

# Hematoma Block Versus Sedation for the Reduction of Distal Radius Fractures in Children

David M. Bear, MD, Nicole A. Friel, MD, Charles L. Lupo, MD, Raymond Pitetti, MD, W. Timothy Ward, MD

**Purpose** To determine which mode of anesthesia, hematoma block (HB) or procedural sedation (PS), was preferable for distal radius fracture (DRF) reduction in children.

**Methods** Fifty-two children (mean age, 12 y; range, 5–16 y) presenting with DRFs requiring reduction were prospectively enrolled and offered either PS or HB for anesthesia. Following reduction, families completed a satisfaction survey regarding mode of anesthesia and overall care (rated 0–10, with 10 being the best score) and an assessment of discomfort (rated 0–10, with 0 being no pain). Length of stay in the emergency department (ED) and complications related to procedure and method of anesthesia were recorded. Radiographic alignment was evaluated before and after reduction.

**Results** Twenty-six patients underwent reduction with either PS or HB. Midazolam was used in addition to HB in 8 patients. One patient was converted from HB to PS due to inadequate block. There was no significant difference in prereduction and postreduction angulation between the groups, and reductions maintained satisfactory alignment. Overall satisfaction and satisfaction with anesthesia were excellent for both groups, with respective means of 9.5 and 9.5 for PS and 9.3 and 9.6 for HB. Patient discomfort was minimal in both groups, with a mean of 1.6 for PS and 2.2 for HB. Length of stay was significantly shorter for HB patients, with patients spending a mean of 2.2 hours less in the ED. Three patients required further intervention following initial reduction. One patient in each group required revision reduction, and 1 PS patient underwent closed reduction and pinning.

**Conclusions** Use of HB for the reduction of pediatric DRFs provided radiographic alignment, patient satisfaction, and pain control comparable with that of PS, while significantly decreasing ED time and resources. (*J Hand Surg Am.* 2015;40(1):57–61. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)

**Type of study/level of evidence** Therapeutic II.

**Key words** Distal radius, hematoma block, procedural sedation.

PEDIATRIC DISTAL RADIUS FRACTURES (DRFs) are commonly treated in the emergency department (ED). As opposed to adults, closed reduction and casting of these fractures can provide definitive treatment. Thus, performing an adequate initial reduction

and immobilization is critical to a successful outcome. To achieve this goal, effective and safe levels of analgesia and anesthesia are essential to aid in fracture reduction and to minimize pain and allay the apprehensions of the child.<sup>1</sup>

From the Department of Orthopaedic Surgery, and the Division of Pediatric Emergency Medicine, Department of Pediatrics, University of Pittsburgh School of Medicine, Pittsburgh, PA.

Received for publication June 12, 2014; accepted in revised form August 28, 2014.

The authors would like to acknowledge the Pittsburgh orthopedic residents for their invaluable assistance in this research.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

**Corresponding author:** David M. Bear, MD, Orthopedic and Sports Medicine Clinic, 1435 G St. Springfield, OR 97477; e-mail: [dbear81@gmail.com](mailto:dbear81@gmail.com).

0363-5023/15/4001-0011\$36.00/0  
<http://dx.doi.org/10.1016/j.jhssa.2014.08.039>

A variety of anesthetics and analgesics can be used when performing a reduction, including various local (hematoma block [HB]) and regional (Bier, axillary, supraclavicular) blocks, as well as procedural sedation ([PS]; nitric oxide, ketamine, midazolam).<sup>2–6</sup> PS represents one of the most commonly used anesthesia methods for DRF reduction in children.<sup>7–9</sup> Prior to the initiation of this study, nearly all pediatric DRFs at the ED of our children's hospital were reduced using PS. Although PS has previously been shown to provide excellent pain relief, it can have several side effects, such as nausea and vomiting, respiratory depression, dysphoria, and hallucinations.<sup>1,9</sup> Furthermore, PS requires a major use of ED resources and time and may increase the cost of care compared with simpler methods of anesthesia.

