Original Article

Comparison of two different doses of dexmeditomidine to prevent tourniquet pain during intravenous regional anaesthesia with lidocaine

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Abstract

Background and Objectives: Intravenous regional anaesthesia (IVRA) has been used for more than a century. Dexmeditomidine has found to prolong the action of the action of local anaesthetics through a peripheral mechanism. Our study compares the efficacy of two different doses (0.5mic/kg and 1mic/kg) of dexmeditomidine added to IVRA with lidocaine to prevent tourniquet pain. **Study design:** A prospective, randomized, double-blind study. **Methods:** This study was carried out in 60 normotensive, ASA grade I and II patients, aged 18 to 60 years who were scheduled for elective orthopedic forearm and hand surgeries under intravenous regional anaesthesia (IVRA). The patients were divided into two groups of 30 each. Group I received 40ml of 0.5% lidocaine and 0.5 mic/kg dexmeditomidine after proximal cuff inflation. Group II received 40ml of 0.5% lidocaine and 1 mic/kg dexmeditomidine after proximal cuff inflation. When anaesthesia was established, the distal cuff inflated and proximal cuff deflated. Time of onset and offset of sensory and motor blocks, and time to tourniquet pain were recorded. Postoperative VAS score, time to first rescue analgesic were recorded. **Results:** The onset times of both sensory and motor blocks were shortened in group II as compared to group I. Prolonged sensory - motor recovery times, prolonged tolerance time for tourniquet were found in group II. Significantly lower postoperative VAS scores, longer time to first postoperative rescue analgesic were recorded in group II. **Conclusion:** Addition of 1 mic/kg dexmeditomidine to lidocaine for IVRA delays the onset of unbearable tourniquet pain and increases time to first rescue analgesic in the postoperative period as compared to 0.5 mic/kg dexmeditomidine.
Key Words: Dexmeditomidine, intravenous regional anaesthesia, lidocaine, motor block, sensory block, tourniquet.

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INTRODUCTION

Intravenous regional anaesthesia is a simple, safe and reliable technique of anaesthesia for forearm and hand surgeries[1]. IVRA is also known as Bier's block as it was first performed by August Bier in 1908[2]. It provides excellent anaesthesia and postoperative analgesia. But this technique is limited by torniquet pain and lesser duration of postoperative analgesia.[3] To improve the quality of this block and postoperative analgesia various adjuvants to lidocaine have been tried with varying results. Studies have shown that opioids lack significant effect in IVRA.[4] Alpha-2 agonists have gained popularity due to their sedative, analgesic and central sympatholytic properties. Dexmeditomidine is the new alpha-2 agonist having 8 times more affinity for alpha-2 adrenoreceptors than clonidine.[5] It reduces norepinephrine release at neuroeffector junction, inhibits neurotransmission of sympathetic nerves and decreases plasma catecholamines, which results in a slight decrease in blood pressure and lowering of the heart rate.[6] In the current study we aimed to compare the effects of two different doses of dexmeditomidine (0.5mic/kg and 1mic/kg) when added to

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lidocaine during IVRA. We planned to investigate the onset and recovery times of sensory-motor blocks, quality of anaesthesia, haemodynamic stability, intraoperative and postoperative pain and any other side effects of dexmeditomidine.

