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ORIGINAL ARTICLE

Randomized Comparative Study of Bupivacaine with Sodium Bicarbonate And Potassium Chloride as Adjuvants for Brachial Plexus Block By Supraclavicular Approach

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Abstract

Background : Supraclavicular block is the most easiest, consistent and time efficient technique for upper limb surgeries. **Aims and objectives:**To study and compare the efficacy of sensory and motor block of bupivacaine with potassium chloride and bupivacaine with sodium bicarbonate in supraclavicular block. **Material and methods:** This clinical study was conducted in 70 patients of ASA I and II, aged 20-60 years, scheduled for upper limb surgeries. Patients were randomly divided into two study groups. Group A received 30 ml of 0.375% bupivacaine with 0.2mmol of potassium chloride. Group B received 30ml of 0.375% bupivacaine with 0.17mmol of sodium bicarbonate. **Results**:Both the groups were comparable in patient's age, sex, weight and duration of surgery ($p>0.05$). The mean onset of sensory and motor block was 7.5±0.69minutes and 3.91±0.91minutes respectively in group A and 9.34±0.76minutes and 5.8±0.47minutes respectively in group B. The mean duration of sensory block was 472±30.17minutes (Group A) and 647.14±19.63minutes (Group B). The mean duration of motor block was 249.42±14.13minutes (Group A) and 399.42±27.00minutes (Group B). These observations were statistically significant (pvalue<0.001). **Conclusions:**Bupivacaine with potassium chloride has early onset of sensory and motor block. Bupivacaine with sodium bicarbonate has prolonged duration of sensory and motor block.

Key Words

Bupivacaine, Supraclavicular Blocks, Potassium Chloride, Sodium Bicarbonate, Upper Limb Surgeries

Introduction

Regional anaesthesia has taken over as the principle technique for upper limb surgeries with the introduction of newer and safer local anaesthetics and better advantages. Brachial plexus block is a versatile and reliable regional anaesthetic technique with multiple applications. [1] It was first performed by HALSTED in 1884 who injected cocaine under direct vision and blocked roots of brachial plexus. [2] This has become the most used peripheral block for forearm and hand surgeries due to low incidence of complications as compared to more proximal approaches. [3] The advantages are effective analgesia with good motor blockade, awake patient, extended post operative analgesia, early ambulation, early resumption of oral feeding, minimal number of drugs used, no airway manipulation, more cardiovascular and respiratory stability, less incidence of post operative nausea and vomiting and ideal operating conditions can be met. [4] Supraclavicular brachial plexus block was first described by Kulenkampff in 1911. [4] It is the most easiest , consistent and time efficient technique

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for upper limb surgeries. The main disadvantage of local anaesthetics is their short duration of action and delayed onset. To overcome this , adjuvants like opioids, vasoconstricting agents, magnesium , ketamine , clonidine, steroids, alkalinizing agents were tried. [5] Potassium salts were first used as adjuvants in 1912. [6] Addition of KCL to local anaesthetics increase the concentration of potassium extracellularly and causes depolarization of membrane. [7] This prevents passage of a propagated impulse from depolarised area to the normal segment of the nerve thus producing effective sensory and motor blockade. Alkalinisation of local anaesthetics raises the ph of the solution and has been shown to increase the speed of nerve blocks. Perthes in 1912 and Pearson in 1955 demonstrated that nerves could be identified by electrostimulation. [8] In this study , we aimed to study the effect of addition of KCL and sodium bicarbonate to Bupivacaine for supraclavicular block in patients scheduled for upper extremity surgeries using peripheral nerve locator. The primary objective was to study and compare the efficacy of sensory and motor block of bupivacaine. The secondary objectives were to compare the quality of sensory and motor blockade and to look for complications (if any).

Material and Methods

The study was conducted in the department of anaesthesiology and intensive care , Government medical college, Jammu for a period of one year. After obtaining approval from the institutional ethical committee (approval number IEC/GMC/2019/806) and obtaining written informed consent, 70 patients of ASA I and II, aged 20-60 years, of either sex, scheduled for upper limb surgeries under supraclavicular block were enrolled for this prospective comparative clinical study.

