The analgesic efficacy of ultrasound-guided transversus abdominis plane block for retroperitoneoscopic donor nephrectomy: A randomized controlled study

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ABSTRACT

Background: Transversus abdominis plane (TAP) block is suitable for lower abdominal surgeries. Blind TAP block has many complications and uncertainty of its effects. Use of ultrasonography increases the safety and efficacy. This study was conducted to evaluate the analgesic efficacy of ultrasound (USG)-guided TAP block for retroperitoneoscopic donor nephrectomy (RDN). **Methods:** In a prospective randomized double-blind study, 60 patients undergoing laparoscopic donor nephrectomy were randomly divided into two groups by closed envelope method. At the end of surgery, USG-guided TAP block was given to the patients of both the groups. Study group (group S) received inj. Bupivacaine (0.375%), whereas control group (group C) received normal saline. Inj. Tramadol (1 mg/kg) was given as rescue analgesic at visual analog scale (VAS) more than 3 in any group at rest or on movement. The analgesic efficacy was judged by VAS both at rest and on movement, time to first dose of rescue analgesic, cumulative dose of tramadol, sedation score, and nausea score, which were also noted at 30 min, 2, 4, 6, 12, 18, and 24 h postoperatively. Total tramadol consumption at 24 h was also assessed. **Results:** Patients in group S had significantly lower VAS score, longer time to first dose of rescue analgesic (547.13±266.96 min vs. 49.17±24.95 min) and lower tramadol consumption (103.8±32.18 mg vs. 235.8±47.5 mg) in 24 h. **Conclusion:** The USG-guided TAP block is easy to perform and effective as a postoperative analgesic regimen in RDN, with opioids-sparing effect and without any complications.

Key words: *Drugs – bupivacaine and tramadol, retroperitoneoscopic donor nephrectomy, transversus abdominis plane block, ultrasound*

INTRODUCTION

In the last two decades, laparoscopic donor nephrectomy (LDN) has brought great benefits, enabling patients to recover quickly from surgery and allowing them to return to normal activities. LDN is a unique surgical procedure in which live donors who are healthy volunteers undergo a major surgical trauma that causes postoperative pain and discomfort without any direct therapeutic benefit of the procedure.[1,2]

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The most common approach to postoperative pain relief for LDN is multimodal using nonsteroidal anti-inflammatory drugs (NSAIDs), opioids, and local infiltration of anesthetic. Opioids are effective for treatment of postoperative pain, but can cause adverse effects such as nausea, vomiting, decreased gastrointestinal motility, respiratory depression, and sedation, which further increase the morbidity of the donor. Local infiltration does not relieve deep muscular pain, and NSAIDs are nephrotoxic.[3]

In the last decade, a novel approach to block the abdominal wall neural afferents via the lumbar triangle of Petit has been described by Rafi in 2001, known as transversus abdominis plane (TAP) block.[4,5] However, landmark technique is associated with difficulties like anatomical variation of triangle of Petit, difficulty in palpation of angle in obese patients, and complications like colonic puncture, liver injury, nerve injury, or unpredictable spread of local

anesthetic.[6,7] Hebbard *et al.* in 2007 have subsequently described the ultrasound (USG)-guided approach to the TAP block.[8,9] Real-time ultrasound provides reliable imaging of three muscular layers of anterolateral abdominal wall and assessment of correct needle placement and local anesthetic injection, thus potentially increasing the success rate and safety of the TAP block compared to the landmark technique.

So, we hypothesized that the TAP block, as a part of multimodal analgesic regimen, would result in decreased opioid (tramadol) consumption and improved analgesia in the first 24 h after retroperitoneoscopic donor nephrectomy (RDN).

