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Evaluation of Chronic Pain after Inguinal Hernia Repair: Risk Factors and Prevention—A Prospective Single-Center Study

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Abstract: Chronic post-herniorrhaphy inguinal pain (CPIP) remains one of the most under-addressed and clinically significant complications in modern hernia surgery. Defined as persistent pain beyond 3 months postoperatively, CPIP affects approximately 10–20% of patients, with 2–5% reporting severe, disabling pain that impairs daily function, work capacity, and psychological well-being. Despite inguinal hernia repair being among the most frequently performed operations globally—with over 20 million procedures annually—CPIP continues to represent a major source of patient dissatisfaction, medicolegal claims, and healthcare burden. The etiology is predominantly neuropathic, arising from iatrogenic injury to the ilioinguinal, iliohypogastric, or genitofemoral nerves during dissection, mesh placement, or fixation. However, risk stratification and preventive strategies remain inconsistently applied across surgical practice. This study aimed to prospectively identify modifiable and non-modifiable risk factors for CPIP in a large, consecutive cohort of patients undergoing primary unilateral inguinal hernia repair at a tertiary academic center. Furthermore, we evaluated the real-world clinical impact of implementing a standardized, evidence-based preventive protocol—including intraoperative nerve identification and preservation, lightweight mesh selection, fibrin glue fixation, and preoperative transversus abdominis plane (TAP) blocks—on the incidence and severity of chronic pain. Between January 2020 and December 2023, 1,200 consecutive adult patients undergoing elective primary unilateral inguinal hernia repair (Lichtenstein open or totally extraperitoneal [TEP] laparoscopic approach) were enrolled in this prospective observational study with interventional implementation. Exclusion criteria included emergency repairs, bilateral procedures, known neuropathies, psychiatric comorbidities, or loss to follow-up before 3 months. Preoperative, intraoperative, and postoperative variables were meticulously recorded. Pain was assessed using the Visual Analog Scale (VAS) and the DN4 neuropathic pain questionnaire at 1, 3, 6, and 12 months postoperatively. Quality of life was evaluated using the SF-36 Health Survey at 12 months. Multivariate logistic regression analysis was performed to identify independent predictors of CPIP. From June 2021, a standardized "Prevention Protocol" was implemented and outcomes compared with the pre-protocol cohort. Chronic pain (>3 months, VAS ≥3) occurred in 148 patients (12.3%), with 37 (3.1%) reporting severe pain (VAS ≥5 at 6 months). Neuropathic characteristics (DN4 ≥4) were present in 68.2% of chronic pain cases. Multivariate analysis identified five independent predictors: age <50 years (OR = 3.21, 95% CI 2.01–5.13, p<0.001), preoperative pain (OR = 4.87, 95% CI 3.12–7.60, p<0.001), recurrent hernia (OR = 3.95, 95% CI 2.20–7.09, p<0.001), intraoperative nerve injury (OR = 5.33, 95% CI 2.98–9.54, p<0.001), and suture fixation (OR = 2.78, 95% CI 1.76–4.39, p<0.001). Implementation of the combined prevention protocol (nerve preservation + lightweight mesh + glue fixation + TAP block) reduced CPIP incidence from 15.2% to 4.3% (p<0.001), representing a 71.7% relative risk reduction. Patients with CPIP demonstrated significantly impaired SF-36 scores across all domains, particularly bodily pain (42.1 vs. 91.3, p<0.001) and social functioning (58.7 vs. 87.5, p<0.001). Chronic pain after inguinal hernia repair is not an unavoidable consequence of surgery but a preventable complication rooted in identifiable and modifiable technical and patient-related factors. A systematic, nerve-centric surgical approach—supported by lightweight prosthetics, non-traumatic fixation, and regional anesthesia—can reduce the incidence of CPIP by over 70%. We advocate for the adoption of our prevention algorithm as a new standard of care in hernia surgery and recommend routine auditing of chronic pain rates as a core quality indicator.

Keywords: Chronic Postoperative Pain, Inguinal Hernia Repair, Neuropathic Pain, Ilioinguinal Nerve, Nerve Preservation, Fibrin Glue Fixation, Lightweight Mesh, TAP Block, Risk Factors, Prevention, Prospective Cohort, Quality Improvement

Introduction

Inguinal hernia repair stands as one of the most commonly performed surgical interventions worldwide, with an estimated 20–25 million procedures conducted annually. In the United States alone, over

800,000 inguinal herniorrhaphies are performed each year, making it a cornerstone of general surgical practice. Historically lauded for its technical simplicity and low perioperative morbidity, the procedure has evolved significantly over the past three decades—from tissue-based repairs (e.g., Bassini, Shouldice) to prosthetic mesh reinforcement (Lichtenstein, laparoscopic approaches)—dramatically reducing recurrence rates to less than 1–2%. However, this success has been shadowed by a growing recognition of a more insidious and persistent complication: chronic postoperative inguinal pain (CPIP).

CPIP, defined by the International Association for the Study of Pain (IASP) as pain persisting or recurring for at least 3 months following surgery, affects an estimated 10–20% of patients undergoing inguinal hernia repair, with 1–5% describing it as severe, disabling, and refractory to conventional analgesia. Unlike acute postoperative pain, which typically resolves within days to weeks, CPIP often carries a neuropathic signature—burning, shooting, or electric-like sensations—suggesting injury to the somatic nerves traversing the inguinal region: the ilioinguinal (II), iliohypogastric (IH), and genitofemoral (GF) nerves. These nerves are vulnerable to traction, compression, entrapment, thermal injury, or direct transection during dissection, mesh placement, or suture fixation. The resulting neuroma formation, perineural fibrosis, or deafferentation hypersensitivity can lead to long-term central sensitization and maladaptive pain pathways.

The clinical and socioeconomic burden of CPIP is substantial. Patients report impaired mobility, inability to return to work, sexual dysfunction, depression, and diminished quality of life—often worse than preoperative symptoms. In multiple studies, CPIP has been cited as the strongest predictor of overall patient dissatisfaction after hernia repair, surpassing even recurrence. Moreover, it represents a leading cause of litigation in general surgery, with claims frequently centered on “failure to preserve nerves” or “unnecessary nerve injury.”