MATERIAL AND METHODS

After obtaining the ethical committee approval, a randomized controlled study was formulated. The study population comprised 60 patients with ASA physical status I and II, aged 18- 60 years, scheduled for elective forearm and hand surgery (fractures of radius, ulna metacarpal bones,carpal tunnel syndrome, ganglion excision etc) were included in the study. Patients with cardiovascular disease, epilepsy, hypertension, chronic obstructive pulmonary disease, morbid obesity, heart block, diabtes mellitus, renal disease, pregnancy, Raynod's disease, sickle cell disease were excluded from the study. All patients were examined one day before surgery. Included patients received necessary information about the study and gave their written consents. The patients were randomly assigned to one of the two groups each containing 30 patients. These are: Group I (dexmeditomidine 0.5mic/kg Group) and Group II (dexmeditomidine 1mic/kg Group).These groups were determined with closed envelopes. The subjects were blinded to the treatment they received. The anaesthesiologists who prepared and administered the medications were provided to be different. All the patients were premeditated with inj. midazolam 0.02 mg/kg intravenously. On arrival to operation theatre routine monitoring was started. The patient's baseline heart rate, systolic BP, diastolic BP, mean BP and oxygen saturation (SpO2) were recorded. Two intravenous cannulae were placed; one on the dorsum of hand to be operated and other on opposite hand for IV infusion of crystalloids. A double tourniquet was positioned on the operative arm. Then the operative extremity was exsanguinated with Esmarch bandage. The proximal tourniquet was inflated to 250 mmHg. Circulatory isolation of the arm was confirmed by absence of radial pulse and loss of pulse oxymetry tracing. Group I received 40 ml of 0.5% lidocaine + 0.5mic/kg of dexmeditomidine through the cannula on operative arm. Group II received 40 ml of 0.5% lidocaine + 1mic/kg of dexmeditomidine through the cannula on operative arm. The solution was injected over 90 seconds by an anaesthesiologist blinded to the study drugs. The sensory block was assessed every 30 seconds after inflation of tourniquet, by pin prick method. Sensory testing was done at thenar eminence for median nerve, hypothenar eminence for ulnar nerve and first web space for radial nerve. Sensory recovery was also assessed at these areas at 30 seconds intervals after deflation of torniquet. Motor function was assessed by asking the patient to flex and extend the wrist and fingers. Sensory block onset time was noted as the time from injection of study drug to the achievement of complete sensory block. Motor block onset time was the time from injection of study drug to complete motor block. After achievement of complete sensory and motor blocks, distal tourniquet was inflated to 250mmHg and proximal tourniquet deflated and patient handed over to surgeons for surgery. Mean arterial pressure (MAP), heart rate (HR) and SPO2 were recorded before and after tourniquet inflation, 5,10,15,30, 45,60,75 and 90 min after the injection of study drug. Hypotension (20% reduction from baseline) was treated with IV fluids and 6mg of inj. Ephedrine IV. Bradycardia (HR < 55/min) was treated with inj. Atropine 0.6 mg IV. The visual analog scale (VAS) was used to evaluate tourniquet pain at the intervals of 5, 10, 15, 25, 35 and 45 min after tourniquet inflation. VAS score: 0 = no pain and 10 = worst pain imaginable. For tourniquet pain 50mic fentanyl was given IV for VAS>3. Time to first tourniquet pain was noted. It was measured before and after tourniquet application, 5, 10, 15, 20 and 40 min after the injection of study drug. The tourniquet was not deflated before 40 min of drug injection and was not inflated more than 90 min. At the end of surgery tourniquet was released by the cyclic deflation technique. Sensory and motor block recovery times were noted. Postoperatively Patient's pain and sedation scores were noted o min (just after tourniquet deflation), 15 min, 30 min, 60min,120 min,240 min and 300min after deflation. Degree of sedation was assessed by Ramsay sedation scale[7]: 1 = anxious and/or agitated 2 = co-operative, oriented and tranqill 3 = responds to commands only 4 = exhibits brisk response to light glabellar tap or loud auditory stimulus 5 = exhibits sluggish response to light glabellar tap or loud auditory stimulus 6 = exhibits no response. Patients were given inj diclofenac sodium 75 mg IM when their VAS was > 3. The duration of analgesia was the time between tourniquet deflation and first injection of diclofenac. At the end of surgery, the quality of anaesthesia was assessed according to the following numerical scale. 4 = excellent (no complaint from patient), 3 = good (minor complaint with no need of analgesics, 2 = moderate (complaint which required analgesics), 1 = unsuccessful (patients given general anaesthesia). MAP, HR and SPO2 were recorded 0 min (immediately after deflation of tourniquet), 5, 10, 15, 20, 30 and 40 min after tourniquet deflation. Any local and systemic complications if any were recorded during the study period.

Statistical Analysis

The results obtained in this study were presented in tabulated manner and analysed using Microsoft Excel and SPSS software (version 10,2010) for windows. The two groups were compared by using t test. The results were expressed as mean ± SD. P value <0.05 was regarded as statistically significant, p<0.001 highly significant, p<0.0001 extremely significant and p>0.05 was regarded as non significant.

