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Multiple gunshot suicides: potential for physical activity and medico-legal aspects

Received: 23 December 1996 / Accepted: 17 March 1997

Abstract Out of 138 clearly defined gunshot suicides which were autopsied, 11 persons (8%) fired two or more gunshots to the body. From these 11, 5 cases involved 2 gunshots to the head where the bullets fired first had missed the brain. The trajectories were restricted to the chest in three cases and a combination of gunshots to the head and chest including two perforating heart wounds without immediate incapacitation occurred in three more cases. Reliable incapacitation is based on physiological effects (tissue disruption) and can only be achieved by decreasing the functioning capability of the CNS. This can be accomplished by direct disruption of brain tissue or indirectly by cerebral hypoxemia from massive bleeding. Targets of immediate incapacitation are restricted to certain CNS areas and targets of rapid incapacitation include the heart, the (thoracic) aorta and the pulmonary artery. Other major blood vessels and major organs (lungs, kidneys, liver, spleen) constitute targets of delayed incapacitation. This general classification can be derived from the literature and is illustrated by the cases presented. A thorough post mortem can exclude or quantify the potential for physical activity. Typical features of single gunshot suicides such as contact shots, classical entrance wound sites and soot/backspatter on a hand also occur in multiple gunshot suicides.

Key words Gunshot wounds · Multiple gunshot suicides · Incapacitation · Physical activity · Reconstruction

Introduction

Suicidal gunshots are generally intended to kill rapidly. Therefore, the head/neck or the thorax are the target in

more than 95% of the gunshots in suicides (e.g. Eisele et al. 1981; Stone 1992). Despite this, some suicides are able to fire two or more gunshots to these body regions. Possible homicide is suspected in such cases but if the suicidal nature of the incident is properly determined, an evaluation of the potential for physical activity following all but the last gunshot is possible. This is a question frequently relevant in the reconstruction of shootings regardless of the number of entrance wounds.

Multiple gunshot suicides have been published in the form of case reports (e.g. Mason et al. 1967; Habbe et al. 1989) or as a series (Hudson 1981; Introna and Smialek 1989). Spitz et al. (1961) reported the physical activity (or lack of it) in 62 gunshot fatalities excluding head wounds and Karger (1995b) published a review of 53 gunshots to the head with lack of immediate incapacitation including 28 multiple suicidal head shots. It is the intention of this study to elaborate incapacitation caused by gunshot wounds and to find common features in multiple gunshot suicides.

Materials and methods

The autopsy records of the Institute of Legal Medicine, University of Münster, from 1967 to 1995 were checked for clearly defined gunshot suicides. As the number of gunshots was recorded in each case, all cases involving more than one suicidal gunshot could be identified. The autopsy record, the alcohol report and the prosecution department record including the police report were available in every case. Additional information such as the firearms examination report could be obtained in the majority of cases. Screening

Table 1 The methods used for determining the sequence of the gunshots

Method	Cases
Witness	1
Reconstruction	2, 4
Subsequent injuries	3, 9, 10, 11
Assumed from subsequent injuries	5, 6
Undetermined (closely grouped wounds)	7, 8

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Table 2 Summary of 11 cases of multiple gunshot suicides GSW = sequence (except for cases 7 and 8) of gunshot wounds; Alc. = Blood alcohol concentration. The wounded organs listed are not complete in every case but represent the most critical ones involved

