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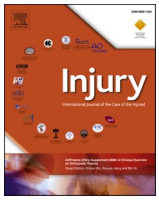

Use and efficacy of haematoma blocks in managing closed reduction of distal radial fractures by emergency nurse practitioners: A matched case-control study design

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ABSTRACT

Background: Displaced distal radial fractures are common among all age groups, but increasingly in older patients, and are frequently managed by emergency nurse practitioners. Most can be manipulated and reduced in the emergency department, often by procedural sedation and analgesia, which can be time consuming and often requiring multiple resources. Using haematoma blocks may offer advantages.
Aim: To examine the use and efficacy of haematoma blocks in managing close reduction of distal radial fractures by emergency nursing practitioners compared to procedural sedation.
Design: Matched case-control study.
Results: Compared to those who had procedural sedation and analgesia ($n = 100$), the haematoma block group ($n = 100$) had a shorter procedure time (0.4 hrs vs. 0.7 hrs, $Z = -1.24$, $p < .001$), time from reduction to discharge (1.5 hrs vs. 4.6 hrs, $Z = -2.98$, $p < .001$), overall ED length of stay (2.8 hrs vs. 4.9 hrs, $Z = -3.49$, $p < .001$) and minimal pain post reduction (0/10 vs. 4/10, $Z = -2.6$, $p = .001$). No adverse events were noted in the haematoma block group compared to 23 % in the procedural sedation and analgesia group.
Conclusion: Hematoma block is a safe, effective and efficient alternative to procedural sedation in the reduction of distal radial fractures by emergency nurse practitioners.

Introduction

Traumatic injuries accounted for nearly 2 M (21.6 %) presentations to an Australian emergency department, of which 26.8 % related to limb injuries, [1] with the third most common (18.8 %) site of injury involved the hand and wrist [2]. Of the nearly 320,000 patients who presented to an emergency department (ED) in New South Wales with a limb injury, 2.5 % ($n = 7826$) were diagnosed with a closed distal radial fracture, of which 90 % were discharged the same day with an estimated health system cost of 1.7 M [3,4]. Displaced distal radius fractures are often managed through manipulation, reduction and immobilisation. Performing an adequate initial reduction and immobilisation is critical in reducing risk of ischaemia and nerve damage even if they later have formal surgical reduction in theatre. Effective and safe levels of analgesia are essential to allow fracture reduction [5,6].

Management of the closed distal radial fractures depends on severity. Undisplaced fractures can be treated conservatively with a cast alone, while displaced or impacted fractures (volar tilt greater than −5° to 20°) [7] are treated either with closed reduction and immobilisation with cast or surgical fixation. A significant number of those going onto have surgical fixation also require closed reduction and immobiliation in the ED: over 60 % of distal radial fractures are displaced and managed in the ED by closed reduction to improve alignment, release tension in the surrounding neurovascular structures and reduce pain and discomfort [8].

The management of traumatic injuries can be time consuming and often requiring multiple resources. The process of reducing the fracture is painful, and a form of anaesthesia is required both for the comfort of the patient and to allow enough muscle relaxation to obtain a satisfactory outcome. Analgesia in the ED for closed reduction of distal radial fractures r can be facilitated by intravenous procedural sedation or haematoma block. Transcutaneous injection into the fracture, haematoma block, is a recognised method to provide analgesia for reduction [9]. Emergency nurse practitioners are increasingly part of the

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emergency department workforce and frequently manage traumatic limb injuries. To the best of our knowledge, there is no evidence within published literature of the use and efficacy of haematoma blocks by emergency nurse practitioners. Thus, the aim of this study was to examine the use and efficacy of haematoma blocks in managing closed reduction of distal radial fractures by emergency nurse practitioners compared to procedural sedation and analgesia.

Methods

Study design

A matched case-control design was used. Approval was obtained from the local Human Research and Ethics Committee before undertaking this study.