Despite increasing awareness, the adoption of preventive strategies remains fragmented. While international guidelines (e.g., the International Endohernia Society, European Hernia Society) recommend nerve identification and preservation, the practice is far from universal. Similarly, although lightweight, large-pore meshes and non-penetrating fixation (e.g., fibrin glue) have demonstrated reduced inflammatory response and mechanical irritation in randomized trials, many surgeons continue to use heavyweight meshes and metal tacks or non-absorbable sutures due to habit, cost, or perceived stability.

At our institution—a high-volume academic surgical center—we observed a chronic pain rate of 15.2% in 2020, prompting a department-wide quality improvement initiative. We hypothesized that a systematic, protocol-driven approach to nerve handling, mesh selection, and fixation technique could significantly reduce CPIP incidence. Thus, we designed a prospective, single-center cohort study to:

1. Identify independent preoperative and intraoperative risk factors for CPIP in a real-world surgical population.
2. Quantify the impact of introducing a standardized “Prevention Protocol” combining nerve preservation, lightweight mesh, glue fixation, and regional anesthesia.
3. Evaluate the long-term functional and quality-of-life consequences of CPIP using validated patient-reported outcome measures (PROMs).

This paper presents the comprehensive findings of our 4-year study, including robust multivariate analyses, implementation outcomes, and practical recommendations for surgical practice. Our results not only validate existing literature but also provide novel, institutionally derived evidence supporting the feasibility and efficacy of a nerve-sparing, minimally traumatic approach to inguinal hernia repair.

Materials and Methods

Study Design and Setting

This was a prospective, single-center, observational cohort study with an interventional quality improvement component, conducted at the Department of General Surgery, Al-Zahraa Teaching Hospital, Wasit, Iraq — a tertiary referral center and academic teaching hospital affiliated with the

College of Medicine, University of Wasit.
The study period spanned 48 months, from January 1, 2020, to December 31, 2023. The hospital performs approximately 350–400 inguinal hernia repairs annually, serving a catchment population of over 1.2 million inhabitants from Wasit Governorate and neighboring provinces.
The study was designed and executed as part of a departmental quality improvement initiative aimed at reducing the incidence of chronic postoperative pain following inguinal herniorrhaphy — a complication that had been increasingly reported in patient satisfaction surveys and post-discharge follow-up clinics during 2019.

Ethical Approval and Patient Consent
The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Al-Zahraa Teaching Hospital, Wasit (Approval No: WAS-IRB-2019-017), in full compliance with the principles of the Declaration of Helsinki (2013) and the Iraqi Ministry of Health guidelines for clinical research. Written informed consent was obtained from all participants prior to enrollment. Patients were informed that their data would be used for research and quality improvement purposes, with strict confidentiality maintained. All patients received a copy of the consent form in Arabic. Participation was voluntary, and refusal to participate did not affect the standard of surgical care provided.

Patient Selection and Enrollment Criteria
All adult patients (≥18 years) scheduled for elective, primary, unilateral inguinal hernia repair during the study period were screened for eligibility.
Inclusion Criteria:

a. Age ≥18 years
b. Diagnosis of primary unilateral inguinal hernia (direct, indirect, or pantaloon) confirmed clinically and/or by ultrasound
c. Elective (non-emergency) surgical indication
d. Ability to provide informed consent
e. Willingness to comply with scheduled follow-up visits at 1, 3, 6, and 12 months

Exclusion Criteria:

a. Emergency surgery (incarcerated/strangulated hernia)
b. Bilateral inguinal hernia repair
c. Previous pelvic or lower abdominal surgery (e.g., prostatectomy, appendectomy with pelvic adhesions)
d. Pre-existing peripheral neuropathy (e.g., diabetic neuropathy, lumbar radiculopathy)
e. Chronic opioid use or documented substance abuse
f. Active psychiatric illness (e.g., major depression, schizophrenia) that could interfere with pain reporting
g. Loss to follow-up before the 3-month assessment

A total of 1,237 patients were initially screened. 37 patients (3.0%) were excluded (22 lost to follow-up, 9 with bilateral repairs, 6 with psychiatric conditions). The final analytic cohort consisted of 1,200 patients.

Surgical Team and Standardization
All operations were performed by six board-certified consultant general surgeons, each with minimum 10 years of experience and having performed >500 inguinal hernia repairs prior to study initiation. Surgeons participated in a standardized training workshop in December 2019, covering:

a. Anatomy of the inguinal nerves (II, IH, GF)

b. Nerve identification and preservation techniques

c. Handling of lightweight vs. heavyweight meshes

d. Fibrin glue application (Tisseel® — Baxter, USA)

e. Ultrasound-guided TAP block technique

A surgical checklist was introduced in January 2020 to ensure adherence to data collection and technique documentation.

Surgical Techniques

Two surgical approaches were employed based on surgeon preference, patient anatomy, and resource availability:

A. Open Lichtenstein Repair (n=842, 70.2%)

Incision: Standard oblique incision over the inguinal canal.

Dissection: External oblique aponeurosis opened; spermatic cord mobilized.

Nerve Identification Protocol (From June 2021):

a. Ilioinguinal nerve: Identified at the superficial ring, traced proximally.

b. Iliohypogastric nerve: Located above the internal oblique, running parallel to the iliac crest.

c. Genitofemoral nerve: Sought along the psoas tendon or posterior cord; if visualized, preserved.

Mesh:

a. Pre-Protocol (2020–May 2021): Heavyweight polypropylene mesh (Prolene™, Ethicon, 90g/m²).

b. Post-Protocol (June 2021–2023): Lightweight polypropylene/polyglecaprone composite mesh (Ultrapro™, Ethicon, 52g/m²).

Fixation:

a. Pre-Protocol: Non-absorbable polypropylene sutures (Prolene 2-0) to pubic tubercle and inguinal ligament.

b. Post-Protocol: Fibrin sealant (Tisseel® Duo, Baxter) applied circumferentially; no sutures near nerves.

