Surgical Management Principles of Gunshot-Related Fractures

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KEYWORDS

• Ballistic • Bullet • Fracture • Gunshot • Wound

KEY POINTS

- Initial assessment should begin with Advanced Trauma Life Support principles, inspection of soft-tissue damage and contamination, a thorough neurovascular examination, local wound care, imaging, and fracture stabilization.
- High-risk wounds are those involving high-energy weapons, delayed presentation, large soft-tissue deficits, multiple projectiles, exposed bone, and those occurring on a battlefield or farm environment.
- Most low-risk gunshot fractures can be treated similarly to closed fractures. Stable injuries can be treated with cast immobilization, antibiotics, and daily wound care.
- Operative intervention is indicated for unstable fracture patterns, wounds with exposed bone, high-risk wounds, associated vascular injury, or associated compartment syndrome.
- Bullet tracts do not decompress compartments, and compartment syndrome should be managed with full-length fasciotomies.

INTRODUCTION

Nonfatal gunshot injuries are a common problem, estimated to occur approximately 60,000 to 80,000 times per year in the United States.[1,2] Several studies have reported that roughly half of all hospital admissions for gunshot wounds require fracture care, underscoring the importance of the orthopedic surgeon in the overall management of these patients.[1–4] Gunshot missiles most commonly penetrate the bones of the spine, femur, tibia and fibula, hand, and forearm, and may acutely result in life-threatening or limb-threatening injuries.[2] Furthermore, despite appropriate initial treatment, early and late sequelae such as compartment syndrome, nerve palsy, bone and soft-tissue deficits, and lead toxicity may additionally incur a significant morbidity in this population. The purpose of this review is to discuss contemporary management strategies for gunshot-related fractures, with special attention paid to the initial evaluation, role of debridement, principles of fixation, need and duration of antibiotic therapy, and management of sequelae.

INITIAL EVALUATION

The Advanced Trauma Life Support (ATLS) protocol should be the initial priority in a gunshot-wound victim. After primary stabilization, a history and

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secondary survey should be performed by the orthopedic surgeon. The patient or law enforcement officers may provide clues relating to the weapon involved in the shooting. Shotguns are considered low-velocity weapons but with a high injury potential as a result of multiple, high-mass projectiles. More extensive tissue damage is associated with multiple shots, close range, higher-velocity weapons, and expanding missiles (eg, hollow-point ammunition) (**Figs. 1** and **2**). Although forensic science can help to determine entry versus exit wounds, ammunition type by examination of wounds, and the position of the patient at the time of missile entry, it is not the job, nor within the scope of expertise, of the treating physician to attempt to establish these facts. The forensic information is generally not helpful for treating the patient at hand. Furthermore, these conclusions can be erroneous, leading to legal confusion in later criminal proceedings.

The patient should be fully exposed and examined for wounds, and the anatomic structures in the trajectory of each bullet wound should be evaluated thoroughly. The appearance of the limb should be inspected for color, soft-tissue damage, gross contamination, compartment swelling, joint effusion, and the presence of exposed bone fragments. Wounds presenting with pulsatile bleeding and/or diminished distal pulses should raise suspicion for vascular injury, and may require emergent surgical exploration.[5] Even in the presence of normal pulses, one should consider checking an ankle-brachial index on all gunshot-related injuries of the extremities, and obtain angiography or ultrasonic vascular testing for ratios less than 0.9. A thorough neurologic examination, including testing with pinprick for sharp/dull sensation, should also be documented as a baseline. All wounds can be labeled with a metallic marker for easier identification on radiographs, and all missiles should then be accounted for either with a retained bullet fragment or an exit wound. Characterization of periarticular or perivascular injuries may be enhanced via computed tomography (CT). All wounds are then copiously irrigated and dressed; the authors generally pack small wounds daily with ¼-inch iodinated gauze strips, and dress larger wounds with iodinated vaseline gauze sheets. Tetanus prophylaxis is considered in all patients with an unknown immunization status. Fractures are reduced and stabilized with padded plaster splints. Fractures involving retained fragments in the hip joint or fractures of the femur that cannot be immediately treated are stabilized with skeletal traction via distal transosseous pins.

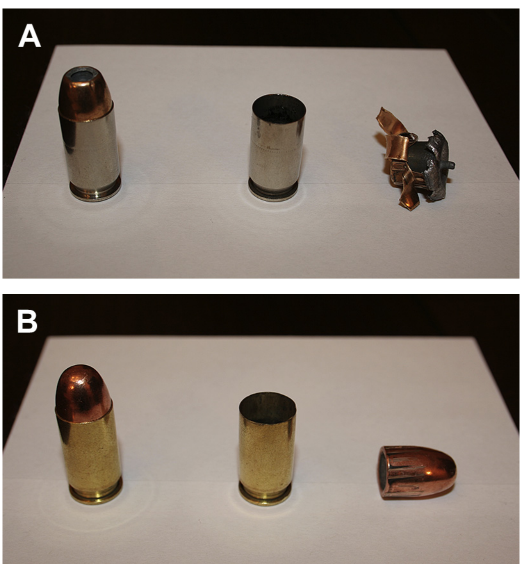

Fig. 1. Hollow-point (expanding) versus full-metal-jacket ammunition. (*A*) .45 Automatic Colt Pistol Federal 230 grain HydraShok (Hollow point). Shot at 850 feet per second (fps) from a SIG 220 gun. (*B*) .45 Automatic Colt Pistol Remington 230 grain, full metal jacket. Shot at 860 fps from a SIG 220 gun. Note that the hollow-point bullet collapses on itself and disperses its kinetic energy to the surrounding tissue in the body.

ROLE OF DEBRIDEMENT

The common myth that bullets fired from a gun are sterile has been disproved in several studies.[3,6,7] Bacteria and clothing debris are commonly translocated into the wound from the blast effect, and cause contamination. However, despite the fact that many surgeons consider the wound contamination to be similar to that of open fractures, current evidence has demonstrated that not all wounds require debridement as is done for open fractures. For example, Dickey and colleagues[7] presented a prospective randomized trial of 73 patients with stable, nonoperatively managed gunshot-related fractures, and noted similar infection rates between those with and without antibiotic prophylaxis. Knapp and colleagues[8] reported on 222 stable long-bone fractures treated nonoperatively, and similarly found no difference in infection rates between those treated with intravenous or oral antibiotics. The authors' preference for stable low-energy gunshot fractures without exposed bone is to allow the wounds to close by secondary intention via daily packing changes; additionally, a 5-day course of an oral first-generation cephalosporin as prophylaxis is prescribed, because of the unknown degree of initial contamination and the potential for poorer personal hygiene in the urban population. Stable