KJP

Korean J Pain 2024;37(4):332-342
https://doi.org/10.3344/kjp.24172
pISSN 2005-9159, eISSN 2093-0569

Clinical Research Article

Effect of ultrasound-guided ilioinguinal-iliohypogastric nerve block on chronic pain in patients undergoing open inguinal hernia surgery under spinal anesthesia: a randomized double-blind study

Rajendra Kumar Sahoo[1], Amit Pradhan[2], Priyadarsini Samanta[3], Laxman Kumar Senapati[2], and Ganesh Chandra Satapathy[2]

[1]Department of Anesthesiology, Pain & Palliative Care, Kalinga Institute of Medical Sciences, KIIT Deemed To be University, Bhubaneswar, Odisha, India, [2]Department of Anaesthesiology, Kalinga Institute of Medical Sciences, KIIT Deemed To be University, Bhubaneswar, Odisha, India, [3]Department of Physiology, Kalinga Institute of Medical Sciences, KIIT Deemed To be University, Bhubaneswar, Odisha, India

ABSTRACT

Background: Pre-operative ilioinguinal-iliohypogastric nerve block (II-IHNB) has a proven role in lessening acute postoperative pain and opioid consumption following hernia repair. However, its role in preventing post-herniorrhaphy groin pain (PHGP) is still unknown. The current study aims to assess pre-operative II-IHNB's impact on PHGP three and six months after open inguinal hernia repair under spinal anesthesia.

Methods: Seventy patients posted for inguinal hernia surgery were randomly allocated into group A (received ultrasound-guided II-IHNB with 10 mL of 0.5% ropivacaine and 4 mg [1 mL] dexamethasone) and group B (received ultrasound-guided II-IHNB with 11 mL of 0.9% normal saline). The time to first analgesic request, pain scores, opioid consumption, DN4 score, and PHGP at 3 and 6 months were analyzed using appropriate statistical tests.

Results: The numerical pain rating scale at movement in group A was significantly reduced at all the time intervals of 3, 6, 12, and 24 hours compared to group B. Total opioid usage was lower in group A (3.71 mg [3.90]) *versus* group B (12.14 mg [4.90]) with a mean difference of −8.43 mg (95% CI −10.54, −6.32), $P < 0.001$. The time required for the first rescue analgesic was significantly longer in group A (360 min [180–360]) *versus* (180 min [180–360]) in group B ($P < 0.001$). However, there was no difference in the incidence of PHGP at three and six months between the two groups.

Conclusions: Pre-operative ultrasound-guided II-IHNB reduces postoperative analgesic requirement but does not reduce the incidence of chronic PHGP following hernia surgery at 6 months.

Keywords: Analgesia; Anesthesia, Spinal; Chronic Pain; Hernia, Inguinal; Nerve Block.

Received May 24, 2024; Revised June 27, 2024; Accepted July 13, 2024

Handling Editor: Ki Tae Jung

Correspondence: Laxman Kumar Senapati
Department of Anaesthesiology, Kalinga Institute of Medical Sciences, KIIT Deemed To be University, Bhubaneswar 751024, Odisha, India
Tel: +91-7325919472, Fax: +91-0674 2725708, E-mail: meet.laxmans1@gmail.com

Previous presentation at a conferences: Interim study data was presented as a faculty competition paper at the 16th Asian and Ocenic Society of Regional Anaesthesia and Pain Management Conference & 12th Academy of Regional Anaesthesia of India National Conference (AOSRA-AORA) in October 2022 in Mumbai, India.
The completed study was presented at the 38th National Pain Conference (Indian Society for Study of Pain-38th ISSPCON) at Pune and bagged two awards -Best Paper Award and Lokapur Foundation Clinical Research Award.

INTRODUCTION

Inguinal hernia surgery is one of the most frequent surgical operations worldwide [1]. Chronic pain in the form of chronic groin pain also known as post-herniorrhaphy groin pain (PHGP) is a well-known and common complication following inguinal hernia surgery [2]. Three months following surgery, pain that remains in and around the surgical site is referred to as chronic post-surgical pain (CPSP) [3]. PHGP is characterized as pain lasting ≥ 3 months after hernia surgery [4,5]. The overall incidence of PHGP has been quite variable in different studies with the highest incidence reported as 63% [4] and an average of 12% reported their pain as moderate to severe intensity [6,7]. In the studies defining chronic pain as persistent pain beyond 3 months, the rates ranged from 16% to 54%, and in the studies using a 6-month definition, the rates ranged from 10% to 23%. This wide variance is probably due to several variables, including the fact that different criteria of chronic pain, methods of measurement, and follow-up schedules are used in various research [2]. The prevalence of CPSP is an interplay of anesthetic, surgical, and patient factors. In the context of hernia surgery, it has been found that PHGP is less frequent after laparoscopic hernia surgery [6,7].

Once patients develop PHGP, it becomes challenging to treat those patients. Various treatment options have been reported including medication, nerve blocks, pulsed radiofrequency, nerve stimulation, mesh/staple removal, and neurectomy [8]. However, emphasis should be given to reducing the incidence and/or severity of PHGP. In this context, regional nerve blocks may be an option and should be considered in hernia surgery patients' overall perioperative anesthetic care [5,9].

Preoperative ilioinguinal-iliohypogastric nerve block (II-IHNB) has proved to lessen the severity of acute postoperative pain and the usage of opioids [10]. However, its significance in reducing chronic groin pain (PHGP) is unclear. Hence, the authors chose to perform a study with the primary objective of determining pre-operative II-IHNB's effects on chronic groin pain (PHGP) at three- and six months post-surgery in patients who had undergone open inguinal hernia repair with spinal anesthesia (SA). The secondary objectives were to analyze the time to the first rescue analgesic request and the total opioid administered in the initial 24 hours. The hypothesis was that a preoperative ultrasound-guided II-IHNB could potentially reduce the PHGP at three and six months.

