ELSEVIER

Forensic Science International
76 (1995) 47–53

Forensic Science International

Frequency of blood spatters on the shooting hand and of conjunctival petechiae following suicidal gunshots wounds to the head

P. Betz*[a], O. Peschel[a], D. Stiefel[b], W. Eisenmenger[a]

[a]*Department of Legal Medicine, University of Munich, Munich, Germany*
[b]*Bavarian Bureau of Criminal Investigation, Frauenlobstr. 7a, 80337 Munich, Germany*

Received 29 February 1994; revision received 13 May 1995; accepted 9 June 1995

Abstract

A total of 103 suicidal and 29 homicidal gunshot fatalities were evaluated. In 42% of the suicides, characteristic findings like blood spatters and/or powder soilings, could be found on the shooting hand by naked-eye inspection indicating the importance of an accurate examination of the deceased's hands at autopsy for a preliminary diagnosis. Petechial hemorrhages of the conjunctivae due to the gas pressure after discharge of the weapon were observed in 22% of those cases with contact shot wounds to the head/neck, but not in cases of distant shot injuries following the use of non-high velocity ammunition. Therefore, conjunctival petechiae can be regarded as an additional but optional sign of contact head shots in cases without alterations possibly influencing the development of conjunctival pin-point bleedings. The evidence of such findings can be of practical importance if the entrance shot wound cannot be examined for whatever reason.

Keywords: Gunshot suicide; Blood spatters; Conjunctival hemorrhages; Firearms

* Corresponding author.

SSDI 0379-0738(95)01793-I

1. Introduction

The differentiation between suicidal and homicidal gunshots is mainly based on the entrance wound morphology and the detection of gunshot residues on the shooting hand [4,6,10,13]. In addition to the chemical analysis of gunshot residues, the appearance of tissue particles or blood spatters on or in the barrel of the weapon as well as on the hands of the deceased can contribute substantially to the reconstruction of the case [1,3,11,12]. In particular at autopsy, the naked-eye detection of biological traces or powder soilings on the shooting hand is of great importance for a preliminary diagnosis. In order to elucidate the percentage of cases in which these 'suicidal markers' can be observed without extensive analysis, the present study was performed. Another aspect of the study was to provide information on the frequency of conjunctival petechiae in head shot fatalities and to investigate whether such findings can support the assumption of contact gunshot wounds to the head in cases in which an examination of the entrance injury cannot be performed.

2. Material and methods

In the period January 1991–November 1993, a total of 103 suicidal and 29 homicidal gunshot fatalities without signs of relevant putrefaction were autopsied at the Department of Legal Medicine, Munich, Germany. The individual age ranged between 1 and 85 years; 6% of the suicides (6 out of 103 cases) were committed by females, but 48% (14 out of 29) of the homicide victims were female. The presence of visible gunshot residues on the hands like powder soilings or blood spatters and of petechial haemorrhages of the conjunctivae was recorded in contact or distant shot wounds. Differentiation was made between the localization of the injuries (head/neck or trunk) and, if possible, between the firearms used (revolver, pistol rifle/shotgun).

3. Results

In 97 out of the 103 cases (94%) contact injuries could be found localized on the head (right or left temple, frontal, nose, cheek-bone, mouth, chin, submental, occipital) or the neck. Only six suicides showed shot injuries to the chest and in none of them (weapon used: rifle/shotgun) were blood spatters found on the hands. In 18 suicides, a revolver was used, 52 suicides were performed with a pistol, in 22 cases the weapon was a rifle or shotgun and in the remaining 11 fatalities the type of the gun was not recorded in the investigation files. In 33 out of the 103 gunshot suicides (32%), blood spatters were detectable on the hands by naked-eye inspection (revolvers 33%, pistols 35% rifles/shotguns 27% and 27% of the fatalities with unknown weapons). Visible powder soilings were additionally detected in two further suicides (2%) and eight cases (8%) showed exclusively powder soilings, but no blood spatters, leading to a total of 43 out of 103 cases (42%) with characteristic signs on the shooting hand. In analyzing the frequency of such visible traces

dependent on the calibre of the guns, a positive correlation was found in the group 'pistols', but no clear results were obtained in the cases in which revolvers or long guns were used (Table 1).

In none of the investigated 29 gunshot homicides were visible blood spatters or powder soilings found on the victims' hands.

