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Research Article

A Comparative Study between Intravenous Lidocaine (0.5%) and Prilocaine (0.5%) in Intravenous Regional Anesthesia (Bier's Block)

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ABSTRACT

Background: Bier's block is a reliable, straightforward, and safe technique for anesthetizing upper limb. This study aimed to compare between the effectivity of IV Lidocaine (0.5%) and IV Prilocaine (0.5%) in Bier's block in terms of onset and recovery time of sensory and motor block, tourniquet tolerance, vital signs during and after surgery, and the need for intraoperative analgesia.

Subjects and Methods: This study was conducted at Erbil Teaching Hospital and Emergency Hospital, from the period of May 2021 to October 2021. In this prospective, randomized, double-blind study, two groups of 25 patients were prepared for hand operation. Patients in group A were given IV Lidocaine (0.5%) while patients in group B were given IV Prilocaine (0.5%). Sensory and motor block and their recovery times, tourniquet pain, intra-operative analgesic needs, vital signs, and visual analog scale (VAS) scores were recorded.

Results: No significant difference was found in the onset of sensory and motor block in both Lidocaine (5.5±1.6 min) and Prilocaine (5.9±1.6 min) groups (*p*-value=0.319), while the recovery of sensory block after releasing tourniquet was significantly shorter in Prilocaine group (7.4±1.4 min vs. 5.4±0.8 min) (*p*-value=0.003). The VAS score of Prilocaine group during and after surgery was significantly higher, with more patients receiving analgesia (5 vs. 2).

Conclusions: Both IV Lidocaine (0.5%) and IV Prilocaine (0.5%) appeared to be effective local anesthetics in Bier's block of distal upper extremity, intraoperatively and postoperatively. IV Lidocaine (0.5%) provided greater analgesia, while IV Prilocaine (0.5%) exhibited quicker sensory block recovery after tourniquet cuff release.

Introduction

Bier's block or intravenous regional anesthesia (IVRA) has a major role in anesthesia for operations that involve the distal parts of upper and lower limbs (1,2). Various studies have been done using a double-lumen pneumatic tourniquet and injection of a local anesthetic agent, especially Prilocaine or Lidocaine intravenously with good results.

The intravascular blood of the involved extremity forces out by exsanguination. Immediately after that, pneumatic tourniquets are applied to inhibit blood flow to the exsanguinated area. The anesthetic drug of choice, such as Prilocaine or Lidocaine is injected into the

limb while tourniquets limit the local anesthetic drug within the desired area (3.4). IVRA is a simple, reliable, and not costly technique (2) with a success rate varying from 94% to 98% (5). But the duration of local anesthetic drugs and the time of the tourniquet application limit the use of Bier's block to short operations that last less than 60 minutes. Additionally, the fast recovery process of the Bier's block makes it highly suitable for performing surgeries in an ambulatory setting (6,7). Delayed onset of action, toxicity of local anesthetic drugs, poor muscle relaxation, tourniquet pain, and minimal postoperative analgesia are a number of limitations impacting Bier's block and its usage which needs to be take into consideration (8,9).

Local anesthetic toxicity may occur from systemic absorption of the injected drug, inadvertent intravascular injection, and rapid gush of the local anaesthetic drug into the systemic circulation due to loosening the tourniquet cuff in Bier's lock (9,10). Toxicity by the local anaesthetic drug affects the central nervous system (CNS) and cardiovascular system (CVS). Minor toxicity signs and symptoms include perioral numbness, tinnitus, agitation, confusion, drowsiness, auditory changes, and metallic taste. If not treated signs and symptoms of moderate toxicity appear, including convulsion, respiratory arrest, and coma. More sever toxicity could affect CVS in addition to the CNS leading to hypotension, and bradycardia, followed by arrhythmia, hypertension, ventricular tachycardia, ventricular fibrillation, and cardiac arrest (10,11). Treatment depends on the clinical picture. General measures include reassurance, oxygen therapy, and respiratory support to prevent acidosis. If a seizure occurs, it is treated by benzodiazepine, propofol, or thiopental. In case of cardiac arrest, advanced cardiopulmonary resuscitation (CPR) is needed with a small dose of adrenaline. Amiodarone should be used to treat ventricular arrhythmias. Lipid emulsion therapy can be used for the local anaesthetic toxicity, and should be started as soon as possible. If cardiovascular stability could not be achieved, cardiopulmonary bypass is recommended until the local anaesthetic is metabolized (10,11).

