Original Article

Postoperative analgesic efficacy of ultrasound-guided ilioinguinal-iliohypogastric nerve block compared with medial transverse abdominis plane block in inguinal hernia repair: A prospective, randomised trial

Nidhi Bhatia *, Indu Mohini Sen, Banashree Mandal, Ankita Batra

Department of Anaesthesia & Intensive Care, Postgraduate Institute of Medical Education and Research (PGIMER), 160012 Chandigarh, India

A R T I C L E   I N F O

A B S T R A C T

Purpose: Analgesic efficacy of ultrasound-guided transverse abdominis plane block, administered a little more medially, just close to the origin of the transverse abdominis muscle has not yet been investigated in patients undergoing unilateral inguinal hernia repair. We hypothesised that medial transverse abdominis plane block would provide comparable postoperative analgesia to ilioinguinal-iliohypogastric nerve block in inguinal hernia repair patients.
Methods: This prospective, randomised trial was conducted in 50 ASA I and II male patients $\geq$ 18 years of age. Patients were randomised into two groups to receive either pre-incisional ipsilateral ultrasound-guided ilioinguinal-iliohypogastric nerve block or medial transverse abdominis plane block, with 0.3 ml/kg of 0.25% bupivacaine. Our primary objective was postoperative 24-hour analgesic consumption and secondary outcomes included pain scores, time to first request for rescue analgesic and side effects, if any, in the postoperative period.
Results: There was no significant difference in the total postoperative analgesic consumption [group I: 66.04 mg; group II: 68.33 mg (*P* value 0.908)]. Time to first request for rescue analgesic was delayed, though statistically non-significant (*P* value 0.326), following medial transverse abdominis plane block, with excellent pain relief seen in 58.3% patients as opposed to 45.8% patients in ilioinguinal-iliohypogastric nerve block group.
Conclusion: Medial transverse abdominis plane block being a novel, simple and easily performed procedure can serve as an useful alternative to ilioinguinal-iliohypogastric nerve block for providing postoperative pain relief in inguinal hernia repair patients.

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1. Introduction

Inguinal hernia repair, a commonly performed surgical procedure [1], is associated with around 60% incidence of moderate to severe postoperative pain [2]. It is also associated with a 0–54% incidence of chronic pain, especially in patients complaining of significant preoperative and immediate postoperative pain [3–5]. A significant part of post-hernia surgery pain is caused by abdominal wall incision. A number of medications and non-pharmacological techniques have been used to provide analgesia, but an optimal pain management technique is not yet available [6]. Recently, there has been a growing interest in the use of peripheral nerve blocks for providing postoperative pain relief. These include ilioinguinal-iliohypogastric nerve (IIN-IHN) blocks and transverse abdominis plane (TAP) blocks [1,7,8].

Postoperative pain relief provided by TAP blocks and ilioinguinal-iliohypogastric nerve blocks have been compared in the past. There have been reports, including case-series, retrospective data as well as prospective studies, suggesting that in comparison to ilioinguinal-iliohypogastric nerve blocks, TAP block provides better or at least comparable postoperative analgesia in patients undergoing inguinal hernia repair [7,9]. However, a recent prospective, randomised trial by Fredrickson et al. [9] in infants and children undergoing inguinal hernia repair suggested that USG-guided ilioinguinal block provided more effective analgesia than TAP block. The reason stated for this was the anatomical

* Corresponding author.
  E-mail address: nidhi.bhatia75@gmail.com (N. Bhatia).

variability encountered in the course of the ilioinguinal-iliohypogastric nerves, which are not consistently closely approximated until they reach the level of anterior superior iliac spine [9].

For a successful TAP block of both the ilioinguinal and iliohypogastric nerves, local anaesthetic (LA) needs to spread caudad and medial to reach both nerves [9]. In the present study, we thus decided to administer ultrasound-guided TAP block medially, close to the origin of the transverse abdominis muscle (medial TAP block) and compare its postoperative analgesic effect with that of ultrasound-guided IIN-IHN block. It was hypothesised that ultrasound-guided medial TAP block would provide comparable postoperative analgesia to IIN-IHN block in patients undergoing unilateral inguinal hernia repair under subarachnoid block. The primary outcome measure of our study was 24 hour intravenous tramadol (rescue analgesic) consumption and secondary outcome measures included pain scores, time to first request for rescue analgesic and side-effects, if any, in the postoperative period.

