

Efficacy of transversus abdominis plane block in postoperative pain management of laparoscopic totally extraperitoneal inguinal hernia repair: a propensity score-matched analysis

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Purpose: Transversus abdominis plane (TAP) block is a promising technique for postoperative pain control. In this study, we aimed to evaluate the efficacy of the TAP block in managing postoperative pain after laparoscopic totally extraperitoneal (TEP) inguinal hernia repair.

Methods: In this retrospective study, medical records of patients who had received ultrasonography-guided TAP blocks after surgery from January 2019 to August 2023 were reviewed and compared with those of patients who had not received. Propensity score matching was controlled for age as a confounder. Postoperative pain levels were measured using the numeric rating scale (NRS).

Results: After matching, 95 patients were included in each group. The TAP block group (2.7 vs. 4.0, $P < 0.001$) had significantly lower NRS scores immediately and early postoperative pain than the control group (1.9 vs. 2.5, $P < 0.001$). However, there was no significant difference between the 2 groups in terms of postoperative complications ($P > 0.05$).

Conclusion: TAP block is effective and safe for managing immediate and early postoperative pain in laparoscopic TEP inguinal hernia repair and does not increase the risk of complications.

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Key Words: Abdominal muscles, Inguinal hernia, Laparoscopy, Postoperative pain

INTRODUCTION

Laparoscopic totally extraperitoneal (TEP) inguinal hernia repair has emerged as a minimally invasive technique. It

has several advantages. For example, unlike the traditional open inguinal hernia repair, it is associated with reduced postoperative pain levels and risk of complications and can enhance recovery [1,2]. However, despite these benefits,

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postoperative pain management is still important to ensure patient comfort and promote early mobilization [3]. Conventional analgesic approaches, particularly systemic opioid administration, may be associated with potential adverse effects such as respiratory depression, sedation, and nausea. Consequently, there is a growing interest in investigating alternative pain management strategies to improve patient outcomes after laparoscopic TEP inguinal hernia repair [4,5]. Recently, transversus abdominis plane (TAP) block has emerged as a promising adjunctive strategy for pain control in abdominal surgeries [6-8].

TAP block is a regional anesthesia technique involving the administration of local anesthetic into the TAP, thereby providing targeted pain relief after abdominal surgeries. Recent studies have reported that the TAP block has positive outcomes particularly in reducing postoperative pain after abdominal surgery. However, further research must be performed to evaluate its efficacy.

This study aimed to evaluate the efficacy of the TAP block against postoperative pain in patients undergoing laparoscopic TEP inguinal hernia repair.

METHODS

Ethics statements

This study was approved by the Institutional Review Board of Keimyung University Dongsan Medical Center (No. 2024-01-067). This study was performed in accordance with the Declaration of Helsinki and written informed consent was waived due to its retrospective nature.

Study design

This study used a monocentric retrospective design to assess the efficacy of the TAP block administered immediately after laparoscopic TEP hernia surgeries. Data were retrospectively extracted from the charts of patients who underwent hernia repair surgery from January 2019 to August 2023 at Keimyung University Dongsan Medical Center.

Patient selection

TAP block has been used since December 2020. During this time, patients were informed of the availability of postoperative TAP block and TAP block was performed in those patients who opted for it.

The patients were categorized into the TAP block and control groups. The control group was treated with NSAIDs or opioids without the TAP block after laparoscopic TEP surgery. Meanwhile, the TAP block group received the postoperative ultrasonography (USG)-guided TAP block. The postoperative pain control method was similar between the TAP block and control groups. The inclusion criteria included patients who

underwent laparoscopic TEP hernia repair. The exclusion criteria included patients who had femoral hernia and those who underwent conversion to open hernia repair, laparoscopic transabdominal preperitoneal (TAPP) hernia repair, secondary hernia repair due to recurrence, and cooperative surgery with other departments owing to medical conditions such as robot-assisted laparoscopic radical prostatectomy and cholecystectomy.

