TECHNICAL NOTE

Stellan Ståhling,[1] *and T. Karlsson,*[2] *M.D., Ph.D.*

A Method for Collection of Gunshot Residues from Skin and Other Surfaces

REFERENCE: Ståhling S, Karlsson T. A method for collection of gunshot residues from skin and other surfaces. J Forensic Sci 2000;45(6):1299–1302.

ABSTRACT: A method of collecting gunshot residues from the skin of persons who have been injured by firearms has been developed. The method uses a commercially available, adhesive, transparent plastic film. This method is also useful for collecting gunshot residues from other objects, such as leather. The shooting distance is later estimated by ocular, microscopic or IR examination in combination with various chemographic tests.

KEYWORDS: forensic science, GSR, shooting distance, MGT, KTM, SPM, MSPM, adhesive plastic film

Introduction

The criminal use of firearms is an increasing problem in most societies (1). In Sweden, the frequency of homicidal fatalities caused by firearms has increased in the last ten-year period. In the United States (2,3) South Africa (4–6) and other countries (7) the criminal use of firearms is even higher.

The forensic medical examination of a gunshot wound will result in the determination, or at least estimation of several factors, one of which is the shooting distance. These factors are also important in the determination of the manner of death (8).

The forensic medical determination of shooting distance is still based mainly on variables described in classic textbooks of forensic medicine (e.g., 9) such as the presence of visible soot or of powder tattooing (10). The naked eye can be complemented by light-microscopy (11) and the use of a dissecting microscope.

Chemical tests (e.g., the modified Griess test for nitrites (MGT) (12), the sodium rhodizonate test for lead residues (13) the Copper-Nickel Test (KTM), the Sheet Printing Method (SPM or the modified MSPM) (14) and X-ray fluorescence analyses (XRF) (15) are used to detect gunshot residues (GSR) on clothes worn by persons injured by firearms, and to reveal the spread of GSR on the clothing close to the entrance wound, to estimate the shooting distance.

Similar techniques, such as flameless atomic absorption spectrometry (FAAS) and scanning electron microscopic analyses are used to detect the presence but not the spread of GSR on swabs for AAS and adhesive collected samples for SEM from the hands of persons suspected of having fired a firearm.

Although some of these techniques (EDX and scanning electron microscopic analyses) can be used on excised gunshot wounds (10), they are not suitable for routine analyses on tissue specimens. In addition, the excision of a skin area adjacent to the wound large enough to allow for an assessment of the spread of GSR is not always possible by ethical reasons.

To avoid removing samples of human skin tissue, a series of experiments were performed to find a method suitable for transferring GSR from the skin to a carrier. In this paper, the use of a commercially available transparent, adhesive plastic film "adhesive plastic" as such a carrier is presented.

Materials and Methods

Materials

Adhesive plastic film, type BN-line, thickness 50 μm with soft surface was used. This adhesive polymer film ("book cover") is sold by common bookstores in reels 25 m long and 60 or 80 cm wide to cover and protect the surfaces of maps and books. BN-line is the sales name of this product in Sweden. It is manufactured by Tenza Ltd., Carlton Park Industrial Estate, Saxmundham, IP17NL Suffolk, England. The price in Sweden for a reel 60 cm in width is about USD 50.

An ordinary permanent felt-tip marker pen of any color can be used to mark the location of the gunshot wound and other anatomical fixed points on the non-adhesive side of the polymer film. Paper strips, approximately 20 cm long and 2 cm wide, cut from ordinary writing paper were pasted to the sides of the adhesive film to provide rigidity.

All reagents used were the standard chemicals used by the laboratory for the Modified Griess Test (MGT), Copper-Nickel Test (KTM) and Sheet Printing Method (SPM or the modified MSPM) (12–14).

The blank test of the BN-line plastic film and also the photographic paper used was performed. The surface of these materials was examined by SEM/EDX and found free from lead, copper and nickel, the elements used for the determination of shooting distance.

Methods

The whole procedure for shooting distance determination was the same as that used for clothing. MGT was, however, carried out

[1] Forensic engineer, SKL, National Laboratory of Forensic Science, S-58194 Linköping, Sweden.

[2] Department of Forensic Medicine in Stockholm of the National Board of Forensic Medicine, Sweden.

