SHORT REPORT

Transcatheter Embolisation of Type 1 Endoleaks after Endovascular Aortic Aneurysm Repair with Onyx: When No Other Treatment Option is Feasible

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Type 1 endoleaks following endovascular aortic aneurysm repair are associated with poor outcomes and re-intervention is recommended as soon as possible after diagnosis. When standard endovascular or surgical treatment options are unsuitable due to severe co-morbidity or adverse anatomic factors, patients can be treated by transcatheter embolisation of the endoleak itself. We describe six such patients with proximal and distal type 1 endoleaks, who have been successfully treated by transcatheter embolisation with Onyx. The embolisation technique, advantages of using this relatively novel liquid embolic agent and potential pitfalls are discussed.
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The success of endovascular aneurysm repair (EVAR) relies on achieving an adequate proximal and distal seal to exclude the aneurysm sac from the systemic circulation. Type 1 endoleaks are associated with an increased risk of post-procedural aneurysm rupture and late aneurysm-related death, and re-intervention is recommended as soon as possible after diagnosis.[1]

Standard endovascular treatment options for type 1a endoleaks include the insertion of an aortic cuff to extend endograft coverage more proximally, or placement of a large-calibre balloon-expandable stent (e.g. Palmaz or Sinus) inside the proximal endograft to improve the seal. Standard therapy for type 1b endoleaks involves distal extension of endograft coverage.

If an endoleak persists despite these measures, definitive therapy may require conventional open surgery, visceral artery bypass combined with stent-graft extension or the use of chimney or periscope grafts to extend proximal and distal landing zones. Patients not eligible for these more complicated procedures due to severe co-morbidities or adverse anatomical factors may be treated by transcatheter embolisation of the endoleak itself.

There is limited published experience of type 1 endoleak embolisation and previous reports have involved coils[2] and *n*-butyl 2-cyanoacrylate (*n*-BCA).[3] Onyx (ev3, Irvine, CA, USA) is a relatively novel non-adhesive liquid embolic agent, which is most commonly used to treat intracranial arteriovenous malformations. It is comprised of ethylene vinyl alcohol dissolved in dimethyl sulphoxide and suspended micronised tantalum powder to provide contrast for visualisation under fluoroscopy. We describe a small series of six patients who underwent Onyx embolisation of type 1 endoleaks in our tertiary referral centre. All had contraindications to conventional type 1 endoleak management techniques and open conversion. The clinical details of these patients are presented below and are summarised in Table 1.

PATIENT 1

A 65-year-old female patient underwent endovascular repair of a juxtarenal abdominal aortic aneurysm (AAA) with a Ventana fenestrated aortic endograft (Endologix, Irvine, CA, USA). The graft moved inferiorly during EVAR resulting in occlusion of the left renal artery fenestration and a proximal type 1 endoleak (Fig. 1(a)). Due to the fenestrated nature of the device, the usual endovascular techniques for treating type 1 endoleaks were deemed unsuitable. Therefore, a decision was made to embolise the endoleak cavity with Onyx.

The presence and location of the type 1a endoleak was confirmed by aortography. The endoleak entry point was engaged with a sidewinder catheter and selective angiography demonstrated the extent of the endoleak cavity (Fig. 1(b)). A more stable position was obtained with a microcatheter and Onyx was injected slowly into endoleak (Fig. 1(c)) until the entire endoleak cavity including the entry site was occluded (Fig. 1(d)). A follow-up duplex scan at 6 weeks and a computed tomography (CT) aorta at 3 months show no evidence of endoleak and stable aneurysm sac size.

PATIENT 2

An 82-year-old male patient presented with a proximal type 1 endoleak 12 months after EVAR with a custom-made 42-mm diameter Zenith endograft (W. Cook Europe, Bjaeverskov, Denmark) for an AAA. The endoleak was unsuitable for standard treatment options largely due to the oversized graft diameter.

Following a confirmatory aortogram, the entry site of the proximal type 1 endoleak was identified and selectively

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Table 1. Summary of patients treated with Onyx embolisation.

No	Pathology	Initial treatment	Endoleak	Indication for Onyx
1	Juxtarenal AAA	Fenestrated EVAR with Ventana	1a	Unsuitable for fenestrated cuff. Unfit for open surgery.
2	Infrarenal AAA	EVAR with oversized (42 mm) graft	1a	Oversized cuff/stent not available. Unfit for open surgery.
3	Chronic type B dissection & infrarenal AAA	Hybrid TEVAR with 3 vessel visceral bypass from right CIA	1b	Unsuitable for limb extension due to R CIA visceral artery bypasses.
4	Descending TAA	TEVAR to coeliac origin	1b	Unsuitable for hybrid procedure and fenestrated/branched endografts.
5	Infrarenal AAA	Tube graft from outside hospital	1a	Infected graft. Unsuitable for fenestrated cuff. Unfit for open surgery.
6	Infrarenal AAA	EVAR, short angulated neck	1a	Unsuitable for aortic cuff. Unfit for open surgery.

catheterised. A microcatheter was placed into the aneurysm sac and the endoleak cavity and the entry site were embolised with 34 ml of Onyx. Follow-up imaging with duplex ultrasound at 1 month shows no residual endoleak and stable sac size.

