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ORIGINAL ARTICLE

Transversus abdominis plane block reduces postoperative pain intensity and analgesic consumption in elective cesarean delivery under general anesthesia

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Abstract
Purpose It is reported that following abdominal surgery, transversus abdominis plane (TAP) block can reduce postoperative pain. The primary outcome of this study was the evaluation of the efficacy of TAP block on pain intensity following cesarean delivery with Pfannenstiel incision.
Methods Fifty pregnant women were randomized blindly to receive either a TAP block with 15 ml 0.25% bupivacaine in both sides (group T, $n = 25$) or no blockade (group C, $n = 25$) at the end of the surgery, which was performed with a Pfannenstiel incision under general anesthesia. The pain intensity in the patients was assessed by a blinded investigator at the time of discharge from recovery and at 6, 12, and 24 h postoperatively, with a visual analogue scale (VAS) for pain.
Results The women in the TAP block group had significantly lower VAS pain scores at rest and during coughing and consumed significantly less tramadol than the women in group C [50 mg (0–150) vs. 250 mg (0–400), $P = 0.001$]. There was a significantly longer time to the first request for analgesic in the TAP block group [210 min (0–300) vs. 30 min (10–180) in group C, $P = 0.0001$].
Conclusion Two-sided TAP block with 0.25% bupivacaine in parturients who undergo cesarean section with a Pfannenstiel incision under general anesthesia can decrease postoperative pain and analgesic consumption. The time to the first analgesic rescue was longer in the parturients who received the TAP block.

Keywords Analgesia · Cesarean delivery · Pain intensity · TAP block

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Introduction

The pain and discomfort following cesarean delivery is mostly due to the abdominal wall incision and dissection of muscles; it delays early ambulation and breast feeding. This can lead to postoperative complications such as thromboembolic disorders [1]. So, providing an effective and safe postoperative analgesic method seems to be mandatory. Opioid analgesia remains the most effective means of relieving pain in a wide variety of conditions [2]; however, it may cause adverse effects such as nausea, vomiting, pruritus, urinary retention, and respiratory depression [3–5]. As the analgesia and the side effects of opioids are dose-dependent, a multimodal approach may enhance analgesia, which in turn would decrease the side effects [3].

Mc Donnell and colleagues have reported that a transversus abdominis plane (TAP) block can decrease the postoperative pain following abdominal surgery [6]. The landmarks of this block were first described in 2001 by Rafi [7]. The TAP block has been performed for postoperative analgesic control in patients undergoing radical prostatectomy, hysterectomy, cesarean delivery under spinal anesthesia, and laparoscopic surgery [8, 10–15].

To our knowledge, the use of the TAP block in parturients who have cesarean delivery under general anesthesia has not been surveyed in any studies so far. So, we

designed this study to evaluate the analgesic effect of the TAP block as part of a multimodal analgesic regimen. The primary outcome of this study was the effect of the TAP block on postoperative pain intensity. Postoperative analgesic consumption and the time until the first analgesic request were considered as the secondary outcome.

Methods

After getting the approval of the Institutional Ethics Committee and having the informed consent signed, 50 ASA physical status I–II term primiparous single-tone pregnant women aged 20–40 years scheduled for elective cesarean section with Pfannenstiel incision, under general anesthesia, were enrolled in the study. The women were scheduled for elective cesarean section performed with a Pfannenstiel incision under general anesthesia.

Patients with a history of addiction (including opioids and benzodiazepines), sensitivity to prescribed analgesics, psychological disorders, or coagulopathy, and any patients with surgical complications during cesarean section, infection of the block injection site, and those receiving any drugs within 48 h of surgery (except for the study protocol) were excluded from this study.

In a controlled, randomized double-blind design, patients were allocated to 2 groups, using a computer-generated randomization list, to receive either 30 ml of bupivacaine 0.25% (15 mL in each side) as a TAP block (group T, $n = 25$), or no blockade (group C, $n = 25$) at the end of surgical procedure.

At the time of the preoperative visit, a trained investigator explained the study plan and the scale [visual analogue scale (VAS) for pain] used in the study to the patients. Drug solutions were prepared and blocks were done by an anesthesiologist who was not involved in the data collection, and patients received their block when they were under anesthesia; thus, both the investigators and the patients were blinded to the group assignment.

