Forensic Science International: Genetics 7 (2013) 22–27

Contents lists available at SciVerse ScienceDirect

Forensic Science International: Genetics

journal homepage: www.elsevier.com/locate/fsig

Persistence of biological traces in gun barrels after fatal contact shots

Christian Schyma *, Burkhard Madea, Cornelius Courts

Institute of Forensic Medicine, University of Bonn, Stiftsplatz 12, 53111 Bonn, Germany

ARTICLE INFO

Article history:
Received 9 February 2012
Received in revised form 24 April 2012
Accepted 17 May 2012

Keywords:
Suicide
Gunshot wounds
Forensic ballistics
Contact shot
Forensic genetics
Victim DNA
STR typing

ABSTRACT

In the majority of cases suicidal shots are put to the head. Typically the gun's muzzle is held against the head.

The aim of the present prospective study was to investigate whether victim DNA could reliably be recovered from the inside of the barrels of firearms that were used in 20 cases of homicidal or suicidal close contact shots. Additionally, it was investigated whether such biological traces were eliminated by subsequent firing.

After autopsy sterile swabs were used to collect samples from the anterior part of the barrel thereby avoiding the muzzle. In some cases prior endoscopic inspection had revealed traces of blood and soft tissue in the barrel.

For 16 cases, another swab was used to also collect sample from the posterior part of the barrel entering from its rear end. Then one shot was fired through the weapon using the same ammunition as in the suicidal shot and the sampling procedure was repeated. DNA was extracted using a magnetic beads based protocol, quantified, and STR-systems were amplified using several commercially available multiplex-STR-PCR-kits.

For samples taken after the first shot DNA-analysis yielded STR profiles eligible for reliable individualization in 17 of 20 cases. After a second shot had been fired 8 or more STR systems were amplified successfully in 14 of 20 barrels.

1. Introduction

Statistically, the majority of fatalities in Europe caused by firearms are cases of suicide [1–7] which is reflected in forensic casework. Nevertheless, the differentiation between suicidal and homicidal gun shots has to reliably be based on forensic evidence by medical examiners and police investigators. Not only can an autopsy confirm the oftentimes obvious cause of death, but also document crucial findings. The morphology of entry wounds and soot cavities can indicate an exposure to muzzle gas pressure and thus point to an occurred close contact shot. Although contact shots cannot prove that suicide was indeed committed or attempted, they are characteristic for suicides [8,9]. Backspatter from the victims' hands represents valuable evidence to reconstruct the hands' position when the fatal shot was fired [8,10,11]. Finally topographic gunshot residue (GSR) collection from the victim's hands allows a mapping of GSR to determine whether or not the victim fired the gun [12].

Occasionally, e.g. after emergency care has been administered to persons surviving an attempt of suicidal shooting, traces of GSR cannot be analysed. In these cases inspection of the firearm may provide supplemental information. Ideally, typical traces of backspatter can be located on the outside of the weapon, but more often firearms used in suicidal shootings are covered in blood or characteristic stains are masked by splashes of blood. However, the inside of the gun barrel is generally not affected by such secondary staining.

As early as 1934, Brüning and Wiethold described the presence of traces of blood and tissue within gun barrels as a consequence of contact shots [13]. In another, preliminary study, 21 firearms used in suicidal shootings had been examined using a technical endoscope: 20 barrels showed visible biological traces. In eleven cases with positive morphological findings – from small calibre weapons up to 12/70 shotguns – STR systems could successfully be PCR-amplified and the resulting profiles matched with the respective victims' profiles [14,15]. However, in these studies only 8 STR systems were analysed and the procedures for sampling and DNA extraction were not standardized.

In a recent study we were first to present experimental models to emulate backspatter from contact shots and showed that profilable victim DNA may reproducibly be recovered from gun barrels even after a subsequent or "cleaning" shot had been put through the gun [16]. The aim of the present study of cases of suicide by firearm was to investigate if and to what extent biological traces and STR-profilable victim DNA in particular can be recovered from such firearms' barrels and can then be quantified

* Corresponding author. Tel.: +49 228 738317; fax: +49 228 738339.
E-mail address: christian.schyma@ukb.uni-bonn.de (C. Schyma).

1872-4973/$ – see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.fsigen.2012.05.008

Table 1
Description of the case collective.

