

## Type II endoleaks: diagnosis and treatment algorithm

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**Abstract:** Elective abdominal aortic aneurysm (AAA) repair is recommended for aneurysms greater than 5.5 cm, symptomatic, or rapidly expanding more than 0.5 cm in 6 months. Seventy-five percent of AAAs today are treated with endovascular aneurysm repair (EVAR) rather than open repair. This is fostered by the lower periprocedural mortality, complications, and length of hospital stay associated with EVAR. However, some studies have demonstrated EVAR to result in higher reintervention rates than with open repair, largely due to endoleaks. Type II is the most common, making up 10–25% of all endoleaks. Type II endoleaks, can potentially enlarge and pressurize the aneurysm sac with a risk of rupture. However, many type II endoleaks spontaneously resolve or never lead to sac enlargement. Imaging surveillance and approaches to management of type II endoleaks are reviewed here.

**Keywords:** Abdominal aortic aneurysm (AAA); endoleak; embolization; type II endoleak

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### Introduction

Elective abdominal aortic aneurysm (AAA) repair is recommended for aneurysms greater than 5.5 cm, symptomatic, and/or rapidly expanding more than 0.5 cm in 6 months (1). Guidelines recommend repair when an aneurysm exceeds 5.0 cm for women given evidence that AAA rupture at smaller sizes than men and have poorer outcomes. Seventy-five percent of AAA s today are treated with endovascular aneurysm repair (EVAR) rather than open repair, given decreased periprocedural mortality, complications, and length of hospital stay (2-4). However, some studies have demonstrated EVAR to result in higher reintervention rates, largely secondary to endoleak, a complication not present in the surgical counterpart (5-8). An endoleak results from continued perfusion of the aneurysm

sac despite endograft deployment. It occurs in 20–25% of patients, and are categorized from type I to V (9,10). Type II is the most common, making up 10–25% of all endoleaks (10). They occur from retrograde collateral blood flow into the aneurysm sac, typically from a lumbar artery or the inferior mesenteric artery (IMA). Other less common sources include retrograde flow from accessory renal, gonadal, and median sacral arteries, and the internal iliac artery if not embolized when covered by a limb extending into the external iliac artery (11).

Type II endoleaks, can potentially enlarge and pressurize the aneurysm sac with a risk of rupture. However, many type II endoleaks spontaneously resolve or never lead to sac enlargement. This is different than a type I and III endoleak which significantly pressurizes the aneurysm sac with significant risk of rupture. In a study involving 474 patients

with type II endoleaks, there were no late AAA ruptures attributable to a type II endoleak. All-cause mortality and aneurysm-related mortality did not differ between patients with and without a type II endoleak. In addition, there was no difference in all-cause mortality or aneurysm-related mortality in patients who had a type II endoleak-associated sac growth who underwent reintervention and those in whom the type II endoleak was not treated (12). Similar findings were seen in an older study by Silverberg, *et al.* with 154 patients with type II endoleaks. Seventy-five percent of type II endoleaks resolved spontaneously and no pure type II endoleak was associated with rupture (13). Some studies have shown different results. In a study by El Batti *et al.*, patients with a type II endoleak had more complications, including death, rupture, reintervention or conversion (14). In a meta-analysis of outcome data of 10 EVAR trials, analysis showed that in the absence of a type I or III endoleak, intervention on a type II endoleak should be reserved if a type II endoleak occurs after 6 months, persisted more than 12 months, or aneurysm sac pressure was >20% of systolic blood pressure (15). Conversely, a more recent meta-analysis also analyzing data from 10 EVAR trials failed to demonstrate adequate information to support a threshold for intervention due to the rarity of rupture and sac expansion associated with pure type II endoleak (16).

It should be noted that a few have advocated preemptive embolization of the IMA to mitigate type II endoleaks. A meta-analysis demonstrated that the rate of type II endoleaks after IMA embolization was 19.9%, compared to 41.4% without IMA embolization. However, the authors surmised that given the treatment of type II endoleaks is needed in less than 20% of cases, that this complication can be treated successfully in 60–70% of cases, and that the aneurysm rupture risk is <1% with an isolated type II endoleak, data did not support preemptive IMA embolization (17).

