Comparative study between magnesium sulfate and ketamine added to lidocaine in ultrasound-guided supraclavicular brachial plexus block in upper limb surgery

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Introduction Supraclavicular brachial plexus (SBP) block is an excellent substitute for general anesthesia during upper limb operations. It prevents undesirable effects of using general anesthesia and upper airway instruments. Moreover, it reduces the duration of hospitalization and costs and provides complete muscle relaxation. The ultrasound-guided technique requires a lower anesthetic volume to provide an efficient block and decreases the risk associated with intravascular injections and trauma to the surrounding tissues.

Aim We conducted this study to compare the effect of ketamine versus magnesium sulfate as additives to lidocaine on onset and duration of sensory and motor block and duration of analgesia time, postoperative visual analog scale (VAS), total analgesic need, stress response (cortisol and blood glucose), and adverse effects in ultrasound-guided supraclavicular brachial plexus (SBP) block for patients who electively underwent upper limb surgeries.

Patients and methods A total of 90 patients aged 21–65 years, with American Society of Anesthesiologists status I, II, and III, scheduled for elective upper limb surgeries under SBP block, were divided into three equal groups in a randomized controlled fashion: group C (n=30) received 25 ml 2% lidocaine plus 5 cm saline, group K (n=30) received 25 ml 2% lidocaine plus 2 mg/kg ketamine, and group M (n=30) received 25 ml 2% lidocaine plus 250 mg magnesium sulfate (total volume in all groups 30 ml). Hemodynamic variables such as mean arterial blood pressure and heart rate, onset and duration of sensory and motor block, postoperative VAS, time to first analgesic request, total analgesic need, stress response (cortisol and blood glucose), and adverse effects were recorded for each patient.

Results The sensory block duration was 438.0±80.4 min in group K, 280.2±42.6 min in group M, and 132.0±24.6 min in group C, with a P value less than 0.001, which was statistically significant, whereas the motor block duration was 500±79 min in the group K, 342±50 min in group M, and 200±35 min in group C, with a P value less than 0.001, which was statistically significant, indicating a prolongation in block duration in the ketamine group followed by magnesium group and then control group. The most significant and highest VAS pain scores were found in the control group at all time points ($P<0.001$), whereas the K group had the lowest VAS. Postoperative analgesic requirement was less in K group when compared with other groups ($P<0.001$).

Conclusion Both ketamine and magnesium sulfate prolong the duration of analgesia without any major adverse effects. Ketamine is a better adjuvant to lidocaine for SBP than magnesium sulfate, as it has lower VAS and less postoperative analgesic requirement in upper limb surgeries.

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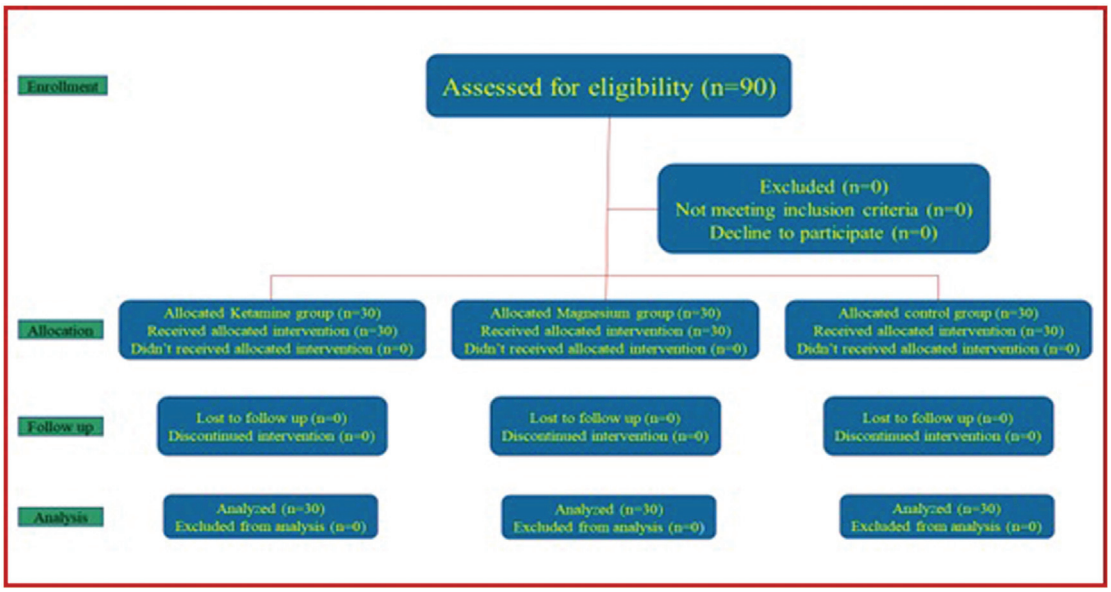
Introduction

