Endovascular Repair of Ruptured AAAs

In treating AAAs, endovascular repair may hold the key over open repair to lowering mortality.

BY TAKAO OHKI, MD, PHD, AND FRANK J. VEITH, MD

In elective aneurysm repair using endovascular technology, it has not yet been possible to show any clear benefit in terms of mortality as compared to open repair. This is one area in which there is much room for improvement, and there are some early data that indicate endovascular therapy may become the procedure of choice for treating aneurysms.

MAGNITUDE OF THE PROBLEM

Aneurysms kill approximately 15,000 Americans on an annual basis, and most, if not all, such patients die from some form of rupture. It is the third leading cause of sudden death in men over 60, largely because once an aneurysm ruptures, the mortality rate has been reported to be 80% to 90%. The classic triad on which we still rely includes abdominal or back pain, hypotension or syncope, and a known aneurysm or a pulsatile abdominal mass at the initial presentation. If the patient fulfills all three of the triad, he or she will go straight to the OR; if the patient has two of the triad, the patient will typically get a CT scan, confirm the leak, and then be moved to the OR. The patient may or may not undergo CT scanning depending on how severe the symptoms are. Despite efforts in pre-emptive aneurysm treatment, the incidence of rupture and death continues to increase and is now approximately threefold

Figure 1. CT scan of a patient with a large retroperitoneal hematoma.

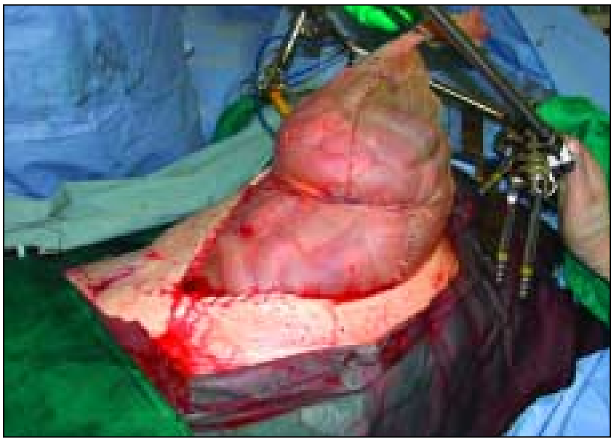

Figure 2. Successful open repair to treat a rupture results in an entirely new set of complications.

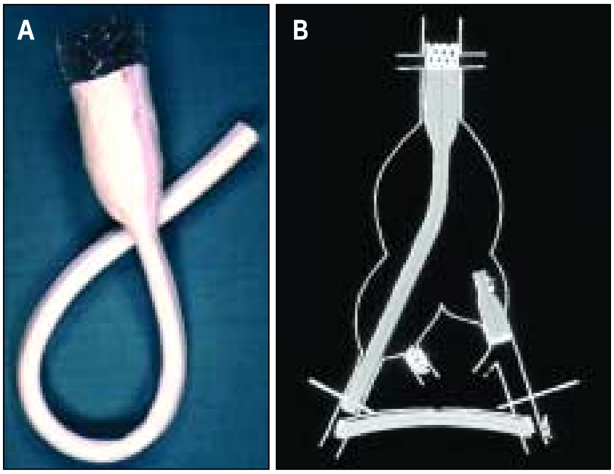

Figure 3. The MEG device.

what it was decades ago; this trend is probably related to the aging population. In any case, it is clear that surgeons have not done a satisfactory job in preventing rupture.

CHALLENGES

Figure 1 shows the CT scan of a patient with a large retroperitoneal hematoma. The presence of a retroperitoneal hematoma prompts the diagnosis of a ruptured AAA. Although the gold standard continues to be open repair, its major shortcoming is a mortality rate ranging from 35% to 75%; on average it is approximately 50% among those patients who make it to the hospital. Despite the major advancements made in the nonsurgical aspects of care, including transportation and critical care, this rate has remained largely unchanged over the last 40 years since the first AAA repair was performed. The reason for this lack of improvement includes the fact that the invasiveness of the surgical procedure has largely gone unchanged. Some minor improvements include the use of a low-porosity graft, an inclusion technique for proximal anastomosis, and more liberal use of a supraciliac clamp as opposed to an infrarenal clamp. However, the bottom line is that the open surgical technique remains very invasive, especially for these critically ill patients. Once you enter the abdominal cavity, you may encounter a pool of blood or a retroperitoneal hematoma that may obscure the anatomy, making the placement of the clamp extremely difficult. On top of that, the patient is dying by the minute, and the anesthesiologist is yelling at you that the pressure is going down. Even if one makes it through the surgery successfully, you are now faced with hypothermia, DIC, colonic ischemia, abdominal compartment syndrome, reperfusion injury, and ultimately multiorgan failure (Figure 2).

