

CASE REPORT

PATHOLOGY/BIOLOGY

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Upon a Failure to Equal Entry and Exit Wounds: A Possible Case of Tandem Bullets in View of the Literature

ABSTRACT: Forensic medicine specialists take account of the projectiles remaining in the body when determining whether there are an equal number of entry and exit wounds. The absence of projectiles should suggest blank cartridges, a single exit wound despite several firings and bullet embolization, whereas the presence of more projectiles than expected may indicate tandem projectiles and multiple projectiles entering through the same hole. Radiological examination of the whole body, follow-up of the bullet trajectories, examination of the clothes, and examination of the gun and projectiles play a key role in solving difficult cases. We review such situations based on a case of tandem bullets. Two 7.65-mm bullets created lethal wounds entering through a 32-year-old victim's neck followed the same trajectory to a certain point and diverted. We discussed the possibilities in cases that show inequalities between entry and exit wounds, in light of relevant literature.

KEYWORDS: forensic science, autopsy, firearm death, entry wound, exit wound, tandem bullet, bullet embolization

Forensic medicine specialists do not have difficulty in determining the cause of death in cases of firearm injuries at autopsy. In fact, autopsies of such cases are important in that they reveal information and evidence about how the crime was committed. Detection of entries and exits of bullets, following the trajectories, and finding and keeping the projectiles remaining in the body are of great importance in terms of solving forensic cases. Forensic medicine specialists perform the aforementioned procedures at autopsy and mostly reach the following formula:

$$\text{Entry wounds} = \text{exit wounds} + \frac{\text{the number of projectiles recovered from the body}}{\text{recovered from the body}}$$

However, sometimes situations that confuse forensic medicine specialists may arise. Therefore, we will present a case of two bullet wounds but three bullets in the body found at autopsy in light of the relevant literature. The main purpose of this article is to discuss all possibilities and ways of thinking in cases that show inequalities between entry and exit wounds, using a tandem bullet case, rather than presenting it. The Scientific Board of Council of Forensic Medicine reviewed and approved publication of this case.

Case

A 32-year-old man dying from a firearm injury was found to have two entry wounds:

- A wound 5 cm below to the lobule of left auricle surrounded by an abrasion ring.
- A wound at the level of the beginning part of the sternocleidomastoid muscle under the chin on the left side of the neck

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surrounded by ecchymosis, abrasion ring, and powder tattoo in the inferior and the posterior.

Radiological examination of the body showed a total of three bullet images—two bullet images on the head and one bullet image on the right breast.

Examination of the internal organs revealed that the bullet entering through wound 1 traveled inferior and anterior from left to right; injured vena jugularis externa and bifurcation of left carotid externa at the left side; broke the left clavicle and lodged in the right side of the anterior chest. A jacketed, deformed bullet with rifling marks was obtained from this region.

Two bullets were found to enter the body through wound 2 consecutively, traveled superior, posterior and interior, struck the base of the left petrous bone, from which the bullets diverted inside the bone because of the billiard effect. One bullet entered through the midcranial fossa and the left temporal lobe into the brain tissue and lodged in the left side of the brainstem and the other bullet traveled to the right and upward, created a hollow in the bony structures, entered into the cranial space through the right cellar region, cut the right frontal lobe, ruptured the skull in the frontoparietal region, and lodged in the scalp (Fig. 1). The base of the bullet removed from the brainstem was open and enlarged and one side of its base was smashed. The bullet removed from the scalp was jacketed, its tip was slightly smashed, and there were rifling marks on it (Fig. 2).

Examination showed that all three projectile bullets had a diameter of 7.65 mm and were similar in terms of rifling marks under microscopic examination. As a result, all three projectile bullets were reported to have been fired from a fully automatic or a semi-automatic gun. The gun was not sent to our council for ballistic examination by the court; so, we do not have detailed information about the properties of the gun. Blood and urine samples were not found to contain alcohol and other toxic substances.

