

**ORIGINAL RESEARCH**

Buckle fractures in children: Is urgent treatment necessary?

Probably not. This study suggests that subacute treatment doesn't adversely affect outcomes and it saves money, too.

Abstract

PURPOSE ▶ To determine whether the clinical outcome of buckle fractures in children differs between those treated acutely on the same day of trauma and those treated subacutely, and whether a change in practice patterns based on these data would result in cost savings.

METHODS ▶ In this retrospective cohort study—approved by the Institutional Review Board—we reviewed the cases of 341 consecutive patients <18 years of age seen by the pediatric orthopedic clinic for treatment of isolated extremity buckle fractures between July 1, 2004 and August 31, 2007. Time from injury to treatment was used to divide patients into 2 groups: acute (≤ 1 day; $n=155$) and subacute treatment (>1 day; $n=186$). Clinical outcome at final orthopedic follow-up was recorded for each patient. We defined adverse outcome as fractures requiring manipulation, clinically apparent deformity, or functional impairment. Charge analysis compared differences in management costs for patients with buckle fractures presenting initially to the emergency department (ED) and those seen solely in the orthopedic clinic.

RESULTS ▶ No adverse outcomes were identified in either acute or subacute treatment groups. Total clinical visits did not vary (acute, 3.2 vs subacute, 3.1; $P=.051$). Presence of mild angulation of fractures on radiographs did not differ significantly between acute and subacute management groups at initial presentation (6.5% vs 8.6%; $P=.541$) or at final follow-up (12.2% vs 12.4%; $P=1.0$). A cost savings of approximately \$3000 could have been realized for each patient

referred to the ED who might otherwise have been seen subacutely in the orthopedic clinic.

CONCLUSIONS ▶ No adverse clinical outcomes resulted from subacute treatment of stable buckle fractures. Cost and time savings may be realized with subacute management of buckle fractures without affecting clinical outcome.

Next time a child in your care has a suspected fracture as a result of a fall and x-ray films reveal a buckle fracture, consider telling parents there's no need for an urgent visit to the ED. As long as the pain is manageable, treating the injury within a day or so will likely be more convenient for the family, will cost less, and will not result in any complications for the child.

Buckle (or torus) fractures—the most common type of fracture occurring in the pediatric population and accounting for a large number of visits to primary care physicians (PCPs), EDs, and orthopedic clinics each year¹—involve impaction of bone along only 1 cortex and are therefore inherently stable.² Even with only minimal immobilization, the overwhelming majority of buckle fractures heal without complication.³ Although many patients present directly to the ED for management of these fractures, many others present initially to their PCP, given the relatively minor nature of their symptoms and mechanism of injury.

At our institution, the radiology department and referring physician jointly triage outpatients when radiographs requested by the referring physician show evidence of a fracture.

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 The cost savings with each patient seen subacutely in the orthopedic clinic was \$2971.

Stable and unstable fractures are referred for immediate care—in the pediatric orthopedic clinic if the clinic is open and appointments are available; otherwise in the ED for initial splinting, with follow-up in the orthopedic clinic as soon as possible.

Referral of patients with buckle fractures for same-day care in the ED may bring about unnecessary costs and inconvenience for patients and families. However, policy at our institution dictates that all fractures, including stable buckle fractures, be referred for treatment immediately, once identified.

To determine whether patients with buckle fractures can be safely counseled on the possibility of nonurgent management, we compared the clinical outcomes of pediatric buckle fractures treated acutely or subacutely. The results of our study have practical implications for the timing of treatment or referrals, and for the management of buckle fractures by appropriately trained PCPs, especially in settings where orthopedic consultation may not be readily available.

Methods

Patient selection

The Vanderbilt Children's Hospital institutional review board approved this retrospective cohort study, with waiver of patient consent. We reviewed 1923 consecutive charts of patients who were seen in the hospital's pediatric orthopedic clinic for stable fractures between July 1, 2004 and August 31, 2007. We identified patients for our study population by current procedural terminology (CPT) codes for fracture care that were compatible with buckle fracture or other stable fracture management without manipulation. Applicable CPT codes included the following fracture sites: radial head/neck (24650), ulnar shaft (25530), distal radius with or without ulnar styloid (25600), metacarpal (26600), phalanx of hand or foot (26720, 28510), distal fibula (27786), and metatarsal (28470).

