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Research Article

Nerve block with alkalinized local anaesthetics: a clinical comparative study

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ABSTRACT

Background: A number of clinical studies have been performed in an attempt to establish the effects of alkalinization on potency of local anesthetics. A clinical comparative study was carried out to evaluate to study the effect of alkalinizing lignocaine, bupivacaine and their alkalinized counter parts for brachial plexus blockade.
Methods: A clinical comparative study was done on 100 patients in the Orthopedic and General Surgery operation theaters of Gauhati Medical College Hospital, Guwahati, India during the period from November 1997 to October 1998. Patients were divided into 4 groups of 25 each. The four drugs were lignocaine, bupivacaine and their alkalinized counter parts. The supraclavicular approach to the brachial plexus was used.
Results: The study observed a reduction in the latency of onset of surgical anaesthesia by both alkalinized lignocaine and bupivacaine. The effect of lignocaine being more pronounced at 44.26% against 33.9% of bupivacaine. Alkalinization of both lignocaine and bupivacaine enhanced the quality of sensory block as well as improved the quality of motor block.
Conclusions: From present study, we conclude that addition of sodium bicarbonate to commercially available local anaesthetic solutions enhances the quality of local anaesthetics, by a quicker onset of action, more profound sensory and motor block.

Keywords: Alkalinization, Lignocaine, Sodium bicarbonate, Bupivacaine, Brachial plexus blockade

INTRODUCTION

Brachial plexus block has now proved to be a safer and effective method of regional anaesthesia. But it is a common observation that surgeries on upper limb are still being performed mainly under general anaesthesia despite unanimous consensus toward regional anaesthesia, due to one or the other reasons. Various approaches have been described such as supraclavicular, parascalene, interscalene, subclavian perivascular, infraclavicular and axillary, but they all are associated with some technical difficulties, inadequate blocks and significant complications.[1] Hempel V has described the method for supraclavicular brachial plexus block; where longitudinal placement of the needle is done in relation to the brachial plexus from lateral to medial with a high success rate.[2] Kothari D has described lateral approach of supraclavicular brachial plexus block associated with minimal complication and high success rate.[3]

Commercially available preparations of local anesthetics are hydrochloride salts which are acidic, those with epinephrine being even more acidic. Increasing the pH of the local anesthetic solution towards the physiological range has been reported to improve the quality of neural blockade in vitro.

Lignocaine and bupivacaine are the two most commonly administered drugs in brachial plexus block by the supraclavicular route.[4]

This clinical comparative study tries to evaluate objectively the aims of the study and effectiveness of technique, as well as a clinical comparison of the two drugs lignocaine and bupivacaine and their alkalinized variants.

The aim of the study was to observe for any changes in the latency of onset of anaesthesia, the duration of action of the drugs, to study the intensity of analgesia and motor blockade, incidence of side-effects and complications.

METHODS

A clinical comparative study was conducted in the Orthopedic and General Surgery OTs of Guwahati Medical College Hospital, Gauhati, India during the period from November 1997 to October 1998. 100 cases were randomly selected for brachial plexus block with supraclavicular approach. The patients were of either sex, needing to undergo surgery of the upper limb, either as elective cases or on an emergency basis

The cases were divided into 4 groups on the basis of the drug used. Each group had 25 patients.

Group I - received 30ml of 1% plain lignocaine.

Group II - received 30ml of 1 % alkalinized lignocaine.

Group III - received 30ml of 0.33% plain bupivacaine.

Group IV - received 30ml of 0.33% alkalinized bupivacaine.

Inclusion criteria

Patients of ASA Category I and II, in the age group 16 to 60 years of either sex were selected for this study. Both elective and emergency cases were included in this study.

All elective cases had a detailed history taken, local examination and thorough systemic examination conducted. Routine Laboratory investigations, chest x-ray and ECG were undertaken as mandatory step to the anaesthetic approach.

For emergency cases stress was laid on detailed history and thorough physical examination.

Exclusion criteria

Patients with a history of epilepsy, cardiovascular diseases of severe degree, neurological and haemolytic diseases were excluded from this study.

Local infection, extensive tissue destruction was also a reason to exclude patients from this study.

Very apprehensive patients, patients with a history of psychiatric problems and alcoholism or drug abuse were not included in the study.

All the relevant information was recorded on a pretested, predefined, semi-open pro forma sheet.

Statistical analysis

All accumulated data were compared by Student's t-test. The data was expressed in mean±SD, number and percentage.

RESULTS

Patients in the age group 16 to 60 yrs were included in the study. Patients were divided into categories age wise (Table 1).

