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Original Research Article

Comparison of ultrasound-guided versus conventional technique for caudal block in paediatric patients

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ABSTRACT

Background: Caudal blocks have been recommended for surgical procedures mainly below umbilicus. Their use has increased in paediatric cases as they are easy to perform with low complication rates. There have been reports of this technique being performed as a sole anaesthetic in children who may not be a suitable candidate for general anaesthesia. This study was conducted with an aim to compare the traditionally used landmark guided technique of caudal block with ultrasound-guided technique in terms of intra-operative analgesia, haemodynamic parameters, time required to perform block and demand for rescue analgesia.

Materials and Methods: This prospective randomized comparative study was carried out in 68 paediatric patients divided in two study groups (Group C and Group U) undergoing elective lower gastrointestinal and genito-urinary tract surgeries over a period of two years in a tertiary care hospital.

Results: The intra-operative haemodynamic parameters were comparable in both the groups. There was a significant increase in time taken to perform the block in Group U as compared to Group C (6.5 minutes v/s 15 minutes) (p-value <0.001). The success rate at first puncture was 52.2% in Group C and 47.8% in Group U. The majority of patients were relaxed and comfortable in the 1st hour post-operatively. The requirement of rescue analgesia in the post-operative period was comparable in both the groups.

Conclusion: The conventional technique is easier and less time consuming as compared to the ultrasound-guided technique, which is newer and the practitioner needs expertise. The quality of analgesia provided by both the techniques is comparable. The frequency of complications associated with the block are fewer with the ultrasound-guided approach. Ultrasonography is the modality of choice specially in cases where detection of sacral anatomy and landmarks is difficult. However, further studies are needed to establish the role of ultrasonography in performing caudal block.

1. Introduction

Caudal epidural block is one of the most widely administered techniques of regional anaesthesia in paediatric patients. It is an efficient way to offer intra-operative and post-operative analgesia for sub-umbilical surgical interventions. It decreases the stress hormone response to surgery.[1] These blocks have been performed for surgical procedures mainly below umbilicus such as inguinal hernia repair, circumcision, anal atresia, treatment of intussusception, orthopaedic procedures involving pelvic girdle, cast application to immobilise new-borns with hip dysplasia.[2] Their use has increased in paediatric cases as they are easy to perform with low complication rates and can be used in elective surgeries.[3] There have been reports of this technique being performed as a sole anaesthetic in children who may not be a suitable candidate for general

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anaesthesia such as those with muscular dystrophies and in malignant hyperthermia suspects. The block is quite safe and the incidence of harmful sequelae is very low, the most serious being block failure followed by urinary retention.[4] Caudal epidural block is usually combined with General Anaesthesia in order to provide efficient post-operative analgesia. It also reduces the intra-operative requirement of opioids and inhalational agents.[5] However, there is an increased incidence of systemic toxicity related to local anaesthetics that can be attributed to the recent popularity and usage of caudal anaesthesia.[6] The conventional technique is performed with the patient in lateral position or in prone position. The two sacral cornu are located by palpation at the level of sacrococcygeal joint. The block is given using 'single shot technique'. There is risk of dural or vascular puncture. Ultrasound guided block is performed after visualization of the sacral cornu and hiatus and then injecting the drug in sacral canal under direct vision.[7] Hence, Ultrasonography-guided caudal blocks have become popular among paediatric anaesthesiologists for promoting safety of the technique and lowering the complication rates.[8] The success rate of the conventional caudal anaesthesia method in paediatric patients is reportedly 75% which is likely due to variations in sacral anatomy.[9] Ultrasonography provides extensive anatomical information to perform neuraxial blocks, more so in caudal blocks.[10] It helps in visualization of the sacral hiatus, sacrococcygeal ligament, dura mater, epidural space and the local anaesthetic distribution within the epidural space. However, it is currently unknown if the use of ultrasonography improves the success rates of caudal blocks in children. In the current study, we aimed to compare the two techniques of administering caudal block in paediatric patients. Our primary objective was to compare the two techniques based on efficacy of analgesia as indicated by the intra-operative haemodynamic parameters. Our secondary objective was to compare the two techniques based on the number of post-operative complications, requirement of rescue analgesia, number of punctures and time taken to perform each block.

