Original Research Article

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Comparison of Ultrasound Guided Transversus Abdominis Plane Block and Caudal Epidural Block for Pain Relief in Children Undergoing Unilateral Inguinal Herniotomy

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Abstract

Context: Transversusabdominis plane block (TAP) has emerged as a simple, safe technique for post-operative analgesia in lower abdominal surgeries for adults. Its superiority over the most preferred caudal block in paediatric surgeries is unclear. *Aims:* To evaluate the efficacy of the Ultrasound (USG) guided -TAP block in comparison with the Caudal Block, for pain relief in paediatricinguinal herniotomies. *Settings and Design:* After obtaining institutional ethical committee approval, a Randomised Control Trial was conducted in 60 children,undergoing elective unilateral inguinal herniotomy in our tertiary care hospital. *Methods and Material:* Childrenof age 1-7years, weighing 5-20kg of ASA I/II were randomly allocated into two groups after obtaining parental consent.Group T received USG-guided TAP block (0.5ml/kg of 0.25% bupivacaine) and Group C received Caudal block (1ml/kg of 0.25% bupivacaine). The intra-operative hemodynamics and analgesic requirement were recorded. Pain in the post-operative period was assessed using FLACC pain score. Time to first rescue analgesia, cumulative opioid consumption, along with the incidence of side effects were noted in the first 12hrs of the post-operative period. Statistical analysis was performed using SPSSv16. *Results:* The duration of postoperative analgesia in Group T (8.6hrs±1.84), was significantly more than that of Group C, (4.57hrs±1.406). The pain scores and the mean opioid consumption were significantly less with Group T. Time to urine voiding was prolonged in Group C. *Conclusions:* ThoughCaudal block provided better intra-operative analgesia, the duration of post-operative analgesia was longer with USG-guided TAP block for pediatric inguinal herniotomy.

Keywords: USG Guided; Transversusabdominis; Paediatric; Pain; Haemodynamics; Post-Operative Analgesia; Opioid Consumption.

Introduction

Perioperative pain in paediatric population is undertreated in a substantial percentage, due to myths that children do not feel pain. The developmental and cognitive differences in children also pose difficulty in assessment of their pain [1].

In reality, children tend to have more physical and emotional reactions to pain than adults, requiringoptimal pain relief to prevent acute and long term adverse effects [2]. Transversus Abdominis Plane (TAP) block,is effective in reducing post-operative pain scores and morphine consumption in adults [3,4]. This study was conducted to compare the efficacy of the USG-guided TAP block with the widely used Caudal block [5,6] for post-operative pain relief in pediatric population undergoing inguinal herniotomy.

Materials and Methods

After obtaining the Institutional Ethical Committee approval, a Randomised Control Trial was conducted in 60 children, undergoing elective

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unilateral Inguinal Herniotomy in our tertiary care hospital during the period December 2015 – January 2017. Children belonging to age group 1-7 yrs, weighing 5-20kg, of ASA status I – II to undergo unilateral Inguinal Herniotomy, 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 and Group C, with 30 patients in each, using computer generated random numbers. Children in 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.

Children undergoing bilateral Inguinal Herniotomy, belonging to ASA status III, IV, of age < 1yrs or >7yrs, weighing <5 kg or >20kg with known allergy to the drugs used in the study or any local infection at the site of the block administration or with any contraindications for caudal anaesthesia such as major sacral malformations, meningitis, raised intracranial hypertension and parent refusal are excluded from the study.

Children were fasted for 8hrs for milkand solids, and 2hrs for clear liquids [7]. Children in both the groups were sedated with oral midazolam syrup, 0.5mg/kg 30 minutes before the surgery and were shifted to the operating room [7]. Baseline vital signs were recorded following application of standard monitoring (ECG, HR, NIBP, SpO2). An intravenous access was secured using a 22 gauge IV cannula and children were premedicated with glycopyrrolate 8mcg/kg given intravenously 5 min before induction. Jackson Rees modification of Ayre's T-piece was used for General anaesthesia. Fentanyl 1mcg/kg was given intravenously during preoxygenation with 100% oxygen for 3mins with an appropriate sized face mask. GAwas induced with propofol 2mg/kg and muscle paralysis was achieved using succinylcholine 1.5mg/kg. An Ambu LMA of appropriate size was inserted and the child was allowed to breathe spontaneously. Anaesthesia was maintained with 50% N_2O: 50% O_2 and 2% Sevoflurane.MAC was not monitored in our study. A MAC of 2% was used based on the results of studies which have shown that MAC of sevoflurane with nitrous oxide in children of age1-3yrs and 5-12yrs was around 2.0±0.2% [8].

