Original Article

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Low Interscalene Brachial Plexus Block with Dexmedetomidine and Clonidine as Adjuvants to Local Anaesthetic Mixture: A Double-blind Randomised Clinical Study

Anaesthesia Section

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ABSTRACT

Introduction: For routine and emergency upper limb surgeries, brachial plexus block is better alternative to general anaesthesia. As compared to classic Interscalene brachial plexus Block (ISB), Low Interscalene Block (LISB) deposit Local Anaesthetic (LA) more caudad causing sensory-motor blockade of upper limb. It acts as bridge between supraclavicular and classic ISB. Local anaesthetic mixture are used to shorten the onset of sensory-motor blockade. Alongside, various adjuvants are mixed with LA to further improve quality of block.

Aim: To compare the efficacy of dexmedetomidine and clonidine as adjuvants to LA mixture in LISB for upper limb surgeries to assess onset and duration of sensory-motor block and to observe any complication associated with block.

Materials and Methods: This double-blind, randomised prospective clinical study was conducted on 90 patients, aged 18-60 years, posted for upper limb surgeries with American Society of Anaesthesiologists (ASA) grade I, II at a tertiary care centre of Government Medical College, Patiala, Punjab, India from February 2021 to November 2021. The patients were randomly divided into three groups. Group I: levo-bupivacaine 0.5% (20 mL)+lignocaine 2% (10 mL)+Normal Saline (NS) (1 mL), group II: levo-bupivacaine 0.5% (20 mL)+lignocaine 2% (10 mL)+dexmedetomidine 50 mcg (1 mL), group III: levo-bupivacaine 0.5% (20 mL)+lignocaine 2% (10 mL)+clonidine 50 mcg (1 mL). The parameters observed were: onset and duration of sensory and motor block, any intraoperative complication. Data was compiled with the help of MS-Excel and analysis done with IBM Statistical Package for Social Sciences (SPSS) version 22.0.

Results: The mean onset time of sensory and motor block was faster in group II (4.20±0.62, 5.25±0.89 min) as compared to group III (5.24±0.99, 6.23±0.96 min) and group I (6.48±0.87, 7.03±1.02 min). The mean duration of sensory and motor block was prolonged in group II (743.38±12.55, 673.21±22.29 min) as compared to group III (480.65±14.72, 433.03±7.28 min) and group I (311.28±5.75, 272.03±6.09 min). No adverse effect was observed during this study.

Conclusion: Dexmedetomidine was more effective than clonidine as an adjuvant to LA mixture (0.5% levobupivaciane+2% lignocaine) in low interscalene brachial plexus block and no episode of pneumothorax and phrenic nerve palsy was seen.

Keywords: Motor block, Pneumothorax, Sensory block

INTRODUCTION

The brachial plexus regional anaesthesia facilitates surgery on ambulatory and conscious patients, providing perfect intraoperative anaesthesia, analgesia and muscle relaxation with fewer adverse effects, decreased requirement of postoperative opioids, shorter hospital stay, unlike general anaesthesia [1-3]. Brachial plexus can be blocked through several approaches classified as: classic interscalene block, low interscalene, supraclavicular block, infraclavicular and axillary block [4].

Low interscalene approach has conquered the drawbacks of the classical interscalene approach. In the low approach on interscalene groove, the site selected for blockade of brachial plexus is two-third of the distance caudally from the C6 vertebral level. It is known to involve a short effect distance from the C5 nerve root to the C8 nerve root and to diffuse local anaesthetics via the deep cervical fascia and reported to achieve appropriate sensory-motor block required for upper limb surgeries [5]. According to the latest anatomic study, the phrenic nerve separates inferomedially from brachial plexus 3 mm for each centimetre the nerve courses caudally, [6] thus moving caudal from the C6 level, phrenic nerve shifts away. Hence phrenic nerve blockade is avoided by LISB [7].

Various types of LA and their combinations are being used so as to reduce the dose and to have a synergistic action for achieving block [8]. Combining two amide LA agents like (bupivacaine and lignocaine) offers the clinician and patient the best effects of both drugs, the fast onset of lignocaine and prolonged duration of bupivacaine [9].

Nowadays, levobupivacaine (S(–)-enantiomer of bupivacaine having a similar pharmacological profile, with lesser cardiotoxicity and having a wider safety margin when compared to racemic bupivacaine and therefore is being favoured LA for regional block [10,11].

