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## Bullet Embolism: Six Cases and a Review of the Literature

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A peripheral embolus of a bullet following a gunshot wound of a major artery or the heart is a rare occurrence. Perusal of the literature reveals only 44 cases of arterial bullet embolus since 1885 [1-20]. We have encountered six cases in Brooklyn, New York, in the past five years. The rarity of this entity prompts this report and review of the literature.

### Case Reports

#### *Case 1*

A 23-year-old Negro man was admitted to a hospital with a gunshot wound of the left chest. On admission, the blood pressure was unobtainable and the pupils were non-reactive. Prior to surgery, the patient experienced two cardiac arrests from which he was resuscitated. In the operating room, he experienced a third cardiac arrest and a left thoracotomy was performed for internal cardiac massage. The heart beat was restored but blood pressure remained unobtainable. A liter of blood was removed from the left pleural cavity. The abdominal cavity was opened and found to be filled with blood. A wound of the spleen was discovered and a splenectomy was performed. The patient experienced a final cardiac arrest and was pronounced dead 3 h and 10 min after admission to the hospital. An X-ray of the abdomen during surgery had failed to reveal the bullet. At autopsy, there was a bullet wound of entrance in the chest in the left anterior axillary line. The bullet had fractured the fifth and sixth ribs and perforated the left lower lobe of the lung. It had continued through the diaphragm, the spleen (removed at surgery), and the stomach, penetrated the abdominal aorta and was carried to the right femoral artery. A caliber—.38 Special bullet weighing 155.4 grains was recovered from the right femoral artery, 2 in. below its origin.

#### *Case 2*

A 41-year-old Negro man was admitted to the hospital with a gunshot wound of the left side sustained 1½ h previously. An exploratory laparotomy revealed perforating bullet wounds of the small bowel and the right external iliac artery and vein. The patient experienced a cardiac arrest and was pronounced dead 1½ h after admission. At autopsy, the gunshot wound of entrance was located in the left upper quadrant of the abdomen

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2 in. to the left of the midline just above the level of the umbilicus. The bullet was recovered from the distal portion of the right femoral artery. It was identified as a caliber—.22 short hollow point bullet, weighing 27.3 grains.

#### *Case 3*

A 27-year-old Negro man was shot twice during an altercation. On admission to the hospital, he underwent an exploratory laparotomy for a gunshot wound of the abdomen. He died during the procedure. At autopsy there were two gunshot wounds of the body. The first wound, located in the forehead, extended only through the subcutaneous tissue. No bullet was recovered. The second bullet wound was in the left side of the abdomen. The bullet had perforated the colon and several loops of small bowel. Because of the surgical intervention, the entrance site of the bullet in the arterial system could not be located. A caliber—.22 short bullet weighing 26.9 grains was recovered from the left femoral artery.

#### *Case 4*

A 22-year-old Negro man was shot in the chest during an altercation on the street. He was dead on arrival at the hospital. At autopsy, there was a gunshot wound of entrance in the left chest. The bullet was found to have perforated the sternum, heart, and vena cava entering the thoracic aorta. A caliber—.22 short bullet weighing 27.6 grains was recovered from the distal portion of the right femoral artery.

#### *Case 5*

A 23-year-old white man, serving as a private guard, was shot and killed while trying to break up an altercation. At autopsy, there was a gunshot wound of the left upper quadrant of the abdomen. The bullet had perforated the small bowel and entered the lower abdominal aorta. The bullet, a caliber—.22 short, lodged in the midportion of the right femoral artery.

#### *Case 6*

The deceased, a 52-year-old Negro man, was shot and killed in a grocery store. The bullet had perforated the left upper arm and entered the left axilla in the anterior axillary line. It then perforated the left upper lobe of the lung and entered the arch of the aorta. A caliber—.22 long rifle bullet weighing 38 grains and flattened on one side, was found lodged in the proximal portion of the right femoral artery.