2. Patients and methods

This prospective, randomised trial was approved by the institutional ethics committee (IEC-06/2015-206) and registered with the Clinical Trial Registry of India (registration number: CTRI/2015/09/006196; URL: http://ctri.nic.in). The trial was conducted in a tertiary care hospital of North India from 15-10-2015 to 31-10-2016.

After obtaining written, informed consent, 50 ASA I and II male patients $\geq$ 18 years of age scheduled to undergo elective, primary, unilateral open inguinal hernia repair (mesh herniorrhaphy) under subarachnoid block (SAB) were enrolled in the study. We excluded patients with body mass index $\geq 40 \ kg/m^2$, local infection at the puncture site, allergies/contraindications to any of the drugs used in the study, chronic hepatic, renal disease, cardiac disease, pre-existing neurological deficits or psychiatric illness, preoperative opioid or non-steroidal anti-inflammatory drug treatment for chronic pain, regional block refusal/contraindication, inability to understand the scoring systems to be used in the study and inability to consent to the study.

Subjects were randomised using a computer-generated table of random numbers into 2 groups of 25 patients each, to receive either pre-incisional ipsilateral ultrasound-guided ilioinguinal-iliohypogastric nerve block (group I) or ultrasound-guided medial TAP block (group II), with 0.3 ml/kg of 0.25% bupivacaine. Group assignments were sealed in sequentially numbered, opaque envelopes that were opened by an anaesthesiologist not involved in the study.

All patients presented to operation theatre on the day of surgery after overnight fasting. They were evaluated preoperatively to assess the fitness for SAB and administered premedication in the form of tablet alprazolam 0.5 mg two hours prior to the scheduled surgery. All patients were explained about the 11-point numeric rating scale (NRS) for pain where 0 stands for no pain and 10 stands for worst imaginable pain. Postoperative nausea and vomiting was assessed using a 3-point scale system (0: no nausea, vomiting, 1: nausea present but no vomiting, 2: vomiting present with or without nausea). Patients who failed to understand the scoring systems were excluded from the study design.

At the time of surgery, patients were shifted to the operating room and monitored for heart rate (HR), non-invasive blood pressure (NIBP), electrocardiogram (ECG), oxygen saturation (SpO2), and temperature using multichannel monitors (Datex-Ohmeda S/5 Avance). After achieving intravenous (i/v) access, patients were positioned for performing spinal anaesthesia under full aseptic precautions. Subarachnoid puncture was performed

with 26-G Quincke's needle in the L2–L3 or L3–L4 intervertebral space and 12–15 mg of 0.5% heavy bupivacaine was injected. Following this, patients were turned supine and administered either IIN-IHN or medial TAP block. All blocks were performed using 22-G echogenic needle and high-frequency (5–10 MHz) ultrasound probe (Sonosite, Inc. Bothell. WA 98021 USA). The blocks were performed in the operating room by a single anaesthetist, well experienced in USG-guided regional anaesthesia. This anaesthetist was not involved in further data collection during the course of the study. The anaesthetist involved in postoperative patient management and data collection was also blinded to group allocation.

2.1. USG-guided IIN-IHN block

Patients were placed in supine position and the block was performed under full aseptic precautions. For giving this block, the probe was placed on the line joining the anterior superior iliac spine (ASIS) to the umbilicus. The adult IIN-IHN was visualised between the internal oblique and transverse abdominis muscles and within 1 to 3 cm from the ASIS. Using the in-plane technique, the drug was deposited around the nerves.

2.2. USG-guided TAP block via the medial approach (medial TAP block)

Patients were placed in supine position and the block was performed under full aseptic precautions. USG probe was placed in a space between iliac crest and the costal margin in the region of the anterior axillary line, with the orientation of the probe perpendicular to the line joining the anterior superior iliac spine and the inferior rib. Once the external oblique, internal oblique, and transverse abdominis muscles were visualised, the transducer was moved medially to the point where the internal oblique muscle disappeared (Fig. 1). The injection target area was within 1-inch lateral to the point where internal oblique muscle was seen to disappear (Figs. 2 and 3).

