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Clinical Research

Endovascular Repair of Ruptured Abdominal Aortic Aneurysm Is Associated with Lower Incidence of Post-operative Acute Renal Failure

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Background: Acute renal failure (ARF) after surgical treatment of ruptured abdominal aortic aneurysm (AAA) is an independent predictor of post-operative mortality. Open repair for ruptured AAA has been the gold standard treatment; however, there has been a recent trend in increased utilization of endovascular repair (EVAR) for treatment of ruptured AAA. The purpose of this study was to retrospectively review and compare the incidence of ARF among patients treated with open versus endovascular repair of ruptured AAA.

Methods: American College of Surgeons National Surgical Quality Improvement Program database was searched for surgeries performed for AAA during 2005–2010. Patients' demographics and co-morbidities (diabetes mellitus, hypertension, chronic obstructive pulmonary disease, congestive heart failure, myocardial infarction, peripheral arterial disease) were collected. Incidence of ARF after surgery was reviewed. We also collected American Society for Anesthesiologists scores, operating times, functional status, post-operative complications, and mortality.

Results: Of total 2179 operations for ruptured AAA, incidence of mortality within first 30 days after operation was 17% after EVAR for ruptured AAA and 33.2% after open repair of ruptured AAA. Incidence of ARF was 6.9% after EVAR for ruptured AAA and 13.5% after open repair of ruptured AAA. Odds ratio for mortality after open repair was 1.94 (confidence interval [CI] 1.51–2.49) when compared with EVAR ($P < 0.001$), and odds ratio for developing ARF after EVAR was 1.62 (CI 1.14–2.29) as compared with open AAA repair ($P < 0.05$) in multivariable logistic regression models. Open repair of ruptured AAA and totally dependent functional status were associated with post-operative mortality and ARF.

Conclusions: Incidence of mortality and post-operative ARF for ruptured AAA is significantly higher when treated with open repair, as compared to EVAR. Totally dependent functional status was associated with post-operative mortality and ARF.

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INTRODUCTION

Elective endovascular repair of abdominal aortic aneurysm (EVAR) for repair of intact abdominal aortic aneurysm (AAA) is associated with decreased rate of postoperative complications and mortality.[1–3] Randomized controlled trials have shown that the short-term mortality after elective open AAA repair is 4.6% while it is 1.6% after elective EVAR.[2,3] With advancements in technology and increasing proficiency of vascular surgeons in performing EVAR, the number of EVARs performed annually has gradually surpassed the open AAA

repairs.[1] More and more surgeons are now performing EVARs for ruptured AAAs. Several series have shown improved outcomes for patients with ruptured AAAs, when treated with EVAR.[4–7] Development of acute renal failure (ARF) after aortic aneurysm surgery is associated with high mortality rates.[8–16] The purpose of this study is to specifically examine the incidence of post-operative renal failure among patients who present with ruptured AAA and are treated with EVAR and compared with those who are treated with open surgical repair.

METHODS

Data Set

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) Participant Use File[17] is a de-identified dataset, generated and operated by the ACS. The dataset is compliant with Health Insurance Portability and Accountability Act. All patient identifiers are deleted from the database before the compilation of data files and hence there is no need for patients' consent or institutional review board approval. It has more than 250 participant academic and community United States hospitals. Methods used to extract data from NSQIP database have been described previously.[18–22] Data are collected by using a systematic sampling method. Surgical operations are divided into 8-day cycles. At each NSQIP site, the first 40 operations performed within each 8 day that meets program inclusion criteria are entered in the database. NSQIP program limits the number of cases per cycle for certain higher volume and lower risk surgeries to ensure heterogeneity. At each ACS-NSQIP site, a trained clinical nurse is assigned for data collection. Outcomes have been shown to be highly reliable with less than 1.5% variable disagreements during annual audits.[20] To ensure complete follow-up, patients with incomplete 30-day outcomes are excluded from the database.

Patients

All patients who underwent any operation for repair of ruptured infrarenal AAA procedure from 2005 to 2010 were identified, using current procedural terminology (CPT) codes from NSQIP database. CPT codes used were as follows: 34800, 34802–34805 (EVAR) and 35081, 35082, 35091, 35102, 35103 (Open repair).

EVAR group included those patients who underwent emergent endovascular repair of ruptured AAAs. Open AAA repair included those patients who underwent emergent open repair of ruptured AAAs.

Outcomes

The main outcomes were mortality and ARF in the first 30 days after surgery. ARF is defined in the NSQIP database as ''a patient who did not require dialysis preoperatively, worsening of renal dysfunction postoperatively requiring hemodialysis, peritoneal dialysis, hemofiltration, hemodiafiltration or ultrafiltration.'' Basic demographic data included in the study were age, gender, race, and body mass index. Several pre- and peri-operative variables were also included: diabetes mellitus, smoking status, functional status, congestive heart failure, myocardial infarction, hypertension, pre-operative renal failure, dialysis dependency, blood transfusions, sepsis, blood urea nitrogen (BUN), creatinine, American Society for Anesthesiologists (ASA) classification, type of anesthetic, operative time, cardiac arrest, superficial surgical site infection, and deep incisional surgical site infection.

Statistical Analysis

All variables were initially summarized by study group using counts and percentages for categorical variables and means, medians, and standard deviations for continuous variables. Differences between variables among study groups were tested using *t*-tests for continuous variables and chi-squared tests for categorical variables.

Multivariable logistic regression was used to examine whether mortality and ARF differed by study group after accounting for patient demographics, pre-operative variables, and peri-operative variables. We modeled categorical variables using reference categories, with the reference selected either as a convenient value or as the most prevalent value. ASA group 1 (No disturb) was combined with ASA group 2 (Mild disturb) and ASA group 4 and 5 were combined due to small sample sizes in groups 1 and 4. For the same reason, systemic inflammatory response syndrome, sepsis, and septic shock were all grouped into one category. A categorical effect was used for year of operation. For continuous variables, we used graphical methods and cubic splines to investigate non-linear functional forms, but linearity was appropriate for all continuous variables. Pre-surgical BUN and serum creatinine were log-transformed