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Compliant Occlusion Balloons

Use of compliant occlusion balloons during EVAR for AAA rupture.

BY MANISH MEHTA, MD, MPH

Regardless of improvements in surgical techniques and perioperative management, the mortality rate of open surgical repair for ruptured abdominal aortic aneurysms (AAAs) has remained notably high, ranging from 35% to 70%.^{1,2} Endovascular techniques are evolving and offer the potential for improved outcomes in treating high-risk patients that present with aneurysm rupture.³⁻⁵ There are many aspects of the endovascular approach that are vital to successful management of ruptured AAA

patients consisting of vascular surgeons'/interventionists' ability to become comfortable with the fundamental steps and techniques of the procedure, including the use of aortic occlusion balloons for obtaining hemodynamic control in unstable patients; acquiring an inventory of standard equipment that is necessary for emergent endovascular aneurysm repair (EVAR); and a standardized approach that allows for early diagnosis of ruptured AAAs and seamless transition of the patient from the emergency room to an operating room that is setup for both endovascular and open surgical repair. This article discusses these issues, with particular attention to the operative technique and the use of aortic occlusion balloons for EVAR of ruptured AAAs in hemodynamically unstable patients.

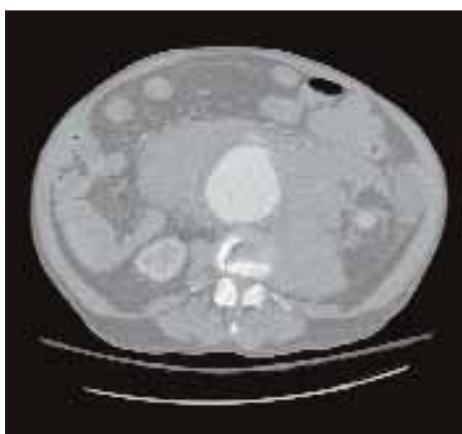


Figure 1. Ruptured AAA.

In 2002, at the Albany Vascular Institute for Health and Disease, we developed a standardized approach for treating ruptured AAAs that included training emergency room physicians, anesthesiologists, operating room nursing staff, interventional radiology technologists, and vascular surgeons/interventionists who would routinely participate in managing patients with acute aortic emergencies.⁵ The fundamentals of the protocol include a heightened awareness among the emergency room staff to suspect

the diagnosis of a ruptured AAA and notify the on-call vascular surgeon and the operating room. In the emergency room, hemodynamically stable patients undergo an expeditious computed tomography scan and are subsequently transferred to the operating room, and hemodynamically unstable patients are directly transferred to the operating room without a preoperative computed tomography scan for an endovascular-first approach and conversion to open surgical repair as needed.

Depending on local logistics and comfort level, ruptured AAA patients can undergo EVAR with anesthesia ranging from local to general, via percutaneous or femoral artery cutdown approaches. Regardless of the technique, following ipsilateral femoral artery access, the floppy guidewires are exchanged for stiff wires, which are

TABLE 1. PROPERTIES OF COMPLIANT OCCLUSION BALLOONS

| Occlusion Balloon | Introducer Sheath | Catheter Length | Maximum Balloon Diameter |
|-------------------------------|-------------------|-----------------|--------------------------|
| Reliant (Medtronic Vascular) | 12 F | 100 cm | 46 mm |
| Coda (Cook Medical) | 14 F | 100–120 cm | 32, 40 mm |
| Equalizer (Boston Scientific) | 14–16 F | 65, 110 cm | 20, 27, 33, 40 mm |

