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Rate of secondary intervention after open *versus* endovascular abdominal aortic aneurysm repair

Harish Krishnamoorthi, MD,[a,b] *Haekyung Jeon-Slaughter, PhD,*[c,d] *Amanda Wall, BS,*[a] *Subhash Banerjee, MD,*[c,d] *Bala Ramanan, MBBS,*[a,b] *Carlos Timaran, MD,*[a,b] *J. Gregory Modrall, MD,*[a,b] *and Shirling Tsai, MD*[a,b,*]

[a] *Department of Surgery, Section of Vascular Surgery, Dallas Veterans Affairs Medical Center, Dallas, Texas*
[b] *Department of Surgery, Section of Vascular Surgery, University of Texas Southwestern Medical Center, Dallas, Texas*
[c] *Department of Medicine, Section of Cardiology, Dallas Veterans Affairs Medical Center, Dallas, Texas*
[d] *Department of Medicine, Section of Cardiology, University of Texas Southwestern Medical Center, Dallas, Texas*

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ABSTRACT

Background: Although long-term durability and improved perioperative outcome of endovascular abdominal aortic aneurysm (AAA) repair has been demonstrated, some studies have suggested an increased rate of secondary interventions compared with open AAA repair. More recent data suggest that rates between the two modalities may be similar. We investigated the rate of secondary intervention in patients undergoing endovascular aortic aneurysm repair (EVAR) or open AAA repair for intact AAA and the effect of secondary intervention on long-term mortality in these two groups of patients.

Methods: A retrospective, single-institution review was conducted between January 2003 and December 2012. Secondary intervention was defined as any intervention within 30 d of the procedure or an AAA repair-related procedure after 30 d, which included repair of endoleaks and incisional hernia repair. Group differences in demographic and baseline characteristics were examined using Cochran-Mantel-Haenszel and Wilcoxon rank sum tests for categorical and continuous variables, respectively.

Results: A total of 342 patients underwent operative repair of intact AAA. Two hundred seventy four patients underwent EVAR and 68 patients underwent open AAA repair. The mean age overall was 68.6 y and was not significantly different between the two repair groups. The overall rate of secondary intervention was significantly lower in the EVAR group compared with the open AAA repair group (11% *versus* 27%, $P = 0.001$). In the EVAR group, 30 patients underwent 37 secondary interventions. In the open repair group, 18 patients underwent 20 reinterventions. The most common secondary intervention was repair of type 2 endoleak ($n = 13$, 4.7% of patients) after EVAR and incisional hernia repair ($n = 4$, 5.9% of patients) after open AAA repair. Most secondary interventions (15/20) after open AAA repair occurred within 30 d, whereas most secondary intervention (33/37) after EVAR occurred after 30 d. Comparison of late (>30 d) reintervention between the two groups revealed a significantly lower rate of secondary intervention after open AAA repair

* *Corresponding author*. University of Texas Southwestern, Surgery, 5323 Harry Hines Boulevard, MC 9157, Dallas, TX 75390-9157. Tel.: +1 214 645 0550; fax: +1 214 645 0551.
E-mail address: shirling.tsai@utsouthwestern.edu (S. Tsai).
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(27.8% of all reinterventions after open *versus* 86.7% of all reinterventions after EVAR, $P < 0.001$). The overall 10-y mortality rate was 39.1%, and not statistically different between the two repair groups. Estimated survival analysis demonstrated no significant effect of secondary intervention on mortality after EVAR (logrank $P = 0.45$). Secondary intervention after open repair did not significantly affect long-term survival (logrank $P = 0.05$).

Conclusions: This study highlights the dramatic change in practice pattern in AAA repair over time. In this study, patients treated with EVAR had a significantly lower overall rate of secondary intervention compared with patients treated with open AAA repair. This was likely secondary to increased perioperative morbidity and mortality and a bias toward more complex patients in the open repair group. In the long term, however, there were significantly fewer reinterventions after open AAA repair. Secondary interventions did not affect long-term survival after EVAR.