There were a total of 76 male patients and 24 female patients in the study (Table 2).

Table 1: Age distribution.

Age (years)	Number				Percentage			
	Group 1	Group 2	Group 3	Group 4	Group 1	Group 2	Group 3	Group 4
16-25	11	10	08	04	44	40	32	16
26-35	06	11	09	13	24	44	36	52
36-45	06	03	04	03	24	12	16	12
46-55	00	00	03	04	0	0	12	16
56-60	02	01	01	01	8	4	4	4

Table 2: Gender distribution.

Sex	Total number	Group wise sex distribution			
		Group 1	Group 2	Group 3	Group 4
Male	76	14	18	23	21
Female	24	11	7	2	4

Alkalinized lignocaine showed a marked reduction in onset time to surgical anaesthesia (44.26 percent quicker) which was statistically highly significant (p<0.01), likewise highest grade of motor block achieved was also much quicker (31.74%) and statistically significant at (p<0.01).

Quality of sensory block was found to be much better in Group 2, alkalinized lignocaine with 100% of cases achieving a good block; while in Group 1 it was noted that only 76% achieved a good block while 24% were graded as having a having a fair block.

Table 3: Weight and ASA status of patients in the four study groups.

Characteristics	Group 1	Group 2	Group 3	Group 4
Weight (kg)	57.24	56.84	55.16	57.72
mean±sd	± 14.72	± 15:03	± 12.69	±14.75
No. of ASA I patients	24	21	25	23
No. of ASA II patients	1	4	0	2

Table 4: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 1 (Lignocaine plain) and group 2 (Alkalinized lignocaine).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group 2	Group 3	Group 4	
Group 1 lignocaine plain	12.2+3.05	12.6±5.56	76	24	0	0	44	56	0	0	61.8+4.97
Group 2 lignocaine alkalinized	6.8±0.81	8.6±1.10	100	0	0	0	96	4	0	0	48.52 ±6.03
Percentage	44.26	31.74									21.48
P-value	<0.01	<0.01									<0.01

The duration of anaesthesia was significantly reduced by 21.48% it being 48.52±6.03 minutes in Group 2, as compared with 61.8+4.97 minutes in Group 1. This reduction in duration was found to be statistically significant at p<0.01 (Table 4).

The onset of surgical anaesthesia is statistically significantly faster at 13.6±1.82 minutes as compared to plain bupivacaine which was found to have onset of surgical anaesthesia at 20.6±1.04 minutes in this study (p<0.01). Likewise duration of anaesthesia was significantly shorter (p<0.01) at 161.2±11.66 minutes in group 4 alkalinized bupivacaine, as compared to 183.2±9.88 minutes in Group 3 comprising of non-alkalinized bupivacaine.

The percentage difference being 33.9 for onset of surgical anaesthesia, 40.81 for onset maximal motor block and 12% for duration of action (Table 5).

Onset of surgical anaesthesia was found to be significantly shorter at 12.2.±3.05 minutes in Group 1 (p<0.01) as compared with 20.6±1.04 minutes in Group 3. Onset of maximum motor blockade in Group 1 was at 12.6±5.56 minutes, while it was found to be 26.56±2.2 minutes in Group 3, the difference being statistically significant (p<0.01). 76% of patients in Group 1 were found to have good quality of block as compared to 32% in group 111 while fair block was found in 24% and 68% respectively. 44% of Group 1 patients achieved Grade 1 motor block compared to 20% of Group 3, Grade 2 block was achieved in 56% and 68% patients respectively. While 12% in Group 3 had Grade 3 block there were no patients in this grade from Group 1 (Table 6).

Comparing Group 1 with Group 4, it was found that onset of surgical anaesthesia is significantly quicker in Group 1 i.e. Lignocaine plain (p<0.01). The motor block was achieved faster (p<0.01) and the duration of action was also noted to be statistically significantly shorter in Group 1 (Lignocaine plain) as compared to Group 4 i.e. alkalinized bupivacaine (Table 7).

Onset of surgical anaesthesia was significantly quicker at 6.8±0.81 min for alkalinized lignocaine, as compared to 20.6± 1.04 min for plain bupivacaine (p<0.01). Also statistically significant was onset of maximal motor block at 8.6±1.10 min and 26.56±2.2 min respectively (p<0.01), while duration of anaesthesia was 48.52±6.03 min and 183.2±9.88 min respectively (p<0.01). Also compared in the table are quality of sensory block and grade of motor block (Table 8).

