Impact of an endovascular program on the operative experience of abdominal aortic aneurysm in vascular fellowship and general surgery residency

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Abstract

\textbf{Background:} This study was performed to determine the impact of an endovascular program (EVP) on open and endovascular abdominal aortic aneurysm (AAA) operations in a residency training institution.

\textbf{Methods:} Over an 8-year period ending in September 2001, hospital records of all patients undergoing open or endovascular AAA repair were retrospectively reviewed. Data were analyzed to determine the changing patterns of case volume, type of operative repair, and complexity of open repair with regards to the training of both general surgical chief residents and vascular fellows.

\textbf{Results:} A total of 849 AAA operations were performed during the study period. The initiation of the EVP in 1997 resulted in a steady increase in the total annual AAA cases \((P < 0.05)\), due in part to an increase in endovascular AAA operations despite a decrease in the annual open AAA volume. EVP had a positive impact on the overall operative experience of vascular fellows owing to the large increase in their endovascular AAA experience (annual mean pre-EVP 3 ± 0.8 versus post-EVP 47 ± 9.6, \(P < 0.01\)). A significant reduction occurred in the vascular fellows’ open AAA experience (annual mean pre-EVP 40 ± 12.7 versus post-EVP 19 ± 9.4, \(P < 0.05\)). EVP did not affect the endovascular AAA experience of general surgery chief residents (annual mean pre-EVP 1 ± 0.8 versus post-EVP 3 ± 1.5, not significant). A significant reduction occurred in chief residents’ open AAA experience (annual mean pre-EVP 39 ± 9.7 versus post-EVP 18 ± 7.4, \(P < 0.05\)). EVP did not affect the operative experience of complex open AAA operations in either vascular fellows or general surgery residents.

\textbf{Conclusions:} An endovascular program has a positive impact on the aortic aneurysm practice in an academic institution, as evidenced by the significant increase in annual endovascular AAA cases despite a decrease in open AAA operations. Although vascular fellows continued to maintain sufficient experience in both open and endovascular AAA operations, general surgery chief residents suffered a significant decrease in their open AAA experience. Further evaluation of the residency system is warranted to better optimize the training paradigm of both vascular fellowship and general surgery residency. © 2003 Excerpta Medica, Inc. All rights reserved.

\textbf{Keywords:} Abdominal aortic aneurysm; Endovascular therapy; Surgical education; Surgery residency

The first operative repair of abdominal aortic aneurysm (AAA) performed by Dubost et al [1] in 1952 marked a new era in vascular surgical history and set forth the technical principle of operative aneurysmorrhaphy. In their original description, the aortic aneurysm sac was opened after aortic clamping and an aortic homograft was used to create an interposition bypass graft [1]. This operative technique has been adopted and refined by surgeons around the world in the ensuing years. With continual improvement in modern anesthesia and critical care, open aneurysmorrhaphy has been proven to be effective in the treatment of AAA with low perioperative morbidity and mortality.

The concept of endovascular aortic aneurysm operation was introduced in 1991 by Parodi et al [2] who successfully excluded a AAA using a stent-graft device through a femoral artery approach. Numerous studies since then have shown that endovascular aortic aneurysm is efficacious in

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the treatment of AAA with significantly lower morbidity and less convalescence than the conventional open AAA operation [3–5]. The introduction of endovascular AAA technique has created an enormous impact in vascular surgery. Despite studies that showed possible complications can occur after endovascular repair, such as device migration, infection, and endograft failure; industry and news media have heightened the public awareness of this minimally invasive operation [6–10]. As a result, many institutions have noted more patients prefer the endovascular repair rather than an open operation owing to the perceived benefits of shorter hospitalization and expedient recovery [11–14]. While such a change in the AAA treatment modality may not significantly affect a community-based surgical practice, it could potentially impact on the operative training of surgical residents and vascular fellows in an academic institution. With recent studies indicating that endovascular AAA procedures have affected the volume of conventional open aneurysm operations [15,16], the possibility exists that the volume of open operations may decrease dramatically for surgical trainees such that they may not gain the necessary experience for their future practice.

This study was conducted to determine the changing pattern of the aortic aneurysm operations during the past 8 years at our institution and evaluate the impact of our endovascular program (EVP) on the training in both general surgery residency and vascular surgery fellowship.