METHODS

After obtaining approval from the hospital ethical committee and written informed consent, 60 ASA risk I and II patients scheduled for RDN, between 24 and 60 years of age of either sex, were enrolled in a prospective, randomized, double-blind, controlled study. The trial was registered with the local institutional review board (IRB). The trial was carried out between December 2009 and December 2011 at the Institute of Kidney Diseases and Research Centre and Institute of Transplantation Sciences (IKDRC-ITS), Ahmedabad, Gujarat, India. Patients allergic to local anesthetics drugs, opioid addicts, and with psychiatric disorders were excluded from our study. Initial preoperative counseling was done to gain the confidence of the patient, thereby minimizing the emotional component of pain. The nature of the procedure was explained and the patients were taught to assess the intensity of pain using visual analog scale (VAS). Patients were randomly allocated to group S (study group n=30) and group C (control group n=30) by a block randomization table and closed envelope method, which was unknown to the investigators. The patients, anesthesiologists, and the resident staff providing postoperative care were blinded to group assignment.

All patients received balanced general anesthesia. They were premedicated with inj. Glycopyrrolate (0.004 mg/kg), inj. Fentanyl (2 μg/kg), Ranitidine 50 mg, and inj. Ondansetron 0.15 mg/kg. Induction of anesthesia was achieved with inj. Thiopentone sodium (7 mg/kg). The trachea was intubated 90 seconds after giving vecuronium 0.1 mg/kg bolus. Anesthesia was maintained with O_2/N_2O, isoflurane, and maintenance dose of vecuronium. Pulse, electrocardiogram (ECG), non-invasive blood pressure (NIBP), peripheral oxygen saturation (SpO_2), end-tidal CO_2 ($ETCO_2$), and urine output were monitored throughout the procedure. After completion of surgery and before extubation, patients were positioned in the supine position. TAP block was performed by the first investigator with experience of more than 5 years of USG-guided blocks. It was done on the same side of surgery under ultrasonographic guidance with a SonoSite MICRO MAXX™ portable ultrasound device (SonoSite™, Bothell, WA, USA) and a linear 6-13 MHz ultrasound transducer. Once the external oblique abdominis muscle (EOAM), internal oblique abdominis muscle (IOAM), and transversus abdominis muscle (TAM) were visualized at the level of the anterior axillary line between the 12th rib and the iliac crest [Figure 1], the puncture area and the ultrasound probe were prepared in a sterile manner. After identification of the neuro-facial plane between IOAM and TAM, block was performed with an 18-G Touhy needle. The needle was directed to approach the TAP with "in-plane" USG-guided technique [Figure 2]. Once the tip of the needle was placed in the space between the IOAM and TAM, 25 ml of inj. Bupivacaine (0.375%) or normal saline was injected after negative aspiration, according to the group allocated. The drug was seen spreading in TAP as a dark oval shape [Figure 3]. Inj. Diclofenac sodium 1.5 mg/kg IM was given to every patient before extubation. After completion of the procedure, patients were shifted to the post-anesthetic care unit (PACU).

Primary outcome measure in this study was 24-h tramadol consumption. Secondary outcome measures included time for first dose of tramadol, VAS scores, and the associated side effects. Postoperatively, apart from vital data, pain score, sedation and nausea score were recorded. Assessment of pain was done using VAS both at rest and on movement at intervals of 30 min, 2, 4, 6, 12, and 24 h postoperatively. When the VAS score was more than 3, inj. Tramadol 1 mg/kg was given as a rescue analgesic. Time to first dose of rescue analgesic and total tramadol consumption in 24 h was noted. Side effects due to opioid and complications related to TAP block like subcutaneous bruising and inadvertent vessel puncture were noted. Patients were given inj. Ondansetron 0.15 mg/kg IV before they were administered inj. Tramadol. All postoperative assessments were made by an investigator blinded to the study group.

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Statistical analysis

The sample size was calculated on the basis of 24-h tramadol consumption of patient undergoing RDN in an initial pilot study. Mean±standard deviation (SD) of 24-h tramadol consumption in the control and study groups of

pilot study was 204±16.73 mg and 179±26 mg, respectively. Based on this, 23 patients per group would be required for an experimental design incorporating two equal groups, using α=0.05 and a power of 95%.

