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ORIGINAL RESEARCH

A study on hemodynamic changes in ultrasound guided supraclavicular brachial plexus block single injection versus triple injection for upper extremity surgeries in paediatric patients

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ABSTRACT
The primary cardiac electrophysiologic effect of local anaesthetic agent is a decrease in the maximum rate of depolarization in the purkinjefibres and ventricular muscle. This is due to decrease in the availability of sodium channels. Bupivacaine decreases cardiac output by decreasing sympathetic tone, heart rate and venous return. It also decreases central venous pressure. Patients of age 6-12yrs, undergoing upper limb surgeries under Supraclavicular block with ASA-1 status were included in study. Patients with drug allergy or upper respiratory tract infections were excluded. Patients were randomly assigned into 2groups, Group SI and TI with 50 patients each. Study was carried out to assess success rate of block achieved based on changes in hemodynamic parameters. There was no statistical difference in hemodynamic variables seen in both groups. There were no complications seen.

Key words: Brachial block, paediatric anesthesia, hemodynamic changes

INTRODUCTION

The knowledge and understanding of brachial plexus and its dermatomal, myotomal and sclerotomal distribution are essential for brachial plexus block and its application for upper limb surgeries. The relationship of the brachial plexus to the surrounding muscular, vascular and connective tissues is also vital for mastering various approaches to block the brachial plexus[1].

The Brachial Plexus supplies the motor innervations and nearly all the sensory supply of the upper limb.

Bupivacaine Hydrochloride is available in sterile isotonic solutions with and without epinephrine (as bitartrate) 1:200,000 for injection via local infiltration, peripheral nerve block and caudal and lumbar epidural blocks. Solutions are clear and colourless[2].

Multiple-dose vials contain methylparaben 1mg/ml added as a preservative. Sodium metabisulfite 0.1mg/ml is added as an antioxidant and anhydrous calcium disodium edetate 0.1mg/ml is added as a stabilizer. Single-dose solutions contain no added bacteriostat or anti-microbial agent and unused portions should be discarded after use[3].

The primary cardiac electrophysiologic effect of local anaesthetic agent is a decrease in the maximum rate of depolarization in the purkinjefibres and ventricular muscle. This is due to decrease in the availability of sodium channels. Bupivacaine decreases cardiac

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output by decreasing sympathetic tone, heart rate and venous return. It also decreases central venous pressure. There is an increase in blood flow to lower limbs with decrease in incidence of deep vein thrombosis[4].

Bupivacaine is highly arrhythmogenic. It reduces the cardiac contractility by blocking the calcium transport. In lower concentration, it produces vasoconstriction while in higher concentration, it causes vasodilatation.

Lignocaine stabilizes the electrical activity of any excitable tissue. It stabilizes aberrant conduction and the automaticity in abnormal or damaged fibres and suppresses cardiac arrhythmias. So, it is useful in treatment of ventricular arrhythmias.

It causes vasoconstriction at lower concentration and vasodilation at higher concentration due to stimulation and inhibition of calcium release respectively[5, 6].

METHODOLOGY

SOURCE OF DATA

It is a prospective, randomized double blind study in pediatric patients of American Society of Anesthesiologists (ASA) physical status I and physical status II between age group of 6 to 12 years posted for elective upper extremity surgery under Supraclavicular block.

STUDY DESIGN

Prospective, randomized double blind study.

SAMPLE SIZE: 100.

- 50 for each group.
- (50 for Single Injection-SI and 50 for Triple Injection-TI).

INCLUSION CRITERIA

1) Age-6 to 12 years of either sex.
2) Patients belonging to American Society of Anesthesiologists (ASA)-Grade I and II.
3) Mallampatti Class I and II.
4) Patients undergoing elective surgeries under Supraclavicular Brachial Block.

EXCLUSION CRITERIA

1) Patients with Cardiorespiratory illness or congenital heart disease.
2) Patients with any known allergy to Local Anesthetics.
3) Patients with anticipated difficult airway.
4) Patients' attender's refusal for the procedure.
5) Patients with active Upper Respiratory Tract Infection (URTI).
6) Patients with accidental vascular injury.

PROCEDURE

After obtaining necessary institutional ethical committee approval and informed written consent from parents, 100 patients satisfying the inclusion and exclusion criteria were randomly allocated into two groups of 50 patients each using a computer-generated random number table.

GROUP SI: Single Injection Technique
GROUP TI: Triple Injection Technique

After thorough pre-anaesthetic check-up and necessary laboratory testing, patients were kept nil orally for 4-6 hours before surgery.

On the day of surgery, patients were shifted to preoperative room. A patent 20-22G intravenous line was secured. Before giving premedications, vitals were recorded.

Patients were sedated with IV Inj. Midazolam (0.05-0.25 mg/kg) and were transferred to the operation theatre under observation.

AllpatientsweresupplementedwithOxygen(4-6 L/min)throughafacemask. Premedicated with InjGlycopyrrolate 0.004mg/kg and InjOndansetron 0.1mg/kg.

