Acta Clin Croat 2024; 63: 207-213

doi: 10.20471/acc. 2024.63.01.26

Case Report

CIVILIAN GUNSHOT VICTIM WITH LOW-ENERGY BULLET INJURIES TO LOWER EXTREMITIES AND ATYPICAL LEFT DISTAL FEMUR FRACTURE: A CASE REPORT

Marijana Bekić[1], Dejan Blažević[2,3,4], Denis Mulabdić[5], Marko Ostojić[6], Dinko Vidović[2,7,8] and Marijo Bekić[5]

[1]Dubrovnik Medical High School, Dubrovnik, Croatia;

[2]Department of Traumatology, Sestre milosrdnice University Hospital Center, Zagreb, Croatia;

[3]University of Applied Health Sciences, Zagreb, Croatia;

[4]School of Medicine, Catholic University of Croatia, Zagreb, Croatia;

[5]Dubrovnik Genereal Hospital, Dubrovnik, Croatia;

[6]Department of Orthopedics, Mostar University Hospital, Mostar, Bosnia and Herzegovina;

[7]School of Dental Medicine, University of Zagreb, Zagreb, Croatia;

[8]School of Medicine, University of Zagreb, Zagreb, Croatia

SUMMARY – This case report details the management of low-velocity gunshot wounds (GSWs) in a 28-year-old man, emphasizing the distinctive challenges and treatment strategies in urban civilian settings. This study contributes to medical literature by providing insights into the complexities of treating atypical fractures caused by GSWs, especially involving nonstandard ammunition. The patient, involved in an urban gunfight, sustained multiple low-velocity GSWs to his lower limbs. The diagnoses included an atypical intra-articular fracture in the left distal femur and a foreign body in the right lower leg. Treatment involved emergency surgery with K-wire stabilization for the left femur fracture and exploratory surgery for the right leg. No foreign bodies were found in the right leg, but subsequent analysis revealed pseudo-encapsulated calcification, indicative of previous fat necrosis. In 15 days after the initial trauma, the final surgical intervention took place, during which a low-contact condylar plate was placed on the left distal femur. Postoperative recovery was successful, with the patient regaining full mobility and range of motion after one year. Low-velocity GSWs in civilian settings can result in complex atypical fractures requiring specialized surgical intervention and management.

Key words: *Case report; Distal femoral fracture; Gunshot wounds; Intra-articular fractures; Low-velocity trauma; Surgical fixation techniques*

Introduction

Gunshot wounds (GSWs) are penetrating injuries inflicted by a projectile such as bullet fired from a firearm. GSWs are categorized by projectile speed and Gustilo open fracture classification[1], as follows:

Correspondence to: *Dejan Blažević, MD, PhD*, Department of Traumatology, Sestre milosrdnice University Hospital Center, Draškovićeva 19, HR-10000 Zagreb, Croatia
E-mail: dejan.blazevic@live.com

Received February 15, 2024, accepted March 25, 2024

- low-speed: under 1,100 ft/s (340 m/s); typical in small handguns, causing Gustilo Anderson type 1 or 2 wounds;
- medium-speed: 1,200-2,000 ft/s (340-610 m/s); common in shotguns or larger handguns; and
- high-speed: 2,000-3,500 ft/s (610-1,100 m/s); from powerful rifles, causing wounds similar to Gustilo Anderson type 3.

Tissue damage depends on projectile mass, velocity, firearm type, distance, and direction. Physical characteristics such as composition, shape, fragmentation, and deformation can affect the wound[2,3]. Management can vary from urgent surgical intervention to observation, depending on the extent of the injury. An additional challenge today involves nonstandard and nonmetallic materials, which can be readily produced using modern technology[3-5].

Case Report

We present a case of a 28-year-old man who sustained multiple low-velocity gunshot wounds on his lower limbs during a gunfight that occurred amid an illegal drug trade in an urban area.