In children belonging to Group T, USG-guided TAP block was given. After insertion of the LMA, with the child in the supine position, a high frequency (6-13Hz) linear probe, connected to Sonoray Ultrasound machine was used to scan the anterior abdominal wall, under strict aseptic precautions. The probe was first placed transversely at the level of the umbilicus and adjustments were made to obtain good images of the Rectus abdominis muscle. The probe was then slid laterally, towards the posterolateral part of the abdominal wall to lie between the iliac crest and subcostal margin, across the midaxillary line. It was then adjusted to obtain a clear view of the abdominal wall muscles, from superficial to deep, namely External Oblique, Internal Oblique and Transversusabdominis muscle and the peritoneal cavity deeper to it (Picture 1).

A 5cm 23 gauge block needle with side port, was introduced anteriorly under aseptic precautions, in plane to the ultrasound probe, until the tip of the needle lay in the plane between the Internal Oblique & Transversus Abdominis muscles [9,10]. One ml of 0.9% saline was injected in the plane, to confirm the correct placement of the needle. Following negative aspiration for blood, 0.5ml/kg of 0.25% bupivacaine was injected in the Transversus Abdominis Plane, which was seen as a dark hypoechoic shadow between the two muscles, pushing the internal oblique anteriorly and Transversus abdominis muscle deeper. USG- guided TAP block was given by a senior anaesthesiologist with minimum experience of 20 cases with ultrasound guided TAP block.

Children belonging to Group C, were placed in left lateral position with knees drawn up to chest. After skin preparation with betadine solution, the sacral hiatus was identified by palpating the sacral cornua with the index finger of the non-dominant hand.

A 23gauge needle was inserted at 45-60 degrees to the skin over the sacral hiatus. After piercing thesacrococcygeal membrane which was felt as a distinct pop, the needle angle was dropped to 20 to 40 degrees from the skin and advanced about 2-4mm into the caudal space [11]. The position of the needle in the caudal space was confirmed by the "whoosh test" by injecting saline. After careful negative aspiration for blood or CSF, 1ml/kg of 0.25% bupivacaine was injected into the caudal space. Caudal block was given by an experienced anaesthesiologist.