HB anesthesia represents an alternative to PS treatment and may be equally effective. A HB can be performed rapidly, requires few ED resources, and may carry less risk than PS.<sup>6,10,11</sup> HB sedation performed in adults with DRFs is safe and effective, with peripheral absorption levels well below that required to cause systemic toxicity.<sup>12</sup> Despite a lack of evidence, there is a frequent perception that, whereas HBs are effective in adults, they are less appropriate in children. Luhmann et al<sup>4</sup> previously demonstrated good outcomes of HB with nitrous oxide for pediatric DRF reduction. There is little literature, however, on the efficacy of HB alone for the reduction of these fractures in children.

The goal of the present study was to compare HB with PS in order to determine the preferable mode of anesthesia for treatment of DRFs in children. Although the majority of pediatric DRFs are currently reduced using PS, we hypothesized that HB anesthesia could be equally effective, while saving significant ED time and resources and reducing complications.

## MATERIALS AND METHODS

Fifty-two children presenting to our institution's children's hospital ED with displaced DRFs were prospectively enrolled into this study. Institutional board review approval was obtained prior to initiation of enrollment. Patients between the ages of 5 and 18 years were eligible. Patients were included in the study if they had a closed displaced DRF amenable to reduction and casting in the ED. Patients were excluded from the study if they had an open fracture, had another injury in addition to the wrist fracture, or if the treating surgeon determined the fracture would require operative fixation. Enrollment took place between January 2012 and January 2014. Patients enrolled in the study represented all of the patients eligible during the study period who were agreeable

to taking part in the study. Informed consent for each patient was obtained by the junior orthopedic surgery resident on call, who also performed the fracture reduction and casting.

Patients were prospectively enrolled into 1 of 2 anesthesia treatment groups, HB or PS. The patient and his or her family were allowed to choose the treatment group after the potential risks and benefits of each were described. Patients enrolled in the PS group received a standardized medication regimen administered by the treating ED physician. An initial intravenous medication regimen of ketamine (2 mg/kg), midazolam (0.1 mg/kg), and atropine (0.01 mg/kg) was given. Subsequent doses of these medications were administered at the discretion of the ED physician. Throughout the sedation, vital signs were continuously monitored, and both a nurse and an ED physician were present. Patients continued to be monitored closely while waking from anesthesia. Ondansetron was administered as needed for nausea.

Patients in the HB group received a block using up to 10 mL of 1% lidocaine without epinephrine. This amount of lidocaine was determined to be a safe weight-based dose for all patients in the study. If deemed necessary by the ED physician or the orthopedic resident, patients were given a dose of either oral midazolam (12.5 mg or 20 mg;  $n = 8$ ) or a 0.1-mg/kg dose of IV morphine ( $n = 8$ ), prior to HB administration. To perform the HB, the patient's skin was cleansed with alcohol, the fracture was palpated dorsally, and a 21-gauge needle was directed into the fracture hematoma. Once entry into the hematoma was confirmed by aspirating a small amount of blood into the syringe, lidocaine was injected into this site. After 5 minutes, efficacy of the block was tested by moving the patient's wrist and noting a marked decrease in fracture pain. If at any time before or during the reduction and casting, the patient's pain was not well controlled, the HB was abandoned, and the patient was converted to PS. Parents were generally allowed to stay with the patient during HB administration; parents of patients in the PS group were routinely required to leave the room.

All patients underwent reduction with the assistance of a mini C-arm to confirm adequate alignment. Patients were placed into long-arm fiberglass casts, which were later converted to short-arm casts at a subsequent clinic follow-up appointment. Final radiographs after reduction and casting confirmed maintenance of satisfactory alignment. Prior to discharge, the patients and guardians were asked to complete a single survey, without the presence of a doctor, regarding satisfaction with mode of anesthesia and overall fracture care (rated 0–10, with 10

being the best score). Patients also rated their discomfort using the Wong-Baker FACES pain rating scale (rated 0–10, with 0 being no pain and 10 being the worst possible pain). Time spent in the ED was defined as the time from when a patient was placed in a room to the time of discharge from the ED. Complications related to mode of anesthesia were also recorded.

Patients underwent routine follow-up care in the office with surveillance radiographs until fracture healing was noted. Radiographic alignment in coronal and sagittal planes was evaluated prereluction, post-reduction, and in the office for up to 12 weeks. Sagittal alignment measurements were based on the degree of dorsal tilt of the distal radius from neutral (0°) and not based on the preinjury alignment. The need for repeat reduction or operative intervention was evaluated. Subgroup analysis was performed by evaluating differences based on fracture location and the presence of an ulna fracture, and differences between the 2 treatment groups were determined statistically using the Student *t* test or chi-square with *P* less than .05 being significant.

