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Efficacy of ultrasound guided transverse abdominis plane block for postoperative analgesia in laparoscopic cholecystectomy, a prospective randomised controlled trial

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ABSTRACT

Background and Aims: Ultrasound Guided (USG) Transverse Abdominis Plane (TAP) block is a relatively new regional analgesic technique for postoperative pain relief after abdominal surgery. However, the efficacy and safety of TAP block after laparoscopic cholecystectomy is not well established. This prospective, randomized, controlled, double blind study was designed to compare analgesic efficacy of USG guided TAP block over conventional analgesics in patients undergoing laparoscopic surgery during post-operative period. **Methods:** One hundred American Society of Anesthesiologists (ASA) physical status I and II patients undergoing laparoscopic cholecystectomy were randomised into two groups. Patients in Group A (n = 50) received standard analgesics along with USG guided TAP block after induction of anaesthesia while patients in Group B (n = 50) received only standard analgesics postoperatively as per standard protocols of the institution. USG guided TAP block was given using high frequency linear probe (6-13 MHz) with 'in-plane' technique. Once the tip of the needle was confirmed in the facial plane between the Internal Oblique muscle and Transverse Abdominis muscle, Injection Ropivacaine 0.25%, 30 ml was administered bilaterally. Each patient was monitored in Post Anaesthesia Care Unit (PACU). Time duration for demanding first dose of opioid, total dose of opioid used, opioid induced and TAP block technique related complications, hospital stay, Visual Analogue Scale (VAS) scores on rest and coughing at 0.5, 1, 2, 4, 6, 12, 24 hours were recorded in each patient. At the end of study data was analysed using appropriate statistical tests and value of $p< 0.05$ was considered significant. **Results:** Group A patients had a lesser demand of opioid (mean ± SD) 2.44 ± 2.44 mg as compared to patients in Group B (3.96 ± 2.56 mg)($P<0.01$). VAS scores at rest and coughing were (mean ± SE) 1.21 ± 0.07 and 1.43 ± 0.01 in group A and 1.72 ± 0.09 and 2.18 ± 0.18 in Group B ($P<0.01$). There was no difference in time duration for demanding first dose of opioid by patient postoperatively, hospital stay, and opioid related complications in both groups. There was no TAP block technique related complication seen during study. Patients had better analgesic satisfaction after TAP block. **Conclusion:** USG guided TAP block is a safe and effective mode of postoperative analgesia in 24 hours after laparoscopic cholecystectomy.

Key words: Cholecystectomy, Laparoscopy, Ultrasound Guided TAP Block

INTRODUCTION

Various routine methods to control post-operative pain after laparoscopic abdominal surgeries are used, like conventional systemic analgesics including Paracetamol, Non Steroidal Inflammatory Drugs (NSAIDs), IV-PCA (Intra venous–patient controlled analgesia), intra

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peritoneal injection of local anaesthetic drugs, thoracic epidural analgesia, low pressure pneumo-peritoneum and warm air. However, all these methods are associated with various complications which limit their usefulness[1–5].

Peripheral nerve blocks of the lower abdominal nerves is considered to be an effective alternative as it helps in avoiding side effects and complications of other analgesic methods. Transverse Abdominis Plane (TAP) block provides better pain relief to patients after abdominal surgeries and was first described by Rafi in 2001[6]. TAP block involves blockage of sensory nerve supply of anterolateral abdominal wall, that is, T7-T12 intercostal nerves, ilioinguinal and iliohypogastric nerves, lateral cutaneous branches of dorsal rami of L1-3.

Conventional TAP block was a landmark guided technique at "Petit triangle" between neurofascial planes by "double pop" method[7]. The clinical utility of conventional Transverse Abdominis Plane block is limited and the degree of block achieved is unpredictable. The major reason for less efficacy of this block is lack of clearly defined anatomical landmarks, leading to uncertainty regarding the exact location of needle position and lack of evidence of deposition of Local Anesthetic (LA) in correct plane[8]. This blind technique also leads to fatal complications like bowel puncture, liver injury[9]. Due to all these limitations, conventional TAP blocks were not well accepted.