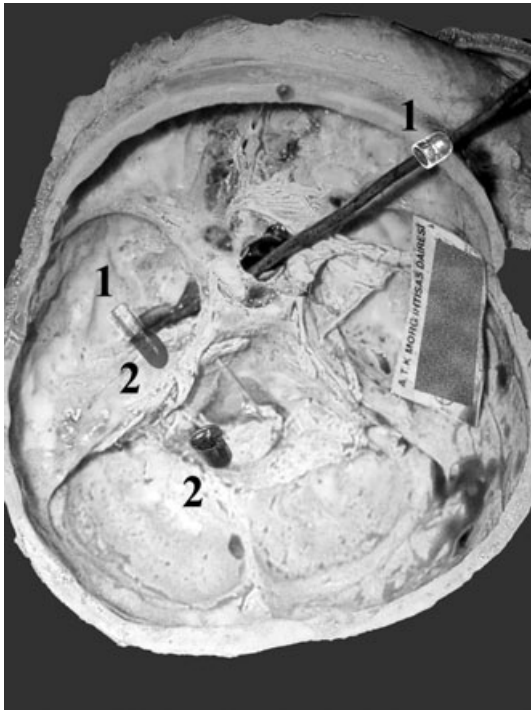


FIG. 1—Trajectories of two different projectiles. Two tandem bullets entered through the neck, traveled upward, backward, and then inward and reached the left lateral of the sella turcica, where they hit the interior wall of the petrous bone and diverted to two different directions. One bullet (number 1 in the figure) traveled to right, anterior, and upward and created a channel reaching the sella and stopped at the top of the right head. The other (number 2 in the figure) perforated the petrous bone and remained in the posterior fossa. The trajectory of the first bullet is shown by a metal stick passing through it.

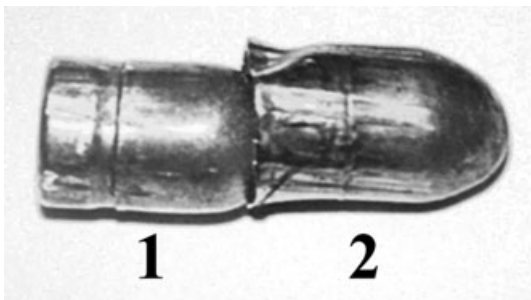


FIG. 2—Note the two tandem projectiles. Although they do not express the characteristic appearance of piggy-back arrangement completely, they fit each other, partially. Secondary impacts (like petrous bone for this cases) may affect the appearance. Note the widening at the base of the frontier bullet (number 2) and the shortening of length on bullet at the rear (number 1).

In conclusion, the body had two bullet entries, and all three bullets entering through these wounds remained in the body, and both wounds were lethal.

Discussion

Upon a failure to equal bullet entry and exit wounds, one can assume that the bullets have remained in the body and mostly this is the case. However, not only are the number of bullet entries and the number of bullet exits equal, but also fewer or more projectiles can be detected in the body than expected. These types of

inequalities may result from many combinations of conditions and may lead to difficulties in breaking cases.

One frequent condition is that after the projectiles enter and exit the body, they re-enter the body, which creates a new entry wound. Autopsy studies have frequently revealed such cases, which have been reported in the literature (1,2). In these cases, there are at least three different lesions and at first it may be difficult to distinguish entry wounds from exit wounds. A careful follow-up of the trajectory is necessary to shed light on the cases.

Another alternative is blank cartridge and tear-gas cartridge cases. In these cases, there are no projectiles or any objects projected, and the only thing responsible for the damage is hot compressed gas (3–5). In fact, it causes lacerations and burns in the skin and the tissues below, but no exit wounds or projectiles are detected. In addition, these wounds have irregular trajectories, which are not very deep. It is expected that entry wounds are contact wounds, and therefore, fumes and remains of the gunpowder are frequently present below and around these wounds (5).

The third alternative is that a spent bullet lodges in the entry hole and then falls out. To our knowledge, there have been no such cases published. However, it is known that bullets may fall out of the body in the crime scene in pathological practice. Finding that bullet in the crime scene or in the body bag will help to break the case. Unlike the earlier case, Grey (6) reported an unusual condition in which the bullet entered through the temporal region, ricocheted off the internal surface of the bone in the left part of the cranium, traveled back through the same trajectory, and exited the entry hole. Grey (6) also noted that a bullet was found in the crime scene and that evidence on the bullet and the gun supported the findings.

Another condition often reported in the literature is the cases in which more than one bullet enters the body through one hole, and such bullets are called *tandem bullets*. The case present here is also a case of tandem bullets. Sometimes, one of the tandem projectiles may not be a bullet. In fact, Ellis reported a case in which a projectile entered the body in tandem with a barrel-cleaning brush in 1997. In addition, Mihailovic et al. reported a case in which a projectile entered the body in tandem with a nail and a screw (7,8).

There have been other cases in which more than one bullet exited through the same hole. De Giorgio and Rainio (9) described two shotgun pellets converging in the chest wall. In another case reported by Hiss and Kahana (10), two different projectiles entering through the back, traveled toward each other with a decreasing angle, and exited through the same defect. Caution should be exerted with the follow-up of the bullet path so that such cases can be solved.

There have been cases of more than one projectile entering the body through a single hole in the literature, and they have even been documented in the textbooks (11–16). They are also mostly called *tandem bullets*. This is thought to result from a bullet remaining in the barrel although the gun is fired. This bullet will leave the barrel at the tip of the bullet fired later. Transfer of kinetic energy results in both objects moving in a forward direction as a single projectile and a single entry wound would be created. The reason why the bullet remains in the barrel is attributed to failure of ignition to create sufficient discharge speed, which is in turn ascribed to insufficient propellant and loss of its ignition characteristics as in oil infiltration and chemical breakdown of the gunpowder because of age (16). Using homemade cartridge cases and projectiles also increases the likelihood of ignition failure (13). In such cases, the base of the bullet located in front is concave and the tip of the bullet is bent backward (piggy-back arrangement).