Statistical analysis was performed using Statistical Package for the Social Sciences software, version 12.0 (SPSS Inc., Chicago, Illinois, USA)., Data were expressed as mean±SD for continuous variables and no. (%) for categorical variables. Continuous variables were compared using independent two-sample *t*-test. Fisher exact test and Chi-square analysis were used for comparing categorical data. P<0.05 were considered to be statistically significant.

RESULTS

Sixty-two patients were enrolled in the study. In the study group, one patient was excluded due to poor window on ultrasound due to previous surgical scar, while in the control group, one patient withdrew from the study. This prospective study was carried out in 60 ASA I and II patients, who underwent left-sided RDN. They were randomly divided into two different groups. Group S patients received TAP block with Bupivacaine (0.375%) 25 ml. Group C patients received TAP block with placebo (i.e., with normal saline) 25 ml. Both groups were comparable in terms of age, sex, weight, and height [Table 1].

VAS score at rest and on movement was higher in the control group as compared to the study group at all the time intervals, and it was significantly higher at 30 min, 2, 4, 6, and 12 h, and the graphs in Figures 4 and 5 show that pain score was decreased at 24 h in both the groups.

First dose of rescue analgesia required in group S was at 547.133±266.9 min and in group C was at 49.17±24.95 min, which was statistically significant. Total dose of tramadol consumption in group S was 103.83±32.18 mg and in group C was 235.83±47 mg, which showed that tramadol consumption was significantly decreased in group S [Table 2]. There was no statistically significant difference in both the groups in sedation and nausea score.