Introduction

Abdominal aortic aneurysm is a leading cause of death in the United States for patients over age 65 y, with more than 13,000 deaths due to aneurysmal rupture.[1,2] Open surgical repair was the standard of care before the widespread adoption of endovascular aortic aneurysm repair (EVAR).[3] Since then, EVAR has become the dominant method of abdominal aortic aneurysm (AAA) management, such that over 70% of AAA repairs are performed via EVAR. Multiple large prospective trials including the DREAM, OVER, and EVAR trials have demonstrated significantly reduced perioperative morbidity and mortality with EVAR compared with open repair.[4-6] However, these same trials also revealed increased secondary intervention rates in the EVAR group, as well as a loss of the mortality advantage after 2 y.[5] In very-long-term follow-up at 15 y of these large trials, patients who underwent EVAR were found to have increased overall and aneurysm-related mortality compared with those who underwent open AAA repair.[1]

Few studies have examined the rate and effect of secondary interventions on long-term mortality of patients undergoing EVAR and open repair. Recent long-term follow-ups suggest increased mortality after EVAR,[7] typically associated with increased rupture and aneurysm-related mortality. The same studies show increasing secondary interventions over time with EVAR but only sporadically for open repair.[8]

This study examines long-term 10-y all-cause mortality in patients undergoing open and endovascular AAA repair and the association between secondary interventions and mortality.

Materials and methods

Retrospective chart review was performed in patients undergoing open or endovascular AAA repair to collect follow-up data. Patients with ruptured AAA were excluded. Outcomes included in this study are all-cause mortality and need for a secondary intervention within the follow-up period of 10 y. Secondary intervention was defined as any reintervention within 30 d or any AAA-related reintervention after 30 d. This study was approved by the IRB at the Dallas Veterans Affairs Medical Center.

Patients were stratified into two groups based on mode of AAA repair (EVAR *versus* open repair). Descriptive statistics of demographic and baseline characteristics are presented for all patients and across the two groups. Baseline and demographic characteristics included gender, age, diabetes, hypertension, coronary artery disease, chronic obstructive pulmonary disease, creatinine, and AAA size at the time of repair. For each group, patients with and without the need for secondary intervention within 10 y were also compared in demographic and baseline characteristics. Group differences in demographic and baseline characteristics were examined using Cochran-Mantel-Haenszel and Wilcoxon rank sum tests for categorical and continuous variables, respectively.

Kaplan–Meier curve analysis was used to examine EVAR and open repair group difference in 10 y outcomes. Log-rank chi-square statistics was used for a statistical significance. All statistical analyses were performed using SAS 9.4 version (SAS Institute, Cary, NC) and *P*-value <0.05 was used as a statistical significance criterion.

Results

There were 342 patients who underwent AAA repair at the Dallas Veterans Affairs Medical Center between January 2003 and December 2012, of which 274 patients underwent EVAR and 68 patients underwent open repair. Patients with ruptured AAA were excluded; however, patients with symptomatic AAA were included. The mean age overall was 68.6 y and was not significantly different between the two repair groups. The study population was overwhelmingly male. Charts were reviewed for follow-up until 2015, thus providing for at least 3 y follow-up. The mean follow-up was 49 mo (SD of 29 mo) for the EVAR group and 78 mo (SD 46 mo) in the open repair group (Table 1).

The distribution of cases between open AAA repair *versus* EVAR is shown in Figure 1. In 2003 and 2004, open repairs outnumbered EVAR. However, starting in 2005, EVAR was the predominant mode of AAA repair. This institution was a study site in the OVER trial, and during trial enrollment, six patients in this cohort were randomized to open repair and six patients in this cohort were randomized to EVAR. Based on chart review, outside of the OVER trial, in the majority of cases, EVAR was considered if the AAA met anatomic criteria for an