Jentzen et al. (17) reported a case in which three projectiles entered through the same hole and traveled from the right temple to the cranial wall and to the right temporal lobe. It was one of the few cases showing that projectiles from different firings are able to enter the body through the same hole. In fact, lack of piggyback arrangement, that is, the base of the projectiles was intact and there were three different muzzle imprints around the entry hole, confirms that three projectiles entered through a single hole. The authors justifiably excluded tandem bullets as the three projectiles were expelled in three different firings, but entered the body through the same hole. However, Simons reported that three bullets removed from the right orbita displayed compatible deformities on their tips and bases and were called *tandem bullets*. Ballistic examination of the gun showed that gunpowder in the bullets was mixed with oil (18). In a case report, Hildebrand first thought two single shots entered through the same bullet hole, but changed his mind in later stages of examinations (19).

Although not directly related to our topic, one should remember that the jacket and the core may enter the body separately as a result of their separation in high-velocity jacketed ammunitions (20). Although wounds are caused by a single shot in such cases, there will be more than one wound and no difference between the number of wounds and the projectiles will be detected.

Another condition that should be kept in mind is bullet embolization. Bullet and pellet particles may enter the vascular system and may cause vascular emboli. Similarly, spent bullets entering the cranial parenchyma may migrate within the parenchyma depending on gravity and may not be seen on the site they were first detected on radiography (21,22). So, a forensic pathologist does see the wound but does not find the bullet at first glance. Although such migrations are rare in practice, they may be confusing for forensic pathologists. In a study on the soldiers wounded in Vietnam, 0.3% of 7500 fire-arm injuries caused bullet emboli (23). There have been many case reports showing that projectiles entering the caval system or the subclavian veins migrated to the right ventricle and the lungs, whereas particles entering through the thorax to the pulmonary veins and the left ventricle caused emboli in the peripheral arterial system, even in the coronary artery (24–29). In an unusual case of an injury in the neck, a bullet was reported to migrate as a result of swallowing (30). In such cases, the inability to locate the bullet in the expected site may cause difficulties in the interpretation of the location of the bullet. Therefore, the whole body should be exposed to a radiological examination and bullet trajectories should trace carefully.

As for the general characteristics of the case presented here, two bullets entered through the wound numbered 2 and followed the same trajectory to the petrous bone and when the bullet in front stuck in the petrous bone, the other one hit it. Then, depending on a billiard effect, the bullets diverted from their route. The bullet at the back traveled to the right and upward and lodged in the scalp. The bullet in front traveled slightly to the left and lodged near the brainstem. The fact that these two bullets entered the body through the same hole can be explained in two ways:

- They might have been tandem bullets, discharged through a single shot, crashed at the petrous bone, and diverted from the bone.
- Two separate shots might have entered through the same bullet hole and two bullets crashed at the petrous bone and diverted from the bone.

We are in favor of the former explanation based on the following data:

- Even if the bullets had been fired separately and entered the body through the same wound, the likelihood for the bullets to travel

through the same path would have been low. Jentzen et al. (17) found out that three shots fired separately followed three different paths in the body. However, tandem bullets are expected to cause a single trajectory (31). In the case presented here, there was a single trajectory till the petrous bone, where the trajectory was divided into two. If there had been two trajectories from the same entry wound, this might have suggested two different shots entering through a single wound, not tandem bullets.

- The base of the bullet in front was open, which may have resulted from the crash within the barrel. However, the tip of the bullet at the back did not have a defect matching with that of the bullet in front. We can attribute the deformities on the lateral and the distal parts of the bullet in front and on the lateral and the distal parts of the bullet at the back to the crash around the petrous bone.

Failure to know that a gun was found in the present case can be considered as a limitation. Finding the gun can provide evidence necessary to solve the case. In some cases of tandem bullets, it has been reported that a bullet incompatible with the gun was used. In addition, it has been claimed that using a bullet incompatible with the gun, such as a smaller one, allowed pressure and gas emerging after a shot to escape through the space between the bullet and the barrel, which prevented a deformity in the barrel. This assumes great importance in that a bullet remaining in the barrel may create higher pressure in the next shot and expand and perforate the barrel (18). If the barrel is not damaged, tandem bullets are more likely to occur. Detection of an incompatibility between the size of the bullet and the barrel may be useful in solving cases.

