Effect of neostigmine versus dexamethasone on quality of intravenous regional anesthesia: a randomized double-blinded controlled study

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Background
Pain is a great problem after surgical trauma. Acute postoperative pain incidence was reported to be more than 60% and was not adequately controlled. The authors aimed to investigate the effect of neostigmine versus dexamethasone on the duration of anesthesia and postoperative analgesia when added to lidocaine in a Bier block.
Materials and methods
This randomized double-blind controlled study was carried out on 75 patients scheduled for elective surgeries under intravenous regional anesthesia (Bier block). They were randomly allocated into three groups: group C (n=25, received intravenous 3 mg/kg lidocaine 2%), group D (n=25, received intravenous 3 mg/kg lidocaine 2%+8 mg dexamethasone), and group N (n=25, received intravenous 3 mg/kg lidocaine 2%+0.5 mg neostigmine). Visual analog scale (VAS) was used postoperatively to assess pain. Sensory and motor block characteristics and duration of postoperative analgesia were evaluated.
Results
The pain scores with the postoperative VAS data were statistically significant lower in the group D patients than those of groups C and N at 90 min, 105 min, and 120 min ($P<0.05$). Moreover, it was found that no statistically significant differences of VAS values were recorded among the three studied groups preoperatively and postoperatively at 15, 30, 45, 60, and 75 min. Duration of the postoperative analgesia was significantly longer in group D than group C and group N.
Conclusion
The addition of dexamethasone 8 mg to lidocaine 2% (3 mg/kg) during intravenous regional anesthesia provided better postoperative analgesia. When compared with the control group or the neostigmine group, dexamethasone increased the duration of postoperative analgesia.

Keywords:
analgesia, dexamethasone, intravenous regional anesthesia, neostigmine, postoperative, upper limb surgeries

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Introduction

After surgical trauma, pain is a great problem. This pain may start a mixture of mechanisms, such as inflammatory, visceral, or somatic in origin and may persist to be chronic pain if inappropriately treated. The acute postoperative pain incidence was reported to be more than 60% and not adequately controlled in spite of intensive effort [1].

Intravenous regional anesthesia (IVRA) was first described by August Gustav Bier, a German Surgeon, in 1908 for anesthesia of hand and forearm [2]. It is important especially in poor-risk patients and in emergency situations, as it is easy to administer, reliable, cost-effective, and relatively safe for operations on limbs. The patient can be discharged on the same day as there is very little anesthetic hangover. It is highly enjoyable as a rapid return to normal function almost immediately after cuff release and one is able to assess neurological signs after fracture reduction [3].

However, the resulting postoperative pain from rapid dissipation of the block is one of the limitations of this technique, as is 'tourniquet pain.' Several adjuvants such as opioids, tramadol, nonsteroidal anti-inflammatory drugs, dexmedetomidine, muscle relaxants, potassium, alkalization with sodium bicarbonate, magnesium, and nitroglycerine have been tried to overcome these problems [3–6]. The

ideal IVRA solution should have rapid onset, reduced dose of local anesthetic, reduced tourniquet pain, and prolonged postdeflation analgesia [7].

Our primary outcome was the effect of neostigmine versus dexamethasone on the duration of anesthesia and postoperative analgesia when added to lidocaine in Bier block. Secondary outcomes were to evaluate their onset and quality of anesthesia, detecting intraoperative and postoperative complications occurring with this technique and patients' satisfaction.

Materials and methods

Eligibility

The Institutional Ethics Committee, Faculty of Medicine, Assiut University, approved the current study on November 2016 (ID no. IRB17100648). Clinical Trials Registration was approved by ClinicalTrials.gov (ID no. NCT03021772). All patients were provided with complete information about anesthesia and analgesia techniques that would be delivered to them. We obtained a written informed consent from each patient scheduled for elective forearm orthopedic surgery. The study was conducted in Assiut University Hospital from January 2017 to July 2018.

Randomization and participants

This randomized double-blind controlled study, using a computer-generated randomization program, was carried out on 75 patients scheduled for elective surgeries under IVRA (Bier block). Our statistician was responsible for the computer-generated tables of random numbers and had the codes for all patients. Only the statistician had the access to the key of the closed opaque envelops. The trial was double blinded, that is, neither the investigators (doctors) nor the participants (patients) were aware of the group allocation.