then used to advance large sheaths (12 to 18 F) into the aorta. The primary goal of these sheaths is to gain access into the aorta in order to traverse a compliant aortic occlusion balloon to the target location for aortic occlusion comparable to aortic cross-clamping in hemodynamically unstable patients. Once access to the target location with the occlusion balloon is obtained, the need for aortic occlusion dictates when the occlusion balloon will be inflated, and the remainder of the endovascular procedure is carried out in standard fashion. If inflation of the aortic occlusion balloon is required to maintain a viable blood pressure, then the remainder of the EVAR procedure should be conducted expeditiously to limit the time of aortic occlusion aortic clamping and prevent further development of complications of ongoing bleeding such as abdominal compartment syndrome. During the procedure, just before deployment of stent grafts, the aortic occlusion balloon can be deflated from the suprarenal level and withdrawn, and the stent grafts are deployed subsequently; this will avoid trapping the compliant occlusion balloon in between the aortic neck and the stent grafts, which is usually of little consequence. In hemodynamically unstable patients, the occlusion balloon can be redirected into the aortic neck from the same side that the stent graft's main body was delivered because it already has wire access, and this does not interfere with the remainder of the procedure.

Currently, there are three different compliant occlusion balloons that are readily available, with subtle differences (Table 1). These occlusion balloons can be used for obtaining and maintaining aortic occlusion by gentle inflation in hemodynamically unstable patients and for aortic stent graft molding at overlap zones as well as proximal and distal fixation sites. When choosing a particular occlusion balloon, it is important to consider not just the balloon catheter characteristic but also the



Figure 2. An aortic occlusion balloon at the suprarenal aorta with sheath support. To facilitate stabilization of balloon catheter during inflation and maintain aortic occlusion at the suprarenal level, the sheath supporting the balloon should be advanced fully into the aortic neck prior to inflation of the occlusion balloon. This will prevent downward displacement and prolapse of the occlusion balloon into the aortic aneurysm.

particular indication when the catheter will be used. Occlusion balloons are composed of compliant materials such as polyurethane, latex, or silicone, and they have low burst pressures of <5 atm. Their primary function is not angioplasty but rather molding to their surroundings with gentle inflation and function in the capacity of obtaining proximal aortic occlusion in native aorta at suprarenal, supraceliac, and/or thoracic aorta or iliac artery occlusion when managing iliac artery disruption during EVAR and thoracic endovascular aortic repair. Important occlusion balloon characteristics include maximum inflated balloon diameter and length, balloon compliance and material, and minimum sheath size requirement to accommodate the occlusion balloon.

Tips for using occlusion balloons during EVAR for rupture (Figure 1) are listed:

- To facilitate stabilization of the balloon catheter during inflation and maintain aortic occlusion at the suprarenal level, the sheath supporting the balloon should be advanced fully into the aortic neck prior to inflation of the occlusion balloon (Figure 2). This will prevent downward displacement and prolapse of the occlusion

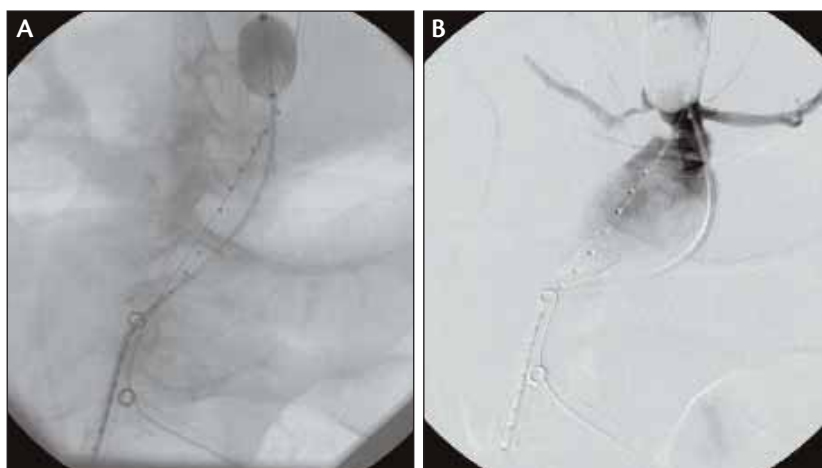


Figure 3. Inability to fully engage the sheath into the aortic neck due to tortuous aortoiliac morphology or presence of significant occlusive disease in the iliac arteries might result in downward displacement of the inflated aortic occlusion balloon (A). Observe the strain on the balloon catheter in the aortic aneurysm as forward traction is applied to keep the occlusion balloon in adequate position at the suprarenal level (B).

