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Caudal Block Versus Ultrasound-Guided Transversus Abdominis Plane Block For Postoperative Analgesia In Children Undergoing Unilateral Inguinal Hernia Surgery: A Comparative Study.

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ABSTRACT

Among regional anaesthetic techniques, Single shot caudal epidural block is the oldest and the most widely used technique with the drawback of short postoperative analgesia. Transversus Abdominis Plane (TAP) block under ultrasound guidance has been reported in recent studies as an easy and safe alternative to caudal block with added advantage of longer postoperative analgesia. This study was undertaken to compare the efficacy of the Ultrasound- guided TAP block with the Caudal epidural block in providing intra-operative and post- operative pain relief in children undergoing inguinal herniotomy. Eighty children satisfying the inclusion criteria were included in the study. After obtaining informed consent from the parents/guardian of the patients, they were randomly allocated into two groups, Group T receiving USG-guided TAP Block with 0.5ml/kg of 0.25% bupivacaine and Group C receiving Caudal Epidural Block with 1ml/kg of 0.25% bupivacaine, with forty patients in each. The duration of post-operative analgesia with TAP block group (517 mins) was significantly longer than Caudal block group (258 mins) (p value<0.05). The TAP block group had significant reduction in pain scores at 3, 4 and 5 hours postoperatively in comparison to Caudal group. The pain scores were lower in TAP block group compared to Caudal group at all observational times up to 24 hours after surgery. The mean analgesic requirement in the first 24 post-operative hours was significantly higher in Caudal group(396.75mg) when compared to TAP block group(217.1mg) (p value<0.05). Ultrasound-guided TAP block provided prolonged post-operative pain relief than single shot Caudal epidural block and reduced the mean analgesic consumption in the first 24 post-operative hours after inguinal herniotomy in children of age 1-6 years. Caudal epidural block provided better intra-operative analgesia than USG guided TAP block for inguinal hernia repair.

Keywords: Ultrasound, Paediatric, Transversus abdominis plane block, postoperative analgesia, Caudal block.

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INTRODUCTION

A substantial percentage of peri-operative pain in paediatric population is undertreated due to the misconception that children do not feel pain. It is partly due the fact that developmental and cognitive differences in children pose a challenge in assessment of pain [1]. Local anaesthetics should be incorporated into the initial pain management strategy to provide children with the best perioperative pain relief. This is done by combining a regional anaesthetic technique, such as neuraxial blockade, peripheral nerve blockade, or local infiltration of the wound with general anaesthesia or sedation [2]. Among the regional techniques, Caudal block is the oldest and most used regional technique of anaesthesia [3]. The primary drawback of a single-shot Caudal block is that it can only provide short term relief from post-operative pain, necessitating the use of supplementary analgesics [4] Regional nerve blocks performed under ultrasound guidance are becoming increasingly popular because they are safer and have a lower incidence of adverse effects when compared to neuraxial blocks and landmark-guided blocks. Transversus Abdominis Plane block (TAP) block is an abdominal field block, which provides myocutaneous analgesia, by depositing local anaesthetic drug in the plane between the two muscles, namely Internal Oblique and Transversus Abdominis [5]. This study was undertaken to compare the efficacy of the Ultrasound- guided TAP block with the Caudal epidural block for intra-operative and post-operative pain relief. Since, Inguinal hernia repair is one of the most frequently performed paediatric surgical procedure [6], this study was conducted in children undergoing inguinal herniotomy.

