Perioperative pain alleviation of forearm fractures using a combination of hematoma block and intravenous regional anesthesia with the addition of ketamine and lidocaine

Hany A. Ibraheem, Wesam N. Ali, Mohamed M. Mohamed

Department of Anesthesia and ICU, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Mohamed M. Mohamed, MBBCh,
Department of Anesthesia, Faculty of Medicine, Assiut University Hospital, Assiut 74111, Egypt.
Tel: +20 882 346 981;
Fax: 088-2332278 - 2080278.
e-mail: mamdouh372@gmail.com

Received 25 August 2019
Revised 08 September 2019
Accepted 10 October 2019
Published 16 May 2020

Journal of Current Medical Research and Practice
2020, 5:174–179

Introduction
Forearm fractures usually require reduction before fixation. Hematoma block (HB) is easy and efficient for the reduction of those fractures with instantaneous pain release. Intravenous regional anesthesia (IVRA) is proper for forearm surgeries; unfortunately, it is painful during lifting and wrapping the arm. A combination of HB and IVRA can bring the benefits of them both. We assessed the effect of adding ketamine to IVRA versus to HB in patients receiving both blocks for forearm fractures.

Patients and methods
This study was a prospective, double-blinded, randomized controlled trial, performed in Assiut University Hospital. Forty-four patients with closed forearm fractures needing closed reduction and internal fixation with k-wires were involved to receive combined HB and IVRA, with ketamine (0.5 mg/kg) either within the HB group A (n=22) or within the IVRA group B (n=22). Data collection involved the evaluation of hemodynamics, the onset of HB and IVRA, tourniquet discomfort, numerical rating scale score, first analgesia demand time, and total analgesic time.

Results
The median (range) of preoperative and intraoperative numerical rating scale scores was significantly lower in group A at the 3rd, 5th, and 10th minutes. The average time (min) with regard to first rescue analgesia was significantly higher in group A (154.5±8.169) than in group B (121.2±12.25). No significant hemodynamic changes were noticed.

Conclusion
Adding ketamine to HB in patients with forearm fractures receiving a combination of HB and IVRA can afford better analgesia throughout the conduction of IVRA and prolongs postoperative analgesia better than adding it to IVRA.

Keywords:
acute pain, hematoma block, intravenous regional anesthesia, upper limb fractures

J Curr Med Res Pract 5:174–179

2357-0121

Introduction

Forearm fractures are prevalent, and pain release is really important in those cases that usually require handling for reduction followed by surgical fixation [1].

The typical characteristics of perfect analgesia throughout the reduction are decided by its ease, safety, and budgets. However, it is difficult even financially to provide this anesthesia to this great population of trauma patients; hence, simpler techniques have been introduced such as regional nerve blocks, intravenous regional anesthesia (IVRA), hematoma block (HB) and sedation [1–3]. Among the many techniques, HB and IVRA are good choices. HB is easy to be performed and was performed successfully for the reduction of upper limb fractures in the emergency room with fast pain release, but it does not offer muscular relaxation acceptable for any surgical interference [4,5]. IVRA is simple, consistent, and cost-effective [6], but it is painful during exsanguination. The combination of HB and IVRA can effectively handle this problem thanks to the former use of the HB [1]. Many drugs have been used as an adjuvant to lidocaine for IVRA such as dexamethasone, morphine, fentanyl, ketorolac, and atracurium, etc., [7]. Ketamine is a good adjuvant with IVRA. It enhances the anesthesia quality and postoperative analgesia [8].

Ketamine has local anesthetic potentials. In addition to spinal cord NMDA receptors, scientists recently found that peripheral unmyelinated sensory nerve fibers have NMDA receptors. This clarifies why ketamine decreases the tourniquet pain when used with IVRA [9].

In our study, we aimed to assess the effect of adding ketamine to IVRA versus adding it to HB, in patients

receiving a combination of HB and IVRA for the anesthetic management of forearm fractures.

Patients and methods

Type of the study

This study was a prospective, double-blinded, randomized controlled trial.

