Guide Catheter Surface Treatment to Minimize Endovascular Trauma

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Statement of Purpose: Guide Catheters (GC) routinely utilized to access endovascular sites and deliver balloons, stents, coils, and guidewires, and contrast agents, can cause frictional damage to intra-vascular walls as well as initiate thrombus generation. According to previously published studies of gas-plasma-treated catheter materials, catheter-on-catheter friction-lowering qualities associated with increased surface polarities are quite persistent (1,2). The purpose of this investigation was to determine if lowering of GC/vascular wall frictional forces could be achieved while also retaining Critical Surface Tension (CST) values associated with minimal thrombosis (3,4), thus maintaining overall biocompatibility during endovascular treatment.

Methods: A pin-on-disc reciprocating friction/wear device (5) was used to articulate As-Received (AR), Detergent-Washed and distilled water-rinsed (DW), and Gas-Plasma-Treated (PT) Guide Catheter segments against saline-lubricated interior surfaces of longitudinally slit and flattened segments of preserved human umbilical cord vein grafts of known surface properties supporting a 30-year record of blood-compatible performance in peripheral arterial reconstruction (6,7). New Guide Catheters, of 4 different brands (GC A to D), were selected from endovascular supplies of the Toshiba Stroke Research Center (SUNY/Buffalo), and their exterior surfaces characterized by comprehensive contact angle measurements to determine CSTs and surface energies, and MAIR-IR spectroscopy to determine surface chemical compositions (8) in their AR, DW, and PT states prior to Coefficient of Friction (CoF) determinations at normal loads of 30 - 70 g. Gas plasma treatment of detergent-washed catheter samples was done for 2 min in room air, using a Harrick Plasma (Ithaca, NY) device.

Results: MAIR-IR of AR catheter segments revealed three of the four devices were nylon-type polyamide polymers, and the fourth a polyurethane polymer, each catheter with a different type of manufacturer-applied coating that variably transferred to the analytical prism during IR analysis. Three of the AR devices displayed CST values between 20 and 30 mN/m, previously associated with minimal thrombogenicity of angiographic catheters (3,4). CoF varied from approximately 0.4 to nearly 0.6 for AR catheters moving against the saline-lubricated surfaces of vein graft segments. Much lower values for catheters have been sought by others studying lubricious substances (9). DW catheters had relatively low water contact angles in both their AR and DW states, and PT conditions, it had the highest CST in both its AR and PT conditions.

Conclusions: These results support the conclusion that, when both members of an articulating couple are sufficiently polar and hydrophilic to maintain at least a vicinal layer of frank bulk water between them, hydrodynamic lubrication can be sustained for materials that otherwise resist bioadhesion and, thus, minimize tissue damage. Under the conditions reported here, the manufacturer-applied coatings on the 4 representative GC brands (GC A to D) did not produce coefficients of friction as low as the gas-plasma-treated catheters. Treating as-manufactured GC with gas-plasma processes could produce surface zones of intrinsically high polarity, while maintaining thrombo-resistant qualities associated with retained low CSTs.


Acknowledgments: NIH Grants R01 EB002873 and NS43924

Simple increases in hydrophilicity are not sufficient to account for these results, noting that the highest CoF (0.22) for a PT catheter was for GCD. Although GCD had relatively low water contact angles in both its AR and PT conditions, it had the highest CST in both its AR and PT conditions.

CoF values