Long-term survival after acute kidney injury following ruptured abdominal aortic aneurysm repair

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ABSTRACT

Objective: Acute kidney injury (AKI) is a major complication of ruptured abdominal aortic aneurysm (RAAA). Severe AKI is associated with high morbidity and mortality in the short term. The objective of this study was to determine the association between AKI after RAAA repair and long-term survival.

Methods: We conducted a retrospective cohort study of all patients undergoing RAAA repair in three hospitals between 2004 and 2011. Outcomes were long-term survival after RAAA repair, incidence of postoperative AKI, and chronic dialysis rates. Survival rates were compared between different AKI groups (no AKI, Risk, Injury, Failure) with Kaplan-Meier survival analyses and log-rank tests. Univariable and multivariable Cox regression analyses were carried out to assess the association of survival with AKI, preoperative shock, postoperative shock, and sex. The main analysis focused on the group of patients surviving initial hospital stay.

Results: Our study encompassed 362 patients with RAAA. AKI occurred in 267 of 362 patients (74%). At discharge, 267 patients were alive (74%). Median survival in this group was 7.2 years. Survival was not significantly different between the four AKI groups ($P = .07$). However, the univariable Cox regression analysis demonstrated a significant association between Failure and reduced long-term survival compared with having no AKI (hazard ratio, 1.85; 95% confidence interval, 1.15-2.97). This association did not remain significant after multivariable adjustment. Four patients were discharged with chronic dialysis, and four other patients needed chronic dialysis later after discharge.

Conclusions: This study demonstrates no significant independent association between AKI after RAAA repair and long-term survival. Only a small proportion of patients developed end-stage renal disease at a later stage in life. (J Vasc Surg 2017;■:1-7.)

Ruptured abdominal aortic aneurysm (RAAA) carries a high mortality. Up to 80% of the patients do not survive the immediate consequences of AAA rupture.[1] One of the main complications of RAAA is acute kidney injury (AKI). Up to three-quarters of patients who survive RAAA repair suffer from AKI.[2,3] The incidence of severe AKI after RAAA repair ranges between 16% and 36%.[2-4] The cause of AKI after RAAA is multifactorial and consists of prolonged hypovolemia leading to renal ischemia, acute-on-chronic kidney disease, general atherosclerotic disease, suprarenal aortic cross-clamping in open repair, and use of nephrotoxic contrast agents and medication.[2,3,5] We previously reported that patients with severe AKI after RAAA have a higher risk of dying than patients without AKI (combined 30-day and in-hospital death rate; adjusted odds ratio, 6.36; 95% confidence interval [CI], 2.23-18.13).[3] Up to a quarter of patients with AKI after RAAA require renal replacement therapy (RRT) during admission, and 2% of patients are discharged with permanent RRT.[3]

Until recently, it was thought that AKI and chronic kidney disease were two distinct syndromes. It was common belief that long-term outcomes after recovery from AKI are benign.[6] However, new observational studies have shown an association between AKI and the development of chronic kidney disease and even increased mortality.[6] More specifically, it has been demonstrated that preoperative reduced renal function and postoperative AKI are associated with increased long-term mortality after cardiac surgery.[7,8] Much less is known about the long-term consequences of AKI after RAAA. The few reports that have been published demonstrate an association between AKI after RAAA and increased mortality after 1 year.[2,4] As a consequence, some authors suggest more intensive monitoring of renal function after postoperative discharge.[2,7]

We have carried out this study to confirm these claims about long-term effects of AKI. The primary aim of our study was to assess the association between AKI after

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RAAA repair and long-term survival. The secondary aim was to determine the incidence of long-term end-stage renal disease. We hypothesized that AKI is associated with reduced long-term survival in patients with RAAA and is associated with increased end-stage renal disease.

ARTICLE HIGHLIGHTS

- **Type of Research:** Multicenter retrospective cohort study
- **Take Home Message:** Of 362 patients with ruptured abdominal aortic aneurysm, 74% developed acute kidney injury (AKI) after repair based on the Risk, Injury, Failure, Loss, and End-stage (RIFLE) criteria. Survival at a median of 7.2 years was not associated with AKI, and the risk of end-stage renal disease during follow-up was small.
- **Recommendation:** This study suggests that, although AKI is common after repair of ruptured abdominal aortic aneurysm, it is not associated with a reduction in long-term survival.