■ Inclusion and exclusion criteria. Inclusion criteria among this screened population were an isolated buckle fracture mentioned in the official radiology report or pediatric orthopedic clinical note, and age <18 years at the time of injury. We excluded patients for the following reasons: uncertain date of injury (n=67), lack of

final clinical follow-up (n=59), acute manipulation of the fracture (n=10), multiple concurrent injuries (n=11), or known metabolic bone disease (n=3) or coagulopathy (n=1).

After initial patient selection, a CAQ-certified pediatric radiologist (with additional fellowship training in pediatric musculoskeletal radiology) and a board-certified orthopedic surgeon (with pediatric orthopedic fellowship training) examined available radiographic images to confirm the diagnosis of a buckle fracture. We further excluded patients whose radiographic findings did not meet criteria for isolated buckle fractures.

Study populations

The final study population consisted of 341 children with confirmed isolated buckle fractures. We assigned patients to acute or subacute treatment groups based on the length of time between injury and presentation for care. Patients were assigned to acute treatment (n=155) if they presented for care on the same day as the injury. All others first seen >1 day after documented time of injury were assigned to subacute treatment (n=186).

We determined length of time between injury and presentation based on data available in the electronic medical record. If the injury was first documented in the orthopedic clinic, we reviewed notes to determine when the patient had initially sought care, and whether from our institution, a PCP, or an outside ED. If documentation showed that initial contact with any health care professional occurred within 1 day of the injury, we assigned the patient to acute management.

Data analysis

Data collection from computerized medical records included date of injury, date of initial care, anatomic location of fracture, mechanism of injury, referring physician, whether the patient was seen initially in the ED, date of last orthopedic follow-up, number of clinical visits, and clinical outcome. Clinical outcome was judged as "good" or "poor" at the last orthopedic follow-up visit, approximately 3 to 4 weeks after injury. A poor clinical outcome could indicate a clinically apparent deformity or functional impairment, need for subacute manipulation, or refracture. We deemed 1 patient's outcome uncertain due to an ambiguous final clinical note,

and we had this case reviewed by a pediatric orthopedist. Any visit to a PCP, ED, or orthopedic clinic was included in the total number of a patient's clinical visits.

Consulting radiologists also noted the presence and degree of fracture angulation for each patient on initial and follow-up films. Degree of angulation was rated as mild ($<10^\circ$), moderate (11° - 20°), or severe ($>20^\circ$). Follow-up films were not available for 14 patients (5.2% of acutely treated patients; 3.2% of subacutely treated patients), as final clinical follow-up occasionally occurred outside our institution. In these cases, we relied on the clinical note to determine degree of angulation, if present.

We obtained total charges (technical and professional) for buckle fracture treatment for patients treated initially in the ED and for patients seen initially in the orthopedic clinic.

Statistical analysis

We used an independent samples *t*-test to compare mean patient ages, times from initial treatment to final treatment, and the numbers of clinical encounters for patients in the acute and subacute treatment groups. For the acute treatment group, time from injury to initial care, by definition, was considered "0." For the subacute treatment group, we constructed 99.9% confidence intervals around the mean time from injury to initial care to determine whether or not they included "0."

We used Fisher's exact test to gauge differences in the proportions of absent or mild initial angulation, absent or mild final angulation, and the point of initial care between the acute and subacute treatment groups. We used Pearson's chi-squared test to assess between-group differences in the distribution of fracture sites (forearm, hand/foot, or leg), mechanism of injury (fall, direct blow, other), change in angulation (none, improved, worsened), and point of entry into the health care system (PCP, ED, orthopedic clinic). We performed statistical analyses with the statistical package SPSS v15 (SPSS, Inc., Chicago, Ill).

Results

Patient characteristics

Of the 1923 pediatric patients with stable fractures seen in the orthopedic clinic at our

institution during the study period, 588 had isolated buckle fractures. Of these, we excluded 151 based on predefined criteria (see Methods). After consensus review of radiographs by a pediatric orthopedist and pediatric radiologist, we excluded an additional 96 patients with inconclusive radiographs. The final study group numbered 341 pediatric patients with confirmed isolated buckle fractures.

The forearm was most commonly affected, with isolated distal radius fractures accounting for 67.7% (231/341) of all fractures, and combined radius/ulna fractures accounting for 14.7% (50/341). The most common mechanism of injury was a fall (85.9%; 293/341), usually a direct fall, with a higher percentage of patients with direct falls in the acute management group (TABLE 1). Mean age and sex were not significantly different for the 2 treatment groups.

