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Ultrasound Guided Quadratus Lumborum Block Versus Transversus Abdominis Plane Block for Post-operative Analgesia in Patients Undergoing Total Abdominal Hysterectomy

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Abstract

Objective: Quadratus lumborum (QL) block has emerged as a good option to be included in multimodal analgesia for abdominal surgeries. The aim of the present study was to compare the effectiveness of the QL block with the more established transversus abdominis plane (TAP) block along with a control group in terms of duration of analgesia as the primary outcome in total abdominal hysterectomy (TAH).

Methods: This randomised, double-blind, controlled trial was performed after ethics committee approval and written informed consent. Ultrasound-guided QL (group Q) and TAP (group T) blocks were administered on either side using 20 mL of 0.25% bupivacaine after surgery under general anaesthesia, and group C did not receive any intervention.

Results: There was a significant difference in the duration of analgesia among the groups ($P = .00$). It was significantly longer in group Q (mean = 8.05 hours; 95% CI, 7.28, 8.81) compared to group T (mean = 5.59 hours; 95% CI, 4.63, 6.45) and group C (mean = 1.19 hours; 95% CI, 1.04, 1.34). The verbal rating score ($P = .001$) and the cumulative analgesic consumption ($P = .00$) were the least in group Q. There was no complication in any of the groups. However, the level of satisfaction in patients receiving QL blocks did not differ significantly than in those receiving TAP block.

Conclusion: It is highly recommended to include QL block as a part of multimodal analgesia in TAH as it is superior to TAP block in analgesic effect.

Keywords: Analgesia, pain management, hysterectomy, quadratus lumborum block, transversus abdominis plane block

Introduction

Total abdominal hysterectomy (TAH) is associated with medium to high-level pain. Effective postoperative pain management requires a combination of pre-emptive analgesia, regional and peripheral nerve blocks to provide multimodal analgesia.[1]

Quadratus lumborum (QL) block is a recently developed new technique in the domain of peripheral nerve blocks and has shown promising results, but only a few studies have been performed to prove its efficacy. It is an ultrasound (US)-guided abdominal wall block that has been used to provide post-operative analgesia in abdominal surgery and has been compared with the more established transversus abdominis plane (TAP) block in this regard. Some studies have shown this block to be superior to TAP block in providing postoperative pain relief as shown by decreased opioid consumption and thus have a role in multimodal analgesia.[2,3] The analgesic efficacy and longer-lasting effect of QL block have been attributed to the spread of local anaesthetic (LA) to thoracic paravertebral and

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epidural space, providing additional sympatholytic effect in the thoracolumbar fascia (TLF), which can provide visceral pain relief.[4]

Since the first study on QL block by Blanco et al.,[5] most of the studies have been performed in patients undergoing Caesarean section. The outcome studied mostly is the effect of QL block on post-operative opioid consumption. The duration of analgesia provided by QL block and TAP block has not been studied much. Yousef[6] compared the duration of analgesia provided by the QL block and TAP block in his study on patients undergoing TAH. He has shown a significant difference between the duration of analgesia provided by the QL block as compared to the TAP block. We have tried to validate the efficacy of these two blocks further.

Our study aimed to evaluate the analgesic effects of the US-guided posterior approach QL block and TAP block in patients undergoing TAH. The hypothesis that bilateral QL block provides a longer duration of analgesia in patients undergoing TAH when compared with bilateral TAP block was tested.

The primary outcome was the duration of analgesia after QL block as compared to TAP block determined by the time to first rescue analgesia. Secondary outcomes were total analgesic consumption, pain intensity (verbal rating scale [VRS]) scores, hemodynamic changes like the heart rate (HR), mean arterial pressure (MAP), complications, if any, and patient satisfaction score during 24 hours.