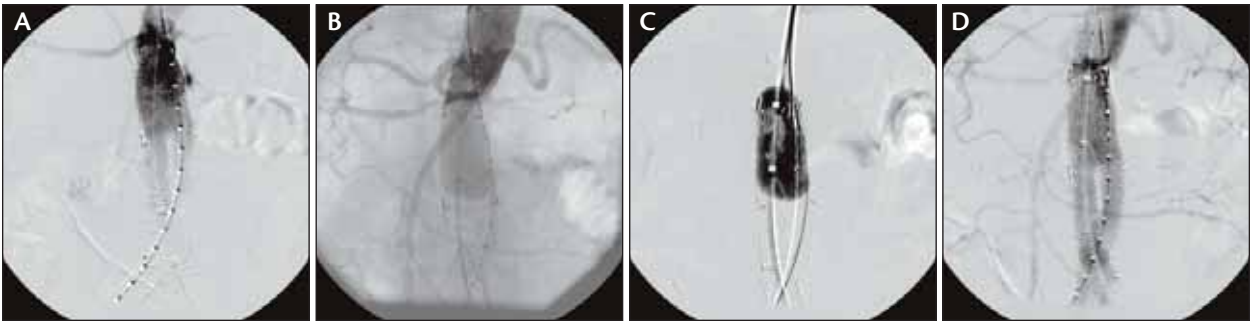


Figure 4. Reliant balloon (Medtronic Vascular, Santa Clara, CA) shown deployed in ruptured aorta after implantation of EVAR device (A). Reliant compliant occlusion balloon inflated gently to maintain aortic occlusion while proximal aortic stent graft extension is planned (B). Reliant occlusion balloon molding aortic neck after the placement of proximal aortic cuff (C). Completion arteriogram illustrating adequate seal of ruptured aortic neck (D).

TABLE 2. RELIANT® STENT GRAFT BALLOON CATHETER INFLATION TABLE

| 46-mm Balloon | |
|---------------|---------|
| Diameter (mm) | mL (cc) |
| 10 | 3 |
| 20 | 9 |
| 30 | 19 |
| 40 | 41 |
| 46 | 60 |

sion balloon into the aortic aneurysm. This generally requires the sheath to be at least 30 to 35 cm in length.

- Inability to fully engage the sheath into the aortic neck due to tortuous aortoiliac morphology or presence of significant occlusive disease in the iliac arteries might result in downward displacement of the inflated aortic occlusion balloon, particularly when the patient regains his or her blood pressure (Figure 3). In this scenario, while performing the remainder of the steps of EVAR for rupture, forward traction on the balloon catheter needs to be maintained at all times while the occlusion balloon is inflated.

- Aortic occlusion balloons are also helpful in managing iatrogenic arterial injuries during endovascular procedures. An occlusion balloon can be gently inflated at the site of or proximal to the injury/arterial rupture while proximal or distal stent graft extensions are planned to cover the site of arterial injury (Figure 4).

- Aortic occlusion balloons can also be helpful in maintaining aortic control and function as aortic clamps during emergent conversion of endovascular to open surgical repair.

CONCLUSION

In summary, compliant occlusion balloons have become a standard tool in the armamentarium of vascu-



Figure 5. Reliant stent graft balloon catheter.

lar specialists. At the Albany Vascular Institute for Health and Disease, we use these balloon catheters on a daily basis while treating elective and emergent aortic aneurysms. Our bias is to have a standardized approach to most vascular and endovascular procedures, and the Reliant® stent graft balloon catheter, used as an occlusion balloon, fits the mold in that it is easy to use, has one size that accommodates aortic diameters up to 46 mm (Table 2, Figure 5), has quick inflation and deflation times, at constant low pressures it conforms nicely to the various aortic shapes

and maintains occlusion or molding as needed, and can be navigated through 12-F delivery sheaths. ■

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