A total of 75 patients were randomly allocated into three equal groups: group C included 25 patients and received intravenous 3 mg/kg lidocaine 2% for Bier block (diluted with normal saline; NaCl 0.9% to a total volume of 40 ml), group D included 25 patients and received intravenous 3 mg/kg lidocaine 2%+8 mg dexamethasone for Bier block (diluted with normal saline; NaCl 0.9% to a total volume of 40 ml), and group N included 25 patients and received intravenous 3 mg/kg lidocaine 2%+0.5 mg neostigmine for Bier block (diluted with normal saline; NaCl 0.9% to a total volume of 40 ml). Patients were included in this study who meet the following criteria: age from 20 to 60 years, both sexes, American Society of Anesthesiologists grade I–II, elective forearm orthopedic surgery, and surgical time did not exceed 90 min. Patients were excluded from the study when they met any of the following criteria: patient refusal, any contraindication to regional anesthesia (e.g. coagulopathy, infection at the needle insertion site, or vascular insufficiency), allergy to amide local anesthetics, a personal history of seizures, peripheral neurologic diseases, sickle cell anemia, liver disease, renal dysfunction, and cardiac conduction abnormalities.

Anesthetic protocol

Before the procedure

All patients in this study underwent preanesthetic checkup including detailed history and thorough general, physical, and systematic examination. Weight and height were carefully recorded. All patients fasted 6–8 h before surgery, and on arrival to the operating room, standard anesthesia monitors were applied to the patient, and the baseline readings were recorded, including ECG, heart rate (HR), noninvasive blood pressure (NIBP), and peripheral O_2 saturation (SpO_2). With no premedication, an intravenous cannula 20 or 18 G was inserted in another limb away from the surgical site, and all patients were infused the calculated volume (500–1000 ml) and rate of normal saline (NaCl 0.9%). Tourniquet was used for all surgeries, so blood loss was minimal.

Anesthetic technique

Equipment required for IVRA included pneumatic tourniquet (checked for leaks before the procedure), Esmarch bandage, study solution (local anesthetic solution and the adjuvants), and resuscitation equipment, including airway devices. Advanced cardiac life support drugs for local anesthetic toxicity were available.

Procedure

While patient was placed in the supine position, a 22 G cannula was placed intravenously as distal as possible in the arm to be anesthetized. We applied the double pneumatic tourniquet (two tourniquets each 6 cm wide) on the operated arm with generous layers of padding, ensuring that no wrinkles are formed and the tourniquet edges did not touch the skin. By using the Esmarch bandage, the arm was exsanguinated. If this was impossible, elevating the arm for 2–3 min while compressing the axillary artery could achieve exsanguination. The upper (proximal) tourniquet was

inflated to at least 100 mmHg higher than the patient's systolic blood pressure (250–300 mmHg). We confirmed circulatory isolation of arm by inspection of the color of the limb, absence of radial pulse, and loss of pulse oximetry tracing in the ipsilateral index finger. The study solution was then injected. Overall, 40 ml of a standard volume was injected into the upper limb. It was given over a period of 90 seconds through the 22 G intravenous cannula in the operated hand.

The venous pressure may exceed the tourniquet pressure, and the local anesthetic solution may escape into the systemic circulation if the injection was too rapid. The surgical team waited till surgical anesthesia was achieved.

Evaluation of motor block was by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve), and flexion at the elbow (musculocutaneous nerve) on a three-point scale for motor function (0: normal motor function, 1: reduced motor strength but able to move fingers, 2: complete motor block) [11]. Sensory block (four nerves) was assessed by a blunted needle prick using a three-point scale [0: normal sensation, 1: loss of sensation of cold (analgesia), and 2: loss of sensation of touch (anesthesia)] [12] in addition to cold sensation test. Assessment of median nerve at thenar eminence, ulnar nerve at hypothenar eminence, and first web space for radial nerve was done. Then, the distal tourniquet, which overlie part of the anesthetized arm could then be inflated to at least 100 mmHg higher than the patient's systolic blood pressure (250–300 mmHg) and the proximal one deflated to relieve tourniquet pain. Till 20 min after local anesthetic injection, the cuff should not be deflated because systemic toxic doses of local anesthetic might occur.

Cuff deflation should be performed in cycles with deflation/inflation times of less than 10 seconds until the patient no longer showed signs of systemic toxicity (e.g. tingling of the lips, tinnitus, or drowsiness). Following tourniquet release after end of surgery, the patient should be monitored closely for about 30 min.

Outcome measures

The primary outcome of this study was the visual Analogue scale (VAS) scores postoperatively to assess pain in the post-anesthesia care unit (PACU). Secondary outcomes included hemodynamic variables, sensory block characteristics, motor block characteristics, duration of postoperative analgesia, and any adverse effects related to anesthetic technique or the drugs used.

Data collection

Patients' data

Demographic data and clinical characteristics included patients' sex, age, weight, height, BMI, and American Society of Anesthesiologists classification.

