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Original Article

Anaesthesia Section

Dexamethasone as an Adjuvant to Bupivacaine in Supraclavicular Brachial Plexus Block in Paediatrics for Post-operative Analgesia

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ABSTRACT

Introduction: Sensory blockade of the brachial plexus with local anaesthetics for perioperative analgesia leads to stable haemodynamics intraoperatively, smoother emergence from general anaesthesia and decreased need for supplemental analgesics or suppositories in the Post-operative period. However, increasing the duration of local anaesthetic action is often desirable because it prolongs surgical anaesthesia and analgesia. Various studies in adults prove that steroids increase the duration of action of local anaesthetics when used as adjuncts.

Aim: The study aimed at determining the efficacy of dexamethasone as an adjuvant to bupivacaine for Post-operative analgesia following sensory blockade of the brachial plexus in paediatrics.

Materials and Methods: The study was divided into two groups of 15 each, group BD receiving dexamethasone (0.1mg/kg) as an adjunct to bupivacaine 0.125% and group B receiving bupivacaine alone. The duration of analgesia was taken as time from completion of the block to the patient receiving rescue analgesia, the haemodynamics were measured until 180 minutes after surgery, the incidence of Post-operative Nausea and Vomiting (PONV) was measured.

Results: The duration of analgesia in the group BD was 27.1±13.4 hours and was significantly higher as compared to the group B, in which it was 13.9±11.3 hours ($p<0.05$). The pulse rate measured Post-operatively between both groups at 20 minutes (p-value 0.634), 60 minutes (p-value 0.888), 120 minutes (p-value 0.904) and 180 minutes (p-value 0.528) showed no statistical significance. Likewise the mean blood pressure measured between the two groups at 20 minutes, 60 minutes, 120 minutes and 180 minutes Post-operatively showed no significance. There was no significant difference in incidence of PONV in both groups with p-value of 0.624.

Conclusion: Dexamethasone as an adjuvant to local anaesthetic in brachial plexus blocks significantly, prolongs duration of analgesia in children undergoing upper limb surgeries.

Keywords: Stable haemodynamics, Post-operative analgesia, Ultrasound, Wong baker scale

INTRODUCTION

Brachial plexus block is a well-established technique in upper limb surgery [1]. Upper limb surgeries common in paediatric age group include supracondylar fractures, forearm fractures, implant removals, cross-finger flaps etc. Sensory blockade of the brachial plexus for perioperative analgesia leads to stable haemodynamics intraoperatively, smoother emergence from general anaesthesia and decreased need for supplemental analgesics or suppositories in the Post-operative period [2]. The most commonly used drugs for this purpose are local anaesthetics. However, increasing the duration of local anaesthetic action is often desirable because it prolongs surgical anaesthesia and analgesia. Adjuvants to local anaesthetics commonly used are clonidine, opioids like fentanyl and morphine, soda bicarbonate, vasoconstrictors and dexamethasone to name a few. Dexamethasone helps by attenuating the release of inflammatory mediators, reducing ectopic neuronal discharge and inhibiting potassium channel-mediated discharge of nociceptive C-fibres [3]. Addition of steroid to local anaesthetics effectively and significantly prolongs the duration of analgesia as well as producing earlier onset of action in adults [4,5].

The use of ultrasound guidance allows real-time visualization of anatomical structures, shows the spread of the anaesthetic solution injected. This is an attractive option in paediatric patients as most regional anaesthetic techniques are administered while under general anaesthesia [6]. A vast body of literature supports the safety and efficacy of performing regional anaesthetic techniques in children. It has been shown that combined regional and general anaesthesia can decrease hospital stay and improve outcomes in paediatric patients [7]. Despite some controversy regarding the performance of regional anaesthesia in sedated children, there is consensus among paediatric anaesthesiologists regarding the importance and feasibility of safely providing regional anaesthetic techniques under general anaesthesia [8]. With this background, the following study was carried out to assess the efficacy of dexamethasone as an adjuvant to bupivacaine for brachial plexus blocks, under ultrasound guidance with general anaesthesia.