Vitals were recorded after premedications.

Intermittent dose of 0.5 mg/kg of Propofol was injected intravenously to sedate the patient during the procedure as per the requirements.

- A portable ultrasound machine (GE Ultrasound Healthcare) with a 8 to 18 MHz linear transducer probe was used for all patients.
- Under aseptic precautions, the supraclavicular area was scanned for the best view ofthe brachial plexus.
- In this view, the brachial plexus was viewed superficially and lateral to the subclavian artery and was visualized as a group of hypoechoic halos (bunch of grapes pattern) surrounded by hyperechogenic thin rim of connective tissue.
- In single injection technique, the needle (26x1 1/2G, 38mm) was advanced in- plane toward the brachial plexus and when the tip was visualized adjacent to the hypoechoic shadows, a mixture of Inj. Lidocaine Hydrochloride 2% and Inj. Bupivacaine Hydrochloride 0.5% was injected in the sheath surrounding brachial plexus after frequent negative aspirations.
- While injecting the drug, spread of the drug around the plexus was visualized through the sonographic view.
- In triple injection technique, the tip of the needle was inserted in-plane into three different positions that is 11 o'clock, 7 o'clock and 5 o'clock and the drug was injected.

RESULTS

Table 1: Comparison of Heart rate in SI group and TI group

	Group SI		Group TI		Z	p-value
	Mean	SD	Mean	SD		
Baseline_HR	102.20	6.30	101.40	6.19	0.641	0.523

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5min_HR	99.52	6.34	98.68	6.21	0.669	0.505
10min_HR	98.02	6.44	97.24	6.23	0.616	0.540
15min_HR	96.54	6.35	95.84	6.23	0.556	0.579
Post 5min_HR	95.36	6.35	94.64	6.26	0.571	0.569
Post 10min_HR	94.28	6.47	93.54	6.14	0.587	0.559
Post 15min_HR	93.36	6.64	92.84	6.38	0.399	0.691
Post 20min_HR	92.86	6.68	92.30	6.62	0.421	0.675
After 5min_HR	92.56	6.67	91.92	6.72	0.478	0.634
After 10min_HR	92.46	6.72	91.60	6.71	0.641	0.523
After 15min_HR	92.92	6.56	92.04	6.58	0.670	0.504
After 20min_HR	93.60	6.52	92.72	6.41	0.680	0.498
After 25min_HR	94.88	6.78	94.04	6.63	0.627	0.532
After 30min_HR	95.42	6.85	95.10	6.54	0.239	0.812
After 45min_HR	94.10	6.84	93.88	6.53	0.165	0.870
After 60min_HR	92.76	6.90	92.56	6.55	0.149	0.882
After 75min_HR	92.48	9.13	93.65	7.68	0.519	0.606
After 90min_HR	99.71	4.79	97.44	7.58	0.689	0.502

Table shows Heart rate of both the groups in different time intervals. When we compared both the groups, the p value was found to be statistically insignificant as $p>0.05$ at all intervals.

Table 2: Comparison of Mean Arterial Pressure in SI group and TI group

	Group SI		**Group TI**		**T**	**p-value**
	Mean	**SD**	**Mean**	**SD**		
Baseline MAP	89.13	4.03	90.09	4.87	-1.074	0.285
5min_MAP	87.12	4.03	88.03	4.96	-1.003	0.318
10min_MAP	85.40	4.14	86.21	4.86	-0.900	0.370
15min_MAP	83.75	4.26	84.56	4.78	-0.899	0.371
Post 5min_MAP	82.16	4.36	82.85	4.92	-0.746	0.458
Post 10min_MAP	80.76	4.20	81.36	5.27	-0.629	0.531
Post 15min_MAP	79.61	4.57	80.71	5.50	-1.081	0.282
Post 20min_MAP	79.33	5.03	80.23	5.72	-0.829	0.409
After 5min_MAP	78.89	5.00	79.67	5.77	-0.716	0.476
After 10min_MAP	79.16	4.73	79.55	5.48	-0.378	0.707
After 15min_MAP	80.08	4.29	80.51	4.84	-0.467	0.642
After 20min_MAP	81.16	4.00	81.47	4.58	-0.357	0.722
After 25min_MAP	82.57	3.99	83.00	4.65	-0.492	0.624
After 30min_MAP	83.07	4.43	83.61	4.87	-0.587	0.558
After 45min_MAP	81.40	4.16	81.84	4.66	-0.498	0.620
After 60min_MAP	80.24	3.97	80.61	4.45	-0.443	0.659
After 75min_MAP	81.87	7.93	81.48	5.78	0.209	0.835
After 90min_MAP	80.10	4.33	84.07	6.31	-1.423	0.177

Table shows MAP of both the groups in different time intervals. When we compared both the groups, the p value was found to be statistically insignificant as $p>0.05$ at all intervals.

