

Comparative Study between Bupivacaine and Bupivacaine Plus Potassium Chloride for Brachial Plexus Block

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Abstract

Background: Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. The prime duty of any anesthesiologist is to relieve pain in the perioperative period. Today regional anesthesia is well established as equal to general anesthesia in effectiveness and patient acceptability. Regional anesthesia is blocking of peripheral nerve conduction in a reversible way using local anesthetic agents.

Materials and Methods: Sixty patients of age group between 20 and 70 years of either sex of ASA Grade I and II category posted for various types of upper limb surgeries. The patients were randomly allocated into two groups. Supraclavicular brachial plexus block was performed. Group I (potassium group) – 30 ml of 0.375% bupivacaine with 0.2 mmol of potassium chloride (prepared by adding 0.1 ml of potassium chloride and 10 ml distilled water to 20 ml of 0.5% bupivacaine). Group II (plain bupivacaine group) received 30 ml of 0.375% bupivacaine only. The following parameters were observed after performing supraclavicular brachial plexus block in both groups: (1) The onset time of sensory and motor blockade. (2) The quality of sensory and motor blockade. (3) The duration of blockade.

Result: The onset of sensory and motor blockade was early in potassium group when compared to plain bupivacaine group, the duration of the blockade was prolonged in potassium group when compared to other group, the quality of blockade was better in potassium group when compared to other group.

Conclusion: The present study concludes that addition of potassium chloride to bupivacaine had a significant clinical advantage over plain bupivacaine on onset time, duration and quality of sensory and motor blockade in brachial plexus block.

Key words: Brachial plexus block, Bupivacaine, Potassium chloride, Supraclavicular approach

INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage.¹

It is always a subjective experience. Pain has been a major concern of humankind, and it has been the object

of ubiquitous efforts to understand and to control it. Peripheral nerve blocks provide longer and more localized pain relief than neuraxial techniques while also avoiding the side effects of systemic medications. Regional anesthesia of the extremities and of the trunk is a useful alternative to general anesthesia in many situations.²

Regional anesthesia denotes interruption of pain impulse by physiological blockade at a certain point along their pathway of transmission in the peripheral nerves. Trephination was practiced by Incas, and their tradition holds that the “shaman” performing the procedure chewed cocoa leaves and spat into the wound producing local anesthetic effect.³

Brachial plexus nerve block was reportedly first accomplished by Halsted, when “he freed the cords and

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nerves of the brachial plexus after blocking the roots in the neck with cocaine solution.”⁴

Brachial plexus block evolved into a valuable and easy procedure for upper limb surgeries. Hirschel⁵ introduced axillary and supraclavicular techniques. Most of the local anesthetic agents developed in between 1900 and 1940 were basically aminoester compounds. They lost their importance due to the short duration of action, associated allergic reactions, and systemic toxicity.

Lofgrens *et al.*⁶ continued the work with great energy, and after investigating with, more than a hundred compounds found xylocaine, a local anesthetic preparation, which marked a considerable advance.

In 1957 (David 1998⁷) synthesized bupivacaine, an amide local anesthetic and was first clinically used in 1963 by Telivuo.

The main drawback of long-acting drugs was a delayed onset of action. To overcome this drawback following were tried like, addition of enzymes,⁸ buffered and carbonated solution,⁹ opioids,¹⁰ vasoconstricting agents,¹¹ alkalinizing and warming up local anesthetic solution,¹² and potentiation of blockade by pain and muscular exercise.¹³

Of these, only additions of carbonates and potassium to local anesthetics have stood the test of time. Hence, an attempt was made to compare the effects of adding potassium chloride to bupivacaine for the onset of time and duration of sensory and motor blockade following supraclavicular brachial plexus block.

MATERIALS AND METHODS

The present study entitled “comparative study between bupivacaine and bupivacaine plus potassium chloride on the onset time and duration of brachial plexus block” was carried out at Mahatma Gandhi Hospital, Warangal, from January 2013 to April 2014.

Sixty patients of age group between 20 and 70 years of either sex of ASA grade I and II, admitted from January 2013 to April 2014, were selected for the study. The patients were undergoing elective and emergency surgery of the upper limb.

