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Journal of Anaesthesia and Therapeutics

RESEARCH ARTICLE

Dexmedetomidine as an Adjuvant to Lignocaine Versus Lignocaine Alone to Evaluate the Quality of Intravenous Regional Anaesthesia for Upper Extremity Surgeries: A Double Blind Randomised Controlled Study

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Citation: Sumedha Deole, Sumita Bhargava, Anjali Bhure (2022) Dexmedetomidine as an Adjuvant to Lignocaine Versus Lignocaine Alone to Evaluate the Quality of Intravenous Regional Anaesthesia for Upper Extremity Surgeries: A Double Blind Randomised Controlled Study . J Anaesth Ther 3: 101

Abstract

Bier's block has always been an excellent and safe option for upper limb anaesthesia since the replacement of procaine with lidocaine in 1963 by Holmes. Adjuvants have greatly changed the quality and safety of anaesthesia. In this study we evaluate the efficacy of dexmedetomidine 0.5 mcg/ kg as an adjuvant to lignocaine versus lignocaine alone to evaluate the quality of intravenous regional anaesthesia.

Methods: 42 patients requiring upper limb surgery were randomized to receive IVRA with lignocaine alone (Group L) or lignocaine with dexmedetomidine (Group LD). Parameters like onset of sensory and motor block, the time required to deflate the distal tourniquet, intraoperative fentanyl requirement and duration of postoperative analgesia were noted.

Results: The onset of sensory and motor block was significantly rapid in group LD compared to Group L. Sensory block :(2.52±0.51 v/s 5.19±0.81). Motor block (7.61±0.8 v/s11.52±1.5 min). The intraoperative fentanyl requirement was lesser in group LD. The mean values of inflation time were 22.24±3.14 min in patients of Group L and 38.6±4.93 min in patients of Group LD with p value <0.05 which signified the time required to inflate the distal cuff was more in LD group than L group. The duration of postoperative analgesia was prolonged in Group LD

Conclusion: Dexmedetomidine 0.5 mcg/kg as an adjuvant to lignocaine shortens the onset of sensory and motor block, prolongs the inflation time of distal cuff and provides longer postoperative analgesia.

Keywords: Dexmedetomidine; Adjuvant; Lignocaine

Introdution

Intravenous regional anaesthesia was first described in 1908 by August Bier for anaesthesia of the upper limb like hand and forearm [1]. After losing popularity following the advent of brachial plexus blocks Holmes revived the technique in 1963 when he substituted Lidocaine for the use of procaine [2]. IVRA is suitable for operations of the distal extremities in situations where it is easy as well as safe to apply an occlusive tourniquet. It is used for surgical procedures of the upper extremity but can also be used for procedures involving the lower extremity [1].

The advantages of IVRA are its simplicity, reliability and cost effectiveness [3]. It is regional anaesthesia technique which is easy to perform, with success rates varying between 94% to 98% [4]. For these reasons, it remains a popular choice among anaesthesiologists. However, constraints of anaesthetic duration and tourniquet time limits the use of this technique to short procedures lasting approximately 20-60 minutes [5]. The rapid recovery of function make this technique suited for surgeries performed in an ambulatory setting.

Limitations of this procedure include smaller duration of block, tourniquet discomfort and inability to provide adequate postoperative analgesia. To improve block quality and to overcome these limitations various drugs from different classes like lornoxicam [6], opioids [7] ketorolac [8], neostigmine [9], clonidine [10], muscle relaxants [11] and meperidine [12] etc. were studied. However, very short duration of analgesia was the reason for continued study of newer additives to the block [13].

α-2-adrenoceptor agonists have been studied for their sedative, analgesic cardiovascular stability and perioperative sympatholytic effects with reduced anaesthetic requirements [14]. Dexmedetomidine is a potent and highly selective α_2 adrenoceptor agonist ($\alpha_2 : \alpha_1$ 1620:1) and is almost 8 times more potent than clonidine ($\alpha_2 : \alpha_1$ 200:1) and when given intravenously it is known to reduce the requirement of anaesthetic agents by up to 90%.