RESULTS

There was no difference between two groups according to age, sex, weight, duration of surgery and tourniquet time (table1). The mean onset of sensory block in Group II was significantly shorter than Group I. This difference was statistically significant (P<0.05). The onset of motor block in Group II was also significantly shorter than Group I. (P<0.05) (Table 2). The sensory and motor recovery times were significantly prolonged in group II than group I (P<0.05) (Table 2). Tourniquet pain onset time was comparatively more in group II than group I (p<0.05) Table 3). 4 patients in group I and 3 patients in group II required inj. Fentanyl intraoperatively. This difference was statistically insignificant. (p>0.05) (Table 3). Time to first rescue analgesic (duration of analgesia) was significantly longer in group II than in group I (P<0.0001). Postoperative VAS was below 4 in both groups upto 5 hours in group I but it was below 3 in group II (Table 4). The difference was statistically significant. Quality of anaesthesia was excellent in both the groups (Table 3). Both the group showed comparable low level of sedation as depicted by Ramsay Sedation Scale after deflation of tourniquet. The difference was statistically insignificant. (p>0.05) (Table 5). There was temporary fall in Mean arterial pressure (MAP) in both groups after release of tourniquet, but the fall was comparatively more significant in group II than in group I (p<0.05) (fig 1). The fall in MAP was not more than 20% of baseline value. There was no significant change in heart rate (HR) intraoperatively, but there was temporary decrease in HR in both groups after release of tourniquet. The difference between two groups was statistically significant (p<0.05) (fig 2). The fall in HR was not more than 20% of baseline value. SPO2 was normal intraoperatively as well as postoperatively in both the groups. No any complication was observed in any group.

Table 1: Patients characteristics data Data were expressed as mean (± SD) as number

Sex (F/M)	13/17	16/14
Weight (kg)	55.63 ± 7.79	53.13 ± 7.37
Duration of surgery (min)	41.5 ± 12.12	42.0 ± 11.57
Tourniquet time (min)	51.2 ± 14.5	53.4 ± 13.2

Table 2: Onset and recovery times (min)

	Group I (n = 30)	Group II (n = 30)
Sensory block onset	2.4 ± 1.9	1.9 ± 1.2
Sensory block recovery	8.5 ± 1.3	9.5 ± 2.1
motor block onset	4.2 ± 1.7	3.4 ± 1.8
motor block recovery	9.6 ± 1.4	11.4 ± 1.2

Data presented as mean ± SD.

Table 3: Initial time 0f tourniquet pain, number of patients who needed fentanyl (VAS > 3), duration of postoperative analgesia and quality of anaesthesia

	Group I (n = 30)	Group II (n = 30)
Initial time of tourniquet pain (min)	43.2 ± 2	47 ± 3**
Number of patients requiring fentanyl	4	3
Duration of postoperative analgesia (min)	238.4 ± 2.7	290 ± 3.1*
Quality of anaesthesia (grade)	3	4

* p < 0.0001, ** p < 0.05

Table 4: Postoperative pain score (VAS 0 – 10)

Time (min)	Group I (n = 30)	Group II (n = 30)
0	0	0
15	0	0
30	2	1
60	2	1
120	3	1
240	3	2
300	3	2

Table 5: Ramsay sedation score after tourniquet deflation.

Groups	30 min	60min	90 min
I	2	1	1
II	2	2	1

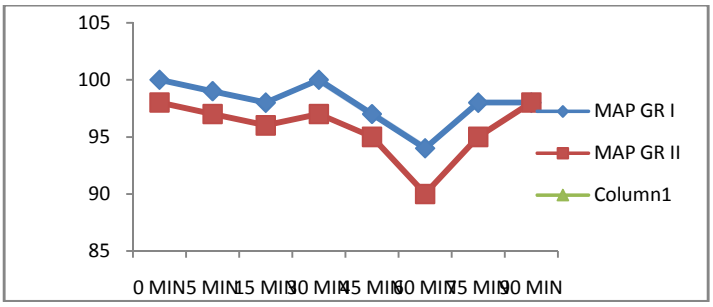

Figure 1: Comparison of mean arterial pressure (MAP in mmHg) between Group I and Group II. Time (min)