Study setting

This study was carried out at the Orthopedic Trauma Unit of Assiut University.

Study approval

The study protocol and patient consent have been accepted by the local ethics committee, Faculty of Medicine, Assiut University.

Clinical trials registration ID: NCT03377907.

Study participants

(1) Sample size calculation:
   (a) A sample size of 18 patients for each group was required to spot a minimal effective difference of 30 min for first analgesic request time among the two studied groups. Considering an alpha error of 0.05, this yielded a power of the study of 95%.
   (b) Four (22%) patients were added to each group to compensate for the violation of the study protocol.
   (c) Intention to treat analysis was used.

(2) Inclusion criteria:
   (a) All patients aged more than 18 years.
   (b) American Society of Anesthesiologists I or II.
   (c) Patients with a closed fracture of the distal radius within 1 week, planned for closed reduction and internal fixation (CRIF) with k-wires.
   (d) Patients arranged for surgery anticipated to be less than one and a half hours.

(3) Exclusion criteria:
   (a) Patients with ischemic heart disease.
   (b) Infected fracture.
   (c) Inherited blood or bleeding disorders.
   (d) Known allergy to any drug in the study.

(4) Consent:
   (a) We obtained written informed consent from all patients before enrollment.

(5) Allocation:
   (a) Patients were allocated (according to computer-generated randomization table) to receive combined HB and IVRA with ketamine (0.5 mg/kg) either within the HB Group A (n = 22) or within the IVRA group B (n = 22) by using opaque closed envelopes.
   (b) Masking of grouping involved the patient and the outcome-assessing physician.

Procedure

Preoperative evaluation (history, examination, and relevant investigations) was carried out. Before the surgery, we clarified the procedure and the numerical rating scale (NRS) to the patients.

We asked the patient to make three pain scores on a scale of 0 (no pain) to 10 (worst pain conceivable) over the previous day. The average of the three scores was used to denote the preoperative pain score.

After assuring fasting status, the basic anesthesia monitoring (pulse oximeter, ECG, noninvasive blood pressure) was attached, and the intravenous line was inserted; thereafter, midazolam 2:3 mg intravenous was given.

In this trial, we first performed HB at the fracture site by clinical palpation and radiograph guidance. A 5 ml syringe was used to localize the fracture hematoma. Passive reflux of darkish blood in the syringe after positive aspiration of blood from the fracture site was performed to approve accurate needle location. Afterwards, the drug was slowly injected while monitoring the consciousness level and the ECG. Lidocaine 1% was used in the dosage of 10 ml (plus 0.5 mg/kg ketamine for group A). Pain was evaluated by the NRS score by questioning the patient until the NRS score reached 3, and again at 5 min, at 10 min and then during elevation and wrapping of the limb. Onset of HB was the time for the NRS score to reduce to 3, and the block was considered failed if the score was above 4 for more than 5 min duration.

Only when HB analgesia was confirmed, IVRA could be performed. We placed a double tourniquet in the upper arm above the elbow. Thereafter, we inserted a 22 G intravenous cannula distal to the fracture site. Then we elevated and wrapped the limb using pressure bandage starting from the distal part of the upper limb and then spirally toward the proximal part, and 2: 3 min were permitted for exsanguination of the arm. Thereafter, we inflated the proximal cuff to a 100 mmHg pressure higher than the patient's systolic blood pressure, and we confirmed that by palpating the tourniquet and absence

of radial artery pulsation. Lidocaine 2% was used in the dose 2.5 mg/kg diluted with saline to a whole volume of 40 ml (plus 0.5 mg/kg ketamine for group B) [9], which was injected gradually into the exsanguinated upper limb. Successful IVRA was determined if the patient had lost pinprick sensation, and its time was recorded; thereafter, the surgeon could start the surgery. After 15: 20 min of proximal cuff inflation, we inflated the same pressure to the distal cuff, and the proximal cuff was gradually deflated. Throughout the surgery, we classified the quality of surgical anesthesia according to the conditions shown in Table 1.