Preoperative data

Basic monitoring of HR, NIBP, and SpO_2 was done. Preoperative investigations, including prothrombin time, prothrombin concentration, and International Normalized Ratio (INR) to avoid any risk of bleeding, were done. Basal assessment of motor power and sensation of the limb was done. The standard value of VAS was set as the score during passive exercise before the surgery [13].

Intraoperative data

Basic monitoring (HR, NIBP, and SpO_2) was done every 10 min till the end of surgery.

Regarding sensory and motor block, both blocks were evaluated until 20 min after injection. Onset time of sensory/motor block was defined as the time interval between the end of total study drug administration and complete block. Complete sensory block was defined by anesthetic block (score 2) on all nerve territories. Complete motor block was defined as absence of voluntary movement on hand and forearm (score 2) and recording duration of surgery (minutes).

Postoperative data

(1) Assessment of pain severity: in the PACU, the severity of postoperative pain was assessed using the VAS between 0 and 10 (0=no pain and 10=the most severe pain) every 15 min for 2 h postoperatively. Patients with VAS greater than or equal to 4 were treated with supplemental analgesia in the form of intravenous paracetamol (Perfalgan, paracetamol 1000 mg; UPSA Laboratories, Bordeaux, France) 15 mg/kg infused over 10–15 min.
(2) Recovery from sensory and motor block: Recovery from sensory block was defined as the time interval between deflation of tourniquet and return of touch sensation that was assessed by pinpricks using a three-point scale [0: normal sensation, 1: loss of sensation of cold (analgesia), and 2: loss of sensation of touch (anesthesia)] [12]. Recovery from motor block was defined as the time interval between deflation of tourniquet and

return of ability to move fingers using a three-point scale (0: normal motor function, 1: reduced motor strength but able to move fingers, and 2: complete motor block) [11].

(3) Duration of sensory and motor block: duration of sensory block was defined as the time interval between the complete sensory block and the complete resolution of anesthesia on all nerves. Duration of motor block was defined as the time interval between the complete motor block and the complete recovery of motor function of the hand and forearm.
(4) Duration of analgesia was defined as the time interval between onset of sensory block to the time of the first analgesic requirement.
(5) Documentation of any complications: it included local anesthetic toxicity and drug additive complications, for example, tinnitus and metallic taste. Lipid emulsions were prepared and ready for treating any local anesthetic toxicity.

Sample size calculation

The sample size of this study was calculated using G*Power 3 software [10] where the incidence of postoperative pain after surgeries was found to be more than 70%, and the intervention that can cause 50% reduction of this pain would be interesting. With a power of 90% and type I error of 5%, the minimum required sample size was 21 participants in each group. To compensate for dropouts, the number of patients in each group was increased to be 25 participants (total sample of 75 patients).

Statistical analysis

The collected data were verified and analyzed using SPSS version 23 (IBM-SPSS Inc., Chicago, Illinois, USA). Data were expressed as mean±SD, numbers, and percentages. For variables with more than two categories, analysis of variance test was calculated to test the mean differences of the data (age, weight, duration of surgery, sensory block characteristics, motor block characteristics, and duration of analgesia). For variables with more than two categories with repeated measures (VAS), repeated measure analysis of variance test was calculated to test the mean differences of the data over time; post-hoc test was calculated using Bonferroni corrections for pair wise analysis. *P* value less than or equal to 0.05 was considered statistically significant.

Results

Study population

A total of 80 patients were scheduled for elective forearm orthopedic surgeries; five of them were excluded before randomization. The final analysis included 75 patients. A flow diagram of the study is shown in Fig. 1. Regarding the demographic data and the clinical characteristic, there was no statistically significant difference among the three studied groups ($P>0.05$) (Table 1).

There was no statistically significant difference among the three studied groups over the intraoperative period of the study regarding the HR (Fig. 2), mean blood pressure (Fig. 3), or the oxygen saturation (Fig. 4).

Analgesia assessment

VAS score data follow-up was assessed in PACU by an anesthesiologist blinded to the study drug used or patient group allocation. VAS was recorded before induction of anesthesia (preoperative) and within 2 h after the end of surgery (postoperative). Significant pain was defined as one that had VAS more than or equal to 4 and required a supplementary dose of analgesia (intravenous paracetamol 15 mg/kg was administered). Regarding the VAS data postoperatively, it was found that the pain scores were statistically significant lower in group D patients than those of groups C and N at 90, 105, and 120 min ($P<0.05$) (Table 2). Moreover, it was found that no statistically significant differences were recorded among the three studied groups preoperatively and postoperatively at 15, 30, 45, 60, and 75 min.