Methods

After approval by the Institutional Ethics Committee of All India Institute of Medical Sciences Patna, on June 25, 2019 (Number: 2019/377), the study was registered to the clinical trial registry of India (registration number for the trial was CTRI/2019/11/021866). Guidelines for good clinical practice were followed. This trial was conducted and reported according to the Consolidating Standards of Reporting Trials (CONSORT) 2010 statement. The study was randomised, controlled and double-blind with a parallel-group comparison in design. It was conducted at the department of anaesthesiology of a tertiary care centre, from June 2019 to January 2020.

Seventy-six patients scheduled for TAH under general anaesthesia belonging to American Society of Anesthesiologists (ASA) risk classification I or II, between the ages of 35 and 65 years and with body mass index (BMI) of 18-30 kg m^{-2} were analysed in the study after written informed consents in their own language.

Exclusion criteria were localised infection at the proposed site of injection, inability to comprehend the scoring systems to be employed due to physical or mental problems, known allergy to the drugs to be used (LAs, opioids), coagulopathy, thrombocytopenia, opioid tolerance or dependence, renal or hepatic impairment and patient with any neurological disorder.

Routine ASA monitoring included electrocardiogram, HR, pulse oximetry and noninvasive arterial blood pressure and capnography after endotracheal intubation. After explaining the procedure to the patient, the general anaesthesia was performed with the administration of propofol 2 mg kg^{-1}, fentanyl 2 mcg kg^{-1} and vecuronium 0.1 mg kg^{-1} intravenously (iv). Anaesthesia was maintained using isoflurane (0.8-1.2 Minimum Alveolar Concentration (MAC)), air and oxygen mixture (1:1). Injections of paracetamol 15 mg kg^{-1} thrice a day were given to all patients, the first dose intraoperatively just after induction. After the completion of the surgery, the proposed block was administered according to the group allocated. Ondansetron 4 mg iv was injected about 30 minutes before the extubation.

Three consultant anaesthesiologists experienced in US-guided regional anaesthesia performed the blocks. US unit (SonoSite M-Turbo) with a curvilinear (5-2 MHz) sterile transducer for QL block and linear transducer (10-15 MHz) for TAP block were used. 21G 100-mm needle (Sonoplex, Vygon SA, Ecouen, France) was used for blocks.

The blocks were performed in the supine position. The pillows underneath the hip and shoulder were placed to the side to be blocked in order to slightly elevate it. In group Q, a QL block via the posterior approach was performed by placing the curvilinear transducer on the midaxillary line between 12th rib and iliac crest. The probe was then moved posteriorly to see the aponeurosis of the transversus abdominis muscle. The QL muscle and the pararenal fat were imaged medial to the aponeurosis. The needle was advanced in-plane in anteroposterior direction under US guidance through the muscle layers of the abdominal wall. The needle tip was moved towards the transversus aponeurosis and positioned posterior to the border of the QL muscle. Two millilitres of saline 0.9% was injected to verify the needle position. If necessary, the needle was repositioned. If it was confirmed that the needle was at an appropriate location, 20 mL of 0.25% bupivacaine was administered, and a similar process was

Main Points

- QL block has recently been used to provide postoperative analgesia in abdominal surgery and has been compared with the more established TAP block.
- Our study aimed to evaluate the analgesic effect of the US-guided posterior approach QL block over TAP block in patients undergoing TAH in terms of duration of analgesia as the primary outcome.
- Patients receiving the QL block had significantly prolonged duration of analgesia as compared to TAP block.
- We recommended to include QL block as a part of multimodal analgesia in TAH.

repeated on the other side. The injection was given after repeated negative aspiration in aliquots of <5 mL.

In group T patients, a TAP block was performed in the supine position by placing a linear US probe (10-15 MHz) in a transverse plane between the lower costal margin and the iliac crest. After identification of transversus abdominis muscle below external oblique and internal oblique muscles, 2 mL of normal saline was injected for the confirmation of appropriate space, and then 20 mL of 0.25% of bupivacaine was deposited in the plane on either side with intermittent aspiration.

