Introduction

We evaluated the in vivo performance of a modified ePTFE-based arteriovenous (AV) graft design with potential to reduce thrombosis failures. More than 430,000 End Stage Renal Disease patients in the US depend on hemodialysis to survive. Prosthetic AV grafts represent the safest vascular access option for this 40% of hemodialysis patients who are unable to achieve or sustain the preferred means of functional access via a fistula between natural vessels. An AV graft device that significantly reduces thrombosis failure would provide a more reliable option for these patients.

STAR Biointerface technology (Healionics, Seattle, WA) combines tightly controlled sphere-templated microporosity and macrotexturing to promote a highly vascularized device-tissue interface that prevents the usual formation of a dense fibrotic foreign body capsule (Marshall et al., US Patent 7372422). We hypothesized that applying the technology to the exterior of a vascular graft would improve flow stability by suppressing the mechanical squeezing effect of the perigraft capsule, thereby enabling radial expansion in response to stenotic resistance.

Methods

Control grafts (N = 2) were ePTFE standard 6 mm vascular graft tubing (Vascutek, Scotland) with no radial reinforcement. STAR-treated test grafts (N = 4) were modified by dip-coating the outer surface with MED-2214 silicone to create an adhesive layer, and then adhering a monolayer of ~300-µm size granules of sphere-templated microporous MED-4830 silicone with ~35-µm spherical pores interconnected by ~50-µm interpore openings. Sheep (65-80 kg) were heparinized, and vascular grafts were placed on standard antiplatelet therapy (aspirin, clopidogrel, cilostazol) for these patients. We evaluated the in vivo performance of a modified ePTFE-based AVF graft design with potential to reduce thrombosis failures as depicted schematically as (see sectioning map, left) for ePTFE control (top 2 rows) and STAR-treated ePTFE (bottom 2 rows). Control grafts have visually obvious focal stenosis, but not for controls.

Results

Flow Increased in Response to Hyperplasia.

When a flow-restricting orifice is placed at the outflow of an expandable thin-wall tube (such as the case when a stenotic lesion occurs in a natural artery), it paradoxically causes increased flow under certain conditions (Robardt S. Circulation. 1955; Feb 21(2):180-7). This phenomenon is known as the “negative-resistance effect” because the reduction in flow resistance due to expansion of the arterial lumen upstream from the resistance causes the increase in resistance at the outflow leading to giving a net reduction in the total flow resistance. By preventing formation of the usual mechanically-constructing fibrotic capsule, the STAR-treated grafts appear to harness this favorable self-stabilizing effect.

Conclusions

The results suggest that treating the adventitial surface of ePTFE AV grafts with the microporous textured STAR Biointerface significantly reduces stenosis from neointimal hyperplasia.

Acknowledgments

This research was supported by NIDDK award R43DK103512. Expanded PTFE vascular graft tubing substrates were provided by Vascutek, LTD in Teterboro, NJ. CRO services for the animal study were provided by Surpass, Inc.