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ORIGINAL ARTICLE

Effectiveness of Hematoma Block in Acute Pain Management and Closed Reduction of Fractures in Children Presenting to DHQ Kohat: An Exploratory RCT

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ABSTRACT

Background: Extremity fractures are common in children, particularly involving the lower segments of limbs, causing significant pain and anxiety. Adequate pain management is crucial during treatment.

Methods: An exploratory randomized controlled trial study, between October 2019 and January 2020, compared hematoma block (HB) and intravenous analgesia (IVA) for pain management and closed reduction of simple extremity fractures in children. Two groups (64 children each) with forearm and shin bone fractures were randomly assigned HB or IVA. Pain levels were assessed using the visual analog scale before and after closed reduction at 5, 15, and 30 minutes. Fracture reduction quality was evaluated using X-rays.

Results: Most fractures occurred in 8.5-year-old boys. HB resulted in significantly greater pain reduction compared to IVA, with continued improvement over time. Both methods achieved successful fracture reduction, but HB showed superior improvements in X-ray parameters such as angulation, shortening, and cortical apposition. Guidelines for pediatric forearm and shin bone fracture treatment in emergency settings were proposed based on X-ray parameters.

Conclusion: Hematoma block emerges as a superior choice for pain management and closed reduction of pediatric forearm fractures, especially in resource-limited settings. Its efficacy in reducing pain and achieving better fracture alignment, as evidenced by X-ray parameters, supports its recommendation as a primary method in managing pediatric extremity fractures.

Keywords: Extremity fractures, Pediatric pain management, Hematoma block, closed reduction

INTRODUCTION

Fractures of the forearm and shin bones comprise half of all childhood fractures and are commonly treated in emergency departments (EDs). With global incidence rates on the rise, timely and effective management in the ED is crucial. Closed reduction, a mainstay treatment, aims to restore anatomical alignment and alleviate pain. However, ensuring adequate pain relief during this procedure is paramount, as it not only improves patient comfort but also reduces economic and psychological burdens on families and healthcare systems.[1] Despite the importance of pain management in fracture treatment, there's a lack of consensus on the most effective methods. Children's fractures, predominantly occurring between ages 6 to 14, often result from falls and sports-related injuries. These fractures, particularly of the distal radius and midshaft forearm, represent a significant portion of childhood injuries and can impact daily activities for weeks.[2]

Complications such as malunion and growth disturbances underscore the necessity for comprehensive management. Yet, limited research focuses on understanding the demographics and causes of childhood fractures, despite evidence suggesting a potential link between childhood fractures and adult bone health.[3] Understanding the epidemiology and mechanisms of childhood fractures is essential for developing effective prevention strategies and optimizing treatment outcomes. While incidence rates may vary between regions and age groups, fractures continue to pose a significant public health concern. By addressing the complexities of childhood fractures, we can work towards reducing their incidence and mitigating their long-term impact on individuals and healthcare systems alike.[4] The prevalence of limb traumas is challenging to define due to their acute nature. However, it can be understood as the number of people living with trauma-induced loss, deformity, or impairment at a specific time. In the US, disability caused by limb trauma was estimated at 35.8 per 1000 people in 1996, accounting for 12% of all disabilities from trauma. In the UK, disability due to trauma was estimated at 6 per 1000 people, excluding certain injury mechanisms, but could exceed 20% if included.[5]

Fractures are breaks in bone continuity and can be complete or incomplete. Incomplete fractures, often seen in children, include cracks, buckling, or tearing of the cortex. Children's fractures primarily result from low-energy trauma, with falls from bed height being common. Playground injuries and sports activities also contribute significantly. Birth-related trauma, like clavicle fractures from delivery, and non-accidental trauma, such as spiral fractures from child abuse, is notable causes.[6] Fractures of the femoral shaft and shin bones often stem from high-energy trauma or accidents. Most childhood fractures, particularly in the upper extremities, result from falls, with the forearm being a common site due to its sturdy cortical bone. Children's active play increases their risk of skeletal injury, often leading to falls where they instinctively extend their upper limbs for protection.[7] During such falls, the pronated hand strikes the ground, causing rapid supination of the forearm. This mechanism typically fractures the radius first due to its absorption of the highest energy load. Longitudinal compression forces primarily break forearm bones, with injury patterns indicating supination apex volar fractures as most common.[8]

