Original Clinical Article

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Conscious sedation and reduction of fractures in the paediatric population: an orthopaedic perspective

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Abstract

Purpose Closed reduction under conscious sedation in the emergency department (ED) has been demonstrated to provide cost-effective, timely care. There has been little research into the efficacy of conscious sedation and reduction from an orthopaedic trauma perspective. This study describes the epidemiology and outcomes associated with fracture conscious sedation and reduction in our level I paediatric ED.

Methods All fracture patients presenting overnight to our level I trauma centre ED between 01 June 2016 and 30 June 2017 were identified. Patient records were reviewed to determine diagnoses, treatments and outcomes. The rate of repeat intervention after successful conscious sedation and reduction and rate of changes in management in which the orthopaedic resident's overnight management plan to provide procedural sedation was altered to surgical intervention after morning case review rounds was calculated.

Results Conscious sedation and reduction was performed on a total of 386 patients covering ten fracture types during the course of our study, with distal radius fractures (n = 167, 43.3%) comprising the majority of cases. A total of 53 cases (13.7%, 53/386) lost alignment and required repeat intervention, consisting of 33 cases (8.5%, 33/386) that required repeat surgery and 5.2% (20/386) that required cast wedging. In all, 12 patients (3.1%, 12/386) initially reduced under conscious sedation required a change in management and surgical intervention. There were five cases of growth arrest and two cases of malunion.

Conclusions Conscious sedation and reduction provides an alternative to general anaesthesia for many paediatric trauma injuries without compromising patient outcomes

Level of Evidence IV

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Introduction

The initial management of displaced fractures often requires urgent closed reduction (CR) followed by immobilization. While reduction can be accomplished under general anaesthesia in the operating room (OR), CR under conscious sedation in the emergency department (ED) has been demonstrated to provide cost-effective and timely care.[1-4]

The majority of conscious sedation literature focuses on the efficacy of various pharmacological agents based on pain scores, anxiolytic effect, provider/patient satisfaction and adverse effects.[2,5-9] However, there is limited data regarding the epidemiology, orthopaedic outcomes and rates of lost reduction after successful reduction associated with conscious sedation and reduction. Currently, the ability of conscious sedation and reduction to produce acceptable reductions in adults has been investigated for dislocated hip prostheses and ankle fracture-dislocations.[10,11] In children, Cassinelli et al[12] and Mansour et al[13] assessed the rates of loss of reduction associated with conscious sedation for spica casting of paediatric femur fractures, while Betham et al[1] looked at the rate of repeated intervention and time-effectiveness of conscious sedation and CR for paediatric forearm fractures. Herein, we describe the epidemiology and outcomes associated with fracture conscious sedation and reduction in our level I paediatric ED over the course of one year of care.

Methods

All fracture patients presenting overnight to our paediatric level I trauma centre ED between 01 June 2016 and 30 June 2017 were considered in our analysis. Patient selection for conscious sedation and reduction was systematically determined through our trauma triage safety programme.[14] Within our system, postgraduate year 3 orthopaedic surgery residents rotate overnight trauma call duties with in-house support from emergency medicine and radiology physician staff. Residents are

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supervised remotely by an attending board-certified paediatric orthopaedic surgeon.[15] Based off of internally-developed guidelines, residents triage patients into three groups: 1) patients who received definitive treatment (usually conscious sedation fracture reduction and casting) and are discharged home; 2) patients admitted directly to the hospital for infection, complex multi-trauma care, orthopaedic surgery or other clinical issue requiring immediate hospitalization; and 3) discharged patients who meet criteria for a satellite orthopaedic trauma OR, in which less-acute, stable, operative fracture cases receive surgical intervention at a dedicated satellite location trauma OR that week.[14] These internally-developed criteria include orthopaedic fracture type, medical and anaesthesia guidelines for cases that are appropriate for general anaesthetic in the OR opposed to conscious sedation and reduction.[14]

The overnight events are then reviewed in a morning trauma case conference attended by orthopaedic residents and attending paediatric orthopaedic surgeons in which plans of care, surgical planning and dispositions are reviewed and finalized. Following this trauma case review, care coordinators contact patients to verify the plan of care with their families, notify them of any changes and confirm that there have been no new issues.[14,15]

Patient medical records were reviewed to determine diagnoses, treatment received, rates of changes in management and treatment outcomes of those patients that were deemed suitable for and received conscious sedation and reduction. We assessed for two major outcomes: 1) repeat intervention involving either cast wedging or surgical intervention for fractures that lost alignment after conscious sedation and reduction; and 2) changes in management, in which the orthopaedic resident's overnight management plan to provide procedural sedation and reduction was altered to surgical intervention after case review during morning rounds.

