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ORIGINAL INVESTIGATION

Quadratus lumborum or transversus abdominis plane block for postoperative analgesia after cesarean: a double-blinded randomized trial

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KEYWORDS
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Abstract
Background: Multimodal analgesia (MMA) is the current standard practice to provide post-cesarean analgesia. The aim of this study was to compare the analgesic efficacy of quadratus lumborum (QL) block and transversus abdominis plane (TAP) block as an adjunct to MMA.
Methods: Eighty mothers undergoing cesarean delivery under spinal anesthesia were randomized to receive either TAP or transmuscular QL block (QLB) with 20 mL 0.375% ropivacaine on each side. Postoperatively, all the subjects were assessed at 2, 4, 6, 8, 12, 18, and 24 hours. The primary outcome was the time to first analgesic request. The secondary outcomes were the pain scores during rest and movement, number of doses of tramadol, postoperative nausea-vomiting, sedation, and mother's satisfaction with the pain management.
Results: The median (IQR) time to first analgesic request was 12 (9.25, 13) hours in the QL group and 9 (8.25, 11.37) hours in the TAP group ($p = 0.0008$). Patients in QL group consumed less doses of tramadol than those in TAP group ($p < 0.0001$). Pain scores were significantly lower in the QL group at all time points ($p < 0.0001$) except at 8th hour when at rest, $p = 0.0024$, and on movement, $p = 0.0028$. The maternal satisfaction was significantly higher in the QL group ($p = 0.0017$).
Conclusion: Our study showed the significant delay in time to first analgesic request in QL group patients. Patients in the QL group had lower pain scores, required fewer analgesic supplements, and had more satisfaction. Nausea-vomiting and sedation were comparable.

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Introduction

Cesarean is a major surgical procedure with substantial postoperative pain.[1] Effective pain-relief facilitates early mobilization and enables the mother to take adequate care of the new born. Despite there being varied choices of drugs and routes of administration, we have yet to achieve a safe and effective method of pain control after cesarean.[2,3] Patient controlled analgesia (PCA) provides better pain relief and patient satisfaction compared to the earlier practices. However, unwanted effects like sedation, nausea-vomiting, and pruritus remain a major issue with opioids even when used in PCA.[2] In addition, secretion of opioid into breast milk remains a unique concern in this population.[4] At present, multimodal analgesia (MMA) is considered the standard practice for postoperative pain management.[3] Peripheral nerve block like transversus abdominis plane (TAP) block is an effective component of multimodal analgesia after cesarean.[5] Meta-analyses have also shown that it provides effective analgesia for somatic pain and reduces the opioid consumption.[6,7] Contrary to this, other studies have observed that the QLB could provide better analgesia then TAP block in cesarean patients.[8,9] Among various approaches of QLB, the transmuscular approach (TQLB) has better analgesic profile due to paravertebral spread.[10–12] However, it is not yet established that TQLB is equally superior to TAP as the other approaches of QLB to provide postoperative analgesia in cesarean. Therefore, we conducted a double-blinded randomized trial to compare the TAP and the TQLB for postoperative analgesic efficacy in cesarean.

Methods

After approval from the institutional ethical committee, the study was registered with the Clinical Trial Registry of India (CTRI/2017/12/010987 [Registered on: 27/12/2017].