Patients and methods

From June 1993 to September 2001, the hospital records of all patients who underwent either open or endovascular aortic aneurysm operations as identified by the International Classification of Diseases, 9th revision (ICD-9) code at the Emory University Hospital were retrospectively reviewed. An EVP was initiated in January 1997 owing in part to the institutional participation in the clinical trial of the Guidant/EVT (Endovascular Technologies, Menlo Park, CA) stent-graft device. Data were collected with attention to the changing pattern of aortic aneurysm operations as impacted by the endovascular program, operative participation of surgical residents and vascular fellows, and complexity of aortic aneurysm operations during the study period. Patients who presented with ruptured aortic aneurysm (n = 15) or thoracoabdominal aortic aneurysm (n = 68) were excluded from the analysis.

The vascular surgery service at Emory University Hospital is composed of seven full-time vascular staff who were divided into two separate teams. Each vascular team was led by either a vascular fellow or a general surgery chief resident, who rotated on a 6-week period. The vascular fellow switches the rotation on a 12-week cycle. The Emory University Hospital represents one of the four teaching hospitals in which the general surgery residents gain their vascular operative experience, and it is the only hospital that the vascular fellow spends his or her entire clinical training. All aortic operations were performed jointly by a vascular staff with either a chief surgical resident or vascular fellow. Aortic endovascular procedures were preferentially performed jointly by the vascular fellow and a vascular staff.

Aneurysm operations were classified into three groups based on their treatment modality or anatomical complexity: (1) endovascular AAA group, which included patients who underwent successful implantation of endovascular aortic endograft; (2) infrarenal AAA group, which denoted patients who underwent open aortic aneurysmorrhaphy with infrarenal aortic clamping; and (3) complex AAA group, which was defined by open aortic aneurysm repair requiring either suprarenal aortic clamping or concomitant bypass of renal, hypogastric, or mesenteric vessels. Intraoperative conversions to open repair after attempted initial endograft implantation (n = 5) were classified as an infrarenal AAA repair.

All endovascular AAA operations were performed in the operating room. All endografts used (Ancure, Guidant EVT, Menlo Park, California; EXCLUDER, W.L. Gore and Associates, Flagstaff, Arizona; AneuRx, Medtronic AVE, Sunnyvale, California; and Talent LPS, World Medical Manufacturing/Medtronic AVE, Minneapolis, Minnesota) were inserted intraluminally through either a groin incision for common femoral artery access or retroperitoneal incision for iliac artery access.

The chi-square test or Student t test was used to determine the significance of differences in categorical variables as indicated. Probability values of less than 0.05 were considered statistically significant. All values were expressed as means ± standard deviation. An SAS statistical package was used for analysis (version 5.0; Abacus Concepts, Berkeley, California).

Results

During the study period, a total of 849 patients underwent aortic aneurysm repair. Among them, endovascular repair was performed in 302 patients (36%). The annual endovascular, conventional open, and total aortic aneurysm operations during the study period are depicted in Fig. 1. Since the EVP was instituted in 1997, there was a marked increase in annual endovascular operations with a corresponding decline in open aortic aneurysm operations performed annually (P < 0.05, Fig. 1). The overall aortic aneurysm operation performed per year increased steadily since the EVP (P < 0.05).

The annual aortic aneurysm procedures performed by vascular fellows are shown in Fig. 2. There was an overall increase in the total aortic aneurysm procedures performed annually by vascular fellows since the EVP (P < 0.05). This was due largely to the rise in the endovascular AAA cases as shown in Table 1 (annual mean pre-EVP 3 ± 0.8 versus post-EVP 47 ± 9.6, P < 0.01). No significant change occurred in the operative experience of open complex AAA cases per year by vascular fellows (annual mean pre-EVP 11 ± 2.3 versus post-EVP 15 ± 5.3, not significant [NS];
Table 1. In contrast, the routine infrarenal AAA volume performed by vascular fellows showed a significant reduction after the EVP (annual mean pre-EVP 40 ± 12.7 versus post-EVP 19 ± 9.4, \( P < 0.05 \); Table 1).

The annual aortic aneurysm procedures performed by surgical chief residents are depicted in Fig. 3. There was a reduction in the AAA cases performed annually by chief residents throughout the study period, which was due largely to the decline in the open infrarenal AAA cases as shown in Table 2 (annual mean pre-EVP 39 ± 9.7 versus post-EVP 18 ± 7.4, \( P < 0.05 \)). The annual volume of complex AAA procedures performed by surgical chief residents did not change after the EVP (annual mean pre-EVP 14 ± 4.3 versus post-EVP 8 ± 6.4, NS; Table 2). Similarly, no significant change in endovascular AAA cases per year per chief residents occurred throughout the study period (annual mean pre-EVP 1 ± 0.8 versus post-EVP 3 ± 1.5, NS; Table 2).