Postoperatively, until discharge, all patients received intravenous (i/v) paracetamol 1 g 6 hourly, with the first dose being given at the end of surgery. The patients were transferred to the post-anaesthesia care unit (PACU) and monitored for HR, NIBP, RR, NRS for pain during rest as well as movement, PONV and sedation (1 = alert; 2 = occasionally drowsy; 3 = frequently drowsy; 4 = sleepy, easy to arouse; 5 = somnolent, difficult to arouse), on admission to PACU and then at 1 h, 2 h, 4 h, 8 h, 12 h, 18 h and at 24 hour interval by an investigator blinded to group allocation. Patients with NRS of $\geq$ 4 at rest or those demanding analgesic were provided with i/v tramadol 2 mg/kg as first dose and i/v tramadol 1 mg/kg as subsequent doses. Patients were discharged home from the ambulatory surgical unit on the day of surgery when they were pain free (NRS < 4 on coughing), without postoperative nausea and
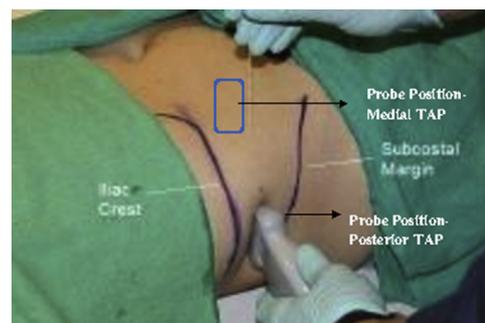

Fig. 1. Probe position in medial transverse abdominis plane (TAP) block.

Fig. 2. Sonoanatomy of medial transverse abdominis plane (TAP) block. EO: external oblique muscle; IO: internal oblique muscle; TA: transverse abdominis muscle; B: point of disappearance of internal oblique muscle; A: injection target area (1 inch lateral to point B).
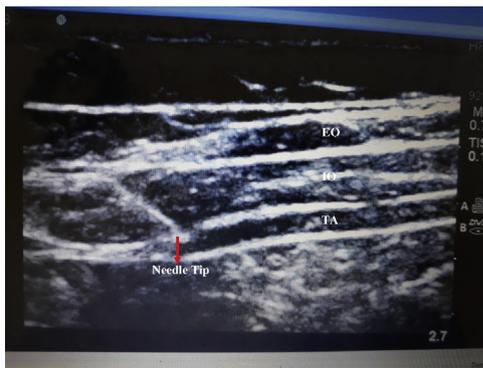

Fig. 3. Needle position in medial transverse abdominis plane (TAP) block. EO: external oblique muscle; IO: internal oblique muscle; TA: transverse abdominis muscle; needle tip is 1 inch lateral to the point where internal oblique muscle disappears.

vomiting (PONV), and when they completed all discharge criteria, with the advice to continue oral tablet paracetamol 1 g 6 hourly for initial 24 hours and then as and when required. After discharge, patients were telephonically asked about the presence of pain, both at rest and on movement, as well as about the presence of PONV. Those with NRS of $\geq$ 4 at rest were asked to take oral tablet tramadol 50 mg.

We recorded a 24-hour analgesic consumption (i/v tramadol consumption, with 1.5 mg oral tramadol = 1 mg i/v tramadol [10]) and time to providing first rescue analgesia. The presence of PONV, sedation, or any other side effects was also noted. Patients complaining of PONV were given injection ondansetron 4 mg i/v. In case of presence of PONV at home, they were advised to take tablet ondansetron 8 mg orally. At the end of 24 hours, patients were asked about their overall opinion of the quality of pain relief they had received using the following – excellent; very good; good; poor.