Sensory and motor block

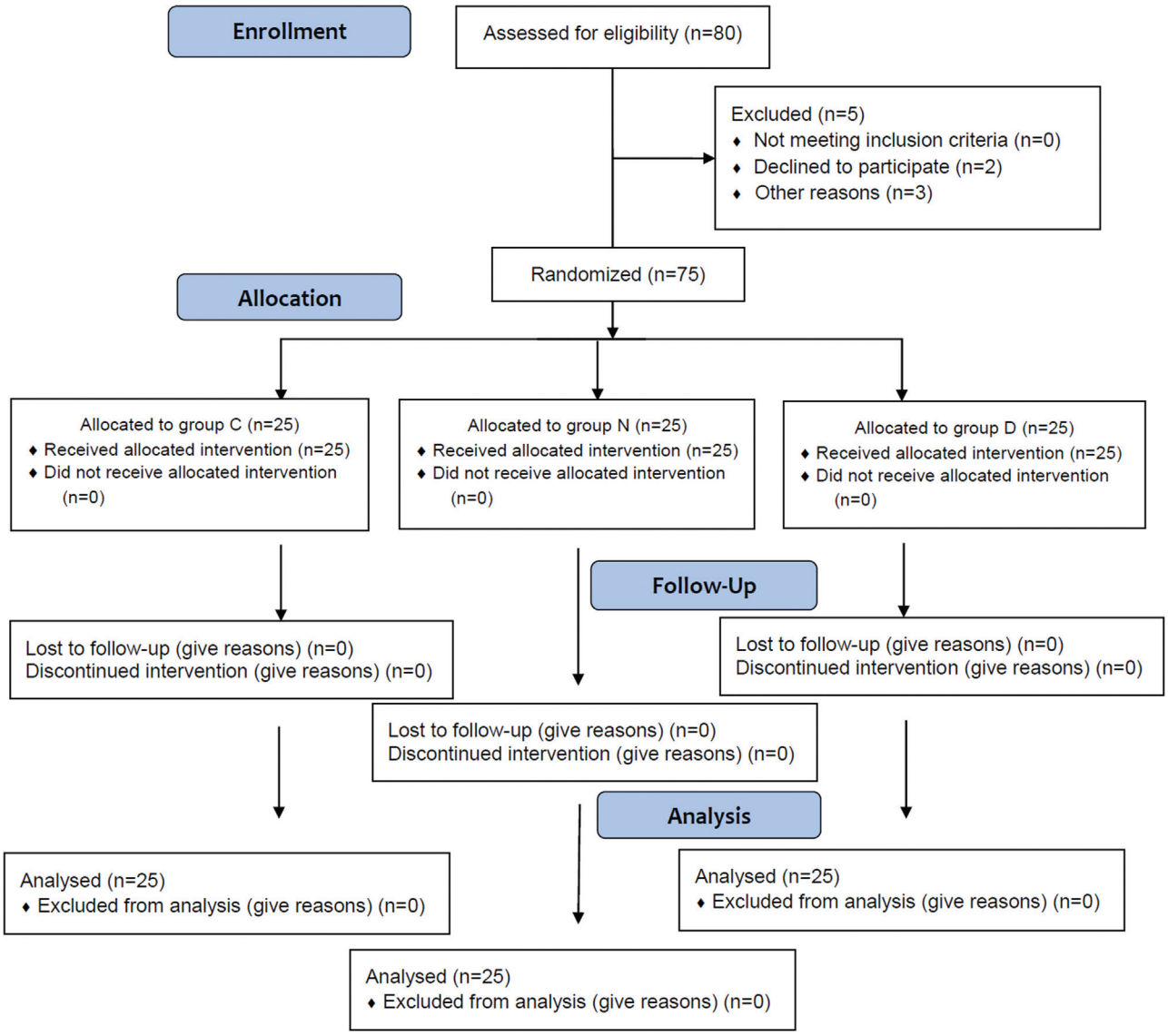
Regarding onset of sensory block, it was found that there was a statistically significant difference among the three studied groups ($P=0.003$) (Table 3). It was significantly shorter in group D than group C and group N, with *P* value less than 0.05.

Regarding onset of motor block, it was found that there was a statistically significant difference among the three studied groups ($P=0.0001$) (Table 3). It was significantly shorter in group D than group C and group N, with *P* value less than 0.05.

Regarding recovery from sensory block, it was found that there was a statistically significant difference among the three studied groups ($P=0.0001$) (Table 3). It was significantly longer in group D than group C and group N, with *P* value less than 0.05.

