D31 Redesign of a StepMeter for Direct *In Vivo* Measurement of Barefoot Skin Friction

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After attending this presentation, attendees will understand some of the issues in barefoot tribometric slip-resistance testing, specifically assessment of barefoot slip resistance, and how current research is being conducted to address these issues and improve the biofidelity of these measurements.

This presentation will impact the forensic science community by allowing the collection of a cohort of data on barefoot subjects to characterize the subject-to-subject variation in barefoot pedestrian slip resistance on different surfaces.

Background: Testing of floor-surface slip resistance is routinely conducted using walkway tribometers. These devices use a sample of outsole material to test floor surfaces, either in the laboratory or *in situ*; however, none of these devices operates (or slips) in the manner of a human pedestrian. Approximately 15 years ago, to assess the biofidelity of tribometric floor slip-resistance testing, a custom StepMeter was developed.[1] This device assessed a human subject stepping onto a floor surface wetted with water. The device was later modified to test a seated subject, as that posture provided greater reliability as shown by a steeper logistic-regression curve.[2-4] In 2011, the American Society for Testing and Materials (ASTM) F2508 Standard Practice for Validation and Calibration of Walkway Tribometers Using Reference Surfaces methodology was adopted.[5] The StepMeter was validated using this protocol with a Neolite® Test Liner (NTL) test foot; however, assessment of barefoot slip with this device and the F2508 protocol identified differences between the inert test foot and *in vivo* subjects.[6,7] It is believed that these differences are intrinsic to the *in vivo* foot, but need to modify the StepMeter to be able to collect the range and quantity of *in vivo* data needed to characterize barefoot slip. This presentation will discuss the redesign of the StepMeter.

Figure 1: Seated subject in StepMeter

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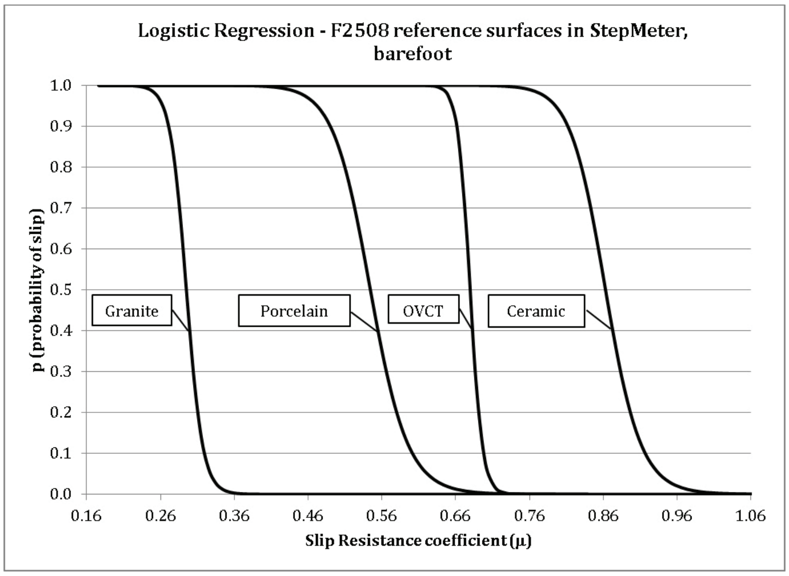

Figure 2: ASTM 2508 StepMeter assessment using logistic regression of a seated barefoot subject.

Redesign: A redesign of the StepMeter was undertaken to achieve two general goals: improving the trial-to-trial repeatability of testing and automating the testing process. To improve the trial-to-trial repeatability of testing, the redesign addressed the following areas: (1) the manner in which the test surface was inclined was re-engineered to allow for greater precision in angular incrementation; (2) the manner in which the test surface was inclined was re-engineered to create a constant "drop" distance; (3) the carriage used to maintain a vertical lower leg was re-engineered to maintain better torsional rigidity; (4) the attachment of the device to the test subject was re-engineered to allow a greater range of test subjects; (5) a system was developed for automatically incrementing the surface inclination between trials; (6) a system was developed to automatically lift the leg to prepare for the next trial; (7) a latch/release mechanism was developed for "dropping" the foot onto the test surface; and, (8) a system to automatically identify and classify a trial as "slip" or "no slip" was developed.

Endpoint: Reliability of a measurement is affected by three factors: (1) the testing apparatus; (2) the tester (the person making the measurements); and, (3) the lability of that which is being measured. It is suspected that this third aspect is paramount for barefoot skin friction; the *in vivo* foot changes with repeated testing, and subject-to-subject differences in the foot, may make ASTM F2508 inapplicable to barefoot slip-resistance characterization. The redesigned StepMeter will allow the collection of a cohort of data on barefoot subjects to characterize the within- and between-subject variation in barefoot pedestrian slip resistance on different surfaces.

Reference(s):

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Walkway Safety, Barefoot Tribometry, StepMetern

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