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TECHNICAL NOTE

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Gunshot Residue Deposits on the Gas Pistons of Assault Rifles

ABSTRACT: A novel technique is presented to determine whether certain assault rifles using gas-cycling have been fired since their last cleaning. The presence of soot on the head of the gas piston of a weapon allows an examiner to make an estimate of how many times a particular firearm was fired. This is an important observation, as the cleaning of this element is essential to achieve a good operation of the firearm and hence is part of the daily military maintenance. This result is valid for different types of ammunition. The quantity of gun shot residue increases linearly with the number of shots.

KEYWORDS: forensic science, firearm investigation, gun shot residues, number of discharges

A frequently asked question in forensic science is whether a firearm has been fired within a well-specified time frame. The use of a firearm within a time period can give an indication of its involvement in a specific crime to criminal investigators if no bullets or spent cases were recovered from the crime scene or when they lack sufficient individual characteristics for firearm identification. Recently, Jan Andrasko and co-workers (1–3) developed a technique capable of determining the time lapse since the last firing of a weapon or a cartridge case. Due to its recent and time-consuming application to firearms investigation, this technique based on solid-phase micro-extraction sampling is only applied in a few laboratories.

Recently, we were asked whether several FNC assault rifles were fired within a specified time period, during which they were reported missing from the army. In a first approach, the firearms were subjected to a visual examination, which revealed the presence of a small amount of gunshot residue in the barrels of the firearms as well as copper traces in the chambers and on the breech faces of the firearms. During repeated test firing and cleaning of these weapons, no substantial difference in these quantities could be observed to draw a conclusion on the use of the firearms. This initial approach turned out to be inconclusive.

The FNC is a gas-operated, magazine fed shoulder weapon of caliber 5,56 × 45 mm NATO, which delivers both semi-automatic and automatic fire through a selective control. It is manufactured by Fabrique Nationale in Herstal (Belgium) and is in use in a number of countries. For a good operation of the gas reloading mechanism, a well maintained gas tube and piston is essential. The cleaning of these elements is performed by a small tool furnished by the manufacturer and is an essential part of the daily maintenance of the firearm.(4) For military firearms which are not in actual use, we can expect these parts of the weapon to be in clean condition.

In this paper, we examine the deposits on the head of the gas piston of a FNC assault rifle and show that they can be used to determine whether a firearm has been fired, and to provide an estimate of the number of shots fired by this firearm.

Technical details

The examined firearms were six FNC assault rifles of which four were Model III and two were Model II. When firing a cartridge, the bullet passes through the bore uncovering the gas port. A portion of the expanding gas pressure is allowed to enter the gas tube and hits the central area of the head of the gas piston. This pressure pushes the gas piston towards the rear. In this type of firearm, the gas piston is integrated within the breech block. As the breech block moves backward, the spent cartridge case is ejected and a spring is compressed, which slows down its movement. When returning to its initial position, a new cartridge is loaded into the chamber of the firearm and the firing pin is armed.

The gas, which enters the gas cylinder, contains partially unburned powder particles that adhere firmly to the exposed surfaces due to their high temperature. The gas regulator adjusts the amount of gas needed to recycle while minimizing the recoil of the firearm. It does so by allowing unwanted gas to exit the firearm. The gas regulator on this type of firearm has two positions corresponding to firing bullets or grenades (4).

The heads of the gas piston were thoroughly cleaned and photographed prior to the experiment. The firearm was assembled and fired. After disassembly, another photograph was made of the gas piston. This was repeated for up to ten shots per each firearm. Ammunition of caliber 5,56 × 45 mm NATO made by Fabrique National, Remington, and Sellier & Bellot was used to perform the test-firings. Multiple test series were carried out under the same experimental circumstances to ensure the reproducibility of the data.

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Results and Discussion

The results of the examination of the head of the gas piston are displayed in Figs. 1 and 2 for ten and six shots fired, respectively, through two different firearms. For Fig. 1, ammunition from Fabrique Nationale was used. Different types of ammunition were used in Fig. 2. A single shot fired with the firearm leaves sufficient gun shot residue to allow for a visual inspection. It can be seen that the quantity of deposits increases progressively with an increasing number of shots fired with both rifles, relatively independent of the type of ammunition.

When comparing Fig. 1 and Fig. 2, one notes that the total quantity of deposited material is different from one firearm to another. This is in agreement with the observations made on the other four firearms. This dependence implies that all testing should be performed with the firearm in question.

