Endovascular Repair of Ruptured Abdominal Aortic Aneurysms

Techniques and strategies for optimal outcomes.

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Endovascular repair of ruptured abdominal aortic aneurysms (rEVAR) has become an established treatment option alongside conventional open repair. Theoretically, rEVAR has several advantages, including the option to perform the entire procedure or parts of the procedure under local anesthesia, thus avoiding the hypotensive effects of general anesthesia, and the fact that using a percutaneous approach minimizes blood loss and avoids laparotomy. Several randomized trials have been performed to compare open surgery with rEVAR, and these have found rEVAR to be a valid option in suitable patients but have failed to show superiority across the board.[1] However, a number of single-center and multicenter studies have indicated that rEVAR might indeed be the best option.[2,3] Some groups even argue that rEVAR is the preferred option in all patients when using adjunctive chimney techniques. The debate has continued and has often focused on certain technical points that are critical for rEVAR to be successful. The aim of this article is to outline a basic description of rEVAR and to highlight tips and techniques that are important for achieving a good result.

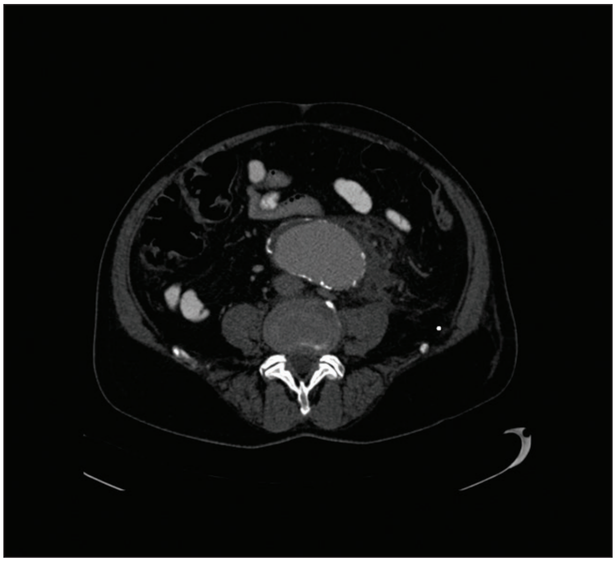

Figure 1. Axial CT scan of a ruptured aortoiliac aneurysm. Note the retroperitoneal hematoma on the left side.

PREOPERATIVE PLANNING

To perform rEVAR appropriately, a preoperative contrast-enhanced CT scan is almost mandatory (Figure 1).[4] The identification of appropriate proximal and distal sealing zones, as well as evaluation of the iliofemoral access, is critical to success (Figure 2). In contrast to elective EVAR, the overwhelming goal of rEVAR is rapid sealing of the infrarenal aneurysm rupture and ensuring short-term patient survival. Even though long-term EVAR durability remains important in these patients as well, we find that compromises in the initial repair can often be corrected later with adjunctive procedures, if necessary. From a planning standpoint, this implies that a more liberal view on landing zones is often taken. A short, angulated, or tapered infrarenal neck that might be outside of the stent graft's instructions for use, thus jeopardizing mid- and long-term durability, might nevertheless be sufficient to achieve a short-term seal and fixation and treat this deadly condition. The same is true for distal landing zones, where the use of oversized distal cuffs, liberal indications for internal iliac embolization, and extension of the limbs to the external iliac arteries or use of uni-iliac devices are more often used than in the elective setting.