A total 80 full-term parturients aged 20–40 years scheduled for elective cesarean under spinal anesthesia were enrolled into the study after obtaining written informed consent. The patients excluded from the study were those who have history of drug allergy, BMI (body mass index) > 35 $kg.m^{-2}$ or weight < 50 kg. This is to avoid technical difficulty in administering the block and to limit maximum ropivacaine dose to 3 $mg.kg^{-1}$. Patients who had contraindications to regional anesthesia, bleeding diathesis, and infection at the site of block were excluded. Patients with severe pre-eclampsia, eclampsia, and who had intraoperative complications or post-partum hemorrhage were also excluded. Patients were randomly allocated into two equal groups, QL and TAP (40 patients in each group), using a computer-generated sequence of random numbers (Fig. 1) by technical staff. The group sequence was concealed in a sealed opaque envelope which was opened only after obtaining informed consent by the assisting nurse. The observer was blinded and the patient was not informed about the technique received. As per standard institutional protocol, preanesthetic check-up was done and all the patients were premedicated with injection metoclopramide (10 mg) and ranitidine (50 mg) intravenously (IV), 1 hour before surgery. In the operation room, noninvasive monitors were connected and co-loading with 500 mL Ringer's lactate was done while patients received a standard spinal anesthesia with 12.5 mg of 0.5% hyperbaric bupivacaine with 26G Quincke spinal needle in sitting position. Heart rate, blood pressure & oxygen saturation were monitored in the operating room. At the end of the surgery, both blocks were performed bilaterally with complete aseptic precautions (gown, gloves, facemask, and protective sheath for the ultrasound probe) and under ultrasound guidance (SonoSite M-Turbo©). A 21G, 100-mm needle was used. A total 40 mL of 0.375% ropivacaine (obtained by mixing 20 mL of 0.75% ropivacaine with 20 mL of normal saline) was injected for bilateral blocks. To give TAP block, a linear high frequency ultrasound probe (6–13 MHz) was placed transversely in the mid axillary line between the iliac crest and the costal margin. The three layers of muscles, the external oblique, the internal oblique, and the transversus abdominis were identified. Using the in-plane technique, needle was inserted (from anterior to posterior direction) until the tip of the needle reached between the internal oblique and the transversus abdominis. Hydro-dissection with 1–2 mL saline was done to separate the fascial layers. After the correct localization, 20 mL of the drug was injected with repeated aspiration to avoid the accidental intravascular injection. To perform the TQLB, the patient was placed in the left lateral position. A low-frequency convex probe (5–2 MHz) was placed just cranial to the iliac crest in the transverse plane. Transducer was then moved dorsally maintaining the transverse orientation until the QL muscle was identified at its attachment to the lateral edge of the transverse process of the L4 vertebra. After identifying the various muscles, the needle was inserted in-plane from the posterior edge of the convex probe through the QL in an anteromedial direction. The needle tip was placed between the psoas major (PM) muscle and the QL muscle. Hydro-dissection was done with 1–2 mL of saline and then the local anesthetic drug was injected into the fascial plane after negative aspiration. We used the single decubitus position to give bilateral block to avoid the difficulty of positioning as suggested earlier (Fig. 2A–D).[13] The patients were monitored closely while performing the block for any signs of LA toxicity. Following the block, patients were shifted to the postoperative area and monitored over a period of 24 hours for pain at rest, pain on movement (on flexion of lower limbs while patient is in supine position), nausea, and sedation at an interval of 2, 4, 6, 8, 12, 18, and 24 hours after surgery. Postoperatively, all the patients received 75 mg diclofenac IV 12-hourly (one dose was given in the operation room during skin closure). All the subjects were asked to rate their pain at rest and on movement using a visual analogue scale (VAS) with ''0'' representing no pain and ''10'' being the worst imaginable pain. Injection tramadol 50 mg IV was given as rescue analgesic whenever the patient demanded or if visual analogue score (VAS) was > 3. The time to first analgesic request was noted in all the subjects. The total supplemental doses of tramadol consumed in 24 hours were recorded. The severity of postoperative nausea-vomiting (PONV) was measured according to a 4-point rating score (0: absent, 1: mild, 2: moderate, and 3: severe or vomiting). If any patient complained of nausea or vomiting (score 1 or more), 4 mg ondansetron IV was given. Sedation was assessed by a 4-point scale (1: fully awake; 2: somnolent and responds to verbal stimuli; 3: somnolent but