The frequency of petechial hemorrhages of the conjunctivae in suicides with contact gunshot injuries to the head/neck was about 22%. In evaluating the percentage of positive results dependent on type and calibre of the weapons used, the group 'rifle/shotgun' revealed a higher percentage of positive findings (32%) than that of pistols (20%) or revolvers (17%), but no clear relationship between the appearance of conjunctival petechiae and different calibres of the guns was found (Table 2).

In six out of the 29 homicides, contact injuries to the head were found and in three of these six cases petechial hemorrhages had developed. In none of the remaining 23 homicides with distant shot injuries did conjunctival pin-point bleedings occur.

Table 1
Frequency of visible blood spatters and/or powder soilings on the shooting hand in 103 suicidal gunshot fatalities

	Calibre/type	*n*	Blood spatters	Powder soilings	Both	Total
Revolvers	0.22 Magnum	3	1 (33%)	0	0	1 (33%)
	0.320	1	1	0	0	0
	0.357 Magnum	3	0	0	0	0
	0.38 Special	9	4 (44%)	1 (11%)	0	5 (56%)
	10.4 mm	1	0	0	0	0
	11 mm	1	0	0	0	0
	Total	18	6 (33%)	1 (6%)	0	7 (39%)
Pistols	0.22	1	1	0	0	1
	6.35 mm	9	2 (22%)	0	0	2 (22%)
	7.65 mm	32	10 (31%)	1 (3%)	1 (3%)	12 (38%)
	9 mm	10	5 (50%)	2 (20%)	0	7 (70%)
	Total	52	18 (35%)	3 (6%)	1 (2%)	22 (42%)
Rifles/shotguns	Shotgun	6	1 (17%)	1 (17%)	1 (17%)	3 (50%)
	0.22	11	2 (18%)	0	0	2 (18%)
	6 mm	1	0	0	0	0
	0.243 Winchester	1	1	0	0	1
	0.270	1	1	0	0	1
	7 mm	1	0	0	0	0
	7.62 mm	1	0	0	0	0
	Total	22	6 (27%)	1 (5%)	1 (5%)	8 (36%)
Weapon unknown		11	3 (27%)	3 (27%)	0	6 (54%)

Table 2
Frequency of conjunctival petechiae in 97 suicides with contact gunshot injuries to the head/neck

	Calibre/type	*n*	pet − asp	pet + asp	pet (total)	asp − pet[a]
Revolvers	0.22 Magnum	3	0	0	0	1 (33%)
	0.320	1	1	0	1	0
	0.357 Magnum	3	1 (33%)	0	1 (33%)	1 (33%)
	0.38 Special	9	0	1 (11%)	1 (11%)	5 (56%)
	10.4 mm	1	1	0	1	0
	Total	18	3 (17%)	1 (6%)	4 (22%)	7 (39%)
Pistols	0.22	1	0	0	0	0
	6.35 mm	9	2 (22%)	1 (11%)	3 (33%)	0
	7.65 mm	30	7 (23%)	0	7 (23%)	5 (17%)
	9 mm	9	1 (11%)	0	1 (11%)	6 (67%)
	Total	49	10 (20%)	1 (2%)	11 (22%)	11 (22%)
Rifles/shotguns	Shotgun	5	2 (40%)	0	2 (40%)	0
	0.22	10	3 (30%)	1 (10%)	4 (40%)	2 (20%)
	0.243 Winchester	1	0	0	0	0
	0.270	1	0	0	0	0
	7 mm	1	1	0	1	0
	7.62 mm	1	0	0	0	0
	Total	19	6 (32%)	1 (5%)	7 (37%)	2 (10%)
Weapon unknown		11	2 (18%)	1 (9%)	3 (27%)	2 (18%)

[a]pet, conjunctival petechiae; − pet, without conjunctival petechiae; − asp, without aspiration; + asp, with aspiration.