As the gun shot residue deposit increases in a continuous way, an estimation of the quantity of shots fired with the assault rifle can be made by performing a series of test firings. The bottom right photograph of the tile screen of Fig. 1 shows the head of the gas piston of the firearm as it was transferred to the laboratory. When comparing the quantity of the gun shot residue deposits with the series of test firings, it can be estimated that the number of shots fired by the firearm is higher than 9.

The deposit of gun shot residue can be quantified. Although the settings of the camera for taking the individual pictures differ as

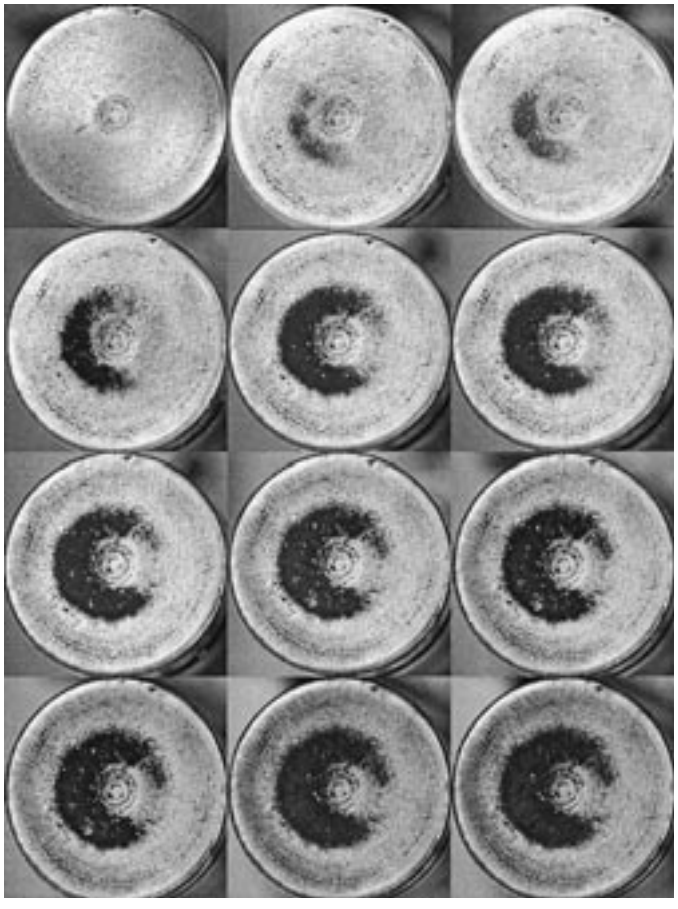

FIG. 1—*Tile screen consisting of photographs of the head of the gas piston. The top left photograph shows the cleaned head, prior to the test firing. The top middle position is the head of the gas piston after firing a single shot. A small quantity of gun shot residue deposit can be seen. This quantity increases for two shots (top right photograph) up to ten shots (bottom middle photograph). The bottom right photograph was the condition in which the firearm was transferred to the laboratory for investigation. It can be deduced that the number of shots fired with it is higher than 9. The ammunition used is from Fabrique Nationale.*

