

Vertebral Artery Insult at the Transverse Foramina by Gun Shot Wounds: Report of Two Cases

Ateşli Silah Yaralanmasına Bağlı Transfers Foramende Vertebral Arter Hasarı: İki Olgu Sunumu

ABSTRACT

The vertebral artery (VA) is well protected through its course at the cervical transverse foramina and penetrating injuries of VA are mostly caused by gun shot wounds. The mechanism of injury in these wounds is described as the kinetic energy transferred by the bullet, which always depends on its mass and speed. Thus, the size of the pellet is the most important factor for the tissue damage, shock waves and direct injury. Civilian gun shot wounds are generally caused by low velocity firearms, In this report, we described two cases with cervical gunshot wound characterized with transverse foramina damage and VA insult. The first patient was assaulted by bullet that resulted in vertebral artery occlusion, whereas a smaller pellet was found in the second one and arterial flow was not influenced on the site of the damaged transverse foramina. Successful management of these injuries should include careful analysis of the bullet characteristics that is directly related to the intensity of damage.

KEYWORDS: Cervical spine, Gun shot, Transverse foramina, Vertebral artery

ÖZ

Transfers foramenler içinde yerleşmiş olan vertebral arterler iyi korunmuşlardır ve hasarlanmaları genellikle ateşli silah yaralanmalarına bağlıdır. Bu tür yaralanmalarda hasar mekanizması mermi çekirdeğinin hızı ve taşıdığı kinetik enerjinin aktarımı ile açıklanabilir. Dolayısıyla mermi çekirdeğinin boyutu, doku hasarında en önemli faktördür. Sivil ateşli silahlar genellikle yavaş hızlıdır ve şiddetli doku hasarı görülmez. Bu yazıda servikal ateşli silah yaralanması sonucu transvers foramen hasarına neden olmuş ve vertebral arter akımını tehdit eden iki olgu sunulmuştur. İlk olguda mermi çekirdeği vertebral arter akımına engel olmuş, ancak ikinci olguda daha küçük bir saçma nedeniyle yaralanan transvers foramende vertebral arter akımı devam ettiği görülmüştür. Bu olguların başarılı tedavisi için mermi çekirdeğinin yapısı değerlendirilmeli ve bunların yapacağı doku hasarı gözönüne alınarak plan yapılmalıdır.

ANAHTAR SÖZCÜKLER: Boyun omurgası, Ateşli silah, Transvers foramen, Vertebral arter

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INTRODUCTION

Vertebral artery (VA) injury can occur with penetrating or non-penetrating trauma. Asymptomatic unilateral VA occlusion on magnetic resonance (MR) angiography has been detected in up to 19% of blunt cervical trauma cases, particularly after fracture dislocation or compression fractures (5). However, penetrating VA injury is less common than non-penetrating trauma because of its well-protected and hidden localization within the transverse foramina (7). Penetrating VA injuries are uncommon and mostly caused by firearms (10). Here, we report two cases with cervical transverse process injury due to gunshot wound and suspected vertebral artery injury.

Case 1

A 31-year-old man was assaulted with a firearm. He was alert and awake with slight weakness and paresthesia on left arm during the initial physical examination. He was hemodynamically stable, with a blood pressure of 130/80 mm Hg, a heart rate of 76 beats per minute and a respiratory rate of 12 breaths per minute. He had no dysphagia and dyspnea. Cervical spine X-rays revealed a bullet adjacent to the transverse process of the fourth cervical vertebra (C4) (Figure 1A). Cranial computerized tomography (CT) was normal and the cervical spinal CT scans revealed a mass effect on the trachea due to a soft

tissue fragment and minor bony injuries to the left transverse process of C4 (Figure 1B, C). There was no flow on the left vertebral artery just a few segments proximal to the bullet which was compatible with a dominant right VA on four-vessel digital subtraction angiography (DSA) and this was critical to compensate the flow in the left PICA and basilar artery (Figure 1D). There was also no pseudoaneurysm or arteriovenous fistula (AVF) with intact contralateral vertebral artery and both carotid arteries. Gabapentin was prescribed at a dose of 1800 mg per day and the patient was discharged after a week. His weakness had improved and his paresthesia decreased at the two-year follow-up. Control DSA revealed no flow on left VA without any pseudoaneurysm or AVF (Figure 1E).

