Comparison of lidocaine–dexmedetomidine and lidocaine–saline on the characteristics of the modified forearm bier block: A clinical trial

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Abstract

Background and Aims: Forearm Modified Bier Block (FMBB) reduces local anesthetic systemic toxicity risks compared to the traditional method. This study was designed and implemented to compare the effects of lidocaine–dexmedetomidine (LD) and lidocaine–saline (LS) on the characteristics of the MFBB in distal forearm and hand surgery.

Material and Methods: In this randomized double-blind trial, which was conducted after obtaining institutional ethical committee approval, 60 patients were enrolled and randomly divided into two groups. In both groups, the analgesic base of the block was 20 mL lidocaine 0.5% that was supplemented by 1 μg/kg dexmedetomidine in the LD group or 1 mL of 0.9% saline in the LS group. Patients were evaluated for the onset and duration of sensory block, time of the first request for postoperative analgesic, and analgesic request frequency during the first 24 h after surgery.

Results: Sensory block onset in the LD group (7.1 ± 1.4 min) compared to the LS group (8.4 ± 1.4) was faster ($P = 0.008$). Duration of the sensory block in LD group (49.7 ± 7.2 min) was longer than LS group (33.3 ± 2.6) ($P < 0.001$). Compared to LS group, time of the first request for postoperative analgesic in LD group was later ($P = 0.6$), and had lesser analgesic requests during the first 24 h after surgery ($P < 0.001$).

Conclusion: Based on our study's finding, adding dexmedetomidine to lidocaine in the MFBB increases the duration of sensory block.

Keywords: Analgesics, anesthesia, dexmedetomidine, nerve block, pain

Introduction

Intravenous regional anesthesia (IVRA) has advantages such as being as easy and simple procedure, being less invasive, having a high effect rate, resulting in good muscle relaxation, being a controllable anesthesia, not damaging peripheral nerves, and leading to quick recovery.[1]

The advantages of forearm tourniquet named hereinafter Modified Forearm Bier Block (MFBB) compared to the traditional IVRA included but not limited to the following: using a single tourniquet, using a lower local anesthetic medication dosage for a good quality of analgesia, having less tourniquet inflation time, having shorter sensory beginning time, and having less ischemic postoperative pain. These

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advantages make this method an ideal anesthetic method for short ambulatory operations of hand and wrist that last less than 30 min.[2,3]

In order to enhance the quality of regional blocks in the presence of fixed doses of local anesthetics, supplementary opioids (fentanyl, morphine, and tramadol), ketamine, midazolam, and clonidine has been utilized.[4] Dexmedetomidine is a selective alpha 2 agonist receptor that has sedative and analgesic properties and it has been used as a major supplement to local anesthetics in recent years.[5,6]

It seems that adding dexmedetomidine to local anesthetics in regional nerve blocks modulate pain pathways within the dorsal horn of the spinal cord by plummeting release of substance P, so it can be effective for postoperative pain control and increasing block duration and quality.[5] However, very few reports to date have evaluated effects of dexmedetomidine as an additive to local anesthetics in IVRA.[6-8] Therefore, in the present study we compared the effects of adding dexmedetomidine or saline to lidocaine on the properties of the MFBB in distal forearm and hand surgery.

Material and Methods

After approval by the Independent Ethics Committee of our institution (Ethic ID: IR.MUK.REC.1396.259 approved at 11-12-2017), registration of study in Iranian Registry of Clinical Trials (IRCT20170823035874N2), and written informed consent, this randomized double-blind clinical trial was performed on 60 selected patients from January 2018 to December 2018. Patients were electively scheduled for soft tissue surgery or distal forearm/hand fractures and dislocation close reductions. The patients were randomly divided into two groups using blocks randomization method. The inclusion criteria of the study were being 18 years old or older and having American Society of Anesthesiologist Physical Status I or II. The patients with history of cardiovascular disease, dyspnea, diabetes, allergy to local anesthetics, sickle cell disease, kidney or liver disease, opioid addiction, peripheral vascular or nerve disease, alcoholism, epilepsy or antiepileptic medications, psychiatric disorders, and the patients with crushed lesions, infection, cellulitis, edema of the upper limb, pregnancy, and severe pain during surgery that led to changing the anesthesia method were excluded.