No.	Sex/age	Firearm/bullet	GSW	Entrance wound	Exit wound	Wounded organs	Range of fire	Additional features
1	m, 36 y	9 mm Luger pistol, FMJ	1.	Right cheek	Left eyelid	Below base of skull	Contact	Backspatter right hand, schizophrenia
2	m, 56 y	Three-barreled firearm (see text)	1. 2.	Right temporal Submandibular Pre-laryngeal	Left frontal Right face Vault	Left frontal lobe Lower face Exenteratio cranii	Contact Contact Contact	Backspatter both hands, "doubled" gunshot
3	m, 48 y	Revolver .44 Rem. Mag. wadcutter	1. 2.	Chin Right temporal	Left to the nose Left temporal	Lower face Pons, midbrain, frontal lobes	Contact Near contact	Backspatter right hand and trousers, alc. 1.31 g/L
4	m, 52 y	16 gauge side-by-side shotgun	1. 2.	Right temporal Right temporal	Right face \	Right face Both frontal lobes	Contact (tangent.) Near contact	Endogenous depression
5	m, 29 y	Rifle, .22 lr lead bullet	1. 2.	Right temporal Right temporal	Right parietal \	Scalp (tangential) Right temp & left frontal lobe	Contact Contact	Backspatter left hand, psychiatric history
6	m, 20 y	P 38 pistol, 9 mm Luger FMJ	1. 2.	Left chest Precardiac	Left lateral thorax Left back	Left lung Left ventricle	Contact Near contact	Extended suicide, alc. 0.31 g/L
7	m, 38 y	Revolver .38 special	1 2, 3	Precardiac Precardiac	Left back \	1-3: Left lung, stomach, pancreas	Contact Contact	alc. 1.34 g/L
8	m, 33 y	Revolver, .22 lr RN lead bullet	1 2, 3, 4, 5	Left chest Left chest	Left back \	1-5: Left lung, laceration of truncus of pulmonary artery	1-5: Contact	Backspatter right arm, alc. 1.60 g/L
9	m, 27 y	Mauser pistol 7.63 mm FMJ	1.	Precardiac	Midline back	Left lung, both vestibules (exit perforation 2 x 3 cm)	Near contact	Pistol in right hand
10	m, 23 y	Walther pistol 08, 6.35 mm FMJ	2. 1. 2.	Ventral neck Precardiac Midline frontal	Occipital Left back Occipital	Pons, mesencephalon Left ventricle (exit 1 x 2 cm) Brain stem, cerebellum	Near contact Contact Near contact	
11	m, 32 y	Rifle, .22 lr lead bullet	1. and 2. 3.	Left chest Midline frontal	Left back \	Left lung Temporal brain, cerebellum	Contact Contact	Manual reloading

for drugs was performed when the previous history indicated the possibility of drug abuse. The sequence of the gunshots was determined according to Table 1.

Results

Out of 138 gunshot suicides 11 persons (8%) fired more than one gunshot to the body (Table 2). In eight cases two suicidal gunshots were involved, in two cases three gunshots and in one case five gunshots. In almost half of the cases (5/11), the head was the target for two gunshots and in three cases, the trajectories ($n = 2, 3$ and 5) were restricted to the left chest. A combination of gunshots to the head and chest was present in the remaining three cases. The six cases of injury to the lungs were all restricted to the left side and showed a hemato-pneumothorax up to 2.3 l in case 9. In the three cases of injury to the heart, tamponade was found at autopsy. Small blood stains typical for the droplets from backspatter were found at autopsy on one or both hands in 4 of the 5 cases of multiple gunshots to the head. Backspatter was also present on the right arm in case 8 where five gunshots restricted to the thorax were fired through a shirt (Table 2). The firearms used ranged from three weapons firing .22 lr bullets to one .44 Magnum revolver and two long-barreled hunting weapons and the range of firing was always contact or near contact (Table 2). Except for case 1, all individuals were alone and predominantly at home at the time of the suicide and a suicide note was found in three cases. Blood alcohol was positive in five cases with a maximum of 1.60 g/L (Table 2) and screening for drugs was negative in the four cases investigated. The social and medical history indicated psychiatric disorders in four cases (Table 2).

Of these 11 cases 6 showed special features which warrant a more detailed description:

Case 2: The firearm used was a "drilling", i.e. a combined hunting weapon with two shotgun barrels (16 gauge), one rifled barrel (7.62×51 mm) and two triggers. The trigger at the front has a hair trigger so that the second gunshot could have been fired "automatically" or "simultaneously": either by unintentionally operating the rear trigger immediately after the front trigger ("doubling") or the rear trigger was pulled while the hair trigger was set, which can have enabled the recoil-induced motion of the weapon to overcome the minimal trigger pull weight of the front trigger.

Case 5: The first gunshot shaved the head and caused a tangential trajectory 7 cm in length which was restricted to the scalp but did not affect the skull or brain.

Case 8: The cylinder of the .22 revolver used (Weihrauch, model HW9) can hold six cartridges. After the incident, 5 spent cartridge cases and one unfired cartridge with a firing pin impression at the base were found in the cylinder. Consequently, the trigger was pulled six times but discharged only five gunshots, three of which perforated the truncus of the pulmonary artery.

