Section A -Research paper

Ketamine versus Dexamethasone as an adjuvant to lidocaine in intravenous regional anaesthesia for below elbow surgeries

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Abstract:

Background: Intravenous regional anaesthesia (IVRA) is safe, technically simple but it has several disadvantages as limited duration, tourniquet pain and lack of post-operative analgesia.

Objective: This study was carried out to evaluate the effect of adding ketamine versus dexamethasone to lidocaine on the characters of IVRA.

Methods: This randomized double-blind controlled study was carried out on 75 patients scheduled for elective below elbow surgeries under IVRA. They were randomly allocated into three equal groups: Lidocaine group (L group) that received 3mg/kg lidocaine, Lidocaine/Ketamine group (L/K group) that received 3mg/kg lidocaine plus 0.1mg/kg ketamine and Lidocaine/Dexamethasone (L/D group) that received 3mg/kg lidocaine plus 8 mg dexamethasone.

The primary outcomes were the characters of IVRA (onset, potency, tourniquet tolerance time and recovery time) and secondary outcomes were the hemodynamics (heart rate, mean arterial blood pressure and peripheral oxygen saturation) changes and the rate of the associated side effects.

Results: Each of ketamine and dexamethasone produced a significant improvement of the characters of IVRA (i.e. enhanced onsets of both sensory and motor blocks, increased intra-operative analgesic potency, prolonged tourniquet tolerance time, and prolonged postoperative analgesia after release of tourniquet), non- significant hemodynamic changes beside absence of the associated side effects with superiority of ketamine over dexamethasone in enhancing the block onset, increasing block potency and in prolonging tourniquet tolerance time.

Conclusion: Addition of each of ketamine and dexamethasone to lidocaine was safe and improved the characters of intravenous regional anesthesia, without associated side effects; however ketamine was superior to dexamethasone.

Keywords: Dexamethasone; Intravenous regional anaesthesia; Ketamine; Lidocaine; Tourniquet pain

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Introduction:

Intravenous regional anesthesia (IVRA), or Biers block is an effective anesthetic technique used for short surgical procedures upon the extremities. It is simple, reliable and cost-effective, with success rates between 94% and 100% **(1).**

Lidocaine is the local anesthetic agent widely used for IVRA and is the only anesthetic approved by the FDA for intravenous regional (2).

The disadvantages of IVRA are systemic LA toxicity, slow block onset, poor muscle relaxation, tourniquet pain and short postoperative pain relief **(3,5).**

In attempt to improve intra and postoperative characters of the IVRA, many adjuvant are used as opioids, tramadol, ketamine, nonsteroidal anti-inflammatory drugs, dexamethasone,

midazolam, dexmedetomidine and nitroglycerine, magnesium, sodium bicarbonate, potassium, gabapentin pretreatment **(6,8).**

The aim of the current study was to evaluate the effect of adding of each of ketamine and dexamethasone as adjuvant to lidocaine on the characters of the produced IVRA for elective minor below elbow surgeries.

Patients and methods:

This prospective randomized double-blind controlled clinical study was carried out at Zagazig University Hospitals from December 2022 to May 2023 after obtaining approval of Institutional Review Board (IRB# 9679-1-7-2022) and informed consent from the patients. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

This study included seventy five adult both sex patients undergoing minor elective below elbow surgeries. *The inclusion criteria* were patients of the American Society of Anesthesiologists (ASA) physical Status class I and II, aged between 21 to 64 years old and their body weight ranged from 65-85Kg, scheduled for minor elective below elbow surgeries (i.e. surgeries that did not need more than 60 min.). *The exclusion criteria* were patient refusal, uncooperative patients, difficult vein, infection at the needle insertion site, crush injury, sickle cell disease, allergic reaction to the tested drugs, peripheral vascular and neurological diseases, myasthenia gravis, coagulopathy, hepatic and renal diseases beside pregnancy, cardiac conduction abnormalities and operations that need more than one hour.

All patients were visited at the night of operation for clinical evaluation, explaining IVRA technique and to recording the base lines of heart rate (HR), mean arterial blood pressure (MABP), respiratory rate (RR), and peripheral arterial oxygen saturation (SpO_2). No premedication was prescribed.

