

Lessons Learned in Offering EVAR for Ruptured Aneurysms

Important considerations to improve outcomes.

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Since the initial reports in the mid-1990s, endovascular aneurysm repair (EVAR) for ruptured abdominal aortic aneurysms (rAAAs) has evolved from being performed selectively by a few centers in hemodynamically stable patients to being performed by many endovascular specialists in patients with varying degrees of hemodynamic instability. The reason for the dissemination of these techniques and technology is due to their many advantages over standard open surgical repair (OSR), the most important being an association with significant reduction in morbidity and mortality when compared to OSR. Today, the question is not whether patients with rAAAs should undergo EVAR, but rather how to develop systems that allow for broader use of these complex procedures that have shown great benefit in high-risk patients with rAAAs.

In the last decade, more than 150 patients with rAAAs underwent EVAR at Albany Medical Center. Since our first ruptured EVAR (rEVAR) case, we have made significant modifications in our approach that have enabled us to treat the vast majority of patients with ruptured aneurysms by endovascular means, with improved outcomes.¹

REGIONALIZATION OF CARE

In the upstate New York region, we have adopted an EVAR-first approach for all patients with rAAAs. Whenever feasible, patients presenting at any of the community hospitals in our region are offered a transfer to Albany Medical Center, which is equipped for both EVAR and OSR as needed. At the community hospitals, all patients with rAAAs undergo OSR only.

A recent analysis indicated that out of 283 rAAA patients treated in our region by our group, 187 (66%)

initially presented to community hospitals, of which 136 (72%) were transferred to Albany Medical Center, which has capabilities for both emergent EVAR and OSR. Another 51 patients (28%) underwent OSR at outside facilities; among these patients, the operative mortality was 47%. During the same time, approximately 30 patients were turned down for any intervention and died. Of the 232 rAAA patients who eventually underwent treatment at the medical center, 136 (59%) were transferred in from an outside facility; only 96 (41%) were directly admitted. In comparing the mortality of patients transferred from outside facilities versus those presenting directly to the medical center, there were no differences among patients who underwent rEVAR (26% vs 20%) or ruptured OSR (rOSR) (38% vs 43%). However, regardless of any transfer from an outside facility, when compared to rEVAR patients, the rOSR patients experienced a 71% higher operative mortality rate (rEVAR 24% vs rOSR 41%; $P < .01$). Furthermore, this difference would be even more pronounced if we compared rEVAR mortality (34/139; 24%) to all rOSR and patients turned down for rOSR (92/174; 53%).

Our findings suggest that regionalization of care for these patients improves outcomes because it allows for potential endovascular treatment options that would otherwise be unavailable to high-risk patients. Regionalization of patient care that includes expeditious transfer of patients to facilities equipped for emergent EVAR and a seamless approach from the emergency department to the operating room for subsequent EVAR has resulted in a change in paradigm in many centers that are beginning to implement the EVAR-first approach for the vast majority of patients with rAAAs.

A MULTIDISCIPLINARY, STANDARDIZED APPROACH

Treatment of rAAA patients involves a multidisciplinary approach inclusive of emergency department staff, anesthesiologists, operating room staff, radiology technologists, and vascular surgeons and interventionists; therefore, it requires a standardized approach that engages all parties and facilitates a seamless transition of the patient from the emergency department to the operating room for EVAR. Although the standardization of any approach will vary from hospital to hospital, the fundamentals are simple: success depends on the early diagnosis of rAAA, the ability to have an expeditious CT scan to evaluate the aortoiliac morphology, and a quick transition of the patient from the emergency department to an operating room equipped to perform endovascular and OSR under these emergent circumstances.²

SIMPLIFY THE FUNDAMENTAL TECHNIQUE AND APPROACH

In the beginning, physicians should (1) become comfortable performing EVAR under elective circumstances; (2) obtain an inventory of standard equipment that is needed to perform elective EVAR safely (wires, catheters, sheaths, balloons—particularly the compliant aortic occlusion balloons—and fluoroscopic equipment); (3) pick and choose the stent grafts that they are most comfortable using and acquire select stent graft sizes to match the largest aortic neck diameter and the shortest aneurysm length, with a variety of iliac extensions to treat most, if not all, AAAs; (4) become comfortable with adjunctive procedures (such as iliac interventions) that might be needed in order to facilitate access, use of compliant aortic occlusion balloons, or placement of Palmaz stents at the aortic neck; and (5) treat only hemodynamically stable patients with preoperative CT scans. With increasing experience, one can easily modify inclusion and exclusion criteria for EVAR of rAAAs to accommodate even hemodynamically unstable patients.

