2-Chloroprocaine and Bupivacaine for lower abdomen and lower limb surgeries under spinal anesthesia: Effects on Haemodynamics

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Abstract
Systemic absorption of local anesthetics produces effects on the cardiovascular and central nervous systems. At blood concentrations achieved with normal therapeutic doses, changes in cardiac conduction, excitability, refractoriness, contractility, and peripheral vascular resistance are minimal. However, toxic blood concentrations depress cardiac conduction and excitability, which may lead to atrioventricular block and ultimately to cardiac arrest. In addition, with toxic blood concentrations myocardial contractility may be depressed and peripheral vasodilation may occur, leading to decreased cardiac output and arterial blood pressure. Patients aged between 18 to 60 years of either gender, belonging to ASA Grade I and II, for elective lower limb and lower abdominal surgeries under spinal anaesthesia. In this present study, diastolic blood pressure recordings were not statistically significant between the two groups observed at different time intervals.

Keywords: 2-Chloroprocaine, Bupivacaine, Haemodynamics

Introduction
The CVS effects of spinal anaesthesia are similar in some ways to the combined use of intravenous α1 and β-adrenergic blockers. It decreases heart rate and arterial blood pressure. The sympathectomy that accompanies the technique depends on the height of the block, extending for two to six dermatomes above the sensory level. This results in venous and arterial vasodilatation, but because of the large amount of blood in the venous system (approximately 75% of total blood volume), the venodilation effect predominates because of the limited amount of smooth muscle in arteries. If normal cardiac output is maintained, total peripheral resistance should decrease only by 15% to 18% in normovolemic healthy patients, even with near total sympathectomy [1].

Heart rate during high spinal anaesthesia typically decreases as a result of blockade of the cardioaccelerator fibers arising from T1 to T4. The heart rate may decrease as a result of a fall in right atrial filling, which decreases outflow from intrinsic chronotropic stretch receptors located in the right atrium and great veins [2].

Bupivacaine hydrochloride is 2-piperidine carboxamide, 1 butyl N, 6 dimethyl phenyl, monohydrochloride, monohydrate. Bupivacaine molecule is a tertiary amine separated from an aromatic ring system that is a benzene ring by an intermediate chain. The tertiary amine is a base that is a proton acceptor. The chain contains an amide linkage (-NHCO-) therefore; it is classified as an aminoamide compound. This amide linkage contributes to the anaesthetic potency. The aromatic ring system gives a lipophilic character to its portion of molecule whereas; the tertiary amine end is relatively hydrophilic [3].

The primary cardiac electrophysiological effect of a local anaesthetic is a decrease in the maximum rate of depolarization in Purkinje fibers and ventricular muscle. This action by Bupivacaine is far greater compared to Lidocaine. Also, the rate of recovery of block is slower with Bupivacaine. Therefore there is complete restoration of Vmax between action potential particularly at higher rates. Bupivacaine reduces the cardiac contractility. This is by blocking the calcium transport. Low concentration of Bupivacaine produces vasoconstriction whereas a high dose causes vasodilatation. Chloroprocaine, like other local anesthetics, blocks the generation and the conduction of nerve impulses, presumably by increasing the threshold for electrical
excitation in the nerve, by slowing the propagation of the nerve impulse and by reducing the rate of rise of the action potential. In general, the progression of anesthesia is related to the diameter, myelination and conduction velocity of affected nerve fibers. Clinically, the order of loss of nerve function is as follows: (1) pain, (2) temperature, (3) touch, (4) proprioception, and (5) skeletal muscle tone [3]. Systemic absorption of local anesthetics produces effects on the cardiovascular and central nervous systems. At blood concentrations achieved with normal therapeutic doses, changes in cardiac conduction, excitability, refractoriness, contractility, and peripheral vascular resistance are minimal. However, toxic blood concentrations depress cardiac conduction and excitability, which may lead to atrioventricular block and ultimately to cardiac arrest. In addition, with toxic blood concentrations myocardial contractility may be depressed and peripheral vasodilation may occur, leading to decreased cardiac output and arterial blood pressure [5]. Following systemic absorption, toxic blood concentrations of local anesthetics can produce central nervous system stimulation, depression, or both. Apparent central stimulation may be manifested as restlessness, tremors and shivering, which may progress to convulsions. Depression and coma may occur, possibly progressing ultimately to respiratory arrest [6]. However, the local anesthetics have a primary depressant effect on the medulla and on higher centers. The depressed stage may occur without a prior stage of central nervous system stimulation.