The exclusion criteria were patient’s refusal, progressive neurological disorders, severe kidney or liver dysfunction, and history of bleeding disorders. Each patient was visited preoperatively, and the procedures were explained and informed written consent was obtained. Investigations such as hemoglobin %, total count, differential count, erythrocyte sedimentation rate, random blood sugar,

electrolytes, urine albumin and sugar, chest X-ray, and electrocardiogram were done.

All the patients were pre-medicated with injection midazolam 2 mg slow IV 30 min before surgery. Each patient was randomly assigned to one of the two groups (30 patients each), Group I or Group II.

Group I (potassium group) received 30 ml of 0.375% bupivacaine with 0.2 mmol of potassium chloride (prepared by adding 0.1 ml of potassium chloride and 10 ml distilled water to 20 ml of 0.5% bupivacaine).

Group II (plain bupivacaine group) received 30 ml of 0.375% bupivacaine only.

Each patient was made to lie supine without a pillow, arms at the side, head turned slightly to the opposite side with the shoulders depressed posteriorly and downward by molding the shoulders over a roll placed between the scapulae. The supraclavicular area was aseptically prepared and draped. The anesthesiologist stands at the side of the patient to be blocked, facing the head of the patient since this position allows better control of needle.

An intradermal wheal was raised approximately 1 cm above the midclavicular point. The subclavian artery palpable in supraclavicular fossa was used as a landmark. The tip of index finger was rested in supraclavicular fossa directly over the arterial pulsation. A filled 10 ml syringe with a 23 gauge, 32 mm needle attached was held in right hand and patient was instructed to say “now” and not to move as soon as he felt a “tingle” or “electric shock-like sensation” going down his arm. The needle was inserted through skin and advanced slowly downward (caudal) rolled slightly inward (medially) and slightly backward (posteriorly).

As soon as paresthesia was elicited, the needle was fixed in position, and after confirming negative aspiration of blood, 30 ml of the respective drug was injected depending on whether the patient was allotted to either of Group I or II.

Time of onset of sensory block was recorded using pinprick in skin dermatomes C4-T2 once in every 3 min for the first 30 min after injection and thereafter every 30 min till patient regained normal sensations. The same observer assessed the motor block at same time intervals.

The person doing the procedure did not know whether the dilution contained plain bupivacaine or with potassium chloride. Onset of sensory block was from the time of injection of drug to time of loss of pain on pinprick. Onset of motor block was from the time of injection to time of complete loss of movement.

Sensory block was assessed by pinprick with a short beveled 25G needle as:

- Grade 0 - No pain,
- Grade 1 - Mild pain-grimace,
- Grade 2 - Moderate pain-withdrawal, and
- Grade 3 - Severe pain-screams.

Motor block was graded according to the movement of upper limb by the patient as:

- Grade 5 - Normal movement of upper limb,
- Grade 4 - Movement against resistance,
- Grade 3 - Movement against gravity,
- Grade 2 - Movement along gravity but not against resistance,
- Grade 1 - Flickering movement and,
- Grade 0 - No movement.

Grade 3, 2, 1 were partial block. Grade 0 complete motor paralysis that is when the patient could not move his limb at all.

The duration of sensory blockade was the time in minutes from the onset of analgesia to the recurrence of pain to pin prick. The duration of motor blockade was the time in minutes from the onset of paresis to the recurrence of motor movements.

The quality of sensory and motor block was studied and graded as per whether the blocks were complete, incomplete, or totally absent.

The usage of adjuvants after the block was graded according to whether the surgery was done under general anesthesia (Grade 3) due to complete failure of block, whether opioids were used during intraoperative period (Grade 2) or if adjuvants of any kind were not used throughout the surgery (Grade 1).

The heart rate and blood pressure were recorded at intervals of 5 min. The patients were watched for bradycardia, convulsions, restlessness, disorientation, drowsiness, and any other complications.

All the values were expressed as mean \pm standard deviation. Statistical comparison was performed by Student's *t*-test and Chi-square test.

$P > 0.05$ was considered to be statistically not significant, a $P < 0.05$ as statistically significant, a $P < 0.01$ statistically highly significant and a $P < 0.001$ as statistically very highly significant.

RESULTS

The present study was conducted on 60 consenting patients aged between 20 and 70 years. Group I received 30 ml of

0.375 % bupivacaine with 0.2 mmol of potassium chloride. Group II received 30 ml of 0.375% bupivacaine for brachial plexus block by supraclavicular approach.

Demographic Data

Gender distribution

The two groups were similar in sex-wise distribution as shown in Figure 1.

