Trends in Treatment of Ruptured Abdominal Aortic Aneurysm: Impact of Endovascular Repair and Implications for Future Care

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OBJECTIVE: Our aim was to determine national trends in treatment of ruptured abdominal aortic aneurysm (RAAA), with specific emphasis on open surgical repair (OSR) and endovascular aneurysm repair (EVAR) and its impact on mortality and complications.

METHODS: Data from the Nationwide Inpatient Sample (NIS) from 2005 to 2009 were queried to identify patients older than 59 years with RAAA. Three groups were studied: nonoperative (NO), EVAR, and OSR. Chi-square analysis was used to determine the relationship between treatment type and patient demographics, clinical characteristics, and hospital type. The impact of EVAR compared with OSR on mortality and overall complications was examined using logistic regression analysis.

RESULTS: We identified 21,206 patients with RAAA from 2005 to 2009, of which 16,558 (78.1%) underwent operative repair and 21.8% received no operative treatment. In the operative group, 12,761 (77.1%) underwent OSR and 3,796 (22.9%) underwent EVAR. Endovascular aneurysm repair was more common in teaching hospitals (29.1% vs 15.2%, $p < .0001$) and in urban versus rural settings. Nonoperative approach was twice as common in rural versus urban hospitals. Reduced mortality was seen in patients transferred from another institutions (31.2% vs 39.4%, $p = 0.014$). Logistic regression analysis demonstrated a benefit of EVAR on both complication rate (OR = 0.492; CI, 0.380–0.636) and mortality (OR=0.535; CI, 0.395−0.724).

CONCLUSIONS: Endovascular aneurysm repair use is increasing for RAAA and is more common in urban teaching hospitals while NO therapy is more common in rural hospitals. Endovascular aneurysm repair is associated with reduced mortality and complications across all age groups. Efforts to reduce mortality from RAAA should concentrate on reducing NO and OSR in patients who are suitable for EVAR. (J Am Coll Surg 2013;216:745−755. © 2013 by the American College of Surgeons)

Endovascular repair for ruptured abdominal aortic aneurysm (RAAA) was first reported by Marin and colleagues in 1994.[1] Early results suggested a decrease in overall mortality for patients treated by an endovascular approach. Since that report, many others have applied this technique with varying degrees of success, and the resources required for a successful endovascular aneurysm repair (EVAR) program for RAAA have been described.[2] Two small randomized trials comparing open surgical repair (OSR) and EVAR in patients with RAAA have shown no benefit of EVAR; however, <50% of RAAA patients were randomized in these trials.[3,4] Two larger trials comparing EVAR and OSR for RAAA are underway in Europe: the Immediate Management of the Patient with Rupture: Open vs Endovascular Repair (IMPROVE) aneurysm trial and the Endovasculaire vs Chirurgie dan les Aneurysmes Rompus (ECAR) trial.[5,6] The endovascular approach has been applied with increasing frequency across the United States in the last decade. Our objective was to document the recent trends in management of RAAA in the United States with specific reference to the use of EVAR, and to examine the implications of these findings for the future care of patients with RAAA.

METHODS

Data used in this study were obtained from the Nationwide Inpatient Sample (NIS) from the Healthcare Cost and Utilization Project of the Agency for Healthcare

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Abbreviations and Acronyms

EVAR = endovascular aneurysm repair
NIS = Nationwide Inpatient Sample
NO = nonoperative
OR = odds ratio
OSR = open surgical repair
RAAA = ruptured abdominal aortic aneurysm

Research and Quality. This database contains information abstracted from approximately 8 million hospitalizations annually, and comprises a stratified sampling frame of 20% of all US hospital discharges. All patient identifiers have been removed from this database. The NIS represents the largest all-payer inpatient care database available and provides a unique opportunity to estimate national trends in admissions related to specific diseases and their associated clinical outcomes.[7,8] The NIS database was queried for the period January 1, 2005 to December 31, 2009 for patients with a principal discharge diagnosis of RAAA as defined by ICD-9C-CM code 441.5. We excluded cases of AAA without mention of rupture based on the following code: 441.4. We also excluded patients younger than 60 years of age, as this group probably included some patients with connective tissue disorders and might not represent typical degenerative AAA patients. We identified those patients that underwent OSR based on ICD procedure codes 38.44, 38.34, and 39.25, and those that underwent EVAR based on procedure code 39.71. We identified patients with a diagnosis of RAAA without associated ICD procedure codes to capture patients that underwent nonoperative (NO) treatment. The numbers of OSR, EVAR, and NO were determined for each year and for the entire time period and were compared by hospital status (ie, rural, urban teaching, urban nonteaching) as well as by the impact of patient demographics and preoperative comorbidities.

The cohort of patients selected was characterized by baseline patient characteristics, including age, sex, ethnicity, and type of hospital admission (direct vs transfer). Comorbid conditions, such as congestive heart failure, valvular heart disease, coronary artery disease, peripheral vascular occlusive disease, cerebrovascular disease, hypertension, chronic obstructive pulmonary disease, renal insufficiency, and obesity were also identified.

Operated patients were assessed for the occurrence of specific clinical outcomes related to their admission by type of repair (OSR vs EVAR). We evaluated in-hospital mortality, mean length of stay, and discharge status to skilled nursing facilities. In-hospital postoperative medical complications, such as myocardial infarction, pulmonary embolism, pneumonia, and acute renal failure, were assessed for all subgroups. In addition, surgical complications, such as acute mesenteric ischemia, major hemorrhage, thrombectomy, major amputation, and surgical site infection, were also assessed for all subgroups. Rates of mortality and major complications were collected for OSR and EVAR and compared by year and hospital status (ie, urban teaching, urban nonteaching, rural). Open surgical repair and EVAR were compared using logistic regression analysis controlling for preoperative characteristics, teaching hospital status, and postoperative complications. For the EVAR group, the impact of laparotomy on overall mortality was assessed.

These RAAA patients were compared on a year-by-year basis to determine nationwide trends in clinical outcomes and resource use. Additional analyses pertaining to specific subgroups of RAAA patients (eg, EVAR vs OSR patients) were performed to determine whether these subgroups were at increased risk for adverse outcomes. This study was conducted in full compliance with Institutional Review Board policies for clinical research at the Washington Hospital Center.

Statistical analyses

Chi-square test was used to examine the bivariate relationship between the procedure option vs the patient's demographic characteristics (such as age, sex, and race), clinical characteristics (such, as coexisting condition, complication, discharge disposition, and mortality), and hospital characteristics (such as teaching status and location). Multiple logistic regression analyses were also performed to evaluate the impact of the use of EVAR compared with OSR on the risks of complication and mortality after controlling for patients' demographic characteristics, coexisting condition, and hospital characteristics. A p value <0.05 is considered statistically different and results in the rejection of null hypotheses. Data processing and statistical analyses were performed using SAS version 9.1 (SAS Institute, Inc.).

RESULTS

During the study period (2005−2009), 21,206 patients were identified with RAAA. Of these patients, 12,761 (59.5%) underwent OSR and 3,796 (17.9%) underwent EVAR. One hundred and thirty-six (0.64%) patients received both EVAR and OSR (likely reflecting conversion from EVAR to OSR) and 4,649 (21.9%) patients were identified that had a diagnosis of RAAA, but underwent no operative procedure. As expected, the mortality rate for those that did not undergo EVAR or OSR was