Guide Catheter Surface Treatment to Minimize Endovascular Trauma

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Background

Guide catheters **[GC]** are routinely utilized to access endovascular sites to deliver balloons, stents, coils, guidewires, and contrast agents. The GC can cause **frictional damage to intra-vascular walls**, and can initiate **thrombosis**. Previously published studies indicate that reduced catheter-on-catheter friction associated with increased surface polarity is quite persistent.[1,2] **The purpose of this investigation was to determine whether reduced friction of GC on vascular wall surfaces could be achieved while also retaining critical surface tension [CST] values associated with minimal thrombosis.**[3,4]

Materials & Surface Characterization

Guide Catheters [GC] – new; 4 different brands from supplies of the Toshiba Stroke Research Center (Univ. Buffalo); designated as GC-A, -B, -C, -D.

Vascular Tissue – preserved human umbilical cord vein grafts with known, blood-compatible surface properties[6,7]

Lubricating Fluid - physiologic saline

GC Surface Characterization – comprehensive contact angle analyses (to determine CSTs, polarities and surface energies) and MAIR spectroscopy (to determine surface chemical compositions)

Catheter Modification

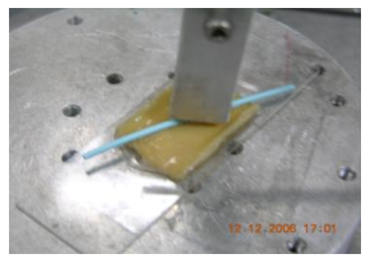
Each of the 4 catheter types (GC-A to –D) was evaluated in 3 conditions:

→ **AR**: as-received
→ **DW**: washed with lab detergent & rinsed with distilled water
→ **PT**: DW'd, then gas-plasma-treated (2min, air, Harrick PDC-32G)

References: **1.** Triolo & Andrade (1983) JBMR 17:129-147. **2.** Triolo & Andrade (1983) JBMR 17:49-165. **3.** Wilner et al. (1978) Circ Res 43:424-428. **4.** Baier (2006) Mater Sci: Med 17:1057-1062. **5.** Meyer et al. (2006) J Adhesion 82:602-627. **6.** Baier et al. (1980) Vasc Surg 14:145-157. **7.** Dardik et al. (2002) J Vasc Surg 35:64-71.

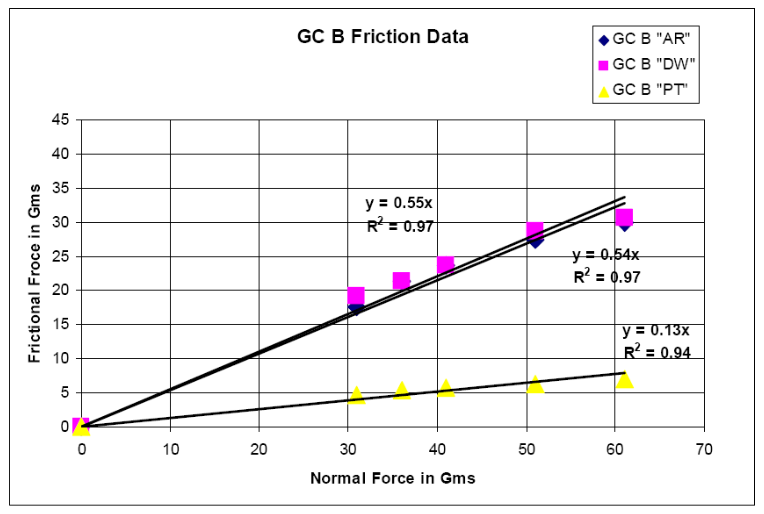
Coefficient of Friction [CoF]

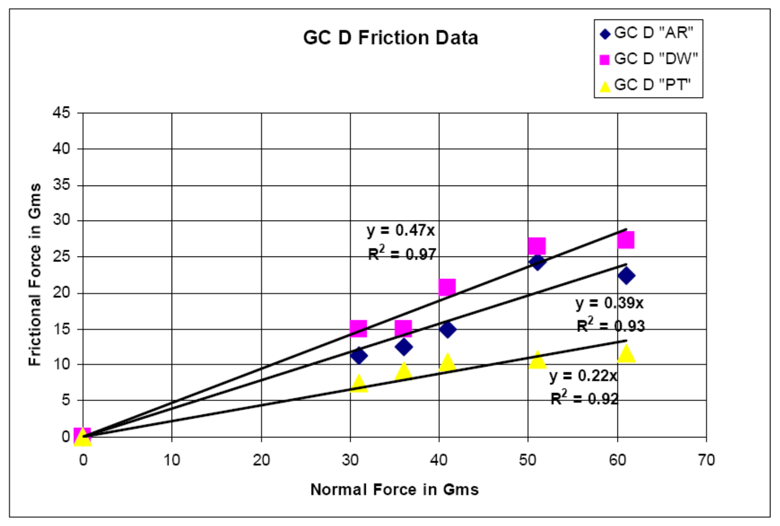
Pin-on-disk friction device[5] – catheter segment held in place on vertical column over saline-lubricated interior surface of vascular graft; graft was fixed to the reciprocating stage of the apparatus