Transversus abdominis plane block technique

The TAP block was performed by an anesthesiologist as follows: Immediately after surgery, the patient was placed in the supine position. The area extending from the iliac crest to the inferior costal margin of the operative side, which demarcates the pertinent landmarks for the procedure, was exposed. The USG-guided technique was started by positioning the high-frequency (13–6 MHz) linear array transducer transversely above the iliac crest at the mid-axillary line. Upon achieving clear visualization of the external oblique, internal oblique, and transversus abdominis muscle layers, a 23-gauge spinal needle was advanced in-plane until it reached the inter-fascial plane between the internal oblique and transverse abdominis muscles. To confirm if the needle tip was placed optimally, saline was administered, and intermuscular plane expansion was assessed on USG images. Subsequently, 30 mL of 0.375% ropivacaine was administered to each hernia side.

Surgical procedure

Under general anesthesia, all patients underwent surgery in the supine position. A 10-mm incision was made on the skin around the umbilicus toward the hernia site. After the anterior rectus fascia was identified, a horizontal 10-mm incision was made through it. After the rectus muscle was exposed, the preperitoneal area behind the muscle was dissected bluntly using a Kelly clamp, and the posterior rectal sheath was exposed using the narrow Deaver retractor. The preperitoneal area was insufflated using a 10–12-mm balloon trocar (Spacemaker Pro, Medtronic). Then, the balloon was removed, and carbon dioxide gas was insufflated into the extraperitoneal space at a pressure of 8–10 mmHg. A 30° videoscope was inserted through the port. A 5-mm trocar port was placed 3 cm above the symphysis pubis. Then, another 5-mm trocar was placed between the camera port and the suprapubic port. The extraperitoneal space was dissected to establish a critical view of the myopectineal orifice [9]. The inferior epigastric vessels were identified along the lower portion of the rectus muscle and were protected. The anterior superior iliac spine was laterally dissected. The preperitoneal space was dissected, and the herniated sac was retracted using atraumatic forceps. A prosthetic graft was inserted via the camera port and placed on the anterior abdominal wall covering the myopectineal orifice.

The graft was fixed with the absorbable Tacker fixation device (Medtronic) in case of mesh migration. The 2 groups underwent surgery performed by the same surgical team. Surgical duration was defined as the time between the start of the skin incision and skin closure or the end of the TAP procedure.

Statistical analysis

The baseline characteristics of the participants were recorded and statistical tests were performed between the 2 groups. Continuous variables were presented as means \pm standard deviations (SDs) and subjected to independent 2-sample t-tests. Categorical variables were presented as frequencies and proportions and subjected to either the chi-square test or Fisher exact test. Additionally, paired t-tests were used to compare pain scores before and after 6 hours within groups.

Propensity score matching (PSM) was performed to balance the control group and TAP block group. The variables significant in baseline characteristics, such as age, were used as the PSM variables. To calculate the PS, logistic regression was used, and a greedy algorithm was applied for optimal matching. All statistical analyses were performed using SAS software (ver. 9.4, SAS Institute) with a significance level of 0.05. The primary outcome of the study was postoperative pain level assessed using the numeric rating scale (NRS). The highest postoperative NRS score within the first 6 hours was selected, and the highest score from 6 hours postoperatively to discharge was selected. For this study, we defined pain within 0–6 hours of surgery as "immediate postoperative pain" and pain between 6 and 24 hours of surgery as "early postoperative pain." The secondary outcomes were the frequency of postoperative painkiller usage and development of postoperative complications including seroma, bruise, surgical site swelling, and voiding difficulty.