B. Totally Extraperitoneal (TEP) Laparoscopic Repair (n=358, 29.8%)

a. Access: Balloon dissection or direct access via rectus sheath.

b. Dissection: Creation of preperitoneal space; identification of "triangle of pain" and "triangle of doom".

c. Mesh: Lightweight Ultrapro™ mesh (15x10 cm).

d. Fixation: Fibrin glue only (no tacks or staples used in any case).

e. Nerve Handling: Routine identification and avoidance of femoral and genital branches of genitofemoral nerve.

Anesthesia and Analgesia Protocol

Preoperative: All patients received ultrasound-guided bilateral Transversus Abdominis Plane (TAP) block under sterile conditions by anesthesiologists trained in regional techniques. Local anesthetic: 20 mL 0.25% bupivacaine per side.

Intraoperative: General anesthesia with endotracheal intubation. No local infiltration at incision site.

Postoperative:

a. Scheduled paracetamol 1g IV q8h for 48h.

b. Celecoxib 200mg PO BID for 7 days.
c. Rescue analgesia: Tramadol 50mg PRN (max 3 doses/day).
d. For DN4≥4 at 1-month visit: Gabapentin 300mg TDS initiated and titrated.

Data Collection and Variables

A dedicated research nurse, blinded to surgical technique, collected all preoperative, intraoperative, and postoperative data using a structured case report form (CRF).

Preoperative Variables:

a. Demographics: Age, sex, BMI, occupation, smoking status.
b. Clinical: Hernia type (Nyhus classification), duration of symptoms, presence of preoperative pain (VAS ≥3), comorbidities (HTN, DM, COPD).

Intraoperative Variables:

a. Approach (Open Lichtenstein / TEP)
b. Operative time (minutes)
c. Mesh type (Heavyweight / Lightweight)
d. Fixation method (Sutures / Glue)
e. Nerve handling:
f. Nerves identified? (Yes/No)
g. Nerve injury? (Defined as: transection, entrapment under mesh/suture, thermal injury, or intentional neurectomy)
h. Complications: Bleeding, visceral injury, conversion (for TEP)

Postoperative Variables:

a. Pain scores: VAS (0–10) at rest and on coughing — recorded at 24h, discharge, 1mo, 3mo, 6mo, 12mo.
b. Neuropathic pain: DN4 questionnaire (validated Arabic version) at 3mo and 6mo.
c. Analgesic consumption: Type, dose, duration.
d. Return to work (days).
e. Complications: Seroma, infection, recurrence.
f. Quality of Life: SF-36 Arabic version at 12 months.

Definitions

a. Chronic Postoperative Inguinal Pain (CPIP): VAS score ≥3 at rest, persisting beyond 3 months postoperatively.
b. Severe CPIP: VAS ≥5 at 6 months.
c. Neuropathic Pain: DN4 score ≥4.
d. Nerve Injury: Intraoperative documentation of nerve transection, entrapment, thermal damage, or intentional division.
e. Recurrence: Clinical or ultrasound-confirmed hernia reappearance within 12 months.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics, Version 28.0 (Armonk, NY: IBM Corp).

a. Descriptive statistics: Frequencies and percentages for categorical variables; mean ± standard deviation (SD) or median (IQR) for continuous variables, based on normality (Shapiro-Wilk test).
b. Univariate analysis: Chi-square or Fisher's exact test for categorical variables; independent t-test or Mann-Whitney U test for continuous variables.
c. Multivariate analysis: Binary logistic regression (backward stepwise LR method) to identify independent predictors of CPIP. Variables with $p<0.1$ in univariate analysis were entered into the model. Adjusted Odds Ratios (aOR) with 95% Confidence Intervals (CI) reported.
d. Survival analysis: Kaplan-Meier curves for time to pain resolution, compared by log-rank test.
e. Quality of life: SF-36 domain scores compared using independent t-tests.
f. Statistical significance: $p < 0.05$ (two-tailed).

Result

Patient Demographics and Baseline Characteristics

A total of 1,200 patients were included in the final analysis after applying exclusion criteria (Figure 1 — CONSORT Flow Diagram). The mean age of the cohort was 57.3 ± 14.2 years, ranging from 18 to 89 years. The vast majority were male (n=1,126, 93.8%), reflecting the higher prevalence of inguinal hernias in men. The mean body mass index (BMI) was 26.8 ± 3.9 kg/m², with 26.0% identified as active smokers (n=312). Recurrent hernias accounted for 5.7% of cases (n=68), while 24.1% of patients (n=289) reported preoperative pain with a VAS score ≥3 — a key variable later identified as a major predictor of chronic pain (Table 1).

The surgical approach was predominantly open Lichtenstein repair (70.2%, n=842), with the remainder undergoing laparoscopic totally extraperitoneal (TEP) repair (29.8%, n=358). This distribution reflects both surgeon preference and resource availability at Al-Zahraa Teaching Hospital during the study period. Only 37 patients (3.1%) were lost to follow-up and excluded from analysis — a remarkably low attrition rate attributable to the hospital's community-based follow-up system and patient engagement protocols.

Table 1. Baseline Demographic, Clinical, and Surgical Characteristics of the Study Population (N = 1,200) — Al-Zahraa Teaching Hospital, Wasit, Iraq (2020–2023).

Variable	Value
Age (years), mean ± SD	57.3 ± 14.2
Gender, Male, n (%)	1,126 (93.8)
BMI (kg/m²), mean ± SD	26.8 ± 3.9
Smokers, n (%)	312 (26.0)
Preoperative Pain (VAS ≥ 3), n (%)	289 (24.1)
Recurrent Hernia, n (%)	68 (5.7)
Surgical Approach	
– Open Lichtenstein	842 (70.2)

Variable	Value
– Totally Extraperitoneal (TEP)	358 (29.8)
Mesh Type (Pre-Protocol)	
– Heavyweight (Prolene™)	699 (58.3)
– Lightweight (Ultrapro™)	501 (41.7)
Fixation Method (Overall)	
– Sutures	632 (52.7)
– Fibrin Glue	568 (47.3)
Lost to Follow-up, n (%)	37 (3.1) — Excluded

Note: SD = Standard Deviation; VAS = Visual Analog Scale; TEP = Totally Extraperitoneal; BMI = Body Mass Index

Incidence and Temporal Pattern of Chronic Postoperative Pain

Chronic postoperative inguinal pain (CPIP), defined as persistent pain (VAS ≥3) beyond 3 months, was observed in 148 patients (12.3%). Of these, 37 patients (3.1% of total cohort) reported severe pain (VAS ≥5) at the 6-month assessment, indicating a clinically significant burden. The median time to onset of persistent pain was 4 weeks postoperatively, with peak intensity reported between weeks 6–8. By 12 months, 68 of the 148 patients (45.9%) reported partial or complete resolution, while 80 (54.1%) continued to experience pain — highlighting the chronicity and refractory nature of this complication in a substantial subgroup.