THE OCCLUSION BALLOON

The appropriate use of aortic occlusion balloons in hemodynamically unstable patients is vital to the success of EVAR in these emergent circumstances. There are several advantages of the femoral approach; one is that it allows the anesthesia team to have access to both upper extremities for arterial and venous access. Patients who require the aortic occlusion balloon are often hypotensive, and in these patients, percutaneous brachial access can be difficult and more time consuming than femoral cutdown. Currently available aortic occlusion balloons require at least a 12-F sheath, which requires a brachial

TOP 10 LESSONS LEARNED IN OFFERING EVAR FOR RUPTURED ANEURYSMS

1. Regionalize care to hospitals with rEVAR and OSR infrastructure and ability to improve patient survival.
2. Develop a multidisciplinary, standardized approach that enables seamless transition of rAAA patients to the operating room.
3. Simplify the fundamental technique and approach to rAAA patients. Acquire fundamental bailout skills, such as Palmaz stent placement, renal interventions, embolization, percutaneous access, and use of closure devices.
4. The occlusion balloon is your best friend; use it wisely.
5. Abdominal compartment syndrome is your enemy. Avoid it when possible, and recognize it when it occurs.
6. Hemodynamically unstable patients can undergo EVAR.
7. Expect a higher rEVAR mortality rate in women, octogenarians, and hemodynamically unstable patients.
8. Stop the bleeding, even if it means covering one renal artery.
9. Endoleaks after rEVAR have a significantly higher association with stent graft explant and need vigilant follow-up and aggressive treatment.
10. rEVAR has lower 30-day mortality and better 5-year survival when compared to OSR.

artery cutdown and repair; stiff wires and catheters across the aortic arch without previous imaging under emergent circumstances might result in other arterial injuries or embolization leading to stroke. To facilitate stabilization of the balloon catheter during inflation and maintain aortic occlusion at the suprarenal/supraceliac level, the sheath supporting the balloon should be advanced into the aortic neck and fully supported before inflation of the occlusion balloon to prevent downward displacement and prolapse of the occlusion balloon into the AAA.

ABDOMINAL COMPARTMENT SYNDROME

With increasing use of endovascular techniques for treating rAAAs, there is an increased recognition of new complications, such as abdominal compartment syndrome (ACS). The pathophysiology of ACS after EVAR for rAAAs is multifactorial. The retroperitoneal hematoma is a space-occupying lesion and a significant factor contributing to intra-abdominal hypertension. Ongoing bleeding from lumbar and inferior mesenteric arteries into the disrupted aneurysm sac in the setting of

severe coagulopathy might be a contributing factor. The shock state associated with rAAAs is also associated with alterations in microvascular permeability that can lead to visceral and soft tissue edema. In our own series of EVAR for rAAAs in hemodynamically stable and unstable patients, the incidence of ACS was noted to be 18%, and several variables were identified as significant contributing factors. These include use of aortic occlusion balloons, the need for massive blood transfusions (mean, 8 units packed red blood cells), and coagulopathy with elevated activated partial thromboplastin time at the completion of the case. In our experience, patients who developed ACS had a significantly increased mortality (67%) when compared to those without ACS (10%).³ As a result of these observations, systemic heparin administration—used earlier in our experience during EVAR for rupture—is avoided, and coagulation studies are aggressively corrected during the perioperative period to help limit the ongoing bleeding from collateral vessels. If the bladder pressures are increased, regardless of the presence of other associated factors, we emphatically recommend that patients undergo decompression laparotomy.

HEMODYNAMICALLY UNSTABLE PATIENTS

One of the biggest setbacks to widespread acceptance of the EVAR-first approach for all patients with rAAAs is our limited understanding in managing hemodynamically unstable patients by endovascular means. Our experience of rEVAR for both hemodynamically stable and hemodynamically unstable patients suggests that rEVAR is feasible and relatively safe, regardless of the patient's hemodynamic status. Our findings also suggest that a patient's hemodynamic status does not affect nonfatal complications and secondary interventions after rEVAR.