2. Materials and Methods

A prospective double-blinded randomized comparative study was conducted on 68 patients between 6 months to 5 years of age, who were divided into two groups (Group C and Group U) of 34 patients each belonging to ASA class I/II, undergoing elective lower abdominal and genito-urinary tract surgeries who were enrolled after institutional ethics committee approval at a Tertiary care Hospital over a span of two years. Children with deranged coagulation profile, local infections on the back, spine anomalies and pre-existing neurological deficits were excluded from the study.

Sample size calculation - For comparative study design we have at 95% confidence level and statistical power of 80% with effect size 0.7 with mean (SD) 2.16 (1.85) and 2.87 (2.41) for group 1 and group 2 respectively in the study done by Erbuyun et al.[3] Our total required sample size for the study was 68.

After enrolment, group assignment was done by a computer-generated number sequence (www.randomizatio n.org) to avoid selection bias. A detailed pre-anaesthetic check-up was carried out in all the patients. Anaesthetic procedure was explained to the parent/guardian of the patients undergoing lower abdominal or genitourinary surgery and written informed consent was taken. No premedication was given on the day of surgery. The patient was shifted to the operating room after ensuring adequate fasting status. After application of standard ASA monitors (ECG, Non-invasive blood pressure, oxygen saturation probe), inhalational induction was done using 7-8% Sevoflurane and intravenous access was achieved, followed by securing the airway using Supraglottic airway device or Endotracheal tubes of appropriate size. After securing the airway, the anaesthesia was maintained using oxygen in nitrous oxide (1:1) with sevoflurane.

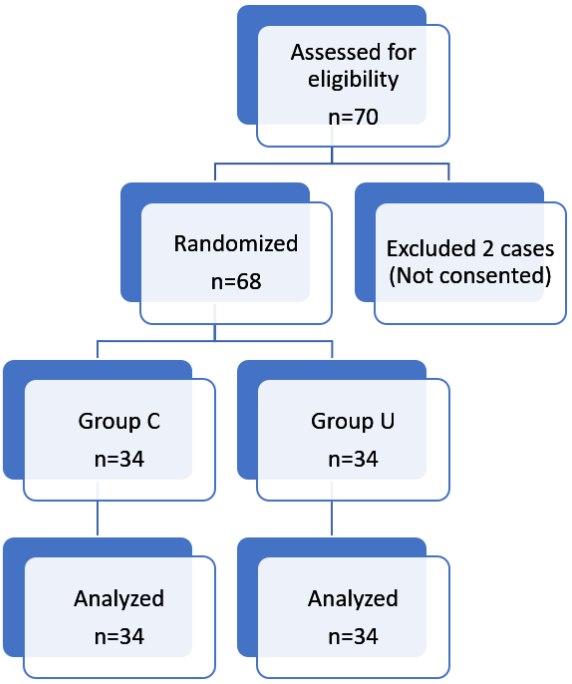

Fig. 1: The CONSORT diagram of the study

Administration of caudal block using conventional technique - The patients were put in lateral position with hips and knees flexed. After optimum sterilization of the skin using chlorhexidine solution, the two sacral cornua were palpated along the spinous process line at the level of sacrococcygeal joint. After palpation of sacral cornua

and hiatus, a 21G BD needle was inserted into the skin at 60-80 degrees angle until the sacrococcygeal ligament was punctured which was confirmed by a popping sensation. The angle of the needle was then reduced to 20-30 degrees and the depth of insertion increased to 2 mm after the ligament had been pierced successfully to enter sacral canal. After ensuring the absence of blood or Cerebrospinal fluid in the aspirate, over one minute using 'single shot technique' under continuous haemodynamic monitoring.U were positioned similarly. The skin of the patient was adequately sterilized. UA linear probe of 13

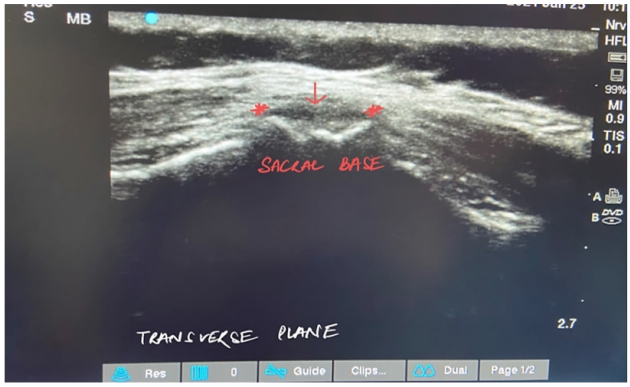

Fig. 2: Transverse sonoanatomy of the sacrum - * indicate the two sacral cornua and ↓ indicates the sacrococcygeal ligament –typical 'frog-eye' appearance

