Original article:

Study of effect of addition of Ketamine and Atracurium to Lidocaine in Intravenous Regional Anaesthesia

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Abstract:

Background: Intravenous regional anaesthesia (IVRA), was discovered way back in 1908 by August Bier. Bier's technique, though effective, was cumbersome to use and an improvement in it was needed. IVRA technique was reintroduced by Holmes (1963). He described IVRA technique with the advantage of greater simplicity over methods advocated previously. IVRA is useful for surgeries of upperlimbs (hand and forearm) with short duration. IVRA is easy and provides reliable surgical anaesthesia but has major drawback of tourniquet pain and no postoperative analgesia. This study was conducted to evaluate the effect of adjuvants like ketamine and atracurium to lidocaine with respect to intraoperative conditions and postoperative analgesia.

Aims & Objectives: To study the effect of addition of ketamine and atracurium to lidocaine in IVRA with respect to block characteristics, tourniquet pain and postoperative analgesia.

Materials and Methods: In a prospective randomised study, sixty patients of physical status ASA I and II, aged 20-50 years undergoing ambulatory hand and forearm surgery were included. Group I received 150mg of 0.5% lidocaine, group II received 100mg of 0.5% lidocaine + 30mg ketamine, and group III received 100mg of 0.5% lidocaine + 30mg ketamine + 2mg atracurium.

Results and Conclusion: Lidocaine group provides reliable surgical anaesthesia. With addition of ketamine, improved block characteristics and prolong postoperative analgesia is observed with lower Visual Analouge Score. Further more, addition of atracuriumhelps with better intraoperative condition and satisfaction rates.

Key words: Lidocaine, ketamine, atracurium, intravenous regional anaesthesia.

Introduction:

IVRA, as the name suggests is an technique of providing regional anaesthesia in upper and lower limbs by injecting local anaesthetic in the same limb to be operated. Limb surgeries provides choice of various anaesthetic procedures like Peripheral Nerve Block (PNB) and General Anaesthesia(GA), but these technique require great skill and knowledge and there is always risk of pulmonary aspiration under GA. IVRA require no specific skill other than simple intravenous(i.v.) puncture to inject local anaesthetic drug. So, it is easy and less cumbersometo administer. IVRA was first described by August Bier in 1908 for anaesthesia of hand and forearm[(1)]. After its discovery, it became obscure for a period of more than 50 years. After it lost popularity due to invention of peripheral nerve blocks like brachial plexus block, Holmes revived the technique in 1963 when he substituted lidocaine for use of prilocaine[(2)].Surgeries of the distal extremities, where it is safe and easy to apply an occlusive tourniquet can be performed by IVRA technique. Surgical procedures of the upper extremity are

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mainly done under IVRA, but procedures involving the lower extremity can also be done[1].

In IVRA, anaesthesia is obtained by i.v. injection of local anaestheticin the limb which is exsanguinated of vascular spaceand is isolated from rest of the circulation with help of two tourniquet.It is usually suitable for minor surgeries of hand and forearm. No expertise or skill is required. Only knowledge required is the anatomy of distribution of peripheral veins in the limb to be operated. Primary advantage provided by IVRA are its simplicity, reliabilityand cost effectiveness[3]. It is a regional anaesthetic technique that is easy to perform, with success rates of 94% to98%[4].Also sophisticated instruments like Peripheral nerve stimulator used for PNB are not available at rural hospitals due to financial constraints, so it is popular choice in rural hospitals.For these reasons, it remains a popular choice among anaesthesiologists. Drawbacks like shorter anaesthetic duration and tourniquet time limit the use of this technique to short surgical procedures of duration 20–60 minutes[5]. The recovery of function is rapid which makes this technique ideal for short duration hand and forearm surgeries. It allows early ambulation following surgery and reduces the cost of stay in hospital.Along with tourniquet pain, there is insufficient muscle relaxation, postoperative analgesia and local anaesthetic toxicity[4].