Anesthesia methods were explained to the patients, and they were provided with a complete packet about the aims and methods of research the night before their surgery. The next morning, they were asked to sign the informed consent form. All patients were fasting 8 h for solids and 4 h for clear liquids. At the operating room (OR), standard heart monitoring (ECG), noninvasive blood pressure (NIBP) and pulse oximeter (SPO2) were mounted. Then, basal heart rate (HR) and mean arterial blood pressure (MAP) were recorded, a 20G venous cannula was fixed in the patient's non-injured hand, and infusion of 5 mL/kg lactate ringer fluid was started.

A 22G cannula was fixed into the distal of the surgical limb. The limb's blood was drained by placing it above the heart for 3 min and wrapping it with esmarch bandage. Then, a strip of webril bandage was wrapped over the proximal elbow and a single tourniquet was applied. The tourniquet was inflated to a pressure of 150 mmHg higher than the patient's initial systole blood pressure. A double-blinded intravenous anesthetic drug that was previously prepared and labeled by the pharmacy was infused by an anesthesiologist at a rate of 1 mL/s, and the venous cannula was removed. The start of injection was recorded as the base time of the block. During the operation, patients received 5 L/min supplementary oxygen through a face mask.

In each of the two groups, the base of the MFBB contained 20 mL of 0.5% lidocaine. In one group 1 µg/kg of dexmedetomidine (LD) and in the other group, 1 mL of 0.9% saline (LS) was added to the lidocaine. The patients were placed into sextet blocks and randomly divided into groups LD and LS by one of the colleagues. Hospital pharmacy was responsible for coding, and labeling of the intervention medications. Anesthesia induction and monitoring of patients in the operating room were performed by anesthesiologists who were not aware of the coding. Anesthesiology residents who were not aware of coding were responsible for evaluating the patients in PACU and ward.

The primary outcome of the study was duration of sensory block. Duration of sensory block was recorded from the time the tourniquet inflated to the time of sensation recovery. Secondary outcomes of the study included sensory and motor block onset, duration of surgery, tourniquet time, time of the first request for analgesic, analgesic request frequency within 24 h after surgery, level of sedation, hemodynamic changes, complications of the block, and surgeon's satisfaction with the anesthesia method.

The sensory block was evaluated by using a hypodermic needle with a short bevel using a pinprick method every 30 s. When the patient had no sensation, it was recorded as sensory block onset. Motor block was evaluated by voluntary movement of the fingers and wrist. When the patient was unable to perform any voluntary movements, it was recorded as motor block onset.

Duration of surgery was considered from incision time to the time of dressing; tourniquet time was recorded from when the tourniquet inflated to the time of deflation. The time of the first request for postoperative analgesic was documented when the patients requested analgesic for the first time after surgery. The total dose of analgesic used within 24 h was recorded as the total dose of ketorolac ordered within 24 h after surgery. Level of sedation was evaluated using four-point Modified Ramsay Sedation Score (1 = Anxious/restless or both, 2 = Cooperative, orientated and tranquil, 3 = Responding to commands, 4 = Brisk response to stimulus) every 10 min from when the tourniquet inflated to the time of discharge from PACU. Hemodynamic parameters, including MAP and HR, were recorded at baseline in OR every 30 min for 12 h and then hourly for 24 h. The surgeon's satisfaction with the anesthesia method was also measured and noted using the four-point Likert scale (1 = very satisfied, 2 = satisfied, 3 = dissatisfied, 4 = very dissatisfied). For postoperative pain relief, intravenous ketorolac 30 mg slowly intravenous injection as needed was ordered.

To calculate the sample size, $\alpha = 0.05$, $\beta = 0.20$, and 40% differences for the duration of sensory block, as primary outcome, between the two groups were considered.

$$N = 2 \times \left(\frac{z_{1-\alpha} + z_{1-\beta}}{d - \delta_0} \right)^2 \times p \times (1 - p)$$

The data were analyzed using Stata 13 software. For analyzing, descriptive variables such as mean, standard deviation, frequency, and relative frequency and descriptive charts were used.

Independent *t*-test and ANOVA were used to analyze the analytical data, and non-parametric methods (Mann–Whitney and Kruskal–Wallis) were used in case they did not present the assumptions for the tests. The Chi-square test was used to examine the association of the grouped variables such as gender.

Results

During the study, 82 patients were eligible, 12 patients refused to participate in research. In 2 patients, the anesthesia method was changed due to pain during the surgery. Six patients met exclusion criteria (1 epilepsy, 3 drugs and alcohol addiction, 1 chronic kidney diseases, and 1 chronic bronchitis), finally, 62 patients completed the study and data of 59 of them were analyzed [Figure 1].