The primary outcome of the present study is to compare the onset of sensory and motor block intraoperative fentanyl requirement, duration of post-operative analgesia following IVRA with or without the use of dexmedetomidine. The secondary outcome is to assess the sedation and haemodynamic effects. We hypothesised that addition of Dexmedetomidine to Lignocaine will improve the quality of intravenous regional anaesthesia for upper extremity surgeries.

Materials and Methods

This was a randomized double blind controlled study held at the department of anesthesia at a tertiary care centre spread between November 2018 to October 2020.

A study population of 42 patients was determined and patients included all who required an upper limb surgery of less than 90 minutes duration after obtaining written informed consent and ethical committee clearance. Patients included were between 18 to 60 years of age with ASA physical status of I or II. Patients with Raynaud's disease, sickle cell anaemia, peripheral vascular disease, skin disease on operating hand, crush injury or open wound and patients with allergy to study drugs were excluded from the study. Study participants were randomized by sealed envelope technique into two groups (Group L and Group LD). Group L (Lignocaine) received 0.5% preservative free lignocaine (3mg/kg) diluting upto 40ml. Group LD (lignocaine + dexmedetomidine) received Dexmedetomidine 0.5mcg/kg along with 0.5%preservative free lignocaine (3mg/kg) diluting with normal saline upto 40ml. The Anaesthetist not involved in the study prepared the drug, participants in the study were blinded to which group they will be allotted while the attending Anaesthetist was blinded to the study drug as per group allocation. No patients in either of two groups were premedicated. Premedication with sedatives and narcotics was deliberately avoided so as to avoid any interference in the assessment of sensory and motor blockade.

On arrival at the operation theatre (OT), 2 intravenous cannulae was placed before establishing the anaesthetic block. One 22G cannula in a vein on the dorsum of the operative hand and the other 20G cannula in the non-operative hand for crystalloid infusion with Ringer Lactate 10 ml/kg. Premedication was given with Injection Ranitidine 1 mg/kg and Injection Ondansetron 0.1 mg/kg. All the patients were monitored with standard monitoring including an ECG(electrocardiogram), non-invasive blood pressure and pulse oximetry (SpO2). Continuous monitoring was done during the procedure and baseline vital parameters were recorded.

The operative upper limb was elevated for 3 min, and then exsanguinated with Esmarch bandage. The proximal tourniquet was inflated to 100mm Hg more than systolic blood pressure to a minimum of 250 mm Hg. The drug was injected by the anaesthesia resident slowly over 1 minute in the operative arm after inflation of proximal cuff as per the group allocation. Sedation was assessed by using Ramsay sedation score [72]

Circulatory status of the operative arm was confirmed by inspection of the hand, by the absence of the radial pulse, and loss of pulse oximetry tracing of the ipsilateral index finger. Patient's electrocardiogram and non-invasive blood pressure, Spo2 were monitored continuously in all patients using multipara monitor.

Sensory block was assessed every 30 seconds after injection of lignocaine using a standardized pin prick technique with a 25gauge short-bevelled needle in the distribution of ulnar, median, radial, medial, and lateral antebrachial cutaneous nerves.

Motor function was assessed by asking the subject to flex and extend fingers at 30 seconds interval, and complete motor block was achieved when no voluntary movement was possible. Onset of sensory blockade was defined as time from the complete injection of drug till loss of pin prick sensation in all the dermatomes. After complete sensory block was achieved, the surgery was allowed to start.

Tourniquet pain was assessed by using Numeric Rating Scale (NRS) and the degree of sedation by Ramsay sedation score (scale 1-6) at 0,5,10,15,20,40 mins intraoperatively till end of surgery.

If patient complained of proximal tourniquet pain the distal tourniquet was inflated to 100mmhg more than systolic blood pressure to a minimum of 250mm Hg, the proximal tourniquet was released and surgery was continued.

After inflation of distal cuff if the tourniquet pain was subsided , no analgesia was administered to the patient . But if the distal tourniquet pain persisted or when the NRS score was 4 or > 4 intravenous boluses of fentanyl 25mcg(microgram) was administered for tourniquet pain treatment .

Tourniquet was deflated by cyclic deflation technique at the end of surgery. If surgery was completed within 20 min after the injection of the drug, tourniquet was kept inflated for a minimum of 20 min. After tourniquet deflation, hemodynamic variables and pain (NRS) and sedation scores were noted at 30 min and 2, 4, 6, 12, and 24 h.