There were also regular recordings of heart rate, arterial oxygen saturation, mean arterial blood pressure, NRS score, tourniquet discomfort, and surgery duration. We were vigilant to notice any signs of local anesthetic toxicity, such as perioral numbness, tinnitus, blurring of vision, arrhythmia, convulsions, and coma, especially during tourniquet deflation.

Postoperative pain was recorded using the time of first request of analgesia (30 mg ketorolac intravenous) and total analgesic time.

Statistical analysis

Data were analyzed using the SPSS program (Statistical analysis was done using the computer program IBM, SPSS, Statistical Package for Social Sciences, Version 23, 2016 Egypt). The data were tested for normality using the Kolmogorov–Smirnov test and for homogeneity variances before further statistical analysis. Data were represented as mean ± SD, median (range), and number (%), as appropriate; we used the independent *t* test to compare means between parametric data, Mann–Whitney to compare nonparametric values in the studied groups, and χ^2 test for categorical data. *P* value less than 0.05 was considered statistically significant.

Results

From April 2017 to July 2018, 60 patients were screened for participation in this study. After revising the inclusion and exclusion criteria, 44 patients were assigned and divided randomly (using a computer-generated random table) into one of the two studied groups.

(1) Demographic characteristics such as age, weight, sex, and American Society of Anesthesiologists are shown in Table 2. No significant difference was found between groups with regard to these characteristics ($P > 0.05$).
(2) Surgical data (Table 3):

Table 1 Quality of surgical anesthesia

Category	Description
Category I	No pain of incision, tourniquet or positioning at any time during surgery (NRS=0)
Category II	Experienced mild pain of tourniquet or positioning but not of incision at any time during surgery (NRS=1-2)
Category III	Experienced mild to moderate pain of surgery or experienced discomfort or pain of positioning or tourniquet at any time during surgery (NRS=3-4)
Category IV	No pain relief. Patient required additional/ supplemental anesthesia in the form of sedation or GA/DA (NRS ≥ 5)

NRS, numerical rating scale.

Table 2 Patients' data

Variables	Group A	Group B	*P*
Age (years)	36.82±13.57	39.04±13.513	0.588
Weight (kg)	79±11.079	79.59±10.563	0.857
Sex			
Female	10 (45.5)	9 (40.9)	0.761
Male	12 (54.5)	13 (59.1)	
ASA classification			
I	19 (86.4)	17 (77.3)	0.698
II	3 (13.6)	5 (22.7)	

Data presented as mean±SD and *n* (%). ASA, American Society of Anesthesiologists.

Table 3 Surgical data

Variables	Group A	Group B	*P*
Duration of surgery (min)	44.68±12.39	47.27±11.39	0.474
Onset of HB (min)	1.022±0.499	1.068±0.355	0.729
Loss of pinprick sensation (min)	5.863±1.903	6.386±1.675	0.339
Tourniquet pain			
No	18 (81.8)	20 (90.9)	0.664
Yes	4 (18.2)	2 (9.1)	
Quality of surgical anesthesia			
I	19 (86.4)	16 (72.7)	0.4565
II	3 (13.6)	6 (27.3)	

Data presented as mean±SD and *n* (%). HB, hematoma block.

(a) With regard to the mean duration of surgery, meantime for onset of HB and the meantime for the onset of IVRA (guided by the time of loss of pinprick sensation), there was no statistically significant difference between both groups (Fig. 1).
(b) Four patients experienced tourniquet pain in group A, and only two patients in group B experienced tourniquet pain.
(c) An overall 79.5% (35) of the patients were in category I, which implies an NRS score of 0 and no tourniquet discomfort during the surgery. Only 20.5%[9] suffered from mild pain NRS of 1: 2 during surgery. None of the patients had a field in category III or IV, and no one required general anesthesia.
(d) The median (range) of preoperative and intraoperative NRS score in 40 min is shown in Table 4. It was significantly lower in group A