The severity of limb trauma in children depends on injury location, type, and extent of bony and soft tissue damage. Complications such as pain, stiffness, deformity, and disability can lead to functional deficits and increased mortality. Limb trauma may disrupt school attendance and recreational activities, impacting both physical and psychological well-being. Diagnosing fractures in children involves clinical examination and imaging techniques like X-rays, crucial for ensuring appropriate management and minimizing long-term dysfunction.[9] However, interpreting X-rays correctly is vital, considering factors like age-related anatomy and growth variations. Other imaging modalities like CT, MRI, and ultrasound may be necessary for difficult cases.[10]

Pain management in fractures is critical but often

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inadequate, especially in emergency settings. Techniques like hematoma block and intravenous analgesia are commonly used. Hematoma block, a form of local anesthesia, involves injecting anesthetic into the fracture hematoma to reduce pain and enable closed reduction. Lidocaine is commonly used for hematoma block due to its safety and efficacy. Intravenous analgesia, using drugs like ketorolac, is also effective and preferred for pain management in children, with minimal side effects compared to opioids.[11]

Various techniques, including closed reduction and stabilization with casts or surgical intervention, are employed based on fracture severity and patient factors. Acceptable alignment after closed reduction depends on age and fracture location. Overall, effective pain management and appropriate fracture management are essential for minimizing morbidity and ensuring optimal outcomes in children with limb trauma.

Objective of Study: The study aimed to assess the effectiveness of hematoma block compared to intravenous analgesia in managing acute pain associated with fractures of the forearm and shin bones in children. Additionally, it aimed to evaluate the efficacy of hematoma block and intravenous analgesia in the closed reduction of such fractures.

METHODOLOGY

Study Design: An exploratory randomized controlled trial was conducted. The RCT number of this study is ACTRN12620001138976.

Study Setting: The study took place at the Orthopedic Department of KMU-Institute of Medical Sciences (DHQ Teaching Hospital), Kohat between October 2019 and January 2020.

Inclusion Criteria: Participants aged between 7 to 14 years with simple or closed fracture patterns of the forearm or shin bone, and fracture duration of less than 24 hours were included. Additionally, parental consent and child assent were required for participation.

Exclusion Criteria: Children with any comorbid diseases, intra-articular or epiphyseal fractures, as well as undisplaced forearm and shin bone fractures not requiring manipulation, were excluded from the study. Patients with multiple fractures were also excluded.

Data collection: 124 children with simple, closed forearm or shin bone fractures, aged 7 to 14 years, were enrolled between October 2019 and January 2020 at DHQ Teaching Hospital. Patients underwent general assessment and exclusion criteria were applied. Informed consent was obtained, followed by randomization into anesthesia treatment groups. Pain assessment using VAS scale was conducted, and X-rays taken. Analgesics were administered, pain reassessed, and fracture reduction performed. Stabilization with back slab was done, followed by post-reduction X-ray. Pain assessment was repeated after 15 and 30 minutes. The assessor remained blinded.

Patients were allocated into two groups using a predetermined computer-generated number sequence. The groups were designated as Group HB for those receiving Hematoma Block and Group IVA for those receiving intravenous analgesia for fracture reduction. Upon admission, the attending medical officer assigned patients to their respective treatment groups based on the generated sequence, and this information was communicated to the orthopedic surgeon.

