Trends in aortic aneurysm surgical training for general and vascular surgery residents in the era of endovascular abdominal aortic aneurysm repair

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Hypothesis: **The emergence of endovascular abdominal aortic aneurysm (AAA) repair may negatively impact the open AAA experience of general surgery residents.**

Methods: **Prospectively collected data on general and vascular surgery resident training in AAA repair for a 5-year period (1997 to 2001) at a single institution were retrospectively reviewed. Five general surgery residents and one vascular resident completed training yearly. Institutional volume of open and endovascular repair of AAA was also assessed.**

Results: **The cumulative mean general surgical resident experience with open AAA repair fell significantly over a 5-year period; 9.5 ± 2.5 cases were performed per general surgical resident finishing in 1997, 7.5 ± 0.3 cases in 1998, 4.6 ± 0.4 cases in 1999, 4.0 ± 1.3 cases in 2000, and 4.2 ± 1.0 cases in 2001 ($P = .03$). The vascular resident experience with open AAA repair did not change significantly over the 5-year period. However, the active development of an endovascular AAA program increased total AAA exposure of the vascular resident from 26 cases in 1997 to a mean of 70 cases in 2000 and 2001. The institution volume of open nonsuprarenal AAA repairs fell 38% during the 5-year period ($P = .33$) during a period when endovascular AAA repair increased from 9 (1996) to 55 (2000) cases ($P < .001$). The complexity of open AAA surgery also increased: 23.3% of open cases (7/30) in 2000 were juxta/pararenal versus 2.9% (1/35) in 1996 ($P = .05$).**

Conclusion: **The introduction of endovascular AAA repair may have negatively impacted general surgical resident training in open AAA repair. The number of open AAA cases declined, and their complexity significantly increased. Many uncomplicated AAAs were managed with endovascular means. At programs with such a paradigm shift in AAA treatment, expectation that general surgery residents gain the proficiency necessary to safely perform AAA repair without additional training may be unrealistic. (J Vasc Surg 2002;36:685-9.)**

As defined by the American Board of Surgery, "A General Surgeon certified by the American Board of Surgery is one who has acquired during training specialized knowledge and experience related to the diagnosis, preoperative, operative and post-operative management, including the management of complications, in nine primary components of Surgery. . . [including the] Vascular System. . .."[1] Within large segments of the vascular surgical community, many believe that the "specialized knowledge and training" in vascular diseases obtained in general surgery training programs is frequently inadequate to allow for superior, independent management of the full spectrum of vascular surgery.[2-4]

Treatment outcomes are becoming increasingly recognized as an important benchmark for accreditation purposes. The American Board of Surgery has recently suggested linkage of certain outcome measures and recertification. Interestingly, ample data show a strong correlation between training and outcome after treatment for abdominal aortic aneurysms (AAAs). In a study of 5878 AAA repairs performed in Ontario, Canada, between 1992 and 1996, the risk-adjusted mortality rate was 3.5% for Canadian-boarded vascular surgeons and 6.2% for general surgeons ($P = .003$).[5] In a study of 13,415 AAA repairs in Florida between 1992 and 1996, surgeons with certification for added qualifications in vascular surgery had a 24% lower risk of death or major complications ($P = .009$).[6] These large population-based studies reflect the outcome of general surgeons who were trained before the widespread introduction of endovascular AAA repair (EAR).

Recently, a paradigm shift has been seen regarding AAA repair in many vascular surgical practices. EAR has supplanted traditional open AAA repair in most cases in some centers.[7] These trends may be more pronounced in some academic/teaching medical centers because of their involvement in Food and Drug Administration (FDA) trials of various aortic endografts.[7-10] Exposure to EAR was largely limited to centers participating in FDA trials until endograft approval in late 1999. As such, the possible detrimental effects on general surgical resident training may not yet be apparent nationally.

