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# BMI-stratified predictors of recurrence after inguinal hernia repair: The role of perioperative celecoxib and dexamethasone

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**Abstract**: **Background**: Inguinal hernia recurrence after repair is common, especially in obese individuals, but the influence of perioperative analgesics on long-term outcomes across body mass index (BMI) ranges is unknown. **Objectives**: This study assessed whether perioperative celecoxib and dexamethasone are associated with inguinal hernia recurrence and if this varies by BMI. **Methods**: This retrospective study analyzed clinical data from patients undergoing inguinal hernia repair between January 2021 and December 2024. Using 1:1 nearest-neighbor propensity score matching (PSM), 280 patients who received perioperative celecoxib and dexamethasone (study group) were compared with 280 who did not (control group). The primary outcome was hernia recurrence within one-year post-surgery, confirmed by clinical examination or imaging. Secondary outcomes included 72-hour pain scores, postoperative nausea and vomiting, chronic pain at three months, complications, recovery parameters and quality of life measures. Predictors of recurrence, including treatment, BMI category and their interaction, were assessed using multivariable Cox regression. Multivariable logistic regression was applied to evaluate risk factors for chronic pain. **Results**: PSM leads to a good balance of baseline characteristics between the two groups ($P$>0.05). The overall one-year recurrence rate was 5.0% (28/560). Multivariable analysis revealed that perioperative celecoxib and dexamethasone were independently associated with lower recurrence risk (HR=0.45, 95% CI: 0.24-0.84, $P$=0.011). A significant interaction with BMI was noted ($P$=0.032), indicating a stronger association in obese (HR=0.32, 95% CI: 0.14-0.71) than non-obese patients (HR=0.68, 95% CI: 0.31-1.52). The study group also demonstrated lower acute pain scores, reduced postoperative nausea/vomiting ($P$<0.001) and decreased chronic pain risk (aOR=0.42, 95% CI: 0.23-0.78, $P$=0.006). They returned to daily activities sooner and reported better quality of life (both $P$<0.001). Complication rates were comparable between groups. **Conclusion**: Perioperative celecoxib and dexamethasone were associated with reduced hernia recurrence, particularly in obese patients and improved pain control without increased complications.

**Keywords**: Body mass index; Celecoxib; Dexamethasone; Inguinal hernia; Obesity; Propensity score matching; Recurrence of hernia

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## INTRODUCTION

Inguinal hernia is a common disease in general surgery, which is mainly managed through surgical repair. In clinical practice, laparoscopy and open surgery are the main methods (Murad *et al.*, 2024; Al-Sharabi *et al.*, 2025). Despite the progress of surgical technology, complications such as postoperative pain, nausea, vomiting, recurrence and chronic pain are still common. These problems will damage the quality of life after surgery, prolong recovery time and increase the burden of health care. Among them, obese patients have a special abdominal wall structure, postoperative inflammatory reaction is more obvious and the risk of complications is relatively high, which brings challenges to clinical treatment (Olsson *et al.*, 2023; Miranda *et al.*, 2025).

Rational use of drugs during perioperative period is an important means to optimize postoperative outcomes. As a non-steroidal anti-inflammatory drug, celecoxib can effectively relieve postoperative pain (Gupta *et al.*, 2021). Dexamethasone has a definite effect in reducing postoperative inflammatory response and preventing nausea and vomiting (Lavand'homme *et al.*, 2023; Nazemroaya *et al.*, 2022). Current evidence on their combined perioperative use for inguinal hernia repair remains limited, particularly regarding efficacy differences across BMI subgroups, such as obese versus non-obese patients.

While previous studies have established the efficacy of celecoxib and dexamethasone in reducing postoperative pain and nausea following inguinal hernia repair(Saito *et al.*, 2021; Watanabe *et al.*, 2022), their primary focus has

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been on short-term symptomatic outcomes. The potential impact of these perioperative anti-inflammatory agents on long-term surgical outcomes, particularly hernia recurrence, remains largely unexplored. To date, no study has specifically examined whether the combination of celecoxib and dexamethasone is associated with reduced recurrence risk, nor has any investigation explored whether such an association might vary across BMI subgroups. This gap is clinically relevant, given the well-established link between obesity and both heightened inflammatory response and increased recurrence risk (Rosca *et al.*, 2023; Golik *et al.*, 2024).

Given this context, this retrospective cohort study employed propensity score matching (PSM) to assess the impact of perioperative celecoxib and dexamethasone combination therapy on outcomes following inguinal hernia repair. By exploring its effects separately in obese and non-obese patients, this study aims to provide preliminary evidence that may inform perioperative management strategies and patient prognosis. We hypothesized that perioperative use of celecoxib combined with dexamethasone would be associated with a lower one-year recurrence rate after inguinal hernia repair and that this association might be modified by BMI, potentially being more pronounced among obese patients. The use of PSM allows for a robust retrospective evaluation of how perioperative anti-inflammatory analgesics may correlate with long-term recurrence, with the potential to reveal BMI-dependent patterns. By providing observational evidence supporting a potential role of systemic anti-inflammatory drugs in recurrence reduction, this study may offer insights that could inform individualized approaches for high-risk obese patients, although these findings require confirmation in future prospective studies.