Table 5: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 3 (Bupivacaine plain) and group 4 (Alkalinized bupivacaine).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group 2	Group 3	Group 4	
Group 3 bupivacaine plain	20.6± 1.04	26.56±2.2	32	68	0	0	20	68	12	-	61.8+4.97
Group 4 alkalinized bupivacaine	13.6±1.82	15.72 + 5.77	88	12	0	0	80	20	-	-	48.52 ±6.03
Percentage	33.9	40.81									21.48
P-value	<0.01	<0.01									<0.01

Table 6: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 1 (Lignocaine plain) and group 3 (bupivacaine plain).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group 2	Group 3	Group 4	
Group 1 lignocaine plain	12.2±3.05	12.6±5.56	76	24	0	0	44	56	-	-	61.8±4.97
Group 3 bupivacaine plain	20.6±1.04	26.56+2.2	32	68	-	-	20	68	12	-	183.2 ± 9.88
P-value	<0.01	<0.01									<0.01

Table 7: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 1 (Lignocaine plain) and group 4 (Alkalinized bupivacaine).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group 2	Group 3	Group 4	
Group 1 lignocaine plain	12.2±3.05	12.6±5.56	76	24	-	-	44	56	-	-	61.8±4.97
Group 4 alkalinized bupivacaine	13.6±1.82	15.72+5.77	88	12	-	-	80	20	-	-	161.2 ± 11.66
P-value	<0.01	<0.01									<0.01

Onset of surgical anaesthesia was significantly faster ($p<0.01$) in Group 2 (6.8±0.81 min) as compared to alkalinized bupivacaine Group 4 (13.6±1.82 min). 100% patients in group it had good block compared to 88% in Group 4, while 96% had Grade 1 motor block compared 80% in Group 4. Duration of anaesthesia was significantly different being 48.52±6.03 min Group 2 compared to 161.22±11.66 min in Group 4 (Table 9).

Table 8: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 2 (Alkalinized lignocaine) and group 3 (Bupivacaine plain).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group	Group	Group 4	
Group 2 alkalinized lignocaine	6.8±0.81	8.6±1.10	100	-	-	-	96	4	-	-	48.52±6.03
Group 3 bupivacaine plain	20.6±1.04	26.56+2.2	32	68	-	-	20	68	12	-	183.2 ± 9.88
P-value	<0.01	<0.01									<0.01

Table 9: Comparison of the onset of surgical anaesthesia, onset maximal motor blockade, quality of sensory block and grade of motor block between group 2 (Alkalinized lignocaine) and group 4 (Alkalinized bupivacaine).

Study group	Onset of surgical anaesthesia (minutes)	Onset of maximal motor block (minutes) mean±sd	Quality of sensory block (%)				Grade of motor block (%)				Duration of anaesthesia (minutes) mean±sd
			Good	Fair	Poor	Failure	Group 1	Group 2	Group 3	Group 4	
Group 2 alkalinized lignocaine	6.8±0.81	8.6±1.10	100	-	-	-	96	4	-	-	48.52±6.03
Group 4 alkalinized bupivacaine	13.6±1.82	15.72+5.77	88	12	-	-	80	20	-	-	161.2 ± 11.66
P-value	<0.01	<0.01									<0.01

DISCUSSION

In recent years, there has been a growing interest in the practice of regional techniques. The development of local anaesthetic agents with lower toxicity and long duration of action had contributed to this change.5-8

Carbonated local anaesthetics being difficult and expensive to manufacture are not widely available. An alternative was sought for and addition of sodium bicarbonate to the local analgesic solution was thought of. Sodium bicarbonate was postulated to have a dual mechanism of action.9

It is well known that relative alkalinity of local anesthetics may be a major determining factor in altering the onset of action of local anesthetics. Increasing the pH towards pKa of a drug by alkalinization increases the concentration of non-ionized form and it is this non-ionized fraction that diffuses rapidly to the inner axonal surface producing quicker onset of analgesia.10

This study attempted at clinically studying the effects of alkalinizing two commercially available local anaesthetic solutions, lignocaine hydrochloride and bupivacaine hydrochloride, by addition of sodium bicarbonate solution. The results obtained in this study will be discussed in the light of other like studies.

The patient was of a similar demographic character, with regard to age, sex, weight and ASA status (Table 1-3).

Our study observed that the mean onset of surgical anaesthesia was 12.2±3.05 minutes for plain lignocaine, 6.8±0.81 minutes for alkalinized lignocaine the difference of 5.4 minutes in between the groups is statistically significant ($p<0.01$) and denotes a reducing by 44.26% for latency of onset of action. Likewise maximal motor block was noted at 12.6±5.56 minutes for plain lignocaine and 8.6±1.10 minutes for alkalinized lignocaine, the difference again being statistically significant ($p<0.01$) at 4 minutes; the difference being that of 31.74%.