MATERIALS AND METHODS

1. Study design

This randomized double-blind study was conducted from July 2022 to August 2023 following acceptance from the institutional ethics committee of Kalinga Institute of Medical Sciences (vide approval number KIIT/KIMS/IEC/755/2021 dated 19/10/2021) and recorded with the Clinical Trial Registry of India (Registration No. CTRI/2021/12/038501, https://www.ctri.nic.in). Every patient gave their informed, written consent. Eighty patients were evaluated to see if they could participate in the research. Six patients were excluded from the study - three patients needed to be switched to general anesthesia (GA) due to failure of SA, two patients required conversion to GA due to prolonged surgery and one patient opted for laparoscopic hernia repair under GA. So, 74 patients were arbitrarily assigned into two groups out of which 4 patients were lost to follow-up. So, finally, 70 patients were included for analysis. The CONSORT (Consolidated Standards of Reporting Trials) design and process of the study is depicted in **Fig. 1**.

2. Patients

This study comprised patients aged 18–70 years who were planned for open unilateral inguinal hernia repair under SA and had physical status grades I–III based on the American Society of Anaesthesiologists physical status. The study excluded participants with communication difficulties, a history of previous groin surgery, and any condition that would preclude them from receiving peripheral nerve blocks or SA such as preexisting coagulopathy, bleeding disorder, and severe renal, hepatic, and cardiac disease.

3. Randomization and blinding

The randomization process was carried out by an impartial researcher who was not involved in the interventions or evaluations. Both the patients and the researcher, who conducted all the assessments during the study period, were unaware of the randomization process. Two identical groups of 35 patients each were formed at random using the numbered envelope method. Each patient randomly chose an envelope containing the notes from groups A and B and presented it to the interventionist. The notes were sealed and kept separate. Before the procedure, the interventionist unveiled the patient's treat-

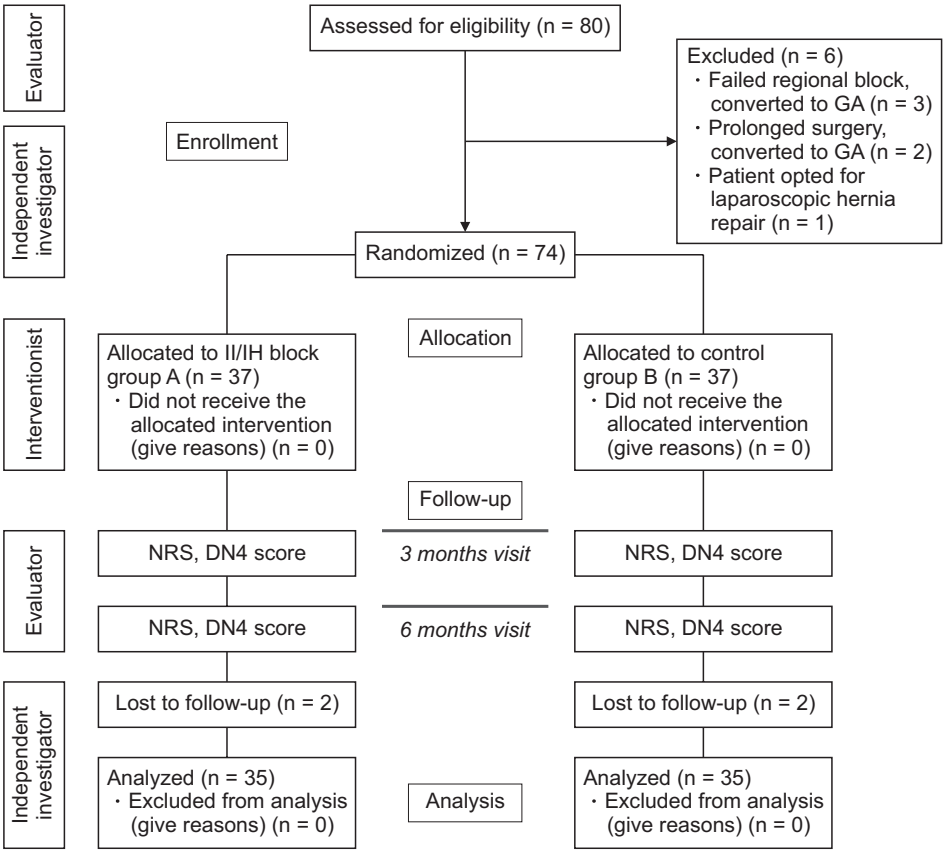

Fig. 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram for enrolment, group allocation, follow-up, and analysis. GA: general anesthesia, II/IH: ilioingional iliohypogastric, NRS: numerical rating scale, DN4: Douleur neuropathique 4 questions.

ment assignment by opening the sealed envelope. The injectate was prepared by an anesthesia technician who was not involved in this investigation. The procedure was only known to the anesthesia technician and the anesthesiologist conducting the case. The patients were ignorant of the group allocation. Another anesthesiologist blinded to the group allocation and interventions measured the outcome.

4. Sonography-guided block

The regional blocks were performed in the block room after establishing an intravenous (iv) line and standard monitoring like electrocardiography, pulse oximetry, and non-invasive blood pressure. An anesthesiologist experienced in regional anesthesia and musculoskeletal ultrasound for over 13 years performed all the II-IHNBs. The anesthesiologist performing blocks was unaware of the medication. The II-IHNB was performed under ultrasound guidance (SonoSite Edge II; FUJIFILM Sonosite, Inc.) with the help of a linear high-frequency (6–13 MHz) probe. The skin was infiltrated with 1 mL of 1% lidocaine and then the II-IHNB was performed using a 20-gauge, 50 mm block needle (Stimuplex Ultra 360; B Braun Melsungen). The previously described ultrasound-guided II-IHNB technique was followed, and the needle was inserted from medial to lateral in an in-plane approach targeting the fascial plane between the internal oblique and transversus abdominis muscle where the II-IH nerves travel [11] (**Fig. 2**).