There was no significant difference in age and gender distribution, tourniquet time, and surgical duration between the two groups ($P = 0.2$) [Table 1]. Sensory block onset in the LD group was significantly faster than LS group (7.1 min vs. 8.4 min) ($P = 0.008$), and the duration of the sensory block in the LD group was significantly longer than LS group (49.7 vs. 33.3 min) ($P < 0.001$) [Table 2]. In the LD group, compared with the LS group, the time of the first request (9.9 vs. 7.3 h) for postoperative analgesic was longer ($P = 0.6$), had reduced analgesic requests, and total dose during the first 24 h after surgery ($P < 0.001$) [Table 2]. Table 3 reveals that the combination of lidocaine with dexmedetomidine significantly increases intra and postoperative analgesia in the patient ($P = 0.04$) and the surgeon's satisfaction during surgery ($P = 0.01$) [Table 3]. The trend of MAP and HR changes were the same in two groups, and there was no significant difference between groups in terms of changes in MAP and HR during the study ($P > 0.05$). However, there was a change in MAP over time within the groups as the MAP decreased over the time ($P = 0.000$) [Figure 2]. The changes in HR also had a reducing trend within the groups over time ($P = 0.000$) [Figure 3].

Discussion

We observed from this study that adding dexmedetomidine to lidocaine in the MFBB prolongs the time of sensory block and consequently the first request for postoperative analgesic, reduced analgesic request frequency during the first 24 h after surgery, and accelerate the onset of sensory block. To the best of our knowledge, the effects of dexmedetomidine were not investigated in the MFBB; however, few studies exist about the effect of adding dexmedetomidine to lidocaine in the traditional IVRA.

Sardesai *et al.* performed a study on 60 patients who had forearm surgery, dividing them into two equal groups. They did IVRA with 40 mL lidocaine 0.5% as a base of anesthesia and added 1 μg/kg clonidine in one group and 1 μg/kg dexmedetomidine in another group.[5] In that study, dexmedetomidine resulted in a faster onset of sensory block and a delayed recovery compared to clonidine. Furthermore, visual analogue scale (VAS) was higher in the clonidine group at 10, 15, and 40 min during surgery and 30 min and 2 h after surgery.[5]

Memiş D *et al.* also evaluated the effect of adding dexmedetomidine to lidocaine in IVRA in 30 patients who underwent hand surgery. They investigated the quality of the anesthesia, onset and duration of blocks, hemodynamic changes during surgery, and perioperative analgesia. They concluded that combination of dexmedetomidine-lidocaine resulted in improvement of anesthesia quality and perioperative analgesia without producing side effects.[8] In the study of

Table 1: Demographic and clinical characteristics of study participants

Variable	Lidocaine-saline (*n*=29)	lidocaine -Dexmeditomidine (*n*=30)	P
Sex, *n* (%)			0.6
Male	23 (79.3)	24 (80.0)	
Female	6 (20.7)	6 (20.0)	
Age year, (mean±SD)	33.8±3.7	40.9±20.4	0.2
Duration of surgery (min),(mean±SD)	15±3	14±4	0.2
Tourniquet application time (min), (mean±SD)	24±3	22±4	0.2

Table 2: Block properties and analgesia requirements between two study groups

Variable	Lidocaine-saline (*n*=9)	lidocaine -Dexmediyomidine (*n*=30)	P
Time for sensory block onset (min), (mean±SD)	8.4±1.4	7.1±1.4	0.008*
Duration of sensory block (min), (mean±SD)	33.3±2.6	49.7±7.2	<0.001*
Analgesia request for first time (hour), (mean±SD)	7.31±2.6	9.90±2.3	0.6
N. of analgesic request, *n* (%)			
No analgesic request	2 (6.9)	14 (46.7)	<0.001**
1 time	8 (27.6)	13 (43.3)	
2 times	5 (17.2)	3 (10.0)	
3 times	14 (48.3)	0 (0)	

*Independent sample t-test. **Fischer exact test*

Table 3: Comparison of RAMSY Sedation Score and Surgeon satisfaction from anesthesia between two study groups

	Lidocaine-saline (*n*=29)	lidocaine -Dexmediyomidine (*n*=30)	P
RAMSY Sedation Score			0.04*
0	0	0	
1	17 (58.6%)	9 (30.0%)	
2	12 (41.4%)	21 (70.0%)	
3	0	0	
Surgeon satisfaction from anesthesia			0.01‡
1	0	0	
2	3 (10.4)	2 (6.7%)	
3	15 (51.7)	1 (3.3%)	
4	11 (37.9%)	27 (90.0%)	