### **Discussion**

Arterial embolism of a bullet is a rare occurrence. It should be suspected whenever there is a penetrating bullet wound with failure to discover the bullet in the expected region. The clinical diagnosis is strongly suggested if the patient has symptoms of acute ischemic pain in an extremity after being shot. Absence of a peripheral pulse on physical examination tends to confirm this diagnosis. From a medicolegal viewpoint, bullet embolism is extremely important as recovery of the bullet may be necessary for ballistic comparison.

In 1951, Keeley published a case report of a bullet embolus with a resume of the literature [1]. He summarized 21 cases of peripheral arterial bullet embolus from 1885 to 1951, as well as one case of a shell fragment embolus. Since Keeley's report, 22 additional cases of bullet embolus have appeared in the English speaking literature [2-20]. A summary of these cases is given in Table 1. Cases of missile fragment embolus other than bullets, bullet emboli following venous wounds, and embolism into the pulmonary circulation are excluded. The cases which we have personally encountered in the past five years are summarized in Table 2.

TABLE 1—Summary of twenty-two reported cases.

Reference	Entrance	Embolus Site	Caliber/Weapon	Outcome
2	Thorax	Rt Femoral a.	9 mm	Survived
3	Heart	Iliac a.	pistol	Survived
4	Heart	Multiple sites	.410 shotgun	Survived
5	Abdominal aorta	Lt femoral a.	rifle (?)	Died
6	Heart	Rt axillary a.	.45	Survived
7	Thoracic aorta	Rt posterior tibial a.	.22	Survived
8	Thoracic aorta	Rt popliteal a.	.22	Survived
9	Heart	Rt common iliac a.	.32	Survived
10	Thorax	Lt posterior tibial a.	.22	Survived
11	Abdominal aorta	Lt popliteal a.	.22	Survived
	Lt comm iliac a.	Lt popliteal a.	.38	Survived
	Thoracic aorta	Rt iliac a.	?	Died
12	Thorax	Rt profunda femoris a.	.22	Survived
13	Thoracic aorta	Lt. femoral a.	.22	Survived
14	Heart	Rt brachial a.	air rifle	Survived
15	Heart	Rt profunda femoris a.	.22	Died
16	Heart	Rt Common carotid a.	.32	Survived
	Thoracic aorta	Lt anterior tibial a.	?	Died
17	Thoracic aorta	Lt popliteal a.	.22	Survived
18	Thorax	Rt internal iliac a.	pellet	Survived
19	Neck	Lt middle cerebral a.	shotgun	Survived
20	Thoracic aorta	Rt popliteal a.	.22	Survived

TABLE 2—Summary of authors' cases.

Entrance	Site of Embolus	Caliber/Weapon	Outcome
Abdominal aorta	Rt femoral a.	.38 Special	Died
Rt iliac a.	Rt femoral a.	.22 short	Died
Abdomen	Lt femoral a.	.22 short	Died
Thoracic aorta	Rt femoral a.	.22 short	Died
Abdominal aorta	Rt femoral a.	.22 short	Died
Thoracic aorta	Rt femoral a.	.22 long rifle	Died

The 28 cases reported in Tables 1 and 2 were reviewed to see what conclusions, if any, could be drawn from them. Of the 28 victims, all were men. The specific site of entrance into the arterial system was visualized and described in most of the reports. Table 3 gives the distribution of entrance sites into the arterial system for 22 of these cases. In the six remaining cases, only the general area of penetration was specified: the neck and abdomen in one case each and the thorax in four cases. While embolism usually occurs immediately following entrance of the bullet into the circulation, a significant delay can nevertheless occur. Keeley, described three such cases, the longest delay being 26 days after entrance into the vascular system [1]. In Sommer and Wongthongsri's case, the bullet was initially lodged in the right sinus of Valsalva [12]. Twenty days later it was dislodged by the tip of a catheter during cardiac catheterization, the bullet finally lodging in the right profunda femoris artery.