Supraclavicular brachial plexus (SBP) block is an excellent substitute for general anesthesia during upper limb operations. It prevents undesirable effects of using general anesthesia and upper airway instruments. Moreover, it reduces the duration of hospitalization and costs and provides complete muscle relaxation. The ultrasound-guided technique requires a lower anesthetic volume to provide an efficient block and decreases the risk associated with intravascular injections and trauma to the surrounding tissues [1]. Efforts have been made to enhance the outcomes of the block by adding various adjuvants to the local anesthetic agents. Drugs such as opioids, naloxone clonidine, midazolam, dexmedetomidine, epinephrine, and recently dexamethasone, have been used along with local anesthetics for this purpose with varying degrees of success [2]. Ketamine, an N-methyl-D-aspartate receptor antagonist, has been explored for its local anesthetic properties. It exerts analgesic properties by epidural, caudal, and spinal routes by a multitude of mechanisms involving N-methyl-D-aspartate, cholinergic, adrenergic, and 5-hydroxytryptamine receptors (5-HT receptors) [3]. However, its

Figure 1



Consort flow diagram.

clinical usefulness has expanded to include a role in the management of a wide range of conditions including acute and chronic pain, and, nowadays, as a rapidly acting antidepressant [4]. Magnesium is the second most abundant intracellular cation and the fourth when the extracellular medium is also considered. It is involved in more than 300 known reactions, such as hormone binding to receptors, flow of transmembrane ions, regulation of the adenylate kinase system, muscle contraction, neuronal activity, vasomotor tone, cardiac excitability, release of neurotransmitters, and calcium binding to calcium channels [5]. Magnesium sulfate does not let catecholamines be released from the adrenal and peripheral nerve endings. Therefore, catecholamines receptors are blocked. So, magnesium sulfate results in sympathetic blocks [6]. Some studies also have demonstrated that the magnesium seems to reduce postoperative pain [7]. The stress response to surgery includes several hormonal changes initiated by neuronal activation of the hypothalamic-pituitary-adrenal axis. Hypothalamic activation of the sympathetic autonomic nervous system results in an increased secretion of catecholamines from the adrenal medulla and in the release of norepinephrine from presynaptic nerve terminals. The increased sympathetic activity causes the well-recognized cardiovascular effects of tachycardia and hypertension [8]. Tissue damage resulting from traumatic injury or surgical procedures activates signaling cascades that lead to the transmission of pain signals. Avoidance of pain-related morbidities is necessary for recovery and rehabilitation after surgery or traumatic insult [9].