## MATERIALS AND METHODS

### *Study design*

The data is taken from the records of patients who received inguinal hernia repair in our hospital from January 2021 to December 2024. According to the World Health Organization (WHO) Asian Body Mass Index (BMI) standard (2004), patients with BMI≥25.0 kg/m2 are defined as obese and patients with BMI <25.0 kg/m2 are defined as non-obese. In order to minimize the confounding deviation, 1:1 nearest neighbor PSM was applied between patients (study group) who received cilexibuga dexamethasone in the perioperative period (study group) and patients who did not receive it (control group). In the end, 560 patients were registered, 280 per group. The study aimed to compare one-year hernia recurrence risk between these groups and to examine the modifying effect of BMI on treatment outcomes. Figure 1 illustrates the study design and workflow.

### *Ethics statement*

Ethical approval was granted by the Hospital Ethics Committee (Approval No.: 20250030) and the study complied with the Declaration of Helsinki and international standards for medical research ethics. As a retrospective analysis based on archived clinical data, the Ethics Committee granted a waiver of informed consent. All data were anonymized to fully protect participant privacy and confidentiality throughout the research.

### *Inclusion and exclusion criteria*

Inclusion criteria (Weyhe *et al.*, 2018; Ashley *et al.*, 2021; Golik *et al.*, 2024): (1) Age ≥ 18 years old, regardless of gender; (2) Inguinal hernia (direct hernia, indirect hernia or femoral hernia) was diagnosed by clinical symptoms, physical examination and ultrasound or CT examination; (3) first inguinal hernia repair (open or laparoscopic surgery); (4) Tension-free repair with synthetic mesh; (5) Complete clinical records.

Exclusion criteria (Alansari *et al.*, 2023; Nikkolo *et al.*, 2025): (1) Emergency surgery, recurrent hernia, bilateral hernia or combined with other abdominal surgery; (2) History of long-term use of non-steroidal anti-inflammatory drugs or glucocorticoids (continuous use >1 week before surgery); (3) Hypersensitivity to celecoxib, dexamethasone, or any component thereof; (4) Complicated with severe liver and kidney insufficiency, active gastrointestinal ulcer, inflammatory bowel disease; (5) pregnant or lactating women.

### *Sample size calculation*

The sample size was estimated on the basis of the primary outcome, the 1-year rate of recurrent hernia. According to previous reports(Golik *et al.*, 2024), the recurrence rate of obese patients was 6.67% at 1-year follow-up after inguinal hernia repair, while the recurrence rate of non-obese patients was 2.35%. Assuming combination therapy would significantly lower recurrence in the obese subgroup, with $\alpha$=0.05 (two-sided) and $\beta$=0.2 (80% power), we estimated a minimum requirement of 278 patients per group. Accounting for a potential 5%-10% loss to follow-up typical in retrospective studies, we ultimately enrolled 280 patients per group, yielding a total sample size of 560.

### *Treatment methods*

All treatment options were based on the actual clinical decision of the patient at the time of presentation and the study group received 200 mg oral celecoxib two hours before their surgical procedure. "Dexamethasone is administered intravenously after induction of anesthesia at a dose of 5-10mg (10mg for obese patients and 5mg for non-obese patients)." The control group received other standardized multimodal analgesia regimens without celecoxib and dexamethasone (Saito *et al.*, 2021; Liang *et al.*, 2020). All operations were performed by senior hernia surgeons. Perioperative care was conducted according to our institution's Enhanced Recovery After Surgery (ERAS) protocol.