Patients who refused, patients with progressive neurological disorder, history of bleeding disorder, known allergy to local anaesthetic drug, infection at the puncture site and BMI> 35 kg/ square meter were excluded from the study. Patients were randomly allocated to one of the two study groups according to computer generated randomisation table. Group A: Patients received 30 ml of 0.375% bupivacaine with 0.2mmol (0.1ml) of potassium chloride. Group B: Patients received 30ml of 0.375% bupivacaine with 0.17mmol (0.2ml) of sodium bicarbonate. 30 ml of 0.375% bupivacaine= 22.5 ml of 0.5% bupivacaine + 7.5 ml Normal saline. A thorough pre-anaesthetic evaluation was performed in all patients. All patients received nil per oral orders as per protocol. Tab. Alprazolam 0.25 mg was given at bed time a night before surgery and Tab. Pantoprazole 40mg was given with a sip of water on the morning of surgery. An IV access with 18 G cannula was established and infusion of Ringer Lactate was started(10ml/kg). All patients were pre medicated with injection midazolam 2mg slow IV 30 mins before surgery. In the operating room, all routine monitoring were applied. Baseline values of heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, oxygen saturation were recorded. The patient was kept in supine position, 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 anaesthesiologist stood at the side of the patient to be blocked, facing the head of the patient.

An intradermal wheal was raised approximately 1cm above the midclavicular point with 2 ml of 2% lignocaine. The Subclavian artery palpable in supraclavicular fossa was used as a landmark. The point of needle insertion was located immediately cephalad to the palpating finger. The nerve stimulator was connected to the stimulating needle and was set to deliver a 0.8 to 1.0 mA current at 1 Hz frequency and 0.1 milliseconds of pulse duration. The needle was inserted first in an anteroposterior direction, almost perpendicularly to the skin. The needle was slowly advanced until the upper trunk was identified by a muscle twitch of the shoulder muscles or up to 1 cm, if there is no response. At this point, the orientation of the needle was changed to advance it now caudally under the palpating finger, with a slight posterior angle. This strategy directed the needle from the vicinity of the upper trunk (shoulder twitch) to the front of the medial trunk (biceps, triceps, pectoralis twitch) on its way to the lower trunk (fingers twitch). Once the elicited motor response of the fingers was obtained at 0.3 mA, the injection was carried out after gentle aspiration. The heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and arterial saturation was recorded every 5 minutes intraoperatively for the first 30 minutes ; thereafter every 10 minutes. Time of onset of sensory block was recorded using pinprick using a blunt 25 G hypodermic needle in skin dermatomes C4-T2 every one minute till the blockade occurred, taking the time of supraclavicular injection as zero, and every 30 mins thereafter. The checking of sensory level was suspended during the surgery. The onset of sensory block was the time of injection of drug to time of loss of pain on pinprick. The sensory blockade was assessed and scored as 0- no pain, 1- mild grimace, 2- moderate pain-withdrawal, 3- severe pain. The time of onset of motor blockade was recorded by modified Bromage score. It was assessed every one minute till the motor blockade occurred and every 30 mins thereafter as 0-able to raise extended arm to 900 for 2 secs, 1-able to flex elbow and

Table 1. Demographic Profile of Patients

Data/groups	Group A	Group B
Age(years)	34.22±11.53	36.65±11.4
Sex(male:female)	25:10	21:14
Weight(kgs)	62.31±5.26	64.31±7.31
Duration of surgery(mins)	94.71±25.40	86.57±27.96

Table 2- Sensory and Motor Blockade Characteristics

Parameter/groups	Group A	Group B	P-value
Onset of sensory block(mins)	7.57±0.69	9.34±0.76	<0.001*
Onset of motor block(mins)	3.91±0.91	5.8±0.47	<0.001*
Duration of sensory block(mins)	472±30.17	647.14±19.63	<0.001*
Duration of motor block(mins)	249.42±14.13	399.42±27.00	<0.001*

P<0.001 is statistically highly significant. Data is presented as mean± standard deviation.

Fig-1. Mean Heart Rate at various Intervals till the Surgery Lasted in Beats per Minute.

