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# A comparative study between ultrasound-guided ilioinguinal/iliohypogastric nerve block versus transverse abdominis plane block in patients undergoing oblique inguinal hernia repair

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## Abstract

**Background:** Combined ilioinguinal-iliohypogastric (IIN/IHN) block and transverse abdominis plane (TAP) block are used under ultrasound (USG) visualization for postoperative pain control in patients undergoing inguinal hernia repair surgery. This study compares USG-guided TAP versus IIN/IHN block for post-operative analgesia efficacy in adults undergoing inguinal hernia surgery, among 100 patients randomized into group A received TAP block by using levobupivacaine 0.5% 25 ml and group B received IIN+IHN blocks by using levobupivacaine 0.5% 10 ml before induction of general anesthesia.

**Results:** The mean duration (in minutes) to require rescue analgesia was found to be  $1003.2 \pm 99.6$  (min) in group A and  $1317 \pm 69$  (min) in group B. In a comparison of these two values the difference in the meantime to rescue analgesic requirement was statistically significant ( $p < 0.001$ ).

**Conclusions:** USG-guided IIN/IHN block delays the need for rescue analgesia and reduces the postoperative analgesic requirement compared to USG-guided TAP block.

**Keywords:** Ilioypogastric nerve block, Ilioinguinal nerve block, Inguinal hernia, Ultrasound guided

## Background

Postoperative pain is a common complication that occurs after surgery. It is associated with nausea and vomiting, risk of thromboembolic events, and cognitive dysfunction. USG TAP block or ultrasound-guided ilioinguinal and iliohypogastric nerves (IIN/IHN) may be used as components of multimodal analgesia with a comparable effect following open inguinal hernioplasty [10]. In this study, levobupivacaine was used to compare

between ultrasound-guided IIN/IHN versus ultrasound-guided TAP following inguinal hernia repair.

Anatomically, the sensory nerve supply of the inguinal region is from the T12–L2 nerves. The ilioinguinal and iliohypogastric nerves (branches of T12 and L1) are located between the internal abdominal oblique and transverse abdominis muscles just superior to the anterior superior iliac spine [6].

Medially, the ilioinguinal and iliohypogastric nerves penetrate the internal abdominal oblique abdominal muscle to lie between the internal inguinal ring and the external oblique muscle. The ilioinguinal and iliohypogastric nerves provide nerve supply to part of the

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structures in the inguinal canal being on the anterior surface of the spermatic cord [5].

Transverse abdominis plane block has a potent analgesic effect after lower abdominal surgery, but few data are comparing ilioinguinal/iliohypogastric nerve block with ultrasound-guided TAP block in patients undergoing inguinal hernia repair [15]. During the first 24 h after surgery, US-guided IIN+IHN (a truncal block) is purported to be superior to US-guided TAP (a compartment block) in terms of the opioid-sparing effect, i.e., IIN+IHN provide significantly better analgesia [4].

Levobupivacaine is a local anesthetic drug that belongs to the amino amide group. It is the *S*-enantiomer of bupivacaine with less cardiotoxic effect, less vasodilation, and a longer action duration [9].

### Aim of the study

The aim of the study is to compare the analgesic characteristics of TAP block vs IIN/IHN block in patients undergoing inguinal hernia repair under GA.

The primary outcome measure was the mean duration to require rescue analgesia.

The secondary outcome measures were total morphine consumption over the first 24 h postoperative. The outcomes included Assessment of the vital signs mean arterial blood pressure, heart rate, and respiratory rate 0 (at PACU), 4, 8, 12, and 24 h postoperative. Assessment of pain was by the visual analog scale (VAS) upon arrival to PACU (0 hr), then at 4, 8, 12, and 24 h postoperative [11].

### Methods

The study is designed as a prospective, randomized study with an allocation ratio of 1:1 arranged in parallel groups.