Acute vs subacute management outcomes

Of the 341 patients included in the study, 155 patients were treated acutely and 186 patients were treated subacutely. For the subacute management group, mean time between injury and treatment was 2.5 ± 2.6 days (TABLE 2). We observed no poor clinical outcomes in either acute or subacute management groups. All patients, regardless of time elapsed from injury to initial splinting, recovered without complication. The difference in number of clinical visits between the acute and subacute management groups was not significant (acute 3.2 ± 0.5 ; subacute 3.1 ± 0.5). The mean length of clinical follow-up from initial splinting to discharge from orthopedic care was higher in the acute management group (acute 32.9 ± 17.1 days; subacute 28.9 ± 13.4 days).

Most patients presented with non-angulated fractures, regardless of time from injury to initial presentation (TABLE 2). The degree of angulation worsened in a small proportion of fractures during convalescence. The difference in initial angulation, final angulation, or change in angulation between acute and subacute management groups was not significant.

A higher proportion of patients in the acute treatment group presented directly to the ED for care, whereas a higher proportion of patients in the subacute treatment group



Evidence suggests that families may prefer less acute management options that allow greater convenience and flexibility.

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 Treating buckle fractures nonurgently yields significant cost and time savings without affecting final clinical outcome.

TABLE 1
Baseline characteristics of study populations

	Acute (n=155)	Subacute (n=186)	P value
Age, y ± SD (range)	7.9 ±4.0 (0.9-17.8)	7.9 ±3.8 (1.0-16.4)	.901
Male, n (%)	79 (51.0)	86 (46.2)	.384
Site of fracture, n (%)			.022
Forearm	142 (91.6)	151 (81.2)	
Hand or foot	12 (7.7)	33 (17.7)	
Leg	1 (0.6)	2 (1.1)	
Mechanism of injury, n (%)			.045
Fall	141 (90.9)	152 (81.7)	
Direct blow	5 (3.2)	15 (8.1)	
Other/unknown	9 (5.8)	19 (10.2)	

SD, standard deviation.

presented to their PCP during routine working hours and were referred to the orthopedic clinic (TABLE 2). For both acute and subacute management groups, we compared outcomes for patients seen initially in the ED or orthopedic clinic. No adverse outcomes occurred among any of the studied patients.

Charge analysis

We compared total charges (professional and technical) for managing buckle fractures initially in the ED with those initially seen in the orthopedic clinic. Total charge per patient in the ED, including subsequent follow-up in the orthopedic clinic, was \$4397 (\$2516, professional; \$1881, technical). Total charge per patient for treatment only in the orthopedic clinic was \$1426 (\$918, professional; \$508, technical). Total charge per patient was \$2971 more for patients treated initially in the ED.

Between July 1, 2004, and August 31, 2007, 159 patients (46.6%) with buckle fractures entered the health care system through their primary care physician. Of these, 44 patients were seen acutely by the physician; 115 patients were seen on a subacute basis. Of the 44 patients seen acutely, 24 (54%) were referred directly to the ED; 20 (45%) were referred to the orthopedic clinic. Of the 115 patients seen subacutely, 27 (23%) were referred directly to the ED, and the remaining 88 (76%) were referred to the or-

thopedic clinic. In sum, 51 patients (32%) were seen initially by a PCP, who referred them to the ED. The cost savings with each patient seen subacutely in the orthopedic clinic was \$2971, and avoiding ED treatment for all patients could have yielded a total gross savings of approximately \$150,000.

Discussion

Buckle fractures are inherently stable and almost universally heal without complication.^{4,5} Perhaps because of the high likelihood of good outcome, there is a relative paucity of articles in the recent literature addressing the management of this common pediatric fracture. Older studies have addressed casting vs splinting and the need for follow-up, but no study has yet examined whether immediate treatment is necessary.^{6,7} Although some studies have noted incidentally that many children have delayed presentation for care,⁵ none has specifically examined the clinical or economic impact of a delay in care or the effect of subacute treatment on outcomes.

■ **Delayed treatment does not adversely affect clinical outcome.** Our study objective was to compare clinical outcomes of buckle fractures treated acutely on the same day of injury with outcomes of those treated subacutely. The 2 groups did not differ in extent

