

# Embolization for Type I and Type II Endoleaks

An overview of embolization techniques and materials for these indications.

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**E**ndoleak, a persistent arterial communication between the aneurysm sac and systemic circulation, is the most common complication of endovascular aneurysm repair (EVAR). Endoleaks can appear in an early or late phase and are classified into five types according to their origin. In 10% to 45% of cases, such complication can be associated with dilation of the aneurysm sac, especially in patients with an aneurysm with complex anatomy,<sup>1</sup> which has been shown to require endovascular treatment again in 8.7% of cases over an average period of  $12 \pm 1.3$  months.<sup>2</sup> This article describes the approaches and materials used for embolization of type I and type II endoleaks, with a brief explanation of the technique we use at our institution.

## TYPE I ENDOLEAK

The continuous pressure within the sac can increase the risk of aneurysm rupture. Type I endoleak requires immediate treatment due to the high flow volume and subsequent higher risk of sac rupture. Treatment for persistent type Ia endoleak is more challenging and has been reported in 2.9% to 6.9% of all EVAR procedures.<sup>3</sup> They are routinely treated with balloon dilatation of the proximal sealing zone, use of EndoAnchors (Medtronic), or cuff insertion. However, these techniques have limitations, such as insufficient landing zone or failure.<sup>4</sup>

### Embolization Access Approaches and Materials

Golzarian et al proposed the use of transarterial embolization to treat type I endoleaks.<sup>5</sup> Liquid embolic agents (N-butyl cyanoacrylate [NBCA] and ethylene-vinyl alcohol copolymer) and coils alone or in combination can be considered valid tools. There are many types of coils available with varying profiles; they may be more or less soft, detachable or not, have a working platform of 0.010, 0.014, 0.018, or 0.035 inches; with or without fibers; or designed for neurologic or peripheral applications. However, selection of the most appropriate coil should be based on the flow and anatomic

characteristics of the case. Generally speaking, softer coils are preferable to allow a better filling of the perigraft space. Also, detachable coils may be preferred to increase the safety of the procedure.

Following Golzarian et al's initial experience, various approaches have been proposed, such as transarterial, translumbar, and transabdominal. Choi et al described a transarterial or transabdominal approach using NBCA in seven patients (five type Ia endoleak, one type Ib endoleak, and one type Ia/Ib endoleak) in which a primary attempt to exclude type I endoleak failed.<sup>6</sup> For transarterial embolization, selective catheterization of the aneurysm sac was performed with a 5-F catheter placed between the aortic wall (type Ia endoleak) or iliac arterial wall (type Ib endoleak) and the stent graft. For cases in which the transarterial approach failed, a percutaneous transabdominal approach was attempted. The authors reported a technical success rate of 86%, with shrinkage or stability of the aneurysmatic sac diameter in six of seven patients.

In patients treated with chimney EVAR (ChEVAR), type Ia gutter endoleak remained a challenging problem, with an incidence of 10.7%.<sup>7</sup> In this setting, transarterial access to the gutter endoleak can be considered a valid option. The translumbar technique is also feasible, but in some situations, patient positioning is more challenging and can limit the arterial access. Massimi et al reported a novel transcaval technique to treat a type I gutter endoleak in a case of three-vessel ChEVAR for a pararenal aneurysm.<sup>8</sup>

## TYPE II ENDOLEAK

Type II endoleaks are the most frequent type of endoleak, with an incidence ranging between 10% and 45%.<sup>9,10</sup> They are correlated with sac reperfusion caused by collateral vessels such as the inferior mesenteric artery, lumbar arteries, and iliolumbar arteries. Type II endoleaks can be considered benign in approximately 40% to 58% of cases, as they are not associated with sac enlargement and resolve spontaneously.<sup>10</sup>

However, when type II endoleak is responsible for a progressive increase of the aneurysm sac (ie, > 5 mm in 6 months), there is consensus that treatment is required.<sup>8-11</sup> A direct correlation between type II endoleak and sac rupture has not been demonstrated. Walker et al reported a rupture rate of 1% in their experience, with no difference in all-cause or aneurysm-related mortality in groups that underwent observation compared with treatment for sac growth due to type II endoleaks.<sup>12</sup>

### Embolization Access Approaches and Materials

Embolization can be considered the treatment of choice for type II endoleaks, and transarterial, translumbar, trans-sealing (perigraft), percutaneous sac puncture, and transcaval approaches have been described.<sup>13,14</sup> Different embolic agents, coils, microcoils, glue, liquids, and plugs can be used alone or in combination.<sup>10,13</sup> Selection of the embolic agent is based on the morphology of the endoleak and the selected technique.

Technical success of embolization is fairly high, ranging from 84% to 100%, depending on the technique.<sup>10</sup> However, one-third of cases failed to either completely resolve or show signs of sac diameter stabilization or shrinkage.<sup>10,13,14</sup> The reason for this is due to the morphology of type II endoleaks. Type II endoleaks have been likened to arteriovenous malformations, and for this reason, both inflow and outflow must be interrupted. If only one is occluded, perfusion of the sac can be maintained by recruiting other side branches.<sup>15</sup> Sarac et al reported that freedom from sac enlargement > 5 mm was as low as 44% after embolization at 5-year follow-up.<sup>16</sup> In cases of embolization failure with persistent type II endoleak, laparoscopic surgery or surgical conversion with stent graft explant should be considered. Recurrent type II endoleak can be correlat-

ed to recanalization from nonembolized, thrombosed branches or vasa vasorum.<sup>17</sup>