RESULTS

The current study included 284 patients. In total, 100 patients were included in the TAP block group and 184 in the control group. The TAP block and control groups differed significantly in terms of age. Age is a factor that can affect pain. Thus, the patients were matched by age via PSM. After PSM, 95 patients were each assigned to the 2 groups. The 2 groups were similar in terms of demographic characteristics including age, sex, body mass index, and previous surgical history (Table 1). Table 2 shows the baseline perioperative data assessed via univariate analysis. The perioperative variables, except surgical duration, significantly differed between the 2 groups (Table 2). The mean and SD of surgical durations in the control group were 40.2 ± 15.3 minutes before and 39.4 ± 13.9 minutes after PSM. Meanwhile, the surgical durations of the TAP block group were 51.6 ± 16.5 minutes before and 51.4 ± 16.8 minutes after PSM ($P < 0.001$). The TAP block group had a significantly lower pain score in the immediate postoperative period than the control group. This significant difference persisted in the early postoperative period as well (Table 2, Fig. 1). In the TAP block group, the average NRS score in the immediate postoperative period before PSM was 2.7 ± 1.2 . Then, it remained consistent after PSM. Compared with the TAP block group, the control group had a higher average NRS score before and after PSM (3.9 ± 1.6 vs. 4.0 ± 1.5 , respectively; $P < 0.001$). Before and after PSM, the TAP block group consistently had lower average NRS scores (1.9 ± 0.8 and 1.9 ± 0.7 before and after PSM, respectively) within the early postoperative period. Compared with the TAP block group, the control group had higher average NRS scores before (2.6 ± 1.4 , $P < 0.001$) and after PSM (2.5 ± 1.4 , $P < 0.001$). The 2 groups significantly differed in terms of the frequency of postoperative opioid and NSAID usage (Table

Table 1. Demographic characteristics of patients

Variable	Before PSM			After PSM		
	Control group (n = 184)	TAP block group (n = 100)	P-value	Control group (n = 95)	TAP block group (n = 95)	P-value
Age (yr)	63.5 ± 15.7	57.4 ± 20.3	0.010 ^{a)}	59.4 ± 18.8	58.6 ± 19.1	0.769 ^{a)}
Sex						
Female	16 (8.7)	14 (14.0)	0.165 ^{b)}	12 (12.6)	14 (14.7)	0.673 ^{b)}
Male	168 (91.3)	86 (86.0)		83 (87.4)	81 (85.3)	
Body mass index (kg/m ²)	23.7 ± 4.0	24.6 ± 13.0	0.476 ^{a)}	23.4 ± 3.5	24.6 ± 13.3	0.410 ^{a)}
Previous surgical history						
None	119 (64.7)	73 (73.0)	0.152 ^{b)}	63 (66.3)	69 (72.6)	0.345 ^{b)}
Abdominal surgery	65 (35.3)	27 (27.0)		32 (33.7)	26 (27.4)	
Prostate cancer surgery	0 (0)	0 (0)		0 (0)	0 (0)	

Values are presented as mean \pm standard deviation or number (%). PSM, propensity score matching; TAP, transversus abdominis plane. PSM variable: age.

^{a)}Independent-samples 2-tailed t-test, ^{b)}chi-square test.

Table 2. Perioperative data

Variable	Before PSM			After PSM		
	Control group (n = 184)	TAP block group (n = 100)	P-value	Control group (n = 95)	TAP block group (n = 95)	P-value
Symptomatic inguinal bulging lump						
Yes	5 (2.7)	3 (3.0)	>0.999 ^{b)}	3 (3.2)	3 (3.2)	>0.999 ^{b)}
No	179 (97.3)	97 (97.0)		92 (96.8)	92 (96.8)	
Preoperative diagnosis						
Unilateral inguinal	140 (76.1)	83 (83.0)	0.175 ^{a)}	73 (76.8)	78 (82.1)	0.369 ^{a)}
Bilateral inguinal	44 (23.9)	17 (17.0)		22 (23.2)	17 (17.9)	
Femoral	0 (0)	0 (0)		0 (0)	0 (0)	
Hernia type						
Inguinal (indirect)	140 (76.1)	71 (71.0)	0.126 ^{a)}	74 (77.9)	66 (69.5)	0.123 ^{b)}
Inguinal (direct)	41 (22.3)	23 (23.0)		20 (21.1)	23 (24.2)	
Femoral	3 (1.6)	6 (6.0)		1 (1.1)	6 (6.3)	
Surgical duration (min)	40.2 ± 15.3	51.6 ± 16.5	<0.001 ^{a)}	39.4 ± 13.9	51.4 ± 16.8	<0.001 ^{a)}
Tacker						
Not employed	104 (56.5)	54 (54.0)	0.683 ^{b)}	59 (62.1)	50 (52.6)	0.187 ^{b)}
Employed	80 (43.5)	46 (46.0)		36 (37.9)	45 (47.4)	
Pain score 6 hr before surgery	3.9 ± 1.6	2.7 ± 1.2	<0.001 ^{a)}	4.0 ± 1.5	2.7 ± 1.2	<0.001 ^{a)}
Pain score 6 hr after surgery	2.6 ± 1.4	1.9 ± 0.8	<0.001 ^{a)}	2.5 ± 1.4	1.9 ± 0.7	<0.001 ^{a)}
P-value	<0.001 ^{c)}	<0.001 ^{c)}		<0.001 ^{c)}	<0.001 ^{c)}	

