Effect of Alkalinization of Mixture of Local Anaesthetics on Sensory Nerve Block in Patients Underwent Upper Limb Surgery

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ABSTRACT

Aim and objectives: To evaluate effectiveness of adding sodium bicarbonate to local anesthetic mixture on sensory nerve block in patients underwent upper limb surgery.

Materials and Methods: Study was done on 60 patients for a period of 12 months. Patients were divided into 2 groups of 30 each. Group-I: Bupivacaine (0.5%/15ml) + lignocaine (2%) with Adrenaline (15ml) + normal saline (10ml). Group-II: Bupivacaine (0.5%/15ml + lignocaine (2%/15ml) with Adrenaline (15ml) + Sodium bicarbonate (4ml) + normal saline (6ml). Two group’s demographic data, onset of nerve block and duration of nerve block were recorded and compared. The present study ethically cleared by institutional human ethical committee of Apollo BGS hospital Mysore.

Results: Group-II showed increased duration of sensory nerve block compared to group-I. Group-II showed decrease in onset (8.03 min) of sensory block compared to group-I (13.50 min). Usage of adjuvant drugs are less in group-II compared with group-I.

Conclusion: Addition of sodium bicarbonate to local anesthetic mixture significantly decreases the onset of sensory nerve block with increase in the duration of nerve block.

Keywords: Adrenaline, Anaesthesia, Bupivacaine, Sensory nerve block, Lignocaine, Sodium bicarbonate.

INTRODUCTION

"Regional anaesthesia" is the term first used by Harvey Cushing in 1901 to describe pain relief by nerve block. [¹] Regional nerve blocks are based on the concept that pain is conveyed by nerve fibers, which are amenable to interruption anywhere along their pathway. Brachial plexus block has now evolved into valuable and safe alternative to general anaesthesia for upper limb surgeries. It is a great tool in the anaesthetic armamentarium for relief of pain preoperatively, per-operatively and post operatively. Since its introduction by William Steward Halsted in 1885, who performed the block by exposing the roots, it has undergone many changes and modifications to arrive at a better technique.
Regional anaesthesia can reduce or avoid the hazards and discomfort of general anaesthesia including sore throat, airway trauma, and muscle pain. It also offers a number of advantages to outpatients undergoing surgery. These techniques provide analgesia without sedation, prolonged postoperative analgesia and allow earlier patient’s discharge. Regional anaesthesia reduces the requirements of opioids. It reduces the incidence of postoperative nausea and vomiting. It can be used alone or in combination with sedation or as a part of balanced analgesia with general anaesthesia. [2]

In new trend of day care surgeries with minimal hospital stay and less financial burden on the patients, brachial plexus block seems to be a better alternative to general anaesthesia. The innervations of the upper limb are derived almost completely from the brachial plexus. Complete block can thus be achieved by means of a single injection. [3] Pain relief after upper limb surgery can be achieved by various regional anaesthetic techniques. The supraclavicular brachial plexus block is one among the most popular regional nerve blocks performed. The easy and predictable landmarks make it a popular approach.

Bupivacaine and lignocaine are the most commonly administered drugs in brachial plexus blocks, however, onset of action and duration of anesthesia are the limiting factors. To minimize these drawbacks, many drugs including buprenorphine, clonidine, morphine, verapamil, tramadol and dexamethasone have been co-administered with local anesthetic to improve the quality and duration of action. [4-8] One technique that may decrease this delay is referred to as 'alkalinisation' of the local anaesthetic solution. [9] This means adding a planned amount of a basic solution (typically sodium bicarbonate) to the local anaesthetic solution before injecting it into the target tissues. This practice may also decrease the pain on injection of the solution. [10] Alkalinization of local anesthetic solution to speed the onset of action, with varying degrees of success has been studied by several workers. [11,12]

It is not clear yet whether freshly prepared alkalinised local anaesthetic mixture would improve the quality, onset and duration of supraclavicular brachial plexus block. This prospective study was a randomized, controlled trial to compare the onset, the quality and duration of analgesia with alkalinized-anaesthetic mixture with anaesthetics mixture alone in sensory nerve block in patients underwent upper limb surgery.

**MATERIALS AND METHODS**

*Study design:* Random sampling, computerized randomization, double blind, controlled trial.

*Study settings:* Department of Anaesthesiology, Apollo BGS Hospital, Mysore, Karnataka.

