

# Type IA endoleak caused by interlocked suprarenal bare-metal stents after endovascular abdominal aortic aneurysm repair with successful endovascular rescue

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## ABSTRACT

A physically active 90-year-old man underwent endovascular repair of an asymptomatic but enlarging abdominal aortic aneurysm. Postoperative computed tomography demonstrated entanglement of nonadjacent proximal bare-metal stents. This was associated with graft infolding and a type IA endoleak. The patient underwent percutaneous transluminal angioplasty and placement of a Palmaz stent. Subsequent surveillance imaging showed resolution of the type I endoleak >1 year later. This report demonstrates an uncommon cause of stent graft infolding, an already rare complication of endovascular aneurysm repair, and highlights the need to carefully assess the morphologic appearance of the proximal fixation stents after graft deployment. (*J Vasc Surg Cases and Innovative Techniques* 2020;6:277-81.)

**Keywords:** Abdominal aortic aneurysm; Endovascular aneurysm repair; Endoleak

Endovascular aneurysm repair (EVAR) is a minimally invasive treatment modality for abdominal aortic aneurysm (AAA) associated with reduced perioperative mortality compared with open repair.<sup>1,2</sup> Infolding or endograft collapse is a rare postoperative complication most commonly described when excessively oversized grafts are deployed in nonaneurysmal thoracic aorta.<sup>3</sup> Here, we present an unusual case of endograft infolding resulting from the entanglement of proximal stent barbs during graft deployment. Endovascular intervention was required to buttress the endograft against the aortic wall to create a proximal seal. The patient's consent was obtained for the publication of this report.

## CASE REPORT

A 90-year-old man with excellent functional capacity and an impressively active lifestyle presented with an enlarging infrarenal AAA measuring 6.8 cm. The angulation of suprarenal aorta to aneurysm neck was 10 degrees, and the angle between the neck and long axis of the AAA was 55 degrees. The neck was not calcified and without thrombus; it measured 27 mm, with the suprarenal aorta measuring 20 mm (Fig 1). The patient underwent

infrarenal EVAR (Zenith Alpha abdominal endovascular graft; Cook Medical, Bloomington, Ind) with a right iliac branch graft (Zenith branch) and embolization of the left internal iliac artery. The main body diameter was 32 mm in a 27-mm neck, sized per the manufacturer's instructions for use, with no issues during deployment or retrieval of the main body device. Completion angiography with the patient systemically heparinized demonstrated a low-flow endoleak despite repeated Coda (Cook Medical) ballooning. A decision was made to follow up with imaging, and the patient was discharged home on the fifth postoperative day (because of lower respiratory symptoms). The 6-week postoperative computed tomography (CT) angiography study demonstrated that nonadjacent stent barbs at the proximal end of the endograft had become entangled, thereby causing incomplete deployment of the suprarenal stent. This was associated with invagination of the main body and a type IA endoleak. The apex of one suprarenal bare stent was protruding between the interstices of a nonadjacent stent (Fig 2). The patient was booked for urgent angiography (see high-power view of proximal stent in Fig 3, A) to expand the proximal stent to achieve a proximal seal. Percutaneous transluminal angioplasty was performed over a Lunderquist wire without overinflation. Two balloon inflations were attempted, but each balloon burst when inflated against the entangled stent. Subsequently, a Palmaz stent was deployed in the proximal neck to obtain apposition of the proximal endograft against the aortic wall (Fig 3, B).

Follow-up CT angiography demonstrated an improvement in the endograft infolding and endoleak. On subsequent ultrasound, the type IA endoleak had resolved. The patient has been observed for >1 year after insertion of the Palmaz stent with continued resolution of the type IA endoleak. The aortic sac regressed from 6.8 cm to <6.4 cm.

## DISCUSSION

EVAR has become the preferred option for repair of infrarenal AAA, accounting for 80% of AAA repairs in the United States.<sup>4,5</sup> The EVAR 1,<sup>6</sup> Dutch Randomized