The patient provided written approval, consenting to the publication of this case study and any associated figures. The firearm used, a Beretta 7.65 mm caliber handgun (Fig. 1), was recovered by the police. Six 7.65 mm shell casings were found at the crime scene (Fig. 2), along with the remaining two 7.65 mm bullets, one intact and one fragmented (Fig. 3). The patient was then brought to the emergency department of a local hospital by the Emergency Medical Services and was hematologically stable, with a Glasgow Coma Scale of 15. Upon arrival, the patient was examined, and venous blood samples were obtained and sent for analysis.

The x-rays were taken upon arrival, and the patient was admitted to the Intensive Care Unit for observation while awaiting further treatment. On clinical examination, bilateral lower limb entry wounds were observed with no neurological or vascular compromise in either extremity. The first bullet created a 5-millimeter oval penetrating wound above the left knee with no evidence for a ballistic exit. Two perforating wounds (entry and exit) were observed anterolaterally on the right lower leg without significant hemorrhage (Fig. 4).

Radiographs of the left knee showed an atypical intra-articular fracture in the distal femur, affecting the metaphysis and medial epicondyle, resulting from a ballistic impact (Fig. 5). Radiographs of the right lower leg showed a foreign body measuring 8.5 mm on the medial aspect of the tibial shaft with subcutaneous trauma in an anterolateral projection but no evidence for fractures.

The patient was assessed by an aneesthesiologist and admitted for emergency surgery. Tetanus prophylaxis was administered. Preoperatively, intravenous crystalloid penicillin, gentamicin, and metronidazole were given as antibiotic prophylaxis. Surgical exploration and fracture reduction of the left extremity were performed, and four K-wires were inserted under radiological guidance to stabilize the distal femur fracture (Figs. 6 and 7). No foreign bodies were identified during the surgery.

The right leg was cleaned, debrided, and surgically explored to identify any foreign material, but the search was unsuccessful. Postoperatively, drains were placed in both limbs for 24 hours. Further exploration of the right extremity was attempted five days later; however, no foreign material could be located. Two adipose tissue fragments, one measuring 2 cm in diameter and the other measuring 1.3 cm in diameter, were subsequently analyzed by a pathologist. In the larger piece, fragmented, hard, granular, yellowish-white material was observed. Histologically, basophilic calcified mineral deposits were visible within the adipose tissue.

Surrounding the calcification was older granulation tissue and a thin layer of acellular, hyalinized connective tissue. These findings were consistent with a pseudo-encapsulated calcification that likely developed at the site of previous fat necrosis. Calcinosis could also be considered. The smaller fragment contained fat and connective tissue with hemorrhagic foci but no other histopathologic changes. The material did not contain any plastic or metal parts.

During hospitalization, the patient remained stable with normal vital signs. The levels of C-reactive protein decreased steadily. His body temperature was 36.8 °C. At 15 days after the initial trauma, the final surgical intervention took place, during which a low-contact condylar plate was placed on the left distal femur (Fig. 8). The procedure and early postoperative period ended well, and the wound healed completely. Thromboprophylaxis with low-molecular-weight heparin was administered at the department. The patient was mobilized using crutches and received

physical therapy. One year after the surgery, the patient reported no pain and exhibited normal walking ability with full weight-bearing capacity. The range of motion in the left knee was fully restored, spanning from 0 to 130 degrees. Three years after the surgery, the patient still had no complaints and maintained full range of motion in the left knee. Figure 9 shows final follow-up radiographs three years after the surgery.