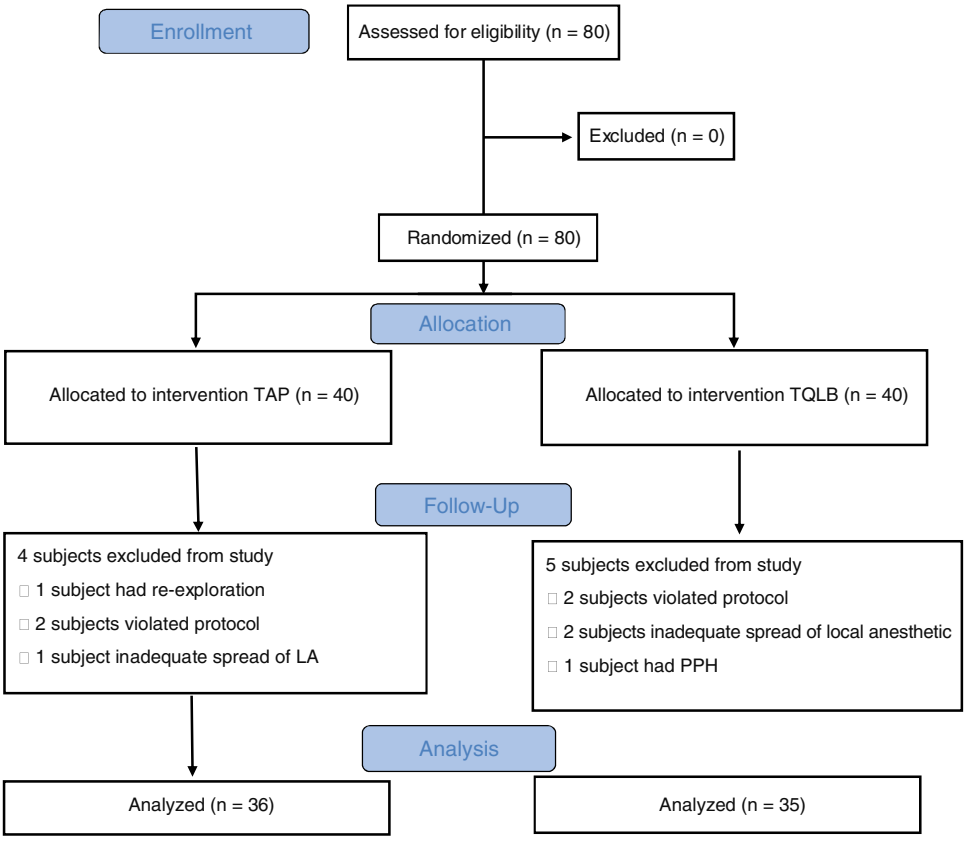

Figure 1 Flow diagram of randomization and follow-up of enrolled patients. LA, Local Anesthetic; TAP, Transversus Abdominis Plane; TQLB, Transmuscular Quadratus Lumborum Block.

responds to tactile stimuli; 4: somnolent and responds to only painful stimuli). At the end of the study, patients were asked to rate their satisfaction with the pain management on a 3-point scale (1: dissatisfied, 2: satisfied, 3: highly satisfied). Primary outcome was the time to the first dose of rescue analgesic. The secondary outcomes were the total doses of tramadol (rescue analgesic) consumed in the postoperative period over 24 hours, VAS score for pain at rest and on movement, PONV, and patient's satisfaction.

The sample size was calculated with the help of the computer software MedCalc version 19.2.1. The sample size was calculated based on the results obtained from a pilot study which was conducted at our institute. In that study, the time to first analgesic request (mean ± SD) in hours was 9.69 ± 2.83 hours. The sample size was aimed to detect a 20% difference in the time to first analgesic request. Assuming the power of the study at 80% and a clinical significance of 95%, a total of 70 subjects were required to detect this difference. To account for attrition, we enrolled 80 subjects into the study. The study was started in February 2018 and was completed in November 2019. The results were analyzed using the statistical software (MedCalc version 19.2.1.). The maternal and intraoperative characteristics were assessed using the Student's *t*-test (two-tailed, unequal variances) and the chi-square test as appropriate. Continuous data was assessed for normality using the Kolmogorov-Smirnov test of normality. Normally distributed data (represented as Mean ± SD) was assessed using the Student's *t*-test (two-tailed, unequal variances) and non-normally distributed data [represented as median (range)] was assessed using the Mann-Whitney U test. Ordinal data was represented as median & interquartile range (IQR) and assessed using the Mann-Whitney U test. The time to first analgesic request was assessed using the log rank test. A p-value < 0.05 was considered significant.

