JAMA Insights

Sequelae and Care After Firearm Injury

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Firearm injury is caused by a weapon that uses a powder charge (handguns, rifles, and shotguns) and creates a wound or injury. According to the US Centers for Disease Control and Prevention (CDC), more than 48 000 firearm-related deaths occurred in the US in 2022. Firearm-related injuries are estimated to affect 120 000 individuals in the US annually.[1] Low-velocity firearm injuries are caused by weapons with projectile speed of 2000 feet per second or less (most handguns) and high-velocity injuries are caused by weapons with projectile speed of more than 2000 feet per second (military or hunting rifles).[2] High-velocity injuries are associated with increased risk for substantial tissue damage and fracture.

Multimedia

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Patients who survive a firearm injury require ongoing care in the outpatient setting, which is often performed by nontrauma clinicians.[3,4] Although there is extensive research on optimal care during the initial emergency department visit and hospitalization, limited data exist on best practices for addressing the medical, psychological, and social sequelae of gunshot injury. This article reviews evidence about the care of patients with firearm injury, excluding the topic of recovery after brain or spinal cord injury.

Chronic Pain

Patients commonly develop chronic pain after firearm injury. A survey of adult patients with moderate to severe injuries due to firearms and motor vehicle crashes treated at 3 level I trauma centers in Boston reported that at 6 to 12 months after injury, 67.7% of firearm injury survivors (42 of 62) experienced daily pain compared with 56.9% of matched motor vehicle crash survivors (145 of 255) (adjusted odds ratio, 3.10 [95% CI, 1.26-7.60]).[4] A multimodal pharmacologic approach to pain control may include nonsteroidal anti-inflammatory drugs, nonopioid analgesics such as acetaminophen, muscle relaxants, γ-aminobutyric acid analogues such as gabapentin, and transdermal local anesthetics. In individuals with severe injury, use of low-dose opioids for a short-term 7-day period after injury may be used for pain control. Nonpharmacologic pain management of a gunshot injury may include massage and laser therapy.

Peripheral Nerve injury

Gunshot injuries can cause peripheral nerve injuries ranging from neurapraxia, a mild, temporary injury that results in partial loss of impulse conduction, to complete nerve transection, which is more common with high-velocity injuries and in those with an accompanying fracture or vascular injury. Patients with known nerve transection should be referred to a peripheral nerve specialist at the initial outpatient clinic visit for electromyogram testing. For less severe injuries, initial outpatient pain control and referral to occupational therapy can yield improvement. In a single-center study of 117 patients with upper extremity gunshot injuries, 30% (38 of 117) had peripheral nerve injury using the American Spinal Injury Association scale and the Medical Research Council muscle power scale.[5] Accounting for loss to follow-up, 68% of patients with upper extremity gunshot injuries (23 of 34) had improved nerve function by clinical assessment at 1 year with no further operative intervention since the time of the injury[5]; however, complete resolution of nerve palsy occurred in only 24% of patients (8 of 34).[5]

Retained Bullet Fragments

The exact prevalence of retained bullet fragments among survivors of firearm violence is unknown, and no practice guidelines currently exist for management. In a single-center study of 298 patients admitted with a nonfatal gunshot injury, 225 (75.5%) had 1 or more retained bullet fragment and 202 (89.8%) were discharged from the hospital without fragment removal.[3] Surgical removal may be limited by difficulty accessing the retained bullet, fragmentation of the ballistic, and proximity to critical anatomic structures (eg, aorta, spinal cord).[6] Surgical removal is typically indicated for retained bullet fragments in joints, cerebrospinal fluid, and the eye and those causing pain, infection, or affecting weight bearing.[6] Other indications for bullet fragment removal may include palpable foreign bodies, cosmetic concerns, patient request, and high lead levels. Patients should be informed that if removed, ballistics must legally per-protocol undergo the appropriate chain of custody with institutional security personnel and local law enforcement.[7]