As adjuvants alpha-2 adrenergic receptor agonists, clonidine and dexmedetomidine have been used frequently, because of their sedative, perioperative sympatholytic, analgesic and cardiovascular stabilising effects [4]. For many years clonidine has been used as an adjunct to local anaesthetic agents in various regional techniques [12]. It is a selective α-2 adrenergic agonist with some α-1 agonist properties [13]. Clonidine improves sensory and motor blockade of neuraxial and peripheral nerves after injection of local anaesthetic solution without affecting the onset [12]. Dexmedetomidine new alpha-2 adrenergic receptor agonist, which is characterised by being eight times more selective towards α2 adrenoreceptors as compared to clonidine [13]. Its α2:α1 binding selectivity ratio is 1620:1 compared to 220:1 for clonidine, and thus alongside enhancing sensory and motor blockade, it also reduces the unwanted haemodynamic side-effects of α1 receptors [14,15].

Keeping in mind the combination of LA mixture (0.5% levobupivacaine having longer duration of action plus 2% lignocaine having rapid onset of action) and adjuvants, the present study was designed to

compare the effects of dexmedetomidine and clonidine as adjuvants to LA mixture in upper limb surgeries using LISB approach. The primary objectives were sensory-motor blockade. The secondary objectives were intraoperative monitoring of Blood Pressure (BP), Respiratory Rate (RR), Heart Rate (HR) ans SpO_2 and intraoperative complications.

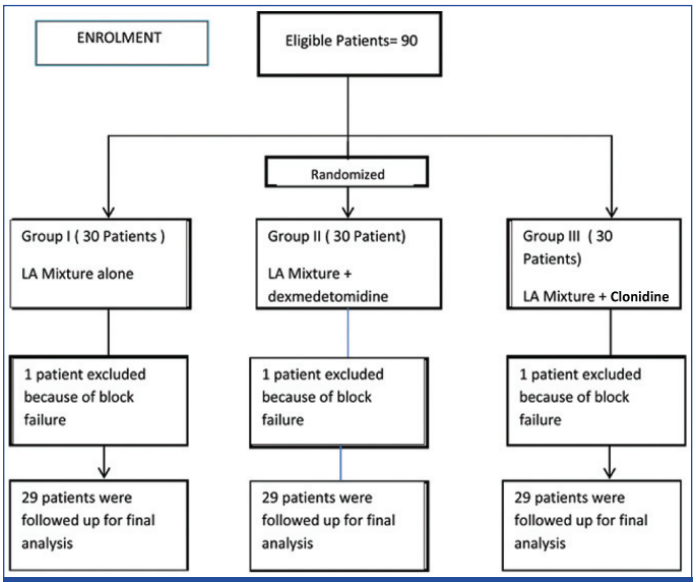
MATERIALS AND METHODS

The double-blind, randomised prospective clinical study was conducted at tertiary care centre, from February 2021 to November 2021. The Ethics Committee Approval (No BFUHS/2K21p-TH/5412 dated 22/01/2021) and written informed consent from patients were obtained.

Inclusion criteria: This study included 90 patients, aged 18-60 years of either gender, posted for upper limb surgeries with ASA grade I, II.

Exclusion criteria: Patients who refused, had known allergy to medications used in this study, infection at the site injection or had coagulopathy were excluded from the study.

Ninety patients were randomly divided into three groups of 30 each using computer generated randomisation [Table/Fig-1].



[Table/Fig-1]: CONSORT chart.

Sample size calculation: The three independent groups to be compared were of equal size n, and were drawn from the population. Sample size was calculated by using the formula:

$$n=(r+1)/r\ SD^2\ (Z\beta-Z\alpha)^2/(d)^2$$

n=Sample size, α=0.05, β=0.001 and 1-β is power of study=95%

Minimum required n=25.088=25, but a sample size of 30 for each group was considered.

Group I: Levo-bupivacaine 0.5% (20 mL)+Lignocaine 2% (10 mL)+NS (1 mL)

Group II: Levo-bupivacaine 0.5% (20 mL)+Lignocaine 2% (10 mL)+Dexmedetomidine 50 mcg (1 mL)

Group III: Levo-bupivacaine 0.5% (20 mL)+Lignocaine 2% (10 mL)+Clonidine 50 mcg (1 mL)

One ampule of clonidine containing 150 mcg/1 mL diluted with NS to get 50 mcg/mL of clonidine)

Depending upon the group allotted, the syringe labelled with the patient's name containing the respective drug solution was handed to the investigator, performing the block, by an assistant who did not participate in the study. An independent observer not included in the study then observed the parameters. Blinding was opened at the end of the study.