After approval of Ain-Shams University Hospitals' ethical committee (FMASU 27/2019) and obtaining Informed written consent from each patient, the study was held in the operation room of our institutional hospital over one year from October 2019 to September 2020. This study was carried out upon 100 male patients over the age of 21, with American society of anesthesiologist (ASA) physical status of 1–2 and average body weight, who were undergoing unilateral inguinal hernia repair surgery.

They were randomized into 50 patients in each group: group A, in which patients received transverse abdominis plane block (TAP) technique block, and group B, in which patients received ilioinguinal/iliohypogastric block (IIN/IHN) block technique. Computer-generated random number tables and sealed opaque envelopes were used to randomize the samples.

Exclusion criteria included patients under the age of 21, infection at the site of injection, psychiatric illness or

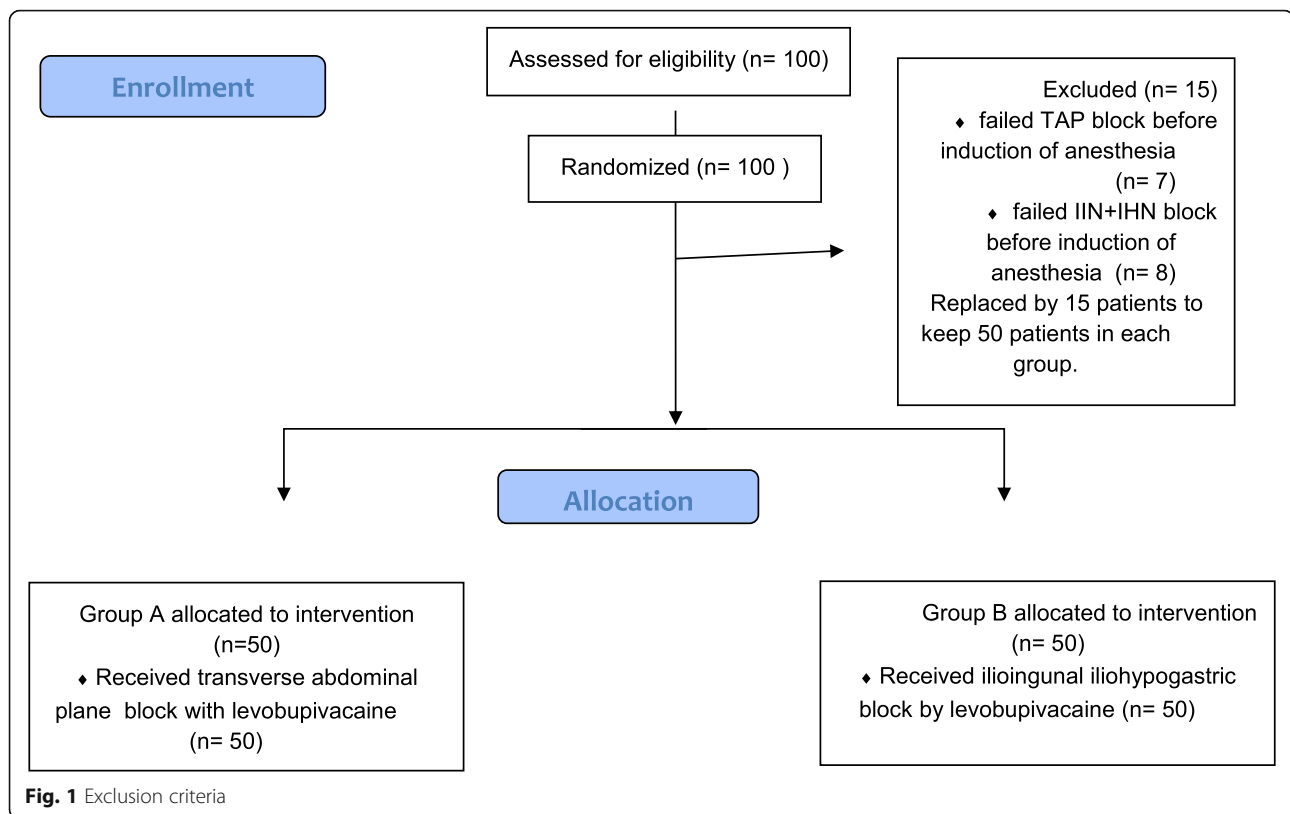
uncooperative patient, coagulopathy disorder, use of anticoagulants or antiplatelet therapy, allergy to local anesthetic drugs, and failed sensory block after 30 min from completion of the procedure preoperative, chronic opioid analgesic users, drug addicts, and alcoholic patients (Fig. 1).

