Baruch Glattstein,[1] M.Sc.; Arie Zeichner,[2] Ph.D.; Asya Vinokurov,[1] M.Sc.; Nadav Levin,[3] M.Sc.; Chen Kugel,[4] M.D.; and Jehuda Hiss,[5] M.D.

Improved Method for Shooting Distance Estimation. Part III. Bullet Holes in Cadavers*

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ABSTRACT: An improved method to estimate firing distance on human body surfaces is described. The novel part of the method includes a chemical test in addition to the traditional visual and microscopic examinations of the gunshot wounds. This chemical test consists of a transfer of the gunpowder residues from the area of a gunshot wound to an adhesive lifter; the residues are then visualized as total nitrite after alkaline hydrolysis by the Modified Griess Test (MGT). When cadavers are in an advanced stage of decomposition or when gunshot wounds are in hairy areas, the information obtained by this chemical test can be crucial for shooting distance evaluation. In other cases it may improve the accuracy of the examination. In some cases, the results obtained by this test may assist in the discrimination between entrance and exit gunshot wounds.

KEYWORDS: forensic science, criminalistics, shooting distance, adhesive lifter, Griess reagent

In Parts I and II of this series (1,2) an improved method was described for the estimation of shooting distance on clothing and on objects that cannot be processed in the laboratory. This method is based on the transfer of gunpowder residues from the target to an adhesive lifter. After the application of the adhesive lifter, vaporous deposits of lead and copper around the entrance bullet hole may be visualized on the target by the Sheet Printing Method (SPM) with sodium rhodizonate and rubeanic acid, respectively. To obtain total nitrite visualization, the Modified Griess Test (MGT) is carried out after alkaline hydrolysis on the gunpowder residues transferred to the adhesive lifter.

In many shooting cases, bullets hit surfaces of various parts of the human body directly without passage through any intermediate medium. For the purpose of assessing the shooting distance (3–5), most of the forensic literature describes only visual and microscopic methods for the examination of the appearance of the wound and discharge particle patterns around it.

Shooting distances on human body surfaces can be divided roughly into four ranges: contact, near contact range, intermediate range, and distant range (3,4). In contact wounds, the muzzle of the weapon is held against the surface of the body at the time of discharge. The appearance of tearing, scorching, soot, or the imprint of muzzle characterizes contact wounds. In near contact wounds, the muzzle of the weapon is not in contact with the skin, being held a short distance away (few cm). In near contact range, a wide zone of powder soot overlaying seared blackened skin surrounds the entrance wound. An intermediate range gunshot wound is one in which the muzzle of the weapon is held away from the body at the time of discharge, yet is sufficiently close so that gunpowder grains expelled from the muzzle along the bullet produce "powder tattooing" of the skin. Microscopic examination is conducted to verify the presence of partially burnt or unburnt gunpowder particles. In the distant range no damage effects or discharge particle patterns are observed around the gunshot wound.

Although sodium rhodizonate and rubeanic acid reagents were proposed for the visualization of lead and copper patterns around the gunshot wounds (6,7), in practice the authors are not aware of any chemical tests that are conducted for the estimation of shooting distance on cadavers.

As in cases of clothing and other objects, many problems can be encountered when the assessment of shooting distance on cadavers is based merely on visual and microscopic examinations. The typical problems are (3–5): 1. When using small caliber ammunition (short .22 or .32 S&W), the typical marks of contact gunshot wound may be absent. 2. Gunpowder tattooing may not be produced on the skin in hairy parts of a body and gunpowder particles will be hardly discernible. 3. Whenever shots were inflicted through glass panes, glass particles may produce visual patterns that can be similar to the gunpowder tattooing around a gunshot wound (3,6). 4. The discoloration characteristic of a decomposed body can be similar to the color of soot. Furthermore, it may also mask tattoo marks. 5. In rare instances, insects may produce patterns that resemble gunpowder tattooing on cadavers.

[1] Scientific officers, Toolmarks and Materials Laboratory, Division of Identification and Forensic Science, Israel Police National Headquarters, Jerusalem, Israel 91906.

[2] Assistant director for R&D, Division of Identification and Forensic Science, Israel Police National Headquarters, Jerusalem, Israel 91906.

[3] Head of Toolmarks and Materials Laboratory, Division of Identification and Forensic Science, Israel Police National Headquarters, Jerusalem, Israel 91906.

[4] Forensic pathologist, National Center of Forensic Medicine, Tel-Aviv, Israel.

[5] Director, National Center of Forensic Medicine, Tel-Aviv, Israel.