MATERIALS AND METHODS

This was a prospective double blind randomized controlled trial conducted in Father Muller Medical College and Hospital over a period of 8 months from October 2014 to June 2015. The study was carried out on 30 paediatric inpatients scheduled for forearm and hand surgery after obtaining Institutional Human Ethics Committee approval and written informed parental consent. The study was performed on American Society of Anaesthesiologists (ASA) physical status 1 and 2 patients with an age range of 4-12 years scheduled for forearm and hand surgery, under general anaesthesia.

The primary outcome was measured as duration of analgesia which was defined as time from when block was given, to the time where child complained of moderate pain. Secondary outcomes measured were Post-operative pulse rate, blood pressure, nausea and vomiting.

Exclusion criteria involved were parental refusal to include their child into the study, patient with coagulopathy, infection at the site of block, peripheral neuropathy, neurological disorders and any known allergy to local anaesthetics.

During pre-anaesthetic checkup detailed assessment of airway, respiratory and cardiovascular system was carried out. Basic laboratory data was reviewed and all patients were kept nil per oral for 8 hours prior to the surgery. Patients were randomly divided into 2 groups of 15 each, Group B (0.125% bupivacaine 0.5ml/kg) and Group BD (0.125% bupivacaine 0.5ml/kg + 0.1mg/kg of dexamethasone). Randomization was done by the sealed envelope technique.

Two anaesthesiologists were involved in the study.

Anaesthesiologist 1: Randomized, allocated the patients to the study groups and loaded the drugs for the brachial block.

Anaesthesiologist 2: Blinded to the drug injected to the patients, performed the block and monitored the Wong Baker (FACES) scale in the Post-operative ward [9].

The patients were shifted to the operation theatre and the following monitors were connected–Noninvasive Blood Pressure (NIBP), pulse oximetry, electrocardiography (ECG), precordial stethoscope. Intravenous (IV) cannula was secured and 500 mL of Ringer Lactate was started. All patients received standard general anaesthesia. The patients were preoxygenated and fentanyl 1mcg/kg I.V. was given. Anaesthesia was induced with thiopentone sodium 5mg/kg intravenously followed by 0.08mg/kg of vecuronium after confirming adequate mask ventilation. Airway was secured with cuffed endotracheal tube. Relaxation was maintained with vecuronium in doses of 0.02mg/kg every 20 minutes. Anaesthesia was maintained with nitrous oxide 66% and oxygen 33% and isoflurane 0.4%. Intraoperative monitoring of heart rate, blood pressure, electrocardiogram, and oxygen saturation was undertaken and recorded at 5 minute intervals.

The Brachial plexus block was administered by the supraclavicular approach under ultrasound guidance. The block was performed after administering general anaesthesia, prior to the start of operative procedure. The children were in supine position with their heads facing away from the side of the block. The region was prepped with betadine solution and the hockey stick linear probe of the ultrasound (5-10MHz) with sterilized plastic wrap and gels, and 22G 50mm needle was used. The probe was placed in the coronal - oblique plane in the supraclavicular fossa and the puncture was in plane from lateral to medial. The dose of bupivacaine [10] used was 0.5ml/kg in both groups and that of dexamethasone [11] used in Group BD was 0.1mg/kg.

At the end of the surgery, the neuromuscular blockade was reversed using neostigmine 0.05mg/kg and atropine 0.02mg/kg intravenously and the trachea was extubated. On arrival in the Post-operative ward baseline blood pressure, heart rate and oxygen saturation was monitored. Monitoring of vital parameters such as pulse rate and blood pressure was continued for 3 hours Post-operatively after which the paediatric patient was shifted out of the Post Anaesthesia Care Unit (PACU). Post-operative pain monitoring was done at varied intervals by Wong Baker scale. The time to first rescue analgesic was noted and injection paracetamol 15mg/kg intravenous was given at the time of demand. The haemodynamic variables and incidence of Post-operative nausea and vomiting was compared between the two groups.

STATISTICAL ANALYSIS

Data obtained from the study was analysed using the computer software Statistical Package for Social Sciences (SSPS) version 10. Data are expressed in Frequency, Percentage, Mean and Standard Deviation (SD). Student's t-test was used to compare the mean value between two groups. To compare different groups with each other, non-parametric Mann Whitney's U-test was employed. For all statistical evaluations, a two tailed probability p-value of < 0.05 was considered significant.