Type II endoleaks can be divided into type IIa where there is a single causative vessel involved with “to-and-fro” flow in the aneurysm sac, and type IIb, where multiple vessels are involved, behaving similar to arteriovenous malformations (AVM). Type IIa endoleaks have greater propensity to spontaneously resolve than type IIb, which are more complex and difficult to treat (18). Predictors of persistent type II endoleaks include numerous collaterals, large central nidus (>15 mm), high blood flow (velocity >100 cm/s), and anticoagulation. Factors associated with aneurysm growth include a type IIb endoleak, IMA

>2.5 mm, a lumbar artery >1.9 mm, and more than 2 lumbar arteries that extend from the aneurysm sac (19). A type II endoleak may be early, occurring within 30 days of EVAR, persistent, lasting longer than 6 months, or late, occurring after 1 year (18).

### Imaging of type 2 endoleak

After EVAR has been completed, our follow-up protocol is a CT angiography (CTA) at 1, 6, and 12 months, and annually thereafter. In the setting of aneurysm sac shrinkage and absence of an endoleak, some patients may be followed every 2 years. In patients with renal insufficiency, follow up may be performed with duplex ultrasound and non-contrast CT. Contrast enhanced ultrasound has emerged as an alternative strategy and has a high sensitivity and specificity for the detection of endoleaks. Time-resolved magnetic resonance angiography is used selectively at our institutions, sometimes to better determine the flow dynamics of an endoleak seen on CTA as well as to optimize a treatment strategy in complex cases (20).

A proper imaging protocol is necessary to ensure endoleaks are identified. A three-phase scan consisting of a non-contrast scan, an arterial phase, and delayed imaging is considered the standard of care, and review of previous studies is mandatory. There is newer data that suggests dual-source dual-energy multidetector CT may be as accurate as the standard triphasic protocol with a significant radiation dose reduction (21–23). The latter protocol is especially promising given the significant radiation exposure patients encounter during CT follow-up imaging after EVAR. Once an endoleak is identified, it is important to determine the endoleak type in order to direct urgency and management. Cross-sectional imaging may not always elucidate the type of endoleak present, making angiography the next step in management. Diagnostic angiography should include an aortogram, as well as selective angiography of the superior mesenteric artery (SMA) and bilateral hypogastric arteries. Power injection runs with adequate contrast volume and frame rate are required. Super-selective angiography of secondary and tertiary branches of the SMA and hypogastric arteries is often necessary to identify endoleaks which may not be well seen on nonselective angiograms. If a type III endoleak is suspected, angiography performed with a pigtail catheter tip within the endograft may be useful. Placement of an occlusion balloon above the pigtail catheter in the graft may increase the sensitivity for type III endoleak assessment. A type Ib endoleak can be uncovered in a similar

fashion, wherein a compliant balloon can be deployed in the iliac limb as an angiogram is performed with the pigtail tip at the distal seal site. This may force contrast into the aneurysm sac from the distal seal site if a type Ib endoleak is present. Furthermore, filling of the IMA or lumbar arteries on cross-sectional imaging does not always represent a type II endoleak as we have seen many patients who have a subtle type Ia endoleak creating an inflow into the aneurysm sac, with resultant outflow in the IMA or lumbar vessels. This is best appreciated on aortography.

It is important to remember that the presence of one type of endoleak does not exclude the presence of another. Moreover, treatment of one endoleak does not preclude the subsequent development of another. Many times, endoleaks are complex and must be managed expectantly. Therefore, longitudinal follow-up of these patients is mandatory (20).

### Treatment strategies

There are multiple approaches to the management of type II endoleaks, including transarterial, translumbar, transcaval, and surgical approaches. Transarterial and translumbar approaches are the most commonly used. There are conflicting data in the literature regarding the best approach. An early study published in 2002 looked at transarterial embolization *vs.* translumbar embolization, where 20 patients underwent IMA embolization and 13 underwent translumbar embolization. There was an 80% failure rate with transarterial embolization with recanalization of the original endoleak cavity compared to 8% failure rate with translumbar embolization (24). A more recent study published in 2017 reported 23 patients undergoing 35 embolizations. There was no significant difference in aneurysm sac growth, persistent type 2 endoleak, or complications. However, direct sac puncture did carry a shorter fluoroscopy time and total procedure time (25). A larger retrospective study with 84 patients with a type 2 endoleak compared 62 patients undergoing translumbar embolization with coils and n-butyl cyanoacrylate and 23 patients undergoing transarterial embolization with embolization of the inferior mesenteric or lumbar artery. Success was 72% in patient undergoing translumbar embolization, and 78% with transarterial embolization, which was not statistically different (26).