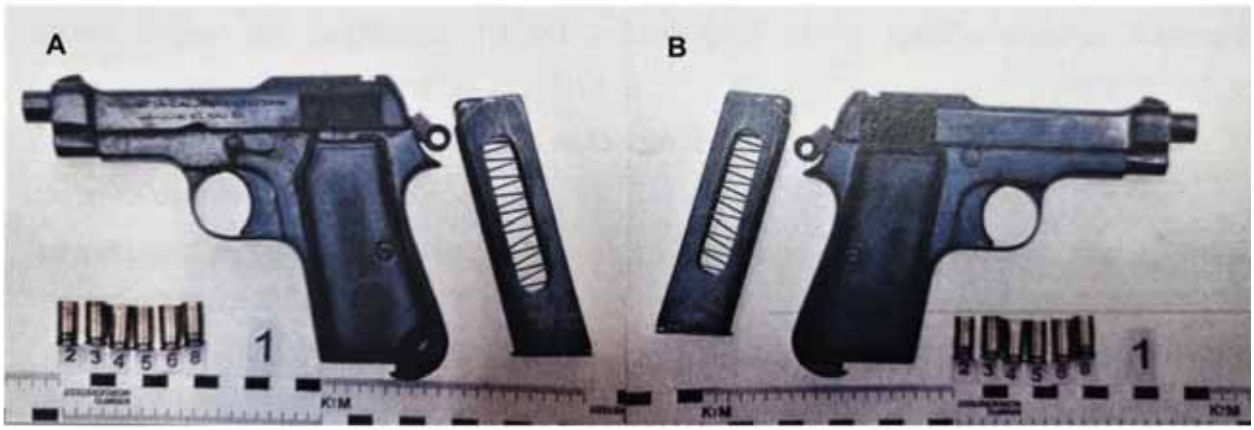

Fig. 1. The low-velocity firearm recovered from the crime scene, identified by the police as a Beretta cal. 7.65 mm Gardone V.T. 1942 XX handgun: (A) left side view; (B) right side view.

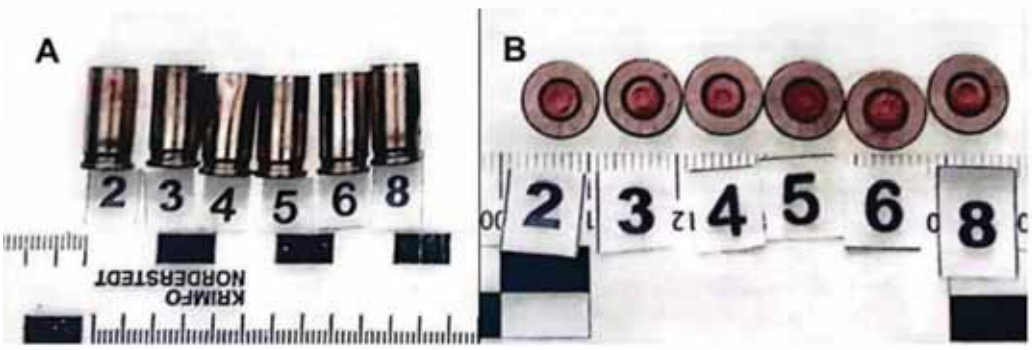

Fig 2. The 7.65 mm shell casings identified by the police at the crime scene: (A) anterior view; (B) bottom view.

Fig. 3. The 7.65 mm bullets and fragments identified by the police.

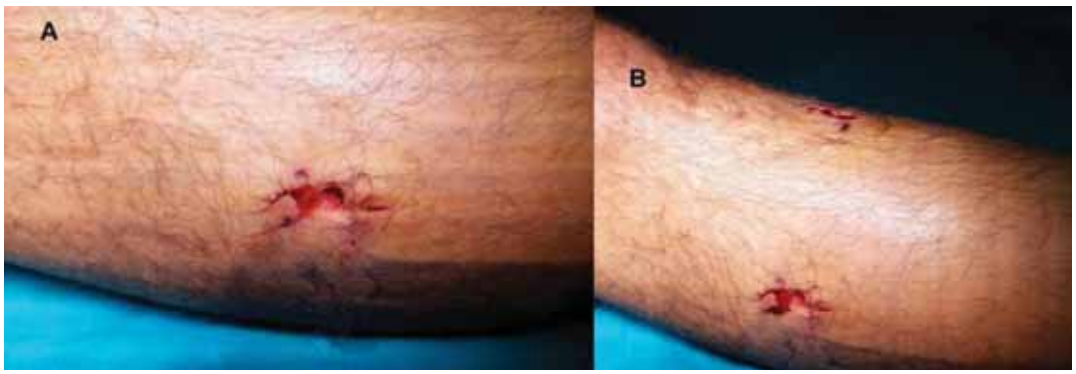

Fig 4. Initial clinical photograph of the right leg revealing a circular 1x1 cm exit wound (A) with a circumferential stellate pattern from the gunshot injury (B).