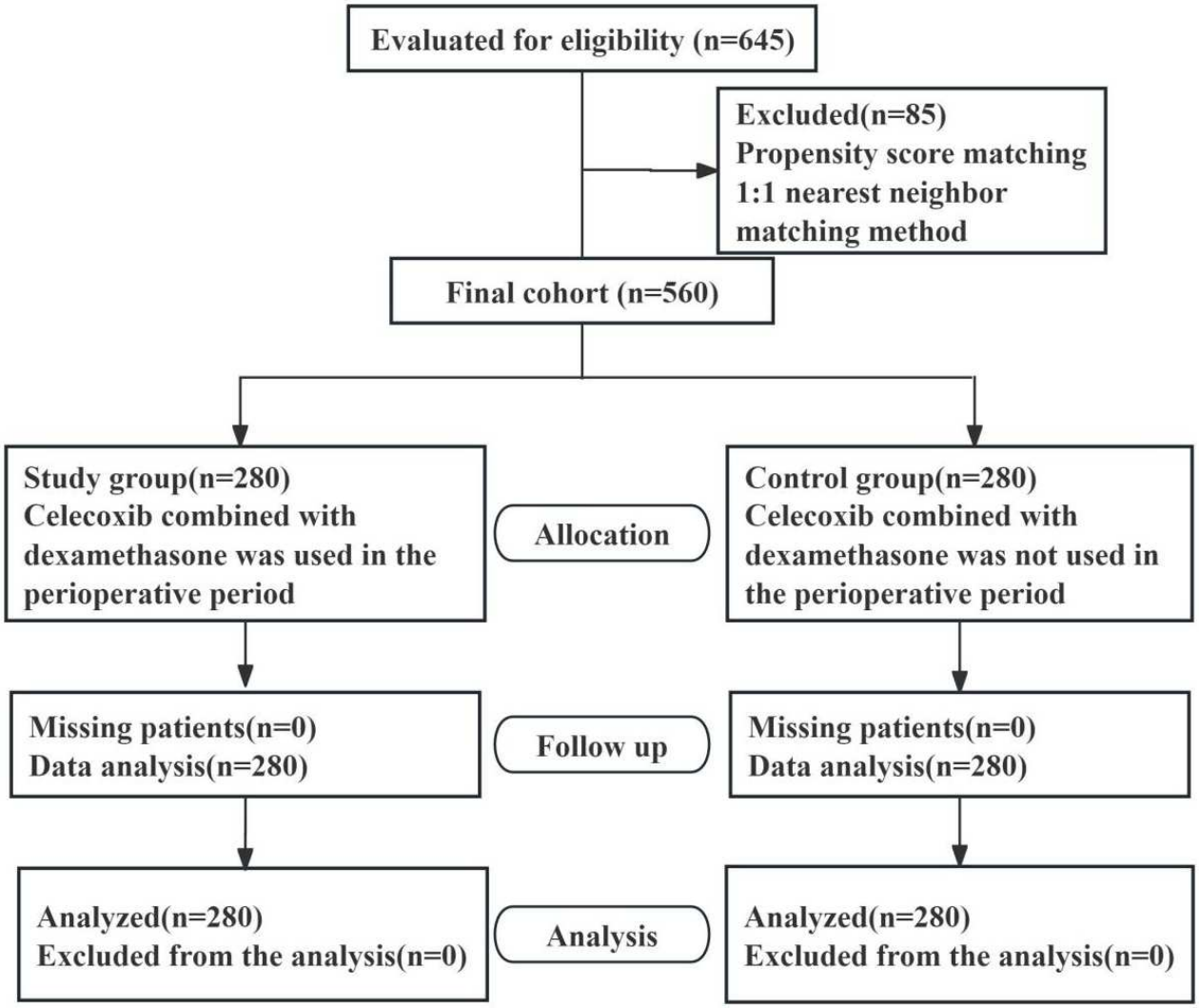


**Fig. 1**: Flow chart of the study

***Observation indicators***

By querying the hospital electronic medical record system, influence system and nursing records, the data of the following observation indicators were retrospectively extracted and collected.

***Baseline data***

Demographic data (age, male, BMI), clinical comorbidities (American Society of Anesthesiologists (ASA) classification, hypertension, diabetes), current smokers, hernia-related characteristics (hernia type, hernia classification, recurrent hernia, preoperative chronic pain) and surgery-related characteristics (surgical method, mesh type, intraoperative drainage and operation duration) were extracted. All baseline data were obtained from admission medical records, evaluation records and archived preoperative imaging data.

***Main outcome measures***

The primary outcome was recurrence of ipsilateral inguinal hernia within one year after surgery, defined as a clinically detectable bulge confirmed by abdominal ultrasound or computed tomography. According to the hospital's standardized follow-up protocol, all patients were scheduled for a clinical examination at the outpatient clinic approximately one year postoperatively. Imaging was performed if recurrence was suspected based on symptoms (e.g., pain, palpable mass) or physical findings. To minimize detection bias, the diagnosis of recurrence was independently reviewed by two surgeons who were blinded to the patients' treatment group allocation, using clinical notes and imaging reports. Any disagreement was resolved by consensus or consultation with a third senior surgeon.

***Secondary outcome measures***

(1) *Postoperative acute pain*: visual analogue scale (VAS, 0-10) at rest and cough at 6, 24 and 72 hours after surgery (Iqbal *et al.*, 2024).

(2) *Postoperative nausea and vomiting (PONV)*: any nausea or vomiting requiring medical intervention within

24 hours after surgery.
(3) *Postoperative chronic pain*: 3 months after surgery, VAS score continued ≥4 points and affected daily activities (Gutlic *et al.*, 2024).
(4) *Postoperative complications (Jacob et al., 2015)*: incision infection, seroma, hematoma, urinary retention, mesh infection, etc. occurred within 30 days after surgery.
(5) *Recovery indicators*: time to first out-of-bed activity, length of postoperative hospitalization and the duration until resuming non-physical work.
(6) *Quality of life*: the special scale recommended by the European Hernia Society EuraHS-QoL (Castañeda-Vozmediano *et al.*, 2025) was used to evaluate.

***Statistical analysis***
Retrospective data were analyzed using SPSS 26.0. Normally distributed continuous variables are expressed as mean ± standard deviation and compared using the independent samples t-test. Non-normally distributed data are presented as median (interquartile range) and compared via the Mann-Whitney U test. Categorical variables are shown as number (percentage) and analyzed using the chi-square test or Fisher's exact test as appropriate(Pang *et al.*, 2025). To control for baseline confounding factors, variables that may affect treatment allocation or prognosis were used as covariates (Ashley *et al.*, 2021; Bhardwaj *et al.*, 2024) (including age, gender, BMI, ASA classification, comorbidities, hernia characteristics and surgery-related variables), Logistic regression generated propensity scores, which were then used for 1:1 nearest-neighbor matching with a 0.02 caliper. Balance was verified by standardized mean differences (SMD), with SMD<0.1 considered acceptable. The primary endpoint, postoperative recurrence, was analyzed with univariate and multivariate Cox proportional hazards models. Potential predictors with $P$<0.1 in univariate analysis or clinical relevance were entered into the multivariate model, which always included "perioperative combination therapy," "BMI category," and their interaction term. Hazard ratios (HR) with 95% confidence intervals (CI) were estimated via forward stepwise selection (likelihood ratio test). Interaction significance was tested with likelihood ratio tests. For secondary binary results (for example, chronic pain), logistic regression is used to calculate the unadjusted and adjusted odds (OR/aOR) of 95% CI. Repeated measurement variance analysis is applied to longitudinal data (for example, VAS pain score and EuraHS-QoL score) to evaluate intergroup differences, time effects and group time interactions. All tests adopt the double-tail method and the significance is set to $P < 0.05$.