For each patient, full history, physical examination, and investigations, including complete blood count, coagulation profile, tests of kidney and liver functions, and electrocardiography (ECG), were performed in the anesthesia clinic prior to surgery. The patients were informed about the procedure and the visual analog scale (VAS) to rate their pain after surgery. Visual analog scale (VAS) is a validated, subjective measure for acute pain. Scores are recorded by making a handwritten mark on a 10-cm line representing a continuum between “no pain” and “worst pain” [13].

On arriving at the operation room of Ain Shams University Hospitals, the intervention was done before applying general anesthesia at the operation room as we inserted an 18G intravenous cannula in the non-dominant hand of each patient. Midazolam hydrochloride, 0.03 mg/kg IV (Dormicum, 5 mg/ml; Roche, Basel, Switzerland), was given to all patients plus supplemental oxygen (40% via mask; 5 L/min) was applied during the procedure. Five-lead electrocardiogram (ECG), pulse oximetry, non-invasive blood pressure (NIBP), and capnography (after induction of GA) were the components of basic intraoperative monitors. Dash 5000, General Electric, Medical Systems Information Technologies, Inc. Tower Ave., Milwaukee, WI, USA, was the monitor utilized. Ringer's solution was instilled throughout the surgery at a rate of 5 ml/kg/h.

### Group A (transversus abdominis plane block (TAP) group)

The orientation mark of the ultrasonic linear probe (Sonosite, M Turbo-C, Bothell, WA, USA) was placed at the level of the umbilicus on the anterior abdominal wall. The probe was then moved laterally, between the iliac crest and the subcostal border, to the anterolateral section of the abdomen wall. The in-plane insertion was used to advance a 21-gauge 120 mm Locoplex Sono Tap cannula from anterolateral to medial direction after local anesthetic (LA) infiltration with lidocaine 2% (2 ml). The injection location was between the internal oblique and transversus abdominis muscles' aponeurosis. With intermittent aspiration, levobupivacaine 0.5% 25 ml (maximum dose 2 mg/kg) was administered, and the accurate placement of the needle was confirmed by the expansion of the LA solution as a dark shadow between the aponeurosis of the internal abdominal oblique (which moved anteriorly) and the transversus abdominis muscles pushing the muscle deeper [2].



### Group B (ilioinguinal/iliohypogastric group)

The ultrasound linear probe (Sonosite, M Turbo-C, Bothell, WA, USA) was placed across the anterior superior iliac spine, with the transducer's superior margin pointing directly toward the umbilicus in an oblique plane. The iliohypogastric nerve can be observed directly behind the ilioinguinal nerve. The overlying skin was sterilized with an antiseptic solution, and a 21-gauge 120-mm Locoplex Sono Tap cannula was advanced in-plane from a point just below the inferior border of the transducer toward the ilioinguinal nerve, which is located between the internal abdominal oblique and transverse abdominis muscles in the facial plane. Levobupivacaine 0.5% 10 ml was injected (maximum dose 2 mg/kg) [2].

An independent investigator who was blinded to the previously executed block judged the success of the sensory block by the elimination of ice-cold sensation in the inguinal crease 30 min after completion of the block. Seven patients with a failed block in group A and eight patients with a failed block in group B were excluded from the study and substituted by other patients to keep 50 patients in each group.