Patients and methods

This prospective randomized controlled study was conducted at Al-Zahraa University hospital on 90 patients subjected to elective upper limb surgery that started from October 2016 to October 2018 after approval by local ethical committee of Al-Zahraa University hospital, Al-Azhar University, and after written informed consent was taken. Patients aged 21–65 years, of both sexes, with American Society of Anesthesiologists class status I, II, and III (as inclusion criteria), were enrolled in this study (Fig. 1). Exclusion criteria included patient's refusal, hypersensitivity to drugs of study, coagulopathy, local skin site infection, traumatic nerve injury of upper limb, BMI more than 40, severe pulmonary disease, inability to consent to participate in the study, and any drugs or opium abuse. Patients were randomly allocated by computer-generated sequence using sealed opaque envelopes into three equal group (30 patients in each group): control group (group C): 25-ml lidocaine 2% (20 mg/ml; Alexandria Co. for Pharmaceutical & Chemical Industries, Alexandria, Egypt) plus 5 ml saline; ketamine group (group K): 25-ml lidocaine 2% plus 2 mg/kg ketamine (50 mg/ml; Sigmatec Pharmaceutical Industries, Giza, Egypt) (5-ml volume); and magnesium sulfate group (group M): 25-ml lidocaine 2% plus 250-mg magnesium sulfate (100 mg/ml; EIPICO, Nasr City, Egypt) (5-ml volume) (total volume in all groups 30 ml). After arrival to operating room and securing18-G intravenous cannula in the nonoperated arm, the first sample of venous blood (4 ml) was taken to measure serum blood glucose and blood cortisol level. All

patients were premedicated in the induction room with 0.02 mg/kg intravenous midazolam. Supplemental oxygen (4 l/min) was delivered by nasal cannula, and on arrival to the operating room, 500-ml lactated Ringer's solution was infused intravenously. Patients were monitored using a five-lead ECG, pulse oximeter, and noninvasive blood pressure. The block was achieved with the patient in the supine position, 45° table head up (beach-chair position), and with the head rotated toward the nonoperative side. The lateral aspect of the neck was cleaned using an antiseptic iodine solution and draped. A linear array ultrasound transducer (sonosite, M turbo) was used in the study. The probe was placed in the supraclavicular fossa in coronal oblique plane to visualize the plexus. The pulsating, hypoechoic subclavian artery was identified, lying above the hyperechoic first rib. The hypoechoic nerve structures (trunks or divisions) were visualized posterolateral to the artery with a characteristic 'honey comb' appearance. The needle entry point was infiltrated with 2-ml lidocaine 2%. A sterile 50-mm 18-G intravenous cannula was advanced using an in-plane technique. When the needle was seen well, the tip was directed toward the nerve bundle. After a negative aspiration, the local anesthetic was injected at corner pocket and around the plexus. Local anesthetic dispersion at the time of injection was seen by ultrasound. If the spread did not reach some part of the plexus, the needle tip position was readjusted to produce a suitable distribution of local anesthetic. Primary outcome of the study is to evaluate the onset and duration of sensory and motor block of ketamine versus magnesium sulfate when added to lidocaine in SBP guided by ultrasound. Secondary outcomes of the study are to evaluate visual analog scale (VAS), first request of analgesia, total analgesic requirements, and recorded complications.

The studied parameters

The hemodynamic parameters

Mean arterial blood pressure (MAP) and heart rate (HR) were monitored preoperatively (basal), 15 min, 30 min, and every 15 min after basal till the end of surgery.

Evaluation of onset and duration of sensory block

It was performed every 5 min after administration of the studied drugs. The sensory block was quantified as 0=anesthesia (no sensation), 1=analgesia [decreased (dull) sensation], and 2=no block (normal sensation), by using the pinprick test and comparing with the contralateral limb. The time elapsed from the injection to the onset of analgesia in the central sensory region of each of the main peripheral nerves (ulnar, radial, medial, and musculocutaneous) was taken as the time of onset of the sensory block.

Evaluation of onset and duration of motor blocks

The motor block was evaluated by modified Bromage scale [10]:

(1) Grade 0: normal motor function.
(2) Grade 1: ability to move only fingers.
(3) Grade 2: complete motor block with inability to move elbow, wrist, and fingers.

Visual analog scale

After operation, VAS for pain that ranged from 0=no pain to 10=the worst imaginable pain was assessed and recorded at 1, 2, 6, 12, and 24 h after the operation by an anesthesiologist. A rescue dose of analgesia in the form of diclofenac sodium 75 mg was given to patients with VAS score more than or equal to 4.

