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Cytology in ballistics

An experimental investigation of tissue fragments on full metal jacketed bullets using routine cytological techniques

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Summary. Particulate matter on bullets may be used to decide which target they have passed through, and tissue fragments are the obvious candidates for study. In order to determine if recognizable tissue fragments could be found on full metal jacketed bullets, 44 such bullets were fired against anesthetized pigs and 36 were recovered. On 4 bullets fragments of tissue could be identified by routine cytological techniques. The procedure should be attempted in selected cases where it is imperative to know if a bullet has passed through tissue.

Key words: Ballistics – Cytology – Tissue identification – Full metal jacketed bullets

Zusammenfassung. Partikel auf Geschossen können benutzt werden, um festzustellen, welche Gegenstände sie passiert haben; Gewebsfragmente sind hierfür besonders geeignet. Um festzustellen, ob wiedererkennbare Gewebsfragmente auf Vollmantelgeschossen zu finden sind, wurden 44 Geschosse gegen betäubte Schweine abgefeuert. Auf 4 von den wiedergefundnen 36 Geschosse wurden Gewebsfragmente gefunden, die durch gewöhnliche cytologische Metoden identifiziert werden konnten. In ausgewählten Fällen, in welchen es von äusserster Wichtigkeit ist zu beweisen, daß ein Geschoß ein Gewebe durchdrungen hat, sollte der Versuch des Nachweises angestellt werden.

Schlüsselwörter: Ballistik – Cytologie – Gewebe-Identifikation – Vollmantelgeschosse

Introduction

The presence of particles embedded in or adhering to the surface of bullets may give the forensic scientist an indication of which material the bullet has passed through. This has been reported using scanning electron microscopy (di Maio et al. 1987), and recently cytology has been proposed in the search for tissue fragments (Nichols and Sens 1990, 1991). Since the reports previously published deal with the US scene where expanding bullets are the norm, these results could not be expected a priori to be applicable to the types of bullets commonly seen in Europe, where the full metal jacketed (FMJ), military type bullet dominates. It was therefore decided to investigate experimentally if tissue remnants could be found on FMJ bullets.

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Material and methods

The semi-annual operation exercise at the Defense Training Centre was chosen to supply the set-up for the investigation. This exercise trains national service doctors, who may have very little practical surgical experience, in the basics of the treatment of gunshot wounds. The doctors operate on anaesthetized pigs, which have been shot with different weapons – all military. The exercise itself, or a similar set-up using recently sacrificed pigs, has been used by the author on previous occasions (Knudsen 1988; Knudsen et al. 1990).

In this investigation the exercise was not interfered with in any way, since the object of interest was the bullets after they had passed through the animals. Such exercises with experimental animals are conducted according to the rules laid down by the Ministry of Justice. The animals are looked after by civilian and military veterinarians, a civilian veterinarian from the University of Copenhagen holding the authorization for the use of the animals. He constantly supervises the proceedings and completely controls everything in connection with the animals.

All 17 animals used in the 2 days of exercise were used for the investigation. The animals were anaesthetized according to the standard regimen for the exercise. Having been sedated, an ear vein is cannulated and anaesthesia induced by administration of azopromazine and pentobarbital sodium intravenously, and an endotracheal tube is inserted. The anaesthesia is maintained by intravenous infusion of pentobarbital sodium, ketamine, atropine or diazepam as required. The pigs are intubated and suspended head down to minimize the risk of airway obstruction and shot as quickly as possible. The range is 10 metres, and the animals are shot in each thigh and in the abdomen.