The site of lodgement of a bullet embolus is predominately a lower extremity. Of the 28 cases, embolism was to a lower extremity in 23 instances and to an upper extremity in only 2 of the cases. In the remaining three cases, there were emboli of a shotgun pellet to the brain [19], a bullet to the neck [16], and multiple shotgun pellets to the upper extremities and internal carotid arteries [4]. In the review by Keeley, embolism to the lower extremities was predominately to the left side: 14 cases to the left iliac and femoral arteries compared to 2 cases to the right iliac and femoral arteries [1]. This high incidence of

TABLE 3—*Documented entrance sites.*

Entrance Site	Number of Cases
Thoracic aorta	9
Heart	7
Abdominal aorta	4
Left common iliac a.	1
Right external iliac a.	1
Total	22

embolism to the left side was explained as being due to the small angle at which the left iliac artery takes origin from the aorta. Thus, the left iliac artery nearly approximates a direct continuation of the aorta. Twenty-three cases of lower extremity embolus were reviewed for this paper. In only one case was the side of embolus not specified. Of the remaining 22 cases, 14 involved emboli to the right side and eight to the left. This is a reversal of the left sided predominance noted in Keeley's paper [1]. It may well be that there is no preference for the right or left side by bullet emboli. Only the accumulation of more cases will settle this point conclusively.

There were ten deaths among the 28 cases reviewed. Seven of these deaths resulted from wounds of the aorta. Garzon and Gliedman [8] referred to a high incidence of aortic wounds in cases where death occurred. Of the 19 deaths reviewed by them, 16 resulted from wounds of the aorta. Our data tend to confirm this observation.

In all the papers reviewed, there was no consideration given to the importance of either caliber or type of weapon. The caliber or type of weapon was specified in 25 of the 28 cases we reviewed. Table 4 lists the causative missiles. Iskeceli [5] describes the weapon in his report as a rifle. However, careful reading of the article suggests that the weapon was in fact, a shotgun. Because of this ambiguity the Iskeceli case is placed in the unknown category in Table 4. Caliber and type of weapon are of interest in that smaller missiles predominate in our series. Caliber—.22 rimfire bullets, shotgun pellets, and airgun pellets were the missiles in 18 of the 25 cases. These bullets and pellets are all small, lightweight, low velocity missiles possessing a low kinetic energy and typically causing penetrating rather than perforating wounds. If these projectiles lose their kinetic energy upon penetration of a major artery or the heart, they will be swept along by blood to their final point of lodgement. Missiles with higher velocities and higher kinetic energies tend to perforate the body. Therefore, unless they have lost considerable amount of kinetic energy before entering the body, they will be less likely to become emboli. In Katz's case [9] the caliber—.32 bullet fired from a revolver lost kinetic energy after ricocheting from a cigarette lighter before entering the body.

TABLE 4—*Causative missiles.*

Missile	Number of Cases
Caliber .22 rimfire bullet	14
Caliber .32 bullet	2
Caliber .38 bullet	2
Caliber 9 mm bullet	1
Caliber .45 bullet	1
Pellet (airgun)	2
Shot (shotgun)	2
Unknown	4
Total	28

Our six cases were all encountered between 1966 and 1971. Prior to this time, a case had never been encountered in 15 years of prior medicolegal experience. One possible explanation for this may be the appearance of large numbers of so-called "Saturday Night Specials" in the 1960's. These weapons are cheaply made firearms mostly chambered for the caliber—.22 cartridges. As discussed previously, the caliber—.22 cartridge possesses a relatively low kinetic energy and is therefore more susceptible than bullets of greater weight and velocity to result in emboli. Five of the 6 cases involved caliber—.22 rimfire bullets.

In view of the cases presented, it is recommended that bullet embolism be suspected and total body X-rays performed in all instances of penetrating missile wounds in which an X-ray or autopsy fail to reveal the projectile in the expected region.