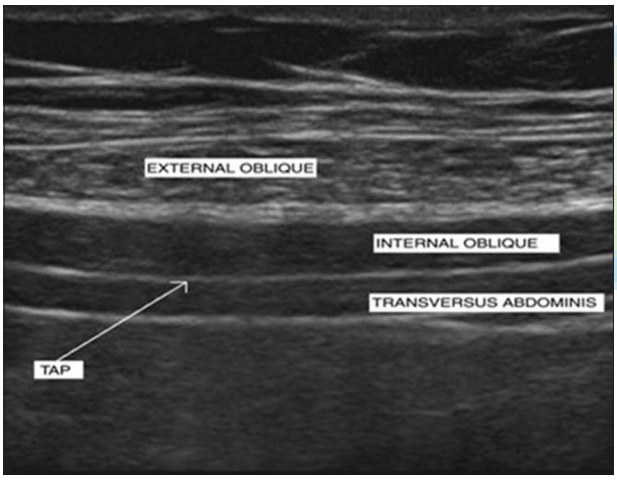

Figure 1: Ultrasound-guided picture of transversus abdominis plane plane

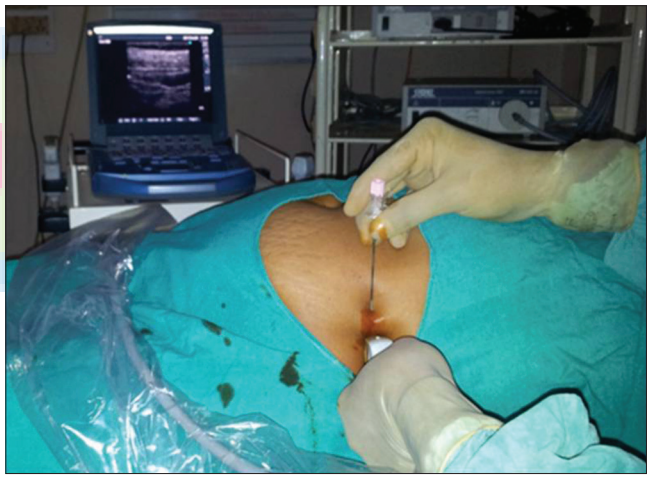

Figure 2: Technique of USG-guided in-plane transversus abdominis plane block

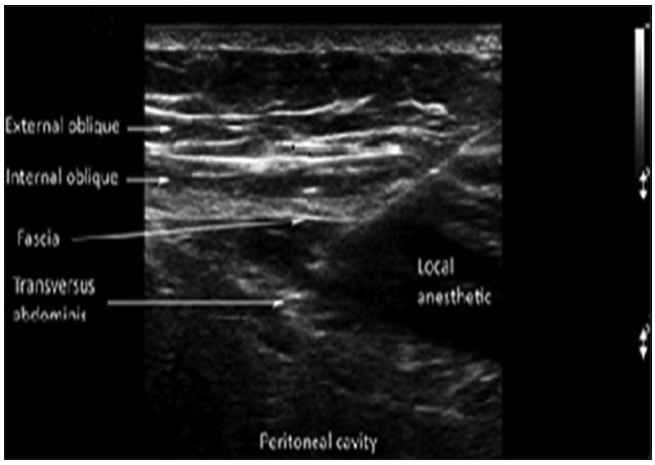

Figure 3: Visualization of spread of drug

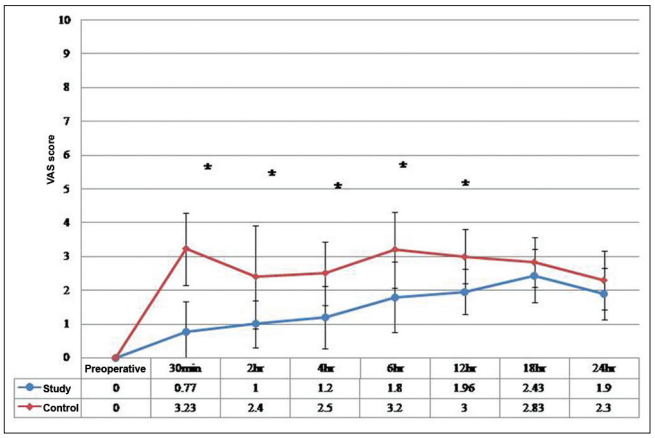

Figure 4: Graph depicting visual analog scale scores at rest

Table 1: Demographic data

Group	Group A (study)	Group B (control)	*P* value
Age (years)*	45±9.6	42±7	0.228
Sex (m/f)*	8/22	7/23	0.766
Weight (kg)*	60±10	60±10	0.890
Height (cm)*	163±8	160±7	0.111

*$P>0.05$

Table 2: Time for first dose of rescue analgesia and total tramadol consumption in 24 h

	Time for first dose of rescue analgesia in minutes	Tramadol dose in mg
Group S	547.13±266.96*	103.8±32.18
Group C	49.17±24.95*	235.8±47.5

*$P<0.05$

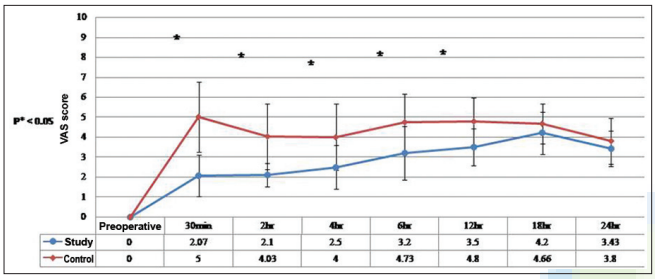

Figure 5: Graph depicting visual analog scale scores on movement

Hemodynamically, both the groups were comparable all the time. No complications related to the TAP block technique were observed in both the groups.

DISCUSSION

The cause of pain after laparoscopic procedure is multifactorial. In LDN, pain may be because of insertion of the ports and due to the lower abdominal incision of 6-9 cm for the extraction of the kidney.[3] This pain is mostly parietal in origin and conducted by the lower intercostal nerves and iliohypogastric and ilioinguinal nerves (i.e., T10-L1). Pelvic organ nociception or diaphragmatic irritation from residual pnemoperitoneum can lead to shoulder tip discomfort, but this is more common in transperitoneal laparoscopic surgery than retroperitoneoscopic surgery. Ureteric colic and urinary catheter discomfort may also contribute to the development of postoperative pain in these patients.[2]

The use of USG-guided sensory block of anterior abdominal wall with local anesthesia for postoperative pain relief is an attractive method. USG-guided TAP block has been shown to be a promising technique for providing analgesia after surgery involving anterior abdominal wall.[5,8,9] Considering the intraoperative spillage or leaking of the local analgesic from the TAP plane, and to prolong the analgesic effect, we decided to give USG-guided TAP block postoperatively.

