◆ TECHNICAL NOTE ◆

A Simple Technique to Facilitate Antegrade Thoracic Endograft Deployment Using a Hybrid Elephant Trunk Procedure Under Hypothermic Circulatory Arrest

Peter H. Lin, MD[1]; Alan Dardik, MD, PhD[2]; and Joseph S. Coselli, MD[3]

[1]Division of Vascular Surgery and Endovascular Therapy, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, and Michael E. DeBakey VA Medical Center, Houston, Texas, USA. [2]Department of Surgery, Yale University School of Medicine, and VA Connecticut Healthcare System, New Haven, Connecticut, USA. [3]Division of Cardiothoracic Surgery, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, and Texas Heart Institute at St. Luke's Episcopal Hospital, Houston, Texas, USA.

Purpose: To describe a technique to facilitate antegrade thoracic endograft deployment using a hybrid elephant trunk operation under hypothermic circulatory arrest.
Technique: When using a nitinol-based endograft in a hybrid endovascular aortic arch repair performed in a hypothermic patient, the endograft does not expand fully when the body temperature is typically maintained below 20°C. Immersing the nitinol-based thoracic endograft in a sterile hot saline bath (48°C) for 1 to 2 minutes prior to deployment warms the stent-graft to a physiological temperature of 38°C, which it maintains for several minutes while being deployed.
Conclusion: Although the described technique represents an off-label approach to the use of a TAG device, we believe warming a nitinol-based endograft may potentially improve the technical success of this hybrid operation when the patient is under hypothermic circulatory arrest.

Key words: elephant trunk, aortic arch reconstruction, thoracic aneurysm, circulatory arrest, hybrid endovascular procedure, hypothermia, nitinol stent-graft

Since the elephant trunk technique was described by Borst et al.[1] in 1983, this 2-staged surgical reconstruction has been widely adopted in treating patients with extensive aneurysm disease involving the aortic arch. In this staged operation, prosthetic graft replacement of the aortic arch and ascending aorta was first performed through a median sternotomy, with an elephant trunk extension of the arch graft into the descending aorta. This is followed by a second-staged operation in which the elephant trunk graft is extended into the descending thoracic aorta through a lateral thoracotomy incision.[2]

The advent of thoracic endovascular technology has become an added armamentarium in this treatment approach, as several authors have reported a hybrid elephant trunk procedure using a single surgical approach through a median sternotomy with aortic arch replacement and antegrade thoracic endograft deployment in the descending thoracic aorta.[3–5] Because this approach is performed under circulatory arrest, a thoracic

The authors have no commercial, proprietary, or financial interest in any products or companies described in this article.

Address for correspondence and reprints: Peter H. Lin, MD, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston VAMC (112), 2002 Holcomb Blvd., Houston, TX 77030, USA. Fax: 1-713-794-7352; E-mail: *plin@bcm.edu*

endograft made of thermal memory nitinol may not fully deploy in a profoundly hypothermic environment. We describe a simple technique to facilitate antegrade thoracic endograft deployment using a hybrid elephant trunk operation under hypothermic circulatory arrest.

TECHNIQUE

In a single-staged hybrid elephant trunk procedure consisting of total aortic arch replacement and antegrade thoracic endograft repair of the descending thoracic aortic aneurysm, circulatory arrest is maintained at a mean tympanic temperature of 17°C. With longitudinal opening of the aortic arch, the aortic graft is invaginated such that ~15 cm of the graft is inserted into the descending thoracic aorta. The folded edge of the invaginated graft is sutured to the aorta just distal to the left subclavian artery. The invaginated portion of the graft is then pulled back into the field. Under fluoroscopic guidance, a 22-F introducer sheath (W.L. Gore & Associates, Flagstaff, AZ, USA) is inserted through the proximal opening of the aortic graft. Next a thru-and-thru guidewire is established from the aortic sheath to a 6-F right femoral artery sheath. The TAG Thoracic Endoprosthesis (W.L. Gore & Associates) is immersed in a hot sterile saline bath for ~1 minute to raise its temperature. The device is inserted through the introducer sheath and deployed in an antegrade fashion in the descending thoracic aorta just above the celiac artery. Full endograft expansion is visualized upon immediate device deployment. The endograft is remodeled with a balloon, and the introducer sheath and guidewire are removed. The orifice of the brachiocephalic vessel is reattached to an opening in the aortic graft. After thorough removal of air, the graft is clamped, and cardiopulmonary bypass is resumed. The proximal aortic graft is anastomosed to the ascending aorta. Re-warming is initiated, and the patient is weaned off cardiopulmonary bypass.

DISCUSSION

The TAG Endoprosthesis is a thoracic endograft with a nitinol-based exoskeleton and an expanded polytetrafluoroethylene (ePTFE) fabric cover.[6] Because of the thermal shape memory of the nitinol metal, the endograft expands fully when deployed at a physiological body temperature above 38°C.[7] However, the endograft does not expand fully when deployed under hypothermic circulatory arrest in which body temperature is typically maintained below 20°C. A poorly expanded nitinol-based endograft may lead to undesirable consequences, such as device migration or dislodgement. Although immediate balloon angioplasty following hypothermic device deployment may enhance endograft expansion, it is possible that the insertion of an aortic angioplasty catheter may dislodge a partially-expanded endograft distally in the descending thoracic aorta.

Our technique of immersing a nitinol-based thoracic endograft in a sterile hot saline bath prior to deployment is simple to perform. Hot saline solutions are commonly kept in the operating room at a temperature of 120°F (48°C) so that it can be mixed with cold saline for irrigation purposes. By immersing a TAG device in a hot saline bath of 48°C for 2 minutes, then keeping the device in a room temperature environment, we observed that the device was able to maintain a physiological temperature of 38°C for at least 10 minutes as determined by an infrared laser temperature probe. We estimate that this provides sufficient time for physicians to remove the device from the hot saline bath and deploy it in the descending thoracic aorta while the nitinol device remains well above its ideal temperature for full expansion. In our experience, it takes us less than 3 minutes following removal of the TAG device from the saline bath before it is fully deployed in the descending thoracic aorta under hypothermic circulatory arrest.

Conclusion

The merging of open and endovascular approaches has created an exciting treatment strategy in patients with complex aneurysm disease. Although the described technique represents an off-label approach to the use of a TAG device, we believe this technique may potentially improve the technical success of

this hybrid operation when the patient is under hypothermic circulatory arrest.

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