International Congress Series 1288 (2006) 535–537

www.ics-elsevier.com

BPA analysis as a useful tool to reconstruct crime dynamics Part I

P. Fratini, T. Floris, M. Pierni, L. Talamelli, L. Garofano *

Raggruppamento Carabinieri Investigazioni Scientifiche, Reparto di Parma, Italy

Abstract. This paper concerns a case of two bodies which were found dead in their bedroom, shot several times with a semiautomatic pistol. It was essential to establish if we were dealing with a double homicide, or rather the shooting of the first victim, followed by suicide of the second. We refer to the technical activities we conducted at the crime scene and the analytical approach we adopted, based on DNA as well as BPA analyses of the bloodstains we recovered, studied and collected during CSI. Following this method, also supported by ballistic exams, it was possible to establish the exact position of the first victim, and obtain affordable and useful results. For investigation, we need to aim at an integrated analytical approach which uses contributions from all aspects of forensics, especially when DNA and other analyses are available. © 2006 Published by Elsevier B.V.

Keywords: Forensic science; Bloodstain pattern analysis; Terminal ballistic; Crime scene reconstruction

1. Introduction

Physics, trigonometry and biochemistry of blood are the main fields of science surrounding the study of blood projected in free flight. In this regard, BPA, especially when it is integrated with other forensic techniques, can play a relevant role in the investigation [1–5]. In this case, the reconstruction of the crime dynamics was carried out by means of BPA coupled with the ballistic analyses made on the evidence collected during the CSI activities.

2. Materials and methods

On June 20th 2003, techs from the Ballistic and DNA units of our lab conducted an accurate inspection at the scene of the crime, where two naked victims were found dead on the bed. During the CSI activities, the positions of cartridge cases and bullets (cal.9×21 mm) were acquired and gunshot residues (GSRs) on the hands of both victims were collected by using adhesive stubs. The ballistic items recovered were then analyzed by means of a comparison microscope (Leica DMC),

* Corresponding author. Tel.: +39 0521 537701; fax: +39 0521 206396.
E-mail address: risprcte@carabinieri.it (L. Garofano).

0531-5131/ © 2006 Published by Elsevier B.V.
doi:10.1016/j.ics.2005.10.013

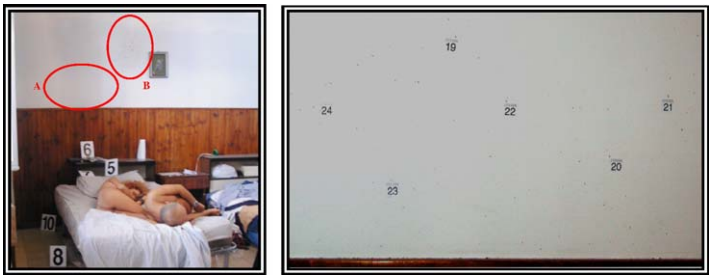

Fig. 1. A picture of the crime scene and view of area "A" where most significant blood droplets of the woman were projected by the shots (red arrows show the direction of pattern). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

while the stubs were carbon coated (Bal-Tec Med020) and analyzed by SEM/EDX (FEI Quanta400). Moreover, we photographed and measured the position, size and dimension of the bloodstains projected on the wall behind the bed (see Fig. 1). Two areas of the wall which exhibited an interesting pattern, were named "A" and "B"; the most representative bloodstains were labelled and measured for BPA calculations. As the analytical method employed is the same for both areas, the following details refer to area "A" only (see Fig. 1 and Table 1).

Bloodstains were collected by an "OralSwab" (Whatman) and/or scraped from the wall. Phenol–chloroform extraction was conducted, followed by quantification with Slot-Blot procedure using Quantiblot kit (ABD). Results were analyzed with GeneGnome (Syngene Bio Imaging) with Slot Quant Software (Hitachi v. 2.1.5.5). Genotyping were done by PCR using both Identifiler, Yfiler (ABD) and PowerPlex 16.2 kits (Promega) according to the original protocols. PCR fragments were separated with capillary electrophoresis using both ABI Prism 310 and 3100 Automatic Sequencer (ABD) and the size call allele was done by GeneMapper v. 3.2 (ABD). By using a laser distancemeter, we first acquired all measurements of the bedroom (i.e. distance between the walls, position and dimension of the bed) and of the chosen bloodstains (i.e. X = distance from the right wall; Y = distance from the floor), in order to obtain an exact topography plan by means of computer software. All the directions of significant bloodstains were 2D-analysed to determine the area of convergence which was located on the wall (see red arrows in Fig. 1). Every labelled bloodstain was then photographed (see Fig. 2) and the respective width "W", length "L" and directional angle "α" were measured. The impact angle "θ" and the string angle "β" were calculated using the trigonometrical formulas: $\theta = \arcsin(W/L)$ and $\beta = \arctan(\tan\theta/\sin\alpha)$ [2,4].