First request of analgesia

First request of analgesia for each group was obtained and registered. Diclofenac sodium (75 mg/3 ml; PHARCO Pharmaceutical, Cairo, Egypt) intramuscular was given to patients postoperatively when VAS score equal to or above four. Total amount of diclofenac sodium and times were recorded.

Laboratory investigation

Serum blood glucose and cortisol levels were assessed preoperatively and at 4, 12, and 24 h postoperatively.

Postoperative complications

Supraclavicular block can result in some complications, so early detection of complications is important; these complications include vascular puncture, inadvertent intravenous injection, Horner syndrome, hematoma formation, LA toxicity, pneumothorax, and dyspnea.

Statistical analysis

All patients included in the study completed the study. Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean±SD. Qualitative data were expressed as frequency and percentage. One-way analysis of variance was used when comparing between more than two means. Post-hoc test: least significant difference was used for multiple comparisons between different variables. Kruskal–Wallis test was used for multiple-group comparisons in nonparametric data. χ^2 test of significance was used to compare proportions

between qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *P* value was considered significant as follows:

(1) *P* value less than or equal to 0.05 was considered significant.
(2) *P* value less than or equal to 0.001 was considered as highly significant.
(3) *P* value more than 0.05 was considered insignificant.

Table 1 Demographic data

Demographic data	Ketamine group (*N*=30) [*n* (%)]	Magnesium group (*N*=30) [*n* (%)]	Control group (*N*=30) [*n* (%)]	*P* value
Sex				
Female	8 (26.7)	10 (33.3)	10 (33.3)	0.813
Male	22 (73.3)	20 (66.7)	20 (66.7)	
Age (years)				
Mean±SD	34.60 ±16.08	35.33±11.88	35.73 ±10.56	0.944
Weight (kg)				
Mean±SD	93.33±6.34	91.33±6.81	89.67±7.30	0.121
Duration of surgery (min)				
Mean±SD	61.00 ±19.67	58.00±13.49	57.33±5.21	0.564
ASA				
I	21 (70)	21 (70)	20 (66.7)	0.203
II	5 (16.7)	6 (20.0)	6 (20.0)	
III	4 (13.3)	3 (0.0)	4 (13.3)	
Site of operation				
Arm	2 (6.7)	6 (20.0)	2 (6.7)	0.273
Forearm	14 (46.7)	12 (40.0)	18 (60.0)	
Hand	14 (46.7)	12 (40.0)	10 (33.3)	

ASA, American Society of Anesthesiologists.

Results

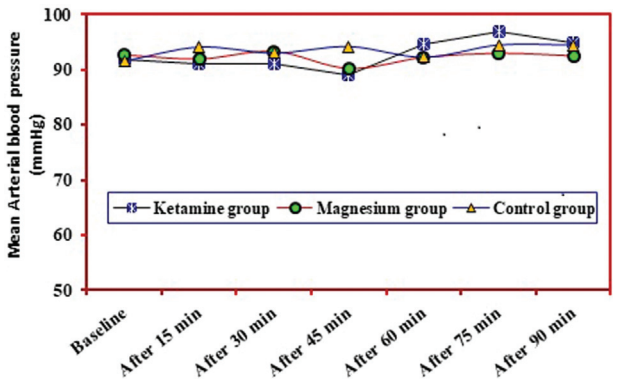
The variables in demographic data did not show a statistically significant difference among groups with respect to age, sex, the patient's weight, American Society of Anesthesiologists, and duration of surgery (Table 1).

Hemodynamic variables (MAP and HR) showed no statistically significant difference among the three studied groups (Figs 2 and 3).

There was no difference observed in the onset of action of sensory and motor blockade among the three studied groups (Table 2).

