## CASE REPORT

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# Testing Conflicting Scenarios—A Role for Simulation Experiments in Damage Analysis of Clothing

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**ABSTRACT:** Damage to clothing is commonly encountered in serious crimes of violence such as homicide and rape. Examination of damage to clothing and other textiles may provide valuable information as to the possible implement that caused the damage and the manner in which it was caused. Damage analysis may corroborate or refute a particular crime scenario.

This report describes two recent cases examined at the Victoria Forensic Science Centre laboratory where opposing views as to the origin of the damage to the clothing of the victim were proposed. The results confirm the value of simulation experiments mimicking each case scenario. They also demonstrate that it may not be possible to unequivocally choose between opposing scenarios because of limitations inherent in damage analysis.

**KEYWORDS:** forensic science, criminalistics, scenarios, simulations experiments, damage, clothing, textiles

### Definitions of terms

**Simulation.** An experiment designed to reconstruct a proposed scenario as accurately as possible.

**Stab-cut.** Cut produced by penetration of an implement through the material.

**Slash-cut.** Cut produced by implement cutting along material.

**Wear and tear.** Damage caused to garments in the course of everyday wear, such as matting of yarn ends and ''pilling.''

**Planar array.** Ends of fibers or yarns line up in the same plane.

Damage to garments may be the crucial factor in cases of homicide and assault, where the basis of the defense is one of ''self-defense,'' or in cases of sexual assault where consent is the issue. Previous literature has shown that it is possible to distinguish a cut from a tear, a stab-cut from a slash-cut and whether the damage was ''recent'' (1). It has also been shown that stab-cut dimensions in clothing do not accurately reflect the knife blade width (2). Few studies, however, have been published associating particular weapons with particular damage or utilizing simulation experiments to include or exclude a particular crime scenario.

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This laboratory examines approximately 20 cases per year where the interpretation of damage has been vital in the investigation, prosecution and/or defense of a crime (3). Comments as to the manner of the damage caused and whether it accords with a crime scenario have been sought by investigators and opinions have been solicited as to whether the scenario provided was feasible.

Generally, cases involve two competing explanations for the cause of the ''evidence'' damage, provided by the prosecution and the defense. Each explanation, or hypothesis, can then be tested to see if it can be falsified, thus following the basis of scientific methodology. In the vast majority of cases one hypothesis is confirmed and the other refuted by the damage examination. However, the following two cases recently examined at our laboratory could not unequivocally discriminate between each proposed hypothesis.

### Case Reports

*Case 1 (4)*

An outdoor barbecue was held and as the evening progressed the party became rowdy and drunken and a dog was stabbed and killed. A fight broke out between two men and one required medical attention. It was alleged the accused stabbed the complainant causing 18 wounds to the body. During the committal the defense claimed that only two of the wounds were due to stabs from the knife, and the remainder were due to rolling on a broken wine bottle. The examining doctor, when cross-examined, could not exclude the possibility these remaining wounds were caused by the bottle. Because it was dark, there were no eyewitnesses prepared to support either story. DNA profiling of bloodstains could not resolve the issue. It thus became important whether the examination of the damage to the clothing could support or refute the defendant's version of events.

The clothing of the complainant, the knife and the broken wine bottle were brought to the laboratory for examination. There was damage detected to a pair of jeans, a singlet (vest) and a T-shirt that was considered distinct from ''hospital''-type damage (the clothing was cut off the complainant by ambulance officers). The knife had a single cutting edge which curved to a point from a maximum width of approximately 2.8 cm. The wine bottle was in two pieces that could be fitted together, although the neck area and rounded base of the bottle were missing.

*Case 2 (5)*

The defendant had an argument with his ex-girlfriend late one night. He picked up a kitchen knife and an incident occurred in

FIG. 1—*Knife from Case 2 with bent blade.*

which the knife became embedded in the victim's right shoulder. Ambulance officers attended and pulled the knife out, so the question of what weapon caused the injury was not an issue. What was contested, however, was how the knife became embedded, as it was alleged that the victim ''blacked-out'' during the incident and consequently could not say what occurred. The defendant claimed he threw the knife at her dog and it accidentally hit her and became embedded. The prosecution alleged he deliberately stabbed her; this went towards intent and the seriousness of the charge.

The upper body clothing consisting of a cardigan (knitted jacket), a shirt and a T-shirt, and the knife, were brought into the laboratory for examination. There was damage detected to the cardigan, the shirt and the T-shirt that was considered distinct from hospital-type damage. The knife was a kitchen-style and had a stainless steel blade with a moderately sharp, serrated single cutting edge. The blade was bent out of alignment at an angle of approximately 10 deg from the plane of the handle (Fig. 1).