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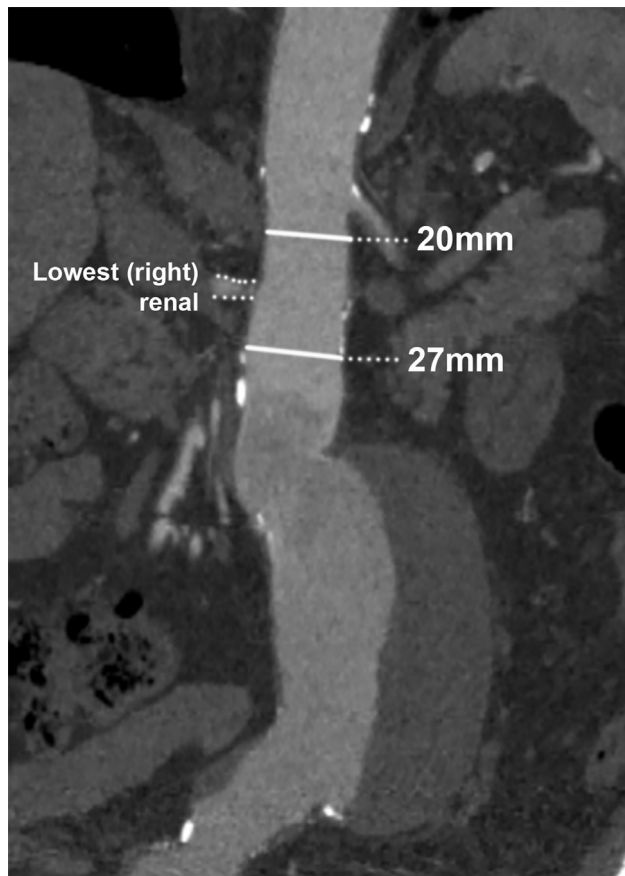
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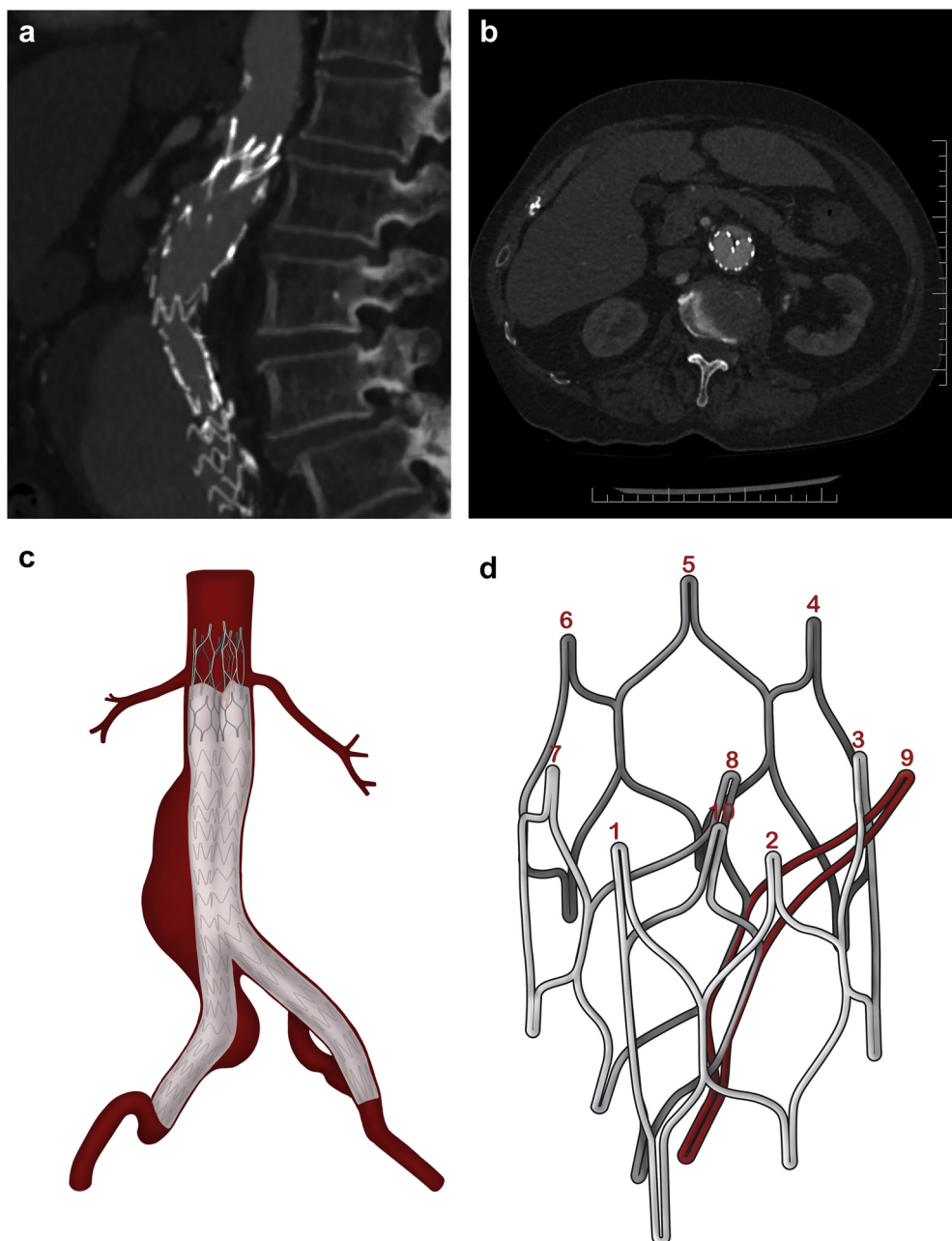