4. Discussion

The differentiation between suicidal and homicidal gunshot fatalities is — besides the reconstruction of the death scene and the investigation of the entrance wound — mainly based on the evidence of gunshot residues or blood spatters on the shooting hand. In particular, gunshot residues like powder soilings can be present even though they are not detectable by naked-eye examination indicating the importance of a further chemical analysis. By these techniques positive results can be obtained in approximately 40–90% of the cases with variations dependent on the weapon used [5,6,10,13]. At autopsy, however, the naked-eye detection of characteristic signs on the shooting hand can contribute to the preliminary reconstruction of the case and seems, therefore, to be of considerable practical importance. In previous studies different results concerning visible shot residues, in particular on the weapon, were reported, while studies dealing with the frequency of characteristic signs on the shooting hand are very rare. In the old German forensic literature, Brüning and Wiethold [1] detected blood spatters on the hand only 'in a few' of hundreds of investigated suicides, but described in 24 out of 42 (57%) selected cases biological traces on or in the barrel of the weapon used. A considerably higher percentage of such findings was reported by Fraenckel and

Strassmann in 1925 [3] who found these characteristic signs in or on the weapon in 'nearly all cases' with contact gunshot wounds. Recently, Stone supported this view and described positive results of 53% in the barrel or 74% on the barrel of revolvers and 57% and 76% in or on pistols, respectively [11]. The frequency of characteristic signs on the shooting hand was investigated by Zwingli [13] in 144 suicidal gunshot fatalities of the years 1929–1938. This author found blood spatters in 14% of the cases (5% of the revolvers and 20% of the pistols) and powder soilings were noticed in 29 of these 144 cases (20%) with higher percentages in suicides performed by revolvers (46%) when compared to pistols (12%). Furthermore, Reed [6] observed blood on the hands in 44% of the investigated suicides but it is not clear whether blood spatters or larger sized areas of blood, which cannot be interpreted as a characteristic sign of the shooting hand, were detected.

In our series, relevant differences between the groups 'revolvers' and 'pistols', as described by Zwingli [13], could not be obtained. Visible powder soilings were found on the shooting hand only in a rather low percentage of the cases ($\sim$ 10%) but blood spatters occurred in 32%, giving a total of 43% of our cases in which characteristic signs were detectable on the shooting hand by naked-eye inspection. A further differentiation of the frequency of positive results dependent on the calibres of the weapons resulted in a clear tendency to higher percentages of blood spatters in cases of increased calibres in particular of pistols. Since the gas pressure following the discharge of the gun is assumed to be responsible for the development of back spatters on the weapon and on the shooting hand [9], this observation can easily be explained by the usually greater gas pressures of cartridges with larger calibres. In evaluating the suicides performed with revolvers however, this tendency could not be confirmed probably due to the comparatively small number of cases. The (surprising) observation that blood spatters were more frequent after discharge of 0.38 special revolvers when compared to the 0.357 calibre Magnum could be explained by the fact that, in two out of our three cases, with the use of a 0.357 Magnum revolver 0.38 special cartridges were fired.

The rather low frequency of visible powder soilings (6–10% of our cases) as another characteristic sign of the shooting hand and the absence, at least partially, of relevant differences between the groups, 'revolvers — pistols — rifles/shotguns', can probably be explained by a difficult naked-eye detection of slight powder traces, whereas faint blood spatters can also be detected by accurate investigation. Therefore, in practice, the detection of visible powder soilings seems to be inferior to that of blood spatters at autopsy, but positive results can be expected more frequently following chemical analysis [5,6,10,13] indicating their importance for a conclusive diagnosis. With regard to these results, it can be emphasized that the evidence of visible 'markers' of the shooting hand, i.e. powder soilings and especially blood spatters, already contribute to the diagnosis of a suicide at autopsy in a considerable number of the cases ($\sim$ 43%), whereas negative results provide no reliable information. Furthermore, the detection of these characteristic signs supports the conclusions drawn from the investigation of the entrance wounds showing typical features of contact shots, like soiling patterns on the skin surrounding the characteristic entrance injury, perhaps in combination with a muzzle impression. Since the

head is the most favoured site (~ 80–90%) of suicidal gunshots [2,8,11], the combination of a typical injury pattern on this topographical location and the evidence of biological traces or powder soilings on the hands can be regarded as a strong (but not unambiguous!) sign for suicide.