In the control group C, no block was administered. The general anaesthesia was reversed using neostigmine 0.05 mg kg^{-1} and glycopyrrolate 0.01 mg kg^{-1}. All patients' pain was evaluated by a verbal rating scale (VRS: 0: no pain, 10: the worst imagined pain). In all three groups, the time when the patient shifted to the recovery after the reversal of anaesthesia was considered as time zero. VRS at time zero was the baseline score after the block and was recorded in all patients.

If the patient experienced VRS >3, then diclofenac (1.5 mg kg^{-1}) was administered. Then, if this was not sufficient after 30 minutes, tramadol (1 mg kg^{-1}) was also given intravenously. If the pain was still persistent after 30 minutes, analgesia was provided by iv morphine (0.1 mg kg^{-1}) up to a maximum dose of 5 mg. The maximum used diclofenac dose was 150 mg, and the tramadol dose was 400 mg through the 24 hours.

The patients were questioned for their pain severity at 0th minute, 15th minute, 30th minute, 1st hour, 2nd hour, 6th hour, 12th hour and 24th hour after the blocks. The total required doses of analgesics through 24 hours were calculated.

Patients' satisfaction score was assessed using a 7-point Likert verbal rating scale after 24 hours (1—extremely dissatisfied, 2—dissatisfied, 3—somewhat dissatisfied, 4—undecided, 5—somewhat satisfied, 6—satisfied and 7—extremely satisfied).

The haemodynamic parameters like HR, MAP, oxygen saturation (SpO_2) and respiratory rate (RR) were recorded after the block, and patients were monitored up to 24 hours after blocks.

Adverse events such as bradycardia (HR <50 bpm or 20% decrease from the baseline value), hypotension (fall in blood pressure by 20% from the baseline or an absolute MAP <60 mmHg), bradypnoea (RR <8 breaths min^{-1}), desaturation (SpO_2 <94%), nausea, vomiting, dryness of the mouth and other possible events during or after the procedures were all noted and managed.

Randomisation and blinding

Patients were randomly distributed to either QL block (group Q) with 20 mL of 0.25% bupivacaine injected on either side (n=25) or TAP block (group T) with 20 mL of 0.25% bupivacaine on each side (n=26) and control (group C) with no intervention (n=25). A clinician not involved in the data collection or in the patient care randomly assigned the enrolled patients into three groups using a list of computer-generated random numbers, and sequentially numbered opaque sealed envelopes were prepared. The anaesthesiologists who administered the block were not involved in uncoding the data, and the observer who recorded all pain scores was also blind to the used method.

The randomisation codes were concealed from the investigators till all measurements, and calculations were entered into the database for all patients. The patients, the investigators and all medical caregivers were blinded to the group allocation. One hour before the block was performed, a nurse, not otherwise participating in the study, opened a sealed opaque envelope containing group allocation. The nurse then filled two syringes 2 × 20 mL labelled "study medicine" with the allocated solution, bupivacaine 2.5 mg mL^{-1}, if it was not the control group. All data were entered into the database before entering the randomization codes. The principles for intention-to-treat analysis were followed.

Statistical Analysis

Sample size calculation was performed using a priori G*Power version 3.0.10 (G*Power, University of Dusseldorf). Our primary outcome was the duration of analgesia, which was expected to be longer in the QL group than the TAP group. From the mean of a previous study, the duration of analgesia for the TAP block was 243.00 ± 97.36 minutes, and for the QL block, the mean was 447.00 ± 62.52 minutes.[7] Considering type I error ($\alpha = 0.05$) and type II error ($\beta = 0.2$ or power of study 80%), the a priori sample was 20. Expecting a 35% dropout rate in the geographical region of the study, the sample size came out to be 27 for each group.