The severity of postoperative pain was measured and recorded using a 10-cm VAS, where $0 =$ no pain and $10 =$ the worst possible pain. Patients were asked to score the pain at different times after the operation, both at rest and during coughing, including the time of discharge from recovery and 6, 12, and 24 h later.

In the operating room, an infusion of 7 mL/kg lactated Ringer's solution was commenced. All patients were monitored with an electrocardiogram (ECG), non-invasive blood pressure, and pulse oximetry. All patients received rapid sequence induction of anesthesia. Anesthesia was induced with sufentanil 5 μg and thiopental sodium 5 mg/kg, and the trachea was intubated after the administration of succinylcholine 1.5 mg/kg. After tracheal intubation, anesthesia was maintained with isoflurane 0.8%, N20 50%, and 0.4 mg/kg atracurium. After the delivery of the neonate, 0.1 mg/kg morphine and 15 μg sufentanil was administered. Ventilation was adjusted to maintain normocapnia (end-tidal carbon dioxide partial pressure 4.7–5.3 kPa). Patients were actively warmed to keep core temperature normothermic.

At the end of the surgical procedure and wound dressing, the patients in group T received the TAP block. The TAP block was performed bilaterally as described by Mc Donnell et al. [6]. The triangle of Petit was identified and a blunt regional anesthesia 22-G needle of 50-mm length was inserted at a right angle and advanced until a second "pop sensation" indicated the correct needle position in the transversus abdominis fascial plane. Fifteen ml of bupivacaine 0.25% was injected in each side. No injection was done in the control group (group C). Subsequently, anesthetic administration was stopped and neuromuscular blockade was antagonized by IV administration of 2.5 mg of neostigmine along with 1.0 mg atropine. Patients were considered awake when they opened their eyes on command or after gentle tactile stimulation; they were extubated soon thereafter.

Patients in both groups were advised that they could ask for rescue analgesia at any time following the surgery. Intravenous 50 mg tramadol was given as a rescue analgesic at minimum 4-h intervals and all patients received a 100-mg diclofenac suppository daily.

It was estimated that a minimum of 22 patients in each group would be required in order to have a 95% power of detecting three scores in the VAS for pain, considering $SD = 2.7$ at a significance level of 0.05. This number was raised to 25 in each group to allow a predicted drop-out $\times$ of almost 10%. Bonferroni correction was applied for multiple comparisons and in these cases, P value was adjusted at 0.001.

Statistical analysis was performed using the SPSS package (SPSS, Chicago, IL, USA) version 13.5. The distribution of data was checked by the Kolmogorov–Smirnov test. Age, weight, height, and duration of surgery followed a normal distribution, so they were compared between two groups by independent t Student's test. The VAS for pain and the time to first analgesic rescue and postoperative tramadol requirement did not follow a normal distribution, so they were compared in groups by the Mann–Whitney U-test. Two-tailed P values of < 0.05 were taken as significant.

Results

We randomized 50 patients; 2 patients (one in each group) were excluded from the study because of surgical complications.

Demographic characteristics, ASA physical status class, intraoperative opioid administration, and the duration of surgery were similar in the two groups (Table 1).

The VAS pain scores during coughing were measured in the recovery room and 6, 12, and 24 h following the surgery; the scores were (medians, with ranges in parentheses): 7 (1–10), 8 (5–10), 5 (3–8), and 4 (0–6), respectively, in group C and 0 (0–5), 4 (1–6), 3 (0–6), and 0 (0–5) in group T. At the same times, the VAS pain scores at rest were 4 (0–8), 6 (3–9), 3 (1–5), and 0 (0–3) in group C and 0 (0–2), 1 (0–4), 1 (0–3), and 0 (0–1) in group T. Apart from the pain at rest 24 h following discharge from the recovery room, there was a significant difference in the VAS for pain both at rest and during coughing, measured over time between the two groups (Mann–Whitney *U*-test, between-subjects effects, $P < 0.001$) (Figs. 1, 2). The changes in VAS for pain over time were significant in each group (Friedman test, tests of within-subjects effects, with significant interaction between the VAS pain score and group, $P < 0.001$) (Figs. 1, 2).