Table 4 Intraoperative numerical rating scale score

NRS score	Group A	Group B	*P*
Preoperative	7 (5-9)	7 (5-9)	0.9
3 (min)	1 (0-3)	2 (0-3)	0.03
5 (min)	1 (0-3)	1 (0-3)	0.011
10 (min)	0 (0-2)	0 (0-2)	0.023
20 (min)	0 (0-1)	0 (0-2)	0.62
30 (min)	0 (0-0)	0 (0-1)	0.31
40 (min)	0 (0-0)	0 (0-2)	0.58

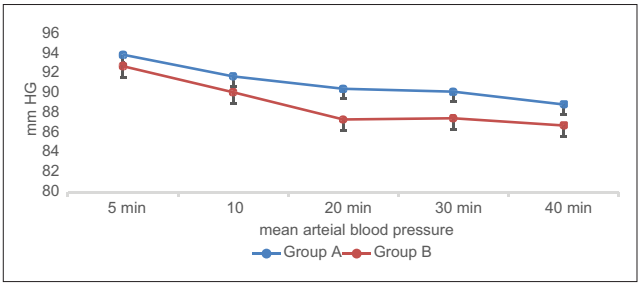
Data are presented as median (range). NRS, numerical rating scale $P<0.05$ is considered statistically significant.

at 3, 5, and 10 min (time of conduction of biers block and allowing it to act), and then, after 10 min, there were no statistically significant differences between the two groups.

All the patients were hemodynamically stable (Figs. 1–3) with no statistically significant differences between the two groups and no one experienced drug toxicity.

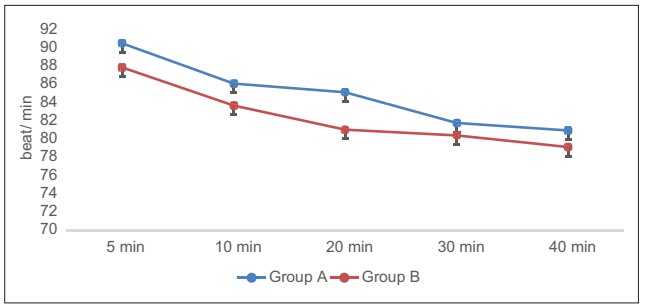
In the postoperative phase, the average time for first rescue analgesia and the total analgesic time were significantly higher in group A than in group B (Fig. 4).

Figure 1



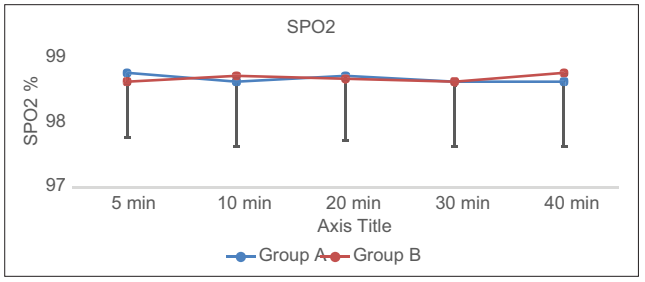
Intraoperative MAPB (mean arterial blood pressure).

Figure 2



Intraoperative heart rate.

Figure 3



Intraoperative SpO_2.

Discussion

IVRA is effectively used as a sole technique for distal extremity fractures with good results. However, it is painful for the patient when the recent fracture is handled, especially during exsanguination to conduct IVRA. Insufficient exsanguination leads to bad quality of block [3]. HB offers fast pain relief for closed reduction of arm fractures in the ER and is described to be safer, faster, less costly and results in a shorter hospital stay than when general anesthesia is administered [10], but it does not deliver muscular relaxation and is inadequate for any surgical maneuver [4,11].

