Differences in Mortality, Risk Factors, and Complications After Open and Endovascular Repair of Ruptured Abdominal Aortic Aneurysms

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WHAT THIS PAPER ADDS

In this study peri-operative variables that affected outcome after ruptured abdominal aneurysm repair were analysed. The added value of this study is the comparison of independently significant variables between endovascular and open surgery, demonstrating that preoperative risk factors influence outcome differently, depending on the type of repair. This information could promote a treatment selection process, based on risk estimates that are repair-dependent.

Objective/background: Endovascular aneurysm repair (EVAR) for ruptured abdominal aortic aneurysm (rAAA) has faced resistance owing to the marginal evidence of benefit over open surgical repair (OSR). This study aims to determine the impact of treatment modality on early mortality after rAAA, and to assess differences in postoperative complications and long-term survival.

Methods: Patients treated between January 2000 and June 2013 were identified. The primary endpoint was early mortality. Secondary endpoints were postoperative complications and long-term survival. Independent risk factors for early mortality were calculated using multivariate logistic regression. Survival estimates were obtained by means of Kaplan–Meier curves.

Results: Two hundred and twenty-one patients were treated (age 72 ± 8 years, 90% male), 83 (38%) by EVAR and 138 (62%) by OSR. There were no differences between groups at the time of admission. Early mortality was significantly lower for EVAR compared with OSR (odds ratio [OR]: 0.45, 95% confidence interval [CI]: 0.21–0.97). Similarly, EVAR was associated with a threefold risk reduction in major complications (OR: 0.33, 95%CI: 0.15–0.71). Hemoglobin level <11 mg/dL was predictive of early death for patients in both groups. Age greater than 75 years and the presence of shock were significant risk factors for early death after OSR, but not after EVAR. The early survival benefit of EVAR over OSR persisted for up to 3 years.

Conclusion: This study shows an early mortality benefit after EVAR, which persists over the mid-term. It also suggests different prognostic significance for preoperative variables according to the type of repair. Age and the presence of shock were risk factors for early death after OSR, while hemoglobin level on admission was a risk factor for both groups. This information may contribute to repair-specific risk prediction and improved patient selection.

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INTRODUCTION

Since the introduction of endovascular aneurysm repair (EVAR) in 1991 by Volodos et al.[1] and Parodi et al.,[2] the use of this less invasive treatment for infra-renal aortic aneurysms has expanded significantly. Nowadays, >60–70% of all elective abdominal aortic aneurysm (AAA) repairs are performed with EVAR.[3,4] This is not the case for ruptured AAA (rAAA), for which the use of EVAR has not yet achieved generalized acceptance.[5,6] In general, rAAA are frequently fatal with a mortality of up to 80%,[7] but patients surviving until they receive hospital care, might expect to benefit from a minimally invasive technique.

For elective surgery, randomized trials have demonstrated a nearly uniform threefold reduction in peri-operative mortality and prolonged survival benefit for EVAR over open surgical repair (OSR), which is maintained for at least 2 years.[8,9] These results, also confirmed by large registries and national audits,[10] have justified a shift

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towards a preferential use of EVAR. For rupture, however, evidence of a similar advantage is still lacking.

The aim of this study was to determine the impact of treatment modality on early mortality after rAAA repair, and to evaluate the differences in the prognostic capacity of preoperative variables in determining early survival for EVAR and OSR. Additionally, we investigated the differences in major postoperative complications and assessed any survival advantage related to treatment modality during follow-up.

METHODS

The study complied with the Declaration of Helsinki. According to our institutional guidelines, no formal ethical approval was required.

Patients

The study population consisted of all consecutive patients who underwent AAA repair between January 2000 and June 2013 at a single, tertiary institution. For this study, only patients with confirmed rAAA were included. Some of these patients have previously been included in a published 20-year overview of institutional trends in the management of rAAA.[7] Patients with infected aneurysms and those having had prior aneurysm repair were excluded from the analysis.

Data collection

All possible operation codes and surgical reports were retrospectively retrieved, and hospital charts and computed tomography angiographies (CTAs) were checked for the presence of rupture. If confirmed, patient demographics, clinical baseline characteristics, intraoperative details, and clinical and laboratory outcome were obtained. Baseline characteristics on admission included age, gender, state of consciousness, blood pressure, and pulse rate. Duration from the emergency room (ER) to the operating theatre, operation duration, body temperature, blood pressure and pulse rate during operation, type of anesthesia, blood loss, and usage of blood products and fluids were derived from operative and anesthesia reports. Laboratory results on admission were also obtained. Postoperative complications and events were retrieved from hospital registries. Survival status and the exact date of death of treated patients were obtained via the national civil registry.

Missing data

Baseline data that were not retrievable were analyzed for differences between the OSR and EVAR groups. There were no significant differences in the number of missing data in either group, except for blood loss and the volume of intraoperative transfusion, owing to a lack of documentation about minimal blood loss and transfusions needed with an EVAR procedure. Only variables with $<3\%$ missing data were included in multivariate models.

Institutional management of rAAA

The Erasmus University Medical Center is a tertiary teaching institution with full capacity for endovascular and open vascular surgery (24 hours a day/7 days a week), serving about 1.5 million people living in the Rotterdam and surrounding area. Owing to the characteristics of the institution, a relatively high proportion of AAA repairs are done for rupture. Although the logistics involved in EVAR have been adapted and improved over time, the capacity to offer both treatment options was present throughout the entire study period. This made EVAR available for any anatomically suitable patient on any day and at any time. The choice of treatment is individualized, but preference is generally given to EVAR in older patients.

If a patient presents at the ER with a suspected rAAA, the on-call surgical team is informed. On arrival of the patient in the ER, an ultrasound of the abdominal aorta is done to confirm the presence of an aortic aneurysm if the patient is not known to have an AAA. Otherwise, a CTA can be performed immediately. Patients are managed by permissive hypotension in the ER, and resuscitation is started only if the patient becomes unconscious.

According to protocol, a multi-slice CT scanner is used for rAAA CTA. The patient is scanned from nipple to pubic symphysis with a collimation of 118*0.6, and plain and contrast series are acquired after administering 120 mL of Visipaque 320 contrast. Anatomical suitability for EVAR is determined by the surgeon's expectations and experience. In anatomically complex cases, or whenever time allows, a dedicated post-processing workstation (3Mensio Vascular 4.2 software; 3Mensio Medical Imaging, Bilthoven, the Netherlands) is available for sizing and planning. After diagnosis, informed consent is obtained whenever possible.

Aneurysm repair is performed either by consultant vascular surgeons or by residents during their vascular subspecialization under the direct supervision of a consultant vascular surgeon. For EVAR, repair is performed in the operating theatre using a mobile C-arm. Preference is given to local anesthesia for EVAR, although the decision depends on the individual case.

For OSR, a midline transperitoneal approach is preferred, and aorto-aortic or aorto-bi-iliac reconstruction is performed depending on the presence of concomitant iliac aneurysms. Postoperatively, intra-abdominal pressure using a vesical pressure probe is only checked when there is clinical suspicion of abdominal compartment syndrome.

Definitions

Rupture was defined by either direct visualization of fresh blood in the retroperitoneal or peritoneal compartments during OSR, or visualization of peri-aortic hematoma on the immediate preoperative CTA.[11] Early mortality was defined by in-hospital mortality or death within 30 days of surgery. Major complications were defined as one of the following: respiratory; cardiac; cerebrovascular; renal failure (estimated glomerular filtration rate [eGFR] $<$ 30); abdominal; wound; bleeding-related; lower limb ischemia; graft-related.