Table 1 Demographic data and duration of surgery

	TAP group ($n = 24$)	Control group ($n = 24$)
Age (years)[a]	27.88 ± 3.9	25.54 ± 3.8
Weight (kg)[a]	68.8 ± 3.0	69.9 ± 4.2
Height (cm)[a]	162.1 ± 3.37	162.8 ± 3.34
Duration of surgery (min)[a]	56.9 ± 7.2	59.7 ± 7.3
ASA physical status class (I/II)	14/10	15/9

TAP transversus abdominis plane (block), *ASA* American Society of Anesthesiologists

There were no significant differences between the groups

[a] Values are expressed as means ± SD

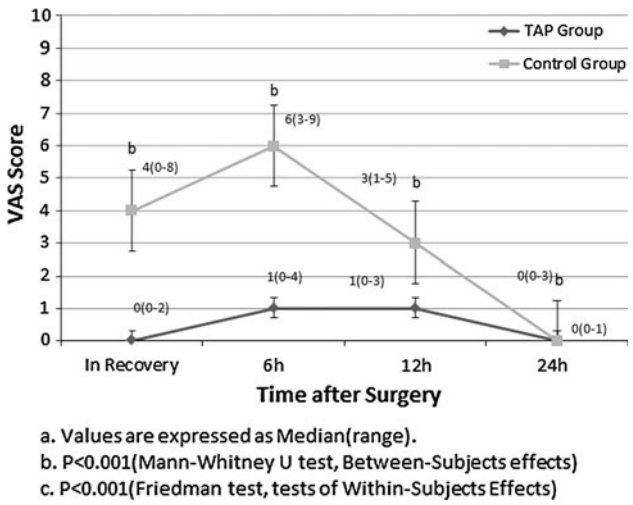

Fig. 1 Postoperative visual analogue (*VAS*) pain scores at rest. *TAP* transversus abdominis plane (block)

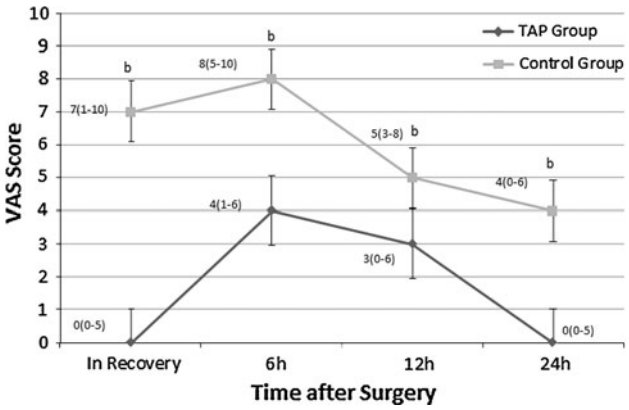

Fig. 2 Postoperative VAS pain scores during coughing

Table 2 Postoperative analgesic consumption and time to first opioid request

	TAP group ($n = 24$)	Control group ($n = 24$)
Time to 1st opioid request (min)[a]	210 (0–300)	30 (10–180)[b]
Postoperative tramadol requirement (mg)[a]	75 (0–150)[b]	250 (0–400)

[a] Values are expressed as mean ± SD

[b] $P < 0.001$

In the patients who received the TAP blockade, the time until first request for analgesic was significantly longer in group T [210 min (0–300 min) vs. 30 min (10–180 min) in group C; $P = 0.0001$] (Table 2).

The total tramadol consumption was significantly lower in group T than in group C [50 mg (0–150 mg) in group T vs. 250 mg (0–400 mg) in group C, $P = 0.001$] (Table 2).

Discussion

The present study demonstrates that in elective cesarean delivery performed under general anesthesia with a Pfannenstiel incision, bilateral TAP blockade with 30 mL 0.25% bupivacaine (15 mL in each side) could decrease 24 h postoperative pain intensity and analgesic consumption. The time to first analgesic rescue was longer in parturients who received the TAP block. In both groups, the maximum pain intensity was at the 6th hour after the surgery, and it decreased after this time. Yet the pain intensity at each measured time was less in mothers who received the TAP block. Exceptionally, the pain scores at rest 24 h following discharge from the recovery room were the same in both groups.

The pain and discomfort after cesarean delivery delays early ambulation and breast feeding, which can result in

postoperative complications and the mother's discomfort [1]. So, providing effective and safe postoperative analgesia can prevent these morbidities. These goals are likely achieved through a multimodal approach. Opioids are often used for postoperative pain control. However, there are some concerns about opioid administration to breast-feeding women. Intravenous opioids can appear in the milk, so they can potentially induce some side-effects in the neonate [9].