## RESULTS

***Comparison of baseline data***
Initially, 645 patients were included in the study, divided into 295 (study group) and 350 (control group). Pre-match analysis shows that there is a significant baseline imbalance in age, BMI, ASA level, hypertension and diabetes (all $P$<0.05), indicating that there is a significant selection bias. After 1:1 propensity score matching (caliper=0.02) based on age, BMI, gender, ASA class, hernia type, surgical method, mesh type and operative time, 560 patients (280 per group) were successfully matched. Post-matching analysis showed no significant differences in any baseline characteristics between the two groups (all $P$>0.05, Table 1). This indicates that PSM has successfully balanced known underlying confounding factors between the intervention group and the control group, greatly enhancing the comparability between the groups and providing a reliable basis for the subsequent accurate assessment of the relationship between combined treatment and postoperative outcomes.

***Recurrence of hernia one year after operation***
***Recurrence rate of hernia within 1 year after operation***
The 1-year overall recurrence rate was 5.0% (28/560). Data in table 2 demonstrate that the study group's recurrence rate (3.21%) was notably lower than the control group's (6.79%), with statistical significance confirmed at $P$=0.044.

A multivariate Cox regression model was employed to further adjust for confounders. Following adjustment for covariates such as age, BMI, diabetes and operative technique, perioperative combination therapy continued to demonstrate independent associated with lower recurrence risk (HR=0.45, 95% CI: 0.24–0.84, $P$=0.011), as detailed in Table 3. The interaction term between "combination" and "BMI group" in the model was statistically significant ($P$=0.032), indicating that the association between combination therapy and recurrence risk differed between obese and non-obese patients. Stratified analysis showed that the association was more pronounced in obese patients (HR=0.32, 95% CI: 0.14-0.71) than in non-obese patients (HR=0.68, 95% CI: 0.31-1.52).

***Postoperative acute pain score***
Repeated-measures ANOVA showed that the study group had consistently lower VAS pain scores at all postoperative time points compared to the control group (all $P$<0.001), with significant main effects of time ($P$<0.001) and group-time interaction ($P$<0.001), indicating more rapid pain reduction in the study group (Table 4). For example, at 6 hours postoperatively, pain scores were 3.2 ± 1.0 in the study group versus 4.5 ± 1.3 in controls; by 72 hours, scores were 1.0 ± 0.7 and 2.0 ± 0.9, respectively. These results suggest that the perioperative combination of Celecoxib and dexamethasone provides more effective and lasting acute analgesia.

***Incidence of PONV and other complications***
As presented in Table 5, the incidence of PONV was significantly lower in the study group compared to the control group (12.5% vs. 23.2%, $P$<0.001).

**Table 1**: Patient baseline characteristics before and after PSM

| Indicators | Before PSM | | | | After PSM | | | |
|---|---|---|---|---|---|---|---|---|
| | Study group (n=295) | Control group (n=350) | Statistics | *P* value | Study group (n=280) | Control group (n=280) | Statistics | *P* value |
| Demographics | | | | | | | | |
| Age, years | 56.8 ± 11.5 | 62.1 ± 12.3 | t=-5.70 | <0.001 | 57.2 ± 11.4 | 57.9 ± 11.8 | t=-0.70 | 0.483 |
| Sex (Male/Female), n (%) | 272/23 (92.2/7.8) | 310/40 (88.6/11.4) | χ2=2.44 | 0.118 | 258/22 (92.1/7.9) | 260/20 (92.9/7.1) | χ2=0.11 | 0.744 |
| BMI, kg/m² | 26.5 ± 3.7 | 25.0 ± 4.0 | t=4.92 | <0.001 | 26.4 ± 3.6 | 26.1 ± 3.7 | t=0.95 | 0.344 |
| Comorbidities | | | | | | | | |
| ASA class ≥III, n (%) | 70 (23.7) | 125 (35.7) | χ2=10.79 | 0.001 | 68 (24.3) | 71 (25.4) | χ2=0.08 | 0.773 |
| Hypertension, n (%) | 100 (33.9) | 155 (44.3) | χ2=6.99 | 0.008 | 95 (33.9) | 92 (32.9) | χ2=0.07 | 0.795 |
| Diabetes, n (%) | 48 (16.3) | 85 (24.3) | χ2=6.15 | 0.013 | 45 (16.1) | 48 (17.1) | χ2=0.11 | 0.744 |
| Current smoker, n (%) | 94 (31.9) | 120 (34.3) | χ2=0.42 | 0.518 | 89 (31.8) | 85 (30.4) | χ2=0.14 | 0.711 |
| Hernia Features | | | | | | | | |
| Type (Direct), n (%) | 108 (36.6) | 130 (37.1) | χ2=0.02 | 0.894 | 102 (36.4) | 98 (35.0) | χ2=0.12 | 0.729 |
| EHS Classification (III/IV), n (%) | 121 (41.0) | 140 (40.0) | χ2=0.07 | 0.792 | 115 (41.1) | 110 (39.3) | χ2=0.18 | 0.674 |
| Recurrent hernia, n (%) | 10 (3.4) | 25 (7.1) | FET | 0.034 | 9 (3.2) | 8 (2.9) | FET | 1 |
| Preoperative chronic pain, n (%) | 48 (16.3) | 80 (22.9) | χ2=4.27 | 0.039 | 45 (16.1) | 48 (17.1) | χ2=0.11 | 0.744 |
| Surgical Features | | | | | | | | |
| Approach (Laparoscopic), n (%) | 170 (57.6) | 190 (54.3) | χ2=3.67 | 0.055 | 165 (58.9) | 160 (57.1) | χ2=0.18 | 0.674 |
| Mesh type (Lightweight), n (%) | 125 (42.4) | 160 (45.7) | χ2=3.40 | 0.065 | 115 (41.1) | 120 (42.9) | χ2=0.20 | 0.652 |
| Intraoperative drain, n (%) | 40 (13.6) | 85 (24.3) | χ2=11.78 | <0.001 | 38 (13.6) | 40 (14.3) | χ2=0.06 | 0.814 |
| Operative time, min | 69.8 ± 15.2 | 74.6 ± 18.1 | t=-3.77 | <0.001 | 70.1 ± 14.9 | 69.3 ± 15.3 | t=0.63 | 0.532 |