Age distribution

The two groups were similar in age as shown in Table 1.

Weight distribution

The two groups were similar in weight as shown in Figure 2 (Tables 2 and 3).

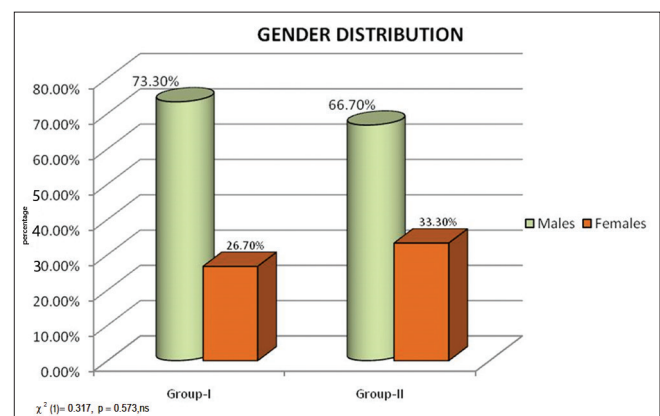


Figure 1: Sex distribution

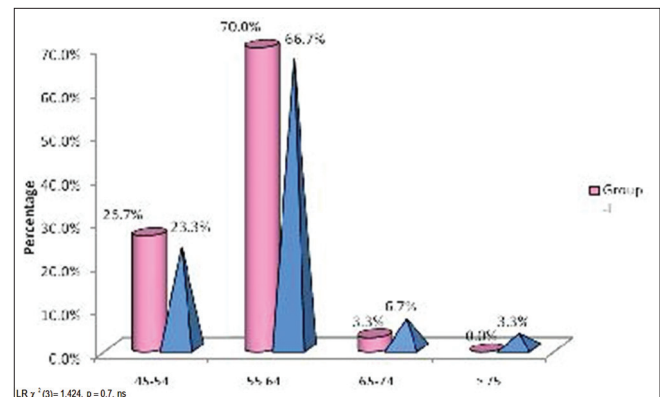


Figure 2: Weight distribution

Table 1: Age distribution

Age (years)	No. of cases (%)		
	Group I	Group II	Total
21-30	7 (23.3)	12 (40.0)	19 (31.7)
31-40	8 (26.7)	5 (16.7)	13 (21.7)
41-50	11 (36.7)	12 (40.0)	23 (38.3)
51-60	4 (13.3)	1 (3.3)	5 (8.3)
Total	30 (100)	30 (100)	60 (100)

$\chi^2 (3) = 3.852, P = 0.278$

Table 2: Means of age and weight in both groups

Group	Mean	N	Standard deviation	Minimum	Maximum	P Value
Age						
Group I	41.03	30	10.301	22	60	$t(58)=1.135$ $P=0.261$, ns
Group II	38.00	30	10.396	25	60	
Total	39.52	60	10.374	22	60	
Weight (kg)						
Group I	56.37	30	4.476	48	65	$t(58)=1.303$ $P=0.198$, ns
Group II	58.27	30	6.617	50	80	
Total	57.32	60	5.682	48	80	

Onset of sensory and motor blockade

In Group I, the mean onset time of sensory blockade was 10.43 min, and motor blockade was 9.43 min when compared to Group II having sensory onset of 26.33 min and motor onset of 23.93 min (Figure 3).

Duration of sensory and motor blockade

In Group I, the mean duration of sensory blockade was 467.67 min, and motor blockade was 477.67 min when compared to Group II having sensory duration of 205.67 min and motor duration of 215.67 min (Figure 4).

Comparison of mean onset between the groups

The onset of sensory and motor blockade was earlier in case of Group I when compared with Group II. The $P < 0.001$ which is statistically highly significant (Figure 5).

Comparison of mean duration between the groups

The duration of both sensory and motor blockade was prolonged in Group I when compared to Group II. $P < 0.001$ which is very highly significant (Figure 6).

Quality of sensory blockade

The quality of sensory blockade was better in Group I and the value was statistically significant when compared with Group II (Figure 7).