All the statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) version 23 (IBM SPSS Corp.; Armonk, NY, USA). The data were expressed as means and confidence intervals (CIs) for continuous data. The median and interquartile range was recorded for ordinal data. Normal distribution of data was tested by the Shapiro–Wilk Test, and graphical plots and Levene's test were used for homogeneity of the study population. For the continuous data, one-way analysis of variance (ANOVA) was used for multiple group comparison and unpaired student's t-test for intergroup comparison if data were normally distributed and homogenous. Bonferroni correction was utilised

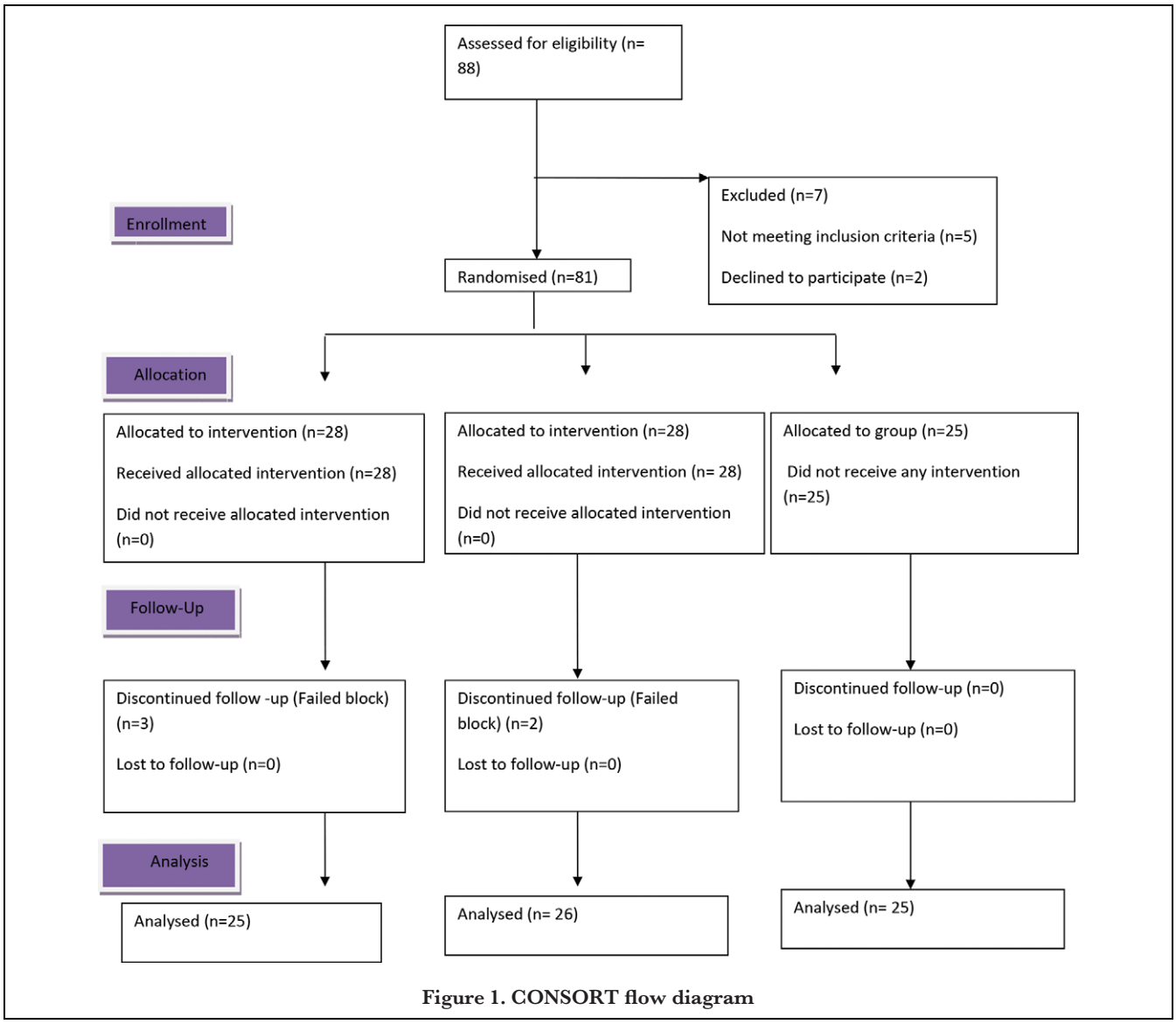

Figure 1. CONSORT flow diagram

for post hoc analysis. For ordinal data, eg, VRS scores (secondary outcomes), Wilcoxon rank-sum and chi-square for intergroup comparison were applied. Mann–Whitney test for failed normality was done. A *P*-value of less than .05 was considered significant for statistical analysis.

