

Postoperative Analgesic Efficacy Of Modified-Thoracoabdominal Nerves Block Through Perichondrial Approach And Transversus Abdominis Plane Block In Patients Undergoing Open Hysterectomy With Bilateral Salpingo-Oophorectomy: A Randomized-Controlled Study

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Abstract

Introduction: This study aimed to compare the postoperative analgesic effect of modified-thoracoabdominal nerves block through perichondrial approach (M-TAPA) and transversus abdominis plane (TAP) block in patients who underwent open hysterectomy with bilateral salpingo-oophorectomy.

Materials and Methods: This study is a single-center, open label, prospective, randomized-controlled trial. Patients were divided into three groups: Group Control (n=15), Group M-TAPA (n=15) and Group TAP (n=15). Group M-TAPA and Group TAP patients received a bilateral M-TAPA and bilateral lateral-TAP blocks under ultrasound guidance with the use of bupivacaine 0.25% with a standard dose of 20 ml for each side. The primary outcome was the numerical rating scale (NRS) scores of the patients. Secondary outcome was total tramadol consumption by the patients followed up for postoperative 24 hours.

Results: When the groups were compared in terms of static and dynamic NRS scores, there was a statistically significant difference between Group Control and the other groups. There was no statistically significant difference between Group M-TAPA and Group TAP in terms of NRS scores at all times. Total tramadol consumption was higher in Group Control while there was no statistically significant difference between Group M-TAPA and Group TAP.

Conclusion: In this study, although no statistically significant difference in analgesic efficacy was found between M-TAPA and TAP blocks after open TAH+BSO surgeries, both techniques provided clinically acceptable analgesia compared to the control group.

Key words: Postoperative Pain; Analgesia, Regional; Nerve Block; Transversus Abdominis Plane Block; Gynecologic Surgical Procedures; Multimodal Analgesia.

Introduction

Moderate to severe pain is reported in 15–50% of patients during the first 24 hours following open gynecologic surgeries, and this can increase postoperative morbidity and contribute to chronic pain development (1). Open total abdominal hysterectomy (TAH) with bilateral salpingo-oophorectomy (BSO) is particularly associated with high pain levels, with numerical rating scale (NRS) scores typically between 6 and 8 (2). Therefore, effective pain control is essential in these patients. Multimodal analgesia has become a

standard approach, and regional anesthesia techniques such as plane blocks are increasingly used as part of this strategy. Plane blocks aim to provide abdominal analgesia by targeting the thoracolumbar nerves between T6 and L1. These include the anterior branches of the T7–T12 intercostal nerves and the L1 spinal nerve, which innervate the anterolateral abdominal wall (3). Most of these nerves pass through the transversus abdominis plane (TAP), located between the internal oblique and transversus abdominis muscles (TAM). For this reason, the lateral TAP

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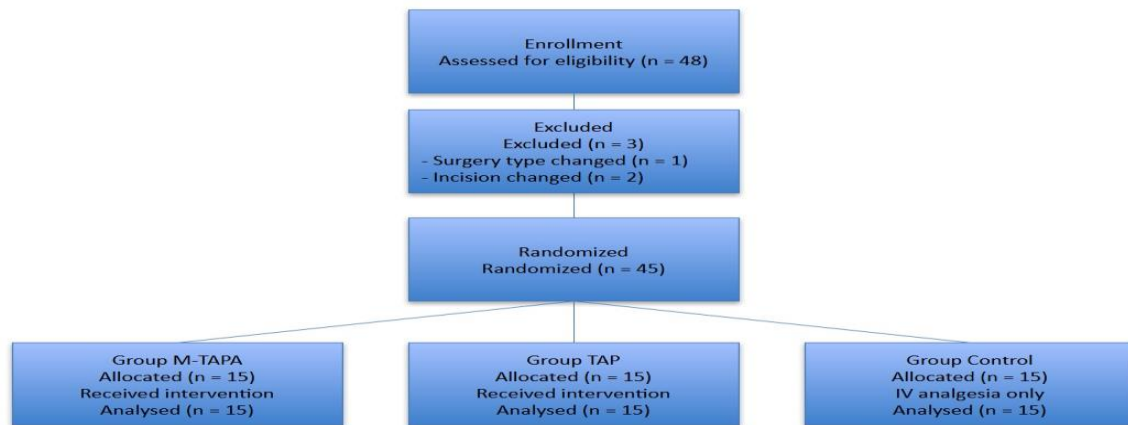