Quality of motor blockade

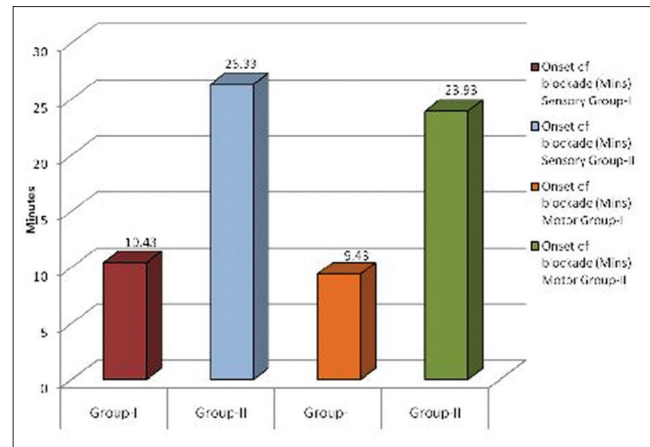
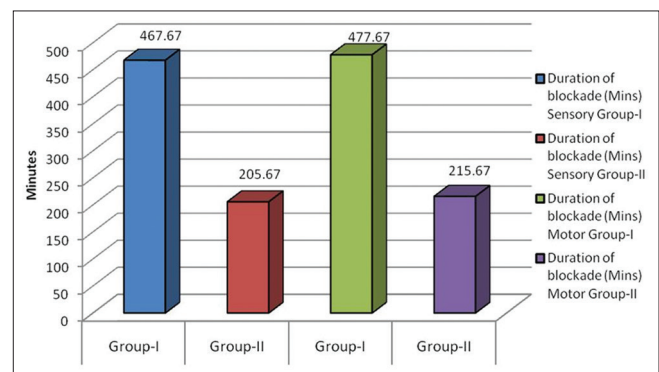
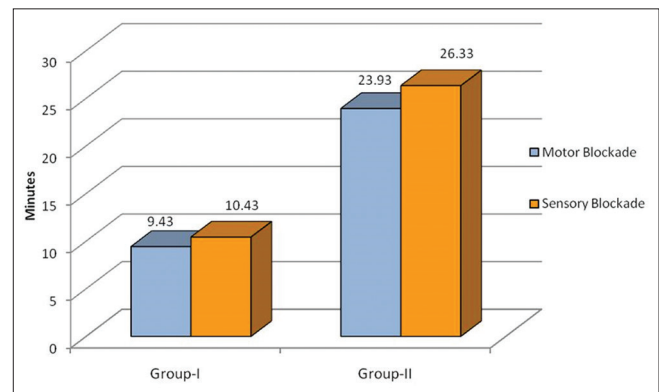
The quality of sensory blockade was better in Group I and the value was statistically significant when compared with Group II (Figure 8).

Quality of motor blockade

The number of adjuvants used in Group I were significantly less when compared to Group II. $P < 0.05$ which is statistically significant (Figure 9).

DISCUSSION

Brachial plexus block is widely used in our practice for elective forearm and hand surgeries. It provides good

