

# The analgesic efficacy of oblique subcostal transversus abdominis plane block after laparoscopic hysterectomy

## A randomized, controlled, observer-blinded study

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### Abstract

**Background:** We aimed to assess whether an ultrasound (US)-guided oblique subcostal transversus abdominis plane (OSTAP) block would improve the postoperative pain scores and decrease the tramadol consumption after a laparoscopic hysterectomy.

**Methods:** Sixty-six female patients with American Society of Anesthesiologists I, II, or III, aged 18 to 65 years who were scheduled for laparoscopic hysterectomy for benign gynecologic pathologies were recruited in this randomized, controlled, observer-blinded trial. Sixty patients completed the study. Patients were randomized into 2 groups. In the OSTAP group, the patients received a bilateral OSTAP block with 40 mL of 0.375% bupivacaine and in the Sham group received an US-guided bilateral OSTAP with 40 mL of 0.9% saline. All patients received tramadol patient-controlled analgesia for the first 24th hour. Patients in the Sham group received an US-guided bilateral OSTAP with 40 mL of 0.9% saline. The primary outcome was the 24th hour tramadol consumption. The secondary outcomes included visual analog scale (VAS) scores during movement, the tramadol consumption at the 1st, 4th, and 12th postoperative hours, and nausea scores at the 24th hour postoperatively.

**Results:** At all time points, tramadol consumption of the OSTAP group remained significantly lower when compared with Sham group. The OSTAP group showed a statistically significant reduction at the postoperative 24th hour tramadol consumption (mean difference 22 mg, 95% confidence interval -38.4 to -5.6 mL;  $P = .009$ ). Compared with the Sham group, OSTAP block reduced the VAS scores at all time points during movement. Nausea scores at the 24th postoperative hour were significantly lower in the OSTAP group compared with the Sham group.

**Conclusion:** We concluded that bilateral US-guided OSTAP blocks reduced 24th hour tramadol requirements and VAS scores after laparoscopic hysterectomy. The OSTAP block is a promising technique for producing effective and prolonged postoperative analgesia in patients undergoing laparoscopic hysterectomy surgeries.

**Abbreviations:** ASA = American Society of Anesthesiologists, IV = intravenous, MAP = mean noninvasive arterial pressure, OR = operating room, OSTAP = oblique subcostal transversus abdominis plane, PCA = patient-controlled analgesia, TAP = transversus abdominis plane, US = ultrasound, VAS = visual analog scale.

**Keywords:** laparoscopic hysterectomy, oblique subcostal transversus abdominis plane block, tramadol, ultrasonography

## 1. Introduction

The presentation of laparoscopy into benign gynecology treatments has dramatically changed hysterectomy practice patterns.<sup>[1]</sup> Although a laparoscopic hysterectomy is associated with

diminished pain, many patients struggle against postoperative pain even after laparoscopic operations. Incisional and trocar site pain are the most important source of suffering, at the same time there are additional perioperative difficult situations that causes pain.<sup>[2]</sup> As a result of pneumoperitoneum, stretching of the intra-abdominal cavity, blood left in the abdomen, and dissection of the pelvic region, patients experience high levels of postoperative pain rather than open lower abdominal operations.<sup>[3]</sup>

Previous studies have founded contradictory results for midaxillary lateral approach transversus abdominis plane (TAP) block for open and laparoscopic hysterectomies. While Atim et al<sup>[4]</sup> showed that ultrasound (US)-guided TAP block reduced movement pain after total abdominal hysterectomy, Ghisi et al<sup>[5]</sup> found that TAP block did not reduce morphine consumption during the first postoperative 24 hours after elective total laparoscopic hysterectomy. In a meta-analysis, TAP block was recommended for the improvement of pain scores postoperatively in gynecologic procedures.<sup>[6]</sup>

Compared with other gynecological laparoscopic procedures, total laparoscopic hysterectomy requires longer operation time and is thus exposed to more tissue manipulation. Also, the head-down position and carbon dioxide pneumoperitoneum during surgery may aggravate pain. Therefore, pain patterns after

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laparoscopic hysterectomy were expected to have intensities incomparable to the postoperative pain following open hysterectomies.<sup>[2]</sup> Thus, a fascial plane block including upper thoracic dermatomes might be useful for pain management after laparoscopic hysterectomy. An oblique subcostal transversus abdominis plane (OSTAP) block is an US-guided regional anesthesia technique that anesthetizes the nerves of the lower and upper anterior abdominal wall, specifically from T6 to L1.<sup>[7]</sup> There were not enough studies in the literature evaluating the OSTAP block for pain management after laparoscopic hysterectomies.