Results

A total of eighty patients (n = 40 TAP group and n = 40 QL group) were enrolled into the study. Four patients in the TAP group were excluded from study (one subject underwent re-exploration; two subjects violated the protocol and one subject had inadequate drug spread). Five patients in the QL group (two patients because of inappropriate LA spread, two because of protocol violation and one due to postpartum hemorrhage) were excluded from study. A total of 71 patients (n = 35, QL and n = 36, TAP) were analyzed as shown in the consort diagram (Fig. 1).

Demographic variables and intraoperative characteristics are shown in Table 1. The median (IQR) time to the first analgesic request was 12 (9.25, 13) hours in the QL group and 9 (8.25, 11.37) hours in the TAP group. This difference was significant [p = 0.0008; 95% confidence interval (C.I.), 10.30 to 12.00)] (Fig. 3) (Table 1). The median (IQR) number of tramadol doses consumed in the TAP group was 1.5 (1, 2) compared to 0 (1, 2) in the QL group (p < 0.0001; 95% C.I., 0 to 1) (Table 1). At all points during the study period

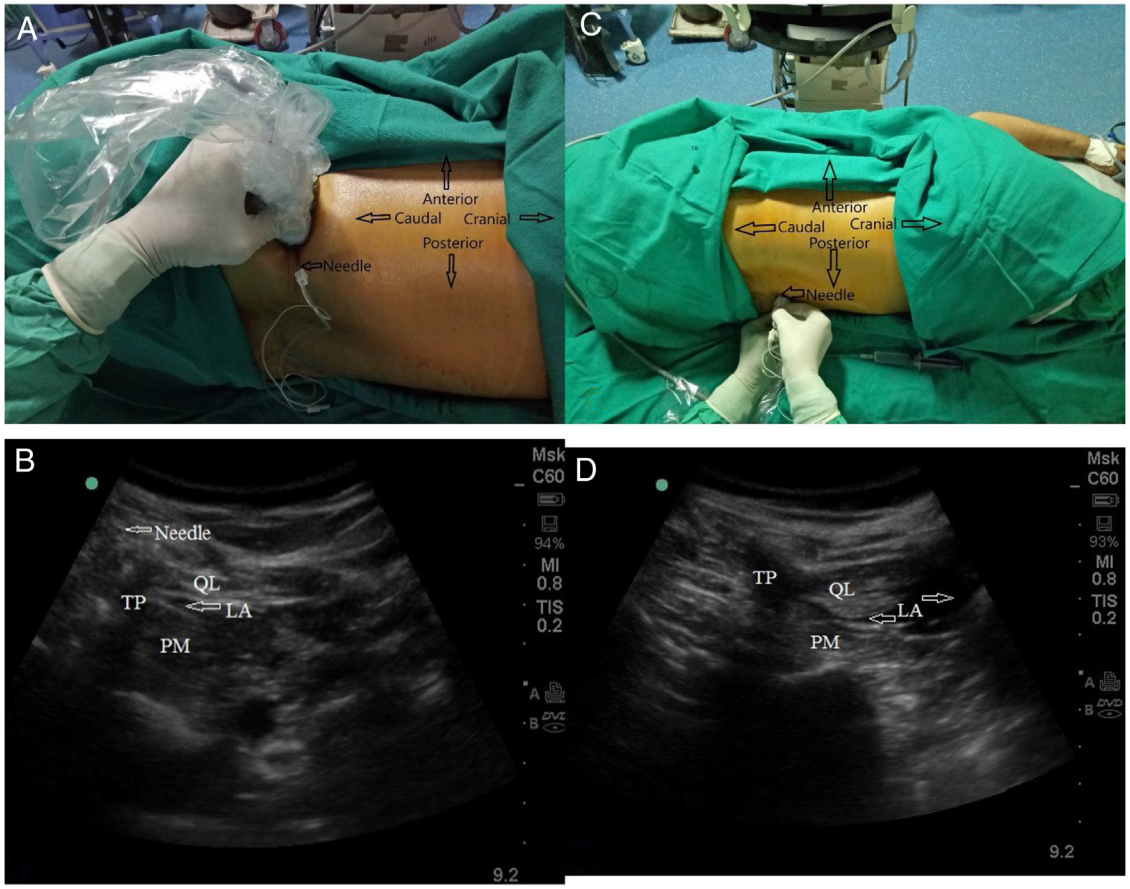

Figure 2 A, The patient in lateral position. B, Curvilinear probe (2–6 MHz) just above and posterior to the iliac crest with the needle entering from the posterior to anterior direction and its corresponding Sonoanatomy. C, Ultrasound probe position and needle entry for quadratus lumborum block of the opposite side and its corresponding Sonoanatomy (D). QL, quadratus lumborum; PM, psoas major; TP, transverse process (L4); LA, local anesthetic.