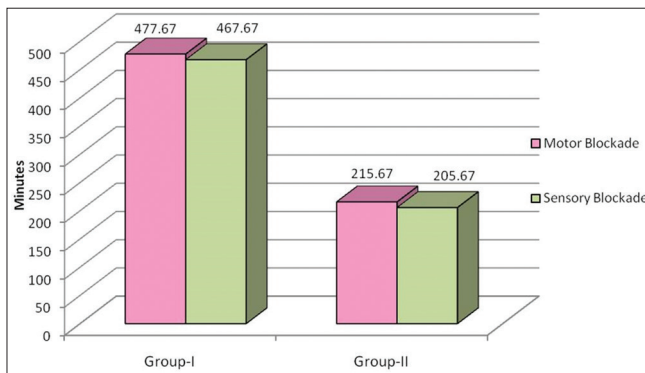
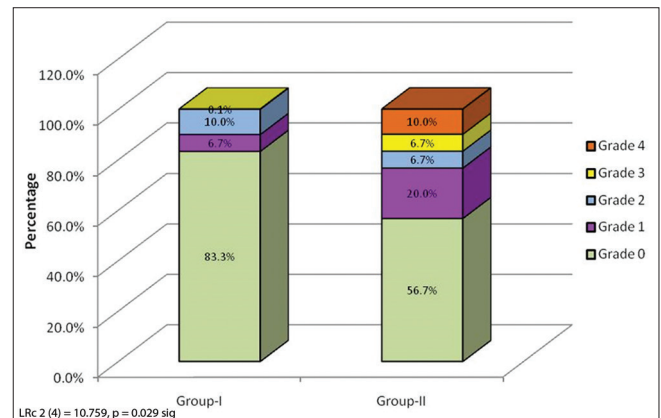
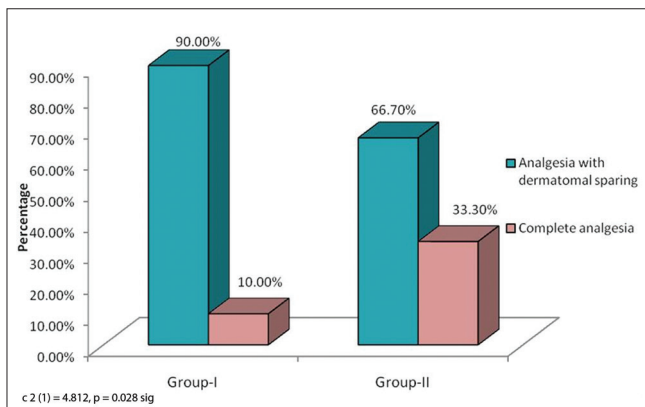
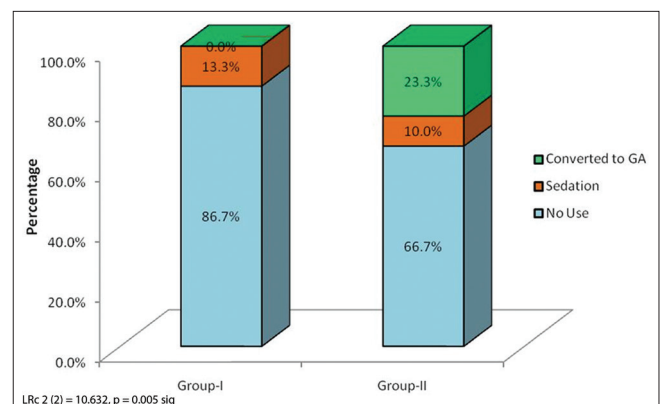
**Figure 3: Comparison of onset of sensory and motor blockade****Figure 4: Comparison of duration of sensory and motor blockade****Figure 5: Mean onset of sensory and motor blockade**

intra- and post-operative analgesia. Many substances have been added to local anesthetic agents in an attempt to prolong their duration of action. Among them, addition of carbonated solution and potassium to local anesthetic has stood the test of time.

Addition of potassium chloride to local anesthetic solutions increases the extracellular potassium concentrations and depolarizes the membrane.¹⁴

Table 3: Comparison of onset and duration of sensory and motor blockade

Group	Mean	N	Standard deviation	Minimum	Maximum	P Value
Onset of blockade (min) sensory						
Group I	10.43	30	1.633	8	13	$t(58)=20.889$
Group II	26.33	30	3.836	20	33	$P=0.0001$ HS
Onset of blockade (min) motor						
Group I	9.43	30	1.547	8	12	$t(58)=20.740$
Group II	23.93	30	3.503	18	30	$P=0.0001$ HS
Duration of blockade (min) sensory						
Group I	467.67	30	26.579	420	520	$t(58)=44.60$
Group II	205.67	30	18.134	170	240	$P=0.0001$ HS
Duration of blockade (min) sensory						
Group I	477.67	30	26.579	430	540	44.60
Group II	215.67	30	18.134	180	250	$P=0.0001$ HS

**Figure 6: Mean duration of sensory and motor blockade****Figure 8: Quality of motor blockade****Figure 7: Quality of sensory blockade****Figure 9: Adjuvants used**

We conducted studies on sixty patients with demographic data in terms of age, weight and sex being similar in both groups. The data collected was analyzed for statistical significance by Student's *t*-test and Chi-square test.

The onset of the blockade in potassium group was earlier when compared to plain bupivacaine group. In our study, the mean onset of sensory and motor blockade in potassium group was 10.43 and 9.43 minutes, respectively. The results of our study support the findings of Khosla *et al.*¹⁵ Who showed that addition of potassium chloride to bupivacaine

significantly enhanced the onset of both sensory and motor blockade. In contrast to our study, the delayed onset of blockade proposed by Parris and Chamber¹⁴ may be due to the lower concentration of bupivacaine (0.25%) when compared to our study (0.375%).