PATIENT 3

A 68-year-old male patient underwent hybrid thoracic endovascular aortic repair (TEVAR) with three visceral artery bypass grafts arising from the distal right common iliac artery (CIA) for thoraco-abdominal aortic dissection and an infrarenal AAA. A 6-year follow-up CT showed a distal type 1 endoleak from the right CIA above and close to the origin of the visceral bypass grafts, secondary to interval dilatation of the right CIA. The usual treatment option of distal limb extension was not feasible in this case due to the presence of visceral bypass grafts. Therefore, the patient was referred for embolisation with Onyx.

Angiogram through a cobra catheter and microcatheter in the endoleak cavity confirmed communication with the aortic aneurysm sac. Onyx was injected slowly and carefully to avoid migration towards the visceral artery bypasses. Completion angiography confirmed successful abolition of endoleak and preservation of the visceral bypass grafts. Duplex follow-up at 1, 3, 7 and 10 months shows no evidence of endoleak and stable sac size.

PATIENT 4

A 79-year-old man underwent TEVAR from the proximal descending aorta to the coeliac axis origin for a descending thoracic aortic aneurysm. A CT scan at 2 months showed a large distal type 1 endoleak with an enlarging aneurysm sac. The patient was unfit for a hybrid solution and unsuitable for fenestrated/branched endografts.

The endoleak cavity was successfully embolised with 9 ml of Onyx via a cobra catheter and microcatheter. Completion angiography showed no residual flow of contrast medium at the site of the previously seen endoleak. Follow-up CT images at 6 months were significantly marred by a beam-hardening artefact from the tantalum but the aneurysm sac has remained stable and a duplex ultrasonography (US) shows no evidence of endoleak.

PATIENT 5

A 62-year-old male who underwent EVAR for an infrarenal AAA presented 3 years later with an infected graft and type 1a endoleak due to inferior migration of the endograft. The patient was unfit for open surgery or fenestrated cuff. The endoleak sac was successfully embolised with Onyx and the aneurysm sac was unchanged on 1-month follow-up CT scan.

PATIENT 6

A 77-year-old man who underwent previous EVAR for an infrarenal AAA presented 2 years later with inferior migration of the stent graft and type 1a endoleak secondary to a short angulated neck. The patient was not fit for open repair and the neck morphology was unsuitable for an aortic cuff. The endoleak was embolised with Onyx and a follow-up duplex scan at 6 weeks shows no evidence of endoleak and stable sac size.

DISCUSSION

The published experience of endoleak embolisation with Onyx is very limited. The largest series reported six patients who were treated with Onyx embolisation of type 1 endoleaks following EVAR.[4] The authors reported 100% technical success, although there were early occlusions of renal artery chimney grafts in one patient, and another patient experienced late stent-graft migration resulting in fatal aneurysm rupture at 18 months post embolisation. Another study described a single successful case of Onyx embolisation for a proximal type 1 endoleak following EVAR.[5]

Our experience with Onyx embolisation has been positive with no recurrent endoleaks at up to 10 months of follow-up. The procedure itself is not technically challenging for operators with sufficient training and expertise in embolisation procedures as the endoleak cavity can be accessed with relative ease.

However, there are limitations to this technique and Onyx has its own particular drawbacks. First, Onyx is highly radiopaque and the microcatheter tip becomes obscured as the endoleak cavity is filled. It is therefore important to be aware of the location of the microcatheter tip and to maintain a stable position to avoid the risk of non-target