Setting and participants

This study was undertaken at a metropolitan tertiary referral hospital in New South Wales with an annual ED census of 70,000 presentations. At the time of the study, the department had 3.5 FTE of Nurse Practitioners. Prior to the study, displaced distal radial fracture were reduced under procedural sedation and analgesia.

An electronic search was performed of the local medical record database for all patients aged over 16 years with a single, isolated displaced distal radius fracture, for which the clinical team deemed closed reduction was necessary. Patients with open fractures or multiple injuries, delayed presentation (≥5 days), treated at an outside facility or any other haematoma bloke related contraindication (Table 1), were excluded. The search revealed 261 patients.

A population-based retrospective 1:1 propensity-matched case-comparison study. Cases were all patients (n = 120) who presented between 1st October 2023 to 31st 0ctober 2024 who underwent haematoma block for reduction of closed distal radial fracture. Controls were selected from patients (n = 141) who presented to the ED between 1st September 2022 to 31st September 2023 (before implementation of haematoma block protocol) who underwent procedural sedation and analgesia to facilitate fracture reduction.

Power calculations were based on the average ED length of stay for patients who underwent closed reduction in ED. To detect a 10 % decrease in ED length of stay with a significance level of 0.05 (two-sided) and power of 0.80, 90 patients were required in each group. As the efficiency loss using the Mann-Whitney U test in preference to the t-test is estimated to be 10 %, [10] 10 % was added to each group to compensate for the use of non-parametric tests. Matching was undertaken using the SPSS FUZZY extension (version 2.0.3), a logistic regression algorithm using propensity scoring, [11,12] by a researcher not associated with the study, with the following parameters: age (± 3 years), sex, and triage category (± 1). Controls that were unable to be matched within parameter tolerances to cases were omitted. Of 261 patients, 200 were successfully matched using these criteria.

Table 1
Contraindications for HTB.

Open fracture	Due to the possibility of contamination (e.g. soil, debris), open fractures require emergent surgical intervention and washout.
Allergies	Known allergy to the anaesthetic drug being used.
Infection	Cellulitis or skin breakdown over fracture site increases risk of infecting the haematoma.
Neurovascular deficit	Neurovascular deficit in the affected limb.
Bleeding disorders	Patients taking anticoagulant medications are a relative contraindication. Patients with haematological disorders (e.g. haemophilia, thrombocytopenia, Von Willebrand disease), HTBs are not recommended.
Patient behaviour	Cognitive impairment, needle-phobia, agitation or aggression may impact on procedural safety.

Data collection

The following data were extracted from the local electronic medical record system for each case and control using a standardised template and transferred into SPSS: [13] age, sex, triage category, pain level (on presentation to ED and 30 min post-reduction) [14,15] using 11-point (0–10) visual analogue scale, radiography reports, procedural medication and doses administered, diagnosis, waiting time, procedural time (from administration of anaesthetic to application of cast), number of reduction attempts, procedural sedation was required, total ED length of stay, patient disposition and follow-up care. Information recorded on the template was compared to the patient's electronic medical record. To ensure accuracy, 20 % of obtained records were randomly selected by the local data manager not associated with the study and verified against the original record. No data transcription errors were noted.

Procedure

Once initial examination and radiography was completed confirming displaced distal radial fracture requiring closed reduction, patient consent was obtained prior to the haematoma block. For the haematoma block, 0.75 % ropivacaine was used. The haematoma block was administered using standard aseptic non-touch technique in the following way:

- Dorsal aspect of wrist is palpated to locate fracture 'step-off' site.
- Injection site cleansed using disinfectant (e.g., ChloraPrep™), sterile field maintained, sterile gloves donned.
- Needle inserted approximately 30 degrees to skin just proximal of fracture (approx. 1 cm) on the dorsal aspect along the plane of the radius injecting local anaesthetic in small amounts as needle advanced toward fracture.
- Needle advanced into the haematoma, confirmed by observing blood return within the hub of the needle / on aspiration.
- Local anaesthetic (10–15 mL) injected slowly into the haematoma.
- Pause for 10–15mins to allow for maximum effectiveness of anaesthetic prior to reducing the fracture [16].

