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Atypical gunshot wound: Bullet trajectory analyzed by computed tomography

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ABSTRACT

INTRODUCTION: Gunshot injuries are a result of a bullet or projectile fired from a weapon that penetrates the body. Homicide, suicide, and occasionally, accidental events are a significant cause of firearm-related injuries. In rare cases, the damage from the gunshot injury can be masked due to an atypical bullet trajectory.

PRESENTATION OF CASE: A 63-year-old male was found with a gunshot wound to the anterior left knee. Computed tomography (CT) scans revealed a bullet track extending from the anterior aspect of the left knee that traveled cephalad subcutaneously and entered into the peritoneal cavity, perforating the distal descending colon. The bullet was found to be at rest adjacent to the spleen and posterior chest wall, with no injury to the lungs, kidneys or the spleen. The patient required a sigmoid colectomy with descending colostomy and was subsequently discharged home without any complications.

DISCUSSION: Intra-abdominal organ damage from a gunshot wound to the distal limb is a rare occurrence. Atypical gun shot wounds, such as this case, have the potential for multiple issues including: delayed diagnostic tests, inaccurate radiological readings, and inappropriate medical management.

CONCLUSION: If an abnormal trajectory is maintained, it is possible for a bullet to traverse half the length of the body without the patient realizing it. Accurate CT analysis and quick decisions in surgical and medical management are critical takeaways to provide quality care to patients with these injuries.

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1. Introduction

Gunshot injuries are a result of a bullet or projectile fired from a weapon that penetrates the body. Homicide, suicide, and occasionally, accidental events are a significant cause of firearm-related injuries. Due to the amount of force behind these projectiles, it can easily penetrate through soft tissue and organs causing severe damage. Most injuries result in profound morbidity and mortality [1]. However, in rare cases the extent of injury from a gunshot wound can be masked due to an atypical bullet trajectory. Through three-dimensional computed tomography (CT) analysis this case report will examine the atypical trajectory of a bullet and its implication in both medical and surgical management.

2. Presentation of case

In February 2015, a 63-year-old male presented to the emergency room of a community-based hospital with a chief complaint of left lower extremity pain after an accidental, close-range gunshot wound to the left leg. The patient was at home and describes that he dropped a bag that had a gun in it, which caused the firearm to discharge and hit the man in the leg. The entry site was at the anterior portion of the left knee and there was no exit wound that could be found. On physical exam, the patient was conscious and had both motor and sensory nerves intact in all four limbs. He did not complain of any abdominal pain, shortness of breath, or any other discomfort aside from the leg pain. Vital signs were stable and there was no significant bleeding at the site of injury. Immediately, complete blood count (CBC) and comprehensive metabolic panel (CMP) were ordered along with multiple imaging studies including: X-rays of the chest, femur, and knee; CT of the abdomen, pelvis, and head; and a CT angiography of the abdominal aorta and iliofemoral artery. All laboratory findings were within normal limits. CT scan revealed a bullet track extending from the anterior aspect of the left knee that traveled cephalad subcutaneously (Fig. 1) and entered into the peritoneal cavity while

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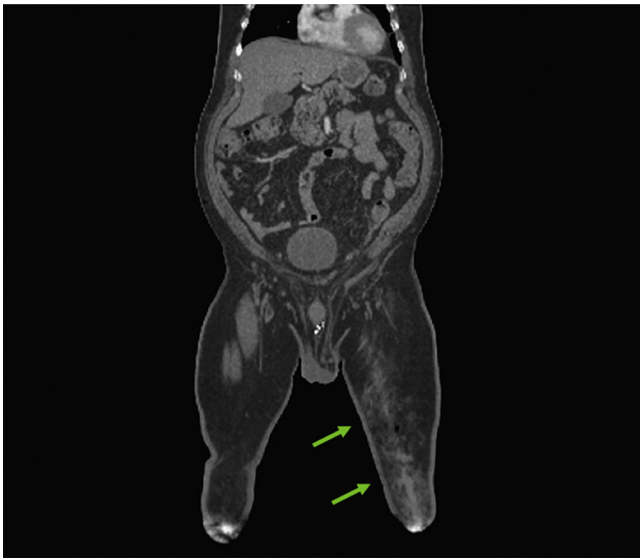


Fig. 1. Coronal view of CT angiography shows a bullet tract extending from the anterior aspect of the left knee and travels cephalad up the left lower extremity in the subcutaneous fat (arrows).

