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# The effect of transversus abdominis plane block combined with PCIA of different doses of butorphanol on postoperative analgesia after cesarean delivery : a double blind randomized controlled trial

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**Abstract:** Background: To investigate efficacy and safety of ropivacaine transversus abdominis plane (TAP) block combined with patient-controlled intravenous analgesia (PCIA) of different doses of butorphanol for postsurgical analgesia after cesarean delivery (CD).

Methods: Women with term pregnancy of 37 to 42 weeks scheduled for elective CD under general anesthesia. Patients were randomized 1:1:1:1 to ropivacaine 75 mg TAP block alone (T group), ropivacaine 75 mg TAP plus butorphanol 6mg PCIA (TB1 group), ropivacaine 75 mg TAP plus butorphanol 8mg PCIA (TB2 group) and ropivacaine 75 mg TAP plus butorphanol 10mg PCIA (TB3 group). The primary outcomes were postoperative uterine contraction pain, incision pain under the resting state and the moving state, number of PCA compression and observer's assessment alert/sedation (OAA/S) scores; the secondary outcomes were incidence of postoperative drowsiness, dizziness, nausea and vomiting. The study was approved by the Ethics Committee of Yantai Yuhuangding Hospital. All participants provided their informed consent.

Results: At postoperative 30min, 2h, 4h, 24h and 48h timepoints, there was no significant difference on VAS scores of incision pain between the T group and TB1 group ($p > 0.05$). VAS scores of TB2 and TB3 groups were higher than T group ($p<0.05$). Compared with TB1 group, number of PCA compression was significantly more than the TB2 and TB3 groups ($p<0.05$) and no statistic difference was found between TB2 and TB3 groups ($p > 0.05$). The incidence of OAA/S scores less than 5 was higher in TB3 group than T, TB1 and TB2 groups at postoperative 4h, 24h and 48h ($p<0.05$). Incidence of postoperative drowsiness, dizziness, nausea and vomiting was higher in the TB3 group than T, TB1 and TB2 groups ($p<0.05$). And there was no statistic difference between T, TB1 and TB2 groups on postoperative complications.

Conclusion: TAP combined with butorphanol-PCIA was an effective postoperative analgesic strategy for cesarean delivery. As the sufficient analgesia intensity and the lower postoperative complications, butorphanol 8mg in PCIA is the most appropriate dose.

**Keywords:** TAP; analgesia; PCIA; cesarean delivery; butorphanol

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## 1.Introduction

Cesarean delivery (CD) is the most common inpatient procedure around the world[1]. The pain and discomfort following CD is mostly due to the abdominal wall incision and dissection of muscles which delays early ambulation and breast feeding. This can lead to postoperative complications such as thromboembolic disorders[2].

Previous studies have reported that a transversus abdominis plane (TAP) block can decrease the postoperative pain following abdominal surgery[3]. The TAP block has been performed for postoperative analgesic control in patients undergoing radical prostatectomy, hysterectomy, laparoscopic surgery and cesarean delivery under spinal anesthesia[4-6]. Recent years, general anesthesia for CD has been universal. And Eslamian et al. demonstrated that two-sided TAP block with 0.25% bupivacaine in parturients who undergo cesarean section with a pfannenstiel incision under general anesthesia could decrease postoperative pain and analgesic consumption[7]. Only TAP block still could not reach a satisfactory analgesia. Additional analgesics is still needed.

Patient-controlled intravenous analgesia (PCIA) with opioid analgesics, such as sufentanil, is considered to be an effective method to treat post-caesarean wound pain[8-10]. However, the previous studies have demonstrated that the effect of opioid analgesics on uterine cramping pain was not better or even worse than non-steroidal anti-inflammatory drugs[11]. Butorphanol, an analgesic with kappa-opioid receptor agonist properties, has promising targets for treating visceral pain including pain induced by uterine cervical distension[12]. Previous study demonstrated that PCIA using tramadol combined with butorphanol provided a better analgesic effect and accelerated postoperative rehabilitation compared with sufentanil, and may be

an optimal analgesic strategy for women undergoing CD[13].

This study enrolled patients undergoing CD with general anesthesia and used TAP block combined PCIA with different doses of butorphanol for postoperative analgesia. In order to investigate the appreciate analgesic strategy for CD with general anesthesia.

## 2.Materials and Methods

### *2.1Patients Selection*

The study was performed at Yantai Yuhuangding Hospital, from 09/2020 to 09/2022, for patients who received CD under general anesthesia.

The inclusion criteria were patients who underwent CD and agreed to cooperate with the anesthesiologists for the analgesic regimen. The American Society of Anesthesiologist (ASA) class of the included patients was I, II and III. Exclusion criteria were patient with history of local anesthetic allergy, age younger than 18 years, vegetative nerve functional disturbance, serious cardiovascular disease, hepatorenal insufficiency, history of malignant disease, daily use of any type of analgesics, breast feeding, previous chemotherapy, radiation therapy, or both.