Comments

The introduction of endovascular therapy has transformed the practice of vascular surgery in many important ways. The enthusiasm for endovascular therapy is in part driven by its possibly reduced morbidity rates, shorter hospital course, and less anesthetic risks compared with conventional surgical procedures. The heightened public awareness of this minimally invasive treatment has made endovascular therapy an integral part of modern vascular surgical practice. Many hospitals are faced with the possibility that endovascular surgery is replacing many traditional open operations. While many regard this as an inevitable evolution in vascular surgery, it has an important implication in residency training programs. Although the increase in endovascular volume could potentially better prepare vascular fellows for their future surgical practice, this may dilute the open operative experience which general surgery residents receive in their training.

Our study showed that an endovascular program had a positive impact on the overall AAA volume at our institution. This steady increase in the total AAA volume was largely due to the increase in endovascular operations, despite a steady decline in open AAA operations (Fig. 1). Before 1999, the majority of the AAA patients were treated with conventional open repair rather than with the endovascular technique at our institution. By 2001, however, patients with AAA were twice more likely to undergo endovascular repair than an open aneurysm operation. Such a changing pattern of AAA treatment approach was due in part to several reasons. First, the approval of aortic endograft by the FDA in 1999 significantly increased our ability to treat patients with AAA with either a challenging
anatomy or severe comorbid risk factors. Prior to that time, only patients with an ideal aortic anatomy and with qualified stringent physiologic inclusion criteria were permitted to be enrolled in a clinical trial for endovascular repair. Many patients who initially did not qualify for the clinical trial and declined to undergo open repair were reevaluated by our vascular staff, and subsequently underwent endovascular repair with Food and Drug Administration approved endograft devices. Second, the local media coverage of endovascular AAA repair in our community has heightened the public awareness of this minimally invasive treatment. We correspondingly witnessed a growing proportion of patients with AAA who requested endovascular treatment on their initial clinic visit. Third, our institution, as a tertiary referral hospital, received a steady increase of referrals from physicians of surrounding community hospitals, that did not offer such a therapy due in part to lack of physician training and radiological equipment needed to perform this operation.

The endovascular program created different impacts on the training of our vascular fellows and general surgery chief residents. Our study showed that an endovascular program increased the overall aortic aneurysm volume for vascular fellows, as evidenced by the dramatic increase in the endovascular AAA volume despite an annual reduction in the routine infrarenal open AAA procedures. The fellow’s operative experience of complex AAA operation was not affected by the endovascular program. Since only one vascular fellow graduates annually from our institution, the vascular fellow continues to receive a wide spectrum of aortic aneurysm operative experience despite the reduction in open AAA volume. The average number of open AAA operations, including both infrarenal and complex aneurysm cases, performed by three most recent vascular fellows was above 40 cases per year, which remained well above the minimum guideline of 10 cases of aortic aneurysms as suggested by the Joint Vascular Surgery Societies to acquire proficiency and for hospital privileging [17].

In contrast, our endovascular program created a negative impact on the overall operative AAA experience of our general surgical chief residents, owing in part to the significant decrease in their open infrarenal aneurysm experience. Because endovascular AAA operations were preferentially performed by the vascular fellows, the increase in endovascular AAA volume did not benefit the operative experience of the surgical chief residents. Moreover, with eight chief residents graduating from the general surgery residency annually at our institution, these open AAA cases were further divided among these chief residents who rotated in the vascular service. Although these chief residents rotate through other community hospitals during their chief resident year, they obtained the majority of their vascular experience while rotating in the vascular service at our institution. A separate review of the operative case log at our institution revealed that the average number of AAA cases performed annually by the graduating chief residents was eight cases per year prior to 1999. However, the operative experience had decreased significantly to an average of four AAA cases annually per chief resident since 1999.