Figure 1: Flow diagram of the study

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block is frequently used in gynecologic surgeries (4–7). In 2019, Tulgar et al. described the Modified Thoracoabdominal Nerve Block through the Perichondral Approach (M-TAPA), in which local anesthetic is applied beneath the costochondral cartilage to achieve widespread abdominal analgesia (8). M-TAPA block has been successfully applied in laparoscopic inguinal hernia repairs, open gynecological surgeries, laparoscopic cholecystectomies, and laparoscopic sleeve gastrectomies (9–12). To date, no study has directly compared the analgesic efficacy of the TAP block and the M-TAPA block in patients undergoing open TAH+BSO surgery. We hypothesized that the M-TAPA block might provide superior postoperative analgesia compared to the lateral TAP block, due to its potentially wider dermatomal spread and ability to reach both anterior and lateral branches of the thoracoabdominal nerves. The aim of this study was to compare the effectiveness of lateral TAP and M-TAPA blocks in managing postoperative lower abdominal pain in patients undergoing open TAH+BSO surgery. The study also evaluated their impact on total tramadol consumption within the first 24 hours after surgery.

Materials and Methods

Local ethics committee approval (Date: 11.04.2023, decision no: 2023-04/04) was obtained for this prospective, open label, randomized controlled study. Participants were informed verbally and in writing about the study and the blocks, and their informed consent was obtained. The study was registered retrospectively

at clinicaltrials.gov with registration no NCT05901090. This report conformed to the applicable Consolidated Standards of Reporting Trials (CONSORT) guidelines. The study included 45 adult female patients, American Society of Anaesthesiologists (ASA) I-II-III who underwent open TAH+BSO surgery for benign pathology between April and June 2023. The exclusion criteria were as follows: patients who did not consent to the study, who had coagulopathy, who were about to undergo laparoscopic TAH+BSO, who were hemodynamically unstable, who had a total body weight <50 kg, who had anticoagulant use, who had signs of infection in the area where the blocks were to be performed, who were allergic to local anaesthetic drugs, who could not cooperate during postoperative pain assessment, who were operated with an incision other than the pfannenstiell incision, and who had malignant pathology. Patients were divided into three groups according to age, body mass index (BMI), operation time and ASA values: Group Control (n=15), Group M-TAPA (n=15) and Group TAP (n=15) (Figure 1). Randomization was done by selecting computer-generated numbers using an online randomization program (research randomiser) consisting of three sets from 1 to 45. The patients knew which group they belonged. The patients' group information was known to the anaesthesiologist, who performed all blocks. Postoperative pain assessment was performed by another anaesthesiologist who did not perform the blocks. All patients were routinely monitored using non-invasive blood pressure, SpO₂, and 5-lead ECG (Electrocardiogram). NRS scale was

used for postoperative pain assessment. The NRS scale is a numerical scale ranging from 0 to 10. 0-2 meant no pain, 3 meant mild pain, 4-7 meant moderate pain, 8 meant severe pain, and 9-10 meant unbearable pain (13). The scale was explained to all participants preoperatively. All patients included in the study underwent standard general anaesthesia protocol. Induction was performed with using propofol 2 mg/kg, fentanyl 1 mcg/kg and rocuronium 0.5 mg/kg. After induction and 2-3 minutes of preoxygenation, trachea was intubated and patients were connected to the anaesthesia machine. The mechanical ventilator was set to: tidal volume: 6-8 ml/kg, frequency: 12-14 /minute, positive end-expiratory pressure: 5 cmH₂O, fresh gas flow: 2 L/min. End-tidal carbon dioxide level was maintained between 30-35 mmHg. Anaesthesia was maintained with sevoflurane in a mixture of 70% air and 30% oxygen. When a 20% increase in heart rate and mean arterial pressure was observed during surgery, fentanyl at a dose of 1 mcg/kg was administered as an additional analgesic. Patients in the block groups underwent M-TAPA block and TAP block following the surgical closure before the reversal. Group Control patients did not receive any block. After sterile conditions were met, group M-TAPA patients underwent bilateral M-TAPA block with an 80 mm sonovisible needle under ultrasound guidance in supine position after surgical closure, before neuromuscular reversal. The transducer was placed above the condrium at the 9th-10th level in the sagittal plane for block application. The probe was then used to obtain a deep angle and visualize the underside of the costochondrium. The sonovisible needle was advanced through the skin and subcutis to the chondroid. The target was confirmed by administering a test dose with 5 ml saline. After validation, 20 ml of 0.25% bupivacaine was injected. The same procedure was performed on the contralateral side, and one patient received a total of 40 mL of local anaesthetic for bilateral M-TAPA block. Group TAP patients underwent bilateral lateral-TAP block with an 80 mm sonovisible needle under ultrasound guidance in supine position after surgical closure, before neuromuscular reversal. For the lateral-TAP block, a transducer was placed midway between the end of the ribs and the iliac crest on the midaxillary line. Skin, subcutaneous adipose tissue, external oblique muscle, internal oblique muscle, transversus abdominis muscle, and peritoneum were all visualized. The needle was inserted into the interfascial plane between the internal oblique and transversus abdominis muscles. The target