In operating room, for all study participants, a suitable size sphygmomanometer cuff was applied around the arm of non operated upon limb, electrocardiogram (ECG) leads were fixed to the chest of patient, and pulse oximeter probe was applied to one of the big toes for continuous monitoring of HR, rhythm, MABP, RR and SpO_2.

In the upper limb to be operated upon, iv cannula was inserted into the most peripheral vein, then a pre-checked double-cuffed pneumatic tourniquet was applied to a well padded proximal third of the arm and exsanguinations of this limb was achieved by application of Esmarch bandage on the above heart raised limb. Immediately and after applying of Esmarch bandage, the proximal cuff of the pre-applied double cuff pneumatic tourniquet was inflated to a pressure of 100 mmHg above the initial systolic pressure. After securing pneumatic tourniquet, Esmarch bandage was removed and the limb was lowered and checked for colour (pale colour) and arterial occlusion (absence of radial pulse) to be sure of the efficacy of the applied pneumatic tourniquet. After that, the local anaesthetic mixture was slowly injected. When sensory block reached to the level of middle third of the arm, the distal cuff of pneumatic tourniquet was inflated to a pressure of 100 mmHg above the initial systolic pressure. Then, the proximal one was deflated.

The study participants were randomized using a computer-generated random numbers table into three equal groups. These three groups were Lidocaine group (L or control group) which received 3mg/kg preservative-free lidocaine, Lidocaine/Ketamine group (L/K group) which received 3mg/kg preservative-free lidocaine plus 0.1mg/kg of Ketamine and Lidocaine/Dexamethasone group (L/D group) which received 3mg/kg preservative-free lidocaine plus 8 mg of Dexamethasone.

The volume of the lidocaine with or without adjuvant increased to 40ml by normal saline and the local anesthetic mixture was injected over 60 seconds in the three groups.

In this study, the following parameters were recorded:

I. The primary outcomes (characters of IVRA):

1. Onset time of sensory and motor block:

Onset time of sensory and motor block was calculated per minutes from the moment of local anaesthetic mixture administration to the moment of loss of pin prick sensation at the middle third of the arm for the first and to to the moment at which the patient was unable to flex his fingers, wrist, and elbow joints for the later.

2. Intra-operative analgesic potency:

It was evaluated by assessing intra-operative surgical pain intensity, the total amount of supplemental systemic fentanyl which was needed to relief surgical pain and Tourniquet tolerance time.

Intra-operative surgical pain intensity score was evaluated by Visual Analogue Scale (VAS) and it was estimated at skin incision, every 5 minutes during the operation, and at skin closure. The mean of all these score values were detected in each group. Tourniquet tolerance time was the time from the moment of tourniquet inflation to the moment at which tourniquet pain intensity score according to VAS became above 3. Intraoperative surgical pain intensity score above 3 according to VAS was releaved by intravenous administration of 50 mcg fentanyl. Tourniquet pain intensity score above 3 according to VAS was relieved by alternating inflation and deflation of tourniquet cuffs.

3. Recovery time of each of sensory and motor block after tourniquet deflation:

These are the time from the moment of deflation of tourniquet till the moment of return of pin prick sensation of the limb for the first and till the moment at which the patient can flex his fingers, wrist, and elbow joints for the later. These were assessed every 2 minutes.

4. The time to ask for post operative analgesia:

It was the time in minutes from the moment of tourniquet deflation to patient reporting pain intensity above 3 according to VAS and the amount of systemic diclofenac sodium that was needed to alleviate postoperative pain from the moment of deflation of tourniquet till the end of the first 24 hours postoperatively. Post-operative pain intensity was assested every 15 minutes. Diclofenac sodium (75 mg im every 8 hours) was given to relieve postoperative pain. The total consumed amount of diclofenac sodium for relieving pain in the 1st 24 hours postoperatively was also recorded.