Conscious sedation and reduction was achieved using either ketamine, a ketamine-midazolam regimen or ketamine-propofol regimen at our institution. In our system, all forearm fracture patients receive a long arm cast.[16] Patients only receiving immobilization do not receive conscious sedation at our institution.

Results

Epidemiology

A total of 1298 fractures covering 34 different diagnoses were seen during the course of our study. Of these, ten fracture types received conscious sedation and reduction (Table 1). Conscious sedation and reduction was performed on 386 total patients, with distal radius fractures (n = 167, 43.3%), both-bone forearm fractures (n = 100, 25.9%) and tibia/tib-fib fractures (n = 53, 13.7%) comprising the majority of cases.

When considering the ten fracture types receiving sedation, conscious sedation and reduction was performed in 40.0% (386/966) of all cases. The rate of conscious sedation and reduction by diagnosis was highest for both-bone forearm fractures (81.3%, 100/123) and distal radius fractures (63.5%, 167/263), lowest for femur fractures (2.6%, 2/76) and type II supracondylar humerus fractures (4.4%, 4/90).

The percentage of displaced fractures receiving conscious sedation and reduction was high for both-bone forearm fractures (86.2%, 100/116) and distal radius fractures (86.1%, 167/194). A high percentage of displaced finger/thumb fractures (84.6%, 11/13) and tibia/tib-fib fractures (75.7%, 53/70) also received conscious sedation and reduction. At our institution, a small amount of femur fractures (3.0%, 2/66) and type II supracondylar humerus fractures (5.6%, 4/72) were managed using procedural sedation and reduction, with the majority of the femur and supracondylar humerus displaced fracture

Table 1 Diagnoses receiving conscious sedation and reduction

Diagnosis	Conscious sedation and reduction in ED	General anaesthesia and reduction in OR	ED care*	Displaced fractures receiving CS, %	All fractures receiving CS, %
Ankle fracture	12	21	59	*36.4*	*20.3*
Both bone forearm fracture	100	16	123	*86.2*	*81.3*
Distal radius fracture	167	27	263	*86.1*	*63.5*
Femur fracture	2	64	76	*3.0*	*2.6*
Finger/thumb fracture	11	2	52	*84.6*	*21.2*
Simple/isolated forearm fracture and dislocation	29	47	99	*38.2*	*29.3*
Humeral shaft fracture	6	7	50	*46.2*	*12.0*
Type I/II supracondylar humerus fracture	4	68	90	*5.6*	*4.4*
Tibia/tibia-fibula fracture	53	17	144	*75.7*	*36.8*
Toe fracture	2	3	10	*40.0*	*20.0*

*All cases with given diagnosis receiving care in the ED, including those receiving immobilization only

ED, emergency department; OR, operating room; CS, conscious sedation

Table 2 Outcomes after conscious sedation and reduction

Diagnosis	Lost alignment - surgery required	Lost alignment - wedging required	Change in management - required surgery	Growth arrest	Refracture	Malunion	Lost to follow-up	Total receiving conscious sedation	Lost alignment, %
Ankle fracture	1	0	1	1	0	0	0	12	*8.3*
Both-bone forearm fracture	13	5	1	0	2	0	11	100	*18.0*
Distal radius fracture	12	10	3	3	1	1	11	167	*13.2*
Femur fracture	0	0	1	0	0	0	0	2	*0.0*
Finger/thumb fracture	1	0	0	0	0	0	0	11	*9.1*
Forearm fracture	2	0	6	0	1	1	4	29	*6.9*
Humeral shaft fracture	1	0	0	0	0	0	0	6	*16.7*
Type II supracondylar humerus fracture	0	0	0	0	0	0	0	4	*0.0*
Tibia/tibia-fibula fracture	3	5	0	1	2	0	5	53	*15.1*
Toe fracture	0	0	0	0	0	0	0	2	*0.0*
Total	33	20	12	5	6	2	31	386	*13.7*

cases instead receiving general anaesthesia and reduction in the OR.

