Operating Room Intervention Rates After Orthopaedic Resident-reduced Pediatric Both-Bone Forearm Fractures Relative to the Academic Calendar

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Background: The purpose of this study was to evaluate the operating room (OR) intervention rates and quality of fracture reductions for pediatric diaphyseal both-bone forearm fractures performed by orthopaedic residents relative to the academic year. OR intervention was defined as any procedure performed in the OR, including closed reduction and casting, and was used to identify fractures that required secondary intervention after initial closed reduction performed by an orthopaedic resident in the emergency department.

Methods: A retrospective analysis identified pediatric patients presenting at our institution with both-bone forearm fractures from July 2010 to June 2016. Emergency-room sedation time, highest experience of orthopaedic resident documented to be present at the time of sedation (in postgraduate months), and frequencies of OR intervention were obtained by chart review. Fracture characteristics were determined by radiographic review. Immediate postreduction radiographs were used to measure cast indices, and adequacy of reduction was determined by post-reduction angulation and translation.

Results: During the time period studied, 470 both-bone forearm reductions under sedation were performed by an orthopaedic resident at our institution. Of these, 41 fractures (41 patients) required 42 OR interventions (40 involved surgical fixation and 2 were repeat closed reductions). The academic year was divided into quartiles. The April to June quartile had the highest overall percentage of OR intervention (10.6%), followed by July to September (8.6%); however, there was no significant difference between quartiles in the percentages of reductions that needed OR intervention ($P=0.553$). There was also no correlation between the experience level of the resident performing the reduction (based on postgraduate months) and the frequency of OR intervention ($P=0.244$). The anteroposterior (AP) and lateral reduction grades did not vary based on quarters ($P=0.584$; 0.353). The ability to obtain adequate reduction and the rate of unacceptable cast index were also not significantly different between quarters ($P=0.347$ and 0.465).

Conclusions: We found no significant difference in rates of OR intervention or the quality of reduction for pediatric both-bone diaphyseal forearm fractures treated by orthopaedic residents relative to the academic year.

Level of Evidence: Level III—comparative cohort study.

Key Words: resident education, operating room intervention rates, both-bone forearm fracture, cast index, closed reduction, learning curve, July effect, academic year

(*J Pediatr Orthop* 2019;00:000–000)

See one, do one, teach one is the mantra often used in medical training. Although not taken literally, learning on the job is a fact of medicine, whether it is in the clinic, on the hospital floor, in the operating room (OR) or emergency department (ED). Competency and procedural skills are achieved through experience, and these skills have learning curves that vary in difficulty.[1–3] To progress along the learning curve, supervision and oversight are often balanced with autonomy and independence,[1–3] with the goal of facilitating trainee education without compromising patient care. The current orthopaedic literature suggests that resident involvement in the OR does not compromise patient safety or increase complication rates, and may even decrease overall surgical complications.[4–6] Furthermore, a true "July effect" (a perceived increase in medical error corresponding to new residents and increased responsibility) has not been demonstrated in the surgical setting for shoulder, hip, and knee arthroplasty or elective spine surgery.[7–10] Compared with the OR, the ER provides orthopaedic residents more independence and autonomy in regards to initial management, decision making, and performing procedures. This makes the ER an ideal setting to study resident outcomes and examine whether there is a true July effect. In this study, we focused on the outcomes of pediatric both-bone forearm fractures, because it is one of the most commonly encountered fracture patterns.[11–13]

The purpose of this study was to evaluate the quality of reductions of diaphyseal both-bone forearm fractures

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No funding was received in support of this study.
The authors declare no conflicts of interest.
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DOI: 10.1097/BPO.0000000000001441

performed by orthopaedic residents relative to the academic year and resident experience. The primary outcome was the need for OR intervention. Secondary outcomes were radiographic quality of reduction, cast index (CI), and sedation times. Factors including patient age, sex, and fracture characteristics were also considered to determine whether these variables impacted our primary and secondary outcomes.