5. Interventions

In group A (n = 35), ultrasound-guided II-IHNB was administered with 10 mL of 0.5% ropivacaine and 4 mg (1 mL) dexamethasone (total 11 mL) followed by SA. In group B (n = 35), ultrasound-guided II-IHNB was administered with 11 mL of 0.9% normal saline followed by SA. All subjects received SA with a 25G spinal needle in the seated position at L3-L4 or L4-L5 interspace (12–15 mg of hyperbaric 0.5% bupivacaine) inside the operation theatre. All patients received iv paracetamol 1 gm and diclofenac 75 mg iv infusion when the surgical procedure was coming to an end.

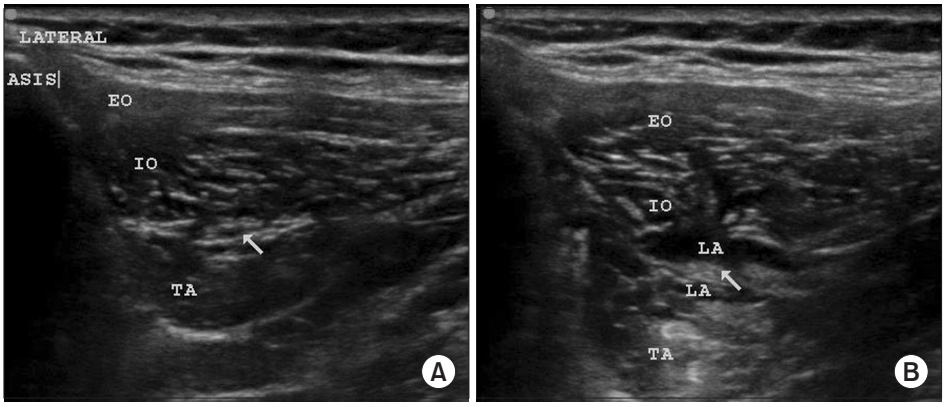

Fig. 2. Scanning technique for iliohypogastric-ilioinguinal nerve block. (A) The figure shows the sono-anatomy of the block with ilioinguinal/iliohypogastric nerves (the white arrow indicates the fascial plane between IO and TA where the nerves typically travel). (B) The figure shows the local anesthetic (LA) spread around the nerves (marked with a white arrow). ASIS: anterior superior iliac spine, EO: external oblique, IO: internal oblique, TA: transverse abdominis.

6. Outcome measures

The pre-procedural baseline pain score was assessed both at rest and movement (patient in the sitting position with legs hanging) and documented on a numeric pain rating scale (NRS) (0 = no pain; 10 = worst imaginable pain).

Subjects were moved to the observation area of the post-anesthesia care unit (PACU) after surgery. The NRS scale evaluated pain intensity at rest and with movement after arrival in the PACU, and then at 3, 6, 12, and 24 hours post-operatively. Postoperative pain management was done by IV paracetamol 1 g thrice daily. For analgesic rescue with IV tramadol 50 mg, NRS ≥ 4 was taken into consideration. The first analgesic request, the total opioid consumption in the first 24 hours, and possible adverse effects like nausea/vomiting, sedation, or block-related complications were noted.

Every patient was monitored at three and six months to determine whether PHGP, as well as neuropathic pain, was or was not present at the site of hernia repair by an anesthesiologist blinded to the intervention. The intensity of chronic pain was divided into mild (NRS 1 to 3), moderate (NRS 4 to 6), and severe (NRS 7 to 10). To assess the likelihood of neuropathic pain, the Douleur Neuropathique 4 (DN4) questionnaire was used [12]. One point was added to each question with a 'yes' answer and zero points for each 'no'; with a score of more than four indicating a significant possibility of neuropathic pain. If any patient complains of moderate to severe intensity PHGP, they are called to the hospital for a detailed evaluation.

Primary outcome measures were the incidence of PHGP by presence or absence of pain at the surgical site at three and six months after surgery. The DN4 score was utilized to find out what percentage of patients had neuropathic pain. The secondary outcome measures were NRS scores at rest and with movement at 3, 6, 12, and 24 hours, time to first rescue analgesic (tramadol) request, total opioid consumption (morphine equivalents in mg) in the first 24 hours, and postoperative complications.

7. Sample size calculation

Considering the research by Onur et al. [13], sample size calculation was performed based on the Leeds Assessment of Neuropathic Symptoms and Signs Score (LANSS) at 3 months for chronic neuropathic pain. The formula $N \geq [(Z_{1-\alpha/2} + Z_{1-\beta})^2 \times (\sigma_1^2 + \sigma_2^2/r)] \div (\mu_1-\mu_2)^2$ was used, where N is the total sample size, σ is standard deviation (SD), μ is the mean, $Z_{\{1-(\alpha/2)\}}$ considered as 1.96 with accepted confidence level 95%, $Z_{(1-\beta)}$ as 0.84 with the power of the study 80%. With software nMaster version 2.0, assuming a 1:1 participant ratio for groups A and B, the sample size came out to be 62 with 31 patients in each group. For a total sample size of 70, 35 patients in each group were included, factoring in an additional 10% for potential drop-outs.