### Summary

Six cases of peripheral arterial embolus are described. The site of entrance in the arterial system was the aorta in four instances and the iliac artery in one. In one case, the site of entrance could not be identified. The bullet lodged in the femoral artery in all instances. A perusal of the literature revealed 44 other cases of peripheral arterial bullet embolus since 1885. A review of 22 of the most recent of these cases, in addition to our six cases, contradicts previous observations that bullet emboli of the lower extremities go to the left side in preference to the right. The caliber, physical characteristics, and velocity of the missile appear to be of importance as causative factors in missile embolism. In 18 of the 25 cases in which caliber or type of weapon was specified, the bullet or pellet was a small lightweight projectile possessing low velocity and low kinetic energy. A projectile with these properties is likely to lose most of its energy within the body, rendering it susceptible for translocation within the arterial system.

### References

- [1] Keeley, J. H., *Journal of Thoracic Surgery*, JTSUA, Vol. 21, 1951, pp. 608-620.
- [2] Movin, R., Russell, J., and Valle, A. R., *American Journal of Surgery*, AJSUA, Vol. 91, 1956, pp. 118-120.
- [3] Ransdell, H. T. and Glass, H., *American Journal of Surgery*, AJSUA, Vol. 99, 1960, pp. 788-797.
- [4] Kinmonth, J. B., Burton, J. D., Longmore, D. B., and Cook, W. A., *British Medical Journal*, BMJOA, Vol. 2, 1961, pp. 1666-1668.
- [5] Iskeceli, O. K., *Archives of Surgery*, ARSUA, Vol. 85, 1962, pp. 184-185.
- [6] Saltzstein, E. C. and Freeark, R. J., *Annals of Surgery*, ANSUA, Vol. 158, 1963, pp. 65-69.
- [7] Williams, D. J., *Journal of Trauma*, JOTRA, Vol. 4, 1964, pp. 258-261.
- [8] Garzon, A. and Gliedman, M. L., *Annals of Surgery*, ANSUA, Vol. 160, 1964, pp. 901-904.
- [9] Katz, G. and MacKenzie, U. F., *South African Medical Journal*, SAMJA, Vol. 40, 1966, pp. 76-77.
- [10] Habein, H. C. and Christensen, R. K., *Rocky Mountain Medical Journal*, RMMJA, Vol. 63, 1966, pp. 36-38.
- [11] Taylor, M. T., Schlegel, D. M., and Habegger, E. D., *American Journal of Surgery*, AJSUA, Vol. 114, 1967, pp. 457-460.
- [12] Sommer, L. S. and Wongthongsri, W., *American Heart Journal*, AHJOA, Vol. 74, 1967, pp. 92-95.
- [13] Stanford, W., Crosby, V. G., Pike, J. D., and Lawrence, M. S., *Annals of Surgery*, ANSUA, Vol. 165, 1967, pp. 139-141.
- [14] Neerken, A. J. and Clement, F. L., *Journal of the American Medical Association*, JAMAA, Vol. 189, 1967, pp. 579-580.
- [15] Fatteh, A., Shah, Z. A., and Mann, G. T., *Journal of Forensic Medicine*, JFOMA, Vol. 15, 1968, pp. 139-143.
- [16] Trimble, C., *Annals of Surgery*, ANSUA, Vol. 168, 1968, pp. 911-916.
- [17] Dillard, B. M. and Stable, T. W., *Archives of Surgery*, ARSUA, Vol. 98, 1969, pp. 326-328.
- [18] Blackford, J., Bowers, J. D., Taylor, P. H., Heydinger, D. K., *American Journal of Surgery*, AJSUA, Vol. 118, 1969, pp. 469-471.
- [19] Van Gilder, J. C. and Coxe, W. S., *Journal of Neurosurgery*, JONSA, Vol. 32, 1970, pp. 711-714.
- [20] Painter, M. W. and Britt, L. G., *American Surgeon*, AMSUA, Vol. 37, 1971, pp. 106-108.

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