Then, after 30 min from the block, induction of general anesthesia with fentanyl (1 µg/kg) and propofol (1.5–2 mg/kg) using neuromuscular blocker atracurium

(0.5 mg/kg) at induction then 0.1 mg/kg as a maintenance dose. The patient's airway was secured by a laryngeal mask. Isoflurane maintained general anesthesia (1.2% mean alveolar concentration) in a 50% mixture of oxygen in the air. The target of the mechanical ventilation was to keep the end-tidal carbon dioxide (ETCO<sub>2</sub>) within 35–40 mmHg. Datex-Ohmeda, Inc. 3030 Ohmeda Drive, Madison, WI 53707-7550, USA, was the anesthetic machine utilized.

Thirty minutes before skin closure, 1 g of paracetamol was injected. At the end of the surgery, the residual neuromuscular block was reversed with IV neostigmine 0.05 mg/kg and atropine 0.01 mg/kg, followed by awake removal of the laryngeal mask after oral suction, in a semi-sitting position. The patient was transferred to the post-anesthesia care unit (PACU) when he could sustain head lift, follow verbal commands, hand grasp for 5 s and achieve a tidal volume of more than 6 ml/kg with a respiratory rate fewer than 35 breaths/min, being hemodynamically stable [2].

Upon arrival to PACU (0 h), the pain was evaluated at rest and on the movement of the leg. Discharging from PACU when the Modified Aldert Score was more than nine for each patient [1].

The mean duration in minutes for rescue analgesia was recorded postoperatively as the primary outcome.

Assessment of vital data as regard MAP, respiratory rate, and heart rate at 0, 4, 8, 12, and 24 h postoperatively was recorded. Evaluation of the pain was done later at 4, 8, 12, and 24 h postoperatively, and when VAS > 4, patients received morphine (0.2 mg/kg) as rescue analgesia. VAS was assessed by the median and interquartile range (IQR) at 0,4, 8,12, and 24 h postoperatively as shown in the results. The number of patients who required analgesia at 12 h and 24 h and total dose of morphine consumption was recorded as shown in the results.

Regarding Intraoperative monitoring, any event of hypoxia, hypotension (decrease blood pressure by 20% from baseline) managed by ephedrine (initial dose 5–10 mg IV bolus then titration), bradycardia (decrease heart rate less than 60 beats per minute) managed by atropine (0.01 mg/kg) and tachycardia (increase heart rate more than 100 beats per minute) were recorded.

#### Statistical analysis

The statistical program for social sciences, version 20.0, was used to examine our data (SPSS Inc., Chicago, IL, USA). The mean  $\pm$  standard (SD) deviation was used to express quantitative data. Frequency and percentage were used to express Qualitative data. When comparing two means, the independent-sample *t*-test of significance is utilized. Testing for non-parametric data between two groups by using Mann-Whitney *U* test. Applying chi-square ( $\chi^2$ ) test of significance was done to compare proportions between qualitative parameters. The confidence interval was set at 95%, while the acceptable margin of error was set at 5%. *P* values  $\leq 0.05$  were considered significant, *P* values  $\leq 0.001$  were regarded as very significant, and *P* values  $> 0.05$  were considered inconsequential.

#### Sample size calculation

Prior to the study, the number of patients of each group was determined after a power calculation according to

data obtained [3]. In the study, mean duration (in minutes) to require rescue analgesia was  $320.6 \pm 114.2$  (min) in TAP block group and  $410 \pm 116.24$  (min) in ilioinguinal and iliohypogastric nerve block group, and medium effect size ( $f=0.345$ ). By using G.Power 3.19.2 software, 50 patients in each group was considered as a sample size to provide 80% power for independent samples *T*-test at the level of 5% significance and confidence interval 95%.

#### Results

One hundred patients were arranged as 50 patients in each group: group A received transverses abdominis plane block technique from October 2019 to March 2020, group B received ilioinguinal/iliohypogastric block technique from March 2020 to September 2020. No statistically significant difference was detected between the two groups according to demographic data as age, body mass index (BMI), ASA, duration of surgery as ( $p=0.330, 0.123, 0.182, 0.193$ , respectively) as shown in Table 1.