was confirmed by administering a test dose with 5 mL saline. 20 mL of 0.25% bupivacaine was subsequently injected (Image 1). The procedure was repeated on the contralateral side. One patient received a total of 40 mL of local anaesthetic for bilateral lateral -TAP block. In the M-TAPA and lateral-TAP block applications, the linear probe with high-frequency (7-11 MHz) of the same ultrasound was used. All patients were extubated after neuromuscular reversal with sugammadex. The surgeries were performed by the same surgical team. The duration of surgery was recorded. Local anaesthetic infiltration was not applied in any operation. All patients received 1 g paracetamol and 50 mg dextketoprofen intravenously (i.v.) 30 minutes before skin closure. Ibuprofen 400 mg (maximum dose 1200 mg/day) i.v. every 8 hours was used as part of a postoperative routine analgesia protocol in all participants. The first pain assessment was performed in the recovery room and recorded as static NRS0. Other NRS scoring for postoperative pain assessment was done statically (in rest) and dynamically (with cough) at the 1st, 6th, 12th, 18th and 24th hours. 50 mg tramadol hydrochloride was administered intravenously to patients with NRS $\geq$ 4. Total tramadol consumption and frequency of side effects (nausea, vomiting) were recorded. The study's primary outcome was NRS scores, and the secondary outcome was total tramadol consumption. The effect size was calculated to be $d: 1.341$ in the sample calculation performed with G Power 3.1.9.7 (Franz Faul, Germany) using the data from the study which established the efficacy of M-TAPA block "Modified thoracoabdominal nerve block through perichondrial approach (M-TAPA) vs local infiltration for pain management after laparoscopic cholecystectomy surgery: a randomized study" by Hande Güngör et al (14). The power analysis was based on the NRS scores (i.e., the static NRS scores in the PACU), which were the primary outcomes of this study. It was concluded that a minimum of 13 samples in each group and 39 samples in total would be required to reach the calculated effect size, at least 95% power, and 5% margin of error. Finally, the study included 48 patients, with each group consisting of 16 for possible dropouts. Statistical analyses were performed with the help of SPSS version 25.0 program. The conformity of the variables to normal distribution was analysed by histogram plots and Kolmogorov-Smirnov test. Descriptive analyses were presented using mean, standard deviation, and median values. Categorical variables (ASA, nausea, vomiting) were compared with Chi-Square Test. Kruskal Wallis test was

Table 1: Demographic data of the patients.

		Group Control (n=15)	Group M-TAPA (n=15)	Group TAP (n=15)	P
	I	1	2	3	
ASA	II	12	13	12	0.282
	III	2	0	0	
BMI (kg/m ²) [Mean ± SD]		30.13±5.48	29.26±4.7	28.83±4.4	0.854
Age (year) [Mean ± SD]		47.93±7.64	50±11.04	48.27±8	0.961
Surgery duration (minute)[Mean ± SD]		58.67±16.74	59.2±10.64	69±30.25	0.661

Chi-square and Kruskal Wallis tests were used. Continuous variables are expressed as mean and standard deviation and categorical variables n. **n**: number of the patients, **ASA**: American society of anesthesiologists, **BMI**: body mass index, **SD**: Standard deviation **kg**: kilogram, **m2**: square-meter.

Table 2: Comparing the mean values of total tramadol consumptions and NRS scores.