Preanaesthetic checkup including detailed clinical history, airway examination and thorough systemic examination was done on every patient. Fasting protocol was followed. Premedication with alprazolam 0.25 mg and omeprazole 20 mg orally given the night before elective surgery.

Anaesthesia Technique

On the day of surgery, after shifting the patient to the operating room, all standard monitors were connected, which included Non Invasive Blood Pressure (NIBP), five lead Electrocardiograph (ECG), pulse oximeter for monitoring vitals. Intravenous line was secured for intravenous fluid.

The patient was made to lie in the supine position with the arm by the side of the trunk and the head slightly turned away from the side to be blocked. The following landmarks for block were marked: The clavicle, posterior border of clavicular head of sternocleidomastoid muscle, external jugular vein (usually crosses the interscalene groove at the level of trunks).

Identification of interscalene groove was made easier by asking the patient to raise head off the table to accentuate the sternocleidomastoid muscle. While palpating the interscalene groove, patient was asked to sniff forcefully to make the muscles tense.

Under aseptic preparation of the area, skin wheal was raised with 1-2 mL of LA at the determined needle insertion site.The fingers were pressed between the anterior and middle scalene muscles to shorten the skin brachial plexus distance. The stimulating needle connected with the peripheral nerve stimulator was inserted 3-4 cm (approximately two finger breadths) above the clavicle and advanced at an angle almost perpendicular to the skin plane.The nerve stimulator was initially set to deliver 0.8-1.0 mA (2 Hz, 0.1 ms). The needle was advanced slowly until appropriate twitches of muscles of the brachial plexus were elicited. This typically occurred at 1-2 cm depth in most patients. Once appropriate muscles twitches were elicited, LA solution was injected slowly in increments of 5 mL with intermittent aspiration to rule out the intravascular injection.

Following parameters were observed after injecting anaesthetic solution:

Primary Outcomes

Onset of sensory blockade: After injecting drug, the time to achieve grade 3 Hollmen scale was considered as onset of sensory blockade.

Hollmen scale 3 [16]

1=normal sensation of pinprick

2=pinprick felt as sharp-pointed but weaker compared with the same area in other limb

3=pinprick recognised as touch with a blunt object

4=no perception of pinprick

Onset of motor blockade: Time to achieve grade 3 of Hollmen scale was considered as onset of motor blockade.

Hollmen scale 3

1=normal muscle function

2=slight weakness in function

3=very weak muscular action

4=complete loss of muscle action

Duration of sensory block: From the time of administration of drug till regression of block to grade 2 using Hollmen scale.

Duration of motor block: From the time of administration of drug till recovery of grade 2 of Hollmen scale i.e. slight weakness in muscle function.

Secondary Outcomes

Monitoring of the patients for BP, SpO_2, RR, HR was done continuously and recorded throughout the surgery and observed

for any intraoperative complication (bradycardia, hypotension, hypoxaemia or any signs of horner's syndrome, hoarseness of voice, breathing difficulties or use of accessory muscles of respiration or drop in saturation below 90% suggestive of diaphragmatic palsy or pneumothorax).

In case of pain, supplementary analgesia was given with intravenous 50 µg of fentanyl. Block was considered inadequate when sensory anaesthesia was not achieved within 30 min. General anaesthesia was given subsequently to these patients, who were then excluded from the analysis.

STATISTICAL ANALYSIS

Data was compiled with the help of MS-Excel and analysis done with IBM SPSS version 22.0. Results were reported in terms of Mean, Standard Deviation (SD) (min-max) and percentage. Analysis of Variance (ANOVA), Tukey post hoc test, Kruskal Wallis H test were applied to find the significance of study parameters on a continuous scale among three groups (intergroup analysis) on metric parameters and Pearson Chi-square test on a categorical scale between the groups, respectively. Statistical significance was taken as p-value <0.05, and p-value <0.001 was taken as statistically highly significant. The p-value >0.05 was taken as statistically non significant.

RESULTS

As shown in [Table/Fig-2] all three groups were comparable in the terms of mean age, gender, weight and ASA grade (p-value was >0.05).

