Original Article

Comparison of ultrasound-guided transversus abdominis plane (TAP) block versus local infiltration during paediatric laparoscopic surgeries

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ABSTRACT

Background and Aims: The purpose of this study was to compare the analgesic efficacy of ultrasonography-guided transversus abdominis plane (TAP) blocks with local port site infiltration in children undergoing laparoscopic surgeries. **Methods:** After ethics committee approval and informed consent, 92 children aged 2–12 years posted for laparoscopic surgeries were randomly divided into Group T and Group L. Port site infiltration was performed in Group L by the surgeon at the time of port placement and end of surgery with 0.4mL/kg of 0.25% bupivacaine. Bilateral TAP block was performed in Group T after induction of anaesthesia, under ultrasonographic guidance with a Logiq E7 GE portable ultrasound unit and a linear 5–10 MHz probe. A 22G hypodermic needle and 0.4 mL/kg of 0.25% bupivacaine were used on each side for the TAP block. The parameters recorded were intraoperative haemodynamics, opioid requirements, postoperative pain scores and the need for rescue analgesia in the first 6 h postoperatively. **Results:** The median (interquartile range) pain scores were significantly lower in the TAP block group than the local infiltration group at 10 min [2 (0–2.5) vs 2 (3–4); $P = 0.011$], 30 min [1.5 (0–3) vs 3 (2–5); $P < 0.001$], 1 h [1.5 (0–2) vs 2 (2–3); $P < 0.001$] and 2 h [2 (0–2) vs 2 (1.5–2.5); $P = 0.010$] postoperatively. The need for intraoperative opioids and rescue analgesia was also significantly lower in the TAP block group ($P < 0.001$). **Conclusion:** TAP block is superior to local infiltration for intra- and immediate postoperative analgesia in paediatric laparoscopic surgeries.

Key words: Anaesthesia, children, laparoscopic surgeries, postoperative pain, ultrasonography

INTRODUCTION

Regional anaesthesia is an essential aspect of modern paediatric anaesthesia which provides superior and long-lasting analgesia without the risk of respiratory depression. Although abdominal laparoscopic surgery is known for less pain compared with that of laparotomy, many patients still complain of considerable postoperative pain. Pain after laparoscopic surgeries is caused by the incision and visceroperitoneal pain due to peritoneal stretch and inflammation.[1] A promising approach to the provision of postoperative analgesia after abdominal surgery is to block the sensory nerve supply to the anterior abdominal wall by placing a local anaesthetic in the transversus abdominis plane (TAP). The TAP block was first described by McDonnell *et al*. in 2004,[2] and a ultrasonography (USG)-guided technique was subsequently described by Hebbard *et al*.[3] USG-guided TAP block provides excellent pain relief in lower abdominal surgeries.[4] We aimed to study whether USG guided TAP block was superior to local infiltration for intra and postoperative analgesia for paediatric laparoscopic surgeries.

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METHODS

After Institutional Ethics Committee approval (IEC(I)/OUT/1064/17 dated 18/05/2017), registration with the Clinical Trials Registry, India (CTRI/2017/06/008729), informed consent from parents and assent from children older than 7 years, 92 children in the age group of 2–12 years, posted for elective laparoscopic hernia repair, orchidopexy, appendicectomy or cholecystectomy, were enrolled in the study. The exclusion criteria were any contraindication to TAP block, namely, surgical scar or distorted anatomy at the site of injection, known allergy to local anaesthetics and children with known cardiovascular, respiratory, hepatic or renal disease. The withdrawal criterion was conversion of laparoscopic surgery to open surgery.

Randomisation was done using the website www.randomisation.com to divide the patients into two groups to receive either TAP block (Group T) or local infiltration (Group L) randomly. The patients and the investigator enrolling the patients were blinded to the intervention. Allocation concealment was done using sequentially numbered opaque sealed envelopes (SNOSE technique). The study was carried out in paediatric surgery operation theatre of a tertiary care referral hospital and the postoperative data were collected in the surgical ward.

If intravenous access was present, midazolam 0.05 mg/kg was given as premedication. Fentanyl 2 μg/kg IV was given and anaesthesia was induced using propofol 2–3 mg/kg and atracurium 0.5 mg/kg. If intravenous access was not present, induction was done using sevoflurane and IV access was established; midazolam 0.05 mg/kg, fentanyl 2 μg/kg IV and atracurium 0.5 m g/kg IV were given after achieving IV access. Endotracheal intubation was done using an appropriate size endotracheal tube. Anaesthesia was maintained using a 50:50 mixture of air and oxygen along with desflurane. Pressure-controlled ventilation and low fresh gas flows were used.