Results

Eighty-eight patients were considered eligible; of these, 81 patients were randomly assigned into three groups and 76 of them were included in the analysis (Figure 1). Baseline characteristics did not show significant differences among the groups (Table 1).

Patients receiving the QL block had a prolonged duration of analgesia compared to the TAP block with a standardised mean difference of 0.68 (95% CI, 0.54, 0.84). Group Q had a longer duration of analgesia (mean = 8.05 h; 95% CI, 7.28, 8.81) as compared with the Group T (mean = 5.59 h; 95% CI, 4.63, 6.45) and the control group (Group C) (mean = 1.19 h; 95% CI, 1.04, 1.34). There was a significant difference among the groups ($P = .00$) and intergroup analysis between any two groups (all $P = .00$). Figure 2 shows the duration of analgesia in the study groups.

Analgesic efficacy of 150 mg of diclofenac and 100 mg of tramadol are equivalent to 10 mg of morphine injection.[8,9] A cumulative analgesic consumption score (CACS) of 1 was given to 150 mg of diclofenac or 100 mg tramadol or 10 mg of morphine, and the mean analgesic score was calculated after summing up the scores of all the analgesics consumed accordingly. At 24 hours, the CACS was significantly lower in group Q (mean = 0.74; 95% CI, 0.50, 0.98) compared to

Table 1. Baseline characteristics of patients

Variables	Group Q (n = 25)	Group T (n = 26)	Group C (n = 25)	*P*
Age (years)	43.6 ± 8.54	43.96 ± 6.44	42.52 ± 8.267	0.79 (ANOVA)
ASA 1/2	20/5	19/7	17/8	.61 (Chi square)
BMI (kg/m^2)	23.51 ± 2.02	23.41 ± 1.47	23.15 ± 1.28	0.72 (ANOVA)

Data are presented as mean ± SD and counts.
ASA, American Society of Anesthesiologists; BMI, body mass index.