Values are presented as number (%) or mean ± standard deviation.
PSM, propensity score matching; TAP, transversus abdominis plane.
PSM variable: age.

^{a)}Independent t-test, ^{b)}chi-square test, ^{c)}paired t-test.

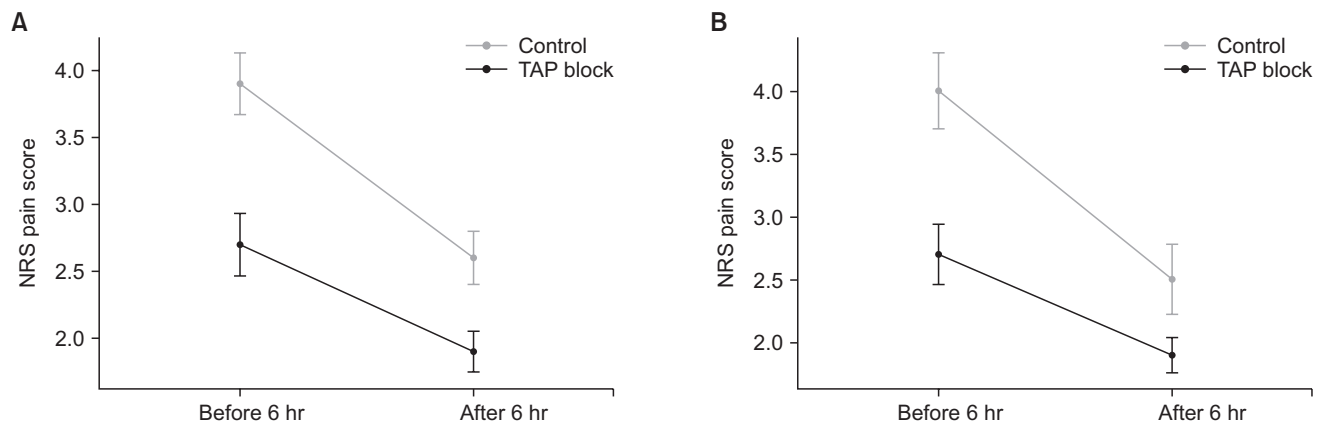


Fig. 1. Comparison of the numeric rating scale (NRS) scores within and 6 hours after surgery between the control and transversus abdominis plane (TAP) block groups. The mean NRS scores with confidence intervals before (A) and after (B) propensity score matching (PSM) of the 2 groups.

3). However, there was no statistically significant difference in terms of the incidence of postoperative complications between the 2 groups (Table 4).

DISCUSSION

The efficacy of the USG-guided TAP block in managing

postoperative pain after laparoscopic TEP hernia repair has been significantly interesting based on several studies [7,10]. Our study showed that the postoperative USG-guided TAP block was effective for managing postoperative pain in laparoscopic TEP hernia repair.

