Title: **Victim's posture and protective clothing changes the approach in an edged-weapon attack**

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Diverse groups of people use edged-weapons (i.e. knives, spears, swords) professionally. The training received affects how the edged-weapon is used and the area of the body targeted. There is a growing body of information available on the internet which is aimed at the training individuals in offensive knife attacks. This poster aims to raise awareness of this issue and highlight how a trained individual modifies an attack sequence depending on their victim's posture and the protective clothing worn. A male trained in the Filipino martial arts discipline of Eskrima performed attack techniques on a static mannequin covered with a long sleeved upper body garment and leggings, a police custodian helmet and a HG1 + KR1 police body armour. In some simulated attacks the target was also dressed in a police high-visibility tactical vest on top of the body armour. High-speed video was used to capture each simulated attack and the impact location on the torso recorded using ultra-violet sensitive liquid applied to the weapon. Target posture was modified by adjusting the arm position of the mannequin. In a second series of experiments a PermaGel™ male target torso was used so that penetrating damage could be assessed. Data collected identified the change of attack due to victim's posture and vulnerability of the neck, underarm area and groin.

INTRODUCTION

Knives, typically used by males, are the primary weapon in a large number of offences, and are the major cause of homicide in England and Wales [1-3]. During a domestic attack, a weapon of convenience is typically used (e.g. a kitchen knife), but some cases involve purchase of a specific weapon [4-6]. Injuries sustained during an edged-weapon attack may be classified as stab or slash wounds, and both may occur during a single attack [7]. Clothing may provide a degree of protection to a victim during an attack [8-11]. Police officers often attend such incidents and can become

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victims; they are also vulnerable as potential targets in planned attacks. These officers will be wearing uniforms, body armour and a custodian helmet as a minimum, but also may be wearing tactical vests and outer foul-weather protective clothing.

Diverse groups of people use edged-weapons (i.e. knives, spears, swords) professionally; examples include butchers and meat handlers, soldiers, martial arts practitioners and re-enactors. The training received affects how the edged-weapon is used and the area of the body targeted [12-15]. Historical evidence for edged-weapon use is provided by the archaeological record and written texts. The earliest stone tools and weapons are approximately 2.6 million years old and 1.5 million years old respectively [16, 17]. Numerous books exist that describe edged-weapon usage and can be broadly divided into historical discussions, military tactics, indigenous techniques and martial arts e.g. [12-15, 18, 19]. Within reputable martial arts schools edged-weapon training is generally reserved for people who have reached a certain level of competence (e.g. first level black belt). This ensures that an individual's character and temperament can be assessed and unsuitable candidates excluded from training. No such filter is possible with the range of edged-weapon related materials posted on the internet especially within social media, with respect to someone training alone or in a small group; such methods of knowledge transfer can lead to dangerous techniques and practices.

With increasing evidence of planned attacks and actual incidents of police officers and military personnel being targeted, this work aimed to assess how a victim's posture and wearing of body armour might affect how a trained user of edged-weapons would attack.

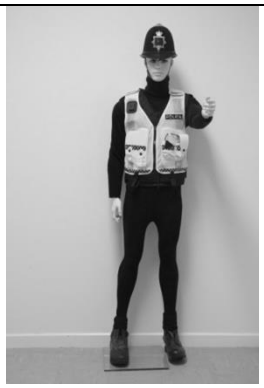
METHODS

Two experimental set-ups were used:

i) A shop mannequin with moveable arms (up and down), neck (side-to-side) and waist (side-to-side) was dressed in leggings, a long sleeved top, a custodian helmet and a HG1 + KR1 body armour (Figure 1). For some tests, a high-visibility tactical jacket was added to the ensemble.
ii) A hollow polymeric, headless, retail display male torso mannequin (height = 865 mm; waist = 760 mm; chest = 915 mm) was used to create a two-part mould (Figure 2). PermaGel™ was cast into the mould to form a complete torso. The PermaGel™ torso was dressed in a HG1 + KR1 body armour with a high-visibility tactical vest was placed over it. This dressed ensemble was attached to a mounting frame using Velcro® straps.