MATERIALS AND METHOD

A prospective randomised comparative clinical study was conducted in eighty children of age group 1-6 years, undergoing unilateral inguinal herniotomy in Government medical college and hospital, Tiruvannamalai in the year between 2022-2023.We calculated that 33 patients per group would be required for an experimental design incorporating two equal-sized groups using confidence limit at 95%, prevalence 5% and margin of error 7.5%. Thus minimum 40 patients have to be selected in each group. Thus, eighty children satisfying the inclusion criteria were included in the study. After obtaining informed consent from the parents/guardian of the patients, they were randomly allocated into two groups, Group T(Receiving USG-guided TAP Block with 0.5ml/kg of 0.25% bupivacaine(n=40)) and Group C(Receiving Caudal Epidural Block with 1ml/kg of 0.25% bupivacaine(n= 40)), using simple randomization and closed envelope method according to computer generated table of random numbers. Children of age group 1-6 years, weighing 5- 20kg, of ASA status I – II who were undergoing unilateral inguinal herniotomy, were included in the study. Parent refusal for consent, children undergoing Bilateral Inguinal Herniotomy, children with known allergy to the drugs used in the study, local infection at the site of the block, children with contraindications for caudal anaesthesia such as major sacral malformations, those with meningitis, with raised intracranial hypertension were exclude from the study. All children were fasted 6 hours for milk and solids and 2 hours for clear liquids. All parents were explained about the anaesthetic technique and perioperative course during the pre- operative visit. Preanesthetic evaluation was done on the day prior to surgery. After shifting the patient to the operating room, patient age, I.P. No., body weight, and baseline vital parameters like heart rate, blood pressure, oxygen saturation and respiratory rate were recorded using standard monitoring. Intravenous access was secured with appropriate size intravenous canula. Children in both groups were premedicated with Inj. Glycopyrrolate 10mcg/Kg and Inj. Midazolam 5mcg/Kg intravenously 5minutes before induction. Jackson Rees modification of Ayre's T-piece was used for induction of anaesthesia. Anaesthesia was induced with Injection Ketamine 2mg/kg and maintained on spontaneous ventilation with 40% O2: 60% N2O mixture and sevoflurane 1.5-2%. The children in Group T received Ultrasound guided Transversus Abdominis Plane block with 0.5ml/kg of 0.25% isobaric bupivacaine. Children in Group C received caudal epidural block with 1ml/kg of 0.25% isobaric bupivacaine. After administration of block, baseline parameters such as pulse rate, systolic blood pressure, diastolic blood pressure, mean BP, oxygen saturation and electrocardiogram was recorded. Hemodynamic variability (Heart rate and mean arterial pressure) was noted every 5mins from time of block for 20mins and then every 10 mins till the end of surgery. At the time of skin incision, if there was 20% increase in baseline parameters, it was considered as failure of block and the case was excluded from the study. Intraoperatively, when there was 20% increase in heart rate and mean arterial pressure from the baseline, it was due to inadequate analgesia requiring supplementation. In such cases, we supplemented with 1mcg/kg of fentanyl intravenously and additional analgesic requirement was noted down. Any side effects or adverse events which occurred during the block procedure, intra-operative period and post-operative period were recorded. All children were assessed for pain using FLACC behavioural pain assessment score (Facial expression, Crying, Legs, Activity state and Consolability). and

their vitals were monitored during the immediate post-operative period in the recovery room, every hour for the first 6 hours, every two hours for the next 6 hours and at 24 hours after surgery. When the FLACC pain score >3, the children were given 15mg/kg of Paracetamol intravenously as rescue analgesia and total analgesic requirement in the first 24 hours was noted down.

Statistical Analysis

The data was initially entered into the customized proforma designed for the specific requirement of the study and then into Microsoft Excel for analysis. Statistical Software IBM SPSS Version 20.0.0.0 was used for calculating the P values. Descriptive statistics were presented in the form of numbers and percentages. Mean comparison between the two groups was done using Unpaired 't' test. Pearson chi-square and Fisher's Exact Test was used for non-parametric comparison between the two groups. The Mann-Whitney U test was used for comparing the median values of FLACC score between the two groups (as FLACC score failed the normality test). A p value of <0.05 was taken as statistically significant. The final data was presented in the form of tables and graphs.

RESULTS

Both groups were comparable demographically i.e., age, sex, weight, height, and ASA grading (Table 1-4). Mean duration of surgery (Table 5) in Caudal group was 32.25±4.229 minutes and TAP block group it was 33.50±5.335 minutes. The above association found to be statistically insignificant (p>0.05) which shows the mean duration of surgery in both groups is comparable. The mean pulse rate was calculated at base line, 0 min, 5 min, 10 min, 20 min, 30 min and 40 min in both the groups(Table 6). After analysis, it was found that patients belonging to TAP block group, the mean pulse rate was114.08±19.57 and 113.67±17.78 beats per minute and in the Caudal Group, the mean Pulse rate was 105.92±12.89 and 106.30±13.13 beats per minute between 10 and 15 minutes, respectively. The increased mean pulse rate in TAP block group compared to the Caudal Group is statistically significant as the p<0.05 test indicating a true difference among intervention groups. No significant changes in pulse rate from baseline value were seen between the two groups (p>0.05) in rest of the time periods. There is significant increase (10 min, 15 min and 20 min) in mean arterial pressure in TAP block group compared to caudal group during the intra-operative period (Table 7). Around 47.5% of patients belonging to TAP block group required intraoperative fentanyl supplementation, whereas only 2.5% in Caudal Group required intraoperative fentanyl supplementation (Table 8). The difference was found to be statistically significant (p <0.05). The mean duration of postoperative analgesia (Table 9) in Caudal group was 4.30 hours. In TAP block group mean duration of postoperative analgesia was 8.63 hours. The difference in postoperative analgesia between groups was statistically significant (p<0.0001). The immediate, 1st and 2nd hour of the postoperative period FLACC pain scores were similar in both the groups. During the 3rd, 4th, and 5th postoperative hours, pain scores were significantly higher in group C with caudal block than group T with TAP block. The overall mean FLACC pain scores at various time at various intervals were significantly lower in TAP Block Group (p<0.05(Table 10). The total analgesia consumed in first 24 hours in Caudal Group was 396.75±137.60 mg. In TAP Block Group mean total analgesia consumed in first 24 hours was 217.13±75.87 mg. The difference in total analgesia consumed between groups was statistically significant (p<0.001). The cumulative doses of rescue analgesia (Table 11) were significantly less in group T than group C. Even though fewer side effects were seen in TAP block group when compared to group C, the above association found to be statistically insignificant (p>0.05) which shows that side effects of both the groups are comparable (Table 12).