Table 3: Comparison of SpO2 in SI group and TI group

	Group SI		**Group TI**		**Z**	**p-value**
	Mean	SD	Mean	SD		
Baseline_SPO2	99.38	0.83	99.38	0.78	0.000	1.000
5min_SPO2	100.00	.000a	100.00	.000a		
10min_SPO2	100.00	.000a	100.00	.000a		
15min_SPO2	100.00	.000a	100.00	.000a		
Post 5min_SPO2	100.00	.000a	100.00	.000a		
Post 10min_SPO2	100.00	.000a	100.00	.000a		
Post 15min_SPO2	100.00	.000a	100.00	.000a		
Post 20min_SPO2	100.00	.000a	100.00	.000a		
After 5min_SPO2	100.00	.000a	100.00	.000a		

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After 10min_SPO2	100.00	.000a	100.00	.000a		
After 15min_SPO2	100.00	.000a	100.00	.000a		
After 20min_SPO2	100.00	.000a	100.00	.000a		
After 25min_SPO2	100.00	.000a	100.00	.000a		
After 30min_SPO2	100.00	.000a	100.00	.000a		
After 45min_SPO2	100.00	.000a	100.00	.000a		
After 60min_SPO2	100.00	.000a	100.00	.000a		
After 75min_SPO2	100.00	.000a	100.00	.000a		
After 90min_SPO2	100.00	.000a	100.00	.000a		

Table shows SpO2 of both the groups in different time intervals. When we compared both the groups, the p value was found to be statistically insignificant as $p>0.05$ at all intervals.

DISCUSSION

Upper limb surgical procedures can be performed under general anaesthesia and regional anaesthesia. Regional anaesthesia is the technique of choice as it has the advantages of excellent surgical field, good postoperative analgesia, minimal hemodynamic changes, early ambulation, cost effectiveness and lower rate of complications.

The brachial plexus can be blocked through four approaches-the interscalene approach, the supraclavicular approach, the infraclavicular approach and the axillary approach. Of these, the supraclavicular approach at the level of trunks and divisions, blocks the plexus at its most compact form producing predictable and complete block of the upper limb. Initially the plexus was localised by landmark technique and elicitation of paraesthesia, both the techniques have a high failure rate and increased risk of complications. This was followed by the invention of peripheral nerve stimulator to locate the nerve. This method increased the success rate of the blocks but the risk of complications remainedhigh.The advent of ultrasonography hasrevolutionised the field of regional anaesthesia. Real time ultrasound which enables us to accurately localise the plexus, place the needle and deposit the drug. This increases the success rate of the block and reduces the complications. Therefore, ultrasound guided brachial plexus block through supraclavicular approach is the most preferred method in our institution.

Numerous injection techniques of supraclavicular block have been described. The single injection technique, the double injection technique, the triple injection technique and targeted intracluster technique are some of the techniques in vogue. Studies have shown the single injection is equally efficacious as the multiple injection technique but the latter has the advantage of faster onset.

Our study was a prospective, randomised double blinded study with sample size as 100 divided in two groups, Group Single Injection(SI) and Group Triple Injection (TI) having 50 patients each. Patients between the age of 6 to 12 years were selected as limited studies have happened on this age group of patients. Both male and female patients were included in this study. Patients undergoing surgeries on upper limb were selected for this study.

Moayeri*et al.* [7] published a study on the architecture of brachial plexus and surrounding structures by examining sagittal cross-sections of frozen shoulder from cadavers in 2008 which concluded that there is marked differences in neural architecture and size of surrounding tissue compartments between proximal and distal parts of brachial plexus. This explains why some injections within epineurium do not result in nerve injury and affects onset time of block.

Tran *et al.* [8] did a prospective, randomised study in 2009, the single and double injection techniques with ultrasound guided supraclavicular block were compared and concluded that onset time was shorter and performance time was longer in double injection group, so there were no differences in anaesthesia related time in both the groups. Double injection group required greater number of needles passes and so provided faster onset of sensory and motor block. The success rates and incidence of complications were comparable.

Abrahams *et al.* [9] did a study in 2009 comparing peripheral nerve blockade done using ultrasound guidance and nerve stimulator guidance which concluded that blocks performed using ultrasound guidance were more successful, took less time to perform, had faster onset, had long duration of anaesthesia and also decreased risk of vascular puncture during block performance than compared with block performed with peripheral nerve stimulator guidance. There was also no statistical significance in the incidence of paraesthesia and neurological symptoms in both the groups.

Duggan E, El Beheiry H, Perlas A, *et al.* [10] conducted a study in 2009 regarding the Minimum Effective Volume of Local Anesthetic required for Ultrasound-Guided Supraclavicular Brachial Plexus Block Regional Anesthesia & Pain Medicine and concluded that the minimum effective anesthetic volume in 50% and calculated effective volume in 95% of patients were 23 mL and 42 mL respectively. Seven patients received supplemental LA, with no patient requiring general anesthesia.

CONCLUSION

- There was no statistical difference inhemodynamicvariables seen in both the groups.

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- Single Injection technique had short performance time compared to triple injection technique.

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