There were significant differences between LM -LS, and LD-Ls groups (Tukey test). ‡There were significant differences between LM -LS, LD-Ls groups (Tukey test)

Kol IO *et al.*, dexmedetomidine induced a faster onset of a sensory-motor block and a delayed recovery compared to lornoxicam and placebo.[9]

Gupta B *et al.* also concluded that adding dexmedetomidine when added to IVRA significantly improves the intraoperative conditions by providing greater excellence of block and delivers longer duration of analgesia in IVRA.[10]

Abdelkader AA *et al.* investigated the effects of adding dexmedetomidine to lidocaine on the properties of the IVRA for upper limb surgeries. They showed that dexmedetomidine was safe in this anesthesia method, shortened onset of block, improved the quality of the sensory-motor block, and prolonged postoperative analgesia.[11]

In our study, dexmedetomidine effectiveness on the properties of the IVRA was consistent with all of the above mentioned studies.[7-11] Gupta A *et al.* added two different doses of

dexmedetomidine to lidocaine in IVRA and concluded that adding 1 μg/kg compared with 0.5 μg/kg improved the block quality and analgesia after surgery.[12] Like Gupta A *et al.* we used 1 μg/kg dexmedetomidine and get the same result regarding postoperative analgesia.

In contrast with our results, Gandhi R *et al.* in their study added dexmedetomidine to bupivacaine in the brachial plexus block, and concluded that dexmedetomidine not only had no effect on the duration of the sensory-motor block, but also delayed its onset.[13] A possible explanation for this contradiction can be associated with the type of local anesthetic (bupivacaine versus lidocaine) and injection method (intravenous versus perineural).

Dexmedetomidine is a selective agonist of alpha 2 receptors with the tendency of 8 times more than another member of this drug group (clonidine). The sedation and analgesic mechanism of adrenergic α2 receptors are not fully understood, but they seem
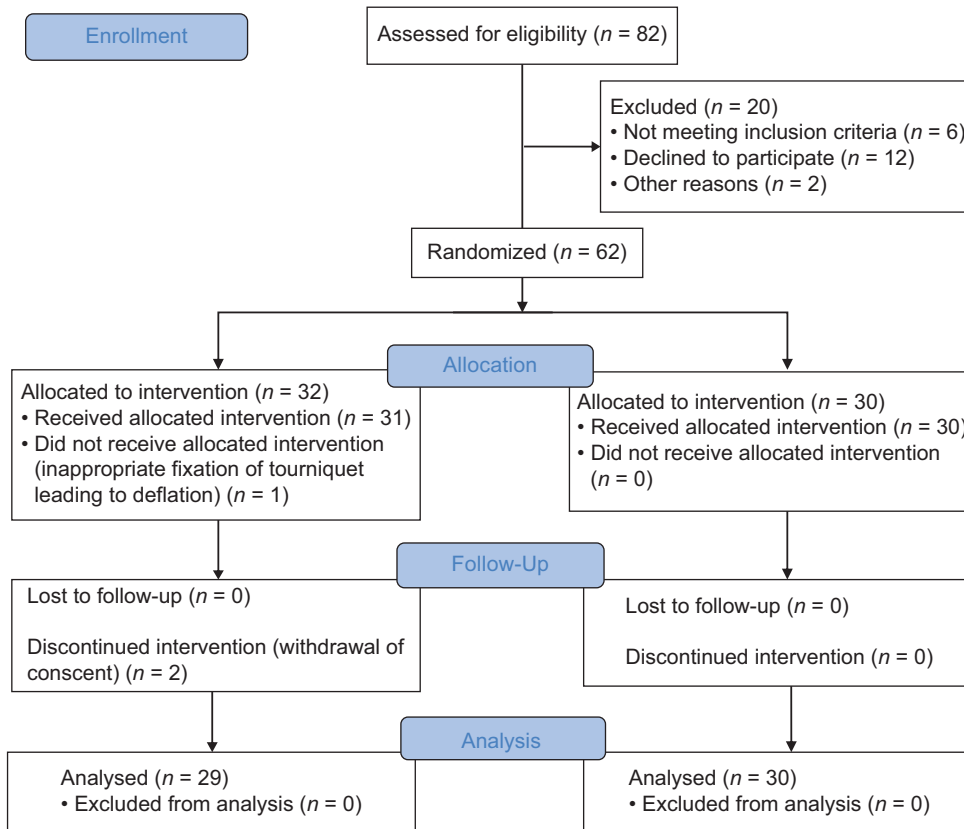
Figure 1: Flowchart of the study

