

Effect of Ultrasound Guided Supraclavicular Brachial Plexus Block on Intraoperative Opioid Consumption and Quality of Postoperative Analgesia in Closed Reduction and Pinning of Paediatric Supracondylar Fracture of Humerus

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ABSTRACT

Background: Supracondylar fracture of the humerus is one of the commonly encountered injuries in paediatric age group accounting for 16% of all paediatric fractures and 60% of all paediatric elbow fractures, classically occurring as a result of fall on an outstretched hand. Regional anesthesia may represent one of the best solutions for intraoperative and postoperative paediatric pain management however, due to lack of proficiency and the increased risk of complications in children and difficulty in obtaining cooperation compared to adults, it is not the method of choice for most of the anesthesiologists in children.

Methods: A total of 50 paediatric patients were included who were to undergo CRPP and divided into two groups Group I- General anaesthesia alone (n = 25), Group II- General anaesthesia with USG guided supraclavicular brachial plexus block studied for the intraoperative opioid consumption as well as postoperative analgesia quality, duration and Opioid consumption.

Results: Demographic data were similar in both groups (I and II). Time to first dose of analgesia after surgery in the group I was 54.8±5.4 min and 746.6±40.2 min (p<0.001). The incidence of PONV was 24% (group I) and 16% (GroupII). Duration of analgesia was significantly higher (746.6±40.2 min) and mean pain scores lower in first 24 hour. The fentanyl consumption was higher intraoperatively and rescue analgesic doses were more in group I.

Conclusion: USG guided brachial plexus block is an excellent and effective means for analgesia in CRPP for supracondylar fracture with lower intraoperative Opioid consumption and better postoperative analgesia, lower pain scores and Opioid consumption in first 24 hour post operative period.

Supracondylar fracture of the humerus is frequently seen injury in children (male>female) accounting for 16% of all paediatric fractures and 60% of all paediatric elbow fractures, aetiology being fall on an outstretched hand [1-2]. The usual age of presentation is 5-7 years (90% cases) and extension type injury is more common than flexion type [3].

Anaesthesia is required for the distraction of fracture segments for closed reduction and pinning of supracondylar fracture. Mostly the procedure is done under general anaesthesia and infrequently we see nerve blocks as a sole method of anaesthesia used because it is difficult to obtain cooperation from children first for performing nerve block and then for procedural

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manipulations like distraction of fracture segments and percutaneous pinning [4-5].

Analgesia methods for paediatric patients involve acetaminophen, NSAIDS, opioids as well as peripheral nerve blocks all being utilised as modalities for postoperative pain management in paediatric patients [6]. Regional anesthesia may represent one of the best solutions for intraoperative and postoperative paediatric pain management; however, due to lack of expertise, difficulty in obtaining cooperation and increased risk of complications in children compared to adults, peripheral nerve blockade is not the method of choice for most of the anesthesiologists, especially among younger paediatric patients. Use of USG guidance in nerve block has a multiple advantages that requirement for anatomical landmarks, or eliciting of paraesthesias or observation of motor response using nerve stimulator is not needed. A direct visualisation of brachial plexus, its surrounding structures is possible and direct visualisation of spread of local anaesthetic solutions during nerve block procedure is possible hence makes USG guided nerve blocks an effective modality for paediatric patients where most blocks are given in anaesthetized state [7].

The aim of this study was to evaluate use of USG guided supraclavicular brachial plexus block in analgesia for percutaneous pinning for supracondylar fracture of humerus in children.

Methods

After approval by institutional ethics committee and obtaining a written informed consent from parents/guardian, this study was done in the time period from July 2018 to June 2019. A total of 50 paediatric patients who were scheduled to undergo closed reduction percutaneous pinning (CRPP) of supra-condylar fracture were studied.

Exclusion criteria

- Patient or parent refusal
- History of bleeding diathesis
- Preoperative neurovascular injury
- Patients requiring open reduction
- cognitive disability
- Associated other traumatic injuries

Included patients were allocated randomly (using computer generated random table method) into two equal groups:

Group I- General anaesthesia alone (n = 25),

Group II- General anaesthesia with USG guided supraclavicular brachial plexus block (n=25).

PREANAESTHETIC PREPARATION: - After initial assessment of patients in emergency department all children were kept fasting 6 hours for solids and 2 hours clear liquids. On arrival to preoperative room IV cannula was secured and premedication given with injection

midazolam 0.02mg/kg and injection glycopyrrolate 0.02 mg/kg in preoperative room.