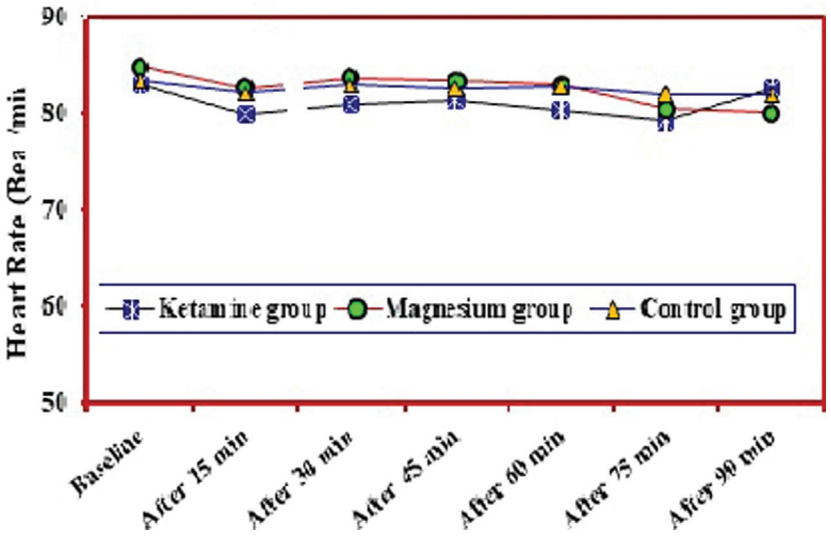
The sensory block duration was 438.0±80.4 min in group K, 280.2±42.6 min in group M, and 132.0

Figure 2



Comparison between groups according to mean arterial blood pressure.

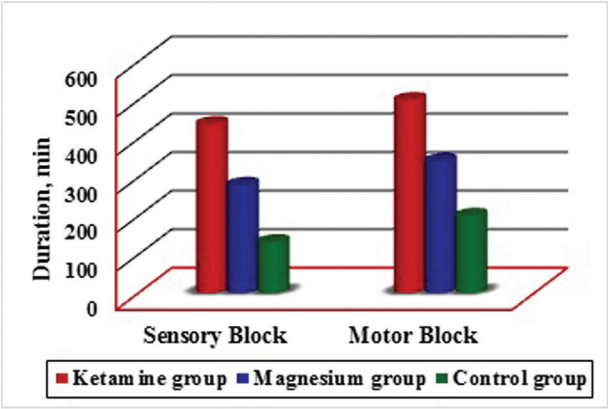
Figure 3



Comparison between groups according to heart rate.

±24.6 min in group C, with *P* value less than 0.001, which was statistically significant, whereas the motor block duration was 500±79 min in the group K, 342±50 min in group M, and 200 ±35 min in group C, with *P* value less than 0.001, which was statistically significant, indicating a prolongation in block duration in the ketamine group followed by magnesium group and then control group (Fig. 4).

Figure 4



Duration of sensory and motor block.

VAS was increased postoperatively in all groups but less increase in K group than the other groups ($P<0.01$) (Table 3).

The mean time of first request of analgesia was 7.23 ±1.38 h in K group and 4.67±0.71 h in M group and 2.73±0.45 h in C group, which shows a highly statistically significant increase in mean time of first request of analgesia in ketamine group compared with magnesium and control groups ($P<0.01$). The total dose of analgesia (diclofenac sodium) was statistically

Table 4 First request of analgesia and total dose of postoperative analgesia

Analgesia	Ketamine group (*N*=30)	Magnesium group (*N*=30)	Control group (*N*=30)	*P* value
First request of analgesia (h)	7.23±1.38	4.67±0.71[a]	2.73 ±0.45[ab]	<0.001**
Total dose of analgesic [diclofenac (mg)]	75	150[a]	150[a]	<0.001**

Using one-way analysis of variance. [a]Significant difference between group ketamine ($P<0.05$, S). [b]Significant difference between group magnesium ($P<0.05$, S). **P value less than 0.001 (HS).

Table 2 Onset time and duration of motor and sensory block

Time	Ketamine group (*N*=30)	Magnesium group (*N*=30)	Control group (*N*=30)	*P* value
Onset time (min) (mean±SD)				
Sensory block	16.20±1.86	16.00±1.23	17.80±1.83	0.273
Motor block	21.13±2.00	21.93±1.87	21.07±2.21	0.191
Duration (min) (mean±SD)				
Sensory block	438.0±80.4	280.2±42.6[a]	132.0±24.6[ab]	<0.001**
Motor block	500±79	342±50[a]	200±35[ab]	<0.001**

Using one-way analysis of variance. [a]Significant difference between group ketamine ($P<0.05$, S). [b]Significant difference between group magnesium ($P<0.05$, S). *P* value more than 0.05 (NS). **P value less than 0.001 (HS).

