



JSRR

Journal of Surgical Research & Reviews

www.internationalmedicalpublishing.com



Research Article

Section: General Surgery

Comparative Evaluation of Gall Bladder Extraction via Epigastric & Umbilical Ports during Laparoscopic Cholecystectomy: A Prospective Randomized Study

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HIGHLIGHTS

- Umbilical extraction reduces pain.
- Retrieval is easier umbilically.
- Epigastric extraction is faster.
- No port-site complications occurred.
- Umbilical approach improves outcomes.

Key Words:

Laparoscopic cholecystectomy
Gall bladder retrieval
Umbilical port
Epigastric port
Postoperative pain
Port-site complication

ABSTRACT

Introduction: Postoperative port-site pain is a major concern after laparoscopic cholecystectomy (LC). The epigastric or umbilical port used for gall bladder extraction may influence wound pain due to tissue trauma, but evidence remains inconclusive. **Aim & Objective:** To compare postoperative port-site pain, ease of gall bladder retrieval, and extraction time between epigastric and umbilical port extraction during laparoscopic cholecystectomy. **Material & Methods:** A prospective randomized controlled trial was conducted over 24 months in a tertiary-level surgical unit. Seventy-two eligible patients were randomized into two equal arms: Group I (epigastric port extraction, n = 36) and Group II (umbilical port extraction, n = 36). Port-site pain was quantified using the Visual Analogue Scale (VAS) at 6, 12, 24, and 36 hours after surgery. Ease of retrieval was documented by the primary surgeon on the same VAS, and total extraction time was recorded in seconds. **Results:** Patients in the umbilical port group demonstrated significantly lower mean port-site pain scores (7.20 ± 0.80) compared with the epigastric group (7.74 ± 0.61), with $P = 0.0019$. Surgeon-rated ease of retrieval was also significantly superior in the umbilical group ($P = 0.0015$). Conversely, mean extraction time was substantially shorter in the epigastric cohort (30.12 ± 10.95 s vs. 52.40 ± 14.87 s; $P < 0.0001$). No port-site infection or hernia was recorded in either group during the six-week follow-up. **Conclusion:** The umbilical port is associated with meaningfully reduced postoperative wound pain and superior ease of gall bladder retrieval when compared with the epigastric port. Despite requiring more extraction time, the umbilical approach is recommended as the preferred site for GB removal during conventional four-port LC.



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Article History: Received 24 July 2026; Received in Revised form 09 September 2026; Accepted 16 September 2026

How To Cite: Sudhanshu Sharma & Satyam Kumar Kesharwani. Comparative Evaluation of Liver Function Tests in Patients with Refractory Psoriasis Treated with Tofacitinib & Apremilast: A Retrospective Cohort Study. *JSRR : Journal of Surgical Research & Reviews*. 2026;3(1):1-6.

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INTRODUCTION

Laparoscopic cholecystectomy has firmly established itself as the procedure of choice for symptomatic benign gallbladder pathology. Its ascendancy over conventional open surgery is well supported by evidence demonstrating reduced postoperative morbidity, abbreviated convalescence, improved cosmetic outcomes, & earlier return to daily activities. Despite these recognized merits, pain in the immediate postoperative period remains a clinically significant challenge and the leading reason for overnight admission following elective LC.

The aetiology of post-LC pain is multifactorial. Contributing elements include diaphragmatic irritation from residual carbon dioxide, tension created during peritoneal insufflation, incisional trauma from trocar insertion, and mechanical tissue injury at the port site during gall bladder extraction. Of these, incisional pain tends to predominate in both severity and duration over the initial 48 hours, surpassing visceral and referred shoulder-tip pain in impact.

The terminal phase of laparoscopic cholecystectomy - extraction of the excised gall bladder - is performed either through the epigastric or the umbilical port, the selection being largely guided by the surgeon's familiarity and institutional preference. Proponents of the epigastric approach highlight the directness of access to the gallbladder fossa and shorter operative extraction time. Supporters of the umbilical route cite biomechanical and anatomical advantages that translate into reduced wound trauma and lesser postoperative discomfort. In the absence of a robust consensus, the question of which port is optimal for GB retrieval remains open.

This study was designed to systematically compare the two retrieval techniques across several clinically relevant endpoints: postoperative port-site pain, ease of extraction as rated by the surgeon, time required for retrieval, and the incidence of port-site complications including wound infection and incisional hernia.

The principal aim of this investigation was to determine whether extraction of the gall bladder via the umbilical port offers a clinically meaningful advantage over the epigastric port in terms of patient-reported postoperative pain. Secondary aims encompassed comparison of surgeon-assessed ease of retrieval, objective measurement of extraction time, & evaluation of port-site complication rates in both cohorts. **Figure 1.** Comparative mechanisms of postoperative pain associated with gallbladder extraction through epigastric and umbilical ports during laparoscopic cholecystectomy.

