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Efficacy of Ultrasound-Guided Transversalis Fascia Plane Block (TFP) for Postoperative Analgesia in Inguinal Hernia Repair in Adults Under Spinal Anesthesia: A Randomized, Double-Blinded, Controlled Trial

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Abstract

Background: Inguinal herniorrhaphy is a commonly performed surgical procedure that is performed under spinal anesthesia. Effective postoperative pain management is crucial for preventing complications and improving patient comfort. The use of multimodal analgesia is essential for pain management. An innovative regional analgesic treatment that covers the T12–L1 dermatomes, the transversalis fascia plane block (TFPB) is appropriate for this procedure. Additionally, it provides long-lasting pain relief that goes beyond the effects of spinal anesthesia.

Aim of Study: The aim of the study was to assess the effect of TFPB on the total 24-hour postoperative morphine consumption in patients who underwent inguinal herniorrhaphy.

Patients and Methods: Eighty patients undergoing spinal anesthesia for inguinal hernia surgery were involved in this randomized, double-blind, controlled trial. After receiving a TFPB, each patient was allocated into one of two groups: Study group TFPB was given 20 milliliters of 0.25% bupivacaine. Twenty milliliters of saline were given to the control group. Postoperatively, paracetamol was administered at 8-hour intervals, with morphine as rescue analgesics.

Results: At rest and during coughing pain scores (VAS) at 2, 4, and 8 hours postoperatively, in group TFPB were considerably lower (p<0.001). TFPB group consumed significantly less opioids (8.1±4.3mg) postoperatively than Control group (16.1±3.2mg, p<0.001). The TFPB group had a significantly longer time to first rescue analgesia (p<0.001).

Conclusion: The TFP block is an efficient postoperative analgesic modality for inguinal hernia repair under spinal anesthesia, as it reduces opioid consumption, improves pain relief, and enhances patient recovery and mobility.

Research and ethics committee approval number: ID: MS-48-2023.

Clinical Trials registration ID: NCT06219837.

Key Words: *Analgesia – Chronic pain – Regional anaesthesia – Open inguinal hernia repair (OIHR) – Nerve block – Ultrasonography.*

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Introduction

INGUINAL hernia repair is among the most common surgical operations carried out globally. More than 20 million inguinal hernia repairs, either open or laparoscopic, are performed annually *[1]*. Pain following a herniorrhaphy can be either nociceptive or neuropathic.

Visceral or somatic tissue injury via surgical dissection, suturing, or mesh is the original cause of nociceptive discomfort. Nerve damage may result from inadequate treatment, leading to neuropathic persistent chronic pain *[2]*. The incidence of chronic pain may reach up to 20% within 1–5 years of open inguinal hernia repair (OIHR) *[2]*.

Effective postoperative pain management is therefore crucial *[3]*. Therefore, procedure-specific pain management guidelines, for inguinal repair surgeries analgesia, recommend a multimodal analgesic approach including regional nerve block techniques, which effectively reduces chronic pain *[4]*.

The subcostal nerve (T12), ilioinguinal nerve (L1), iliohypogastric nerve (T12-L1), and occasionally the genitofemoral nerve (L1-L2) supply sensory innervation to the incision site of the in-

guinal hernia repair surgery [3]. Multiple regional nerve blocks have been tested for their efficacy in providing postoperative analgesia following OIHR, including (continuous wound infiltration, transversus abdominis TAP, quadratus lumborum QL, erector spinae ES, iliohypogastric n IH/ilioinguinal n II, and transversalis fascia plain block TFPB) with favorable outcomes **[3,5-8]**.

Hebbard et al., originally reported the transversalis fascia plane block (TFPB) using ultrasonography (US) guidance in 2009. The anterior and lateral branches of the T12 and L1 nerves can be blocked by injecting a local anesthetic (LA) between the transversalis fascia and the deep investing fascia of the transversus abdominis muscle [9].

The TFPB ansethitize the ilioinguinal, iliohypogastric, and subcostal nerves very close to the lumbar plexus. This block's efficiency has been tested in iliac crest bone graft harvesting, cesarean section, and inguinal herniorrhaphy **[7,10,11]**. However, most studies examining the use of the TFPB in inguinal herniorrhaphy were performed in patients under general anesthesia **[6,7]**.

The purpose of this study was to examine the efficacy of ultrasound-guided transversalis fascia plane block as a postoperative analgesic modality, as part of multimodal analgesia, in patients having OIHR under spinal anesthesia.