*Study duration:* 12 months

*Inclusion criteria*
- Age group: 18 to 60 years
- ASA Grade 1 and 2 of both Gender for elective surgery
- Orthopedic, plastic and reconstructive upper limb surgeries lasting more than 30 minutes

*Exclusion criteria*
- Age group: <18 yrs and >60 yrs
- ASA Grade 3 and 4,
- Weight < 30 kg or > 100 kg,
- Emergency surgeries,
- History of adverse reactions to local anaesthetic drugs,
- Progressive neurological disorders,
- Patient refusal,
- History of bleeding disorders,
- Severe kidney or liver dysfunction,
- Patients having opposite side pneumothorax or collapsed lung,
- Patients having bilateral upper limb surgery.

**Study groups**

Study was done on 60 patients for one year. Total 60 patients were included in the study. All the patients were divided into two groups of 30 in each group.

Group-I: Bupivacaine (0.5%/15 ml) + lignocaine (2%) with Adrenaline (15 ml) + normal saline (10ml).

Group-II: Bupivacaine (0.5%/15ml) + lignocaine (2%) with Adrenaline (15 ml) + Sodium bicarbonate (4ml) + normal saline (6 ml).

**Procedure**

All patients visited and evaluated thoroughly on the day prior to surgery. During the preanesthetic evaluation a thorough evaluation of all the systems was undertaken. The anaesthetic procedure to be undertaken including development of paraesthesia was explained to the patients and an attempt was made to alleviate the anxiety of the patient. A written informed consent was taken. Preanesthetic preparation of patient was a period of overnight fasting. A meticulous airway assessment was done. Routine laboratory examinations were conducted including complete hemograms, urine analysis and whenever appropriate, blood sugar, ECG and chest X-ray. All drug solutions were prepared by an anaesthesiologist not involved in administration of anaesthesia, patient care and data collection.

Intravenous access was obtained in the limb opposite to that undergoing surgery with 18 G cannula. The following monitors were connected in the operating room to the patients: ECG monitor, Pulse oxymeter and Non-invasive blood pressure monitor.\[13\]

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 moulding 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 superior to the clavicle above the midclavicular point. The subclavian artery palpable in the supraclavicular fossa used as a landmark. A filled 10ml syringe with a 23 gauge, 32 mm long needle attached was held in the right hand and the patient instructed to say “now” and not move as soon as he felt a “tingle” or “electric shock like” going down his arm.\[14\]

The tip of the index finger was rested in the supraclavicular fossa directly over the arterial pulsation. The needle was inserted through the skin wheal and advanced slowly downward (caudal), rolled slightly inward (medially) and slightly backward (posteriorly), so that the shaft of the needle was almost parallel to the patient’s head. With the index finger and thumb of the left hand, the hub of the needle was firmly held and the movement of the needle was controlled all the time.

As soon as paraesthesia was elicited, the needle was fixed in position and 40 ml of the respective drug was injected depending on whether the patient was allotted to Group I or Group II.

**Parameters were observed**

The sensory block was recorded using pin prick in skin dermatomes C4–T2, once every 5 minutes for the first 30 minutes after injection and then once every 1hr for first 3hr, then every 30 minutes till the patient regained normal sensations. Onset time of sensory blockade, duration of sensory blockade, quality of block was assessed. Grades of quality of sensory blockade and grades of the usage of adjuvants were also recorded.\[15\]
Statistical analysis
The data was analyzed by SPSS (16.0) version software. Unpaired t test applied to find the statistical significant between the groups. P value less than 0.05 considered statically significant at 95% confidence interval. The data was expressed in MEAN±SD, number and percentage. [16]

RESULTS
The minimum age in groups I and II were 20 years. The maximum age in group I and II was 56 years and 55 years respectively. The mean age in group I and II were 37.96±10 and 35.16±10 years respectively. There was no significant difference in age of patients between Group I and Group II (P > 0.05). In group-I 20 were males (10), females (10) and in group-II males (18) and females (12). The minimum body weight in groups I and II were 40 kg and 46 kg respectively. The maximum body weight in groups I and II were 79 kg and 77 kg respectively. The mean body weight in group I and in group II was 61.8 ± 10 and 69.9 ± 11 kg respectively. There was no significant difference in the body weight of patients between group I and group II (p > 0.05).