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In this study, the authors describe the feasibility of applying adhesive lifter to the entrance bullet wound in human body surfaces to visualize the total nitrite patterns, as was reported for clothing and other exhibits (1,2). Examples of the method's application in casework are shown.

Experimental

Total Nitrite Pattern Visualization

Materials—A transparent adhesive lifter ("JAC Vinyl," 25 cm by 25 cm by 80 μm) with a protective cover (supplied by ISA Ltd., Greasley Street, Bulwell, Nottingham, England). The purpose of using a transparent lifter is in the possibility to mark the location of the gunshot wound on the back of the lifter. Two percent KOH in ethanol. Modified Griess Test (MGT) reagent: 3% Sulfanilamide and 0.3% N-(1-naphthyl)ethylenediamine dihydrochloride dissolved in 5% phosphoric acid (AR). Fixed photographic paper.

Procedure—The adhesive lifter is applied *firmly* by hand to the area of a gunshot wound. The entrance hole or the hole shape is marked on the back of the transparent adhesive lifter. The adhesive lifter is then removed from the wound, attached again to the silicone paper cover, and sent to the laboratory. In the laboratory the adhesive lifter is removed from the silicone cover, attached to a cardboard, sprayed *lightly* with the KOH solution, and placed in an oven at about 100°C for 1 h. The photographic paper is sensitized by dipping it into the MGT reagent solution for a few seconds. The excess solution on the photographic paper is removed by wiping with filter paper. It is important to remove the excess solution completely. The sensitized paper is placed on the adhesive lifter and for about 1 min is subjected to a pressure of 1.3 atm in the press at about 70°C (1,2). Four gunshot fatality cases illustrate how the chemical method was applied and provided various types of information.

Case 1

A multiple-gunshot-wounds male victim was examined at the National Center of Forensic Medicine. Beneath the left earlobe an entrance wound was detected (Fig. 1*a*). None of the characteristic features of contact or intermediate shooting range could be detected by visual examination. After applying the chemical method described, gunpowder particles were visualized in the entrance wound track (Figs. 1*b* and 1*c*). This phenomenon is characteristic of an only contact gunshot wound, when all the gunpowder particles enter the wound track. They may be visualized in the entrance of the wound track when the lifter is applied firmly to the wound. In this case, only the chemical method was useful for shooting distance estimation.

Case 2

A decomposed cadaver (Fig. 2*a*) was found with a gunshot wound in the neck (Fig. 2*b*). Due to the blackish discoloration of the skin, the presence of soot or gunpowder tattooing could not be observed visually. The visualized total nitrite pattern of about 5 cm diameter (Fig. 2*c*) was obtained on the lifter, indicating a close range shot. This case demonstrates the potential of the chemical method for shooting distance estimation on cadavers in an advanced stage of decomposition.

Case 3

An entrance gunshot wound to the left parietal was observed on the cadaver of a young female (Fig. 3*a*). No gunpowder particles were observed visually on hair before shaving, and no gunpowder tattooing around the entrance wound was found after shaving. The total nitrite pattern that was visualized on the adhesive lifter (that was applied before shaving) indicated a close shot range (Fig. 3*b*). This case demonstrates the problem of shooting distance assessment of gunshot wounds present in hair-covered areas of cadavers based only on visual examination, and success of the chemical method.

Case 4

The body of a male was found with a gunshot wound in the right temple (Fig. 4*a*). Under the gunshot wound there was an abrasion the size of 2.0 by 2.5 cm. In this case, there was much blood around the gunshot wound (Fig. 4*a* is a photograph of the wound after application of the adhesive lifter and washing of the wound area). Figure 4*b* shows that the adhesive lifted a considerable amount of blood. In spite of this fact, it was possible to visualize the gunpowder residues on the lifter (Fig. 4*c*). The visualized total nitrite pattern on the filter was in the form of an arc with a "tail." The form of an arc indicated that part of the muzzle was at an angle and part was in firm contact with the skin. No gunpowder residues could be visualized in the firm contact region. The size of the "tail" was similar to the size of the abrasion.

Discussion

The casework examples presented above demonstrate the feasibility of lifting gunpowder residue particles by using adhesive lifter from the skin or hair-covered areas of the cadavers and visualizing them by the MGT after alkaline hydrolysis.

Since there is an inherent problem of carrying out test firings on the same target materials, the reference target material may be a cotton cloth. In such cases an appropriate opinion can be that any obtained total nitrite pattern around a gunshot wound is evidence for an intermediate shooting distance. In the first three cases presented above, the chemical method was crucial for the estimation of shooting distances.