Outcomes

A total of 53 cases (13.7%, 53/386) lost alignment and required repeat intervention, consisting of 33 cases (8.5%, 33/386) that required repeat surgery and 5.2% (20/386) that required cast wedging (Table 2). Both-bone forearm fractures (18.0%, 18/100), humerus fractures (16.7%, 1/6) and tibia/tib-fib fractures (15.1%, 8/53) showed the highest rates of lost alignment, while none of the femur fracture, type II supracondylar humerus fractures or toe fractures required repeat intervention.

In all, 12 patients (3.1%, 12/386) initially reduced under conscious sedation required a change in management and surgical intervention, with the highest rates coming with femur fractures (50.0%, 1/2) and forearm fractures (20.7%, 6/29). There were five total cases of growth arrest, one occurring with an ankle fracture (8.3%, 1/12), one occurring after a tibia/tib-fib fracture (1.9%, 1/53) and three occurring after distal radius fractures (1.8%, 3/167). Malunion was observed in two cases (a distal radius fracture and a forearm fracture requiring osteotomy). The first malunion case occurred in a six-year-old female patient with a distal radius fracture. The fracture demonstrated moderate dorsal angulation of 20° at the two-week follow-up date. There was no additional intervention provided as the alignment was determined to be within acceptable limits by the attending surgeon given the patient's age and growth remodelling potential. Radiographs obtained at seven-months follow-up continued to show ongoing remodelling and an open physis. The second malunion case occurred in a 12-year-old female patient with a radial neck and proximal ulna fracture. The fracture healed routinely until the four-month follow-up visit, when radial head subluxation on attempted pronation was discovered. The patient received a radius neck osteotomy which healed without complication. There were no cases of nonunion and no cases of compartment syndrome.

Discussion

While previous studies have focused on the efficacy of procedural sedation agents, there has been little research into the efficacy of conscious sedation and reduction from an orthopaedic trauma perspective. In our study, we determined the epidemiology and outcomes associated with paediatric fracture conscious sedation and reduction.

Conscious sedation and reduction in the ED has been shown to decrease time to manipulation and reduce length of stay when compared with traditional manipulation under anaesthesia, all while achieving adequate levels of reduction.[1-4,17] As a result, it would benefit both patients and hospital systems to attempt procedural sedation and reduction whenever clinically appropriate, particularly in the current environment of hospital capacity overcrowding.[18,19] In our study, conscious sedation and reduction was provided to fractures determined to be appropriate through our internally-developed guidelines utilizing orthopaedic, medical and anaesthesia considerations.[14] In our series, over 80% of displaced both-bone forearm fractures, distal radius fractures and finger/thumb fractures were treated with conscious sedation and reduction. Prior studies have demonstrated a 90% successful reduction rate in dorsally angulated, stable distal radius fractures.[20]

While conscious sedation and reduction has been shown to provide benefit to the patient in the short-term with faster times to manipulation and shorter length of stay, this benefit can only be solidified if undesirable outcome rates remain low. Our series had no episodes of compartment syndrome or nonunion and only two cases of malunion (0.05%). In addition, the overall rate repeated intervention due to lost alignment remained low at 13.6%, similar to the 15% rate that Betham et al[1] described for paediatric forearm fractures. Furthermore, patients that

required repeat intervention with cast wedging ultimately avoided general anaesthetic in the OR, leaving the rate of lost alignment requiring surgical intervention with general anaesthetic lower at 8.5%. The range of repeated intervention rates did not rise to an unacceptable level, with both-bone forearm fractures showing the highest rate of repeated intervention at 18.0%. Our data provides information for ED physicians, hospital administrators, parents and patients on expected outcomes of conscious sedation fracture reduction in the ED. By providing an alternative to general anaesthesia for many paediatric traumatic injuries without compromising patient outcomes, procedural sedation and reduction is an effective tool to utilize in the care of paediatric orthopaedic fracture cases.

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COMPLIANCE WITH ETHICAL STANDARDS

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ETHICAL STATEMENT

Ethical approval: This study was a retrospective review of existing patient medical records and did not involve human participants or animals.

Informed consent: This study was approved by the Institutional Review Board at our institution and did not require informed consent.

ICMJE CONFLICT OF INTEREST STATEMENT

None declared.

AUTHOR CONTRIBUTIONS

BWY: Data curation, methodology, formal analysis, investigation, writing – original manuscript.

PMW: Conceptualization, investigation, methodology, project administration, resources, supervision, visualization, writing – reviewing and editing.

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