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Research Article

POSTERIOR QUADRATUS LUMBORUM BLOCK VERSUS SUBCOSTAL TRANSVERSUS ABDOMINIS PLANE BLOCK IN LAPAROSCOPIC CHOLECYSTECTOMY

***N.S.Surya Prakash and MD.Ayathullah**

S.V.S Medical College and Hospital, Mahbubnagar

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ABSTRACT

Background and objectives: Effective perioperative analgesia with laparoscopic cholecystectomy enhances early recovery, ambulation, and discharge. Subcostal TAP block has been shown to reduce perioperative opioid use and provide effective perioperative analgesia.Currently,theQLB is performed as one of the perioperative pain management procedures for patients undergoing abdominal surgery. Inthe current study, we hypothesized that the analgesic efficacy of posterior QLB would be equal to or better than the subcostal TAP block in laparoscopic cholecystectomy. **Methods:** 106 patients were randomized for elective laparoscopic cholecystectomy. They were randomly allocated to 2 equal groups, 53 patients each. First group, patients received posterior QLB. Second group, patients received subcostal TAP block. **Results:** Data from 98 patients were analyzed (48 patientsin QLB group and 50 patients in the TAP group). The cumulative postoperative fentanyl consumption at 24hours in patients required postoperative opioids shows no significant difference between the two groups but with lessnumber of patients needing postoperative opioids in QLBgroup (17/48) than in the TAP group (28/50). The time to the first postoperative request for rescue analgesia was significantly longer in QLB group than in the TAP group.There was no significant difference between the two groups as regard PONV, and pain scores at 1, 6, 12, and 24 hours postoperatively. **Conclusion:** Posterior quadratus lumborum block can pro-vide better effective postoperative analgesia in patients undergoing laparoscopic cholecystectomy than subcostal transverses abdominis plane block does.

INTRODUCTION

In laparoscopic cholecystectomy, overall pain is aconglomerate of three different and clinically separate components: Incisional pain (somatic pain) due to trocar insertion sites, visceral pain (deep intra-abdominalpain), and shoulderpain. Without effective treatment, this ongoing pain may delay recovery, mandate inpatient admission, and thereby increase the cost of such care. Moreover, it has been hypothesized that intense acute pain after laparoscopic cholecystectomy may predict development of chronic pain (e.g., post laparoscopic cholecystectomy syndrome).

The uses of peripheral nerve blocks that deliver local anesthetic into the transversus abdominis fascial plane have become popular for operations that involve incision(s) of the abdominal wall. Thus, the Transversus Abdominis plane (TAP) block has been shown to reduce perioperative opioid use in elective abdominal surgeries. However, the efficacy of the TAP block is reportedly only reli-able in providing analgesia below theumbilicus. The ultrasound-guided sub costal transverses abdomen is plane (STAP) block is a recently described variation on the TAP block which produces reliable supraumbilical analgesia. Deposition of local anesthetic in this plane has shown to block the thoracolumbar intercostal nerves which are derived from anterior divisions of spinal segmental nerves T6toL1 anesthetising somatic nerves of abdominal wall but visceral pain following surgery is still an issue.

Currently, the quadratus lumborum block (QLB) is performed as one of the perioperative pain management procedures for all generations (pediatrics, pregnant, and adult) undergoing abdominal surgery. The local anesthetic injected via the approach of the posterior QLB (QLB type-2) can more easily extend beyond the TAP to the thoracic paravertebral space or the thoracolumbar plane , the posterior QLB entails a broad-er sensory-level analgesic and may generate analgesia from T7 to L1. In this study, the posterior QLB (type2) was compared with the subcostal TAP block in laparoscopic cholecystectomy.

METHODS

After institutional Review Board approval the study was conducted between October 1st 2021 and March15th2022.

Corresponding author:* **N.S.Surya Prakash
S.V.S Medical College and Hospital, Mahbubnagar.

Inclusion criteria were patients programmed for elective laparoscopic cholecys-tectomy, ASA I or II, and age over 18years and less than 60-years-old. Exclusion criteria include patient refusal, bleeding or coagulation abnormality, local skin infection and sepsis at site of the block, known hypersensitivity to the study drugs, body Mass Index > 40 kg/m^2, emergency laparoscopic cholecystectomy, and if laparoscopic cholecystectomy turned into open cholecystectomy.

