

Gunshot Fractures of the Forearm Are Bad Actors!

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Purpose: Gunshot fractures are common in urban centers. Gunshot fractures of bones with good soft-tissue cover have low infection rates, such as the femur and humerus. The forearm, however, has less coverage, particularly over the ulna, which may place these injuries at higher risk for infection. The current study sought to evaluate a large series of gunshot fractures of the forearm to determine the complication rates and what factors may lead to infection, nonunion, or compartment syndrome.

Methods: We performed a retrospective analysis of a consecutive series of gunshot forearm fractures at 8 trauma centers. Data abstracted included: age, gender, ISS, number of gunshot wounds (GSWs) total and to the forearm, bone fractured, and side of injury, fracture pattern and location, energy of GSW, nerve or vascular injury, antibiotics, disposition of bullet, the presence of bullet fragmentation, and the amount of bone loss (estimated by length and % circumference). Outcomes assessed were infection, compartment syndrome, and nonunion.

Results: 157 patients (87% male, aged 18-68 [average 30]) had 159 forearm fractures (84 L; 75 R). The average number of GSWs sustained to the body was 3, and to the forearm was 1.2. There were 56 isolated radius, 76 isolated ulna, and 27 both-bone fractures. 85% of fractures were comminuted, 40% were proximal, 60% had bullet fragmentation, and 30% had a retained bullet. Neurovascular injury was common with 39% having a nerve injury and 20% having an arterial injury (Figure). Follow-up was to union or diagnosis of nonunion and averaged 862 days. 7 patients (8%) developed a compartment syndrome. There were 16 (10%) infections (11 deep, 5 superficial) and 19 patients (12%) developed a nonunion (5 radius, 10 ulna, 4 both). Deep infection was more common in the ulna (8 deep, 3 superficial) than the radius (2 deep, 3 superficial). Four of the infections occurred in both-bone fractures, all of which were of the ulna. Vascular injury correlated with compartment syn-

drome ($P = 0.003$) but not with infection or nonunion. Proximal fracture location was not associated with compartment syndrome, contrary to prior studies. Bullet fragmentation correlated with infection of both radius and ulna fractures ($P = 0.002$) and all infections occurred in comminuted fractures. Ulnar infection was associated with more distal fractures with less soft-tissue cover ($P = 0.02$) and with bone loss ($P = 0.0001$) while radial infection correlated with median or anterior interosseous nerve (AIN) injury ($P = 0.004$ and $P = 0.04$) and with a dorsal approach being used ($P = 0.03$). Nonunion of the radius was associated with nerve injury and bone defect size (26 mm x 80% vs 12 mm x 30%; $P < 0.0001$). Nonunion of the ulna was associated with infection ($P = 0.0003$) and also with bone defect size (29 mm x 75% vs 11 mm x 27%; $P < 0.0001$).

Conclusion: Gunshot fractures of the forearm are serious injuries that carry a higher infection (10%) and much higher nonunion rates (12%) than blunt injuries. Ulnar-sided infection was more common and more commonly deep. This may be related to the poor coverage of the ulna predisposing to wound problems. Bones that were more directly hit, represented by a comminuted pattern with bullet fragmentation and bone loss, predisposed patients to complications. Infections occurred only in comminuted patterns and were associated with bullet fragmentation while increased bone loss predisposed to nonunion. Gunshot fractures of the forearm are bad actors and patients should be

VASCULAR INJURIES'		
At Least One Vascular Injury	32	20.1%
Brachial Artery	8	5.0%
Radial Artery	16	10.1%
Ulnar Artery	14	8.8%
NERVE INJURIES		
Any Nerve Injury	63	39.6%
Radial Nerve	26	16.4%
Ulnar Nerve	37	23.3%
Median Nerve	19	11.9%
Anterior Interosseous Nerve	10	6.3%
Posterior Interosseous Nerve	14	8.8%

counseled regarding the high complication rate. In particular, the ulna is at particular risk for infection if not well covered. Further work will be needed to determine if operative measures should be taken to treat bone loss.