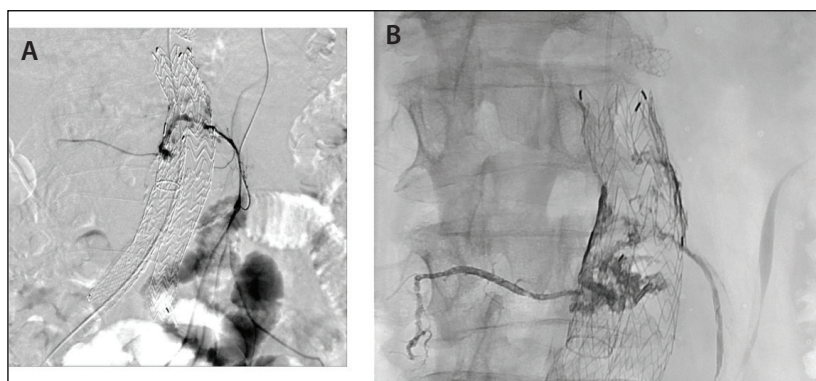
Transarterial embolization is one of the most common methods to occlude a type II endoleak. Several papers reported very good outcomes, with technical success ranging from 65% to 100% and a low complication rate (Figure 1).<sup>18,19</sup> However, embolization of both inflow and outflow is not always possible. In elderly patients, navigation of the Riolano arcade could be difficult or impossible. Stavropoulos et al reported the experience of 89 patients, with a technical success of 78% and no complications.<sup>20</sup> One of the main advantages of transarterial embolization is that multiple feeding arteries can be embolized in a single session in addition to the aneurysmatic sac.

Another option is direct percutaneous sac puncture, which presents some advantages because it allows for a complete seal of the sac and, at the same time, embolizes the side branches (Figure 2). For these reasons, this technique has shown a higher success rate and freedom from reintervention in more complex cases involving multiple inflow/outflow vessels.<sup>21</sup> With this method, Onyx liquid embolic (Medtronic) is preferred because it allows complete exclusion of the aneurysmal sac, reducing the incidence of sac reperfusion. In the case of a high-volume sac and high flow, a combination of Onyx and coils is preferable; an initial cast is created with coils (large diameters to fill most of the sac), followed by Onyx injection. This technique also reduces the amount of Onyx required. For complex morphology, the more fluid version (18 centistokes) can easily navigate into the feeding vessels to achieve complete sealing.

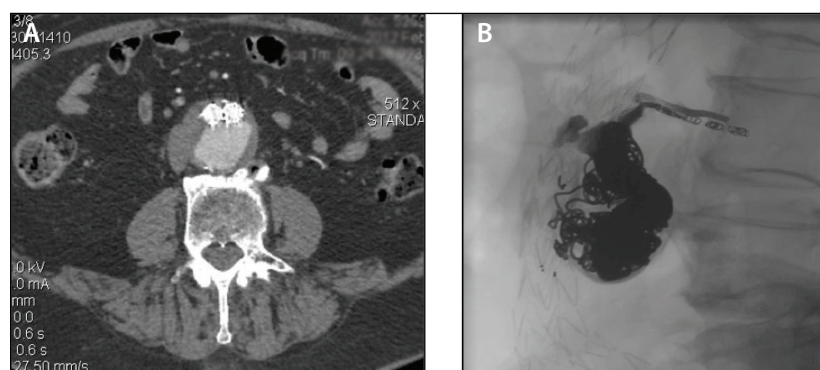
Several studies have reported the advantages of Onyx compared with other liquid embolic agents.<sup>18,22</sup> However, some negative aspects must be considered, including cost and image artifacts during follow-up.

To avoid these artifacts, contrast-enhanced ultrasound can be used for follow-up evaluation of the sac after embolization. Uthoff et al treated 21 cases of type II endoleak with direct sac puncture using different embolic agents.<sup>21</sup> Direct sac puncture was considered effective, and complications (7.4%) were mainly secondary to the embolic agent selected.

A transcaval approach is another frequently used method to seal type II endoleaks and has been validated by several authors, with a technical success rate of 94.4%.<sup>23</sup> This technique is preferable when the endoleak is



**Figure 1.** Transarterial embolization performed after catheterization of the Riolano arcade via the superior mesenteric artery (A). In the same session, embolization of the feeding lumbar artery, aneurysmatic sac, and inferior mesenteric artery was achieved using Onyx 34 (3 mL) (B).



**Figure 2.** A large type II endoleak was detected at 1-year CT follow-up. Due to the enlargement of the aneurysmatic sac (> 12 mm), percutaneous direct embolization was performed (A). The sac was filled initially with detachable microcoils (Concerto, Medtronic), followed by an injection of Onyx 34 and 18. Additionally, a feeding lumbar artery was occluded with the liquid embolic agent (B).

predominantly on the right side of the aneurysm sac and/or when direct access to the sac is not feasible with other techniques. However, Scali et al reported a 50% failure rate after 8 months due to endoleak recurrence.<sup>24</sup>

## HOW WE DO IT

For treatment of type II endoleak, our first choice is a direct percutaneous translumbar approach, which we have found to be feasible and safe. Moreover, it allows for complete sealing of the aneurysmatic sac with a very low incidence of sac reperfusion. In our experience of more than 50 cases, technical success was achieved in all patients with 97.9% freedom from reintervention for recurrent endoleak.

We suggest using a combination of coils and liquid embolic agents, but not glue because it is too fluid and has a higher risk of nontarget embolization. Advantages include better control of the liquid material due to a reduced blood flow; the creation of a cast within the sac, which reduces procedure time; and less embolic agent required. We also suggest the use of detachable coils to increase the safety of the procedure. Additionally, it is not necessary to enter the sac at the location of the endoleak. Once the catheter is inside the sac, it can navigate easily within the thrombus to achieve a successful embolization. Furthermore, selective embolization of the inflow/outflow vessels is also not necessary. The complete exclusion of the sac is enough to exclude the leak and avoid reperfusion. ■

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