Pain Assessment: The Visual Analog Scale (VAS) is commonly used worldwide for pain assessment. Patients mark their pain intensity on a ten-centimeter horizontal line anchored by 0 (no pain) and 10 (extreme pain) scores. Other scales include Numeric Rating Scale (NRS) and Categorical Scale, which use numbers or words/visuals to represent pain intensity, respectively.

Patient Grouping: Hematoma Block Group: Patients received 2% xylocaine solution without adrenaline, dosed at 2.5 ml/kg weight, administered through a 22 G needle at the fracture hematoma site. Pain was assessed with VAS five minutes post-administration. Intravenous Analgesia Group: Patients received ketorolac injection (Toradol) at 0.5 ml/kg weight via an intravenous cannula. Pain assessment followed the same protocol. All patients underwent post-reduction x-rays and were placed in plaster casts.

Radiograph Assessment: Radiographic alignment was evaluated pre- and post-reduction in antero-posterior and lateral views. Acceptable reduction criteria included <10% translation, <5 degrees rotation/angulation, and <10 mm shortening. Rotation was evaluated by comparing cortices on both sides of the fractured bone.

Statistical Analysis: Data was analyzed using SPSS version 22.0. Descriptive data were compared, and ordinal/categorical data were analyzed using chi-square. Significance was determined at $P < 0.05$.

Ethical consideration: Both the child and their parents or guardian were briefed about the potential risks associated with the analgesic procedure, and consent was obtained from both parties. Approval for the study was obtained during the 79th meeting of KMU-AS&RB on September 24, 2019, under reference number DIR/KMU/EB/AS/000573. Ethical clearance was also obtained from the ethical committee of Khyber Medical University under reference number DIR/KMU-EB/EC/000.

RESULTS

A total of 128 patients aged 7 to 14 years with fractures of the forearm and shin bone were enrolled. Among them, 86% had forearm fractures and 14% had shin bone fractures. Most forearm fractures were mid-shaft (53%), followed by distal third (27%) and proximal third (3%). The majority of tibial shaft fractures were in the mid part (7%). All fractures were closed and extra-articular. Patients were evenly randomized into two groups: Hematoma block and intravenous analgesia, with no significant differences in age, gender, or fracture characteristics observed between the groups (Table 1).

Table 1: Demographics of children with fractures

	HB Group	IVA Group	P value / %
Number of children	64	64	
Mean age (years (95% C.I.))	8.6 (7.7)	9.0 (7.9)	P > 0.05
Sex distribution (M:F)	39:15	41:13	P > 0.01
Fall in the playground	34 patients	36 patients	57%
Fall from height	17 patients	14 patients	29%
Road traffic injuries	4 patients	5 patients	8%
Other injuries	5 patients	4 patients	6%

The mean age in the Hematoma Block group was 8.6 years (±1.16 y) and 9.0 years (±1.23 y) in the intravenous analgesia group ($P > 0.05$), as shown in Table 1. Fractures of the forearm had a mean age of 9.7 years, while shin bone fractures had a mean age of 11.2 years, with no significant gender difference observed ($P > 0.05$). Among 128 patients, 90 were boys and 38 were girls, with boys predominantly affected across all fracture sites. For forearm shaft fractures, boys constituted 72% and girls 28% ($P<0.001$). Most fractures occurred in the mid-shaft and were typically seen on the day of injury (84.5%). Majority of forearm and shinbone fractures, regardless of gender, were due to indirect trauma, primarily from falls while playing (64%), with some occurring due to sports-related injuries (19.3%) and road traffic accidents (7%).

Comparison of pain before closed reduction using visual analog scale showed no statistical difference between the Hematoma Block and Intravenous Analgesia groups ($P > 0.05$). The average VAS scores before reduction were 7.01 ± 1.60 for the Hematoma Block group and 6.95 ± 1.76 for the Intravenous Analgesia group.