METHODS

Data

This study was approved by our institutional review board. Retrospective analysis identified 4237 patients who were presented to the pediatric ED at our institution with forearm and radial fracture-specific ICD 9 and ICD 10 codes from July 2010 to June 2016. Of these, 1015 patients were confirmed to have had sedation and closed reduction of diaphyseal both-bone forearm fractures. Exclusion criteria included fracture-dislocation variants (Monteggia and Galeazzi types), isolated radial or ulnar shaft fractures, patients older than 13 years of age, mechanism involving motor vehicle accidents, previous fracture in the ipsilateral forearm, buckle fractures, and grossly open fractures. "Poke hole" (< 1 cm) open fractures were included because previous studies have demonstrated that these can be acceptably treated conservatively along with antibiotics.[14] During our manual chart review, we removed patients that did not meet inclusion criteria from our "working" patient list, including any grossly open fracture. Patients with documented type I open fracture were not specifically marked/identified. After exclusion criteria were applied, 470 fractures (465 patients, 3 with simultaneous bilateral fractures and 2 with a contralateral fracture at a later date) remained and were used for further data analysis.

Date of admission and ED sedation time were obtained by chart review. Charts were also reviewed to determine the resident(s) involved with the reduction and their level of experience at the time of the reduction. Level of experience was reported as postgraduate months (PGM) in an attempt to distinguish a postgraduate year (PGY) 2 resident in July (PGM = 13) from the one in June (PGM = 24). For cases when 2 residents were present, the resident with more experience was recorded. Initial radiographs were reviewed in a blinded fashion by a single PGY5 orthopaedic resident to determine fracture location (proximal, middle, or distal) based on an equal one-third division of the length of the diaphysis. Fracture characteristics were also documented, including obliquity, apex volar versus dorsal, greenstick patterns, and whether radial and ulnar fractures occurred at different levels. Cortical contact was also documented using the prereduction anteroposterior and lateral radiographic views. Fractures were characterized as to having no cortical contact only if both the radius and ulna fractures were displaced. If the radius or ulna had any area of cortical contact, the fracture was classified as such.

Immediate postreduction radiographs were reviewed in a blinded fashion by a single PGY4 orthopaedic resident to assess the quality of the reduction. Adequacy of reduction was determined by postreduction angulation and translation, in both the sagittal and coronal planes. An "anatomic" reduction was defined by minimal translation and angulation, a "good" reduction with <10 degrees of angulation and/or ≤ 2 mm of translation, a "fair" reduction as angulation between 10 and 20 degrees and/or translation of 2 to 5 mm. A "poor" reduction was defined by any angulation ≥ 20 degrees or translation of > 5 mm.[15] A second binary criterion was used, with "adequate" reduction defined as postreduction angulation of <20 degrees for distal-third, <15 degrees for middle-third, and <10 degrees for proximal-third fractures in females 8 years of age or younger and males 10 years of age or younger. For females aged 8 years or above and males 10 years or above, any postreduction angulation of ≤ 10 degrees was deemed "adequate."[16,17] Immediate postreduction radiographs were also used to measure the CI, defined as the ratio of sagittal to coronal width from the inside edges of the fiberglass cast at the fracture site, when possible using the hospital picture archiving and communication system (Fig. 1).[18] This was performed by another PGY5 orthopaedic resident in a blinded fashion. The CI could not be calculated for 5 fractures (1.1%) because of inadequate radiographs. Any discrepancies during the radiographic evaluation were reviewed by the senior author (J.J.S.).

FIGURE 1. Cast index (CI) defined as the ratio of sagittal to coronal width from the inside edges of the cast at the fracture site (CI = A/B).[18] Actual measurements were performed at the fracture site; however, arrows in figure were placed just proximal to fracture site to allow for visualization of the fracture.

OR intervention was defined as any procedure performed in the OR, including closed reduction and casting, and was used to identify fractures that required secondary intervention after initial closed reduction performed by an orthopaedic resident in the ED. Indications for operative intervention, type of procedure, and any repeat sedations or reductions were also documented. All OR interventions were supervised by attending staff.