In Group L, port site infiltration was administered with 0.4 mL/kg of 0.25% bupivacaine by the surgeon at the time of port placement and at the end of surgery. In Group T, bilateral TAP block was performed under ultrasonographic guidance with a Logiq™ E7 GE portable ultrasound unit (GE Healthcare, Milwaukee, WI, USA) and a linear 5–10MHz probe. For appendicectomy, inguinal hernia and orchidopexy, the posterior approach of the block was used. The puncture area and the ultrasound probe were prepared in a sterile manner. Once external oblique, internal oblique and transversus abdominis muscles were visualised at the level of the mid axillary line between the 12th rib and the iliac crest, the block was performed using a 22G hypodermic needle and in-plane technique. After negative aspiration for blood, 0.4 mL/kg of 0.25% bupivacaine was administered under direct USG guidance in the space between the transversus abdominis and the internal oblique muscles. Similarly, TAP block was performed on the other side. For laparoscopic cholecystectomy, the subcostal approach of TAP block was used. The probe was placed parallel to the subcostal border and injection was given using an in-plane technique. The total volume of bupivacaine did not exceed 20 mL.

Paracetamol 15 mg/kg was administered intravenously to both the groups at the beginning of surgery. Haemodynamics at 5 min after tracheal intubation were considered as baseline. If the heart rate, blood pressure or both increased by 15% relative to the baseline, 1 μg/kg of fentanyl was administered. The heart rate and mean arterial pressure were recorded at the time of port placement and every 15 min thereafter intraoperatively. Any additional requirement of opioid was noted. Pain scores were assessed postoperatively using the FLACC (Face Legs Activity Cry Consolability) scale for preverbal children less than 3 years of age and Wong-Baker FACES scale for children more than 3 years of age at 10, 30, 60 min and hourly thereafter up to 6 h postoperatively. If the pain score was more than 4, diclofenac was given as rescue analgesic at a dose of 1 mg/kg intravenously. Any adverse effects such as nausea, vomiting and sedation were noted. The pain scores were noted by an anaesthesiologist not aware of the study groups. Our primary objective was to evaluate the pain scores of patients receiving USG-guided TAP blocks versus local infiltration in the postoperative period. The secondary objective was to evaluate the haemodynamics and the need for additional opioid administration intraoperatively.

In the study conducted by Atim *et al*. mentioned in the meta-analysis by Yu *et al.*, the difference between the mean VAS scores at 2 h post surgery was 1.3.[4] The standard deviation in the TAP block group was 1.7 while that in the Local infiltration group was 2.6 with a confidence interval of 95% and a power of study 80%. Using these values, the sample size was calculated as 45 in each group. Statistical analysis of the demographic data such as age and weight was done

using Student's *t*-test while that data on sex and type of surgery were analyzed using Chi-square test. The continuous outcomes were measured using Student's *t*-test or Mann-Whitney *U*-test. A *P* value <0.05 was considered significant.

RESULTS

The study was conducted over a period of 6 months from May 2017 to October 2017. Data from 92 patients was analysed in this study [Figure 1]. There was no significant difference in the demographic profile of the two groups with respect to age, sex and the average duration of surgeries [Table 1]. The number of patients undergoing laparoscopic hernia repair (24 vs 21), orchidopexy (11 vs 9), appendicectomy (8 vs 12) or cholecystectomy (4 vs 3) was also comparable between Group L and Group T ($P = 0.71$). The postoperative pain scores were significantly lower in Group T at 10 and 30 min, 1 and 2 hours than in Group L [Table 2]. After 2 h, the pain scores were similar in the two groups. The need for rescue analgesia was also significantly lower in the TAP block group (8/46) when compared with the local infiltration group (30/46; $P < 0.001$) [Table 3]. Half of the patients who underwent cholecystectomy in the TAP group (two of four) required rescue analgesia.

The intraoperative heart rates were significantly lower in TAP block group at port placement, 30 and 60 min compared with the local infiltration group [Table 4]. The mean arterial pressure was also lower in the TAP block group at the time of port placement and 30 min intraoperatively [Table 5]. The requirement for intraoperative opioids was also considerably lower in the TAP block group [Table 3]. No adverse events such as nausea, vomiting or sedation were noted in both the groups.

Table 1: Demographic characteristics of the two groups

	Group T	Group L	*P*
Age in years (mean±SD)	6.3±3.8	5.5±2.9	0.298
Sex (M/F)	31/9	32/8	0.784
Weight (mean±SD)	18.8±1.4	17. ± 2.1	0.359
Duration in min (mean±SD)	102.0±7.8	100.0±8.2	0.254

SD – Standard deviation

Table 2: Pain scores in the two groups

Time	Group L, median (IQR values)	Group T, median (IQR values)	*P*
10 min	2 (3-4)	2 (0-2.5)	0.011
30 min	3 (2-5)	1.5 (0-3)	<0.001
1 h	2 (2-3)	1.5 (0-2)	<0.001
2 h	2 (1.5-2.5)	2 (0-2)	0.010
3 h	2 (0-2)	2 (0-2)	0.352
4 h	2 (0-2)	0 (0-2)	0.267
6 h	0 (0-2)	0 (0-2)	0.509

IQR – Interquartile range

Table 3: Need for intraoperative opioids and postoperative rescue analgesia in the two groups

Group	Group L	Group T	*P*
No. of patients who received intraoperative opioids	38	5	<0.001
No. of patients who received postoperative rescue analgesia	30	8	<0.001