Patients and Methods

This randomized, double-blind, controlled trial was conducted at the general surgery theatre of Cairo University Hospitals after approval from the Research and Ethics Committee (ID: MS-48-2023) and registration in the clinical trial registry site (ID: NCT06219837) From October 2023 till January 2025. Informed consent was obtained from all the participants. The Consolidated Standards of Reporting Trials (CONSORT) Guidelines were followed.

Eighty patients aged 18–60 years with ASA I and II who underwent inguinal herniorrhaphy under spinal anesthesia were enrolled and completed the study. Refusal of regional anesthesia, infection in the back or at the injection site for the TFP block, and coagulation disorders were the exclusion criteria.

According to the intervention used patients were randomly assigned to one of two groups:

- Group TFPB: Ultrasound-guided TFP block group (n=40).
- Group Control: Control group (n=40)

Computer-generated sequences were used for randomization, and opaque envelopes were used for randomization concealment. The patients did not receive premedication before spinal anesthesia.Standard monitoring, including pulse oximetry, noninvasive blood pressure, and electrocardiography, was performed upon arrival at the operating room. Then, an intravenous access 18 gauge was inserted. All patients received 3ml/kg normal saline 0.9% as a co-load with spinal anesthesia, and fluid maintenance was administered according to fluid deficits. In sitting position, patients' back are sterlized then a spinal needle was introduced through the L3 to L4 or L4 to intervertebral space, and 15mg of 0.5%.

Hyperbaric bupivacaine (AstraZeneca Pharmaceuticals, Cambridge, United Kingdom) and 25μ fentanyl were injected. Thereafter, the patients were repositioned supine, and surgery was initiated after spinal anesthesia was stabilized.

- *Group TFPB:* Ultrasound-guided TFP block group.

After termination of surgery, in aseptic conditions a higher frequency linear Ultrasound probe is positioned obliquely over the lateral abdomen between the iliac crest and the costal margin as described by Hebbard [9]. In the region where the peritoneum separates from the transversus abdominis muscle while curving backward, preperitoneal perinephric adipose tissue was located adjacent to the transverse fascia. The optimal location for the block was chosen to be as far posterior as possible to reduce the likelihood of liver injury or penetration of the peritoneum. A block needle, 100-150mm in length, was introduced through the posterior side of the transversus abdominis muscle into the plane of the transverse fascia using the 'in plane' approach. Twenty milliliters of a 0.25% bupivacaine solution was then injected.

Control group:

The same technique as in group TFPB was used, but with 20ml saline.

An expert anesthetist, with more than 50 successful TFP blocks, performed all the study blocks on the operated side. Then the patients were then transported to the post-anesthesia recovery unit (PACU). VAS scores at T0, T2, T4, T8, T12, and T24 were used to measure pain [T0 was at the time of arrival in the PACU and then at 2, 4, 8, 12, and 24 hours postoperatively]. Regular analgesia was prescribed as 1g of paracetamol every 8h. When the VAS was greater than 3, rescue analgesia in the form of 3 mg of morphine was given intravenously (IV) at intervals of 20 minutes until the VAS was less than 3, with a daily maximum dose of 40mg.

The total amount of morphine consumed within the first 24 hours after surgery was the primary endpoint. VAS scores at rest and during coughing, time to first rescue analgesia (the period between completing the block and the first request for rescue analgesia or VAS >3), patient satisfaction, and complications (PONV, injection site hematoma, and local anesthetic toxicity) were the secondary end-

points. A 4-point Likert scale was used to assess patient satisfaction (1 being poor, 2 being moderate, 3 being good, and 4 being excellent).

Sample size justification:

Total consumption of the rescue analgesia throughout the first 24 hours was our primary endpoint. A pilot study including ten patients, who experienced postoperative TFPB after inguinal hernia surgery under spinal anesthesia, was done. 20 milliliters of 0.25% bupivacaine were given to the first five individuals (block group), and 20 milliliters of saline were given to the second five (control group).

The TFPB group's total morphine consumption over the first 24 hours was 11.7±4.2, while the Control group's was 18.4±3.5. The sample size was calculated using the G power 3.1.9.2. A study power of 95%, alpha error of 0.05, and doubling the SD required a minimum total of 72 patients; this number was raised to 80 patients (40 patients per group) to account for potential drop-outs.

Statistical methods:

With IBM SPSS statistics (Statistical Package for Social Sciences) software version 22.0, IBM Corp., Chicago, USA, 2013, the gathered data were coded, tabulated, and statistically examined. Independent *t*-tests were used to compare quantitative data, which were expressed as mean ± standard deviation (SD). The chi-square test was used to compare qualitative data, which were expressed as numbers and percentages. When the *p*-value is less than 0.05, it is considered significant; otherwise, it is considered non significant.