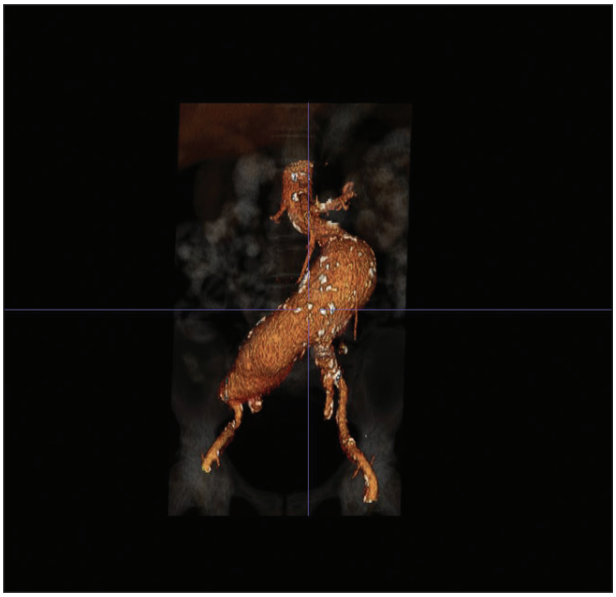

Figure 2. Three-dimensional reconstruction showing a large infrarenal aneurysm with a concomitant right common iliac aneurysm extending to the iliac bifurcation.

Evaluation of iliac access is imperative for a successful procedure. When access is compromised in terms of arterial diameter, calcification, or angulation, a plan must be made to overcome this. Facilitating access with adjunctive procedures, selecting devices with low-profile delivery systems, or choosing a uni-iliac device are all options to overcome access issues.

Although the planning phase for cases of ruptured aneurysms is often under significant time constraints, and perhaps with limited imaging available, it is vital to make the most of the imaging and to spend a few extra minutes reviewing the possible pitfalls of the individual case so that alternate treatment plans can be made. In our experience, it is often much better to take pre-emptive action than to deal with a difficult situation missed in the initial planning.

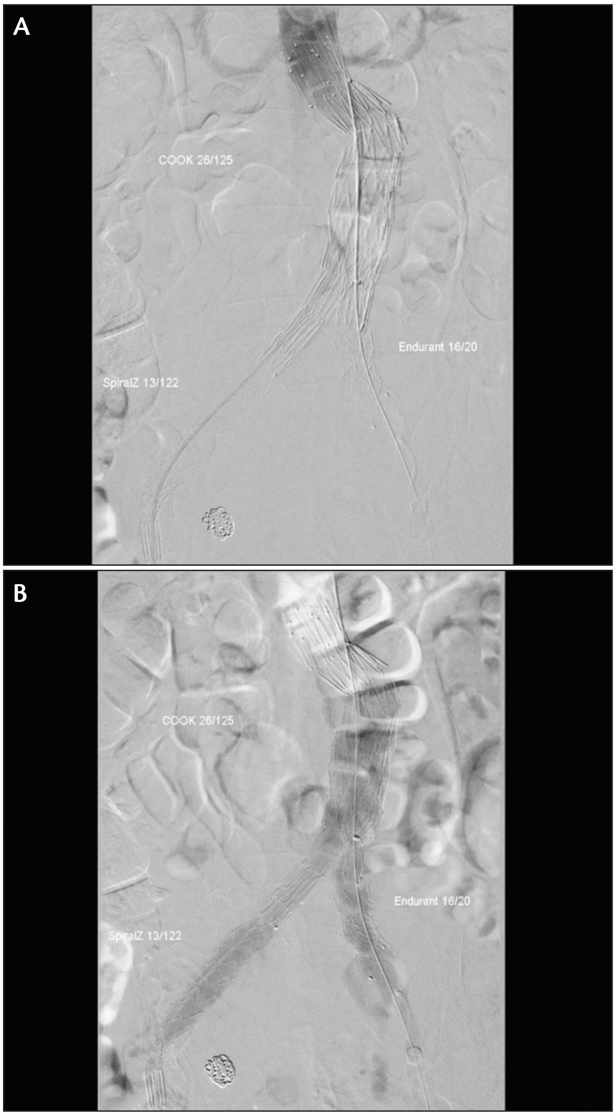

Figure 3. Final angiogram after placement of a Zenith Flex device (Cook Medical) combined with an Endurant limb (Medtronic) on the left side (A). On the right side, the hypogastric artery has been embolized and the stent graft extended into the external iliac artery (B).