Case 2

A 20-year-old man was subjected to a gunshot injury. He was neurologically intact and physical examination was normal apart from the entry zone of the pellet on the neck. His systemic condition was stable and there were no signs of hypovolemic shock. The pellet was localized at the transverse process of C6 on direct X-rays (Figure 2A,B). Cranial CT scan was normal and the cervical spinal CT scan revealed slight bony damage to the left side of the C6 transverse process (Figure 2C). Control and follow-up Doppler ultrasound (DUS) measurements of flow for bilateral vertebral and carotid arteries were

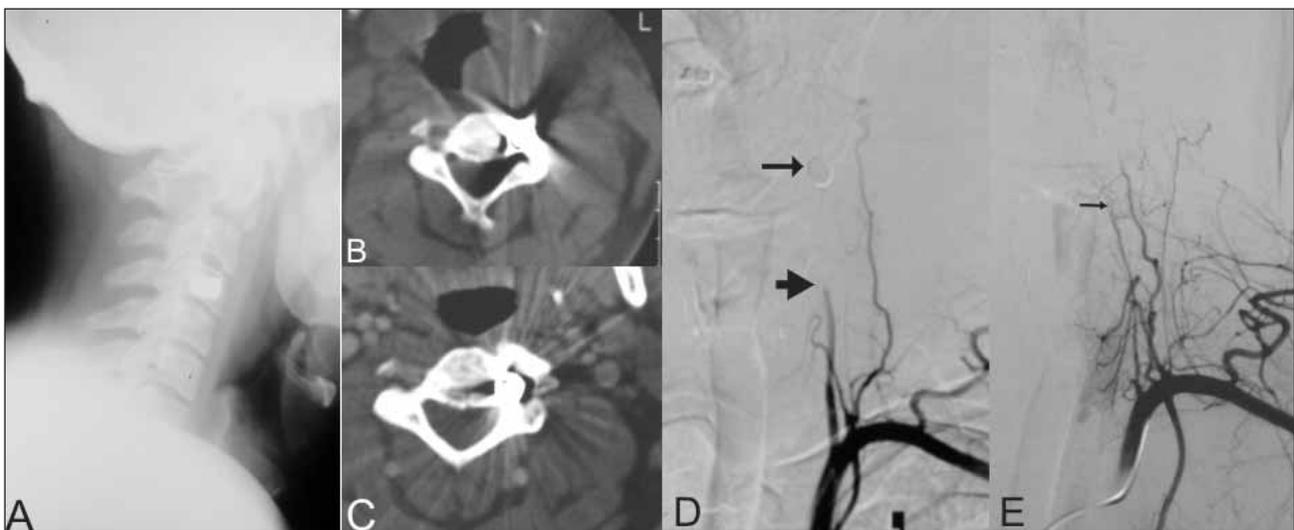


Figure 1: A. Lateral cervical X-ray revealed the bullet at the level of fourth cervical vertebra (C4), B. Axial CT of cervical spine at the level of C4 demonstrated a mass effect on the trachea due to a soft tissue fragment and metallic piece to the left transverse process, C. Same axial CT section after two years of follow-up showed decompression of trachea, D. Four-vessel DSA at the time of diagnosis did not detect any flow on the left VA (thick arrow) a few segments proximal to the bullet (thin arrow), E. There was still no flow distally of the vertebral artery (arrow) after two years.