We now have an increasing number and variety of endografts, and it is very natural to try to use endovascular techniques to improve the results of open surgical repair for ruptured AAAs. Endovascular specialists can now avoid going into the hostile field and repair the aneurysm through the intravascular route, which is largely unaffected by the hemorrhage. However, there have been only a few reports in the literature on this topic despite the extensive availability of endografts.[1,2] This relative paucity may be related to some inherent limitations of endovascular repair applied to this acute setting, including the fact that endovascular repair requires the things that result in delay in obtaining aortic control, which have been deemed quite inappropriate in this acute setting. The diameter and length measurements, the procurement or fabrication of the device, and also the time it takes to deploy the endograft all lead to this delay. Also, when the anatomy is very straightforward, any of these endografts are very easy to place, but aneurysms that are large enough to treat and certainly those that are large enough to rupture, have a wide variety of anatomies, many of which may make endografting quite challenging.

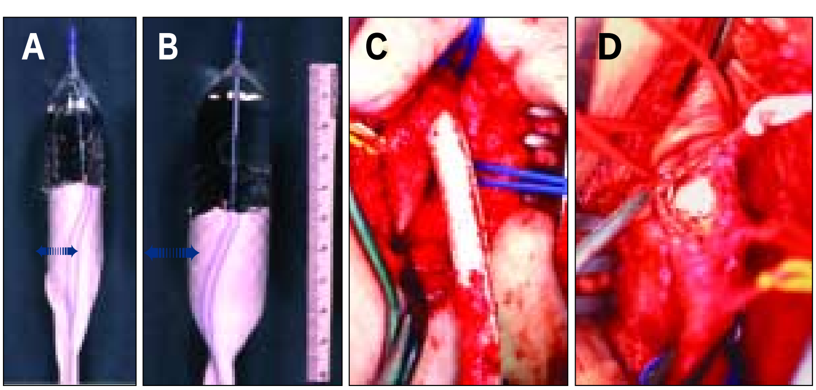

Figure 4. Demonstration of the customization capability of the MEG device.

SOLUTIONS

Use of a Proximal Occlusion Balloon

Our solution to these challenges was to use a graft that has the ability to be customized intraoperatively to varying diameters (neckwise) and varying lengths. We also liberally use an aortic occlusion balloon to obtain proximal control prior to the placement of the endograft. The percutaneous occlusion balloon is placed from the brachial artery and will be

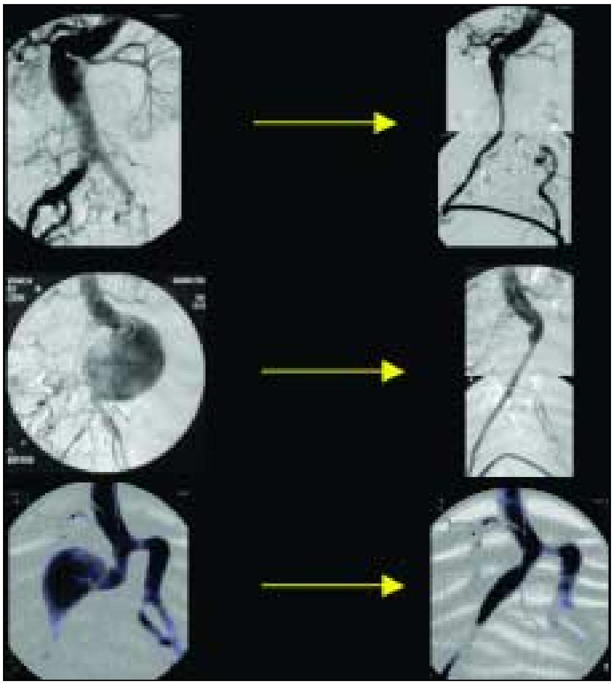

Figure 5. Demonstration of the versatility of the MEG to deal with tortuous anatomy.