In the current study, at 0, 4, 8,12, 24 h, the mean arterial blood pressure as in Table 2, heart rate as in Table 3, and respiratory rate as in Table 4 showed no statistically significance in group A compared to group B as  $p=0.535, 0.432, 0.437, 0.284$ , and  $0.178$ , respectively, for MAP; as regards heart rate,  $0.642, 0.113, 0.163, 0.128$ , and  $0.106$ , respectively; and  $0.355, 0.426, 0.317, 0.105$ , and  $0.087$ , respectively, for respiratory rate.

Patients in group A received mean total dose of morphine 8 mg higher than patients of group B who received mean total dose of morphine 5 mg as shown in Table 5.

As regard VAS, patients of group A were highly significant than group B at 12 and 24 h postoperatively, as  $p$  value = at 0, 4, 8, 12, and 24 h, respectively, as shown in Table 6.

The time to first request of analgesia was shorter in group A than group B as shown in Table 7.

**Table 1** Difference between group A and group B as regard demographic data

Demographic data	Group A (n=50)	Group B (n=50)	<i>p</i> value
<b>Age (years)</b>			
Mean $\pm$ SD	42.97 $\pm$ 11.60	43.50 $\pm$ 12.62	0.330
<b>BMI [wt/(ht)<sup>2</sup>]</b>			
Mean $\pm$ SD	26.10 $\pm$ 7.01	26.52 $\pm$ 7.69	0.123
<b>ASA: number(%)</b>			
I	33 (66%)	37 (74%)	0.182
II	17 (34%)	13 (26%)	
<b>Duration of surgery (min)</b>			
Mean $\pm$ SD	63.65 $\pm$ 17.19	64.71 $\pm$ 18.77	0.193

*T* independent sample *t* test,  $\chi^2$  chi-square test, ASA American Society of Anesthesiologist, SD standard deviation, BMI body mass index. *P* value  $> 0.05$  NS

**Table 2** Difference between group A and group B according to postoperative mean arterial blood pressure (mmHg)

Postoperative mean arterial blood pressure	Group A (n=50)	Group B (n=50)	p value
At 0 h	87.82±3.51	86.80±3.47	0.535
At 4 h	89.35±3.58	88.15±3.60	0.432
At 8 h	90.76±3.60	88.34±3.62	0.437
At 12 h	92.88±3.64	89.05±3.63	0.284
At 24 h	96.46±3.74	93.09±3.76	0.178

Data are expressed as mean ±SD or numbers and p value

**Table 3** Difference between group A and group B according to postoperative heart rate (beat/min)

Postoperative heart rate (beats/min)	Group A (n=50)	Group B (n=50)	p value
At 0 h	72.20±2.89	73.03±2.92	0.642
At 4 h	77.43±3.09	75.67±3.06	0.113
At 8 h	82.46±3.30	81.36±3.26	0.163
At 12 h	85.80±3.43	83.75±3.48	0.128
At 24 h	90.81±3.70	87.61±3.61	0.106

Data are expressed as mean ±SD or numbers and p value

**Table 4** Difference between group A and group B according to postoperative respiratory rate (min)

Postoperative respiratory rate (/min)	Group A (n=50)	Group B (n=50)	p value
At 0 h	10.76±2.47	11.73±2.70	0.355
At 4 h	15.42±3.55	14.26±3.34	0.426
At 8 h	17.16±3.94	15.99±3.74	0.317
At 12 h	16.63±3.83	15.35±4.00	0.105
At 24 h	15.32±3.53	14.72±3.16	0.087

Data are expressed as mean ±SD or numbers and p value

**Table 5** Total dose of morphine (mg) group A compared to group B

Total consumption of morphine (mg)	Group A (n=50)	Group B (n=50)	t test	p value
Mean±SD	8.24±2.06	5.15±2.16	6.381	< 0.001**

t independent sample t test; \*\*p value < 0.001 HS

**Table 6** Group A in comparison to Group B according to postoperative visual analog scale

Postoperative visual analog scale	Group A (n=50)	Group B (n=50)	p value
At 0 h	1 (0–1)	1 (0–1)	0.544
At 4 h	1(1–1)	1 (0–1)	0.224
At 8 h	1 (1–1)	1 (0–1)	0.089
At 12 h	2 (2–3)	1 (1–2)	< 0.0001
At 24 h	3 (3–4)	2 (1–3)	< 0.0001