2.3. Statistical analysis

Normality of quantitative data was checked by measures of Kolmogorov Smirnov tests of normality. If data was normally distributed, student *t*-test was applied for comparison of 2 groups. Mann-Whitney *U*-test was used for statistical analysis of skewed continuous variables or ordered categorical data. Proportions were compared using Chi square or Fisher's exact test whichever was applicable. Wilcoxon Signed rank test was used for skewed data or for scores (time related variables). For comparison (time related variables) of haemodynamics, repeated measure ANOVA was

applied. A 95% confidence interval of median difference between the two study groups was calculated using Hodges-Lehman method. All statistical tests were two-sided and performed at a significance level of α = 0.05. Analysis was conducted using SPSS for Windows (version 22.0; SPSS Inc., Chicago, IL, USA).

To calculate the sample size, we did 10 pilot cases in each group and found the mean consumption of rescue analgesic in group I to be 66.5 mg and in group II to be 69.3 mg. Considering both block techniques to be equally effective and taking 5.5 mg dose of rescue analgesic as a clinical acceptable margin with 7 mg pooled standard deviation, our sample size came out to be 25 in each group with 80% power and 5% level of significance.

3. Results

A flow chart of study subject flow through the study is provided in Fig. 4. Patients in both the groups were comparable with regards to age, weight, height and duration of surgery (Table 1). Medians of the total consumption of rescue analgesic in the initial 24 hours after surgery and median time to first request for rescue analgesic was compared between the two groups. In patients receiving IIN-IHN block, median of total consumption of rescue analgesic was 66.04 mg (IQR = 0 to 137.5 mg), whereas in patients belonging to medial TAP group, median of total consumption of rescue analgesic was 68.33 mg (IQR = 0 to 140 mg). This difference was however statistically not significant (*P* = 0.908). Though the time to first request for rescue analgesic was slightly delayed following medial TAP block, however this difference was statistically non-significant, with median time to first request for rescue analgesic being same in both the groups i.e. 4.00 hours (IQR = 4.00 to 8.00 hours in IIN-IHN group and 4.00 to 18.00 hours in medial TAP group; *P* = 0.326). NRS scores at rest and in movement were comparable between the two groups (Figs. 5 and 6). Pain relief was graded as excellent by 58.3% of the patients in medial TAP group as opposed to 45.8% of the patients in IIN-IHN group. However there was no statistically significant difference between the groups. None of the patients in either of the two groups complained of nausea, vomiting or any other side effects.

4. Discussion

Inguinal hernia repair surgeries are one of the most commonly performed procedures, with majority of them being performed on a day-care basis [11]. Though not a very extensive surgery, inguinal hernia repair is still associated with significant postoperative pain, with a high incidence of chronic pain in untreated patients [7]. In order to provide postoperative pain relief in these patients, both ilioinguinal-iliohypogastric nerve (IIN/IHN) block and TAP block have been used in the past, with variable outcomes. In a recent systematic review evaluating the analgesic effect of TAP block in various abdominal surgeries, TAP block was found to be superior to landmark-guided, but inferior to USG-guided IIN/IHN block [12]. Few case series and retrospective data have suggested that in inguinal hernia repair patients, USG-guided TAP block could serve as an effective alternative to USG-guided IIN/IHN block [9].

