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TECHNICAL NOTE

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A Method for Enhancing Gunshot Residue Patterns on Dark and Multicolored Fabrics Compared with the Modified Griess Test*

ABSTRACT: In using infrared or infrared-enhanced photography to examine gunshot residue (GSR) on dark-colored clothing, the GSR particles are microscopically examined directly on the fabric followed by the modified Griess test (MGT) for nitrites. In conducting the MGT, the GSR is transferred to treated photographic paper for visualization. A positive reaction yields an orange color on specially treated photographic paper. The examiner also evaluates the size of the powder pattern based on the distribution of nitrite reaction sites or density. A false-positive reaction can occur using the MGT due to contaminants or dyes that produce an orange cloud reaction as well. A method for enhancing visualization of the pattern produced by burned and partially unburned powder is by treatment of the fabric with a solution of sodium hypochlorite. In order to evaluate the results of sodium hypochlorite treatment for GSR visualization, the MGT was used as a reference pattern. Enhancing GSR patterns on dark or multicolored clothing was performed by treating the fabric with an application of 5.25% solution of sodium hypochlorite. Bleaching the dyes in the fabric enhances visualization of the GSR pattern by eliminating the background color. Some dyes are not affected by sodium hypochlorite; therefore, bleaching may not enhance the GSR patterns in some fabrics. Sodium hypochlorite provides the investigator with a method for enhancing GSR patterns directly on the fabric. However, this study is not intended to act as a substitute for the MGT or Sodium Rhodizonate test.

KEYWORDS: forensic science, gunshot residue, Griess test, powder patterns, sodium hypochlorite, bleach, firearms, crime scene investigation

When a weapon is fired a conical plume of particles exits the muzzle's bore. The larger particles travel farther than the smaller ones although the air resistance impedes the travel of all particles (1). Some factors affecting gunshot residue (GSR) patterns include: distance, caliber, type of propellant, type of weapon, target material, and muzzle-to-target angle (2).

The estimation of distance from the weapon's muzzle to an article of clothing may be an important factor in an investigation (3). Reconstructing the events surrounding a shooting and estimating the muzzle-to-target distance may be used to corroborate other evidence in the case (4). Muzzle-to-target distances were first estimated by direct observation of the visible GSR patterns or by GSR patterns produced by the Walker test when compared with test shots at known distances that produced a similar GSR pattern. The Walker test was replaced with the modified Griess test (MGT) (5) and the MGT became the preferred method for examining nitrite compounds in GSR patterns (6). After completing the MGT, the sodium rhodizonate test can be performed on the garment to test for lead (7).

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Material and Methods

Twelve samples of dark and multicolored fabric were placed over a 203 × 254 mm (8 × 10 in.) cardboard form and stapled around the cardboard edges. The fabric was not stretched but pulled tight enough to eliminate wrinkles in the fabric. After firing, each sample of fabric was collected and covered with paper to avoid cross contamination of the GSR before testing.

A model 686 .357 Magnum Smith & Wesson revolver (Smith & Wesson, Springfield, MA) with a 4-in. barrel was used to produce GSR patterns by firing .38 Special caliber Winchester Western ammunition with lead round-nose bullets at a muzzle-to-target distance of 7.62 cm (3 in.) into 24 samples of dark or multicolored fabric. The 24 samples were paired and arranged into two groups. Group 1 of the samples was tested with the MGT and group 2 was tested with sodium hypochlorite to evaluate the visualization enhancement of the two tests.

The materials prepared for the MGT were 12 sheets of 203 × 254 mm (8 × 10 in.) Kodak polycontrast RC (resin coated), type F photographic paper fixed with Kodak fixer for 10 min at 20°C (68°F). After fixing, it was washed in 20°C (68°F) water for 10 min and dried in an RC dryer. The desensitized photographic paper was then immersed in a solution containing equal volumes of 0.5 g of sulfanilic acid in 100 mL of distilled water and 0.28 g of α-naphthol in 100 mL of methanol and allowed to dry at 20°C (68°F). Also, 12 pieces of 203 × 254 mm (8 × 10 in.) cotton cheesecloth were soaked in 15% acetic acid for 1 min. Each sample of fabric was then covered with a piece of treated photographic paper with the surface of the GSR pattern adjacent to the paper's emulsion. The piece of cheesecloth was placed on the back of the