8. Statistical analysis

For interpretation, version 26 of the Statistical Package for Social Sciences (SPSS) software was utilized. To ascertain if the data distribution was normal, the Shapiro–Wilk test was employed. Data are expressed using the median (range) for non-parametric data and the mean ± SD for quantitative data. For categorical data, proportion and frequency are used. Quantitative data like age, body mass index, duration of surgery, and total opioid consumption were derived using the Student's unpaired *t*-test. The Mann–Whitney test and standardized test statistic values were utilized to assess non-parametric quantitative data

Table 1. Baseline demographic characteristics and post-operative analgesic profile in studied groups

Variable	Group A	Group B	(95% CI) Mean difference	*P* value
Age (yr)[a]	54.8 ± 14.8	48.9 ± 18.2		0.177
BMI (kg/m²)[a]	24.3 ± 2.8	24.1 ± 4.1		0.967
Duration of surgery (min)[a]	95.0 ± 19.6	90.7 ± 23.5		0.310
ASA[b]				
1	15 (42.9)	24 (68.6)		0.053
2	19 (54.3)	11 (31.4)		
3	1 (2.9)	0 (0.0)		
Side of hernia surgery				
Left	13 (37.1)	11 (31.4)		0.615
Right	22 (62.9)	24 (68.6)		
Patients requiring rescue analgesia[c]	19 (54.3)	35 (100)		< 0.001
Time to the first request for rescue analgesia (min)[d]	360 (180–360)	180 (180–360)		< 0.001
Total opioid consumption in the first 24 hr (morphine equivalents in mg)[a]	3.71 ± 3.90	12.14 ± 4.90	(–10.54, –6.32) –8.43	< 0.001

Data is expressed as mean ± standard deviation, number (%), or median (interquartile range).

Group A: ilioinguinal iliohypogastric nerve block with ropivacaine, Group B: ilioinguinal iliohypogastric nerve block with normal saline, CI: confidence interval, BMI: body mass index, ASA: American Society of Anesthesiologists physical status class.

[a]Unpaired *t*-test. [b]Chi-square test. [c]Fischer's exact test. [d]Mann–Whitney *U*-test. $P < 0.05$ is considered statistically significant.

like NRS scores and time to first analgesic request, represented as the median and interquartile range (IQR). The Chi-square or Fischer's exact test was performed, depending on the context, to analyze qualitative variables that were stated as frequencies and percentages (%) like American Society of Anesthesiologists (ASA) groups, DN4 score, and PHGP intensity. *P* values less than 0.05 were deemed noteworthy.

RESULTS

Seventy subjects in all ultimately concluded the study. The two groups had similar characteristics, such as age, body mass index, the span of surgery, side of hernia surgery, and ASA status (**Table 1**).

1. Post-operative NRS score

Group A (IL-IHNB) participants had reduced pain scores at rest at all assessment periods. They also demonstrated statistically significant differences in NRS score at 3 hours ($P < 0.001$) and 6 hours ($P = 0.013$) post-operatively and compared to group B (**Table 2**). Upon comparing NRS scores at movement, the NRS score in group A was significantly reduced ($P < 0.05$) across all the periods (3, 6, 12, and 24 hours) compared to group B (**Table 3**, **Fig. 3**).

2. Post-operative analgesic requirement

In group A, 19 patients (54.3%) didn't need rescue analgesia, whereas everyone in group B required rescue analgesics which had statistical significance (Fischer exact $P < 0.00001$). The median (IQR) time for seeking the initial rescue analgesic was substantially longer in group A (360 [180–360] min) as opposed to group B (180 [180–360] min), $P < 0.001$. The mean ± SD total opioid usage in the 24 post-operative hours, as morphine equivalents, was considerably reduced in group A (3.71 ± 3.90 mg) *versus* group B (12.14 ± 4.90 mg) with a mean difference of –8.43 mg (95% confidence interval: –10.54, –6.32), $P < 0.001$ (**Table 1**).

3. PHGP

After the three months following surgery, the extent of PHGP was comparable in both groups, with 16 patients (45.7% of patients) in each group experiencing PHGP. At 3 months and 6 months, there was no statistically significant difference in the two groups NRS scores of chronic pains (*P* value 0.913 and 0.496 respectively). Seventy-five percent of patients (out of 16 patients having PHGP)

Table 2. Numerical rating pain scores at rest (NRS-R) at different time intervals in 24 h post-operatively

Post-operative time	Group A	Group B	Standardized test statistic	P^a value
Baseline	0 (0–2)	0 (0–0)	−2.156[c]	0.031
3 hr	0 (0–2)	2 (0–3)	3.551[c]	< 0.001
6 hr	2 (0–3)	2 (0–2)	2.492[c]	0.013
12 hr	1 (0–2)	2 (0–2)	1.140[b]	0.254
24 hr	0 (0–2)	2 (0–3)	1.739[b]	0.082

Values are expressed as median (interquartile range).
Group A: ilioinguinal iliohypogastric nerve block with ropivacaine, Group B: ilioinguinal iliohypogastric nerve block with normal saline.
[a]Mann–Whitney *U*-test. [b]Retain the null hypothesis. [c]Reject the null hypothesis. $P < 0.05$ is considered statistically significant.

Table 3. Numerical rating pain scores at movement (NRS-M) at different time intervals in 24 h post-operatively

Post-operative time	Group A	Group B	Standardized test statistic	P^a value
Baseline	4 (0–3)	3 (0–3)	−1.143[b]	0.253
3 hr	2 (0–4)	5 (0–3)	4.410[c]	< 0.001
6 hr	3 (0–2)	4 (0–2)	3.450[c]	0.001
12 hr	2 (0–1)	3 (0–3)	1.981[c]	0.048
24 hr	2 (0–1)	3 (0–4)	3.082[c]	0.002

Values are expressed as median (interquartile range).
Group A: ilioinguinal iliohypogastric nerve block with ropivacaine, Group B: ilioinguinal iliohypogastric nerve block with normal saline.
[a]Mann–Whitney *U*-test. [b]Retain the null hypothesis. [c]Reject the null hypothesis. $P < 0.05$ is considered statistically significant.

