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Comparative Study of Potassium Chloride and Sodium Bicarbonate as an adjuvant to Lignocaine Hydrochloride with Adrenaline in Supraclavicular Brachial Plexus Block

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***Abstract**: This is a double blind randomized clinically controlled comparative study of addition of potassium chloride and sodium bicarbonate to lignocaine hydrochloride with adrenaline in brachial plexus block. 60 patients of ASA I and II of aged between 20 to 60 years of either sex posted for upper limb surgery were randomly allocated into two groups A and B. Group A received 30 ml of lignocaine hydrochloride with adrenaline (1:200000) and sodium bicarbonate (7.5%w/v). Group B received 30ml of lignocaine hydrochloride with adrenaline (1:200000) and potassium chloride (15%w/v compare). We observed onset of block, duration of block and duration of analgesia. It was observed that in group B onset of sensory block was earlier when compared to group A and it is statistically not significant (3.11±1.6 v/s 5.6±2.83, p value >0.05). Onset of motor block was earlier in group A when compared to group B (9.15±1.87 v/s 13.73±2.05) and this is statistically significant (p value<0.001). Duration of sensory block (162.66±30.83 v/s 142.25±20.83), duration of motor block (186.83±40.18 v/s 152.25±29.74) and duration of analgesia (276.50±32.14 v/s 218.75±20.15) was prolonged in group B when compared to group A and it is statistically significant (p value<0.001).*

***Keywords:** Adjuvants-sodium bicarbonate-potassium chloride-lignocaine hydrochloride-adrenaline-brachial plexus block.*

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I. Introduction

Brachial plexus block is preferentially used technique for anesthesia of upper limb due to its easy accessibility and simplicity with predictable land marks. Prolonged latency following brachial plexus anesthesia presents a potential problem in the busy clinical setting. Efforts to improve onset time have centered on the choice and modification of local anesthetic solutions. Alkalization has been shown to improve neural blockade in animal models[1], and research involving alkalization of different local anesthetic solutions has been undertaken in various clinical settings in man: brachial plexus [2-7], epidural anesthesia [8-10], and various others [11,12]. The results produced have been conflicting, ranging from no effect to improvement in both onset and duration of anesthesia. Although the pharmacology is well understood, the topic remains one of controversy. Technique, agent specificity, the addition of adrenaline, and the degree of change in pH have been suggested as possible explanations [1, 7].

The choice of local anesthetic agent is also important in determining the latency of neural blockade. Traditionally, lignocaine has been used during brachial plexus anesthesia to produce a relatively rapid onset time. However, the duration of anesthesia is often less than with other local anesthetic agents. This study has aimed to compare between potassium chloride and sodium bicarbonate as an adjuvants to lignocaine hydrochloride with adrenaline on latency, and duration of anesthesia.

II. Materials and methods

After approval from the institutional ethical committee and informed and written consent were taken from patients. 60 patients who required upper limb surgery were selected for this study. The age of patients ranged from 20 to 60 years of either sex. Prior to selection a thorough pre-anesthetic clinical evaluation was carried out and only ASA grade I and II patients were included in this study. Exclusion criteria included progressive neurological disorder, severe liver or kidney disease,cardio pulmonary disease, patients with bilateral upper limb surgery or any history of previous adverse reaction to local anesthetic drug and patients with hyperkalemia. Patient who weighed less than 50 kg or more than 65kg were also excluded from the study as a

fixed amount of local anesthetic was used. Patients having contra lateral pneumothorax or collapsed or partially collapsed lungs were also excluded from the study.

The patients were randomly allocated into two groups A and B according to the drug received. For each Group 30 patients were allotted .Group A patients received 30 ml of 1.5% lignocaine hydrochloride with adrenaline{ (28 ml lignocaine with adrenaline (1:200000)(pH=4.37) +2ml of sodium bicarbonate 7.5% w/v) (ph 6.5)} and Group B patients received 30ml of 1.5% lignocaine hydrochloride with adrenaline{lignoacine hydrochloride with adrenaline (1:200000)+ 2ml (4 milli equivalents) of potassium chloride 15% w/v (ph 6)}.Mixture was inverted, without shaking, 30 times over a period of 45to 60 seconds. PH of the solution was estimated by an electronic pH meter.

