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The Combination Effect of Lidocaine, Ketamine and Atracurium in Intravenous Regional Anesthesia

ARTICLE INFORMATION

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ABSTRACT

Background: intravenous regional anaesthesia (IVRA) is an effective method of producing anaesthesia of the extremities. Disadvantages are the rapid loss of anaesthesia after the deflation of the tourniquet and the rapid development of postoperative pain. It is important to search for agents with longer durations of action, better nerve fibre selectivity, lesser degrees of motor blockade and lower incidences of systemic toxicity.

Objectives: This study was designed to evaluate and compare the clinical effects of intravenous regional anaesthesia, with lidocaine alone, or in a combination with ketamine and atracurium for better analgesia, and to examine the possible clinical advantages of using muscle relaxants (i.e., atracurium) with intravenous regional anaesthesia.

Methods: In prospective, randomized study, sixty patient ASA physical status I, aged 20-50years underwent surgeries on distal regions of upper limbs, patient assigned randomly into 3 groups each of 20 patients, group I received 30ml of 0.5% lidocaine (150mg), group II received 30ml of mixing 0.5% of lidocaine (100mg) plus 30mg ketamine, while group III received 30ml of mixing 0.5% lidocaine (100mg) plus 30mg ketamine plus 2mg atracurium. All the results were tabulated and analyzed statistically with student's unpaired *t*-test and chi-square test.

Results: Addition of 30mg of ketamine to 0.5% lidocaine resulted in rapid onset of sensory block, motor block, and lower visual analogue scale scores for pain compared with the group that received lidocaine only. The addition of atracurium to the combination of lidocaine and ketamine resulted in improved operating conditions and rapid onset of both sensory and motor blocks with less pain during surgery.

Conclusions: drug combination of ketamine, atracurium and low dose of lidocaine lead to rapid onset of sensory block, motor block, lower VAS score for pain, and decrease adverse effect of Bier's block accompany lidocaine alone, decrease drowsiness which accompany ketamine use alone in IVRA.

Introduction:

Intravenous regional anaesthesia (IVRA) is a method of producing analgesia in distal part of limb by i.v injection of local anaesthetic agent into the vein of same limb while circulation in the limb is occluded by application of tourniquet. This method of peripheral block, "Bier's Block", was discovered by August Bier in 1908, who inject procaine i.v, this technique is most useful for surgery on arm but can be used for legs as well^(1,2). IVRA is a safe and reliable technique; also the need for specific anatomical knowledge is not required⁽³⁾.

The modern technique was described in the 1960s⁽⁴⁾, where an i.v canula is placed in each hand. The limb is exsanguinated by raising it with the brachial artery compression or by rubber bandage. A tourniquet is inflated around the upper arm to a value higher than systolic pressure (twice systolic BP is usually quoted). Local anaesthetic injected slowly. A more distal tourniquet may be inflated after 5-10min. and the original deflated to

reduce the discomfort. Mechanism of action unclear but may include:

- Compression by the tourniquet.
- Ischemia.
- Drug action on nerve trunk.
- Drug action on nerve endings.

Motor and sensory block occur within 5-10 min, giving a good muscle relaxation and avoiding the risk and complication of general anaesthesia⁽⁴⁾. Conversely, limitations of IVRA may include⁽⁵⁾:

1. Tourniquet must inflate continuously.
2. Possibility of release of local anaesthetic drug to circulation leading to toxicity (dizziness, muscle twitching, seizure and loss of consciousness), cardiac toxicity is rare; it occurs with bupivacain and appear as tachycardia or dysarrhythmia and even VF or cardiac arrest.
3. Duration of surgery is limited by time of arterial tourniquet.

Different drugs can be used in Bier's block, include local anaesthetic agents, non steroidal anti inflammatory drugs, opioid and muscle relaxant⁽⁶⁾. Ketamine has effective local anaesthetic properties and capable of provide sympathetic, sensory and motor block⁽⁷⁾. Atracurium by its effect on muscle spindles can reduce central input, lead to loss of muscle tone and control of voluntary movements and alleviate muscle spasm during and after surgery.

This study was designed to evaluate and compare the clinical effects of intravenous regional anaesthesia, with lidocaine alone, or in a combination with ketamine and atracurium for better analgesia, and to examine the possible clinical advantages of using muscle relaxants (i.e., atracurium) with intravenous regional anaesthesia.

Methods:

This prospective, randomized study was carried out in the department of anaesthesiology at Baghdad Teaching Hospital, Medical City Complex, Baghdad, Iraq.

Sixty ASA-1 physical status patients, aged 20-50 years, were enrolled in the present study. Patient with neurological, cardiovascular and peripheral cardiac disease, were excluded, moreover, two patients refuse this technique and had been excluded.

Patients were randomly assigned into 3 groups each of 20 patients: Group I received 30ml of 0.5% lidocaine (150mg), Group II received a 30ml mixture of 20ml of 0.5% of lidocaine (100mg) plus 30mg ketamine, while Group III received a 30ml mixture of 20ml of 0.5% lidocaine (100mg) plus 30mg ketamine plus 2mg atracurium.

All surgeries were done on distal regions of upper limbs included contracture release, tendon repair, wound debridement and foreign body removal in the hand. Each patient received 30ml of test solution plus 5mg diazepam i.v plus 10ml/kg normal saline. Before administration of IVRA, a canula was inserted on each hand and two tourniquets were applied; the 1st one on the proximal part of the operated limb and the 2nd distal to the proximal one. The 1st tourniquet is inflated and 30ml of test solution was injected slowly over 90 second, 10 min later, the 2nd tourniquet was inflated and the first one was deflated. The radial artery pulsation assured to be absent.