Case	Age	Location of body	Weapon		Entry	Exit wound	Ammunition
			Origin/normal use	Legality			
1	47	Car		Illegal	Left temple	None	Lead round nose
2	71	Chair	Sport shooting	Legal	Mouth	None	Lead round nose
3	59	Bed	Heirloom	Illegal	Mouth	None	Lead round nose
4	69	Home	Heirloom	Illegal	Right temple	None	Lead round nose
5	88	Cellar	Unknown		Forehead	Vertex	Lead round nose
6	90	Cellar	Heirloom	Legal	Mouth	None	Lead round nose
7	72	Forest	Heirloom	Legal	Forehead	None	Lead round nose
8	53	Riverside		Illegal	Mouth	Vertex	Full metal jacket
9	60	Proximity of cemetery		Illegal	Right temple	Left temple	Full metal jacket
10	40	Forest	Duty pistol	Legal	Mouth	None	Action-4[a]
11	53	Bed	Sport shooting	legal	Right temple	Left temple	Full metal jacket
12	53	Couch	Hunting	Legal	Right temple	None	lead round nose
13	86	Car		Illegal	Left thorax	Left back	Semi jacketed
14	68	Car	Unknown		Forehead	None	Hollow-point
15	73	Living room	Sport shooting	Legal	Mouth	Vertex	Lead round nose
16	50	Home	Sport shooting	Legal	Mouth	Vertex	Full metal jacket
17	49	Hotel room	Hunting	Legal	Submental	None	Lead shot
18	60	Bureau	Hunting	Legal	Submental	None	Lead shot
19	46	Living room	Sport shooting	Legal	Mouth	Krönlein-shot[b]	Semi jacketed
20	77	Bed room	Free	Legal	Right temple	External soft tissue injury	Blank cartridge

[a] Action-4 is an expanding brass bullet (RUAG).
[b] Krönlein-shot: exenteration of the brain.

and used for forensic individualization. Moreover, we compared the performance of our experimental models to the extent of retention of victim DNA in gun barrels in real cases and we assayed whether real biological traces persist in gun barrels even after subsequent firing.

2. Materials and methods

2.1. Cases

Over a three year period 16 autopsy cases with fatal gunshot wounds and the respective firearms were prospectively collected. Two other cases in which the firearm was available passed an external post-mortem examination (cases no. 4 and 19). The oldest case dated from 2002, when the prosecution had ordered GSR-analysis. For comparison the Colt revolver had been confiscated, stored and forgotten (case no. 15). One weapon was examined while the victim was in clinical care (case no. 5). The characteristics of our case collective are displayed in Table 1.

2.2. Firearms

The characteristics of the firearms analysed in this study are summarized in Tables 1 and 2. In all cases except for case no. 1 sample collection was completed before the usual examinations by police firearms identification departments were performed. The two .357 Magnum calibre weapons – a revolver and a lever action rifle – had been loaded with .38 special ammunition. Two rifles had been sawed off long time ago. The origin or normal manner of use of the firearms, if known, is indicated in Table 1.

2.3. Sampling procedure

All samples were collected using sterile, DNA-free cotton swabs moistened with sterile, desalted water to wipe the inner surface of the firearms' barrels.

The swabbing procedure was refined during the study and a scheme for partial swabbing was established. As illustrated in Fig. 1 one half of the inner surface of the barrel was swabbed, both in the anterior and posterior part of the barrel. Then, a shot was fired using the same kind of ammunition that was originally used in the respective case.

Finally, second samples were collected by intensively swabbing the complete inner surface of the front and rear end of the barrel.

In some cases, the barrel was examined endoscopically using a 21.5 cm "Technoscope" (Karl Storz GmbH & Co., KG, Tuttlingen, Germany).

2.4. Means to avoid contamination

All work was conducted wearing gloves and an aerosolproof facemask.

Before collecting the samples, in all cases the muzzle was thoroughly cleaned with sterile water to prevent any contamination from introducing the swab into the barrel.

2.5. DNA extraction

After sampling, swabs dried for at least 2 h in a dark place at room temperature. DNA was extracted from all samples using the magnetic bead based PrepFiler Forensic DNA Extraction Kit (Applied Biosystems, Foster City, CA, USA), according to manufacturer's prescriptions.

2.6. DNA quantification and detection of PCR inhibitors

DNA concentration and the presence of PCR inhibitors were measured by quantitative PCR (qPCR) using the Quantifiler™ Human DNA Quantification Kit (Applied Biosystems). When a sample contained PCR inhibitors as indicated by an impaired amplification of an internal positive control, that sample was discarded.

Table 2
Weapons and calibres.

Type	Pistol	Revolver	Rifle	Shotgun
n	6	5	7	2
Calibre	.22 long rifle	.38/.357	9 mm	Other
n	7	5	3	5