Cases 9 and 10: In both cases the first gunshot perforated the heart but both persons were able to fire a second gunshot to their head. In case 9, both vestibules and the septum were perforated with the largest injury (exit from left vestibule) measuring approx. 2×3 cm. The exit defect of the left ventricle in case 10 measured 1×2 cm and the entrance defect in the anterior wall was about half that size.

Case 11: The weapon was an old .22 rifle which did not have a magazine. So the suicide was able to manually reload after the first and the second gunshot to the left chest and then fire a third gunshot to the head.

Discussion

Early statistical studies reported that multiple gunshots account for 6–10% of all suicidal shootings (Schrader 1942) while more recent publications state a frequency of 1.3–4.6% (Missliwetz 1977; Eisele et al. 1981; Hudson 1981; Ropohl and Koberne 1990). Compared to this the relative frequency of 8% for multiple gunshot suicides in this study appears to be high. If case 2 is excluded because of the possibility of automatic discharge of the second gunshot, the resulting frequency of 7.2% is still high. One reason may be a negative selection of cases: autopsies are less frequently carried out in obvious suicides than in multiple gunshot suicides. Whereas the thorax was the most frequent target in previous studies (Hudson 1981; Introna and Smialek 1989), the 26 entrance wounds in this series were evenly distributed between the head (13) and the thorax (13). The male sex of the victims, the age distribution, the incidence of alcohol detected in the blood and the frequency of psychiatric disorders do not markedly differ from single gunshot suicides (e.g. Thorsen 1984; Avis 1994). The absence of drugs in the four cases investigated indicates that stimulants are not characteristic for multiple gunshot suicides.

However, this does not explain why individuals are able to fire several gunshots to critical body regions. The crucial question is how does a bullet stop the physical activity of the person it strikes? Reliable incapacitation is based on physiological effects, i.e. tissue disruption which reduces the functioning capability of the central nervous system (CNS). The two sole mechanisms to accomplish this are direct disruption of brain tissue or indirect elimination of the CNS by cerebral hypoxemia from bleeding (Smith 1987; Fackler 1987, 1992; Newgard 1992). Incapacitation from shock waves or "nerve shock" is not supported by experiments or theoretical considerations (Harvey et al. 1947; Fackler and Peters 1991) and the momentum transferred to the victim does not cause displacement or knock down (Fackler 1992; Karger and Kneubuehl 1997). High energy deposit is an abstract value which neglects not only the target area but also features essential to the missile-tissue interaction such as the wounding mechanisms or the tissue properties (Fackler 1988; McPherson 1994). Hampered physical activity but not incapacitation may be produced by injuries to sensory or optical areas of

the CNS, to the spinal cord and large peripheral nerves or to static structures such as long bones or joints.

Direct injury to certain CNS centres essential for physical activity will cause immediate incapacitation. Such "targets of immediate incapacitation" are the upper cervical spinal cord, the brain stem, the cerebellum, large parts of the diencephalon and midbrain including the basal ganglia, the motor cortex and major paths of motor conduction such as the capsula interna (Karger 1995 b). But the confined space provided by the unyielding walls of the skull results in high intracranial peak pressures in the range of 100–2000 kPa (Watkins et al. 1988), which can greatly increase the extent of intracranial wounding compared to non-confined tissue (Karger 1995 a). Therefore, it is not necessary for the projectile to directly hit the targets of immediate incapacitation if intracranial pressure effects damage these areas sufficiently in the form of cortical contusion zones or intracerebral hemorrhages (Karger 1995 a).

In the five cases reported involving two gunshots to the head, all the bullets which were fired first did not penetrate the neurocranium. Consequently, even the use of powerful firearms such as a 16 gauge shotgun or a .44 Magnum revolver did not incapacitate the victim, particularly since commotio cerebri is not possible in craniocerebral gunshots (Karger 1995 a). Introna and Smialek (1989) also reported three cases of two or more gunshots to the head where all but the last one missed the brain. But a considerable number of multiple craniocerebral gunshots have been reported and are therefore compatible with continuing physical activity. When 35 case reports of intracerebral trajectories not resulting in immediate incapacitation were reviewed, 28 trajectories were confined to the frontal brain and the remaining 7 were mostly from bullets causing very limited tissue disruption which missed targets of immediate incapacitation (Karger 1995 b).