II. Secondary outcomes:

These are the following:

1. Haemodynamic changes:

Mean HR (beat per minute) and MAP (mmHg) and peripheral oxygen saturation (SpO_2) were detected and recorded immediately before operation (base line), then at 2, 5 and 15 and 30 minutes after Tourniquet deflation.Bradycardia was considered when the decrease in HR becomes more than 30% of basal reading and hypotension was considered when the decrease in MAP becomes more than 30% of basal reading **(9).** Ephedrine (0.02 mg/kg/iv) and atropine (0.0 mg/kg/iv) were given for treatment of hypotension and bradycardia respectively. Hypoxemia was considered when the peripheral oxygen saturation (SpO_2) becomes < 92% (on room air) for 30 seconds or more.

3. The incidences of the various associated side effects:

The associated side effects as systemic local anaesthetic toxicity, bradycardia, hypotension**,** hypoxemia and sedation. Sedation level was assessed by means of six points Ramsay agitation/sedation scale that is presented in **Table 1 (10).** Sedation was considered when sedation score becomes > 2 according to Ramsay agitation/sedation scale intra or postoperatively**(9).** Bradycardia was treated with IV atropine (0.5 mg). Hypotension was treated with IV ephedrine (5 to 10mg bolus). Hypoxemia was corrected with O_2 supplementation via a face mask till return back of SpO_2 to the normal level on room air.

Table (1): Ramsay agitation/sedation scale (10).

Response to stimuli	**Sedation score**
Patient anxious or agitated or both	**1**
Patient cooperative, oriented and tranquil.	**2**
Patient respond to commands.	**3**
A brisk response to light glabellar tap.	**4**
A sluggish response to light glabellar tap.	**5**
No response to stimulus.	**6**

At the end of the operation, the tourniquet deflation was performed in cycles with deflation/inflation times of less than 10 seconds until the patient no longer showed signs of systemic local anaesthetic toxicity (e.g. tingling of the lips, tinnitus, or drowsiness). Following tourniquet release after end of surgery, the patient was monitored closely for about 30 min.

Tourniquet deflation will be never done before passing 30 minutes after local anaesthetic mixture injection even if the operation had been finished before lapsing that time.

The tourniquet was not deflated before 30 minutes and was not inflated for more than 1.5h.

One hour after tourniquet deflation postoperatively, all patients will be discharged to ward.

Sample size calculation:

The sample size was calculated using Open Epi program. On the basis of **Elmetwaly study (11),** the sensory block onset times was 4.4 ± 1.2 min in Lidocaine/ketamine group and 6.5 ± 1.1 min in Lidocaine (Control) group. At 80 % power and 95% CI, the estimated sample size will be 75 cases, 25 in each group**.**

Statistical analysis:

The data will be analyzed by using SPSS software program. The Values were presented as mean or median and standard deviation. Quantitative data were statistically analyzed by Student t-test.

Ratios and % data were statistically analyzed by Chi-square test. In all tests, P values below 0.05 were considered statistically significant.

Results:

Patients demographic data (age, sex, height, and weight and ASA physical status classes), duration of surgery, tourniquet time and distribution of the various types of surgeries of the three studied groups were statistically comparable **(Table 2).**

Table (2): Patients' demographic data, duration of surgery, tourniquet time and the various types of surgeries in the three studied groups.