CHOOSING THE RIGHT DEVICE

Theoretically, the correct device can be discussed at length in view of the many different devices that are currently available. Most of these devices have pros and cons with regard to device profile, ability to treat short and angulated necks, suitability for chimney repairs, available sizes for iliac sealing, and available size ranges. In reality, one has to choose from what is available on the shelf (Figure 3). No studies have thus far have shown any one device to be superior in treating ruptured abdominal aortic aneurysms, and in fact, most devices have been shown to work sufficiently well. The important thing is to use a device that one is very familiar with. To avoid complications, it is of utmost importance that both the operator and the team have extensive knowledge of the chosen device. This experience is ultimately gained in the elective setting, where detailed knowledge of the graft behavior in vivo and the intricacies of the delivery system and optimal ancillary equipment are determined. It is very likely that the performance of a graft for rEVAR depends much more on this experience than from trying to match an optimal graft to the individual patient anatomy.

We find it advantageous to always perform an initial repair with the final outcome in mind. Thus, when treating patients with unfavorable anatomy, it is vital to try to predict where a possible failure will come during follow-up (type Ia and b endoleaks, migration, etc.) and to choose a graft that will be amenable to further treatment.

BIFURCATED OR UNI-ILIAC DEVICE?

The default design should be a bifurcated device. This avoids crossover femoral-femoral bypass that usually requires general anesthesia and has a much higher risk of postoperative groin infections. By appropriately using occlusion balloons (described later), the hemodynamic stability of the patient can mostly be ensured during placement of a bifurcated stent graft without the need to convert to a uni-iliac repair. The main indication for using a uni-iliac system is in the setting of unilateral iliac occlusion or a severely compromised access that cannot be overcome. In situations where the patient is in complete circulatory collapse, a uni-iliac system is also a more rapid fix, particularly if hemodynamic improvement is not achieved with balloon occlusion. It can sometimes be challenging to get an occlusion balloon in place quickly due to iliac compromise, and if the operator is not experienced in using an occlusion balloon, it is probably better to go straight to a uni-iliac repair than to waste time. Again, it is vital that this is decided preoperatively based on the clinical scenario and the preoperative imaging.

ANESTHESIA AND GROIN APPROACH

Most experienced centers perform rEVAR under local anesthesia. The advantage of local anesthesia is that it is very quick, and it does not affect patient hemodynamics. The main disadvantages are that a patient under distress might have difficulty keeping still during the procedure, as well as patient discomfort. Precise placement of an endograft can also be cumbersome if the patient has difficulty holding his or her breath. We find that it is very rare that we convert a case to general anesthesia due to these issues. When the aneurysm rupture has been sealed, one can move to general anesthesia if additional procedures are needed (eg, groin exposures, etc.). General anesthesia might even be beneficial at the end of the procedure and during the initial postoperative phase if the patient needs significant volume resuscitation or ventilator management, or to promote muscle relaxation to alleviate abdominal hypertension.

A percutaneous approach is favored for rEVAR, regardless of how the groins are to be closed at the end of the procedure. Starting the procedure with a standard arterial puncture is fast and keeps focus on the aortic repair. Initial groin exposure takes more time and often leads to either blood loss through oozing during the case or leg ischemia as the bleeding through the arteriotomy necessitates vessel clamping. If one chooses to use a percutaneous closure device, this is placed before introduction of the stent graft or a sheath for an occlusion balloon. This adds a few minutes to the procedure before the stent graft is placed, which might be a disadvantage, but also completely avoids groin exposure at the end of the case, which is an advantage. The use of percutaneous closure devices is probably best reserved for patients with contained ruptures that are stable, when the extra time needed is of less concern.

We mostly use a semipercutaneous approach with a fascial closure stitch.[5] This technique has been previously described and combines the advantages of a percutaneous approach but removes the time needed to place a closure device. At the end of the procedure, a small, oblique skin incision is used to expose the femoral fascia that is then closed with a U stitch. This can always be done under local anesthesia. If one prefers to do a conventional femoral artery closure, this can also be done, even though the case is performed starting with only a standard puncture. Exposing the femoral artery with the delivery sheath in place is very straightforward, and with this approach, one avoids the downsides of performing formal arterial exposure at the start of the case.