Willschke in 2005 first described USG guided TAP (ilioinguinal) block in children undergoing inguinal hernia repair where he found USG guided ilioinguinal nerve blocks with better results compared to conventional methods[10]. Thereafter, USG guided TAP block was again introduced as a newer technique with better results and minimal complication rates.

Direct ultrasonic visualization of anatomy of anterior abdominal wall and neurovascular structures, direction of needle insertion, its accurate localisation in fascial plane and direct visualisation of deposition of LA in correct plane has led to decreased complications and better block results. Use of USG guided TAP block can reduce time length taken for intervention, decrease number of attempts, increase the accuracy and reduce the time of onset of effect and with almost negligible possibility of accidental puncture of gastrointestinal organs.

Now, role of USG guided TAP block has been described in lower abdominal surgeries, gynaecological surgeries and as pain relief after many other surgeries. In this study, we evaluated analgesic efficacy of ultrasound guided TAP block for 24 hours postoperatively, as part of multimodal analgesic regime, in patients undergoing laparoscopic cholecystectomy.

METHODS

This prospective, double blind, randomized controlled trial was conducted on 100 ASA grade I/II adult patients (>18years), undergoing laparoscopic cholecystectomy under General Anaesthesia (GA) after getting approval from Hospital Ethical Committee. A written informed consent was taken from the patients after explaining them regarding the purpose, methods, effects and complications of the study.

A total 100 patients were studied, out of which 50 received USG guided TAP block with standard intravenous analgesics (GROUP A) and 50 received only standard intravenous analgesics (GROUP B). Patients with Body Mass Index (BMI) >40, coagulopathy disorders, allergy to amide local anesthetics, inability to understand VAS score or study protocol, opioid addiction, infection at local needle site insertion, patient refusal were excluded from the study.

By means of the preliminary clinical study, the sample size was calculated so that reduction of VAS 3 or more would be statistically significant with the significance level, α, of 0.05 and the power of test, 1-β, of 80%. We calculated that 43 patients would be required per group, and selected 50 patients per group, considering the patients that might be excluded.

On entry of patient into study, Pre Anaesthesia Check-up (PAC) including physical, general, systemic examination and routine investigations were done and hence any exclusion criteria were ruled out. Also, on pre-anesthetic visit each patient's baseline heart rate and blood pressure were recorded. Visual Analogue Scale (VAS) score was explained to the patient before surgery and patients who were not able to understand were excluded from the study.

After fulfilling inclusion criteria, patients were randomly allocated to Group A or Group B on the basis of random number system (a person not related to study was asked to choose from closed envelope containing slips of either group before induction of anaesthesia)**.** The computer generated randomization protocol was prepared outside the hospital and was delivered to hospital in sealed opaque envelope.

All patients were premedicated with Tab lorazepam 2 mg,

pantoprazole 40 mg HS before surgery. After taking the patient to operating theatre, IV line was established and monitoring initiated with ECG, NIBP, EtCO2 and SpO2. Induction of GA was done with Injection Fentanyl 1µ gm/Kg, Propofol 2 mg/Kg and rocuronium 0.6 mg/Kg body weight and anaesthesia was maintained with 1MAC Sevoflurane in N2O/O2 (50/50%) mixture. Injection paracetamol 1 gm and injection diclofenac 75 mg were administered i.v after induction of anaesthesia and before skin incision in both the groups.

After induction of GA and stabilization of vitals, USG guided TAP block was given by a senior consultant having two years of experience in USG guided nerve blocks bilaterally on anterior abdominal wall using high frequency linear probe (6-13MHz). After preparing the abdomen and USG probe in a sterile manner, the abdomen was scanned at the level of anterior axillary line between the costal margin and iliac crest. The External Oblique muscle (EOM), Internal Oblique Muscle (IOM), and Transverse Abdominis Muscle (TAM) were identified and then the block was performed with a 21G 100 mm sharp tip needle utilizing an 'in-plane' technique. (Figure 1). Once the tip of the needle was placed in the fascial plane between the IOM and TAM, Injection Ropivacaine 0.25%, 30ml was administered after negative aspiration for blood under direct ultrasonic vision. The contralateral block was performed similarly. In Group B, no TAP block was given and only standard intravenous analgesics were given as per institution protocols.