Eligible 106 patients were randomly allocated by the sealed opaque envelope method according to the an-esthetic technique used into 2 equal groups (QLB and TAP groups). All patients were assessed preoperatively by history, physical examination, basal laboratory investigations (complete blood picture, INR, liver functions, and kidney functions tests), ECG, and ECHO if needed. The day before the surgery all patients were familiar with the use of visual analogue scale score identifying 0 as no pain and 10 as worst imaginable pain. Demographic data as age, sex, and BMI were registered.

On arrival to operating room, peripheral intravenous cannula (18-20 G) was inserted and 500 ml ringer solu-tion started to be infused. Standard monitoring startedby electrocardiography (ECG), non-invasive blood pres-sure, and pulse oximetry. General anesthesia was then induced using IV propofol at a dose of 2mg. kg, fentanyl 1 µg. kg, atracurium besylate 0.5 mg.kg to facilitate en-dotrachealintubation. Patients were then mechanically ventilated to maintain end tidal CO_2a round 35 mm Hg. Anesthesia was then maintained using is oflurane 1%, and 60% air in oxygen mixture and top up doses of atra-curium. Intravenousfluids were given per bodyweight and according to intraoperative loss.

After induction of general anesthesia, Paracetamol infusion (15 mg.kg) was given by intravenous infusion to all patients in both groups. In both groups, the block was performed and patients received 20 mL of 0.375%isobaric bupivacaine for each side and we waited 15minutes before surgery start. Fentanyl boluses (0.5µg.kg) was given in case of increase in intra operative mean arterial blood pressure or heart rate of more than 20% of baseline for longer than 5 minutes and dose given was registered. The operation was maintained with normal pressure CO_2 pneumoperitoneum between 10 and 12 mm Hg and conventional 4-portlaparoscopic cholecystectomy. The four ports for the surgery were placed above the umbilicus, below the xiphoid process. These port sites are located between the T_6 and T_{10} dermatomes. All patients were extubated at the end of surgery after neuromuscular reversal. The duration of the surgery was recorded.

In PACU, Ketorolac 30 mg ampoule was given by in-travenous infusion to all patients and then every 8hours in the first postoperative 24 hours. Sensory assessment to evaluate the success of the blockade was undertaken at 1 h postoperatively by pinprick method using blunt needle with minimal skin deformation testing presence or absence of sensory changes from T4- L2 when compared to C3-4 dermatomes. Blockade was considered successful when there were sensory changes at T6-7down to T10-11 dermatomes. Criteria for discharge of patients from PACU are: pain control (VAS≤3), absence of nausea and vomiting, hemodynamic stability, and alert or appropriately responsive to voice and duration of stay at PACU was recorded. Pain was assessed using VAS at 1, 6, 12, 24 hours postoperatively. Any patient deemed to have nausea and or vomiting was recorded. Duration of analgesia was considered as the time interval from an immediate post-operative period until VAS score reached 4. Fentanyl boluses (20 µg) was given if VAS is more than 3 and it might be repeated after 30 minutes until VAS is ≤3 and total dose of fentanyl given was recorded.

In posterior QLB group (type 2), the patients were put in the lateral position and a linear 6-13 MHz ultra-sound transducer (Toshiba SSA-660A, Japan) was placed in the anterior axillary line to visualize the typical triple anterior abdominal layers. Then, the probe was placed in the midaxillary line and at this juncture the anterior abdominal layers started to taper. When the probe was placed in the posterior axillary line as per the posterior approach, sono anatomy showed first the transverses abdomen is disappearing then the internal oblique and external oblique forming aponeurosis and appearance of QL noticed. The posterior aspect of the QL muscle was confirmed, and a 22-gauge 100 mm spinal needle was then guided, in plane, and the needle tip was inserted into this aspect of the QL muscle. Following aspiration, the local anesthetic was then injected into the LIFT(lumbar interfascialtriangle) behind the QL muscle.

