Radiographic Overuse in Pediatric Clavicle Fractures: A Retrospective Analysis Supporting Streamlined Follow-Up

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INTRODUCTION: Clavicle fractures in pediatric patients are typically managed nonoperatively due to the immense remodeling potential of the clavicle. Management usually consists of several weeks of activity modification and sling immobilization with radiographic follow-up often left to the discretion of the treating physician. This raises concerns over unnecessary imaging and its associated healthcare costs and radiation exposure, particularly in children.

This study aims to quantify follow-up visits in which repeat radiographs were performed to evaluate pediatric nonoperative clavicle fractures. Given the healthcare costs and radiation exposure associated with additional radiographs, we also seek to propose a standardized treatment protocol for the management of all similar cases. We hypothesized that the majority of children will receive imaging only at the initial consultation; however, those who receive repeat imaging at subsequent follow-up visits will have no change in clinical management resulting from these additional studies.

METHODS: A retrospective observational study was conducted on pediatric patients, reviewing charts of children 8 years of age or younger within a 5-year period (January 2018 - December 2022) who presented with a clavicle fracture. Children were excluded if the fracture was managed operatively, initial radiographs were not available, or repeat imaging was warranted due to concomitant shoulder girdle fracture or history of ipsilateral shoulder surgery.

RESULTS:

The charts of 244 children with a mean age of 3.5 ± 2.7 years were reviewed for the number of visits with clavicle radiographs. The majority of fractures were mid-clavicular (96.7%), of which 56.1% were nondisplaced and 40.6% were minimally displaced (Table 1).

The average number of total radiographic views for all children across all visits was 3.4 ± 1.8 views. Of 244 children, 52.9% had only initial radiographs (mean age 2.9 years), 29.5% had up to two visits (mean age 3.6 years), 13.5% up to three (mean age 4.8 years), and 4.1% had four visits (mean age aged 4.9 years) (Table 2). There was a significant difference in age between children who received a different number of follow-up radiographs ($P < 0.001$), with the number of follow-up radiographs increasing as the age of the child increased (Table 2).

The mean time from injury to follow-up was 4.2 days (initial), 23.2 days (second), 50.4 days (third), and 72.8 days (fourth) (Table 3). Routine healing was seen in all third and fourth radiographs.

The majority of initial radiographs were ordered by the emergency department (59.6%), with orthopedic surgery ordering 89.4% of second-visit radiographs, 97.6% of third-visit radiographs, and 100% of fourth-visit radiographs.

DISCUSSION AND CONCLUSION: Eliminating third and fourth visits alone could have avoided 43 total 2-view radiographs. Considering the cost of a clavicle radiograph series is approximately $470 and is associated with an average radiation exposure of 1 mSv, these visits cost an estimated $20,210 and resulted in 43 mSv of total radiation exposure across 43 children and five years.

The mean age at injury increased with each imaging group: 2.9 years for children imaged only at the initial visit, 3.6 years at the second visit, 4.8 years at the third, and 4.9 years at the fourth visit. The increased frequency of imaging in older children may reflect higher perceived reinjury risk due to greater activity levels.

The average time to third-visit imaging was 50.4 days (approximately seven weeks), and to fourth-visit imaging was 72.8 days (over ten weeks) following the initial injury. While the majority of nonoperative, uncomplicated pediatric clavicle fractures heal clinically within six weeks with no pain and return to full function, imaging beyond six weeks in this cohort may not hold clinical value in the larger pediatric population.

Although initial radiographs were often ordered in the ED, the majority of follow-up imaging was ordered by orthopedic surgery. Orthopedics was responsible for 89.4% of third radiographs and 97.6% of fourth radiographs, underscoring the need for evidence-based guidelines in orthopedic follow-up.

The findings indicate excessive imaging in the management of uncomplicated, nonoperatively-managed clavicle fractures in the pediatric population, consistent with previous studies. We propose a standardized follow-up protocol consisting of a single radiographic evaluation at the initial orthopedic consultation, with no routine follow-up imaging for Allman IA and IB clavicle fractures in children 8 years old or younger unless clinically indicated by persistent symptoms or concern for nonunion.

Allman Classification	n	%
Ia	137	56.1
Ib	99	40.6
Ic	0	0
IIa	7	2.9
IIb	1	0.4
IIc	0	0
IIIa	0	0
IIIb	0	0
IIIc	0	0

Table 1. Distribution of Clavicle Fractures by Allman Classification

	n	Average age (years)	SD	
Radiographs at 1st Visit	129	2.929	2.6293	Rho = 0.26 P < 0.001
Radiographs at 2nd Visit	72	3.625	2.9066	
Radiographs at 3rd Visit	33	4.778	2.3263	
Radiographs at 4th Visit	10	4.9	1.792	

Table 2. Distribution of Radiograph Follow-Up Visits Among Pediatric Patients

Average time (days) to radiographs from injury	Days
1st Visit (n = 244)	4.1
SD	9.2
2nd Visit (n = 115)	23.2
SD	17.6
3rd Visit (n = 43)	50.4
SD	23.8
4th Visit (n = 10)	72.8
SD	18.8

Table 3. Average Time From Injury to Radiograph Acquisition by Follow-Up Visit