Methodology

Study population: Patients aged between 18 to 60 years of either gender, belonging to ASA Grade I and II, for elective lower limb and lower abdominal surgeries under spinal anaesthesia.

Study Design: A randomized prospective observational single blinded study.

Sample size and sampling procedure

Accordingly sample size calculated was 50. Hence 50 study subjects were taken for the study in each group.

Inclusion criteria

- ASA Grade I and II.
- Patients undergoing lower abdomen and lower limb surgery.
- Patients aged between 18 - 60 years.

Exclusion criteria

- Pregnant patients undergoing non-obstetric surgeries.
- Patients allergic to Bupivacaine or 2-Chloroprocaine.
- Patients in whom SAB is contraindicated.

In this study 100 patients of ASA Grade I and II, aged between 18-60 years undergoing lower abdomen and lower limb surgery were included.

Group B: 50 patients received intrathecal 10 mg of 0.5% Bupivacaine heavy.

Group C: 50 patients received intrathecal 50mg of 1% 2-Chloroprocaine.

Results

Table 1: Association between ASA and two study groups (N=100)

| Gender | Group B (n=50) n (%) | Group C (n=50) n (%) | P Value |
|--------|----------------------|----------------------|---------|
| Female | 37 (74)              | 20 (40.0)            | 0.136   |
| Male   | 33 (66)              | 30 (60.0)            |         |

Chi-Square Test, P Value Not Significant

In this present study, group B had more ASA I and group C had more ASA II patients. But the distribution was statistically not significant.

Table 2: Comparison of heart rate between two study groups (N=100)

| Heart rate      | Group | P Value | Unpaired T-test Significance |
|-----------------|-------|---------|-----------------------------|
| B (n=50) Mean (SD) | C (n=50) Mean (SD) | | |
| Baseline in bpm  | Baseline in bpm  | 0.114   | Not significant |
| At 10 minutes in bpm | At 10 minutes in bpm | 0.443   | Not significant |
| At 20 minutes in bpm | At 20 minutes in bpm | 0.671   | Not significant |
| At 30 minutes in bpm | At 30 minutes in bpm | 0.862   | Not significant |
| At 40 minutes in bpm | At 40 minutes in bpm | 0.602   | Not significant |
| At 50 minutes in bpm | At 50 minutes in bpm | 0.201   | Not significant |
| At 60 minutes in bpm | At 60 minutes in bpm | 0.184   | Not significant |
| At 90 minutes in bpm | At 90 minutes in bpm | 0.583   | Not significant |
| At 120 minutes in bpm | At 120 minutes in bpm | 0.272   | Not significant |
| At 150 minutes in bpm | At 150 minutes in bpm | 0.002   | Significant |
| At 180 minutes in bpm | At 180 minutes in bpm | 0.04    | Significant |

In this present study, the heart rate observed among the two groups was statistically significant only at 150 and 180 minutes time period post lumbar puncture.
In this present study, systolic blood pressure recordings observed at different time intervals were not statistically significant between the two groups.

**Table 4: Comparison of DBP between two study groups (N=100)**

| DBP      | Group | P Value | Unpaired T-test Significance |
|----------|-------|---------|------------------------------|
| Baseline in mmHg | B (n=50) Mean (SD) | 80.6 (4.12) | 81.18 (3.46) | 0.447 | Not significant |
| At 10 minutes in mmHg | C (n=50) Mean (SD) | 71.58 (5.97) | 71.88 (5.94) | 0.791 | Not significant |
| At 20 minutes in mmHg | B (n=50) Mean (SD) | 69.48 (3.44) | 69.46 (3.03) | 0.975 | Not significant |
| At 30 minutes in mmHg | C (n=50) Mean (SD) | 71.24 (2.82) | 71.78 (2.68) | 0.329 | Not significant |
| At 40 minutes in mmHg | B (n=50) Mean (SD) | 73.86 (3.01) | 74.34 (2.93) | 0.422 | Not significant |
| At 50 minutes in mmHg | C (n=50) Mean (SD) | 80.9 (2.19) | 81.62 (2.2) | 0.104 | Not significant |
| At 60 minutes in mmHg | B (n=50) Mean (SD) | 80.48 (3.09) | 81.46 (2.68) | 0.094 | Not significant |
| At 90 minutes in mmHg | C (n=50) Mean (SD) | 81.66 (2.45) | 82.26 (2.51) | 0.23 | Not significant |
| At 120 minutes in mmHg | B (n=50) Mean (SD) | 81.26 (2.18) | 81.4 (2.03) | 0.74 | Not significant |
| At 150 minutes in mmHg | C (n=50) Mean (SD) | 80.24 (1.87) | 80.96 (2.39) | 0.09 | Not significant |
| At 180 minutes in mmHg | B (n=50) Mean (SD) | 81.32 (2.27) | 82.04 (2.53) | 0.13 | Not significant |