In the present clinical study, we aimed to assess whether US-guided OSTAP blocks would decrease tramadol consumption and improve postoperative pain scores after laparoscopic hysterectomies.

## 2. Materials and methods

The study was approved by the medical ethics committee of the affiliated Mugla Sıtkı Kocman University Training and Research Hospital and was registered at Australian New Zealand Clinical Trial Registry (ACTRN12618000524291). After signing informed consent forms, 66 female patients with American Society of Anesthesiologists (ASA) physical status I to III, aged 18 to 65 years who were scheduled for laparoscopic hysterectomy were recruited in this randomized, controlled, observer-blinded trial.

Patients were excluded from this study if they had a history of chronic opioid therapy during the previous 6 months, conversion to an open surgical technique, aspartate aminotransferase and/or alanine aminotransferase (>250 IU), creatinine level > 1.4 mg/dL, currently pregnant or lactating, known allergies to any drug used in the study, local infection at the block site, and opioid abuse. Patients were randomly divided into 2 groups: the Sham group and the oblique subcostal-TAP group (OSTAP group); there were 33 patients in each group.

After the patients arrived at the operating room (OR), standard monitoring procedures per the ASA were applied. All patients received a standard general anesthetic regimen, which included remifentanyl (intravenous [IV], 0.5–1 µg/kg per min), propofol (IV, 1–2 mg/kg titrations), and rocuronium bromide (IV, 0.6 mg/kg) during anesthesia. Intraoperative remifentanyl consumptions recorded. Anesthesia was maintained using desflurane at 1 minimum alveolar concentration with a fractional inspired oxygen of 0.4 with an air mixture of 0.6 to maintain the bispectral index of 40 to 60 during all operations. Mechanical ventilation was achieved using a pressure-controlled volume in the guaranteed mode to maintain end-tidal carbon dioxide at 35 to 40 mm Hg.

Sequence generation from a computer-generated random binary number list was performed by an anesthesiologist not involved in the study. A sealed opaque envelope was used for allocation concealment. Patients were randomized into 2 groups following a computer-generated sequence of numbers. There were 2 certified anesthesiologists to perform OSTAP procedures on the patients. For each randomized patient, the OR anesthesiologist took the corresponding sealed envelope from a folder, which indicated the treatment assigned to the patient, while the other anesthesiologist was blind to the group and the preparation of the syringes including local anesthetic or saline. Preoperatively, after induction and intubation, and before the initiation of surgery, OSTAP blocks were performed under US guidance using a linear 6 to 13 MHz US probe (SonoSite M-Turbo; FUJIFILM SonoSite, Bothell, WA). Subcostal TAP block

was performed as it was technically described in a technical report on Oblique Subcostal TAP by Hebbard et al.<sup>[8]</sup> The anesthetist stood on the right side of the patient in the supine position, and both sides were blocked from this position, starting from the xyphoid with the right-hand holding the needle and the left-hand holding the probe. The skin was prepared using 2% chlorhexidine solution and the probe was placed obliquely on the upper abdominal wall along the subcostal margin near the xyphoid process in the midline of the abdomen. To perform the block as recommended<sup>[8]</sup> the rectus abdominis and underlying transversus abdominis muscles were identified near the costal margin and xyphoid. The probe was then moved laterally, first the aponeurosis of external, internal oblique, and transversus abdominis were identified than we moved the probe laterally until the transversus abdominis muscles were identified (Fig. 1). The 100-mm needle (Stimuplex D; Braun Medical, Melsungen, Germany) was directed toward the transversus abdominis fascia. Injections were done between rectus abdominis and transversus abdominis muscles along the subcostal line (Fig. 2).