Procedural sedation and analgesia was carried out following local policy [17] A senior experienced emergency physician led the pre-procedure huddle and established the aims of sedation, clarified patient risks, sedation agents and analgesics, rescue plan and team roles. In addition to the senior emergency physician, the clinical team consisted of an attending physician and two emergency nurses.

Data analysis

Data were analysed using SPSS version 29 [13] An alpha coefficient of 0.05 was accepted as indicating statistical significance. Distributions were examined using the Kolmogorov-Smirnov test for normality. As data were not normally distributed, the population was described using medians, interquartile ranges and 95 % confidence intervals for continuous data, and frequencies and percentages for categorical data. Differences between groups was explored using the non-parametric Mann-Whitney U test. Frequency of adverse events between groups was compared using Chi-square. T-test was used to compare degree of dorsal tilt, radial angulation and radial shortening.

The primary outcome measure was any difference in post reduction pain scores between the two groups of patients. The secondary outcome measure of interest was the frequency of successful reduction on first attempt. Successful reduction was defined as <10 degrees of dorsal tilt and <5 mm of radial shortening [18] The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) checklist for case control studies guided the research process and reporting [19].

Results

A total of 200 patients were matched and enrolled into the study. The median patient age across both groups was similar (61yrs, IQR 52.0–67.8yrs, vs. 63.0yrs, IQR 61.0–71.0yrs), and the vast majority (71 %) of participants were female with intra-articular fractures (71 % vs. 79 %) of the distal radius and self-presented to ED (69 % vs. 80). There were no significant differences in patient age, sex, triage category, time to examination or initial pain score at triage (Table 2). The majority (47 % vs. 44 %) of patients did not report taking any analgesia prior to arriving at the ED. Methoxyflurane was not used at the study site and was only available to patients (15 %) who presented to ED via ambulance. Conversely, nitrous oxide was only accessible to patients (23 %) following triage in ED prior to fracture reduction.

In the control group, propofol (71 %, median dose 60 mg, IQR 40–65 mg), ketamine (32 %, 20 mg, IQR 12.5–25 mg) or midazolam (11 %, 5 mg, IQR 3–6.6 mg) were used to sedate patients prior to reduction. Pre-sedation, the average reported pain score was 5/10 (IQR 4–7/10). Most (84 %) received a single bolus of intravenous fentanyl (81 %, 50mcg, IQR 50–75mcg) compared to morphine (19 %, 5 mg, IQR 2.5–6 mg). While the majority (71 %) did not require additional pain relief during or following the procedure, additional fentanyl boluses were administered to nearly a quarter (29 %) of patients intra- and post-procedure (16 %, 25mcg, IQR 10–33.3mcg, and 13 %, 25mcg, IQR 10–25mcg respectively) to manage breakthrough pain. A total of 22 patients were admitted for open reduction and internal fixation. In the haematoma block group, an average of 15mls (IQR 10–15) of ropivacaine was infiltrated into the fracture haematoma. A total of 23 patients were administered nitrous oxide during infiltration of ropivacaine. Post haematoma block (median 11.5 min, IQR 9.9 – 12.8) the average reported pain score was 0/10 (IQR 0–0/10). Few patients required nitrous oxide (N_2O) during (12 %, median N_2O concentration 60 %, IQR 50–66.3 %) to manage anxiety, or following closed reduction (6 %, median N_2O concentration 50 %, IQR 50–60 % respectively) to manage pain. The majority (92 %) of patients did not require any additional analgesia post reduction. No patients required subsequent procedural sedation. Following orthopaedic review, a total of 16 patients were admitted for open reduction and internal fixation due to fracture stability.