### *2.2 Procedures*

This current prospective study was designed and performed according to the CONSORT recommendations[14]. All data from the current study can be acquired from the corresponding author (LC). Patients were screened in the obstetrics ward 1 day before the surgery. Demographic characteristics were recorded by the investigators. Simple randomization was performed, and patients were allocated to receive TAP, TAP plus butorphanol 6mg for PCIA, TAP plus butorphanol 8mg for PCIA and TAP plus butorphanol 10mg for PCIA according to a computer-generated random numbers table using the sealed enveloped technique. Intra- and postoperative data were recorded by the investigators during follow-up. Patients and all investigators in the study were blinded to the group allocation.

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 propofol 3-4 mg/kg and rocuronium 0.6mg/kg, and the trachea was intubated after the administration. After tracheal intubation, anesthesia was maintained with sevoflurane 1-1.5%. After the delivery of the neonate, 0.6-0.8ug/kg 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, patients received the TAP block. The TAP block was performed bilaterally as described by Mc Donnell et al.[15]. 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 ropivacaine 0.375% was injected in each side. 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. Subsequently, PCIA with butorphanol was used for TB1, TB2 and TB3 groups.

Our primary outcomes included the VAS score at the rest (VR) and VAS score at the movement (VM), at postoperative 30min、2h、4h、24h and 48h. VAS score at rest was defined as the VAS score measured when patients relaxed. VAS score at the movement was defined as the VAS score measured when the patients moved. VAS score was assessed to measure the pain degrees of patients. Patients chose the best suitable images for their pain which were concordant with numeric pain degrees, where 0 = no pain, 1 - 3 = mild pain, 4 - 6 = moderate pain, 7 - 8 = severe pain, 9 - 10 = worst pain. The secondly outcomes was the incidence of PCA compressions, OAA/S less than 5 scores and butorphanol related complications including drowsiness, dizziness, nausea and vomiting.

### *2.3 Statistical Analysis*

The collected data was analyzed using SPSS software (version 19, SPSS Inc., USA). The quantitative variables are expressed as mean ± SD. The categorical variables were expressed as percent (%). The differences of categorical variables by groups were assessed by $\chi 2$. The means of quantitative variables between before and after the intervention across each group were compared by paired student's t-test. The

differences in means between the two groups were analyzed by independent student's t-test. The differences were statistical significance if $p < 0.05$.

Results

The study was performed from 11/2021 to 12/2022. 130 patients participated in the trail, while 10 patients dropped out of our study. Data of the rest 120 patients were included in the analysis. The characteristics of the included patients relating to average ages, body mass index (BMI), ASA score and surgery duration were shown

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**Table 1 The demographic characteristics of enrolled patients**

| | T | TB1 | TB2 | TB3 | P |
|---|---|---|---|---|---|
| Number | 30 | 30 | 30 | 30 | P > 0.05 |
| Age | 27.1 (5.3) | 27.5 (3.9) | 27.3 (4.2) | 27.4 (4.7) | P > 0.05 |
| BMI | 27.6 (3.5) | 27.5 (4.8) | 27.9 (3.8) | 27.7 (4.3) | P > 0.05 |
| ASA | | | | | |
| I | 14 | 13 | 16 | 17 | P > 0.05 |
| II | 14 | 16 | 12 | 13 | P > 0.05 |
| III | 2 | 1 | 2 | 0 | P > 0.05 |
| Surgery duration | 57.2 (16.4) | 58.3 (15.8) | 60.3 (17.1) | 58.8 (16.2) | P > 0.05 |

ASA: American Society of Anesthesiologist, BMI: Body mass index. The data were expressed as mean (SD).

**Table 2 Postoperative pain related data for the 3 groups**

| | 30min | 2h | 4h | 24h | 48h |
|---|---|---|---|---|---|
| incision pain (rest) | | | | | |
| T | 2.7 (0.7) | 2.5 (0.5) | 2.7 (0.7) | 2.8 (0.6) | 3.0 (0.8) |
| TB1 | 2.6 (0.6) | 2.3 (0.5) | 2.5 (0.6) | 2.6 (0.7) | 2.9 (0.6) |
| TB2 | 2.0 (0.3)[ab] | 1.8 (0.5)[ab] | 1.7 (0.4)[ab] | 1.9 (0.6)[ab] | 2.1 (0.6)[ab] |
| TB3 | 1.9 (0.4)[ab] | 1.7 (0.3)[ab] | 1.8 (0.5)[ab] | 2.0 (0.6)[ab] | 2.0 (0.4)[ab] |
| incision pain (move) | | | | | |
| T | 3.6 (0.8) | 3.5 (0.9) | 3.5 (0.6) | 3.8 (0.8) | 3.7 (0.9) |
| TB1 | 3.5 (0.5) | 3.4 (0.4) | 3.3 (0.5) | 3.7 (0.6) | 3.6 (0.5) |
| TB2 | 2.5 (0.4)[ab] | 2.6 (0.6)[ab] | 2.5 (0.5)[ab] | 2.6 (0.4)[ab] | 2.6 (0.5)[ab] |
| TB3 | 2.4 (0.5)[ab] | 2.5 (0.5)[ab] | 2.6 (0.4)[ab] | 2.4 (0.5)[ab] | 2.6 (0.6)[ab] |
| PCA compression | | | | | |
| TB1 | 10.5 (4.2) | | | | |
| TB2 | 5.3 (2.7)[b] | | | | |
| TB3 | 5.1 (2.4)[b] | | | | |
| OAA/S<5 | | | | | |
| T | 0 | 0 | 0 | 0 | 0 |
| TB1 | 0 | 0 | 1 | 0 | 0 |
| TB2 | 0 | 0 | 1 | 1 | 0 |
| TB3 | 0 | 2 | 9[ab] | 8[ab] | 6[ab] |

The data were expressed as mean (SD); a: compared with T group, P<0.05, b: compared with TB1 group, P<0.05

in Table 1. There was no significant different between the two groups (p> 0.05).

