Manipulation Of Paediatric Wrist Fractures Without Portable X-Ray In The Emergency Department

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Citation

P Rees, A Roche, J Sampath, E Byrne. *Manipulation Of Paediatric Wrist Fractures Without Portable X-Ray In The Emergency Department*. The Internet Journal of Orthopedic Surgery. 2010 Volume 18 Number 2.

Abstract

The purpose of this study was to evaluate the early outcome following the manipulation of distal radius and ulna fractures under ketamine sedation in paediatric patients.Patients presenting with fractures of the distal radius and ulna and manipulated in the Emergency department (ED) were identified from the ED databases and retrospectively reviewed. 40 children were identified. No patient had neurovascular (NV) symptoms prior to manipulation under anaesthetic (MUA). No patients required admission for complications related to ketamine sedation following MUA. Fracture angulation improved significantly. 4 patients required admission for repeat MUA +/- K-wire stabilisation/open reduction internal fixation (ORIF) due to failure of reduction. There were no neurological/vascular complications on discharge. All patients had made excellent functional recovery on discharge. Manipulation of paediatric forearm fractures under ketamine is safe. Excellent radiological and clinical results were noted for the majority of patients. Most requiring further operative intervention were all completely displaced on radiographs in two orthogonal views. We therefore highlight a fracture pattern that is not suitable for MUA in the absence of portable x-ray.

INTRODUCTION

Forearm fractures are the most common of all fracture patterns seen in children in the UK. Historical data has demonstrated them to account for over a third (35.8%) of all childhood fractures with an annual incidence of 16/1000.[1] This incidence has not changed significantly in recent years.[2] The investigation and management of these patients is likely to account for a significant personnel workload and financial burden in emergency and orthopaedic departments. Numerous management options are available to address these fractures, ranging from simple manipulation and casting/splinting to formal reduction and fixation in the operating theatre.[3-5] This treatment will clearly depend on the degree of deformity present and also the age of the patient.

Sedation and analgesia for these painful and anxiety provoking procedures remain a controversial topic within paediatric trauma management. Techniques include nitrous oxide, ketamine and midazolam, with each having its own merits and disadvantages with unique side effect profiles.[6]

Ketamine has been utilised for such procedures since its introduction in 1970. It is unique in its ability to produce cortical dissociation, which results in a state of profound analgesia, sedation, amnesia and immobilisation.

At our institution, children with forearm fractures requiring manipulation were traditionally admitted and placed on the emergency list for a formal manipulation in theatre under general anaesthetic. Recently there has been a move to managing these patients on an “out-patient” basis. These patients are managed solely in the emergency department under ketamine sedation without the aide of portable x-ray. The purpose of this study was to evaluate the early outcome following the manipulation of distal radius and/or ulna fractures under ketamine sedation in paediatric patients.

MATERIALS & METHODS

Case notes were reviewed to gain data for patient demographics following approval by the local institutional review board. Details recorded included mechanism of injury, complications, admission rates, further interventions and follow-up details in all children. Patients presenting with distal forearm fractures that were manipulated in the ED between October 2005 and August 2008 were identified from the ED databases and retrospectively reviewed. Patients were included if they had a distal forearm fracture(s), and had completed clinical and radiological follow-up. Patients were reviewed by a senior orthopaedic doctor to assess suitability for MUA in the ED.

A history and examination were carried out, and initial

neurovascular status was documented, for all patients. All manipulations were performed in an ED resuscitation cubicle. Sedation with ketamine (Initial dose 1.0-1.5mg/kg IV) was performed by a senior ED physician with training in sedation techniques and airway management. The patient's pulse, blood pressure and oxygen saturation levels were monitored throughout. The manipulation was performed by an orthopaedic surgeon of varying grades (Senior house officer, specialist registrar or consultant) and a plaster of paris cast was subsequently applied. Patients were recovered in a quiet room following manipulation with one to one nursing supervision until they were fully conscious. They were then kept in the department for a further 1 hour and if well were discharged home. Plain radiographs were performed on admission, post-manipulation and at out-patient follow-up. Angulation was measured in 2 orthogonal planes for each and reviewed by two authors (PAR and AR). This was performed manually on "hard copy" x-rays performed prior to the integration of a computerised x-ray system (Picture Archive Communication System - GE Healthcare, UK) at our institution in July 2007. All x-rays after this date were analysed using the software. All x-rays were reviewed and fracture patterns were sub-divided into commonly used descriptive patterns. All patients were followed up in the out-patient department to assess clinical functional outcomes.

Statistical analysis included simple descriptive statistics and the unpaired t test.

RESULTS

47 children (1 with bilateral fractures) were identified from the ED database (4 patients had incomplete data sets and therefore were excluded, a further 3 patients were excluded as they had mid-shaft forearm fractures). The final study population was 40 children (1 with bilateral fractures). The mean age was 9 years (3-14). There were 12 female and 28 male. The commonest mechanism of injury was simple falls as illustrated in Table 1.

Figure 1

Table 1 - The mechanism of injury to the patient

Mechanism of injury	n
Fall from standing height	20
Fall from height	9
Fall from bouncy castle/trampoline	2
Fall involving stairs	2
Fall from scooter	3
Direct blow to wrist/forearm	4
Total patients	**40**

The radiological pattern of injury, with commonly used descriptive terms is documented in Table 2.

Figure 2

Table 2 - Distribution of fracture patterns amongst study population (SH=Salter Harris classification).