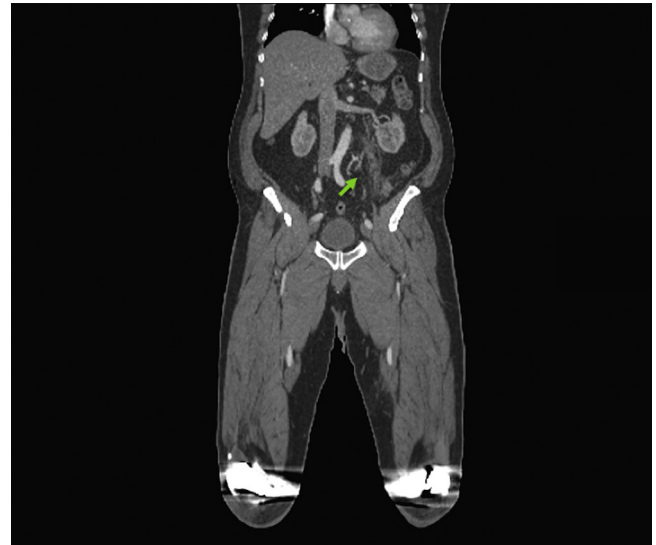


Fig. 3. Bullet tract is shown traveling up through the retroperitoneum posteromedial to the left kidney (arrow).

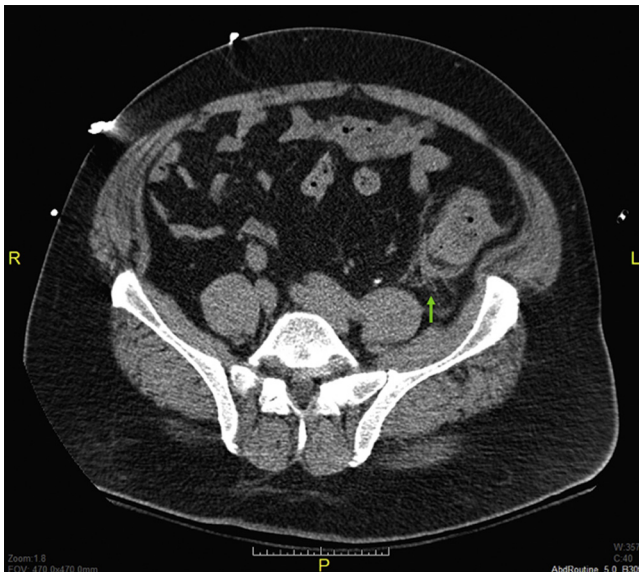


Fig. 2. Axial view shows perforation of the distal descending colon as evidenced by fluid accumulated on the medial side of the descending colon (arrow). Mural thickening of an adjacent portion of the descending colon also suggests a perforated colon.

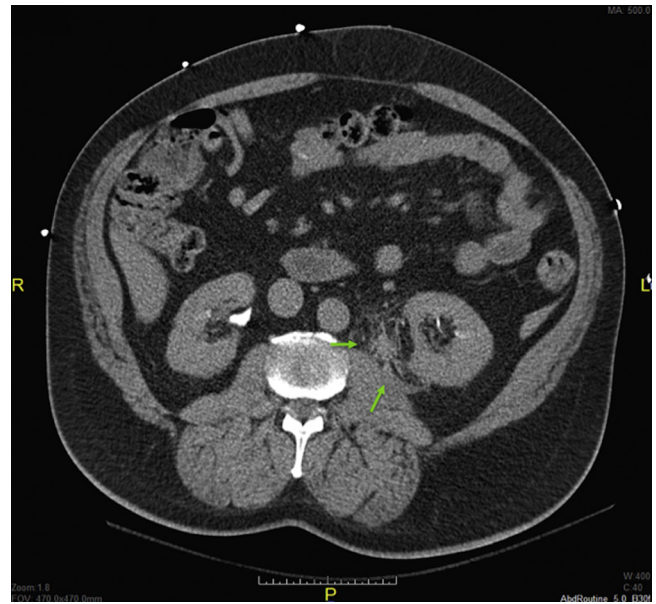


Fig. 4. Axial view shows some mild hematoma and perinephric fat stranding in the retroperitoneum medial to the left kidney (arrows).

simultaneously perforating the distal descending colon (Fig. 2). The track continued to travel up through the retroperitoneal space at a posterior-medial angle (Figs. 3 and 4) and was finally found to be at rest adjacent to the spleen and posterior chest wall (Fig. 5), with no injury to the lungs, kidneys, or the spleen. In the operating room, a chest tube was placed for a minor left hemothorax and subsequent exploratory laparotomy was performed. The trauma surgeon performed a sigmoid colectomy and a descending colostomy without any complications. The patient was seen in clinic and has been doing well. He is awaiting adequate recovery for colostomy reversal soon.