MATERIALS & METHODS

Study Design and Setting

This investigation was conducted as a prospective, single-blinded, randomized controlled trial within the Department of General Surgery at a tertiary-care academic hospital over a 24-month period. Ethical approval was secured from the Institutional Review Board prior to patient enrollment, and the study was registered with the Clinical Trials Registry of India. Written informed consent was obtained from all participants before randomization.

Eligibility Criteria

Inclusion: Adults aged 18–70 years scheduled for elective four-port LC for benign gallbladder disease (cholelithiasis, polyp, or chronic cholecystitis) were eligible for inclusion.

Exclusion: Patients were excluded if they had acute cholecystitis, gallbladder empyema or mucocele, suspected malignancy, a history of chronic analgesic or systemic corticosteroid use, previous upper abdominal surgery, or if intraoperative conversion to open cholecystectomy was required.

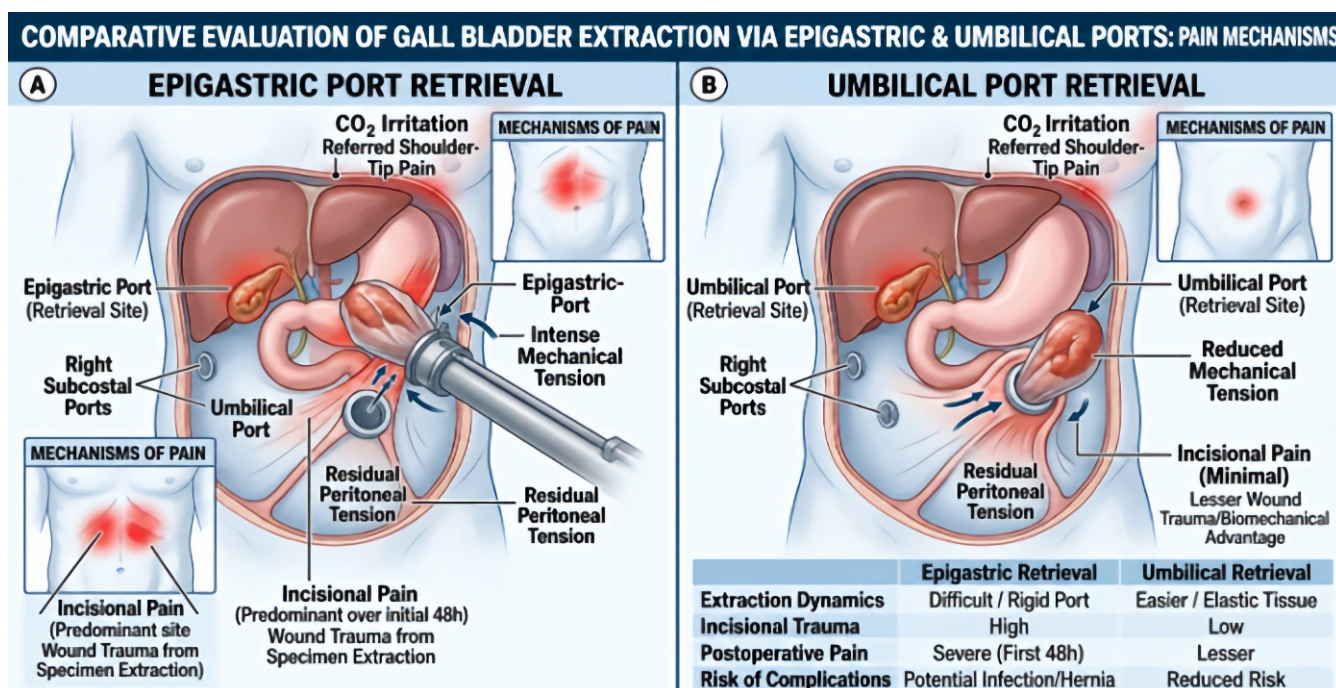


Figure 1: Comparison of pain mechanisms in epigastric versus umbilical gallbladder extraction.

Randomization and Blinding

Eligible patients were allocated to either Group I (epigastric port extraction) or Group II (umbilical port extraction) through computer-generated block randomization in a 1:1 ratio. Allocation concealment was maintained using sequentially numbered sealed opaque envelopes. Patients were blinded to group assignment throughout the perioperative period; however, blinding of the operating surgeon was not feasible given the nature of the intervention.

Surgical Protocol

All procedures were performed under general anaesthesia following standardized preoperative preparation. Prophylactic intravenous cefuroxime (1.5 g) was administered 30 minutes before skin incision. Pneumoperitoneum was established using a closed-entry technique with CO₂ insufflation to a pressure of 12–14 mmHg. The standard four-port layout was employed: one 10-mm epigastric port, one 10-mm umbilical camera port, and two 5-mm working ports in the right subcostal region along the anterior axillary and mid-clavicular lines.

