C52 Prediction of Slip Events During Walking: An Analysis of Utilized Coefficient of Friction and Available Slip Resistance

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After attending this presentation, attendees will understand how measures of available floor slip resistance and peak utilized coefficient of friction (COF) relate to the probability of a slip occurring during walking on a level surface.

This presentation will impact the forensic community and/or humanity by demonstrating that knowledge of an individual's peak utilized COF and the available friction (as measured by the variable incidence tribometer) can be used to predict the probability of a slip event during level walking in young adults. As measures of static coefficient vary across tribometers, the relationships reported in the current study will likely apply to the variable incidence tribometer only. However, other tribometers could be assessed using similar procedures to determine their ability to predict slip probability.

Introduction: A slip is likely to occur when the utilized coefficient of friction (COF_U) of an individual exceeds the available slip resistance of the floor surface. Floor surface slip resistance is commonly measured using a device called a tribometer, but different types of tribometers often yield measurements that do not correlate well with each other. Although several standards have been developed for tribometers that measure static COF, it is unclear to what extent static COF measures can be used to predict the probability of a slip occurring. The purpose of this study was to investigate the relationship between static measures of slip resistance (measured using a variable incidence tribometer) and peak COF_U (as measured from a force plate) on the probability of a slip occurring during level walking.

Methods: Twenty-eight healthy males (mean age = 27.4 ± 4.4 years; mean mass = 86.3 kg) and 24 healthy females (mean age 25.0 ± 2.7 years; mean mass = 63.3 kg) participated in this study. Ground reaction forces (AMTI force plates; 1200 Hz; 4th order, 45 Hz low-pass Butterworth filter) and kinematic data (VICON Motion Analysis, 6cameras, 120 Hz) were recorded simultaneously as subjects walked at a self-selected speed along a 10-meter walkway. All subjects wore Rockport walking shoes and ambulated under conditions of normal and reduced floor surface slip resistance. Subjects were not told during which trial the contaminant (WD-40) would be applied, nor the location of the contaminant application. To ensure safety during testing, subjects wore a fall-arresting body harness attached to an overhead trolley which traversed the length of the walkway. The available slip resistance of the floor surface was measured using a variable incidence tribometer. The ratio of shear to vertical ground reaction forces obtained from the forceplate was used to calculate the COF_U throughout stance for each subject. During weight acceptance, the peak COF_U resulting from a shear force that would contribute to a forward foot slip was identified. To determine the relationship of the observed slip events to the calculated *slip resistance difference* (i.e., the difference between available slip resistance and peak COF_U) logistic regression analysis was performed. A second logistic regression determined the relationship of the observed slip events to knowledge of only the *available slip resistance*.

Results: Fourteen of the original 52 subjects were excluded from final analysis as they either perceived in advance that the surface might be slippery (n=3) or they did not fully step on the force plate where the contaminant had been placed. On the average, the self-selected walking velocity of the remaining 38 participants was 96.6 ± 13.0 m/min, the mean peak COF_U was μ = 0.21 ± .04, and the average available slip resistance was μ = 0.23 ± .04. Fourteen of thirty eight subjects (37%) experienced a heel slip during the trial in which the contaminant was applied. *Slip resistance difference* was a significant predictor of slip outcome (p = 0.004). Overall the model correctly predicted 89.5% of the slip outcomes, and accounted for 48.5% of the variance in slip outcomes (R_L^2 = .485). In the second model generated, *available slip resistance* also significantly predicted slip outcome (p = 0.012). Overall, the second model correctly predicted 78.9% of the slip outcomes, and *2 CA 90089* accounted for 16.2% of the variance in slip outcomes (R_L = .162).

Discussion: The results from this study indicate that the available slip resistance, as measured by the variable incidence tribometer, can accurately predict slip events. Knowledge of the available slip resistance, in combination with an individual's peak COF_U allowed for the greatest accuracy in predicting slip outcome (89.5%). With knowledge of only the available slip resistance, the accuracy of prediction was reduced to 78.9%, over the range of floor surface slip resistance values evaluated in this study (μ = 0.15 to μ = 0.31).

Conclusions: Knowledge of an individual's peak COF_U and the available friction (as measured by the variable incidence tribometer) can be used to predict the probability of a slip event during level walking in young adults. As measures of static coefficient vary across tribometers, the relationships reported in the current study will likely apply to the variable incidence tribometer only. However, other tribometers could be assessed using similar procedures to determine their ability to predict slip probability.

 ** Presenting Author*

Coefficient of Friction, Slip Probability, Variable Incidence Tribometer

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