	L group (n=25)	**L/K group (n=25)**	**L/D group (n=25)**	**Tests**	
				f/X^2	**P-value**
Age (years).	**34.12 ± 10.16**	**34.04 ± 9.55**	**35.72 ± 9.76**	**0.233**	**0.793 NS**
Weight (kg).	**74.83 ± 4.13**	**76.48 ± 6.29**	**75.65 ± 3.67**	**1.960**	**0.148 NS**
Height (cm).	**173.36 ± 5.16**	**174.32 ±6.11**	**173.8 ± 5.57**	**1.590**	**0.211 NS**
BMI (Kg/m^2)	**23.47 ± 2.92**	**24.5 ± 3.42**	**23.38 ± 2.72**	**1.042**	**0.358 NS**
Sex ratio (Male/Female ratio).	**18:7**	**19:6**	**17:8**	**4.097**	**0.129 NS**
ASA ps classes (Class I/II ratio).	**21: 4**	**20:5**	**19:6**	**0.397**	**0.820 NS**
Duration of surgery (min.).	**45.50 ± 6.52**	**44.22 ± 6.28**	**43.3 5 ± 6.28**	**0.372**	**0.690 NS**
Tourniquet time (min).	**52.60 ± 7.63**	**51.32 ± 7.72**	**53. 34 ± 7.55**	**0.888**	**0.416 NS**
Distribution of the various types of surgeries [N (%)]:					
-Carpal tunnel release.	**3 (12.0%)**	**4 (16.0%)**	**2 (08.0%)**	**3.302**	**0.993 NS**
- Ganglion excision.	**3 (12.0%)**	**2 (08.0%)**	**3 (12.0%)**		
- Fracture fixation.	**5 (20.0%)**	**6 (24.0%)**	**4 (16.0%)**		
- Tendon repair.	**5 (20.0%)**	**3 (12.0%)**	**4 (16.0%)**		
-Foreign body removal.	**3 (12.0%)**	**5 (20.0%)**	**6 (24.0%)**		
- Plate and screw removal.	**4 (16.0%)**	**3 (12.0%)**	**3 (12.0%)**		
- Tendon lengthening.	**2 (08.0%)**	**2 (08.0%)**	**3 (12.0%)**		

Data were expressed as Mean ± Standard Deviation (SD) or numbers (%).
n =Group number. N= Number of each surgery type.
L group = Lidocaine group. L/K group =Lidocaine/Ketamine group.
L/D group =Lidocaine/Dexamethasone group.
ASA ps class =American Society of Anesthesiology physical status class.
f = one way ANOVA test. P>0.05 = non-significant difference (NS).

The onset of both sensory and motor block of IVRA was statistically highly significant faster (P<0.001) in L/K and L/D groups than in L group, and in L/K group than in L/D group. The mean of intra-operative VAS score was statistically highly significant lower (P<0.001) in both **L/K** and **L/D groups** than in **L group** and in **L/K group** than in **L/D group**. The total fentanyl consumptions (µg/patient) was statistically highly significant less in **both L/K and L/D groups** than in **L group** and in **L/K group** than **in L/D group**. Tourniquet tolerance time was statistically significantly longer in **both L/K and L/D groups** than in **L group** and in **L/K group** than in **L/D group.** Both sensory and motor block recovery times after tourniquet deflation were statistically highly significant longer in **L/K and L/D groups** than in **L group** (P<0.001), and in **L/K group** it was statistically comparable **(P>0.05)** with that in **L/D group** (**Error! Reference source not found.**).

Table (3): The characters of the produced anaesthesia in the three studied groups.

Variables	L group (n=25)	L/K group (n=25)	L/D group (n=25)	L group vs L/K group	L group vs L/D group	L/K group vs L/D group
Onset of sensory block (min).	6.54 ± 1.14	4.74±1.81*	5.56±0.90	P<0.001	P<0.001	P<0.001
Onset of motor block (min).	10.63±2.40	6.53±1.85*	7.37±1.45	P<0.001	P<0.001	P<0.001
The mean of intra-operative VAS scores.	2.61±0.84	0.79±0.25*	1.24± 0.15	P<0.001	P<0.001	P<0.001
The mean of intra-operative fentanyl consumptions (µg/patient).	77.2±5.32	24.5±3.5*	41.24± 4.1	P<0.001	P<0.001	P<0.001
Tourniquet tolerance time (min).	12.32±2.1	29.36±2.1*	21.36±2.1	P<0.001	P<0.001	P<0.001
Sensory recovery time after tourniquet deflation (min).	5.35±0. 45	7. 9 ±1.34*	7.55±1.25	P<0.001	P<0.001	P>0.429
Motor recovery time after tourniquet deflation (min).	6.7 5± 1.15	8.52±1.14*	8..3 4±0.24	P<0.001	P<0.001	P> 0.156
Time to ask for the 1st post- operative analgesia (min).	50.36 ± 5.36	71.25 ± 6.32 *	70.32 ±5.36	P<0.001	P<0.001	P>0.577
The consumed amount of Diclofenac Na^+ during the 1st 24 hrs post-operatively (mg/patient).	180.25 ± 55.36	88.6 ± 10.25*	90.36 ±9.58	P <0.001	P<0.001	P>0.533

Data were expressed as Mean ± Standard Deviation (SD) or numbers (%).
n =Group number. N= Number of each surgery type. L group = Lidocaine group. L/K group =Lidocaine/Ketamine group. L/D group =Lidocaine/Dexamethasone group.
P< 0.001 = significant difference. P>0.05 = non-significant difference.

