

UNUSUAL VENOUS BULLET EMBOLISM - CASE REPORT

Abstract

Bullet embolism is rare complication of penetrating gunshot trauma. We are presenting a case of a single gunshot with entrance wound located on external side of a left thigh. The upward directed trajectory extends to the left lateral side of the neck, but the bullet has been recovered from right external iliac vein. The bullet migration was explained due to one rare variation of the mouth of vena cava superior and inferior.

Key words: Gunshot injuries; Bullet embolism; Autopsy; Forensic pathology.

Introduction

Bullet embolism is an uncommon consequence of penetrating vascular trauma^{1,2} that is often related to serious complication in survivors³. Three types of bullet embolism are known: arterial, venous and paradoxical⁴. Embolization occur twice as often in the arterial than in the venous system⁵, while according to Colquhoun et al.⁶ it is even less frequent in veins. While in veins, bullets more often follow the direction of blood flow, but in some 15% bullets may cause embolization in a retrograde manner moving against blood flow due to effect of gravity or the Valsalva's maneuver^{7,8}.

We present a case of accidental gunshot wound to lateral aspect of left thigh, penetrating upwards through abdominal cavity, diaphragm, and thorax to the left side of neck where internal jugular vein was pricked. Subsequent to arrival into vein's lumen, haven't left it but it went against blood flow causing embolization of right external iliac vein. Medico-legal aspects of missile embolism are discussed in regard to the given case, and a review of literature was performed. The possible explanation for retrograde venous embolization has been discussed and related to rare anatomic variation of heart.

Case report

A 45-year-old man was injured in own apartment; allegedly victim's gun (caliber 6.35 mm) accidentally had fired. The event was witnessed by victim's girlfriend, and his friends. According to the police investigation, victim kept the gun in his trousers, fixed by belt. He was alone in bedroom, and while getting down trousers, the gun accidentally fell on the floor and fired. Following the infliction of gunshot injury to left thigh, the victim finished dressing, went back to dining room where other people were present, took a seat, and collapsed. An ambulance was called immediately. Medical team was only able to pronounce death upon arrival.

Autopsy Findings

Post-mortem examination of was performed on the first day following death. X-ray was not used prior to the autopsy. External examination of the body revealed single gunshot wound on lateral aspect on left thigh, about 84 cm above the heel level. The wound was oval, longitudinally orientated, and its size was 5x7 mm. Abrasion semi-ring was observed below the lower edge of the wound; its width was to 3 mm. Powder residua were detected on the skin surrounding the wound. No other injuries were discovered during external examination.

Body cavities were opened, and left thigh dissected. Subsequent internal examination, with organs *in situ*, revealed that the bullet, after having penetrate through the soft tissues of the left thigh, upwardly had entered into abdominal cavity, passed through colon, spleen and stomach; wound track further advanced through the left hemidiaphragm into the chest cavity, continuing throughout the left lung, and left superior thoracic aperture up to the subcutaneous tissue on the left lateral aspect of neck. Approximately 700 ml of blood was found in the left pleural cavity, as well as 300 ml in the abdominal cavity. Bones has been injured along the wound track.

Neck dissection revealed intensive subcutaneous bruising of the lower part of left lateral region, where laceration, approximately 20 mm long, was noticed on the wall of internal jugular vein. The opposite side of venous wall remained imperforated, although intima was bruised. The overall length of bullet track from entry wound on left thigh to the point of internal jugular vein piercing was 78 cm. Attempts to locate and recover the bullet in the neck, adjacent to the verified damage of left internal jugular vein, or to trace its further penetration, had failed. At that point dissection was stopped, and X-ray was requested.

Radiological investigation did not reveal presence of metal foreign objects in neck and head but indicated presence of metal bullet in right – lower quadrant of pelvis (Figure).

As there was a single gunshot entrance wound, no history of firearm related trauma, and that the wound path was successfully tracked up to the damaged wall of the left internal jugular vein, the only plausible explanation was that bullet embolism had occurred.

Further dissection revealed a bullet that had embolized the right external iliac vein, some 1.5 cm proximal to its origin. At the point where the embolize bullet was retained the vein diameter was approximately 8mm, and its wall was not bruised. Recovered bulled was of 6.35 mm (0.25) caliber, copper jacketed, round nose, without signs of deformation; its weight was 3.25 gram.

These findings leads us to conclusion that the bullet, once penetrated into internal jugular vein, went through left brachiocephalic vein and superior vena cava into right atria of heart, while, from that point, it went retrograde by gravity down inferior vena cava to embolize right external iliac vein. Therefore, while progressing with further organ removal and their dissection, we were looking for signs of trauma produced by migrating bullet on veins and/or in the heart. However, no such signs (e.g. bussing of intima and/or endocard in right atrium) were detected. Still, while examining the heart, we noticed that intervenous tubercle (of

Lower) is rather small (its thickness was 3mm whereas width was 2 mm). Otherwise, no macroscopic pathology has been exposed by examination of the heart.

Other autopsy findings were insignificant. Blood alcohol concentration was 0.85‰ (18.45 mmol/l), whereas toxicological screening of blood and urine samples was negative.

Discussion

For the first time ever reported in 1834, embolization of blood vessels in association with penetrating firearm injuries is considered to be a rare event^{1,5}. Majority of available references on bullet vascular embolization are case studies. There are very few papers reporting on the incidence of bullet embolization, mainly based on several consecutive cases observed^{7,9-14}. Larger cohort studies are even fewer and most of them were monitoring embolization in period of military activities. Rich, et al⁹, in their report on 7,500 casualties from Vietnam war, who sustained vascular trauma, reported missile embolization incidence of about 0.3% (observed in 22 wounded). The incidence of missile embolization after penetrating injury was about 1.1% in the Afghanistan and Iraq Wars (of 346 casualties surveyed)^{9,15}. In civilian setting the incidence of embolization is still unknown and there is an assumption that it is higher¹⁶.