Table 1: Age distribution

Age Group (years)	Group				Total	
	Group C		Group T			
	No.	%	No.	%	No.	%
2 years	10	25.0%	8	20.0%	18	22.5%
3 years	6	15.0%	7	17.5%	13	16.3%
4 years	7	17.5%	7	17.5%	14	17.5%
5 years	10	25.0%	8	20.0%	18	22.5%
6 years	7	17.5%	10	25.0%	17	21.3%
Total	40	100.0%	40	100.0%	80	100.0%

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Mean± SD	3.95± 1.467	4.13± 1.488	4.04± 1.471

t value	-.530, df = 78
P value	.598, Not Significant

Unpaired 't' test applied.

Table 2: Sex distribution

Sex	Group				Total	
	Group C		Group T			
	No.	%	No.	%	No.	%
Male	34	85.0%	38	95.0%	72	90.0%
Female	6	15.0%	2	5.0%	8	10.0%
Total	40	100.0%	40	100.0%	80	100.0%

Pearson Chi-Square = 2.222, df = 1, p value = .136, Not significant

Table 3: Weight distribution

Groups	No.	Mean ± SD (kg)	't' value	P value
Group C	40	14.03 ±3.84	.800, df = 78	.426
Group T	40	13.40±3.10		

Unpaired 't' test applied. P value = 0.426, Not significant

Table 4: ASA grade distribution

ASA Grade	Group				Total	
	Group C		Group T			
	No.	%	No.	%	No.	%
Grade I	40	100.0%	40	100.0%	80	100.0%
Grade II	0	0.0%	0	0.0%	0	0.0%
Total	40	100.0%	40	100.0%	80	100.0%

Table 5: Comparison of mean duration of surgery between the groups

Duration of Surgery	Group				Total	
	Group C		Group T			
	No.	%	No.	%	No.	%
20 minutes	0	0.0%	1	2.5%	1	1.3%
30 minutes	31	77.5%	24	60.0%	55	68.8%
40 minutes	9	22.5%	15	37.5%	24	30.0%
Total	40	100.0%	40	100.0%	80	100.0%

Mean±SD	32.25±4.229	33.50±5.335	32.88±4.824
't' value	-1.161, df = 78		
P value	.249, Not Significant		

Unpaired 't' test applied.

Table 6: Intra-operative variations in pulse rate

Time interval	Group C Mean±SD	Group T Mean±SD	't' value	P value
Base line	106.95±12.69	103.85±13.38	1.063, df=78	.291
0 min	107.00±12.57	103.58±13.49	1.174, df=78	.244
5 min	106.43±13.06	105.58±14.35	.277, df=78	.783
10 min	105.92±12.89	114.08±19.57	-2.199, df=78	.031*
15 min	106.30±13.13	113.67±17.78	-2.110, df=78	.038*
20 min	106.50±13.27	108.78±15.39	-.708, df=78	.481

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30 min	104.53±12.67	105.77±13.15	-.428, df=77	.670
40 min	98.56±10.19	102.79±11.02	-.924, df=21	.366