		Group Control (Mean ± SD)	Group M-Tapa (Mean ± SD)	Group Tap (Mean ± SD)	P
Total tramadol consumption (milligram)		146.67±12.91	103.33±39.94	103.33±29.68	<0.001*
	0 th hour	7.2±0.68	4.8±1.78	4.47±1.25	<0.001*
	1 st hour	7.13±0.99	4.87±1.55	4.53±0.92	<0.001*
	6 th hour	5.27±0.96	3.67±0.98	3.8±0.94	<0.001*
Static NRS values	12 th hour	3.93±0.96	3.2±1.08	3.07±0.8	0.044*
	18 th hour	3.87±1.25	2.6±0.99	2.53±0.74	0.004*
	24 th hour	2.4±0.51	1.67±0.62	1.93±0.26	0.002*
	1 st hour	7.93±1.44	5.93±1.44	5.67±0.82	<0.001*
	6 th hour	6.27±0.96	4.67±0.98	5±0.93	<0.001*
Dynamic NRS values	12 th hour	5±0.93	4.2±1.08	4.07±0.8	0.024*
	18 th hour	4.87±1.25	3.6±0.99	3.73±0.88	0.009*
	24 th hour	3.4±0.51	2.67±0.62	2.93±0.26	0.002*

Kruskal Wallis test was used. Continuous variables and pain scores are expressed as mean and standard deviation. **NRS**: numerical rating scale, **SD**: Standard deviation ***p<0.05**: statistically significant

used for the evaluation of nonnormal (nonparametric) variables (dynamic and static NRS scores, total tramadol consumption, age, BMI, duration of surgery) between the groups. P-values below 0.05 were classified as statistically significant results.

Results

Three patients were excluded from the study because the incision was converted to a midline incision in two of them, and one patient had TAH+ unilateral salpingo-oophorectomy. The study included 45 patients who underwent TAH+BSO surgery through the pfannenstiell incision. No complications related to the blocks were observed in the study. No perioperative hemodynamic instability was observed in any patient. Postoperative nausea was reported in six patients in Group Control, five in Group M-TAPA, and four in Group TAP, but there was no statistically significant difference in nausea between the groups (p=0.741). Postoperative

vomiting was reported in four patients in Group Control, four patients in Group M-TAPA and three patients in Group TAP, but the difference between the groups was statistically insignificant (p=0.887). When the groups were compared in terms of demographic data (BMI, ASA, age, duration of surgery), no statistically significant difference was observed (Table 1). When the groups were compared in terms of the number of patients requiring tramadol postoperatively, no statistically significant difference was found between the groups at the 1st hour (p=0.343), 6th hour (p=0.102), 12th hour (p=0.143) and 18th hour (p=0.209). No patient required tramadol in the 24th postoperative hour. Over the first 24 postoperative hours, total tramadol consumption was higher in the Control group than in both block groups (146.67±12.91 mg vs 103.33±39.94 mg and 103.33±29.68 mg; p<0.001). Static and dynamic NRS scores decreased over time in all groups; for example, mean static NRS declined from 7.2±0.68 at 0 h to 2.4±0.51 at 24 h in the

Control group and from 4.8 ± 1.78 to 1.67 ± 0.62 and 4.47 ± 1.25 to 1.93 ± 0.26 in the M-TAPA and TAP groups, respectively. When the groups were compared in terms of static and dynamic NRS scores, there was always a statistically significant difference between Group Control and the other groups ($p < 0.05$). When NRS scores were compared at all times, there was no statistically significant difference between Group M-TAPA and Group TAP (Table 2).

Discussion

In this study, no statistically significant difference in analgesic efficacy was found between M-TAPA and TAP blocks after open TAH+BSO surgeries. Both blocks provided clinically acceptable analgesia compared to the control group. This is the first study in the literature to compare these two blocks in gynaecologic surgeries performed through the pfannenstiell incision (completely in the lower abdomen). Postoperative pain is typically higher in open gynecologic surgeries than in laparoscopic ones, likely due to greater tissue trauma from wider incisions and the use of mechanical instruments such as scissors and clamps (15–17). Previous studies and meta-analyses have shown that the lateral TAP block provides moderate analgesia after open abdominal hysterectomy, with NRS scores typically ranging from 4 to 5 depending on the analgesic protocol (4,6,18). Our findings in the TAP group are consistent with this range. The development of the posterior TAP block technique began the search for a more effective block in the lower abdomen than lateral TAP block. A meta-analysis comparing lateral and posterior TAP blocks found that the posterior TAP block was more effective than the lateral TAP block in terms of pain scores and morphine consumption. The superior efficacy of the posterior TAP block may be due to its ability to block the cutaneous branches of the thoracolumbar nerves before they enter the TAP plane, allowing for wider dermatomal coverage including the paravertebral space (19). In a study by Yousef comparing the quadratus lumborum block (QLB) and lateral TAP block after total abdominal hysterectomy, the QLB group had significantly lower opioid consumption and VAS scores (20). Similarly, Blanco et al. reported better analgesic outcomes with QLB compared to TAP block after cesarean section, attributing this to broader dermatomal coverage—T7 to T12 in QLB versus T10 to T12 in TAP (21). The wider spread of local anesthetic in QLB, potentially reaching the thoracolumbar plane and paravertebral space, is thought to underlie this difference. These