Table 2: Location of fractures according to group

		HB Group	IVA Group
Fracture Location	Distal Third	36 (64%)	41(69%)
	Mid Shaft	16 (32%)	12 (29%)
	Proximal Third	2 (4%)	1(2%)

However, Hematoma Block demonstrated more effective pain relief after 5, 15, and 30 minutes of closed reduction, as shown in Table 2. There was a significant decrease in VAS scores

after 5 minutes (3.29 ± 0.4) and 15 minutes (2.77 ± 0.6) for Group HB compared to the scores of (5.14 ± 0.5) after 5 minutes and (4.97 ± 0.7) after 15 minutes for Group IVA. Hematoma Block group (2.25 ± 0.2) also experienced a further decrease in pain intensity after 30 minutes compared to Group IVA (3.72 ± 0.). The average VAS score before administration of Hematoma Block was 8.12, decreasing to 2.94 after 5 minutes and 2.1 after 30 minutes. In contrast, the VAS score in the Intravenous Analgesia group was 7.98 before administration, 4.63 after administration, and 4.4 after 30 minutes.

Manipulation in the form of closed reduction was done after administrations of hematoma block or intravenous analgesia. Fracture Characteristics between IVA and HB Group are shown in Table 3. X rays were evaluated for anatomical realignment before and after closed reduction maneuvers. The following findings and their means calculated. The mean values of angulation and shortening were significantly different in the pre and post reduction radiographs of hematoma block group, as compared to the IVA group ($P < 0.001$). P value was calculated by using Paired t-test.

Table 3: VAS scores before and after administration of hematoma block and intravenous analgesia

	HB Group	IVA Group	P Value
VAS before reduction	8.01 ± 1.60	7.95 ± 1.76	P > 0.05
VAS 5 min, after reduction	3.29 ± 0.4	5.14 ± 0.5	P < 0.001
VAS 15 min, after reduction	2.77 ± 0.6	4.97 ± 0.7	P < 0.001
VAS 30 min, after reduction	2.15 ± 0.2	4.42 ± 0.7	P < 0.001

Table 4: Fracture Characteristics of Radius/Ulna between HB and IVA Groups

Radius/ulna	Pre reduction (HB Group)	Post reduction (HB Group)	Pre reduction (IVA Group)	Post reduction (IVA Group)
Angulation	34°	3	32	10
Rotation	19 °	2	17	8
Shortening	7 mm	1 mm	9	5 mm
Cortical Apposition	12%	96%	16%	90%

** P < 0.001; * P < 0.01

Angulation exceeding 15º was observed in over 80% of all shaft fractures, primarily dorsally seen on lateral X-rays, with a mean value of 32º for radius and ulna upon arrival. Hematoma Block (HB) group exhibited angulation and shortening within acceptable ranges ($P < 0.001$), significantly better than the Intravenous Analgesia (IVA) group. HB showed a reduction from 34° to 3° in angulation before and after reduction, while IVA showed 32° to 10° (Table 4). Rotational deformity averaged 18° before reduction and 2° after in HB, and 17° to 5° in IVA, with no significant difference between the groups ($P > 0.05$).

Forearm fractures commonly exhibited more than 8 mm shortening, particularly in the distal third (71%), with mean shortening of 8.2 mm in HB and 7.8 mm in IVA groups. Post-reduction, HB showed 1 mm shortening while IVA showed 4 mm. Cortical apposition was less than 20% before reduction, increasing significantly post-reduction in both groups (Table 3), with HB reaching 92% and IVA 86% after reduction. Almost all fractures achieved anatomical alignment after closed reduction ($P < 0.001$), with HB demonstrating significantly better results than IVA. However, four fractures did not achieve anatomical alignment, two of which had excessive rotation and two were fractures at different levels of radius and ulna. No systemic complications from local anesthetics were noted during or after the procedure.