## RESULTS

Fifty-two patients were prospectively enrolled (*n* = 26 for each group). Two patients in each group were lost to final follow-up. One HB group patient was converted to PS owing to an inadequate block. The mean patient age in the HB group was 13.3 years (range, 6–16 y) and 12.2 years (range, 5–16 y) in the PS group (*P* = .15). Whereas there was one 6-year-old in the HB group and one 5-year-old in the PS group, the remaining patients were all age 9 and older. Specific fracture characteristics are detailed in Table 1.

### Satisfaction and pain survey

The average overall patient satisfaction with fracture care (0–10 scale) was 9.3 in the HB group and 9.5 in the PS group. The average satisfaction with method of anesthesia used (0–10 scale) was 9.6 in the HB group and 9.5 in the PS group. No difference was detected between the groups with either overall patient satisfaction (*P* = .63) or satisfaction with anesthesia (*P* = .65). Patient discomfort (rated 0–10) was minimal in both groups, with a mean of 2.2 in the HB group and 1.6 in the PS group. No significant difference was detected in patient discomfort between the groups (*P* = .31).

### Time spent in the ED

Patients receiving HB spent an average of 231 minutes in the ED compared with 365 minutes in the PS group, an average difference of 58% (134 min) (*P* < .001).

**TABLE 1. Comparison of Patient and Fracture Characteristics Between PS and HB Groups**

	PS	HB
<b>Number</b>	26	26
<b>Age (y)</b>	12.3 ± 0.5	13.3 ± 0.4
<b>Sex</b>	21 M, 5 F	20 M, 6 F
<b>Fracture location</b>		
Metaphyseal	13 (50%)	12 (46%)
Salter-Harris I/II	13 (50%)	14 (54%)
<b>Angulation</b>		
Dorsal	23 (87%)	23 (87%)
Volar	3 (13%)	3 (13%)
<b>Ulna fracture</b>		
Styloid	11 (42%)	17 (65%)
Metaphyseal	9 (34%)	3 (12%)
None	6 (24%)	6 (23%)

### Radiographic outcomes

Sagittal and coronal DRF angulations were significantly improved after reduction in both the HB and the PS groups (*P* < .001). Average sagittal angulation in the HB group was 22° of dorsal angulation before reduction, 3° after reduction, and 5° at final follow-up. Average sagittal angulation in the PS group was 24° of dorsal angulation before reduction, 3° after reduction, and 7° at final follow-up. No significant differences were detected between the 2 groups at any of the 3 time points. Average coronal angulation in the HB group was 7° of radial deviation before reduction, 1° after reduction, and less than 1° at final follow-up. Average coronal angulation in the PS group was 10° of radial deviation before reduction, 1° after reduction, and 2° at final follow-up. No significant differences were detected between the 2 groups at any time point.

### Subgroup analysis

No difference was found for any outcome measure when groups were subdivided into those with and those without associated ulna fractures. Similarly, no differences were found when groups were subdivided according to DRF location or patient age. HB patients receiving midazolam had similar outcomes to those who did not receive it.

### Complications and further interventions

Three patients required revision treatment in the operating room. One patient in each group required revision closed reduction and casting, and one PS group patient underwent closed reduction and percutaneous

pinning. One HB group patient developed paresthesias prior to discharge, and one HB patient returned to the ED with paresthesias. Symptoms notably improved after their casts were bivalved. Ten PS patients, compared with 1 HB patient, developed nausea severe enough to receive ondansetron treatment. Infections did not occur in either group. No other complications or medication side effects were noted in either group.