In the OSTAP group (OSTAP, n=30), patients received US-guided bilateral OSTAP blocks with 40 mL of 0.375% bupivacaine (20 mL for each side) and an IV tramadol patient-controlled analgesia (PCA) (basal infusion: 10 mg/h, bolus 20 mg every 15 minutes, maximum dose 90 mg/h) for the first 24 postoperative hours. Patients in the Sham group (Sham, n=30) received US-guided bilateral OSTAP with 40 mL 0.9% saline.

The surgical technique administered for the procedure was 2-port total laparoscopic hysterectomy with a multichannel port as described in a technical report.<sup>[9]</sup> In this surgical technique, a 1.5-cm vertical intraumbilical skin incision was made, a 1.5-cm rectus fasciotomy was performed to enter the peritoneal cavity and a wound retractor was inserted into the supraumbilical area and a laparoscope was inserted through the trocar. To perform the 2-port laparoscopic hysterectomy, another trocar was inserted at the left iliac fossa under laparoscopic view.

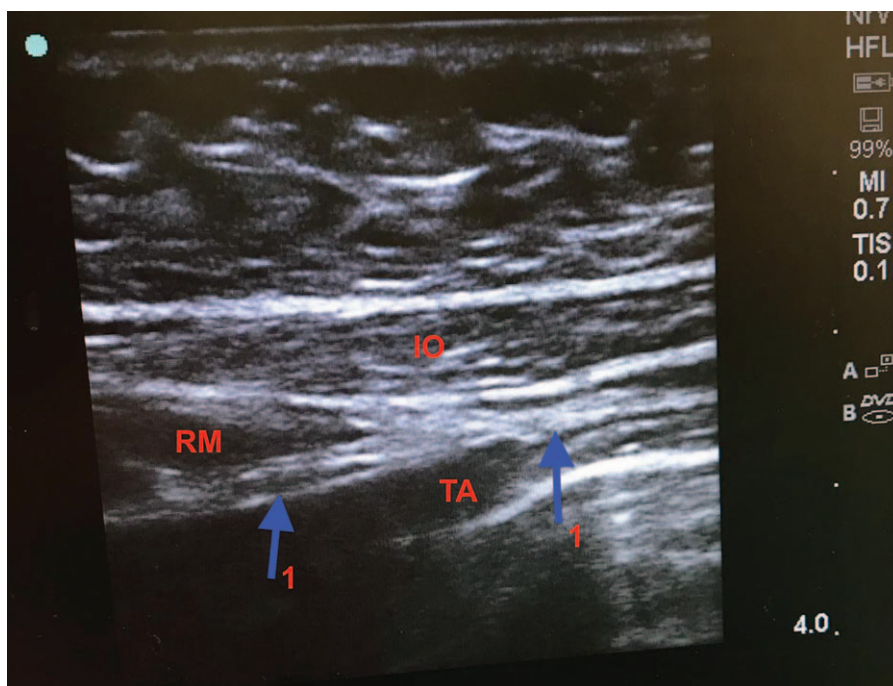
Heart rate and mean noninvasive arterial pressure (MAP) were recorded at 0, 5, 15, 30, 45, 60 minutes after intubation and then every 30 minutes thereafter.

Twenty minutes before the completion of surgery, all patients received dextropropofol trometamol (75 mg), ondansetron (0.1 mg/kg), and a loading dose of tramadol (1 mg/kg). Following loading dose of tramadol, the tramadol PCA was administered. All 2 groups received the same tramadol PCA.

After extubation, patients of both groups were transferred to the recovery room if they were able to perform a 5-second head lift and communicate with simple words. After staying 30 minutes at the recovery room and achieved a modified Aldrete Score of more than 8, patients were transferred to the gynecology ward. The severity of pain according to the visual analog scale (VAS), total and cumulative tramadol consumption, and the incidence of nausea and vomiting were assessed by the anesthesiologist who were blinded to the group assignment.

The pain severity during movement was assessed using a 10-cm VAS (0=no pain and 10=worst imaginable pain) after 1st, 4th, 12th, and 24th hours. Tramadol PCA was checked after 1st, 4th, 12th, and 24th hours and recorded. In the case of a VAS score of 4 or more, standard postoperative analgesia regimen consisted of intramuscular dextropropofol trometamol (75 mg), 12-hourly, was carried out.