Duration of postoperative analgesia was the time from deflation of tourniquet to the first dose of diclofenac injection. Total amount of diclofenac consumption over first 24 h after surgery was noted. Inj Diclofenac 75mg was administered when NRS was 4 or more than 4.

Any signs and symptoms of Local anaesthetic toxicity like perioral numbness, tinnitus, nausea, vomiting, pain, skin rashes, hypotension, bradycardia, convulsions were vigilantly looked for and the patients were strict monitoring was done . Hypotension (25% decrease from baseline) was treated with Mephentermine (3-6 mg bolus), bradycardia (25% decrease from baseline value) was treated with IV atropine 0.6 mg and arterial oxygen saturation less than 91 % was treated with oxygen supplementation.

Sample size was determined from data of previous studies using Ratio=1:1 (alpha: beta) to establish a sesire power of Power of 90% and Sample size was calculated as 42 patients. The result of the study was analyzed by following statistical methods .Descriptive statistics was used, mean and standard deviation for quantitative variables. Inferential statistics included test of significance for comparison of effects in two groups.Two independent sample t-test were used to compare difference in means of two groups.Chi -square test was used to compare difference in proportion of two groups. Data was coded and analysed in statistical software STATA, version 10.1,2011.

Results

There was no significant difference in between both the groups with respect to the demographic data (Table 1). The sensory and motor block onset times in Group LD was compared to Group L ($p<0.001$) (Table 2). The majority of patient in Group LD had far less or no requirement of intraoperative fentanyl supplementation (Table 2). The mean inflation time of distal tourniquet was prolonged in Group LD as compared to Group L (Table 2). The duration of postoperative analgesia was prolonged in Group LD as compared to Group L (Table 2). The haemodynamic variables were comparable between both the groups during the entire study period.

The intraoperative NRS scores for tourniquet pain intraoperatively and postoperative pain for the first 5 hours after tourniquet deflation were significantly less in Group LD as compared to Group L. (Figure 1). Sedation scores were comparable between the two groups at all time period except for 40 mins intraoperatively and first 1-hour post tourniquet deflation, during which participants in Group LD were more sedated than Group L ($p<0.001$). (Figure 2 and 3).

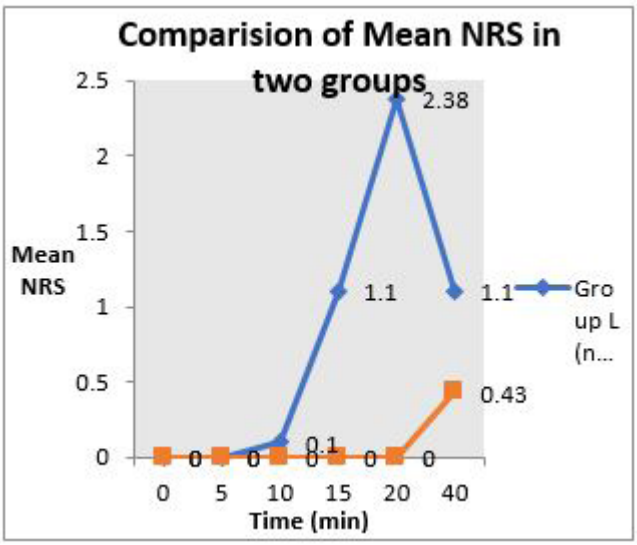
None of the patients in any group developed hypotension, bradycardia, hypoxemia during surgery or during the first 24 hours postoperative

Baseline characteristics			Group L(n=21)	Group LD (n=21)	P value
Age		Mean +/- SD	26.57+/- 6.58	35.01+/-13.08	0.8367
Gender	Males	Number	5 (23.81)	7(33.33)	0.4667
	Females	(percentage)	16 (76.19)	14(66.67)	
Weight		Mean +/- SD	67.76+/-12.08	60.19+/-13.88	0.6977
Height			161.62+/- 5.38	157.57+/-7.34	0.0583
BMI			23.64+/- 3.99	24.09+/- 4.51	0.7351
ASA	Grade 1	Number (percentage)	20 (95.24)	20 (95.24)	1.000
	Grade 2		1 (4.76)	1 (4.76)	