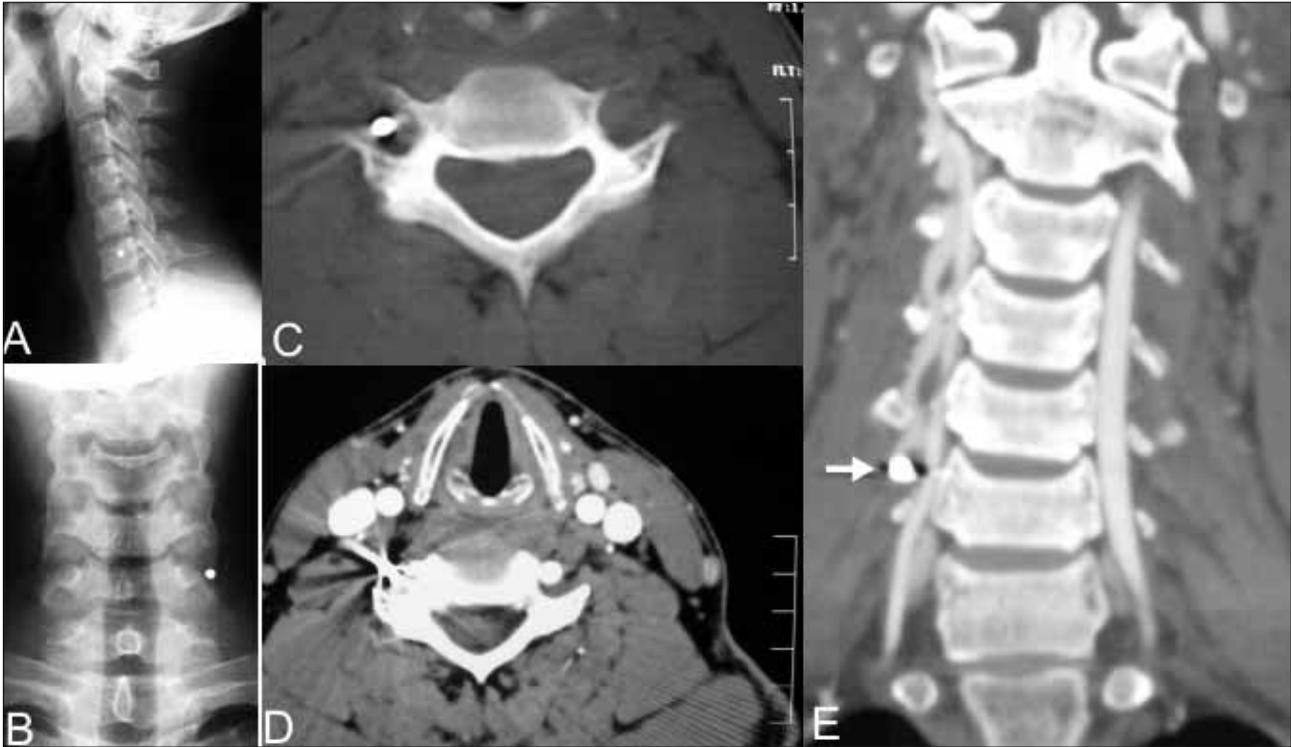


Figure 2: A, B. Lateral and anteroposterior cervical X-ray revealed the bullet at the level of the sixth cervical vertebra (C6), C. Axial CT of cervical spine at the level of C6 demonstrated a metallic fragment within the limits of the right transverse foramen without mass effect, D. Axial CT angiographic section of the same segment after nine months of follow-up showed the retained metallic fragment at the same localization and flow of contrast, E. Reconstructed CT angiography demonstrated the same metallic fragment (arrow) and normal bilateral vertebral artery flow.

completely normal. CT and CT angiography at the nine-month follow-up confirmed normal flow in the vertebral arteries (Figure 2D, E).

DISCUSSION

The VA is vulnerable to high-speed penetrating injuries that result in serious neurological conditions. The neck can be divided into three anatomic zones for penetrating wounds and these arteries can be injured in the different regions (11). Zone 1 extends from the clavicles to the inferior aspect of the cricoid cartilage; zone 3 extends superiorly from the angle of the mandible to the base of the skull while zone 2 is the region between zone 1 and 3. VA injury at zone 1 and 3 is difficult to evaluate clinically and neuroradiologically due to overlying bony structures (2). However, vascular injuries at Zone 2 can be assessed with the initial evaluation, which is quite practical to determine whether urgent surgery is necessary or not. Cases with stable hemodynamic status are candidates for further clinical examinations like CT, DUS and DSA (12, 14).

Urgent surgical exploration was recommended for all patients with a gunshot wound to the neck before 1990 (6, 11). However, accumulating clinical experience for this injury pointed to the importance of detailed radiological analyses and importance of preoperative evaluation on clinical success in the last decade. About eighty percent of all transcervical gunshots can be treated with conservative measures with close follow-up (14). Moreover, cases featuring clinically occult vascular injury with a benign natural course can only be managed conservatively (1,4). Most authors agree that clinical examination and ancillary investigations should replace mandatory surgical exploration in Zone I and III injuries (8,9). Sofianos et al. insisted on conservative management of zone 2 gunshots (13).

We report two cases of cervical gunshot wound at Zone 2 with a hemodynamically stable condition and emphasized the importance of supportive measures for the injuries at this particular region. The first case had slight weakness and paresthesia on the side of cervical bullet entry zone. Urgent DSA was performed and an obstruction of left VA was

observed at the level of C4. This type of vertebral artery obstruction is well tolerated if contralateral vertebral artery supply is adequate. Besides, minor complaints associated with this injury could easily recover with conservative measures.

Mechanism of injury associated with gunshot wounds depend on the kinetic energy of the bullet which can be calculated with the formula as " $KE = \frac{1}{2}mv^2$ " (KE: kinetic energy, m: mass, v: velocity) (3). Civilian gunshot wounds are low velocity injuries. Thus, the mass of the pellet becomes a more important determinant of civilian gunshot wounds. Direct or crush injury, shock waves and temporary cavitation are the defined mechanisms of injury (15). All of the mechanisms and in particular temporary cavitation are influenced by the pellet diameter that is at least 30 times larger than original dimension. After the collapse of temporary cavitation, a permanent cavity could remain and a region of damaged tissue can result in the development of abnormal vascular sprouts like AVF. The second patient was shot by a smaller pellet and his neurological condition was quite normal. The patient was followed with sequential DUS that appeared to be normal at every follow-up. Moreover, DUS is noninvasive and more cost-effective than DSA.

VA injury can be associated with gunshot wounds even when there is no direct trauma to the transverse foramina of cervical vertebra. Management of the cases depends on the hemodynamic and neurological status as well as the bullet characteristics such as velocity, size, design and composition. Consequently, the intensity of injury is directly proportional to the kinetic energy transferred by the bullet. Complications like VA obstruction, dissection, pseudoaneurysm or AVF should be kept in mind when following a gunshot with a bigger bullet. Nevertheless, most cases have a tendency to remain clinically stable in correlation with the size of pellet.

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