Brachial plexus block was given by conventional supraclavicular approach. Onset of sensory and motor block was tested at every one minute interval for a maximum of 30 minutes. Onset of sensory block was determined by loss of pinprick sensation. Onset of motor block was judged by loss of finger movements. Latency of sensory blockade is calculated from the time of injection to loss of pinprick sensation. Latency in motor blockade is determined from the time of injection to loss of finger movements. Duration of blockade is calculated from loss of pinprick to reappearance of pinprick sensation. Duration of motor block being the time taken from loss of finger movements till the patients started moving their fingers. Duration of analgesia is calculated from loss of pinprick sensation to first requirement of analgesia by the patient in the post operative ward. Routine monitoring of patients was done preoperatively, after injection and postoperatively. All patients were kept under observation for 24 hours.

III. Observations and Results

Data is analyzed and tabulated and subjected to statistical analysis by using student "t" test (two tailed distribution and unpaired) to find the significance between two groups and tabulated below (level of significance $t>2$ and $p< 0.05$).

Age and sex distribution of the patients:

Age in years	No. of patients					
	Group A(n=30)			Group B(n=30)		
	M	F	Total	M	F	Total
20-30	7	3	10	2	4	6
31-40	6	2	8	5	2	7
41-50	3	3	6	3	5	8
51-60	4	2	6	6	3	9
Total	20	10	30	16	14	30

Distribution of patients according to the surgical procedures:

Surgical procedures	Group A(n=30)	Group B(n=30)
Radial plating	2	5
Radial head incision	2	2
Ulnar nailing	1	4
Tension band wiring of elbow	3	-
Dynamic compression plating of humerous	3	5
Radial plating and ulnar plating	5	1
Debridement	2	4
Amputaion	2	-
Excision of swelling	4	3
Tendon repair	3	2
Post traumatic contracture release and split skin grafting	1	1
K wire fixation	2	3
Total	30	30

Onset of block (minutes)

Parameters	Group A(n=30)	Group B(n=30)	t value	p value
Sensory block	5.16±2.83	3.11±1.68	1	>0.05
Motor block	9.15±1.87	13.73±2.05	8.4	<0.001

Duration of block (minutes)

Parameters	Group A(n=30)	Group B(n=30)	t value	p value
Sensory block	142.25±20.23	162.66±30.83	3.4	<0.001
Motor block	152.25±29.74	186.83±40.18	3.9	<0.001
Analgesia	218.75±20.15	276.50±32.14	5.7	<0.001

IV. Discussion

William Halsted in 1885 introduced the concept and use of nerve block and infiltration anesthesia by injection of cocaine. One important aspect of regional anesthesia is relatively slow onset and limited duration of action. Various measures have been tried to improve the nerve blockade of local anesthetics like use of rapidly acting agents like chlorprocaine, longer acting agents like etidocaine, bupivacaine, addition of hyaluronidase, addition of dextran enzymes, oils, glycols, vasoconstrictors, compounding of local anesthetics, warming of local anesthetic solution, addition of clonidine, fentanyl, addition of potassium chloride and alkalization of local anesthetic solution [9,13,14,15,16,17,18,19,20,21,22,24]. Adrenaline is the commonest adjuvant used to prolong the duration of local anesthetics. It acts by causing vasoconstriction and thereby delays the absorption of local anesthetic from the site of injection.

In this study we compared addition of sodium bicarbonate and potassium chloride as an adjuvant to lignocaine hydrochloride 1.5% with adrenaline (1 in 200000). Ph of the freshly prepared solutions of group A and group B was 6.5 and 6 as measured by the electronic PH meter respectively.