## Methods

The damage was first examined macroscopically at the fabric level. The fabric construction and composition were noted, namely, weaves and knits. The degree of ''wear and tear'' in the materials was also described. The damage was then examined microscopically at the yarn and fiber level, using a WILD M650 stereomicroscope varying to $\times 40$ magnification. Points such as planar array and distortion were noted (1,6).

Simulation experiments were initiated to reconstruct the provided scenarios. They were performed in order to assess the particular features produced by a given implement (Case 1), or to determine the manner in which the damage occurred (Case 2).

Following each simulation experiment the damage produced was also examined macroscopically and microscopically. This damage was then compared with the ''evidence'' damage and assessed as to whether it was similar or dissimilar in characteristics.

## Results

### *Case 1*

Information was received from the medical report as to the location of the wounds to the complainant. The minimum number of thrusts to the upper body could be estimated by overlaying the T-shirt and the singlet.

In the first series of experiments the knife and the region of broken glass from the wine bottle that most represented a blade were consecutively thrust into the jeans and the singlet, with the garments loose or under tension. The T-shirt was not considered, as the damage was less informative because of the nature of the knit.

The second series of experiments involved a plastic bag of sand of weight approximating a human body (approximately 50 kg) covered in a purchased singlet similar in style and material to that from the complainant. A wine bottle similar to the ''evidence'' bottle was smashed to simulate the broken pieces. The bag of sand was then pushed and rolled a number of times onto the broken glass. These experiments were performed in order to determine the type of damage produced when a body falls or rolls on broken glass.

The ''evidence'' damage consisted of four stab-type cuts in the upper front left thigh area of the jeans (wearer's perspective Figs. 2 and 3). The right leg portion was not examined due to the extensive presence of what appeared to be mold affecting the appearance of the damage. The singlet was a machine rib knit and was heavily stained with blood. There were eight stab-type cuts and one puncture in the lower front (Fig. 4). There were two stab-type cuts in the center right back (Fig. 5). All of the cuts accorded approximately with the wounds to the body.

In the simulations manual thrusts with the glass produced irregular cuts and punctures with some features of tearing. The knife produced regular and irregular cuts and punctures. It was noted that the ''evidence'' stab-type cuts were neater than any of those produced by the broken glass. In the singlet covering the bag of sand damage consisted of predominantly slash-type cuts with discontinuities or were irregular with puncture-like features (Fig. 6). However, when the severance followed the rib line of the garment, the profile of the simulated damage was straight and mirrored a knife blade cut (Fig. 7). The number of cuts produced in the singlet in any one action was dependent on the number of shards or ''points'' on the bottle that penetrated the garment in that action.

Considering the ''evidence'' damage it was concluded that one cut to the left leg of the jeans, one cut to the back of the singlet

FIG. 2—*Area of damage to upper left leg of the jeans (Case 1).*

FIG. 4—*Cuts and puncture in lower front of singlet (Case 1).*


FIG. 3—*Two of the stab-type cuts in the jeans (Case 1).*

FIG. 5—*Cuts in center back of singlet (Case 1).*

and one cut to the lower front of the singlet were consistent with a stab from a single-bladed knife and it was highly unlikely that glass from the broken wine bottle produced the cuts. The remaining 11 cuts in the three garments may have been caused by either a knife or broken glass, due either to the absence of outstanding characteristics or because the cuts approximated the ''line'' (such as the rib or the warp) of the material.

Because punctures may be caused by a variety of sharp objects, both of the scenarios provided may account for the puncture holes detected to the upper body garments. It was also noted that the broken bottle fragmented further with consecutive thrusts with the sack of sand, and the evidence bottle provided was in two pieces (although some pieces were missing). Thus the number of contacts with the bottle could not be postulated as the number of shards likely to penetrate the garment(s) was unknown.

This evidence was presented uncontested at the trial. Information from the police informant indicated that it was the uncooperative demeanor of the complainant that swayed the jury to acquit the defendant on charges of attempted murder, although 18 stabs from a knife were never proven.

*Case 2*

The first scenario proposed, that of stabbing the right shoulder at close range, is regularly encountered with stab-type injuries so it was not reconstructed.

The second scenario was simulated by purchasing a knife similar to that located in the complainant's shoulder. A pork leg providing a support medium similar to human flesh was strapped to the chest area of a mannequin, over a T-shirt. Information was not provided as to the throwing distance or the method of rotation or throwing of the knife. Consequently the scenario was investigated using varying distances and methods of throwing by two volunteers.