Earlier research showed that smaller bullets with lesser energy are more frequently associated with bullet embolization. Di Maio reported caliber 0.22 to be most commonly associated with bullet embolization, whereas it rarely occurs with larger or faster bullets^{10,17,18}. Likewise, in the case that we are presenting, the bullet was of rather small caliber 6.35 mm (0.25).

The majority of cases describe anterograde migration through the arterial system. Embolization in the venous system is less common, caused by bullets mostly migrating to the right side of the heart or pulmonary artery. Only 4% of missiles were ultimately located in a peripheral vein¹⁹. Combined, antero-retrograde venous embolization is one of the most

uncommon forms, met only in individual cases²⁰. Likewise, there are only a few reports of retrograde migration in this group, with patient position, respiration, and missile caliber identified as contributing factors²¹⁻²³.

The case that we are presenting is in conformity with the previous experiences, since the short 6.35 mm (0.25") missile had penetrated the wall of internal jugular vein, without significant damage on the opposite side of venous wall. After penetrating the vein, the bullet was taken by bloodstream down to the right atrium of the heart. Many factors could cause the missile to lose its kinetic energy and remain trapped in the blood vessel, letting the blood flow to carry it. Missiles of lesser mass and lower initial velocity would have less kinetic energy. In our case, it was a caliber 6.35mm, with mass of 3.2g and relatively low initial velocity of 240m/s, that gives it kinetic energy of 92J²⁴. Besides, there are factors related to the target such as density, strength and elasticity of the tissue penetrated by the missile that could significantly decrease its kinetic energy²⁴.

Trajectory through the soft tissue of left leg, as well as abdominal and thoracic organs further had decreased initially low kinetic energy of the missile in the reported case, so that it was stopped once it had penetrated the wall of jugular vein. Brought by the bloodstream, the missile had reached the right atrium (anterograde part of the path).

Intervenous tubercle (Lower), located at the point where the cava veins are meeting causes the blood descending from the superior vena cava to be turned aside into the auricle, which otherwise would have fallen into the inferior vena cava.²⁵ In the reported case, the existing anatomic variation – small intervenous tubercle (Lower), in our opinion, along with suddenly decrease blood pressure due to hemorrhage caused by the gunshot wound, had contributed the missile to continue its path downward inferior vena cava. Gravity could further contribute to retrograde to bullet migration along inferior vena cava, into the right external iliac vein.

We have determined that at the level where the bullet was located by postmortem X-ray and subsequently reached on dissection, diameter of external iliac vein was bigger than the diameter of the missile. As the missile retrograde movement obviously was not interrupted due to a small lumen the sound explanation might be that change of the position of the victim from upright to sitting could have play a role.

The final position of the embolize missile is determined by initial direction of its trajectory, the caliber, and site of penetration into the vascular system. However respiratory activity and position of the body once the missile had penetrated into the circulation, the gravity, and vascular arborization could have an impact on final position of the embolize missile. Thus missile emboli may have be found in heart chambers ²⁶, big arteries such as pulmonary arteries ^{1, 4, 27} or aorta ²⁸, and small vessels including cerebral or coronary arteries ^{29, 30}, branches of the portal vein ³¹, as well as in peripheral veins ^{20, 32}.

In the presented case the embolization occurred shortly after the gunshot injury had been sustained. On contrary, bullet embolization may be delayed for days, weeks or even years causing an unanticipated event. Further, clinical manifestations of bullet embolization might be delayed as well such overwhelmingly being associated with venous embolization. In 80% of cases, following arterial occlusion by missile or its fragment, peripheral ischemia and pain would appear shortly after embolization ⁷. Contrary to this, two thirds of patients with venous embolization would remain asymptomatic or onset of symptoms may be sometimes delayed for months or even years following firearm injury ^{7, 19, 33-35}.

Although venous bullet embolization can be asymptomatic, the complications can be severe, like cardiac valvular destruction, endocarditis, sepsis, venous thrombosis, thrombophlebitis, and many others. Most experts agree that even with asymptomatic patients it is better to extract projectiles as soon as possible (during first 6 weeks). The risk for extraction in the early reports was quite substantial, with many patients requiring

thoracotomy, or cardiopulmonary bypass. Since the advent of endovascular techniques, more cases of venous bullet emboli could be managed by an endovascular or hybrid approach, or by combining endovascular with surgical techniques^{16, 33, 36}.

Conclusion

In cases of gunshot wounds medical examiners should be persistent in attempt to locate entry and exit wounds. If the exit wound cannot be located, especially in cases of chest gunshot injuries³⁷ and/or in patients with signs of regional ischemia, bullet embolism should be considered. Occasional examples from the surgical practice shows that quick exploratory X ray is necessary and could be a crucial point for the successful treatment of those patients^{22, 38, 39} as well as it can help solving the cases of post-mortem examination.

From forensic point of view in postmortems of firearm related fatalities it is necessary to determine exact trajectory of missile(s). Use of X-ray or post-mortem imaging techniques in cases of fatal shooting without exit wound could be confusing while locating the bullet or its fragments at sites distant from its entry wound. Even though it is well known that initial trajectory of the missile can be altered within the body due to internal ricochet, it should be kept in mind that penetration into the vascular system and missile embolization could have the same effect. Thus it is of paramount importance, beside careful external examination and post-mortem X-ray study, to perform a complete autopsy and trace penetration of a missile, i.e. its trajectory of projectile, necessary for determining the position of the firearm in regards to the body, which in turn suggest position of the assaulter to the victim⁴⁰.

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