The local anesthetic of choice for IVRA should has a minimum side effect, with a fast onset of action for a sensory and motor block, minimum intraoperative pain, minimum pain from the tourniquet pressures, and extended analgesia after torniquet deflation. There are different types of local anesthetic agents and adjuncts and each has its own advantages and disadvantages, and it is difficult to select a suitable one (12). Lidocaine is the most common local anaesthetic agents used for regional anaesthesia, often combined with epinephrine (which acts as a vasopressor and extends its duration of action at a site by opposing the local vasodilatory effects of lidocaine). In USA, Lidocaine is a preferable local anaesthetic agent for IVRA (1). However, Prilocaine is mostly used for IVRA in Europe (1). It is an amide-type local anaesthetic agent with fast onset of action, and intermediate potency and duration. Prilocaine has less systemic toxicity as it is a secondary amine comparing to the tertiary amine Lidocaine (2,12).

The present study aimed to compare the time it takes for sensory and motor block to start and recover, tourniquet tolerance, the need for analgesia during and after surgery, as well as any hemodynamic adverse events that arise when using IV Lidocaine (0.5%) 3mg/kg (30 ml) and IV Prilocaine (0.5%) 3mg/kg (30 ml) during IVRA in patients undergoing carpal tunnel release surgery or ganglion excision

Subjects and Methods

This prospective randomized double-blind study was conducted at Erbil Teaching Hospital and Emergency Hospital, during the period of six months (May 2021 to October 2021), after obtaining an approval from the Iraqi Scientific Council of Anesthesia and Intensive Care Committee. A total of fifty patients participated in this study, 43 patients had Carpel Tunnel Syndrome and 7 patients were prepared for ganglion excision. The procedures were explained thoroughly to the patients, and consequently, they all signed informed consent.

The inclusion criteria included age between 30 to 76 years, ASA I and II, and weight between 70- 90 kg. Exclusion criteria included patient refusal, hypersensitivity to the local anesthetics, impaired perfusion of the limb, DVT or limb thrombophlebitis, non-controlled hypertension, neuropathies, arrhythmias, surgeries that expected to take more than 1 hour, serious burns in the operation site, scleroderma, sickle cell anemia, and Paget's disease.

Patients brought to the theater and were kept under close monitoring for mean arterial blood pressure (MAP), oxygen saturation (SpO_2), and heart rate (HR). Double pneumatic tourniquets were placed on the upper arm to be operated. A blue color cannula (22 gauge) was placed on the back of both hands. Limb exsanguination was done by Esmarch bandage followed by inflating the proximal tourniquet to a pressure 100 mmHg higher than the patient's systolic blood pressure but no more than 250 mmHg. The effectiveness of the torniquet was confirmed by observing the limb for pallor, absence of capillary refilling, the lack of ulnar and radial pulses, and loss of pulse oximeter tracing in the ipsilateral index finger. The patients were divided into two groups, each containing 25 patients: Group A (Lidocaine) received IV Lidocaine (0.5%) 3mg/kg diluted by 30 ml of normal saline (isotonic), and group B (Prilocaine) received IV Prilocaine (0.5%) 3mg/kg diluted by 30 ml of normal saline (isotonic). The drug was injected slowly over nearly 1 minute through the cannula which was placed on the dorsum of the hand. Following the drug administration, the start of sensory loss was examined at 1-minute intervals by a pinprick examination, which was implemented in 4 positions; in the distribution of the radial nerve, ulnar nerve, median nerve, and the musculocutaneous nerve. The start of sensory anesthesia was reported as a time to loss of pinprick pain. Functions of the motor nerves were checked through examination of the flexion and extension of the wrist and fingers of the patients, while total motor block recorded if the voluntary movement was not possible. After completion of sensory and motor block, the surgery began. The MAP, SpO_2 and HR were recorded before and after the administration of the drugs at 1, 5, 10, 15 and 30 minutes and at 10 and 20 minutes after tourniquet deflation.

The visual analog scale (VAS score) was used to check the grade of sensory loss ranging from 0 = free of pain to 10 = the hardest imaginable pain. It was recorded before inflating the torniquet and then after inflation at 1, 5, 10, 15 and 30 minutes and after releasing it at 10 and 20 minutes and at 1, 2, 4 and 6 hr postoperatively in the ward. Fentanyl (1 µg/kg) was injected during operation for tourniquet pain relief if the VAS score was higher than 4 out of 10. Seven patients who required fentanyl were recorded (2 patients in Lidocaine group and 5 patients in Prilocaine group). Tourniquet pain was checked at 5 minutes intervals after inflation of the proximal cuff. If the pain of the

pressure of the proximal cuff became unbearable, the distal cuff was inflated and then the proximal cuff was released. In both groups, the time until the patient became unbearable of the proximal cuff pressure was recorded.

After the operation was accomplished, the distal cuff deflated slowly and the appearance of pain was checked at 1 minute intervals. In all patients, the time of the operation, the time of the tourniquet (proximal and distal cuff), and the time it took for the senses to recover was observed (time needed from tourniquet deflation until the pain recovery in all innervated areas indicated by pinprick test applied in 30 seconds intervals). The time it took for a motor block to recover was also observed (the time needed after deflating the tourniquet up to the fingers' movement).