Table 3 Visual analog score in the three studied groups

Visual analog score	Ketamine group (*N*=30)	Magnesium group (*N*=30)	Control group (*N*=30)	Kruskal–Wallis	*P* value
After 1 h					
Median (IQR)	1 (1)	1 (1)	1 (1)	0.588	0.558
Range	1–2	1–2	1–2		
After 2 h					
Median (IQR)	1 (2)	2 (1)	3 (1)	10.589	<0.001**
Range	1–3	1–4	2–5		
After 6 h					
Median (IQR)	2 (2)	3 (1)	4 (2)	6.006	<0.001**
Range	2–4	2–5	2–6		
After 12 h					
Median (IQR)	2 (1)	3 (2)	4 (2)	7.253	<0.001**
Range	2–4	2–5	2–6		
After 24 h					
Median (IQR)	1 (1)	2 (2)	3 (2)	9.514	<0.001**
Range	1–3	2–4	2–5		

IQR, interquartile range. Using Kruskal–Wallis. *P* value more than 0.05 (NS). *P value <0.05 significant. **P value less than 0.001 (HS).

Table 5 Comparison between groups according to cortisone (μg/ml)

Time	Ketamine group (*N*=30)	Magnesium group (*N*=30)	Control group (*N*=30)	*P* value
Preoperatively				
Mean±SD	15.66±3.50	15.00±4.45	14.31±1.62	0.314
After 4 h				
Mean±SD	20.51±3.03	15.57±2.91[a]	14.53±1.16[ab]	<0.001**
After 12 h				
Mean±SD	17.35±3.11	15.12±2.87[a]	15.21±2.56[a]	0.004*
After 24 h				
Mean±SD	13.35±4.61	16.81±3.51[a]	16.87±3.83[a]	<0.001**

Using one-way analysis of variance. [a]Significant difference between group ketamine ($P<0.05$, S). [b]Significant difference between group magnesium ($P<0.05$, S). **P value less than 0.001 (HS).

Table 6 Comparison between groups according to glucose (mg/dl)

Glucose (mg/dl)	Ketamine group (*N*=30)	Magnesium group (*N*=30)	Control group (*N*=30)	*P* value
Preoperatively				
Mean±SD	101.87±21.91	102.13±15.23	100.33±10.74	0.903
After 4 h				
Mean±SD	112.00±16.84	103.00±13.75[a]	105.53±13.05[a]	0.034*
After 12 h				
Mean±SD	106.20±15.86	104.93±13.70[a]	113.00±17.68[ab]	0.043*
After 24 h				
Mean±SD	105.33±14.15	108.07±11.19	106.53±21.50	0.807

Using one-way analysis of variance. [a]Significant difference between group ketamine ($P<0.05$, S). [b]Significant difference between group magnesium ($P<0.05$, S). *P* value more than 0.05 (NS). **P value less than 0.05 (S).

Table 7 Comparison between groups according to postoperative complications

Postoperative complications	Ketamine group (*N*=30) [*n* (%)]	Magnesium group (*N*=30) [*n* (%)]	Control group (*N*=30) [*n* (%)]	χ^2	*P* value
Hypotension	0 (0.0)	0 (0.0)	2 (6.7)	8.700	0.191
Nausea	0 (0.0)	2 (6.7)	2 (6.7)		
Vomiting	0 (0.0)	2 (6.7)	2 (6.7)		
No	30 (100.0)	26 (86.7)	24 (80.0)		

χ^2, χ^2 test. *P* value more than 0.05 (NS).

significant less in K group compared with other groups ($P<0.01$) (Table 4).