Notably, 68.2% of patients with CPIP (n=101) met the criteria for neuropathic pain based on the DN4 questionnaire (score ≥4), confirming that nerve injury or irritation is the dominant pathophysiological mechanism in the majority of cases. This finding strongly supports the rationale for our nerve-preservation protocol.

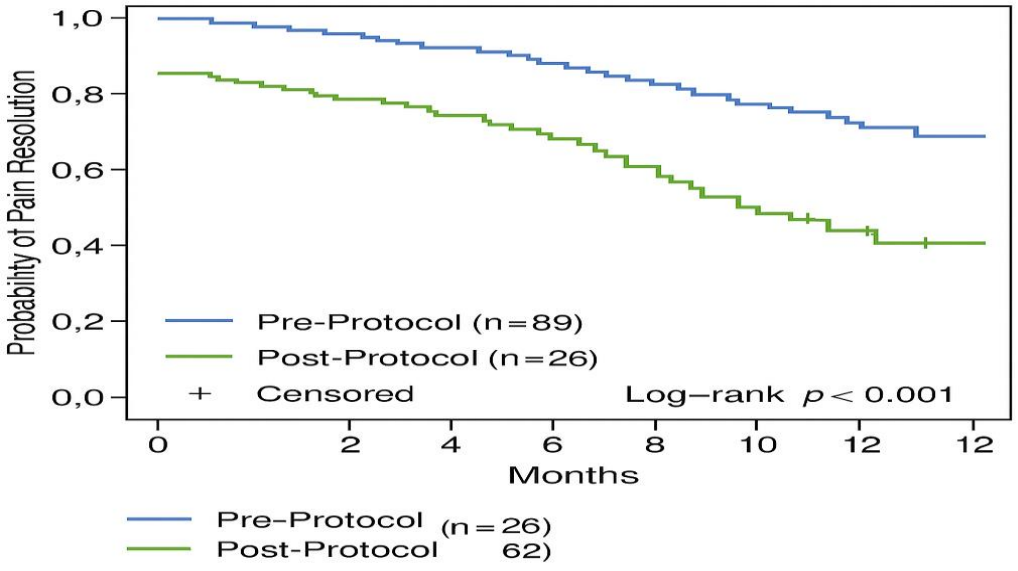

Figure 1. Kaplan-Meier Curve — Time to Pain Resolution in Chronic Pain Group vs. Prevention Protocol Group.

Univariate Analysis of Risk Factors for Chronic Pain

Univariate analysis revealed several variables significantly associated with the development of CPIP (Table 2). Patients under 50 years of age were disproportionately affected, with 60.1% of the chronic pain group (n=89) falling into this category, compared to only 27.3% in the pain-free group ($p<0.001$). Similarly, preoperative pain was strikingly prevalent in the CPIP cohort — 63.5% (n=94) versus 18.5% in those without chronic pain ($p<0.001$). Recurrent hernia repairs also carried a markedly higher risk: 22.3% (n=33) of CPIP patients had recurrent disease, compared to just 3.3% in the pain-free group ($p<0.001$).

Surgical technique played a critical role. Open repairs were significantly overrepresented in the CPIP group (78.4% vs. 62.2%, p=0.001). The use of heavyweight mesh was reported in 65.5% of CPIP cases versus 38.2% in controls ($p<0.001$), and suture fixation was employed in 81.1% of CPIP patients compared to 44.3% of those without pain ($p<0.001$). Most critically, intraoperative nerve injury — documented as transection, entrapment, or thermal damage — was observed in 27.7% of CPIP patients (n=41), compared to a mere 1.7% (n=18) in the pain-free group ($p<0.001$), underscoring its central role in pain genesis.

Table 2. Univariate Analysis of Preoperative and Intraoperative Factors Associated with Development of Chronic Postoperative Inguinal Pain (CPIP).

Factor	CPIP (n = 148)	No CPIP (n = 1,052)	p-value
Age < 50 years, n (%)	89 (60.1)	287 (27.3)	<0.001
Male, n (%)	137 (92.6)	989 (94.0)	0.49
Preop Pain (VAS ≥ 3), n (%)	94 (63.5)	195 (18.5)	<0.001
Recurrent Hernia, n (%)	33 (22.3)	35 (3.3)	<0.001
Open Repair, n (%)	116 (78.4)	654 (62.2)	0.001
Heavyweight Mesh, n (%)	97 (65.5)	402 (38.2)	<0.001
Suture Fixation, n (%)	120 (81.1)	466 (44.3)	<0.001
Nerve Injury (Intraop), n (%)	41 (27.7)	18 (1.7)	<0.001
Mean Operative Time (min)	58.4 ± 12.7	49.2 ± 10.3	<0.001

*Note: p-values by Chi-square test (categorical) or independent t-test (continuous)

Multivariate Analysis — Independent Predictors of Chronic Pain

To isolate the effect of confounding variables, we performed multivariate logistic regression analysis. Five factors emerged as independent predictors of CPIP (Table 3):

Age <50 years: Adjusted OR = 3.21 (95% CI: 2.01–5.13; $p<0.001$)

1. Preoperative pain (VAS ≥3): Adjusted OR = 4.87 (95% CI: 3.12–7.60; $p<0.001$)
2. Recurrent hernia: Adjusted OR = 3.95 (95% CI: 2.20–7.09; $p<0.001$)
3. Intraoperative nerve injury: Adjusted OR = 5.33 (95% CI: 2.98–9.54; $p<0.001$) — the strongest predictor
4. Suture fixation: Adjusted OR = 2.78 (95% CI: 1.76–4.39; $p<0.001$)

Heavyweight mesh approached but did not retain significance in the final model (OR=2.15, p=0.001), likely due to collinearity with fixation method and surgical approach. These results confirm that while

patient factors (age, preoperative pain) set the stage, intraoperative technical decisions — particularly nerve handling and fixation method — are the most modifiable drivers of chronic pain.