## DISCUSSION

Numerous methods of analgesia and anesthesia are available for DRF reduction and casting in children.<sup>2-6</sup> An ideal anesthetic agent would be easy to administer, effective, safe, inexpensive, agreeable to patients and parents, rapidly provided, and not require monitoring or special equipment.<sup>13</sup> We believe that HB satisfies these criteria for the majority of pediatric patients. Although most pediatric DRFs are currently treated with the use of PS for anesthesia, this study demonstrated that HB provided similar excellent satisfaction and pain control as PS, while reducing the time spent in the ED by over 2 hours. Although PS has been effective in prior research<sup>7-9</sup> and in our study, it requires substantial time and resources. The children are also exposed to numerous medications, each with its own potential side effects. At our institution, an ED physician and nurse must be present for PS and casting. On a busy day, the treating surgeon may have to wait at least 1 to 2 hours before the ED physician and nurse are available for the procedure. In rare circumstances, PS is not offered owing to lack of personnel, which highlights how labor intensive PS can be. Continuous monitoring is used throughout sedation, because patients may develop a reaction to the anesthetics or, in the event that a patient becomes overly sedated, may require airway manipulation. Once an acceptable reduction is obtained, patients are discharged when they are alert and not nauseated, a side effect that occurred in more than one-third of patients in our PS group. This recovery will frequently take a minimum of an hour prior to discharge. In contrast, HB-assisted reduction can be performed rapidly with minimal use of hospital resources and does not require personnel other than the treating surgeon.

We believe that HB should be considered the default anesthesia method for the majority of pediatric patients undergoing DRF reduction. In the uncommon event that the HB does not provide adequate anesthesia (one patient in our study), patients should be converted to PS, with minimal time or resources having been wasted. Based on our results, we further believe HB can be used in the office setting. For patients presenting to the clinic with a DRF requiring

reduction, consideration should be given toward performing HB-assisted reduction as an alternative to taking the patient to the operating room for reduction. This would further decrease cost of care for treatment of this fracture.

For children, a variety of techniques including local, regional, and sedation methods have been described for fracture reduction,<sup>4,14</sup> but few studies directly compare these modes. In a prospective, randomized evaluation of mid- to distal radius reduction in children using ketamine/midazolam sedation or nitrous oxide plus HB, the authors demonstrated minimal distress levels in both groups, with fewer adverse events and significantly decreased procedural time in the nitrous oxide plus HB group.<sup>4</sup> No infections were reported in the HB group. These findings are similar to our results. However, unlike patients undergoing HB alone, multiple patients in both treatment groups experienced postanesthesia vomiting, ataxia, headaches, hallucinations, and nightmares.

In another comparative study, pediatric DRFs were retrospectively reviewed.<sup>9</sup> Patients reduced using either HB or PS had higher rates of fracture redisplacement than patients who underwent reduction with general anesthesia.<sup>14</sup> In our study, 2 patients (1 in each group) had redisplacement of their fractures, requiring operative intervention. Despite these 2 patients, there was no significant redisplacement between the immediate postreduction and the final reduction angulation in either group.

Although there is little literature on HB reduction of DRFs in children, HB has previously been evaluated for these fractures in adults.<sup>5-7</sup> Similar to the results of our current study, these studies support the safety, efficacy,<sup>5</sup> and ability to obtain adequate fracture reduction with HB alone.<sup>11</sup> They also do not show an increased risk of infection in patients treated with HB. In a study of HB with or without sedation compared with general anesthetic for adult DRF reduction, there was decreased procedural time, adequate analgesia, longer postreduction analgesia, and comparable radiographic outcomes in the HB group.<sup>6</sup> These findings are also comparable with our results for HB. Although the current study did not evaluate the length of postreduction analgesia, it seems likely that patients in the HB group would have had longer analgesia than PS.

Although a formal quantitative cost analysis was not performed in the present study, a qualitative comparison of the 2 groups suggests a considerable cost savings with HB. In addition to being a convenience to the patient and family, the reduced ED time in the HB group translates to a marked decrease in



cost. Costs are decreased both by reducing the indirect cost of occupying an ED room and by reducing the opportunity cost, because spending less than 50% of time treating a patient allows another patient to be treated during that time. Given the markedly fewer hospital resources needed to perform a HB, the direct costs (physician and staff fees, medication cost, supply cost, facility cost) are certainly reduced for HB compared with PS.