Unpaired 't' test applied. P value <0.05 was taken as statistically significant

Table 7: Intra-operative variations in Mean Arterial Pressure

Time interval	Group C Mean ± SD	Group T Mean ± SD	't' value	P value
Base Line	68.2±3.45	69.60±3.48	-1.807, df=78	.075
0 min	68.35±3.44	69.78±3.29	-1.893, df=78	.062
5 min	68.58±30	69.70±2.64	-1.463, df=78	.148
10 min	68.48±3.31	73.50±5.64	-4.857, df=78	.000*
15 min	68.53±3.64	73.33±5.09	-4.849, df=78	.000*
20 min	68.15±2.81	72.95±5.49	-4.926, df=78	.000*
30 min	68.15±3.24	72.21±4.29	-4.752, df=77	.000*
40 min	69.33±3.67	71.86±4.82	-1.337, df=21	.195

Unpaired 't' test applied. P value <0.05 was taken as statistically significant

Table 8: Intra operative Fentanyl requirement

Characteristics	Group C		Group T		P value
	No.	%	No.	%	
Intra operative Fentanyl requirements	1	2.5%	19	47.5%	P<0.0001

Pearson Chi-Square = 21.600, df =1, p <0 .0001, Significant

Table 9: Mean duration of postoperative analgesia

Groups	Mean ± SD (hours)	Mean differences	't' value	P value
Group C	4.30±1.18	4.325	-11.419, df=78	0.000*
Group T	8.63±2.08			

Unpaired 't' test applied. P < 0.0001, Significant

Table 10: Comparison of postoperative mean FLACC pain score

Duration	Group C	Group T	'U' value	P Value
	Mean±SD	Mean±SD		
0 hour	.00±.00	.00±.00	800	-
1 hour	.13±.40	.03±.15	739.5	.149
2 hours	.45±.87	.05±.22	615	.006*
3 hours	1.62±1.83	.20±.56	355.5	.000*
4 hours	2.15±1.23	.60±.84	214.5	.000*
5 hours	2.30±1.50	1.38±1.03	548	.002*
6 hours	2.25±1.19	1.43±1.13	733	.002*
8 hours	2.42±1.17	2.15±.94	722.5	.253
10 hours	2.13±1.32	1.55±1.35	753.5	.059
12 hours	1.70±1.60	1.25±1.42	765.5	.189
24 hours	.10±.30	.08±.26	780	.697

Mann-Whitney U test applied. P value <0.05 was taken as statistically significant

Table 11: Cumulative dose of rescue analgesia between the groups

Groups	Group C	Group T	't' value	P value
Cumulative dose of rescue analgesia	396.75±137.60	217.13±75.87	7.230, df=78	0.000*

Unpaired 't' test applied. P < 0.0001, Significant

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Table 12: Comparison of Side effect between the groups

Side effects	Group				Total	
	Group C		Group T			
	No.	%	No.	%	No.	%
PONV	8	20.0%	3	7.5%	11	13.8%
No side effects	32	80.0%	37	92.5%	69	86.3%
Total	40	100.0%	40	100.0%	80	100.0%