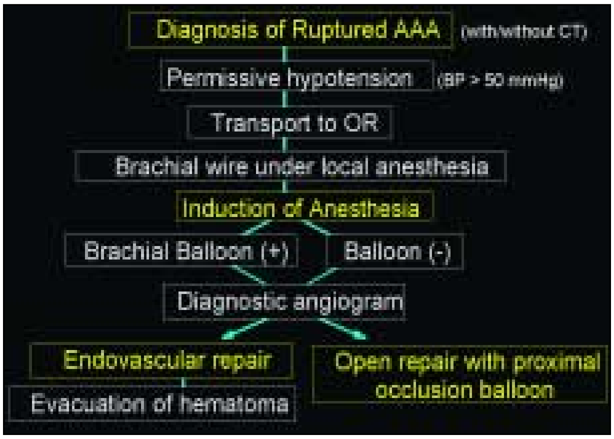

Figure 6. The "all comer" policy at Montefiore Medical Center.

parked somewhere in the descending thoracic aorta. This technique buys time so that the groin dissection can be performed. This concept is not new; in 1976 there was a report of five occlusion balloons being placed from the axillilary artery to obtain temporary hemostasis.[3] In those days, however, the treatment was obviously open repair.

The other policy that we adopted was a permissive hypotension policy. We do not resuscitate the patient even if they have severe hypotension. The concept is that if you resuscitate them with crystalloids they would further bleed and it becomes a vicious cycle. Even if the patient's blood pressure ranges from 50 to 70, it is best to leave them alone. If they die, they die. Even if you resuscitate them, it doesn't mean that you can save them.

The Vascular Innovation "One Size Fits Most" Endograft

In most cases, we have used the Montefiore Endovascular Graft (MEG)/Vascular Innovation Graft (Vascular Innovation, Inc., New York, New York), which is an endograft fabricated from a balloon-expandable Palmaz stent (Cordis Corporation, a Johnson & Johnson company, Miami, FL) and a PTFE graft (Figure 3). This device has an intraoperative customization capability; we call it the "one size fits most" endograft. The customization capability is provided by adjusting the inflation pressure of the balloon, which results in the maximal stent diameter between 20 mm and 28 mm, depending on the pressure one applies to the balloon (Figure 4). The other aspect is that the endograft is always manufactured too long such that it would emerge from the femoral arteriotomy so that one can simply cut it as it emerges and adjust the length accordingly. The three aneurysms in Figure 5 have totally different anatomy, but they were all treated with the exact

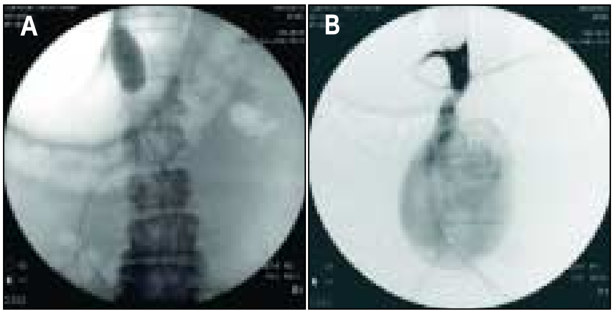

Figure 7. The brachial balloon was inserted from the brachial artery, and was inflated in the descending thoracic aorta.

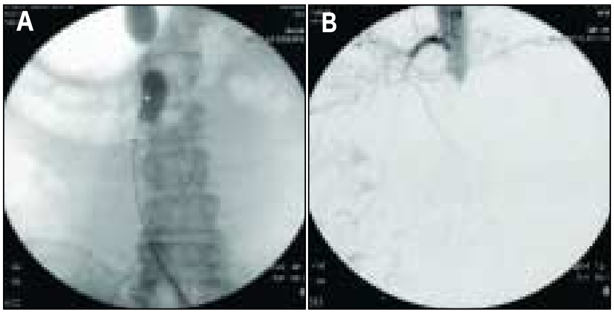

Figure 8. The visceral and the renal arteries are perfused, providing much more time to work with the groin dissection and endograft deployment.

