Luck of the Draw: Comparing Outcomes of Ballistic and Blunt Elbow Fractures

Robin Maria Litten[1], Doriann Marie Alcaide, Ryan McIlwain, Reid Harrison Reeves, Nigel Blackwood, Clay A Spitler
[1]Orthopaedic Surgery

INTRODUCTION:

Ballistic injuries are on the rise with increasing civilian gun violence in the U.S., resulting in over 48,000 deaths and twice as many nonfatal injuries in 2024. While extremities are the most common location for gunshot wounds, elbow involvement is rare, comprising only 3.8% of upper extremity cases.

Elbow fractures are particularly challenging due to the joint's complex anatomy and high risk for neurovascular injury. Ballistic trauma further complicates management through extensive soft tissue damage and a higher risk of complications like heterotopic ossification and infection. These factors can lead to increased reoperation rates and worse functional outcomes. However, existing research is limited by the rarity of these injuries and poor stratification by mechanism. This study aims to compare outcomes between ballistic and blunt elbow fractures, hypothesizing worse outcomes in the ballistic group due to the severity of associated tissue damage.

METHODS: After IRB approval, a retrospective review was conducted of operatively treated elbow fractures (distal humerus, proximal ulna, and radius) at a Level I trauma center from January 2014 to January 2024, identified using CPT codes 24545, 24546, 24579, 24586, 24665, 24666, and 24685. Patients with ballistic trauma were matched 1:1 by age and OTA/AO fracture classification to controls with blunt trauma. Exclusion criteria included age <18, <6 months of follow-up, inadequate documentation, and humeral shaft fractures without distal extension.

The primary outcomes assessed were nonunion, infection, heterotrophic ossification, hardware removal and hardware failure. Nonunion was defined as lack of radiologic union at 3 or more cortices at 6 months after index surgery. Hardware failure was classified as implant fracture or loosening. Secondary outcomes included reoperation rates, range of motion (ROM) and injury characteristics. Demographics, comorbidities, substance use, fracture patterns, and perioperative data (injury severity score, operative duration, transfusion rate) were collected from the medical record.

Categorical variables were compared using chi-square or Fisher's exact tests, and continuous variables with independent t-tests. A p-value <0.05 was considered significant; analyses were performed using IBM SPSS Version 29.0.1.0.

RESULTS:

A total of 76 patients were included, 38 in each cohort. The mean patient age for both cohorts was of 35.79 years. There was a significant difference in sex with the ballistic group having a higher percent of males (76.3% vs 52.6%; p<0.001), alcohol (52.6% vs 23.7%; p=0.009) and drug use (42.1% vs 18.4%; p=0.025) (Table 1). The most common mode of injury for the patients in the blunt injury cohort was multiple vehicle accident (55.3%), followed by fall from height (23.7%). The ballistic cohort had a higher rate of nerve injury when compared to the blunt injury cohort (42.1% vs 15.8%; p=0.011) and lower rates of hardware removal (15.8% vs 39.5%; p=0.021) and lower functional ROM (43.5% vs 71.9%; p=0.034). There was no difference in rates of nonunion, infection, range of motion, compartment syndrome or vascular injury (Table 2).

DISCUSSION AND CONCLUSION:

Despite higher rate of nerve injury in ballistic elbow fractures, clinical outcomes are comparable to those with blunt elbow fractures except in hardware removal rates but patients with ballistic elbow fractures do have lower rates of functional elbow range of motion.

Table 1. Demographic and clinical characteristics of patients with ballistic and blunt elbow fractures.

	Ballistic (n=38)	Blunt (n=38)	p-value
Age, mean (SD)	35.79 (11.7)	35.79 (11.4)	1.000
Sex, n (%)			0.031
Male	29 (76.3)	20 (52.6)	
Female	9 (23.7)	18 (47.4)	
Race, n (%)			<0.001
White	8 (21.1)	33 (86.8)	
Black	29 (76.3)	3 (7.9)	
Other	1 (2.6%)	2 (5.3%)	
BMI (kg/m²), mean (SD)	27.8 (7.0)	28.6 (8.3)	0.664
Drug use, n (%)	16 (42.1%)	7 (18.4%)	0.025
Alcohol use, n (%)	20 (52.6%)	9 (23.7%)	0.009
Tobacco use, n (%)	23 (60.5%)	16 (42.1%)	0.108
Diabetes, n (%)	1 (2.6%)	3 (7.9%)	0.304
HTN, n (%)	4 (10.5%)	8 (21.1%)	0.208
CVD, n (%)	5 (13.2%)	0	0.054

SD = standard deviation, BMI = body mass index, kg/m² = kilograms per meter squared, HTN = hypertension, CVD = cardiovascular disease.

Table 2. Comparison of postoperative outcomes between ballistic and blunt trauma patients.

	Ballistic (n=38)	Blunt (n=38)	p-value
Nonunion, n (%)	7 (18.4%)	4 (10.5%)	0.328
Infection, n (%)	6 (15.8%)	5 (13.2%)	0.744
Hardware failure, n (%)	7 (18.4%)	3 (7.9%)	0.175
Hardware removal, n (%)	6 (15.8%)	15 (39.5%)	0.021
MUA, n (%)	3 (7.9%)	8 (21.1%)	0.103
Postoperative neuropathy, n (%)	17 (44.7%)	10 (26.3%)	0.093
HO, n (%)	0	5 (13.2%)	0.054
Reoperation, n (%)	0.5 (0.9)	1.0 (1.6)	0.084
Follow up (days), mean (SD)	387 (296)	410 (252)	0.716
Flexion at last visit (°), mean (SD)	106 (28)	113 (26)	0.397
Extension at last visit (°), mean (SD)	15 (11)	12 (23)	0.919
Functional ROM (°), mean (SD)	10 (43.5%)	23 (71.9%)	0.034

MUA = manipulation under anesthesia, HO = heterotopic ossification, ROM = range of motion, ° = degrees, SD = standard deviation.