The primary purpose of this study was to examine general surgical resident experience as a primary surgeon for AAA repair between academic years 1996 and 1997 through 2000 and 2001 at a single tertiary care institution. During this time interval, an active EAR program was

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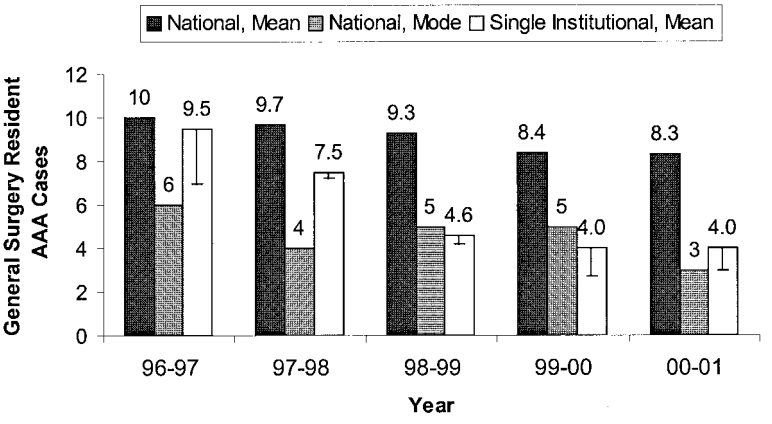

Fig 1. General surgery resident AAA cases: national mean, national mode (most frequent number of cases performed), and institutional mean. Institutional decline in general surgery resident exposure to AAA repair was statistically significant ($P = .03$).

established. Our hypothesis was that the emergence of EAR may have negatively impacted the AAA experience of general surgery residents. The operative experience of vascular residents (fellows) was also examined for the same 5-year period. Finally, institutional trends in the methods of AAA treatment were studied.

METHODS

The Ochsner Clinic Foundation administrates a general surgical training program that finishes five chief residents per year. Each graduating resident is required to complete a comprehensive list of operative cases as part of the Residency Review Committee (RRC) for Surgery requirements. These prospectively collected case logs from residents finishing between academic years 1996 and 1997 through 2000 and 2001 were retrospectively assessed for AAA procedures. Cases under the categories of "infrarenal aorta, elective" and "infrarenal aorta, emergent" were counted when listed under "surgeon, chief year" or "surgeon, junior years." Cases listed as "first assistant" were not included. General surgery residents did not act as teaching assistants for AAA repair. National data on general surgery resident AAA cases were obtained from the RRC for Surgery resident statistics summaries.

The institution also supports a RRC-accredited vascular resident training program (fellowship) that finishes one trainee yearly. For purposes of comparison, the AAA experience of these trainees was also examined in a similar fashion. To give an accurate comparison with general surgery residents, vascular resident experience with suprarenal AAA was not included. In years 2000 and 2001, the official case-reporting document of the RRC for vascular residents distinguished between open repair and EAR. Before 2000, the type of AAA repair was not distinguished, so the comparative open repair and EAR experience of the vascular residents finishing in years 1997, 1998, and 1999 was abstracted from the their personal case logs.

The institutional experience with AAA was retrospectively reviewed via a search of medical records. Calendar years 1996 through 2000 were searched for EAR or open AAA repair. Open AAA repair was considered juxtarenal if repair necessitated placement of the proximal clamp above one or both renal arteries. The procedure was considered pararenal if a bypass or reimplantation of a renal artery was also necessary. Details regarding our experience with and selection criteria for EAR have been previously described.[10-13] Most patients who underwent EAR were enrolled in phase II/III FDA clinical trials.

Trends in institutional and resident AAA volume and AAA complexity over the study period were assessed with Pearson χ^2 test, Kruskal-Wallis test (nonparamentric analysis of variance), or Kendall test as appropriate. Data are presented as the mean ± the standard error of the mean.

