



Effects of a fragmenting handgun bullet: Considerations for trauma care providers

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ABSTRACT

Introduction: Expanding or fragmenting bullets have been known to cause extensive injuries since they became available in the late 19th century. Although these bullets are now banned from international warfare, their use by civilians and law enforcement is still legal in the US. In this case report, we describe the complex injuries and subsequent complicated hospital course of a civilian trauma patient who was shot with a newly-designed fragmenting bullet, known as a Radically Invasive Projectile (RIP) bullet.

Case report: A 22-year-old man presented as a trauma activation after a gunshot wound to his left chest. He subsequently underwent chest tube placement, an emergent thoracotomy, and an exploratory laparotomy. In the operating room, the patient had multiple ballistic fragments lodged within his left thoracic cavity and left upper abdomen. These fragments caused multiple penetrating injuries resulting in an 18 day hospital stay with numerous complications. He underwent 4 emergency operations, 2 separate admissions to the intensive care unit (ICU), and the placement of 4 chest tubes. He was ultimately discharged home in stable condition.

Conclusion: Expanding or fragmenting bullets are designed to inflict significantly more tissue damage than non-deformable bullets. This type of ammunition is prohibited in international warfare on the basis that it does not serve a military advantage but can result in excessive wounding and unnecessary suffering. There is no such ban for handgun ammunition for domestic use in most countries including the United States. Ammunition manufacturers have recently released a fragmenting bullet that is designed to inflict a maximum amount of tissue damage. In this case report, we described the devastating effects of this bullet on a civilian trauma patient.

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Background

Non-deforming bullets fulfill the limitations set in place by the Hague Declaration of 1899, and they remain the standard for international warfare today [1]. For example, military bullets are made of a lead core surrounded by a hard metal casing, commonly referred to as having a “full-metal-jacket,” which allows the bullets to penetrate the target with minimal deformity [1]. However, ammunition used for domestic purposes in the U.S. such as hunting, personal protection or law enforcement are not bound by

international agreements. In recent years, bullet manufacturers designed deforming ammunition to increase the “stopping power” of handguns in order to make the ammunition more destructive. This type of ammunition is specifically prohibited for use in international warfare [2,3]. However, the United States does not fully recognize this prohibition [4].

The Radically Invasive Projectile (RIP™, G2R Technologies,) bullet is a 96 g solid copper fragmenting round that is shot from a 9 mm handgun with a velocity of 1300 fps. The round is composed of 8 manufactured segments (called “trocars” by the manufacturer in a reference to the surgical device) on a solid penetrating base. The *trocars* are designed to fragment upon entry and penetrate further within the body after the bullet enters its target in order to maximize the amount of tissue affected (Fig. 1) [5,6]. These bullets were recently introduced to the US market despite multiple historical accounts which advocate against ammunition of this type.

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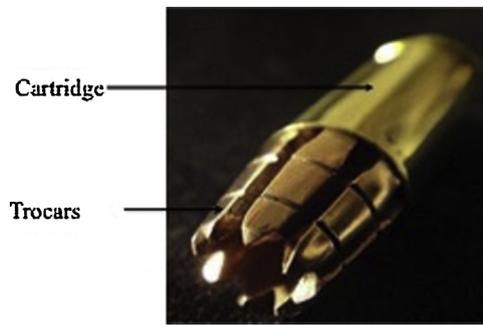


Fig. 1. The Radically Invasive Projectile (RIP) bullet is a 96 g solid copper fragmenting round composed of 8 trocars mounted on a solid penetrating base. The trocars are designed to fragment upon entry into the target.

The violent deformation of bullets may shed fragments as they expand [7]. Also, these bullets may strike bone or hard objects near the target that cause fragmentation. These fragments act as secondary projectiles and lead to more direct tissue destruction. While many publications have described expanding and deforming bullets, case reports on the effects of fragmenting handgun bullets are lacking [8]. The objective of this study was to present a clinical case report documenting the injuries sustained by a 22-year-old man who was shot with a fragmenting handgun bullet and also to discuss the potential dangers of having this type of ammunition available for public or law-enforcement use.

Case report

A 22-year-old man presented as a trauma activation to our Level I Trauma Center following a gunshot wound to his left posterior upper chest. Upon arrival to the trauma bay, he was tachycardic, hypotensive, and had an obvious penetrating injury to his left chest. A left chest tube was emergently inserted with immediate drainage of approximately 350 mL of blood. A chest x-ray showed multiple ballistic fragments overlying the left chest, left upper quadrant of his abdomen, T12 vertebral body, and the left shoulder (Fig. 2). He also had a left third rib fracture and a left hemo-pneumothorax. The

patient declined hemodynamically despite volume resuscitation. Bedside sonography by the trauma team demonstrated cardiac tamponade with poor left ventricular filling. Due to his deteriorating condition and a high suspicion of injury to his heart, a left thoracotomy was performed in the Emergency Department. A large amount of blood was evacuated from the pericardial sac, the aorta was clamp-occluded and the patient was emergently taken to the operating room for a formal thoracotomy and exploratory laparotomy. In the operating room (OR), multiple fragments were found in the chest, pericardial sac, and the diaphragm with potential for intra-abdominal injury. The thoracotomy incision was extended caudad into a laparotomy incision and the abdomen was explored. There was a moderate hemoperitoneum, but no hollow viscus injuries were identified. The fragments caused multiple penetrating injuries including a laceration of the left upper lobe of the lung, a partial thickness laceration of the right ventricle, a laceration of the left hemidiaphragm, and injury to the left lateral lobe of the liver. The patient subsequently underwent wedge resection of the left upper lobe of the lung. Injuries to the left hemidiaphragm were repaired with permanent suture. The injured section of the left lateral lobe of the liver was also resected using a linear stapler. Finally, the left chest and abdomen were packed and a negative pressure closure device was used to leave the cavities open in a damage control fashion. The patient was then transferred to the trauma intensive care unit intubated and in critical condition for continued resuscitation.

