Sedation for Forearm Fracture Reduction in the Pediatric Emergency Department: Impact on Hospitalization and Length of Stay

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ABSTRACT **Background:** Children with forearm fractures who present to the emergency department (ED) often need a closed reduction. In our institution, until 2017, pediatric trauma patients presented to the general trauma ED (GTED) where no sedation services for pediatric patients were available. From 2017, patients presented to the pediatric emergency department (PED) where closed reductions were performed under sedation when appropriate.

Objectives: To compare GTED and PED with regard to length of stay (LOS) and hospitalization rates of pediatric patients with forearm fractures who needed a closed reduction.

Methods: Our retrospective observational study was conducted at a regional hospital. The study population consisted of all patients younger than 18 years of age who presented to the ED with a forearm fracture that needed a closed reduction. The primary outcome measure was the hospitalization rate. The secondary outcome measure was LOS in the ED.

Results: The study comprised 165 patients with forearm fractures who needed a closed reduction; 79 presented to the GTED and 96 presented to the PED. Hospitalization rates were lower for patients undergoing closed reduction under sedation in the PED compared to the GTED (6.3% and 21.5%, respectively; $P = 0.003$). Median ED LOS was longer among patients undergoing sedation in the PED compared to the GTED (237 vs. 168 minutes respectively, $P < 0.0001$).

Conclusions: Sedation for forearm fracture reduction in a hospital's PED was associated with a decrease of more than three times in hospitalization rate. Despite the need for more resources, PED LOS was only mildly increased.

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KEY WORDS: closed reduction, emergency medicine, fracture, pediatric, sedation

Long bone fractures and particularly forearm fractures are some of the most common reasons for admission to the emergency department (ED) [1]. Children with forearm fractures who present to the ED commonly need a reduction, which is a painful procedure that often requires multimodal analgesia administration [2].

Historically, the reduction took place in the operating theaters under general anesthesia. However, recent studies have shown that the reduction can also be performed safely under procedural sedation in the ED [3-6]. Betham et al. [7] described a shorter hospital length of stay (LOS) and time to procedure when forearm fracture reduction was performed under sedation in the ED compared to the operating theaters under general anesthesia.

Until 2017, all pediatric trauma patients presenting to our institution were treated in the general trauma ED (GTED) where no sedation services for pediatric patients were available. Closed reductions of fractures were performed by orthopedic residents under general anesthesia in the operating theaters or with no sedation. From 2017, following structural changes, pediatric trauma patients presented to the pediatric emergency department (PED), where all closed reductions were performed by the orthopedic residents under sedation.

We compared hospitalization rates and LOS of pediatric patients who underwent a closed reduction of forearm fractures under sedation in the PED versus pediatric patients with forearm fractures who presented to the GTED and needed a closed reduction.

PATIENTS AND METHODS

DESIGN AND POPULATION

This retrospective observational study was conducted at a single center ED. Emek Medical Center in Afula is a regional hospital serving northeastern Israel with 110,000 annual ED presentations distributed among separate EDs within the main ED (22,000 to the GTED and 23,000 to the PED).

All patients younger than 18 years discharged from the ED with a diagnosis of fracture were extracted from the electronical medical records. Only patients with midshaft and metaphyseal ulnar and/or radial fractures that needed a reduction were included. We compared all patients presenting to the GTED between 1 January 2015 and 30 June 2016 with patients who presented to the PED between 1 January 2018 and 30 June 2019.

The study was approved by the institutional review board.

VARIABLES AND OUTCOME MEASURES

Variables that were extracted from the EMR included age, sex, time of arrival to the ED, time of discharge from the ED, hospitalization, and analgesia administration. The primary outcome measure was the hospitalization rate. The secondary outcome measure was LOS in the ED.

DATA ANALYSIS

Chi-square test or Fisher's exact test was used for categorical variables. Student's *t*-test or Wilcoxon tests were used for continuous variables. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 24 (SPSS, IBM Corp, Armonk, NY, USA). *P*-value < 0.05 was considered statistically significant.

RESULTS

The study comprised 175 patients; 79 patients presented to the GTED and 96 presented to the PED.

Overall median age (interquartile range, IQR) was 12.1 years (9.5–14.9) years with 77.1% males. Patient characteristics are presented in Table 1. All patients who presented to the PED underwent a reduction under sedation. Among 79 patients who presented to the GTED, 11 were admitted and underwent reduction in the OT. All other patients underwent fracture reduction in the GTED with either hematoma block or no analgesia [Table 1].