Ideal local anaesthetic for IVRA should have properties like short onset, long lasting anaesthesia with a low dose and minimal side effect. Thus, studies have been conducted in search of local anaesthetic and various drug combination to provide better IVRA. Such studies are, IVRA in combination withketorolac[6],NSAIDs[7-9], paracetamol[8], ketamine[10].

Among various studies, role of ketamine in IVRA has found a better place with encouraging results[11]. Ketamine used in concentration between 0.3%-0.5% provides complete sympathetic, sensory and motor blockade when injected into the isolated extremity[12].

To further modify IVRA intraoperative conditions various neuromuscular blocking agents have been studied[13].Atracurium as an adjuvant in IVRA is used as it acts on muscle spindle; it reduces central input from these structures, which results in loss of muscle tone and control of voluntary movements with a decrease in nervous inputs to the brain[14]. Atracurium has also shown to alleviate muscle spasms and reduce pain both during and after surgery[15].

Aims & Objectives:

To study the effect of addition of ketamine and atracurium to lidocaine in IVRA with respect to block characteristics, tourniquet pain and postoperative analgesia.

Methodology:

This prospective randomized study was conducted after approval of Institutional Ethical Committee.

Sixty adult patients were included in the study. Patients were randomly divided into three groups with 20 patients in each group.

Inclusion criteria:

-ASA physical status I and II

-Age between 20 - 60 years

-Surgeries over forearm and hand with duration less than 60 minutes.

Exclusion criteria:

-Patients with Raynaud's disease, sickle cell anemia,cardiovascular disease, neurological disease

-history of allergy to local anaesthetics.

Patients were premedicated with Inj.midazolami.v. 0.05 mg/Kg. After arriving in the operating room, patients were placed supine and their vitals like mean arterial blood pressure (MAP), peripheral oxygen saturation (SPO2) and heart rate (HR) were monitored. 22-gauge intravenous (IV) cannula was inserted in the dorsum of the hand of thesurgical

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extremity and 20-gauge IV cannulawas inserted in the non-operative arm for crystalloid infusion. The operative arm was elevated for 2 minfor passive drainage of blood followed by exsanguination with an esmarch bandage. A pneumatic double tourniquet was placed on a padding layer of soft cloth around upper arm, and the proximal cuff was inflated to 250 mmHg. Circulatory isolation of the arm was verified by inspection, absence of radial pulse, and loss of pulse oximetry tracing in the epsilateral index finger.

After exsanguination of the arm, 30 ml of drug solution was injected over 20 seconds by an anaesthesiologist. After injection, IV cannula was removed and pressure was applied over the puncture site in a sterile manner. The sensory block was assessed by pinprick performed with a 22-gauge needle every 30 seconds until the dermatomal sensory block of medial and antebrachial cutaneous, ulnar, median and radial nerves achieved. Motor function was assessed by asking the patients to flex and extend his/her wrist and fingers and complete motor block was noted when no voluntary movement was possible. Sensory block onset time was noted as the time elapsed from drug injection to complete sensory block achieved in all dermatomes. Motor block onset time was the time elapsed from injection of study drug to complete motor block. After complete sensory and motor blocks were achieved, the distal tourniquet was inflated to 250 mmHg, and the proximal tourniquet was released and the surgery was started. MAP, HR and SPO2 level were monitored intraoperatively. Patients were asked about feeling of pain after deflating the tourniquet and at end of surgery. Pain as assessed by Visual Analogue Scale (VAS).

Patients were questioned about pain during surgery and at 5 and 15 minutes after deflation of the tourniquet. The pain was measured using a 0-10 cm VAS where 0 indicates no pain and 10 indicates the worst level of pain. When pain due to tourniquet was > 3 on the VAS, patients were given inj.nalbuphine 5 mg intravenously with increments upto 0.1 mg/kg intraoperatively. Oxygen was administered with face mask if SPO2 was lower than 91%. At the end of the operation patients were asked to quantify the operative conditions such as tourniquet pain or incisional pain.At the end of the operation, the tourniquet deflation was performed by cyclic deflation technique.