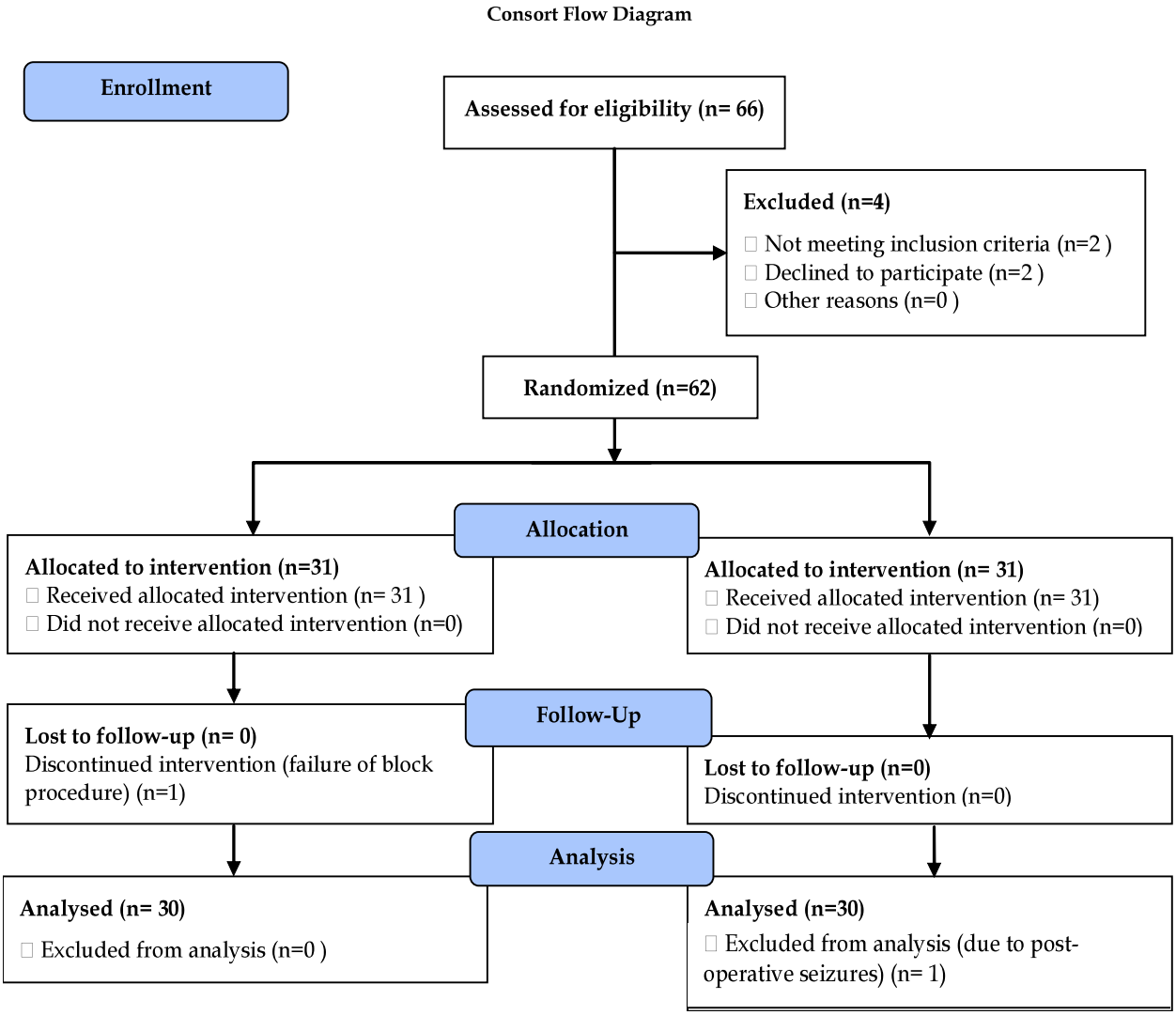
Surgical procedure was started 15mins after the administration of the block. An investigator who was unaware of the block given, was made to record HR, NIBP and SpO2, every 5mins from the beginning of the surgical procedure until the removal of the LMA. A 20% increase in heart rate or mean arterial pressure despite administration of 2% sevoflurane intraoperatively, was considered as inadequate analgesia and was treated

by supplementation with fentanyl at a dose of 1mcg/kg.

Any adverse events which occured during the block procedure, intra-operative period and after LMA removal were recorded. All children were assessed for pain using FLACC behavioural pain assessment score (Facial expression, Legs, Activity state, Crying and Consolability) [12] and their vitals were monitored during the immediate post-operative period in the recovery room, then every

Flacc Behavioural Pain Assessment Score

Criteria	Score 0	Score 1	Score 2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, uninterested	Frequent to constant quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking ,or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting, back and forth, tense	Arched, rigid or jerking
Cry	No cry (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or being talked to, distractible	Difficult to console or comfort



hour for the first 6 hrs and every two hourly for the next 6hrs, after surgery.

Interpreting the Behavioural Score

Each category is scored on the 0–2 scale, which results in a total score of 0–10.

- Score of 0 = Relaxed and comfortable
- Score 1–3 = Mild discomfort
- Score 4–6 = Moderate pain
- Score 7–10 = Severe discomfort or pain or both

When the FLACC pain score >3, the children are given 1.5mg/kg of tramadol intravenously as rescue analgesia. Post-operative analgesia was defined as the duration of analgesia from the immediate post-op period to the time at which the first rescue analgesic was required. Children who required rescue analgesia during the immediate post-operative period were excluded from the study, implying failure of the block procedure.