Received 22 Sept. 1999; and in revised form 1 Dec. 1999; accepted 6 Dec. 1999.

in the reverse order, because the adhesive plastic film is not permeable to vapors (the vapors from the acid solution). The procedure for the reverse Modified Griess Test is as follows:

Wipe the emulsion-coated side of the photographic paper with a piece of cotton cloth saturated with a solution of 15% acetic acid. Apply the solution to the entire surface, but lightly. Too much solution will cause an indistinct or hazy result due to pigment migration. Immediately place the photographic paper emulsion side down on the questioned surface. Cover the backside of the photographic paper with a dry cotton cloth. Apply a hot iron to the backside of the photographic paper. Note, that the back was previously covered by cotton cloth or an appropriate substitute. Separate the photographic paper and the questioned item. Any orange indications on the photographic paper are the result of a chromophoric reaction chemically specific for the presence of nitrite residues.

Procedure

Adhesive plastic film was cut into suitable dimensions, not larger than 18 by 24 cm. The two short sides of the adhesive surface were stabilized by approximately 2 cm wide paper strips. This procedure simplifies the handling of the film and the performance of the chemographical tests.

Collection of GSR from the Object—The adhesive side of the adhesive plastic film was aligned to the gunshot wound so that the bullet hole was positioned in the center. While one of the paper strips was kept against the object, the paper protecting the adhesive was gradually removed and the adhesive surface of the film was fixed against the object (Fig. 1). Following the gradual removal of the protective paper, the adhesive was pressed by hand against the injured skin (in a manner similar to laminating a map with plastic). When the plastic was attached, the other surface was pressed repeatedly by hand to ensure good contact (Fig. 2). The adhesive film was pressed particularly well against the bullet hole to collect any GSR deposited in the abrasion ring or close to the entrance wound in loose-contact entrance wounds.

The identifying case number, the position of the bullet hole, and other reference points on the injured body area were marked by a felt-tip pen directly on the non-adhesive side of the transparent film (Fig. 3). Photographs were taken of the gunshot

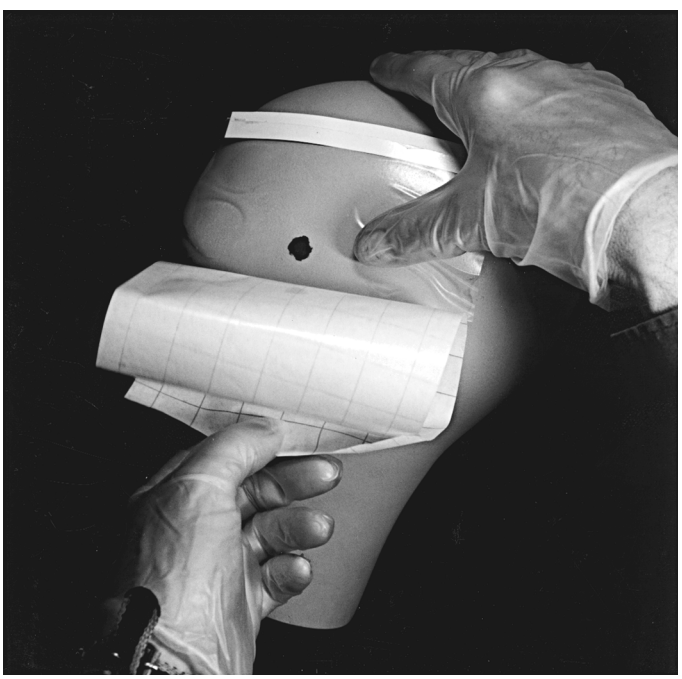

FIG. 1—*Apply adhesive plastic film over the injured area so that the bullet hole is positioned in the center.*

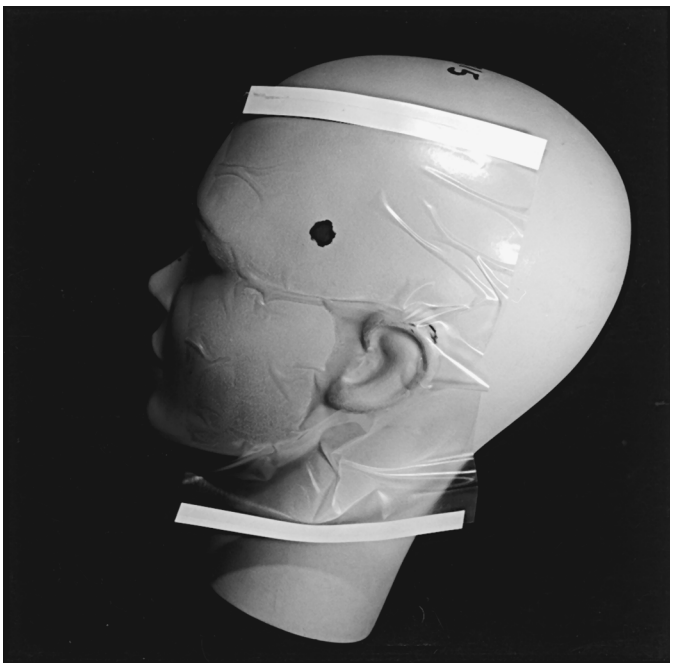

FIG. 2—*When the adhesive plastic film is attached to the skin, press it firmly by hand against the object. Gunshot residues will thus be embedded in the adhesive layer.*

FIG. 3—*Mark directly on the adhesive plastic film the position of the bullet hole and other reference points on the body as well as directions up and down.*

wound through the adhesive film with its markings before the film was removed.