Nausea was assessed using a categorical scoring system (0=none, 1=mild, 2=moderate, 3=severe). The rescue antiemetic ondansetron (0.1 mg/kg) was given when a patient complained of a nausea score of 2 or more or was vomiting. The primary



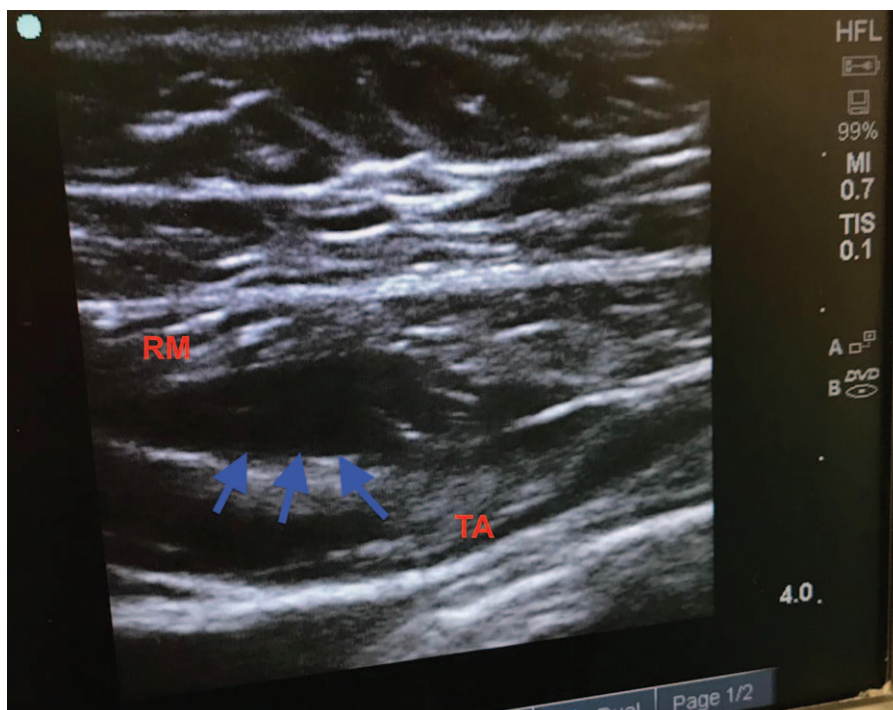
**Figure 1.** Sonographic anatomy of the oblique subcostal transversus abdominis plane block. Arrow 1 denotes transversus abdominis fascial plane. IO=internal oblique muscle, RM=rectus muscle, TA=transversus abdominis muscle.

outcome measure of the study was the 24th hour tramadol consumption. The secondary outcome measures of the study included VAS scores and the 1st, 4th, and 12th hour postoperative tramadol consumptions.

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**Figure 2.** Sonographic anatomy of the oblique subcostal transversus abdominis plane block after local anesthetic injection. Arrows denote local anesthetic spreading. RM=rectus muscle, TA=transversus abdominis muscle.



categorical scoring system (0 = none, 1 = mild, 2 = moderate, 3 = severe). The rescue antiemetic ondansetron (0.1 mg/kg) was given when a patient complained of a nausea score of 2 or more or was vomiting. The primary outcome measure of the study was the 24th hour tramadol consumption. The secondary outcome measures of the study included VAS scores and the 1st, 4th, and 12th hour postoperative tramadol consumptions.