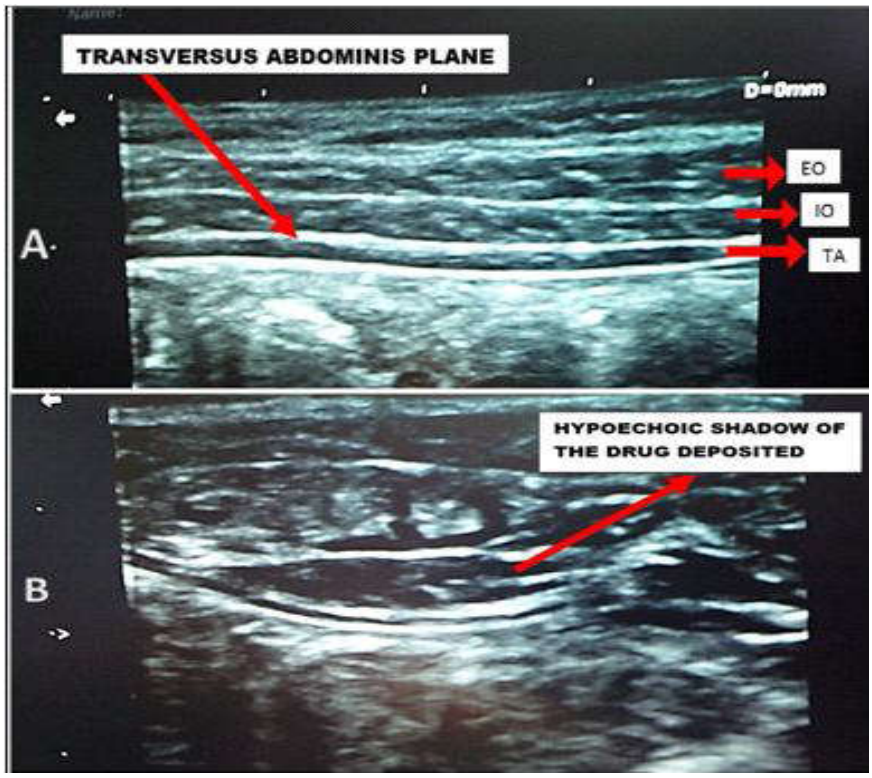
A pilot study was conducted in the study centre.Based on the results of the pilot study, a sample size of sixty patients were required, to set alpha at 0.05 and power at 80%.A sample size of 66 was decided considering, a dropout rate of 10%.

Data were entered in Microsoft excel Ver. 14.0.2010. Jones, Chicago and analysed by using SPSS Inc. Released 2007. SPSS for Windows, Version 16.0. Chicago, SPSS Incand StataCorp. 2003. Stata Statistical Software: Release 8. College Station, TX: Stata Corp LP. Baseline data comparison was done between the group T and Group C using appropriate test. Repeated measures of ANOVA was done to find out the difference in Heart rate and mean arterial pressure in various time period among both the groups.

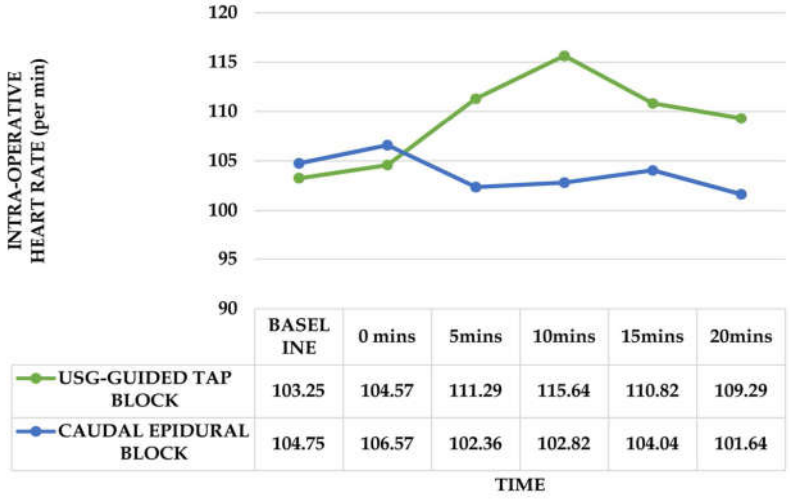
The Post-operative analgesia duration was compared between both the groups by using Student t Test. Similarly, Friedman test was done to find the difference in pain score among the group T and Group C in various time periods.