Reduction Technique and Protocol

In general, the orthopaedic trauma team junior residents (consisting of PGY1 and PGY2 residents) provide ED fracture care during the daytime on the weekdays (Monday to Friday). The orthopaedic trauma team senior residents (PGY4 and PGY5 residents) are available in the hospital during the day if assistance is needed. Weeknight and weekend call teams have 2 to 3 residents (made up of any combination of PGY1, PGY2 and/or PGY3 residents, with the only exception being a team consisting of only PGY1 residents). A senior resident (PGY4 or PGY5) is always available as backup to provide guidance if needed from home during the weekday nights and weekend. The pediatric orthopaedic surgeon on call can also be contacted at any time if questions in management arise. The need for sedation and reduction was determined by the most senior orthopaedic resident providing care in the ED, usually a PGY2 or PGY3. Sedation was provided by the ED physician or by a supervised ED resident or fellow using ketamine or propofol protocols. Mini-fluoroscopic imaging was used during all reduction attempts. Closed reduction principles were applied with recreation of the deformity, followed by traction and reduction. All forearm fractures were placed in a bivalved long-arm fiberglass cast with an elastic bandage overwrapped by the orthopaedic resident, according to our department protocol. Postreduction radiographs were obtained after cast application and completion of sedation for documentation and to provide a comparison for subsequent radiographs to evaluate for displacement and loss of reduction within the cast. There were 3 fellowship-trained pediatric orthopaedic surgeons who shared call responsibilities at our institution during the study period. Patients were referred to these surgeon's clinic for subsequent follow-up.

Statistical Analysis

Fracture characteristics, reduction measurements, and resident experience were compared for operative versus nonoperative patients, and the time in the academic year in which the reduction was performed. The academic year was divided into quartiles with July to September being the first quarter of the academic year, followed by October to Dec, January to March, and April to June. A χ^2 test was used to compare academic quartiles and OR intervention versus nonOR intervention groups on categorical variables, including fracture characteristics and reduction measurements, and to compare frequency of OR intervention across academic quartiles. One-way analysis of variance was used to assess continuous variables across quartiles, with a post hoc Bonferroni for significant results. An independent t test was used to determine whether sedation time and PGM varied between non-OR intervention and OR intervention patients. P-values <0.05 were considered significant.

RESULTS

The average age of the 465 patients with 470 both-bone forearm fractures reduced under sedation by an orthopaedic resident was 8 ± 3 years (range, 1 to 13 y). The fractures occurred in 309 males (66.5%) and 156 females (33.5%). Oblique fractures were more likely to require OR intervention ($P < 0.001$), whereas greenstick fractures were less likely to require OR intervention ($P < 0.001$). The location (proximal, midshaft, and distal), whether the breaks were at different levels, and the apex (volar vs. dorsal) did not impact whether OR intervention was needed ($P = 0.091$, 0.575, and 0.108, respectively; Table 1). When evaluating the impact of cortical contact fracture characteristic on OR intervention rates, fractures with no cortical contact led to a significantly higher incidence of OR intervention ($P = 0.001$), with 19.4% of fractures with no cortical contact requiring OR intervention versus only 4.9% of fractures with at least 1 bone with cortical contact requiring OR intervention. When fractures with greenstick characteristics were removed from the analysis, fractures with no cortical contact still resulted in a higher percentage of operative intervention, but this difference was not significant ($P = 0.126$; Table 1). Similarly, there was a significantly higher rate of OR incidence in older patients ($P = 0.008$). However, greenstick fractures were also highly

TABLE 1. Fracture Characteristics, % Requiring Operating Room Intervention

Fracture Properties	n (%) No Operating Room Intervention (N = 429)	n (%) Operating Room Intervention (N = 41)	P*
Location			0.091
Proximal	25 (86)	4 (14)	
Midshaft	172 (89)	22 (11)	
Distal	232 (94)	15 (6)	
Greenstick	168 (98)	4 (2)	< 0.001
Oblique	235 (87)	35 (13)	< 0.001
Cortical contact			0.126†
Both bones	90 (91)	9 (5)	
One bone	118 (88)	16 (12)	
No contact	48 (80)	12 (20)	
Age group (y)			0.221†
1-4	29 (97)	1 (3)	
5-7	89 (90)	10 (10)	
8-10	70 (84)	13 (16)	
11-13	69 (84)	13 (16)	
Different level	241 (91)	25 (9)	0.575
Apex			0.108
Volar	379 (92)	33 (8)	
Dorsal	47 (85)	8 (15)	

*P-value calculated from a χ^2 test to evaluate whether there is a difference in incidence of operating room intervention based on whether the fracture characteristic was present.