Lead Toxicity and Retained Bullet Fragments

Most bullets fired by and at civilians in the US are made of a lead alloy or have a lead core. Therefore, patients with retained bullet fragments may be at risk of lead toxicity.[6] Elevated blood lead levels (BLLs), defined as more than 5 μg/dL, may cause irritability, headache, memory loss, weakness, abdominal pain, and joint pain. BLLs of 10 μg/dL or higher are associated with increased rates of hypertension and essential tremor.[6] In a meta-analysis that included 462 patients with retained bullet fragments, 11 of 12 studies reported an association between elevated BLLs and retained bullet fragments. The median BLL for retained ballistics was 9.01 μg/dL, which was 5.47 (95% CI, 3.70-7.24) μg/dL higher than in controls ($P < .01$).[6] Accompanying fractures and multiple ballistic fragments are independent predictors for elevated BLL. These patients should undergo BLL testing every 90 days for the first year after injury and, if technically feasible, removal of bullet fragments if BLL is greater than or equal to 5 μg/dL.[6]

Posttraumatic Stress Disorder (PTSD)

PTSD is the persistence of symptoms such as flashbacks, nightmares, and anhedonia that affect daily life for more than 1 month after injury. The abovementioned survey reported that survivors of gunshot injury were more likely to screen positive for PTSD (33 of 62 [53.2%]) compared with matched survivors of motor vehicle

crashes (59 of 255 [23.1%]) 6 to 12 months after injury (odds ratio, 2.50 [95% CI, 1.70-5.81]) .[4] Similarly, in a retrospective cohort study of 630 patients with orthopedic injuries, those with gunshot wound trauma had higher mean PTSD scores than those without gunshot wound trauma (4.87 vs 1.75; mean difference, 3.21 [95% CI, 1.99-4.26]; $P < .001$) based on the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* short screening questionnaire (range, 0-7; higher scores indicate worse symptoms).[8] Treatment for PTSD includes trauma-focused cognitive behavioral therapy or exposure therapy. Selective serotonin reuptake inhibitors may be prescribed as an alternative first-line therapy in those with known psychological comorbidities or as an adjunct to therapy.[9] The α_1 adrenergic receptor antagonist prazosin taken at night can be useful for patients with PTSD and sleep disturbances.[9]

Functional Limitations and Quality of Life

In the abovementioned survey, a new functional limitation in an activity of daily living was reported at 1 year after firearm injury by 38% of survivors (24 of 63), and 59% (37 of 63) had not returned to work.[4] Based on the physical and mental component scores from the 12-Item Short Form Health Survey, overall physical and mental health–related quality of life was lower among survivors of firearm violence compared with 255 matched motor vehicle crash survivors at 1-year follow-up (physical: adjusted mean difference, −4.33 [95% CI, −8.36 to −0.31]; mental: adjusted mean difference, −7.89 [95% CI, −12.84 to −2.93]).[4]

Risk for Reinjury

In a retrospective cohort study of 2153 firearm injury survivors in a combined hospital and police dataset from 2008 to 2019, excluding accidental and self-inflicted firearm injury, 9.5% (205 of 2153) experienced recurrent gunshot injury.[10] The predicted incidence was 3.6% at 1 year, 11.4% at 5 years, and 15.8% at 10 years.[10] Compared with those not experiencing recurrent gunshot injury, patients with recurrent firearm injury were younger (21 vs 27 years, $P < .001$), male (95% vs 85%, $P < .001$), and Black (93% vs 73%, $P < .001$).[10] Health care–based violence intervention programs provide conflict resolution skills, career preparation, educational advancement, housing options, and food security with a goal of preventing recurrent violent injury. The Health Alliance for Violence Intervention lists active programs in the US and their outcomes.

Conclusions

Firearm injury survivors frequently experience chronic pain, nerve injury, retained bullet fragments that may cause lead toxicity, physical limitations, and PTSD and are at risk for reinjury. In addition to supportive medical and psychiatric care, survivors of firearm injury may benefit from health care–based violence intervention programs.

ARTICLE INFORMATION

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