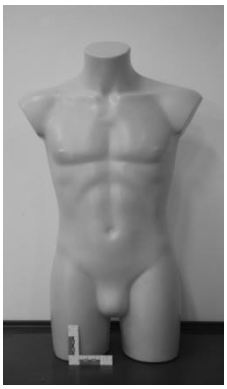
Ethical approval for the study was granted by Cranfield University and the work was conducted on 15th July 2014. A male trained in the Filipino martial arts discipline of Eskrima performed attack techniques on both the dressed mannequin and the dressed PermaGel™ torso. All attacks were filmed using high speed video (Phantom V12).

a) dressed mannequin including body armour



b) one-armed stop position, body armour, high-visibility vest

Figure 1. Dressed mannequin – typical poses and dress conditions.



a) complete mannequin

b) front and back sections of mannequin

c) PermaGel™ torso on frame

Figure 2. Mannequin and PermaGel™ torso.

When attacking the dressed mannequin a training blade was used; this was dosed with ultra-violet sensitive liquid to allow mapping of the targeted areas on the mannequin. Tests were conducted with i) both arms vertically down (i.e. by the side of the body) and ii) one arm raised to 90° (i.e. arm out-stretched in a 'stop' position).

When attacking the dressed PermaGel™ torso, a number of edged-weapons were used and damage caused to the torso and / or protected areas noted. During these attacks the participant wore protective gloves.

RESULTS AND DISCUSSION

Attacks performed on the **dressed mannequin** lasted 0.33 s to 5.05 s and comprised of 1 to 15 distinct impacts. The ultra-violet sensitive liquid allowed impact sites that did not penetrate the dressed mannequin to be identified. High-speed video identified that these impacts were primarily caused by the side of the blade or a point impact and a dragging of the blade.

Scenarios involving arms located vertically by the side of the body typically resulted in impacts to the legs, groin, unprotected torso, face and neck. Scenarios involving a raised arm typically resulted in impacts to the arms, face and neck. Adding body armour resulted in impacts primarily to the neck and groin. Neck and face impacts involved either slashing or a penetrating wound caused by the point of the blade being driven into the mannequin. Typical impacts are illustrated in Figure 3.Whilst the use of the high-visibility jacket framed the body armour, the attacker also noted that it was somewhat distracting when first encountered compared to just the body armour.

The PermaGel™ torso was primarily targeted in the under-arm, groin and neck regions (e.g. Figure 4). The high-visibility tactical vest framed the body armour and high-lighted exposed areas of the body.

CONCLUSIONS

This preliminary study has suggested vulnerabilities when a trained edged-weapon user attacks a person wearing soft body armour. An individual trained in offensive knife techniques will adapt an attack with consideration of protection in order to reach vulnerable anatomy. Further work is recommended to increase awareness of this and offer practical solutions to defeat such attacks.

Figure 3. Dressed mannequin - typical impacts (impact site marked).

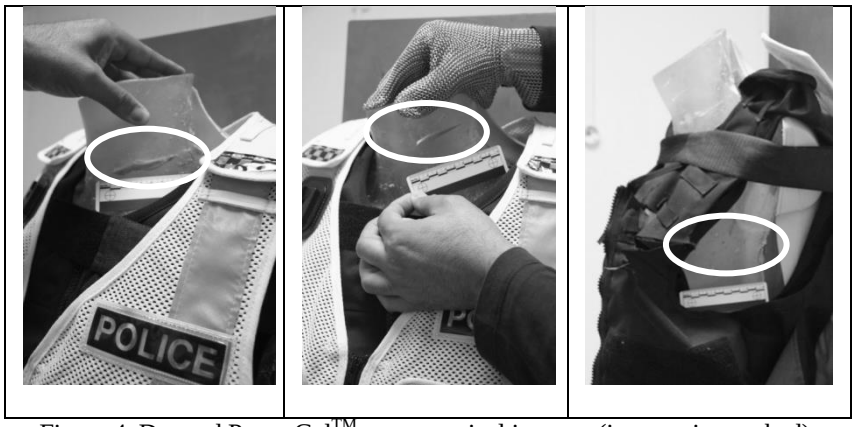


Figure 4. Dressed PermaGel™ torso - typical impacts (impact site marked).