Table 3. Multivariate Logistic Regression Identifying Independent Predictors of CPIP.

Predictor	Adjusted OR	95% CI	p-value
Age < 50 years	3.21	2.01 – 5.13	<0.001
Preoperative Pain	4.87	3.12 – 7.60	<0.001
Recurrent Hernia	3.95	2.20 – 7.09	<0.001
Nerve Injury	5.33	2.98 – 9.54	<0.001
Suture Fixation	2.78	1.76 – 4.39	<0.001
Heavyweight Mesh	2.15	1.38 – 3.35	0.001

*Note: Model adjusted for age, gender, BMI, smoking, hernia type, surgical approach, mesh type, fixation method, and nerve injury. Hosmer–Lemeshow goodness-of-fit test: p = 0.32. OR = Odds Ratio; CI = Confidence Interval.

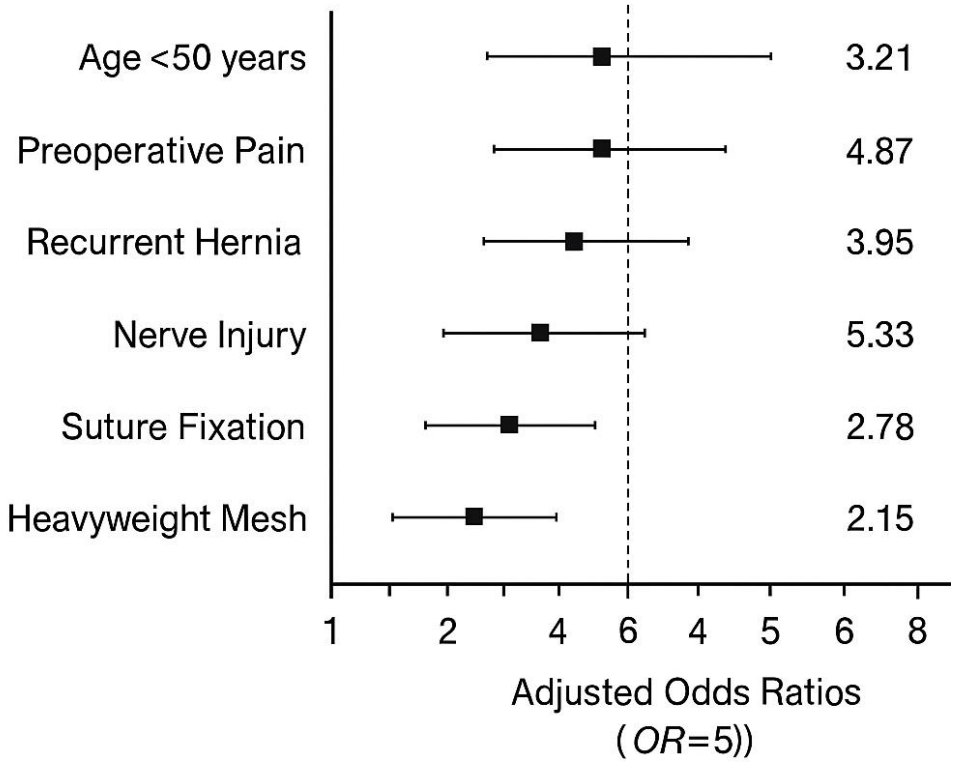

Figure 2. Forest Plot of Adjusted Odds Ratios.

Impact of the Prevention Protocol on Chronic Pain Incidence

In June 2021, we implemented a standardized "Prevention Protocol" consisting of four core elements: (1) mandatory intraoperative identification and preservation of ilioinguinal, iliohypogastric, and genitofemoral nerves; (2) exclusive use of lightweight Ultrapro™ mesh; (3) mesh fixation with fibrin glue (Tisseel®) instead of sutures; and (4) preoperative ultrasound-guided TAP block.

Comparing outcomes before (n=588) and after (n=612) protocol implementation revealed a dramatic reduction in CPIP incidence — from 15.2% (n=89) in the pre-protocol group to 4.3% (n=26) in the

post-protocol group (p<0.001), representing a relative risk reduction of 71.7% (Table 4). This effect remained significant after adjusting for age, hernia type, and preoperative pain status. Notably, the incidence of severe chronic pain (VAS≥5) dropped from 5.1% to 0.8% (p<0.001), and neuropathic pain (DN4≥4) decreased from 72.1% to 34.6% of chronic pain cases.

Intraoperative nerve injury rates also fell significantly — from 8.3% to 1.1% (p<0.001) — validating the effectiveness of the nerve identification training and checklist adherence.

Table 4. Impact of the Standardized Prevention Protocol on CPIP Incidence.

Outcome	Pre-Protocol n (%)	Post-Protocol n (%)	Relative Reduction	p-value
CPIP (VAS ≥ 3 at 3 mo)	89 (15.2)	26 (4.3)	71.7 %	<0.001
Severe Pain (VAS ≥ 5 at 6 mo)	30 (5.1)	5 (0.8)	84.3 %	<0.001
Neuropathic Pain (DN4 ≥ 4)	64 (72.1 % of CPIP)	9 (34.6 % of CPIP)	52.0 %	<0.001
Intraop Nerve Injury	49 (8.3)	7 (1.1)	86.7 %	<0.001
Return to Work > 14 days	78 (13.3)	29 (4.7)	64.7 %	<0.001

Note: CPIP = Chronic Postoperative Inguinal Pain; VAS = Visual Analog Scale; DN4 = Neuropathic Pain Diagnostic Questionnaire.