#### *Transarterial embolization*

The transarterial approach is the first line of approach at

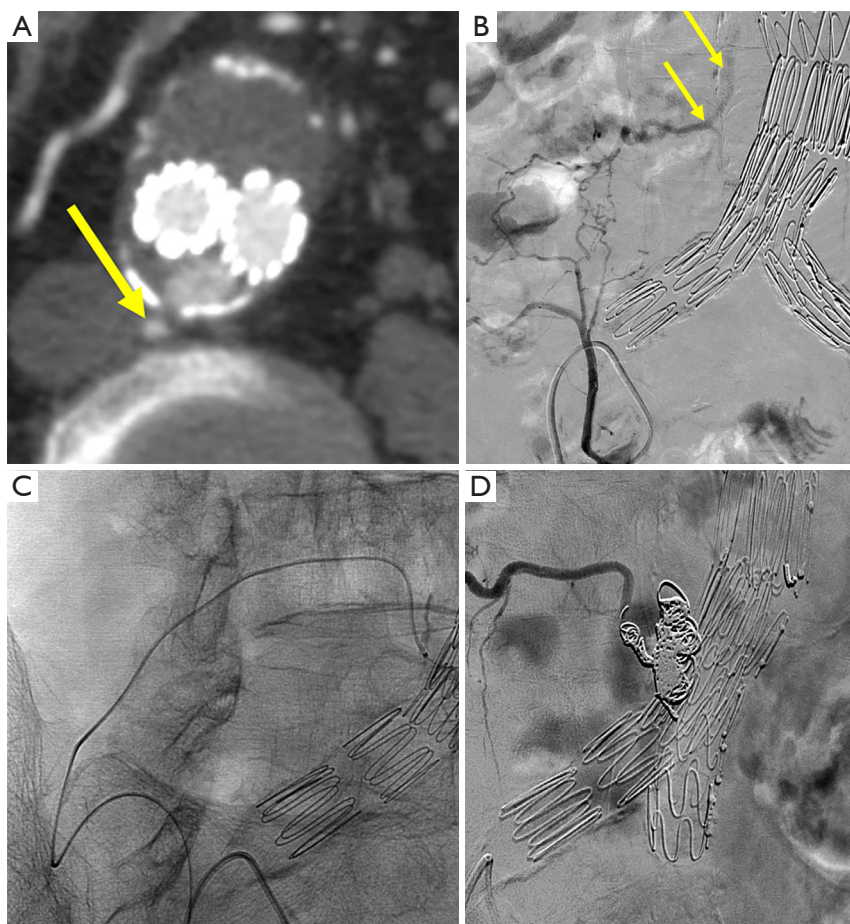
our institutions. When addressing the IMA, a microcatheter is advanced in a retrograde fashion from the SMA via the arc of Riolan or the marginal artery of Drummond to the IMA. When embolizing a lumbar artery, the microcatheter is advanced from the internal iliac artery to the iliolumbar artery to the culprit lumbar artery (*Figure 1*). In all cases, it is important to advance the microcatheter to the aneurysm sac; however, collateral pathways can be long and tortuous and potentially very difficult or impossible to maneuver. The goal is to completely obliterate the endoleak nidus and eliminate all inflow and outflow vessels. Proximal embolization is not recommended as a type II endoleak will recur by recruiting additional aortic branch vessels.

The procedure is performed with stable access in the SMA or the internal iliac artery with a 5-Fr Cobra catheter or reverse-curve catheter, such as a Sos or Simmons. If there is significant tortuosity and inability to achieve stable access, a steerable guiding sheath such as a Destino (Oscor Inc., Palm Harbor, USA) or Morph (BioCardia, Inc., San Carlos, USA) can be utilized. A 150-cm long microcatheter with a 0.021-inch inner diameter or smaller, such as Echelon or Rebar (Medtronic, Minneapolis, USA) is recommended for Onyx [ethylene-vinyl alcohol copolymer (EVOH)] liquid embolic system (Medtronic).

Possible embolization materials include coils, EVOH, n-butyl-cyanoacrylate glue, and coils. Coils are the most widely used. The advantage of EVOH is that it can fill the endoleak nidus and the inflow and outflow vessels. It is also radiopaque, therefore, monitoring the injection and avoiding nontargeted embolization can be performed. Cyanoacrylate glue can be utilized in a similar manner such as after coiling when blood flow has slowed. Its viscosity can be adjusted by adjusting the quantity of ethiodol (27). A less typical approach is to utilize an MVP microvascular plug (Medtronic). The advantage of such a plug is that it leads to minimal artifact on imaging after intervention. Whereas EVOH, glue and coils make assessing for endoleak on post intervention CT scans difficult due to beam hardening artifact, the MVP plug has little associated artifact. Alternatively, MRI is an alternative to image for endoleak which minimizes artifact from the above embolic agents.