Anaesthesia:- In the operating room, patients were monitored with ECG, non-invasive blood pressure and pulse oximetry. All the patients were started with IV fluid and induction of anaesthesia done with propofol 2mg/kg, fentanyl 1mcg/kg and inj atracurium 0.5mg/kg and intubated with an appropriate sized tracheal tube. Anaesthesia maintenance was done with oxygen, nitrous oxide, and sevoflurane. After this, the patients of group II were given supraclavicular brachial plexus block under USG guidance described as follows.

Technique

Each child was placed supine on the operating table, with the head turned 45 degree to the opposite side and a linear high frequency probe of 12 MHz was placed firmly over the supraclavicular fossa. The probe was placed immediately superior to the clavicle at approximately its midpoint and manipulated to obtain a cross-sectional view of the subclavian artery. The brachial plexus is seen as a collection of hypoechoic oval structures lateral and superficial to the artery. A cutting bevel needle was used and its passage towards brachial plexus visualised under USG by placing needle in plane to USG probe. The predetermined volume of drug solution (0.5ml/kg body weight of 0.25% bupivacaine plus 1mcg/kg dexmedetomidine as adjuvant) was administered around the brachial plexus and spread of drug solution was observed in tissue planes under ultrasound imaging

After this the surgeon was allowed to perform the procedure. The maintenance of general anaesthesia was done with oxygen, nitrous oxide and sevoflurane similar to as in the group I. Any sign of intraoperative increase in baseline arterial pressure or heart rate of $\geq 20\%$ during surgical manipulations of arm like distraction of fracture or during pinning was defined as insufficient analgesia and was treated with additional doses of fentanyl (0.5 $\mu\text{g kg}^{-1}$). All the patients were given inj paracetamol 15mg/kg iv at the completion of surgery. At the end of the procedure inhalational anaesthetic was stopped and patients muscle relaxation was reversed with neostigmine and glycopyrrolate. After extubation patients were shifted to post-anaesthesia care unit (PACU) for observation and heart rate, SpO₂, and ventilatory frequency were monitored continuously, and data were recorded every 15 min until the child was awake and cooperative. In all the patients a separate anaesthesia resident was given responsibility of pain assessment, done with FLACC score upto 8 yrs and numeric pain score from more than 8 yrs. The duration of postoperative analgesia was defined as the time between extubation and FLACC score ≥ 4 or numeric rating score of >4 . At this point, supplemental inj fentanyl 0.5 $\mu\text{g kg}^{-1}$ was given i.v. as a rescue analgesic. Duration of postoperative analgesia was from the time of extubation to the first use of rescue analgesia. Pain scores were assessed at 0, 1, 2, and 4 h

and then at 6, 12, and 24 h. and the total number of rescue analgesic doses were recorded.

Sample Size and Sample Technique.

A total of 22 subjects were required in each group to be able to reject the null hypothesis that with probability (power) 0.9. The Type I error probability associated with this test of this null hypothesis is 0.05 (p value < 0.05). 25 children were taken in each group to take care of any dropouts from study.

Data analysis

Statistical analysis was performed by the SPSS program for Windows, version 17.0. Continuous variables were presented as mean \pm SD, and categorical variables as absolute numbers and percentages. Descriptive statistics were given as mean and standard

deviation for numerical variables. Student t-test was used to compare between groups of normally distributed data. Categorical variables were analyzed using the chi-square test. For all statistical tests, a p-value less than 0.05 were taken to indicate a statistically significant difference.

Results

As shown in (Table 1), there was no significant differences between the groups in terms of baseline patient characteristics and the two groups did not differ preoperatively with respect to mean age, weight, Mean arterial pressure (MAP), Heart rate (HR) and respiratory rate (RR) (with P value >0.05).

Table 1- Demographic data and haemodynamic parameters as mean \pm SD

Demographic data and baseline parameters	Group I	Group II	P value
	Mean \pm Sd	Mean \pm Sd	
Age (years)	6.85 \pm 1.2	6.74 \pm 1.4	0.81
Weight (kg)	19.25 \pm 4.3	19.72 \pm 4.2	0.52
MAP (mmHg)	67.1 \pm 3.9	69.04 \pm 3.8	0.49
HR	105.5 \pm 7.2	101.29 \pm 6.8	0.51
RR	16.2 \pm 1.2	16.4 \pm 0.82	0.89

Table 2- Intra-operative parameters like, duration of anesthesia and block time as mean \pm SD

	Group I	Group II	P value
	Mean \pm Sd	Mean \pm Sd	
Intraoperative fentanyl (mcg/kg body wt)	2.04 \pm 0.7	1.34 \pm 0.4	<0.001
Duration of anaesthesia(min)	52.2 \pm 7.2	59.2 \pm 4.82	<0.05
Supraclavicular block time(min)	0	6.55 \pm 1.82	

As shown in (Table 2), there was more fentanyl consumption intraoperatively in group I. The longer duration of anaesthesia in group-II of about 7 minutes that

was utilised for performing supraclavicular brachial plexus block.

