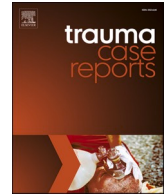




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The trajectory of a low-velocity bullet from the chest to the pituitary gland

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ABSTRACT

The diagnosis and treatment of gunshot injuries requires an understanding of the trajectory of the bullet in each individual case. The majority of gunshot wounds present with easily understandable trajectories resulting in a concise, stream-lined work-up. Occasionally, the initial work-up may reveal a trajectory that is atypical. This can be due to internal bullet deflection, bullet embolism, or bullets that traverse multiple body cavities. Here we present the case of a gentleman who was shot in the left posterior chest, with the bullet ultimately lying-in profile with the patient's pituitary gland. The patient suffered injuries to his left lung, left internal jugular vein, and right optic nerve. On hospital day 1, he required neurosurgical operative intervention for increased somnolence and computed tomography findings which revealed tension pneumocephalus. On hospital day 15, he was discharged home after making a full recovery with the exception of continued blindness in the right eye. Gunshot wounds involving multiple body cavities can increase the complexity of a patient's injury pattern and require increased vigilance and complete history, physical examination, and imaging to ensure optimal outcomes.

Introduction

Injury secondary to penetrating trauma is directly related to the trajectory of the offending object. While stab wounds typically produce a more predictable injury pattern, gunshot trajectories can be more irregular. High energy projectiles can ricochet, fragment, and deform surrounding tissue, creating a missile trajectory that is far from the straight line one might expect. Here we present a patient's gunshot wound resulting from a bullet entering the posterior left chest, traversing the neck, and ultimately residing intracranially. Along with this atypical trajectory, the patient's clinical presentation added to the novelty of this case.

Case presentation

A 56-year-old male sustained a gunshot wound to the left posterior chest after being ambushed by a group of individuals while he was sitting in the driver seat of his car. At presentation to the hospital, the patient was alert with a Glasgow Coma Scale of 15; however, he was hemodynamically unstable with a heart rate of 144 and a blood pressure of 89/59. The patient complained of shortness of breath, pain at the site of his entry wound, and right eye blindness. Initial examination revealed a single left posterior chest entry wound, significant bleeding from bilateral nares, decreased breath sounds on the left side, and a non-expanding left-sided neck

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hematoma. The patient was neurologically intact other than complete vision loss in the right eye. Due to the patient's hemodynamic instability, a left-sided chest tube was placed with 700 cc of blood evacuated immediately. In addition, two units of packed red blood cells were transfused which resulted in normalization of his vital signs.

A subsequent chest X-ray revealed a retained hemothorax with no missile visualized. Since the patient had one gunshot wound to the chest and the missile was not located on the initial chest X-ray, the process of finding the missile was initiated. With the patient's initial complaint of right eye blindness, the decision to X-ray the neck and head was made. A plain film of the neck revealed a missile in the midline that appeared to be intracranial. Computed tomography (CT) of the chest demonstrated a left-sided 8th rib fracture, a moderate retained hemothorax, and pulmonary contusion (Fig. 1). CT angiogram of the neck showed a likely injury to the left internal jugular vein and a large intramuscular hematoma of the sternocleidomastoid (Fig. 2). CT of the brain showed a trajectory through the inferior and superior walls of the right sphenoid sinus, with the bullet's final resting spot being in the sella turcica just superior to the sphenoid sinus. There was a large amount of pneumocephalus without any intracranial hemorrhage (Fig. 3).

Following imaging, the patient was admitted to the Intensive Care Unit for continued monitoring. The following morning the patient was increasingly somnolent, and therefore a repeat CT scan of the brain was performed. The CT demonstrated that the pneumocephalus from the initial scan had increased and progressed to tension pneumocephalus with bifrontal compression of the brain (Fig. 4). Due to the worsening CT findings and change in the patient's neurologic exam, Neurosurgery decided to take him immediately to the operating room to create bilateral burr holes with subgaleal Jackson-Pratt (JP) drains. Due to the trajectory of the missile through the sphenoid sinus, a CT cisternogram also was performed to identify a presumed cerebrospinal fluid leak (CSF). However, the result was equivocal. On further examination, the patient denied otorrhea, rhinorrhea, or having a salty taste in the back of his mouth.

Post-operatively, the patient did well. The patient did not exhibit any neurologic deficits other than his right-sided vision loss which had remained stable since admission. On post-operative day 1, a CT of the brain showed significant improvement in the pneumocephalus with the brain well-expanded. Clinically, the patient continued to show no evidence of a CSF leak. Due to the location of the bullet next to the pituitary gland, Endocrinology was consulted. Levels of TSH, cortisol, ACTH, HGH, somatostatin, FSH, IGF-1, LH, and prolactin were checked, and all remained within normal limits. Throughout his hospital stay, the patient showed no clinical signs of pituitary dysfunction. Ophthalmology was consulted for his right-sided vision loss and it was determined the patient was suffering from traumatic optic neuritis of the right optic nerve. On hospital day 2, the patient's chest tube was removed, and on hospital day 5, JP drains were removed without any complications. While Neurosurgery originally cleared the patient for physical and occupational therapy when his JP drains were removed, a repeat CT of the brain showed an interval increase in pneumocephalus. The patient's neurologic exam, however, remained stable. The CT finding was treated conservatively with bedrest, head of bed elevation, and supplementary oxygen. On hospital day 15, a CT of the brain was repeated and showed nearly complete resolution of the pneumocephalus, so the patient was again cleared for physical therapy and ambulation. The following day, Physical Therapy cleared the patient for discharge home without any restrictions; and on hospital day 16, he ultimately was discharged home.