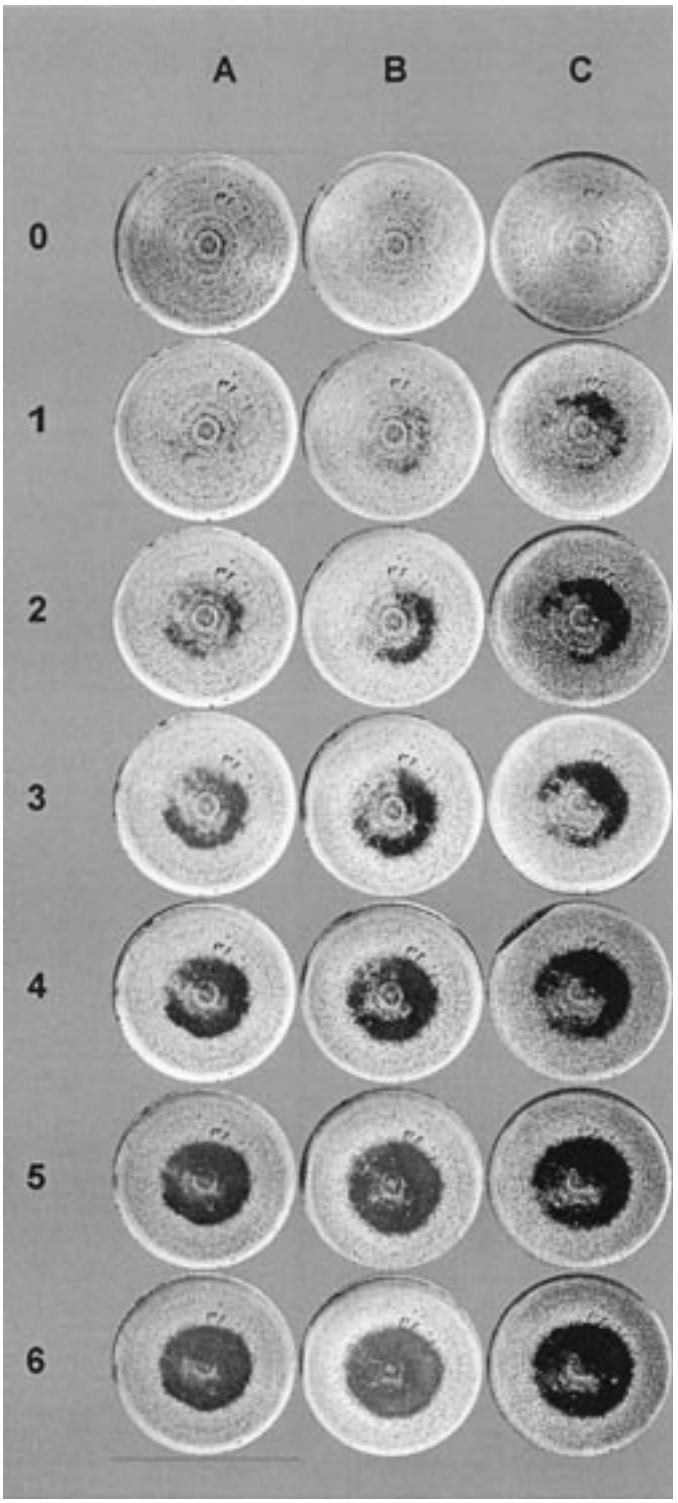

FIG. 2—*Tile screen consisting of photographs of the head of the gas piston for a number of shots fired (vertical scale) and three different types of ammunition. Columns A, B, and C correspond to ammunition from Sellier & Bellot, Remington, and Fabrique Nationale, respectively.*

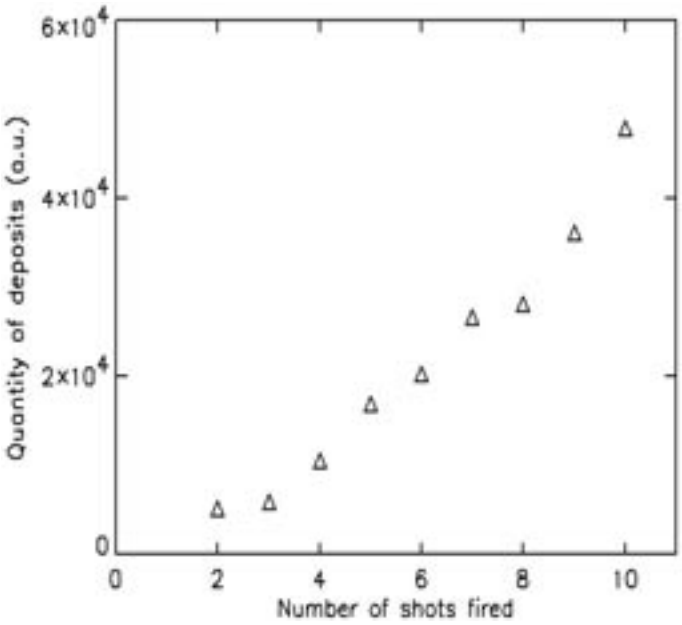

FIG. 3—*The quantity of dark pixels as counted on the photograph of the head of the gas piston, as shown in Fig. 2. These results were obtained with the Remington ammunition.*

well as the alignment of the head of the gas piston, the number of dark pixels can be counted using standard image processing software. The result of this integration is shown in Fig. 3 for the middle column of Fig. 2. Similar results were obtained for the other sorts of ammunition. A clear linear dependence on the number of shots is obtained. For a small number of shots fired, the contribution of the dark pixels is too small to be determined in an accurate way.

This technique can be applied to other firearms that operate using the same principles. It provides a more accurate determination of whether a firearm has been fired since its latest cleaning and an estimation of the number of shots fired than the visual examination of the condition of the barrel and the chamber of a firearm. Its application depends critically on the time of the last cleaning of the firearm.

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