

Early Detection of Type I Endoleaks

How we diagnose and treat type I endoleaks by careful evaluation of patients, devices, and imaging modalities.

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Since the first aortic stent graft was implanted in 1990 by Juan Carlos Parodi, MD, endovascular aneurysm repair (EVAR) has grown immensely in popularity as the first-line treatment for abdominal aortic aneurysms.¹ One of the drawbacks to EVAR, as opposed to standard open aortic repair, is the comparatively high rate of secondary interventions—seen in up to 20% of patients undergoing EVAR.^{2,3} Secondary interventions are usually relatively benign and performed via endovascular means; however, early and late open conversion is reported in 5% to 10% of EVAR procedures in some series.^{2,4,5} The etiologies for secondary interventions include a wide variety of issues, such as graft migration, endotension, limb occlusion, rupture, and infection, but the focus of this article is on the early recognition and treatment of type IA endoleaks.

Type I endoleaks are of concern because they can still pressurize to the aortic wall, and there is often unimpeded antegrade flow into the aneurysm sac. They originate from either the proximal (type IA) or distal (type IB) seal zone.⁶ These endoleaks are mostly high-pressure leaks, and when found early during the first postoperative CT angiography (CTA) or even on completion angiography, are caused by incomplete apposition of the graft to the aortic wall at the proximal neck or distal iliac sealing zones. Later type I endoleaks are related to a multitude of issues, including persistent neck enlargement, endograft migration, or changes in aortic morphology.⁷ Due to continued pressurization of the aortic sac, type I endoleaks may lead to late rupture of aneurysms; therefore, they require intervention when they are encountered.

When evaluating a patient for EVAR, it is important to consider certain anatomic factors that predispose patients to both periprocedural and late type I endoleaks.

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Proximal neck angulation $> 45^\circ$ to 60° and conical or very short aortic necks are strongly associated with proximal type I endoleaks in some studies, whereas aortic neck diameter and distal attachment site diameter do not seem to play a role.^{8,9} Ectatic iliac arteries may also predispose patients to type IB endoleak, so meticulous preoperative planning including centerline measurements of proximal and distal landing zones and diameters (for proper sizing) should always precede EVAR.

It is imperative that the surgeon be aware of the available tools for diagnosis and treatment of type I endoleaks in order to recognize and treat this complication expeditiously and in a controlled manner to avoid costly and potentially devastating complications.

INCIDENCE AND IMPLICATIONS

The overall incidence of early and late type I endoleaks is thought to be up to 20%, depending on the series, device, and local practice patterns, with intraoperative type I endoleaks reported at a rate of 3% to 7%.^{2,10,11} Although type II endoleaks are the most commonly noted type of endoleak on postoperative CTA, type I endoleaks are a not-infrequent finding that leads to the need for secondary intervention. Kelso et al report from their experience at the Cleveland Clinic that endoleaks

are the main indication for open conversion in 73% of EVAR cases, with 39% of these being type I endoleaks.⁴ Significant mortality in the 20% to 25% range is noted for open repair, likely due to the acuity of the indications and the fact that many patients had initially undergone EVAR because they were too high risk for open repair. In fact, 15% of the open conversions were for ruptures, with all of these patients demonstrating either a type I or type III endoleak with migration of the stent graft. This is consistent with the incidence reported by Brinster et al, in which 57% of the open conversions after EVAR were due to endoleak, and 38% were type I.⁵

Thus, the importance of diagnosing and treating type I endoleaks cannot be overstated, especially in light of the fact that secondary interventions have been shown to carry significant morbidity and mortality. Mehta et al also reported a mortality rate of 4.6% for urgent secondary interventions (type I endoleaks) versus elective interventions (type II endoleaks), which are reported at 0.4%.²

DIAGNOSIS

Early diagnosis and prompt recognition are important in the management of type I endoleaks, for the reasons previously mentioned. Typically, intraoperative type I endoleaks are due to challenging proximal neck anatomy and can be seen on the final angiogram postimplant (Figure 1). Remember that the final sequence should be performed with a C-arm gantry aligned in an orthogonal plane to the orientation of the proximal fabric in order to get as accurate an assessment as possible of the proximity of the endograft to the lowest renal artery. Any amount of interval residual neck should be considered for further treatment with a proximal cuff or more aggressive ballooning. Often, further proximal ballooning or placement of an additional cuff while full access is in place is preferable to a “wait-and-see” approach.

Early postoperative CTA should be considered earlier than the traditional follow-up at 1 month in patients for whom there was some question of proximal neck health. Bashir et al described findings of type I endoleak on multiple imaging modalities. On CTA, findings consistent with type I endoleak include a hyperdense acute hemorrhage within the aneurysm sac continuous with the proximal or distal attachment site. MRI is used less frequently due to higher cost and lack of familiarity among vascular surgeons with multiple MR sequences, but it may show hemorrhage with varying signal characteristics. Sometimes, when duplex imaging is performed by an experienced technologist, flow jets can be seen at the proximal or distal attachment sites.⁷

The timing of follow-up and the imaging modality used to follow patients after EVAR remain matters



Figure 1. Angiogram of a type IA endoleak.