Some studies have shown the efficacy of TAP blocks in the reduction of postoperative pain intensity and analgesic requirement in patients who undergo radical prostatectomy, hysterectomy, cesarean delivery, and laparoscopic surgery [8, 10–15]. In one study [11], blockade with 1.5 mg/kg ropivacaine bilaterally in cesarean delivery parturients successfully decreased the postoperative patient-controlled IV morphine requirement. The authors of that study found that the TAP block was effective for 36 h. The fact that the TAP region is relatively poorly vascularized was considered as a reason for this prolonged blockade [11]. At our center, under normal conditions, mothers stay in hospital for 24 h, so in our study postoperative pain intensity and analgesic requirement were assessed for this duration.

Recently, two studies were not able to show any differences between pain intensity or postoperative analgesic requirement when a TAP block was used as a multimodal analgesic regimen in cesarean delivery parturients under spinal anesthesia [16, 17]. However, both studies were performed on parturients who underwent spinal anesthesia, and in one of them, intrathecal morphine was used. It seems that the design of these studies mainly differed from ours. Probably it can elucidate the reason for discrepancy in our findings. However, in another study on cesarean delivery, parturients under spinal anesthesia, the TAP block reduced post-operative morphine requirements [18].

In the TAP block, the T7–T12 intercostal nerve, ilioinguinal nerve, iliohypogastric nerve, and the lateral cutaneous branches of the dorsal rami of the L1–L3 at the neurofascial plane between the internal oblique muscle and transversus abdominis muscle are blocked by local anesthetic. It has been illustrated that a TAP block can provide excellent analgesia for somatic (skin and musculature) pain in the abdominal wall [10, 11]. In our study, the TAP block led to lower pain intensity during coughing in the 24 h after cesarean delivery. This observation shows that the TAP block successfully reduced the somatic pain in our patients. In the first 12 h following the surgery, the pain intensity at rest in the TAP group was lower than that in the control group. However, the pain scores at the 24th hour were similar in the two groups. Probably, the low pain intensity at rest at this time can explain this observation.

There are some concerns about local anesthetic systemic toxicity, especially the systemic toxicity of bupivacaine, in pregnant women. In one study, it was shown that 3 mg $kg^{-1}$of ropivacaine in the TAP block in adult women resulted in potentially toxic plasma concentrations. A relatively high dose of ropivacaine was used in that study and the volume of local anesthetics injected at each site was 20 mL [19]. In our study, we used a low volume and low concentration of bupivacaine successfully; the total dose of the injected bupivacaine was 75 mg. It seems that the risk of systemic toxicity with this dose is probably low, and we achieved prolonged analgesia with this relatively small dose. However, the risk of local anesthetic toxicity with this method should be considered and careful observation of patients seems to be mandatory.

The absence of major vascular or neurologic structures in the block area is an important advantage of the TAP block. However, there are a few hypotheses about the potential side-effects of this block. In one report, the TAP block led to hepatic trauma [20]. Colon puncture or hematoma formation in the injection site is another theoretical side-effect of this block [21].

A high rate of elective cesarean sections under general anesthesia may raise some concerns. In our country, and especially in our patients, there is a great fear of spinal anesthesia and needle insertion in the back or into the spine. So most of our parturients refuse spinal or epidural anesthesia. As patient refusal is one of the contraindications for spinal anesthesia, the rate of cesarean section under general anesthesia in our country is relatively high.

There are some limitations in the present study. Firstly, because of our hospital policy, morphine is not available for post-cesarean delivery pain control; therefore, we have been using tramadol for this purpose. Besides, patient-controlled analgesia pumps are not routinely used for post-cesarean delivery pain control at our Center, so we could not use these devices to more precisely evaluate the analgesic rescue in our parturients. Secondly, because of ethical considerations and our University Review Board suggestion, we did not inject placebo (for example, saline) in the control group. Furthermore, postoperative side-effects such as nausea and vomiting were not in our survey outcome, so we did not evaluate them.

In conclusion, a bilateral TAP block with 0.25% bupivacaine in parturients with elective cesarean delivery performed under general anesthesia with a Pfannenstiel incision can decrease postoperative pain and analgesic consumption up to 24 h postoperatively. The time until first analgesic rescue was longer in mothers who received the TAP block.

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