Results similar to those obtained in our study were noted in studies by Gertel and Bromage.11 They used a 1% carbonated lignocaine solution and noted the mean time of surgical anaesthesia to be 5.2±1.18 minutes as compared to 11.69±1.15 minutes of plain lignocaine.

In our study, 44% of patients injected with non-alkalinized lignocaine had Grade 1 motor block 56% had Grade 2 block, the alkalinized group showed 96% having Grade 1 block and 4% having Grade 2 block. There were no patients in either group showing Grade 3 and 4 motor block. Bromage and Gertel, Shulte-Steinberg and Gromley et al have all noted similar results in their studies, leading them to state that motor blockade is enhanced following carbonation of lidocaine solution.11-13

Duration of action of alkalinized lignocaine, has in our study, been noted to be shorter than of nonalkalinized lignocaine, the durations being 48.52±6.03 97 min and 61.8±4.97 minutes respectively, the difference being 13.28 minutes which represents a reduction by 21.48 percent.

This reduction in the duration of analgesic action has been found by Adriani, who in studies using alkalinized procaine found the duration of action reduced by 6 minutes, Adriani has reasoned this, as due to reaching of maximum effective concentration more quickly followed by rediffusion from tissue at a faster rate.14

The present study also included another local anaesthetic bupivacaine, and its alkalinized variant. Bupivacaine seems the ideal drug for alkalinization, because inspite of its having long duration of action and excellent sensory block, its main drawback being long latency of onset and comparatively lesser degree of motor block.

The present work undertook to study the latency of onset of surgical anaesthesia, intensity of sensory block, grade of motor block and duration of action of non-alkalinized and alkalinized bupivacaine along with lignocaine.

It was observed in this study, that the mean±sd onset of surgical anaesthesia with unalkalinized bupivacaine for brachial plexus block was 20.6±1.04 minutes, this was reduced to 13.6±1.82 minutes when alkalinized bupivacaine was used, and this difference of 7 minutes in the two groups represents a change of 33.9 percent.

Hilger blocked the axillary nerve using bupivacaine, and found the onset of surgical anaesthesia at 28±3.12 minutes in the non-alkalinized group, while the group where bicarbonate was added to the local anaesthetic solution showed a decrease in the latency of surgical anaesthesia to 15.2±2.72 min, signifying an onset quicker by 12.79 minutes, which represents a difference of 54.32 percent.15

In the present study it was observed that with non-alkalinized bupivacaine 20%, 68% and 12% patients achieved Grade 1, 2 and 3 motor block respectively, while this was respectively 80%, 20% and 0% in Group 4, i.e. patients receiving alkalinized bupivacaine. Similarly, 32% of patients receiving plain bupivacaine had good sensory block compared to 80% in the group of patients who were given alkali added bupivacaine and $p<0.05$ i.e. statistically significant difference in each group was seen.

McMoriand using 0.25% bupivacaine for extradural blocks for parturients found 30% better motor blockade with alkalinized bupivacaine, than with un-alkalinized bupivacaine.16

As far as duration of action of alkalinized bupivacaine was concerned, this study noted a shortening of the duration of sensory analgesia by 22 minutes, which signified a reduction by 12 percent from the duration of action of non-alkalinized bupivacaine.

McMorland using plain and alkalinized bupivacaine for extradural blocks noted a shorter duration of action of alkalinized bupivacaine. The duration of action shortened by 21 minutes was found to be statistically significant ($p<0.05$).16

The results obtained by Capogena et al are almost similar to that of our study. They found alkalinized lignocaine to be statistically more significant in all respects for brachial plexus anaesthesia, while alkalinized bupivacaine showed results which too were significant statistically though not to that degree as these seen with alkalinized lignocaine.17 In the present series alkalinization proved to cause changes of equal statistical significance both with lignocaine and bupivacaine, though clinically the magnitude reduction of latency of onset is more in case of lignocaine (44.26%) than in case of bupivacaine (33.9%).

Thus the observation of the present series as well as that of other workers affirms that alkalinization of local anaesthetics (lignocaine, bupivacaine) is beneficial in regards of latency of onset of action, extent of sensory blockade and degree of motor blockade.

CONCLUSION

From this study, we concluded that, addition of sodium bicarbonate to commercially available local anaesthetic solutions enhances the quality of local anaesthetics, by a quicker onset of action, more profound sensory and motor block.

Alkalinization of local anaesthetics is a user friendly adaptation which enhances the efficacy of local anaesthetics.

The limitations of the study were the reduced duration of action of the drugs after alkalinization.

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