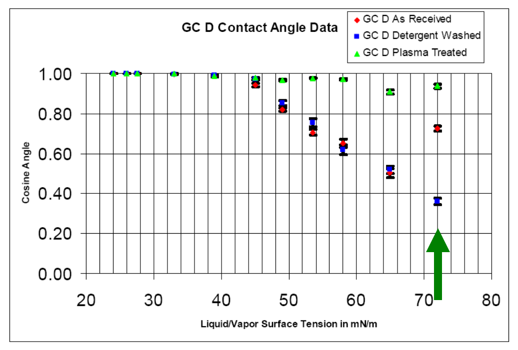
- experimental set-up addresses static CoF, which is relevant to the endovascular use of guide catheters
- device was calibrated with 10 different loads before catheter-on-tissue tests were initiated
- normal loads were placed on the vertical column;

5 different normal loads were used (30-70g)





Catheter Surface Properties

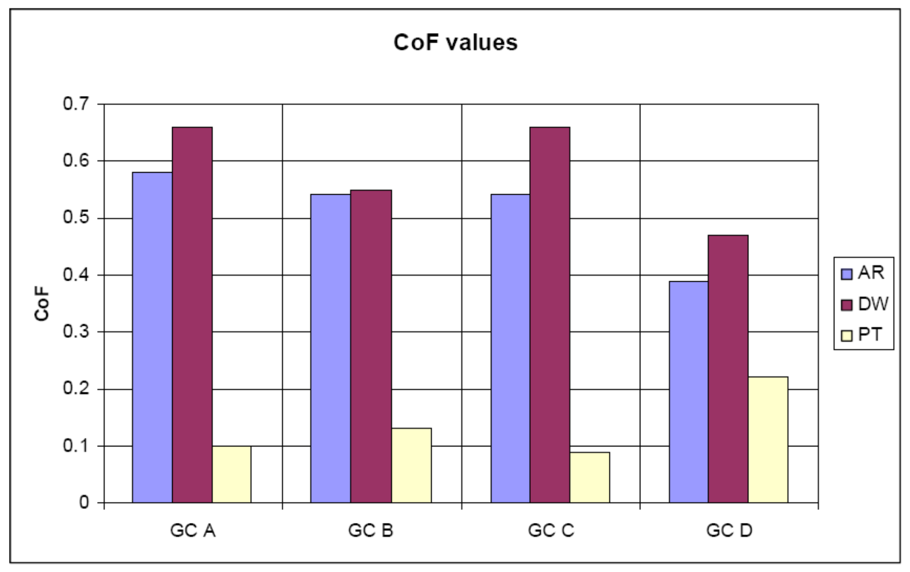


In this example (GC-D), PT & DW treatments changed catheter polarity, as indicated by the water contact angles

