

Fishtail Deformity Complication of Distal Humeral Fractures in Children

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ABSTRACT

Background: This article examines 10 pediatric distal humeral avascular “fishtail” deformities with an average of eight years follow-up. The authors discuss initial injury classification and treatment, timing to presentation of fishtail deformity, and subsequent treatments for this rare injury pattern..

Methods: A retrospective chart review was conducted at The University of New Mexico Hospital to identify patients aged 18 years or younger diagnosed with a distal humerus “fishtail” deformity from 2008 to 2018. Patient demographics, injury characteristics, physical exam findings, timing of fishtail deformity presentation, follow-up time, and pertinent complications were recorded. Intraoperative fluoroscopic and immediate postoperative imaging studies were also reviewed.

Results: Ten patients met inclusion criteria, eight of which underwent operative management for their initial injury, while two patients with involved fractures were treated in closed fashion. On average, fishtail deformity was diagnosed 3.6 years after the index injury, with mean follow-up time of eight years. At time of diagnosis, common presenting symptoms included pain, limitations in range of motion (ROM), peripheral nerve compressive neuropathies, exostoses, and malunion. Additional operative treatment was performed on three patients, which included debridement of exostoses and ulnar nerve decompression. The arc of ROM at last follow-up was 124.5° (7.5° to 132°).

Conclusion: Given its rarity, the authors concluded that calculating a meaningful incidence proportion of pediatric fishtail deformities remains challenging. Additionally, the severity and fracture type of the initial injury do not concretely predict the eventual development of fishtail deformity. Presentation and long-term complications remain variable regardless of treatment option for distal humerus fractures.

Keywords: Deformity; Elbow; Humerus; Necrosis; Pediatrics

INTRODUCTION

A “fishtail deformity” describes an anatomical and radiographic finding of central epiphyseal deficiency in the distal humerus. This finding is likely secondary to osteonecrosis of the trochlea following a variety of distal humeral fractures, including supracondylar, T-condylar, and medial or lateral condylar fractures, all of which are common injuries in the pediatric population.¹⁻³ It is estimated that 64.0% of all distal humeral fractures occur in patients younger than 15 years of age, with a peak incidence in children ages five years to nine years, and a sharp decrease after the age of 15.¹

Among the pediatric population, the incidence of distal humerus fractures is well established in the literature. Supracondylar humerus fractures represent the most frequent type of distal humerus fracture, accounting for 50.0% to 70.0% of all pediatric elbow fractures.³ In contrast, lateral condyle fractures of the distal humerus account for 12.0% to 20.0% of all elbow

fractures in the same population.³ However, literature regarding incidence rates of the fishtail deformity remain sparse.

Pediatric patients who develop a fishtail deformity can experience significant functional disability, including pain and restricted range of motion (ROM).⁴ Despite the prevalence of these fractures, only a limited number of case series are currently available to describe patient presentation and guide subsequent management.⁴⁻¹⁰ To bring awareness to a rare, yet disabling condition, this study aims to contribute to the available literature by reporting on the diagnosis, management, and complications associated with fishtail deformities in 10 patients.

METHODS

Approval was granted by The University of New Mexico Health Sciences Institutional Review Board (IRB #20-305). The authors conducted a retrospective chart review using Current Procedural Terminology (CPT)

codes to identify patients at this Level I trauma center who were diagnosed with a distal humerus fracture and required surgical intervention from 2008 to 2018. This timing was selected to ensure adequate opportunity for follow-up. The CPT codes 24538 (percutaneous skeletal fixation of supracondylar or transcondylar humeral fracture, with or without intercondylar extension), 24545 (open treatment of humeral supracondylar or transcondylar fracture, with or without internal or external fixation; without intercondylar extension), and 24546 (open treatment of humeral supracondylar or transcondylar fracture, with or without internal or external fixation; with intercondylar extension) were used to identify patients. Using these codes ensured that only operative patients who likely had sufficient follow-up imaging studies were included.

Patients' electronic medical records were reviewed for an additional diagnosis of a distal humerus deformity, fishtail deformity, or avascular necrosis of the trochlea. Additionally, the Picture Archiving and Communications System (PACS) was used to identify patients treated nonoperatively who may have developed a fish tail deformity. PACS was queried for reports of elbow imaging with diagnoses of "avascular necrosis," "trochlear dysplasia," "distal humerus deformity," or "fishtail deformity." Inclusion criteria included patients ages 18 years of age and younger with a confirmed distal humerus deformity, fishtail deformity, or avascular necrosis of the trochlea based on chart and imaging reviews. Exclusion criteria included patients who did not have adequate imaging or those diagnosed with a systemic rheumatological disease with involvement of the elbow. Their records were also reviewed to obtain patient demographics, injury mechanism, medical interventions, physical exam findings, timing of fishtail deformity presentation, follow-up time, and complications.