In this present study, diastolic blood pressure recordings observed at different time intervals were not statistically significant between the two groups.

**Table 5: Comparison of MAP between two study groups (N=100)**

| MAP      | Group | P Value | Unpaired T-test Significance |
|----------|-------|---------|------------------------------|
| Baseline in mmHg | B (n=50) Mean (SD) | 97.01 (4.05) | 97.27 (3.25) | 0.72 | Not significant |
| At 10 minutes in mmHg | C (n=50) Mean (SD) | 86.61 (5.98) | 86.65 (6.09) | 0.973 | Not significant |
| At 20 minutes in mmHg | B (n=50) Mean (SD) | 85.09 (2.6) | 85.23 (2.25) | 0.774 | Not significant |
| At 30 minutes in mmHg | C (n=50) Mean (SD) | 86.98 (2.46) | 87.14 (2.46) | 0.746 | Not significant |
| At 40 minutes in mmHg | B (n=50) Mean (SD) | 89.36 (2.47) | 89.74 (2.26) | 0.416 | Not significant |
| At 50 minutes in mmHg | C (n=50) Mean (SD) | 95.68 (2.42) | 95.56 (5.12) | 0.881 | Not significant |
| At 60 minutes in mmHg | B (n=50) Mean (SD) | 96.07 (2.51) | 97.09 (2.24) | 0.03 | Significant |
| At 90 minutes in mmHg | C (n=50) Mean (SD) | 97.71 (2.32) | 98.14 (2.18) | 0.339 | Not significant |
| At 120 minutes in mmHg | B (n=50) Mean (SD) | 97.25 (2.09) | 97.54 (1.7) | 0.444 | Not significant |
| At 150 minutes in mmHg | C (n=50) Mean (SD) | 96.53 (1.67) | 96.5 (4.74) | 0.962 | Not significant |
| At 180 minutes in mmHg | B (n=50) Mean (SD) | 97.06 (2.3) | 97.76 (2.26) | 0.125 | Not significant |

In this present study, only at 60 minutes post lumbar puncture the difference in MAP between two groups was statistically significant.

**Table 6: Comparison of oxygen saturation with pulse oximetry between two study groups (N=100)**

| Pulse Oximetry reading | Group | P Value | Unpaired T-test Significance |
|------------------------|-------|---------|------------------------------|
| Baseline in percentage | B (n=50) Mean (SD) | 95.36 (1.06) | 95.5 (1.09) | 0.517 | Not significant |
| At 10 minutes in percentage | C (n=50) Mean (SD) | 96.42 (1.16) | 96.04 (1.04) | 0.089 | Not significant |
| At 20 minutes in percentage | B (n=50) Mean (SD) | 95.9 (1.35) | 95.5 (1.19) | 0.121 | Not significant |
| At 30 minutes in percentage | C (n=50) Mean (SD) | 95.3 (1.12) | 95.26 (1.06) | 0.855 | Not significant |
| At 40 minutes in percentage | B (n=50) Mean (SD) | 94.82 (1.24) | 95.08 (1.04) | 0.26 | Not significant |
| At 50 minutes in percentage | C (n=50) Mean (SD) | 95.1 (1.09) | 94.81 (1.23) | 0.233 | Not significant |
| At 60 minutes in percentage | B (n=50) Mean (SD) | 95.08 (1.04) | 95.12 (1.11) | 0.853 | Not significant |
| At 90 minutes in percentage | C (n=50) Mean (SD) | 95.27 (1.07) | 95.29 (1.13) | 0.856 | Not significant |
| At 120 minutes in percentage | B (n=50) Mean (SD) | 95.46 (1.03) | 95.89 (1.36) | 0.071 | Not significant |
| At 150 minutes in percentage | C (n=50) Mean (SD) | 96 (1.3) | 96.43 (1.15) | 0.093 | Not significant |
| At 180 minutes in percentage | B (n=50) Mean (SD) | 95.49 (1.09) | 95.36 (1.06) | 0.517 | Not significant |
In this present study, there was no statistically significant difference between oxygen saturation with pulse oximetry recordings observed at different time interval between two groups.