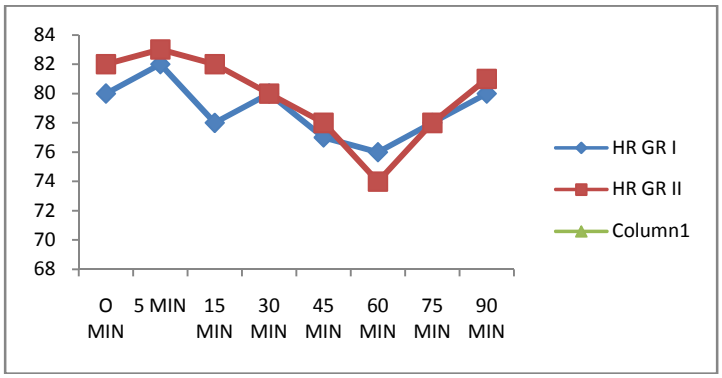

Figure 2: Comparison of Heart rate (HR /min) between Group I and Group II. Time (min)

DISCUSSION

Our study demonstrated that the addition of 1mic/kg dexmeditomidine to lidocaine for IVRA prolonged the initial time of tourniquet pain, the duration of postoperative analgesia and recovery times of sensory-motor blocks than 0.5mic/kg dexmeditomidine without causing any side effects. Intravenous regional anaesthesia (IVRA) is a simple and reliable method of providing anaesthesia for upper extremity surgery. The IVRA has multiple advantages, including ease of administration,rapid onset of action, rapidity of recovery, adequate muscular relaxation and controllable extent of anaesthesia. This technique is very good for short surgical procedures (90min). This technique involves exsanguination of the limb with an elastic bandage and squeezing blood proximally toward the heart. Then Pneumatic tourniquets are applied to the limb and inflated to occlude the blood vessels. Then the local anaesthetic, lidocaine is slowly injected intravenously as distally as possible into the exsanguinated limb. But the IVRA is limited by early tourniquet pain and short duration of postoperative analgesia as compared with peripheral nerve blocks. To overcome these problems, various additives to local anaesthetics like as tramadol, clonidine[8], fentanyl[9], ketorolac[10], neostigmine, nonsteroidal anti-inflammatory drugs (NSAIDs) etc were tried and were found to have controversial results. The α2 adrenoceptor agonists namely clonidine and dexmeditomidine are gaining popularity in IVRA in recent clinical studies. According to their study Gentili M *et al*[11] showed that addition of clonidine 150 µg to lidocaine produced a significant increase in tourniquet tolerance in patients undergoing IVRA. Lurie SD *et al*[12] also reported the efficacy of 1 µg/kg clonidine added to IVRA lignocaine in prolonging the tourniquet tolerance time. Clonidine depresses nerve action potential by a mechanism other than its effect on alpha -2 adrenergic receptors which may account for perineural adjuvant effect to local anaesthetics. Kleinschmidt and coworkers[13] found that clonidine did not improve postoperative analgesia, while Reuben *et al*[14] in 1999 reported that the addition of 1 µg/kg clonidine to lignocaine 0.5% for IVRA in patients undergoing ambulatory hand surgery improves postoperative analgesia without causing significant side effects. Tourniquet pain is a major problem during upper limb surgery under IVRA. The mechanism of tourniquet pain is yet unclear. In their study, Memis[15] and his colleagues found that tourniquet pain was attenuated and total fentanyl consumption was reduced by adding dexmeditomidine to lidocaine during IVRA. In our study we found that 1 mic/kg dexmeditomidine prolonged the initial time of tourniquet pain more significantly than 0.5 mic/kg dexmeditomidine. Abrupt IV introduction of o.5-2 mic/kg dexmeditomidine to lidocaine for IVRA results in moderate hypotension, bradycardia and sedation. Memis and his colleagues found that addition of o.5 mic/kg dexmeditomidine for IVRA enhanced anaesthetic and postoperative analgesic effect of lidocaine without causing any bradycardia and hypotension. In our study we observed temporary fall in HR and MAP in both groups ; but the fall was statistically more significant in group II than group I. This may be due to higher dose (1 mic/kg) of dexmeditomidine in group II causing blunting of central sympathetic response. α –2 agonists produce sedation probably by activation of α-2 adrenoreceptors in the locus coeruleus, which are coupled via a pertussis toxin-sensitive G protein to a change in conductance through ion channel[16]. At the level of the dorsal root neuron, α–2 agonists inhibit substance P release in the nociceptive pathway. This explains their analgesic property. Perioperative dexmeditomidine administration decreased the requirements for opioid or non opioid analgesics both intraoperatively as well as postoperatively[17] Memis *et al.*[15] observed no sedation intraoperatively and also postoperatively with the use of 0.5 mic/kg dexmeditomidine in IVRA. In our study we found low level of sedation in both groups, but difference between the two groups was statistically insignificant.

