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Research Article

Comparison of Ultrasound Guided with Conventional Landmark Technique Caudal Block in Pediatric Patients Scheduled for Lower Abdomen Surgery under General Anesthesia: A Prospective Randomized Study

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ABSTRACT

Background: Perioperative pain in pediatric population is a special concern and Caudal block is easy to perform extensively safe if used in children, resulting in low pain scores and when combined with general anaesthesia, it reduces the requirement for volatile agents, opioids, improved postoperative analgesia, and earlier extubation. Ultrasound guided caudal block has reduced the complication rates such as inadvertent dural or vascular puncture. Aim of the study was to compare the success rate of ultrasound guided with conventional landmark technique caudal block in pediatric patients undergoing lower abdominal surgery under general anaesthesia.

Methods: Hundred pediatric patients, ASA class I, age between 6 months to 7 years of either sex, posted for lower abdomen surgery under general anaesthesia were randomly divided in to two groups. In group C- The group with caudal block using conventional landmark technique was used and Group U- The group with caudal block using ultrasound technique was used. Primary objectives of the study to find out the success rate of block in both the groups.

Results: The demographic data were comparable in group C and group U. Significant difference was seen in the distribution of successful block between group C and group U. (p value 0.008) block was successful in 96% of patients in group U which was significantly higher as compared to group C (76%). significant difference was seen in the distribution of number of attempts between group C and group U. (p value 0.001).

Conclusion: We conclude that Caudal block by ultrasound technique increases the first puncture success rate, decreases the number of multiple needle puncture attempts and overall success rate when compared to the conventional landmark technique in pediatric patients undergoing lower abdomen surgery.

Perioperative pain in pediatric population is undertreated in a substantial percentage, due to myths that children do not feel pain. It is also due to the developmental and cognitive differences in children that pose difficulty in assessment of their pain [1]. In reality, children tend to have more physical and emotional reactions to pain than adults. They require adequate pain relief to prevent acute and long-term adverse effects. In order to provide optimal perioperative pain relief for children, local anaesthetics should be a part of the initial pain management plan which is accomplished by choosing a regional anaesthetic technique such as neuraxial blockade, peripheral nerve blockade or local infiltration of the wound along with General anaesthesia or sedation [2-4]. Caudal block is easy to perform extensively safe if used in children,

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resulting in low pain scores and when combined with general anaesthesia, it reduces the requirement for volatile agents, opioids, improved postoperative analgesia, and earlier extubation [5-6]. Caudal block is performed in children undergoing surgery at the lumbosacral to mid-thoracic dermatomal levels with anticipated moderate-to-severe perioperative and postoperative pain. Traditional approaches of nerve localization include landmark and neuro-stimulation practices, but these have considerable failure rates [7]. The extent of analgesia during epidural blockade with local anaesthesia depends on the anatomic spread of solution within the epidural space, which is determined by the injected volume [8].

Therefore, the success rate of the classic caudal epidural anaesthesia technique in pediatric patients has been reported to be about 85%. Ultrasonography under longitudinal image is helpful for visualization of the sacral hiatus, sacrococcygeal ligament, duramater, epidural space and the spreading of the local anaesthetic agent. Therefore, this significantly increases the block accomplishment and visualization of where local anaesthetic is injected, but can also reduce complication rates as surrounding structures can be avoided [9-10]. There is a risk of inadvertent dural or vascular puncture for the traditional single-shot caudal block performed by inserting the needle into the sacral canal through the sacral hiatus. Ultrasound is becoming an important assistant in regional anaesthesia, permitting real-time imaging of nerves and their neighboring structures. This increases rates of attaining a successful block >95%, by allowing imagining of the injectate entering the accurate plane [11].

We hypothesise that ultrasound guided caudal block has success rate is greater than Caudal Block by landmark technique in paediatric patients undergoing lower abdominal surgery under general anaesthesia. Aim of the study was to compare the success rate of ultrasound guided caudal block with conventional landmark technique caudal block in paediatric patients undergoing lower abdominal surgery under general anaesthesia.

Methods

This Study was conducted after approval from institutional ethics committee and registration with clinical trial registry of India (CTRI/2019/05/019316) between 1st November 2018 to 31st March, 2020. Hundred pediatric patients, ASA class I, age between 6 months to 7 years of either sex, scheduled for elective lower abdomen surgery under general anaesthesia were included in this study. Patients with any allergy to local anaesthetic drugs, Coagulopathy and bleeding disorder, Local site infection, preexisting neuromuscular disorders, Congenital anomalies of lower back, Mental retardation, history of premature birth and delayed development were excluded.