After the test solution was given, onset of sensory block by pin prick just distal to the tourniquet and motor block by inability to move the fingers, were recorded at 1 min. interval. The patients were asked about feeling of pain 5 and 15 min. after deflating the tourniquet and at end of the surgery. Pain was assessed by visual analogue scale (VAS), 10cm line from 0-10 on which the patient marks the point corresponding to the amount of pain 0 indicates no pain and 10 indicates worst level of pain.

Standard monitoring was carried out, by pulse oxymeter, ECG, and non invasive blood pressure checking, patients were further monitored 3 hours postoperatively for any complications.

The parameter were expresses as the mean± SD, P-value less than 0.05 was considered significant, Student's T-test used to determine the significant different between groups.

Results:

In this study, Heart rate, blood pressure, duration of surgery, mean patient age, sex, weight were comparable in all the three groups and there were no statistically significant differences (Table 1).

Results of the present study are illustrated in the following tables:

Table 1: Comparison of age, sex, and duration of surgery among study groups.

Groups	Sex	Age (years)	Duration of surgery (min)
	M:F Ratio	Mean ± SD	
Group I	11:9	45.25±5.15	51.5±4.27
Group II	10:10	43.10±6.98	52.5±5.07
Group III	9:11	42.10±8.45	51.7±4.64
P value	> 0.05	> 0.05	> 0.05

Table 2: Comparison of onset of sensory block among study groups.

Groups	Onset of sensory block		
	Mean ± SD (min)	P value (vs. Group I)	P value (vs. Group II)
Group I	5.35±1.18	-	< 0.01
Group II	4.05±1.28	< 0.01	-
Group III	3.50±0.89	< 0.001	> 0.05

Table 3: Comparison of onset of motor block among study groups.

Groups	Onset of motor block		
	Mean ± SD (min)	P value (vs. Group I)	P value (vs. Group II)
Group I	7.55±1.36	-	< 0.01
Group II	5.50±1.54	< 0.01	-
Group III	4.85±0.93	< 0.001	> 0.05

Table 4: Comparison of mean visual analogue score among study groups.

Groups	Visual Analogue Score (Mean ± SD)		
	During surgery	5 min after deflating the tourniquet	15 min after deflating the tourniquet
Group I	2.20±0.83	1.45±0.61	2.4±0.94
Group II	1.10±0.75	0.65±0.49	1.15±0.67
Group III	0.95±0.83	0.50±0.51	1.05±0.83

Table 5: Incidence of adverse effects during and after the surgical operation among study groups.

Adverse effects	Group I	Group II	Group III
	No.	No.	No.
Loss of consciousness	0	0	0
Restlessness	5	0	0
Bradycardia	3	0	0
Muscle fasciculation	3	3	0
Nausea	0	0	0
Vomiting	0	0	0
Bronchospasm	0	0	0
Drowsiness	2	11	10

Discussion:

IVRA is a simple and effective method of producing analgesia of an extremity by i.v injection of local anaesthesia while circulation is interrupted by application of tourniquet. The present study was aimed to evaluate the effects of drug combinations with lidocaine and to compare the onset of motor and sensory block, and the reduction in its potential toxicity.

In our study we found that combination of drugs with lidocaine give excellent results by prolong analgesia post operative and rapid sensory and motor block, with minimal pain score.

Onset of sensory block in group II was 4.05 ± 1.8 , onset of motor block in group II was 5.05 ± 1.54 , and VAS for pain score at 15 min. after deflation of tourniquet was 1.15 ± 0.67 . All these reading were significantly better than in group I ($P < 0.001$). This is because analgesic effect of ketamine (which contain local analgesic properties) ⁽⁸⁾.

The addition of atracurium in group III resulted in faster onset of motor block (4.85 ± 0.93), as compared to group I (7.55 ± 1.38) in, also group III had a significantly rapid onset of sensor block compare to group I ($P < 0.001$). VAS for pain in group III was 1.05 ± 0.83 which is lower than in group I (2.4 ± 0.94).

Various adverse effects that occur in our study (i.e bradycardia, restlessness, muscle fasciculation) became lower by addition of ketamine or ketamine plus atracurium; this is because we had decrease the dose of lidocaine. However, drowsiness occur in many patients of group II and group III after deflation of tourniquet and persist for 30 min., this is attributed to the use of ketamine.

Lidocaine in maximum dose, as reported by Keneddy et.al ⁽¹¹⁾, yield an extent of analgesia that is excellent, however, the only drawback of such a high dose of lidocaine is high incidence of toxicity. Brown et.al ⁽¹²⁾ used 200mg of 0.5% lidocaine and observes the onset of sensory block was within 3-5 min and no toxic reactions were observed.

Roy and Deshpande ⁽¹³⁾ used 20mg ketamine in IVRA and analgesia was good in 90% and moderate in 10% of subjects. Tomar et.al ⁽¹⁴⁾, also observed that patients who received mixture of local anaesthetics agents for IVRA had more profound analgesia and successful block compared with patient who received individual drug only. They also observed a low incidence of complication in patient who received a drug combination, which confirms our study.

Abdullah and Fadhil ⁽¹⁵⁾ observed that the analgesic effect was more profound in the group that received lidocaine and pancuronium compared with the group that received lidocaine alone. Kulkarni et.al ⁽¹⁶⁾ also observed that by using combination of various drugs, they were able to reduce the dose of lidocaine and hence it's potential toxicity.

Conclusions:

Mixture of local anaesthetics agent for IVRA had more profound analgesia and successful block and low incidence of complication compared with patient who received individual drug only.

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