Journal of Cardiovascular Disease Research
ISSN: 0975-3583, 0976-2833 VOL15, ISSUE 12, 2024

Comparative Study of Ultrasound guided Peripheral Nerve Block and Caudal block for Lower Limb Orthopedic Surgeries in Children

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Abstract

Background and Aim: The aim of our study was to compare the efficacy of ultrasound guided (US) caudal block and peripheral nerve blocks (femoral and sciatic nerve blocks) for intra operative and postoperative analgesia in children undergoing orthopedic lower limb surgery.

Methods: 60 children posted for orthopedic lower limb surgery were divided into two groups. Group CB received US-guided caudal block and group PB received US-guided femoral and sciatic nerve blocks after administration of general anesthesia. The primary aim was to compare the postoperative pain score between the two groups and secondary aims were to compare duration of analgesia, time to 1st rescue analgesia request and parental satisfaction.

Results: Pain score at 6 and 8 h postoperatively was low in PB group compared to CB group which was statistically significant. Time to first rescue analgesic (paracetamol) requirement was significantly less in group PB compared to group CB. Parents of children in group PB were more satisfied than those in group CB.

Conclusion: Ultrasound guided peripheral nerve block like femoral and sciatic block can provide prolonged postoperative analgesia compared to US guided caudal block for lower limb orthopedic surgeries in children.

Keywords: caudal, peripheral nerve, lower limb surgeries, orthopedic, ultrasound

Introduction

Regional anesthesia in children is safe and no cases of permanent neurologic damage has been reported in The Pediatric Regional Anesthesia Network (PRAN) database. Caudal block has been used in infants and young children for postoperative analgesia. Its safety and success rate has been increased with use of ultrasound. But it has its own limitations.[1] Anatomical changes due to increase in age and increase in sacral subcutaneous fat may obscure bony landmarks and closure of the sacral hiatus by calcification of the sacrococcygeal ligament which may reduce the success rate. Real time ultrasound can avoid unintentional dural puncture and complication like total spinal anesthesia.[2] Now a days, success rate of regional nerve blocks has been

much improved in the pediatric anesthetic practice, due to the advancement in the ultrasound and the image quality there by making the procedure easier, safer, with less dose of local anesthetics and fewer complications.[3] The aim of this study was to compare the analgesic efficacy of the ultrasound guided caudal block versus the peripheral nerve blocks for lower limb orthopedic surgeries in pediatrics population. The primary outcome of this study was to assess the postoperative pain score and secondary aims were duration of analgesia, time to 1st rescue analgesia and parental satisfaction.

Methods

This is a prospective randomized trial, conducted at a tertiary care hospital in Odisha after taking consent from parents. Children of age 2–12 years of American Society of Anesthesiologists (ASA) physical status I/II scheduled for orthopedic lower limb surgeries were included in the study. Children having allergy to local anesthetic, preexisting neuropathy and local infection at puncture site were excluded from study. Preanesthetic check up was done in all children and were optimized preoperatively. Computer generated random numbers were used to allocate children through sealed opaque envelopes into two equal groups(CB and PB). The envelope was opened by anesthesiologist, not involved in the study or data collection. Parents and outcome assessors were also blinded to group allocation. Upon arrival in the operating room, an intravenous line was established. Non-invasive blood pressure, electrocardiogram (ECG), temperature probe, capnograph and pulse oximeter were used to monitor patients. General anesthesia was administered as per institutional protocol with laryngeal mask airway.

All blocks were executed under the guidance of a 5–13 MHz linear ultrasound probe covered in a sterile sheath and attached to a Sonosite (M-Turbo; SonoSite Inc. Bothell WA USA) portable ultrasound machine.[4] Group CB received US-guided caudal block. The caudal block was performed by visualizing the sacral hiatus at the level of the sacral cornu after placing the probe transversely obtaining a short axis view, two hyperechoic lines appeared between the sacral cornu, the superficial line is the sacrococcygeal ligament which was pierced by the needle 22-gauge echogenic non-stimulating 5-cm needle (Ultraplex; B. Braun Medical Bethlehem PA, USA) using the out-of-plane approach. After confirming the absence of any blood or cerebrospinal fluid in the aspiration, the caudal mixture (0.5 ml/kg of 0.25% bupivacaine a maximum volume of 15 ml) was injected. Group PB received lower limb peripheral nerve blocks in the form of US guided femoral nerve block with US guided subgluteal sciatic nerve block. For femoral nerve block, the child was positioned supine, the probe was put on the inguinal crease transversely to identify the femoral nerve artery and vein. The femoral nerve was identified lateral to the artery while the femoral vein was seen medial to the artery. An in-plane approach was used 22-gauge echogenic nonstimulating 5-cm needle (Ultraplex; B. Braun Medical) was introduced from lateral to medial towards the femoral nerve and the local anesthetic (0.5 ml/kg of 0.25% bupivacaine) was injected circumferentially around the nerve. For sciatic nerve block the subgluteal approach to the sciatic nerve was used. The child was put in the lateral decubitus position. The probe was placed at the gluteal crease between the greater trochanter and the