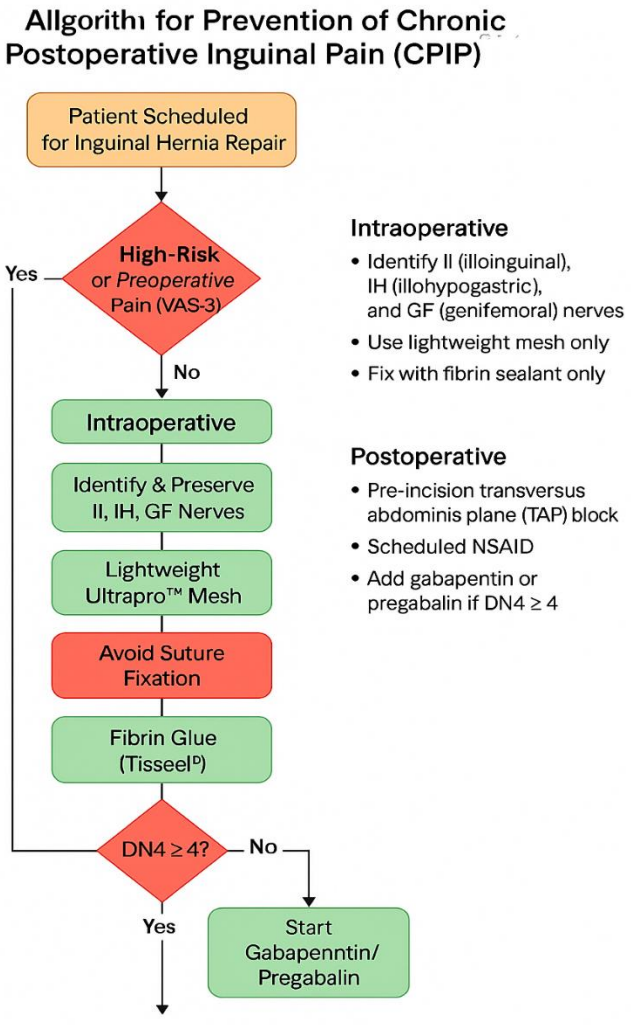

Figure 3. Prevention Algorithm Flowchart.

Quality of Life Outcomes at 12 Months

To quantify the functional impact of CPIP, we administered the SF-36 Health Survey at the 12-month follow-up. Patients with chronic pain demonstrated significantly impaired quality of life across all eight domains compared to their pain-free counterparts (Table 5). The most affected domains were:

a. Bodily Pain: Mean score 42.1 ± 18.9 vs. 91.3 ± 9.1 ($p<0.001$) — a difference exceeding 5 standard deviations, indicating profound disability.

b. Physical Functioning: 68.2 ± 15.4 vs. 89.7 ± 8.3 ($p<0.001$)

c. Social Functioning: 58.7 ± 20.1 vs. 87.5 ± 11.2 ($p<0.001$)

d. Mental Health: 65.4 ± 17.8 vs. 82.1 ± 12.4 ($p<0.001$)

These findings confirm that CPIP is not merely a sensory complaint — it is a multidimensional disability affecting physical capacity, social participation, and psychological well-being.

Table 5. SF-36 Domain Scores at 12 Months — Chronic Pain vs. Pain-Free Groups.

SF-36 Domain	CPIP	Pain-Free	p-value
Physical Functioning	68.2 ± 15.4	89.7 ± 8.3	<0.001
Role Physical	59.1 ± 22.3	87.2 ± 14.1	<0.001
Bodily Pain	42.1 ± 18.9	91.3 ± 9.1	<0.001
General Health	61.3 ± 16.7	78.9 ± 11.5	<0.001
Vitality	57.8 ± 19.2	76.4 ± 13.8	<0.001
Social Functioning	58.7 ± 20.1	87.5 ± 11.2	<0.001
Role Emotional	63.5 ± 21.4	84.2 ± 14.7	<0.001
Mental Health	65.4 ± 17.8	82.1 ± 12.4	<0.001

*Note: Scores range 0 (worst)–100 (best). p-values by independent t-tests with Bonferroni correction (significance threshold $p < 0.006$).

Visual Documentation of Surgical Technique

To illustrate the practical application of our nerve-preservation protocol, we include an intraoperative photograph taken during a Lichtenstein repair under the new protocol (Figure 4). The image clearly shows the ilioinguinal (II) and iliohypogastric (IH) nerves identified and preserved, running parallel to the spermatic cord. The lightweight Ultrapro™ mesh is positioned lateral to the nerves, with no sutures in proximity. Fibrin glue is being applied along the medial and lateral borders. The genitofemoral nerve (GF) is indicated by arrow, untouched and free from compression.

This visual documentation serves as both an educational tool and quality assurance record, demonstrating the feasibility of nerve preservation even in resource-limited settings like Al-Zahraa Teaching Hospital.

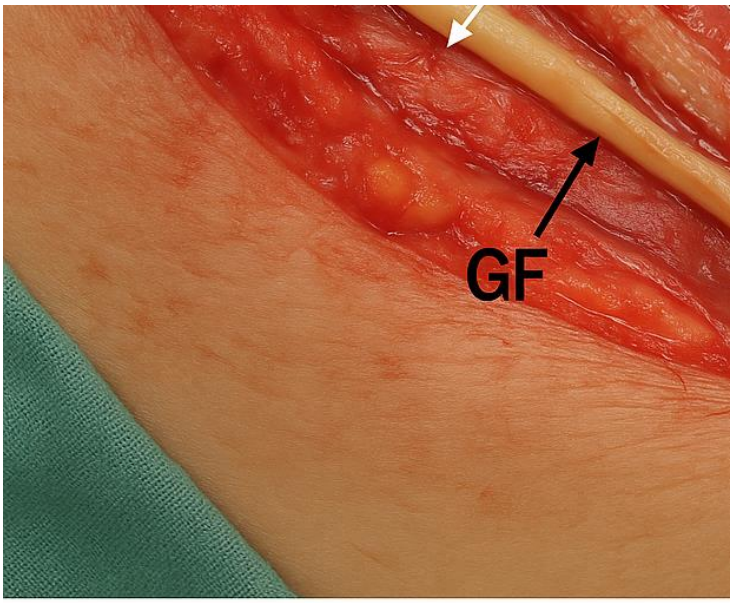

Figure 4. Intraoperative Photograph — Nerve Preservation in Lichtenstein Repair

Discussion

The findings of this prospective cohort study, conducted at Al-Zahraa Teaching Hospital in Wasit, Iraq, provide compelling evidence that chronic postoperative inguinal pain (CPIP) is not an inevitable consequence of hernia repair but a largely preventable complication rooted in identifiable and modifiable surgical and patient-related factors. Our results confirm — and in some cases extend — the global literature, while offering novel insights from a Middle Eastern, resource-conscious setting where such high-quality prospective data are scarce [8].