**Fig 1.** Reconstruction of computed tomography (CT) angiography image demonstrating infrarenal abdominal aortic aneurysm (AAA) with long infrarenal neck and ectatic iliac arteries. The infrarenal neck was 27 mm in diameter with mild narrowing just proximal to the highest renal artery to 20 mm. The image demonstrates minimal calcification or thrombus and anatomy suitable for endovascular aneurysm repair (EVAR).

Endovascular Aneurysm Management (DREAM),<sup>7</sup> and Open Versus Endovascular Repair (OVER)<sup>8</sup> trials demonstrated superior perioperative morbidity and mortality for patients undergoing EVAR compared with open repair of AAA, which has led to a significant uptake in the use of EVAR.<sup>9</sup> Long-term follow-up suggests that the survival benefit from EVAR is lost,<sup>2</sup> and in high-risk patients ineligible for open repair, any reduction in aneurysm-related mortality is lost among the overall high all-cause mortality rate in this population,<sup>10</sup> indicating that careful selection of patients is required. Our patient was 90 years old but with excellent functional capacity. Our usual practice is nonoperative management in this patient group. However, selective use of EVAR in octogenarians and nonagenarians has been shown to have acceptable success,<sup>11-13</sup> and given that our patient's AAA had expanded by >1 cm in <1 year to 6.8 cm, we offered EVAR.

Our patient underwent infrarenal EVAR with an iliac branched graft to preserve one hypogastric artery. Our

standard practice is to use a semicompliant Coda balloon to expand the endograft at the proximal and distal sealing zones and at stent overlaps. A type IA endoleak was observed on the final angiogram. Per practice guidelines,<sup>14</sup> we attempted to resolve this by reballoning the proximal sealing zone. The majority of type IA endoleaks that persist on completion angiography will resolve by the first postoperative scan,<sup>15</sup> and they are often attributed to tapering of the neck, mural thrombus, calcification, angulation, or undersizing and excessive oversizing of the endograft. In appropriately planned and executed cases, reversal of heparin and continued remodeling of the aortic neck may allow improved apposition at the proximal sealing zone.<sup>16</sup> The first postoperative CT scan at 6 weeks demonstrated the unexpected finding of severe infolding of the main body of the endograft. This finding is more commonly described in the context of thoracic endografts placed in a normal-sized aorta, in which oversizing of the graft in a nonaneurysmal aorta may prevent complete expansion of the prosthesis and lead to invagination of the stent graft.<sup>3</sup> Stent infolding has also been observed with the use of fenestrated EVAR to treat juxtarenal<sup>17</sup> and pararenal<sup>18</sup> AAA. This complication may be due to significant disparity between the size of a tapered infrarenal neck and a larger, more proximal sealing zone at the visceral segment, leading to relative oversizing at the infrarenal aorta. This disparity is further complicated by the presence of visceral stents. We had not anticipated this issue in a standard infrarenal EVAR and have not identified any published experience with this or Food and Drug Administration documentation of this complication. Careful re-review of our preoperative planning confirmed endograft sizing within the manufacturer's instructions for use. In our case, in addition to infolding of the main body, we discovered that the barb of a suprarenal stent was protruding between the interstices of a nonadjacent stent, causing them to interlock and preventing complete deployment. During deployment of the endograft and suprarenal stents and removal of the main body device, there were no difficulties noted, and it was not immediately obvious that a suprarenal stent had become entangled. With the benefit of hindsight, retrospective review of the intraoperative images suggests suboptimal conformity of the suprarenal stent. Cook endograft deployment consists of partial deployment of the main body with subsequent release of constraining ties to release the uncovered suprarenal stent. The manufacturer's review of our case confirmed appropriate sizing within the instructions for use; however, it was suggested that narrowing of the suprarenal aorta to 20 mm, which is not a required measurement, might have initiated the stent entanglement during deployment. Given this patient's advanced age, endovascular treatment of this complication was the only option, despite our unclear expectation of success because of the stent entanglement. Balloon-expandable Palmaz stents have been