Written informed consent was taken from all the patients. After careful pre-anaesthetic examination and investigation, patients meeting the inclusion criteria were taken for the study. 100 patients were randomly divided into two group of 50 patients each by computer generated random number. Group C - Caudal block using conventional landmark technique. Group U - Caudal block using ultrasound technique.

The children were fasted 6 hours for solids and 2 hours for clear liquids before surgery. In the operation theatre, baseline values of heart rate, blood pressure and SpO2 were measured. Patients were induced with inhalation of sevoflurane, oxygen and nitrous oxide. Appropriately sized cannula was put, and Ringer Lactate was started at a calculated rate. Inj. fentanyl 2 µg/kg was given. Inj. Vecuronium (0.1 mg/kg) intravenously was given. Patients was mask ventilated for 3 minutes using oxygen and inhalation Sevoflurane. Airway was secured with appropriate sized endotracheal tube. After completion of surgery, the patient will be positioned laterally with their hips flexed to 90°. Under aseptic precaution caudal block was performed in both the groups.

In conventional landmark group, the sacral conus and then sacral hiatus was palpated. A 22- gauge caudal needle was inserted into the skin with at a 60-80-degree angle and until the sacrococcygeal ligament was punctured, as determined with by a "popping sensation." feeling (puncture of the sacrococcygeal ligament). Then, the angle of the needle was reduced to 20-30 degrees and inserted further for an additional 2-3mm, entering into the sacral canal. Confirmation was done by performing ‘swoosh test’ by injecting 1 ml 2% preservative -free lignocaine through 2ml syringe, a stethoscope was placed over the lower lumbar spine to note the presence or absence o or 'swoosh. Absence of any blood or cerebrospinal fluid in the aspiration is verified following which 0.25% bupivacaine will be injected according to Green Armitage regime [12] under hemodynamic and ECG monitoring. In the case of the needle touching the bony tissue, blood aspiration, or bulging into of the subcutaneous tissue, the angle of the needle will be changed and the intervention was repeated.

In ultrasound group, the linear transducer of 10- 13 MHz with was used after sterile gel and sterile plastic cover application. The transducer was applied perpendicular to the caudal canal for scanning. The depth settings were adjusted to suit each patient’s size. The sacral hiatus was visualized via an in-plane technique at the level of the sacral cornus. At this level, the transducer was rotated 90° to obtain the longitudinal view of the sacrococcygeal ligament and sacral hiatus, then placed between the two cornua. A 22- gauge caudal needle was advanced toward the upper third of the sacrococcygeal ligament. The needle advancement was terminated after penetrating the sacrococcygeal ligament. At this level, after confirming the absence of any blood or cerebrospinal fluid in the aspiration and a negative test dose, bupivacaine 0.25% according to green Armitage

regime [12] was given while observing the ultrasound longitudinal image.

Primary objective was success rate of block. A successful block was defined as EVENDOL [13-14] score <3 in postoperative period, for the period of 2 hours. If the score is ≥3 on EVENDOL score, then the block was accepted as unsuccessful and Inj. Paracetamol (15mg/kg) was administered as rescue analgesic (Table 1).

Table 1- Evendol Pain Scale

Behavioral and Environmental Expressions	Sign Absent	Sign Weak or Transient	Sign Moderate or Present about Half the Time	Sign Strong or Present Almost All the Time
Vocal or verbal expression Cries, screams, moans, complains of pain	0	1	2	3
Facial expression Furrowed forehead, frown, fur rowed or bulging brow, tense mouth	0	1	2	3
Movements Restlessnes, agitation, rigidity, muscular tension	0	1	2	3
Postures Unusual and/or antalgic posture, protection of the painful area, immobility	0	1	2	3
Interaction with the environment Can be comforted, interested in playing interacts with people	Normal 0	Low 1	Very Low 2	Absent 3

Secondary objectives were block performing time, number of needle puncture, success at first puncture and complication rate. The block performing time was defined as the period between the insertion of the needle and termination of local anaesthetic administration. The first puncture success rate was defined as puncturing the sacrococcygeal ligament with a single-needle orientation without any withdrawal from the skin. Complications such as vascular puncture or subcutaneous tissue bulging was also be recorded. The visibility of the needle, presence of a turbulence during the injection or presence of a dilatation in the hiatus was recorded for the ultrasonography group.