At postoperative 30min, 2h, 4h, 24h and 48h, patients in both groups mainly suffered from minor pain at rest in the 4 groups. When they had any movement, the pain level was aggravate at these time points. The pain level was not significant different between T group and TB1 group at postoperative 30min, 2h, 4h, 24h and 48h (P > 0.05). And the pain level was decreased in the TB2 and TB3 groups compared with T and TB1 groups both at rest and at movement (P<0.05). Compared with TB2 group, there was no statistic significant difference on VAS scores in the TB3 group at postoperative 30min, 2h, 4h, 24h and 48h both at rest or movement (P > 0.05) (Table 2). At postoperative 2 days, incidence of PCA compressions was significantly lower in the TB2 and TB3 groups compared with TB1 group (P<0.05) and there was no no statistic significant difference on incidence of PCA compressions between TB2 and TB3 groups (P > 0.05). The incidence of OAA/S less than 5 scores was higher in the TB3 group at postoperative 4, 24 and 48h compared with T, TB1 and TB2 groups (P<0.05) (Table 2).

The percentage of postoperative complications related to butorphanol such as drowsiness, dizziness, nausea and vomiting was significantly higher in the TB3 group compared with T and TB1 groups (P<0.05). Although the percentage of postoperative complications was also higher in TB3 group compared with TB2 group, the difference did not reach a statistical difference (P > 0.05) (Table 3).

**Table 3 Postoperative complications for the 3 groups**

| | drowsiness | dizziness | nausea | vomiting |
|---|---|---|---|---|
| T | 0 | 0 | 1 | 0 |
| TB1 | 2 | 3 | 1 | 1 |
| TB2 | 3 | 5 | 2 | 1 |
| TB3 | $12^{ab}$ | $14^{ab}$ | $11^{ab}$ | $8^{ab}$ |

a: compared with T group, P<0.05, b: compared with TB1 group, P<0.05

## 3.Discussion

Inadequate post-operative pain relief after the cesarean section may seriously affect maternal sound mind and body. We aimed to evaluate the postoperative analgesic efficacy of TAP combined with butorphanol-PCIA in patients with cesarean section under general anesthesia. TAP plus butorphanol 6mg PCIA analgesic effect is as poor as Single TAP. Especially in the 24 hours after surgery, the score of incision pain (move) was nearly 4 (p<0.05). It seriously affects sleep and activity, and has a bad effect on mother-child communication. PCA compression is significantly more than other groups (p<0.05). Both incision pain (move) and incision pain (rest) have good analgesic effect in the TB2 and TB3 from 30Min to 48h (p<0.05). PCA compression is significantly less than the TB1 group (p<0.05). But the TB3 had more adverse reactions like drowsiness (12), dizziness (10), nausea (8) and vomiting (6) than TB2 due to opioid use. It follows that TAP plus butorphanol 6mg PCIA has an obvious advantage in postoperative analgesia (p<0.05). The adverse reactions leading to maternal activity limitation are not conducive to postoperative rehabilitation. Early ambulation and breastfeeding are important for maternal recovery and newborn growth.

The TAP is widely used in colorectal surgery, cesarean section, cholecystectomy, hysterectomy, appendectomy, donor nephrectomy, retropubic prostatectomy, and bariatric surgery[16-18].The TAP block reduces the VAS in postoperative 24 hours. In our study, we found similar results that TAP block reduces VAS after the cesarean section. but if the TAP combined with butorphanol-PCIA is more better than Single use of TAP. Multimodal pain management approaches are recommended to improve analgesia, reduce opioid use. Epidural anesthesia is most widely used for postoperative analgesia at CD. But, for patients with contraindications to Epidural anesthesia, general anesthesia is the only option. The TAP can be used as an important auxiliary analgesic method for general anesthesia. Onoshi et al.[19] used TAP block with epidural anesthesia at patients who had cesarean section. The patients gained postoperative comfort and reduced the use of intravenous drugs. Application of multiple analgesics is welcome in the management of postoperative pain. The synergy of different analgesics can achieve a satisfactory analgesic effect and decrease drug dosage, which reduces the incidence of postoperative complications.

## 4.Conclusions

TAP combined with butorphanol-PCIA was an effective postoperative analgesic strategy for cesarean delivery. As the sufficient analgesia intensity and the lower postoperative complications related to opioids. , butorphanol 8mg in PCIA which is the most appropriate dose is worthy of clinical promotion and application.

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