Regarding recovery from motor block, it was found that there was a statistically significant difference among the three studied groups ($P=0.0001$) (Table 3). It was significantly longer in group D than group C and group N, with *P* value less than 0.05.

Figure 1



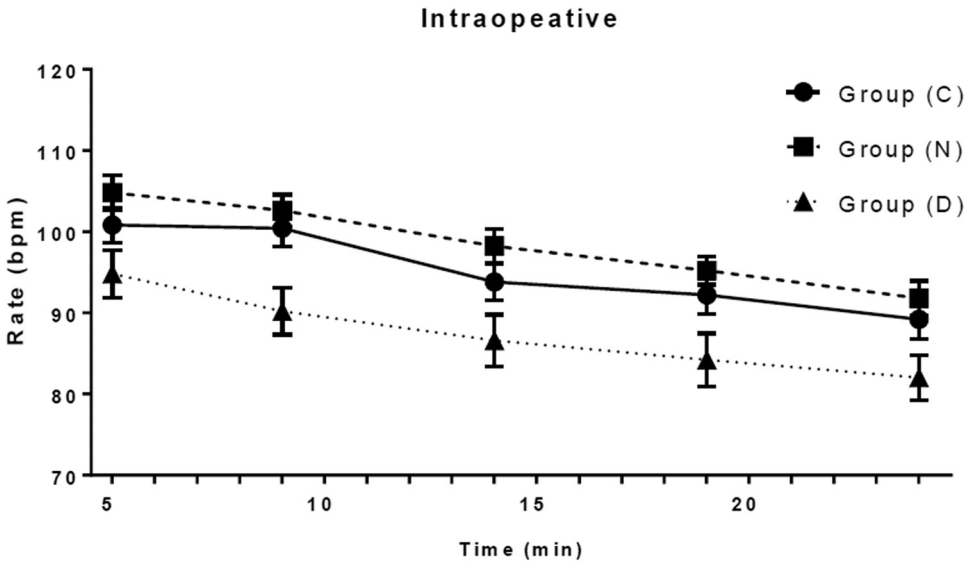
Flow diagram of the three studied groups.

Table 1 Demographic data and clinical characteristics of the three studied groups

	Group C (*n*=25)	Group N (*n*=25)	Group D (*n*=25)	*P* value*
Age (years)	37.28±2.11	35.32±2.32	38.6±2.36	0.59
P value**	P_1=0.81	P_2=0.56	P_3=0.91	
Sex				
Male	14 (56)	17 (68)	15 (60)	0.68
Female	11 (44)	8 (32)	10 (40)	
P value**	P_1=0.67	P_2=0.83	P_3=0.96	
ASA grades				
I	19 (76)	20 (80)	20 (80)	0.93
II	6 (24)	5 (20)	5 (20)	
P value**	P_1=0.94	P_2=0.99	P_3=0.94	
Height (cm)	168.6±2.34	167±2.3	169.9±1.8	0.63
P value**	P_1=0.86	P_2=0.61	P_3=0.90	
Weight (kg)	79.16±2.33	75.4±1.57	75.24±1.83	0.28
P value**	P_1=0.36	P_2=0.99	P_3=0.33	
BMI (kg/cm^2)	28.24±1.25	27.39±0.95	26.22±0.79	0.37
P value**	P_1=0.83	P_2=0.69	P_3=0.34	

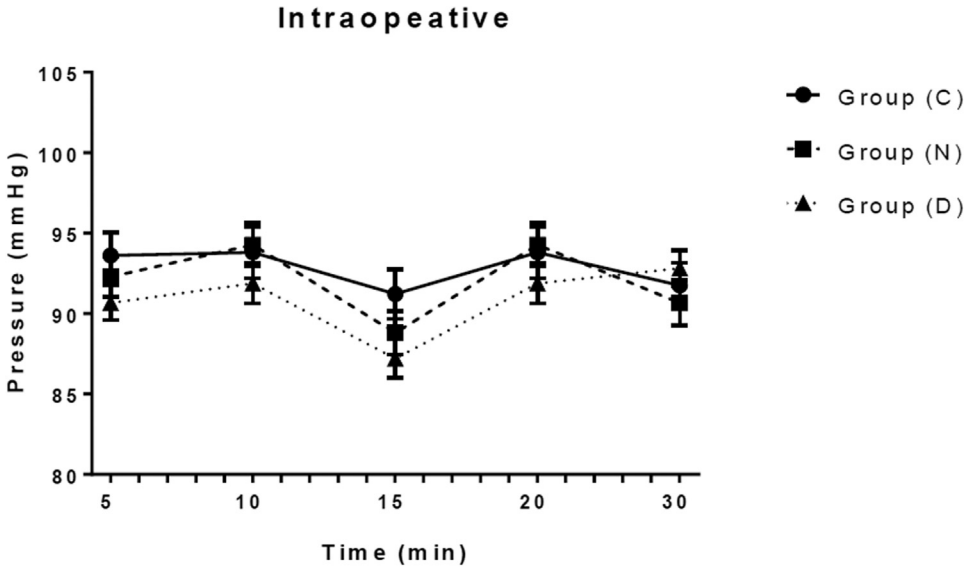
Data were expressed as mean±SD, numbers of patients, and percentages. ANOVA, analysis of variance; ASA, American Society of Anesthesiologists; P_1, C vs N, P_2, N vs D, P_3, D vs C. *Repeated measure ANOVA test was used to analyze the effect of different procedures over time. **Post-hoc comparisons with Bonferroni corrections. $P \leq 0.05$ is considered statistically significant.