### 2.1. Statistical analysis

Sample size was calculated based on data from a preliminary study that involved 10 patients in each group. In this pilot study, 24th hour mean tramadol consumption was  $283.4 \pm 35.7$  in OSTAP group and  $303.5 \pm 42.6$  in Sham group. Data from 58 patients were required to determine a difference of 20 mg in tramadol consumption with a 2-sided type I error of 0.05, along with type II error of 0.20 which brings a power ( $1 - \beta$ ) of 0.80. We then added 15% more patients to compensate for dropouts; therefore, 66 patients were enrolled in total. Shapes of the distributions of the variables were assessed by using Shapiro–Wilk test whether distributions are normal versus positively or negatively skewed. Normally distributed data were detailed with the mean  $\pm$  standard deviation and were analyzed by an independent samples *t* test to observe group-wise significant differences on the outcome variables. Continuous variables without normal distribution were detailed with the median and interquartile ranges and were analyzed by a Mann–Whitney *U* test. Chi-squared test was used as well to compare the difference between categorical variables. A repeated-measures analysis of variance was used to test the difference in continuous variables over time. In addition to this, post hoc analyses were performed using Bonferroni correction for pair-wise comparisons. Since the Mauchly test of sphericity indicated that the assumption of sphericity had been violated, thus Greenhouse–Geisser correction has considered for tests of within-subjects' effect results. In order to understand the relationship between nausea scores and required ondansetron, Kendall's correlation was chosen as an appropriate coefficient since the data indicated nonparametric association between these 2 variables. A *P* value  $< .05$  was considered statistically significant. Data analysis and management were performed by the software Statistical Package for Social Science, version 17 (SPSS Inc, Chicago, IL).

### 3. Results

Of the 66 patients recruited, all of the patients randomized into 2 groups. Thus, 66 patients were randomized, with 33 patients in each arm. Sixty patients completed the study. Six patients were excluded after randomization during follow-up. Of the 6 patients excluded, 3 patients were converted to a laparotomy secondary to a malignancy, 2 patients could not understand how to use the PCA during the follow up, and 1 patient required an additional laparoscopic port (Fig. 3). Patient recruitment started at April 2018 and the participant enrollment lasted at the end of May 2018.

The 2 groups were similar in age, weight, height, and surgical duration. The intraoperative consumption of remifentanyl was not statistically significant between groups ( $P > .05$ , Table 1).

At the time points as 1st, 4th, 12th, and 24th postoperative hours, tramadol consumption of the OSTAP group remained significantly lower when compared with Sham group (Table 2). For the primary outcome, compared with Sham group, the OSTAP group showed a statistically significant reduction at the

postoperative 24th hour tramadol consumption (mean difference 22 mg, 95% confidence interval  $-38.4$  to  $-5.6$ ;  $P = .009$ ). There was no interaction between group and tramadol consumption over time ( $P = .254$ ).

The OSTAP block reduced the VAS scores compared with the control group at the 1st, 4th, 12th, and 24th hours after the operation during coughing (Table 3). There was no interaction between group and VAS scores over time ( $P = .628$ ).

Nausea scores at the 24th hour were significantly lower in the OSTAP group compared with the control group ( $P = .013$ ). There were no significant differences between the groups in terms of vomiting and ondansetron consumption (Table 4). There is a positive and significant correlation between nausea score and required ondansetron ( $r = 0.482$ ,  $P < .01$ ).

Heart rate and MAP variations over time were not significantly varied by 2 groups ( $F [1, 58] = 0.11$ ,  $P > .05$ ) and ( $F [1, 58] = 0.099$ ,  $P > .05$ ), respectively.

### 4. Discussion

This study demonstrated that a bilateral US-guided OSTAP block reduced tramadol consumption and pain scores during the first 24 hours after laparoscopic hysterectomy compared with the Sham group. A meta-analysis by Baeriswyl on the analgesic efficacy of using US-guided TAP blocks exclusively for all types of abdominal surgeries in adult patients demonstrated that the US-guided TAP block provides marginal postoperative analgesic efficacy after abdominal laparotomy or laparoscopy and cesarean delivery.<sup>[10]</sup> A meta-analysis by De Oliveira et al on the postoperative analgesia outcomes for laparoscopic surgical procedures included 10 randomized clinical trials with 633 subject.<sup>[11]</sup> They concluded their analysis as TAP block is an effective strategy to improve early and late pain at rest and to reduce opioid consumption after laparoscopic surgical procedures. In contrast to our study, they found that TAP block was not superior compared with control to reduce early and late pain during movement. We determined pain score while coughing and we evaluated this as movement. Although we did not evaluate the pain during movement, we reached a conclusion as complete relief of pain during partial movement was achieved with OSTAP block.