Sample size calculation was done as follows:

n=15

$n=2(Z_\alpha + Z_\beta)^2 \sigma^2 / d^2$ where $Z_\alpha = 1.96$ with 95% confidence interval

$Z_\beta = 0.84$ at 80% power

$\sigma = \sqrt{\sigma_1^2 + \sigma_2^2} / 2$ (σ_1= SD in group 1, σ_2= SD in group 2

$d = X_1 - X_2$ (mean in group 1 = X_1, group 2 = X_2)

RESULTS

[Table/Fig-1] shows the gender distribution between the groups was unequal, with Group BD having fewer females which was found to be statistically significant p=0.014. There was no statistical significance between the groups with respect to the age and weight.

The pulse rate and blood pressure in both groups pre-operatively and post-operatively showed no significant changes as shown in [Table/Fig-2,3] as both groups received adequate analgesia following surgery. They were followed up for haemodynamics only until 180 minutes after which they were shifted out of PACU.

[Table/Fig-4] shows the duration of surgery was comparable between the groups with Group B lasting for 41.66±12.05 minutes and Group BD, 37.33±11.15 minutes.

[Table/Fig-5] shows the duration of analgesia in group B was 13.93±11.373 hours and in group BD was 27.13±13.421 hours and was highly significant. (p=0.008). This duration was considered as time to when the patient complained of moderate pain (Wong Baker score of 4 or more). [Table/Fig-6] shows no significant difference in the incidence of Post-Operative Nausea and Vomiting (PONV) in both groups.

Number of patients	Group B	Group BD	Total
Male	7 (46.7%)	14 (93.3%)	21 (70%)
Female	8 (53.3%)	1 (6.7%)	9 (30%)
Age	8.80±2.783	8.07±3.105	p-0.501
Weight (kg)	26.80±10.276	27.13±9.79	p-0.928

[Table/Fig-1]: Demographic details of the study participants.
Data presented as mean± SD.

Pulse rate (beats/min)	Group B (n=15)	Group BD (n=15)	p-value
Pre-op	104.60±21.699	112.13±23.802	0.443
20 min post-op	112.60±14.754	109.40±21.060	0.634
60 min post-op	109.93±16.628	110.87±19.183	0.888
120 min post-op	105.07±13.729	104.40±16.186	0.904
180 min post-op	99.80±14.384	96.40±14.759	0.528

[Table/Fig-2]: Pulse rates of the study participants.
Data presented as mean± SD

Characteristics of Blood pressure		Group B (n=15)	Group BD (n=15)	p-value
SBP (mm of Hg)	Pre-op	109.27±9.772	109.87±11.401	0.835
	20 min post-op	117.07±11.925	109.80±12.200	0.090
	60 min post-op	118.20±11.851	111.67±11.368	0.118
	120 min post-op	113.60±12.676	114.20±7.903	0.934
	180 min post-op	112.33±11.896	114.00±8.124	0.738
DBP (mm of Hg)	Pre-op	60.33±7.997	56.73±11.260	0.261
	20 min post-op	64.07±7.545	63.07±8.940	0.852
	60 min post-op	67.20±8.579	67.33±9.766	0.884
	120 min post-op	67.27±9.184	67.60±8.236	0.803
	180 min post-op	70.00±9.827	71.13±8.357	0.934

[Table/Fig-3]: Blood pressure measurements in both the groups.
Data presented as mean± SD

	Time (minutes)	p-value
Group B (n=15)	41.67±12.051	0.316
Group BD (n=15)	37.33±11.159	

[Table/Fig-4]: Duration of surgery. Data presented as mean± SD

	Time (hours)	p-value
Group B (n=15)	13.93±11.373	0.008
Group BD (n=15)	27.13±13.421	

[Table/Fig-5]: Time to rescue analgesia. Data presented as mean± SD

Incidence	Group B (n=15)	Group BD (n=15)	Total
No	12 (80%)	13 (86.7%)	25 (83.3%)
Yes	3 (20%)	2 (13.3%)	5 (16.7%)
Total	15 (100%)	15 (100%)	30 (100%)

[Table/Fig-6]: Incidence of PONV. $\chi^2 = 0.240$ p=0.624.