Figure 2



Intraoperative heart rate readings among the three studied groups.

Figure 3



Intraoperative mean blood pressure readings among the three studied groups.

Duration of analgesia

It was found that there was a statistically significant difference among the three studied groups (P=0.0001) (Table 3). It was significantly longer in group D than group C and group N, with P value less than 0.05.

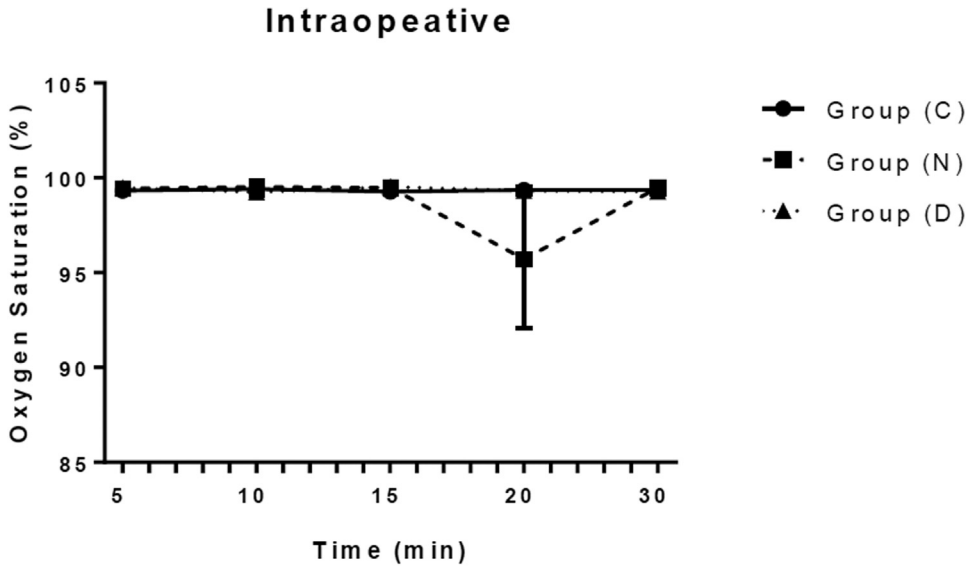
Postoperative complications

No serious adverse effects requiring urgent intervention were recorded in all patients of the three studied groups during the whole study periods. In group C, three cases reported had numbness and one case had dizziness. In group N cases, one case had numbness, three cases had headache, one case had metallic taste, and one case had tinnitus. In group D, one case had headache, one case had metallic taste, and one case had tinnitus. There was no statistically significant difference among the three studied groups (P>0.05) (Table 4).

Discussion

As compared with the other peripheral nerve blocks, one of the problems with IVRA is that there is no prolonged postoperative analgesic effect after the tourniquet release [7]. Various attempts to improve the quality of peripheral nerve block regarding the onset, recovery, and duration and the prolonged postoperative analgesia have been achieved by adding

Figure 4



Intraoperative oxygen saturation readings among the three studied groups.

Table 2 Comparison of the visual analog scale readings among the three studied groups