The thoracolumbar fascia consists of 3 layers: Anterior, middle, and a posterior lumbar fascia. The anteri-or lumber fascia is the extension of the transversal is fascia; it passes anterior to the quadratus lumborum. The middle lumbar fascia passes between the paraspinal muscles and the quadratus lumborum. The posteriorlumbar fascia has a superficial and deep lamina. In the area where the middle lumbar fascia joins the deep lamina of the posterior layer (paraspinal retinacular sheath) on the lateral border of the erector spinae, a triangular structure named the lumbar interfascial triangle is cre-atedand this is ourtarget.

In the subcostal TAP group, the patients were put in the supine position and a linear 6-13MHz ultra sound transducer (Toshiba SSA- 660A, Japan) was placed in the midline of the abdomen 2 cm below the xiphister-num and moved laterally along the subcostal margin. The trans versus abdomen is muscle was identified lying beneath and extending lateral to the rectus abdominismuscle. A22-gauge 100mm spinal needle is introduced in plane with the probe positioned perpendicular to the abdominal wall, directed parallel to the costal margin but oblique to the sagittal plane. The needle insertion point is near the xiphoid processs and the localanesthetic is initially deposited between transversus abdomen is and the rectus abdomen is muscles. The needle is then directed cautiously inferolaterally to progressively distend the trans versus abdomen is plane parallel to the costal margin blocking the intercostal nerves as they emerge to run into the transverses plane from the xiphoid process towards the anterior part of the iliaccrest.

Using a pervious study in TAP block group; the mean ±SD of cumulative morphine consumption at 24hours was 16±9.9mg. Assuming $\alpha = 0.05$ and $\beta= 0.1$ (90% power) and using the 2-tailed Student t test, 49 subjects will be required in each group to detect a 4 mg reduction in the mean cumulative morphine consumption, which will be considered the minimal clinically significant effect. To allow for dropouts, 53 subjects will be assigned to each group with a total sample size of 106 patients.

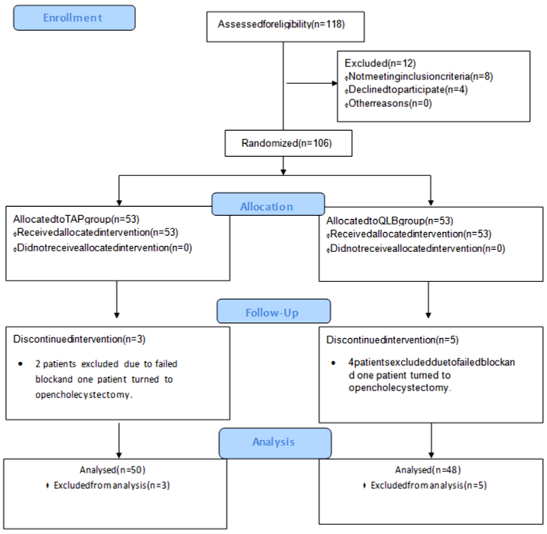

Figure1:CONSORT2010flowdiagram.

Differences between the two groups were analyzed by student's t-test for normally distributed continuous data and were presented as mean ± standard deviation and the Mann-Whitney *U* test for data without normal distribution and were presented as median (range). For categorical data, the chi-square test was used and was presented as number (percentage). P-value < 0.05 was considered statistically significant.

RESULTS

106 patients were randomized, and data from 98patients (48 patients in QLB group and 50 patients in the TAP group) were analyzed (Figure1). Five patients were excluded from the analysis in QLB group, and three patients were excluded from the analysis in the TAP group.

There were no clinically significant differences between the 2 groups as regard age, sex, BMI, and dura-tion of surgery (Table1).

There was no significant difference in VAS at1, 6, 12, 24 hours post operatively (Table 2).

There was no significant difference in cumulative fentanyl consumption at 24hours between the two groups (P = 0.527). The postoperative cumulative fentanyl consumption at 24 hours in patients required postoperative opioids was 58.82±11.11μg in the QLB group and 62.14±17.50μg in the TAP group (Table 3).