RESULTS

A total of 854 operatively treated elbow fractures were identified, eight of which met inclusion criteria, suggesting an incidence of 0.94% among surgically managed pediatric elbow injuries. The PACS query identified an additional two cases that arose in patients treated nonoperatively. In total, 10 patients met inclusion criteria (representative patient is demonstrated in Figure 1). Of the 10 patients, five were women with a mean initial injury age of 4.8 years of age (range: two years to eight years) (Table 1). The average elapsed time from initial injury to deformity presentation was an estimated 3.6 years of age (range: two months to eight years). Six patients presented with a type III supracondylar fracture, five of which were treated with closed reduction percutaneous pinning (CRPP) and one treated with open reduction

percutaneous pinning. Two patients presented with a type I or type II supracondylar fracture, which were treated with a cast and CRPP, respectively. One patient presented with a lateral humeral condyle fracture and was treated with CRPP. The other patient presented with an unspecified elbow fracture, which was treated with closed reduction and casting at an outside institution within the state.

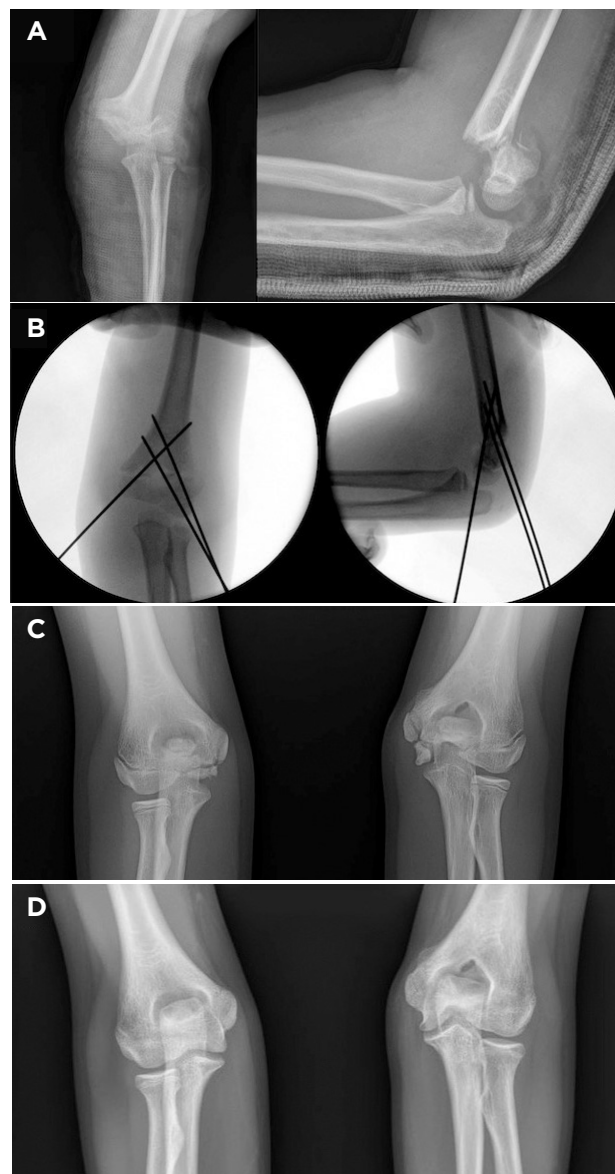


Figure 1. A) Radiographs of a left Gartland 3 extension type supracondylar humerus fracture (patient age 8); B) Fluoroscopic images of treatment with closed reduction and percutaneous pinning; C) Radiograph of bilateral elbows demonstrating development of contour abnormality of the left distal humerus secondary to lateral trochlear ossification center involvement 2.5 years after injury; D) Radiograph of bilateral elbows, four years after injury with resultant central epiphyseal deficiency and characteristic "fishtail deformity."

Table 1. Relevant data for each patient diagnosed with fishtail deformity.

