NOFOR
NOVEL FORENSIC RESEARCH

DOI: 10.5455/NOFOR.2024.10.09

NOFOR. 2025;4(1):16-9

Case Report

Isolated arteria vertebralis dissection resulting from gunshot bullet blast effect: Case report

Abuzer Gulderen[1], Tuba Sahinoglu Gunes[2], Sertac Dalgic[3]

[1]Republic of Türkiye, Ministry of Justice, Council of Forensic Medicine, Gaziantep. Türkiye
[2]Tokat Hospital, Department of Forensic Medicine, Tokat, Türkiye
[3]Republic of Türkiye, Ministry of Justice, Council of Forensic Medicine, Manisa, Türkiye

Received October 24, 2024; Accepted November 06, 2024; Available online April 15, 2025

Abstract

Wound ballistics examines wounds resulting from penetration, permanent cavity, temporary cavity (blast effect), shock waves, primary and secondary fragmentations created by a firearm projectile. As injuries caused by the direct effect of the projectile, such as penetration and permanent cavity, temporary cavities and shock waves can also cause fatal injuries with their indirect effects. In our study, we aimed to discuss a case that was injured in the neck area with a gunshot bullet and had a life-threatening injury as a result of arteria vertebralis injury due to the blast effect of the bullet, in the light of the literature. It was reported that a 17-year-old female patient was injured by firearm projectile. It was sent to us by the judicial authority for the preparation of a forensic report. It is recorded that a filling defect was observed in the right arteria vertebralis. It was determined that the bullet did not directly damage the right arteria vertebralis. It was concluded that the filling defect occurred as a result of the dissection caused by the explosion effect of the firearm. Firearm injuries produces fatal consequences depending on the degree of injury to the tissue or organ compatible with its trajectory. As a result of the pressure effect created by the firearm projectile, injuries occur in the tissues due to the blast effect, also called temporary cavity. Although the blast effect is not due to the direct effect of the firearm projectile, such as penetration and permanent cavity, it causes injuries to adjacent tissues. While tissue damage resulting from blast impact is frequently described in intracranial and intrathoracic injuries in the literature, in our case, isolated arteria vertebralis dissection as a result of blast impact was presented as a rare condition.

Keywords: Blast impact, gunshot wound, forensic examination

INTRODUCTION

Wound ballistics examines the wounds caused by firearm projectile in tissues. Firearm projectile cause injuries in tissue due to penetration, permanent and temporary cavities, shock waves, and primary and secondary fragmentations [1-3].

The history of wound ballistics dates back to the 1830s. The real progress was made in the 1870s with Kocher's hydrodynamic theory of gunshot wounds. According to Kocher's hydrodynamic theory, pressure waves are formed due to the high explosive power of bullets and the displacement of liquids at high speed, and injuries may occur due to the effect of these pressure waves [4].

Just as injuries caused by the direct effect of the bullet, such as penetration and permanent cavity, temporary cavities and shock waves can also cause fatal injuries with their indirect effects [5-7]. In our study, we aimed to discuss a case that was injured in the neck area by a gunshot bullet and had a life-threatening injury as a result of arteria vertebralis injury due to the blast effect of the bullet, in the light of the literature.

CITATION
Gulderen A, Sahinoglu Gunes T, Dalgic S. Isolated arteria vertebralis dissection resulting from gunshot bullet blast effect: Case report. NOFOR. 2025;4(1):16-9. DOI: 10.5455/NOFOR.2024.10.09

Corresponding Author: Abuzer Gulderen, Republic of Türkiye, Ministry of Justice, Council of Forensic Medicine, Gaziantep. Türkiye
Email: md.abuzergulderen@gmail.com

DOI: 10.5455/NOFOR.2024.10.09

CASE

Our case is a 17-year-old female patient and was sent to us for a post-traumatic forensic report. In her medical history; It was learned that she was injured in her jaw by a gun that accidentally went off while she was sitting with her friends in the park. As a result of the examinations performed at the district hospital where she lived, a foreign body was detected in her neck, and she was referred to the university hospital of a nearby province. She underwent surgery due to a fracture in her jaw. The projectile could not be removed because it was close to the spinal cord. During the examination, it was observed that there was no difficulty in speaking, that she had difficulty eating solid foods, that there was no problem in swallowing, and that she occasionally had weakness in her arms and legs. She stated that she had to constantly use a blood thinning medication due to the injury to her vein.