of controversy. Sternbergh et al suggest that the first follow-up surveillance CTA can be substituted by a good duplex scan ultrasound, if no early endoleak was found on angiography. Furthermore, they find that an absence of endoleak on 1-month and 1-year CTA is predictive of relative freedom from long-term aneurysm-related morbidity (94.7%), whereas early endoleak results in 45.9% aneurysm-related morbidity at 5 years.¹² Initial protocols for EVAR surveillance that led to device approval usually called for CT imaging at 1, 6, and 12 months; however, current Society for Vascular Surgery guidelines recommend performing contrast-enhanced CT at 1 and 12 months postoperatively, followed by duplex ultrasonography annually if no endoleak is found. If a new endoleak is found after previous studies have shown complete exclusion of the sac, a search should be undertaken for a type I or type III endoleak.¹³

MANAGEMENT STRATEGIES

Once the diagnosis of an early type I endoleak has been made, prompt treatment should be undertaken to resolve the leak. This includes endovascular measures, as well as open conversion as a last resort. Current endovascular strategies include balloon molding of the stent graft to the proximal or distal seal zone (a first-line strategy) placing proximal or distal extension cuffs, placement of Palmaz stents (Cordis Corporation, Bridgewater, NJ), and coil or glue embolization of the endoleak tract

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in the sac. Many times when there is an intraoperative type I endoleak, balloon molding from the contralateral side of the main body deployment gives a different angle of approach to the neck and can often seal the visible type I endoleak. As previously mentioned, optimizing an orthogonal view of the proximal fabric of the endograft to the lowest renal artery is important in understanding where to mold the device, particularly in necks that are somewhat compromised.

Proximal and distal extension cuffs have very high rates of technical success (98% in a study by Faries et al) but are limited by anatomic constraints (proximal neck length).¹⁴ Palmaz stents are balloon-expandable stents that can be deployed and molded over the proximal portion of the endograft to help create an even better approximation between the stent graft and the seal zone. Arthurs et al report the Cleveland Clinic's experience with 100% technical success in sealing intraoperative type I endoleaks with the use of Palmaz stents, with long-term outcomes for EVAR similar to patients who did not demonstrate an intraoperative type I endoleak. They suggest the use of aortic extenders when the length of the proximal neck is sufficient to accommodate the extra length. Palmaz stents are placed within the lumen of the primary stent graft and can be used even with short necks.¹⁵

For patients with persistent type I endoleak after placement of a Palmaz stent and proximal extensions, coil or glue embolization can be considered. Mehta et al² report a 70% success rate with translumbar coil embolization of type I endoleaks. Sac or gutter embolization with n-butyl cyanoacrylate glue has been reported with good results (92.3% initial success rate). Maldonado and colleagues performed glue embolization via a transfemoral approach, but a direct percutaneous approach has also been reported.^{16,17}

For treatment of distal attachment site endoleaks (type IB) seen on completion angiography or on early follow-up, more aggressive balloon molding is again the first step. If the contralateral hypogastric artery is patent,

then a simple solution for the persistent type IB endoleak is coil embolization of the ipsilateral hypogastric artery with graft extension into the external iliac artery. If the distal type IB endoleak is due to not enough seal zone caused by iliac enlargement, the larger bell-bottom iliac limbs provide an additional endograft solution. Although somewhat innocuous in appearance, the distal attachment site endoleak can adequately pressurize the remaining aneurysm sac and lead to rupture if not promptly treated.

Finally, further extension of the proximal landing zone with newer techniques or even with homemade fenestrations or the snorkel technique deserves mention. The snorkel or chimney approach has been described as a bailout technique to achieve additional proximal seal in a particularly short or angulated neck. In our own recent reports, planned snorkel grafts placed into both renal arteries for juxtarenal aneurysms in elective cases have shown a 98% technical success rate, with minimal morbidity and mortality.¹⁸ In this series, several patients had previous infrarenal endografts with persistent long-term type I endoleaks that required more proximal fixation of a cuff with snorkel stents, and this approach has prevented further sac expansion and repaired the type I endoleak.

The recent approval of custom commercial fenestrated grafts (Zenith fenestrated device, Cook Medical, Bloomington, IN) provides us with yet another endograft component that could be used in the urgent setting to seal a previously placed device in an inadequate neck. Homemade fenestrations have been performed on the back table to customize them to vital side branches and can also be considered when repairing the urgent type I endoleak. The long-term outcomes from these adjunctive techniques will be important to follow with regard to how they affect the natural history of patients with early or persistent type I endoleaks.

CONCLUSION

Type I endoleak is a significant complication following EVAR that causes increased morbidity and mortality, as well as cost to the health care system. Incidence of mortality for secondary procedures related to rupture is reportedly up to 20%, and most of these involve type I endoleaks. Predictors of type I endoleak are based on anatomic considerations and may be avoided by careful case selection, device choice, and accurate intraoperative imaging. When type I leaks are found intraoperatively, repeat balloon molding and angioplasty are frequently sufficient to resolve the issue, but graft extension and balloon-expandable bare-metal stents are also effective adjuncts.

Newer techniques including snorkel, fenestrated, and branched grafts should be subject to the collection of longer-term data, and open conversion should be utilized only as a last resort. Thus, it is up to the endovascular surgeon's discretion to determine the source of a visible intraoperative or early postoperative endoleak and to determine its clinical significance if it is likely to be a type I endoleak. Prompt attention is necessary, as ignoring persistent sac pressurization can lead to aneurysm rupture. The importance of addressing type I endoleaks cannot be overstated, and fortunately, endovascular treatments are very effective and well tolerated, although open conversion is sometimes required. ■

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