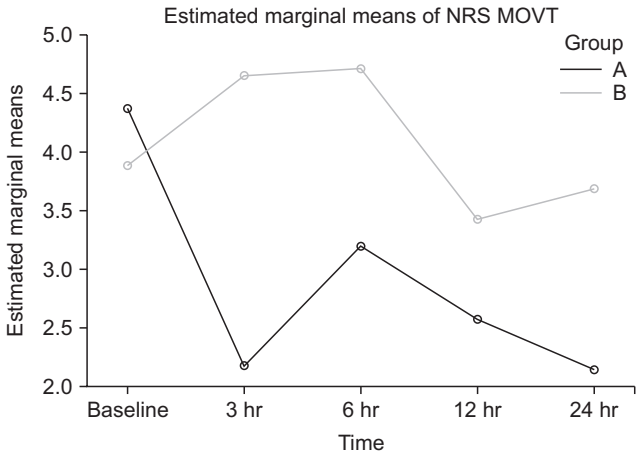

Fig. 3. Numerical rating scale (NRS) pain scores at movement (NRS-M). Values represent the means and standard deviations. Group A: ilioinguinal iliohypogastric nerve block with ropivacaine, Group B: ilioinguinal iliohypogastric nerve block with normal saline.

graded their PHGP as mild in group A compared to 69% of subjects in group B. The remaining 25% of patients and 31% of patients graded their pain as moderate intensity in groups A and B respectively which was statistically insignificant (**Table 4**). It was found that 11 and 15 patients out of 16 patients in each group who developed chronic groin pain had neuropathic pain (DN4 ≥ 4) in groups A and B respectively without any statistical significance (P = 0.171).

Likewise, at 6 months after surgery, the incidence of PHGP was 8.6% in group A and 14.3% in group B without any statistical difference (P = 0.710). Also, 2 out of 3 patients in group A and 3 out of 5 patients in group B who developed chronic groin pain had neuropathic pain (DN4 ≥ 4) without any statistical significance (P > 0.999) (**Table 4**).

Typically, tingling, a sensation of pins and needles, electric shocks, and hypoesthesia to touch were commonly described by patients who had chronic pain (PHGP). None of the patients experienced nausea/vomiting, sedation, local infection, hematoma, and local anesthetic toxicity during the post-operative 24 hours.

DISCUSSION

This randomized research was designed to look into the effect of II-IHNB on the impact of PHGP at 3- and 6 months following hernia surgery. The present trial could not demonstrate any positive impact of the nerve block on the incidence of PHGP at three- and six months following hernia surgery. That means a preoperative II-IH-

Table 4. Severity of post herniorrhaphy groin pain (PHGP) at 3 and 6 months

Variable	Group A	Group B	Standardized test statistic	*P* value
PHGP (3 mo)[a]				
No (n = 38)	19 (54.3)	19 (54.3)		> 0.999
Yes (n = 32)	16 (45.7)	16 (45.7)		
PHGP (6 mo)[a]				
No (n = 64)	32 (91.4)	30 (85.7)		0.710
Yes (n = 8)	3 (8.6)	5 (14.3)		
NRS score (3 mo)[b]	0 (0–3)	0 (0–3)	–0.109[c]	0.913
NRS score (6 mo)[b]	0 (0–0)	0 (0–0)	0.681[c]	0.496
DN4 score (3 mo)[b]	1 (0–5)	3 (1–4)	1.333[c]	0.183
DN4 score (6 mo)[b]	1 (0–3)	2 (1–2)	1.339[c]	0.181
Pain intensity (3 mo)[a]				
Mild	12 (75.0)	11 (68.75)		0.694
Moderate	4 (25.0)	5 (31.25)		
Pain intensity (6 mo)[a]				
Mild	3 (100)	5 (100)		
Moderate	0	0		

Data are given as number (%) or median (interquartile range).
Group A: ilioinguinal iliohypogastric nerve block with ropivacaine, Group B: ilioinguinal iliohypogastric nerve block with normal saline, NRS: numerical rating scale, DN4: Douleur neuropathique 4 questions.
[a]Chi-square test. [b]Mann–Whitney *U*-test. [c]Retain the null hypothesis. $P < 0.05$ is considered statistically significant.

NB could not reduce the occurrence of PHGP. However, it provided excellent postoperative analgesia as evidenced by reduced 24-hour opioid usage, and reduced pain score post-operatively.

Chronic pain in and around the surgical site following inguinal hernia repair is a serious, incapacitating, and known side effect [6]. Incidence of PHGP has been variable across different studies but Cunningham et al.[14] found the incidence to be as high as 63 percent; out of which 12 percent of subjects reported moderate or severe inguinal pain one year following surgery, and three percent experienced severe or very severe chronic pain that interfered with their ability to engage in social and physical activities. Although a one-year threshold has been suggested [15], the most prevalent definition of chronic pain is discomfort that lasts three or six months after surgery [16]. There is currently no consensus on this in the international treatment guidelines [17,18]. The Hernia Surgery Group's recommendations [17] and the original International Association for the Study of Pain (IASP) definition of chronic pain [3] both support a 3-month threshold; however, others contend that 6 months is required following mesh-based hernia surgeries to allow the mesh-related inflammatory response to subside [19]. Even if the precise mechanism underlying this change is not well understood, a 6-month threshold may represent the pathophysiological shift from acute to chronic pain in hernia surgery more accurately [7,17–19]. Therefore, the authors have followed up the patients up to 6 months in the present research. The cause of PHGP, like any other chronic post-surgical pain (CPSP), is yet to be fully understood; however, known factors include pre-existing psychological issues, severe preoperative pain, untreated acute severe postoperative pain, pre-existing anxiety, and direct nerve injury [9]. Whatever may be the cause, peripheral and central sensitization eventually lead to the manifestation of chronic pain. In the past two decades, surgeons and anesthesiologists have tried various techniques to prevent or reduce the incidence and severity of CPSP with variable success. Patient factors, surgical factors, and anesthetic techniques contribute to the end manifestation of CPSP. Anesthesiologists have the knowledge to provide the best analgesia during the perioperative period and contribute to shared decision-making as a multidisciplinary approach to reduce the menace of CPSP. Studies have shown that optimal perioperative pain control reduces the incidence of CPSP [9]. A Cochrane review has shown that epidural anesthesia and paravertebral blocks reduced the likelihood of CPSP in about one out of every four or five patients receiving