On the other hand, when an investigation of the entrance wound cannot be performed during autopsy for whatever reason then it would be very important to discover other morphological features which occur typically after contact shots to the head supporting — but not proving — the diagnosis of a suicide. Such a parameter could be the detection of petechial haemorrhages of the conjunctivae which were found in our series in 21 out of 97 cases (22%) with suicidal and in three out of six cases with homicidal contact gunshot wounds to the head or the neck. The reason for the development of these conjunctival pin-point bleedings seems to be ruptures of small vessels localized in the loose connective tissue of the eyelid or conjunctiva due to the rapid expansion of the gas following the discharge of the weapon tightly pressed to the skull or introduced into the mouth. The lower percentage of positive results in suicides performed with revolvers (17%) when compared, in particular, to rifles or shotguns (32%) can easily be explained by the reduced gas pressure in the barrel due to the construction of this type of weapon. In addition, the gas pressure produced by the discharge of cartridges of long guns can be assumed to be greater, as a rule, than that of handguns. Even though one can expect that the use of larger calibres results in a higher frequency of positive results in comparison to smaller ones, this assumption could not be confirmed in our series probably due to comparatively small numbers of some calibres. Furthermore, the localization of the entrance wound and the track of bullet are of substantial importance for the development of conjunctival petechiae. Our results verify that conjunctival petechiae can occur in cases with entrance wounds or tracks of the bullet in close topographical correlation to the orbital region following the discharge of cartridges of larger as well as of smaller calibres. Since in our series only one out of eight contact shots to the neck resulted in petechial haemorrhages and the weapon used was a shotgun, it would seem that considerable gas pressures only are sufficient for the development of such findings in cases with a more distant entrance injury, for example localized on the neck. On the other hand, it seems possible that (even distant head shot) injuries induced by high-velocity cartridges can result in the development of pin-point bleedings of the conjunctivae due to special biological effects, but in our series the use of such ammunition could not be observed. In distant shots to the head or in contact shots to the chest following the use of 'usual' cartridges, however, no petechial bleedings were found regardless of the weapon used since apparently insufficient gas pressures near the orbital region appear. Therefore, the presence of conjunctival pin-point bleedings, besides other changes like haemorrhages in the fissure of the shoulder joint of the shooting hand [7], can support the diagnosis of suicidal head gunshots in cases without other alterations like aspiration, which could influence the development of such findings, and can possibly provide additional useful information in differentiation suicide/homicide.

References

[1] A. Brüning and F. Wiethold, Die Untersuchung und Beurteilung von Selbstmörderschusswaffen. *Dtsch. Z. Ges. Gerichtl. Med.*, 23 (1934) 71–82.
[2] J.W. Eisele, D.T. Reay and A. Cook, Sites of suicidal gunshot wounds. *J. Forensic Sci.*, 26 (1981) 489–485.
[3] P. Fraenckel and G. Strassmann, Zur Entfernungsbestimmung von Nahschüssen. *Arch. Kriminol.* 76 (1925) 314–316.
[4] R. Heindl, Spuren an der Schiesshand nach Schussmit Faustfeuerwaffen. *Arch. Kriminol.*, 114 (1944) 75–88.
[5] S. Krishnan, Detection of gunshot residues on the hands by trace element analysis. *J. Forensic Sci.*, 22 (1977) 304–324.
[6] G.E. Reed, P.J. McGuire, and A. Boehm, Analysis of gunshot residue test results in 112 suicides. *J. Forensic Sci.*, 35 (1990) 62–68.
[7] V. Schneider and T. Pietrzak, A new sign for establishment of evidence involving suicide by gunshot? *Z. Rechtsmedizin*, 95 (1985) 259–264.
[8] R. Selway, Gunshot suicides in Victoria, Australia 1988. *Med. Sci. Law*, 31 (1991) 76–80.
[9] B.G. Stephens and T.B. Allen, Back spatter of blood from gunshot wounds — observations and experimental simulation. *J. Forensic Sci.*, 28 (1983) 437–439.
[10] I. Stone and C. Petty, Examination of gunshot residues. *J. Forensic Sci.*, 19 (1974) 784–787.
[11] I. Stone, Characteristics of firearms and gunshot wounds as markers of suicide. *Am. J. Forensic Med. Pathol.*, 13 (1992) 275–280.
[12] W. Weimann, Über das Verspritzen von Gewebsteilen aus Einschussöffnungen und seine kriminalistische Bedeutung. *Dtsch. Z. Ges. Gerichtl. Med.*, 17 (1931) 92–105.
[13] M. Zwingli, Über Spuren an der Schiesshand nach Schussmit Faustfeuerwaffen. *Arch. Kriminol.*, 108 (1941) 1–26.