DISCUSSION

Regional blocks are becoming more popular in paediatric surgery. It is known that regional or nerve blocks with general anaesthesia allows for decreased requirement of general anaesthesia drugs, decreased stress response, patients having less pain on awakening and avoidance of the potential side effects that may occur with intravenous use of opioid narcotics. It is also said to provide excellent post-operative pain relief [12]. Supraclavicular brachial plexus blocks with long acting local anaesthetics have been used in paediatrics and are known to provide superior analgesia in the post-operative period, as compared to intravenous bolus or continuous infusions and per rectal routes of administration of analgesic drugs [13].

This study results are comparable to the study done by Choi S et al., in adults where data from nine trials (801 patients) were included with patients receiving either Local Anaesthetic (LA) alone or local anaesthetic with perineural dexamethasone (4-10mg) [14]. Their conclusion was that dexamethasone prolonged the analgesic duration for long acting LA from 730min to 1306min (mean difference 576min). The present study done in paediatric age group showed that addition of dexamethasone showed a statistically significant increase in the duration of post-operative analgesia 27±13.42 hours in group BD as compared to group B where duration of analgesia was 13.93±11.373 hours. This study results were also in agreement to the study conducted by Desmet M et al., where perineural dexamethasone was used in interscalene block for shoulder surgery in adults with their results showing sensory block of 1405 minutes [15]. Vieira PA et al., in his study also found that dexamethasone prolonged median sensory (1457 vs. 833 min, p<0.0001) and motor (1374 vs. 827min, p<0.0001) blockade compared with the control thereby concluding that dexamethasone prolongs the duration of analgesia when added to a local anaesthetic [13]. The present study did not examine the effects of dexamethasone on analgesic quality because of the subjective nature of the outcome and the age group involved in the study. Nonetheless, studies have shown that local anaesthesia with perineural dexamethasone resulted in patients reporting qualitatively 'better' analgesia or lower pain scores than without the use of steroid [13,14,16]. None of the patients in the study groups showed signs of neuronal damage. To date, there are no reports of dexamethasone-induced neuronal damage. To the contrary, in vitro murine studies have actually demonstrated that dexamethasone attenuates the neurotoxicity of bupivacaine at a cellular level [17]. This study also measured incidence of post-operative nausea and vomiting and haemodynamics post-operatively. It showed no statistical significance (p=0.624) although 3 patients in group B (20%) and 2 patients in group BD (13.3%) did complain of PONV. This can be attributed to the effects of general anaesthesia in these patients. The mean systolic and diastolic blood pressure measured at 20 minutes, 60 minutes, 120 minutes and 180 minutes post-operatively showed no statistical significance. There is very limited data on the same in paediatric patients undergoing regional blocks under general anaesthesia. A comparative study done by Kumar S. et al., on ropivacaine and ropivacaine with dexamethasone in supraclavicular brachial plexus block for post-operative analgesia reported no toxicity profile and it was well tolerated with no incidence of post-operative nausea, vomiting, paresthesias or arrhythmias [18].

A study done by Gehdoo RP et al., on post-operative pain management in paediatric patients suggests that it is now widely accepted that the paediatric population require adequate pain relief in the post-operative period for a smoother and rapid outcome [12]. Hence simple nerve block techniques can be used safely to relieve post-operative pain. Newer modalities of pain management should be considered wherever possible.

LIMITATION

The present study did not examine the effects of dexamethasone on analgesic quality because of the subjective nature of the outcome and the age group involved in the study. The sample size of the study population was fairly small. Since, it was paediatric age group, follow-up of haemodynamic parameters following discharge from PACU was difficult.

CONCLUSION

The addition of dexamethasone to bupivacaine significantly prolongs the duration of analgesia in children undergoing upper limb surgeries under supraclavicular brachial plexus block and general anaesthesia with no significant effects on haemodynamics or post-operative nausea and vomiting.

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