In a recent prospective trial conducted on infants and children presenting for elective inguinal surgery, Fredrickson et al. [8] concluded that USG-guided IIN/IHN block provided more effective analgesia than TAP block. In both, TAP and IIN-IHN block, LA is deposited in the plane between the internal oblique and transverse abdominis muscle, but at different points along the course of the nerves, with the LA being administered closer to the nerve in IIN-IHN block. According to previous reports, variable analgesic effect of TAP block could be due to the wide anatomical variability in the course of the ilioinguinal and iliohypogastric nerves. These two
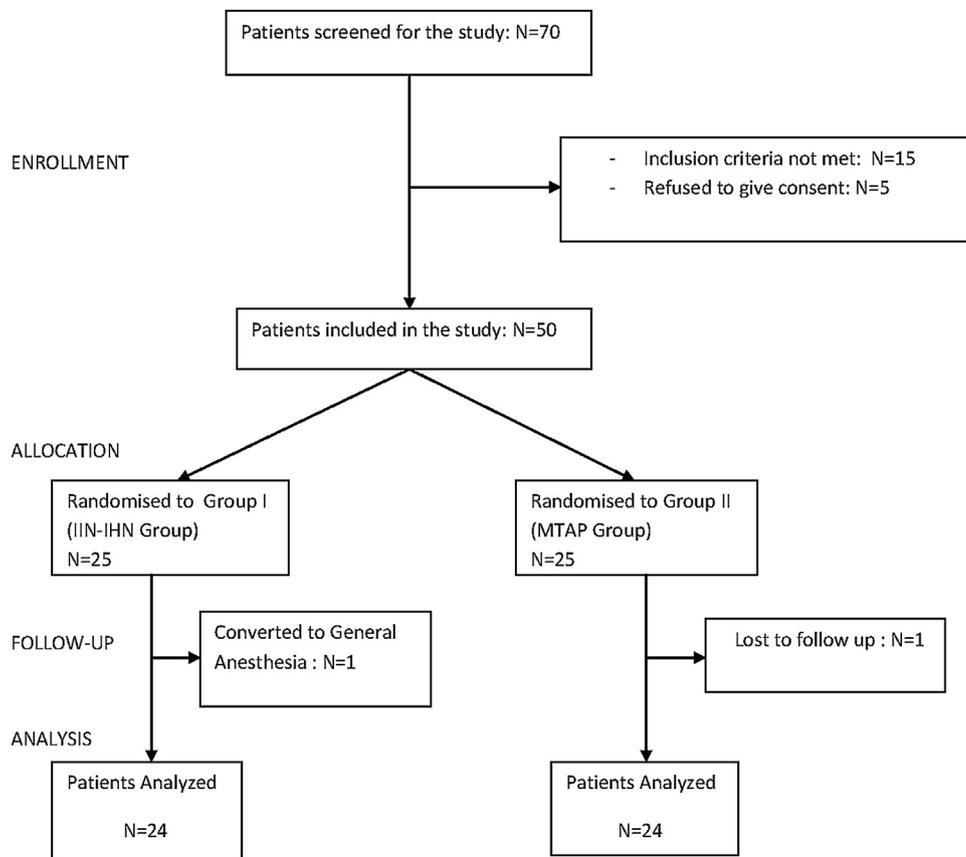
Fig. 4. Flow of participants through the study.

Table 1
Patient demographics.

Demographics	Group I (IIH Group)	Group II (MTAP Group)
Age (years)	52.04 ± 13.27	54.38 ± 10.97
Weight (kg)	69.04 ± 9.01	67.04 ± 6.26
Height (m)	1.69 ± 0.03	1.71 ± 0.05
BMI (kg/m^2)	24.22 ± 3.06	23.09 ± 2.62
Surgery duration (min)	63.13 ± 15.09	62.08 ± 14.44

All values are expressed as mean ± S.D.

Fig. 5. Postoperative Numeric Rating Scale (NRS) scores at rest.

nerves are known to penetrate the transverse abdominis muscle more antero-medially, thus making the classic posterior TAP block ineffective in actually targeting these nerves in the TAP. In order to reach both the ilioinguinal-iliohypogastric nerves, the LA needs to spread more caudad and medially, so that the TAP block of both these nerves is successful. Keeping in mind these anatomical variations in the course of ilioinguinal-iliohypogastric nerves, we decided to administer TAP block a little more medially, 1 inch lateral to the point where internal oblique muscle disappears, just close to the origin of the transverse abdominis muscle. This is the medial TAP block. We found the postoperative analgesia provided by medial TAP block to be comparable to that produced by IIN-IHN block, with there being no statistically significant difference in the 24 hour analgesic consumption between the two groups. In addition, the time to demanding first rescue analgesic was delayed following medial TAP block, with medial TAP block providing excellent pain relief in 58% of patients (as opposed to 45% in IIN-IHN group).