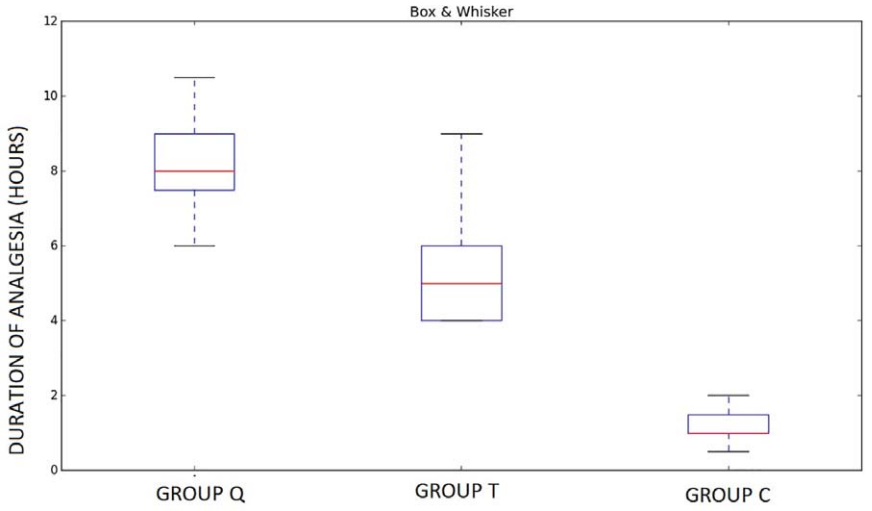

Figure 2. Duration of analgesia

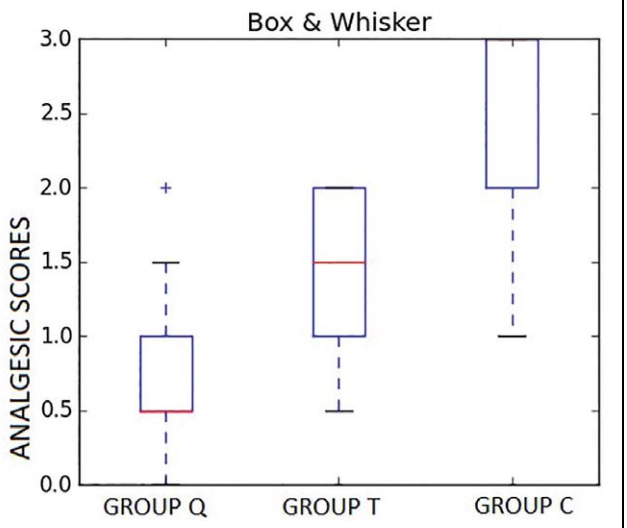

Figure 3. Cumulative analgesic consumption scores

group T (mean = 1.48; 95% CI, 1.26, 1.70) and group C (mean = 2.68; 95% CI, 2.46, 2.90) (P = .00) (Figure 3). However, CACS in group T was also significantly lower than group C (Figure 3).

There were significant group differences in VRS pain scores, which was higher in group C than group T and group Q at all the measured times postoperatively (Figure 4). VRS scores were the least in group Q (Figure 4). Patient satisfaction scores varied significantly among the groups (P = .00). It was significantly higher in group Q (P = .00) and group T (P = .02), when compared with group C. Nevertheless, the satisfaction score in group Q was not significantly different from group T (P = .29) (Figure 5). All patients were hemodynamically stable with regard to the HR, MAP, RR and SpO_2 level (Table 2).

There was no complication detected in any of the groups. Two patients in group Q, two in group T and one in group C suffered from vomiting (treated with iv ondansetron 4 mg),