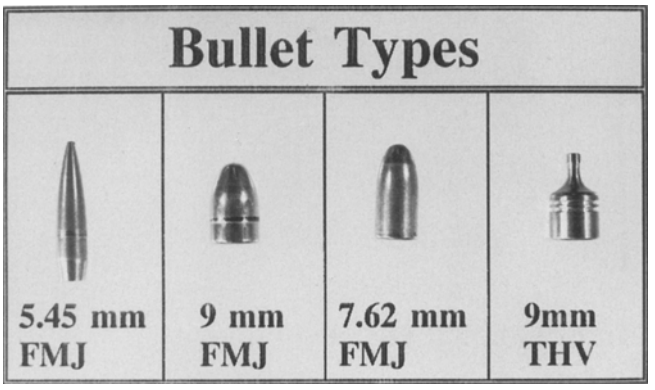

Fig. 1. The bullets used in the experiment

The weapons used were 3 representatives of the types of military weapons that may be met in action. The SIG P210, with a muzzle velocity of approx. 350 m/sec, is a conventional 9 mm × 19 semi-automatic pistol, while as a modern high velocity rifle the 5.45 mm × 39 AK-74 Kalashnikov assault rifle of Soviet design and Chinese license manufacture having a muzzle velocity of 900 m/sec were used. These 2 weapons were used to shoot in the thighs. The shot in the left side of the abdomen at the level of the phrenico-costal recess and the spleen was inflicted by a 7.62 mm M1 Carbine (US Carbine), which is a medium velocity weapon with a muzzle velocity of approx. 600 m/sec.

The ammunition used was that which is regularly supplied for the weapons, FMJ bullets of conventional design, additionally two 9 mm THV bullets (Knudsen 1988) were also used for comparative purposes (Fig. 1).

The velocities of the bullets were measured with photoelectric equipment conforming to NATO STANAG 4114 (TERMA Elektronik: EV 100 Photocell Transducer System and CC 850 Velocity Analyzer) placed midway between the weapon and the suspended animal.

A bullet trap consisting of a loose curtain was placed 1 m behind the animal. The curtain consisted of a Robtex Spall Liner (ROBLON Ltd., DK 9900 Frederikshavn, Denmark), a rubber membrane provided by LINATEX Ltd., DK 2450 Copenhagen SV, Denmark and 2 plates of ballistic protection material (Robguard Hard Armour, ROBLON Ltd.). Bullets that penetrated all layers of the bullet trap and which had enough energy left to penetrate the wooden wall of the shooting range, which has been constructed to avoid ricochets, were lost to the investigation.

The bullets were collected from the ballistic protection material or from the floor using a pair of plastic pincers. Some had to be extracted forcibly from the material, but touching the bullets by hand was avoided at all costs. The bullets were placed in test tubes containing 50% ethyl alcohol in water, the routine fixative in the cytology laboratory of the Institute. After fixation the bullets were agitated mechanically in the test tubes to loosen all particles adherent to them.

The bullets were then removed and the fluid centrifuged at 2000 rpm for 10 minutes. The supernatant was removed except for 2 ml, which was divided in two aliquots. One aliquot was further divided into two portions, which were centrifuged at 1000 rpm in a Shandon Cytospin Cytocentrifuge and stained with May-Grünwald-Giemsa and Papanicolaou. The precipitate from the other aliquot was distributed on 2 plain slides and stained likewise, while the rest was processed through a Milipore®-filter and stained with Papanicolaou. All the preparations were investigated, not knowing which weapon had been used for the particular specimen.

Results

Of the 44 bullets fired, 36 were recovered (Fig. 2) and 5 preparations from each were investigated. The bullets were deformed to varying degrees, some slightly, some were fragmented, and a 5.45 mm bullet had shed its jacket, which was found on the floor, while the steel core was found embedded in one of the plates. The damage to the bullets was similar to what can be expected from bullets recovered by the police in actual case situations. In all preparations numerous foreign bodies and anuclear squamous epithelial cells were found. Since the latter might represent contamination they were not considered indicative of the bullet having passed through tissue. In 4 plain slides – 2 FMJ bullets from the 9 mm P210, 1 FMJ bullet from the 5.45 mm AK-74 and 1 THV bullet from the 9 mm P210 – tissue fragments containing identifiable vital nuclei were found (Figs. 3–6), while the Cytospin and the