Microsoft Excel 2016 was used to process the data. Chi square test was utilized in comparing proportions, and Fisher's exact test was carried out when the expected frequency (value) was less than 5 of more than 20% of the cells of the table. Student's t test of two independent samples (unpaired t test) was carried out to compare the means of two samples. Shapiro-Wilk test was used to test for the normality of data, accordingly, the Wilcoxon signed rank test (non-parametric test) was used whenever it is applicable to compare the median of the same sample but in two different time periods. A p value ≤ 0.05 was considered statistically significant.

Results

Following IV injection of Lidocaine and Prilocaine, there was no significant difference in the beginning of sensory block between the two groups, but the recovery of sensory block was substantially shorter in the Prilocaine group compared to the Lidocaine group after tourniquet removal. With regard to the motor block onset time and recovery time, there were no significant differences between the two groups (Table 1).

Table 1: The onset of sensory and motor block and recovery time.

	Lidocaine (0.5%)	Prilocaine (0.5%)	P value
Sensory block onset (minute)	5.5 ± 1.6	5.9 ± 1.6	0.319
Sensory recovery time (minute)	7.4 ± 1.4	5.4 ± 0.8	0.003 *
Motor block onset (minute)	6.5 ± 1.2	6.0 ± 1.4	0.331
Motor recovery time (minute)	6.9 ± 1.4	7.0 ± 1.2	0.464

* Statistically significant

The VAS score in the Prilocaine group was substantially higher after tourniquet inflation at 15 and 30 minutes, as well as 10 and 20 minutes after deflation. Patients who got intraoperative analgesia (fentanyl 1 μg/kg) in the Prilocaine group (5 patients) exceeded those in the Lidocaine group (2 patients) (Table 2).

Table 2: VAS score changes after tourniquet inflation and deflation.

VAS score	Lidocaine 0.5%	Prilocaine 0.5%	P value
1 minute after tourniquet inflation	3.3 ± 0.7	3.2 ± 0.7	0.434
5 minutes after tourniquet inflation	3.4 ± 0.8	4.2 ± 1.5	0.23
10 minutes after tourniquet inflation	4.1 ± 0.8	4.1 ± 0.5	0.5
15 minutes after tourniquet inflation	3.8 ± 1.1	4.1 ± 0.8	0.001*
30 minutes after tourniquet inflation	4.8 ± 1.6	5.1 ± 1.2	0.001*
10 minutes after tourniquet deflation	4.7 ± 1.1	5.2 ± 0.7	0.001*
20 minutes after tourniquet deflation	3.6 ± 1.4	4.1 ± 1.0	0.001*

* Statistically significant

Regarding the HR, there was no significant difference between the two groups (Table 3).

Table 3: HR changes after drug injection and tourniquet deflation.

HR	Lidocaine (0.5%)	Prilocaine (0.5%)	P value
Before tourniquet inflation	97.7 ± 6.4	97.1 ±9.0	0.464
1 minute after drug injection	97.4 ±6.5	98 .0 ± 9.6	0.466
5 minutes after drug injection	96.9 ± 8.1	99.6 ± 13.4	0.39
10 minutes after drug injection	97.1 ± 7.9	97.5 ± 10.5	0.412
15 minutes after drug injection	98.0 ± 7.0	95.2 ± 12.0	0.372
30 minutes after drug injection	96.0 ± 9.1	95.1 ± 3.3	0.439
10 minutes after tourniquet deflation	95.1 ± 9.8	94.2 ± 11.5	0.461
20 minutes after tourniquet deflation	90.3 ± 8.7	92.6 ± 9.1	0.383

Regarding SpO2, there was no significant difference between the two groups (Table 4).

Table 4: SpO_2 changes after drug injection and tourniquet deflation.

SpO_2	Lidocaine (0.5%)	Prilocaine (0.5%)	p-value
Before tourniquet inflation	99.1 ± 0.5	99.7 ± 0.3	0.074
1 minute after drug injection	99.1 ± 0.4	99.5 ± 0.5	0.17
5 minutes after drug injection	99.1 ± 0.9	99.6 ± 0.4	0.214
10 minutes after drug injection	99.3 ± 0.6	99.2 ± 0.8	0.435
15 minutes after drug injection	99.4 ± 0.6	99.3 ± 0.7	0.43
30 minutes after drug injection	99.6 ± 0.4	99.0 ± 0.4	0.07
10 minutes after tourniquet deflation	99.3 ± 0.7	99.4 ± 0.6	0.43
20 minutes after tourniquet deflation	99.5 ± 0.5	99.6 ± 0.4	0.4

Regarding MAP, there was no significant difference between the two groups (Figure 1).

