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Physical analysis of damaged tissue simulant covered with textiles made by sharp knife stabbing

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The magnitudes of force from the knife stabbing into 10% 250 bloom gelatin (tissue simulant) covered with cotton and jean were measured by a force sensor. Two stabbing actions namely underarm and overarm action stabs for long and contact ranges were investigated. The damages on the target from the two actions were compared in terms of the penetrating force during the stabbing and the patterns of cut fiber ends by using Scanning electron microscope (SEM). The results showed that SEM can distinguish sharp or blunt ends of the damaged fabric and is likely to differentiate different degree of the penetrating force during stabbing on the fabric as well. The physical analysis of the damage to the target may provide important information about the stabbing event and also be considered as an example of the integration of physics into forensic science.

Keywords: Knife stabbing, Stabbing Force, Overarm/Underarm action, Tissue simulant, 250 bloom gelatin

1. INTRODUCTION

A stabbing is the homicide cause. "What was the degree of force involved?" and "how the degree of force varied to the depth or width of stab wounding?" are common questions that the police often ask the medical expert to solve the cause harm. These questions are difficult to quantify about the force magnitude for penetration the skin. Generally, Pathologists only describe the value in relative terms that range from mild through moderate and considerable to severe. A mild level of force would typically be associated with penetration of skin and soft tissue whereas moderate force would be required to penetrate cartilage or rib bone [1]. In addition, typical impact velocities were found to be in the range of 8-12 ms^{-1} [2]. A stabbing can be divided in two main situations: 1) witting stabbing such as, in domestic quarrel between husband and wife or in youthful gang and 2) accidentally stabbing such as, one's person protect oneself from the baddy.

When stabbing occurred, forensic scientists are given an opinion about the weapon that the suspect used or damaged patterns on the clothing. The damaged on clothing may provide valuable information relevant to the possible cause and manner of the damage by studying the cut fiber ends using Scanning electron microscope (SEM).

Researchers in this present study attempt to find out whether different magnitudes of force by stabbing causing different damaged patterns on the clothing or not. The result from this study is expected to assist forensic scientists to link the physical analysis of the damage of the target to the stabbing event.

2. EXPERIMENT

Tissue simulant was prepared following the instruction of VYSE gelatin innovation. It is specially formulated to simulate human body tissue density.

Pasco CI-6746 Economy force sensor was used. The sensor is attached with a small aluminum rod which has a slit for holding a 4 inches single blade. This sensor has a measuring range between -50 N and +50 N.

10 right handed female subjects participated in the study. Shoulder and elbow angles were measured from the 10 subjects by using a goniometer. This angular information ensures that all subjects start their stabbing actions with the same postures.

Cotton and jean covering on tissue simulant or the target were stabbed by a knife for two actions namely overarm and underarm actions. This overarm action initiates the long range stabbing while the underarm action initiates the contact range stabbing. The cut fiber ends of the stabbed patterns on cotton and jean were compared in terms of the damaged shapes by different penetrating forces using SEM. Fiber samples were taken from the two different edges of the stabbed target. The stabbed samples were mounted onto SEM stubs with double-sided adhesive tape. The stub was coated with thin layer of carbon and platinum palladium and then viewed on SEM S-2500 Hitachi. Fiber ends were observed on the SEM screen at 700X. Fiber images were presented in a cross section and were recorded on 100 TMAX black&white negative films Kodak professional ISO 100.

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3. RESULTS AND DISCUSSIONS

In this study, the average forces for the contact range and long range were 10N and 50N, respectively.