ischial tuberosity the gluteus maximus muscle was identified; the sciatic nerve was situated deep to this muscle. An in-plane approach was used for needle guidance 22-gauge echogenic nonstimulating 5-cm needle (Ultraplex; B. Braun Medical). The local anesthetic (0.5 ml/kg of 0.25% bupivacaine) was injected surrounding the nerve. Intraoperatively anesthesia was maintained using an O2/Sevoflurane mixture. An increase of 20% of the mean arterial pressure or heart rate as compared to baseline values required injection of 1 μg/kg of fentanyl intravenously. After surgery ,extubation was done and all children were shifted to post anesthesia care unit. Postoperative pain scores were evaluated by the COMFORT [5] pain score at different time interval postoperatively. When the score was more than 26,IV paracetamol (10 mg/kg) was administered as rescue analgesia. To detect a difference of at least 2 in pain score between the two groups, the sample size calculation required a minimum of 26 patients in each group at α error of 0.05, effect size 1.03 and 95% power of the study. So, we enrolled 30 patients in each group to compensate possible dropouts. Data was analyzed using IBM SPSS version 22. Data were described according to type. Data that were normally distributed were presented as mean and standard deviation, however median and interquartile range were used for not normally distributed data. Comparison between groups was done using the chi-squared test for qualitative variables and Student's *t*-test or Mann–Whitney test for quantitative variables. *P* value < 0.001 was considered significant.

Results

60 patients were randomly allocated in to two groups of 30 each. Group CB received US guided caudal block and Group PB received US-guided femoral and sciatic block. All children underwent orthopedic lower limb surgeries without any significant difference in demographic characteristics.(Table 1)

Table 1: Comparison of demographic characteristics

Variables	**Group PB(n=30) Mean ±SD**	**Group CB(n=30) Mean ±SD**	**P value**
Age (year)	7.6±1.8	7.5±1.4	0.234
Sex ratio (M/F)	18/12	19/11	0.216
Weight (kg)	21.8±11.19	22.24±10.17	0.178
ASA Grade (I/II)	20/10	20/10	0.261
Duration of Surgery (min)	99.6±29.4	97.8±29.9	0.284

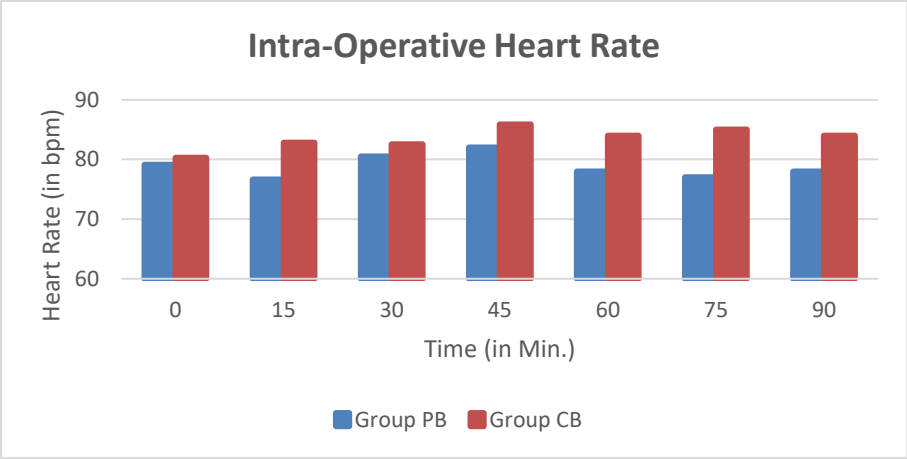
There was no statistically significant difference between the two groups regarding the COMFORT pain score at 2,4,12,18 and 24 hours postoperatively. However in PB group there was a statistically significant reduction in pain score at 6 and 8 hrs postoperatively. (Table 2) (P value < 0.001).

Table 2:COMFORT score measurements in both groups

Time interval	Group PB(n=30) Mean ±SD	Group CB(n=30) Mean ±SD	P value
PACU	21±1.2	21± 1.9	1.0
2h	21± 1.5	22± 2.1	0.163
4h	21± 1.9	23± 2.2	0.168
6h	22± 2.1	24± 2.69	<0.001
8h	22± 2.5	24± 2.87	<0.001
12h	24± 3.3	24± 3.9	0.324
18h	24± 4.1	24± 4.24	0.126
24h	25±5.3	26± 5.8	0.223

Heart rate measurements were lower in PB group compared to CB group but it was not statistically significant. (Figure 1).

Figure 1: Intraoperative changes in heart rate in both group



MAP measurements were lower in PB group compared to CB group but it was not statistically significant. (Figure 2).