The plasma level of cortisone was elevated significantly in the M and C groups after 4, 12, and 24 h; however, in the K group, the cortisol level was elevated significantly after 4 and 12 h, but at 24 h, K group had the lowest cortisone level in comparison with other groups (Table 5).

There was no statistically significant difference in blood glucose level among the three studied groups in the preoperative level ($P>0.05$). However, at 4 and 12 h postoperatively, the increased serum glucose concentrations were statistically significant in the three groups (Table 6).

Postoperative complications were recorded in three groups, which show no statistically significant differences among the groups (Table 7).

Discussion

The present study was conducted to compare the addition of ketamine or magnesium sulfate to lidocaine in SBP block guided by ultrasound on hemodynamic, onset time and duration of both motor and sensory block, stress response, VAS, first request of analgesia, total dose of postoperative analgesia, and postoperative complications.

The results of the current study showed that there was no statistically significant difference found among the three studied groups regarding hemodynamic variables ($P>0.05$). In agreement with the results of the current study, Lashgarinia *et al.* [2], who conducted their study to evaluate the effect of ketamine added to lidocaine in SBP block for patients undergoing elective upper extremity surgery, found that there was no significant difference between the groups in HR or MAP. The results were in accordance with a study done by Akhondzade *et al.* [11] who conducted their

study to evaluate the effect of magnesium sulfate as an adjuvant on postoperative pain in upper limb surgeries by SBP block under ultrasound guidance and found that hemodynamic parameters remained stable with insignificant changes in the two groups at all the measurement intervals.

The results of the current study showed that there was no statistically significant difference found among the three studied groups regarding onset time of both sensory and motor block and duration of block. Similar to our study, Zaman *et al.* [12] found that there was no significant difference in the onset of sensory and motor blockade of axillary block among the three groups ($P<0.05$); however, the difference in duration of sensory and motor blockade of axillary block among the groups was significant. Therefore, they conclude that adding dexamethasone or ketamine could improve the duration of sensory and motor axillary block in patients who were candidates of hand and forearm soft tissue surgery. The results were matched with Sabra *et al.* [13] who conclude that dexmedetomidine prolongs the duration of sensory and motor block and enhances the quality of block as compared with ketamine when used as an adjuvant to bupivacaine in axillary brachial plexus nerve block. Our results were in accordance with a study done by Yangtse *et al.* [14] who conducted their study to evaluate the effect of magnesium sulfate as an adjuvant to local anesthetics on onset of sensory and motor block duration and analgesia, and they conclude that there was no difference observed in the onset of action of sensory and motor blockade. There is a significant increase in duration of analgesia in magnesium sulfate group than control group without any difference in duration of motor blockade. Supporting the current study, Abdelfatah and Elshaer [15] investigated the effectiveness of magnesium sulfate in enhancing lidocaine action in the setting of interscalene plexus block for shoulder arthroscopic and found that there was no difference observed in the onset of action of sensory and motor blockade, but the motor block duration was prolonged in magnesium group. However, Lashgarinia *et al.* [2], who conducted their study to evaluate the effect of ketamine (2 mg/kg) added to lidocaine (5 mg/kg; 1.5%) on the onset and the duration of sensory and motor block and postoperative pain in SBP block for patients undergoing elective upper extremity surgery, found that no significant differences were noted between groups in the onset and duration of the motor and sensory block. Our study disagrees with them in the duration of motor and sensory block, which was prolonged in ours.

In the present study, pain scores were assessed by VAS, and the results showed that there was a highly statistically significant increase in VAS in all periods postoperatively in all groups but less increased in K group than the other groups ($P<0.01$). In agreement with the results of the current study, Lashgarinia *et al.* [2] concluded that ketamine decreased the postoperative pain and the need for analgesics, without significant adverse effects when compared with saline. The results were matched with El Mourad and Amer [16] who found that at 6 and 12 h, patients in dexamethasone group and ketamine group had better VAS scores than the control group, whereas at 6 and 18 h, the pain scores were significantly lower in ketamine group compared with dexamethasone and control groups. Although statistically significant, differences in VAS score were clinically limited. Moreover, the results were in accordance with a study done by Yangtse *et al.* [14] who concluded that addition of 10% magnesium sulfate 2 ml to the local anesthetics prolonged the duration of analgesia in peripheral nerve block.