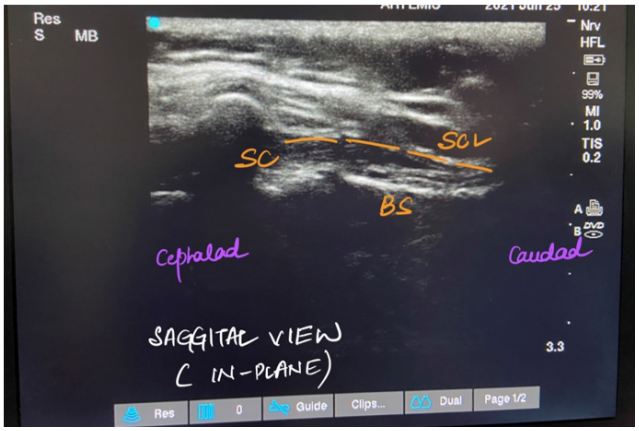

Fig. 3: Longitudinal sonoanatomy of the sacrum – SC - Sacral canal, SCL – Sacrococcygeal ligament, BS – Base of sacrum

The intra-operative hemodynamic parameters were measured – starting before induction of general anaesthesia till completion of surgery, at regular intervals. The number of needle punctures required in order to achieve correct needle placement and injection of local anaesthetic were documented. The time from cleaning and draping the site till injection of local anaesthetic agent was taken as time taken to perform the block. A successful block was defined

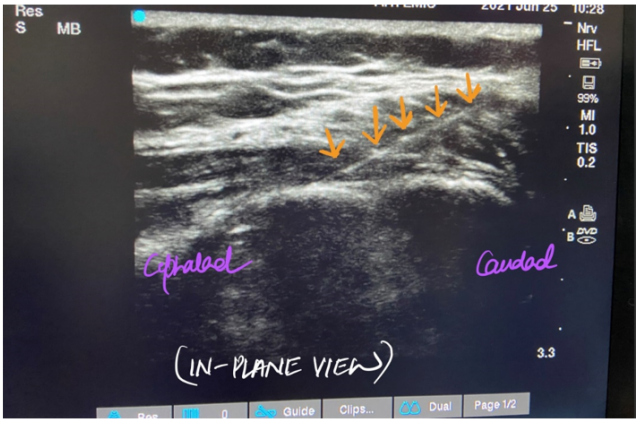

Fig. 4: Arrows indicate the needle in caudal space

as an absence of increase in Mean Arterial Pressure or Heart Rate of more than 15% as measured 5 minutes after skin incision (compared to baseline value just before skin incision). In case of failure of block, 0.5 mcg/kg Fentanyl was administered as and when required intra-operatively. All patients received inj. Paracetamol 10 mg/kg intravenous infusion intra-operatively irrespective of the technique used for caudal block.

After the surgery, the patients were adequately reversed (inj. Neostigmine 0.05 mg/kg and inj. Glycopyrrolate 0.2 mg for every 1 mg of Neostigmine), extubated and shifted to post-anaesthesia care unit for monitoring and observation. The post-operative pain assessment was done using FLACC (Face, Leg, Activity, Cry, Console) scale by the PACU staff, at regular intervals, who were given a copy of the pain assessment chart and were briefed about the procedure. Patients who had a score of 4 or more were given rescue analgesia with inj. Tramadol 1 mg/kg with Ondansetron 100 mcg/kg i/v.

2.1. Statistical analysis

The data was collected and recorded in a tabular form. The continuous data was expressed as (Mean ± Standard Deviation) and categorical data was represented as absolute numbers and percentages. For continuous data, the Kolmogorov–Smirnov test was performed to assess normality and where appropriate the data was analysed with required statistical tests and descriptive statistics. Parametric data was analysed with student's t-test/ independent t-test; alternatively, non-parametric data was analysed using Wilcoxon Signed Rank Test/ Mann-Whitney U test. The test criterion for statistical significance is being considered by the researcher which is generally less than 0.05 ($p<0.05$) but sometime for increased precision is considered less than 0.01 ($p<0.01$). Nominal Categorical data between the groups was compared using Chi-square test or Fisher's exact test as appropriate and Pearson

Correlation Coefficient for Normal data & Spearman Correlation Coefficient for Non-Normal data to observe the extent of relationship between the variables. All major data analysis packages as well as spreadsheets, such as Microsoft Excel and SPSS v 21.0.0 has been used as per requirement. For all statistical tests, the p-value < 0.05 indicates the valid evidence for statistical significance of the data.