Parameters	Group I	Group II	Group III	p-value
Age (years)	38.30±12.89	36.63±12.36	37.53±12.62	0.877
Weight (kg)	67.70±8.87	69.33±7.59	68.53±8.89	0.757
Gender (males/females)	22/8	20/10	23/7	0.854
ASA (I/II)	26/4	27/3	27/3	0.283

[Table/Fig-2]: Demographic data.
p-value calculated using Chi-square test

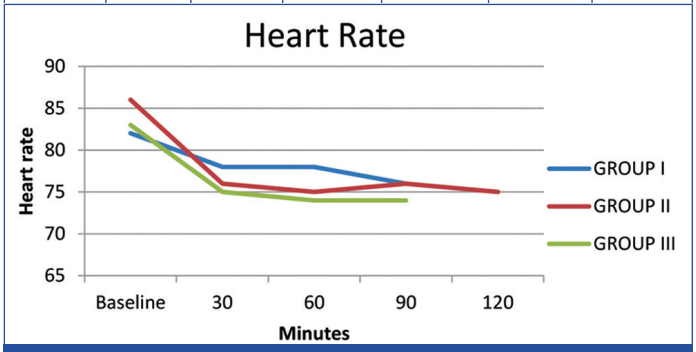
As shown in [Table/Fig-3], onset of sensory blockade and motor blockade were faster in group II as compared to group III and group I. These differences were statistically significant. The mean duration of sensory and motor blockade was maximum in group II as compared to group III and I. These differences were statistically significant.

Variables	Group I	Group II	Group III	p-value		
				Group I vs Group II	Group I vs Group III	Group II vs Group III
Onset of sensory block (in minutes)	6.48±0.87	4.20±0.62	5.24±0.99	<0.001	<0.011	<0.001
Onset of motor block (in minutes)	7.03±1.02	5.25±0.98	6.23±0.96	<0.001	<0.009	<0.001
Duration of sensory block (in minutes)	311.28± 5.75	743.38± 12.55	480.65± 14.72	<0.005	<0.001	<0.001
Duration of motor block (in minutes)	272.03± 6.09	673.21± 22.29	433.03± 7.28	<0.001	<0.001	<0.019

[Table/Fig-3]: Onset time and duration of block for sensory and motor block.
p-value calculated using ANOVA and Tukey Post-hoc test

As shown in [Table/Fig-4], the mean heart rate was comparable in all the three groups at all time intervals. There was no statistically significant difference in the mean HR as the p-value at all times was >0.05.

Time (minutes)	Group I	Group II	Group III	p-value		
				Group I vs Group II	Group I vs Group III	Group II vs Group III
Baseline	83	86	82	0.239	0.896	0.101
30 min	78	76	75	0.210	0.166	0.991
60 min	78	75	74	0.275	0.120	0.896
90 min	76	76	75	0.982	0.210	0.573
120 min	75	75	74	0.993	0.611	0.540



[Table/Fig-4]: Comparison of heart rate (beats/min).
p-value calculated using ANOVA and Tukey Post-hoc test

As shown in [Table/Fig-5], the mean arterial blood pressure was comparable in all three groups. There was no statistically significant difference in the mean as p-value at all times is >0.05. At 10 min, a fall in diastolic blood pressure from baseline was observed in all the patients, but the difference was statistically and clinically insignificant in all three groups.

Time (minutes)	Group I	Group II	Group III	p-value		
				Group I vs Group II	Group I vs GroupIII	Group II vs Group III
Baseline	95	93	94	0.156	0.119	0.990
30	87	85	85	0.606	0.596	1.000
60	87	86	84	0.746	0.197	0.567
90	87	87	85	1.000	0.389	0.386
120	88	86	85	0.742	0.236	0.691

[Table/Fig-5]: Comparison of Mean Arterial Pressure (MAP) in three groups (mm of Hg).
p-value calculated using ANOVA and Tukey Post-hoc test

As shown in [Table/Fig-6], Respiratory rate was comparable in all three groups. There was no statistically significant difference in the mean as p-value at all times was >0.05 in all three groups.

Time (minutes)	Group I	Group II	Group III	p-value		
				Group I vs Group II	Group I vs Group III	Group II vs Group III
Baseline	15	15	14	0.997	0.169	0.195
30	14	16	14	0.392	0.983	0.302
60	14	14	15	0.154	0.986	0.209
90	15	14	14	0.943	0.127	0.235
120	14	14	13	0.611	0.065	0.384

[Table/Fig-6]: Comparison of RR (breaths/minute) in three groups.
p-value calculated using ANOVA and Tukey Post-hoc test

No episode of bradycardia, hypotension or phrenic nerve palsy was observed.

DISCUSSION

In the present study, low interscalene brachial plexus block was used to deposit LA more caudad on brachial plexus in contrast to classic interscalene brachial plexus block, For greater spread to the lower trunk involving the ulnar nerve. Therefore it resulted in

appropriate sensory-motor block required for upper limb surgeries. Moreover, this approach avoids phrenic nerve injury.