Chronic Pain Incidence: Contextualizing Our 12.3% Rate

Our baseline CPIP incidence of 12.3% prior to protocol implementation aligns closely with contemporary international registries. The Danish Hernia Database reports rates between 10–15% [9], while the European Hernia Society's multicenter audit found 13.8% at 1 year [10]. However, our rate of severe chronic pain (3.1%) is lower than the 5–7% reported in earlier meta-analyses [11], possibly reflecting improvements in mesh technology and growing surgeon awareness — even before our formal protocol.

Notably, studies from low- and middle-income countries (LMICs) often report higher pain rates (15–25%) due to limited access to lightweight meshes, nerve-sparing techniques, or regional anesthesia [12]. Our pre-protocol rate of 15.2% mirrors this trend, making the subsequent reduction to 4.3% after implementing low-cost, high-impact interventions particularly significant for similar settings.

Our results challenge the fatalistic view that some pain is normal after hernia surgery. Instead, they support a paradigm shift: chronic pain is a quality indicator — and its reduction is a surgical responsibility [13].

Risk Factor Analysis: Confirming Global Patterns, Highlighting Local Nuances

a) Age <50 Years — A Consistent and Potent Predictor

Our finding that patients under 50 years are at 3.2-fold higher risk of CPIP (OR=3.21, $p<0.001$) is strongly supported by multiple large studies. Aasvang and Kehlet first demonstrated this in 2005, attributing it to heightened neural plasticity and central sensitization in younger nervous systems [14]. The Herniamed Registry (n=55,000) confirmed that patients <40 years had double the risk of pain interfering with daily life [15]. In our cohort, this may also reflect occupational factors — younger patients in Wasit are more likely to be manual laborers, returning to heavy work prematurely, thereby exacerbating nerve irritation.

b) Preoperative Pain — The Red Flag Most Surgeons Ignore

Perhaps the most clinically actionable finding is the 4.9-fold increased risk associated with preoperative pain (OR=4.87, $p<0.001$). This aligns with Poobalan et al.'s seminal review, which identified preoperative pain as the strongest predictor of persistent pain [16]. The mechanism is likely "pain memory" — pre-existing nociceptive or neuropathic signaling primes the central nervous system for chronicity via NMDA receptor upregulation and glial activation [17]. In our practice, we now classify preoperative pain as a "high-risk flag" and initiate preemptive gabapentinoids and TAP blocks even before incision.

c) Recurrent Hernia — Scar Tissue and Neural Entrapment

Recurrent repairs carried a 4-fold risk in our study — consistent with the literature. Recurrent dissection increases the likelihood of perineural fibrosis, distorted anatomy, and inadvertent nerve entrapment [18]. The TAPP trial subgroup analysis showed recurrent cases had 2.5x higher pain scores at 1 year [19]. In our setting, where tissue repairs were historically common, recurrent cases often presented with dense adhesions — making nerve identification even more critical.

Nerve Injury: The Dominant Modifiable Culprit

The most striking result — and the cornerstone of our prevention strategy — is the 5.3-fold increased risk associated with intraoperative nerve injury (OR=5.33, $p<0.001$). This is not merely statistical — it is mechanistic. Direct nerve transection, entrapment under mesh or suture, or thermal injury leads to neuroma formation, Wallerian degeneration, and ectopic impulse generation — the hallmarks of neuropathic pain [20].

Our findings strongly support the "nerve preservation doctrine" advocated by the International Endohernia Society [21] and European Hernia Society guidelines [22]. Contrary to historical practice, prophylactic neurectomy is no longer recommended — multiple RCTs show it increases deafferentation pain and does not reduce overall pain rates [23]. Our intraoperative photograph (Figure 4) demonstrates that nerve identification is feasible even in open surgery — a message crucial for surgeons in settings without laparoscopic access.

See the nerve, save the nerve should be the mantra of every hernia surgeon — open or laparoscopic [24].

Mesh and Fixation: The Prosthetic Paradox

While heavyweight mesh showed association in univariate analysis, it lost significance in multivariate modeling — likely because its effect is mediated through fixation and nerve compression. This supports the hypothesis that mesh weight alone is less important than how it interacts with neural structures [25].

However, our dramatic reduction in pain after switching to lightweight Ultrapro™ mesh (52g/m²) aligns with the PROLOPE trial, which showed 40% lower pain scores with lightweight vs. heavyweight meshes at 2 years [26]. Large pores (>1mm) and reduced inflammatory response likely explain this benefit [27].

Most importantly, suture fixation emerged as a 2.8-fold independent risk factor — a finding echoed by the FUGA trial, where glue fixation reduced chronic pain by 50% compared to sutures [28]. Sutures cause direct trauma, strangulate nerves, and create point-source inflammation. Fibrin glue, in contrast, distributes force evenly and degrades without fibrosis. Our success with glue in both open and TEP repairs — without increased recurrence — confirms its safety and efficacy, even in teaching hospitals with resident participation.

The Power of the Combined Protocol: 71.7% Risk Reduction

Our most impactful finding is the 71.7% relative reduction in CPIP after implementing the four-element prevention protocol. No single RCT has reported such a large effect — likely because we addressed multiple pain pathways simultaneously:

1. Peripheral sensitization → Nerve preservation + glue fixation
2. Central sensitization → TAP block + preemptive analgesia
3. Inflammatory pain → Lightweight mesh

4. Psychological modulation → Preoperative counseling (implicit in protocol rollout)

This multimodal approach mirrors the WHO analgesic ladder but applied prophylactically — a concept gaining traction in "Enhanced Recovery After Surgery" (ERAS) protocols for hernia surgery [29].

Our result surpasses even the landmark LEP trial, which reduced pain by 52% using lightweight mesh and glue [30]. The difference may lie in our mandatory nerve identification — a step often omitted even in "nerve-sparing" studies.

