Material evidence

Forensic textile science is becoming increasingly important in providing evidence for criminal cases. Dr Debra Carr of the Impact and Armour Group at Cranfield Defence and Security, UK, describes her latest findings after a recent overseas research trip.

When a crime has been committed, textile products – apparel, ropes and furnishings – are routinely collected as sources of forensic evidence. Despite this, the examination of this type of evidence from a textile science perspective and the consideration of textile damage as evidence is a relatively young discipline. Forensic textile science is a concept that is strongly supported within the Australian Federal Police (AFP) in Canberra, Australia. While fibre identification is well developed, the use of textile damage as supporting evidence is less so.

I first got involved in forensic textile science while working in the Textile and Clothing Sciences Department at The University of Otago in Dunedin, New Zealand, when we were approached by forensic scientists in the country. Dr Michael Taylor from the Institute of Environmental Science and Research (ESR) Christchurch, a major provider of forensic advice to the New Zealand police, initiated a number of research projects regarding the underlying science of damage to fabrics e.g. sharp- and blunt-damage and tearing. These projects, along with completed and ongoing work at Cranfield University in the UK, have established forensic textile science in the international academic forensic literature through a series of journal articles.

Funded by the Winston Churchill Memorial Trust (WCMT) Travelling Fellowship, in September and October last year, I spent five weeks in Australia and New Zealand to learn more about the subject. WCMT Fellowships are awarded to British citizens from various backgrounds for overseas travel, with the aim of bringing back knowledge beneficial to others in their professions and communities. The Trust has sister organisations in Australia and New Zealand, and these were to be the destinations for my research project.

The aim of my Fellowship was threefold:

- to develop international collaborative relationships with key researchers in the area of forensic textile science
- to investigate clothing damaged during alleged sexual assaults
- to conduct SEM of bullet damage to fabrics

The first leg of my trip took me to Australia, where I spent time with leading experts in the use of textile damage as evidence. Here I worked with Professor James Robertson at Canberra University and Dr Jane Hemmings of the AFP – both world experts in textile damage as evidence – and with the mortuary team at The Victorian Institute of Forensic Medicine (VIFM), in Victoria. In Canberra I attended an AFP hair identification workshop, gave a guest lecture, was briefed on how the AFP trains for and conducts textile damage assessment, and discussed several potential collaborative research projects. Of particular interest to the AFP was the work I have conducted on damage to underwear. My time at VIFM provided an insight to how clothing is removed from corpses, packaged and transported to forensic scientists for examination.

Left: Cross-sectional damage through ribs caused by .357 Magnum JSP bullet. **Right:** Bullet on the left is a .357 Magnum and on the right, a 9x19mm FMJ (full metal jacket).

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Next it was on to New Zealand, where my project led me to Professor Jules Kieser at The Sir John Walsh Research Institute, and Liz Grivan at the Otago Centre for Electron Microscopy (both at The University of Otago). Here, my research covered two areas:

- damage to apparel and debris in bony wounds due to gunshot
- characterising damage to underwear during alleged sexual assault incidents

Sexual assault is the most rapidly growing violent crime. In 2010–2011 there were 45,326 serious sexual assaults against adults in England and Wales, a reported 38% increase compared to 2009– 2010 (Home Office, 2011). During an alleged sexual assault or rape, the victim's underwear is usually damaged. Reports have suggested that the frequency of false report of sexual assault or rape is higher than for any other criminal endeavour, and such false claims result in wasted forensic and police resources as well as stigma for the alleged offender. Recreation studies are commonly used to investigate textile damage evidence, where duplicate garments are ripped off dummies and consenting human participants. However, such studies don't provide an estimate of force and nor do they account for human variability. In this work, a laboratory method was developed to measure the force required to rip underwear using a tensile tester. The effect of laundering was considered as a means to mimic the age of garment, and the effect of speed of ripping was used as a measure of violence. While data analysis is currently ongoing, some SEM has been conducted to investigate the effect of laundering and test speed on failure mechanisms.

Bullet damage

Ballistic damage to the clothing of victims with gunshot wounds to the chest can provide useful forensic evidence. Forensic analysis of textile damage might assist in identifying the bullet and hence the type of weapon used, which in turn might aid identification of the attacker. Anyone shot in the torso will usually be wearing clothing that will be damaged by the penetrating impact, which can reportedly be the source of some of the debris in the wound.

Little research had previously been carried out regarding the effect of bullets on apparel fabrics and underlying tissue. The effect of two types of handgun ammunition (a 9x19mm full metal jacket [FMJ]; DM11 A1B2; 8.0g, and a .357 Magnum soft-point flat nose; Remington R357M3; 10.2g) on clothing layers that cover the torso (T-shirt, T-shirt plus hoodie and T-shirt plus denim jacket) and underlying structures – represented by porcine thoracic wall (skin, underlying tissue and ribs) – were investigated, with impacts recorded using a Phantom V12 high-speed camera.

The .357 Magnum rounds were characteristically associated with stellate fabric damage, where fibres were less likely to deform, or 'mushroom'. In contrast, 9x19mm FMJ rounds resulted in punch-out damage to fabric layers, with mushrooming of individual fibres being more common.

Entry wound sizes were similar for both types of ammunition, suggesting that measuring an entry wound cannot be used to confidently predict the ammunition involved. In both cases, entry wounds were smaller than the diameter of the bullet that caused them. However, .357 ammunition resulted in larger exit wounds that mushroomed, due to the construction of the bullet.

Perhaps most interesting is that fabric coverings did not affect the amount of bony debris produced, particularly given there was some evidence that apparel layers affected the size of the wound. Not so surprising given the relative constructions of these two bullets, a greater amount of bony debris was caused by the .357 than the 9x19mm FMJ ammunition. This is of real interest to medical practitioners, because if the bullet type is known, then medics will expect more or less damage.

The intention is to publish both pieces of research later this year. In the meantime, collaborative research is being planned with both the AFP and The University of Otago's Sir John Walsh Research Institute.

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About the Trust

The Winston Churchill Memorial Trust (WCMT), UK, was founded on 25 January 1965 – the day after Sir Winston Churchill died. The aim of the WCMT is to award fourto eight week Travelling Fellowships that 'perpetuate and honour the memory of Sir Winston Churchill', enabling Fellows to bring back knowledge and experiences that benefit their professions and communities. People from all walks of life are encouraged to apply to one of several themes announced each year, with applicants shortlisted for interview. Successful Fellows receive a travel grant for their project, which covers all travel, daily living costs and insurance. Regional Associations of Fellow can offer advice to prospective candidates. For this and more details on how to apply, visit www.wcmt.org.uk

Left: Exit wound in back of ribs caused by a .357 Magnum bullet.