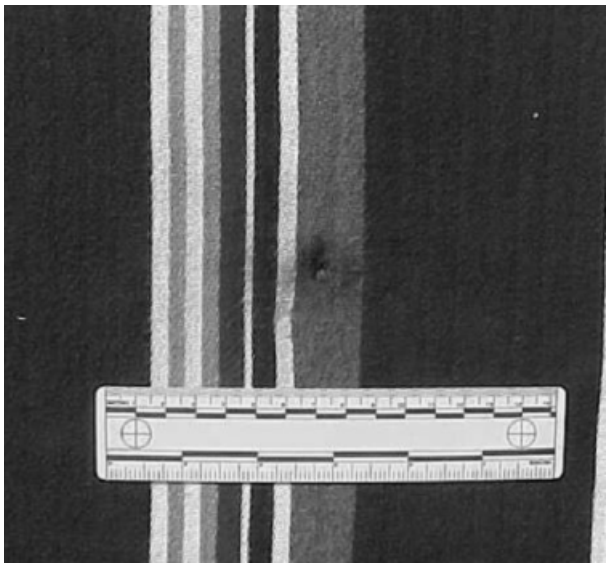

FIG. 1—*Photograph of a multicolored red-and-black bullet hole on 100% cotton fabric before treatment.*

fabric sample and ironed on medium heat for 1 min. One minute was selected for control purposes. An orange color developed on the photographic paper in the presence of nitrites.

A 5.25% solution of sodium hypochlorite was sprayed onto 12 samples of dark or multicolored fabric to determine if bleaching the fabric would enhance visualization of GSR patterns. The solution was sprayed in a mist on each piece of fabric until saturated. In 2–3 min, the fabric colors began fading and losing color due to the application of the sodium hypochlorite solution. A significant amount of the color was removed with the first application, and there was an observable difference in the visualization of the GSR patterns after sodium hypochlorite was applied. After 30 min, the fabric was sprayed with a second application. However, after the second application, there was minimal observable change in the visualization of the GSR pattern.

The 12 types and colors of fabric tested included: red, green, and beige plaid cloth with 100% cotton; striped navy and red with 100% cotton; striped navy, white, green, and red with 100% cotton; burgundy with 100% cotton; black with red floral pattern with 100% rayon; beige, black, and, purple floral design with 100% rayon; black with light-colored floral design with 100% rayon; navy with 100% acetate; navy with 100% wool; black with 70% triacetate and 30% polyester; black-and-white with 50% polyester and 50% rayon; and black with 50% polyester and 50% rayon.

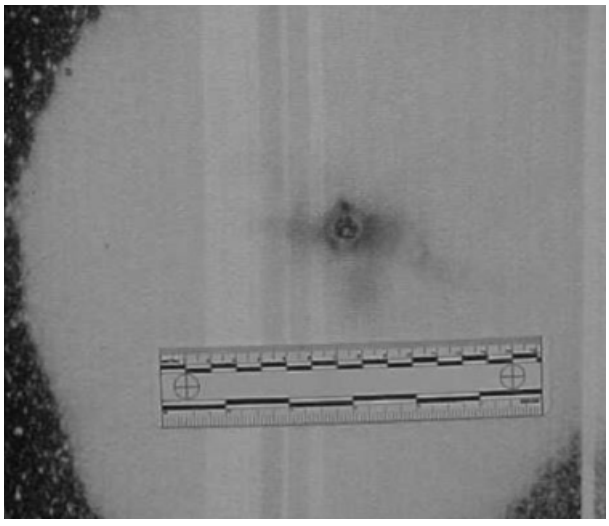

FIG. 2—*Closeup photograph of bullet hole and GSR pattern with sodium hypochlorite treatment.*