The examination revealed that the gunshot bullet entry wound was on the mentum of the jaw, there was no exit hole, the incisors were missing on the right side of the lower jaw, the mouth opening was full and jaw movements were free in all directions, and the muscle strength of the left forearm and hand was reduced by 1 in 5. was seen. In cervical CT examination; Metallic density of a gunshot bullet was observed adjacent to the right peduncle of the C4 vertebra, and there was no radiopathology in the brain CT examination. When bilateral carotid artery CT Angiography was examined by us; In the right vertebral artery injection, it was observed that the right vertebral artery was filled up to the C4 vertebra level and there was a filling defect in its distal part. In the left vertebral artery injection, the right vertebral artery showed retrograde filling over the basilar artery up to the level of the metallic body, and the findings were evaluated in favor of right vertebral artery dissection (Figure 1). In the neurological examination; It was observed that dysesthesia in the lower jaw, hypoesthesia on the outer part of the left shoulder, left shoulder abduction was -5/5, the left arm fell prematurely in the paresis test, and the brain CT examination was normal. MRI could not be performed due to the metallic object. Although the brain CT scan was normal, the numbness and weakness in his left arm were considered as sequelae.

In conclusion; Since the person had a right arteria vertebralis injury, it was concluded that the person's injury created a situation that endangered his life.

Figure 1. Right artery vertebralis filling defect in the left artery vertebralis injection

DOI: 10.5455/NOFOR.2024.10.09

DISCUSSION

The main working principle of firearms, which entered the lives of human beings with the invention of gunpowder and are used to meet basic needs such as protection and nutrition, is to send the bullet in the gun as far and as quickly as possible through the air with the gas pressure created by the combustion of gunpowder [1].

With the development of firearms, especially in the last centuries, and the extreme increase in their use since the 19th century, studies to examine the weapon, the projectile, and the effects of the projectile on the target organ have also increased. The branch of science that carries out these studies is ballistics [8-10]. Ballistics can basically be divided into three groups. İnternal ballistics examine the firing of bullet, external ballistic examine the flight of projectile and terminal ballistics examine of the changes caused projectile on the target. Wound ballistics is a part of terminal ballistics and examines the effects of firearm projectiles on the human or animal body [2,4,6,11]. A projectile entering the body progresses by disrupting and displacing tissues and produces fatal consequences depending on the degree of injury it causes in the tissue or organ compatible with the trajectory [11,12].

Firearm projectiles cause injuries in tissues and organs through penetration, permanent cavity, temporary cavity, shock waves and fragmentation [2,13,14]. While penetration, permanent cavity and primary fragmentation occur due to the direct effect of the bullet, temporary cavity (blast effect), shock waves and secondary fragmentation (injuries caused by bone fragments) are among the indirect effects of the bullet.

Figures 2 shows the permanent and temporary (blast effect) cavity and shock wave formation created by the projectile.