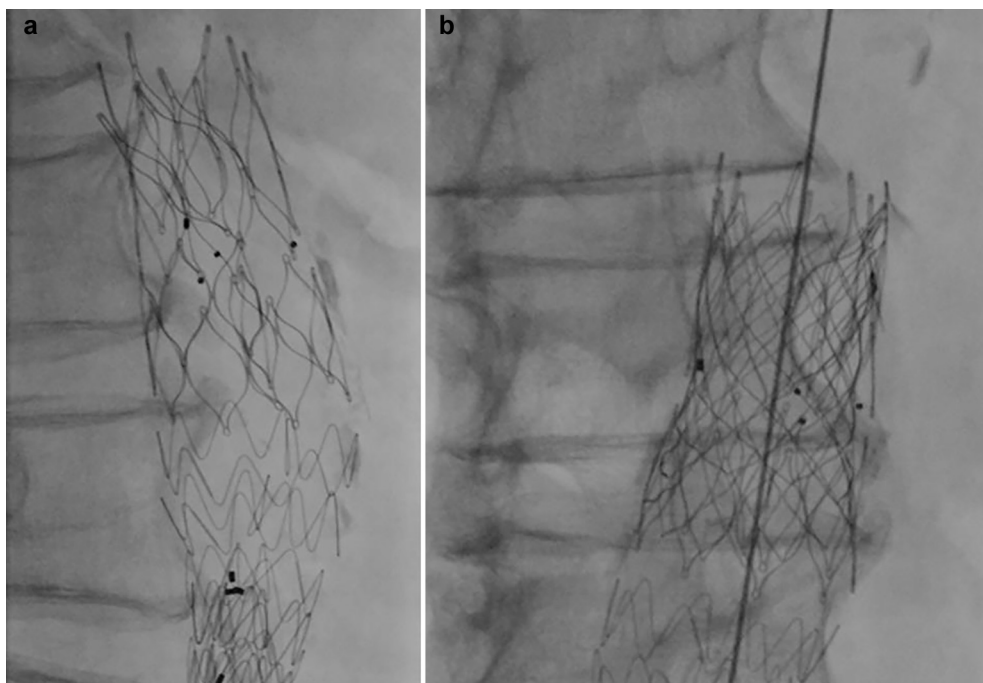
**Fig 2.** Infolding of endograft demonstrated on 6-week postoperative computed tomography (CT) scan. **A** and **B**, Sagittal and axial arterial-phase images of the main body of the endograft within the infrarenal abdominal aortic aneurysm (AAA) sac demonstrating abnormal conformation of suprarenal bare-metal stent and infolding of the main body. **C**, Illustration of endograft derived from CT images with proximal stent entanglement and main body infolding. **D**, Illustration derived from CT image showing stent barbs, numbered 1 to 10, and entanglement of nonadjacent stents.

used successfully as an adjunct to EVAR to improve the proximal seal with hostile aortic neck anatomy and to treat type IA endoleak<sup>19</sup> and also in the case of infolding of a fenestrated endograft.<sup>18</sup> Placement of a Palmaz stent in our case could not disentangle the suprarenal stents but provided sufficient apposition of the endograft to the aortic wall to obtain a proximal seal, which has been maintained for >1 year of follow-up. In our case, open

conversion with explantation of the endograft was not an option in the event of endovascular failure because of the patient's advanced age.

## CONCLUSIONS

We recommend that consideration of EVAR in patients with advanced age take into account the morbidity of additional procedures that might be required in the



**Fig 3.** Selected image from endovascular treatment of infolded stent **(A)** before ballooning and **(B)** after deployment of Palmaz stent with improved appearance of proximal stent.

event of unexpected complications and that close review of intraoperative images be performed to confirm correct conformity of deployed endografts. EVAR planning also requires careful consideration of the aortic region within which the suprarenal stent will be deployed in addition to standard measurements of aortic neck length and angulation.

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