†P-value with greenstick fractures removed.

TABLE 2. Percentage of Fractures Demonstrating Characteristics Within Each Academic Quartile

Fracture Characteristics	July/Aug/Sept (N = 163)	Oct/Nov/Dec (N = 98)	Jan/Feb/Mar (N = 49)	Apr/May/June (N = 160)	P*
Location (%)					0.542
Proximal	6	9	6	5	
Midshaft	47	36	41	39	
Distal	48	55	53	56	
Greenstick (%)	39	34	41	35	0.741
Oblique (%)	59	60	55	55	0.796
Different level (%)	60	63	46	53	0.137
Apex (%)					0.683
Volar	88	90	92	86	
Dorsal	12	10	8	14	

**P*-value calculated from a χ^2 test to evaluate whether the incidence of the presentation of the fracture characteristic varied between academic quartiles.

Apr indicates April; Aug, August; Dec, December; Feb, February; Jan, January; Mar, March; Nov; November; Oct, October; Sept, September.

correlative with age; as age increased there were significantly fewer greenstick fractures ($P < 0.001$), with 63% of the fractures in children between the ages of 1 and 4 years demonstrating greenstick characteristics versus only 17.2% of the fractures in children from the ages of 11 to 13 years. When age was independently analyzed from greenstick fractures, age did not have a significant association with OR intervention ($P = 0.221$; Table 1). Fracture characteristics did not vary in presentation throughout the academic year across quartiles (Table 2).

Of the total fractures, 41 fractures (8.7%) required 42 OR interventions (40 required surgical fixation and 2 were simply repeat closed reductions). Overall, surgical fixation involved Kirshner wire pinning of the radius (n = 12), intramedullary rods (n = 9), plates and screws (n = 13), or a combination of techniques (n = 6). All OR interventions were performed by or directly supervised by attending staff. Indications for OR intervention were loss of reduction (n = 25), unstable fracture pattern as determined by the attending (n = 10), inability to achieve reduction in the ER (n = 5), and inability of the patient to tolerate casting (n = 1). There were 2 repeat closed reductions with casting performed in the OR (4.9%). One of them occurred in August (first quartile) and was definitively treated closed. The other presented in July (first quartile), and required an additional return to the OR on a later date for open reduction and internal fixation; in other words, 2 OR interventions were required.

The greatest number of reductions occurred in May (n = 71), followed by June (n = 62) and August (n = 63). The least number of reductions occurred in January (n = 12) and February (n = 10). Of the reductions performed each month, April had the highest percentage (14.8%) requiring OR intervention, followed by November (12.5%). July had the fourth highest frequency (10.6%) (Fig. 2). There was no significant difference in the frequency of OR intervention based on the month ($P = 0.822$), and there was no correlation between the number of reductions in a month and the percentage requiring OR intervention ($R = 0.451$, $P = 0.141$), that is, busier months did not lead to more OR interventions. The data was reassessed with the academic year divided into quartiles. The July to September quartile had the most reductions performed (163), followed by April to June (160) and October to December (98). The January to March quartile had the least amount of reductions performed (49). The April to June quartile had the highest overall percentage of OR intervention (10.6%), followed by July to September (8.6%) and October to December (8.2%). The January to March quartile had the lowest overall percentage of OR intervention (4.1%). There was no significant association among quartile in which the reduction occurred and the frequency of OR intervention ($P = 0.553$). Excluding greenstick fractures did not result in a significant difference in OR intervention rates across quarterly and monthly analysis ($P = 0.344$ and 0.719, respectively).