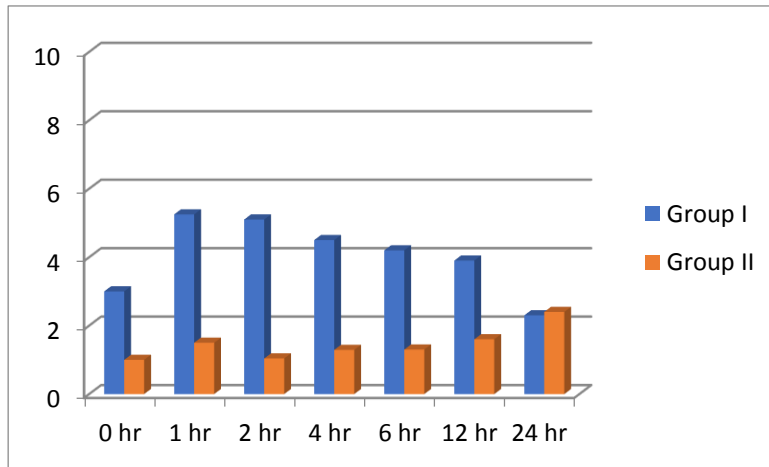
Table 3- Postoperative analgesia, fentanyl requirement and side effects.

	Group I (GA alone)	Group II (GA plus brachial plexus block)	P value
	Time of first rescue analgesic (min)	54.8 \pm 5.4	
Total number of rescue analgesic doses required in 24 hrs	2.7 \pm 1.2	0.8 \pm 0.5	<0.001
Incidence of PONV	6/25	4/25	<0.05

As shown in (Table 3), lesser fentanyl rescue doses/amount was used, fewer patients required rescue analgesic as well as there was longer time to first opioid rescue in groupII as compared to Group I. The incidence of PONV in group-I was 24% and in Group-II was 16%.

As shown in (Table 4) mean pain scores at different postoperative intervals were significantly lower in group-II than in Group-I.

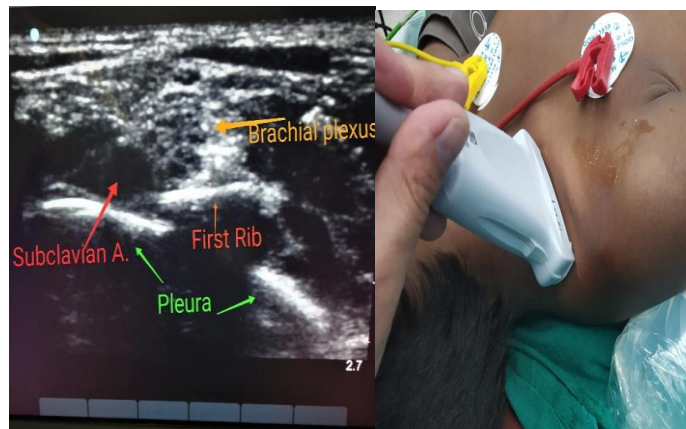
Table 4- Mean pain scores in 24 hours



Picture 1- X-ray showing supracondylar fracture of humerus of a child.



Picture 2- USG probe position and sonoanatomy of brachial plexus in relation subclavian artery, first rib and pleura.



During the PACU stay, Group II group had:

- Lower pain scores and opioid consumption
- Fewer patients requiring opioid rescue
- Longer time to first opioid rescue
- less incidence of PONV

Discussion

The peripheral nerve blocks are safe and effective means of anaesthesia in orthopaedic surgery in adults with advantage of earlier recovery and superior analgesia as compared to general anaesthesia alone. Although the use of peripheral nerve blocks in paediatric patients has a lot of concerns but nowadays is emerging as a safe and effective technique anaesthesia and analgesia [8-9]. The brachial plexus at supraclavicular level in tightly packed which makes it easier to perform nerve block at this level [10]. The main hurdle in paediatric patients is difficulty in obtaining cooperation which increases risk complications like inadvertent vascular puncture or pneumothorax as well as neural injury which has precluded the use of nerve blocks in smaller children by traditional methods like eliciting parasthesias or visualisation of motor response by nerve stimulator [11].