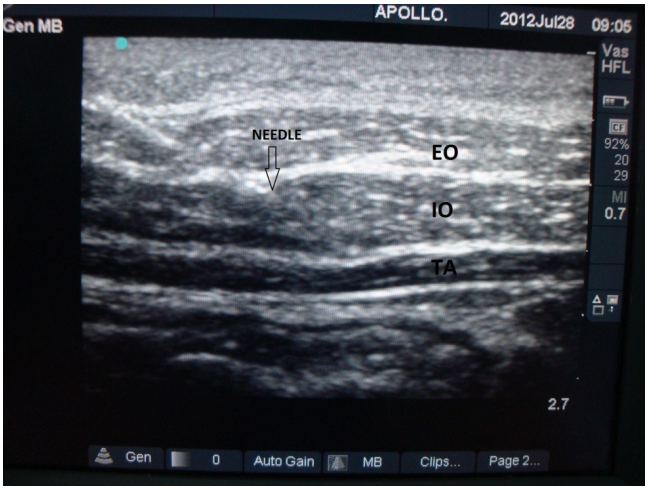

Figure 1. Ultra- sonographic view of anterior abdominal wall (Anterior to Posterior – E.O- External Oblique, I.O – Internal Oblique, T.A-Transverse Abdominis).

Skin incision was given after 15 minutes of TAP block in Group A. The four ports of laparoscopic procedure were placed in anterior abdominal wall. Surgery was carried out routinely and operative time was noted. Vital signs like HR, BP, EtCO2 and SpO2 were monitored and maintained throughout the surgery. At the beginning of skin closure anaesthesia was discontinued and after reversing the residual neuromuscular blockade, tracheal extubation was done.

Postoperatively, after shifting patients to Post Anaesthesia Care Unit (PACU), Injection Paracetamol 1 gm and Injection Diclofenac 75 mg were given intravenously every 6Hourly and 8Hourly respectively for 24 hours in both the groups. Here, each patient was monitored by another doctor for all recordings. Time duration required for the first dose of injection Morphine was noted. After 2 and 24 hours, site of injection of TAP block was inspected to detect any side effects such as hematoma or infection.

Subsequently, vital signs (HR, BP, RR) and VAS scores were assessed at rest and at coughing/ambulation at 30 minutes, 1Hr, 2Hr, 4Hr, 6Hr, 12Hr and 24Hr after shifting to PACU. VAS score was assessed by an anaesthetist who was not present in operation theatre.

Injection morphine 3mg i.v., was given in both the groups if VAS scores ≥ 4/10 and 1mg after every 5 minutes till VAS score became < 3/10 or patient went off to sleep and in between if patient complained of breakthrough pain. Side effects like nausea, vomiting, dizziness, pruritis, urinary retention, respiratory depression and procedure related complications like pain in abdomen or any signs of peritonitis were noted.

RESULTS

One hundred included in the two groups comprising of 50 patients each were comparable in age, gender, BMI, operative procedure time (Table 1). There was no difference in both groups in terms of hospital stay, time duration for demanding first dose of injection morphine and opioid induced complications.

Table 1: Demographic profile of patients in both the groups

	Group A (n=50)	Group B (n=50)	p-value
Age (years) Mean	46.64	46.84	>0.01
Sex (female/male)	38/12	35/15	>0.01
BMI(kg/m^2)	23.9	24.2	>0.01
Hospital Stay (days)	1.52	1.58	>0.01
Time duration for first dose of injection Morphine (min.)	28	22.92	>0.01
Duration of surgery (min.)	42.86	44.60	>0.01

The dose of opioid required was significantly less in Group A as compared to Group B (Table 2).

Table 2: Morphine consumption comparison			
GROUP	Mean Dose of Morphine Used ±SD	Range of Morphine Used (mg)	P Value
Group A	2.44±2.44	0 to 13	0.003
Group B	3.96±2.56	0 to 10	

VAS scores measured at rest (Table 3) and coughing (Table 4) were significantly less in Group A as compared to Group B (Table 3).