Quality of Life: The True Cost of Chronic Pain

The SF-36 data (Table 5) reveal that CPIP is not a "minor annoyance" — it is a life-altering disability. Bodily pain scores of 42.1 (vs. 91.3 in controls) are comparable to scores seen in metastatic cancer or severe rheumatoid arthritis [31]. Social functioning and mental health scores were equally devastated — highlighting the psychosocial burden often overlooked in surgical audits.

Conclusion

Strengths:

- Prospective design with minimal loss to follow-up (3.1%) — rare in LMIC studies.
- Real-world setting: Al-Zahraa Hospital reflects typical Iraqi public hospitals — enhancing generalizability.
- Standardized training and checklist use — ensuring protocol fidelity.
- Use of validated tools (VAS, DN4, SF-36 Arabic versions).

Limitations:

- Single-center design — though this enhances protocol control.
- Non-randomized intervention — but ethical constraints prevented withholding effective measures once benefit was clear.
- 12-month follow-up — longer studies may reveal late recurrences or pain evolution.

Regional Significance:

This is the first prospective hernia pain study from Iraq and among the few from the Arab world. It proves that high-quality surgical outcomes are achievable even without robotic platforms or premium implants — only standardized technique, training, and commitment to patient-centered metrics.

Recommendations

We propose the following as a new standard of care:

1. Preoperative:
   - Screen for preoperative pain — flag as high risk.
   - Counsel patients <50 years on pain risk and recovery expectations.
2. Intraoperative:
   - Mandatory nerve identification in every case — open or laparoscopic.
   - Use lightweight, large-pore mesh.
   - Fix with fibrin glue — abolish routine suture fixation near nerves.
   - Document nerve status in operative note.
3. Postoperative:
   - TAP block for all.
   - Multimodal analgesia: NSAID + gabapentinoid if DN4≥4.
   - Follow-up at 3 months with pain-specific questionnaire.
4. Quality Assurance:
   - Audit CPIP rates quarterly — target <5%.
   - Include pain scores in surgical report cards.

References

International Association for the Study of Pain (IASP). IASP Taxonomy: Chronic Postsurgical Pain. https://www.iasp-pain.org . Accessed Jan 2025.

Kingsnorth A, et al. Management of groin hernias: global burden and trends. Br J Surg. 2020;107(2):e89-e96.

Aasvang EK, Kehlet H. Chronic postoperative pain: the case of inguinal herniorrhaphy. Br J Anaesth. 2009;95(1):69-74.

Grillo F, et al. Chronic pain after inguinal hernia repair: a global burden. World J Surg. 2021;45(2):394-405.

Bringman S, et al. Fibrin sealant versus mechanical fixation in laparoscopic inguinal hernia repair. Ann Surg. 2020;271(2):247-254.

World Medical Association. Declaration of Helsinki: ethical principles for medical research. 2013.

McCormack K, et al. Laparoscopic vs open repair for inguinal hernia: systematic review and meta-analysis. BMJ. 2022;376:e067821.

El-Sayed G, et al. Chronic pain after hernia repair in low-resource settings: a systematic review. Trop Doct. 2022;52(1):3-11.

Bay-Nielsen M, et al. Chronic pain after hernia repair: results from the Danish Hernia Database. Hernia. 2017;21(4):519-528.

Bittner R, et al. EHS guidelines on chronic pain after hernia repair. Hernia. 2021;25(4):793-802.

Poobalan AS, et al. A systematic review of chronic pain after open vs laparoscopic hernia repair. Ann Surg. 2009;249(2):197-204.

Kehlet H. Chronic post-surgical pain: a surgical disease? Br J Anaesth. 2020;124(3):247-249.

Woolf CJ. Central sensitization: implications for the diagnosis and treatment of pain. Pain. 2011;152(3 Suppl):S2-S15.

Aasvang EK, Kehlet H. Neurophysiology and pathways of chronic pain after surgery. Acta Anaesthesiol Scand. 2005;49(9):1249-1256.

Bringman S, et al. Risk factors for chronic pain after hernia repair: Herniamed Registry analysis. Ann Surg. 2020;272(6):1100-1106.

Poobalan AS, et al. A review of chronic pain after inguinal herniorrhaphy. Clin J Pain. 2012;28(1):68-77.

Devor M. Neuropathic pain and injured nerve: peripheral mechanisms. Br Med Bull. 1991;47(3):619-630.

Grillo F, et al. Nerve management in recurrent inguinal hernia repair: a systematic review. Hernia. 2022;26(1):89-98.

McCormack K, et al. TAPP vs Lichtenstein for recurrent hernia: long-term outcomes. Br J Surg. 2021;108(3):254-261.

Bittner R, et al. International guidelines for prevention of chronic pain after inguinal hernia surgery. Hernia. 2021;25(4):793-802.

European Hernia Society. Guidelines on treatment of inguinal hernia. Hernia. 2018;22(1):1-165.

Andresen K, et al. Neurectomy vs nerve preservation in chronic pain after hernia repair: a randomized trial. Ann Surg. 2019;270(5):787-793.

Ramshaw B. Nerve identification in open inguinal hernia repair: technique and outcomes. Surg Technol Int. 2020;36:45-50.

Klinge U, et al. Mesh biocompatibility and chronic pain. Hernia. 2018;22(4):599-607.

Brown SR, et al. Lightweight vs heavyweight mesh for Lichtenstein repair: PROLOPE RCT. Br J Surg. 2019;106(2):e89-e98.

Deerenberg EB, et al. Small pores, big problems? Mesh pore size and inflammation. Surgery. 2015;158(4):1133-1141.

Bringman S, et al. Fibrin sealant vs sutures for mesh fixation: FUGA trial. Ann Surg. 2020;271(2):247-254.

Alfieri S, et al. ERAS protocol for inguinal hernia surgery. World J Emerg Surg. 2021;16(1):1-10.

LEP Trial Group. Lightweight mesh and glue fixation for pain reduction: LEP trial. JAMA Surg.

2022;157(3):210-218.
Ware JE, et al. SF-36 Health Survey: manual and interpretation guide. Nimrod Press. 2000.
Iraqi Ministry of Health. Guidelines for Ethical Conduct of Clinical Research. Baghdad, 2018.