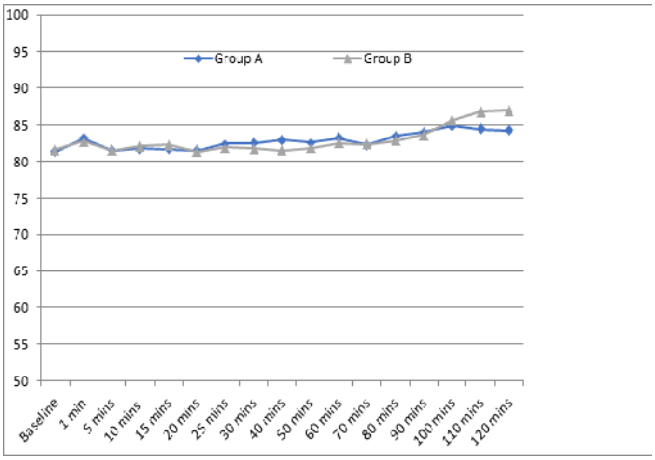
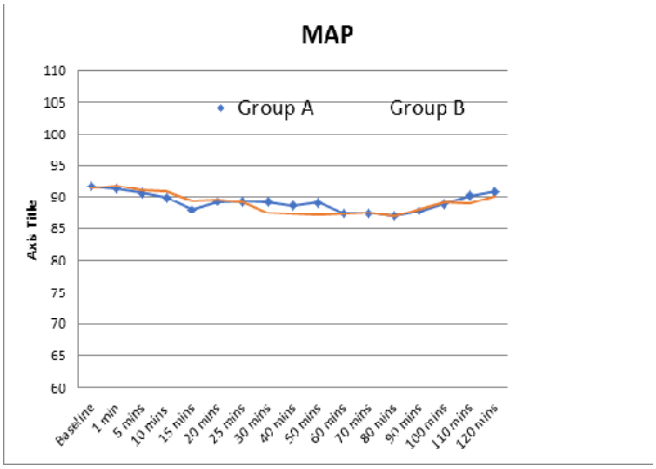


Fig-2: Mean MAP at Various Intervals till the Surgery Lasted



move fingers but unable to raise the extended arm, 2-unable to flex the elbow but able to move the fingers and 3-unable to move arm, elbow, and fingers. The duration of surgery , the duration of sensory block, the duration of motor block, the vital parameters and complications were recorded. The duration of sensory blockade was the time of onset of sensory block to the recurrence of pain to pinprick. The duration of motor blockade was the time of onset of loss of movements to the recurrence of movements(flexion of elbow). These were recorded every 30 mins after the completion of surgery.

The patients were monitored for bradycardia, hypotension, convulsions, restlessness, disorientation, drowsiness or any other complications. Hypotension (systolic blood pressure < 90mmHg) was managed by giving inj. Mephenteramine 6 mg i.v. in incremental doses. Bradycardia (HR< 55bpm) was managed by giving inj. Atropine 0.3mg i.v. The quality of sensory and motor blockade was assessed based on sensory and motor blockade as Grade 1: no supplemental drugs like opioids or sedatives required in the intraoperative period to continue the surgery, Grade 2: analgesics and sedatives are given as supplementation due to inadequate blockade and Grade 3: due to complete failure of the blockade and hence converted to general anaesthesia and these patients are excluded from the study. All statistical calculations were done using the Statistical Package for the Social Sciences (SPSS) software for Microsoft Windows.

Results

All the patients who were randomised completed the study. Both the groups were comparable with respect to age, sex, weight, duration of surgery and ASA classification. [*TABLE-1*]

The mean onset of sensory block was 7.5±0.69minutes in group A and 9.34±0.76minutes in group B. It was found to be statistically significant (p value < 0.05). The mean onset of motor block was 3.91±0.91minutes in group A and 5.8±0.47minutes in group B which was statistically significant. (p value < 0.05). We observed that the mean duration of sensory block was 472±30.17minutes in group A and 647.14±19.63minutes in group B which was found to be statistically significant (p value < 0.05). The mean duration of motor block was 249.42±14.13minutes in group A and 399.42±27.00minutes in group B. These observations were found to be statistically significant (p value < 0.001) [*TABLE-2*]. There were no significant side effects noted in our study. The various complications occurred were Vascular puncture and Horner syndrome. All the complications were treated accordingly and complete recovery was noted. However, there was no mortality seen in our study. Vascular puncture occurred in two patients in group A and three in group B. Horner syndrome occurred in one patient in group A with spontaneous resolution. There were no statistically significant changes in mean heart rate, systolic BP, diastolic BP, mean arterial pressure and oxygen saturation of both groups (p- value > 0.05) [*FIG-1 and 2*].

Discussion

Brachial plexus block is widely used in our day to day practice for elective as well as emergency upper limb surgeries. In order to provide better quality of anaesthesia intraoperatively as well as to prolong the duration of post operative analgesia various adjuvants are added to local anaesthetic solution. Among the adjuvants sodium bicarbonate and potassium chloride have stood the test of time.