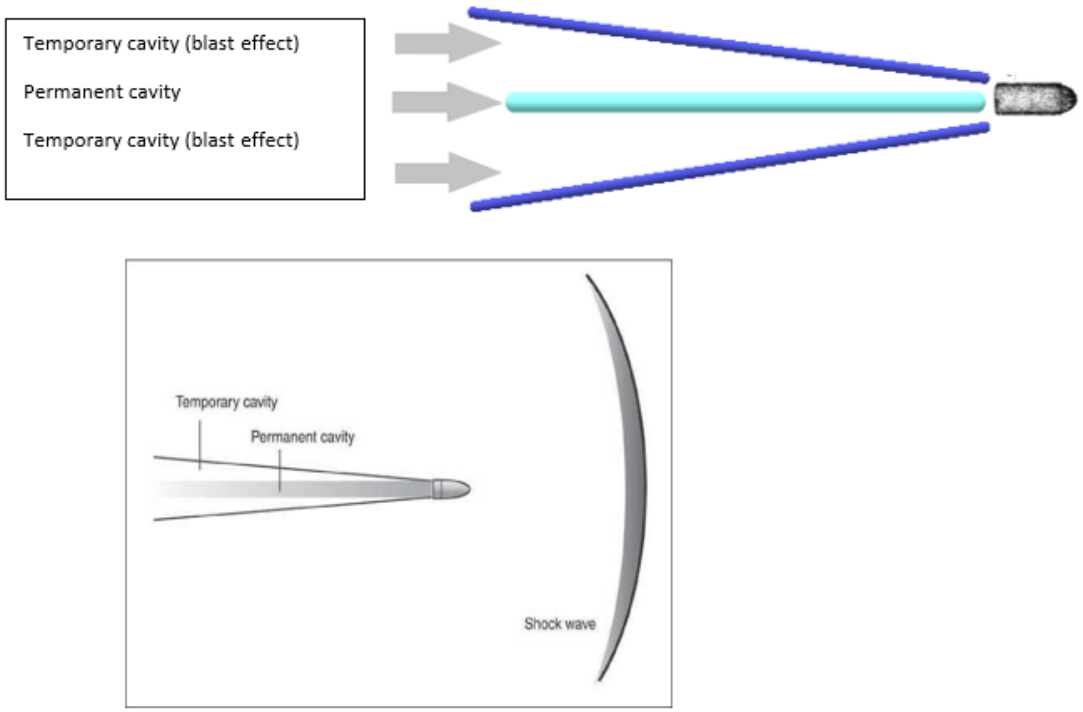

Figure 2. Effects of firearm projectile on tissue

Temporary cavity (blast effect) is the injury that occurs in the tissues due to the pressure effect created by the projectile [15-17]. The blast effect is greater in bullets with high kinetic energy, and most of the energy of these bullets is spent creating temporary cavities. Bullets with high kinetic energy begin to tumble after a while after entering the tissue, and during this movement, the kinetic energy transferred to the tissue and, accordingly, the diameter of the temporary cavity increases [18]. In structures with low tissue thickness, such as the extremities, the temporary cavity is smaller as the bullet leaves the body before it begins to tumble. Injuries due to blast impact are more common in the abdominal and chest cavities due to their large diameter [19]. Due to the blast effect, injury may also occur in parenchymal organs such as the liver, kidney and spleen [20].

Injuries due to blast effects are less common in organs with more elastic tissue, such as the lungs, because they tolerate the tension caused by pressure waves better. Very serious injuries may occur due to the blast effect in tissues with little or no elastic tissue, such as the liver and brain [8]. Injury and temporary displacement occurring in tissues such as skeletal muscle, vessels and nerves due to the temporary cavity appear like blunt trauma [6]. In some studies, it has been reported that the blast effect even causes bone fractures, although rarely [6,21,22].

DOI: 10.5455/NOFOR.2024.10.09

Due to the high conductivity of fluids, blood transmits pressure waves more than parenchymal tissues, and for this reason, injuries due to blast effect in main vascular structures may be more common [2]. In the literature review, although various injuries occur in the body due to blast impact, it is presented that there is no isolated arteria vertebralis injury.

CONCLUSION

Blast effect can also indirectly pose a danger to life. In gunshot wounds, secondary injuries that may be caused by the blast effect and shock wave-related energy, as well as the primary injuries that occur in the tragedy, should not be ignored. Injuries due to blast impact are important to prevent incomplete evaluations that may arise during forensic report preparation and to evaluate fatal and non-lethal injuries during forensic autopsy.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Patient Informed Consent
Informed consent was obtained from the relative of the deceased.