Patients who presented to the PED had lower hospitalization rates when compared to patients presenting to the GTED (6.6% vs. 21.5%, respectively; $P = 0.003$). Among hospitalized patients who presented to the GTED, 13 had closed reduction in the OR, 3 underwent closed reduction with internal fixation, and one was admitted for social services assessment. Among hospitalized patients who presented to the PED, four underwent closed reduction in the OR (two re-reductions and two closed reduction with internal fixation), one patient was admitted for observation, and another one for social services assessment. Table 2 describes the differences in LOS and hospitalization rates between the groups.

Table 1. Patient characteristics

		PED (n=96)	GTED (n=79)	*P*-value
Age in year, median (IQR)		10.7 (8.4–13.3)	14.7 (11–15.8)	< 0.0001
Sex, male, % (n)		78.1 (75)	75.9 (60)	0.116
Sedation / analgesia for forearm reduction in the ED	IV ketamine + propofol % (n)	98.9 (95)		
	IN fentanyl + nitrous %(n)	1.1 (1)		
	Hematoma block % (n)		7.5 (6)	
	Hematoma block + oral analgesia % (n)		12.6 (10)	
	Oral analgesia only % (n)		27.8 (22)	
	No sedation / analgesia % (n)		51.8 (41)	

ED = emergency department, GTED = general trauma emergency department, IN = intranasal, IRQ = interquartile range, IV = intravenous, PED = pediatric emergency department

Table 2. Differences in length of stay and hospitalization rates between the PED and GTED

		PED (n=96)	GTED (n=79)	*P*-value
Hospitalization rate % (n)		6.6 (6)	21.5 (17)	0.003
LOS minutes, median (IQR)	Overall	237 (201–299)	171 (119–251)	0.026
	Discharged	237 (201–297)	168 (104–255)	< 0.0001
	Admitted	291 (206–371)	187 (136–290)	0.319

GTED = general trauma emergency department, IRQ = interquartile range, LOS = length of stay, PED = pediatric emergency department

Overall, patients who presented to the PED stayed 66 minutes longer compared to patients who presented to the GTED (P = 0.026). When compared to patients who underwent reduction under hematoma block in the GTED, there was no difference in median (IQR) LOS between PED and GTED (237, 201–297 minutes vs. 199, 147–304 minutes, respectively; P = 0.118).

DISCUSSION

Procedural sedation and appropriate analgesia have become the standard of care for fracture reduction in the PED when appropriate [8,9]. In our study we found that sedation for closed forearm reduction in the PED was associated with a decrease of more than three times in the hospitalization rates when compared to reduction with no sedation in the GTED. Similarly, reduction of simple pediatric forearm fractures under procedural sedation was previously associated with lesser delay to reduction and a shorter hospital LOS [7]. Moreover, orthopedic surgeons who perform closed reductions in the PED consider procedural sedation as important [10].

More resources are required to perform sedations in the PED (staff, time, and medications). Patients who underwent closed forearm fracture reduction under sedation in the PED had a 66 minutes increase in the median ED LOS compared to the GTED, where closed reduction was performed without sedation. Previous studies reported similar differences in LOS [11,12]. However, when compared to the subgroup of patients who underwent a closed reduction under hematoma block in the GTED, there were no differences in LOS between PED and GTED. Hematoma block was previously evaluated in pediatric patients for closed forearm reduction and showed similar efficacy compared with procedural sedation for pain control, decrease in discomfort, and increased patient satisfaction. However, it was combined with another mode of anxiolysis, such as nitrous oxide [11] or midazolam [12].

Our study has several limitations. First, it was a single center study with the inherent limitation of a retrospective study. Second, patients who underwent reduction in the GTED were older, compared to the patients who underwent reduction under sedation in the PED. This finding could explain the reduced need for anxiolysis in that group. Moreover, the quality of reduction was not assessed in our study (residual angulation, displacement, or rate of re-reduction). This difference could have confounded our result. However, it has been shown previously [3,4] that reduction of forearm fractures under procedural sedation in the PED results in satisfactory outcomes. In our institution, the orthopedic surgeon performed the closed reduction regardless of location (PED, GTED, or OT). Last, pain scores and patient satisfaction were not evaluated in our study, which could confound our findings as well.

CONCLUSIONS

Sedation for forearm fracture reduction in a regional hospital's PED was associated with a decrease of more than three times in hospitalization rate. Despite the need for more resources, PED LOS was only mildly increased. Our results could guide local policy makers with resource allocation.

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Can anything be sadder than work left unfinished? Yes, work never begun.
Christina Rossetti (1830–1894), English writer of romantic, devotional and children's poems

Use the talents you possess, for the woods would be a very silent place if no birds sang except the best.
Henry van Dyke (1852–1933), American author, educator, diplomat, and Presbyterian clergyman