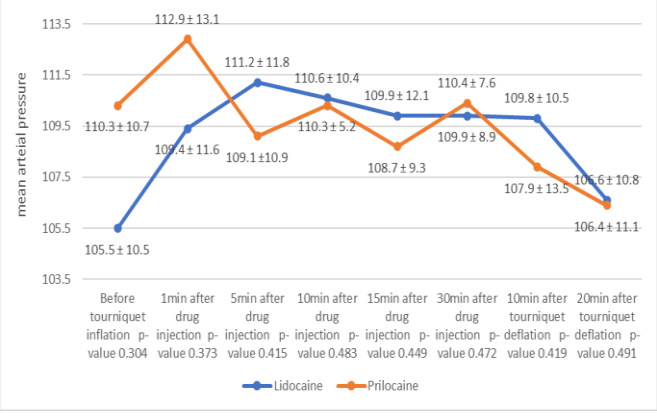

Figure 1: MAP changes after drug injection and tourniquet deflation.

Discussion

In the literature, both Prilocaine and Lidocaine are greatly preferable local anaesthetic agents for IVRA. Prilocaine is more preferable in Europe whereas Lidocaine is preferable in the USA (1). Bier's block was successfully employed in all in the present study. This confirms the works of Santhosh et al (13) and Enroth et al (14) that Bier's block was possible and safe in the cases of upper limb surgeries. Their practise of IVRA was successful and without any toxicity from the local anaesthetic agents had indicated that this is a harmless and effective technique. Using an objective grading method for intraoperative pain, Davidson et al (15) found that Lidocaine (0.5%) was more effective than Prilocaine (0.5%) in providing pain relief. Similar results were demonstrated by this study in which after 15, 30 minutes of tourniquet inflation and 10, 20 minutes of tourniquet deflation, the VAS score in the Prilocaine group was considerably higher.

In the present study, none of the patients had any form of sedation or supplement medication. Also, none of the patients required general anaesthesia. Only 7 patients had pain intraoperatively and received fentanyl (1 µg/kg), 2 patients in the Lidocaine group and 5 patients in the Prilocaine group.

Our study showed that there was no significant difference in the onset of sensory block between the two groups after the drug injections. But, the recovery of sensory block was substantially quicker in the Prilocaine group than in the Lidocaine group (*p*-value = 0.003). Ulus et al (16) utilized different concentration of Lidocaine (2% vs. 0.5%) and found more rapid onset and delayed recovery of sensory block by Lidocaine (2%) concentration. Turan et al (17) added neostigmine to Prilocaine and observed more rapid onset and delayed sensory recovery.

There was no statistically significant difference between the two groups in our study with regard to motor block onset time and motor block recovery duration. In Ulus et al study (16), the onset time of motor block in group 1 (Lidocaine 2%) was shorter than in group 2 (Lidocaine 0.5%), while the recovery time of motor block was longer in group 1 compared to group 2. Also in Turan et al study (17), a shorter onset time and longer recovery time of motor block were noted on adding neostigmine to Prilocaine.

The local anaesthetic toxicity is the most important and dangerous complications of IVRA, which occurs due to accidental entry of the local anaesthetic agents into the systemic circulation by sudden release of the tourniquet or at the end of the operation following rapid deflation of the tourniquet (10,18). In our study, no complications or side effects have occurred. In contrary to our findings, Niemi et al (19) recorded that one patient had postoperative blurred vision and dizziness on giving prilocaine (0.5%) and Asik et al (20) reported more cases of metallic taste, tinnitus, and light-headedness after giving Lidocaine (0.5%). Gurich et al (21) reported five side effects among 430 patients included in their study. One patient had intraoperative vomiting, two patients had postoperative nausea and vomiting, and one patient had postoperative hypotension.

Supplemental medications improve the safety of IVRA by stimulating anaesthetic action and decreasing side effects. For instance, benzodiazepine is mainly used to avoid seizures and fentanyl is used to improve nerve blockage (22). In the present study, adjuvants were not added to the Lidocaine solution that was administered to the studied patients. Many recently published studies have assessed improving the protocol of the procedure by using adjuvants such as fentanyl, pethidine, benzodiazepines, dexmedetomidine or reduced doses of LA with more distal tourniquets (23,24).

No statistically significant difference was identified between the two groups during and after operation in terms of MAP, HR, and SpO_2. This is in agreement with the study of Peng et al (25) that demonstrated the same results.

Conclusion

Both IV Lidocaine (0.5%) and IV Prilocaine (0.5%) are effective and safe local anaesthetics in IVRA for upper limb surgery. Lidocaine provides more analgesia intra and postoperatively, and it is advised for longer procedures, while Prilocaine discloses rapid sensory block recovery after removing the tourniquet.

Conflict of Interest

The authors report that there were no any conflicts of interest.

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Data availability

Data research data are accessible on reasonable inquiry

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