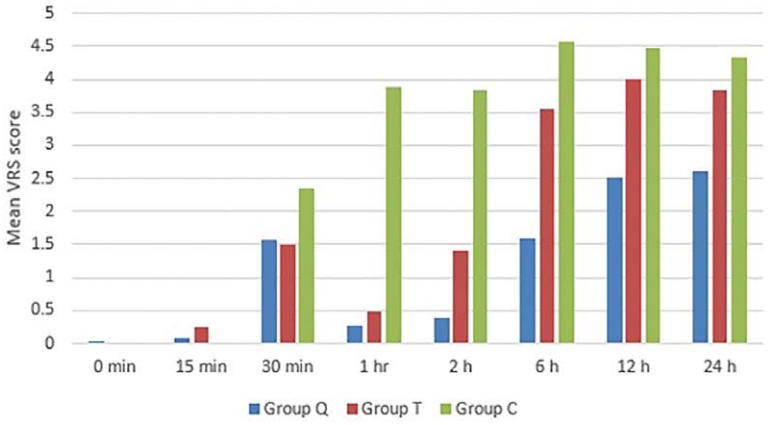

Figure 4. Mean VRS score

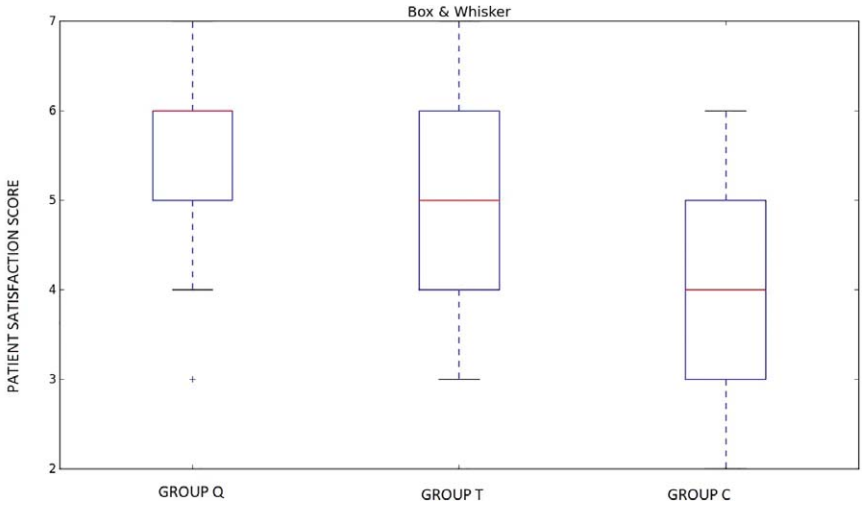

Figure 5. Patient satisfaction score

Table 2. Vital parameters and analgesic scores of patients during various time intervals

Characteristics	Group	0 minutes	15 minutes	30 minutes	1 hour	2 hours	6 hours	12 hours	24 hours	*P* student t test
Mean heart rate	Q	81.26	83.96	84.92	80.46	81.80	82.46	83.15	81.34	.97
	T	85.61	88.31	91.04	92.07	87.27	83.76	84.77	84.23	
	C	89.62	84.67	90	92.77	93.5	91.07	90.73	93.19	
Mean arterial pressure	Q	91.92	88.16	90.76	87.36	92.64	90.12	91.6	89.28	.54
	T	86.12	88.24	92.76	88.8	88.88	89.36	89.64	91.24	
	C	90.44	90.56	91	91.48	87.12	91.24	95.48	84.24	
Mean respiratory rate	Q	14.48	14.72	14.48	14.56	14.56	14.48	14.56	14.56	.385
	T	14.56	14.64	14.56	14.64	14.72	14.64	14.72	14.64	
	C	14.56	14.64	14.56	14.72	14.56	14.72	14.56	14.56	

and one patient in group T experienced shivering (given warming blanket) as adverse effects.

Discussion

The duration of analgesia in patients undergoing TAH was found to be longer in the QL block group as compared to the TAP block and the control groups.

Two studies have compared the duration of analgesia provided by TAP block with that of QL block, one in TAH and another in lower abdominal surgeries.[6,7] However, there was a wide variation in the analgesia duration of these two above-mentioned studies. In 2018, Kumar et al.[7] compared the duration of analgesia provided by the TAP block with the QL block using 0.25% ropivacaine and found the duration of analgesia after the QL to be significantly longer than the TAP block in lower abdominal surgeries. This result was consistent with our study though we used 0.25% bupivacaine. Yousef[6] found the duration of the QL block significantly more than the TAP block in TAH using 0.25% bupivacaine, which was the secondary outcome of their study. None have compared these groups along with the control group, which helps in a better comparison.

Blanco et al.[5] published the first study investigating the analgesic effect of QL block after Caesarean delivery. In a second trial, they compared QL block with TAP block and demonstrated a significantly superior effect of the QL block lasting from 6 to 48 hours.[10] Two explanations of the superior pain relief of QL block when compared to TAP block are that the QL block may facilitate the spread of LA into the paravertebral space, theoretically and that the spread of LA to a network of sympathetic nerves in the TLF is responsible for the long-lasting analgesic effect.[10] Four approaches of QL block have been described.[11] The duration of analgesia may depend on the technique, or the approach of the block, the type of surgery, the concentration and the volume of drugs used for the block.