The complainant's cardigan had a combination cut/puncture in the back right shoulder (wearer's perspective). There was an area

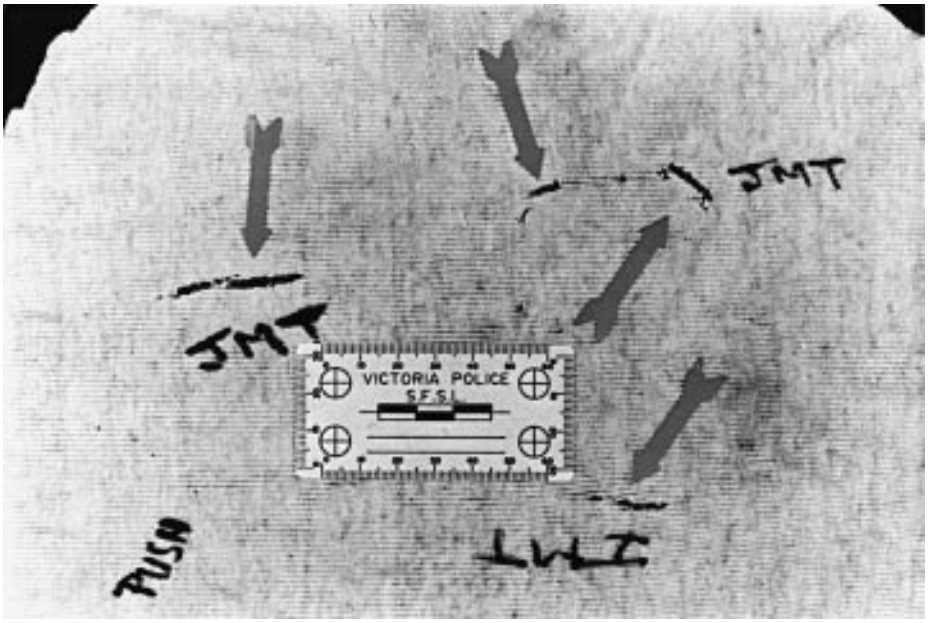


FIG. 6—*Damage produced in singlet covering sack of sand (Case 1).*

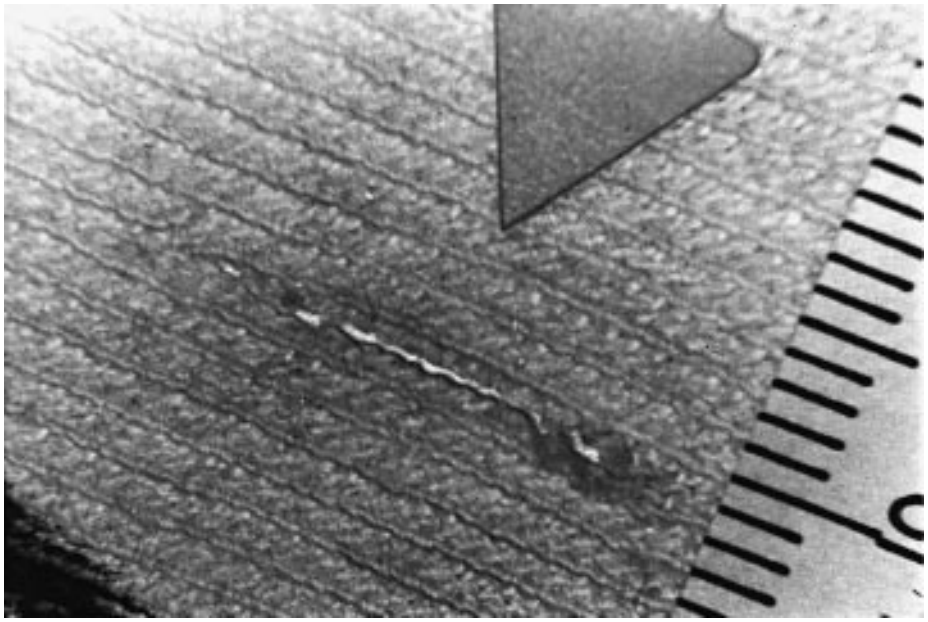

FIG. 7—*Stab from bottle mirroring a knife blade cut (Case 1).*

of damage in the right front shoulder of the shirt which was complicated by ''hospital''-type severances. There was an irregular cut in the right front shoulder of the T-shirt (Fig. 8). Features of this cut were similar to a stab-type cut occurring through ''bunching'' or folds of material in the garment. The areas of ''evidence'' damage described above could be aligned due to the looseness of the knit and style of the cardigan.