regional anesthesia at six months after thoracotomy and breast surgeries, respectively [20]. Wound infiltration (single shot or catheter) has been studied to prevent CPSP, but the results are inconsistent [21]. On the other hand, phantom limb pain was substantially less common at 12 months in a different trial on limb amputation in which a preoperative catheter was placed and local anesthetic infusion was maintained for a median of 30 days [22]. Good perioperative pain control seems to be effective in preventing CPSP in some settings like thoracotomy but has not been consistent in other studies [23]. Elahwal et al. [24] conducted a study involving II-IHNB in cesarean section and the prevention of CPSP. The authors found that II-IHNB not only led to reduced postoperative pain scores but also chronic pain at three and six months. Hence, from an anesthesia point of view, risk stratification and optimal perioperative pain control using the multimodal analgesic technique can prevent or reduce the incidence of CPSP [9].

II-IHNB and transversus abdominis plane (TAP) have been extensively studied and found to provide excellent acute postoperative pain control compared to placebo, or systemic analgesia in multiple studies involving open hernia surgery or cesarean section, and the results are consistent with the authors' trial [10,25–28]. When Aveline et al. [26] assessed conventional/blind II-IHNB with ultrasound-guided TAP for acute open inguinal hernia repair in 273 patients, they discovered that the TAP block offered superior pain management than "blind II-IHNB." They also looked at the occurrence of chronic pain at six months. At six months, the percentage of patients experiencing moderate intensity pain (visual analogue scale > 4 on movement) was similar between the TAP and II-IHNB groups (18.2% *vs*. 22.4%, respectively). In the present study, it was found that 25 percent and 31 percent of subjects (in groups A and B respectively) experienced moderate-intensity pain at three three-month periods while none at 6 months.

Nerve blocks not only provided better postoperative pain relief but also reduced opioid consumption. The NRS pain scores were noticeably lower in group A at three and six hours postoperatively. Likewise, NRS scores at movement were significantly reduced at 3, 6, 12, and 24 hours postoperatively in group A compared to group B. These results coincide with the study by Onur et al. [13], Mostafa et al. [29], Varsha et al. [30], Ferky et al. [31], and Singh et al. [32]. In the present study, the total opioid consumption and need for rescue analgesia in the initial 24 hours following surgery were markedly lessened in group A compared to group B. Reduced opioids led to reduced side effects like nausea, vomiting, and sedation. II-IHNB provides better pain relief, reduces overall hospital stay, and results in faster discharge; hence, it should be offered to all patients undergoing hernia surgery [33]. However, the early discharge part was not investigated in the authors' cohort of patients.

Neuropathic pain is commonly experienced by a vast majority of patients experiencing CPSP and even following hernia surgery. Onur et al. [13] investigated the effect of II-IHNB on acute and chronic neuropathic pain. They found that II-IHNB reduced the severity of neuropathic pain in the first postoperative phase, and further at three and six months after surgery. The commonly utilized scales for the assessment of chronic neuropathic pain are the LANSS, DN4, Neuropathic Pain Symptom Inventory, and painDETECT questionnaires. The authors chose the DN4 questionnaire owing to its high specificity, sensitivity, and easy applicability [34]. In the present study, 11 subjects in group A and 15 subjects in group B were found having neuropathic pain (DN4 ≥ 4) at the end of three months. So, 68.75% and 93.75% of patients in groups A and B, respectively, expressed their pain character as neuropathic from a total of 16 patients in each group who developed PHGP. At 6 months, 66.7% of patients in group A and 60% of patients in group B described their pain as neuropathic.

After hernia surgery, several factors, including preoperative pain, nerve damage, postoperative complications, and, most crucially, early severe untreated post-operative pain can lead to the manifestation of chronic pain. Similarly, surgical factors like extensive tissue handling, nerve injury during dissection, or postoperative adhesions and later neuroma formation can complicate the outcome and potentially enhance the chances of PHGP. Neuropathic pain has also been linked to the insertion of mesh, which increases inflammation and causes scarring. Furthermore, patient factors also play an important role. Various research has shown stress, anxiety, and preexisting psychological problems increase the chance of developing chronic pain. Researchers worldwide are still trying to figure out what exactly leads to CPSP, and there is still no solid answer despite recent advances in neurobiology and advances in postoperative pain management. So, CPSP is a complex interaction of many factors and, in this study, the authors tried to address one component as an anesthesiologist would by providing a regional nerve block and good perioperative pain control.

There are a few limitations of this study. Firstly, the hernia repair was carried out by different surgeons, and, as is widely understood, surgical technique also plays a

great role. It would have been ideal if one surgeon had performed all the surgeries. However, as the institution was a teaching university hospital, this was not possible. Secondly, it would have been preferable to employ patient-controlled analgesia as opposed to demand analgesia to estimate 24-hour opioid intake. Thirdly, we have not added any neuropathic medications like pregabalin or gabapentin in the postoperative pain management protocol. Trials by Clarke et al. [35] and Mishriky et al. [36] have shown favorable outcomes whereas few others like Martinez et al. [37] have not found significant benefits with pregabalin in preventing or reducing CPSP.