One of the main limitations of this study was the lack of randomization. Randomization was initially attempted, and 7 patients were randomized. Unfortunately, the majority of parents were willing to have their children enrolled for prospective evaluation but were not willing to have them randomized. This ultimately led to us abandoning randomization for the study. Two families who were randomized to the PS group refused that treatment and opted for HB instead. The lack of randomization allowed patients to choose their treatment arm, which likely introduced a selection bias into the study. It is possible that patients who were more apprehensive or anxious were more likely to opt for PS, which may have affected our results.

Another potential limitation was the moderate number of patients enrolled. Based on our power analysis, this number allowed for an accurate evaluation of the main outcomes in this study. It is possible that an increased number of patients would have led to a more accurate comparison of side effects between the groups. Aside from nausea, the majority of the potential medication side effects were rare in both groups. Therefore, more patients would be required in order to accurately discern differences in this category. Furthermore, although there was a large age distribution of patients in the study, the vast majority of patients were 9 years and older. It is possible that HB may not be as well tolerated by children younger than age 10; however, we did not have a sufficient number of younger patients to determine this. The method of having both the patients and their guardians fill out a single survey is another potential drawback. It is possible that the presence of a guardian may have introduced some degree of bias in the satisfaction results. Although we do not routinely

bivalve casts at our institution following reduction of DRFs, we will have a lower threshold to do this directly after casting in the future because 2 patients in the HB group experienced paresthesias.

Since the initiation of this study at our institution, families now have a more informed discussion of the risks and benefits of the HB and PS options. As a result, the use of HB for fracture reduction is increasing.

## REFERENCES

1. McCarty EC, Mencio GA, Green NE. Anesthesia and analgesia for the ambulatory management of fractures in children. *J Am Acad Orthop Surg.* 1999;7(2):81–91.
2. Kriwanek KL, Wan J, Beaty JH, Pershad J. Axillary block for analgesia during manipulation of forearm fractures in the pediatric emergency department a prospective randomized comparative trial. *J Pediatr Orthop.* 2006;26(6):737–740.
3. Aarons CE, Fernandez MD, Willsey M, Peterson B, Key C, Fabregas J. Bier block regional anesthesia and casting for forearm fractures: safety in the pediatric emergency department setting. *J Pediatr Orthop.* 2014;34(1):45–49.
4. Luhmann JD, Schootman M, Luhmann SJ, Kennedy RM. A randomized comparison of nitrous oxide plus hematoma block versus ketamine plus midazolam for emergency department forearm fracture reduction in children. *Pediatrics.* 2006;118(4):e1078–e1086.
5. Singh GK, Manglik RK, Lakhtakia PK, Singh A. Analgesia for the reduction of Colles fracture. A comparison of hematoma block and intravenous sedation. *Online J Curr Clin Trials.* Oct 1, 1992. Doc No 23.
6. Funk L. A prospective trial to compare three anaesthetic techniques used for the reduction of fractures of the distal radius. *Injury.* 1997;28(3):209–212.
7. Godambe SA, Elliot V, Matheny D, Pershad J. Comparison of propofol/fentanyl versus ketamine/midazolam for brief orthopedic procedural sedation in a pediatric emergency department. *Pediatrics.* 2003;112(1 Pt 1):116–123.
8. Mitchell L, Archer E, Middleton S, et al. Paediatric distal radial fracture manipulation: multicentre analysis of process times. *Emerg Med J.* 2009;26(1):41–42.
9. McCarty EC, Mencio GA, Walker LA, Green NE. Ketamine sedation for the reduction of children's fractures in the emergency department. *J Bone Joint Surg Am.* 2000;82(7):912–918.
10. Johnson PQ, Noffsinger MA. Hematoma block of distal forearm fractures. Is it safe? *Orthop Rev.* 1991;20(11):977–979.
11. Case RD. Haematoma block—a safe method of reducing Colles' fractures. *Injury.* 1985;16(7):469–470.
12. Meinig RP, Quick A, Lobmeyer L. Plasma lidocaine levels following hematoma block for distal radius fractures. *J Orthop Trauma.* 1989;3(3):187–191.
13. Blasier RD. Anesthetic considerations for fracture management in the outpatient setting. *J Pediatr Orthop.* 2004;24(6):742–746.
14. Zamzam MM, Khoshhal KI. Displaced fracture of the distal radius in children: factors responsible for redisplacement after closed reduction. *J Bone Joint Surg Br.* 2005;87(6):841–843.