3. Results

A total of 68 participants were included in the study. The median age, mean weight, gender, ASA class and surgical duration were comparable in the two groups and statistically insignificant (p >0.05). (Table 1)

The mean time taken to perform the block was 11 ± 8.75 minutes. The median (I.Q.R) block performing time in Group C was 6.5(4.25) minutes and 15(6) minutes in Group U, p value <0.001 (Mann-Whitney test).

The number of punctures required to perform the caudal block were also compared in the two groups (Table 2). The block success rate was comparable between the two groups, p=1. The number of needle punctures required to enter the caudal canal was also comparable and not statistically significant (p=0.389). The success rate at first puncture was also comparable in the two groups (p=1).

The haemodynamic parameters of the patients were studied at regular intervals and comparable between the two groups.

The post-operative pain assessment was done using FLACC score. Majority of patients had mild discomfort in both study groups (47% v/s 58%) at 1^{st} hour post-operatively. At 6^{th} hour, maximum patients were relaxed and comfortable (52% v/s 64%). At 12^{th} and 24^{th} hour also, majority of patients were relaxed and comfortable and the results were comparable between the two groups. The requirement of rescue analgesia was studied between the two groups and it was observed that 49% patients in group C and 51% patients in group U did not require rescue analgesia, however, it was not statistically significant (p=1) (Table 4). The incidence of complications associated with caudal block were compared between the two groups (Table 5).

4. Discussion

Caudal block has been safely used in providing post-operative analgesia in children since many years. The Paediatric Regional Anaesthesia Network (PRAN) has published data on over 1,00,000 paediatric regional blocks and reported high success rates with very few complications. As per the recent data, only 3% blocks are associated with complications.[11] Single shot caudal block via identification of the sacral hiatus remains the most common and preferred technique in providing intra-operative and post-operative analgesia for infraumbilical surgeries in paediatric patients.[12]

Traditional practice to perform the block based on landmarks has been challenged with the advent of newer techniques such as ultrasound and fluoroscopy. It has been observed that the conventional landmark-based technique is associated with 10-20% failure rates.[13] Ultrasonography has been described in literature as an important tool to guide central neuraxial and peripheral nerve blocks. Some of the advantages of ultrasound guided technique are real-time visualization of the needle, avoidance of important structures such as vessels while administering the drug and appreciation of the local anaesthetic spread.[14] It can also identify and locate the sacral hiatus to guide needle placement accurately in the sacral/caudal canal especially in cases where anatomical variations in the sacrum and hiatus makes conventional technique difficult.[15]

We studied the conventional landmark-based technique of single shot caudal epidural block with the ultrasound-guided technique and compared the two in terms of intra-operative hemodynamic parameters and post-operative pain.

The median age of the patients in our study was 2 years. Among the two groups, the median age of the patients in Group C was 2 (3.26) years and 2.25 (3) years in Group U. Since calculated p-value was 0.95, the two groups were not significantly different and comparability is observed. The mean weight of the patients in the study was 12.2 ± 5.5 kgs with the maximum weight being 22 kgs and minimum being 2.7 kgs. The mean weight of the patients in Group C was 11.9 ± 5.8 kgs, whereas it was 12.36 ± 5.3 kgs in Group U. The p-value was 0.76. In our study, 61 patients (89.7%) were male and 7 patients (10.3%) were female. The number of males in Group C were 30 (49.2%) and 31 in Group U (50.8%). The number of females in Group C were 4 (57.1%) and 3 (42.9%) in Group U.

In our study, 54.4% patients underwent inguinal hernia repair, 14.7% underwent orchidopexy, 11.8% underwent hypospadias correction, 7.3% underwent circumcision. The mean ± S.D operative time in our study was 1 ± 0.5 hours and the mean time taken to perform the caudal block was 11 ± 8.75 minutes.

