL: dyslipidemia, DM: diabetes mellitus, CAD: coronary artery disease, CVD: cerebrovascular disease, COPD: chronic obstructive pulmonary disease, Cr: creatinine, eGFR: estimated glomerular filtration rate, ARB: angiotensin receptor blocker, ACEI: angiotensin-converting enzyme inhibitor, CCB: calcium channel blocker

Table 2. Univariate and multivariate analyses of potential risk factors associated with midterm renal function decline.

Variable	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Female	1.08	0.50-2.33	0.853			
Age	1.02	0.98-1.07	0.299			
Aneurysm Diameter	1.00	0.98-1.03	0.837			
SR Fixation	2.00	1.17-3.41	**0.011**	1.95	1.12-3.37	**0.017**
CKD ≥ IIIa	0.93	0.55-1.56	0.781			
CKD ≥ IIIb	1.00	0.52-1.89	0.987			
HT	0.68	0.37-1.25	0.210			
DL	1.17	0.70-1.98	0.553			
DM	1.44	0.60-3.48	0.413			
CAD	1.18	0.68-2.06	0.553			
CVD	0.72	0.35-1.49	0.374			
COPD	1.01	0.61-1.70	0.957			
ARB/ACEI	0.69	0.41-1.16	0.164			
Diuretic	0.75	0.33-1.70	0.490			
Antiplatelet	1.01	0.60-1.70	0.986			
Statin	1.04	0.61-1.75	0.897			
ß-blocker	0.72	0.37-1.38	0.319			

CCB	1.00	0.60-1.69	0.995			
Smoker	1.05	0.51-2.18	0.888			
AKI	4.00	1.03-15.48	**0.045**	2.50	0.60-10.44	0.208

SR: suprarenal, CKD: chronic kidney disease, HT: hypertension, DL: dyslipidemia, DM: diabetes mellitus, CAD: coronary artery disease, CVD: cerebrovascular disease, COPD: chronic obstructive pulmonary disease, ARB: angiotensin receptor blocker, ACEI: angiotensin-converting enzyme inhibitor, CCB: calcium channel blocker, AKI: acute kidney injury

CKD ≥ IIIa indicates eGFR < 60 ml/min/1.73 m^2.

CKD ≥ IIIb indicates eGFR < 45 ml/min/1.73 m^2.

Bold values indicate statistical significance ($p < 0.05$).

Table 3. Patient demographics and characteristics comparing infrarenal and suprarenal fixation in the unmatched and matched cohorts.

	Unmatched cohort			**Matched cohort**		
	IR group (n = 102)	SR group (n = 135)	*p*	IR group (n = 87)	SR group (n = 87)	*p*
Follow-up duration, years, median (IQR)	5.6 (3.8, 6.8)	5.0 (4.0, 6.0)	.14	6.0 (4.1, 7.0)	5.1 (4.0, 6.4)	.14
Age, years, mean (SD)	77.8 (6.2)	76.3 (6.3)	.064	77.4 (6.3)	77.0 (6.4)	.72
Male, n (%)	84 (82.4%)	123 (91.1%)	**.045**	74 (85.1%)	77 (88.5%)	.50
HT, n (%)	80 (78.4%)	102 (75.6%)	.60	67 (77.0%)	66 (75.9%)	.86
DL, n (%)	43 (42.2%)	57 (42.2%)	.99	36 (41.4%)	38 (43.7%)	.76
DM, n (%)	10 (9.8%)	12 (8.9%)	.81	8 (9.2%)	7 (8.0%)	.79
CAD, n (%)	31 (30.4%)	43 (31.9%)	.81	24 (27.6%)	27 (31.0%)	.62
CVD, n (%)	19 (18.6%)	18 (13.3%)	.27	15 (17.2%)	16 (18.4%)	.84
COPD, n (%)	52 (51.0%)	72 (53.3%)	.72	44 (50.6%)	51 (58.6%)	.29
Baseline serum Cr, mg/dl, mean (SD)	1.00 (0.45)	1.00 (0.30)	.93	0.95 (0.29)	0.97 (0.30)	.66
Baseline eGFR, ml/min/1.73 m^2, mean (SD)	60.7 (19.9)	59.5 (16.7)	.63	61.9 (18.2)	61.2 (17.3)	.78
CKD ≥ IIIa, n (%)	51 (50.0%)	76 (56.3%)	.34	43 (49.4%)	43 (49.4%)	1.00
CKD ≥ IIIb, n (%)	20 (19.6%)	28 (20.7%)	.83	14 (16.1%)	16 (18.4%)	.69
ARB or ACEI, n (%)	52 (51.0%)	66 (48.9%)	.75	45 (51.7%)	43 (49.4%)	.76
Diuretic, n (%)	12 (11.8%)	16 (11.9%)	.98	11 (12.6%)	12 (13.8%)	.82
Antiplatelet, n (%)	44 (43.1%)	54 (40.0%)	.63	34 (39.1%)	35 (40.2%)	.88

Statin, n (%)	41 (40.2%)	56 (41.5%)	.84	35 (39.8%)	33 (37.5%)	.76
ß-blocker, n (%)	22 (21.6%)	26 (19.3%)	.66	17 (19.5%)	18 (20.7%)	.85
CCB, n (%)	62 (60.8%)	72 (53.3%)	.25	52 (59.8%)	47 (54.0%)	.44
Current smoker, n (%)	13 (12.7%)	22 (16.3%)	.45	13 (14.9%)	11 (12.6%)	.66
Aneurysm diameter, mm, mean (SD)	51.3 (10.7)	53.7 (8.5)	.051	51.9 (9.5)	52.5 (7.5)	.61
Contrast medium, ml, mean (SD)	90.6 (43.2)	103.2 (47.6)	**.043**	93.7 (39.2)	100.2 (49.7)	.36
Postoperative serum Cr, mg/dl, mean (SD)	0.96 (0.46)	0.95 (0.29)	.81	0.90 (0.30)	0.93 (0.30)	.45
Postoperative eGFR, ml/min/1.73 m^2, mean (SD)	64.1 (21.2)	62.9 (18.4)	.65	65.7 (19.8)	63.7 (18.8)	.50
Acute kidney injury, n (%)	1 (1.0%)	10 (7.5%)	**.026**	-	-	-
Number of times of CE-CT, mean (SD)	4.8 (2.0)	4.6 (1.9)	.45	5.0 (1.8)	4.9 (1.7)	.90

IR: infrarenal, SR: suprarenal, HT: hypertension, DL: dyslipidemia, DM: diabetes mellitus, CAD: coronary artery disease, CVD: cerebrovascular disease, COPD: chronic obstructive pulmonary disease, Cr: creatinine, eGFR: estimated glomerular filtration rate, ARB: angiotensin receptor blocker, ACEI: angiotensin-converting enzyme inhibitor, CCB: calcium channel blocker, CE-CT: contrast enhanced computed tomogram

Bold values indicate statistical significance ($p < 0.05$).