The visualized total nitrite pattern can also be important in cases in which there is a problem to determine whether there is real or pseudo soot or powder tattooing (3,6). The visualized total nitrite around the gunshot wound can also assist in discrimination between entrance and exit gunshot wounds.

A bullet ricocheting off a hard surface may result in the production of secondary fragments that may produce pseudo-powder tattooing of the skin (3). The described method may discriminate between gunpowder and pseudo tattooing of the skin which can be produced by intermediate target, ricochet, or deflected bullet.

The described method has been operational in Israel for more than two years.

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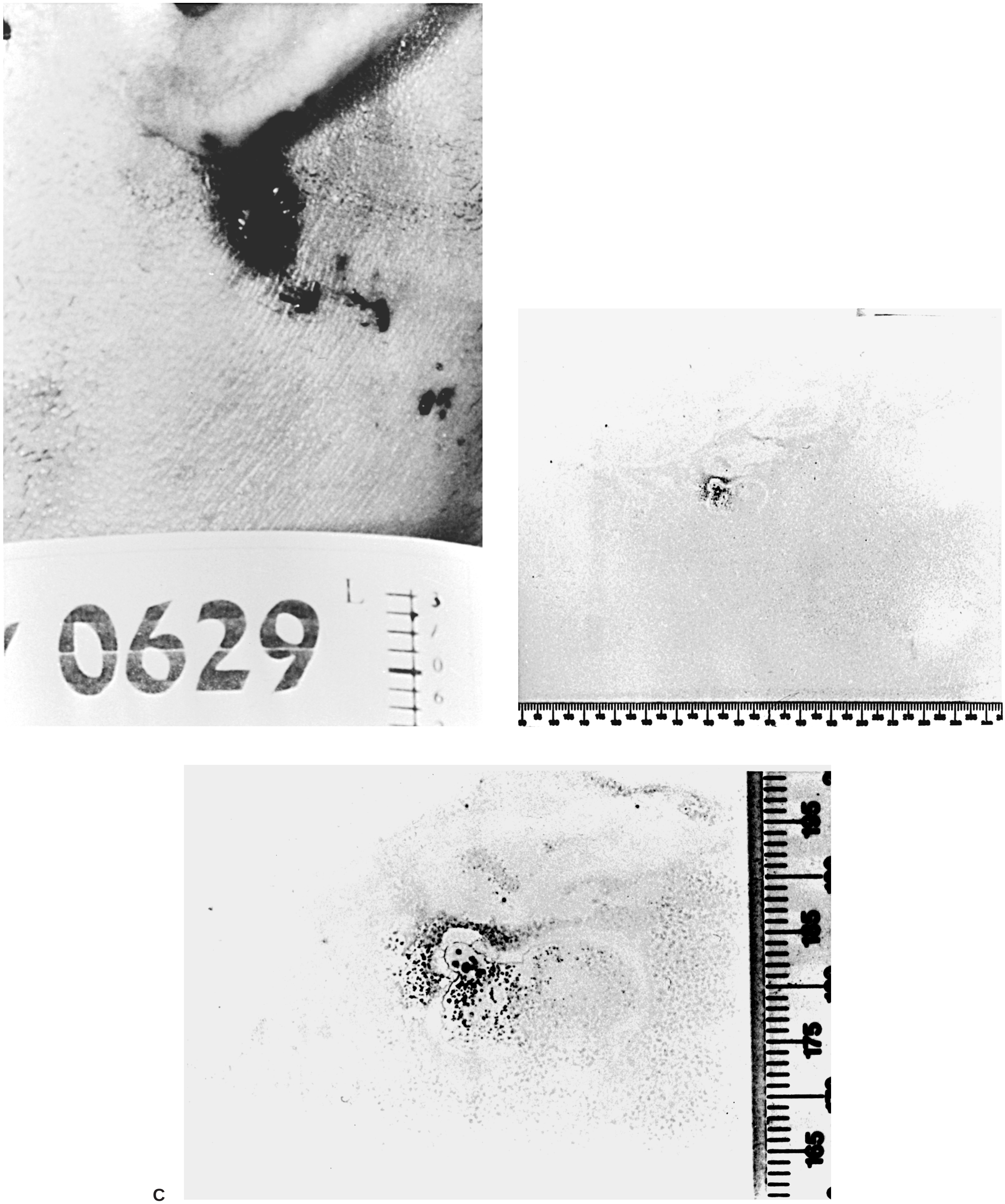
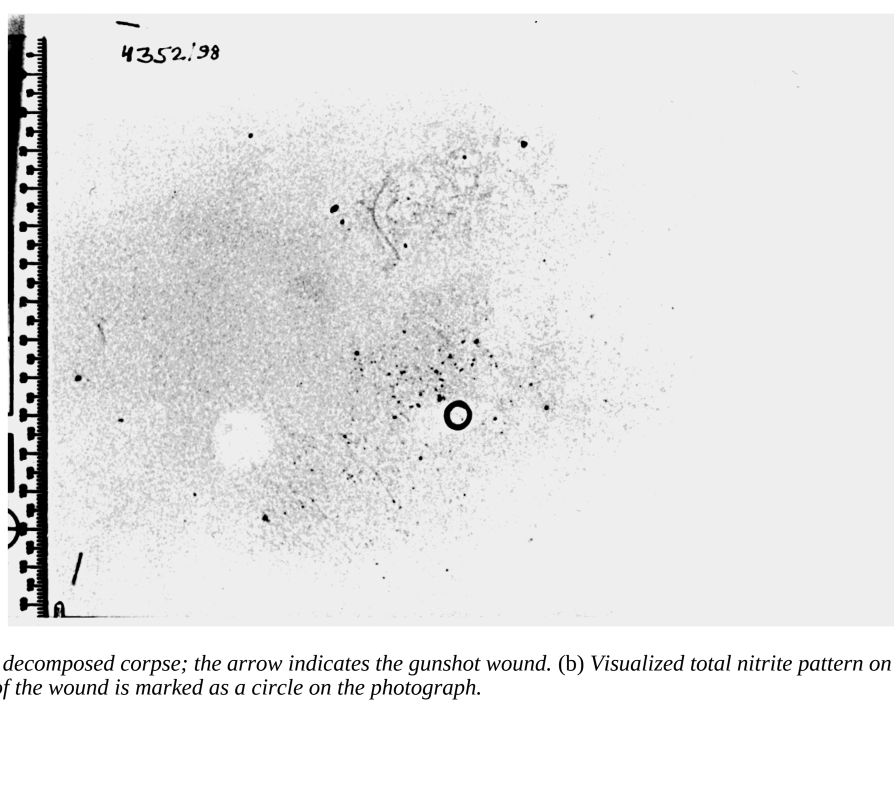