A LA mixture containing a LA having rapid onset can hasten the onset time for sensory and motor blockade. In the present study, 2% lignocaine along with 0.5% levobupivacaine was used to accelerate the onset of the block. Further, adding adjuvants to the LA mixture helped improve the quality and duration of the block. In this study, α2 agonist- Clonidine or Dexmedetomidine as an adjuvant has been used.

Onset of the sensory and motor blockade was fastest in group II as compared to group III and the group I individually.

The results was consistent with those of Kaur H et al., [17], Sreeja R et al., [18], Krishan G et al., [19] and Tripathi A et al., [20] These studies also concluded that the onset of sensory-motor blockade was significantly earlier and the duration of blockade was prolonged in dexmedetomidine group as compared to the group with clonidine and group with LA alone .

Kaur H et al., [17] concluded that addition of 1 μ/kg dexmedetomidine to 0.25% levobupivacaine for supraclaviclar plexus block shortens sensory, motor block onset time and extends sensory-motor block durations. In this study, the drugs studied were 40 mL of solution containing 30 mL 0.5% levobupivacaine and 10 mL 1% lignocaine, and 40 mL of solution containing 30 mL 0.25% levobupivacaine and 10 mL 1% lignocaine with dexmedetomidine 1 μ/kg for supraclavicular brachial plexus block.

Sreeja R et al., [18] reported that the duration of analgesia was significantly higher in Group B {bupivacaine 0.5% (20 mL)+ dexmedetomidine 1 μg.kg-1} as compared to Group A {bupivacaine 0.5% (20 mL)+clonidine 1 μg.kg-1}. The mean time for onset of a sensory block as well as motor block was significantly less in Group B.The study by Krishan G et al., [19] found that both clonidine and dexmedetomidine, when used as an adjuvant to 0.5% levobupivacaine, decreased the onset of sensory and motor blockade and prolonged the duration of sensory and motor blockade but dexmedetomidine was a better alternative to clonidine as an adjuvant to local anaesthetic agent .

Tripathi A et al., [20] concluded that addition of dexmedetomidine prolongs the durations of sensory and motor block and duration of analgesia and improves the quality of anaesthesia as compared with clonidine when injected with bupivacaine in supraclavicular brachial plexus block.

All the three groups in this study were comparable in terms of heart rate, mean arterial blood pressure, respiratory rate. There was no clinical or statistically significant difference amongst any of the groups as the p-value obtained was >0.05. During the present study, no episode of bradycardia, hypotension, hypoxemia was observed in either of the group. This might be because of the use of low doses of dexmedetomidine and clonidine, at which only early onset and prolonged duration of the block were seen without any haemodynamic side-effects. Similar to the present study, when lower dose of dexmedetomidine was used by Swami SS et al., [21], the incidence of bradycardia and hypotension was not significant. In the present study, a 50 μg dose of dexmedetomidine was present in group II. Bernard JM and Macarie P [22] conducted a study evaluating the effects of adding 30-300 μg clonidine to lignocaine for axillary brachial plexus anesthesia. The study concluded that the addition of a small dose of clonidine hastened the onset of the block and improved the efficacy of surgical anaesthesia alongside limiting alpha two agonist side-effects to the sedation only. According to this study, the best dose to use clinically is between 30 μg and 90 μg. In the present study, a 50 μg dose of clonidine was used in group III.

In the present study, there was no episode of diaphragmatic palsy, pneumothorax, Horner syndrome or hoarseness of voice. This was probably because a low interscalene block was used in which the block was performed below the level of the C6 vertebra. At this level phrenic nerve divides 3 mm per cm as it descends caudally from the brachial plexus, thereby reducing the incidence of hemidiaphragmatic palsy and other respiratory complications. Park SK et al., [5] also used a low approach interscalene brachial plexus block on patients undergoing surgery of upper extremities. None of the patients in their study experienced complications. There were no signs of dyspnea or hemidiaphragmatic paralysis.

Limitation(s)

The block was not ultrasound-guided which would have helped use less volume and dosage of the local anaesthetic mixture for achieving an adequate block.

CONCLUSION(S)

The results of the present study concludes that LISB provides adequate sensory and motor block for upper limb surgeries without significant adverse effects. Using LA mixture (lignocaine+ levopuvacaine) provides rapid onset of block due to lignocaine. The addition of dexmedetomidine produces significantly faster onset of sensory-motor blockade with prolonged duration followed by clonidine and LA mixture, respectively. Using LISB approach there is less chance of phrenic nerve blockade and less incidence of ulnar sparing. Therefore, LISB should be preferred for upper limb surgeries with LA mixture.

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