Table 1: Demographic data of group-I and group-II

<table>
<thead>
<tr>
<th>Demographic data</th>
<th>Group-I</th>
<th>Group-II</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-20</td>
<td>7</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-40</td>
<td>11</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41-50</td>
<td>8</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-60</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (MEAN±SD)</td>
<td>37.96±10.78</td>
<td>35.16±10.34</td>
<td>11.26</td>
<td>0.001</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>61.87±0.10</td>
<td>62.96±0.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Onset of blockade was faster in group II (8.03±1.41 min) compared to group I (13.5±2.25 min). This difference was statistically significant.

Table 2: Comparison of onset of sensory blockage between group-I and group-II

<table>
<thead>
<tr>
<th>Groups</th>
<th>Onset of sensory block (min) (MEAN±SD)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-I</td>
<td>13.50±2.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group-II</td>
<td>8.03±1.41*</td>
<td>11.26</td>
<td>0.001</td>
</tr>
</tbody>
</table>

(*P<0.001 significant compared group-I with group-II)

Duration of blockade was longer in group II (8.15±1.65 hours) compared to group I (7.24±1.34 hours) and this difference was statistically significant.

Table 3: Comparison of mean duration time of sensory block between group-I and group-II

<table>
<thead>
<tr>
<th>Groups</th>
<th>duration time of sensory block (hr) (MEAN±SD)</th>
<th>t value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group-I</td>
<td>07.24±1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group-II</td>
<td>08.15±1.65*</td>
<td>-2.33</td>
<td>0.023</td>
</tr>
</tbody>
</table>

(*P<0.001 significant compared group-I with group-II)

The quality of blockade was better in the group-II in which 70% patients had complete analgesia when compared to 53.3% in group-I. But this difference is not statistically significant.

Table 4: Comparison of quality of analgesia between group-I and group-II

<table>
<thead>
<tr>
<th>Grade</th>
<th>Group A</th>
<th>Group B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Percentage (%)</td>
<td>Number</td>
<td>Percentage (%)</td>
</tr>
<tr>
<td>Grade 1</td>
<td>16</td>
<td>53.3</td>
<td>21</td>
</tr>
<tr>
<td>Grade 2</td>
<td>9</td>
<td>30.0</td>
<td>7</td>
</tr>
<tr>
<td>Grade 3</td>
<td>5</td>
<td>16.7</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100%</td>
<td>30</td>
</tr>
</tbody>
</table>

(P value significant compared quality of analgesia between group-I and group-II)

Comparison of usage of adjuvant drugs between group-I and II showed statistically insignificant results.
Table 5: Comparison of use of adjuvant medications in patients between group-I and group-II

<table>
<thead>
<tr>
<th>Adjuvant medications</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage (%)</td>
</tr>
<tr>
<td>No use (A1)</td>
<td>16</td>
<td>53.3</td>
</tr>
<tr>
<td>Sedation (A2)</td>
<td>9</td>
<td>30.0</td>
</tr>
<tr>
<td>Converted to GA (A3)</td>
<td>5</td>
<td>16.7</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100%</td>
</tr>
</tbody>
</table>

P value: 0.331

*P value significant compared quality of analgesia between group-I and group-II*

### DISCUSSION

In recent years, there has been a growing interest in the practice of regional techniques and, in particular, peripheral nerve blocks for surgical anaesthesia and postoperative analgesia. The development of local anaesthetic agents with lower toxicity and long duration of action had contributed to this change. [17-20] Regional anaesthesia with single-shot or continuous peripheral nerve blocks can provide superior analgesia and a lower complication rate compared to parenteral anaesthetics. [21-23] Alkalization appears most effective with commercially prepared epinephrine containing local anesthetics, probably because these solutions are formulated at a lower pH. Thus, the relative effects of raising pH are larger than with plain local anesthetic solutions. [24] Onset time of sensory blockade was faster in our study group. Our result showed that sensory block tended to last longer which was similar to observation of de Jong study. [25]

The present study used adjuvants in 23.4% of patients in study group while 30% patients in control group were given adjuvants. 10% of patients are converted to GA in case group and 3.4% patients in study group. In the study by Gormley W.P et. al adjuvants were used for 81.8% patients in control group and for 50% patients in alkalized group. The decreased requirement of adjuvants suggests better quality of anaesthesia.

### CONCLUSION

From our study we concluded that, addition of sodium bicarbonate as adjuvant to mixture of lignocaine and bupivacaine has showed faster onset of sensory block, better quality of sensory block and significant increase in duration of sensory block in patients underwent upper limb surgery.

### REFERENCES