VAS score was low both at rest and on movement in group S as compared to group C throughout 24 h; however, it was statistically significantly low at 30 min, 2, 4, 6, and 12 h [Figures 2 and 3]. This was similar to the observations of a study performed by Mc Donnell *et al.*[10] on cesarean section delivery, where VAS at rest and on movement was found to be significantly low till 12 h in patients who had received TAP block with local anesthetic. Study performed by Niraj *et al.*[11] on open appendicectomy and Neerja Bharti *et al.*[12] on colorectal surgery also showed similar results.

Time to first dose of rescue analgesia (i.e., tramadol) was statistically significantly prolonged in group S (547.133±266.962 min) compared to group C (49.17±24.96 min) [Table 2]. In studies performed by Mc Donnell *et al.*[10] and D. Belavy *et al.*[13] on cesarean section, the time to first analgesic demand was 3-4 h after completion of the surgical procedure, which was not similar to our study. This difference may be attributed to the TAP block given before the surgery, whereas we had given the TAP block at the end of surgery. Also, one time bolus injections of local anesthetics can provide narcotic-limiting pain relief for 4-8 h after the operation; however, it was about 12 h in our study. Other studies also demonstrated that a single shot TAP technique can produce effective analgesia for 36-48 h, attributing it to relatively poor vascularity and therefore slow drug clearance.[14]

One important measure of analgesic efficacy in our study was the requirement of opioid analgesic during the first 24 h. The 24-h consumption of total tramadol was 56% less in group S as compared to that in group C [Table 2]. Our study results are comparable with those of Dawlatly *et al.*[7] who showed 55% decrease in opioid requirement after USG-guided TAP block in laparoscopic cholecystectomy. Niraj *et al.*[11] showed 45% decrease in opioid requirement with USG-guided TAP block in open appendicectomy.

When the block is performed by the so-called "pop" or "double pop" technique in the anatomical area of the Petit triangle, inadvertent needle position can result in severe complications like bowel puncture, nerve injury, and puncture of the liver. Liver injury with landmark technique has been reported in a short stature woman whose liver was enlarged.[6] We did not observe any of these complications as we performed USG-guided block, which allowed real-time visualization of needle tip and relevant anatomical structures, increasing the margin of safety.

Another important concern is the local anesthetic toxicity, particularly when bilateral blocks are performed, as

administration of local anesthetic between fascia layers is associated with fast absorption kinetics. TAP block has been shown to cause systemic toxicity if the local anesthetic spills over into the adjacent muscles.[15] We did not encounter this complication as the surgical procedure selected required unilateral block and we did not cross the toxic dose of Bupivacaine. Hemodynamic parameters like heart rate (HR), mean arterial pressure (MAP), SaO2, and respiratory rate (RR) remained comparable in both the groups at all the time intervals.

Opioid-related side effects like sedation, nausea, and vomiting are related to the dose of opioids. In our study, sedation score as well as nausea and vomiting score were low and comparable in both the groups in spite of the increased need of opioids. This may be due to the use of tramadol, which is less sedative than morphine, and the prophylactic use of ondansetron.

Limitations to our study were that all the blocks were performed by the same person, so the results could not be generalized. Secondly, we studied the postoperative pain for only 24 h as the patients were shifted to oral analgesics after 24 h of laparoscopic RDN.

From this, we conclude that USG-guided TAP block is a promising new technique for postoperative pain management in RDN as a part of multimodal analgesia without any complications. Further studies are warranted to support these findings before establishing it in routine clinical practice in different types of surgical procedures.

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