The corresponding values of heart rate **(**Error! Reference source not found.**),** mean arterial pressure **(**Error! Reference source not found.**)** and SpO_2 **(Fig. 3**) in the three studied groups were comparable.

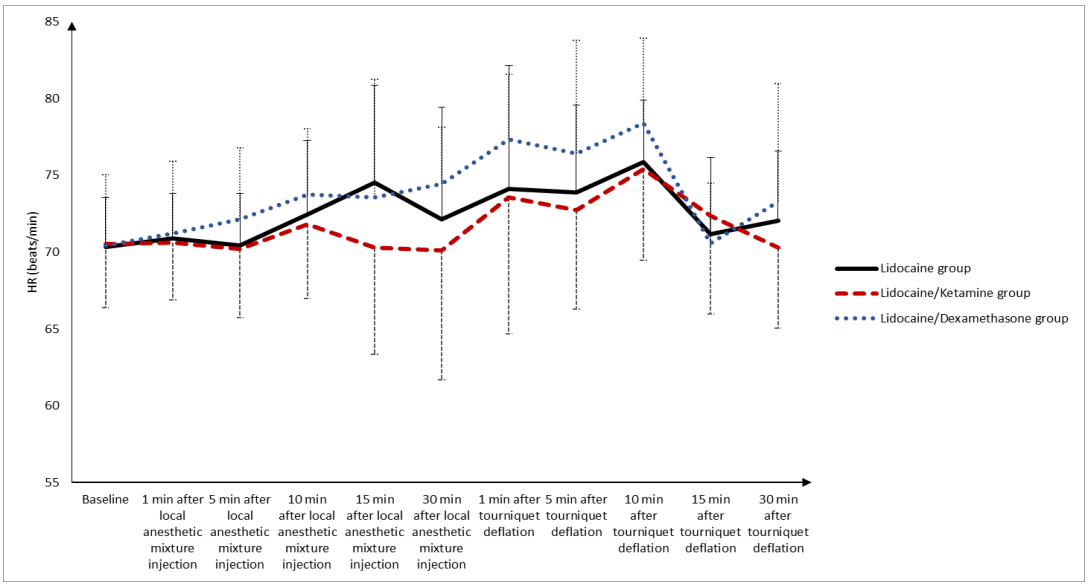

Figure (1): The mean heart rate (beats per minute) at various times of measurements in the three studied groups.