The use of heparin for anticoagulation during rEVAR is debatable. Depending on the clinical status of the patient and the expected complexity of the planned repair, anticoagulation must be administered using careful judgment. If the patient is in severe distress, is hypothermic, and shows signs of poor coagulation, we defer heparin use until the rupture site is sealed. If, however, the patient is stable with a retroperitoneal rupture, we will typically administer 3,000 to 5,000 units of heparin at the start of the case. Close communication with the anesthesiologist and monitoring of the activated clotting time are essential in all cases in order to individualize heparin use.

TECHNICAL ASPECTS

If iliac access is a problem, we use a stepwise approach to overcome this. First, and most obviously, use the side with the best access for the main body of the stent graft, which requires the largest access. Then, start by using dilators (Coons dilators 16–26 F, Cook Medical) to dilate the iliac arteries, if needed. As there is often stenosis at the level of the aortic bifurcation, it is important to use a long enough dilator to reach this level. Many dilators are too short and should be avoided. Limited distinct stenoses can be dilated with standard percutaneous transluminal angioplasty balloons, if necessary. If this is not sufficient, we often use an endoconduit to facilitate access.[6] It is advantageous to have low-profile iliac limbs in stock, even if they do not necessarily belong to the specific stent graft system one uses. In situations of poor access, the use of covered self-expanding peripheral stents that come in large diameters (eg, Fluency Plus, Bard Peripheral Vascular, Inc.) can be used instead of conventional EVAR limbs.

After groin access is achieved, we recommend placement of a large sheath (16 F, 45 cm) in the aorta over a stiff wire (Lunderquist, Cook Medical; Back-Up Meier, Cordis Corporation) through the contralateral iliac artery. Within this sheath, a large balloon for aortic occlusion is positioned (Coda, Cook Medical; Reliant, Medtronic). If the patient is stable, the balloon is not used. The use of an occlusion balloon is not without risk, and it should only be used if needed, as "trash embolization" and aortic rupture from the balloon can occur. In an unstable patient who requires aortic balloon clamping, the sheath is placed in the supraceliac position to provide support for the balloon that is placed in the supraceliac aorta. The sheath position must be maintained until the main stent graft has been deployed so that when the occlusion balloon is deflated, it can be brought out through the sheath again. If the sheath is placed too low (ie, below the proximal end of the endograft), it will not provide support and result in balloon migration, and the balloon will get caught in the barbs of the endograft upon retrieval. The technique of balloon clamping has been extensively described elsewhere.[7]

Once the main endograft is completely deployed and the main delivery system taken out, a new occlusion balloon is placed from the ipsilateral side inside the stent graft below the renal arteries. Once the second balloon is inflated, the first supraceliac occlusion balloon can be deflated and removed.

The main aortic stent graft is positioned at the level of the renal arteries and deployed in standard fashion. It is important to use the preoperative CT as a guide to allow proper C-arm orientation, avoiding parallax and allowing correct placement of the stent graft, particularly in the setting of a compromised infrarenal neck. If an occlusion balloon is used, it can be difficult to visualize the renal arteries, as there is no flow in the aorta. The use of CO_2 as contrast can then be advantageous. The EVAR procedure is then completed in a standard fashion.

When the common iliac arteries cannot be used for distal landing and the stent graft needs to be extended into the external iliac arteries, there are several options for excluding the internal iliac arteries (IIAs). Traditionally, the IIA is embolized at the start of the procedure via a contralateral or ipsilateral approach using coils or other embolic agents. In the setting of a ruptured aneurysm, this can often be a time-consuming procedure that significantly increases the time to aneurysm repair. We favor the approach described by Larzon et al using Onyx (Medtronic).[8] On the side that requires IIA embolization, a 4-F-suitable catheter compatible with Onyx is placed at the start of the procedure in proximity to the IIA origin. This catheter is left after stent graft placement and is thus "jailed" by the stent graft limb extending into the external iliac artery. Onyx is then injected through this catheter and will plug the origin of the IIA. We have found this to be quite predictable and time saving.

SUMMARY

Endovascular repair should be the primary treatment option for ruptured infrarenal aortic aneurysms. It is vital to use an endograft with which the operator and team has extensive experience in the elective setting. Using local anesthesia and a percutaneous approach has many advantages, and aortic balloon occlusion must be used correctly and judiciously to achieve the best outcome. ■

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