Table 4: Difference in the intraoperative heart rate between the two groups

Time (min)	Group L (mean±SD)	Group T (mean±SD)	*P*
5	104.8±14.0	101.9±16.1	0.389
15	111.8±14.3	103.4±14.8	0.011
30	111.8±15.1	101.5±13.9	0.001
45	106.9±15.3	100.5±15.5	0.060
60	107.7±14.5	100.0±15.6	0.024

SD – Standard deviation

Table 5: Difference in the intraoperative mean arterial pressure between the two groups

Time (min)	Group L (mean±SD)	Group T (mean±SD)	*P*
5	63.8±8.5	61.8±7.9	0.258
15	65.8±7.1	61.5±8.6	0.015
30	65.8±7.8	61.6±8.8	0.022
45	63.9±7.8	61.7±8.4	0.219
60	64.4±8.0	61.3±8.6	0.101

SD – Standard deviation

DISCUSSION

With the advancement in surgical technique and anaesthesia, the scope of minimal access surgeries has broadened. Traditionally, laparoscopic surgeries are known to cause less postoperative pain and faster recovery. However, pain after laparoscopic surgeries can be attributed to incision, visceroperitoneal pain due to stretch and inflammation and shoulder pain due to diaphragmatic irritation by the residual insufflated carbon dioxide gas.[1] Thus, it is imperative that we institute a multimodal approach of analgesia rather than just rely on one modality. TAP block is a regional anaesthetic technique that blocks neural afferents of the anterolateral abdominal wall. We observed that the pain scores were considerably lower in the TAP block group when compared with the local infiltration group in the initial 2 h. Although the difference in the pain scores was small, it was statistically and clinically significant considering the number of patients receiving rescue analgesia. The intraoperative requirement of fentanyl was also considerably lower in the TAP block group, as evidenced by decreased haemodynamic response

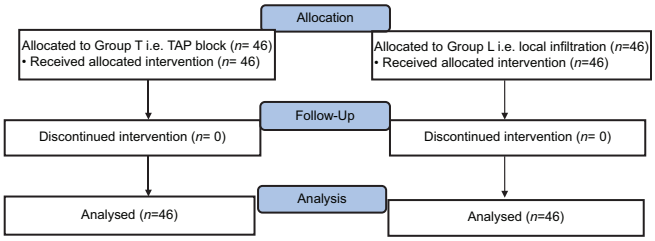

Figure 1: CONSORT 2010 flow diagram

especially at port placement. The study included four types of commonly performed laparoscopic surgeries, inguinal hernia repair, orchidopexy, appendicectomy and cholecystectomy. The patients who underwent cholecystectomy had a higher requirement for analgesia in the postoperative period even in the TAP group. The pain due to peritoneal stretch and shoulder pain is considerably higher in these patients compared with other surgeries. The TAP block provides somatic pain relief only at a standard dose of 0.4–0.5 mL/kg of bupivacaine or ropivacaine. However, the transverses abdominis plane is a continuum of the paravertebral space and a larger dose of 1–2 mL/kg can lead to some visceral pain relief especially in neonates and infants.[5]

There are only a few studies demonstrating the efficacy of TAP block in paediatric laparoscopic surgeries.[6-8] The results of these studies are conflicting. Neither do they unequivocally establish the benefit of TAP blocks nor do they disprove it. In a study conducted at a children's hospital in 2009, 93 patients undergoing laparoscopic appendicectomy received either a TAP block or port site infiltration. The authors concluded that TAP blocks increased the anaesthesia time by 14 min but offered no clinical benefit in terms of analgesia as evidenced by similar morphine requirements postoperatively.[6] However, in a study conducted at a children's hospital in patients undergoing laparoscopic orchidopexy, the children who received TAP block required less intraoperative and postoperative analgesia, with preserved haemodynamic stability and a good degree of parental satisfaction.[7] Albokrinov *et al.* compared TAP block to oral analgesia for laparoscopy and reported reduced pain scores and morphine consumption in TAP block.[8] A systematic review of TAP and rectus sheath block published in 2015 did not find strong evidence for the efficacy of TAP blocks in children due to the paucity and heterogeneity of randomised trials.[9]

One of the strengths of our study is that we have used different approaches of TAP block for cholecystectomy and lower abdominal procedures to optimise the efficacy of the block. This is because the results of a trial done in patients undergoing laparoscopic hernia repair cannot be extrapolated to patients undergoing a more painful and extensive surgeries such as cholecystectomy. Also, we compared TAP blocks to port site infiltration which is the standard procedure in most centres and not to morphine- or opioid-based patient controlled analgesia postoperatively which is used less frequently.

A limitation of our study is the short duration of analgesia of TAP block. Further studies are required to assess the efficacy of adjuvants such as clonidine in TAP block for prolongation of analgesia. The analgesic efficacy of TAP block may vary in different types of surgeries and this study did not have adequate power to provide valid conclusions for each type of surgery.

CONCLUSION

We conclude that TAP block is superior to local infiltration for intra- and immediate postoperative analgesia in paediatric laparoscopic surgeries. We recommend inclusion of TAP block as a part of multimodal analgesia for these surgeries.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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