The following day, the patient underwent an upper endoscopy due to concern for esophageal injury. The endoscopy did not show any evidence of injury. The patient was also taken to the OR for a second look exploratory laparotomy, abdominal washout, and wound closure. There was no evidence of residual or active bleeding within the chest or abdomen. The pericardium was then loosely approximated with absorbable sutures and the chest and abdomen were closed in the usual fashion.

On post-operative day 8, the patient developed leukocytosis, with a white blood cell count of 16,000 mL. A chest CT was then performed which revealed multiple remaining ballistic fragments within the lower left chest wall anterior to the pericardium and within the upper abdomen, as well as a left-sided hydro-pneumothorax that was not being drained by the chest tube in place (Fig. 3). The patient was taken to the OR for video-assisted



Fig. 2. Chest x-ray of a patient with Radically Invasive Projectile (RIP) bullet injury to the left chest demonstrating multiple ballistic fragments throughout the chest.



Fig. 3. CT scout film showing the extent of the injury of the Radically Invasive Projectile (RIP) bullet to the left chest of a patient.

thoracoscopic surgery. He was found to have a retained hemothorax in his left posterior thorax that was evacuated. Post-procedure transthoracic echocardiography showed a large pericardial effusion with concern for early pericardial tamponade. The following day, the patient was taken to the OR for a pericardial window where 600 cc of serosanguinous fluid was evacuated from the pericardium and an additional thoracotomy was performed for decortication of the left lung. The patient recovered in the ICU for one more day and then was transferred to the medical surgical unit. He was subsequently discharged home 19 days after his initial presentation having spent 8 days of this admission in the trauma/surgical ICU.

Discussion

Theodor Kocher was the first person to study the biomechanical consequences of gunshots on the human body [9]. He studied wound ballistics after learning about the horrific injuries suffered during the Franco-Prussian war where soft-lead conical bullets were used in combination with new, more effective “smokeless” nitrocellulose-type gunpowder. The extensive tissue destruction was the foundation of the argument by Kocher and others such as Dr. Paul Von Bruns who lobbied to outlaw these bullets at the Hague Peace Conference in 1899 [1,2]. Their rationale was that bullets inflicted excessively destructive tissue injuries and served no military strategic purpose, unnecessarily increasing the suffering of soldiers. As a result, the Hague Declaration ultimately

prohibited the use of expanding or fragmenting bullets in international warfare for humanitarian purposes. Today’s “NATO round” used by almost all the armies of the world, is the modern iteration of the early design by the Swiss armorer Edouard Rubin inspired by Kocher’s work [9]. It is a so-called “full-metal-jacket” round designed specifically to not deform or fragment on impact and thus mitigate the horrific effects of the emerging warfare technology of that generation.

More recently, domestic handgun ammunition manufacture in the U.S. appears to be moving in the opposite direction from the proposals championed at the Hague Conference. Some bullet manufacturers specifically design bullets that deform or fragment upon impact. The increase in projectile surface area after penetration leaves a higher amount of kinetic energy in the target, leading to more extensive tissue damage. This phenomenon is why deforming bullets are the preferred ammunition of law enforcement in the U.S. First, such a bullet is less likely to exit the target and strike an unintended victim. [10] Second, it theoretically increases the so-called “stopping power” of the round. While the claim of “stopping power” has been used to commercial advantage, its validity remains undetermined [11]. By all accounts, the most reliable way to immediately incapacitate an attacker is to strike a direct blow to the central nervous system followed by a direct hit to major cardiovascular structures. Numerous accounts exist of direct hits to major vessels, the trachea, and even lethal injuries to the heart that resulted in a delay of immobilization of the target of several seconds [11]. As such, increasing the deformation of a

bullet fired from a handgun is of questionable importance and poses instead a significant challenge for treating physicians [10].

Furthermore, while bullet deformation may lead to some fragmentation within the body, fragmentation has not been a specific design feature of handgun bullets manufactured to date. The RIP bullet is an example of a bullet designed to fragment upon impact. The manufacturers of this bullet (G2R Technologies) intended their design to be an “effective one shot manstopper” believing that greater tissue destruction allows for a higher likelihood of immediate immobilization regardless of body area or organ struck [12]. Their design approach rests entirely on ballistic gelatin demonstrations. The value of these experiments in determining relevant properties of ballistic weapons were questioned by Dr. Fackler, the developer of this technology to examine the terminal ballistic properties of ammunition. He was also the first person to criticize the overuse of this technology [13].

In conclusion, this case report is among the first to describe a gunshot wound related to the RIP bullet. We describe the significant injuries caused by this bullet and the patient's subsequent complicated post-operative course related to the extent of his injuries. Small arms manufacturers continue to probe the limits of ballistic design in order to find a single round with enough destructive force that it can instantly incapacitate a target no matter where it strikes the body. This scenario demonstrates the devastating effects that such a bullet can have on the human body, although the “stopping power” of the round remains in question. The capacity for occult damage from the wide dispersion of the RIPs' fragments also needs to be investigated as a factor. The trauma surgeon needs to be aware of the RIP bullet and its potential for extensive injury from the wide internal dispersal of the fragments. It also begs the question of whether modern trauma care providers should protest the use of this type of ammunition and the horrific injuries that it can inflict.

Conflicts of interest or disclosures

Dr. Greiffenstein has worked as a paid technical consultant for Zimmer Biomet, KLS Martin and DuPuy Synthes and leads surgical skills labs for Zimmer Biomet. The authors have no other conflicts of interest or financial disclosures.

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