Our results recorded that the overall analgesic consumption was significantly less in the QL group in comparison with the TAP group. On the other hand, the TAP block was superior to the control group in these aspects. A randomised controlled trial done by Krohg et al.[12] demonstrated a 41% opioid-sparing effect after the QL block in the first 24 hours post-operatively in patients undergoing Caesarean delivery when administered with multimodal analgesia. In 2008, McDonnell et al.[13] described that patients receiving active TAP blocks had a morphine-sparing effect of 70% compared to the control group. The LA doses used by McDonnell et al.[13] were 150 mg of ropivacaine, compared to the maximum dose of 120 mg in the study conducted by Krohg et al.[12] A higher dose of LA may increase the efficacy and/or the duration of the block, but the high serum concentrations may lead to both systemic side effects and toxicity.[14,15] Blanco et al.[10] conducted a randomised controlled trial of 76 patients after Caesarean section and compared the effects of pain management with QL and TAP blocks. Their results showed that the group receiving QL block had less postoperative morphine requirements than the TAP block group.

We observed that the VRS pain scores were significantly less in the QL group than both in the TAP and the control groups. Blanco et al.[10] did not find a significant difference in post-operative pain scores between their two QL and TAP block groups. Zhu et al.[16] demonstrated no difference in VAS scores between patients receiving TAP blocks and QL blocks after 4 and 8 hours of surgery; however, the resting and motor scores 12 and 24 hours after surgery were lower in the QL block group on comparing with the TAP block group. Öksüz et al.[3] reported that patients receiving QL block had less pain scores in comparison to those with TAP block. Kumar et al.[7] also demonstrated lower pain scores in the QL block group than those of the patients in the TAP block group at different time intervals till 24 hours after lower abdominal surgeries. The last two of these findings are consistent with our study. We found the QL block to be superior to the TAP block and the control group in this regard. The techniques of the blocks and the concentration of LA used may account for differences in the results in different studies.

There was no significant difference in the incidence of post-operative nausea, vomiting and other adverse effects among the groups. However, our study was underpowered to infer on this parameter, and a more extensive study with bigger sample size is needed.

We have used the posterior approach for QL block as the point of injection was more superficial and hence safer than other approaches. Also, this approach has a better ultrasonographic resolution. In most of the studies, this approach has been used for similar reasons.[17] A cadaveric study done on different approaches of QL block found no differences in the nerve pattern involved.[18] A study comparing the analgesic efficacy of different approaches of QL block is further required before coming to a conclusion about the effect of the block using different approaches.

There are some limitations to our study. Since this was a US-guided needle placement-based study, it was dependent upon the skills and the expertise of the operator. We overcame this limitation by practicing this block on about 15 patients before starting the study. We do not know the optimal dose of LA for QL block, and a higher dose or volume of LA may have improved and prolonged the analgesic effect. To ensure homogeneous patient groups, those with a BMI more than 30 were excluded from the study. Therefore, we do not know if QL blocks have similar results in obese patients. The given iv analgesics may have some role to play

in VRS score assessment. However, since it was uniformly given to all patients at the same dose and time, its effect may be negated. We have not assessed the dynamic pain scores in this study. Nevertheless, our primary outcome was the duration of analgesia. The assessment of pain intensity and analgesic consumption in clinical pain trials is challenging and represents a limiting factor. This was a single centred small group study.

Conclusions

US-guided QL block prolonged the duration of analgesia and reduced postoperative analgesic consumption in the early management of pain after TAH when compared with the more established TAP block. Both the blocks, however, were superior in analgesic efficacy when compared with control. These blocks are not associated with complications. We thus recommend to include QL block as part of multimodal analgesia as its analgesic effect is a more long-lasting feature than TAP block with analgesic sparing effect, and it can also avoid opioid-related side effects. Further trials are recommended to evaluate the ideal dose, volume and approach for QL block.

Ethics Committee Approval: Ethical committee approval was received from All India Institute of Medical Sciences (2019/377).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Conception - S.N.; Design - S.N.; Supervision - S.N.; Data Collection and/or Processing - R.K., S.J., V.P.A.; Analysis and/or Interpretation - A.A.; Literature Review - E.O., V.P.A.; Writing - S.N.; Critical Reviews - S.N., N.S.

Conflict of Interest: The authors have no conflicts of interest to declare.

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