Postoperative VAS	Group C (*n*=25)	Group N (*n*=25)	Group D (*n*=25)	*P* value*
15 min	0	0	0	0.37
P value**	$P_1>0.99$	$P_2>0.99$	$P_3>0.99$	
30 min	0	0	0	0.37
P value**	$P_1>0.99$	$P_2>0.99$	$P_3>0.99$	
45 min	1.2±0.2	1.12±0.2	1.04±0.2	0.86
P value**	$P_1=0.8$	$P_2=0.8$	$P_3=0.41$	
60 min	2±0.00	2±0.00	2±0.00	0.37
P value**	$P_1>0.99$	$P_2>0.99$	$P_3>0.99$	
75 min	2.56±0.1	2.56±0.1	2.6±0.1	0.95
P value**	$P_1>0.99$	$P_2=0.94$	$P_3=0.94$	
90 min	3.52±0.1	3.52±0.1	3.12±0.07	0.002*
P value**	$P_1>0.99$	$P_2=0.004$*	$P_3=0.004$*	
105 min	4±0.00	3.96±0.04	3.28±0.09	0.0001*
P value**	$P_1=0.94$	$P_2<0.0001$*	$P_3<0.0001$*	
120 min	4±0.00	3.96±0.04	3.28±0.09	0.03*
P value**	$P_1=0.94$	$P_2<0.0001$*	$P_3<0.0001$*	

Data were expressed as mean±SD, numbers. $P\leq0.05$ is considered statistically significant. ANOVA, analysis of variance; P_1, C vs N; P_2, N vs D; P_3, D vs C. *Repeated measure ANOVA test was used to analyze the effect of different procedures over time. **Post-hoc comparisons with Bonferroni corrections.

a wide range of adjuvants to the local anesthetic for Bier's block [9].

We found that combination of dexamethasone with lidocaine produced excellent results by rapid onset of sensory and motor block, with lower pain score values and prolonged postoperative analgesia. Moreover, dexamethasone did not record any serious adverse effects intraoperatively or postoperatively. On the contrary, combination of neostigmine with lidocaine did not have any effect on sensory or motor block and did not prolong postoperative analgesia. We found also that neostigmine did not increase the incidence of intraoperative or postoperative complications. In the present study, the comparison of hemodynamics changes among the three studied groups revealed no statistically significant differences throughout the intraoperative and postoperative periods.

A study by Tomar *et al.* [14] discussed the IVRA with a mixture of lidocaine and bupivacaine. They observed that patients who received the mixture of local anesthetic agents for IVRA had more profound analgesia and successful block compared with patients who received the individual drug only. They also observed a low incidence of complications in patients who received a drug combination.

Table 3 Sensory and motor block characteristics

	Group C (n=25)	Group N (n=25)	Group D (n=25)	P value*
Onset of sensory block (min)	5.52±0.37	5.04±0.32	3.92±0.28	
P value**	P_1=0.55	P_2=0.04*	P_3=0.002*	0.003*
Onset of motor block (min)	10.16±0.39	8.84±0.54	5.16±0.298	
P value**	P_1=0.07	P_2<0.0001*	P_3<0.0001*	0.0001*
Recovery from sensory block (min)	5.36±0.34	5.24±0.4	7.88±0.29	
P value**	P_1=0.97	P_2<0.0001*	P_3<0.0001*	0.0001*
Recovery from motor block (min)	7.92±0.28	7.52±0.39	10.88±0.5	
P value**	P_1=0.76	P_2<0.0001*	P_3<0.0001*	0.0001*
Duration of sensory block (min)	59.96±3.57	58.84±3.28	66.68±3.47	
P value**	P_1=0.97	P_2=0.25	P_3=0.36	0.23
Duration of motor block (min)	62.52±3.601	61.12±3.27	69.68±3.44	
P value**	P_1=0.96	P_2=0.19	P_3=0.31	0.18

Data were expressed as mean±SD, numbers. $P \leq 0.05$ is considered statistically significant. ANOVA, analysis of variance; P_1, C vs N; P_2, N vs D; P_3, D vs C. *Repeated measure ANOVA test was used to analyze the effect of different procedures over time. **Post-hoc comparisons with Bonferroni corrections.

Table 4 Comparison of postoperative complications between the three studied groups

Postoperative complications	Group C (n=25)	Group N (n=25)	Group D (n=25)	P value*
No complications	21 (84)	19 (76)	22 (88)	
Complications	4 (16)	6 (24)	3 (12)	
	P_1=0.74	P_2=0.51	P_3=0.93	
Numbness	3	1	–	
Metallic taste	–	1	1	
Tinnitus	–	1	1	0.53
Headache	–	3	1	
Dizziness	1	–	–	

Data were expressed as numbers of patients, and percentages. $P \leq 0.05$ is considered statistically significant. ANOVA, analysis of variance; P_1, C vs N; P_2, N vs D; P_3, D vs C. *Repeated measure ANOVA test was used to analyze the effect of different procedures over time. **Post-hoc comparisons with Bonferroni corrections.