PHGP is a major concern following hernia surgery. In conclusion, II-IHNB could not reduce the incidence of PHGP compared to the placebo group. Still, it provided excellent pain relief along with a reduced opioid requirement in the 24-hour postoperative period. Hence, the authors recommend that every patient undergoing hernia repair should be offered a pre-operative II-IH nerve block as a part of the multimodal analgesia technique. Moving forward, long-term follow-up data at twelve months with a larger sample size may give better insight into PHGP. Pain is a complex manifestation of various elements, including patient and surgical factors, which was not investigated in this study. Future research should also focus on the addition of genitofemoral block to II-IHNB and pregabalin/gabapentin in the perioperative analgesic regimen with appropriate dose titration to see if these neuropathic medications can lessen the occurrence of PHGP and neuropathic pain.

DATA AVAILABILITY

Data files are available from Harvard Dataverse: https://doi.org/10.7910/DVN/M7OAGK. Further inquiries can be directed to the corresponding author.

ACKNOWLEDGMENTS

The authors sincerely acknowledge the work done by Dr Anusha Kakarla and Mrs Subhadra Priyadarsini in collecting data and providing statistical input respectively.

CONFLICT OF INTEREST

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

FUNDING

No funding to declare.

AUTHOR CONTRIBUTIONS

Rajendra Kumar Sahoo: Concepts, Study design, Data acquisition, Literature review, Manuscript preparation, and Manuscript review; Amit Pradhan: Concepts, Manuscript editing, and Manuscript review; Priyadarsini Samanta: Study design, Statistical analysis; Laxman Kumar Senapati: Concepts, Study design, Literature review, Data acquisition, Manuscript review, and editing; Ganesh Chandra Satapathy: Supervision and critical review.

ORCID

Rajendra Kumar Sahoo, https://orcid.org/0000-0002-9489-0694
Amit Pradhan, https://orcid.org/0000-0002-5589-246X
Priyadarsini Samanta, https://orcid.org/0000-0001-9220-4059
Laxman Kumar Senapati, https://orcid.org/0000-0002-8727-4412
Ganesh Chandra Satapathy, https://orcid.org/0009-0009-1271-8961

REFERENCES

1. Kurzer M, Kark A, Hussain ST. Day-case inguinal hernia repair in the elderly: a surgical priority. Hernia 2009; 13: 131-6.
2. Gram-Hanssen A, Öberg S, Rosenberg J. A critical appraisal of the chronic pain rate after inguinal hernia repair. J Abdom Wall Surg 2023; 2: 10972.
3. Schug SA, Lavand'homme P, Barke A, Korwisi B, Rief W, Treede RD; IASP Taskforce for the Classification of Chronic Pain. The IASP classification of chronic pain for ICD-11: chronic postsurgical or posttraumatic pain. Pain 2019; 160: 45-52.
4. Khan JS, Rai A, Sundara Rajan R, Jackson TD, Bhatia A. A scoping review of perineural steroids for the treatment of chronic postoperative inguinal pain. Hernia 2016; 20: 367-76.
5. Rosenberger DC, Pogatzki-Zahn EM. Chronic postsurgical pain - update on incidence, risk factors and preventive treatment options. BJA Educ 2022; 22: 190-6.
6. Nienhuijs S, Staal E, Strobbe L, Rosman C, Groenewoud H, Bleichrodt R. Chronic pain after mesh repair of inguinal hernia: a systematic review. Am J