The sample size calculation was based on a study conducted by Ahiskalioglu A et al [10]. Based on the above study, 100 pediatric patients were randomly assigned to receive either the conventional landmark technique (n=50) or ultrasound technique. (n=50) Caudal block for lower abdomen surgery under general anaesthesia. it was calculated that 45 patients in each group would provide 80% power to the study with an alpha error of 0.05. We assumed that a 20% baseline ratio of success rate for Caudal block between group U and group C would provide a clinically meaningful effect. Considering a dropout rate of approximately 5%, 50 patients in each group were enrolled.

In statistical analysis Categorical variables were presented in the form of number and percentage (%). On the other hand, the quantitative data were presented as the means ± SD. The data normality was checked by using Kolmogorov-Smirnov test. The comparison of the variables which were quantitative and not normally distributed in nature were analyzed using Mann-Whitney Test and Independent t test was used for comparison of normally distributed data between two groups. The comparison of the variables which were qualitative in nature were analyzed using Chi-Square test. If any cell had an expected value of less than 5 then Fisher's exact test was used. Kaplan Meier survival analysis curve with log rank test was used to compare time of requirement of rescue analgesia between group U and C. the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM version 21.0. For statistical significance, p value of less than 0.05 was considered statistically significant.

Results

No significant difference was seen in the distribution of age(years) between group C and U. (p value 0.569) Age group was 1-3 years in majority of patients in group C and U; 52% in C and 60% in U followed by >3 years in 44% of patients in C and 34% of patients in U. Age group was <1 year in very few patients; 4% of patients in C and 6% of patients in U with no significant difference in distribution between them. No significant difference was seen in age(years) between group C and U. (p value 0.266) No significant difference was seen in the distribution of gender between group C and U. (p value 0.230) No significant difference was seen in weight(kg) between group C and U. (P value 0.158) (Table 2).

Table 2- Comparison of demographic characteristics

Demographic characteristics	Group C (n=50)	Group U (n=50)	P value

Age(years)			
Mean ± SD	3.3 ± 1.74	2.99 ± 1.91	0.266
Gender			
Female	27 (54%)	21 (42%)	
Male	23 (46%)	29 (58%)	0.230
Weight(kg)			
Mean ± SD	13.17 ± 4.41	12.13 ± 4.63	0.158

Table 3- Comparison of EVENDOL score between group C and U.

EVENDOL score	Group C (n=50)	Group U (n=50)	P value
At time of reversal/ awakening			
Sign absent	32 (64%)	34 (68%)	
Sign weak	9 (18%)	14 (28%)	0.025
Sign moderate	2 (4%)	2 (4%)	
Sign strong	7 (14%)	0 (0%)	
At 0-1 hours			
Sign absent	0 (0%)	1 (2%)	
Sign weak	25 (50%)	29 (58%)	0.091
Sign moderate	14 (28%)	17 (34%)	
Sign strong	11 (22%)	3 (6%)	
At 1-2 hours			
Sign weak	0 (0%)	2 (4%)	
Sign moderate	39 (78%)	46 (92%)	0.008
Sign strong	11 (22%)	2 (4%)	

Significant difference was seen in the distribution of EVENDOL score at time of reversal/ awakening between group C and U. (p value 0.025) At time of reversal/ awakening, sign was strong in 14% of patients in group C which was significantly higher as compared to group U (0%). On the other hand, at time of reversal/ awakening sign was weak in 28% of patients in group U which was significantly higher as compared to group C (18%). No significant difference was seen in the distribution of EVENDOL score at 0-1 hours between group C and U. (p value0.091) At 0-1 hours, sign was weak in majority of patients in group C and U; 50% in group C and 58% in group U followed by moderate sign in 28% of patients in group C and 34% of patients in group U and strong sign in 22% of patients in group C and 6% of patients in group U. At 0-1 hrs, sign was absent in very few patients; 0% of patients in group C and 2% of patients in group U with no significant difference in distribution between them. Significant difference was seen in the distribution of EVENDOL score at 1-2 hours between group C and U. (p value0.008) At 1-2 hours, sign was strong in 22% of patients in group C which was significantly higher as compared to group U (4%). On the other hand, at 1-2 hrs, sign was moderate in 92% of patients in group U which was significantly higher as compared to group C (78%). (Table 3)

Significant difference was seen in the distribution of successful block between group C and U. (p value 0.008) block was successful in 96% of patients in group U which was significantly higher as compared to group C (76%). significant difference was seen in the distribution of number of attempts between group C and U. (p value 0.001) Significant difference was seen in the distribution of rescue analgesia used between group C and U. (p value0.008) Rescue analgesia was used in 24% of patients in group C which was significantly higher as compared to group U (4%). No significant difference was seen in the distribution of block performance time (in seconds) between group C and U. (p value0.317) (Table 4)

Table 4- Comparison of successful block, number of attempts, rescue analgesia, block perfomance time between group C and U.