Figure 2: Intraoperative changes in MAP in both group

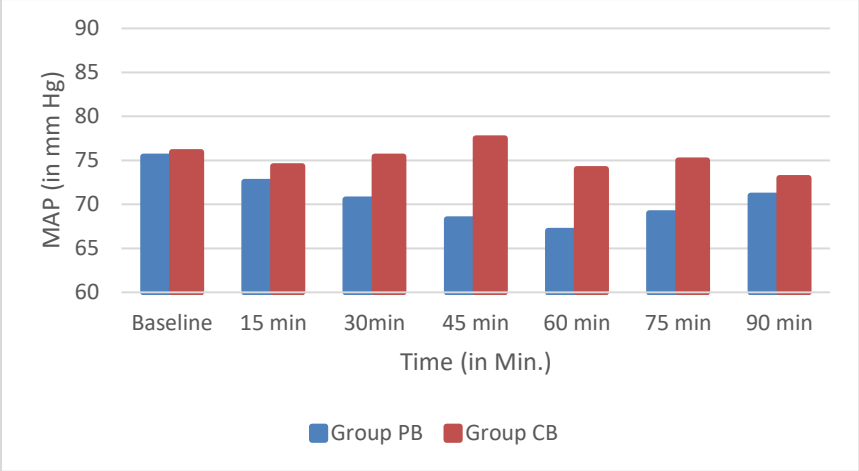


Table 3. Analgesia profile in both groups.

Parameters	**Group PB(n=30) Mean ±SD**	**Group CB(n=30) Mean ±SD**	**P value**
Time of 1st analgesic request block (hr)	9	6	<0.001
Post operative paracetamol consumption(mg)	236.4 ±30.35	390.7±41.5	<0.001
Duration of analgesia (min)	568±48.4	390.7±45.9	<0.001

Time to first analgesic (paracetamol) requirement was delayed and duration of analgesia was prolonged in group PB compared to group CB which was statistically significant. Post operative paracetamol consumption was significantly less in group PB compared to group CB which was statistically significant. (Table 3) Parents of children in group PB were more satisfied than those in group CB which was statistically significant.(Table 4)

Table 4: Comparison between two groups regarding parents' satisfaction

Parents' satisfaction	**Group PB(n=30) (No of Patient)**	**Group CB(n=30) (No of Patient)**	P value
Poor	2	14	<0.001
Good	20	16	<0.001
Excellent	8	0	<0.001

Discussion

Orthopedic pediatric lower limb surgeries can produce severe postoperative pain which can impact the hospital stay. Different regional anesthesia (RA) techniques can provide an effective solution for postoperative pain relief. However recently the use of RA has gained substantial use in pediatric perioperative care. Due to the increased availability and portability of ultrasonography, success of blocks has improved.[7]We compared the US guided peripheral nerve block to caudal block in pediatric orthopedic surgery. There was statistically significant difference between the two groups regarding the COMFORT pain score at 6 and 8 hrs postoperatively. Time to first analgesic requirement was significantly less in group PB compared to group CB. Parents of children in group PB were more satisfied than those in group CB with no recorded complications for both techniques. Our study demonstrated the effectiveness of US guided lower limb blocks (femoral and sciatic nerve blocks) in providing a more prolonged duration of postoperative analgesia and lesser postoperative analgesic requirements compared to US guided CB following lower limb pediatric orthopedic surgeries with better parents' satisfaction. However, this does not mean that US-guided lower limb block is superior to central neuroaxial analgesia as in the first four to six hours both the neuraxial analgesia and the peripheral nerve block provided good comparable analgesia, whereas afterward the analgesia provided by caudal block started to fade.[8] In contrast CB is typically used for infants and young children, however, the advance in the use of US in regional blocks helped the success rate of caudal analgesia in older children.[9] Merrella et al described the advances in peripheral nerve blocks in upper and lower limb surgeries in children which became easier, safer and more successful by the invention of the ultrasound.[10] Marinković et al performed femoral nerve block in pediatric patients who underwent knee surgery. The need for intra- and postoperative analgesics were significantly lower in the block group with an average duration of around eight hours for the block without any complications.[11] Turner et al found that, patients who received US guided femoral nerve block for perioperative femur fracture pain management in the emergency department, had a longer duration of analgesia and required fewer doses of analgesic interventions than those receiving systemic analgesics alone.[12] Black et al reviewed studies comparing peripheral nerve blocks with systemic opioids in pediatrics femoral fractures. They suggested that nerve block provides better and longer lasting pain relief with less adverse events than intravenous opioids for femoral fractures in children.[13] Argun et al in a retrospective study done on pediatrics who underwent orthopedic tumor surgery found that US guided lower limb blocks provided an enhanced and prolonged postoperative analgesia and reduced the analgesic consumption in patients without significant side effects compared to systemic analgesics.[14]When comparing popliteal nerve block with caudal epidural block in children undergoing elective foot surgery, Bumer et al detected comparable and adequate analgesia in both groups. But popliteal block was done using landmark technique with nerve

stimulator and not US guided as in our study.[15] Limitation of our study was small sample size. So large scale studies may be done to validate our study finding.

Conclusion

Ultrasound guided lower limb peripheral nerve block is a simple and safer method to provide adequate and more prolonged postoperative analgesia compared to ultrasound guided caudal block for lower limb orthopedic surgeries in pediatrics population.

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