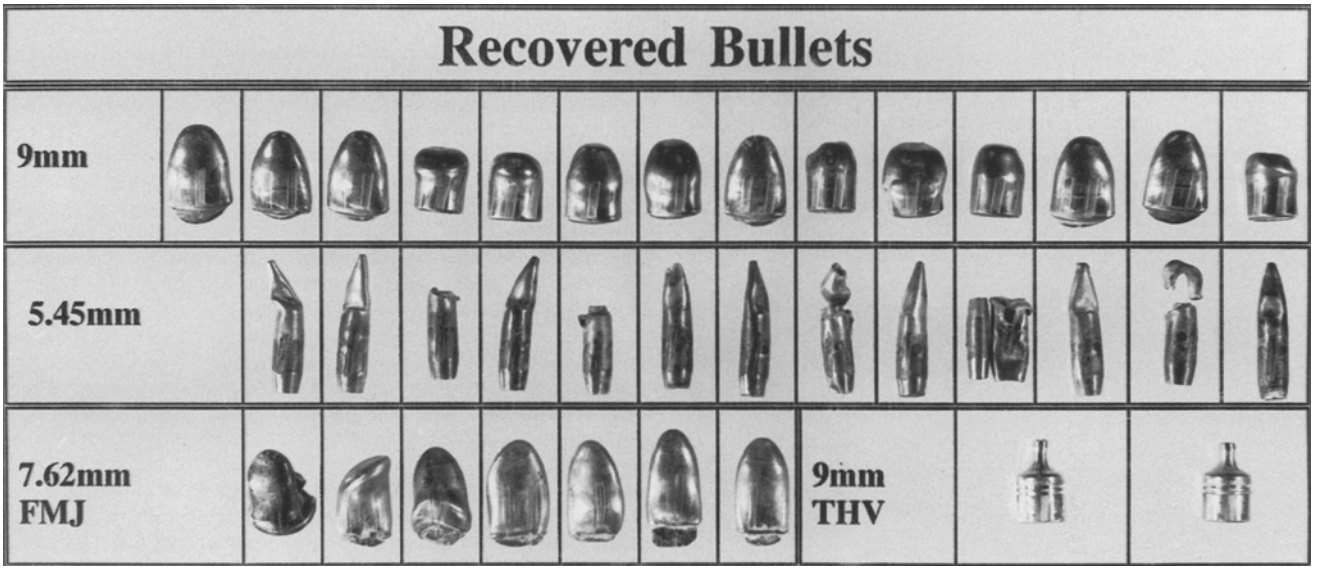

Fig. 2. The recovered bullets

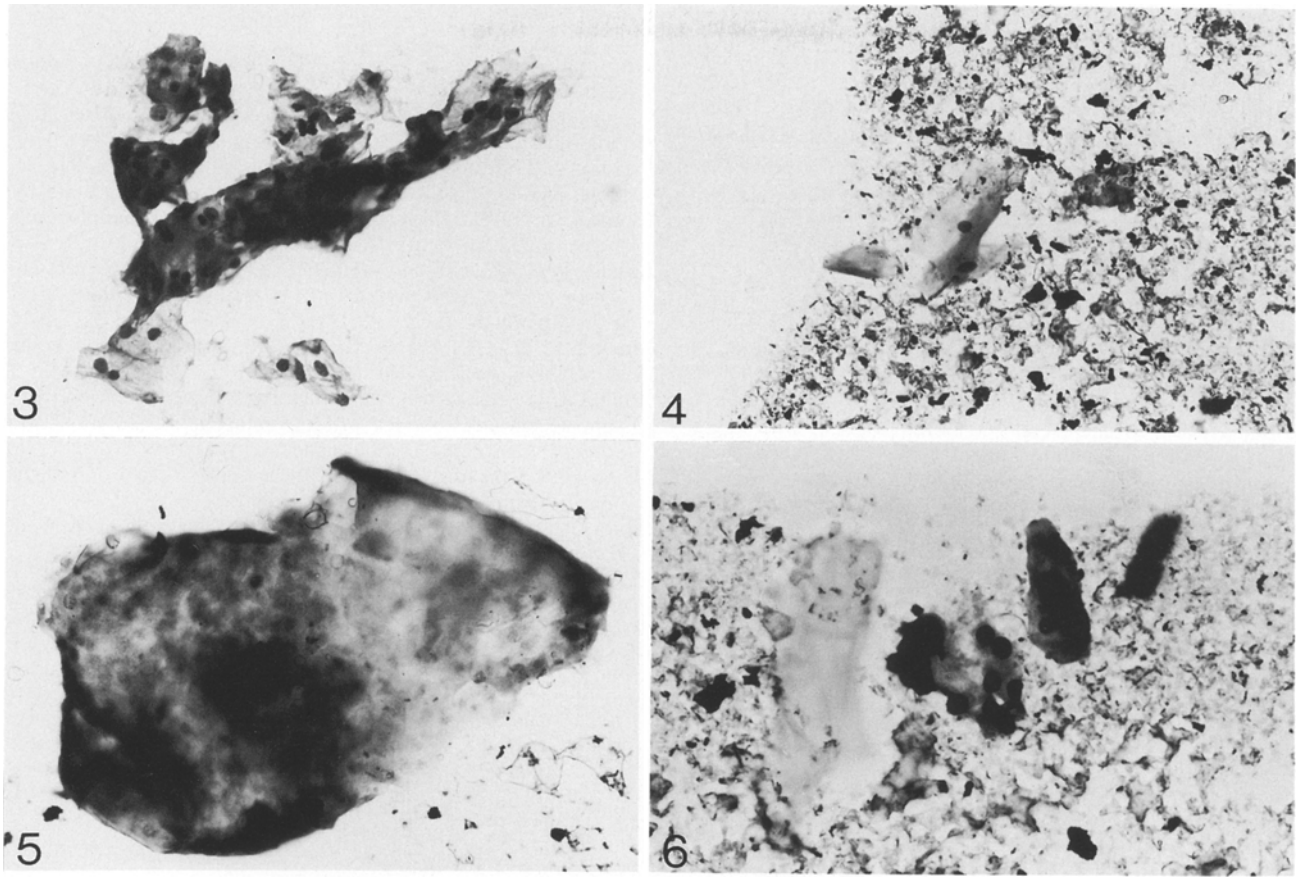

Fig. 3. Sheet of squamous epithelial cells from a 9 mm FMJ bullet. Papanicolaou ×200

Fig. 4. Two squamous epithelial cells from a 9 mm FMJ bullet. May-Grünwald-Giemsa ×200

Fig. 5. Fragment of intensely basophilic material from a 9 mm THV bullet, possibly articular tissue. May-Grünwald-Giemsa ×250

Fig. 6. Cluster of cells from a 5.45 mm FMJ bullet, presumably hematopoietic cells from bone marrow. Papanicolaou ×475

Milli-pore preparations were negative. The slides of the 4 bullets in which identifiable fragments were found contained in one case a large fragment of coherent squamous epithelial cells (Fig. 3) and in another case 2 well preserved squamous epithelial cells (Fig. 4). In one of the other 2 slides a large fragment of tissue, suggestive of articular tissue was seen (Fig. 5) and in the other a small cluster of cells that may well have been from bone marrow (hematopoietic cells) was found (Fig. 6).

Discussion

To look for trace material on bullets is not a new idea, and various methods have been employed (di Maio et al. 1987; Mitchell 1982; Smith and Harruff 1988). The usefulness of a method that identifies tissue on bullets is probably obvious to forensic scientists. A situation which might exemplify this is an incident when both a criminal and law enforcement officers have fired shots, and the decision to persecute depends upon which projectile hit the victim. The forensic scientist can identify which bullet was fired from which weapon comparatively easily, and which bullet had tissue on it will decide the case.