Successful block	Group C (n=50)	Group U (n=50)	P value
No	12 (24%)	2 (4%)	0.008
Yes	38 (76%)	48 (96%)	
Number of attempts			
1	38(76%)	46(92%)	0.001
2	8 (16%)	3 (6%)	
3	4 (8%)	1(2%)	
Rescue analgesia used			
No	38 (76%)	48 (96%)	0.008
Yes	12 (24%)	2 (4%)	
Block perfomance time (in seconds)			
Mean ± Stdev	10.02 ± 0.14	10 ± 0	0.317

Discussion

There are various methods to outline the caudal epidural space, including the palpation method, the whoosh test, fluoroscopy, and ultrasonography. The most use is the palpation method, which includes detection of the characteristic ‘’pop’’ generated when needle penetration into sacrococcygeal ligament. However, the palpation method is not always enough, because confirmation can be done after the clinical effects of the injected drug are detected [15-16].

After the coccyx is palpated, the sacral hiatus can be identified by feeling depression in the skin while proceeding cephalic. However, this method is difficult to do on children who are overweight or who have indistinct anatomical structures. Another method is the identified of posterior superior iliac spine and the sacral hiatus for the equiangular triangle. Kim et al emphasized that it may not be suitable, especially in children aged <6 years, because the triangle formed is not equiangular. [17].

Moreover, the contralateral caudal space in children is very slender, and the sacrococcygeal ligament is so soft that it cannot be identified; thus, intraosseous penetration and blood aspiration can rise. The epidural veins end at

the S4 level in infants. Thus, the intravascular injection while performing conventional method occurs at rates as high as 11 to 42 % [18-19]. Besides, wrong identification of the sacral hiatus can be associated with complications, including multiple placement intraosseous and Dural punctures, subdural block, rectal penetration, blood tap-systemic reaction, or osteomyelitis [20].

In our study significant difference was seen in the distribution of successful block between group C and U. (p value<.05), caudal block was successful in 96% of patients in group U which was significantly higher as compared to group C (76%). Similar to our study Singh Mahima et al. reported The success rate of 94% in US Guided caudal block vs 78% in conventional caudal block group (P=0.04). Ultrasound can be a useful tool to guide the placement of the epidural needle with a potential at technique enhancement, improve patient's acceptance, minimizing failure rates [21].

In our study, first puncture success rate 92 % in group U and 76 % in group C (p=0.001). Similar to our study Wang et al compared the conventional methods and sacral hiatus using ultrasound guidance for pediatric caudal block and indicated that the first puncture success rate was higher, and the durations of block were shorter in Group H than in Group C (92.8% vs 60% and 145 ± 23s vs 164 ± 31s, respectively P < 0.05).[9] Ahiskalioglu A et al also compared caudal blocks performed using ultrasound and conventional methods and found that first puncture success rate was higher in Group U than in Group C (80% vs 63%, respectively p=0.026) [10]. Karaca O, et al also compared Ultrasound-Guided versus Conventional Caudal Block in Children and found that success at first puncture was higher in Group U than in Group C (90.2 vs 66.2%, respectively; p < 0.001) [22]. Liu JZ et al also compared ultrasonography versus traditional approach for caudal block in children and found that the success rate at the first puncture attempt 90.4% vs 66% [23].

This study has several limitations. First, the duration of motor block and analgesic efficacy of LA in the postoperative period was not considered. Second, we only assessed the in-plane technique; future studies should compare the in-plane and out plane methods. Third only compared the caudal block in children between 6 months and 7 years of age.

Conclusion

In conclusion, Caudal block by ultrasound technique increases the first puncture success rate, decreases the number of multiple needle puncture attempts and overall success rate when compared to the conventional landmark technique in pediatric patients undergoing lower abdomen surgery.

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