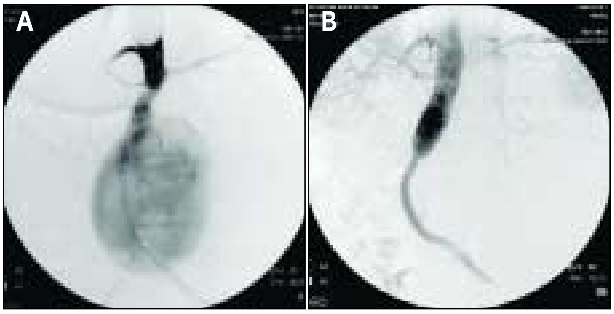

Figure 9. Completion with complete exclusion of the ruptured AAA.

same endograft, which speaks to the versatility of this particular graft.

The other advantage of using the aorto-uni-iliac or femoral approach, as opposed to a bifurcated modular type, is that once you deploy the proximal stent, immediate hemostasis can be achieved, whereas with the modular type one would encounter continued hemorrhage until deployment of the contralateral limb. This process can be quite time consuming. The diagram in Figure 6 shows our policy over the last several years. It is an “all comer” policy; we do not select patients based on their anatomy or their hemodynamic stability. Once the clinical diagnosis of a ruptured AAA has been made, we take the patient to the OR, with or without a CT scan. Obviously, if the patient is stable enough and if there is any question regarding the diagnosis, there is no reason not to obtain a CT scan.

The brachial wire under local anesthesia is deployed in all cases. Using local anesthesia as opposed to general is very important because general anesthesia would release the vasoconstriction that might be responsible for maintaining the patient’s pressure at a precritical level. Once general anesthesia is administered, the hypotension may be exacerbated. Placement of a brachial wire is performed without affecting the vasoconstriction, and once the wire is in, we proceed with general anesthesia. If we see a further drop in blood pressure, we upsize the sheath and place the occlusion balloon over the previously placed wire. Finally, we obtain a diagnostic angiogram and decide whether the patient is a candidate for endovascular repair or if the patient requires open repair for one reason or another. We will use the occlusion balloon even if we decide to perform open repair.

TIPS AND TRICKS

There are some tips, tricks, and pitfalls that one needs to know, including the fact that the CT scan is not always available. Therefore, detailed planning is not possible and one has to play it by ear, which is quite different from elective repair. Obviously, one needs to be prepared to do open surgery in this acute setting. The patient is not always conscious and cooperative. Also, it is very difficult to perform even a groin cutdown while CPR is being performed. Finally, when one inflates the occlusion balloon, one must be conscious about the length of supraceliac aortic occlusion because of concern regarding warm ischemia of the intestine as well as the kidneys. Usually, we deflate it and perfuse the intestine before 30 minutes have elapsed.

A 65-year-old man reported abdominal pain for several days but did not seek medical attention. He was found unconscious at home and fulfilled the triad. He was transported to the OR without a CT scan, and the brachial balloon was inserted under local anesthesia. The brachial balloon was inserted from the brachial artery, and was inflated in the descending thoracic aorta (Figure 7). The blood pressure will almost always immediately increase at this point. There is nothing like proximal clamping to elevate the blood pressure. Once the balloon is inflated, we obtain a diagnostic angiogram. Once the proximal occlusion balloon is inflated and the blood pressure increases, one has more time to plan. The next maneuver is to exchange the supraceliac balloon for an infrarenal balloon. The supraceliac balloon is removed and the infrarenal balloon is inserted from the groin and inflated. By doing

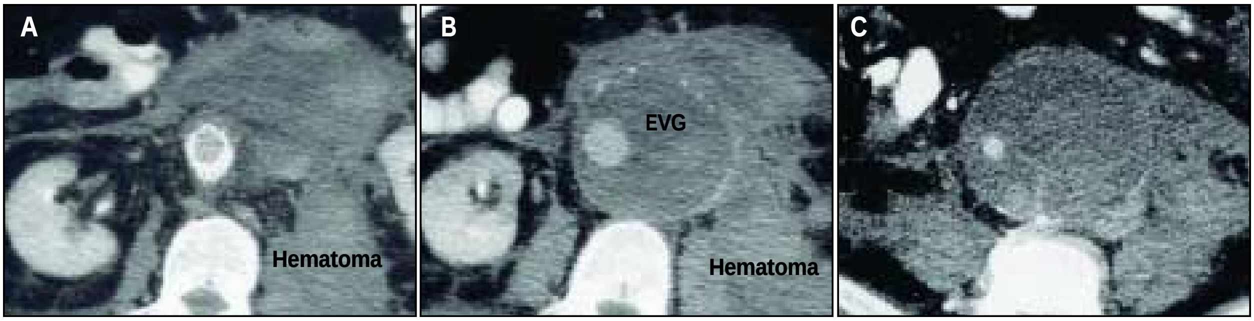

Figure 10. A postoperative CT scan is obtained to confirm the presence of a retroperitoneal hematoma.