To date, there have been several published studies on TAP blocks in laparoscopic hysterectomies. The results of these reports are debatable. Calle et al<sup>[12]</sup> demonstrated a significant decrease in pain at the time of discharge with a VAS score of 3.1 for the blocked patients and 3.8 for the placebo group. Pather et al<sup>[13]</sup> also found that the TAP block resulted in a significantly shorter length of stay and lower opioid use. By contrast, Ghisi et al<sup>[5]</sup> reported that a TAP block did not reduce opioid consumption during the first 24th hour after an elective total laparoscopic hysterectomy. These authors explained their limitations as a result of an inadequate power in their study. Kane et al<sup>[14]</sup> also reported that a TAP block did not improve VAS scores, nor did it decrease narcotic pain medication use. However, no report has compared the efficacy of OSTAP and TAP blocks in laparoscopic hysterectomies.

In contrast to previous studies,<sup>[5,14]</sup> we demonstrated that the OSTAP block provides more effective analgesia than in the placebo group for 24 postoperative hours. Previous studies performed a classical TAP block at the umbilicus level; however, we performed an OSTAP block. These results can be explained by the difference in the extent of the sensory block following the TAP and OSTAP blocks. Results of a cadaveric study have shown that

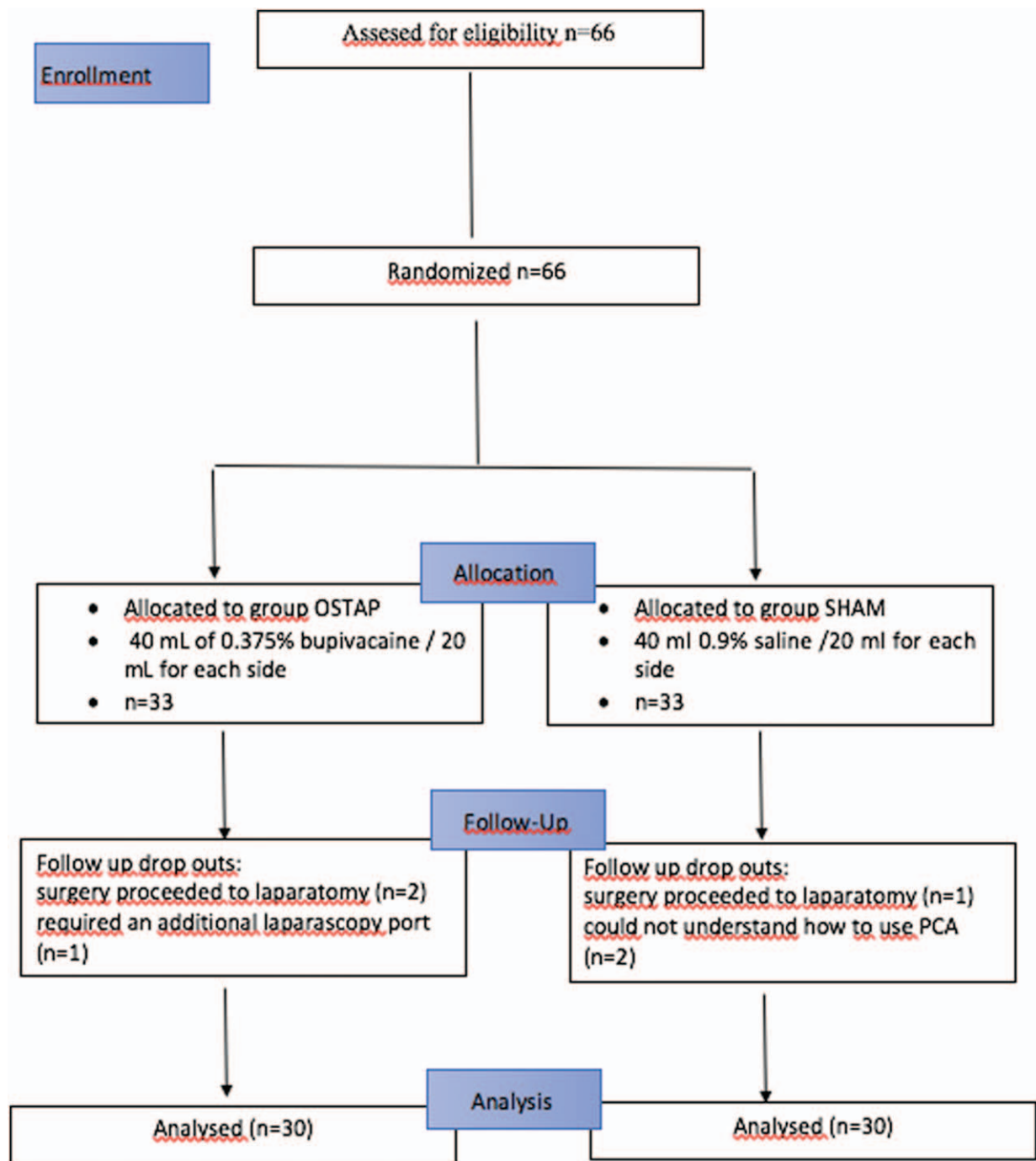


Figure 3. Flow diagram of participants.

**Table 1**

**Patient characteristics and perioperative data.**

	Sham group (n=30)	OSTAP group (n=30)	P
Age, y	47.8 ± 5.2	48.5 ± 5.1	.61
Weight, kg	75.9 ± 10.1	76.1 ± 9.6	.94
Height, cm	163.9 ± 5.1	164.7 ± 4.8	.58
ASA PS (I/II/III)	7/15/8	5/18/7	
Duration of surgery, min	159.1 ± 19.2	159.7 ± 21.2	.92
Remifentanyl consumption, µg	230 (212–250)	230 (217.5–240)	.32

Results are expressed as mean ± standard deviation, median (lower quartile–upper quartile), or number of patients.

ASA PS=American Society of Anesthesiologists Physical Status, OSTAP=oblique subcostal transversus abdominis plane block.