Age at Initial Injury	Gender	Arm Affected	Initial Injury/Fracture Type	Initial Treatment	Initial Complications	Time from Initial Injury to Diagnosis of Fishtail	Elbow ROM at Presentation of Fishtail	Treatments	Elbow ROM at Last Follow-up	Total Follow-Up
8 Years	F	L	Type 3 SCH Fracture	CRPP	None	31 Months	20°-140°	Ulnar Nerve Decompression, Open Excision of Exostoses	0°-140°	8 Years
3 Years	F	R	Type 1 SCH Fracture	Closed Reduction and Casting	None	82 Months	20°-140°	Conservative	0°-140°	9 Years
4 Years	M	R	Type 2 SCH Fracture	CRPP	Malreduction	12 Months	10°-90°	Open Excision of Exostoses	0°-125°	4 Years
4 Years	M	L	Type 3 SCH Fracture	CRPP	None	12 Months	30°-140°	Ulnar Nerve Transposition	0°-140°	10 Years
5 Years	M	R	Lateral Condyle Fracture	CRPP	Nonunion requiring ORIF	2 Months	70°-100°	Deferred Contracture Release	45°-110°	9 Years
7 Years	F	L	Type 3 SCH Fracture, Medial Epicondyle Fracture	CRPP and ORIF	Transient Radial Nerve Neuropraxia	12 Months	20°-140°	Conservative	0°-140°	3 Years
5 Years	M	R	Type 3 SCH Fracture	CRPP	Pin Tract Infection Requiring I&D	36 Months	0°-140°	Conservative	0°-140°	3 Years
4 Years	M	L	Type 3 SCH Fracture	ORPP	Transient Median Nerve Neuropraxia	90 Months	5°-120°	Conservative	5°-120°	8 Years
2 Years	F	L	Distal Humerus (Unspecified)	Closed Reduction and Casting	None	96 Months	30°-140°	Conservative	25°-140°	19 Years
6 Years	F	L	Type 3 SCH	CRPP	Malreduction	60 Months	0°-125°	Deferred Removal of Foreign Body	0°-125°	7 Years

ROM: range of motion; SCH: supracondylar humerus; ORIF: open reduction internal fixation; CRPP: closed reduction percutaneous pinning; I&D: irrigation and debridement

A review of the intraoperative fluoroscopic and immediate postoperative imaging revealed slight rotations in two patients treated with CRPP. Another patient treated with CRPP received two lateral pins placed slightly posterior in the capitellum. Two patients received cross pinning in which the entry point was not from the posterior capitellum. Intraoperative imaging otherwise illustrated adequate reductions and pinning.

Following treatment of the initial distal humeral fractures, postoperative complications were noted in six patients. Two patients were diagnosed with neuropraxia, both of which resolved without operative management. Two patients had malunions of their supracondylar humerus fractures, neither of which underwent revision. One patient experienced lateral condyle malunion requiring open reduction and internal fixation (ORIF), and another experienced a pin tract infection and resultant lateral condyle osteomyelitis requiring irrigation and debridement. Four patients reported no complications following the immediate follow-up period.

Presenting symptoms at the time of diagnosis of a fishtail deformity were variable and included stiffness, pain, mechanical symptoms, and ulnar nerve paresthesias. Restrictions in ROM were the most common symptom, occurring in nine patients. The severity of elbow ROM restriction was variable. Eight patients presented with limited elbow extension and demonstrated flexion contractures ranging from 5° to 70°. Additionally, four patients presented with a loss of elbow flexion, ranging from 15° to 50°. Following fishtail deformity diagnosis, seven patients received nonoperative treatments. Two of these patients deferred the offer of contracture releases and intra-articular free body mass removal. Ulnar nerve transposition/decompression was performed in two cases. Open debridement of exostoses was performed in two cases.

Time from initial injury to last follow-up varied in length with an estimated mean of eight years (range: three years to 19 years). Symptoms at time of last follow-up included mild intermittent pain in one patient, valgus deformity of 15° in one patient, limited ROM in five patients, and mechanical symptoms, such as locking, in one patient. The arc of ROM at last follow-up was 124.5° (7.5° to 132°) compared to an initial arc of ROM of 97.5° (20.5° to 118°) on presentation for an average improvement of 27°.