Jaakola *et al*[18]. found that 1 mic/kg dexmeditomidine given IV was an effective premedication, because it reduced anxiety, sympathoadrenal responses and opioid requirements; but it didn't reduce tourniquet pain. Memis and colleagues [15] found that the addition of 0.5 mic/kg dexmeditomidine in IVRA caused shortening of sensory-motor block onset times. In our study we proved that the onset times of sensory and motor blocks were comparatively shorter in group II than group I. Likewise the recovery times of sensory and motor blocks were significantly prolonged in group II than in group I. Kol, I O *et al*[19] conducted study on addition of dexmedetomidine or lornoxicam to prilocaine in intravenous regional anaesthesia for hand or forearm surgery. They found that addition of dexmedetomidine caused shortening of sensory block onset time and prolonging of sensory block recovery time more than lornoxicam. Some authours used of 0.5 mic/kg dexmeditomidine, while some used 1µg/kg dexmedetomidine in IVRA technique. We decided to compare the two doses of dexmedetomidine (0.5 µg/kg and 1 µg/kg) in IVRA, in terms of onset and recovery of sensory-motor blocks, duration of post-operative analgesia and quality of block. So we conducted a comparative study of two different doses of dexmedetomidine as adjunct to lidocaine in IVRA in 60 Patients of ASA class I and II of either sexes, between 18 and 60 years of age. In this study we found that, the dose of 1µg/kg of dexmeditomidine is better than 0.5µg/kg dexmeditomidine in all respects without causing any side effects. A Esmaoglu *et al*[20] found that addition of 1 µg/kg dexmedetomidine to lignocaine for intravenous regional anesthesia leads to improved quality of anaesthesia and decreased analgesic requirements, but had no effect on the sensory and motor block onset and regression times. But in our study we found shorter sensory and motor onset times and prolonged recovery times in group II (1µg/kg dexmeditomidine) than in group I (0.5 mic/kg dexmeditomidine). Dexmeditomidine also minimizes opioid induced muscle rigidity, prevents postoperative shivering, causes minimal sedation, has better haemodynamic stabilizing effects[21]. We did not observed any side effects of dexmeditomidine in any group. There are some limitations of this study.First,the study population was small.Second,the study was carried out in ASA grade I and II patients only.The study should be carried out in high-risk cardiac patients also to confirm the effects dexmeditomidine on HR, MAP and sedation level.Third,measurement of plasma catecholamines level was necessary to demonstrate effectiveness of the study drug in decreasing sympathetic nervous system activity.

CONCLUSION

From this study we conclude that both doses of dexmeditomidine when added to lidocaine for IVRA provide good quality of anaesthesia with better haemodynamic stability without causing any side effects ; but 1µg/kg dexmeditomidine causes shortning of sensory-motor block onset times, prolongation of sensory-motor recovery times and significant prolongation of postoperative analgesia than 0.5µg/kg dexmeditomidine. 1µg/kg dexmeditomidine produce temporary fall in MAP and HR more than 0.5µg/kg dexmeditomidine after release of tourniquet We recommend further studies regarding doses of drugs or use of different drug combinations that will completely prevent tourniquet pain and provide prolonged duration of postoperative analgesia without causing any side effects.

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