Onset of sensory blockade in group A was 5.16±2.83 and in group B was 3.11±1.68. It was observed that sensory onset was earlier in group B when compared to group A and the difference is statistically not significant (p value>0.05) .Onset of motor block was earlier in group A (9.15±1.87) when compared to group B (13.73±2.05) and this difference is statistically significant (p value<0.001). Dhananjay Ambike etal compared sodium bicarbonate and potassium chloride as an adjuvant to lignocaine hydrochloride with adrenaline 1.5% and reported onset of block was earlier in sodium bicarbonate group, results of our study in onset of sensory blockade was not similar to their study and in onset of motor blockade was similar to their study [23]. Bromage etal by using carbonate salt of lignocaine as compared to hydrochloride salt of lignocaine showed early onset of blockade in bicarbonate group [24]. DiFasio etal adjusted ph of 1.5% lignocaine with adrenaline from 6 to7 by addition of 2 milli equivalents of sodium bicarbonate and showed early onset of blockade [9]. Dr Renju Ninan etal in their study addition of potassium chloride and sodium bicarbonate to bupivacaine showed early onset of both sensory and motor blockade [25]. Capogna G etal postulated that a higher ph required less buffering by tissues which facilitates the liberation of free base which diffuses rapidly into nerve fibers, this is considered as mechanism of action in early onset of blockade and duration of blockade regarding sodium bicarbonate as an adjuvant to local anesthetics [27].

MC Moreland GH has shown that concerning brachial plexus, effects of alkalization were more evident with lignocaine [31].

Duration of sensory blockade in the potassium group (B) was 162.66±30.83 and in sodium bicarbonate group (A) was 142.25±20.83. This difference is statistically significant (p value<0.001). Duration of motor blockade in the potassium group (B) was 186.83±40.18 and in sodium bicarbonate group (A) was 152.25±29.74. This difference is statistically significant (p value<0.001). Duration of analgesia in the potassium group (B) was 276.50±32.14 and in sodium bicarbonate group (A) was 218.75±20.74. This difference is statistically significant (p value<0.001). These observations can be explained by the mode of action local anesthetics and the changes in the ionic milieu during resting and active membrane potential. Huxley and Stampfli have shown A nerve impulse can be effectively blocked by the accumulation of potassium ions outside the neuron .From this experimental concept, it is assumed that the blockade produced by increased K+ concentration outside the nerve membrane [29]. Successive equal increments in the extracellular potassium will have a geometrically decreasing effect on the membrane potential due to an altered Donnan equilibrium - Em α log (K+)O/log (K+) l where Membrane potential, K+I Intracellular potassium concentration, K+O extracellular potassium concentration. The membrane Em will decrease as the extracellular potassium K+O increases [16] .Also inhibition of ionic fluxes across the membrane may play apart [30]. High concentrations of extracellular potassium efflux from the cell and the altered ionic relationships may affect the orientation of lipoproteins in the cell membrane in such a way that the membrane lattice becomes less permeable to lipid soluble substances such as local anesthetics.

Our study results were similar to Dhananjay Ambike etal in duration of blockade and duration of analgesia [24]. Khosa etal showed in their study duration of sensory and motor blockade was significantly increased when compared to other groups [28]. Saritha kumara etal showed potassium chloride added to bupivacaine produced prolonged duration of both sensory and motor blockade when compared to plain bupivacaine [26]. Also Swetha et al reported a significant prolongation of sensory block of the order of 205 mins and motor blockade of 467 mins with bupivacaine and potassium chloride 0.2 mmol. However in our study, adding potassium to Lignocaine rather than Bupivacaine prolongs the duration of sensory blockade of order of 162 mins for sensory blockade and motor blockade of 186 mins which suits most upper limb surgeries [31].

Complications

The expected toxic reactions due to Lignocaine and Potassium chloride were arrhythmias, convulsions, tremors, palpitations. These were not observed in our study. Inadvertent intravascular injection of the drug was prevented by careful aspiration before drug injection and careful and continuous monitoring of vital parameters.

V. Conclusions

In this study we concluded that addition of sodium bicarbonate to lignocaine hydrochloride produced early onset of blockade and addition of potassium chloride prolonged the duration of sensory block, motor block and duration of analgesia significantly.

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