3. Discussion

Quick and appropriate management is important for patients with penetrating injuries. However, this is only possible with

accurate diagnosis. For this patient it was difficult to evaluate the extent of his injuries without having adequate imaging techniques. Since there was no exit wound, it was safe to assume that the bullet was still present in the patient's body. A magnetic resonance imaging (MRI) scan would give greater detail of any soft tissue damage, however, literature has shown that certain bullets have ferromagnetic properties that can cause further damage [2]. Standard of care today indicate that metallic foreign bodies and gunshot bullets adjacent to vital soft tissue structures are a contraindication for MRI. This is due to the risk of secondary dislocation and image degradation from the ferromagnetism properties of the bullet [2]. Therefore CT scans and X-rays were ordered, marginally sacrificing image quality but protecting the patient from any further harm.

Subsequently, this brings up an important area of discussion. Currently, for all gunshot wounds a routine X-ray is typically performed. Indications for a total body CT scan is based on any signs or symptoms of vascular damage or unstable vital signs at the dis-



Fig. 5. The bullet has come to rest in the left chest wall between the left lower ribs immediately posterior to the spleen.

cretion of the tending physician [3]. However, from this case it is important to realize the unpredictable nature of a gunshot wound trajectory, independent from the bullet's entry point on the body. Regardless, if the gunshot occurs without the intention to kill, it has the ability to cause severe vessel damage and furthermore organ damage that may lead to very high mortality rates. Therefore, it is important to recognize that organ damage may not be immediately identified with simple clinical tests and monitoring of vital signs. Therefore, this case challenges current conservative practices with limited imaging tests being ordered. A full body CT scan may be an essential standard of care for gunshot wounds regardless of bullet entry site, especially if an exit wound is not identified. Early imaging tests will be crucial in the setting of these wounds, with the intention for early treatment of all possible wounds before complications occur.

From the coronal section in Fig. 1, we can see that after hitting the anterior left knee, the bullet traveled subcutaneously without causing any major damage. Typically, penetrating traumas of the extremity are considered difficult injuries to manage due to potential major arterial or nerve damage [3,4]. However, overall survival is high despite long-term impairments from injury [5]. Although the patient in our case was hemodynamically stable and passed the neurological exam, it was important to determine if all the structures of the leg were also intact. One key takeaway from this case is not to delay ordering the CT angiography. CT angiography is a reliable imaging test for penetrating injuries and is becoming the primary diagnostic tool of evaluating stable patients with suspected vascular injuries [6,7].

Injuries to the abdominopelvic cavity can have very serious consequences. Vital organs and large vascular structures are vulnerable, and trauma to these areas leads to high mortality rates [8]. Fig. 2 demonstrates the damage a high-speed projectile can do in the abdominal cavity. Although ultrasound (also referred to as FAST: focused assessment with sonography for trauma) has become a useful tool to make quick decisions for penetrating abdominal injuries, CT has still been regarded a critical diagnostic tool [9]. CT with IV contrast can accurately identify hepatic lesions, splenic lesions, kidney lesions, hemoperitoneum, pneumoperitoneum, bowel lesions, urogenital lesions, hematoma, and intra-abdominal vessel injuries [10].

If peritoneal penetration by a bullet is suspected, exploratory laparotomy is indicated [11,12]. When dealing with destructive

colon injuries, defined as a lesion that involves destruction or ischemia of more than 50% of the colon's circumference, immediate colectomy is standard of care for trauma surgeons [13]. Although primary repair with immediate anastomosis avoids colostomy and a secondary procedure, research has shown there can be many complications associated with it. Although some debate remains whether primary repair, delayed anastomosis, or diverting colostomy is the best option, scientific literature has supported that diverting colostomy with a future colostomy reversal has a good outcome for the patient [13–16].

A small percentage of about 15–20% of gunshot wounds to the chest require open thoracotomy procedures [17]. Hemothorax, hemopneumothorax, and pneumothorax are the most common complications. Most wounds are adequately managed conservatively with tube thoracostomy, airway management, and blood replacement. In cases where initial drainage from the chest tube exceeds 1000 mL there is a high risk of major vascular injury and blood clot formation in the pleural cavity, indicating a possible thoracotomy [18]. Fortunately for the patient in our case, there was no organ or vascular damage and a minor hemothorax was adequately drained with chest tube placement.

4. Conclusion

Atypical gun shot wounds, such as this case, have the potential for multiple issues including: delayed diagnostic tests, inaccurate radiological readings, and inappropriate medical management. If an abnormal trajectory is maintained, it is possible for the bullet to traverse nearly half the length of the body without the patient ever realizing it. Ordering full body CT scans and making quick decisions in surgical and medical management are critical takeaways to provide quality care to patients with these injuries.

Conflicts of interest

None.

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None.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images.

Ethical approval

This case report did not require approval from an ethical committee.

Author contributions

Tae Ro contributed as the main writer of this manuscript. Richard Murray, Dan Galvan, and Muhammad H. Nazim contributed to the diagnosis, treatment, and interpretation of the case. Muhammad H. Nazim was the senior author and guide for this paper.

Research registry

N/A.

Guarantor

Tae Ro and Muhammad Nazim.

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