Results

Two of the 84 patients who were enrolled in this RCT were eliminated because they did not fit the inclusion criteria, and two of the patients declined to take part in the study. Randomization, allocation, and analysis were performed on 80 patients. (Fig. 1).

All of the demographic information including age, sex, ASA, and weight, presented in (Table 1), was comparable across the groups.

The TFPB group consumed considerably less morphine in the First 24 hours postoperative than the control group (8.12±4.31 vs. 16.1±3.2mg, respectively, $p<0.001$) (Table 2).

The TFPB group experienced a substantially longer time to initial rescue analgesia than the control group (15.3±6.65 vs. 7.7±2.88min, $p<0.001$) (Table 2). According to the group, the Kaplan-Meier graph displays the time until the first analgesic demand (Fig. 2). There were 35 (87.5%) patients who needed analgesia, with a mean value of 17.48, SE 0.57, and (16.368 to 18.603) 95% CI for the mean in the TFP block group. There were 40 patients (100%) required analgesia, with a mean value of 7.7, SE 0.456, and (6.806 to 8.594) 95% CI for the mean in the control group. According to the Meier Kaplan curve, 12.5% and 0% of patients in the study and control groups, respectively, did not need an opioid rescue dose during the first 24 hours.

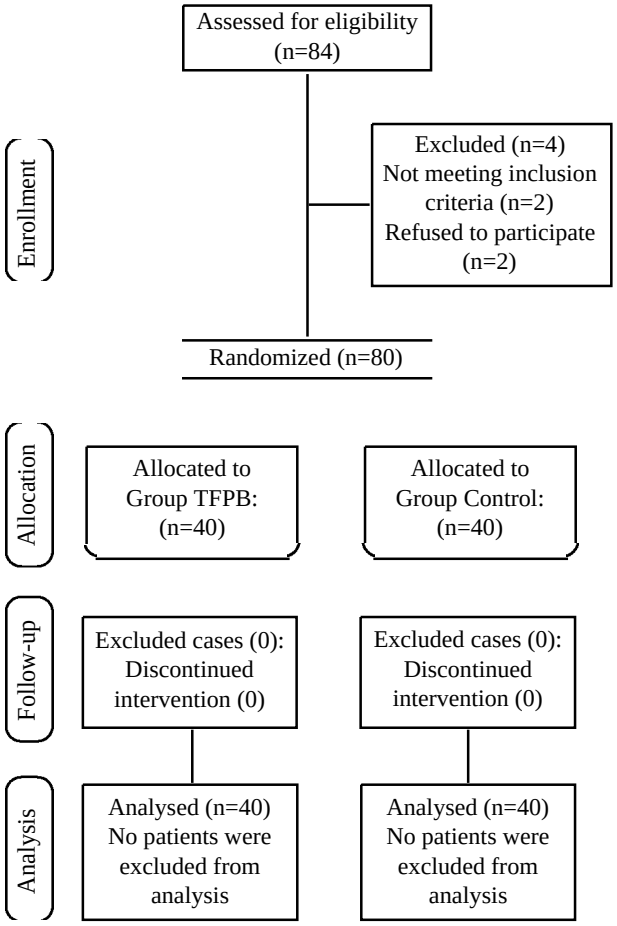

Fig. (1): Participants' flowchart.

Table (1): Patient characteristics.

	TFPB group	Control group	*p*-value
Age	42.18±11.62	42.18±11.9	1
Weight	77.4±4.85	78.5±3.86	0.267
BMI	25.58±1.54	25.85±1.31	0.393
ASA:			
I	37 (92.5%)	37 (92.5%)	1
II	3 (7.5%)	3 (7.5%)	

- Data presented as mean, standard deviation, count and percentage *p*-value <0.05 is considered significant. TFPB means Transversalis Fascia Plane Block.

Table (2): 24-hr morphine consumption and time to first rescue analgesia.

	TFPB group		Control group		*p*-value
	Mean	SD	Mean	SD	
- 24-hr morphine consumption	8.12	4.31	16.1	3.2	0.001*
- Time to first rescue analgesia	15.3	6.65	7.7	2.88	0.001*

- Data presented as mean and standard deviation, *p*-value <0.05 is considered significant. TFPB means Transversalis Fascia Plane Block.