**Table 2**

**Postoperative tramadol consumption in the first 24 postoperative hours.**

Tramadol consumption	Sham group (n=30)	OSTAP group (n=30)	P
1st hour, mg	52.6 ± 16.3	43.3 ± 15.1	.026
4th hour, mg	108.3 ± 22.3	92.0 ± 22.6	.007
12th hour, mg	217.3 ± 22.1	194.6 ± 35.6	.004
24th hour, mg	355.3 ± 28.1	333.3 ± 34.9	.009

Results are expressed as mean ± standard deviation.

OSTAP=oblique subcostal transversus abdominis plane block.

**Table 3****VAS scores for pain during movement at 1st, 4th, 12th, and 24th postoperative hours.**

	Sham group (n = 30)	OSTAP group (n = 30)	P
1st hour VAS score	5 (5–5)	4 (4–5)	<.001
4th hour VAS score	4 (4–5)	4 (4–4)	.032
12th hour VAS score	4 (4–5)	4 (3–5)	.031
24th hour VAS score	3 (2.75–3.25)	3 (2–3)	.035

Results are expressed as median (lower quartile–upper quartile).

OSTAP = oblique subcostal transversus abdominis plane block, VAS = visual analog scale.

US-guided OSTAP blocks involved nerve roots T9, T10, and T11, and could also provide a sensory block of the T7 to T12 thoracic nerves.<sup>[15]</sup> The TAP block involves the T10 to L1 thoracolumbar nerves and the uppermost nerve affected is T10.<sup>[16]</sup> In our study, the surgeon's decision about surgical technique was 2-port laparoscopic hysterectomy with an incision 1.5 cm above the umbilicus and an incision at the left iliac fossa. In our opinion, due to the incision above the umbilicus, the fascial plane block applied in this surgical technique had to affect dermatomes higher than T10. The OSTAP block has a greater cranial spread than the classical TAP block; therefore, it is more likely to provide adequate analgesia for supraumbilical surgery.<sup>[8]</sup> The effectiveness of OSTAP block in other supraumbilical surgeries as laparoscopic cholecystectomy was demonstrated in previous studies.<sup>[16,17]</sup> Therefore, we decided to apply OSTAP in a 2-port laparoscopic hysterectomy technique which is a supraumbilical surgery such as laparoscopic cholecystectomy.