Data are expressed as median, IQR, and p value. p value < 0.001 HS

**Table 7** Group A in comparison to group B according to time to rescue analgesia

Time to rescue analgesia (minutes)	Group A (n=50)	Group B (n=50)	t test	p value
Mean±SD	1003.2 ±99.6	1317±69	18.313	< 0.001**

t independent sample t test; \*\*p value < 0.001 HS

**Table 8** Group A compared to group B according to needs of analgesia (morphine “mg”) 2nd dose and 3rd dose

Needs for analgesia	Group A (n=50)	Group B (n=50)	$\chi^2$	p value
1st dose at (12 h)	30 (60%)	10 (20%)	5.104	0.024*
2nd dose at (24 h)	23(46%)	5 (10%)	6.594	0.012*

$\chi^2$  chi-square test

p value > 0.05 NS; \*p value < 0.05 S



Also, Table 8 shows a statistically significantly higher dose in group A compared to group B according to needs of analgesia (morphine “mg”) 2nd dose and 3rd dose.

As regard intraoperative data recording between the two groups, there was no statistical difference.

## Discussion

Our study aimed to compare the postoperative analgesic efficacy of TAP block versus IIN/IHN block for the patients undergoing unilateral inguinal hernia repair under general anesthesia.

As regards the hemodynamic parameters recorded, in our study, all the MAP recordings (Table 2), between the two study groups at 4, 8, 12, and 24 h postoperatively, showed no clinically or statistically significant difference. Also, there was no statistically significant difference as regards the heart rate and respiratory rate recordings (Tables 3, 4, and 5). In harmony with our finding, Sujatha et al. [14] compared TAP block versus IIN/IHN block with wound infiltration for postoperative analgesia in 60 patients undergoing inguinal hernia surgery. Baseline MAP of both groups was without statistical difference between them. As regard respiratory rate Kamal et al. [8] had performed their study on over 60 patients who underwent inguinal hernia repair comparing between US TAP block versus IIN/IHN block found that no clinically or statistically significant difference between the two groups as regards heart rate and respiratory rate.

As regards the analgesic parameters recorded; in the current study, the VAS was significantly lower in group B (IIN/IHN block) when compared with that of group A (TAP block) and showed a significant difference between both groups at 12 and 24 h postoperatively as ilioinguinal and iliohypogastric nerve block is considered truncal block while TAP block is a compartmental block. Anatoli et al. [2] had shown the same results to the present study (Table 6), compared US TAP block and conventional IIN/IHN block for day-case open inguinal hernia repair, done upon two hundred and seventy-three patients, revealed that median VAS at rest was lower in the IIN/IHN block group at 0, 4, 8, 12, and 24 h postoperative compared to ultrasound-guided TAP group. Also, there were contradictory results to our data, have been reported by Aveline et al., [4] who compared ultrasound-guided TAP block to blind IIN/IHN block for analgesia following open inguinal hernia repair over 273 patients, the results showed that VAS was lower in the TAP group compared to the IIN/IGN block group both at rest and during movement. The explanation of the difference is due to using blind IIN/IGN block while we used USG block for IIN/IHN which increases the accuracy of the block.