FIG. 1—(a) *Gunshot wound under the lobe of the left ear.* (b) *Visualized total nitrite pattern obtained on the adhesive lifter applied on the area of the gunshot wound shown in Fig. 1*a. (c) *Enlarged photograph of the gunshot wound zone shown in Fig. 1*b.

A



B

FIG. 2—(a) *The head of a decomposed corpse; the arrow indicates the gunshot wound.* (b) *Visualized total nitrite pattern on the adhesive lifter applied on the wound. The location of the wound is marked as a circle on the photograph.*

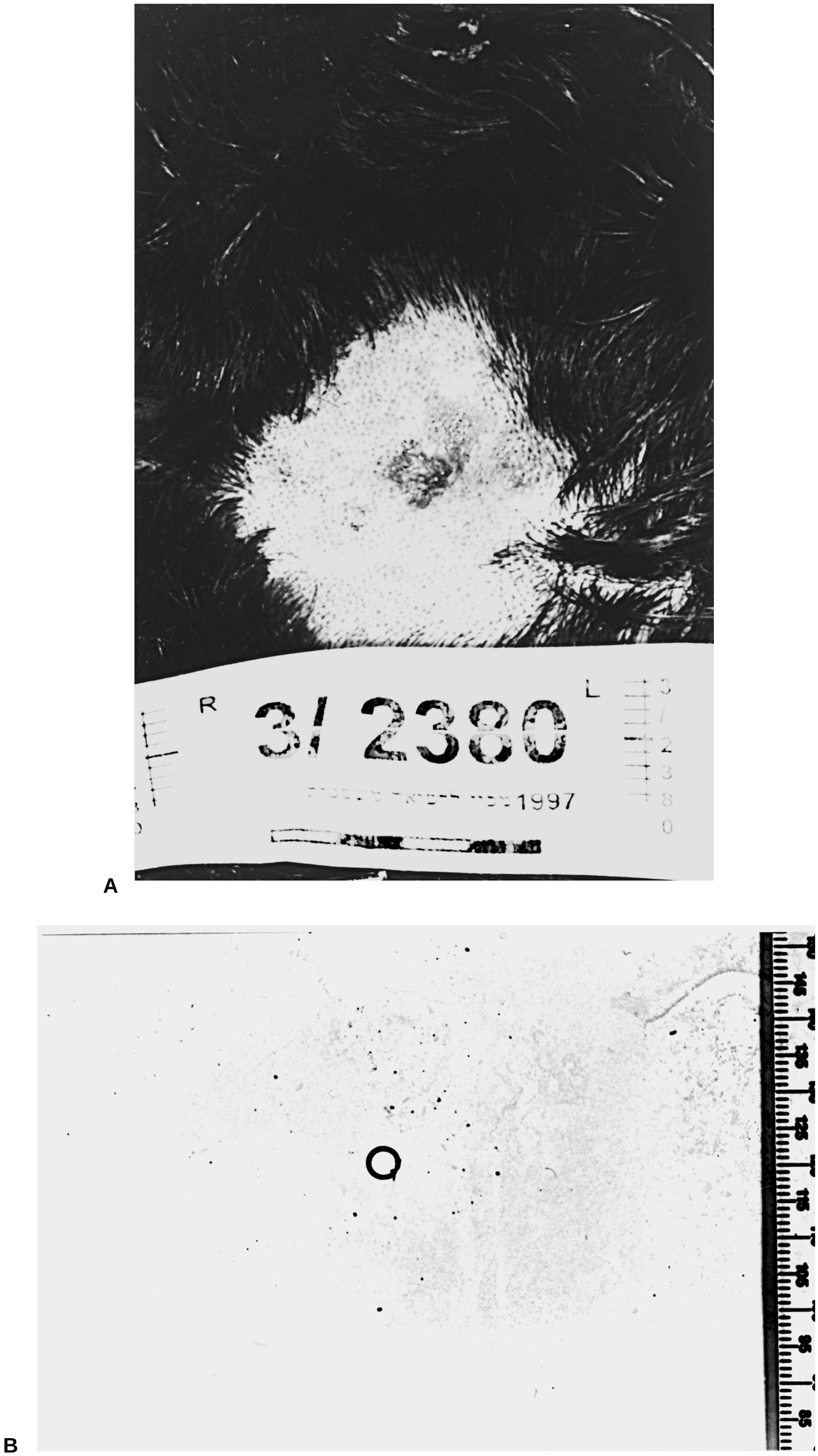


FIG. 3—(a) *Gunshot wound of the head after shaving.* (b) *Visualized total nitrite pattern on the adhesive lifter applied on the hairy area of the wound (before shaving). The location of the wound is marked as a circle on the photograph.*