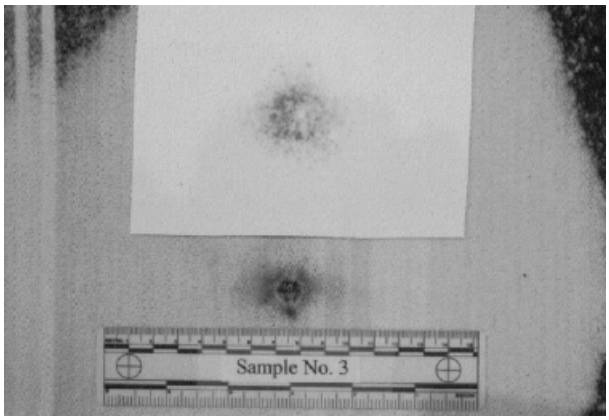

FIG. 3—*Photograph of multicolored red-and-black fabric with bullet hole and GSR pattern with MGT treatment in top portion of the photograph and sodium hypochlorite treatment in lower portion of the photograph.*

An example of the multicolored red-and-black 100% cotton fabric is shown in Fig. 1 with a bullet hole in the fabric before any type of treatment. In Fig. 2, the sample is treated with a 5.25% solution of sodium hypochlorite to enhance the GSR pattern. The bleach eliminated a significant part of the background, enhancing the GSR pattern. Figure 3 illustrates the GSR pattern on treated photographed paper using the MGT on a different sample of the same fabric.

Even though the camera to target distance is closer in Fig. 3, the GSR pattern for the MGT and the sodium hypochlorite are approximately the same size.

Results and Discussion

The GSR patterns on all samples were difficult to differentiate and measure on the untreated fabric. All 12 patterns developed with the MGT were orange in color and were measured and photographed for comparison with the patterns treated with sodium hypochlorite. Ten of the 12 samples treated by applying a 5.25% solution of sodium hypochlorite to bleach the dye from the fabric produced enhanced GSR patterns. Two sample fabrics, the black 100% wool and the fabric containing 70% triacetate and 30% polyester, did not have a visible GSR pattern before testing with sodium hypochlorite. The sodium hypochlorite had no effect on the GSR on the wool and the fabric with triacetate and polyester. The fabrics changed from black to olive green but with no visual GSR pattern. The GSR patterns from the treatment of sodium hypochlorite were also measured and photographed.

The maximum GSR pattern diameters ranged from 55 mm (2.16 in.) to 80 mm (3.14 in.) for the 12 samples that were fired at a distance of 76 mm (3 in.) with an average pattern diameter of 66 mm (2.60 in.) for the MGT patterns. The maximum GSR pattern diameters for the 12 samples treated with sodium hypochlorite ranged from 10 mm (0.39 in.) to 70 mm (2.75 in.) fired at a distance of 76 mm (3 in.) with an average diameter of 34 mm (1.50 in.). Even though the burned and partially unburned powder particles produced a smaller pattern on average than the MGT, the

sodium hypochlorite method yielded some consistency in the measurable pattern uniformity. However, in some patterns a stray particle caused the range of the maximum diameters to vary for measuring the enhanced patterns. The visual GSR pattern sizes on white cotton cloth targets fired from a muzzle-to-target distance of 76 mm (3 in.) approximated the same size GSR patterns as those enhanced with sodium hypochlorite when the sodium hypochlorite bleached the dyes. More importantly was whether the MGT or sodium hypochlorite produced the same size GSR patterns consistently for a given muzzle-to-target distance. The range in pattern sizes for both methods indicates that GSR pattern size is only one factor in estimating the muzzle-to-target distance.

In conclusion, the use of sodium hypochlorite for enhancing GSR patterns gives the investigator an option for examining dark or multicolored fabric that can be bleached. If the dye in the fabric cannot be bleached, then infrared or infrared-enhanced photography and MGT can be used for enhancement of the GSR pattern. Although color intensity is not a data point for MGT evaluation, there was an observable difference in color intensity possibly due to the composition of the fabrics used in the testing.

The sodium hypochlorite method can be used to treat fabric in less than 5 min. Also, after treatment, there is an increased contrast in GSR patterns that allows routine photography of the fabric. Although sodium hypochlorite quickly revealed GSR patterns in the fabric types tested, the destructive and nondestructive effects on GSR were not tested. Furthermore, collection of stain evidence should be conducted before the sodium hypochlorite test is administered.

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