There was no significant difference between the two groups as regard intra operative fentanyl consumption (40 ± 7.07 μg in the QLB group and 42 ± 10.36 μg in the TAP group, P = 0.802). The time to the first postoperative request for rescue analgesia was significantly longer in QLB group (420.58 ± 114.76 minutes) than in the TAP group (267.32±62.32minutes) (P=0.000) (Table 4).

31 out of 48 patients (64.58%) did not require post-operative fentanyl in the QLB group and 22 out of 50 patients (44%) did not require postoperative fentanyl in the TAP group (P = 0.03). Also, there was no significant difference between the two groups as regard length of stay in PACU (38.33±7.60 minutes in QLB group and 39.60±8.38 minutes in the TAP group, P=0.505). There was no significant difference between the two groups as regard the incidence of PONV (P=0.375) (Table4).

Table1 Demographic data (age, sex, BMI, and duration of surgery) in the studied groups

	QLB group (n =48)	TAP group (n =50)	P value
Age (years) Mean ± SD	41.97±11.55	41.70±11.56	0.955
Sex (F/M)	36/12	33/17	0.276
BMI (Kg/m^2) Mean ±SD	30.68±3.06	31.50±4.18	0.281
Surgery duration (min) Mean±SD	36.66±8.40	36.80±6.52	0.937

Data are expressed as mean ± SD, number. P value <0.05 was considered statistically significant. QLB: Quadratus lumborum Block group, TAP: Trans versus abdomen is plane block group, BMI: bodymass index, F: Female, M: Male.

Table2 Post operative visual analogue scale (VAS) scoreat1,6,12,and24 hours in the studied groups.

	QLB group (n=48)	TAP group (n=50)	Pvalue
1h	1.00(0-3)	1.00(0-3)	0.323
6h	1.00(0-5)	2.00(0-6)	0.128
12h	1.00(0-5)	1.00(0-4)	0.722
24h	1.00(0-2)	1.00(0-2)	0.244

Data are expressed as median (range). Pvalue <0.05 was considered statistically significant. QLB: Quadratus lumborum block group, TAP: Trans versus abdomen is plane block group.

Table3 Intra operative and postoperative fentanyl consumption,length of stay in PACU,and time of first request to rescue analgesia in both groups.

	QLB(n=48)	TAP(n=50)	Pvalue
Intraoperativefentanylcon sumption(μg)	40±7.07	42±10.36	0.802
Cumulative post operative fentanyl consumption(24h)(μg)	58.82±11.11	62.14±17.50	0.527
Time of first request to rescue analgesia(minutes)	420.58±114.76	267.32±62.32	0.000

Data are expressed as mean ± SD, median (range). P-value <0.05 was considered statistically significant. QLB: Quadratus Lumborum block group, TAP: Trans versus abdomen is plane block group.

Table 4 Number and percentage of patients whodid not require postoperative fentanyl,length of stay in PACU,and PONV (number and perentage) in both groups.

	QLB (n=48)	TAP (n=50)	Pvalue
Number and percentage of patientsdidnot require postoperative fentanyl	31(64.58%)	22(44%)	0.03
Length of stay in PACU(minutes)	38.33±7.60	39.60±8.38	0.505
PONV(number and percentage)	18(37.5%)	18(36%)	0.375

DISCUSSION

To the best of our knowledge, this is one of the first randomized controlled trials comparing posterior QLB versus subcostal TAP block for postoperative pain re-lief after laparoscopic cholecystectomy. As a part of multimodal analgesia, the results of the current study showed that the posterior QLB was a superior analgesic technique compared to subcostal TAP block for post- operative pain relief after laparoscopic cholecystectomy, with significant higher number of patients who did not require postoperative opioids and delaying the time of the first request to rescue analgesia in QLB group.

The primary outcome of this study was to compare the cumulative postoperative opioid requirements at 24hours.Thesecondary out comes were comparing the intra operative opioid requirements, postoperative visual analogue scale (VAS), length of stay at post anesthesiacare unit (PACU), time of first request to rescue analge-sia, and incidence of PONV.