Note: BMI, Body Mass Index; ASA, American Society of Anesthesiologists; EHS, European Hernia Society; FET, Fisher's Exact Test.

**Table 2**: Comparison of 1-year hernia recurrence rates after surgery [n (%)]

| Group | n | Recurrence, n (%) | statistics | *P* value |
|---|---|---|---|---|
| Study group | 280 | 9 (3.21) | χ2=6.54 | 0.044 |
| Control group | 280 | 19 (6.79) | | |

Note: Comparison performed using the Chi-square test.

No significant differences were observed between groups in any surgical complications, including surgical site infection, symptomatic seroma/hematoma, urinary retention, or mesh infection (all *P*>0.05). These findings indicate that perioperative use of celecoxib combined with dexamethasone was associated with lower PONV incidence, with no observed increase in surgical complications in this cohort.

***Incidence of chronic pain 3 months after surgery and multivariate logistic regression analysis***

***Incidence of chronic pain 3 months after surgery***

Three months after surgery, cumulative chronic pain prevalence stood at 10.0% (56/560). Chronic pain affected 6.4% (18/280) of the study group, while 13.6% of the control group (38/280; *P*=0.001), indicating the possible effect of interventions in reducing chronic pain susceptibility (Table 6).

**Table 3**: Cox regression analysis of factors associated with recurrence following inguinal hernia repair.

| Variable | Multivariable analysis | |
|---|---|---|
| | HR (95% CI) | *P* value |
| Perioperative combination therapy (Yes vs. No) | 0.45(0.24-0.84) | 0.011 |
| BMI category (Obese vs. Non-obese) | 1.18(0.68-2.05) | 0.55 |
| Combination therapy × BMI category (Interaction term) | 0.47 (0.21-0.99) | 0.032 |
| Age (per 1-year increase) | 1.02(0.99-1.05) | 0.21 |
| Sex (Male vs. Female) | 1.32 (0.71-2.45) | 0.38 |
| Diabetes mellitus (Yes vs. No) | 1.30(0.74-2.28) | 0.36 |
| Hypertension (Yes vs. No) | 1.05 (0.60-1.85) | 0.86 |
| Surgical approach (TEP vs. TAPP) | 0.91(0.52-1.59) | 0.74 |
| Hernia type (Direct vs. Indirect) | 1.15(0.63-2.10) | 0.65 |

Note: HR, hazard ratio; CI, confidence interval; TEP, totally extraperitoneal repair; TAPP, transabdominal preperitoneal repair. The multivariable model included all univariate predictors with $P < 0.1$, along with variables considered clinically important.

**Table 4**: Postoperative pain scores within 72 hours ($\bar{x}\pm s$)

| Time point | Study group (n=280) | Control group (n=280) | Statistics | *P* value |
|---|---|---|---|---|
| 6 hours | 3.2 ± 1.0 | 4.5 ± 1.3 | t=-13.52 | <0.001 |
| 24 hours | 2.0 ± 0.8 | 3.0 ± 1.0 | t=-13.38 | <0.001 |
| 72 hours | 1.0 ± 0.7 | 2.0 ± 0.9 | t=-16.23 | <0.001 |
| Time effect | - | - | F=7322.28 | <0.001 |
| Group × Time interaction | - | - | F=31.74 | <0.001 |

Note: VAS, visual simulation scale (0 = no pain, 10 = the most severe imaginable pain). The inter-group comparison at a single time point uses the independent sample t-test, and the overall trend is evaluated through repeated measurement variance analysis.

**Table 5**: Comparison of postoperative nausea/vomiting and other complication rates [n (%)]

| Complication | Study group (n=280) | Control group (n=280) | Statistics | *P* value |
|---|---|---|---|---|
| Postoperative nausea/vomiting (PONV) | 35 (12.5%) | 65 (23.2%) | $\chi2$=11.76 | <0.001 |
| Surgical site infection | 4 (1.4%) | 5 (1.8%) | FET | 0.807 |
| Symptomatic seroma/hematoma | 18 (6.4%) | 22 (7.9%) | $\chi2$=0.35 | 0.550 |
| Urinary retention | 10 (3.6%) | 14 (5.0%) | $\chi2$=0.59 | 0.442 |
| Mesh infection | 1 (0.36%) | 2 (0.71%) | FET | 1.000 |

Note: PONV, Postoperative nausea and vomiting; FET, Fisher's Exact Test; For between-group comparisons, the chi-square test was used, with Fisher's exact test applied when expected frequencies fell below 5.