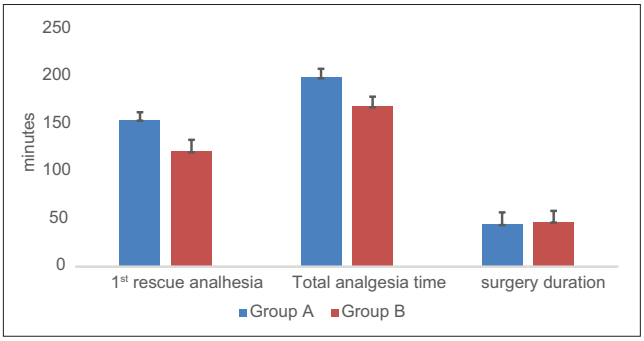
Despite the fact that the literature shows many studies revealing the advantages of IVRA and HB techniques distinctly, to our knowledge, there is no remark of a combination of the two blocks for treating forearm fractures, except for a study by Verma and colleagues. This study showed that the combination of the HB and IVRA can effectively ease the painful wrapping and elevation of the limb during the performance of IVRA (thanks to the preceding HB analgesia). Postoperative analgesia was also significantly better with CRIF and was nearly absent with open reduction with internal fixation; they explained this by mentioning that, during CRIF, the fracture hematoma is not bothered and the local anesthetic is still confined within it, in contrast to open reduction with internal fixation in which the fracture hematoma is cleared by the surgeon. Their study showed clearly that the combination is very safe and efficient [1].

In our research, we have used a combination of HB (10 ml of 1% lidocaine) and IVRA using lidocaine 2.5 mg/kg in a volume of 40 ml and compared the effects of adding ketamine (0.5 mg/kg) to HB (group A) versus adding it to IVRA (group B) for patients who required CRIF for forearm fractures.

We found that there was no significant difference between both groups with regard to the onset of HB, the onset of IVRA, or with regard to tourniquet pain.

The median (range) of NRS score was significantly lower in group A at 3, 5, and 10 min (time of conduction of biers); hence, the wrapping was less painful with ketamine in HB.

Figure 4



First analgesic request time and total analgesic time.

The average time for first rescue analgesia was significantly higher in group A than in group B, thus implying that the postoperative analgesia is superior with ketamine in HB.

The familiar hemodynamic properties of ketamine (tachycardia and elevation of blood pressure) and central nervous system symptoms (e.g. hallucinations) failed to arise in our study when ketamine was injected as an adjuvant within HB and IVRA; this might have occurred because we did not deflate the tourniquet before 40 min and because the hematoma of the fracture acts as an isolated compartment [12].

This is the first clinical study comparing the addition of ketamine to lidocaine within HB or IVRA for patients getting both blocks for treating forearm fractures.

The study carried out by Kumar and colleagues determined that adding 1 mcg/kg dexmedetomidine or 0.5 mg/kg ketamine to lidocaine for biers block enhances analgesia with no complications. They mentioned that ketamine hastened the biers block onset time, delayed tourniquet discomfort onset, and decreased postoperative analgesic consumption with better patient satisfaction than dexmedetomidine or placebo [8].

Another study submitted by Elmetwaly *et al.*[9] presented that, when glyceryl trinitrate or ketamine was used as an adjuvant with local anesthetic in biers block, ketamine reduced tourniquet pain and enhanced the postoperative analgesia.

The study carried out by Yossef *et al.*[13] showed that the addition of magnesium, nitroglycerin and ketamine local anesthesia in IVRA enhanced the analgesia and anesthesia qualities, reduced tourniquet discomfort, augmented first analgesia demand time, and declined postoperative pain, with no complications.

A study by Shaik *et al.*[14] showed that butorphanol hastens the onset of HB when used with lignocaine, offers a very good postinterventional analgesia and reduces 24-h total analgesic consumption with no unnecessary sedation.

The Ross *et al.*[15] study showed that the HB provided a similar quality of analgesia to conscious sedation for treatment of dislocated ankle fractures with superior safety.

Fathi *et al.*[16] also mentioned that ultrasound-guided HB could reduce the manipulation pain for distal radius fractures as successfully as procedural sedation or analgesia, and provide early manipulation and decreased hospital stay.

Limitation

We only observed the patients for 4 h in the postoperative phase. We recommend studying the implication of the combined technique upon the incidence of chronic pain.

Conclusion

Adding ketamine to HB in patients receiving a combination of HB and IVRA for anesthetic treatment of forearm fracture can provide better analgesia for the conduction of IVRA and can prolong postoperative analgesia better than adding it to IVRA.