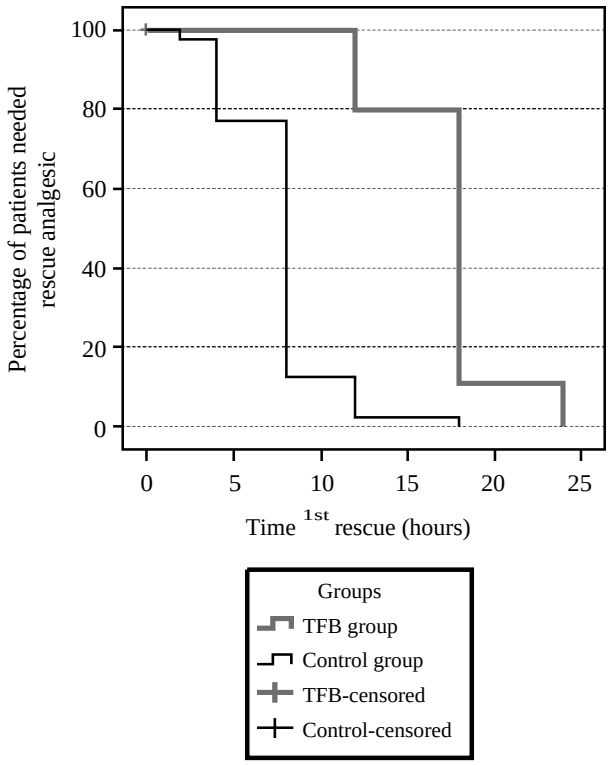

Fig. (2): Kaplan Meier survival analysis for time for first analgesic request of the studied groups.

There was a statistically significant difference.

The TFPB group had significantly reduced VAS values at rest and after coughing, particularly at T2, T4, and T8 postoperatively (*p*-value = <0.001) (Table 3).

The Likert scale revealed a substantial difference in patient satisfaction between the TFPB and control groups (4±0.00 vs. 2.78±0.48, respectively, *p*<0.001) (Table 4). There were no documented problems in either research group.

Table (3): VAS scores at rest and on cough.

VAS scores at rest	TFPB group		Control group		*p*-value
	Mean	SD	Mean	SD	
VAS 2-hr	0.95	0.22	2.1	0.84	0.001*
VAS 4-hr	1.2	0.41	3.33	1.07	0.001*
VAS 8-hr	2.18	0.45	4.22	1.03	0.001*
VAS 12-hr	3.17	1.01	3.68	1	0.029
VAS 18-hr	4.1	1.08	4.25	0.98	0.518
VAS 24-hr	3.48	0.99	3.8	0.99	0.146
VAS scores on cough:					
VAS cough 2-hr	1.95	0.22	3.37	1.13	0.001*
VAS cough 4-hr	2.2	0.41	4.58	1.17	0.001*
VAS cough 8-hr	3.13	0.56	5.15	1.10	0.001*
VAS cough 12-hr	4.13	1.07	4.85	1.08	0.003
VAS cough 18-hr	5.05	1.15	5.15	1	0.68
VAS cough 24-hr	4.45	1.01	4.9	1.01	0.049

- Data presented as mean and standard deviation, *p*-value <0.05 is considered significant. TFPB means Transversalis Fascia Plane Block.

Table (4): Likert scale of both groups.

	TFPB		Control		*p*-value
	Mean	SD	Mean	SD	
Likert scale	4.00	0.00	2.78	0.48	0.001*

- Data presented as mean and standard deviation, *p*-value <0.05 is considered significant. TFPB means Transversalis Fascia Plane Block.

Discussion

This study's primary finding was that postsurgical TFPB decreased overall postoperative opioid consumption and extended the duration of postoperative analgesia in individuals undergoing OIHR under spinal anesthesia.

Our results could be attributed to the mechanism by which TFPB exerts its effects. In the plane that lies between the transversalis fascia and the investing fascia of the transversus abdominis muscle anterior to the iliac crest, where the II and IH nerves penetrate the transversus abdominis muscle, the TFPB targets the II and IH nerves. However, this location varies among individuals [12]. Therefore, the TFPB, being a more proximal block, is more effective and target-specific than other blocks as the TAP and II/IH nerve blocks.

The standard anesthetic management for such surgeries, in general, and in our institute, is spinal

anesthesia using LA with additives, mostly fentanyl, which prolongs the duration of action of spinal anesthesia for up to 4h ***[13]***. However, the analgesic effect of spinal anesthesia after OIHR fades within the first few hours postoperatively ***[14]***. Therefore, the addition of locoregional techniques with longer-lasting effects could be beneficial. In our study, the addition of TFPB after the end of surgery provided an extended duration of postoperative analgesia, as evidenced by the low consumption of rescue analgesics and delayed time of first analgesic request.

