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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-2, 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 [4]. 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-Chlororpocaine.

Results

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

Gender	Group		P Value
	B (n=50) n (%)	C (n=50) n (%)	
Female	13(26)	20 (40.0)	0.136
Male	37 (74)	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	78.32 (8.48)	78.12 (8.77)	0.114	Not significant
At 10 minutes in bpm	65.4 (3.67)	65.9 (3.6)	0.443	Not significant
At 20 minutes in bpm	67.84 (3.64)	68.16 (3.87)	0.671	Not significant
At 30 minutes in bpm	68.56 (4.31)	68.7 (3.73)	0.862	Not significant
At 40 minutes in bpm	72 (3.3)	71.6 (3.57)	0.602	Not significant
At 50 minutes in bpm	70.1 (3.15)	70.9 (3.06)	0.201	Not significant
At 60 minutes in bpm	79.84 (3.56)	80.82 (3.76)	0.184	Not significant
At 90 minutes in bpm	80.16 (4.33)	79.74 (3.22)	0.583	Not significant
At 120 minutes in bpm	77.58 (3.45)	77.36 (4.47)	0.272	Not significant
At 150 minutes in bpm	72.16 (3.76)	74.12 (2.44)	0.002	Significant
At 180 minutes in bpm	75.6 (3.7)	77.06 (3.3)	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.

Table 3: Comparison of SBP between two study groups (N=100)

SBP	Group		P Value	Unpaired T-test Significance
	B (n=50) Mean (SD)	C (n=50) Mean (SD)		
Baseline in mmHg	129.84 (4.59)	129.46 (4.34)	0.672	Not significant
At 10 minutes in mmHg	116.68 (7.88)	116.2 (6.95)	0.747	Not significant
At 20 minutes in mmHg	116.32 (4.02)	116.78 (3.36)	0.536	Not significant
At 30 minutes in mmHg	118.48 (3.8)	118.2 (3.41)	0.699	Not significant
At 40 minutes in mmHg	120.36 (2.93)	120.56 (2.85)	0.73	Not significant
At 50 minutes in mmHg	125.24 (3.87)	123.44 (14.56)	0.402	Not significant
At 60 minutes in mmHg	127.26 (3.52)	128.36 (3.29)	0.11	Not significant
At 90 minutes in mmHg	129.82 (3.24)	129.92 (2.7)	0.867	Not significant
At 120 minutes in mmHg	129.24 (2.87)	129.84 (2.64)	0.28	Not significant
At 150 minutes in mmHg	129.12 (2.56)	127.58 (14.12)	0.451	Not significant
At 180 minutes in mmHg	128.54 (3.32)	129.22 (3.14)	0.295	Not significant

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

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

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

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

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

MAP	Group		P Value	Unpaired T-test Significance
	B (n=50) Mean (SD)	C (n=50) Mean (SD)		
Baseline in mmHg	97.01 (4.05)	97.27 (3.25)	0.72	Not significant
At 10 minutes in mmHg	86.61 (5.98)	86.65 (6.09)	0.973	Not significant
At 20 minutes in mmHg	85.09 (2.6)	85.23 (2.25)	0.774	Not significant
At 30 minutes in mmHg	86.98 (2.46)	87.14 (2.46)	0.746	Not significant
At 40 minutes in mmHg	89.36 (2.47)	89.74 (2.26)	0.416	Not significant
At 50 minutes in mmHg	95.68 (2.42)	95.56 (5.12)	0.881	Not significant
At 60 minutes in mmHg	96.07 (2.51)	97.09 (2.24)	0.03	Significant
At 90 minutes in mmHg	97.71 (2.32)	98.14 (2.18)	0.339	Not significant
At 120 minutes in mmHg	97.25 (2.09)	97.54 (1.7)	0.444	Not significant
At 150 minutes in mmHg	96.53 (1.67)	96.5 (4.74)	0.962	Not significant
At 180 minutes in mmHg	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
	B (n=50) Mean (SD)	C (n=50) Mean (SD)		
Baseline in percentage	95.36 (1.06)	95.5 (1.09)	0.517	Not significant
At 10 minutes in percentage	96.42 (1.16)	96.04 (1.04)	0.089	Not significant
At 20 minutes in percentage	95.9 (1.35)	95.5 (1.19)	0.121	Not significant
At 30 minutes in percentage	95.3 (1.12)	95.26 (1.06)	0.855	Not significant
At 40 minutes in percentage	94.82 (1.24)	95.08 (1.04)	0.26	Not significant
At 50 minutes in percentage	95.1 (1.09)	94.81 (1.23)	0.233	Not significant
At 60 minutes in percentage	95.08 (1.04)	95.12 (1.11)	0.853	Not significant
At 90 minutes in percentage	95.27 (1.07)	95.29 (1.13)	0.856	Not significant
At 120 minutes in percentage	95.46 (1.03)	95.89 (1.36)	0.071	Not significant
At 150 minutes in percentage	96 (1.3)	96.43 (1.15)	0.093	Not significant
At 180 minutes in percentage	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
	B (n=50) n (%)	C (n=50) n (%)	
Yes	4 (8)	3(6)	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 bock 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. Lower 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 pressur), 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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