In the postoperative period if patients complained pain (VAS > 3); rescue analgesia was given in the form of inj.diclofenac sodium 75 mg intramuscularly till VAS ≤ 3.

During the first 2 hours in the post-anaesthetic care unit and later in the surgical ward, patients were questioned for circumoral numbness and tingling, nausea and vomiting, skin rash, tinnitus, gastric discomfort and other side effects were noted if encountered and MAP, HR and VAS scores were assesed every 2 hours postoperatively during the first 24 hours. The primary outcome of this study was to see onsettimes of both sensory and motor blocks. Complications related to the use of the drugs or technique were considered as secondary outcome.

The parameter were expressed as the mean± SD, Pvalue less than 0.05 was considered significant, Student's T-test was used to determine the significant difference between groups.

Observations and Results:

The patient's demographic data were observed for MAP, HR, duration of surgery and complications. Mean age, sex, weight, duration of surgery, tourniquet time were comparable in all the three groups and there were no statistically significant differences.

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Following tables illustrates the result of present study:

Table 1: Comparison of age, sex, duration of surgery and tourniquet time.

Groups	Age (years) (Mean ± SD)	Sex M:F	Duration of surgery (mins)	Tourniquet time (mins)
Group I	35.6 ±6.596	10:10	44.9±4.961	58.65 ±5.039
Group II	36.05±6.516	11:9	45.25±5.108	60.3 ±5.141
Group III	37.5±6.51	10:10	44.4 ±5.009	58.65 ±5.039
P value	>0.05	>0.05	>0.05	>0.05

Table 2: Comparison of onset of sensory block

Groups	Onset of sensory block Mean ± SD (mins)	P value (vs group I)	P value (vs group II)
Group I	4.5±1.05	-	< 0.01
Group II	3.1±0.852	< 0.01	-
Group III	2.65±0.745	<0.001	>0.05

Table 3: Comparison of onset of motor block

Groups	Onset of motor block Mean ± SD (mins)	P value (vs group I)	P value (vs group II)
Group I	7.15±1.565	-	< 0.01
Group II	4.75±1.208	< 0.01	-
Group III	4.3±0.732	< 0.001	>0.05

Table 4: Comparison of mean Visual Analogue Score (VAS)

Groups	VAS 5 min after deflation of tourniquet (Mean ± SD)	VAS 15 min after deflation of tourniquet (Mean ± SD)
Group I	1.5±0.512	2.3±0.470
Group II	0.8±0.267	1.4±0.502
Group III	0.5±0.606	0.9±0.759

Table 5: Number of patients who needed analgesia intraoperatively (VAS >3)

Groups	No. of patients needed analgesia intraoperatively (VAS >3)
Group I	2
Group II	0
Group III	0

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Table 6: Incidence of adverse effects during and after surgery

Adverse effects	Group I	Group II	Group III
Loss of conciousness	0	0	0
Restlessness	4	1	0
Bradycardia	2	0	0
Muscle fasciculations	3	2	0
Nausea	0	0	0
Vomiting	0	0	0
Bronchospasm	0		
Drowsiness	2	9	11

Discussion:

IVRA is a simple and straightforward technique of producing anaesthesia. It has advantages like-

-Rapid Onset And Recovery

-Reliability

-Muscle Relaxation

-Technical simplicity.

Its disadvantages are-

-Poor post operative analgesia

-Limited time of surgical anaethesia

-Potential for systemic local anaesthetic toxicity

In the present study, we used different adjuvants tolidocaine to overcome these side effects. Lidocaine yields good results as sole local anaesthetic agent in IVRA. Previously prilocaine was used for IVRA. Now IVRA is performed using lidocaineand the technique is described as safe and reliable[16]. In this study we tried to compare theeffect of different combination of drugs with different dosage to see any beneficial effects or complications.