Acute cerebral hypoxemia can be caused by massive blood loss with subsequent circulatory depression and unconsciousness. But immediate circulatory arrest is very rare in cardiac or vascular gunshot wounds and even if this occurs, the oxygen stored in the CNS ensures a potential for physical activity for about 10 s (Newgard 1992; Fackler 1992). Therefore, trajectories involving the heart, the aorta (especially in the thoracic region) or the truncus of the pulmonary artery can cause rapid incapacitation ("targets of rapid incapacitation") but they cannot be relied upon to terminate the physical activity of the victim immediately (Fackler 1987, 1992; Newgard 1992). The latent period until incapacitation in cases of considerable injury to large arteries or veins, the lungs, liver, kidneys or spleen will be substantially longer. The slower rate of bleeding and circulatory compensation mechanisms (Newgard 1992) usually offer the potential for sustained physical activity in the range of one or several minutes ("targets of delayed incapacitation").

Of the cases presented, six involved one or more gunshots to the thorax without immediate incapacitation. In three cases (cases 6, 7, 11), the trajectories ($n = 5$) were restricted to targets of delayed incapacitation, mainly to

the lungs without involvement of the pulmonary artery. A considerable number of similar cases have been published (e.g. Spitz et al. 1961; Levy and Rao 1988; Introna and Smialek 1989). A perforating wound of the heart up to 2×3 cm in diameter did not prevent two victims from discharging a second gunshot to the head (cases 9, 10). In case 8 the truncus of the pulmonary artery was repeatedly perforated, which comes close to a destruction of the right heart. The heart was injured by three .22 bullets in a six-shot suicide (Marsh et al. 1989) and Habbe et al. (1989) reported a nine-shot suicide where seven .25 FMJ bullets lacerated the apex of the heart. Other cases of physical activity following penetrating gunshot wounds to the heart have been published by Spitz et al. (1961) and Levy and Rao (1988). In a "worst-case" scenario described by DiMaio (1985) a man was able to walk 20 m after sustaining a hit from a 12-gauge shotgun from a range of 3–4 m which destroyed his entire heart. Missliwetz (1990) reported a similar direct hit from a shotgun where the man walked a distance of 6 m. These very rare examples of immediate circulatory arrest from gunshot wounds represent indisputable evidence that any person sustaining one or more gunshot wounds to the thorax including the heart possesses the potential for physical activity for at least a short time period. However, this potential for physical activity is not necessarily made use of: 80% of 62 gunshot fatalities collapsed following the assault (Spitz et al. 1961), although it is not clearly stated how promptly they collapsed. Obviously, the mental or emotional state of the victim, especially the expectancy of or being prepared for a hit, play an important role, but this psychological aspect can neither be predicted nor reconstructed because it is unreliable (Smith 1987; Fackler 1992; MacPherson 1994). Determination, adrenalin or chemicals even enable persons to discharge aimed gunshots after sustaining a penetrating heart injury. For example, a victim of a .32 caliber gunshot wound which penetrated the heart, lung and liver managed to fire back and wound the assailant in the chest (Spitz et al. 1961).

These results have practical implications for the investigation of fatalities involving more than one entrance wound. The amount and the location of tissue disruption must be established by an autopsy so that the potential for physical activity following the injury can be estimated. Suicide can only be excluded if injuries to targets of immediate incapacitation are caused by more than one bullet. Examination of the firearm and the bullets can exclude the possibility of a "doubled" gunshot (e.g. case 2), the use of an automatic weapon set on full automatic mode (e.g. Al-Alousi 1990) or the simultaneous use of two firearms (e.g. Rommeney 1942; Fatteh et al. 1980; Hudson 1982). The deposition of soot, powder or backspatter traces on a hand verifies the firing hand or the hand used to steady the muzzle and therefore is a strong indication of suicide (Sellier 1982; DiMaio 1985; Karger et al. 1996). Backspatter of blood was present on one or both hands in 4 of the 5 cases of head shots presented. In all cases in this study and in almost every case in two previous studies (Hudson 1981; Introna and Smialek 1989),

the range of fire was contact or near contact and the entrance wounds were located in the "classical" sites, i.e. head and left/precardiac chest. Therefore, atypical sites of entrance wounds and close range or even distant gunshots suggest homicide in single as well as in multiple gunshot fatalities.

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