

Pediatric Floating Elbows...What is All the Fuss About? A Multicenter Perspective

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Purpose: Floating elbow injuries are defined as ipsilateral concomitant fractures of the distal humerus and radius and /or ulna. Although pediatric orthopaedic dogma suggests a high risk of acute compartment syndrome (ACS) and other adverse outcomes, a recent systematic review suggests otherwise. We aimed to assess treatment paradigms and outcomes of pediatric floating elbow injuries and identify a true rate of associated ACS.

Methods: A multicenter retrospective database was created to review patients under the age of 18 years who presented from May 2014 to April 2019 with floating elbow injuries, defined as a distal third humerus fracture and concomitant radius and/or ulna fracture. Patient demographics, injury characteristics, treatment course, and outcomes were evaluated. A severity subclassification was developed based on fracture displacement (Figure 1).

Results: 454 patients were evaluated across 15 institutions (1A: 67, 1B: 92, 2A: 65, 2B: 230). Median age at time of injury was 6.8 years (interquartile range [IQR]: 5.6-8.1 years), and the cohort was 51% male. Median length of follow-up was 2.5 months (IQR: 1.9-4.4 months). 13 patients (2.9%) presented without a palpable pulse or Doppler signal, all of whom had displaced humeral fractures ($P = 0.006$). 84 patients (18.5%) presented with nerve injuries, which were more common in Class 3 fractures ($P < 0.001$), and only 14 (3.1%) had persistent nerve injuries at final follow-up ($P = 0.029$). Displacement largely dictated whether the distal injury was treated with fixation (1A: 16, 1B: 55, 2A: 24, 2B: 175; $P < 0.001$) or immobilization. Open reduction rate of the proximal fracture was 7.7% overall. There was 1 case (0.2%) of compartment syndrome, involving displaced proximal and distal fractures. Most patients returned to activities with no-to-few modifications (1A: 94%, 1B: 90%, 2A: 95%, 2B: 88%). Following Flynn's criteria, early outcomes were excellent or good in 315 patients (69%), fair for 101 patients (22%), and poor for 32 patients (7%). Outcomes did not differ significantly by injury severity subclassification ($P = 0.055$).

Conclusion: This multicenter study of a large cohort of pediatric floating elbow injuries demonstrates a low rate of ACS (0.2%). Closed treatment of the distal fracture is common for nondisplaced fractures. Rates of nerve and vascular injury correlated with injury severity and were comparable to those of isolated component injuries.



	Class 1A	Class 1B	Class 2A	Class 2B
Humeral Fracture	Gartland 1/2	Gartland 1/2	Gartland 3 & 4, T-type	Gartland 3 & 4, T-type
Forearm Fracture	Nondisplaced	Complete/Displaced	Nondisplaced	Complete/Displaced

	Total	Class 1A	Class 1B	Class 2A	Class 2B	P-value
n (%)	454 (100.0)	67 (14.8)	92 (20.3)	65 (14.3)	230 (50.7)	
Humeral Treatment						<0.001*
Closed Reduction	419 (89.3)	67 (100.0)	90 (97.8)	61 (93.8)	201 (87.4)	
Open Reduction	35 (7.5)	0 (0.0)	2 (2.2)	4 (6.2)	29 (12.6)	
Forearm Treatment						<0.001*
Immobilization Only	184 (39.2)	51 (76.1)	37 (40.7)	41 (63.1)	55 (23.9)	
Fixation	270 (57.6)	16 (23.9)	55 (59.3)	24 (36.9)	175 (76.1)	
Pulseless at Presentation	13 (2.8)	0 (0.0)	0 (0.0)	4 (6.2)	9 (3.9)	0.063
Nerve Injury at Presentation	84 (17.9)	5 (7.5)	4 (4.4)	15 (23.1)	60 (26.1)	<0.001*
Nerve Injury at Final Visit	14 (3.0)	0 (0.0)	0 (0.0)	3 (4.6)	11 (4.8)	0.029*
Modified Flynn Outcomes at Final Visit						0.055
Excellent	170 (36.2)	25 (37.3)	45 (48.4)	23 (35.4)	77 (33.5)	
Good	145 (30.9)	27 (40.3)	27 (29.7)	18 (27.7)	73 (31.7)	
Fair	101 (21.5)	9 (13.4)	16 (17.6)	21 (32.3)	55 (23.9)	
Poor	32 (6.8)	5 (7.5)	3 (3.3)	3 (4.6)	21 (9.1)	

Figure 1: Floating elbow injury classifications, treatment, and outcomes characteristics.

Flynn criteria were defined as Excellent for 0-5° varus of Baumann's angle and 0° range of motion (ROM) loss, Good for >5-10° varus and <10° ROM loss, Fair for >10-15° varus and 10-30° ROM loss, and Poor for >15° Baumann's angle and >30° ROM loss. * indicates statistical significance at $\alpha=0.05$.