Our study focused on laparoscopic TEP inguinal hernia repair alone. However, there are significant differences in

Table 3. Frequency of postoperative pain killer usage

Variable	Before PSM			After PSM		
	Control group (n = 184)	TAP block group (n = 100)	P-value	Control group (n = 95)	TAP block group (n = 95)	P-value
Opioid						
0	148 (80.4)	79 (79.0)	0.773 ^{a)}	78 (82.1)	76 (80.0)	0.711 ^{a)}
1	36 (19.6)	21 (21.0)		17 (17.9)	19 (20.0)	
NSAIDs						
0	34 (18.5)	14 (14.0)	0.328 ^{b)}	12 (12.6)	13 (13.7)	0.685 ^{b)}
1	148 (80.4)	83 (83.0)		82 (86.3)	79 (83.2)	
2	2 (1.1)	3 (3.0)		1 (1.1)	3 (3.2)	

PSM, propensity score matching; TAP, transversus abdominis plane.

PSM variable: age.

^{a)}Chi-square test, ^{b)}Fisher exact test.

Table 4. Postoperative complications

Variable	Before PSM			After 1:1 PSM		
	Control group (n = 184)	TAP block group (n = 100)	P-value	Control group (n = 95)	TAP block group (n = 95)	P-value
Postoperative complications						
No	113 (61.4)	62 (62.0)	0.923 ^{a)}	62 (65.3)	59 (62.1)	0.651 ^{a)}
Yes	71 (38.6)	38 (38.0)		33 (34.7)	36 (37.9)	
Seroma						
No	182 (98.9)	99 (99.0)	>0.999 ^{b)}	94 (99.0)	94 (99.0)	>0.999 ^{b)}
Yes	2 (1.1)	1 (1.0)		1 (1.1)	1 (1.1)	
Bruise						
No	132 (71.7)	78 (78.0)	0.251 ^{a)}	73 (76.8)	73 (76.8)	>0.999 ^{a)}
Yes	52 (28.3)	22 (22.0)		22 (23.2)	22 (23.2)	
Swelling						
No	155 (84.2)	79 (79.0)	0.268 ^{a)}	81 (85.3)	76 (80.0)	0.338 ^{a)}
Yes	29 (15.8)	21 (21.0)		14 (14.7)	19 (20.0)	
Voiding difficulty						
No	181 (98.4)	98 (98.0)	>0.999 ^{b)}	94 (99.0)	93 (97.9)	>0.999 ^{b)}
Yes	3 (1.6)	2 (2.0)		1 (1.1)	2 (2.1)	

PSM, propensity score matching.

PSM variable: age.

^{a)}Chi-square test, ^{b)}Fisher exact test.

the pain profiles between TEP and TAPP procedures [7,10]. In addition, previous abdominal surgeries such as laparoscopic cholecystectomy and prostatectomy can affect postoperative pain level in laparoscopic hernia repair. By excluding factors that might confound our results, this study could provide a clearer understanding of the efficacy of the TAP block specifically in TEP hernia repair.

Based on the statistical analysis, the TAP block and control groups significantly differed in terms of age. According to a recent study conducted by Forester et al. [11], age was a predictor of chronic pain after laparoscopic inguinal hernia repair. We hypothesized that the difference in age between the 2 groups could potentially impact our study results. Hence, PSM was

performed to inhibit any potential age-related bias. However, in our study, the mean pain between the 2 groups before and after PSM was almost similar. Moreover, the difference in intensity in both immediate and early postoperative pain did not significantly differ regardless of PSM. Hence, the TAP block had more effect on early postoperative pain than age. Consistent with other studies about the USG-guided TAP block, our research revealed that the TAP block group had a longer surgical duration than the control group [10,12]. The longer surgical duration can be attributed to the additional procedure required for administering the USG-guided TAP block.