In modern anesthesia techniques, the use of regional anesthesia has become a recommendation because of its advantages, such as less analgesic consumption, long analgesia duration, more patient satisfaction, and enhanced recovery after anesthesia (ERAS), in addition to its effect on minimizing the development of chronic postoperative pain ***[4]***. The utilization of U/S technology increased the success rate and reduced the complications that may develop due to the blinded techniques. The U/S-guided TFPB is considered a BASIC skill-level block because it can be easily visualized and identified with a low incidence of failure and short performance time ***[9]***. It is also a safe technique with a lower incidence of peritoneal puncture ***[3]***.

The results of TFPB have been previously demonstrated in clinical trials in patients who underwent hernioplasty and other surgical interventions ***[10,11,15]***. Multiple Ultrasound-guided fascial muscle plane blocks, such as II/IH nerve and TAP blocks, have been used to provide effective postoperative analgesia after OIHR but the results were conflicting ***[8]***. Others have tested the quadratus lumborum and erector spinae blocks ***[3,7]***.

Other trials have Tested TFPB in combination with general anesthesia; as Ahmed Zagloul et al. ***[7]***, who compared the TFPB and quadratus lumborum plane block for perioperative analgesia in inguinal herniorrhaphy surgeries under general anesthesia and revealed comparable results between the two groups. Also, in a retrospective observational study, López-González et al., compared the anterior TAP block and the US-guided TFP block and found that both groups' resting and movement-induced pain scores were comparable. However, we believe that the TFPB is an easy technique that can be performed in the supine position, especially if the patient is awake, as discussed by Ahmed Zagloul et al. ***[7]***.

Few studies have used TFPB in combination with spinal anesthesia to treat postoperative pain. Hale Kefeli et al., ***[3]*** compared TFPB and erector spinae plane block as postoperative analgesia for inguinal herniorrhaphy surgeries under spinal anesthesia and revealed that the use of tramadol 1–3 hours postoperatively was significantly decreased in the TFPB group. The posterior transversus abdominis plane (TAP) block and TFPB were compared for their analgesic efficacy in inguinal herniorrhaphy under spinal anesthesia by Vansh et al. ***[16]***. Although the TAP group had a higher NRS, they found that both blocks were equally effective for postoperative pain relief and patient satisfaction scores.

This study had some limitations. First, we could not attribute our results to obstetric, pediatric, or emergency surgeries involving the lower abdomen. Furthermore, we did not follow up with patients for weeks or months to detect the effect of the block on chronic postoperative herniorrhaphy pain in the present study.

In conclusion:

In adult patients undergoing OIHR under spinal anesthesia, postsurgical TFPB prolonged the duration of analgesia, reduced postoperative opioid consumption, and increased patient satisfaction without complications.

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تأثير التخدير الموضعى للفافة المستعرضة باستخدام السونار كمسكن للألم بعد عملية تصليح الفتق الاربى فى البالغين تحت تأثير التخدير النصفى، تجربة منظبطة عشوائية مزدوجة التعمية

السيطرة الجيدة للألم بعد العملية الجراحية لها تأثير هام على المريض فيما يتعلق بحالته العامة، التئام الجروح، والإقامة فى المستشفى. قدم تخدير موضعى للأعصاب والمسكنات العامة للجسم وخاصة المواد الأفيونية هذه السيطرة ولكن مع تفوق التخدير الموضعى للاعصاب بسبب تجنبه للآثار الجانبية للمواد الافيونية. أصبح إدخال التصوير بالموجات فوق الصوتية فى التخدير بسرعة مجالا للاهتمام المتزايد خاصة التخدير الموضعى للاعصاب، حيث أنه يُمكِّن أخصائى التخدير من عرض صورة للعصب أو المنطقة المستهدفة، وذلك لتوجيه الإبرة بعيداً عن التشريح الحساس، ورصد انتشار المخدر الموضعى.

تم تسجيل ثمانين مريضاً فى شكل مجموعتين مع المرضى الذين تتراوح أعمارهم بين ١٨ إلى ٦٠ عاماً. كانت مجموعة التخدير الموضعي للفافة المستعرضة باستخدام السونار والأخرى المجموعة الضابطة. أجريت الدراسة الحالية فى مستشفى جامعة القاهرة (القصر العينى).

توضح دراستنا أن التخدير الموضعى للفافة المستعرضة الموجه بالموجات فوق الصوتية يوفر فائدة إضافية للتسكين متعدد الوسائط لدى المرضى الذين يخضعون لعمليات جراحية مفتوحة لإصلاح الفتق الإربى. احتاج المرضى الذين تلقوا التخدير الموضعى للفافة المستعرضة إلى تسكين إنقاذ أقل بعد العملية الجراحية مع تأثير أفضل على درجات الألم مقارنة بالمجموعة الضابطة.