**Table 6**: Comparison of chronic pain incidence at 3 months postoperatively

| Group | n | Number of cases of chronic pain (n) | Incidence rate (%) | Statistics | *P* value |
|---|---|---|---|---|---|
| Study group | 280 | 18 | 6.43% | $\chi2$=10.25 | 0.001 |
| Control group | 280 | 38 | 13.57% | | |

Note: The inter-group comparison is carried out using the card-square test.

***Multivariate logistic regression analysis of postoperative chronic pain risk factors***

Multivariable logistic regression analysis was performed to adjust for potential confounders (Table 7). Perioperative combination therapy remained independently associated with lower chronic pain risk (aOR=0.42, 95% CI: 0.23–0.78, *P*=0.006), corresponding to a 58% reduction in the odds of chronic pain. In contrast, preoperative pain emerged as the most impactful independent risk factor, increasing this risk 2.4-fold (aOR=3.40, 95% CI: 1.82–6.34, *P*<0.001). The protective trend of laparoscopic surgery was not statistically significant after multivariate adjustment (aOR=0.60, *P*=0.073), while age, gender and BMI group were not independent predictors. In conclusion, perioperative application of celecoxib and dexamethasone can significantly reduce the risk of chronic pain after inguinal hernia surgery. This effect was stable in patients with different BMI.

**Table 7**: Multivariable logistic regression analyses for chronic pain risk at 3 months postoperatively

| Variable | Multivariable analysis | |
|---|---|---|
| | aOR (95% CI) | *P* value |
| Age (per 1-year increase) | 0.98 (0.96-1.00) | 0.080 |
| Sex (Male vs. Female) | 0.88 (0.49-1.60) | 0.680 |
| Perioperative combination therapy (Yes vs. No) | 0.42 (0.23-0.78) | 0.006 |
| BMI category (Obese vs. Non-obese) | 1.51 (0.87-2.62) | 0.142 |
| Surgical approach (Laparoscopic vs. Open) | 0.60 (0.34-1.06) | 0.073 |
| Preoperative pain (Yes vs. No) | 3.40 (1.82-6.34) | <0.001 |

Note: OR, odds ratio; aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index. The multivariate model included variables with P < 0.1 in univariate testing or deemed clinically relevant.

**Table 8**: Comparison of postoperative recovery outcomes ($\bar{x}\pm s$)

| Recovery outcome | Study group (n=280) | Control group (n=280) | Statistics | *P* value |
|---|---|---|---|---|
| Time to first ambulation (hours) | 6.5 ± 1.9 | 8.8 ± 2.7 | t = -11.65 | <0.001 |
| Postoperative hospital stay (days) | 2.1 ± 0.9 | 2.3 ± 1.0 | t = -2.41 | 0.016 |
| Time to resume normal daily activities (days) | 14.2 ± 4.4 | 17.8 ± 5.8 | t = -8.21 | <0.001 |

Note: All between-group comparisons were performed using independent samples t-tests.

**Table 9**: Comparison of EuraHS-QoL quality of life scores ($\bar{x}\pm s$)

| Time point | Study group (n=280) | Control group (n=280) | Statistics | *P* value |
|---|---|---|---|---|
| Preoperative | 68.5 ± 9.8 | 67.8 ± 9.2 | t=0.85 | 0.397 |
| 3 months postop | 32.8 ± 7.2 | 53.9 ± 9.9 | t=-28.78 | <0.001 |
| 6 months postop | 28.4 ± 4.5 | 48.5 ± 9.8 | t=-30.99 | <0.001 |
| 12 months postop | 26.5 ± 4.2 | 46.7 ± 9.5 | t=-32.31 | <0.001 |
| Time effect | - | - | F=8298.89 | <0.001 |
| Group × Time interaction | - | - | F=1080.81 | <0.001 |

Note: EuraHS-QoL, European Registry for Abdominal Wall Hernias Quality of Life scale, scored from 0 to 90, where lower scores indicate better quality of life. The inter-group comparison at each time point uses an independent sample t-test; analyze the longitudinal trend through repeated measurement analysis of variance.

***Recovery***

Postoperative recovery indicators are summarized in table 8. The study group demonstrated significantly faster functional recovery across multiple measures. Patients in this group ambulated 2.3 hours earlier ($P$<0.001) and resumed normal daily activities 3.6 days sooner ($P$<0.001) compared to controls. The postoperative hospital stay was also marginally shorter in the study group ($P$=0.016). These results suggest that the combination of celecoxib and dexamethasone in the perioperative period may significantly promote early postoperative mobility and accelerate overall functional recovery by providing better analgesic effect.

***Quality of life score***

EuraHS-QoL scores were comparable between groups at baseline ($P$=0.397). Postoperatively, the study group had significantly better (lower) scores at all follow-up time points (all $P$<0.001; Table 9). Repeated-measures ANOVA revealed significant main effects of time ($P$<0.001) and group-time interaction ($P$<0.001), indicating more rapid QoL improvement in the study group. For example, at 3 months, scores were 32.8 ± 7.2 in the study group versus 53.9 ± 9.9 in controls; at 12 months, scores were 26.5 ± 4.2 and 46.7 ± 9.5, respectively. These findings suggest that perioperative combination therapy was associated with early and sustained improvements in quality of life.