Table 1 Demographic variables, intraoperative characteristics, request to first analgesia supplement, number of tramadol doses, and satisfaction of the study participants. Time to first rescue analgesic in QL was significantly more than TAP group $p = 0.0008$, (log rank test)[a] Number of tramadol doses, Median (IQR) were significantly more in TAP group $p < 0.0001$, Maternal Satisfaction was significantly more in QL group $p = 0.0017$ (Man-Whitney U test)[b].

Characteristic	TAP Group (n = 36)	QL Group (n = 35)	*p*-value
Height (cm) (mean ± SD)	150.5 ± 4	150.6 ± 4.2	0.9422
Weight (kg) (mean ± SD)	59.1 ± 5.5	58.6 ± 5.2	0.706
Duration of surgery (min) (mean ± SD)	54.4 ± 2.1	54.2 ± 2.3	0.7914
QL	9 (8.25,11.37)	12 (9.25,13)	0.0008[a]
First analgesic request in hours Median (IQR) (n = 35)			
Number of tramadol doses consumed in 24 hours Median (IQR)	1.5 (1, 2)	**0 (1,2)**	< 0.0001[b]
Maternal satisfaction Median (IQR)	2 (1.25,2)	**2 (2, 3)**	0.0017[b]

of 24 hours the pain scores both at rest and on movement were significantly lower in the QL group compared to the TAP group ($p < 0.0001$) at all time points except at 8th hour where at rest, $p = 0.0024$ and during movement $p = 0.0028$ (Fig. 4). There was no difference in the PONV scores between the TAP and QL groups ($p = 0.836$). There was no difference with respect to sedation between the two groups ($p = 0.185$). The maternal satisfaction score was significantly higher in the QL group (median, (IQR)) 2 (2, 3) compared to the TAP group 2 (1.25, 2), ($p = 0.0017$; Mann-Whitney U test, 95% C.I., 0–1) (Table 1).

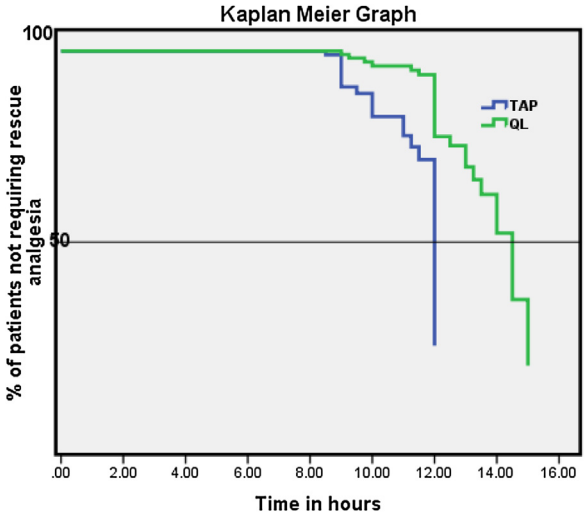

Figure 3 Kaplan Meier graph showing the % of patients in each group not requiring supplemental analgesia over time ($p < 0.0008$, log rank test). TAP, transversus abdominis plane; QL, quadratus lumborum block.