The median (I.Q.R) block performing time in Group C was 6.5(4.25) minutes and 15(6) minutes in Group U. Using Mann-Whitney test, the p-value was <0.001 which was statistically significant. This was opposed to the study done by Ahiskalioglu et al,[7] in which the mean block performing time was 103.1 ± 45.1 seconds by conventional technique and 109.9 ± 49.7 seconds by ultrasound guided technique, accounting for a p-value of 0.463. The statistically significant time difference in performing the block by the two techniques was also not observed in the study done by Karaca et al[9] (p-value 0.705). However, Kollipara et al[16] demonstrated that the mean block performing time was 30.34 ± 7.34 seconds by conventional technique and 53.19 ± 10.97 seconds via

Table 1: Demographics of study participants

Variable	Group C (n=34)	Group U (n=34)	P value	Test
Age (years)	2 (3.26)[a]	2.25(3)	0.95	Mann-Whitney
Weight (kg)	11.9 ± 5.8[b]	12.36 ± 5.3	0.76	Independent t-test
Gender (M/F)	49.2%, 57.1%	50.8%, 42.9%	1	Fisher's exact
ASA class (I/II)	91.1%, 8.8%	100%,0%	0.23	Fisher's exact
Duration of surgery (hrs)	1 (0.63)	1 (0.5)	0.80	Mann-Whitney

a – Values represented as median (I.Q.R)
b – Values represented as mean ± standard deviation

Table 2: Number of needle punctures required to perform block in each group

Punctures	Group C %	Group U %	p-value	Test
1	52.9	47.1		
2	42.9	57.1	0.66	Fisher's exact
3	33.3	66.7		

Table 3: Comparative analysis of caudal block between the two groups

	Group C	Group U	p-value	Test
Block performing time	6.5(4.25)	15(6)	<0.001	Mann-Whitney
Block success rate	88.2%	88.2%	1	chi-square
Number of needle punctures	1(0)	1(1)	0.389	Mann-Whitney
Success at first puncture	52.2%	47.8%	1	chi-square

Table 4: Comparison of rescue analgesia between study groups

Rescue Analgesia	Group C %	Group U %	p- value	Test
Yes	52.9	47.1	1	Chi-square
No	49	51		

Table 5: Complications associated with caudal block between the study groups

Complications	Group C Frequency (%)	Group U Frequency (%)	p-value	Test
Dural puncture	3 (75)	1 (25)	0.61	Fisher's Exact
Intravascular puncture	1 (50)	1 (50)	1	
Soft tissue bulge	1 (100)	0	1	
Local Anaesthetic Systemic Toxicity	0	0	-	

ultrasound-guided technique, accounting for a p-value of 0.0005 which is statistically significant. Nanjundaswamy et al[17] also reported similar results wherein the block performing time was significantly higher by ultrasound guided technique (p-value 0.003).

The block was performed in a single puncture in 75% patients, two punctures in 20.6% patients, three punctures in 4.4% patients. Among the two groups, the block was performed in a single puncture in 52.9% patients in group C and 47.1% patients in group U. Two punctures were required in 42.9% in group C and 57.1% patients in group U. Three punctures were required in 33.3% patients in group C and 66.7% patients in group U. The p-value was 0.664 which was not statistically significant.

In a study conducted by Ahiskalioglu et al[7] the mean ± S.D punctures required to perform caudal block were 1.4 ± 0.7 via conventional technique and 1.32 ± 0.7 via ultrasound-guided technique, with a p-value of 0.060. Another study conducted by Karaca et al[9] observed that the block was achieved in a single puncture in 98 (73.7%) patients via conventional technique and 130 (97.7%) patients using ultrasound-guided technique, the p-value being <0.001. Erbuyun et al[3] also compared the number of needle punctures and observed that 1.06 ± 0.25 punctures were required in ultrasound-guided group as compared to 1.10 ± 0.3 punctures in landmark based technique, the p-value being 0.579. A study was conducted comparing the conventional technique of caudal block with the ultrasound guided technique by Kollipara et al[16] and they observed

that the number of punctures were significantly less in ultrasound guided group (1.09 ± 0.295) as compared to conventional group (1.45 ± 0.667), p-value being 0.01.

In our study, 88.2% patients had a successful caudal block. The block success rate was equal in each of the groups. The success rate at first puncture was 52.2% in Group C and 47.8% in Group U. Since the p-value was 1, it was statistically insignificant. Karaca et al[9] observed that the success rate of block was comparable between the two groups (94.7% in Group C vs 96.2% in Group U, $p > 0.05$) and success at first puncture was higher in group U (90.2 vs 66.2%, $p < 0.001$). Ahiskalioglu et al[7] discerned that the first puncture success rate was higher in Group U as compared to Group C (80% vs 63%, respectively $p = 0.026$) but the block success rates were similar in both the groups (97% vs 93%, respectively $p > 0.05$).