As regard time to rescue analgesia, there was clinically and statistically highly significant shorter time to 1st rescue analgesia in group A with mean $\pm$ SD 1003.2  $\pm$  99.6 min compared to that of group B (ilioinguinal/iliohypogastric nerves block) with mean $\pm$ SD 1317  $\pm$  69 min (Table 7) which is accused to the effectiveness of levobupivacaine with less vasodilation and longer effect plus IIN/IHN block is considered as a truncal block. These results agree with the results that have been reported by Arun et al., [3] his colleagues, in a retrospective cohort study done on 60 patients who underwent elective inguinal hernia surgeries for comparison between the efficacy of TAP block and IIN/IHN block for postoperative pain management. The contradictory results to our data, reported by Hosalli et al. [7] who compared the analgesic efficacy between ultrasound-guided dual TAP block (combining TAP and IIN/IHN block) and IIN/IHN block alone in 200 patients undergoing elective primary unilateral open inguinal hernia repair with a mesh, revealed that the mean time required for the first rescue analgesic dose was 5.59  $\pm$  2.39 and 3.10  $\pm$  1.18 h with respect to dual TAP and IIN/IH group. The explanation of the difference is accused to using Daul TAP (combined TAP and IIN/IHN) while we performed only TAP block.

As regard total analgesia consumed, postoperative morphine requirements were lower during the first 24 h in the IIN/IHN block group as in Tables 5 and 8. This was explained by lower VAS in group B and longer time for rescue analgesia with pharmacological characters of levobupivacaine. The results of this study met the result of a study done by Kamal et al. [8]; over sixty patients revealed that USG-guided IIN/IHN block reduces the postoperative analgesic requirement compared to USG0-guided TAP block. Contradictory results to our data, reported by the results of Salman et al. [12], who performed a prospective, randomized, double-blind study of 64 patients undergoing inguinal hernia repair, found that TAP block provided effective analgesia, reducing total first 24 h postoperative analgesic consumption and morphine requirement. The explanation of the difference is the study had a small sample size and the comparison was between TAP block versus placebo block.

## Recommendations

It will be more useful to study in high-risk hypertensive and cardiac patients and to correlate with plasma catecholamine levels, which reflect the stress response and it is necessary to evaluate postoperative pain on movement in further studies.

## Conclusions

IIN/IHN block was effective in reducing postoperative pain scores, lowering total 24-h postoperative opioid and

analgesic consumption, and delaying the need for rescue analgesia after inguinal hernia repair under general anesthesia, compared to TAP nerves block

### Limitation

No limitation.

### Trial registration

Current Controlled Trials [PACTR202107792304574](https://doi.org/10.1186/17454215/202107792304574), 13 July 2021. Retrospectively registered.

### Abbreviations

ASA: American Society of Anesthesiologist; BMI: Body mass index; CBC: Complete blood count; ECG: Electrocardiogram; ETCO<sub>2</sub>: End-tidal carbon dioxide; HR: Heart rate; Ht: Height; KFT: Kidney function test; LA: Local anesthetics; LFT: Liver function test; IIN: Ilioinguinal nerve; IHN: Iliohypogastric; IQR: Interquartile range; L1: Lumbar spinal root 1; MAP: Mean arterial blood pressure; NIBP: Non-invasive blood pressure; PACU: Post-anesthesia care unit; IV: Intravenous; T1-12: Thoracic spinal roots; TAP block: Transversus abdominis plane block; USG: Ultrasound guided; S: Significant; SD: Standard deviation; VAS: Visual analog score; Wt: Weight

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Not applicable.

### Authors' contributions

AE designed the study, revised literature, performed the analysis, followed the patients, measured vital data, ultrasonographic parameters; recorded the data; and wrote the manuscript. SM design of the work and work revision. AA revised literature, followed the patients, collected the data, performed the analysis, and critically reviewed the manuscript. NE revised statistics performed the analysis, and critically reviewed the manuscript. GS revised literature performed the analysis, and critically reviewed the manuscript. All authors approved the final version of the manuscript.

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### Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due [publishing the clinical data about any study conducted in our hospitals and approved by the institutional ethical committee is against the policy of the Faculty of medicine, Ain Shams university unless there is a reasonable request] but are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

Approval of research ethical committee of Faculty of Medicine, Ain-Shams University was obtained (code number: FMASU 27 /2019) and written informed consent was obtained from the patients after description of the procedure.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare that they have no competing interests.

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