Our finding differs sharply from a recent report that examined the impact of endovascular program on open AAA experience. In a study that analyzed the institutional experience of Stanford University Medical Center, Arko et al [15] noted that the endovascular program significantly increased the endovascular AAA operation without diminishing open infrarenal AAA case volumes. They also noted an increase in the suprarenal AAA cases as a result of the endovascular program. Since the aneurysm case volumes of general surgical residents were not analyzed, it remains unclear regarding the impact of an endovascular program on a general surgical resident’s training. Cho et al [16] reported their experience at Barnes-Jewish Hospital that showed their endovascular program greatly increased the endovascular AAA volume, while the overall open aneurysm experience remained unchanged for the vascular fellow. However, when they examined the operative AAA experience of the general surgery chief residents, they noted a significant reduction of chief residents’ open AAA experience after the institution of the endovascular program. The authors reported their current general surgery residents will graduate with approximately three open infrarenal AAA operations per resident, a finding that was similar to our study.

The marked reduction in the open aortic aneurysm experience among our general surgical trainees as impacted by endovascular surgery raised a question whether the current training paradigm can adequately prepare general surgical residents to perform complex vascular aortic operations in their future without additional training in vascular fellowship. In addition, the decrease in the open aneurysm cases among general surgical residents will result in a reduction of their critical care experience in taking care of complex vascular patients after open aneurysm operations. Given the rapid advancement of current endovascular surgery, a dedicated fellowship training is critical in preparing an individual to competently treat patients with a full array of vascular disease. The reduced aortic operative experience among general surgical chief residents will not adequately prepare them to provide the current standards to perform complex vascular reconstruction, and they should not be expected to perform these operations in their career.

In an effort to improve the current surgical training

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Table 2
Comparison of types of abdominal aortic aneurysm (AAA) operations performed annually by each general surgery chief resident before and after the implementation of the endovascular program (EVP) at the Emory University Hospital

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<tr>
<td>Infrarenal AAA</td>
<td>39 ± 9.7</td>
<td>18 ± 7.4</td>
<td>&lt;0.05</td>
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<tr>
<td>Complex AAA</td>
<td>14 ± 4.3</td>
<td>8 ± 6.4</td>
<td>NS</td>
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<tr>
<td>Endovascular AAA</td>
<td>1 ± 0.8</td>
<td>3 ± 1.5</td>
<td>NS</td>
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NS = not significant.
paradigm, many have advocated residency restructuring with early tracking to reduce general surgery exposure and increase early subspecialty training, which can be accomplished by incorporating a subspecialty fellowship training in the latter portion of a surgical residency [18–20]. In the proposed scenario, residents interested in a vascular surgical subspecialty will undergo either a 3- or 4-year general surgical training followed by either a 3- or 2-year vascular subspecialty training, thus cumulating in a total of 6 years of residency. One obvious advantage of the proposed residency system is that major vascular operations, such as open aortic aneurysm repair, will only be performed by surgical trainees who will practice vascular surgery in their career. Conversely, major general surgical procedures, such as complex alimentary tract reconstructions or endocrine cases, will be performed by residents who are destined to enter a general surgical practice rather than by residents who will never perform these operations in the future. A similar training model is already in existence in plastic surgery residency which can serve as a platform to create a similar training paradigm for vascular subspecialty.

The reduction of open aneurysm operative experience in our general surgical residents as impacted by the endovascular program also underscores the correlation between the outcome of complex vascular surgical procedures and the surgeon’s training and experience. In a study that examined the association of the clinical outcome of AAA operations and the surgeon’s experience, Tu et al [21] found that surgeon specialty and annual surgeon volume significantly influenced the mortality after elective open AAA repair. They noted that general surgeons had a risk-adjusted mortality rate 62% higher than certified vascular surgeons. In addition, low-volume surgeons (fewer than 5 elective AAA cases per year) had a 30-day mortality rate 83% higher than high-volume surgeons (more than 13 cases a year). Another recent study by Pearce et al [22] similarly showed that vascular surgery training was an independent predictor for improved outcome after elective AAA repair in Florida, where vascular surgeons had a 24% lower risk of adverse outcome than general surgeons. Given the diverse treatment options available for patients with AAA today, time has clearly come that general surgery training alone will not provide the necessary training for a surgeon to adequately treat AAA patients without additional subspecialty training.

In conclusion, our study showed an endovascular program significantly increased the overall volume of aneurysm operation at our institution. Furthermore, a marked increased in endovascular AAA volume had a positive impact on the vascular fellowship program. An increase in the endovascular operation has conversely resulted in a decline in open infrarenal AAA operations. Consequently, significantly less open aneurysm operations were being performed by the general surgical chief residents. Such a reduction in the operative aneurysm experience in general surgical residents warrants further evaluation of possible restructuring of the residency training paradigm to better optimize the training of future surgical and vascular trainees.

References