FIG. 4—(a) *Gunshot wound of the right temple.* (b) *The adhesive lifter applied on the area of the wound. The location of the wound was marked by the medical examiner as a circle on the adhesive lifter.* (c) *Visualized total nitrite pattern applied on the adhesive lifter of Fig.* 4b. *Arrow indicates the direction of bullet.*

C

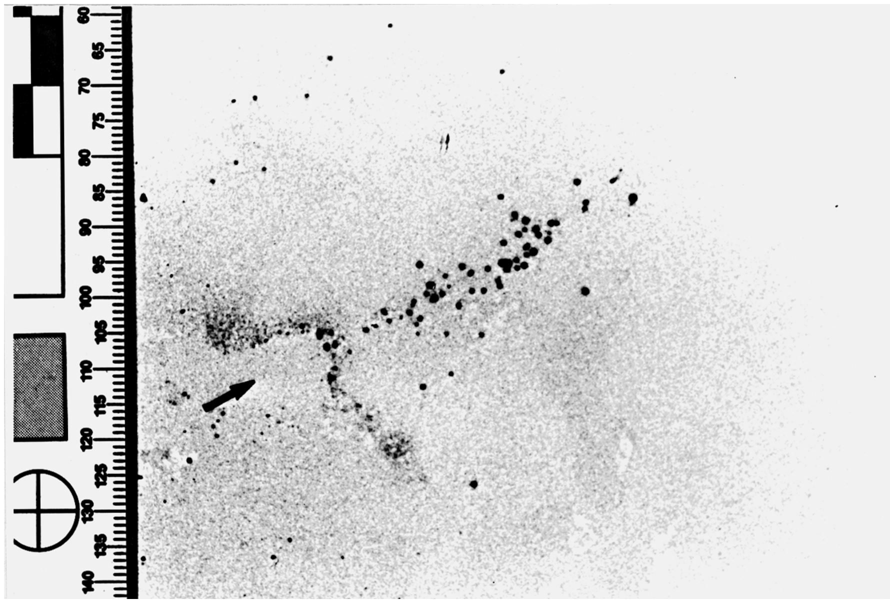


FIG. 4—*(Continued)*

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Additional information and reprint requests:
Baruch Glattstein, M.Sc.
Toolmarks and Materials Laboratory
Division of Identification and Forensic Science
Israel National Police Headquarters
Jerusalem, Israel 91906