Discussion

Bullet trajectories can follow unexpected paths within the human body and add to the complexity of the initial management of a trauma patient. Low velocity bullets, like those commonly seen in civilian trauma, have been described to follow nonlinear projections

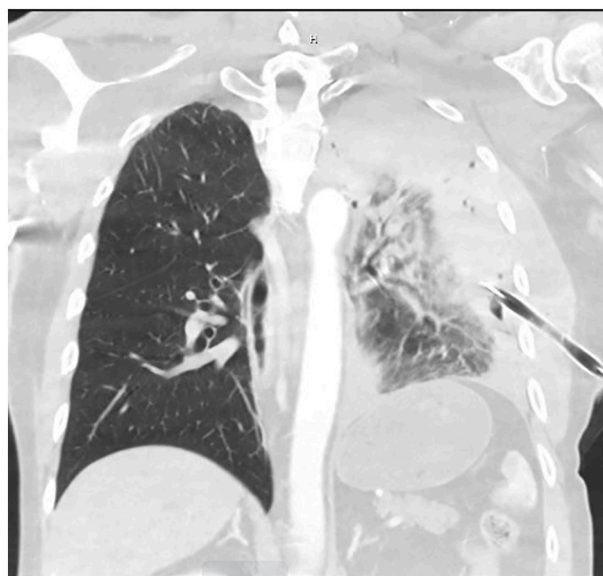


Fig. 1. CT chest showing a retained hemothorax and pulmonary contusion after the placement of a left chest tube.



Fig. 2. CT angiogram of the neck showing an injury to the left internal jugular vein and a large intramuscular hematoma of the sternocleidomastoid.



Fig. 3. CT brain showing the retained bullet and pneumocephalus.

due to their ability to follow fascial planes of lower resistance [1]. Therefore, taking a thorough history and doing a complete physical examination is vital to understand the projectile trajectory. The patient was shot while sitting in a car and assaulted by multiple people, thus making unusual angles of fire possible. On examination, he was found to have one gunshot wound in the chest but was complaining of right eye blindness. In trauma, there is the well-known formula shown below:

Entry wounds = exit wounds + the number of projectiles remaining in the body [2].

Thus, it was known that a missile remained in the patient and further imaging was required when it was not identified in the chest X-ray. Whether the bullet traveled toward the head because of the angle of fire or followed the fascial planes, it was through the history and physical examination that led the team to investigate the neck and head for the missile.

Initial imaging of the patient showed a trajectory that involved the chest, neck, and head, all regions where penetrating injuries can carry high mortality rates [3,4]. The patient's hemodynamics stabilized after the placement of a left-sided chest tube and receiving two units of blood products. However, if the patient had remained hemodynamically unstable, a question as to what was the etiology of the hemothorax would have arisen. With the bullet traveling superiorly from the chest through the neck, the hemothorax could result from a left chest injury or a left neck vascular injury decompressing into the chest. Each scenario would have mandated a different operative approach. By appreciating wound ballistics, the possible underlying structures damaged from the bullet trajectory can be anticipated and allow for optimization of the management of gunshot wound victims.

Additionally, obtaining prompt CT scans provided vital information that ultimately led to the successful treatment of the patient. CT angiogram ruled out an arterial injury in the neck. Thus, the inclusion of a CT scan in the workup for a trauma patient can prevent the patient from undergoing an unnecessary surgical intervention [5]. The CT of the brain showed the route of the bullet and its endpoint in the sella turcica adjacent to the pituitary gland. This helped explain the patient's right-eye blindness and brought forth



Fig. 4. CT brain showing a tension pneumocephalus with bifrontal compression of the brain.

the need to monitor for pituitary dysfunction.

The patient's right vision loss was his most profound morbidity from this trauma. Treatment for traumatic optic neuropathy remains a debated topic. There is little evidence that management with either corticosteroids or surgical optic canal decompression offers any visual benefit over observation alone [6]. Furthermore, a patient's initial visual acuity is a strong predictor of the final visual acuity that will be experienced. On presentation, our patient's visual acuity in the right eye was light perception, and with conservative management was unchanged by the time of his discharge. While initially the patient's right eye blindness seemed like an unusual presenting complaint, through imaging it was made clear how it was related to the trajectory of the bullet.

Panhypopituitarism secondary to a gunshot wound is extremely rare and has only been described a limited number of times [7,8]. In this case, the radiographic evidence from the CT scan showing the proximity of the bullet to the pituitary gland was a concern. This led us to observe for signs and symptoms of hypopituitarism and monitor pituitary function tests. The patient was fortunate and did not demonstrate any of these abnormalities, however his management would have been incomplete without them. Ultimately, CT scanning proved invaluable for this patient, showing the likely bullet path, as well as, injuries accumulated along the way.

Conclusion

Gunshot wounds with atypical trajectories, such as seen in our patient, present unique challenges and can lead to delayed diagnoses if not managed quickly and efficiently. Obtaining a thorough history and physical examination provides invaluable information even in situations like trauma activations. Consideration of a bullet's trajectory when evaluating a gunshot wound victim remains an essential part of the patient's work-up. It can provide insight not only into the potential tissue structures' damage but also into the eventual treatment. Adjunctive imaging studies remain crucial to facilitate appropriate care.

Declaration of competing interest

None.

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