On comparing the two groups, a shorter median procedure time (0.4 hrs vs. 0.7 hrs, $Z = -1.24$, $p < .001$), time from post-reduction to discharge (1.5 hrs vs. 4.6 hrs, $Z = -2.98$, $p < .001$), overall ED length of stay (2.8 hrs vs. 4.9 hrs, $Z = -3.49$, $p < .001$) and reduced post-reduction pain score (0/10 vs. 4/10, $Z = -2.6$, $p = .001$) was noted. Fewer patients required post-reduction analgesia in the haematoma block haematoma block group (18 % vs. 29 %, χ^2 53.2, df 1, $p < .001$). No adverse events were noted in the haematoma block group. Minor complications were observed in 23 cases in the procedural sedation and analgesia group, with apnoea (7 %), hypotension (7 %) and nausea and/or vomiting (6 %) being the most common adverse event observed. Patient disposition was similar across both groups (Table 3). Haematoma block had the highest proportion of successful reductions (91 %) on first attempt compared to procedural sedation and analgesia (82 %). A total of 27 (13.5 %) patients required one further episode of manipulation to achieve better fracture alignment. The radial inclination, dorsal tilt, and degree of radial shortening were found not to differ between the two groups at presentation or following reduction ($p > .05$). Loss of distal radial alignment or adverse outcomes were not observed at outpatient follow-up in either group.

Discussion

The purpose of this study was to examine the use and efficacy of haematoma blocks in managing closed reduction of distal radial fractures by emergency nurse practitioners compared to procedural sedation. Our findings show that hematoma blocks are safe, effective and provide adequate pain management by emergency nurse practitioners. The ideal method of providing analgesia to support reduction would be easy to administer, effective, safe, and not require a wide range of resources. We believe that the hematoma block fulfils these criteria. In this study, the haematoma block method was the most efficient. Patients reported significantly less pain post-reduction and it was associated with a shorter procedural time and ED length of stay. To our knowledge, this is the first study to examine its use by emergency nursing practitioners in managing closed reduction of distal radial fractures.

Although procedural sedation has been effective in prior research, [20] it requires substantial time and resources. In a recent systematic review by Tseng et al. [21] involving 3 studies based on adult patient populations ($n = 301$) comparing procedural sedation to haematoma block in reducing distal radial fractures, they reported no significant reduction in pain prior to fracture reduction on comparing procedural sedation and analgesia and haematoma block (Hedges' g 0.356, 95 % CI − 1.101 to 1.812, $p = 0.632$), however hematoma block did significantly result in a larger decrease in pain following fracture reduction (Hedges' g − 0.600, 95 % CI − 1.170 to − 0.029, $p = 0.039$). In our study, the hematoma block group reported significantly less pain pre- and post-

Table 2
Patient characteristics.

	Procedural sedation group (%)	Haematoma block group (%)	Sig.
N	100	100	
Female	71 (71.0)	71 (71.0)	
Male	29 (29.0)	29 (29.0)	
Age	61.0 (52.0–67.8)	63.0 (61.0–71.0)	$p =$ .18
Triage category	3 (100.0)	3 (100.0)	
Mode of arrival			
Walk-in	69 (69.0)	80 (80.0)	
Ambulance	31 (31.0)	20 (20.0)	
Pain score on arrival to ED	7/10 (6–8/10)	7/10 (6–8/10)	$p =$ .86
Triage to examination time	1.1 hrs (0.7–1.4)	0.9 hrs (0.6–1.1)	$p =$ .31
Radiological fracture features on presentation to ED (mean, SD)			
Dorsal tilt (deg)	23.9 (11.7)	24.1 (10.7)	$p =$ .81
Radial inclination (deg)	15.8 (6.8)	16.1 (8.0)	$p =$ .74
Radial height (mm)	5.6 (3.5)	6.8 (5.0)	$p =$ .77

Table 3
Procedural characteristics.