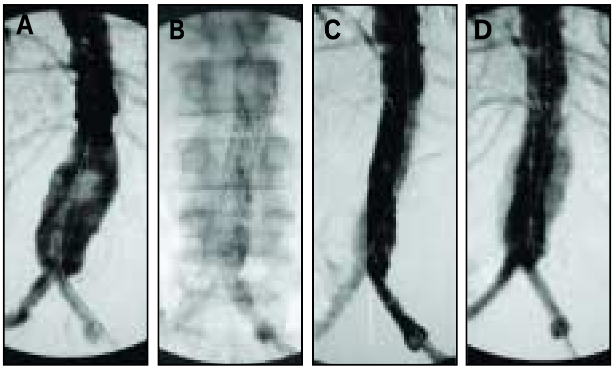

Figure 11. Type IV endoleaks are due to the porous nature of the graft.

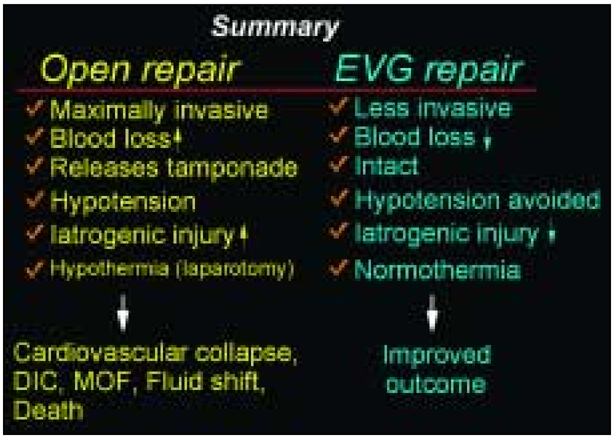

Figure 12. A summary of the limitations of open repair compared to endovascular repair

so, the visceral and the renal arteries are perfused, providing much more time to work with the groin dissection and endograft deployment (Figure 8).

Finally, we place the endograft, which is the rather simple part; Figure 9 is a nice completion with complete exclusion of the ruptured AAA. We do obtain a CT scan postoperatively to confirm the presence of a retroperitoneal hematoma if the patient did not have one preoperatively (Figure 10). Interestingly, abdominal pain has resolved quite rapidly (within a day or two) in all of our patients who were properly diagnosed and successfully treated.

More recently we have been using the commercially available endografts, and because of its versatility and ease of use, our preference was to use the AneuRx device (Medtronic, Inc., Santa Rosa, CA). One of the problems we have faced, however, was related to the blush, or type IV endoleak, which is an endoleak that is due to the porous nature of the graft. This occurrence has been a problem in this acute setting (Figure 11).

During the 3-year period that we incorporated an "all comer" policy, 29 patients with ruptured AAAs came to the ER at Montefiore; one was a misdiagnosis. The mortality rate in the endovascular arm—those patients that had adequate anatomy—was 16%, and those who underwent open repair for reasons such as pararenal aneurysm, bilateral iliac occlusions, or simply the fact that the endovascular surgeon was not present, the mortality rate was still respectable (33%). Although it is a small series, it does show the feasibility of EVAR in this acute setting as well as a tendency in terms of improved outcome.

Open repair has clear limitations in this acute setting, most of which are eliminated when endovascular technology is used (Figure 12). There are concerns related to endovascular repair for elective AAA, including lack of long-term durability and late ruptures. However, when one uses endovascular technology for the ruptured AAA patients, the durability is almost a nonissue because the endograft can serve as a temporary means to control the bleeding. When the patient's overall condition is stabilized, he can then safely undergo elective open repair if endograft failure is encountered.

CONCLUSIONS

The brachial occlusion balloon has been useful for both endovascular and open repair, and the liberal use of this balloon buys time to perform the groin dissection and the endovascular repair. Endovascular repair for AAA using an endograft with intraoperative customization capability is certainly feasible, and we need to prove the efficacy with more cases. This approach has the potential to dramatically lower the mortality rate in this group of patients. ■

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