



De-airing an open stent graft to potentially reduce spinal cord injury

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Abstract

We have occasionally observed a bubble leaving the suture line of an open stent graft; hence, we hypothesized that de-airing an open stent graft could potentially reduce spinal cord injury. Postoperative computed tomography often showed residual air in thoracic aortic aneurysms, confirmed by the presence of a certain amount of air in an open stent graft in a dry lab. We filled CO₂ in the sterilized package of an open stent graft and subsequently filled it with saline, which absorbed the CO₂ and entered into the gap of the graft. The clinical benefit of de-airing an open stent graft to reduce the incidence of spinal cord injury needs to be evaluated.

Keywords Open stent grafting · Spinal cord injury · De-air

Open stent grafting (OSG) is an alternative treatment for extensive thoracic aortic replacement. However, this procedure is associated with a high incidence of spinal cord injury: 6.7% in pre-clinical trials and 1.9% in clinical data [1, 2]. Factors of spinal injury are divided into occlusion and transient ischemia of the spinal artery during surgery [3, 4]. The occlusion may be caused by coverage of the OSG, and embolism with a thrombus, atheroma, and air. Presently, we have been using distal perfusion from the femoral artery during OSG deployment and flooding the operating field with CO₂ to prevent residual air in the descending aortic aneurysm. Conditions under which OSG deployment occurs include: deep hypothermia, ante-grade three neck vessel perfusion, and circulatory arrest of the lower body. Occasionally, air bubbling is observed from the proximal suture line of the OSG during anastomosis of the native aortic wall and OSG. We observed residual air in the descending aortic

aneurysm on postoperative computed tomography in a case with a healed infected thoracic aortic aneurysm (Fig. 1). Although a thoracic endovascular aortic stenting device for aortic aneurysm repair has an irrigation port for de-airing, commercially available OSGs currently do not have this feature. We measured the amount of air derived from six OSGs in a dry-lab setting, and observed that more than 10 mL of air was eliminated from the short and small OSG (diameter 23 mm and stent 60 mm) (Frozenics, Japan Lifeline Co., Ltd., Tokyo, Japan) during the deployment (Fig. 2a, b, Video 1), where it seemed that air came out from three parts: the space between the sheath and the graft, the space inside the graft, and in the gap in the graft wall fabric. We filled the sterilization package containing the OSG with 6 L/min CO₂ for 30 s to 1 min and soaked it with a saline solution for the same amount of time (Fig. 3), where the absence of CO₂ flood caused an increase of residual air in OSG. The gaps in the OSG were first filled with CO₂ and then replaced by the saline-absorbing CO₂. The amount of air that was eliminated from the de-aired OSG was less than 1 mL in a dry lab. CO₂ flood in the descending aorta and retrograde blood perfusion are also recommended to prevent residual air around the OSG. We have used this de-airing technique in 3 cases of OSG deployment, and we have not experienced a spinal cord injury or residual air in the descending aorta. Here, we describe our first patient on whom we performed the de-airing technique of OSG deployment. The patient was a 74-year-old man with annuloaortic ectasia and thoracic aneurysm from the ascending to descending aorta (Fig. 4).

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Fig. 1 Postoperative enhanced computed tomography shows residual air in the descending aortic aneurysm; although distal perfusion was performed during an open stent-graft deployment to fill the space of aneurysm

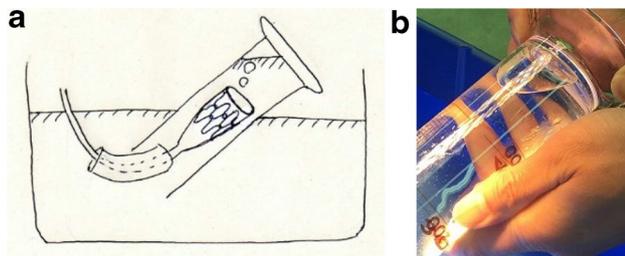


Fig. 2 Dry-lab test to measure the amount of air derived from the open stent graft. **a** Shows a schematic. Open stent graft was deployed in the graduated cylinder that was filled with water. **b** Shows air derived from the open stent graft. Video 1 is the motion picture of (b)

Under cardiopulmonary bypass, the aortic root was replaced using the Bentall technique with carrel patches, and the patient was cooled down at a rectal temperature of 26 °C. The top of the sterilized package of the OSG (Frozenics 37×90 mm, Lifeline, Tokyo, Japan) was opened and filled with CO₂ at a 6 L/min flow for 2 min. A liter of saline was used to fill the package, and the OSG was shaken for 2 min and kept in the saline. The surgical field was maintained with CO₂ at a flow of 6 L/min. Under circulatory arrest, three neck vessels were perfused, and distal perfusion was performed from the femoral artery at a rate of 300 mL/min to prevent air embolism in the lower body. A descending aorta stump was made and blood was aspirated to confirm the direction of the OSG destination. The OSG was introduced into the descending aorta taking care to minimize the time required to move it from the package filled with saline to the descending aorta to prevent air entering the OSG. Distal perfusion from the femoral artery was increased to a rate of 500 mL/min before and during OSG deployment to wash out residual air around the OSG. After OSG was deployed, a Foley balloon was inserted, inflated, and fixed in the OSG, and distal perfusion was controlled from 500 to 800 mL/min to keep femoral pressure fixed at 30–50 mmHg.



Fig. 3 How to de-air open stent graft. Figure shows the open stent-graft soaking for 1 min in the saline-filled package for de-airing after CO₂ gas flood for 1 min in the sterilized package of the OSG

A four-branched J-graft (26 mm Lifeline, Tokyo, Japan) was anastomosed to the OSG and systemic perfusion was restarted, where circulatory arrest time, including low-pressure distal perfusion, from the femoral artery was 39 min. Aortic cross clamp time was 217 min. The patient was extubated on postoperative day 3, and spinal cord injury was not noticed. Postoperative computed tomography showed no air in descending aorta, and level of the distal end of the OSG was Th7 (Fig. 5). The patient was discharged on postoperative day 24 after rehabilitation for a recurrent nerve palsy that resulted in the patient having a difficulty swallowing.

Although open questions still exist regarding this technique, including case assumption, its efficacy to reduce spinal injury, and the relationship between the amount of air and graft size, the low cost and low risk of the de-airing technique might be useful for OSG users.



Fig. 4 Preoperative enhanced computed tomography of a case treated with de-airing technique shows annuloaortic aneurysm and thoracic aortic aneurysm from the ascending to the descending aortic

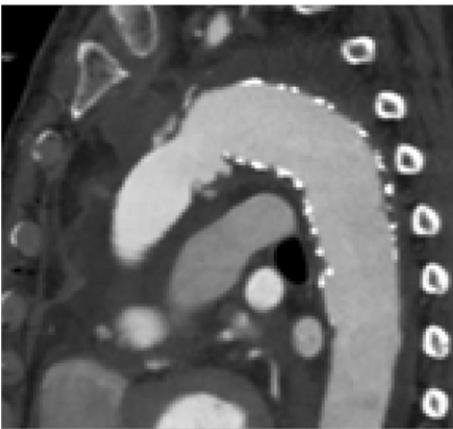


Fig. 5 Postoperative enhanced computed tomography of the case treated with de-airing technique shows no residual in the descending aortic aneurysm. The level of the distal end of the OSG was Th7

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Compliance with ethical standards

Conflict of interest Munetaka Masuda received research funding from Japan Lifeline Co. Ltd. Other authors do not have any conflict of interest.

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