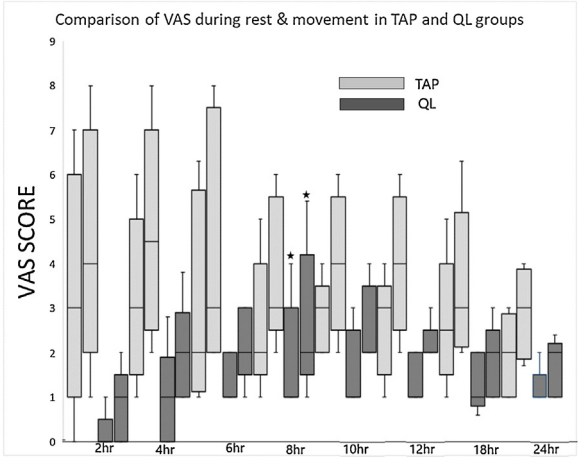

Figure 4 Box and plot graph of pain scores (VAS) over 24 h. At each time point, the first bar represents VAS score of pain at rest in the TAP group; the second bar, VAS score of pain on movement in the TAP group; the third bar, VAS score of pain at rest in the QL group; and the fourth bar, VAS score of pain on movement in in the QL group. The middle line in each box represents the median value, the outer margins of the box represent the interquartile range and the whiskers represent the 10th and 90th percentile at each time point ($p < 0.0001$, except at 8 h marked with * where $p = 0.0024$ at rest and $p = 0.0028$ on movement, Mann-Whitney U test). VAS, visual analogue scale; TAP, transversus abdominis plane; QL, quadratus lumborum.

Discussion

Postoperative pain is the most important concern following cesarean delivery as it interferes with the recovery of mother as well as her interaction with the new born.[4] For managing the postoperative pain after cesarean, opioids are still a preferred choice by many practitioners.[1,2,14,15] However, due to the undesirable side effects of opioids in the mother and concerns of neurological impact on neonates,[4] regional techniques have been used to minimize the dependency on opioids for analgesia. The TAP block as a part of the MMA regimen effectively manages the postoperative pain and reduces the opioid consumption.

However, variable results were observed when TAP block was used as part of MMA in cesarean patients. Studies have shown that the TAP block was effective in reducing pain scores, morphine consumption, and PONV for 24 hours compared to the placebo group.[16,17] Other studies did not find this proposed advantage of analgesia after cesarean.[18,19] There have been many speculations in view of these differential outcomes. One reason could be the spread of the local anesthetic.[20] As it was seen, the analgesia was better when the injection was given more posteriorly (posterior TAP) rather than near the anterior axillary line (lateral TAP).[7] It is believed that injection of local anesthetic during posterior TAP spreads to the thoracic paravertebral space and relieves the visceral pain by blocking the sympathetic nerves.[21] The QL block, which is supposedly a posterior TAP block, also affects the sympathetic nerves and works as a peripheral sympathetic field block.[22] Blanco supported his premise in his first double blind, randomized prospective study of the QL block (type 1) vs. placebo in cesarean and later on comparing the QL block with the TAP block. He found a significant reduction in the morphine consumption and visual analogue scores during 48 hours after the QL block administration.[8,9] Our randomized study has demonstrated the long duration of analgesia and an opioid-sparing effect of the TQLB during the first 24 hours as compared to the TAP block. There are many approaches of the QL block and each one has variable spread of the local anesthetic. However, more clinical studies are required to ascertain if this variable spread affects the block efficacy.[10,12] The analgesic potential of the lateral QL block (QL1) and the posterior QL block (QL2) in cesarean have already been studied.[8,9,23] There are case reports suggesting the efficacy of TQLB in cesarean[24]; however, the effect of TQLB (QL3) is not well studied. We conducted this randomized study to compare the TAP and the TQLB and found that the TQLB was more efficacious than the TAP in reducing the doses of rescue analgesics and provided better pain relief over 24 hours. Even though we did not monitor the visceral and the somatic pain separately, the most probable reason of effective pain relief after TQLB is its potential to block the visceral pain.[24,25]

