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Clinical Research

Early and Late Outcomes of Endovascular Aortic Aneurysm Repair versus Open Surgical Repair of an Abdominal Aortic Aneurysm: A Single-Center Study

Kyunghak Choi,[1] Youngjin Han,[1] Gi-Young Ko,[2] Yong-Pil Cho,[1] and Tae-Won Kwon,[1] Songpa-Gu, Seoul, Republic of Korea

Background: The objective of the study was to compare the treatment outcomes and cost of endovascular aortic aneurysm repair (EVAR) and open surgical repair (OSR) in patients with an abdominal aortic aneurysm (AAA) at a single center.
Methods: Patients treated for an AAA at a single center between January 2007 and December 2012 were retrospectively identified and classified based on the treatment they received (EVAR or OSR). Patient demographics and in-hospital costs were recorded. Long-term survival was calculated using the Kaplan-Meier method.
Results: During the study period, 401 patients with AAA were treated at Asan Medical Center. Among these cases, 226 were treated with EVAR (56%) and 175 received OSR (44%). The mean age of the EVAR group was higher than that of the OSR group (71.25 ± 7.026 vs. 61.26 ± 8.175, $P < 0.001$). The need for intraoperative transfusion and total length of in-hospital stay were significantly lower in the EVAR group ($P < 0.001$). The OSR group showed significantly reduced rates of overall mortality ($P = 0.003$), overall reintervention ($P = 0.001$), and long-term survival (63.98 ± 1.86 vs. 99.54 ± 3.17, $P < 0.001$). The OSR group was charged significantly less than the EVAR group ($12,879.21 USD vs. $18,057.78 USD, $P < 0.001$).
Conclusions: EVAR has advantages over OSR in terms of short-term mortality, in-hospital length of stay, and rates of perioperative transfusion. However, OSR is associated with better long-term survival, lower reintervention rates, and lower costs.

INTRODUCTION

Open surgical treatment of abdominal aortic aneurysms (AAAs) was introduced in 1951 by Dubost, and endovascular aortic aneurysm repair (EVAR) was introduced by Parodi in 1991.[1,2] Comparisons of the outcomes of open surgical repair (OSR) with EVAR began in 1999 with a multicenter randomized study termed EVAR-1 in the United Kingdom. The Dutch randomized endovascular aneurysm management (DREAM), Anevrysme de l'aorte abdominale (ACE), and open versus endovascular repair (OVER) trials followed. Since 2006, EVAR has been used more often than OSR for AAA.[3] This is a consequence of the advantages of EVAR over OSR, which include a short hospital stay, low transfusion volume, and low morbidity resulting from open surgery.[4] However, debates over the benefits of EVAR versus OSR continue. The short-term survival advantage of EVAR disappears within 1 to 3 years,[5] after which graft-related complications and subsequent reintervention rates

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[1]Department of Surgery, University of Ulsan College of Medicine and Asan Medical Center, Songpa-Gu, Seoul, Republic of Korea.

[2]Department of Radiology, University of Ulsan College of Medicine and Asan Medical Center, Songpa-Gu, Seoul, Republic of Korea.

Correspondence to: Tae-Won Kwon, Department of Surgery, University of Ulsan College of Medicine and Asan Medical Center, 88, Olympic-Ro 43-Gil, Songpa-Gu, Seoul 05505, Republic of Korea; E-mail: twkwon2@amc.seoul.kr

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increase, ultimately leading to higher treatment costs. This study aimed to compare the outcomes and costs of EVAR with those of OSR for procedures conducted at a single center.

MATERIAL AND METHODS

Between 2007 and 2012, patients with AAAs who underwent either OSR or EVAR were enrolled in this study. Subjects were limited to those patients undergoing primary elective repair and were excluded in cases of emergency or urgent settings. Patients with a ruptured AAA were also excluded. Patients were selected through a retrospective review, and patient data were analyzed prospectively. Information about patients was collected through the electronic medical record system of the center. Demographics and comorbidities, including age, gender, hypertension, diabetes mellitus, present or past smoking history, coronary artery disease, any respiratory disease, carotid or cerebral vascular disease, total cholesterol levels with or without medication, body mass index, and other data, were collected preoperatively. Before EVAR or OSR procedures, all patients underwent the same laboratory studies, and the anatomy of the aneurysm was observed by computed tomography. Echo and thallium scans were performed to evaluate the presence of coronary artery disease. Pulmonary function tests and carotid artery Doppler ultrasonography were performed on all patients to determine whether they had an AAA. The amount of blood transfused during EVAR or OSR was recorded in the anesthesiology report.

Postoperative outcomes were defined as follows: mortality, in-hospital stay, reintervention, and overall cost. Mortality was categorized as within 4 days of hospitalization, within 30 days of hospitalization, more than 30 days after hospitalization, follow-up mortality after discharge, and overall mortality including all cases. In-hospital stay and the length of stay in the intensive care unit were separately recorded. Reintervention was defined as interventions performed during the follow-up period, and overall cost included the reintervention cost. Costs were expressed in USD.

Statistical Analysis

Patient preoperative demographics, ages, intraoperative transfusion volumes, in-hospital stays, and overall costs were described as means with standard deviation. Means were compared with the Student's *t*-test. Gender, comorbidities, mortality, and frequency of reintervention were compared using the chi-square test and Fisher's exact test. Kaplan-Meier analyses were performed for long-term survival of both groups. Statistical analyzes were performed using the SPSS software package, and the threshold for significant difference was set at $P < 0.05$.

RESULTS

Between 2007 and 2012, 490 patients received treatment at Asan Medical Center. After applying the exclusion criteria, 401 patients were classified as infrarenal fusiform AAA without rupture; 175 and 226 of them underwent OSR or EVAR, respectively. Demographics and comorbidity patient data for the 2 groups are summarized in Table I. Significant differences between the 2 groups were found for age ($P < 0.001$). No significant differences were found for hypertension, diabetes, current or past smoking history, coronary artery disease, cerebral vascular accident history, or chronic kidney disease.

The amount of blood transfusion differed between the 2 groups. Intraoperative red blood cell transfusion was significantly greater in the OSR group (3.82 ± 3.580 vs. 0.76 ± 1.260, $P < 0.001$). In addition, red blood cells and fresh frozen plasma were transfused postoperatively more often in the OSR group, and the volume of transfused red blood cells was markedly higher (1.43 ± 3.951 vs. 0.43 ± 1.259, $P = 0.002$). The duration of intensive care unit stay was significantly shorter in the EVAR group (3.86 ± 11.052 vs. 1.67 ± 4.879, $P = 0.015$). Similarly, the total length of stay was significantly shorter in the EVAR group (11.52 ± 13.072 vs. 6.54 ± 6.781, $P < 0.001$). The amounts of perioperative transfusion, intensive care unit stay, and in-hospital stay are recorded in Table II.

In-hospital mortality was categorized as 4 days, 30 days, or occurred after 30 days. There was no significant difference in mortality between the 2 groups during each of these periods. Overall mortality, which includes follow-up mortality after discharge, was significantly higher in the EVAR group (40 vs. 88, $P = 0.001$; 46 vs. 91, $P = 0.003$, respectively). The median follow-up period was 73.3 months in the OSR group versus 54.4 months in the EVAR group. Based on the Kaplan-Meier survival analysis using the log-rank test, the long-term survival rate was significantly higher in the OSR group ($P < 0.001$; Fig. 1).

Reintervention was classified as early versus late reintervention at 3 months. Early reintervention was not significantly different between the 2 groups,