DISCUSSION

The study primarily focused on mid and distal shaft fractures of the forearm and shin bones, known to have higher non-union rates. Demographics revealed an average patient age of 8.4 years, with a rising trend attributed to the emergence of new collision sports, particularly affecting boys. The increase in mid-shaft forearm fractures contradicted previous studies, possibly linked to the popularity of recreational sports among boys, with implications for higher complication rates like non-union.[12]

In our hospital, intravenous analgesia is commonly used for pain management in children's fractures. Hematoma Block (HB) and Intravenous Analgesia (IVA) offer immediate pain relief, making them attractive options. This study focused on comparing HB and IVA, which required no specialized equipment, facilitating implementation in resource-limited settings. Previous studies comparing hematoma block with other analgesic techniques have highlighted its cost-effectiveness and popularity.[13] The studie's findings align with this, demonstrating the superiority of HB over general anesthesia in terms of pain relief and procedural efficiency. Unlike studies requiring longer wait times, our protocol involving a 5-minute wait before administration proved beneficial, ensuring no significant difference in pain scores between groups pre-administration. However, significant pain reduction was observed post-administration, with HB outperforming IVA in pain reduction scores.[14]

The study highlights the superior efficacy of hematoma block (HB) compared to intravenous analgesia (IVA). Unlike previous research, our protocol involved a 5-minute wait before HB administration, resulting in significant pain reduction post-procedure, with VAS scores comparable to previous studies. This prolonged analgesic effect of HB, attributed to local anesthetic retention at the fracture site, distinguishes it from IVA, where the analgesic disperses throughout circulation.[15] While IVA offers simplicity and reliability, it falls short in ensuring adequate pain relief compared to HB. The studies' findings support HB as a safe and effective analgesic method within recommended dose limits, with no observed adverse effects. Additionally, HB not only alleviates pain but also aids in closed reduction of fractures, as demonstrated in our study.

Comparable studies have shown alternative techniques like Bier block to be effective but more complex. Similarly, studies comparing HB with intravenous propofol have shown superior radiographic acceptability with HB.[16] The study reaffirms these findings, emphasizing the importance of adequate analgesia for successful closed reduction, which IVA failed to provide. In our setting, close reduction typically involves fasting for 5-6 hours and a subsequent hospital stay of 8-12 hours or overnight observation. Conversely, hematoma block allows for immediate, discomfort-free close reduction, significantly reducing patient and hospital resource burden.[17] The study highlights significant differences in post-reduction alignment acceptability favoring the hematoma block group over intravenous analgesia. Similarly, another study found both methods to be convenient for patients and families, reducing costs and freeing up medical personnel for more critical cases.[18]

No serious side effects were reported, and all children underwent successful reduction and stabilization. Radiological parameters showed successful treatment of fractures with specific angulation, rotation, shortening, and cortical opposition values using hematoma block.[19] the study provides clear guidelines for treating pediatric forearm fractures in the emergency setting using hematoma block alone. The protocol is replicable and requires no sophisticated equipment, benefiting both patients and families.[20] In resource-limited settings, hematoma block emerges as a superior choice for pediatric forearm fracture reduction. The study demonstrates comparable rates of adequate reduction and radiographic acceptability between hematoma block and intravenous analgesia groups, affirming hematoma block's efficacy.

Limitation and future Suggestions: The study's scope was restricted by time constraints, preventing inclusion of children from additional hospitals. Additionally, patients were not followed for fracture redisplacement or long-term outcomes, limiting the assessment of treatment efficacy over time. Future research could expand the study's reach to include more hospitals and extend follow-up periods to evaluate the durability of fracture reduction and long-term patient outcomes. This could provide a more

comprehensive understanding of the effectiveness of the interventions studied.

CONCLUSION

In our resource-constrained setting, hematoma block emerges as the preferred option for pain management and closed reduction of forearm fractures in children. Its routine use in emergency settings can effectively address closed fractures of the forearm and shin bone. The study establishes valuable guidelines for managing pediatric forearm fractures in emergencies using hematoma block, offering practical insights for fracture pattern reducibility.

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