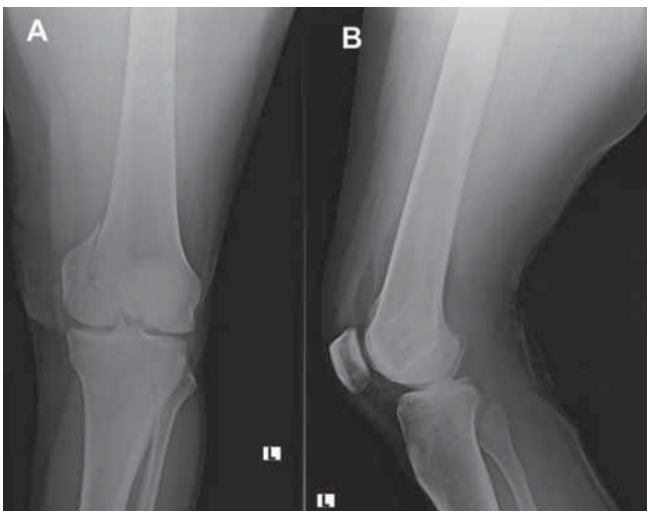

Fig. 5. Radiographs of the left knee taken upon admission and showing an atypical intra-articular fracture in the distal femur: (A) anteroposterior view; (B) lateral view.

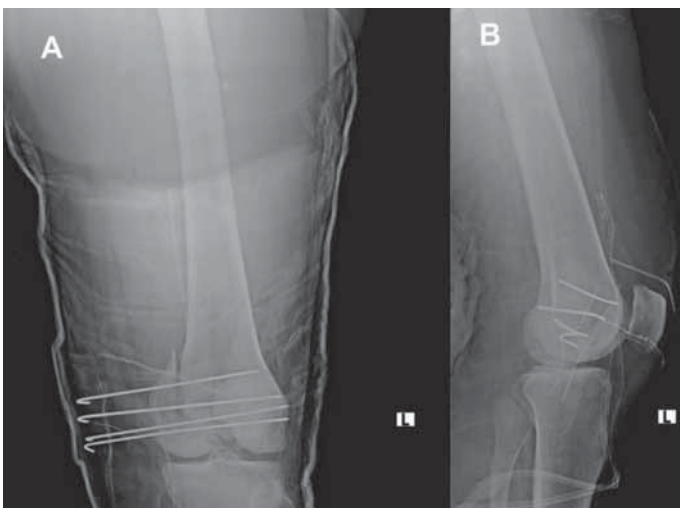

Fig. 6. Radiographs of the left knee after temporary fixation of the femoral condylar fragments with 4-K wires: (A) anteroposterior view; (B) lateral view.

Fig. 7. The patient's left leg was subjected to cleaning, debridement, temporary surgical stabilization of the femoral condyle and drain placement.