RESULTS

General surgery resident experience. Cumulative mean general surgical resident experience with open AAA repair fell significantly ($P = .03$) over a 5-year period; 9.5 ± 2.5 cases were performed per general surgical resident finishing in 1996-1997, 7.5 ± 0.3 cases in 1997-1998, 4.6 ± 1.3 cases in 1998-1999, 4.0 ± 1.0 cases in 1999-2000, and 4.2 ± 1.0 cases in 2000-2001 (Fig 1). General surgery residents acted as first assistants in some EARs but did not act as primary surgeons. Nationally, the general surgery resident mean number of AAA cases was similar in 1996 and 1997 (10.0), but the decline was much less pronounced over the 5-year period when compared with our program (Fig 1). The general surgery resident mode experience with AAA, the number most frequently performed nationwide, was similar to our mean values (Fig 1).

The mean number of total major cases in the defined area of vascular surgery performed by our general surgery residents was 86 and 80 in 1999-2000 and 2000-2001, respectively. The respective national averages were 106.8

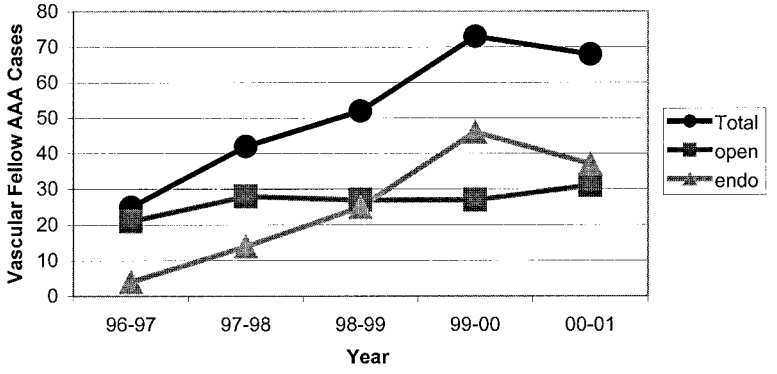

Fig 2. Vascular surgery resident (fellow) AAA cases. Open AAA experience did not change significantly ($P = .29$), but endovascular *(endo)* cases increased dramatically ($P < .0001$), leading to greater than two-fold increase in overall AAA cases.

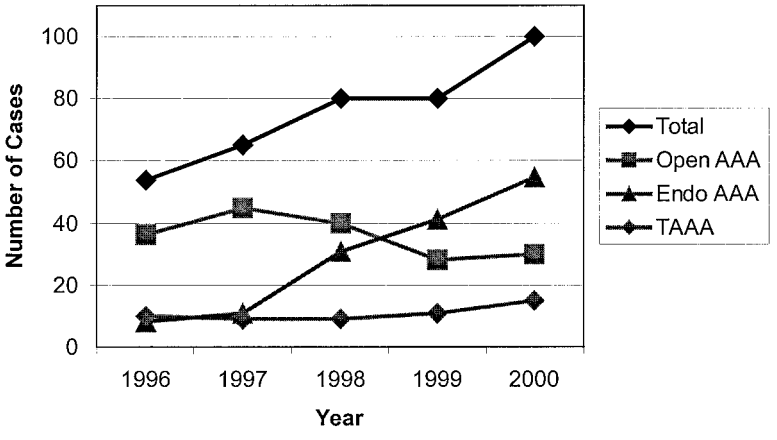

Fig 3. Institutional trends in aneurysm repair. Despite 38% decline in open (nonsuprarenal) AAA cases between 1997 and 1999 ($P = .33$), emergence of EAR *(endo)* significantly increased overall AAA volume. *TAAA,* Thoracoabdominal aortic aneurysm repair.

and 101.7 for the same years, respectively. Forty-four cases are the minimum volume required by the RRC in this defined category.

Vascular surgery resident experience. Vascular resident experience with AAA repair is detailed in Fig 2. Open AAA experience did not change significantly over the 5-year period ($P = .29$). However, exposure to EAR increased dramatically ($P < .0001$), which resulted in a greater than two-fold increase in overall AAA cases. In the last 2 years of this review, the vascular resident performed approximately 70 open repair and EAR cases combined.

