

Are Follow-Up Radiographs Necessary in the Treatment of Nonoperative Pediatric Clavicle Fractures?

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INTRODUCTION: Clavicle fractures are the most common long bone fractures in the pediatric population. It is generally agreed upon that most pediatric fractures should be treated non-operatively. It is current practice to immobilize the shoulder ipsilateral to the fracture and to obtain 2 follow-up (F/U) x-rays around 1 month and 3 months post-injury. The length of immobilization is determined by the age of the child, level of pain, and the severity of the fracture. Return to activity/sports is usually granted 6 weeks post-injury. Complications of treatments include nonunion, malunion, cosmetic deformity (secondary to callous formation during remodeling), and skin tenting. Nonunion and malunion are found to be rare in children. Most clavicle fractures, however, have a positive outcome and heal without complication. Assessing risk-benefit ratio to minimize exposure to x-ray imaging in the pediatric population is important in reducing the risk of unnecessary radiation. The goal of this study is to assess the rates of change in clinical management based on routine F/U x-rays. Our hypothesis is that routine post-injury F/U imaging does not significantly change patient management, except in patients with post-injury complications, and could potentially be eliminated from standard clinical management for this population.

METHODS: This is a single-center retrospective chart review, approved by our university's IRB, which includes all pediatric (age 1-10) clavicle fractures from four attending physicians between 1/1/2010 and 12/31/2023 (N = 615). The inclusion criteria were defined by having at least one in-person F/U visit and having a non-operative treatment plan. Demographics, mechanism of injury, side of injury, time from injury to immobilization, type of fracture, type of immobilization, length of F/U, and the number and dates of F/U x-rays were recorded. Patient outcome characteristics noted included pain at the final visit, physical therapy referrals, limited range of motion, changes in management - defined as further immobilization, further activity restrictions, or additional follow-up appointments needed, and complications - defined as displacement of a fracture, refracture, malunion, nonunion, and cosmetic deformity. Descriptive statistics included mean ± standard deviation (range) for continuous variables and number (percent) for categorical variables. All data analysis was completed with SPSS [Version 30.0.0.0 (172)].

RESULTS: From the 615 fractures screened, 505 fractures from 497 patients (311 male, 186 female) met the inclusion criteria. Cases were excluded for failure to follow up (n=77), virtual follow-up (n=6), operative treatment plan (n=9), and inadequate information in their orthopaedic chart (n=4). 1 case was excluded as a duplicate patient with no new fracture. Additionally, 13 cases were excluded due to the patient not following up as recommended and having fewer than 30 days of F/U. The average age of patients was 5.4 ± 2.7 years old (range, 1-10 years). The average Body Mass Index (BMI) was 17.9 ± 4.07 kg/m² (range, 7.6-36.6 kg/m²). Data to calculate BMI was only available for 273 (54%) patients. A sling was used most often (64%) as immobilization for the duration of treatment, followed by a shoulder immobilizer (27.9%). The average time to initial presentation for a baseline x-ray was 0.70 ± 1.88 days (range, 0-15 days). The average time from injury to discontinuation of immobilization was 3.98 ± 1.24 weeks (range, 1-12 weeks) and the average time from injury to discharge from care was 51.1 ± 28.7 days (range, 15-446 days). During the F/U period, 179 (35.4%) fractures had a 1st F/U x-ray, 226 (44.8%) fractures had 2nd F/U x-rays, 74 (14.7%) fractures had 3rd F/U x-rays, 19 (3.8%) fractures had 4th F/U x-rays, and 2 (0.4%) fractures had ≥ 5th F/U x-rays. Of the 95 (18.9%) cases that had > 2 F/U x-rays, only 4 (4.2%) experienced complications, 2 (2.1%) had a change in management, and 1 (1.1%) had both a complication and a change in management. Additionally, 5 (1.0%) cases had 0 F/U x-rays including 3 cases that were clinical checks and healed without complication, and 2 fracture cases from one patient whose parent refused any F/U x-rays, and the child suffered a refracture 4 months post-initial injury. We observed total of n=15 (3.0%) changes in fracture management including further immobilization (n=2), discontinuation of immobilization due to age of injury (n=1), new immobilization when the diagnosis changed after a follow-up x-ray (n=10), and further activity restrictions (n=2). Complications were noted in n=11 (2.2%) cases including refracture ≤ 6 months of initial injury (n=5), refracture > 6 months from initial injury and within the study period (n=3), and displacement of the clavicle fracture (n=3). There were no cases of malunion, nonunion, or cosmetic deformity. It is also important to note that in 179 cases with only 1 F/U x-ray, only 1 (0.56%) fracture experienced a complication. Further, of the 15 cases with a change in management, 13 (86.7%) changes followed the 1st F/U x-ray, and only 2 (13.3%) changes followed the 2nd F/U x-ray.

DISCUSSION: This study evaluated the necessity of follow-up radiographs in pediatric nonoperative clavicle fractures by determining the rates at which management changed following a F/U x-ray. Our results showed low rates of change of management (3.0%) and complications (2.2%) overall, and even lower rates, 0.4% and 0.8% respectively, in cases with > 2 radiographs taken during F/U period. There have been similar studies that assessed complication rate and need for follow-up in the pediatric population. However, they lack recency. A retrospective study of 537 pediatric clavicle fracture case by Strauss et al. (2012) found that only 2.5% of clavicle fractures treated non-operatively resulted in a complication, which coincides with our study complication rates (2.2%). Increased patient age and completely displaced fractures were found to increase risk of complication, but the relative risk of complication remained low. Given the low risk, Strauss et al. supports the idea that prolonged F/U of typical clavicular fractures is unnecessary. Similarly, Calder et al. (2002) found that pediatric patients with an isolated fracture of the clavicle with no complications at initial clinical review may be safely discharged from further F/U visits. Our data is consistent with this finding and suggests a change in standard-of-care from 2 F/U x-rays to 1 F/U x-ray. As discussed, of the 179 cases with only 1 follow-up x-ray, just 1 case experienced a complication and from analysis of rates of change in management, most of the changes (86.7%) followed the 1st F/U x-ray. Study limitations include observational study design, descriptive data analysis due to limited power, lack of long-term outcomes evaluation, and missing data possibly causing reporting bias. Lastly, further research is required, ideally a prospective, larger sample size study following pediatric clavicle fractures, to determine if the standard-of-care for uncomplicated pediatric clavicle fractures cases could be changed to 1 follow-up x-ray.

SIGNIFICANCE/CLINICAL RELEVANCE: Our study suggests that > 2 F/U x-rays in uncomplicated cases may not be necessary and the standard-of-care could potentially be adjusted to recommending just 1 F/U x-ray rather than 2. Minimizing F/U x-rays proves significant as it works to eliminate the associated costs and radiation exposure.

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IMAGES AND TABLES:

Table 1. Clavicle Fracture (Fx) Change in Management Cases, n=15 (3.0 %)

Variables	Results	Variables	Results
Age, average (range)	6.1 (3-10)	Following which F/U X-ray?, n (%)	
Fx Displaced Yes, n (%)	1 (6.7)	1 st	13 (86.7)
Change in Management, n (%)		2 nd	2 (13.3)
Fx not initially diagnosed - Immobilization	9 (60)	Complications Yes, n (%)	4 (26.7)
Further Immobilization	1 (6.6)	Total F/U X-rays, n (%)	
Further activity restrictions	3 (20)	≤2 (standard of care)	12 (80)
Discontinuation of immobilization	1 (6.6)	>2	3 (20)
Displaced to nondisplaced fracture	1 (6.6)		