There was no significant difference in cumulative fentanyl consumption at 24hours between the twogroups in patients requiring postoperative opioid. 31out of 48 patients (64.58%) did not require postoperative fentanyl in the QLB group and 22outof 50 patients (44%) did not require postoperative fentanyl in the TAPgroup. Time to the first request for postoperative res-cue analgesia was significantly longer in QLB group than in the TAP group. Also, there was no significant differ-ence between the two groups as regard PONV, VAS at 1,6, 12, 24 hours postoperatively, length of stay in PACU, and intra operative fentanyl consumption.

Comparative studies have shown that the QLB covers a topographically broader field (T7-L1, compared to TAP T10-T12) , and yields prolonged pain-free condition compared to the TAP block (24-48 h QLB versus8-12hTAPblock).

Several studies have shown that subcostal TAP block can produce effective perioperative analgesia for laparoscopic cholecystectomy .

Blanco, et.al. in a previous study has compared posterior quadrates lumborum block versus classical transverses abdominis plane block for postoperative pain relief after cesarean delivery. Patients who received QLB had significantly less cumulative morphine doses than patients who received the TAP block (P <0.005)at 12 hours, 24 hours,andupto48hours.

Ökmen, et.al. has compared posterior QLB plus IV PCA(as a part of multimodal analgesia) versus IV PCA for postoperative pain after laparoscopic cholecystectomy. The VAS scores between the two groups and the mean values of the quantity of tramadol use at the 6^{th}, 12^{th}, and 24^{th} hours were found to be statistically significantly lower in QLB plus IV PCA group.

While QLB have been proposed to accomplish somatic as well as visceral analgesia of the abdomen, TAP blockade is limited to somatic anesthesia of the abdominal wall only, so we recommended QLB as an add on block to reduce the requirement of general anesthetic intra operatively or it could be used as the main component of multimodal analgesia postoperatively.

The advantages of using a posterior approach for the QLB when compared to the lateral or the anterior approach is a more superficial point of injection, better ultrasonographic resolution and a potentially safer injection.

There is currently no general consensus on the mechanism(s) of action of QL blockade.We believe that the thoracolumbar fascia and the spread into the paravertebral space play the primary role in the mechanism of action of the quadrates lumborum block.

TLF is a connective tissue tubular structure envel-oping the back muscles, connects the antero lateral abdominal wall with the lumbar para vertebral region. The TLF is on its medial side attached to the thoracic and lumbar vertebrae, cranially continuing with endothoracic, and caudally with the fascia iliaca, potentially ensuring the spread of local anesthetics in the cranio-caudal direction. It is believed that the local anesthetics spread along the TLF and the endothoracic fascia into the paravertebral space, is responsible in part for the analgesia.

In 2011, Carney, et al. showed that contrast spreads from the L1-T5 segment of the paravertebral space. Hence the assumption that visceral anal-gesia results from the spread of anesthetic to the celiac ganglion or sympathetic trunk via splanchnic nerves, as is the case with the paravertebral block. This remains to be confirmed or denied by future research.

An additional mechanism of action of local anesthetics can be explained by the anatomical-histological characteristics of the TLF. Namely, in the superficial layer of the TLF, there is at thick network of sympathetic neurons. In the fascia, there are the high-threshold and low-threshold mechanoreceptors and pain receptors sensitive to the effects of the local anesthetics. These receptors play a role in the development of both acute and chronic pain. The QLB analgesia could be, at least partially, explained by local anesthetic blockade of these receptors.

So far, studies done on cadavers show that the injected contrast can spread cranially to the thoracic paravertebral space and intercostal spaces covering somatic nerves and the thoracic sympathetic trunk up to the T4 level. Blockade of the subcostal, iliohypogastric, and ilioinguinal nerve is consistent. Caudally, contrast can reach lumbar nerve roots, but the results vary and new studies are needed to clarify the link between the type of QLB and the achieved analgesic effect.

All of these data indicate that the QLB provides somatic and visceral analgesia. Obviously, there are variations in the width of achieved analgesia, and in the number of dermatomes covered by QLB. In most of the cases, analgesia is achieved in T7-L1dermatomes, although there are descriptions of cranial spread to T4-T5, and caudal spread to L2-L3 dermatomes.

This study limitations include the need for an assistant for the lateral positioning of the patient for QLB after general anesthesia and were commend longer duration of follow-up in future research to assess the effect on chronic pain management.

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