C21 Assessing the Mechanical Properties of Skin by Indentation Methods

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The goal of this presentation is to discuss the complexities of the mechanical properties of skin relevant to penetration by sharp and blunt weapons. Skin is a complex material that has time dependent properties and the goal of this presentation is to discuss the relevance of these properties to the ability of a weapon to tear and puncture skin.

This presentation will impact the forensic science community by demonstrating to those interested in how weapons penetrate skin, particularly forensic pathologists, but also forensic scientists and engineers that are asked to provide expert opinions on the force required for penetration by weapons.

Stabbing in the United Kingdom with sharp weapons such as knives, glass shards and bottles is a major problem with high numbers of deaths and injuries caused by such crimes. One of the difficulties in understanding the forces required for stabbing is in deconvoluting the effect of the large number of different variables involved (such as weapon geometry, type of stab, type of clothing etc.), for which there is very little data in the scientific literature. Figure 1, for example, shows a glass bottle penetrating a silicone rubber skin simulant. The large elastic deflection of the surface is apparent. The bottle makes contact at a number of points and the large elastic deflection, rigidity of the supporting under layer and viscoelastic response of the rubber are all- important for the penetration force required in this case. The influence of the mechanical properties of skin itself in determining the force required for penetration is discussed. Skin has a complex constitutive behavior and the aim of the work in this paper is to discuss how the mechanical properties of skin vary by using indentation techniques to study the mechanical response. The advantage of modern instrumented indentation techniques is that they allow the load-displacement and time

of an indenter into a material to be continuously monitored and thus the mechanical response of materials can be determined with precision. Additionally, compared to traditional mechanical testing techniques where the specimen preparation and instrument set-up can be complex, instrumented indentation allows a larger number of experiments to be performed and therefore the scatter in the mechanical response to be better established. Skin as a material is viscoelastic, i.e; the properties are time dependent. Also, the mechanical properties of skin can vary with age, location on the body, and levels of hydration. This paper reports on a number of indentation experiments on porcine flesh at different times from death. The experimental methodology has been standardized to ensure repeatability. Additionally, flesh has been tested with differing levels of hydration. The results are compared to the mechanical properties of silicone rubber/foam skin analogues. A number of indenters with both sharp and blunt tip radii have also been tested and the wounds imaged using microscopy techniques to establish whether or not the wounds are of the form of incised wounds or tears.

Figure 1: Complex fracture geometry of a broken glass bottle showing the bottle just out of contact and just in contact with silicone rubber/foam skin simulant. The large elastic deflection of the skin simulant is readily apparent.

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