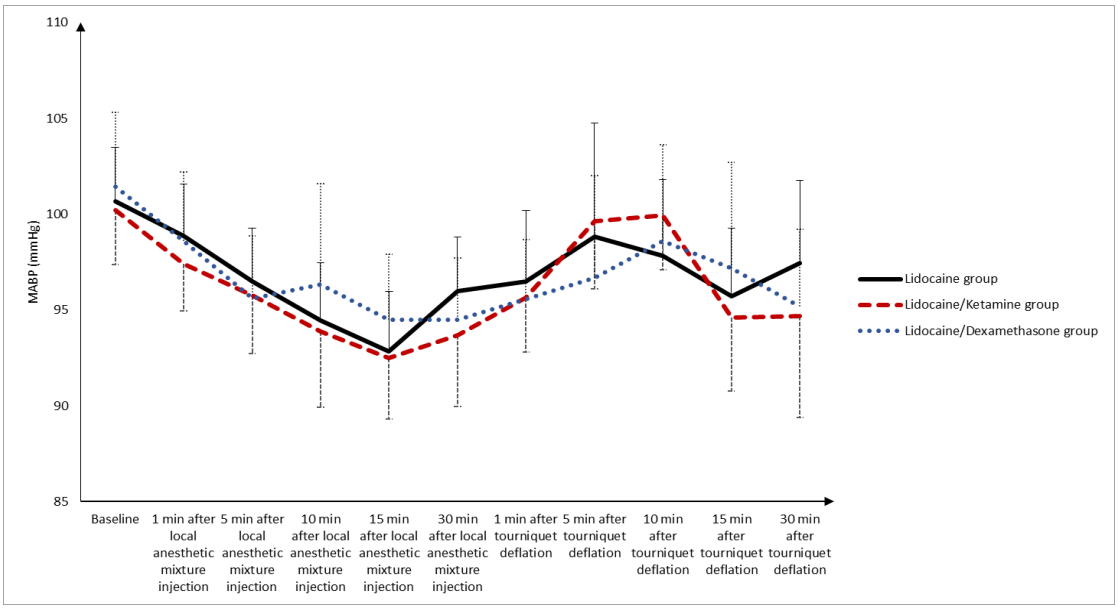

Figure (2): The mean arterial blood pressure (mmHg) at various times of measurements in the three studied groups.

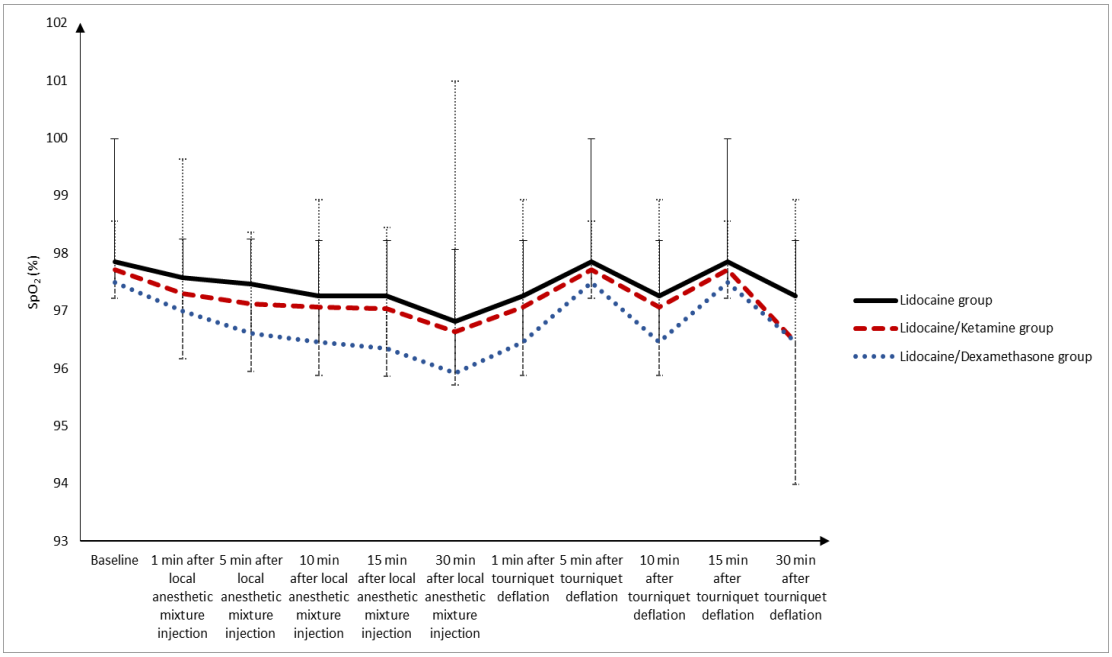

Figure (3): The peripheral oxygen saturation (SpO_2) at various times of measurements in the three studied groups.

The associated side effects in **L group** were bradycardia (4%) and hypotension (4%), hoverer no associated side effects were detected in **L/K and L/D groups.** The incidences of the occurred side effects in **L group** were statistically significant higher than in the other 2 groups.