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REFERENCES

[1] Office for National Statistics and Home Office. 2014. "Chapter 2: Homicide, Crime Statistics, Focus on: Violent Crime and Sexual Offences, 2012/13," Office for National Statistics, London.
[2] Hospital Episode Statistics Analysis, Health and Social Care Information Centre. 2013. "Hospital Episode Statistics, Admitted Patient Care, England 2012-13: External Causes," avaliable on-line http://www.hscic.gov.uk (retrieved 20/11/2014).
[3] Office for National Statistics. 2014. "Recorded Offences Involving the use of Weapons. Office for National Statistics," London.
[4] Karlsson T. 1998. "Homicidal and suicidal sharp force fatalities in Stockholm, Sweden: orientation of entrance wounds in stabs gives information in the classification," *Forensic Science International*, 93: 21-32.
[5] Ormstad, K., Karlsson, T., Enkler, L. and Rajs, J. 1986. "Patterns in sharp force fatalities - a comprehensive forensic medical study," *Journal of Forensic Sciences*, 31: 529-542.
[6] Brennan, I.R., Moore, S.C. and Shepherd, J.P. 2009. "Aggression and attitudes to time and risk in weapon-using violent offenders," *Psychiatry Research*, 178: 536-539.
[7] DiMaio, V.J. and DiMaio, D. 2001. "Wounds caused by pointed and sharp-edged weapons," in *Forensic Pathology*, V.J. Geberth (Ed.), second ed., CRC Press, Boca Raton, 187-228.
[8] Ambade, V.N. and Godbole, H.V. 2006. "Comparison of wound patterns in homicide by sharp and blunt force," *Forensic Science International*, 3: 166-70.
[9] Payne-James, J., Jones, R., Karch, J.B. and Manlove J. 2011. "Assessment, classification and documentation of injury," in *Simpson's Forensic Medicine*, 13th edition., CRC Press, Boca Raton, 76-97.
[10] Green, M.A. 1978. "Stab wound dynamics," *Journal of the Forensic Science Society*, 18: 161-3.
[11] Davison, A.M. 2004. "The incised wound," in *Essentials in Autopsy Practice: Recent Advances, Topics and Developments*, G.N. Rutty (Ed.), Springer, London, 2004, 187-220.
[12] Godhania, K. 2010. "Eskrima: Fillipino Martial Art," Crowood Press Limited, Ramsbury, UK.
[13] Loriega, J., Sevillian, S. 1999. "Steel: The Traditional Knife-Fighting Arts of Spain," Paladin Press, Boulder, USA.
[14] Maynard, R. 1986. "Tanto: Japanese Knives and Knife Fighting," Unique Publications, Glastonbury, UK.
[15] Grosz, C. and Janich, M.D. 2006. "Contemporary Knife Targeting," Paladin Press, Colorado, USA.
[16] Semaw, S., Rogers, M.J., Quadec, J., Renned, P.R., Butler, R.F., Dominguez-Rodrigo, M., Stout, D., Hart, W.S., Pickering. T. and Simpson, S.W. 2003. "Million-year-old stone tools and associated bones from OGS-6 and OGS-7, Gona, Afar, Ethiopia," *Journal of Human Evolution*, 45: 169–177.
[17] Scott, G.R. and Gibert, L. 2009. "The oldest hand-axes in Europe," *Nature*, 461: 82-85.

[18] Spierenburg, P. 1988. “Men and Violence: Gender, Honor and Rituals in Modern Europe and America,” Ohio State University Press, Ohio, USA.
[19] Stephens, F.J. and Boxall, M. 1980. “Fighting Knives: An Illustrated Guide to Fighting Knives and Military Survival Weapons of the World,” Arms and Armour Press, London.