The results also run parallel to the study done by Akhondzade *et al.* [11] who concluded that postoperative VAS values at 24 h were significantly lower in magnesium group than control group. Our observations were similar with Gupta *et al.* [17] who conducted their study using 150 mg magnesium sulfate as adjuvant to ropivacaine in SBP block and concluded that postoperative VAS values were highly statistically significantly decreased in sixth and 12th hours in magnesium group compared with control group, which showed highly statistically significant increase in all VAS records. Supporting the current study, Singh *et al.* [18] conducted their study comparing the effect of magnesium sulfate as an adjuvant to bupivacaine and ropivacaine in ultrasound-guided interscalene block in patients scheduled for orthopedic surgeries around the shoulder and concluded that the duration of sensory and motor block was longer when magnesium was combined with bupivacaine as compared with when used with ropivacaine. The duration of postoperative analgesia was also significantly longer in this group, leading to decreased frequency and total dose of rescue analgesics requirements up to 24 h postoperatively.

In the present study, first request of analgesia was measured and results showed that the mean time for first request of analgesia was 7.23±1.38 h in K group, 4.67±0.71 h in M group, and 2.73±0.45 h in C group, which show a highly statistically significant increase on mean first request of analgesia of ketamine

compared with magnesium and control group according to first request of analgesia ($P<0.01$). Moreover, regarding the total dose of postoperative analgesia, the total dose of analgesia (diclofenac sodium) was statistically significantly decreased in K group compared with other groups ($P<0.01$). These results were in accordance with a study done by Lashgarinia *et al.* [2] who concluded that time of administration of first dose of pethidine was 377.6 ±106.3 min in ketamine group and 207.5±73.6 min in control group, which show highly statistically significant increase in the mean administration of first dose analgesia in ketamine group compared with control group ($P<0.001$), and total dose of analgesia (pethidine) was decreased in ketamine group when compared with control group. The results were matched with Mukherjee *et al.* [19] who concluded that request of first analgesic in magnesium group was 461.71±152.57 min and in control group was 379.79±145.52 min which shows highly statistically significant increase in the mean request of first dose analgesia in magnesium group compared with control group. Moreover, rescue analgesia as diclofenac sodium was 76.82±14.28 in magnesium group and in control group was 104.35 ±18.96, which showed highly statistically significant decrease in magnesium group.The results were in accordance with a study done by Gupta *et al.* [17] who conducted their study using 150 mg magnesium sulfate as adjuvant to ropivacaine in SBP block and concluded that addition of magnesium sulfate prolongs motor block, and rescue analgesia time is increased with magnesium sulfate (491±100.22 min) than control group (377.67±73.31 min). Regarding the blood cortisol level, the results of the current study showed that the plasma concentration of cortisone was increased significantly in the three studied groups in all periods postoperatively. Moreover, regarding the blood glucose level, the results of the current study showed that there was no statistically significant difference in blood glucose level among the three studied groups preoperatively (basal level) ($P>0.05$). However, at 4 and 12 h postoperatively, the increased serum glucose concentrations were significant in three groups. Our observations were similar with Carli [20], who showed that the treatment of postoperative pain was closely connected to stress-induced hormonal release and represented an important factor in postoperative glucose metabolism and the insulin resistance. On the contrary, Bagry *et al.* [21] studied the effect of a continuous peripheral nerve block compared with the patient-controlled analgesia on inflammatory response and observed no difference in glucose, insulin, and cortisol levels measured between the two groups.

Conclusion

We concluded that both ketamine and magnesium sulfate prolong the duration of analgesia when added to lidocaine for SBP without any major adverse effects. Ketamine is better adjuvant to lidocaine for SBP than magnesium sulfate, as ketamine had lower VAS and less postoperative analgesic requirement in upper limb surgeries.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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