Results

Among the 62 patients who were included in the study, one patient was excluded from follow-up due to failure of block procedure. Analysis was performed in 60 patients, excluding the one patient who developed febrile seizure during the 2nd post-operative hour. As seen in Table 1, demographic variables such as Age, Sex, Weight and Height were comparable in both the groups. Heart rate (Figure1) and mean arterial pressure vary significantly from baseline during the intraoperative period in Group T with USG-guided TAP block, whereas it remains stable throughout the intra-operative period with

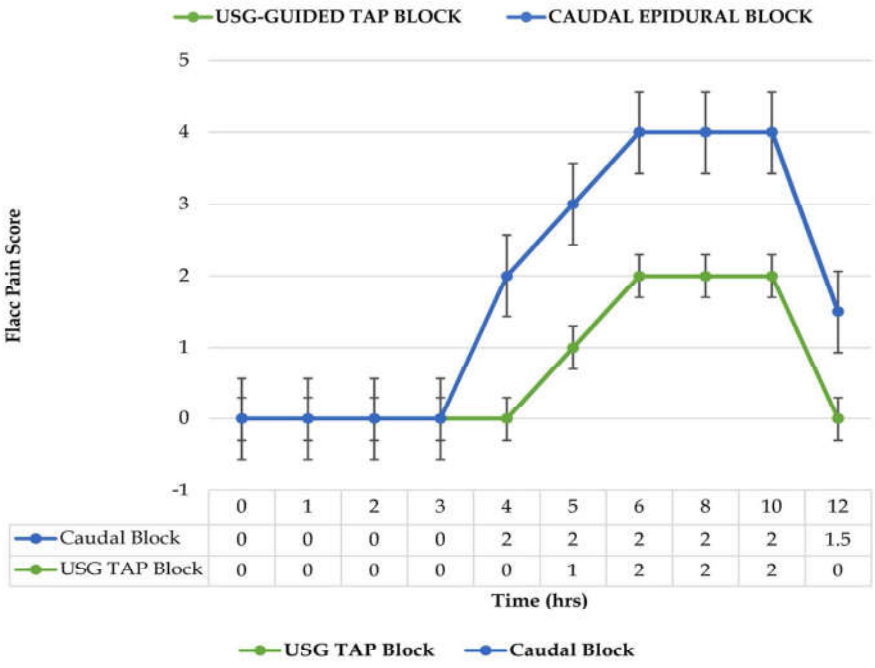


Picture: A. Ultrasound view of the three muscle layers in the abdominal wall (EO- External Oblique, IO – Internal Oblique, TA- TransversusAbdominis muscle)
B. Hypoechoic shadow seen separating the two layers of the TransversusAbdominis Plane after drug deposition



	BASELINE	0 mins	5mins	10mins	15mins	20mins
USG-GUIDED TAP BLOCK	103.25	104.57	111.29	115.64	110.82	109.29
CAUDAL EPIDURAL BLOCK	104.75	106.57	102.36	102.82	104.04	101.64

Fig. 1: Heart Rate Variability during Intra-Operative Period in Group T & Group C



	0	1	2	3	4	5	6	8	10	12
Caudal Block	0	0	0	0	2	2	2	2	2	1.5
USG TAP Block	0	0	0	0	0	1	2	2	2	0

Time (hrs)

Fig. 2: FLACC Pain Score (Median) in the post-operative period (0-12hrs) in Group T & Group C