It is also of importance to determine the shooting range in terms of differentiation of cases. Two single shots at a long range hardly enter through the same wound. In such cases, one has to accept that bullets have left the barrel simultaneously. However, in near- and close-range shootings, the bullet trajectory should be carefully followed. A single trajectory is suggestive of tandem bullets and more than one trajectory and lack of piggy-back appearance suggest separate shots.

In conclusion, when there is a mismatch between the number of entry and exit wounds and the number of bullets lodged in the body, an autopsy should involve the following parameters:

- Radiographic examination: lack of a projectile as opposed to expectations or the presence of projectiles more than expected will guide autopsy. Radiological examination of the whole body, not only the wound, should be performed.
- Examination of clothes: It is important to determine the number of shots and to detect remains of a shot. Examination of clothes and/or wound is necessary to estimate the shooting range.
- Measures and description of the wound.
- Careful tracing of the trajectory: tandem bullets follow the same path.
- Removal of the projectiles lodged in the body: sometimes, a case in addition to a bullet can be recovered in tandem bullet cases (15).
- Comparison of physical characteristics of projectiles: Piggy-back arrangement is in favor of tandem bullets. When they are excessively deformed, pieces of bullets and pellets should be weighed, which helps to determine how many projectiles or shotgun shells they belong to (32).

Tables 1 and 2 show a comparison of the cases we have referred to here in terms of the aforementioned criteria. As shown in the tables, tandem projectiles may appear when both shotguns and handguns are used, and various combinations of bullets and

TABLE 1—Features of injuries and number of projectiles determined on operations and at autopsies. The number of the bullets entering the same wound is given in the column "Number of related projectiles."

Article	Entry Wound Versus Exit Wound	Number of Projectiles in the Body	Number of Related Projectiles	Number of Trajectories in the Body	Number of Muzzle Imprints on the Skin	Location of Wound	Soot, Gunpowder Residue
Rothschild (4)	1 to 0	0	—	1 (irregular defect)	1	Chest	+
Clarot (5)	1 to 0	0	—	1 (irregular defect)	Not described	Head	Not described
Grey (6)	1 to 0	1 from scene	—	1	—	Head	+
Hiss (10)	2 to 1	0	—	2	—	Trunk (back)	—
Lilienstein (15)	1 to 0	3	3	Unknown	Not described	Chest	Not described
Jentzen (17)	1 to 0	3	3	3	3	Head	+
Simmons Case 1 (18)	1 to 0	3	3	1	—	Head	—
Simmons Case 2 (18)	1 to 0	Multiple	2	1	—	Thigh	—
Ellis (7)	1 to 1 (incomplete)	2	2	1	—	Head	Not described
Bentley (13)	1 versus 0	2	2	1	—	Chest	On clothes
Mihailovic (8)	1 to 0	3	3	One common channel, later splits two separate channels	—	Neck	+
Our case	1 to 0	3	2	One common channel, splits two separate channels after striking to bone	1	Neck	+

TABLE 2—Features of guns and projectiles and deformations on projectiles in cases described in Table 1.

Article	Gun	Projectile 1 (Loaded Projectile)	Projectile 2 (Striking Projectile)	Deformities of Projectile		
				Loaded	Striking	Intermediate
Rothschild (4)	8-mm Gas pistol	Blank cartridge		—	—	—
Clarot (5)	8-mm Gas pistol	Tear-gas (blank) cartridge		—	—	—
Grey (6)	Not described	Not described		One bullet with heavy deformity		
Hiss (10)	Unknown			—		
Lilienstein (15)	.38-caliber pistol	Two bullets were retained in body Only a .32-caliber shell casing recovered		Side deformity on shell case Unknown bullet	Unknown	—
Jentzen (17)	.22-caliber revolver handgun	.22-caliber (three bullets)			1. Intact tip, intact base 2. Splitting of tip, intact base 3. Marked deformity on tip, intact base	
Simmons Case 1 (18)	.32-long-caliber revolver handgun	.32 caliber (three bullets)		Deep indentation	Physically normal	Deep indentation
Simmons Case 2 (18)	Nonrecovered shotgun	20-gauge shotgun case	12-gauge shotgun case	Deep excavation in shell fragments	Separated to fragments	—
Ellis (7)	.22-caliber rifle	Barrel-cleaning brush	.22 caliber	Not described	Not described	—
Bentley (13)	9-mm pistol	9 mm	9 mm	Concave base	Flattened head	—
Mihailovic (8)	7.9-mm rifle	1 screw 1 nail	Undetermined	Undetermined	Undetermined	—
Our case	Unknown	7.65 mm	7.65 mm	Excavated deep and side deformities	Lateral deformities in the nose	—

projectiles entering, traveling, and lodged in the body can be detected. Therefore, one cannot consider special combinations of bullets or locations of bullets in the body in the cases reported so far as a risk factor. Forensic specialists should keep all the alternatives listed in the foregoing paragraph in mind when facing a firearm injury, which will facilitate solving cases.

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