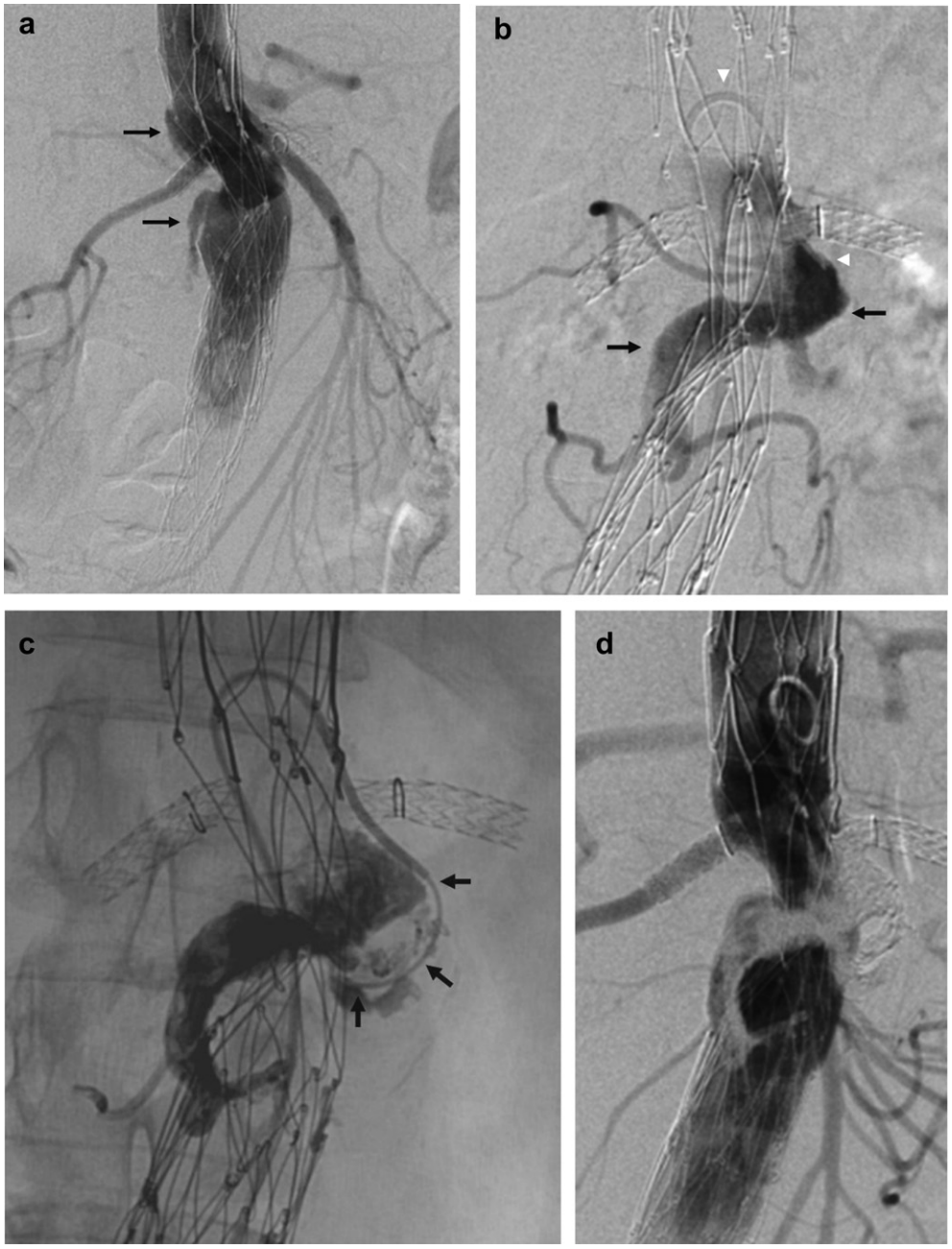

Figure 1. (a) Completion angiogram following placement of Ventana fenestrated aortic endograft shows a proximal type 1 endoleak (arrows) and occluded left renal fenestration. (b) Entry into the proximal type 1 endoleak was achieved with a sidewinder catheter (white arrowheads). Selective angiography demonstrated the extent of the endoleak cavity (black arrows). (c) A more stable position was obtained within the endoleak cavity with a microcatheter (black arrows). Onyx was injected slowly into the deepest component of the endoleak initially and the microcatheter tip was subsequently withdrawn gradually during further slow injection. (d) Completion angiogram shows no residual endoleak after embolisation with 7 ml of Onyx.

embolisation. Second, embolisation is time consuming as Onyx is currently only available in 1.5-ml vials and it must be injected slowly. Third, Onyx is expensive and this may be the determining factor in using alternative embolic agents. Fourth, the tantalum causes significant beam-hardening artefact on follow-up CT and any residual or recurrent endoleak may not be visualised. In these cases, the aneurysm sac diameter will be the only reliable indicator and duplex US may be a better follow-up imaging modality. Finally, our follow-up period of 10 months is relatively short and the long-term ability of Onyx to prevent pressurisation of the aneurysm sac remains to be seen.

In conclusion, Onyx is a useful embolic agent in the treatment of patients with type 1 endoleaks after EVAR, who are not suitable for more standard therapeutic options. The early results of this novel technique are promising and long-term outcomes are awaited.

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CONFLICT OF INTEREST STATEMENT

Both authors declare that there is no conflict of interest.

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