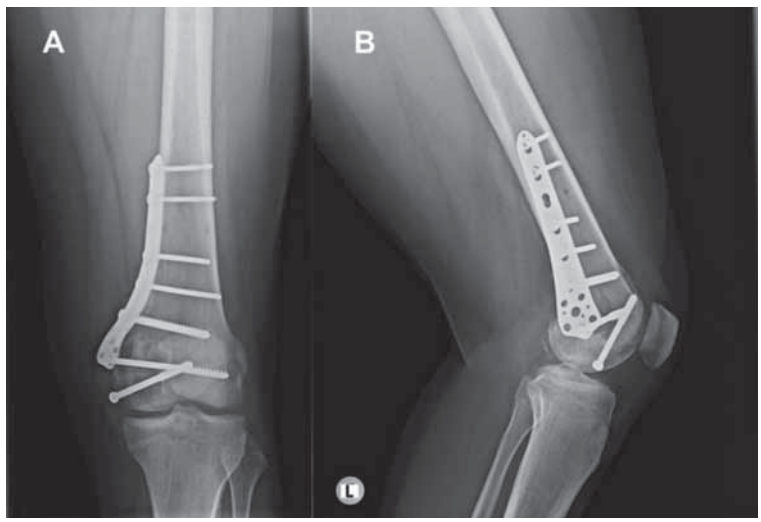

Fig. 8. Radiographs of the left knee after definitive fixation with a single low-contact medial plate: (A) anteroposterior view; (B) lateral view.

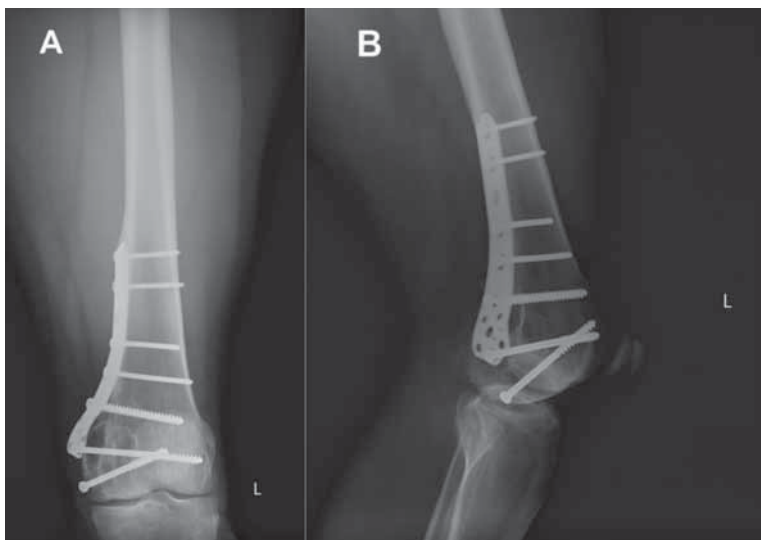

Fig. 9. Final follow-up radiographs of the left knee three years after surgery: (A) anteroposterior view; (B) lateral view.

Discussion

Lower extremity injuries resulting from low-energy gunshot wounds are commonly observed in civilian populations in urban areas[6,7]. Gunshot wounds can be classified into two basic categories based on the weapon type as rifled firearms and smooth-bore firearms (shotguns). The third category includes handmade firearms that use unusual projectiles. Gunshot wounds can also be classified as low- or high-velocity firearm injuries depending on the projectile muzzle velocity[1,5,8].

The level of tissue damage caused by a projectile is connected to the cavitation it generates as it moves through tissue. The magnitude of this cavitation is linked to certain properties of the projectile, including its fragmentation. Moreover, bullets do not fragment, and complications from shattered bone fragments tend to occur more frequently than those from bullet fragments[8-10].

Emerging 3D technology has made homemade weapons much more readily available. While most bullets are composed of lead, acquiring this metal is not always straightforward; in contrast, obtaining gunpowder tends to be much simpler.

Forensic pathologists are required to retrieve the projectile during autopsy to assist in identifying the weapon used and determining the person firing the weapon. The composition of gunshot residue has also been effective in defining 'signature elements' for determining the manufacturer. The movement used by the police is distinctive and marked by the inclusion of elements such as gallium or gadolinium. In contrast, gunshot residue from nonpolice ammunition is less identifiable than that from other ammunition types, necessitating the analysis of residue gathered from the firearm itself[10-12].

Entry wounds are generally smaller and more regular and exhibit invagination of tissue into the wound. In contrast, exit wounds are larger and more irregular, revealing outwardly behaving tissue. Determination of the firing distance depends on the type of firearm used. Small arms, including revolvers and pistols, emit flames for a distance of up to 15 cm, whereas large arms, usually assault rifles, propel flames of up to 30 cm. In small arms, there are smoke and gas components ranging from 15 to 30 cm in length and unburnt particles and metal scraps ranging from 30 to 60 cm in length.