DISCUSSION

The term “fishtail deformity” was first used by Wilson in 1955 to describe radiographic observations following pediatric fractures of the distal humerus.¹¹ Wilson and more recent authors theorized that the sharp angular deformity was the result of a fracture and persistent

gap between the lateral condylar ossification center and the medial trochlear ossification center.¹² This gap is hypothesized to produce a small physeal bar in addition to the malunion. In contrast, physicians have observed a second, less angular deformity that involves the lateral trochlea. The resultant smooth deformity is believed to be associated with osteonecrosis of the trochlear epiphysis and has been associated with supracondylar fractures, medial condyle fractures, and separations of the entire distal humeral epiphysis.^{6,13} Osteonecrosis of the lateral trochlear ossification center results in development failure or possible reabsorption of the lateral trochlea, while the medial ossification center continues to grow normally, which results in an inverted V shape resembling a fish tail.⁶⁻⁷

Current theories support a vascular etiology with avascular necrosis of the lateral trochlea being the primary pathologic process in producing a fishtail deformity.⁷ The trochlea, olecranon fossa, and coronoid fossa are watershed areas, and are therefore vulnerable to injury.¹³ The lateral trochlea obtains its blood supply from two distinct end arterioles.^{14,15} One arteriole arises from lateral humeral vessels, which supplies the capitellum then cross the physis to supply the lateral trochlea.⁷ The other originates from medial humeral vessels and supplies the majority of the medial trochlear epiphysis.⁷ Following distal humeral fractures, the described blood supply to the distal humerus and the watershed area between the two arterioles is potentially vulnerable to disturbances and is involved in the development of a fishtail deformity.⁷

In pediatric patients, fishtail deformities have been described as a complication of distal humeral fractures, particularly supracondylar fractures.⁷ However, they have also been associated with lateral condylar fractures, T-type distal humerus fractures, medial condylar fractures, and Salter Harris 1 epiphyseal fractures.⁸⁻¹⁰ A fishtail deformity can develop following ORIF, CRPP, or conservative treatment of the initial injury. This indicates that the severity of distal humerus fractures or the type of fracture management may not correlate with the risk of developing the deformity.¹¹

In their seven-patient case series, Lehnert reported an average of 7.6 years between the initial injury and presentation of fishtail deformity.⁹ However, other case series have reported a time to presentation of 4.7 years, which is more consistent with the cohort in this study.⁸ Current literature demonstrates that most patients with a fishtail deformity present with stiffness, pain, or decreased ROM, which was consistent in nine out of 10 patients in this study.

The treatment approach to fishtail deformity is often multifaceted and depends on the severity of symptoms. This study demonstrated that conservative management

alone provided mild, but improved ROM, with five of the patients demonstrating full ROM following conservative treatment. In patients with persistent or severe symptoms, operative intervention, including open versus arthroscopic debridement and removal of loose bodies, capsulotomy, contracture release, surgical arrest of the remaining physis, and osteotomy for persistent deformity can be indicated.¹¹ Glotzbecker et al⁸ focused on treatment and outcomes in their 15 patients with fishtail deformities. Of the 15 patients, seven received arthroscopic debridement with six experiencing short-term pain relief and all seven reporting improvement in ROM. Moreover, four of seven patients required a second debridement after the initial intervention.¹¹ In this study, the two patients who underwent open debridement have not undergone repeat debridement after four and eight years of follow-up. Nevertheless, long-term outcomes for debridement and other treatment options are not well described.

Several authors in the literature suggest that fishtail deformity is not a serious clinical condition because there are few symptoms or functional deficiencies in the first few years following its presentation.⁷ However, long term follow-up demonstrates that this deformity can

result in significant disability, especially in adulthood; severe cases can involve limited flexion, limited extension, radial head subluxation, and osteochondritis dissecans.^{6,10} Additionally, underlying fishtail deformity can complicate adult and geriatric trauma management. In a recent case report, an 83-year-old woman with a medial condyle fracture and chronic lateral condyle nonunion with fishtail deformity of the humerus was successfully managed with a semi-constrained total elbow arthroplasty.¹⁶

CONCLUSION

Fishtail deformities are a rare, but potentially debilitating complication of pediatric elbow fractures. Supracondylar fractures are a frequent elbow injury in the pediatric population and are associated with the development of trochlear avascular necrosis. However, a fishtail deformity can also develop with other elbow fractures, such as lateral condyle fractures and transphyseal distal humerus injuries. Clinical presentation with pain and loss of ROM can vary, and presentation time of these symptoms is likely close to four years following the initial injury. Treatment options can be conservative or operative depending on the patient's symptoms.

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