Pearson Chi-Square = 2.635, df = 1, p value = 0.105, Not Significant

DISCUSSION

Optimal treatment of perioperative pain usually multimodal. The administration of sole regional anaesthetic technique to a moving, agitated child is both unethical and unsafe. Hence, even in procedures that can be performed under regional anaesthesia, a sedation or general anaesthesia is usually given for the child to comply with administration of regional anaesthesia.In our study, we induced the patient with injection ketamine 2 mg/kg and was kept on spontaneous ventilation using Jackson Rees modification of Ayer's T-piece with 40% O2: 60% N2O mixture and sevoflurane 1.5-2%.Depending upon the group, a regional anaesthetic technique, either caudal block or TAP block, was given to provide analgesia during the procedure. The adequacy of regional anaesthesia in providing analgesia can only be assessed indirectly using the changes in hemodynamic parameters and also the requirement of supplementary analgesics during the procedure. According to our study, 47.5% of patients in Group T (TAP block) needed supplementation with fentanyl in the intraoperative period, as compared to 2.5% of patients in Group C (Caudal block). This is due to the fact that caudal block is a neuraxial blockade that completely blocks sensory, motor, and autonomic innervation up to the level of blockade. Hence there is complete analgesia in Caudal block, whereas TAP block anaesthetises only the nerves supplying the parietal peritoneum, skin, and muscles of anterior abdominal wall. Thus, visceral peritoneal manipulation and cord traction can trigger a stress response in Group T (TAP block) patients, increasing their heart rate and mean arterial pressure requiring analgesic supplementation. In children undergoing urogenital surgeries, Ray et al., studied caudal block with bupivacaine and ropivacaine administered pre-operatively. During the intraoperative time, he demonstrated no changes in haemodynamic parameter, and neither group needed any supplements. In contrast, 2.5% of the patients in Group C of our study required analgesic supplementation. Since the onset time was not observed in either of the block techniques in our study, the delayed onset of Caudal block might be the responsible for the requirement of analgesic supplementation in patients in Group C. A study by Fredrickson et al., on TAP block for inguinal herniotomy in eight paediatric patients showed that 5 of the 8 children did not need any intra-operative analgesic supplementation [7]. He ascribed the need for intraoperative analgesic supplementation in the remaining 3 patients to the pain experienced during spermatic cord manipulation. Unlike Fredrickson's trial, where only 3/8 patients needed analgesic supplementation, in our study 19/40 patients in the TAP block group required supplementation. The limited sample size utilised in his study may be to contribute for the inconsistency between the studies. The duration of post-operative analgesia with TAP block was found to be significantly longer than caudal block. Studies employing caudal block have shown a 4–6hour post-operative analgesia. In our study, mean post-operative analgesia with caudal block lasted an average of4.3 hours (258 minutes). A double-blind trial carried out by Ivani et al [8] with 40 patients between the ages of 1 and 9 documented a 253-minute post-operative analgesic duration after a single caudal injection of 0.25% bupivacaine, which is comparable with the results of our study.In our study, the time to first rescue analgesia in TAP block group was 517 minutes. Compared to the caudal group, it was found that the TAP group's post-operative pain relief lasted longer. Due to the high vascularity of the caudal space, local anaesthetics are more quickly cleared in caudal block because they are absorbed into the systemic circulation more readily. Compared to other fascial planes, the transversus abdominis plane is relatively avascular. In contrast to the drug volume injected in TAP block, which distributes in a limited fascial plane between two muscles, local anaesthetic drug volume deposited in the caudal space must spread across a larger area to accomplish the required degree of blockade. El Fawy et al., [9] compared Caudal block with USG-guided TAP block for the relief of post- operative pain in open pyeloplasty. His study showed that patients with TAP block had a considerably longer duration to first rescue analgesia, 602 minutes as opposed to 280 minutes in caudal block which is comparable to our study (TAP 517 minutes vs Caudal 258 minutes). Tobias Et al., [10] studied the efficacy of TAP block for lower abdominal surgery in 10 paediatric patients between the age group of 10 months and 8 years, and found that 80% had satisfactory

post-operative analgesia, lasting 7 to 11 hours on average. These findings are in line with those of our study, which found that the average duration of analgesia was 8.6 hours. During the first two hours after surgery, the pain scores in the two groups were comparable. This demonstrates that both caudal block and TAP block are equally effective in reducing pain in the early post-operative period. The Caudal group had considerably greater pain levels after 3-5 hours, necessitating the administration of rescue analgesics. At 3, 4 and 5 hours after surgery in our study, pain scores in Group T with TAP block were lower than those in Group C with Caudal block. FLACC scores were lower in the TAP block group compared to the caudal block group at all observational time points up to 24 hours after surgery. El Fawy et al., [9] who compared USG-guided TAP block with Caudal block for post-operative pain relief in open pyeloplasty, observed that FLACC pain scores were significantly less in TAP block than Caudal block at 2,4,6,8,10,12,24 hrs post-operatively, consistent with the results of our study. Similarly, 40 children undergoing open appendicectomy were included in the study conducted by Carney et al [11]. They were divided into two groups of 20 each, in which one group received TAP block and the other was given placebo. They observed that there was significant reduction in postoperative pain scores at all times in the TAP block group, which was similar to our study results. Over the first 24 post-operative hours, similar to our study, Sahin L et al [12]. found that children receiving ultrasound guided TAP block had lower CHEOPS pain levels when compared to those receiving wound infiltration. The cumulative doses of paracetamol given intravenously as a rescue analgesic was substantially higher in Caudal block patients, who consumed an average of 396.75mg of Paracetamol as opposed to 217.1mg in TAP block group. Since the time to first rescue analgesic was longer in TAP block, children in Group T required lesser number of doses of rescue analgesia. In their study on TAP block vs. placebo in open appendicectomy, Carney et al [11] observed that TAP block was superior to placebo in the first 48 post-operative hours as a part of multimodal analgesia. They observed that TAP block reduced mean morphine requirement in the first 48 hours postoperatively.

CONCLUSION

The observations and results of this study infers that Ultrasound-guided TAP block provided prolonged post-operative pain relief than single shot Caudal epidural block and reduced the mean analgesic consumption in the first 24 post-operative hours after inguinal herniotomy in children of age 1-6 years. Caudal epidural block provided better intra-operative analgesia than USG guided TAP block for inguinal hernia repair.

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