In our study we found that onset of sensory block in group IIwas 3.1±0.852 and in group I was 4.5±1.05. The readings in group II was significantly shorter than in group I ($P < 0.01$). Similarly when results of group III were compared to group I in relation to sensory block characteristics, it was found that onset of sensory block in group III was 2.65±0.745 which was significantly shorter than in group I ($P<0.001$). This showed that results in group II and group III were significantly better as compared to group I. But this was not true when group II and group III were compared. Onset of sensory block in group II was 3.1±0.852 which was longer than in group III (2.65±0.745). Difference was noticed between the two groups, but it was not statistically significant ($P>0.05$).

Similarly, with respect to motor block, onset time in group II was 4.75±1.208 and in group I was 7.15±1.565. The results in group II was significantly shorter than in group I ($P < 0.01$).Onset time of motor block in group III was 4.3±0.73 which was significantly shorter than in groupI ($P<0.001$).The readings in group III and group II was significantly shorter than in group I ($P < 0.01$). When group II and group III were compared, onset of motor block in group II was 4.75±1.208 which was longer than in group III (4.3±0.73),but it was not statistically significant ($P>0.05$).

VAS score for pain was done 5 min and 15 min after deflation of tourniquet. In our study we found that, pain scores at 5 min and 15 min were higher in

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group I (1.5±0.512 and 2.3±0.470 respectively) as compared to group II (0.8±0.767 and 1.4±0.502 respectively). Further more, group III showed VAS at 5min of 0.5±0.606 and at 15 min of 0.95±0.759. From above values it was evident that pain score were lower in group II and group III than in group I. Amongst the three groups only in group Ithe incidence of additional requirement of analgesia during surgery was noted. Other two groups did not encounter any such episode.

The present study is supported by following two studies:

1) G Mir et al (2007)[17]:When ketamine 1% was added to lidocaine 0.25%,a rapid onset of sensory block and motor block was observed. Also lower visual analogue scale scores for pain was observed when compared with the group that received lidocaine only. Improved intraoperative conditions with rapid onset of sensory and motor blocks was seen,which was also associated with less pain during surgery when atracurium was added to the above combination of lidocaine and ketamine.
2) Hassan SarhanHaider et al(2013)[18]: Combination of ketamine, atracurium and low dose of lidocaine results in rapid onset of sensory block, motor block, lower VAS score for pain, and decrease adverse effect of Bier's block seen withlidocaine alone, decrease drowsiness which accompany use of ketamine alone in IVRA.

Lidocaine was used by Kennedy et al[19] in dose of 350 mg, which resulted in excellent analgesia but the drawback with this study was high incidence of toxicity due to high dose of lidocaine. In the present study the onset of sensory block with group Iwas 4.5±1.05 and VAS score after 15 min of deflation was 2.3±0.470. Similar findings were observed in the study conducted by Brown et al.[20] showing that with the use of 0.5% lidocaine the onset of sensory block was within 3–5 minutes without any toxic reactions.

When adjuvants were added, group II resulted in faster onset of both sensor and motor block (3.1±0.852 and 4.75±1.208 respectively) as compared to group I (4.5±1.05 and 7.15±1.565 respectively). Similar results were seen by Kulkani et al [21] when he used different concentration of ketamine added to lidocaine with results stating that, statistically significant (P) difference was found in the onset of both sensory and motor blockade between group which received only lidocaine and group which receivedlidocaine with ketamine.

Addition of atracurium to lidocaine provides greater degree of muscle relaxation which makes reduction of fractures easy and also provides better operative conditions.[22] Similar with ourstudy, there was less painin group III than in group I . Also onset of blocks were faster in group III than in groupI. Result is also supported by study showing that the effectiveness of the addition of a muscle relaxant to IVRA provides better analgesic effect and was more profound in the group that received lidocaine and pancuronium compared with the group that received lidocaine alone.[23]

Limitation of study : was regarding dose of ketamine and atracurium, which was same as in previous studies. More studies with different doses of ketamine and atracurium will help knowing adequate dose for best clinical and post operative analgesia.

Conclusion: In IVRA when lidocaine is combined with adjuvants like ketamine and atracurium it provides profound analgesia, early onset of motor and sensory blockade and good operating conditions.

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