Table 3: Mean VAS score at Rest						
GROUP	0.5 Hr	4 Hr	12Hr	24Hr	Mean	p-value
GROUP A	3.22	0.80	0.14	0.18	1.21	<0.01
GROUP B	4.00	1.04	0.20	0.10	1.43	
Table 3 showing mean VAS score at Rest						

Table 4: Mean VAS score at Coughing						
GROUP	0.5 Hr	4 Hr	12Hr	24Hr	Mean	p-value
GROUP A	4.22	1.26	0.42	0.36	1.12	<0.01
GROUP B	5.46	1.78	0.56	0.34	2.18	
Table 4 showing mean VAS score at Coughing						

There was no TAP block procedure related complication seen during the study. Two patients in Group A and four patients in Group B had nausea during the study which was relieved with Injection Ondansetron 4 mg. i.v.

DISCUSSION

USG guided TAP block is a new regional analgesic technique for post operative pain relief after abdominal surgery. Its role is yet to be established in laparoscopic cholecystectomy. In our study, we have compared the analgesic effect of USG guided TAP block through injecting 0.25% of Ropivacaine[14], 30 ml each for the left and the right anterior abdominal wall with conventional analgesics, after laparoscopic cholecystectomy under general anaesthesia. Total dose of Morphine used post operatively in recovery room during 24 hours was significantly lower in the Group A compared to Group B. Group A patients showed significantly lower VAS scores compared to Group B, as assessed at 30 minutes, 1 hour, 2 hours, 4 hours, 6 hours, 12 hours and 24 hours interval after surgery.

TAP block is a relatively new regional anaesthesia technique. It was initiated by Rafi as a landmark based technique within the iliolumbar "triangle of Petit", bounded anteriorly by Internal Oblique, posteriorly by Latissmus dorsi and inferiorly by iliac crest[7,15]. Conventional TAP block used "Double Pop" technique which depended solely on the palpated sensation without a visual guide. It can cause intestinal puncture and unexpected diffusion of local anesthetic into other body parts. It may result in subsequent motor nerve paralysis, and even severe complication such as liver damage.

Three types of USG guided TAP blocks are described. In classical type, now termed as posterior TAP block, LA is deposited in lateral abdominal wall, in mid-axillary line between Internal Oblique and Transverse Abdominis plane which reliably blocks T10 to L1 nerve roots. Second is subcostal type, in which LA is deposited between Rectus Abdominis and Transverse Abdominis muscle. It blocks T6-10 nerve roots and occasionally blocks T12 nerve root but never L1 nerve root. It provides good analgesia after upper abdominal surgeries[16–18].

Third technique is oblique subcostal block, in which a needle is inserted into TAP plane near the costal margin but medial to linea semilunaris with subsequent needle advancement after hydro dissection occurring along a line from xyphoid toward anterior part of iliac crest. This block causes more segmental nerve blockade as compared to both posterior and subcostal nerve blocks and can be used for both supra and infraumbilical surgeries. Recently, many studies are coming up showing better results of analgesia when a catheter is put by oblique subcostal technique and thereafter continuous analgesic drugs are given by the catheter. Hubbard recommends subcostal approach for block but due to technical difficulty in upper abdominal surgery and being easy and safe procedure, we used posterior TAP block approach for TAP block.

A study in 2009 compared USG guided TAP block to conventional analgesics for 24 hours postoperatively after laparoscopic cholecystectomy on 42 patients in a prospective, randomised, controlled trial. He used 15 ml of 0.5% Bupivacaine on each side under USG guidance. He found more requirement of Sufentanil intraoperatively and Morphine postoperatively in control group[19].

In another study on USG guided TAP block after laparoscopic cholecystectomy in 54 patients, with patients divided into three groups (Group A without TAP block, Group B 0.25 and Group B 0.5) Group B 0.25 and Group B 0.5 received USG guided TAP block with 30 ml of 0.25% and 0.5% levobupivacaine respectively. Intraoperative use of Remifentanil and postoperative demand of rescue analgesics in ICU were recorded by Verbal Numerical Rating Scale (VNRS). They concluded that USG guided TAP block with 0.25% or 0.5% levobupivacaine equally reduced postoperative pain in patients of laparoscopic cholecystectomy and also inferred that concentration of drug didn't improve the efficacy to relieve the pain[20].