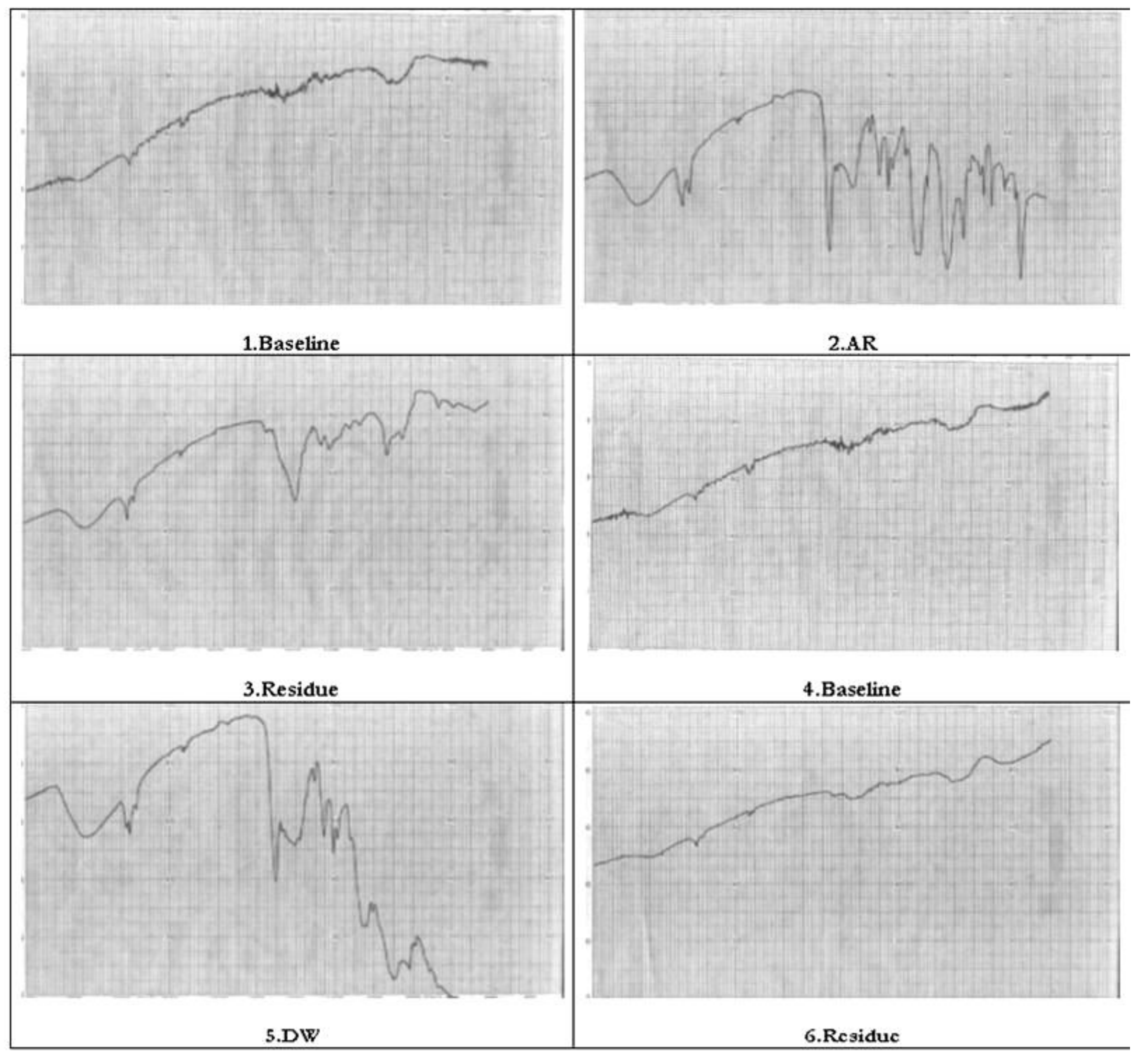
CST [mN/m] **&** *avg water contact angles*			
	AR	**DW**	**PT**
GC-A	**24**, *55*	**24**, *55*	**25**, *25*
GC-B	**25**, *41*	**26**, *69*	**23**, *23*
GC-C	**26**, *63*	**36**, *53*	**30**, *20*
GC-D	**36**, *43*	**37**, *68*	**30**, *19*

Results and Conclusions

- GC-A, -B, and –C had CST values between 20 and 30 mN/m (values previously associated with minimal thrombogenicity[3,4])
- All 4 types of catheters (as-received) had different types of manufacturer-applied coatings that variably transferred to the MAIR test plate during analysis.
- After **DW** treatment, catheters had slightly increased CSTs and water contact angles, providing evidence for partial to complete removal of the manufacturer-applied coatings. MAIR-IR spectra indicated retained hydration in surface zones.
- Each **DW** catheter's CoF was somewhat greater than the value for the **AR** catheter. The CoF of each **PT** catheter was markedly less than the values for the AR and DW catheters.



- **Simple increases in hydrophilicity are not sufficient to account for these results;** the highest **PT** CoF was for GC-D, which had the lowest water contact angle.
- **The manufacturer-applied coatings did not produce CoF as low as the gas-plasma-treated catheters.**
- **Treating as-manufactured GC with gas-plasma could produce surface zones of high polarity -- maintaining thromboresistant qualities while decreasing friction between the catheter and the vascular wall**



Examples of MAIR-IR spectra (GC-B):

1. KRS test plate baseline for spectra #2 & #3
2. GC-B catheter, as-received; polyurethane-based
3. residue on test plate, due to partial transfer of the original coating from the catheter
4. KRS test plate baseline for spectra #5 & #6
5. DW-treated GC-B catheter
6. no significant residue is tranferred from DW GC-B to the test plate [compare with #4]