Fredrickson et al. [8] reported that IIN-IHN block was procedurally more difficult to perform, due to inferior ultrasound image quality and difficulty in imaging the muscle layers directly medial to anterior supe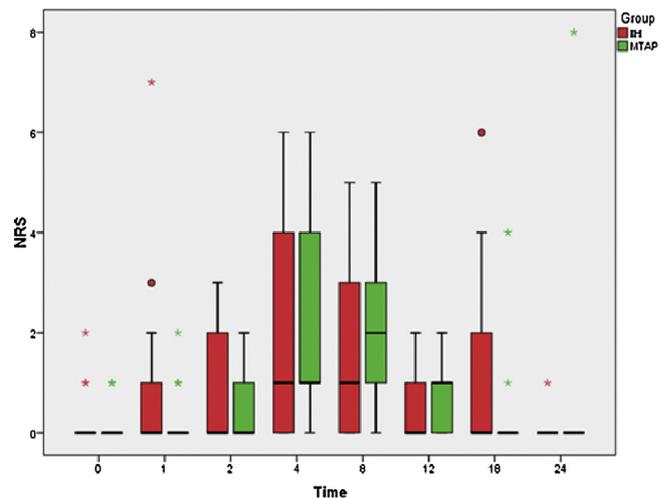rior iliac spine. TAP, on the other hand is easier to identify on ultrasound, with needle placement for block administration being simpler. We did not record the scan time and needle placement time for giving the blocks. However, we did not encounter any difficulties in administering either of the blocks. The medial TAP block, though a new technique, was simple to perform, with the plane being easily identified on ultrasound. In our study, we used a volume of 0.3 ml/kg of 0.25% bupivacaine (approximately 18–20 ml volume) based on previous reports in literature [13,14].

Our study had a few limitations. We did not include a control group (group not receiving any block) in our study, but our main
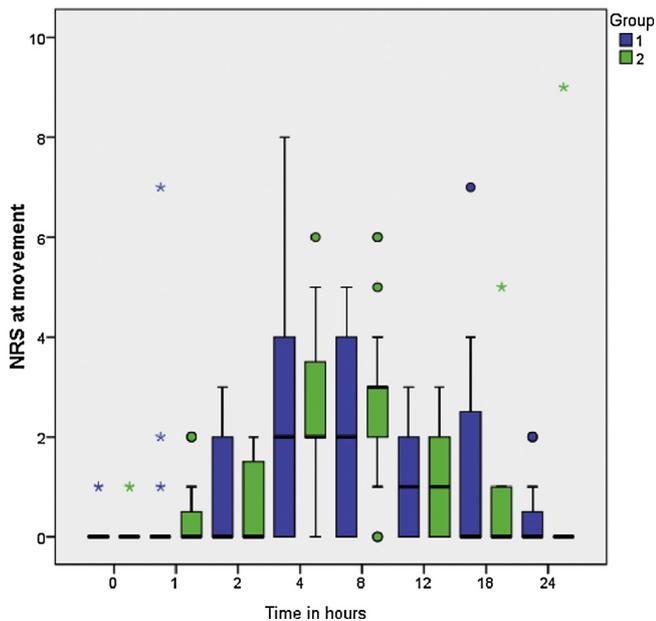
Fig. 6. Postoperative Numeric Rating Scale (NRS) scores on movement.

aim was to compare the two block techniques, knowing that each of them have good analgesic efficacy. Secondly, we did not follow our patients beyond 24 hours, so we are unable to comment on the incidence of chronic pain in our study population. Thirdly, we did not record the scan time and needle placement time for giving the blocks. Given the fact that a new technique of giving TAP block, the medial TAP block, was being done for the first time, it would have been helpful to know the ease of administering medial TAP block.

5. Conclusion

Ultrasound-guided medial TAP block and ilioinguinal-iliohypogastric nerve block provided effective and comparable postoperative analgesia in patients undergoing inguinal hernia repair surgery. Further, medial TAP block being a simple and easily performed procedure can serve as an useful alternative to ilioinguinal-iliohypogastric nerve block for providing postoperative pain relief in post-inguinal hernia surgical patients, with minimal side-effects.

Presentation

Preliminary data for this study were presented at national conference of Indian Society of Anaesthesiologists held at Ludhiana (India) from 26th November to 29th November 2016.

Ethical statement

We confirm that any aspect of the work covered in this manuscript that has involved human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript. A written, informed consent of all patients was taken prior to including them in the study.

Disclosure of interest

The authors declare that they have no competing interest.

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