Inadvertent vascular puncture and pneumothorax in particular, because of the anatomic proximity of the cervical pleura, are complications of supraclavicular brachial block that has made blind technique of PNB use infrequent in paediatric patients [12]. Another disadvantage of blind approach is requirement of higher volumes of local anaesthetics to obtain nerve block that predisposes to the risk of local anaesthetic toxicity [13]. For these reasons, traditional methods of supraclavicular block of the brachial plexus have not been recommended for use in paediatric patients [14]. The development of the real-time ultrasound guidance procedure has dramatically reduced the risks of pneumothorax and vascular puncture as the surrounding structures (pleura, subclavian artery and vein) are visualized [15,16].

As USG regional anaesthetic techniques are being increasingly used in paediatric patients, having main advantages of visualization of the surrounding structures (pleura, subclavian artery and vein) and the real-time control of needle movement, both of which reduce the risk of pneumothorax and hence can be performed safely both in awake as well as after general anaesthesia. With an ultrasound-guided block, the application time is shortened, the block time is extended and the local anaesthetic volume used decreases. [17-20]. In our study it was observed that the USG guided visualization and performance of brachial block was very effective Kapral S, et al also studied the same and concluded that ultrasonographic guidance improves the success rate of interscalene brachial plexus blockade [21]. Similar study was done by Marhofer et al who used ultrasound guidance for infraclavicular brachial plexus anaesthesia

in children and reported in their study comparing the use of neurostimulator and the application of infraclavicular block with ultrasound guidance in children and found that the onset of action was shorter and the duration of motor and the sensorial block was longer with the use of ultrasound. In the ultrasound-guided group, the duration of the sensorial block was 384 minutes, while the motor block time was 310 minutes. In our study the time to first rescue analgesia/ duration of analgesia was 746.6 ± 40.2 min, total number of rescue analgesic doses in 24 hours were significantly (see table-3) which is due to addition of adjuvant (dexmedetomidine) to bupivacaine that increases the duration of block and has opioid sparing effect [22].

There was a significant reduction in number of rescue opioid analgesic doses, time to administer first rescue analgesic dose, and less PONV in group II (see table 3) during postoperative period. McNeely JK et al also reported reduction in postoperative pain and hence less opioid requirement in children receiving parascalene injection with nerve stimulator [23]. The mean pain scores at any time in first 24 hours (see table-4) were significantly lower in group-II as compared to group-I, which itself demonstrates the superior analgesic quality in USG guided nerve block group.

The USG guided supraclavicular block was given after the induction of general anaesthesia because it is difficult to obtain cooperation from paediatric patients to perform block in awake state and there is no need of patient participation as drug injection into plexus can be visualised under USG, there is no need to illicit parasthesia or motor stimulation as in nerve stimulator guided block because vascular structures are under real time visualization while performing the block. It is a common practice to perform nerve block with general anesthesia or deep sedation to ensure that children tolerates the procedure. Rochette A et al who did a review of paediatric regional anesthesia practice during a 17-year period in a single institution and found use of ultrasound better than other methods [24]. Although some studies report that the rate of complications increases in blocks administered under anesthesia, Pediatric Regional Anesthesia Network (PRAN) has reported that complication rates for regional anesthesia applications when awake, under sedation, or under general anesthesia are not different [25-26]. However, ultrasound guided blocks require dexterity, experience and training, especially for paediatric patients [27].

O Donnel et al performed USG-guided axillary brachial plexus block with 20 ml local anesthetic plus clonidine that provided satisfactory anesthesia and superior analgesia, lesser morphine consumption after upper limb trauma surgery when compared with general anesthesia [28]. In our study the time for first rescue analgesic dose was prolonged in group II receiving nerve block. There was significant reduction in number of postoperative

rescue fentanyl doses, lower pain scores, less amount of postoperative fentanyl consumption.

Conclusion

The ultrasound guided supraclavicular block with bupivacaine and dexmedetomidine results in superior postoperative analgesia with lower pain scores as well as reduced intraoperative opioid consumption and lesser requirement of rescue analgesia in postoperative period as compared to general anaesthesia alone. Thus ultrasound guided supraclavicular block is a good, simple and reliable analgesic technique in paediatric patients for operative reduction of supracondylar fracture of humerus.

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