Discussion

The present study was carried out to evaluate the effect of adding 0.1 mg/kg ketamine versus 8 mg dexamethasone to 3mg/kg lidocaine on the characters of the produced IVRA for minor elective below elbow surgeries**.**

Ketamine is a cyclohexanone derivative with analgesic and anaesthetic properties. Although its mechanism of action has been considered to be mainly a noncompetitive antagonism of the N - methyl - D - aspartic acid (NMDA) receptor, ketamine also targets other receptors, such as a - amino - 3 - hydroxy - 5 - methyl - 4 - isoxazolepropionic acid (AMPA) receptors, and has additional acts as an agonist of the sigma 1 receptor. Ketamine is currently used for acute pain management, chronic pain management, and as an anti-inflammatory agent (**12).** Nowadays, it is commonly added to local anaesthetics to improve the quality of peripheral nerve block**.**

Dexamethasone is a long-acting glucocorticoid which has antiinflammatory and analgesic effects. Although its mechanism of action is not fully understood as an adjuvant to local anaesthetics, it has been shown that it applies its anti-inflammatory and analgesic effects by inhibiting phospholipase A2, activation of glucocorticoid receptors and by blocking transmission in nociceptive c-fibers and suppressing the ectopic neuronal discharge **(13, 14).**

The present study, revealed that, addition of 0.1mg/kg of Ketamine as adjuvant to 3 mg/kg of lidocaine in IVRA enhanced the onset times of both the sensory and motor blocks, improved intra-operative anaesthetic potency, prolonged tourniquet tolerance time, delayed the time to 1st ask of postoperative analgesia, decreased the consumed amount of post-operative analgesia, did not affect hemodynamics and respiration and did not associate with side effects.

These findings were in agreement with many reported findings. **Elmetwaly et al., (11)** reported that addition of 0.1 mg/kg of ketamine to 3mg/kg of lidocaine in IVRA of upper limb surgeries significantly enhanced the onset times of both sensory and motor blocks, and significantly prolonged the period of analgesia as well as significantly improved the intra-operative anesthetic quality, significantly delayed tourniquet associated pain, significantly reduced the need intra-operative analgesia and significantly prolonged the time to 1st postoperative ask for analgesia with no significant changes in hemodynamics.

Kumar et al., (15), Haider and Mahdi, **(16) and Opda et al., (17)** reported that, addition of sub-anaesthetic doses of ketamine as adjuvant to lidocaine for IVRA decreased the onset time of each of sensory and motor block of IVRA. **Gorgias et al., (18)** reported that, addition of 0.1mg/kg ketamine to lidocaine in IVRA significantly increased the intra-operative anaesthetic potency, decreased Tourniquet pain and delayed the first request of post-operative analgesia. **Viscomi et al., (19)** reported that, addition of 0.1mg/kg of ketamine to lignocaine for IVRA, significantly increased the duration of tolerance to tourniquet pain and significantly decreased the analgesic consumption for tourniquet pain relief. **Abdel-Ghaffa**r **et al., (20)** reported that, addition of ketamine to lidocaine in patients receiving IVRA significantly reduced intra-operative and postoperative analgesic requirements.

In contrast some workers reported that, the addition of ketamine to local anesthetics has not improved the peripheral, regional, or local analgesia. **Zohar et al., (21)** reported that, ketamine added to local bupivacaine did not enhance analgesia after wound infiltration following Cesarean section. **Clerc et al., (22)** reported that, addition of ketamine to local anaesthetics failed to improve analgesia after intra-articular injection for knee arthroscopy and its addition to bupivacaine for nerve block and wound infiltration after inguinal hernia repair did not improve postoperative pain relief significantly. **Rahimzadeh et al., (23)** reported that the addition of 1mg/kg ketamine to 0.1% Ropivacaine for peri-femoral nerve infusion after operation, in patients who underwent elective knee surgery for repairing the anterior cruciate ligament, under spinal anesthesia, could not improve postoperative pain relief in the first 48 hours after the operation.

Also, the present study, revealed that, addition of 8 mg of dexamethasone as adjuvant to lidocaine in IVRA enhanced the onset times of both the sensory and motor blocks, improved intra-operative anaesthetic potency, prolonged tourniquet tolerance time, delayed the time to 1st ask

of postoperative analgesia, decreased the consumed amount of post-operative analgesia, did not affect hemodynamics and did not associate with side effects. In agreement with the reported findings **Hassani et al.**, **(24)**, **El-Khateeb, et al., (25)** and **Mostafa et al., (26)** reported that, addition of dexamethasone to lidocaine in IVRA of upper limb surgeries significantly enhanced the onset of both sensory and motor block, and significantly prolonged the period of analgesia as well as significantly improved the intra-operative anesthetic quality, significantly delayed tourniquet associated pain, significantly reduced the need intra-operative analgesia and significantly prolonged the time to 1st postoperative ask for analgesia with no significant changes of the recorded hemodynamic and respiratory parameters.