#### *Translumbar embolization*

Some advocate translumbar embolization as the first line of therapy. Ideally, translumbar embolization is performed with combination of CT and fluoroscopy. If CT cannot be utilized, landmarks or cone beam CT may be utilized.



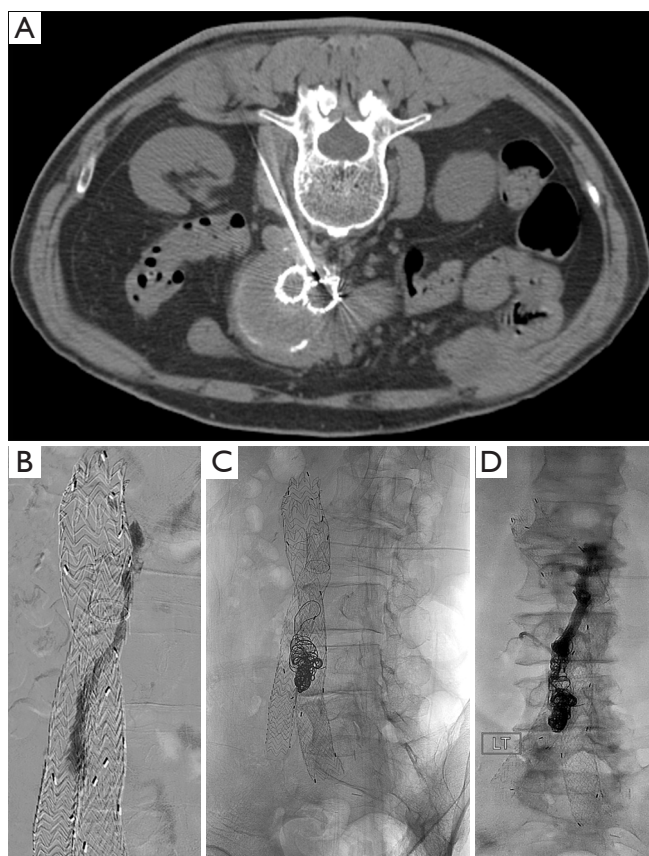
**Figure 1** Management of type II endoleak by catheterization of iliolumbar artery and coil embolization. (A) Contrast enhanced CT demonstrating type II endoleak arising from a right lumbar artery (single yellow arrow) in an 80-year-old man with an enlarging aneurysm sac; (B) selective right hypogastric artery angiogram demonstrates right lumbar branch (double yellow arrows) arising from the iliolumbar artery feeding the endoleak; (C) microcatheter was navigated through the tortuously iliolumbar artery into the endoleak; (D) following coil embolization of the endoleak nidus and feeding artery, post embolization angiogram demonstrates occlusion of the vessel with no residual filling of the endoleak cavity.

The aneurysm sac is accessed at the level the endoleak as demonstrated on CTA. While fusion imaging can be helpful in accessing the proper level, fluoroscopy alone may be used when these more sophisticated technologies are not available. The operator will observe pulsatile blood once the aneurysm sac is successfully accessed. A baseline pressure should be recorded. A diagnostic angiogram or a “saccogram” is performed via a sheath needle to delineate the endoleak cavity and inflow and outflow vessels. A microcatheter is typically advanced to the nidus and attempt to embolize all inflow and outflow vessels as well as the nidus is performed. If there is difficulty addressing all inflow

and outflow vessels, EVOH or cyanoacrylate glue may be utilized to embolize the nidus and vessels (*Figure 2*). A final intrasac pressure should be obtained at the conclusion of embolization.

