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Technical Note

Comparison of three bullet recovery systems

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ABSTRACT

Comparing the marks left on questioned bullets to those left on reference bullets is the main aim of a firearm identification expertise. Thus, producing reference bullets with a questioned firearm is an essential step. Different kinds of system have been developed to safely recover bullets fired from questioned firearms. However, the performance of each system and its impact on traces left on the bullets have not been addressed.

Three bullet recovery systems – a horizontal water tank, a cotton tube and a recently designed fleece – were used to fire seven types of ammunition of various type, shape and casing. The bullets were then described and images of their surface were acquired with an automatic system to study the impact of each system on the bullets.

The water tank is the more efficient system in terms of quality of the marks. However, it cannot be used to fire every type of ammunition. Some of them, such those used by law enforcement, tend to be damaged with this system. A way to mitigate the problem is to use the cotton or the fleece-based systems, the latter being more universal. It requires a cleaning step to remove all the fibres from the surface of the bullet, but the marks left by the weapon are still of interest.

1. Introduction

When firearms are involved in a forensic context, the identification of the firearm is usually among the main questions to address. Thus, if a questioned bullet is found on a crime scene and a questioned firearm seized – either on the scene or through the following investigation – the next step is to obtain reference material. A test-firing process in controlled conditions is then conducted by discharging the questioned firearm using an ammunition sharing ideally the characteristics of the questioned bullet (i.e. brand, model, weight, casing). Such tests necessarily involve bullet recovery systems. They are devices designed to stop the reference bullets without causing them any damage that might deter the marks examination.

Literature about bullet recovery systems mostly consists in short articles published in specialized journals such as the Association of Firearms and Toolmarks Examiners Journal (AFTE Journal). Some references may also be found in more general forensic related journals. A review of these publications shows that water tank is a very common system to recover test fired bullets. However, these tanks are usually expensive custom-made devices, made by steel factory on request of police forces [1,2]. Homemade adjustments are often required to achieve the goal of police forces [3]. In general, water tanks are very useful for small calibres. Larger versions suitable for higher calibres have been developed [4], however the larger the tank the more expensive it is [5]. Vertical versions are also used, implying adjustments [6,7]. The use of a polymer water tank, less expensive, has also been reported [8].

Alternatively, systems devised to recover bullets using cotton are also regularly used. The cotton is sometimes soaked in water [9,10] or alternated with Kevlar® to slow down the bullets [11]. Although the systems based on cotton might be easily transportable [12], they are limited to small calibres and precautions are needed to avoid the cotton catching fire. Anecdotal systems are also mentioned in the specialized literature, such as mix of water, sawdust and cotton [13] or water and cornstarch [14]. Earlier references shows that a lot of tests were performed before water tanks became common [15].

This literature review shows that a variety of techniques are regularly shared by practitioners through specialized journals. However, despite all the adjustments to improve the devices, the publications scarcely address the comparison of different systems, nor the effects on the quality of the traces usually left by the questioned weapon.

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Table 1
Specificities of the ammunition and firearms used for each test.

Test	Calibre	Ammunition	Firearm
1	.22 Long Rifle	Remington, solid point (40 gr)	Colt conversion unit
2	.22 Long Rifle	Remington, hollow point (40 gr)	
3	9 mm Luger	Geco, FMJ tombac (124 gr)	Beretta 92 FS
4	9 mm Luger	Winchester, SXT 9 hollow point (147 gr)	
5	9 mm Luger	MEN, QD-PEP II/s (91 gr)	
6	9 mm Luger	GECO RUAG, Action 4 Sintox forensis (94 gr)	
7	.357 Magnum	Remington, lead flat nose (158 gr)	Colt Python
8	.45 ACP	Magtech, FMC (230 gr)	Colt 1911

The purpose of this study is to compare the performance of three bullets recovery systems. The general aspect of test-fired bullets will be taken into consideration and the influence of each system on the striation left by the barrel will also be explored. Among the tested systems, two are commonly used in practice – water tank and cotton – and the third one is a novel system recently developed.