Gunshot wounds are traditionally considered open injuries. Low-energy GSWs on the limbs can result in intricate damage involving soft tissue, bones, blood vessels, muscle-tendon units, and nerves. Although these wounds have fewer complications than high-energy gunshot injuries, precise knowledge of their anatomy is necessary to evaluate and treat them[7,13]. Fractures of the femur caused by low-velocity gunshot wounds require a brief course of broad-spectrum intravenous prophylactic antibiotics secondary to adequate debridement, irrigation, and definitive wound care.

Our patient sustained a GSW leading to an atypical distal femur fracture, which is characteristic of a Gustilo type 2 injury. In contrast, the right lower leg had a wound ≤1 cm with no associated fracture. Wound exploration revealed no evidence for neurological damage in either wound. The fixation technique with K-wires was performed immediately after the patient's admission. Two weeks after the injury, temporary fixation was converted to minimally invasive plate osteosynthesis. There were no complications, such as deep infection, nonunion, or malunion.

In a study of 100 patients undergoing surgical treatment for gunshot injury to the femur, each injury was classified based on clinical and radiographic signs of deep soft tissue necrosis, graded 1-3. Decisions regarding wound debridement and fracture stabilization were based on examination of the wound and radiographs, not on determining muzzle velocity[8].

Fractures that include bullet fragmentation that is equal to or exceeds 20% of the cortical width have been shown to have a significantly greater risk of delayed healing or failure to heal than fractures with less embedded bullet debris. These findings can influence decisions on the timing of secondary surgeries[10].

Our patient suffered two low-energy gunshot injuries to the lower extremities, one of which caused a bone fracture. However, no ballistic fragment remnants were found in the wounds. Fragments were found near the site of injury and were not associated with the primary injury, suggesting that the lack of bullet or gunpowder in the wound was due to the low energy and old age of the firearm. The soft tissue shadow observed in the radiographs of the right leg, which was suspected to be a ballistic fragment, was not found during surgical exploration. Nonetheless, scar tissue was located at the described site.

In conclusion, fractures caused by gunshot injuries are consistently open and often exhibit an atypical fracture pattern due to bullet impact. Temporary

fixation using K-wires is an alternative approach for temporarily stabilizing an open fracture, as opposed to the use of an external fixator[7,13,15].