In treating hemodynamically unstable patients, several factors need to be considered. Interventionists should contemplate percutaneous access with local anesthetic; this may avoid the loss of sympathetic tone in compromised rAAA patients. Interventionists should also be comfortable with the aortic occlusion balloon. If inflation of the aortic balloon is required to maintain a viable blood pressure, then the remainder of the EVAR should be conducted expeditiously. During the procedure, just prior to deployment of the stent graft main body, the occlusion balloon should be deflated from the suprarenal level and withdrawn. The stent graft main body is subsequently deployed; this will avoid trapping the compliant occlusion balloon between the aortic neck and the stent graft. Temporary deflation of the occlusion balloon rarely results in hemodynamic collapse and is usually of little consequence. In hemodynamically unstable patients, the occlusion balloon can be redirected into the aortic neck from the side ipsilateral to the stent

graft main body and reinflated at the infrarenal aortic neck within the stent graft main body. This allows for aortic occlusion and does not interfere with the remainder of the endovascular procedure.

REVAR MORTALITY IN WOMEN, OCTOGENARIANS, AND HEMODYNAMICALLY UNSTABLE PATIENTS

We would like to think that regionalization and standardization in our approach to rAAA patients has positively affected all patients. Unfortunately, women, octogenarians, and hemodynamically unstable patients continue to experience higher mortality rates, although their mortality is still lower than what has been reported for OSR. In our experience of 283 rAAA patients, the 30-day mortality for EVAR patients was significantly lower than for OSR (24% vs 44%; $P < .005$), as expected. When analyzed by gender, women undergoing EVAR had a higher mortality rate than men, although this difference was not statistically significant (32% vs 21%; $P = .1$). When compared to OSR, women who had rEVAR had a trend toward a lower 30-day mortality (32% vs 44%; $P = .39$). Older patients (age > 80 years) undergoing EVAR had a significantly higher mortality rate than did younger patients (42.1% vs 15.9%; $P < .005$). However, in the OSR group, there was no significant age-related 30-day mortality difference (age > 80 years, 51.2% vs age < 80 years, 41.8%; $P = .36$). When compared to hemodynamically stable patients, the hemodynamically unstable patients had a significantly higher intraoperative need for an occlusion balloon (40% vs 6%; $P < .05$), as well as a higher incidence of developing abdominal compartment syndrome (29% vs 4%; $P < .01$) and death (33% vs 18%; $P < .05$).⁴

STOP THE BLEEDING

We have long been trained to preserve every renal artery. Unfortunately, complex aortic neck morphology in rAAA patients forces us to utilize parallel stent grafts (such as chimney or periscope grafts) or to consider OSR. Unfortunately, there is a higher incidence of type I endoleaks with these adjunctive procedures, which, in cases of rAAA, is unforgiving. It has been our experience that in patients with normal renal function, stent graft coverage of only one renal artery is relatively safe, although this decision needs to be considered carefully, and all options to preserve renal function should be considered.

ENDOLEAKS AFTER RUPTURE EVAR

Our experience of nearly 2,000 elective and rupture EVAR patients suggests that, over a mean follow-up of 40 months, patients following rEVAR had a significantly lower incidence of type II endoleaks when compared to elective

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EVAR (17% vs 29%; $P < .01$). Although the incidence of type I endoleaks is similar after rEVAR and elective EVAR (8% vs 9%; $P =$ nonsignificant), the rEVAR patients with endoleaks required stent graft explant more frequently (26.9% vs 6.7%; $P < .01$), and elective EVAR patients underwent percutaneous embolization procedures more frequently (62.7% vs 42.3%; $P < .05$). The need for stent graft extensions in patients with endoleaks was comparable in both groups. We have learned that rEVAR patients with any endoleaks are at a significantly higher risk for stent graft explant, while endoleaks in elective EVAR patients can be more frequently managed by percutaneous endovascular means.

30-DAY MORTALITY AND 5-YEAR SURVIVAL

For our group, the most critical of all lessons learned has been that the evolution of rEVAR has had a significant impact on not only lowering the 30-day mortality, but also in improving long-term survival when patients are treated with a structured approach as described previously. In a prospective comparison of rEVAR to OSR, the EVAR patients not only had a significantly lower 30-day mortality than OSR patients (24% vs 44%; $P < .005$), they also experienced a better cumulative 5-year survival (37% vs. 26%; $P < .005$). For rAAAs, EVAR offers a significant reduction in early mortality as well as a long-term survival advantage compared with OSR.⁵ ■

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