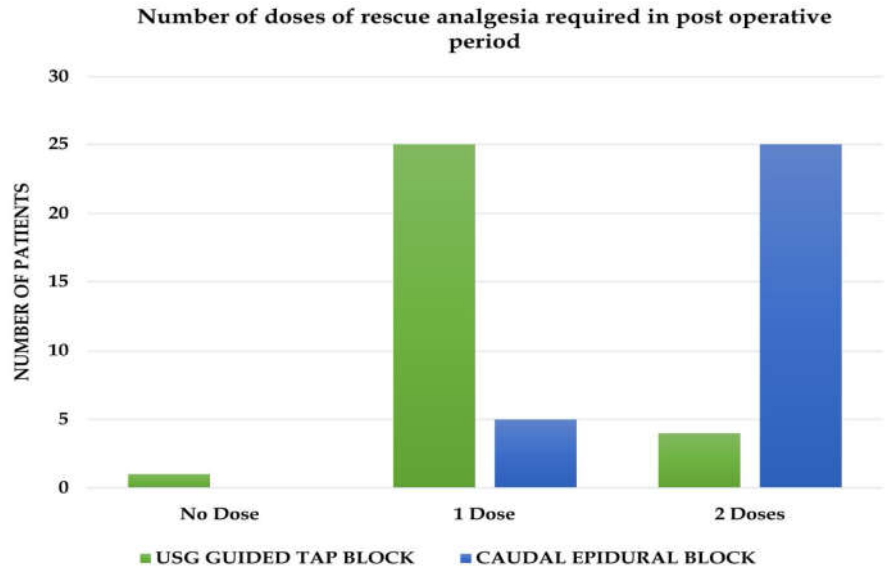


Fig. 3: Requirement of total number of doses of rescue analgesia in the first 12hrs of post-operative period in groups t & c

Table 1: Demographic variables

S. No	Characteristic	Group T	Group C	P value
1.	Age	4.40± 1.831	4.37± 1.650	0.941
2.	Sex- Male	27(90)	28(93.3)	0.640
3.	Weight	13.73± 3.667	13.40±4.090	0.741
4.	Height	110.83± 21.050	104.72± 20.365	0.257

Table 2: Duration of postoperative analgesia

S. No	Characteristic	USG guided TAP block	Caudal Epidural block	P value
1	Duration of Post op analgesia (hrs)	8.60± 1.840	4.57± 1.406	<0.0001

Caudal block in Group C. Around 53.3% (n=16) of patients belonging to Group T required intra-operative fentanyl supplementation, whereas only 3% (n=1) in Group C, required intra-operative fentanyl supplementation.

Duration of Post-operative analgesia was longer in Group T than Group C. TAP block provided postoperative analgesia for 8.60 hrs on average whereas caudal block provided a post-operative analgesia of duration 4.57 hrs on average (Table 2). The difference was found to be statistically significant. Pain scores were similar in both the groups, in the immediate, first and second hour of the post-operative period.

During the 3rd, 4th and 5th post-op hours, the pain scores were significantly high in group C, than group T as seen in Figure 2. FLACC pain scores were less in Group T with TAP block than Group C with Caudal block at all times of observation in the first 12 post-operative hours. The cumulative doses of tramadol required to rescue the patient from post-operative pain was 23.40mg±11.322 in Group T and 38.23mg±15.434 in Group C, the difference found to be statistically significant. As seen in Figure 3, only 4% of patients in Group T required 2 doses of rescue analgesia whereas 83.3% in Group C required 2 doses in the first 12hrs post-operative period for pain relief. Emergence delirium was observed equally in both the groups. 10% (n=3) of the patients in group T had vomiting, whereas 20% of the patients (n=6) in Group C had vomiting in the post-operative period. 1 patient in Group C had post-operative seizure. Time to Urine voiding was longer in Group C (7.4hrs) than in Group T (6.13hrs).

Discussion

Optimal treatment of perioperative pain is usually multimodal. Even in procedures which can be done under regional anaesthesia, a general anaesthesia or sedation is usually given for the child to cooperate for the regional technique. Adequacy of the regional block in supplementing the general anaesthesia can be assessed only indirectly using the changes in haemodynamic parameters and requirement of supplementation by analgesics like opioid [13]. Since pain is associated with stress response resulting in increase in heart rate and blood pressure, the cardiovascular responses were used as a surrogate for adequacy of analgesia.

The heart rate and mean arterial pressure remained constant throughout the procedure in Group C whereas the heart rate and MAP were varying from the baseline, significantly during the 10-15mins period after the beginning of surgical procedure in Group T. This is because Caudal block is a neuraxial blockade which offers complete blockade of sensory, motor and autonomic innervation up to the level of blockade [14]. Hence there is complete analgesia in Caudal block, whereas TAP block anaesthetizes only the nerves supplying the parietal peritoneum, skin and muscles of anterior abdominal wall [15]. Hence cord traction and visceral peritoneal handling can result in stress response, causing rise in heart rate and mean arterial pressure in Group T.