The patient's positioning during TQLB remains a challenge because the patient must be placed in the lateral decubitus position twice to block the respective sides. We overcame this innovatively by administering the bilateral blocks in a single lateral decubitus position (Fig. 2A–D).[13] Recently, supine position has also been described to give bilateral TQLB in pediatric patients[26] and to provide analgesia in cesarean.[27]

Although studies comparing various approaches of QLB for analgesia after cesarean are lacking, it is presumed that the technique where the local anesthetic spreads to the paravertebral space is likely to be more effective.[25,28] Contrary to this, a recent study has shown that the combination of QL2 + QL3 is more effective than the individual QLB.[27] The proposed explanation is that, during QL2 block, the positioning of needle is difficult and its position may vary. This can cause inconsistent spread of the local anesthetic and thus may affect the outcome. However, when it is combined with

the transmuscular QLB (QL3, which has definitive endpoint and consistent drug spread), the pain relief is superior to the individual technique. However, this rationale has yet to be validated by other studies.

The satisfaction with respect to the pain management was significantly more in the QL group than in the TAP group (p = 0.0017). This difference can be easily explained as the patients in QL group have better pain relief and required fewer analgesic interventions. Other studies have observed similar results.[24,29] There was no statistical difference among the QL and the TAP groups with respect to sedation and incidence of PONV.

The local anesthetic systemic toxicity (LAST) is a serious concern whenever a large amount of local anesthetic is used.[5] To obtain an optimal dose of LA for the QL block without compromising on safety (to avoid LAST), the dose reference was taken from Murouchi et al in which 150 mg of ropivacaine (0.375%, 20 mL per side) was considered safe.[30] Bilateral sympathetic block caused by the paravertebral spread of local anesthetic particularly in QL1 block can cause hypotension.[31] However, none of our patients in either group had any block related complications.

Last but not least, the ease of performing the procedure is an important concern. TAP block is an easy procedure while QL blocks are considered technically difficult due to the deep anatomical end point and the positioning.[13,28] However, QLB ends up having an upper hand as it provides long-lasting analgesia and reduces consumption of opioid[24,27] even when compared to the intrathecal opioids.[29] Additionally, various studies have shown the consistent superior analgesic profile of QLB over TAP.[8,9,23,24] Addressing the difficulties in positioning during TQLB, we think that newer approaches may prove helpful in the future to resolve the issues related to patient positioning.[13,26,27]

The major positive aspect of our study was that we conducted a prospective randomized comparative study of TQLB and TAP for postoperative analgesia in cesarean, when very few of such studies were yet available. We think that our study may further contribute to the evidence of superior efficacy of TQLB over TAP. Nonetheless, the present study has its limitations. First and foremost, we kept the study period for 24 hours, when it would have been better to have a longer study period. We have assessed the pain on movement by asking the patient to fold the lower limbs and this should have included more parameters. The assessment of patient satisfaction was only directed at pain management, whereas satisfaction for a parturient may have different aspects. The present study was a single center trial and therefore large multicenter trials are suggested before generalizing the results of the current trial.

Conclusion

Transmuscular quadratus lumborum block (TQLB) provides longer duration of pain relief, reduces the use of supplemental analgesia, and increases the satisfaction in mothers undergoing cesarean when compared to the TAP block.

Conflicts of interest

The authors declare no conflicts of interest.

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