The duration of sensory and motor blockade was significantly increased ($P < 0.001$) in potassium group when compared to other group. This is in agreement with Khosla *et al.*'s¹⁵ findings who found prolonged duration of analgesia.

We have found that depth of sensory and motor blockade was significantly better in potassium group when compared to other group. Bromage and Burfoot¹⁶ also found the intense quality of blockade when potassium was added to lignocaine in epidural blockade.

The decreased requirement of adjuvants in potassium group when compared to other group suggests greater quality of anesthesia. The results of our study support the findings of Parris and Chamber.¹⁴

Thus potassium chloride definitely has a role as an adjuvant to bupivacaine hydrochloride in shortening the onset time, prolonging the duration of action and improving the quality of blockade in brachial plexus block.

Apart from anatomic variations, individual patient's responses and discrepancies in the number of patients studied should also be taken into account to explain the differences among the studies. Further study of other agents and sites of blockade is required.

CONCLUSION

The present study concludes that addition of potassium chloride to bupivacaine had a significant clinical advantage over plain bupivacaine on onset time, duration, and quality of sensory and motor blockade in brachial plexus block.

REFERENCES

1. Stein C, Kopf A. Treatment of chronic pain. In: Miller RD, editor. *Anaesthesia*. 7th ed. Philadelphia, PA: Elsevier, Churchill Livingstone; 2010. p. 1797-814.
2. Tsui BC, Rosenquist RW. Peripheral nerve blockade. In: Barash PG, Cullen BF, Stoelting RK, editors. *Clinical Anaesthesia*. 7th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2013. p. 938.
3. Singer C, Underwood EA. *A Short History of Medicine*. 2nd ed. Oxford: Clarendon Press; 1962. p. 349.
4. Larson MD. History of anesthesia practice. In: Miller RD, editor. *Anaesthesia*. 7th ed. Philadelphia, PA: Elsevier, Churchill Livingstone; 2010. p. 17-20.
5. Hirschel M. Nerve damage from brachial plexus anesthesia. *Zentralbl Chir* 1993;40:77.
6. Löfgren N. *Studies in Local Anesthetics. Xylocaine, a New Synthetic Drug*. Thesis I. Stockholm, Haeggström, 1948. [Reprinted, Worcester, Mass, 1958].
7. David LB, Raymond BF. The history of neural blockade and pain management. In: Cousins MJ, Philip OB, editors. *Neural Blockade in Clinical Anaesthesia and Management of Pain*. 3rd ed. Philadelphia, PA: Lippincott-Raven; 1998. p. 10.
8. Keeler JF, Simpson KH, Ellis FR, Kay SP. Effect of addition of hyaluronidase to bupivacaine during axillary brachial plexus block. *Br J Anaesth* 1992;68:68-71.
9. Bromage PR, Burfoot MF, Crowell DE, Truant AP. Quality of epidural blockade 3. Carbonated local anesthetic solutions. *Br J Anaesth* 1967;39:197-209.
10. Bouaziz H, Brain PK, Macalou D, Heck M, Dap F, Benhamou D, *et al.* Sufentanil does not prolong the duration of analgesia in a mepivacaine brachial plexus block: A dose response study. *Anaesth Analg* 2000;90:383-7.
11. Bonica JJ, Backup PH, Pratt WH. The use of vasoconstrictors to prolong spinal anesthesia. *Anesth* 1951;12:431-41.
12. Heath PJ, Brownlie GS, Herrick MJ. Latency of brachial plexus block. The effect on onset time of warming local anaesthetic solutions. *Anaesth* 1990;45:297-301.
13. Okasha AS, El-Attar AM, Soliman HL. Enhanced brachial plexus blockade. Effect of pain and muscular exercises on the efficiency of brachial plexus blockade. *Anaesth* 1988;43:327-9.
14. Parris MR, Chambers WA. Effects of the addition of potassium to prilocaine or bupivacaine. Studies on brachial plexus blockade. *Br J Anaesth* 1986;58:297-300.
15. Khosa DS, Thind SS, Gupta HK, Jain S. Effects of adding potassium chloride to lignocaine and bupivacaine solutions on the onset time and duration of brachial plexus block. *Indian J Anaesth* 1990;38:119-22.
16. Bromage PR, Burfoot MF. Quality of epidural blockade. II. Influence of physico-chemical factors; hyaluronidase and potassium. *Br J Anaesth* 1966;38:857-65.

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