METHODS

Study design and setting

This is a retrospective cohort study using both prospectively and retrospectively collected data from the Amsterdam Acute Aneurysm (AJAX) cohort database. This database consisted of consecutive patients with RAAA and was part of a prospective cohort study running parallel to the AJAX trial (ISRCTN: 66212637). Details of the AJAX trial and AJAX cohort have been published previously.[9] Consent of the patients was not needed for this study because of the observational study design. This paper includes all items recommended by the Strengthening the Reporting of Observational Studies in Epidemiology statement.[10]

Participants and study size

This study included all consecutive patients from the AJAX cohort who underwent RAAA repair in three hospitals in Amsterdam (AMC, VUmc, and OLVG hospitals) between 2004 and 2011. Patients with preoperative permanent dialysis and those who died during intervention or within 6 hours after arrival to the intensive care unit (ICU) were excluded from current analysis. Also, patients with unknown demographics or unknown short-term outcomes were excluded.

Outcomes

The primary outcome of this study was long-term survival after RAAA repair. Secondary outcomes were the incidence of postoperative AKI according to the Risk, Injury, Failure, Loss, and End-stage (RIFLE) criteria and chronic dialysis rates.[11] The RIFLE criteria define short-term AKI as Risk, Injury, or Failure, and classification is based on serum creatinine (SCr) levels or urine output (Supplementary Table I, online only). The RIFLE criteria previously have been used to classify AKI in patients undergoing RAAA repair.[3,12] AKI categorization was based on the worst SCr level or urine output. SCr level and urine output were recorded during ICU admission up until 1 week.

Baseline SCr level was defined according to the steps recommended by the RIFLE criteria (Supplementary Fig, online only). In brief, baseline SCr level was based on the lowest value of the premorbid SCr, the preoperative SCr, an estimated SCr (obtained through the Modification of Diet in Renal Disease equation), or an imputed value when premorbid, preoperative, and estimated Scr values were unavailable (calculated as the median baseline SCr level of patients with renal comorbidity). Urine output category was estimated in separate blocks of 6, 12, and 24 hours. The lowest block of urine output was used for AKI categorization (Supplementary Table I, online only). In patients treated with RRT, the AKI category before start of RRT was used for analysis. All three hospitals used venovenous hemofiltration as temporary RRT.

The secondary outcome was the incidence of long-term end-stage renal disease. We used the incidence of chronic dialysis as a surrogate marker.

Preoperative and postoperative shock markers. The Glasgow Aneurysm Score (GAS)[13] was included to serve as a surrogate marker for preoperative shock profile. The GAS includes age, presence of shock, myocardial disease, cerebrovascular disease, renal disease, and type of aneurysm repair. As markers of postoperative shock status, we used the Acute Physiology and Chronic Health Evaluation (APACHE) II score, the administration of vasopressors, and fluid balance in the first 24 hours after RAAA repair. The APACHE II score is a measurement of disease severity and includes body temperature, serum electrolyte levels, and the Glasgow Coma Scale score to predict the risk of ICU mortality. Administration of vasopressors was categorized as none (no ICU admission or no vasopressors administered), low dose (norepinephrine <2 mg/min or dopamine <500 mg/min), or high dose (any epinephrine, norepinephrine >2 mg/min, or dopamine >500 mg/min).[3] Fluid balance was categorized in <2 L, 2 to 5 L positive, or >5 L positive.

Data sources

Clinical data were drawn from the AJAX cohort database. Dates of death were retrospectively acquired from the municipal registry of death certificates in August 2016. Under Dutch law, the municipal registry can provide data for research purposes if a patient's privacy is not disproportionally affected. Long-term chronic dialysis data were retrieved from the Dutch national dialysis registry (Renine, stichting Nefrovisie) in December 2016.[14] Chronic dialysis of >28 days is registered in this registry.