Assessment of Bridging Stent Grafts in Branched Endovascular Aortic Repair (EVAR) Procedures Using Intravascular Ultrasound (IVUS)

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INTRODUCTION

Complex endovascular aortic repair (EVAR) procedures such as branched EVAR (BEVAR) require significant amounts of contrast media or radiation exposure. In addition, the use of intra-operative cone beam computed tomography (CT) with its additional radiation exposure is increasing because of its reliability in investigating the anatomy of the implanted stent grafts. In particular, cone beam CT has been shown to deliver high intra-operative endoleak detection rates and technical issues requiring direct intervention.1

Intravascular ultrasound (IVUS) has become a useful diagnostic tool in endovascular procedures. In the case of EVAR, it has been shown to be helpful in assessing the proximal and distal stent graft landing zones, reducing the need for contrast media in patients with compromised renal function.2 In particular, the IVUS technology can characterise the presence of thrombus and calcifications in a reliable way,3 also providing real time vessel diameter measurements. Its usefulness in dissection cases to discriminate between the true and false lumen has already been described.4

Therefore, the present authors developed a diagnostic protocol integrating the use of IVUS technology during BEVAR procedures. The IVUS technology was chosen to prove its applicability in detecting geometric anomalies of the bridging grafts during BEVAR.

SURGICAL TECHNIQUE

After full deployment of the bridging stent graft through the brachial artery, and after angiographic assessment of its patency, a 0.018 High Torque Command Wire (Abbott Laboratories, Abbott Park, IL, USA) was advanced to the distal end of the bridging stent graft.

The Glidecath catheter was then removed and a Vision PV 0.018 IVUS catheter (Volcano, Philips, Amsterdam, The Netherlands) was advanced through the bridging stent graft. After activation of the B mode modality, the IVUS catheter was pulled gently back through the bridging stent graft up to the entry of the branch (Photo 1). The IVUS technique gave a 360° image of the vessel, detecting the presence of mismatch or bridging stent graft kinking using both B mode and Croma fló (Supplementary material).

All branches were investigated sequentially with the IVUS catheter at the end of each bridging stent implantation.

Since the introduction of the IVUS technology at the study clinic, 33 target vessels have been cannulated with the Volcano IVUS system. In two cases a haemodynamic non-relevant kinking of the bridging stent graft (<50% reduction of the diameter) at the level of the ostium of a superior mesenteric artery (Figs. 1–3) and of a left renal artery (Figs. 4–6) was found. No relevant stenosis, dissection, or kinking of the bridging stent grafts and/or at the target vessel were observed (Figs. 2–4). Furthermore, no procedure related complications from using the IVUS technology were detected. This was confirmed in all cases, using the first post-operative CT scan 30 days after the BEVAR procedure.

DISCUSSION

The use of IVUS in conventional endovascular aortic procedures and its potential in reducing radiation exposure and contrast medium use have been described already.5 In peripheral arterial and venous interventions, the application of IVUS has been associated with lower post-procedural complication and amputation rates with a non-significant increase in hospitalisation costs.6 Furthermore, the post-procedural luminal area, measured by IVUS, has been shown to be predictive of short and long term patency, highlighting the clinical utility of adjunctive imaging when performing lower extremity endovascular interventions.7

IVUS has also been evaluated for access vessel assessment prior to transarterial valve repair, with comparable if not more reliable image quality when it comes to the choice of the access, as well as potential radiation and contrast volume reduction.8

At the beginning of this experience, the present authors aimed to apply the IVUS technology to all complex aortic
reconstructions. However, difficulties were encountered when advancing the IVUS catheter through the bridging stent graft via the femoral route, which is the preferred route for fenestrated EVAR (FEVAR). Therefore, it was decided to restrict use of the IVUS technique to BEVAR cases only via brachial access.

In this preliminary experience, the IVUS technology proved to be applicable in studying the anatomy of the bridging stent grafts during BEVAR procedures. The technical success rate was 100%. No relevant stenosis, dissec-

tion, or kinking of the bridging stent grafts were observed.

**Photo 1.** Intravascular ultrasound catheter (5) during pull back from the right renal artery and bridging stent.

**Figure 1.** Intravascular ultrasound image of the stent graft at the level of the ostium of the superior mesenteric artery showing an elliptical shape.

**Figure 2.** Intra-arterial angiography demonstrates minimal (<50%) reduction of the diameter at the level of the ostium of the superior mesenteric artery (blue arrow).

**Figure 3.** Plain radiographic demonstration of the minimal kinking of the superior mesenteric artery (yellow arrow) bridging stent.
The additional procedural time (3.5 mins per vessel in the present experience) and costs should be considered the main drawbacks of this technology. However, the information gained about the anatomy of the bridging stent graft with the IVUS technology may be useful during BEVAR procedures.

**CONCLUSIONS**

IVUS has become an essential tool in the present authors’ practice for assessing bridging stent grafts geometry in BEVAR procedures. At this time, the IVUS technique should be considered a complementary diagnostic tool in complex EVAR. This technique could potentially reduce radiation exposure and procedure costs and thus replace the cone-beam CT.

**APPENDIX A. SUPPLEMENTARY DATA**

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejvsvf.2020.04.003.

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