The non-invasive Blood pressure and Heart rate were compared in both the groups at regular intervals before and after giving the caudal block and the values were comparable in both the groups. Adler et al[18] studied the efficacy of ultrasonography in caudal blocks in 98 patients and observed that in 94 patients, there was no change in heart rate with incision. Similar results were obtained in a study conducted by Nanjundaswamy et al[17] in which there was a significant reduction in heart rate from the baseline value (p-value <0.001) in both the groups but the reduction in MAP was more in landmark-based group as compared to the ultrasound-guided group (15.2% vs 13.7%).

The post-procedural pain was compared between the two groups based on FLACC scale at regular intervals and it was observed that the majority of patients, in both the groups, were relaxed and comfortable (62.5% in Group C vs 37.5% in Group U). At 6^{th} hour post-operatively, 45% patients in Group C and 55% patients in Group U were relaxed and comfortable. However, 57.1% patients in Group C and 42.9% patients in Group U had mild discomfort. At 12^{th} hour, 50% patients in both the groups were relaxed and comfortable and the rest had mild discomfort. Patients who had pain score above 4 were given rescue analgesia and it was observed that the requirement was similar in Group U as well as Group C (51% vs 49%). Wong-Baker FACES pain rating scale as a tool to assess the post-operative pain was incorporated by Erbuyun et al[3] and was conducted till 6 hours post-operatively. They observed statistically significant reduced pain levels at 90^{th} minute in ultrasound guided group but the requirement of rescue analgesia remained the same in both the groups.

We observed that 5.9% of the study population had dural puncture while administering the block, 2.9% had intravascular puncture and 1.5% had soft tissue bulging. There were no cases of local anaesthetic systemic toxicity. Among the two groups, the occurrence of accidental dural puncture was more in Group C (75% vs 25%, p-value 0.61) but it was statistically insignificant. Incidence of intravascular puncture was equal in both the groups and soft tissue bulge was only seen in conventional group. Ahiskaligo et al[7] observed and concluded that the majority of complications occurred in conventional group viz. dural puncture (p-value 0.014) and subcutaneous bulging (p-value 0.031). In their study, there were no cases of intravascular puncture and LAST. Similar results were obtained in a study conducted by Wang et al[19] as there was a higher incidence of intravascular puncture in conventional group (18.6% vs 5.7%), soft tissue bulge was observed in 7.1% patients in conventional group but none in ultrasound guided group. Karaca et al[9] also compared the complications in both the groups and deciphered that the intravascular puncture occurred in 10.5% patients in conventional group (p-value <0.001) but none in ultrasound-guided group. Similarly, 7.5% patients in the conventional group had subcutaneous bulge. Accidental dural puncture and LAST were not reported in any of the two groups. Nanjundaswamy et al[17] observed bloody tap in 23.8% patients in conventional technique group as compared to 3% in ultrasound-guided group. 15.2% patients in the conventional technique group had soft tissue bulge, 1.5% each had dural puncture and rectal perforation. None of these complications were observed in ultrasound-guided group.

5. Conclusion

Caudal block is one of the most widely practiced regional anaesthesia technique in paediatric population. The conventional landmark-based technique is easier and less time consuming as compared to the ultrasound-guided technique, which is newer and the practitioner needs expertise. The quality of analgesia provided by both the techniques is comparable. The frequency of complications associated with the block are fewer with the ultrasound-guided approach. Ultrasonography is the modality of choice specially in cases where detection of sacral anatomy and landmarks is difficult. However, further studies are needed to establish the role of ultrasonography in performing caudal block.

6. Strengths and Limitations

The strength of our study is that it is a prospective randomized comparative study with well-defined criterion for inclusion and exclusion of patients undergoing the aforementioned procedure. The local anaesthetic used was common to both the techniques of caudal block (0.2% Ropivacaine). The post-operative pain assessment was blinded as it was performed by the post-anaesthesia care unit staff. However, there are certain limitations of our study. First, we did not perform the Whoosh and Swoosh tests while administering caudal block via conventional approach. Second, we used the in-plane technique to inject the local anaesthetic via ultrasound-guided approach.

Further studies are needed to compare the efficacy of in-plane v/s out-of-plane technique. Third, the intravascular injection of drug can be better avoided via Ultrasound-guided approach with the help of doppler, hence doppler USG is a better option in conjunction with ultrasound guided technique.

7. Source of Funding

None.

8. Conflict of Interest

None.

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