References

1. Jas van Driel, A Short History of Firearms https://vvnw.nl/wp-content/uploads/2016/03/history.pdf access date 24.05.2018.
2. Genç O, Çaylak H. TORAKSI İLGİLENDİREN ATEŞLİ SİLAH YARALANMALARI. Toraks Cerrahisi Bülteni. 2010;1:29-32.
3. Beyaztaş FY, Can, M, Bütün C. Ateşli silah yaralanmaları. Klinik Gelişim Dergisi. 2009;22:44-7.
4. Maiden N. Historical overview of wound ballistics research. Forensic Sci Med Pathol. 2009;5:85-9.
5. Beyaztaş FY. Ağızdan girişi olan iki ölümcül ateşli silah yaralanma olgusu. Cumhuriyet Üniversitesi Tıp Fakültesi Dergisi. 2000;22:219-22.
6. Dougherty PJ, Najibi S, Silverton C, Vaidya R. Gunshot wounds: epidemiology, wound ballistics, and soft-tissue treatment. Instr Course Lect. 2009;58:131-9.
7. Garrison DH. 'Machinegunner' – MG Julian S. Hatcher. AFTE Journal. 1988;20:129-30.
8. Farjo LA, Miclau T. Ballistics and mechanisms of tissue wounding. Injury. 1997;28:C12-7.
9. Uslu M. DOCOL 22MnB5 çeliğinin balistik özelliklerinin incelenmesi. Master's thesis, Istanbul Technical University, İstanbul, 2007.
10. Heard BJ. Handbook of firearm and ballistics. 2nd edition. Wiley, 2011;101-43.
11. Stefanopoulos PK, Filippakis K, Soupiou OT, Pazarakiotis VC. Wound ballistics of firearm-related injuries--part 1: missile characteristics and mechanisms of soft tissue wounding. Int J Oral Maxillofac Surg. 2014;43:1445-58.
12. Amato JJ, Billy LJ, Lawson NS, Rich NM. High velocity missile injury: an experimental study of the retentive forces of tissues. Am J Surg. 1974;127:454-9.
13. Schyma C, Madea B. Evaluation of the temporary cavity in ordnance gelatine. Forensic Sci Int. 2012;214:82-7.
14. Sellier KG, Kneubuehl BP. Wound ballistics and scientific background. 1st edition. Elsevier, 1994;202-57.
15. Rhee PM, Moore EE, Joseph B, Tang A, Pandit V, Vercruysse G. Gunshot wounds: a review of ballistics, bullets, weapons, and myths. J Trauma Acute Care Surg. 2016;80:853-67.
16. Thierauf A, Glardon M, Axmann S, Kneubuehl BP, Kromeier J, Pircher R, et al. The varying size of exit wounds from center-fire rifles as a consequence of the temporary cavity. Int J Legal Med. 2013;127:931-6.
17. Frank M, Schönekeß HC, Jäger F, Hertel H, Ekkernkamp A, Bockholdt B. Temporary cavity created by free-flying projectiles propelled from a powder-actuated nail gun. Int J Legal Med. 2012;126:801-5.
18. Uzar Aİ, Güleç B, Kayahan C, Özer MT, Öner K, Alpaslan F. Wound ballistics-I permanent and temporary wound cavity effects. Ulus Travma Acil Cerrahi Derg. 1998;4:225-9.
19. Fackler ML. Wound ballistics. A review of common misconceptions. JAMA. 1988;259:2730-6.
20. Barach E, Tomlanovich M, Nowak R. Ballistics: a pathophysiologic examination of the wounding mechanisms of firearms: Part I. J Trauma. 1986;26:225-35.
21. Huelke DF, Buege LJ, Harger JH. Bone fractures produced by high velocity impacts. Am J Anat. 1967;120:123-32.
22. Huelke DF, Harger JH, Buege LJ, Dingman HG. An experimental study in bio-ballistics: femoral fractures produced by projectiles--II. Shaft impacts. J Biomech. 1968;1:313-21.