findings suggest that the lateral TAP block may provide limited analgesia due to its narrower dermatomal spread and insufficient effect on lateral cutaneous branches. This has prompted the exploration of alternative blocks, such as M-TAPA, for more effective lower abdominal analgesia. In a pilot study, Tanaka et al. reported a mean NRS score of 5 at the second postoperative hour after M-TAPA in patients undergoing open hysterectomy with a vertical incision (10). This finding is comparable to our results in the M-TAPA group. Another significant difference between this study and Tanaka et al.'s study is that it focused solely on patients operated on through the Pfannenstiell incision and investigated the analgesic efficacy of this block in the lower abdomen. Studies have reported variable dermatomal coverage for M-TAPA block, ranging from T7–T11 to as wide as T3–L1, depending on volume and technique (8,9). Although the lateral TAP block is known to provide effective somatic analgesia by blocking the anterior branches of the lower thoracic nerves, its ability to affect visceral pain is uncertain. Postoperative pain after open gynecologic surgeries, such as TAH+BSO, involves both somatic and visceral components. However, the TAP block is not known to block visceral afferents, and its impact on visceral pain remains unclear (22). This may explain why the TAP block often yields only partial pain relief in procedures involving significant visceral manipulation. In contrast, blocks like the QLB and ESP have been suggested to provide broader and possibly deeper analgesia, potentially affecting both somatic and visceral pathways due to their proximity to the paravertebral space (23,24). In this context, while M-TAPA may offer broader dermatomal spread than lateral TAP by targeting both anterior and lateral branches of thoracoabdominal nerves, its efficacy on visceral pain is still unknown and needs further investigation. Alver et al. reported that the M-TAPA block provided effective postoperative analgesia, with lower NRS scores and reduced need for rescue analgesics compared to the control group in a randomized controlled trial on laparoscopic inguinal hernia repair using 0.25% bupivacaine (20 ml per side) (11). Although that study was conducted in a laparoscopic setting, it still involved the L1 dermatome, which is also a key region affected in Pfannenstiell incisions. While the Pfannenstiell incision primarily lies within the L1 dermatome, open hysterectomy involves more extensive surgical trauma, including manipulation of visceral structures and ligament dissection, which can activate pain pathways

beyond the L1 level. Thus, achieving adequate analgesia in such procedures requires coverage not only of the L1 dermatome but also adjacent dermatomes such as T10–T12. M-TAPA is theoretically capable of providing broader coverage, including anterior and lateral thoracoabdominal nerve branches. However, in our study, the dermatomal extent of the block was not objectively mapped, making it difficult to confirm its effectiveness at the L1 level. The TAP block, on the other hand, may offer more consistent blockade at L1 but has limited impact on lateral cutaneous branches. The similar analgesic efficacy observed between the two blocks may be due to the limited dermatomal coverage of M-TAPA at L1 and the inability of the lateral TAP block to affect lateral cutaneous branches. However, a dermatomal mapping study is needed to confirm this. Although some differences in NRS scores were observed between groups, the magnitude of these changes (approximately 1 point on the NRS) may not exceed the threshold generally considered clinically meaningful. Previous studies suggest that a change of at least 1.3 to 2.0 points on the NRS is required to be perceived as clinically significant by patients (25).

Study Limitations: The main limitations of this study include the lack of dermatomal mapping, absence of data on preoperative pain levels, use of a fixed volume of local anesthetic, and a limited sample size. Further volume-controlled studies are warranted. Another limitation of this study is its open-label design, which may have introduced measurement bias in patient-reported outcomes such as pain scores. Knowledge of the performed block may have influenced patients' perception of pain due to psychological or expectancy effects.

Conclusion

In this study, no statistically significant difference in analgesic efficacy was found between M-TAPA and TAP blocks after open TAH+BSO surgeries. Both blocks provided clinically acceptable analgesia compared to the control group.

Ethical approval: Local ethics committee approval (Date: 11.04.2023, decision no: 2023-04/04) was obtained for this prospective, open label, randomized controlled study

Conflict of interest: No potential conflict of interest relevant to this article was reported.

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Author contributions: F. B: Conceptualization, methodology development, data analysis, and

drafting of the manuscript. O. G: Literature review, data collection, and preparation of tables and figures. O. A: Statistical analysis, interpretation of findings, and writing of the results section. M.N. T: Supervision of the study, critical revision, and final approval of the manuscript.

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