Immediate pain was distinguished from early pain after surgery using 6 hours as the cutoff point. Since our study

was retrospective in nature, the timing of postoperative pain documentation varied among patients. Hence, it was challenging to establish a proper criterion. After analyzing various data, we found that diving pain at the 6-h mark resulted in similar data distribution. Hence, this time was adopted as the standard. Nevertheless, further prospective studies should consider a more appropriate timing for data collection. Arora et al. [12] found that the USG-guided TAP block was associated with decreased postoperative pain scores for up to 24 hours after laparoscopic inguinal hernia repair compared with the periportal block. Similarly, Mughal et al. [13] reported that the laparoscopic-assisted TAP block was associated with reduced postoperative pain scores at 3 and 6 hours after laparoscopic TEP inguinal hernia repair. Consistent with the previously mentioned studies, this study showed that the TAP block group had significantly lower pain scores in the immediate and early postoperative period than the control group. Notably, the difference in the NRS scores between the 2 groups was greater in the immediate postoperative period than in the early postoperative period. Therefore, the analgesic effect of the TAP block is more evident in the immediate postoperative period than in the early postoperative period. Nevertheless, when the TAP block is additionally performed, an extra cost of 80,000 South Korean Won is incurred as it is not covered by insurance. While the TAP block does lead to a meaningful reduction in pain, the decrease in pain scores is approximately 1 point, which may not be substantial. Therefore, further studies are needed to assess the cost-effectiveness of the TAP block.

Based on several studies, the TAP block is effective in reducing the need for postoperative opioid use. Paasch et al. [14] found that the TAP block was associated with a lower frequency of opioid use after laparoscopic TAPP inguinal hernia repair. Further, Kim et al. [10] reported that the TAP group had a significant decrease in the overall use of analgesics after TEP hernia repair compared with the control group. Unlike previous studies, this study did not find significant differences in the postoperative use of opioids and NSAIDs between the TAP block and control groups. At our center, regardless of the patient's postoperative pain score, routine analgesics are administered for pain management in the early postoperative period. Additional analgesia is administered if the patient has high pain levels. However, the routine administration of analgesics even in patients with relatively low pain scores may have influenced the outcome. Therefore, more randomized control studies should be conducted using predetermined analgesic administration timing based on pain scores.

Previous studies have reported a lower incidence of complications associated with the USG-guided TAP block, such as liver injury and transient femoral nerve palsy [15-17]. Hence, the TAP block is generally safe and associated with a low risk of complications. Recently, Paasch et al. [14] found that patients

who received the USG-guided TAP block did not present with iatrogenic injuries. Similarly, in the current study, the patients did not develop iatrogenic injuries after receiving the USG-guided TAP block. In addition, the TAP block and control groups did not significantly differ in terms of the incidence of postoperative complications. Based on this finding, the TAP block is safe.

The current study has several limitations. First, our study did not have long-term follow-up data. Therefore, the efficacy of the TAP block against chronic pain could not be assessed, and further long-term analyses should be conducted to validate the efficacy of the TAP block against chronic pain. Second, the current study had a retrospective design, which has inherent limitations. Third, the data were not consistent, which could have resulted in differences in the timing of pain score measurement. In our review of the medical records, we were able to obtain NRS scores for both within and after 6 hours of surgery. However, due to the limitations of the available data, we were unable to retrieve pain scores for the first postoperative day. Therefore, our study faces clear limitations in the analysis of early and chronic pain beyond the first day after surgery. Consequently, the criteria for classifying immediate and early postoperative pain were arbitrarily established based on the data obtained from the patients' medical records. Finally, analgesics were administered routinely without clear criteria for administration. This is also a limitation of our retrospective study. In cases where patients reported nonspecific postoperative pain, postoperative painkiller was routinely administered without a clear postoperative pain management protocol. This may have influenced the pain score comparisons between the 2 groups. Therefore, a more detailed analysis through a prospective multicenter study is needed in the future to address these issues.

In conclusion, the TAP block is significantly effective and safe for managing postoperative pain in laparoscopic TEP inguinal hernia repairs. Its application can significantly reduce pain levels in the immediate and early postoperative periods without increasing the risk of complications. This study can provide evidence supporting the continuous development of the TAP block as an additional tool for reducing postoperative pain.

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Conflict of Interest

Eunyoung Jung, serving as a member of the Editorial Board of *Annals of Surgical Treatment and Research*, did not participate

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