The adhesive plastic film was carefully removed and attached to an "overhead" film or, even better, to the rough surface of an ordinary plastic case (Fig. 4).[3] Once attached, the adhesive film was not to be removed from this support. The "overhead" film or plastic case thus protected and supported the GSR particles collected. Prior to their use, the plastic case and overhead film were tested with all the chemographical techniques used to ensure that no contamination of the adhesive plastic film occurs. The case number and other supplementary notes were made on the non-adhesive side of the plastic or on the support film (Fig. 5). The sandwich of adhesive plastic film and supporting film, containing any collected GSR, as well as the photographic evidence of its application to the gunshot wound was sent to the forensic laboratory.

At the laboratory, the adhesive plastic film was first re-examined by eye and by light microscopy to detect any non-burned or partially burned propellant particles present on the adhesive layer. The presence of such particles was regarded as a clear indication of a short shooting distance. The microscopic investigation was followed by IR examination (when available) to detect thin deposits of soot in the injured area at a short shooting distance. Next, the adhesive plastic film was removed from the supporting overhead film (or plastic case) to permit the chemical detection (development) of the GSR.

Three chemographical tests were routinely applied according to the following schedule.

Detection (Development) of the Gunshot Residues—The first test applied was the "reverse" Modified Griess Test (MGT). If the reaction for nitrite ions was positive, orange dots developed in the area around the bullet hole. A positive test indicates a short shooting distance.

The KTM (Copper-nickel Test Method) detects residues from the bullet's jacketing and can, in cases of short shooting distance, reveal whether jacketed ammunition was used. In this test, pink/violet dots develop when nickel-jacketed and olive-green dots when copper/tombac jacketed ammunition has been used.

The last test performed was the SPM or MSPM test for the detection of lead originating from the bullet or from the primer of the ammunition used. When the shooting distance is short, brown dots develop. At a very short shooting distance, an olive-green/pink violet and a brown fog were observed on the adhesive film close to the marking of the bullet hole. This fog is formed by vaporized material from the bullet, the bullet jacket or the primer and can be observed for shooting distances shorter than about 50 cm.

The KTM test was not carried out if it was clear that non-jacketed ammunition had been used in the actual shooting.

Samples of photographic paper with positive color reactions for lead, copper and nickel, respectively, were cut out and examined by SEM/EDX. The presence of all three elements was confirmed by this procedure.

[3] An "overhead" film is a plastic sheet designed for projections in overhead projectors. An ordinary plastic case means a plastic pocket in which paper can be put inside, stored and protected in this way.

FIG. 4—*Attach the adhesive plastic film containing the collected GSR to an overhead film or to the rough surface of an ordinary plastic case.*

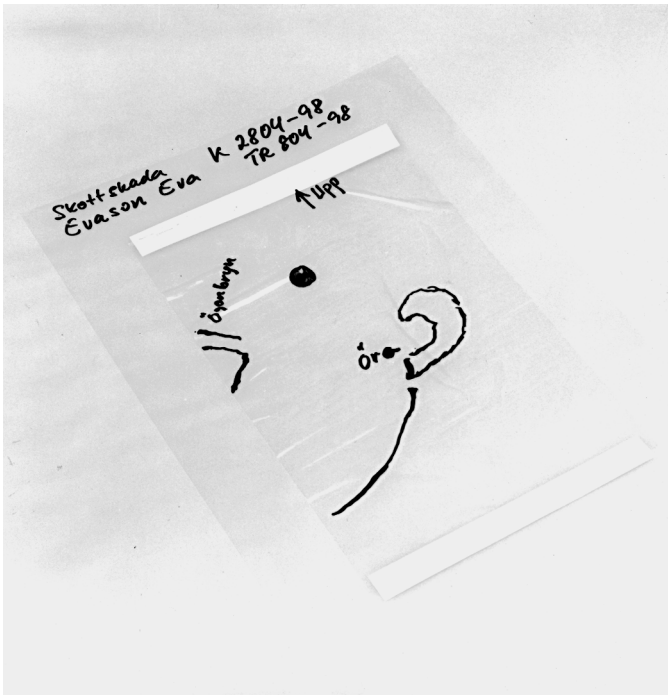

FIG. 5—*Note the case number and other references on the overhead film (or on the plastic case) and send the material to a forensic laboratory for further examination.*