Duration of analgesia is very important for any type of nerve block performed. Longer the duration of analgesia, fewer the consumption of rescue analgesic drugs. So, when we recorded the results of the three groups in the present study, dexamethasone significantly prolonged the duration of analgesia in comparison with control group and neostigmine group. These results reflected the effect of using adjuvants on postoperative analgesia within the period of 2 h after the end of surgery. The values of postoperative VAS were lower in dexamethasone group when compared with control group or neostigmine group. Meanwhile, the values of VAS showed no difference between neostigmine group and control group.

In addition, Bigat *et al.* [15] reported that dexamethasone improved the quality and quantity of pain relief during the first day after IVRA. They reported that adding dexamethasone 8 mg to local anesthetic solution during IVRA provided better postoperative analgesia. It provided a significant decrease in postoperative VAS values (in agreement with our study).

Kuyrukluyildiz *et al.* [16] evaluated the addition of dexmedetomidine or neostigmine to lidocaine for IVRA. Their results showed no difference in pain scores or the postoperative analgesic period of neostigmine group when compared with the control group (in agreement with our study). Masood and Saqib evaluated the effects of neostigmine (0.5 mg) on IVRA when added to lidocaine (3 mg/kg). This study concluded that using neostigmine as an adjunct in IVRA is useful for reducing postoperative analgesia requirement (these findings are against our results) [17].

We found that the onset of sensory block was significantly shorter in dexamethasone group than in control group and in neostigmine group. The onset of motor block was shorter in dexamethasone group than in control group and in neostigmine group. However, we found that there was no significant difference between neostigmine and control groups in onset of sensory block and motor block. Hassani *et al.* [18] agreed with our results. They evaluated the effects of adding dexamethasone to lidocaine on the quality of IVRA. Patients were randomly allocated into two groups and received either 3 mg/kg of lidocaine local intravenous (control group) or 3 mg/kg of lidocaine plus 8 mg of dexamethasone local intravenous (study

group). The results showed that the mean starting time of both sensory and motor blocks was reduced following the addition of dexamethasone to lidocaine.

Other investigators evaluated the anesthetic and analgesic effect of neostigmine when added to lidocaine during IVRA. Their patients were divided into two equal groups: the control group (group C) received lidocaine 0.5% 3 mg/kg plus 1 ml normal saline, whereas the neostigmine group (group N) received 3 mg/kg 0.5% lidocaine plus 1 mg neostigmine. The study results showed no statistically significant difference in both the onset of sensory and motor blocks. These results are in agreement with our findings regarding neostigmine during INRV [19]. Sethi and Wason are not in agreement with our results. They discussed the IVRA using lidocaine and neostigmine for upper limb surgery. In the control group, IVRA was established using 40 ml of lidocaine 0.5% plus 1 ml of isotonic normal saline, whereas in the neostigmine group, patients received 40 ml of lidocaine 0.5% with neostigmine 0.5 mg. Intraoperatively, the neostigmine group had significantly shorter sensory and motor block onset times than those of the control group [8].

The results of the present study showed that the recovery time from sensory block in dexamethasone group was significantly longer than in control group and in neostigmine group. In addition, the recovery from motor block in dexamethasone group was significantly longer than control group and in neostigmine group. However, our results showed no statistically significant difference between neostigmine and control groups in recovery from sensory and motor block.

Hassani *et al.* [18] evaluated the effects of adding the dexamethasone to lidocaine on the quality of IVRA. They reported that mean time of recovery from sensory block was significantly longer in the dexamethasone group than the control group. This is in agreement with our results. Although our results showed that dexamethasone affected the onset and the recovery from sensory and motor blocks, we found that it had no effect on the duration of both blocks. When we compared the results of dexamethasone group with that of other groups, there was no statistically significant difference among the three groups.

Regarding the complications recorded in the present study, there are no serious adverse effects in all patients of the three studied groups during the whole study periods (intraoperative and postoperative), related either to the technique or to the local anesthetic drugs used.

In agreement with our findings regarding complications after IVRA, Atia and Abdel-Rahman evaluated the analgesic effect of neostigmine during IVRA, and they found no increase in the incidence of complications intraoperatively or postoperatively [19]. On the contrary, some investigators are inconsistent with our results regarding the adverse effects observed during the present study.

Conclusion

We concluded that addition of dexamethasone 8 mg to lidocaine 2% (3 mg/kg) during IVRA provided better postoperative analgesia. It increased the duration of postoperative analgesia when compared with the control group or the neostigmine group. In addition, this combination decreased onset time, prolonged recovery time of sensory/motor blocks, and had no effect on the incidence of intraoperative and postoperative complications.

Limitations

Further studies may be needed to assess the effectiveness of dexamethasone in IVRA with larger patient numbers. Furthermore, the role of dexamethasone or neostigmine in the control of tourniquet pain also needs to be assessed.

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Conflicts of interest

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