Institutional abdominal aortic aneurysm experience. During a 5-year period (1996 to 2000), 379 AAA repairs were performed at our institution. Of these patients, 179 underwent open AAA repair, 146 underwent EAR, and 54 underwent thoracoabdominal aortic aneurysm repair. Institutional volume of EAR showed a progressive increase over the 5-year period (Fig 3). Although only nine EARs were performed in 1996, 55 were done during 2000. Total AAA repair volume likewise showed a significant increase over the 5-year period; 53 were performed in 1996 and 100 in 2000 ($P < .0001$).

The institutional volume of open nonsuprarenal AAA repair fell from a high of 45 cases in 1997 to a low of 28 cases in 1999, a 38% decline ($P = .33$; Fig 3). The complexity of nonsuprarenal AAA repairs increased significantly ($P = .05$); 23.3% of open cases (7/30) in 2000 were juxtarenal or pararenal versus only 2.9% (1/36) to 13.3% (6/45) in the preceding 4 years (Fig 4). Thoracoabdominal aortic aneurysm repair volume increased from 10 cases in 1996 to 15 in 2000.

DISCUSSION

General surgery residents who completed their training between 1997 and 2001 have experienced a significant decline in operative exposure to AAA repair at our institution. Similar trends have been reported from other centers with established EAR programs.[7] Our data and those of

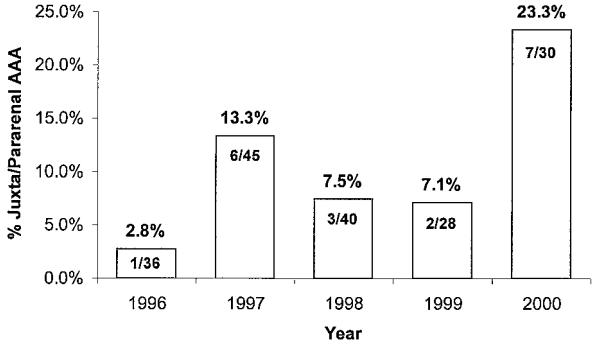

Fig 4. Complexity of open (nonsuprarenal) AAA repair increased significantly ($P = .05$) over 5-year period.

Choi et al[7] suggest that recent trainees in programs with active EAR practices may not be receiving adequate training in this benchmark vascular procedure to allow for safe independent performance. Vascular residents, however, maintained their experience with open AAA repair while also gaining extensive exposure to EAR, similar to the experience of others.[7,14]

Why did general surgery resident volume with AAA cases decline over the 5-year period? The answers are likely multifactorial. First, and perhaps most importantly, open cases declined 38%, from 45 in 1997 to 28 in 1999. Despite the lack of statistical significance of this change (possible type II error), this decline in available open AAA cases was likely clinically relevant. The reduction in available open cases was a contributing if not primary factor in the decline in general surgery resident AAA repair exposure. During this same time period, institutional EAR increased from nine cases (1996) to 55 (2000). Although it remains speculative, this rapid expansion of EAR may have played a causative role in the reduction of institutional open AAA cases performed. Second, in the latter part of our experience, the complexity of open AAA repairs increased significantly. Many of the anatomically simple AAA cases were performed with EAR. Complex open AAA repairs with short or absent infrarenal necks were less likely to be performed by general surgery residents. Third, vascular resident experience with open repair did not change significantly over the study period. Faced with a decline in open procedures, the vascular attending staff believed it most important to maintain the training of vascular residents. As such, the presence of vascular residents likely contributed to the reduction in cases performed by general surgery residents. The main training staff for the vascular residents (WCS, SRM) remained unchanged throughout the 5-year period, and no changes were seen in the number of vascular or general surgical trainees.