References

1. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. J Bone Joint Surg Am. 1976 Jun;58(4):453-8.
2. Adams DB. Wound ballistics: a review. Mil Med. 1982 Oct;147(10):831-5.
3. Stefanopoulos PK, Pinialidis DE, Hadjigeorgiou GF, Filippakis KN. Wound ballistics 101: the mechanisms of soft tissue wounding by bullets. Eur J Trauma Emerg Surg. 2017 Oct;43(5):579-86. doi: 10.1007/s00068-015-0581-1.
4. Bartlett CS. Clinical update: gunshot wound ballistics. Clin Orthop Relat Res. 2003 Mar;(408):28-57. doi: 10.1097/00003086-200303000-00005.
5. Fackler ML. Civilian gunshot wounds and ballistics: dispelling the myths. Emerg Med Clin North Am. 1998 Feb;16(1):17-28. doi: 10.1016/s0733-8627(05)70346-1.
6. Pinto A, Russo A, Reginelli A, Iacobellis F, Di Serafino M, Giovine S, Romano L. Gunshot wounds: ballistics and imaging findings. Semin Ultrasound CT MR. 2019 Feb;40(1):25-35. doi: 10.1053/j.sult.2018.10.018.
7. Abghari M, Monroy A, Schubl S, Davidovitch R, Egol K. Outcomes following low-energy civilian gunshot wound trauma to the lower extremities: results of a standard protocol at an urban trauma center. Iowa Orthop J. 2015;35:65-9.
8. Long WT, Chang W, Brien EW. Grading system for gunshot injuries to the femoral diaphysis in civilians. Clin Orthop Relat Res. 2003 Mar;(408):92-100. doi: 10.1097/00003086-200303000-00010.
9. Maiden N. Ballistics reviews: mechanisms of bullet wound trauma. Forensic Sci Med Pathol. 2009;5(3):204-9. doi: 10.1007/s12024-009-9096-6.
10. Riehl JT, Connolly K, Haidukewych G, Koval K. Fractures due to gunshot wounds: do retained bullet fragments affect union? Iowa Orthop J. 2015;35:55-61.
11. Denton JS, Segovia A, Filkins JA. Practical pathology of gunshot wounds. Arch Pathol Lab Med. 2006 Sep;130(9):1283-9. doi: 10.5858/2006-130-1283-PPOGW.
12. Brożek-Mucha Z. Trends in analysis of gunshot residue for forensic purposes. Anal Bioanal Chem. 2017 Oct;409(25):5803-11. doi: 10.1007/s00216-017-0460-1.
13. Tejan J, Lindsey RW. Management of civilian gunshot injuries of the femur. A review of the literature. Injury. 1998;29 Suppl 1:SA18-22.
14. Knapp TP, Patzakis MJ, Lee J, Seipel PR, Abdollahi K, Reisch RB. Comparison of intravenous and oral antibiotic therapy in the treatment of fractures caused by low-velocity gunshots. A prospective, randomized study of infection rates. J Bone Joint Surg Am. 1996 Aug;78(8):1167-71. doi: 10.2106/00004623-199608000-00006.
15. Nguyen MP, Savakus JC, O Donnell JA, Prayson NF, Reich MS, Golob JF Jr, McDonald AA, Como JJ, Vallier HA. Infection rates and treatment of low-velocity extremity gunshot injuries. J Orthop Trauma. 2017 Jun;31(6):326-9. doi: 10.1097/BOT.0000000000000827. PMID: 28240620.

Sažetak

CIVILNA ŽRTVA PUCNJAVE NISKE BRZINE S OZLJEDAMA DONJIH EKSTREMITETA I ATIPIČNIM PRIJELOMOM DISTALNOG DIJELA LIJEVOG FEMURA: PRIKAZ SLUČAJA

M. Bekić, D. Blažević, D. Mulabdić, M. Ostojić, D. Vidović i *M. Bekić*

Ovaj prikaz slučaja podrobno opisuje postupanje s ozljedama od vatrenog oružja niske brzine kod 28-godišnjeg muškarca, naglašavajući posebne izazove i strategije liječenja u urbanim civilnim okruženjima. Ova studija doprinosi medicinskoj literaturi pružanjem uvida u složenost liječenja atipičnih prijeloma uzrokovanih vatrenim oružjem, posebno uključujući nestandardnu municiju. Bolesnik uključen u urbanu pucnjavu zadobio je višestruke rane od vatrenog oružja niske brzine na donjim ekstremitetima. Dijagnoze su uključivale atipičan intraartikularni prijelom na lijevom distalnom femuru i strano tijelo u desnoj potkoljenici. Liječenje je uključivalo hitnu operaciju sa stabilizacijom K-žicama za prijelom lijevog femura i eksploraciju rane desne noge. U desnoj nozi nisu pronađena strana tijela, ali je naknadna analiza otkrila pseudoinkapsuliranu kalcifikaciju, što ukazuje na prethodnu nekrozu masnog tkiva. Nakon 15 dana od početne traume izvršena je posljednja kirurška intervencija tijekom koje je postavljena kondilarna ploča s niskim kontaktom na distalni lijevi femur. Poslijeoperacijski oporavak bio je uspješan, s tim da je bolesnik nakon jedne godine povratio punu pokretljivost i opseg pokreta. Rane od vatrenog oružja niske brzine u civilnim okruženjima mogu rezultirati složenim atipičnim prijelomima koji zahtijevaju specifično kirurško postupanje.

Ključne riječi: *Intraartikularni prijelomi; Kirurške tehnike fiksacije; Prijelom distalnog femura; Prikaz slučaja; Rane od vatrenog oružja; Trauma niske brzine*