2. Methodology

Seven types of ammunition were discharged and stopped with three different bullet recovery systems. Table 1 summarizes the detailed information of the material. The first recovery system consists in layers of synthetic non-flammable[1] fleece developed by Rubinum Engineering GmbH. The second system is a rectangular horizontal water tank (dimensions: $1.85 \times 1.20 \times .80$ m filled with .9 cubic meter of water) which cannot be used to discharge shoulder weapons firing high initial velocity projectiles. The last one is made of four card boxes filled with cotton, forming a 2 m canal.

For reproducibility purposes, three rounds were fired per type of ammunition with each recovery system. For a given ammunition and recovery system, no discrepancy was noted between each of the three rounds. Thus, only one bullet per ammunition and system was subsequently selected, photographed and described to document its general aspect.

The bullet surface was then scanned with the Evofinder® system (ScannBI Technology Europe GmbH, version 6.3.0.152) to study visually the influence of the recovery system in terms of traces left by the weapon used.

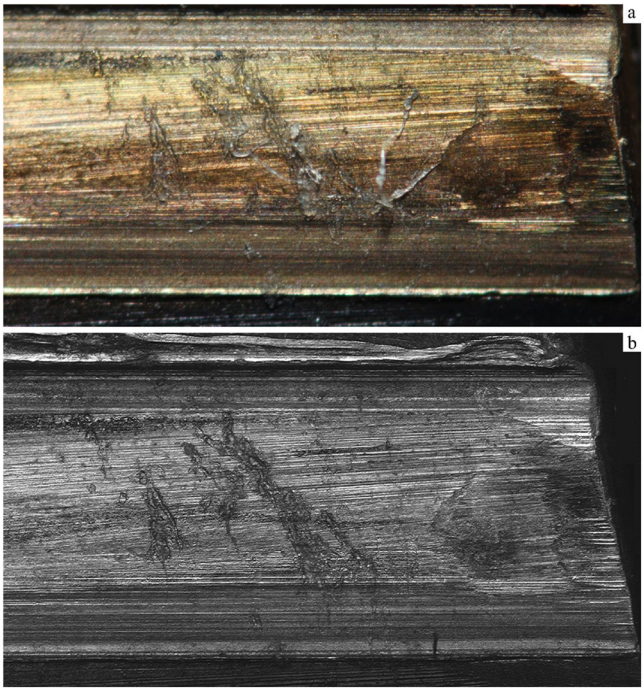

Fig. 1. Fibres in a land impression (a) observed under a comparison macroscope and (b) scanned with the Evofinder® system.

3. Results

3.1. Cleaning process

The bullet is necessarily heated due to the firing process, causing the cotton or the fleece to melt and adhere to the surface of the bullet. As illustrated in Fig. 1a, fibres adhering to the surface might interfere with the examination of traces of interest, especially the individual characteristics of these traces. Images produced with an automatic system such as the Evofinder® also shows affected areas, which might be mistaken for damages to the bullet surface (see Fig. 1b). Consequently, a cleaning step is mandatory when recovering bullets with these systems.

Even if the larger fibres can be removed with a regular cotton tip, the smaller particles are strongly caught in the asperities of the bullet's surface. Thus, the use of an ultrasonic bath is recommended to clean effectively the bullets from the fibres that might deter further examination of the traces left by the firearm. However, precautions need to be taken regarding the time of exposure to avoid detrimental effects [16]. In this study, the ultrasound bath was used for less than 2 min with the .22 Long Rifle calibre bullets (tests 1 and 2) and less than 10 min for the other bullets (tests 3–6 and 8). The cleaning was not necessary for .357 Magnum lead bullets (test 7) since the fibres were not caught on the surface as they were with plated or cased bullets.

3.2. General description of the bullets

Fig. 2 shows the general aspect of a bullet per type of recovery system and ammunition.

Plated .22 Long Rifle round bullets (test 1) are recovered without any general damage when fired in a water tank. On the contrary, hollow point .22 Long Rifle bullets (test 2) will expand in water. The plated coating is also damaged through the process, which may deter further examination of the marks left by the barrel.

Generally, whatever the system used, FMJ bullets (tests 3 and 8) are less damaged than the other types of bullet when recovered. Except from the typical mark on the top of the bullet due to the

[1] According to the Deutches Institut für Normung standards. Testing of combustible materials, response to ignition by a small flame: K1 result for edge ignition test (DIN 53438-2) and F1 result for surface ignition test (DIN 53438-3).