A Motorized Sliding Sled Apparatus for Measuring the Coefficient of Friction of Human Skin in vivo

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Overview
To describe a new motorized sliding sled apparatus and to compare the effect of two barrier films on skin friction properties.

Methods
The apparatus was constructed for in vivo studies of skin friction (drag) based on DaVinci’s classic sliding sled experiments. The apparatus is proven to be useful in studying the influence of various topically applied products on skin friction properties.

Background
Pressure and shear generally receive the majority of attention in the nursing literature when it comes to treating and preventing pressure ulcers. Pressure is a vertical force exerted by gravity on the body. It is generally expressed at a bony prominence where it compresses soft tissue, causing ischemia and subsequent cell death. Shear is caused by friction and is a horizontal force that acts in concert with pressure to distort tissues and cause narrowing of blood vessels. When sufficient shear is applied, the internal capillaries become inadequate for blood to flow through them. Shear is thought to be up to 10x more destructive than pressure alone because of its ability to cause cell death.1,2

Hydration & Skin Friction
It is well documented that as skin becomes more hydrated the coefficient of friction increases. There is a corresponding increase in skin frictional properties. Thus, skin abrasions from sweating oriper, from cool to warm, can increase the coefficient of friction. Shaving or perspiration leaves a layer of sweat on the skin that is more inelastic and increases the forces of shear and chafing. The skin friction was measured at 25 degrees. The precise angle to which the sled was pushed could have dramatically influence the results, and Amonton’s laws no longer provided an appropriate calibration factors. Each experiment was run at least in triplicate.

Results
Two barrier film products produced very different skin friction results (Figure 4). Product A, a commonly used barrier film, was much lower in friction than Product B, a product known to be much tacking to the touch. Barrier film B was still tacky to the touch two minutes after application. This is evident by an approximately four-fold higher coefficient of friction as it attempts to move across the skin surface. In a second experiment, skin friction measurements were taken from the volar forearm of nine subjects before and two minutes after application of the two barrier films. The results of this experiment (Figure 5) show similar data to the previous experiment. The mean (SD) coefficient of friction for barrier film A was two minutes after application was 1062 ± 644 (p<0.0001). An interesting observation was that barrier film A showed a sudden four-fold increase in skin friction (p<0.0001) increase in skin friction compared to untreated skin, indicating that the clinical effectiveness observed for this product may be related more to protection of the skin from hydration and abrasion forces than to an actual reduction in the coefficient of friction. However, it is clear that compared to barrier film B there is a significant reduction in skin friction.

Conclusions
- A computer-controlled sliding sled apparatus based on DaVinci’s classic sliding sled experiments has been constructed that can compare the effect of topically applied products on skin friction.
- The sliding sled apparatus can be used to compare the effect of topically applied products on the skin.
- Two barrier film products produced very different skin friction results.
- Barrier film A quickly to a relatively smooth, lower friction surface compared to barrier film B.
- Barrier film B remained tacky two minutes after application, resulting in a jerky motion of the sled as it attempts to move across the skin surface.

References
2. Aram Grigoryan, cyberDERM Special Projects Group, Media, PA

Acknowledgments
A motorized sliding sled apparatus was constructed for this project.

Figure 1: Schematic drawing of the sliding sled device showing the center section running parallel to the skin. The device consists of a motorized sled, a computerized data collection system, and a 48 mm length of barrier film. A standard 20 mm at 5.25 mm/sec.

Figure 2: Photograph of the entire sliding sled device with the center section running parallel to the skin friction measurement. The device can measure skin tension and frictional forces of shear and chafing.

Figure 3: The device consisted of two sandwiched aluminum plates with a 3 mm diameter hole in the center section. This allowed for real time measurement of the compression and tension forces of shear and chafing.

Figure 4: Triplicate friction force measurements of the standard 20 mm at 5.25 mm/sec. The coefficient of friction for Product A is lower than Product B and provides a much smoother surface of the volar forearm.

Figure 5: The coefficient of friction was four-fold higher for barrier film A compared to barrier film B after two minutes application.