3. Results

Ballistic analyses demonstrated that cartridge cases and bullets were fired by the same pistol "Beretta" cal.9 × 21 mm recovered at the crime scene. SEM/EDX analysis revealed the presence

Table 1
Measurements and calculations on significative blood stains

Bloodstain	X (cm)	Y (cm)	W/L	θ	α	β
19	378	187	0.38	22°	326°	36°
20	340	161	0.66	42°	339°	68°
21	328	175	0.50	30°	355°	81°
22	365	174	0.50	30°	326°	46°
23	391	155	0.50	30°	298°	33°
24	406	172	0.45	27°	299°	30°

Fig. 2. Details of labelled bloodstains present on the area "A" and utilized in BPA calculations.

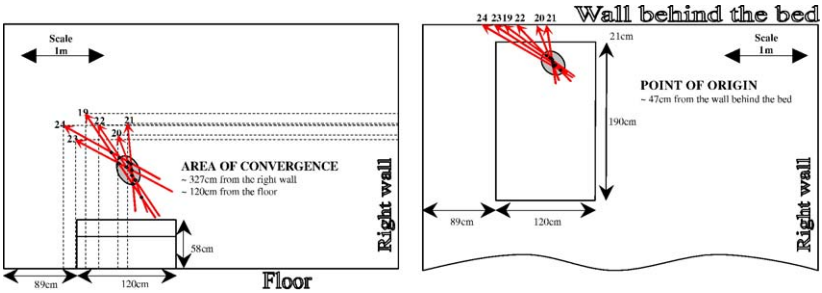

Fig. 3. Left: view of the wall behind the bed; right: view from the top of bedroom (both pictures were reproduced on the same scale).

of GSR particles on all the stubs taken, showing the highest number of GSRs on the right hand of the man. DNA analyses confirmed that the mentioned bloodstains were all referable to the woman. All BPA data were utilized to realize the topography plans (see Fig. 3), which show the trajectories followed by blood droplets before hitting the wall behind the bed.

The point of origin of area "*A*" was ~327 cm from the right wall; ~120 cm from the floor; and ~47 cm from the wall behind the bed. The same approach was utilized for bloodstains present on area "*B*" and a different point of origin on the bed was obtained corresponding to ~310 cm from the right wall; ~105 cm from the floor and ~40 cm from the wall behind the bed.

4. Discussion

Due to the DNA results and the two different patterns calculated through the BPA approach, it was possible to suppose that the woman was lying on the bed during the first shots. Backscattered bloodstains and GSR particles found on her hands suggest that she tried to stop the shooter at the moment of firing. Moreover, the position of ballistic evidence (cartridge cases, bullets and impact marks) [6] indicated that the shooter was standing near the bed while he was firing and that he subsequently sat at the bottom of the bed and shot himself. This case once more shows that by combining BPA approach to DNA, GSR and Ballistic analyses, it is possible to achieve a full understanding of the event and give the exact interpretation to the crime dynamics.

References

[1] T. Bevel, B. Gardner, M. Ross, Bloodstain Pattern Analysis, 2nd ed., CRC Press LLC, 2002.
[2] C. Moore, Three-dimensional models for bloodstain pattern analysis, JFI 52 (2) (2002) 183–203.
[3] A.Y. Wonder, Blood Dynamics, Academic Press, 2001.
[4] A.L. Carter, The directional analysis of bloodstain patterns theory and experimental validation, Can. Soc. Forensi. Sci. J. 34 (4) (2001) 173–189.
[5] S.H. James, W.G. Eckert, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press LLC, 1999.
[6] D.H. Garrison, The effective use of bullet hole probes in crime scene reconstruction, AFTE J. 28 (1) (1996) 57–63.