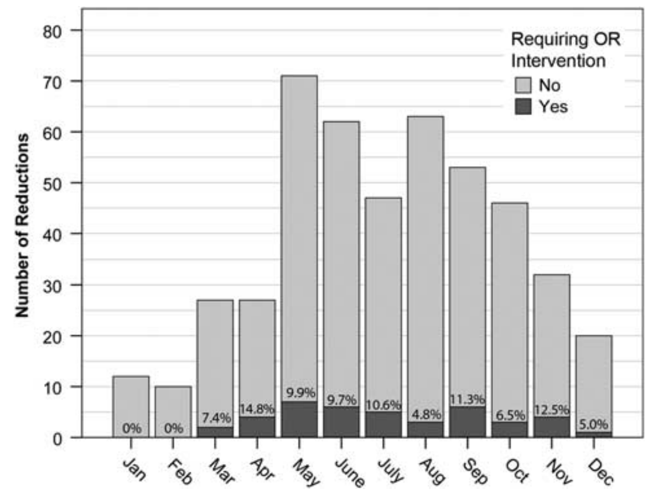

FIGURE 2. Data for fracture reductions based on monthly analysis. Each bar shows the total number of both bone forearm fracture reductions performed each month, with the dark gray area representing the total number of fractures that needed OR intervention and the light gray area representing those that did not. Values listed indicate percentage of total reductions requiring OR intervention for each month (ie, percent of bar shaded dark gray). There was no significant difference in the frequency of operating room intervention based on month ($P = 0.822$). OR indicates operating room.

The majority of reductions (88%) were performed by a PGY2 or PGY3 resident (Table 3). There was no

TABLE 3. The Number and Percent of Total Reductions in the Study Based on the Post Graduate Year (PGY) of the Most Senior Resident Documented Determined by Manual Chart Review

PGY	Reductions, n (%)
1	46 (9.8)
2	207 (44)
3	206 (43.8)
4	8 (1.7)
5	2 (0.4)
Attending	1 (0.2)

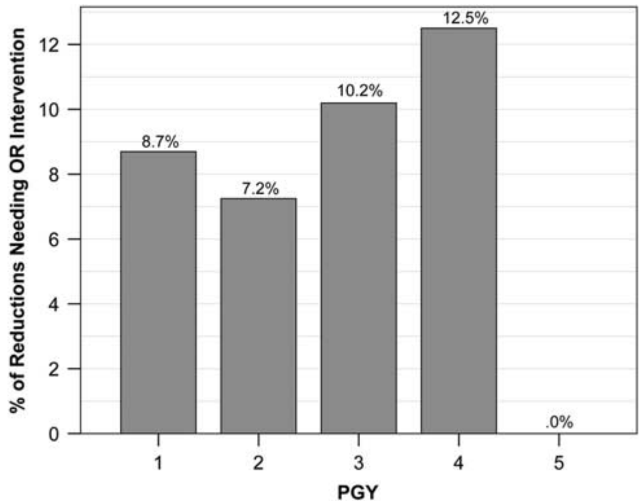

FIGURE 3. The percent of reductions requiring OR intervention based on PGY of the most senior resident that performed the reduction. There was no significant difference in the frequency of OR intervention based on PGY of the resident ($P = 0.834$). OR indicates operating room; PGY, postgraduate year.

correlation between the level of the resident performing the reduction (based on PGM of the most senior resident present) and the frequency of OR intervention ($P = 0.244$). The rate of reductions needing OR intervention also did not vary based on the PGY of the most senior resident involved in the reduction ($P = 0.834$; Fig. 3). When excluding greenstick fractures, OR intervention rates still did not vary based on the PGY of the most senior resident performing the reduction ($P = 0.921$). Based on manual chart review, there was a single orthopaedic resident present for 212 reductions and there was more than 1 orthopaedic resident present for 258 reductions. Of the 258 reductions with more than 1 resident, 174 of those reductions had 1 resident that was more senior (based on PGY), in which case the reduction would be more likely to be a teaching experience. For these reductions there was a 9.8% OR intervention rate, versus 10.7% for more than 1 resident, but of the same PGY, and 7.1% with only 1 resident performing the reduction ($P = 0.501$).