When the purchased knife was thrown at the mannequin from a distance it was found that the knife penetrated the pork flesh, the T-shirt and/or the body of the mannequin when thrown by either the handle or the blade, and remained embedded. Features of the damage produced in the T-shirt were similar to stab-type cuts. Consequently, the hypothesis that a knife could be thrown at an individual, remain embedded in the individual, and produce stab-type cuts in the clothing was considered feasible.

The two scenarios were then considered in conjunction with the profile of the knife. The first scenario, that of a stabbing action, accorded with the bent blade of the knife and the penetration through the three layers of the clothing. It was considered unlikely that the blade of the knife could be bent through a throwing action without a stabilizing resisting force on the handle, such as would be provided in a stabbing action; the simulation experiments did not bend the blade. Thus, the first scenario was considered the more feasible. The possibility that the knife was thrown could not be fully excluded: however; the blade may also have been bent upon removal from the body.

The scenario proposed by the defense in this case was initially thought unlikely by knife throwing experts consulted, such as circus managers. ''Throwing'' knives such as those used in circus acts are weighted in the blade for ease of penetration when thrown. As the ''evidence'' knife was not weighted, it was believed it would be unable to penetrate flesh when thrown. However, simulation experiments did not confirm this belief; the knife, in fact, penetrated the hard plastic of the mannequin, or up to 8 cm in depth of the pork flesh. The blade of the evidence knife was bent, however, and it was considered unlikely that the blade could be bent through a throwing action. At the committal (pre-trial) hearing, the accused pleaded guilty to ''recklessly'' cause serious injury. The Public Prosecutor

FIG. 8—*Cut to right front shoulder of T-shirt, Case 2 (surrounding area has been cut by ambulance officers).*

accepted this plea due to the difficulty of proving the defendant ''intentionally'' caused serious injury.

## Discussion

The results of the case studies show that it may be necessary to attempt to simulate a particular scenario if that scenario is included or excluded by the examiner (unless past experience of similar cases deems this unnecessary).

These two cases illustrate the advantages of simulation experiments in damage analysis. Expertise in damage analysis does not necessarily mean that all scenarios have been previously encountered by the examiner. The cases also illustrate the scientific foundation of damage analysis. The essence of scientific method is that one tests all hypotheses by experiment no matter how apparently self-evident. Simulation experiments are those experiments which are designed to test or falsify the proposed scenario, or hypothesis. It should be remembered, however, as shown in these two cases, that it may not always be possible to unequivocally choose one hypothesis (or scenario) over another due to the inherent limitations of damage analysis.

Some cases of damage to clothing involve the proposal of one scenario only. If this scenario is not supported by the simulation experiment, then a confusing number of alternative scenarios may be put forward by any interested party. The examiner may need to list ''impossibilities'' rather than likely scenarios.

The design of the simulation experiment must be carefully considered to ensure that any experiment is meaningful and relevant. It should be noted, however, that there will always be difficulty in attempting to simulate a scenario as accurately as possible. The damage may be governed by a number of variables which are unknown or cannot be replicated—the body weight and type of the individuals involved, their movement, the angle and type of thrust, and position of the clothing. Consequently, care must be exercised in drawing conclusions.

Finally, this study clearly demonstrates the importance of experimentation in damage analysis. A legal expert in Australia has described miscarriages of justice based upon faulty expert evidence (7). Chester Porter states ''. . . there is no substitute for the actual experiment, and far too much expert evidence is given on the basis of theory rather than testing'' (ibid). The dangers of drawing conclusions from textile damage without proper experimentation should be familiar to forensic scientists in Australia through the ''Dingo'' case (6,8). Consequently, the importance of simulation experiments in damage analysis cannot be overstated.

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## References

1. Monahan DL, Harding HW. Damage to clothing—cuts and tears. J Forensic Sci 1990;35:901–12.
2. Costello PA, Lawton ME. Do stab-cuts reflect the weapon which made them? J Forensic Sci Soc 1990;30:89–95.
3. Taupin JM. Damage identification—a method for its analysis and application in cases of violent crime. Proceedings of the 14th Meeting of the IAFS, August 1996, Tokyo, Japan.
4. Queen v Pretty. Supreme Court, Melbourne, Australia. February 1997.
5. Queen v Mason. Magistrates' Court, Melbourne, Australia. April 1997.
6. Morling T. Royal Commission of Inquiry into Chamberlain conviction. Government Printer of the Northern Territory, Darwin, Australia 1987.
7. Porter C. The evidence of experts. Aust J Forensic Sci 1995;27: 53–8.
8. Pelton WR. Distinguishing the cause of textile fiber damage using the scanning electron microscope (SEM). J Forensic Sci 1995; 40(5):874–82.

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