Among the initial research studies with TAP block, a study by Fredrickson [15] on TAP block for inguinal herniotomy in 8 paediatric patients, demonstrated that 5 patients of the 8 did not require any intra-operative supplementation whereas rest of the 3 patients required fentanyl supplementation, which he attributed to the pain felt during spermatic cord manipulation.

Similarly Ray et al [14] who studied Caudal block with bupivacaine and ropivacaine administered pre-operatively in paediatric patients undergoing urogenital procedures demonstrated no change in haemodynamic parameters during the intra-operative period and no supplementation was required in both the groups.

The duration of post-operative analgesia with TAP block was found to be significantly longer than Caudal block. Studies with Caudal block have demonstrated a post-op analgesia of 4-6hrs [16]. In our study, the mean duration of post-op analgesia with caudal block was 4.6hrs (274min).

The duration of post-operative pain relief was longer in TAP group 516min (8.6hrs) when compared to caudal group. Owing to the high vascularity of the caudal space, the absorption of local anaesthetic into systemic circulation is more in Caudal block, resulting in faster clearance of the local anaesthetic [17]. In contrast, Transversus Abdominis Plane is a relatively avascular fascial plane. The local anaesthetic drug volume deposited in the caudal space has to spread over a larger area to achieve the level of blockade whereas the drug volume injected in TAP spreads in a narrow fascial plane between two muscles [18].

The post-operative pain felt in a superficial surgery like inguinal hernia repair, is mainly due to pain sensations from the skin, muscles and parietal peritoneum, which is effectively blocked by the TAP block, making it effective in providing prolonged post-operative analgesia.

Dalia M [19] achieved similar results in his studyin children of age group 6months to 6years, undergoing open pyeloplasty, where he demonstrated that the patients with TAP block had a significantly longer time to first rescue analgesia, 602min in contrast to 280min in caudal block.

Similar pain scores are observed between the two groups in the first 2hrs after surgery. Its inferred that both caudal and TAP block are equally effective in providing pain relief in the immediate post-operative period. FLACC scores are lower in TAP block group when compared to caudal block group, at all-time points of observation upto 12 post-operative hours. Cumulative doses of tramadol as rescue analgesic were significantly more in Caudal block, with a mean tramadol consumption of 38.23mg compared to 23.40mg 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. Carney et al [20] who studied 40 children undergoing open appendicectomy, observed that TAP block significantly reduced VAS pain scores at rest and on movement at all times of observation and mean morphine requirementsin the first 48hrs postoperatively.

Sevoflurane which was used in the general anaesthesia is responsible for the emergence delirium [21] observed 10% of patients in both the groups. Volatile anaesthetics and opioids (fentanyl) used in General anaesthesia can cause PONV. Incidence of PONV was higher in Caudal group than in TAP block group, probably because of the increased requirements of tramadol [22] in Caudal group. No complications or adverse events related to TAP block was noted in our study. There are rare instances such as Liver trauma with regional anaesthesia block needle while performing landmark guided TAP block, reported by Farooq M and Carey M [23]. As the block was administered under ultrasound guidance, such complications could be avoided, in our study.

The time to first urine voiding, in caudal group (7.4hrs+1.6) was significantly longer than TAP block group (6.13hrs±1.5) but there were no cases of urinary retention which required intervention in both the groups. In studies which compared caudal to non-caudal procedures, many of them showed that caudal block was associated with longer time to urine voiding in the post-operative period. In a study by Markham et al, the incidence of urinary retention was 12/26 in caudal group and 5/26 in ilioinguinal-iliohypogastric nerve block group [24].

Conclusion

Caudal block provided better intra-operative analgesia than USG guided TAP block for inguinal hernia repair. Ultrasound-guided TAP block provided prolonged post-operative pain relief than single shot Caudal block and reduced the mean opioid consumption in the first 12 post-operative hours after inguinal herniotomy in children of age 1-7years.

Key Messages

TAP block performed under ultrasound guidance in children was found to be simple, safe and effective technique, in providing longer duration of post-operative analgesia without much sideffects.

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