The addition of potassium chloride to Bupivacaine solution provides better quality of analgesia, better tourniquet tolerance as well as prolongs the duration of analgesia. It also enhances the onset of sensory blockade without any detrimental side effect even when injected intravascularly because 0.2mmoles of potassium chloride used in this study is too low to cause the cardiovascular complications. Sodium bicarbonate when added to Bupivacaine will change the pH to alkaline state and thereby it enhances the onset of sensory blockade, provides better quality of analgesia, better tourniquet tolerance and prolongs the duration of analgesia. The addition of sodium bicarbonate is cost effective as well as do not have any adverse effect on the hemodynamic status of the individual. Our observations and results showed that both the groups were comparable in patient demographics i.e. age, sex, weight and the duration of surgery with no statistical difference between two groups. The mean onset of sensory block was 7.5±0.69minutes in group A and 9.34±0.76minutes in group B. This difference was statistically significant i.e. group A showed faster onset of sensory block as compared to the other group. The mean onset of motor block was 3.91±0.91minutes in group A and 5.8±0.47minutes in group B. Group A had faster onset of motor block than the other group. This was in accordance with a study done by Shivani *et al.,* [9] in which he concluded that potassium chloride had more intense quality of sensory blockade. Similar observations were found in study conducted by Khosa DS *et al.*,[10] where potassium chloride was added to lignocaine and bupivacaine solutions in brachial plexus block and they concluded that addition of potassium chloride to bupivacaine in brachial plexus block significantly enhanced the onset of sensory blockade and prolonged the total duration of analgesia. The study by Brandis [11] who observed that alkalinisation of local anaesthetic solutions reduce the pain of infiltration. It also reduces the onset of anaesthesia. Our results are also consistent with study done by Shobana *et al*.,[12]who concluded that addition of potassium chloride as an adjuvant to bupivacaine shortens the onset time of sensory and motor blockade whereas the addition of sodium bicarbonate prolongs the duration of sensory and motor blockade. Ambike *et al*., [13] concluded that onset of motor blockade with lignocaine is earlier with lignocaine and sodium bicarbonate. Similar results were found by Mehta *et al*.,[14] who observed that raising the pH of solution produced a reduction in latency of sensory block and motor block and increased in the duration of block. Our study is also in accordance with the study conducted by Bagle [15] concluded that pH adjustment of local anaesthetic solution used in epidural blockade causes early onset of sensory and motor block, adequate level of analgesia, and considerable prolongation of duration of block. Our results are supported by Baruah [16] who concluded that addition of sodium bicarbonate to local anaesthetic solutions enhances the quality of local anaesthetics, by a quicker onset of action, more profound sensory and motor block. Our result is similar to the study of Solanki *et al.*,[17] wherein the duration of post-operative analgesia is significantly prolonged by the addition of 0.2 mmol of potassium chloride. Similar study was conducted by Kosucu *et al*.,[18] who concluded that the alkalinisation of Ropivacaine with sodium bicarbonate provide a shorter onset block time. This is in contrast to study conducted by Chow *et al*.,[19] who concluded that alkalinisation of lidocaine does not significantly hasten

block onset in most terminal nerve distribution. The quality of sensory and motor block was same in both the groups. Shobana *et al.*,[13] concluded that addition of potassium chloride as an adjuvant to bupivacaine shortens the onset time of sensory and motor blockade whereas the addition of sodium bicarbonate prolongs the duration of sensory and motor blockade. Complications which occurred during our study were vascular puncture and Horner syndrome. Vascular puncture occurred in 2 patients in group A (mean % 5.7%) and 3 in group B (mean% 8.5%). Horner syndrome occurred in 1 patient in group A (mean% 2.8%) with spontaneous resolution. This is in contrast to study by Anahi perlas [20], in which six patients complained of shortness of breath and chest pain within one hour of block procedure. In these patients, a diagnosis of ipsilateral hemidiaphragmatic paresis and acute angina was made respectively. But, in our study the side effects/ complications are almost negligible. This might be because of less concentration of potassium chloride or use of nerve stimulator with current of 0.3 mA which leads to deposition of drug in very close proximity of brachial plexus.

Conclusion

With the present study we can conclude that bupivacaine 0.375% with potassium chloride has early onset of sensory and motor block when compared to bupivacaine 0.375% with sodium bicarbonate. At equal volumes, bupivacaine 0.375% with sodium bicarbonate has prolonged duration of sensory and motor block than bupivacaine 0.375% with potassium chloride. The quality of block is same in both the groups. All the drugs are devoid of any significant side effects at the concentration and volumes used for the study. But as very few studies are done on potassium chloride in brachial plexus block, more studies are needed to consolidate our results.

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Conflicts of Interest

There are no conflicts of interest.

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