Surg 2007; 194: 394-400.
7. Aasvang E, Kehlet H. Chronic postoperative pain: the case of inguinal herniorrhaphy. Br J Anaesth 2005; 95: 69-76.
8. Thomassen I, van Suijlekom HA, van der Gaag A, Nienhuijs SW. Intervention techniques for chronic post herniorrhaphy pain. Eur Surg 2012; 44: 132-7.
9. Thapa P, Euasobhon P. Chronic postsurgical pain: current evidence for prevention and management. Korean J Pain 2018; 31: 155-73.
10. Kamal K, Jain P, Bansal T, Ahlawat G. A comparative study to evaluate ultrasound-guided transversus abdominis plane block versus ilioinguinal iliohypogastric nerve block for post-operative analgesia in adult patients undergoing inguinal hernia repair. Indian J Anaesth 2018; 62: 292-7.
11. Eichenberger U, Greher M, Kirchmair L, Curatolo M, Moriggl B. Ultrasound-guided blocks of the ilioinguinal and iliohypogastric nerve: accuracy of a selective new technique confirmed by anatomical dissection. Br J Anaesth 2006; 97: 238-43.
12. Bouhassira D, Attal N, Alchaar H, Boureau F, Brochet B, Bruxelle J, et al. Comparison of pain syndromes associated with nervous or somatic lesions and development of a new neuropathic pain diagnostic questionnaire (DN4). Pain 2005; 114: 29-36.
13. Onur T, Karaca Ümran, Ökmen K, Terkanlıoğlu S, Onur A. The effects of ilioinguinal nerve block on acute and chronic neuropathic pain in patients following inguinal hernia repair with spinal anesthesia: a prospective cohort study. J Surg Med 2022; 6: 120-4.
14. Cunningham J, Temple WJ, Mitchell P, Nixon JA, Preshaw RM, Hagen NA. Cooperative hernia study. Pain in the postrepair patient. Ann Surg 1996; 224: 598-602.
15. Kehlet H, Bay-Nielsen M, Kingsnorth A. Chronic postherniorrhaphy pain--a call for uniform assessment. Hernia 2002; 6: 178-81.
16. Molegraaf M, Lange J, Wijsmuller A. Uniformity of chronic pain assessment after inguinal hernia repair: a critical review of the literature. Eur Surg Res 2017; 58: 1-19.
17. HerniaSurge Group. International guidelines for groin hernia management. Hernia 2018; 22: 1-165.
18. Alfieri S, Amid PK, Campanelli G, Izard G, Kehlet H, Wijsmuller AR, et al. International guidelines for prevention and management of post-operative chronic pain following inguinal hernia surgery. Hernia 2011; 15: 239-49.
19. Kehlet H, Roumen RM, Reinpold W, Miserez M. Invited commentary: persistent pain after inguinal hernia repair: what do we know and what do we need to know? Hernia 2013; 17: 293-7.
20. Andreae MH, Andreae DA. Regional anaesthesia to prevent chronic pain after surgery: a Cochrane systematic review and meta-analysis. Br J Anaesth 2013; 111: 711-20.
21. Humble SR, Dalton AJ, Li L. A systematic review of therapeutic interventions to reduce acute and chronic post-surgical pain after amputation, thoracotomy or mastectomy. Eur J Pain 2015; 19: 451-65.
22. Borghi B, D'Addabbo M, White PF, Gallerani P, Toccaceli L, Raffaeli W, et al. The use of prolonged peripheral neural blockade after lower extremity amputation: the effect on symptoms associated with phantom limb syndrome. Anesth Analg 2010; 111: 1308-15.
23. Sentürk M, Ozcan PE, Talu GK, Kiyan E, Camci E, Ozyalçin S, et al. The effects of three different analgesia techniques on long-term postthoracotomy pain. Anesth Analg 2002; 94: 11-5.
24. Elahwal L, Elrahwan S, Elbadry AA. Ilioinguinal and iliohypogastric nerve block for acute and chronic pain relief after caesarean section: a randomized controlled trial. Anesth Pain Med 2022; 12: e121837.
25. Okur O, Tekgul ZT, Erkan N. Comparison of efficacy of transversus abdominis plane block and iliohypogastric/ilioinguinal nerve block for postoperative pain management in patients undergoing inguinal herniorrhaphy with spinal anesthesia: a prospective randomized controlled open-label study. J Anesth 2017; 31: 678-85.
26. Aveline C, Le Hetet H, Le Roux A, Vautier P, Cognet F, Vinet E, et al. Comparison between ultrasound-guided transversus abdominis plane and conventional ilioinguinal/iliohypogastric nerve blocks for day-case open inguinal hernia repair. Br J Anaesth 2011; 106: 380-6.
27. Hosalli V, Ayyanagouda B, Hiremath P, Ambi U, Hulkund SY. Comparative efficacy of postoperative analgesia between ultrasound-guided dual transversus abdominis plane and Ilioinguinal/Iliohypogastric nerve blocks for open inguinal hernia repair: an open label prospective randomised comparative clinical trial. Indian J Anaesth 2019; 63: 450-5.
28. Faiz SHR, Nader ND, Niknejadi S, Davari-Farid S, Hobika GG, Rahimzadeh P. A clinical trial comparing ultrasound-guided ilioinguinal/iliohypogastric nerve block to transversus abdominis plane block

for analgesia following open inguinal hernia repair. J Pain Res 2019; 12: 201-7. Erratum in: J Pain Res 2023; 16: 681-2.
29. Mostafa SF, Abdelghany MS, Elyazed MMA. Analgesic efficacy of ultrasound guided quadratus lumborum block versus ilioinguinal/iliohypogastric nerve block following pediatric open inguinal hernia repair: a prospective randomized controlled trial. J Anaesthesiol Clin Pharmacol 2023; 39: 134-40.
30. Varsha R, Desai SN, Mudakanagoudar MS, Annigeri VM. Comparison between caudal epidural and ultrasound-guided ilioinguinal-iliohypogastric block with bupivacaine and dexmedetomidine for postoperative analgesia following pediatric inguinal hernia surgeries: a prospective randomized, double-blind study. J Anaesthesiol Clin Pharmacol 2021; 37: 389-94.
31. Fekry DM, Megahed NA, EL-Lakany MH, Yakout MMS. Ultrasound-guided ilioinguinal, iliohypogastric, and genitofemoral nerve block versus spinal subarachnoid blockade for inguinal hernia repair. Res Opin Anesth Intensive Care 2017; 4: 29-34.
32. Singh R, Yadav K, Singh P. Efficacy of analgesia using ilioinguinal-iliohypogastric (IIIH) nerve block, transversus abdominis plane (TAP) block and diclofenac after caesarean delivery under spinal anaesthesia: a non-randomised clinical trial. Indian J Anaesth 2023; 67: 638-43.
33. Santos Gde C, Braga GM, Queiroz FL, Navarro TP, Gomez RS. Assessment of postoperative pain and hospital discharge after inguinal and iliohypogastric nerve block for inguinal hernia repair under spinal anesthesia: a prospective study. Rev Assoc Med Bras (1992) 2011; 57: 545-9.
34. Ünlütürk Z, Öztekin SNS, Alkan H, Şenol H, Betaş S, Erdoğan Ç. Which scale is more useful to detect diabetic neuropathic pain?: a cross-sectional study. BMC Endocr Disord 2022; 22: 56.
35. Clarke H, Bonin RP, Orser BA, Englesakis M, Wijeysundera DN, Katz J. The prevention of chronic postsurgical pain using gabapentin and pregabalin: a combined systematic review and meta-analysis. Anesth Analg 2012; 115: 428-42.
36. Mishriky BM, Waldron NH, Habib AS. Impact of pregabalin on acute and persistent postoperative pain: a systematic review and meta-analysis. Br J Anaesth 2015; 114: 10-31.
37. Martinez V, Pichard X, Fletcher D. Perioperative pregabalin administration does not prevent chronic postoperative pain: systematic review with a meta-analysis of randomized trials. Pain 2017; 158: 775-83.