## DISCUSSION

This PSM-based retrospective cohort analysis systematically evaluated the effect of perioperative celecoxib and dexamethasone on post-repair results of tension-free inguinal hernia. The following three core findings were obtained: First, the use of cilecoxib and dexamethasone in the perioperative period is an independent protective factor for the recurrence of 1-year postoperative hernia; second, this protective effect changes significantly due to BMI, especially in obese patients. Third, this combination can effectively improve acute and chronic pain, accelerate postoperative recovery and improve the quality of life without increasing the risk of surgical complications. These results generally show that it has important clinical potential to extend perioperative anti-inflammatory and analgesic strategies from simple

symptom management to personalized intervention, with the goal of improving long-term surgical results. Postoperative recurrence of inguinal hernia involves multiple links such as mechanical tension, poor healing, inflammation and matrix remodeling. Traditionally, prevention of recurrence has relied on surgical techniques, while perioperative medications have been used primarily for short-term symptom management (Parker *et al.*, 2021; Dawi *et al.*, 2025; Wang *et al.*, 2024; Deng *et al.*, 2025). This is the first clinical study to show that the perioperative combination of celecoxib and dexamethasone can significantly reduce the risk of recurrence at 1 year after surgery by 55%. This elevates the role of pharmacotherapy to a new level that may affect the "core outcome. This finding echoes the mechanisms revealed by basic research. Previous research (Olson *et al.*, 2024) has showed that celecoxib and dexamethasone can synergistically optimize the tissue repair microenvironment by inhibiting prostaglandin E2 and inflammatory cell infiltration, respectively. These findings provide translational evidence supporting the theory that anti-inflammatory modulation improves healing quality by regulating postoperative inflammation and promoting orderly collagen remodeling, thereby enhancing the biologic stability of the repair.

The most clinically instructive finding of this study is the significant BMI-modifying effect of the protective effect of the combination. Interaction analysis verified that the regimen cut recurrence risk by 68% in obese patients, whereas no statistically significant protective effect was detected in non-obese patients. This stratification effect clearly shows that the overall benefit was driven primarily by the high-risk obese cohort. This finding is highly consistent with the existing pathophysiological findings of hernia recurrence related to obesity. A recent study (Shi *et al.*, 2025) examining different obesity metrics confirmed that elevated BMI and waist circumference are independently associated with increased inguinal hernia risk, aligning with the latest international hernia guidelines. Obesity is established as an independent risk factor for hernia onset and recurrence and its background is a chronic and low-grade systemic inflammatory state (Rosca *et al.*, 2023). Another study (Malaussena *et al.*, 2024) confirmed that obesity was significantly associated with recurrence in a retrospective cohort study of patients undergoing abdominal hernia repair and reported that the trend of wound infection and overall complications increased in the obesity group. It is important to clarify that this BMI-dependent finding does not contradict the fact that the two groups were well balanced on BMI after PSM. Propensity score matching ensures that the distribution of BMI is comparable between the study and control groups, allowing for a fair assessment of treatment effects. The conclusion that the combination therapy was associated with greater benefit in obese patients is derived from the significant treatment-by-BMI interaction term in the multivariable Cox model ($P$=0.032), which tests whether the association between treatment and recurrence differs across BMI categories. The interaction being significant indicates that the strength of the association varied by BMI, with a more pronounced association observed in obese patients (HR=0.32) than in non-obese patients (HR=0.68). This statistical approach directly addresses whether the effect of treatment depends on BMI, independent of the overall balance achieved by PSM.The existing intervention studies on obese hernia patients mostly focus on surgical selection, while targeted studies on drug intervention are few. One study (Carron *et al.*, 2024) proposed that obese patients need to strengthen anti-inflammatory intervention during the perioperative period and intravenous non-opioid analgesics and adjuvant drugs play an important role in pain management, but the specific medication plan and efficacy were not clarified. This study is the first to clarify the specific protective value of this combination drug for this high-risk population and also confirms that its additional benefit is limited for non-obese patients with a low inflammatory baseline, which is consistent with a previous randomized controlled trial (Liang *et al.*, 2018), which found that the additional benefit of intensive anti-inflammatory analgesic regimen was not significant in patients with a low inflammatory burden. This reveals a key clinical logic: the intensity of perioperative intervention should match the inherent risk of the patient, thus providing a direct basis for individualized, intensive anti-inflammatory management of obese hernia patients. In addition to the BMI-dependent protective effect of the combination therapy, we also examined conventional risk factors for hernia recurrence. In the multivariable Cox regression analysis, variables such as age, diabetes mellitus and hypertension were not independently associated with recurrence risk. While age showed a marginal association in univariable analysis (HR=1.03, $P$=0.046), this effect was attenuated after adjustment for other covariates. This finding may reflect the relatively small number of recurrence events in our cohort (n=28), which limited statistical power to detect modest effects of these conventional factors (Bhardwaj *et al.*, 2024). Nevertheless, these results are consistent with previous studies showing that while these factors are established risk factors in large population-based studies (Golik *et al.*, 2024; Liang *et al.*, 2018), their independent predictive value may be less pronounced in well-matched cohorts or when stronger effect modifiers (such as the treatment-BMI interaction) are present.

In addition, this study confirms the broadness of benefit and consistency with the safety profile of this regimen. In terms of pain management, the combined cohort scored significantly lower acute pain at all postoperative points in time and the risk of chronic pain was reduced by 58%.

