Re-Introducing Spiral Flow in a Vascular Access Graft Using a Spiral Inducing Stent

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Introduction

Single spiral flow patterns observed in arteries are thought to be initiated by the contraction of the heart and maintained by the geometry of the aortic arch. The turbulent flow patterns found around haemodialysis (HD) vascular access points have been linked to stenosis and are thought to contribute to vascular access failure at the distal anastomosis. The reintroduction of single spiral flow in vascular grafts has been linked to improved graft patency. This study investigated flow patterns through a U-bend of similar geometry to a HD vascular access graft before determining the impact of a single spiral flow inducing stent on flow patterns through the distal anastomosis and beyond the graft.

Material & Methods

An in vitro flow-rig consisting of an acrylic tank 46cm x 64cm, 8mm C-flex vessel-mimic (VM) (Cole-Parmer, UK) in a U-shaped geometry, and a UHDC flow-pump (Shelley Medical Imaging Technologies, ON, Canada) with the ability to simulate pulsed or continuous flow. The tank and VM were filled with tissue-mimic (TM) (9% glycerol in distilled water) and blood-mimic (BM) (Model 707, ATS Laboratories, Bridgeport, USA) respectively. The TM, VM & BM were chosen as the speed of sound in all is approximately 1550m/s. A stent, with the same diameter as the vessel (Vascular Flow Technologies, Dundee, UK), was inserted into the vessel mimic. This stent has a helical ridge down the inside. Images of flow patterns were acquired using an HDI 5000 ultrasound scanner (ATL Ultrasound, USA). For this part of the experiment (also see poster 1577) a continuous flow was used, with flow rates of 300 ml/min, 450 ml/min and 600 ml/min.

Results

When the single spiral flow inducing stent was placed before the U-bend (brachial artery) the geometry of the vessel-mimic rapidly destroyed the single spiral flow pattern created by the stent. When the single spiral flow inducing stent was placed after the u-bend, (distal graft) the spiral stent consistently re-ordered the flow pattern created by the U-bend into a single spiral flow pattern that propagated through the distal anastomosis and 20cm downstream.

Conclusion

This study demonstrates that to reintroduce spiral flow in a u-shaped conduit such as VA graft a single spiral flow inducing stent should be inserted in the distal limb of the graft. Although grafts are now being made which induce single spiral flow (Vascular Flow Technologies, Dundee, UK), it may be appropriate to consider placement of a single spiral flow inducing stent in distal grafts to re-introduce single spiral flow in the distal anastomosis.