On the basis of these explanations, establishment of a firm causal relationship between the introduction of EAR and the decline of general surgery resident AAA cases is not possible. However, other corollary information supports such a hypothesis. The comparison of national data on general surgery resident cases with our institutional experience is consistent with a causal relationship between emergence of EAR and decline of general surgery resident AAA cases. When few EAR cases were being performed at our institution in 1996 and 1997, the number of general surgery resident AAA cases (9.6) was similar to the national mean of 10. However, as EAR became more prevalent, our general surgery resident AAA case numbers declined more precipitously than the national experience (Fig 1), despite a doubling of our institution's AAA case volume. Choi et al[7] also noted a decline in general surgical AAA experience during a period when an active EAR program was established. Most institutions nationwide did not have access to aortic endografts until late 1999, so this potential influence on general surgery resident AAA cases would not have yet occurred. As the use of EAR becomes more widespread, monitoring these national data for the trends now being seen in single center experiences will be important.

Are our general surgery residents receiving adequate training in vascular surgery? The "10 aortic case" requirement for general surgery residents was eliminated nationally by the RRC in Surgery in the late 1990s, presumably because of increasing difficulty in achieving these numbers. The national mode of general surgery resident AAA cases, the number most frequently performed nationwide, was quite similar to our mean values. This suggests that our residents' experience with AAA was roughly comparable with the experience of many others nationwide. Our residents have performed approximately double the minimum of 44 required cases in the defined category of vascular surgery, suggesting that they are indeed receiving more than adequate exposure to vascular surgery. Nationally, general surgery residents have performed approximately 20% more "defined" vascular cases when compared with our residents.

Catheter-based interventions, such as EAR, represent a remarkable paradigm shift in treatment alternatives for vascular disorders. The skill set required for performance of such interventions has not been a significant component of general surgical education. Indeed, such skills have traditionally been the core competencies for other specialties, namely interventional radiologists and cardiologists. The central importance of vascular surgeons integrating this skill set into their practice has been codified by the Association of Program Directors in Vascular Surgery.[15] Vascular residency programs have been encouraged to standardize to 2 years of training with significant exposure to diagnostic and interventional catheter-based procedures.[15]

Is it realistic to expect general surgical residents to attain such catheter-based skills? Additional dedicated training that would extend the residency period would be required. Lengthening the training time to accommodate such training would likely accelerate the current reduction in applicants already seen for general surgery positions. Should general surgery residents be trained to perform only open vascular procedures? The data presented herein suggest that current training may be insufficient to attain this goal. Furthermore, inherent bias is present in a practitioner

who can offer only one treatment alterative. Patients in need of vascular care are best served by a practitioner who can offer the full range of diagnostic and therapeutic alternatives. Fellowship trained vascular surgeons are the only group who can provide such care.

Institutional trends. Over the 5-year period when EAR was introduced, overall AAA volume approximately doubled at our institution (Fig 3). Similar trends in AAA volume have been reported by other centers active in endovascular repair.[7,16,17] The reasons for such an increase in AAA volume are speculative. Certainly, EAR was performed on some patients with conditions deemed unfit for an open repair, thus increasing the total number of repairs. A "referral effect" was also possible, as our institution was the only center performing EAR in our region before the commercial availability of aortic endografts in late 1999. However, our EAR volume actually increased in 2000 after US commercialization of endografts in late 1999.

We experienced a significant increase in the complexity of open aneurysm repair after the introduction of EAR. A greater percentage of these cases were juxtarenal or pararenal. This trend seems intuitive, as many of the patients with longer infrarenal aortic necks underwent EAR. Choi and collegues[7] have also experienced an increase in complexity of their AAA repairs. That such complex AAA repairs may become the norm in the era of EAR has been suggested.[18] The Stanford group found no increase in the complexity of their open infrarenal cases after introduction of EAR[16,17] but did experience a increase in the number of suprarenal AAA cases.[14]

CONCLUSION

General surgery resident exposure to AAA has declined during a period when EAR has become a popular treatment choice. The reduction in open AAA cases and their increasing complexity may have been factors in the trends observed. Training in open procedures did not decline for vascular residents. Because of their modest exposure to open AAA repair in institutions with an active EAR program, it may be unrealistic for recently trained general surgeons to perform AAA repair without additional training.

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