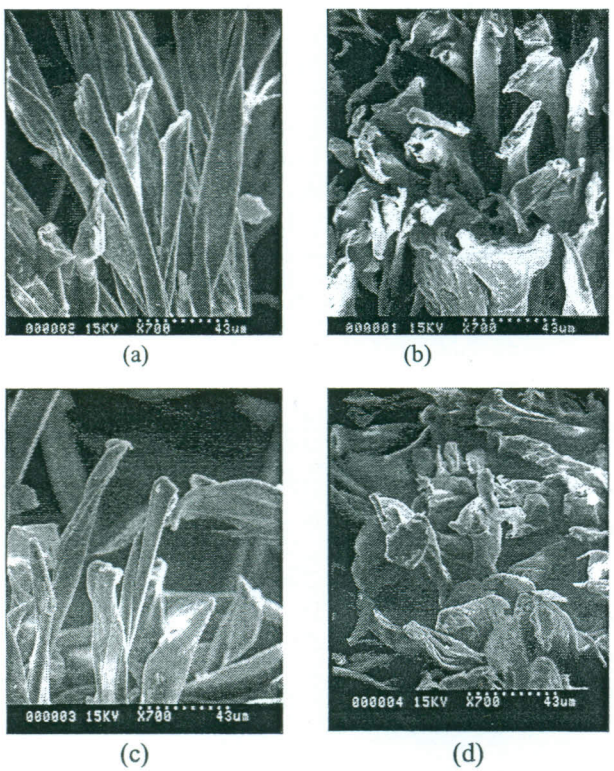
The damaged fiber ends produced by a single-blade knife stabbing appeared differently due to the sharp and blunt edges of the knife.

The SEM micrographs at the same stabbing force (10 N or 50 N) on two damaged clothing clearly showed differences between the sharp and blunt cut fiber ends. The sharp cut fiber ends of jean (Fig 1a,1c) appear smoother than the blunt cut fiber ends(Fig 1b,1d). The fractured and nonuniform fiber ends, showing broken filament or stretched yarns, indicate that the damaged ends caused by the blunt edges of knife.

Table 1: Angular displacement of the shoulder and elbow angle at blade entry

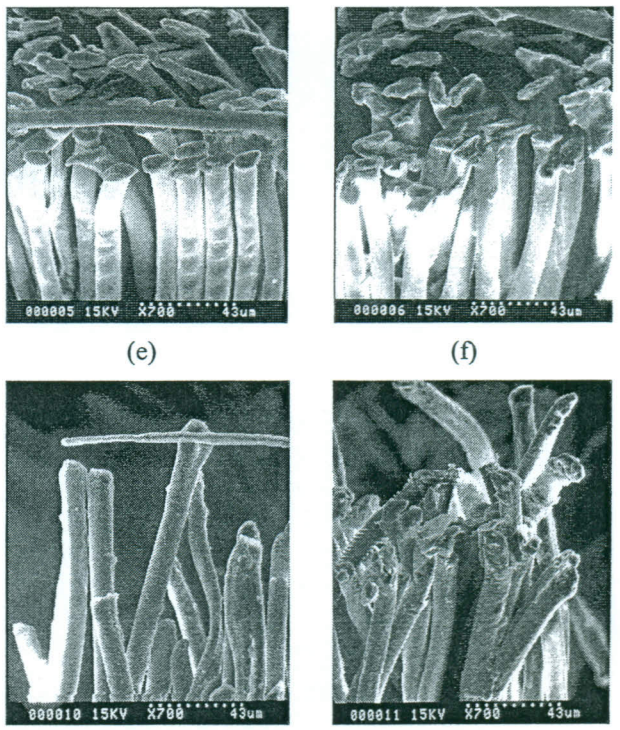
	Long range/ overarm	Long range/ underarm	Contact range/ overarm	Contact range/ underarm
Shoulder(deg)	75	53	86	51
Elbow(deg)	88	138	73	137

For the cotton fiber ends cut by the sharp edge (Fig 1e,1g), smooth ends and stretching of yarns were observed. Rounded or bulb formation could be seen in the blunt cut fiber ends (Fig 1f,1h) for this type of clothing.



(a) (b)

(c) (d)



(e) (f)

(g) (h)

FIGURE 1. SEM micrographs of contact range stabbing on jean with force of 10 N (a,b), long range stabbing on jean with force of 50 N (c,d), contact range stabbing on cotton with force of 10 N (e,f) and long range stabbing on cotton with force of 50 N (g,h).

SEM micrographs of cut fiber ends from 10 N and 50 N stabbing are different as can be seen from (Fig 1a,1c) and Fig (1e,1g). From SEM micrographs, with 10 N contact range stabbing, the fiber ends were stretched and then cut. With 50 N long range stabbing, the fiber ends were snapped leaving no traces of fraying and stretching of yarns. Therefore, SEM micrographs are likely to be used to differentiate magnitude of stabbing forces applied to stabbed targets.

4. CONCLUSION

Scanning electron microscope (SEM) examination can assist and visually confirm the degree of force involved in stabbing.

However, it is recommended to conduct further study on various textiles in order to support the preliminary conclusion in this study.

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