Table 1: Demographic Data

	GROUP L (N= 21)	GROUP LD (N=21)
ONSET OF SENSORY BLOCK (MIN)	5.19±0.81	2.52±0.51
ONSET OF MOTOR BLOCK (MIN)	11.52±1.5	7.61±0.8
INFLATION TIME OF DISTAL CUFF (MIN)	22.24±3.14	38.6±4.93
INTRAOPERATIVE FENTANYL REQUIREMENT (MCG) %	14.21	85.79
TIME REQUIRED TO FIRST RESCUE ANALGESIA (HOUR)	2.61±1.24	5.04±0.92

Table 2: Sensory and motor characteristics, inflation time of distal cuff duration of analgesia among the groups



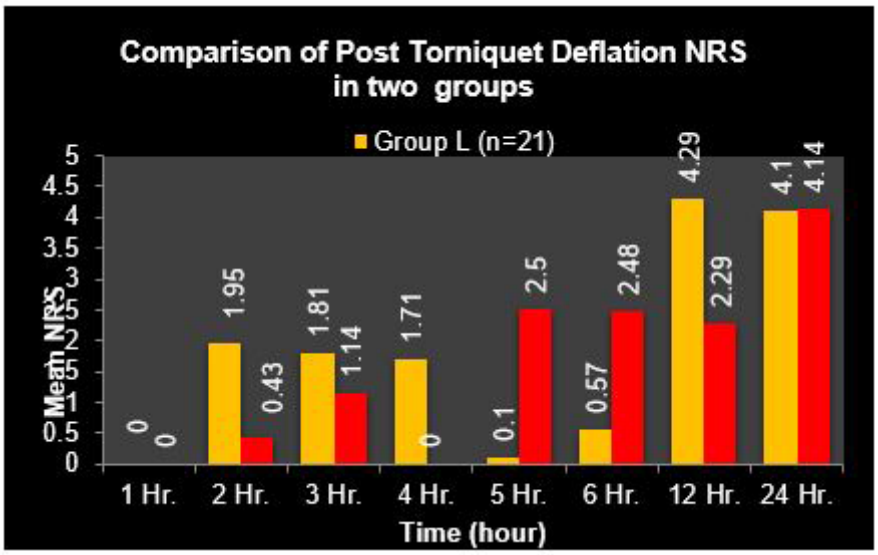


Figure 1: Intraoperative and Postoperative Nrs Score

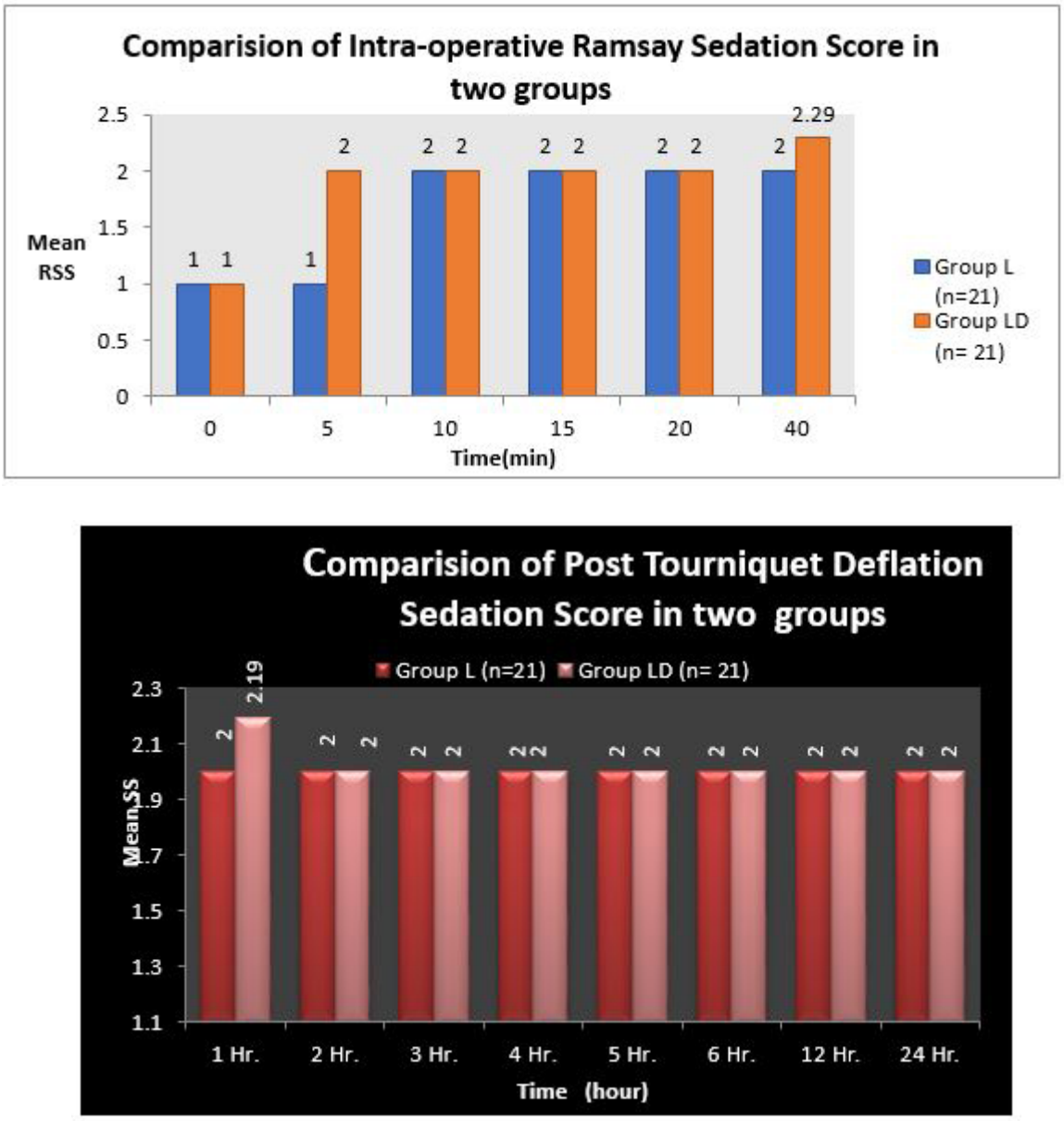


Figure 2: Sedation Scores Intraoperative and Postoperative

Discussion

The present study demonstrates that the use of dexmedetomidine 0.5 μg/kg as adjuvant to lignocaine for IVRA provides better quality of block, leads to earlier onset of sensory and motor block, prolongs the time required to inflate the distal cuff, prolongs the duration of postoperative analgesia without any significant side effect. These observations were associated with more sedation in group LD which was short lived.

This result of this study is similar to the other studies [15,16,17,18,19,] which demonstrated improved the quality of anaesthesia and prolonged the postoperative analgesia with dexmedetomidine. Sardesai *et al.* [19] and Esmaoglu *et al.* [17] used dexmedetomidine in the dose of 1 μg/kg whereas Memis *et al.* [16] used it in the dose of 0.5 μg/kg and found that Dexmedetomidine was effective in both doses. But Gupta *et al.* [18] who compared two different doses of dexmedetomidine and found it to be superior in terms of onset of sensory, onset of motor block, and duration of analgesia when dexmedetomidine was used in the dose of 1 μg/kg when compared to 0.5 μg/kg.

Tourniquet pain, which is a dull aching sensation, is a disadvantage with IVRA. This was also found to be significantly less in the present study with the use of dexmedetomidine as demonstrated by lower NRS scores and less fentanyl requirement in the intraoperative period.

α_2-adrenergic receptors at the nerve endings are thought to play a role in the analgesic effect of the drug by preventing norepinephrine release. [20,21] The actions of dexmedetomidine as found to be mediated via postsynaptic α_2-adrenoceptors activate G-proteins, thereby increasing conductance through potassium channels. Studies in mice have demonstrated that the α_{2A}-adrenoceptor subtype is responsible for relaying the sedative and analgesic properties of dexmedetomidine. [20,21 ,22] Thus, α_2-agonists are an attractive option as an adjuvant in pain management because of their potentiation at central and peripheral sites. [14]

Following deflation of tourniquet, patients in dexmedetomidine group had higher sedation scores for the first 1 h. Tourniquet deflation can lead to an abrupt introduction of dexmedetomidine into the systemic circulation. Acute intravenous administration of dexmedetomidine is known to produce hypotension, bradycardia, and also sedation. [23,24]

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