Introduction

Blood flow in human arteries and veins has been widely reported as single spiral flow and is thought to reduce turbulence that was observed to propagate 17.5 cm downstream. On insertion of a CVC into the vessel mimic with a spiral inlet profile, single and has been linked to the formation of stenosis due to disturbance of the central vein endothelial cells. This study focused on the impact of CVC insertion on flow patterns within a vessel, both during and between simulated HD sessions.

Material & Methods

An in vitro flow-rig consisting of an acrylic tank 46 cm x 64 cm, 8 mm C-flex vessel-mimic (VM) (Cole-Parmer, UK) in a linear geometry, with and without a spiral graft stent in order to produce a single spiral profile (Vascular Flow Technologies, Dundee, UK), 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 1550 m/s. A 25 cm haemodialysis (HD) central venous catheter (CVC) (Cannon II, Long-Term Access) was inserted into the VM and attached to a HD machine ( Fresenius, Germany). Images of flow patterns were acquired using an HDI 5000 ultrasound scanner (ATL Ultrasound, USA). For this part of the experiment (also see poster 1606) a continuous flow was used, with flow rates of 300 ml/min, 450 ml/min and 600 ml/min. 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.

Results

When blood mimic flowed at 330 ml/min through a vessel mimic with a laminar inlet profile, Poiseuille flow was observed. When blood mimic flowed through a vessel mimic with a spiral inlet profile, a flow pattern suggestive of a single spiral flow was observed to propagated 17.5 cm downstream. On insertion of a CVC into the vessel mimic with a spiral inlet profile, single spiral flow was observed to propagated 15 cm downstream of the catheter. Connecting the CVC to a haemodialysis machine and passing blood mimic through the CVC at 320 ml/min destroyed the spiral flow creating a turbulent profile.

Conclusion

This preliminary study has demonstrated that using a spiral inlet profile before a CVC propagates spiral flow in the vessel 15 cm beyond the end of the CVC, in keeping with normal central vein flow which is associated with reduced turbulence. When flow is initiated in the catheter a turbulent pattern is observed, regardless of the inlet profile. These findings may suggest a means of reintroducing normal spiral flow in central veins with a CVC catheter in place in order to reduce turbulence.