**Table 7**: Association between hypotension and study groups (N=100)

| Hypotension | Group | P Value |
|-------------|-------|---------|
| Yes | B (n=50) n (%) | C (n=50) n (%) | 0.695 |
| No | 46(92) | 47(94) |

Chi-Square Test, P Value Not Significant

In this present study, 4 patients in group B and 3 patients in group C developed hypotension at 10 minutes after lumbar puncture. However, there was no statistically significant difference between two groups.

**Discussion**

Spinal anaesthesia is the most common form of anaesthesia for surgeries on the lower part of the body. Lignocaine with its high incidence of TNS and Bupivacaine with its unreliability in low doses, the search for other local anaesthetics continued. Short acting local anaesthetics are preferred now a days to provide unassisted ambulation at the earliest with the requirement that they produce a reliable and well tolerated block without complications. The aim being to reduce health care cost for patient by reducing length of hospital stay which in part is due to post-operative nausea and vomiting, prolonged motor and sensory block, pain, urinary retention and also on the amount of drugs and materials used. Among the short acting local anaesthetics, 2-Chloroprocaine shows a favorable profile for short procedures.

In our hospital, average time taken for infraumbilical surgery is 1 hr 15-45 minutes. Bupivacaine 10mg and 50mg of 2-Chloroprocaine would provide reliable block for such a time period and hence these doses were considered for the study.

The age distribution was 18 to 60 years in both the groups. The mean age distribution in group B was 38.06 ± 11.76 years and in group C was 38.38 ± 12.36 years. Males accounted for 74% in group B and 60% in group C. Females accounted for 26% in group B and 40% in group C.

Group B had 64% ASA I and 36% ASA II patients and group C had 46% ASA I and 54% ASA II patients. The average weight of patients in group B was 62.54 ± 4.95 kg and 62.36 ± 5.03kg in group C. Both the groups had average height of 1.62 ± 0.06 meters. All the patients had normal BMI range. Group B had average BMI of 23.75 ± 1.02 kg per square meters and group C had average BMI of 23.66 ± 0.93 kg per square meters.

There was no statistically significant difference among the two groups with respect to demographic variables like age, sex, ASA physical class, weight, height and BMI.

Duration of surgery was more or less equal in both the groups with group B averaging 50.8 ± 8.59 minutes and group C averaging 49.1 ± 9.18 minutes and was not statistically significant. Patients in both the group underwent procedures in gynecology, orthopedics, plastic surgery, general surgery, urology and vascular surgery with no statistically significant difference between them. Lower abdomen surgeries was more common in both the groups with 60% in group B and 62% in group C.

Limb surgeries averaged about 40% in group B and 38% in group C. With P value of 0.837, there was no statistically significant difference among the two groups with respect to region of surgery.

In the present study, the hemodynamic parameters i.e., mean heart rate, mean systolic blood pressure), mean diastolic blood pressure, mean arterial pressure and mean oxygen saturation by pulse oximetry were assessed and most of the recordings at different time intervals were comparable. Mean heart rate at 150, 180 minutes and MAP at 60 minutes with $P<0.05$ were the only statistically significant recordings among two groups. zero patients in group B and 3 patients in group C developed hypotension. Bradycardia was noted in 3 patients in group B and 2 patients in group C. Hypotension and bradycardia noted among both the groups was statistically non-significant in this study. Similar findings were noted in the study conducted by Camponovo C et al. [7] and Lacasse M et al. [8], both being statistically insignificant.

**Conclusion**

The haemodynamic parameters assessed were stable for both the groups and hence can be considered to provide stable haemodynamic parameters.

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