In the OR intervention group there were significantly fewer reductions by residents in the ED in which the adequacy of reduction was "good" in both the lateral and coronal planes when compared with the reductions that did not require OR intervention ($P < 0.001$; Table 4). In addition, fewer reductions were considered adequate in both planes in the OR intervention group (non-OR intervention: 95% vs. OR intervention: 73%, $P < 0.001$). Unacceptable CI (> 0.8) did not correlate with increased risk for OR intervention ($P = 0.835$; Table 4). Sedation time was significantly higher for patients in the OR intervention group (25 ± 8 min vs. 35 ± 13 min; $P < 0.001$).

The anteroposterior and lateral reduction grades (anatomic, good, fair, and poor) did not vary based on quarter ($P = 0.584$; 0.353; Table 5). The ability to obtain adequate reduction and the rate of unacceptable CI were also not significantly different between quarters ($P = 0.347$ and 0.465, respectively). The highest percentage of acceptable CI was seen in the first quarter (63%, July to September), whereas the worst was seen in the third quartile (53%, January to March). The resident PGM did not correlate with an acceptable CI or an adequate

TABLE 4. Reduction Measurements

Reduction Measurements	n (%) No Operating Room Intervention (N = 429)	n (%) Operating Room Intervention (N = 41)	P*
Coronal grade			< 0.001
Anatomic	0	0	
Good	333 (96)	15 (4)	
Fair	92 (81)	21 (19)	
Poor	4 (44)	5 (56)	
Lateral grade			< 0.001
Anatomic	0	0	
Good	310 (95)	18 (5)	
Fair	111 (89)	14 (11)	
Poor	8 (47)	9 (53)	
Adequate/Inadequate			< 0.001
Adequate	406 (93)	30 (7)	
Inadequate coronal	16 (62)	10 (38)	
Inadequate lateral	7 (88)	1 (12)	
Inadequate both planes	—	—	
Cast Index			0.835
Acceptable (≤ 0.80)	245 (91)	23 (9)	
Unacceptable (> 0.80)	179 (91)	18 (9)	

*P-value calculated from a χ^2 test to evaluate whether there is a relationship between the reduction measurement grade and the need for operating room intervention.

TABLE 5. Percent of Reduction Grades Within Each Quarter

Reduction Measurements	July/Aug/Sept (N = 163)	Oct/Nov/Dec (N = 98)	Jan/Feb/Mar (N = 49)	Apr/May/June (N = 160)	P*
Coronal grade (%)					0.584
Anatomic	0	0	0	0	
Good	74.2	74.4	77.6	72.5	
Fair	22.7	25.5	22.4	25.0	
Poor	3.1	0.0	0.0	2.5	
Lateral grade (%)					0.353
Anatomic	0	0	0	0	
Good	68.7	63.4	75.5	73.5	
Fair	28.8	30.6	24.5	22.5	
Poor	2.5	5.1	0	5.0	
Adequate (%)					0.347
Adequate	90.8	95.9	95.9	91.9	
Inadequate	9.2	4.1	4.1	8.1	
Cast index (%)					0.465
Acceptable (≤ 0.8)	63	57	53	55	
Unacceptable (> 0.8)	37	43	47	45	

*P-value calculated from a χ^2 test to evaluate whether the distribution of reduction measurement grade varied between academic quartiles.

Apr indicates April; Aug, August; Dec, December; Feb, February; Jan, January; Mar, March; Nov; November; Oct, October; Sept, September.

reduction ($P=0.996$ and 0.830, respectively). There was a significant difference in sedation time across academic quartiles ($P=0.009$), with post hoc tests showing a significant difference between April and June (mean, 24±8 min) and July and September (mean, 27±9; $P=0.009$).

DISCUSSION

Orthopaedic resident training is a necessity to develop the next wave of orthopaedic surgeons. The current literature supports resident participation in the OR without an associated increase in complication rates or poor outcomes.[3,4,6,19] To our knowledge, this is the first study to evaluate outcomes of pediatric both-bone forearm fracture reductions performed by orthopaedic residents in the ED relative to the academic year. We found no significant differences in the rate of OR intervention or the adequacy of reductions throughout the year based on month or quarter. We also found no correlation between experience of the resident performing the reduction (measured in PGM) and the likelihood of OR intervention.