In a study on 32 patients undergoing large bowel resection by midline abdominal incision by comparing requirement of routine analgesics like patient controlled morphine requirement, NSAIDs and acetaminophen with USG guided TAP block, it was concluded that TAP block provided highly effective postoperative analgesia in first 24 hours after major abdominal surgeries[8].

The pain associated with laparoscopic cholecystectomy is multifactorial, including the pain arising from the incision sites, the pneumoperitoneum and the procedure itself at local resection site of gall bladder. Factors that may possibly influence the degree of pain after laparoscopic procedures include the volume of residual gas, the type of gas used for pneumoperitoneum, the pressure created by the pneumoperitoneum and the temperature of insufflated gas. The length of the operation and volume of insufflated gas may also be related to postoperative pain[21–25].

Pain after laparoscopic cholecystectomy may be differentiated into three components: 1) visceral 2) abdominal wall and 3) referred to the shoulder. Visceral pain in the biliary tract is carried by the sympathetic fibres originating from T_7 to T_{10} and parasympathetic fibres from both the vagal nerves[26]. The anterior abdominal wall sensory innervations involve six lower thoracic nerves (T6-T12) and first lumbar nerve (L1). Referred pain to shoulder is carried by phrenic nerve. They found that pain is worst in the first 24 hours after the operation. Women were reported to have more pain than men[27].

TAP block involves blockage of sensory nerve supply of anterolateral abdominal wall (i.e., T7-T12 intercostal nerves, ilioinguinal and iliohypogastric nerves, lateral cutaneous branches of dorsal rami of L1-3). The innervation of anterior abdominal wall involves six lower thoracic nerves (T6-T12) and first lumbar nerve (L1). Upon leaving the intervertebral foramina, T6-T12 nerve fibres travel between Internal Oblique and Transverse Abdominis muscle and near the Rectus muscle they pierce Internal and External Oblique muscle to reach the surface.

In a study where block was performed in cadavers using methylene blue dye and healthy volunteers using radio-opaque dye with 0.5% lignocaine, cadaveric dissection revealed dye deposition in TAP and in live volunteers they found complete sensory block from T7-L1 dermatome ensuring complete anterior abdominal block. Similar finding of local anesthetic spread and staining of segmental nerves was supported later by MRI findings. The effect of sensory block weaned off after 4-6 hours[28,29].

Dye injected to TAP is found to distribute at T10-L1 levels[30]. In our study, the sensory level was not precisely assessed because procedure was performed after induction of general anaesthesia. Hence, a systemic study regarding sensory block range and success rate of procedure depending on diffusion properties of local anesthetic is needed.

The dose of and concentration of local anesthetic is also needed to be investigated. A study on effect of bilateral Transverse Abdominis Plane (TAP) block with ropivacaine 0.25% or 0.5% versus saline placebo in 70 patients undergoing outpatient gynaecological laparoscopic surgery, revealed reduced pain, decreased opioid consumption and earlier discharges readiness in patients who received ropivacaine 0.25% or 0.5%. There was no significant change in pain score in patients receiving 0.25% and 0.50% Ropivacaine. In order to avoid potential systemic toxicity, the lower concentration of ropivacaine 0.25% can therefore be used.

Belavy et al., in 2009, did a study on 50 patients for analgesic efficacy of USG guided TAP block versus conventional analgesic in patients undergoing caesarean section using 0.5% of Ropivacaine 20ml on each side. He found decreased dose of Morphine used and better pain satisfaction in TAP block group[31].

Better analgesic results even after posterior TAP block technique in our study may be attributed to large volume of LA (Ropivacaine 30ml) as compared to other studies where 15-20 ml LA is used on each side.

CONCLUSION

USG guided TAP block is a simple, safe and effective regional block method for pain relief in laparoscoipc cholecystectomy in first 24 hours postoperatively. Ropivacaine 0.5 % can be used effectively but further studies are needed to look for toxic effects after systemic absorption and efficacy of low concentration ropivacaine 0.25% to get lesser toxic effects.

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