It was therefore interesting to see the reports that the identification of tissue on bullets was possible (Nichols and Sens 1990, 1991). There is, however, a very important difference between the case illustrated by Nichols and Sens of a .357 bullet found at the scene, and the bullets encountered in this part of the world. In the USA expanding bullets are the norm among law enforcement officers and criminals alike, while in Europe most bullets encountered are of the military, FMJ type. These bullets will, under most conditions, remain intact with the possible exception of certain high velocity rifle bullets (Fackler 1989) and hunting ammunition, which are also deforming or expanding types used in Europe. Since the FMJ bullets will keep their smooth exterior as they pass through the victim, there are few irregularities that can collect the tissue fragments, as is the case with expanding bullets.

The object of this investigation was to find out if a technique similar to that of Nicholas and Sens could be used here. It was to be expected that the tissue fragments would probably be very scant indeed, and this turned out to be the case. Squames which might come from the surface epithelium could not be used to provide evidence of the perforation of the victim; it would be necessary to demonstrate vital tissue. Only tiny fragments of unquestionably

vital tissue were found, but those found were of a size and an appearance that made it reasonable to assume that they had originated from the animal.

In order to be completely sure that the fragments are from one identifiable person, one might investigate if identification on the basis of DNA-fingerprinting would be feasible.

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