Acknowledgements

This study was carried out using local institutional facilities.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1 Verma RN, Hasnain S, Sreevastava DK, Murthy TVSP. Anaesthetic management of forearm fractures using a combination of haematoma block and intravenous regional anaesthesia. Med J Armed Forces India 2016; 72:247–252.

2 Nursing AD-A and E, 2000 Undefined. The advantages and disadvantages of Bier's blocks and haematoma blocks for Elsevier. Available at: www.sciencedirect.com/science/article/pii/S096523020090170X. [Accessed December 22, 2018].

3 Rodola F, Vagnoni S. Medical SI-E review for, 2003 undefined. An update on intravenous regional anaesthesia of the arm. Available at: www.europeanreview.org/wp/wp-content/uploads/91.pdf. [cited 2018 December 22, 2018].

4 Afsar S, Idrees M. Medical MG-GJ of, 2014 undefined. Pain lowering effect of hematoma block for close reduction of distal radius fractures. Available at: http://search.ebscohost.com/login.aspx?direct=true& profile=ehost&scope=site&authtype=crawler&jrnl=18197973&AN=96259533&h=04RBi6k6%2BYJ2iL7ciN8hcZS%2BjwtWnCkrAX66V%2F2VEX0FruNvGFrsAPv

VOouUojviQ5eJUYCxcUnRTwFt%2Ba01Wg%3D%3D &crl=c. [Accessed December 22, 2018].

5 Erika Constantine DSTJTMCPEJGLDWS. Evaluating the hematoma block as an adjunct to procedural sedation for closed reduction of distal forearm fractures. Pediatr Emerg Care 2014; 30:474–478.

6 Vaughn N, Rajan N, Darowish M. Intravenous regional anesthesia using a forearm tourniquet: a safe and effective technique for outpatient hand procedures. Hand 2018;21: 155894471881219.

7 Choyce A, Peng P. A systematic review of adjuncts for intravenous regional anesthesia for surgical procedures. Can J Anesth Can Anesth 2002; 49:32–45.

8 Kumar A, Sharma D, Datta B. Addition of ketamine or dexmedetomidine to lignocaine in intravenous regional anesthesia: a randomized controlled study. J Anaesthesiol Clin Pharmacol 2012; 28:501.

9 Elmetwaly K, Hegazy N, Anaesthesia AA. Does the use of ketamine or nitroglycerin as an adjuvant to lidocaine improve the quality of intravenous regional anesthesia?. 2010. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2945515/. [Accessed December 22, 2018].

10 Brian J. Intra-articular block compared with conscious sedation for closed reduction of ankle fracture-dislocations: a prospective randomized trial. J Bone Joint Surg Am 2008; 90:731–734.

11 Ogunlade S, Omololu A, Alonge T, Salawu S, Bamgboye E. Haematoma block in reduction of distal radial fractures. West Afr J Med 2004; 21:282–285.

12 Kolar P, Schmidt-Bleek K, Schell H, Gaber T, Toben D, Schmidmaier G, *et al*. The early fracture hematoma and its potential role in fracture healing. Tissue Eng Part B Rev 2010; 16:427–434.

13 Yossef IA, Mohamed AZE, Mohamed GF. Different adjuvants to lidocaine in bier's block; comparison between ketamine, nitroglycerin, and magnesium. Egypt J Anaesth 2017; 33:315–321.

14 Shaik NA, Rao SS, Chiruvella S, Rao MS, Reddy SV. Effectiveness of butorphanol as an adjuvant to lidocaine for haematoma or periosteal block: a prospective, randomised, double blind study. Indian J Anaesth 2013; 57:150–155.

15 Ross A, Catanzariti AR, Mendicino RW. The hematoma block: a simple, effective technique for closed reduction of ankle fracture dislocations. J Foot Ankle Surg 2011; 50:507–509.

16 Fathi M, Moezzi M, Abbasi S, Farsi D, Zare MA, Hafezimoghadam P. Ultrasound-guided hematoma block in distal radial fracture reduction: a randomised clinical trial. Emerg Med J 2015; 32:474–477.