	Procedural sedation control group	Haematoma block group	Sig.
Procedure time	0.7 hrs (0.6–0.9)	0.4 hrs (0.3–0.5)	$p <$ .001
Post-reduction pain score	4/10 (5–6/10)	0/10 (0–1/10)	$p <$ .001
Time from end of reduction procedure to discharge (hrs)	4.6 hrs (3.8–6.1)	1.5 hrs (1.3–1.7)	$p <$ .001
ED length of stay (hrs)	4.9 hrs (3.4–6.9)	2.8 hrs (1.1–2.6)	$p <$ .001
Post-reduction radiological fracture features (mean, SD)			
Dorsal tilt (deg)	−2.5 (1.1)	−0.8 (1.8)	$p >$ .05
Radial inclination (deg)	7.1 (2.1)	6.8 (1.8)	$p >$ .05
Radial shortening (mm)	0.8 (2.9)	1.4 (1.8)	$p >$ .05

reduction, and required less breakthrough analgesia compared to patients managed under procedural sedation and analgesia. Technique and adequacy of fracture haematoma infiltration are common causes of block failure [22] Overall failure rate of hematoma block has been reported to be 10.5 % [23] in limb fractures, with block failure rates less common in upper limb fractures (4.05 % to 13.1 %) [22] compared to lower limb fractures (19.5 %) [23] Accuracy and clinician confidence in hematoma block placement may be improved with point-of-care ultrasound, [24–28] however further training is required.

Concerns have been raised regarding the safety of haematoma block such as introduction of infection, [29] local anaesthetic toxicity [30] and compartment syndrome [31] associated with the volume of local anaesthetic being injected. In our study, no adverse events were observed in the hematoma block group which is consistent with literature reporting that these complications appear to be rare, [32–36. In this study, patients received nitrous oxide to relieve acute pain and procedural anxiety as no alternative inhalable anaesthetic was available at the facility. Nitrous oxide is a commonly used anaesthetic gas in EDs in Australia and elsewhere, [37] h however has significant environmental impacts. Methoxyflurane, has a climate change impact of 117.7 times less carbon dioxide equivalents than using 30 min if nitrous oxide [38], although it is more expensive [39] Further study is required to evaluate the use of methoxyflurane managing acute pain during emergent fracture reductions [40–42].

Limitations

This is a matched case-control study which has its limitations. First, this study was conducted at a single metropolitan ED which may limit the generalisability of the findings. Second, this study relied upon clinical documentation made at the time of patient care. It is possible that a complete representation of assessment and treatment may not be captured in retrospective data. Third, assessing subjective outcomes such as pain has its limitations. Although the numerical rating scale is a validated method of assessing pain, it is a single assessment and many other factors can influence patient reports of pain, including anxiety [43–45] Fourth, matching may induce selection bias. To reduce this problem, according to recommendations, [46] we have matched only for strong confounders, age, sex, and triage category. Finally, when assessing the outcome of a manipulation, post-reduction radiography reports were relied upon to indicate a successful outcome. Although the aim of any manipulation is to anatomically reduce the fracture in order to reduce the risk of neurovascular damage, there is evidence that anatomical reduction of the fracture may not correlate with the clinical outcome [47,48] On reviewing outpatient records, no changes or adverse outcomes were reported across both groups.

Conclusion

The use of a hematoma block has shown to be safe and effective method in reducing distal radial and is an essential skill that can be used by emergency nurse practitioners. In this study, hematoma block was superior to IV procedural sedation and was associated with better management of pain, significantly reduced procedural time, length of stay and utilisation of finite ED resources.

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Ethical approval

This study was approved as a quality improvement initiative by the South Eastern Sydney Human Research and Ethics Committee as there was no direct contact with the patients and data were collected retrospectively.

Data statement

The participants in this study did not give written consent for their data to be shared publicly, supporting data is not available.

CRediT authorship contribution statement

Carmel Hagness: Writing – review & editing, Writing – original draft, Validation, Investigation, Formal analysis, Conceptualization. **Michael Golding:** Writing – review & editing, Writing – original draft, Validation, Supervision, Conceptualization. **Wayne Varndell:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

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