#### ***Transcaval approach***

This is rarely performed and is reserved if the endoleak is visualized on the right side or in close proximity to the inferior vena cava (IVC). In this technique, the internal jugular or common femoral vein is accessed and a 10 Fr 40 cm transjugular intrahepatic portosystemic shunt



**Figure 2** Treatment of type II endoleak by translumbar direct sac puncture and embolization with coils and onyx. (A) Direct sac puncture via a sheath needle to access type II endoleak under CT guidance; (B) contrast injection via sheath needle demonstrating endoleak cavity; (C) fluoroscopic image following placement of coils in the caudal aspect of the endoleak cavity; (D) image following embolization of the endoleak nidus with both coils and onyx. Note that the Onyx extends into several lumbar branches.

sheath is pressed up against the wall of the IVC and a Colapinto needle (Cook Medical, Winston-Salem, USA) is used to access the aneurysm sac. Once arterial flow is identified, a 5-F cannula with catheter is navigated into the endoleak nidus. Embolization is then performed similarly to translumbar embolization. A cavagram is obtained at the conclusion of embolization. Potential risks include retroperitoneal bleed, pulmonary embolus from nontargeted embolization, and aortocaval fistula. In a retrospective study of 26 patients who underwent 29 embolization procedures, none of these complications were seen. There was an 83% technical success rate in achieving transcaval access to the

aorta. One-year freedom from intervention was 95% and at a mean of 16.5 months, 70% of patients experienced no further endoleak and had stable or decreasing aneurysm sac diameters (28).

### **Surgical approach**

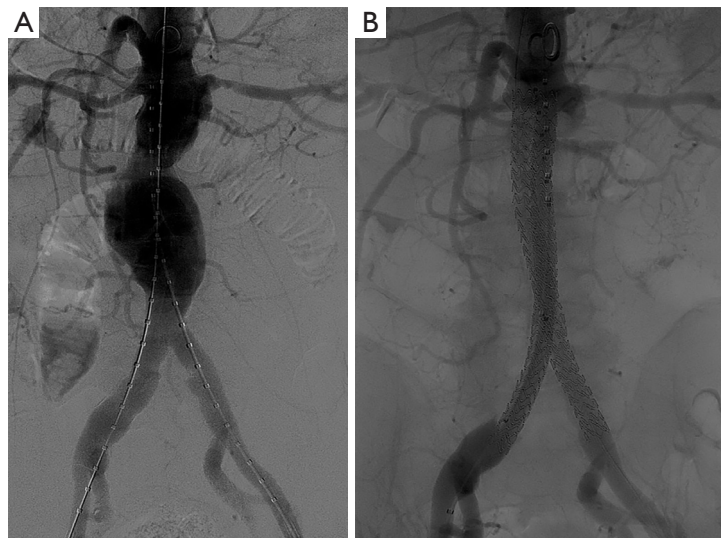
Endovascular approaches are generally preferred over surgical technique. However, sometimes endovascular approaches have suboptimal results and there is continued growth of the aneurysm sac despite multiple endovascular procedures. Surgical approaches include laparoscopic, robotic, and open surgical ligation of mesenteric, lumbar, and other offending arteries, as well as plication of the aneurysm, and graft explantation.

### **Future considerations**

The Nellix endograft (Endologix Inc., Irvine, USA), currently has an FDA Investigational Device Exemption, undergoing efficacy trials, and a European CE mark approval. The device is unique. The sac anchoring endovascular aneurysm sealing system is comprised of two balloon expandable stents that extend in parallel from the non-aneurysmal aorta proximally into the iliac arteries distally. Each balloon expandable stent is surrounded by a polymer filled endobag. The endobags obliterate the aneurysm flow lumen to achieve a seal to resist both lateral and longitudinal displacement forces. Given the filling of the aneurysm sac by the polymer-filled endobag, the device may decrease the incidence of type 2 endoleaks and reintervention rates (*Figure 3*). In a multicenter study with 171 patients treated with the Nellix device and observed for a median of 5 months (range, 0–14 months), technical success was 99% and type II endoleak rate was 2% (29). There were no aneurysm ruptures or need for open surgical conversion.

### **Conclusions**

EVAR continues to be the favored option for AAA repair given its decreased periprocedural morbidity and mortality risk compared to that of surgical repair. However, endoleaks, especially type II endoleak, continue to be a plague for interventionalists following EVAR. Further investigation is needed to determine the most effective management for optimal durable results.



**Figure 3** Utilization of a Nellix device (Endologix) to manage abdominal aortic aneurysm with goal of decreasing type II endoleak. (A) Aortogram demonstrates a 5.7 cm abdominal aortic aneurysm; (B) following placement of a Nellix device, there is no evidence of endoleak. This device may decrease the incidence of type II endoleaks because of filling of the aneurysm sac with polymer filled endobags.

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### Footnote

*Conflicts of Interest:* RT Gandhi is a consultant to Medtronic. The other authors have no conflicts of interest to declare.

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