Results

Figure 6 shows the results obtained by the KTM test on the adhesive plastic film sample from a murdered person. The person was shot in the chest by a "slaughtering-mask" (human killer). "Slaughtering mask" is a 9 mm firearm used to kill animals in slaughterhouses. GSR was collected from the entrance wound. The deposit of residues from the jacket (copper) was very rich, and the shooting distance was estimated to be 10 cm at the most.

FIG. 6—*The KTM test performed on the adhesive plastic film sample taken from a murdered person. The shooting distance was estimated to be 10 cm at the most.*

Discussion

Some factors that obstruct the use of this method are the presence of large amounts of blood in the injured area or when the body was wet or washed prior to examination.

When lead-free primer ammunition for use in indoor ranges such as Sintox or CCI, or when Winchester or Federal's lead-free ammunition has been used, the SPM and the MSPM test are not necessary, while the MGT and particularly the KTM tests generally give good results for short shooting distances. If the type of ammunition is unknown, all the three chemographical tests must be performed.

It is important to perform a blind test. In this test, adhesive plastic film is applied to another area of the injured object, clearly away from the injured area. The blind test confirms that the lead-, copper- or nickel- containing particles detected originate from the shooting and are not merely environmental particles.

Conclusion

The method for collecting gunshot residues from skin of an injured person using adhesive plastic film has been found successful. This method is applicable even for other objects, such as leather, etc. It is simple, rapid, and easily performed even by non-experienced staff in field conditions. Another advantage of this method is that only an adhesive plastic film, felt tip pen and a more rigid supporting "overhead" film or plastic case are required. The material required is cheap and suitable for sending to a laboratory for further examination by various chemographical methods.

References

1. Krug EG, Powell KE, Dahlberg LL. Firearm-related deaths in the United States and 35 other high- and upper-middle-income countries. Int J Epidemiol 1998;27(2):214–21.
2. Tardiff K, Marzuk PM, Leon AC, Hirsch CS, Stajic M, Portera L, et al. Homicide in New York City cocaine use and firearms. JAMA 1994; 272(1):43–6.
3. Bell AC. Female homicides in United States workplaces, 1980–85. Am J Publ Health 1991;81(6):729.
4. Hadley GP, Mars M. Gunshot injuries in infants and children in KwaZulu-Natal–an emerging epidemic? S Afr Med J 1998;88(4): 444–7.
5. Duflou JALC, Lamont DL, Knobel GJ. Homicide in Cape Town, South Africa. Forensic Sci Internat 1988;9(4):290–4.
6. Lerer LB. Women, homicide and alcohol in Cape Town, South Africa. Forensic Sci Internat 1992;55:93–9.
7. Szwarcwald CL, De Casilho EA. Mortality by firearms in the state of Rio de Janeiro, Brazil: a spatial analysis. Rev. Panam. Salud Publica 1998;4(3):161–70.
8. Karlsson T. Multivariate analysis ("Forensiometrics")—a new tool in forensic medicine. Differentiation between firearm-related homicides and suicides. Forensic Sci Internat 1999;101:131–40.
9. v Hofman ER, Haberda A. Lehrbuch der Gerichtlichen Medizin. Urban & Schwarzenberg; 1927.
10. DiMaio VJM. Gunshot wounds practical aspects of firearms, ballistics, and forensic techniques. CRC, 2nd Ed. 1999.
11. Rolfe HC, Curle B, Simmons D. A histological technique for forensic ballistics. J Forensic Med 1971;18(2):47–52.
12. Dillon JH. The modified Griess test: a chemical specific chromophoric test for nitrite compounds in gunshot residues. AFTE J 1990;22 (3):243–50.
13. Dillon JH. The sodium Rhodizonate test: a chemical specific chromophoric test for lead in gunshot residues. AFTE J 1990;22(3): 251–6.
14. Ståhling S. Modified sheet printing method (MSPM) for the detection of lead in determination of shooting distance. J Forensic Sci 1999;44 (1):179–81.
15. Liebhardt E, Hauck G, Spann W. Rontgenfluoreszenzanalytische Bleibestimmung bei bekannter Schussentfernung. Arch Kriminol 1969; 144:92.

Additional information and reprint requests:
Stellan Ståhling
National Laboratory of Forensic Science, SKL
S—581 94 Linköping
Sweden