to be multifactorial.[14] In the central nerves, dexmedetomidine inhibits the substance P in the nociceptive path at the surface of the dorsal root neuron, and also by activating alpha 2 receptors in the locus coeruleus causes sedation and analgesia.[15] In central nerves, $\alpha 2$ agonists can cause sedation and analgesia by decreasing norepinephrine release or independent inhibitory effects on the action potential of nerve fibers.[14]

In the present study adding dexmedetomidine to lidocaine increased the sedation rate after the tourniquet release. Sedation is not an undesirable complication in surgical patients since mild sedation could increase the satisfaction of the patient.

Lack of motor block during and after surgery in patients of both groups was the remarkable point of the present study, which is not consistent with other studies.[8-11] Possible causes included low volume and doses of lidocaine and less anatomical area of the block. The limited A-fibers block due to lower doses of lidocaine can be another possible reason for the lack of block.[15]

In this study, all of patients in the two groups tolerated the MFBB without complications, and the surgeons were well satisfied with the anesthetic method. Chiao *et al.* compared
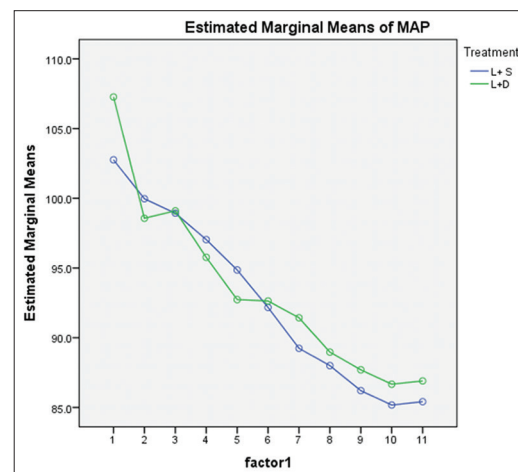

Figure 2: Trend of MAP changes during study time. There is no significant change in MAP inter group changes while Intragroup changes of MAP have significant decrease during study time in two groups

the vital signs and VAS in patients who underwent upper limb surgery through the forearm or traditional IVRA and concluded that forearm tourniquet caused less discomfort, less requirement to interfere with analgesia, and a higher number of patients bypassing the recovery.[2]

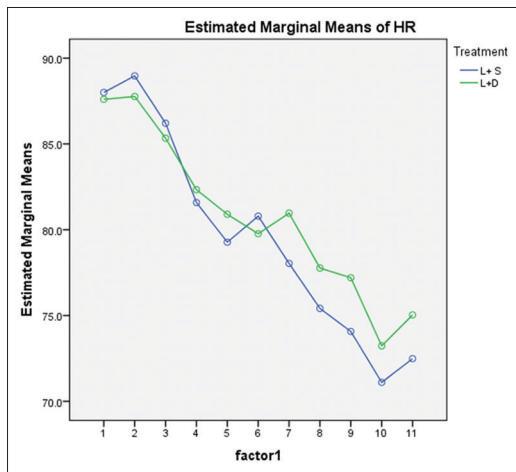Arslanian *et al.* also conducted a retrospective study on 120 patients to introduce the forearm bier block. They

Figure 3: Trend of HR changes during study time. There is no significant difference in Inter group changes of HR while intragroup changes displayed significant decrease in HR during study time in two groups

stated to the advantages of the forearm technique being that it requires less lidocaine, has fewer complications, and has an early deflating of tourniquet. They considered the forearm bier block superior to the traditional method and concluded that it is a safe and effective for upper limb surgery.[16]

This study included some limitations. Firstly, during the surgery, the VAS was not examined. This could help in assessing the quality of the study from the patient's perspective. Secondly, the recovery room bypass was neglected, so the patients with recovery bypass criteria were not assessed.

Conclusion

The results of this study showed that the use of dexmedetomidine in the FMBB is safe and accelerates the onset of the block, increase the duration of analgesia, delays the time of the first request for postoperative analgesic, reduces analgesic request frequency and decrease total dose of analgesic drugs during the first 24 h after surgery.

Conflicts of interest
There are no conflicts of interest.

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