In contrast to the present study findings, **Bigat et al., (27), Jankovic et al., (28), Amin and Farooqui (29)** and **Moallemy et al., (30)** reported that addition of 8mg of dexamethasone to lidocaine for IVRA has no positive effect on the quality of IVRA.

In the present study, ketamine was superior to dexamethasone in enhancing the block onset, increasing block potency and prolonging tourniquet tolerance time.

In contrast, **Zekry et al., (31)** reported that, addition of each of ketamine and dexamethasone as adjuvant to bupivicaine-lidocaine for sciatic-femoral nerve block have positive effects on the quality of nerve block, however neither was superior to the other. **Zaman et al., (32)** reported that, adding dexamethasone or ketamine to lidocaine in axillary block for below elbow surgeries had no effect on the block onset time but prolonged the block duration, however dexamethasone was superior to ketamine.

The controversy between the present study findings and the reported findings of the other workers may be attributed to the difference in the groups sizes, the difference in the doses of the adjuvant drugs, the difference in the type of nerve block, the difference in the type of the used local anaesthetic and the usage or not of premedication.

In the present study, despite the well-known side effects of ketamine such as hallucination, drowsiness, vomiting, sedation and excessive salivation, but none of them was detected in L/K group. This finding was in agreement with some workers. **Gorgias et al., (18) and Abdel-Ghaffa**r **et al., (20)** reported that, addition of ketamine to lidocaine in patients receiving IVRA had no significant adverse effects.

The absence of the will well-known side effects of ketamine L/K group of the present study could be due to the usage of low dose of ketamine and slow release of it into the systemic circulation.

The detected synergistic effect of ketamine to lidocaine was attributed to its' local and central anaesthetic effects beside anti-inflammatory **(33,34).**

The detected synergistic effect of dexamethasone to lidocaine was attributed to its' anti-inflammatory action **(35, 36).**

Tourniquet pain whish is a dull aching pain is a well-known disadvantage of IVRA. It is thought to be mediated by

impulse propagation via small, unmyelinated, slow-conducting C fibers **(38).** In addition to spinal cord NMDA receptors, NMDA receptors have also been identified on peripheral unmyelinated sensory axons. It is well known that ketamine has noncompetitive antagonist of N-methyl-D-aspartate (NMDA) receptors **(38)** and local anaesthetic effect **(39).** This can explain why tourniquet pain tolerance was significantly prolonged in L/K group than both L and L/D groups of the present study.

The detected prolonged sensory block recovery times after release of tourniquet in Ketamine added group may be attributed to the more stay of the combined lidocaine/ketamine than lidocaine alone in the operating limb because Ketamine might increase the binding capacity of local anesthetic to albumin alpha acid glycoprotein **(40).**

The detected prolonged sensory block recovery times after release of tourniquet in dexamethasone added group may be attributed to increasing the efficiency of potassium channels on nociceptive C-fibers, vasoconstriction, and reduction of local anesthetic absorption. Potassium channels have an inhibitory effect on C-fibers transmitting pain **(41, 42).**

The limitations of this study were the relatively small sample size, the uni-center study, the lack of evaluate the surgeon's satisfaction with this type of anaesthesia and the lack of each of systemic Ketamine and dexamethasone as adjuvant to lidocaine IVRA to compare their central versus peripheral sites of action**.**

Conclusion:

Addition of each of Ketamine and dexamethasone to lidocaine for intravenous regional anesthesia improved the characters of anaesthesia, increased tourniquet tolerance time, reduced intensity of tourniquet pain, improved postoperative analgesia, and no associated side effects with the superiority of ketamine over dexamethasone.

Recommendation:

Addition of Ketamine as adjuvant to lidocaine is recommended to improve the quality of intravenous regional anesthesia.

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The authors did not receive any financial support.

Conflict of Interest:

The authors declare that they have no competing interests.

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