These observations are consistent with several authoritative studies. Recent study (Bicket *et al.*, 2025) has show that perioperative celecoxib and dexamethasone significantly relieve pain and reduce the need for opioids, further confirming the reliable analgesic effect of the program (Sahoo *et al.*, 2024). Effective pain control is transformed into accelerated functional recovery. In our cohort, the research group showed significantly earlier walking and faster return to normal activity, which is closely related to the ERAS principle(Yang *et al.*, 2025). This is also consistent with previous findings (Venkatraman *et al.*, 2016) With these findings, effective postoperative analgesia can shorten the recovery time of hernia patients by 3.4 days without increasing complications. The evaluation of the internationally recognized hernia-specific tool EuraHS-QoL showed that the quality of life of the study group improved significantly three months after surgery and this benefit persisted during the one-year follow-up. These findings highlight the long-term patient-centered advantage of this program. Crucially, this broad interest does not come at the expense of security. There was no difference in the incidence of surgical complications (wound infection, symptomatic seroma) between the two groups. This finding directly solved the clinical concern about the increased risk of infection associated with glucocorticoid administration and was consistent with the conclusions of the established study. A meta-analysis (Watanabe *et al.*, 2022) comparing single-dose dexamethasone to placebo in hernia surgery found no significant difference in complication rates, confirming that short-term dexamethasone use does not elevate surgery-related infection risk. In this study, no increased risk of complications was observed when dexamethasone was combined with celecoxib, indicating that this combination regimen has good safety while achieving anti-inflammatory and analgesic benefits, which provides an important safety basis for its clinical promotion.

The present study is limited by the intrinsic constraints of a retrospective design. First, despite rigorous PSM balancing observed confounders, residual confounding from unmeasured variables (e.g., surgeon technique, mesh fixation method, postoperative activity) cannot be excluded. Second, the dexamethasone dosage was not uniform across all patients but was adjusted according to BMI (10 mg for obese patients and 5 mg for non-obese patients), as per the institutional perioperative protocol. This dosing strategy introduces a potential confounder when interpreting the observed BMI-dependent treatment effect. It is possible that the greater recurrence reduction seen in obese patients may partly reflect the higher dexamethasone dose they received, rather than being solely attributable to an interaction between BMI and the anti-inflammatory effects of the combination regimen. Future studies with standardized dosing regimens or dose-stratified analyses are warranted to disentangle these effects. Third, as a single-center investigation, both the patient cohort and treatment regimens were relatively homogeneous, but the generalizability of the conclusions still needs to be verified in diverse populations from different regions and medical centers. Fourth, the follow-up period was 1 year, which covered most of the time window in which recurrences occur, but a few recurrences may occur later. Extended follow-up would facilitate a more comprehensive assessment of the treatment's long-term effects. Fifth, with only 28 recurrence events, the multivariable model may have limited statistical power and risk of overfitting; thus, findings should be considered hypothesis-generating and require validation in larger prospective studies. Sixth, the present study was designed to evaluate the combination regimen of celecoxib and dexamethasone as administered in clinical practice and does not allow for distinction between the individual contributions of each drug.

It is possible that the observed associations with reduced recurrence and improved pain outcomes may be attributable to one agent rather than the combination, or may reflect synergistic effects that cannot be disentangled with the current study design. Preclinical evidence suggests that COX-2 inhibitors and corticosteroids may act through complementary mechanisms to modulate inflammation and tissue repair, but whether the observed benefits in this cohort derive from additive, synergistic, or single-drug effects remains unclear. Future studies employing factorial designs (e.g., 2×2 randomized trials comparing each drug alone and in combination) would be needed to clarify the individual and joint contributions of celecoxib and dexamethasone to postoperative outcomes following inguinal hernia repair. From the results of this investigation, we outline the following future research focus areas: first, prospective multicenter randomized double-blind controlled trials are warranted to verify these data with the highest level of clinical evidence. Second, the optimization of different doses or durations of medication can be further explored to find the best balance between efficacy and safety. Third, translational medicine research is carried out to collect serum or local tissue samples from patients and detect the levels of specific inflammatory factors, aiming at biological verification and providing mechanistic annotation for clinical findings. Fourth, a health economic evaluation could be performed to measure the long-term health care cost savings in reducing recurrence and reoperation and facilitating faster recovery.

## CONCLUSION

In summary, perioperative celecoxib and dexamethasone were associated with a significantly reduced risk of recurrence after inguinal hernia repair, an effect most

pronounced in obese patients. At the same time, this program effectively controls acute and chronic pain, promotes the early rehabilitation of patients and improves the quality of life in an all-round way without increasing surgical complications. These results provide new ideas for the perioperative management of inguinal hernia: for patients at high risk of recurrence, especially obese patients, adopting a perioperative drug strategy with strong anti-inflammatory as the core and optimizing surgical technology at the same time may be an effective step towards personalized precision medicine, which is expected to achieve a slowdown from short-term symptoms. Solve the leap of long-term prognosis improvement.

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None

***Authors' contributions***
Xiulian Xu: Developed and planned the study, performed experiments and interpreted results. Edited and refined the manuscript with a focus on critical intellectual contributions.
Hailin Gan, Yiming Huang, Zhiheng Liu: Participated in collecting, assessing and interpreting the date. Made significant contributions to date interpretation and manuscript preparation.
Ping Xie, Hongyi Qing: Provided substantial intellectual input during the drafting and revision of the manuscript.
All authors have read and approved the final manuscript.

***Data availability statement***
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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***Ethical approval***
This study was approved by the Ethics Committee of the Affiliated Hospital of North Sichuan Medical College (Approval No.: 20250030). This study was performed in adherence with the STROBE guidelines. See supplementary file for the STROBE checklist.

***Conflict of interest***
The authors declare that they have no financial conflicts of interest.

***Supplementary data***
https://www.pjps.pk/uploads/2026/07/SUP1783770653.pdf

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