Classification of Fracture	n
Distal 1/3 complete fracture (radius & ulna) <100% displacment	7
Distal 1/3 complete fracture (radius & ulna) >100% displacement	3
SH I distal radius	2
SH II radius	5
Greenstick/torus distal radius	23
Total	**41**

There were no cases with neurological symptoms or signs of vascular compromise prior to manipulation. No patients required admission for complications related to ketamine sedation following manipulation.

Fracture angulation improved significantly on post-manipulation antero-posterior and lateral radiographs (p values <0.0001) (Table 3).

Figure 3

Table 3 – Mean fracture angulation in antero-posterior and lateral plains pre- and post-manipulation. CI - Confidence intervals.

	Pre-manipulation (Degrees +/- 95% CI)	Post-manipulation (Degrees +/- 95% CI)	P-value
AP radiograph	6.76 +/- 2.67	0.86 +/- 0.88	<0.0001
Lateral radiograph	21.10 +/- 2.80	5.80 +/- 1.07	<0.0001

3 patients were deemed to require temporary admission for observation of swelling, but all were subsequently discharged uneventfully after 24 hours. 4 patients (10%) required admission for further intervention, due to failure of satisfactory reduction on manipulation in the ED (2 distal 1/3 radius and ulna fractures with >100% displacement, 1 distal 1/3 radius fracture with <100% displacement and 1 Salter-Harris II fracture). These patients underwent repeat manipulation under general anaesthesia with the aid of image intensification in the operating theatre. Of these, 2 had manipulation only, 1 had manipulation and K-wire insertion and 1 patient had an open reduction and plate fixation. On clinic follow-up 1 patient had loss of position with angulation at 1 week and was admitted for repeat manipulation and K-wire fixation. There were no neurological or vascular complications at latest follow-up and discharge. All patients made uneventful functional recovery and discharged shortly after plaster removal (mean 5.26 weeks, range 4-11). One patient was referred to physiotherapy.

DISCUSSION

Ketamine has been used as a modality for sedation for a number of decades. Numerous studies have attempted to establish its safety for use amongst the paediatric population, particularly by non-anaesthetists. Green et al commented on the adverse effects of intramuscular ketamine in a large paediatric case series.[7] Although only 431 of 1022 patients had complete data sets, this is still the largest case series to date. They reported a very low incidence of adverse events. Airway compromise affected 1.4%, emesis 6.7% and recovery agitation was seen in 19.2%, although 17.6% of cases were classified as being “mild”. Similar rates have been demonstrated by other groups.[8] In our series no ketamine related complications were recorded, however we do acknowledge the relatively smaller study population.

The exact angulation in paediatric forearm fractures which is deemed acceptable or that requires manipulation is a controversial topic without a strong evidence base. The unique and changing property of the juvenile skeleton to heal and remodel following trauma means that different degrees of angulation are acceptable at different ages. Generally the younger the child the greater potential for remodelling that exists. Ploegmakers et al carried out a meta-analysis to establish guidelines for which forearm fractures should/shouldn’t be manipulated in different age groups.[9] Despite this they were unable to produce clear guidelines on this subject. In a paediatric population parental concerns often influence the doctor’s decision to manipulate a fracture or not. This is driven by the parents’ unwillingness to accept even minor angulation as remodelling takes months to years to complete. Our series has demonstrated a very clear improvement in angulation following manipulation in the ED under ketamine sedation. These findings would be expected as those clinicians performing the manipulation were trained (to differing levels) in Orthopaedic Surgery, however, the absence of an image intensifier did not adversely affect the radiological or clinical results in the vast majority of patients.

In this study we did not objectively measure radial shortening and it’s improvement post-manipulation. We measured angulation in the frontal plane as well as the lateral views when demonstrating reduction effectiveness.

Of the fractures that were not adequately reduced in the ED, 50% were described as “off-ended” fractures (both distal 1/3 radius and ulna fractures with >100% displacement). These manipulations were actually carried out by more junior doctors (senior house officers), had this been recognised, these patients may potentially have had successful manipulations performed by more senior staff.

Limitations of this study include it’s retrospective nature and it’s relatively small study population, but to date and to our knowledge, this is the only case series evaluating the orthopaedic outcome following MUA in the ED in the paediatric population under ketamine sedation. These were a heterogeneous group of injuries i.e. greenstick/completely displaced fractures and as a result it is difficult to analyse them collectively. The decision whether to attempt manipulation in the ED is arguably subjective with patient variables such as age, degree of deformity and parent attitudes to consider. Clinicians’ level of experience is also important. Patient follow up was short, which is likely to be a reflection of normal clinical practice in most busy paediatric units in the UK, as functional recovery is usually

rapid and excellent as seen in our study. Functional outcomes scores, however, were not recorded. Future studies should also include patient/parent satisfaction with this method of managing paediatric wrist fractures.

From this study it is suggested that not all patients are suitable for manipulation in the absence of image intensification. The patients requiring further intervention for their forearm fractures, were mostly patients that had suffered completely displaced fractures on initial radiographic assessment.

CONCLUSIONS

Manipulation of paediatric wrist fractures under ketamine is safe. Excellent radiological and clinical results were noted for the majority of patients. However, patient selection and more importantly, suitable fracture configuration, is key to achieve optimum outcomes. We would therefore always recommend the involvement of an experienced orthopaedic surgeon in the decision-making and management of this patient group. Manipulation under ketamine in the ED could reduce in-patient admissions and potentially the burden on a busy trauma list, whilst helping develop skill sets not frequently utilised by more junior doctors in the UK.

The authors declare no competing interests or external funding sources. There are no acknowledgements to be made.

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