TABLE 2

Clinical outcomes did not differ between acute and subacute management groups

	Acute (n=155)	Subacute (n=186)	P value
Time from injury to initial care, d ± SD (range)	0	2.5 ± 2.6 (1-14)	<.001
Good outcome, n (%)	155 (100)	186 (100)	1.0
Time from initial treatment to final follow-up, d ±SD (range)	32.9 ±17.1 (8-169)	28.9 ±13.4 (9-164)	.016
Number of clinical encounters (primary care physician, ED, or orthopedic clinic), n ± SD (range)	3.2 ±0.5 (2-5)	3.1 ±0.5 (2-5)	.051
Initial angulation, n (%)			.541
None	145 (93.5)	170 (91.4)	
Mild (<10°)	10 (6.5)	16 (8.6)	
Final angulation, n (%)			1.0
None	136 (87.7)	163 (87.6)	
Mild (<10°)	19 (12.2)	23 (12.4)	
Change in angulation, n (%)			.907
No change	144 (92.9)	175 (94.1)	
Worse	10 (6.4)	10 (5.4)	
Improved	1 (0.6)	1 (0.5)	
Point of entry to health care system, n (%)			<.001
Primary care physician	44 (28.4)	115 (61.8)	
ED	108 (69.7)	54 (29.0)	
Orthopedic clinic	3 (1.9)	17 (9.1)	
Location of initial management, n (%)			<.001
ED	132 (85.2)	81 (43.5)	
Orthopedic clinic	23 (14.8)	105 (56.4)	

ED, emergency department; SD, standard deviation.

or angulation of fracture at presentation. We found no difference in outcomes between the groups; all fractures healed without complication. We observed no difference in final angulation of fracture on follow-up imaging. Though our institution routinely obtains follow-up films, it is worth mentioning that the utility of repeat films in pediatric buckle fractures with minimal initial angulation has been debated.⁵ These data suggest that subacute treatment of a buckle fracture is a safe and reasonable option.

■ Non-ED treatment substantially reduces cost. One goal of efficient health care delivery is to decrease the cost and burden of care without increasing long-term morbidity and disability. Evidence suggests that families may prefer less acute management options that allow greater convenience and flexibility, provided that clinical outcomes are not compromised.⁸ In the case of pediatric buckle fractures, higher costs (for both the patient and the hospital) and longer wait times related to ED care may



Pain control and reassurance can help families accept the notion of seeking subacute care.

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A key limitation of this study was the inability to determine differences in pain control between acute and subacute treatment.

be avoided by counseling patients on the option of subacute care. Our study found that referring patients directly to the orthopedic clinic, even if this results in a delay in definitive management, leads to a reduction in health care burden without a change in clinical outcome.

Children with buckle fractures are frequently (46.6%) taken to their PCP for initial care. Many pediatricians and family physicians—especially the increasing number of physicians who have completed additional fellowship training in sports medicine—may prefer to manage buckle fractures within their practices. Many other PCPs may be practicing in communities lacking local orthopedic expertise. The results of this study provide reassurance regarding the positive outcome of buckle fractures. Furthermore, managing buckle fractures in the primary care setting may be even more cost effective than referring patients to a specialty orthopedic clinic—but additional research on this point is needed.

We do not advocate delayed imaging or treatment of suspected fractures. However, once a diagnosis of buckle fracture is confirmed radiographically, our data show that subacute treatment yields significant cost and time savings without affecting final clinical outcome.

Study limitations

This study is limited by its retrospective data collection in 1 pediatric tertiary care hospital. As current clinical practice is to treat all buckle fractures once identified, very few patients with known injury were specifically treated in a subacute fashion. We defined the subacute care group as patients who were treated >1 day from the time of injury. Because initial splinting did not occur in this group, we expect that the observed results would be similar, and

no worse, compared with buckle fracture care directed by a subacute treatment algorithm.

This study examined only patients with a diagnosis of isolated buckle fracture. Non-buckle stable fractures were excluded a priori from our patient population. Although it is possible that most stable fractures (eg, nondisplaced transverse fractures, Salter-Harris I injuries) could be managed subacutely, we addressed only isolated buckle fractures.

Because of the universally positive outcomes in these cases, most of our patients had no orthopedic follow-up beyond 1 month. We are not able to comment on whether any longer-term abnormalities in function occurred. This question could be addressed through a prospective trial requiring reevaluation of each patient at a set endpoint of the study.

Although buckle fractures are inherently stable and do not present a significant risk of displacement with delayed treatment, they are nevertheless painful fractures that can be a cause of considerable anxiety for both patient and family. The goal of the physician, beyond ensuring the best medical outcome, extends to provide emotional support to the patient and family. Pain control and reassurance are therefore central to the discussion of fracture management, and are most likely the driving factor for a patient to seek urgent care. A key limitation of this study was the inability to determine differences in pain control between acute and subacute treatment. As mentioned above, a prospective study would enable the issue of pain control to be better addressed. **JFP**

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(At the time this study was accepted for publication, Dr. Bennett was at Vanderbilt Children's Hospital.)

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