Most of the previous studies administered morphine for postoperative analgesia.<sup>[5,13,18]</sup> We administered tramadol because it is routinely used for postoperative analgesia in our institute, and was also devoid of remarkable respiratory depression, sedation, and dependence.<sup>[19]</sup> Tramadol has a higher incidence of nausea and vomiting than morphine.<sup>[20]</sup> This study also demonstrated that the OSTAP block reduced the postoperative nausea score. When the opioid consumption was reduced, opioid-related complications were subsequently prevented. In the present study, tramadol consumption during the first 24th hour in the blocked group was reduced compared with the Sham group. This reduction was followed by lower nausea scores in the blocked group.

The recommended doses and volumes of local anesthetics during the OSTAP block are not yet established. Although a technical report<sup>[8]</sup> mentioned larger volumes for hydro selection and spread of the block, the recent studies about OSTAP block administered reduced volumes.<sup>[5,16,21]</sup> In this study, we decided to administer 20 mL 0.375% bupivacaine each side based on the description by the reduced volume studies.<sup>[5,16,21,22]</sup>

In our study, despite significance, the difference between groups for tramadol consumption was low and <20% for each time points. TAP blocks have been described to last anywhere from 6 to 24 hours.<sup>[23]</sup> The difference between groups for 1st day total tramadol consumption depended on the decreased effect of OSTAP block. What is remarkable for our study is that although there was a reduction at the 1st and 4th hour postoperatively, tramadol consumption was <20%. This result might be due to sample size or local anesthetic preference. Hutchins et al<sup>[7]</sup> conducted a prospective randomized controlled observer-blinded study comparing bilateral OSTAP blocks with bupivacaine to bilateral OSTAP blocks with liposomal bupivacaine. They concluded that OSTAP blocks with liposomal bupivacaine

**Table 4****Nausea Scores at 24th postoperative hours.**

	Sham group (n = 30)	OSTAP group (n = 30)	P
Nausea score 24th hour	2 (2–3)	2 (1.00–2.25)	.013
No. of patients vomiting/24 h	15	11	.297
Ondansetron consumption, mg	6 (6–8)	6 (0.0–7.5)	.154

Results are expressed as median (lower quartile–upper quartile) or number of patients.

OSTAP = oblique subcostal transversus abdominis plane block.

decreased the total OSTAP blocks with bupivacaine. They founded a 50% reduction in postoperative opioid consumption. For further studies, administration of liposomal bupivacaine would decrease total tramadol consumption.

The strengths of our study include its randomized design, the uniformity of the study population and procedures, and close follow up of patients during the postoperative period. The single blinding with the control group receiving a Sham block supported our results.

The limitations of our study were that pain assessment and postoperative analgesic consumption records were limited to 24 postoperative hours. The difference between the 2 groups regarding the 24 hours tramadol consumption, although statistically significant, was only about 22 mg so a large sample may show more clear results. Another limitation of the study was that through OSTAP was performed after general anesthesia, the sensitive dermatomal extension could not be evaluated in the 2 groups.

In conclusion, the results of this trial indicate that bilateral US-guided OSTAP blocks reduced 24th hour tramadol requirements and VAS scores after a laparoscopic hysterectomy. OSTAP blocks are a promising technique in producing effective and prolonged postoperative analgesia for patients undergoing laparoscopic gynecologic surgeries.

### Author contributions

**Conceptualization:** Melike Korkmaz Toker, Semra Gumus Demirbilek.

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**Formal analysis:** Melike Korkmaz Toker, Semra Gumus Demirbilek.

**Funding acquisition:** Basak Altıparmak.

**Investigation:** Melike Korkmaz Toker.

**Methodology:** Melike Korkmaz Toker, Basak Altıparmak.

**Project administration:** Melike Korkmaz Toker, Semra Gumus Demirbilek.

**Resources:** Melike Korkmaz Toker, Semra Gumus Demirbilek.

**Software:** Melike Korkmaz Toker.

**Supervision:** Basak Altıparmak, Ali İhsan Uysal, Semra Gumus Demirbilek.

**Validation:** Melike Korkmaz Toker, Basak Altıparmak.

**Visualization:** Basak Altıparmak.

**Writing – original draft:** Melike Korkmaz Toker.

**Writing – review & editing:** Melike Korkmaz Toker, Basak Altıparmak, Ali İhsan Uysal, Semra Gumus Demirbilek.

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