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HOW TO DO IT

Folding procedure to diminish type 3 endoleakage after open stent graft surgery with TEVAR extension

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Abstract

We herein report a new procedure to prevent type 3 endoleakage (EL3) after open stent graft (OSG) surgery with thoracic endovascular aortic repair (TEVAR) extension. The OSG Dacron graft portion is reversed and folded inside the OSG stent graft portion intraoperatively, filling the crack between the OSG and TEVAR device. We applied this procedure in two patients with no postoperative complications. Our folding procedure may prevent EL3 after OSG surgery if TEVAR extension is needed in the future.

Keywords Open stent graft · Frozen elephant trunk · Type 3 endoleak · TEVAR

The J Graft open stent graft (OSG), newly developed and renamed the Frozenix OSG (Japan Lifeline, Tokyo, Japan), is widely used in Japan during aortic surgery with the frozen elephant trunk technique (known as OSG repair in Japan). The OSG consists of a stent graft portion and Dacron graft portion (Fig. 1a); the latter is usually trimmed to 2–3 cm or less for proximal anastomosis. Good results of total arch replacement with the frozen elephant trunk technique using the OSG have been reported [1]; however, various conditions (e.g., distal stent graft-induced new entry or false lumen aneurysm) can complicate OSG surgery, necessitating future thoracic endovascular aortic repair (TEVAR) extension [2, 3]. When TEVAR extension is needed after OSG surgery, type 3 endoleakage (EL3) can occur if the TEVAR device is simply connected in the OSG stent graft portion. This occurs because the OSG stent graft portion has an endostent structure inside its graft fabric, resulting in a crack between the OSG and TEVAR device. Moreover, marked EL3 may occur if the TEVAR device has an exostent structure because the endostent and exostent structures can interfere with each other, increasing the crack between them.

This emerging problem remains unresolved. One recommendation to avoid EL3 is to place the proximal landing of the TEVAR device onto a proximal branched graft. However, advancing the TEVAR device through the OSG stent graft portion is sometimes difficult due to the endostent structure of the OSG. An alternative is deep insertion of the OSG, i.e., the Dacron graft portion is trimmed and kept long enough (>4 cm) for proximal landing of the TEVAR device. However, this procedure may promote kinking within the Dacron graft portion.

We herein report a new procedure to prevent EL3, whereby the OSG Dacron graft portion is reversed and folded inside the OSG stent graft portion after OSG deployment. Representative images from one of these cases are shown in Fig. 2. We decided to use an OSG to treat the fusiform distal arch aneurysm, aiming at one-stage repair (Fig. 2). After OSG deployment during systemic circulatory arrest, the Dacron graft portion is trimmed 6–7 cm from the transected aorta (Fig. 2a). Three fixing sutures are applied between the OSG and transected aortic wall using 2–0 Nespolene, and the Dacron graft portion is reversed and folded inside the OSG stent graft portion to line the OSG endostent structure (Fig. 2b). The optimal coverage length inside the OSG stent graft portion (folding length) was ≥5 cm in our preliminary ex vivo experiment. After smoothing out a crumpled graft with forceps, distal anastomosis between the OSG and branched proximal graft was established.

This procedure fills the crack between the two devices if TEVAR extension is later needed. Based on our preliminary ex vivo experiment, which showed that the folding procedure efficiently reduced EL3 and that the optimal overlap length to diminish EL3 in the folding procedure was 5 cm (data not shown), we clinically applied our

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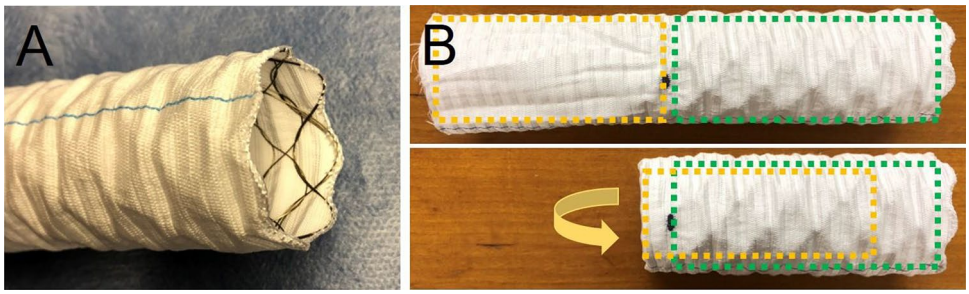

Fig. 1 **a** The OSG stent graft portion has an endostent structure inside its graft fabric. **b** Images before (upper) and after (lower) the folding procedure. Green dotted area, stent graft portion; yellow dotted area, Dacron graft portion. The OSG Dacron graft portion was reversed and folded inside to line the OSG endostent structure with the reversed graft

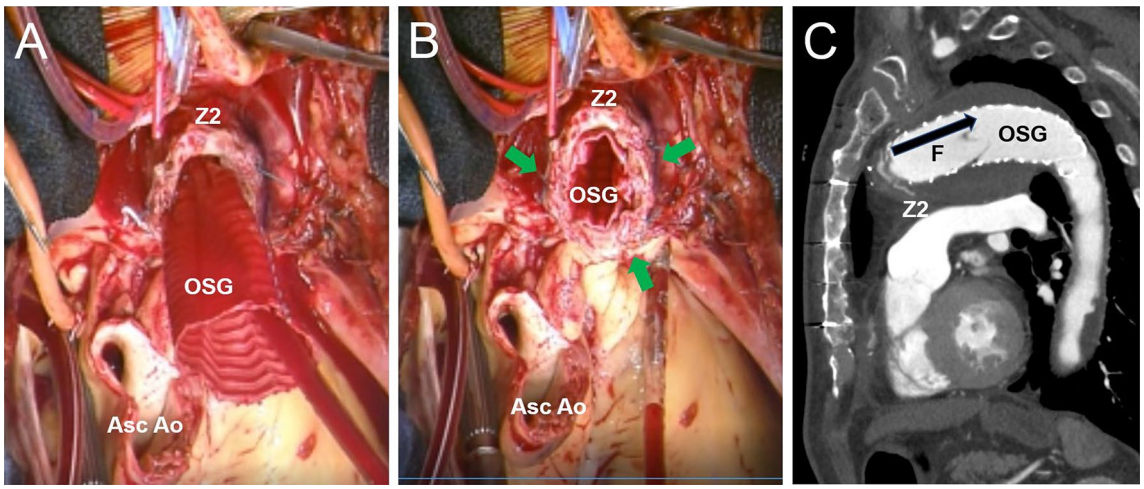

Fig. 2 **a, b** Intraoperative views and **c** postoperative computed tomography image. **a** After the aortic arch was transected in zone 2, the OSG was deployed into the distal arch. **b** After three fixing sutures were applied (green arrows), the OSG Dacron graft portion was reversed and folded inside to line the OSG endostent structure with the reversed graft. The coverage length of the OSG stent graft portion was 5 cm. **c** Sagittal computed tomography image. No thrombus was found between the stented segment and the inverted non-stented segment. *Asc Ao* ascending aorta, *Z2* zone 2, *F* (black arrow): inverted non-stented segment

folding procedure in two patients. The results were acceptable with no postoperative complications such as thrombosis or hemolysis. A postoperative computed tomography image showed no evidence of a thrombus between the inverted non-stented graft and the OSG itself (Fig. 2c). If TEVAR extension is needed in the future, our folding procedure may help to provide better surgical outcomes in OSG procedures.

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Compliance with ethical standards

Conflict of interest Tatushi Onzuka, Kojiro Furukawa, Eiki Tayama, Shigeki Morita, and Akira Shiose declare that no conflict of interest exists.

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