Though not significantly different from the other quarters, the highest percentage of "inadequate" reductions in our study was in the July to September quartile (9.2%), followed by the April to June quartile (8.1%). These quarters are the busiest months in our ED. As a result, our pediatric and adult orthopaedic consultation volume is considerably higher, and residents may be willing to accept a less perfect reduction when trying to optimize time management during this time of year. In addition, we noted a statistically significant increase in sedation times from July to September by a mean of 3 minutes. Although this is a clinically insignificant increase in sedation time, it may be related to the learning curve of allowing junior residents to attempt reduction techniques before a more senior resident steps in to assist. The more frequent inadequate reductions in April to June may also be a result of increased responsibility and independence given to the PGY 1 residents as they prepare for more independence during their PGY 2 year. We used the most experienced resident documented in the chart when examining the impact of resident experience on the quality of the reduction; however, we acknowledge this potential limitation and that a more junior resident may actually have performed the reduction maneuver. In this situation, the highest experienced resident overseeing the procedure may be more apt to accept the initial reduction and, therefore, more deformity. Despite this trend in quality of reduction, OR intervention rates were not affected, and our data analysis determined that busier months did not correlate with an increased probability of OR intervention. CI also did not differ throughout the academic year. Despite this, the rate of reductions achieving acceptable CI (<0.8) was surprisingly low for our residency regardless of the academic year (63% for the highest quarter), highlighting a potential area for improvement in our program. In comparison, the original article by Kamat et al[18] reported that 75% of their casts obtained an acceptable CI.

Due to the retrospective nature of this study, specific indications for OR intervention cannot be conclusively determined. However, several commonly stated factors that influenced the attendings' decision for OR intervention included differential shortening (particularly when radial shortening is >1 cm), unstable fracture patterns (particularly oblique patterns), fractures where radial and ulnar angulation are in opposite directions (dorsal/volar), and fractures with unacceptable angulation. Unacceptable angulation parameters were based on previous literature reporting osteotomy for malunited forearm shaft fractures in children.[17,20] For a midshaft diaphyseal both bone forearm fracture, the parameter used by the attendings in this study was >20 degrees of angulation in any plane in a child of age 8 years or below and >10 degrees in a child older than 8 years of age. In general, less angulation was accepted for more proximal fractures whereas more angulation was accepted for distal fractures, given the potential for greater remodeling when the fracture is in closer proximity to the distal radius and the physis. Finally, fractures that could not be corrected with wedging techniques was also an indication for OR intervention.

A retrospective study by Ho and Wilson[11] reviewed outcomes of reductions of pediatric both-bone forearm fractures performed by physician extenders compared with orthopaedic residents and found no significant difference in major intervention, defined as any intervention that occurred in the OR. The study did find a trend that orthopaedic residents required more minor intervention ($P=0.17$), which they defined as the need for additional premedication, reduction/molding of a new cast in the clinic, placement of a new cast for any reason, splitting of the cast for swelling, trimming of the cast, and nerve palsy that resolved on follow-up. The data regarding minor intervention was not available for this study; it is possible that this data may have demonstrated differences throughout the academic year. Another recent study found increasing child obesity as a risk factor for failure of closed reduction.[21] BMI could not be thoroughly evaluated in this study because of a lack of documentation and is a limitation of our study.

This study should be viewed in light of its limitations. This is a retrospective study design and, therefore, relies on the accuracy and availability of previously collected data. We conducted a thorough, manual chart review and applied strict inclusion/exclusion criteria to minimize errors in data collection. Unfortunately, we do not have information on fracture manipulation and cast wedging procedures performed in our pediatric orthopaedic offices. These procedures can minimize the need for operative intervention and may explain the ability to nonoperatively treat fractures that had an initial inadequate reduction. We also acknowledge that there are many variables and potential differences in tolerance by each pediatric orthopaedic surgeon that can affect probability for OR intervention, not just the quality of the reduction. However, we attempted to control for this by verifying that fracture characteristics did not widely vary throughout the year. Finally, these data represent the experience of one institution, which may not apply to all institutions because of differences in training and hospital protocols.

CONCLUSIONS

We found no significant differences in OR intervention rate or quality of reduction of pediatric both-bone diaphyseal forearm fractures treated by orthopaedic residents relative to the academic year at our institution.

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