Following dissection, clipping, and division of the cystic duct and artery, the excised gall bladder was placed into an endobag to minimize the risk of bile spillage and port-site seeding. Extraction was then performed through the designated port based on group allocation. No local anaesthetic agent was infiltrated at port sites or intraperitoneally. Fascial defects at 10-mm or larger ports were closed with interrupted absorbable sutures (polyglactin 910), and skin was approximated with non-absorbable monofilament sutures (polypropylene).

Standardized multimodal analgesia was provided to all patients: intravenous diclofenac sodium (1 mg/kg every 8 hours) for 24 hours, with intravenous tramadol (1 mg/kg every 8 hours as rescue) reserved for pain scoring ≥ 7 on the VAS. Patients were discharged with oral analgesics after 24 hours provided no complications were evident.

Outcome Measurements

The primary outcome was port-site pain intensity assessed by VAS (0 = no pain, 10 = worst imaginable pain) at 6, 12, 24, and 36 hours postoperatively. All patients received structured education on VAS usage prior to surgery to ensure consistent self-reporting. Surgeon-rated ease of gall bladder retrieval was recorded on the same scale (0 = very easy, 10 = extremely difficult) immediately after extraction. Extraction time was measured in seconds from port insertion of the endobag to its complete delivery through the abdominal wall. Port-site complications - infection, persistent pain, and incisional hernia - were assessed clinically at 7 days, 14 days, 6 weeks, 1 month, and 3 months postoperatively, and by abdominal ultrasonography at 6 months.

Sample Size and Statistical Analysis

Based on an anticipated intergroup VAS difference of 0.9 units

(sourced from comparable published trials), with $\alpha = 0.05$ and statistical power of 80%, the minimum required sample size was 33 patients per arm. To account for potential dropouts of approximately 10%, 40 patients were recruited per group, of whom 36 per group completed the study and were analyzed.

Data were entered and managed in Microsoft Excel and analyzed using SPSS version 24.0. Continuous variables conforming to normal distribution were expressed as mean $\pm$ standard deviation and compared using the independent-samples t-test. Categorical variables were analyzed by the chi-square test. Statistical significance was defined at $P < 0.05$.

RESULTS

Between the study commencement and completion dates, 96 patients were screened for eligibility. Fourteen were excluded (four did not meet inclusion criteria, seven declined participation, three had previous upper abdominal surgery), and 82 were randomized. After accounting for protocol deviations and transfer-related loss to follow-up, 36 participants per group were available for final analysis, yielding a total evaluable sample of 72.

Baseline Characteristics

Pre-operative demographic and biochemical parameters across the two groups are presented in **Table 1**. Neither group differed significantly in age, sex distribution, BMI, liver enzyme levels, or gallbladder wall thickness on ultrasonography. Female patients constituted the majority in both groups, consistent with the known epidemiology of cholelithiasis.

Operative & Postoperative Outcomes

The detailed operative and postoperative findings are summarized in **Table 2**. The mean port-site pain score recorded over the postoperative monitoring period was 7.74 ± 0.61 in the epigastric group versus 7.20 ± 0.80 in the umbilical group, a statistically significant difference ($P = 0.0019$). When pain was examined at individual time points, the umbilical group consistently demonstrated lower scores; at 6 hours, mean VAS was 8.52 ± 1.41 (epigastric) versus 7.40 ± 2.18 (umbilical), and at 12 hours, 7.18 ± 1.02 versus 6.24 ± 1.15 , respectively.

Surgeon-assessed ease of retrieval was also more favourable for the umbilical route, with mean VAS scores of 7.88 ± 0.31 for the epigastric group versus 7.32 ± 0.88 for the umbilical group ($P = 0.0015$), indicating that operating surgeons found umbilical extraction less technically demanding despite the additional time required.

In contrast, GB extraction time was significantly shorter through the epigastric port (30.12 ± 10.95 seconds) compared with the umbilical port (52.40 ± 14.87 seconds; $P < 0.0001$). This prolongation in the umbilical group is attributable partly to the additional steps of camera repositioning and gas port switching, and partly to the relative novelty of the technique among the surgical team. No cases of port-site infection or incisional hernia were observed in either group at any follow-up point throughout the six-week observation period.

Table 1: Preoperative Baseline Characteristics of Both Study Groups

Patient Variable	Epigastric Group (n=36) Mean ± SD	Umbilical Group (n=36) Mean ± SD	P-Value
Age (years)	42.18 ± 6.95	40.07 ± 8.74	0.21
Male: Female Ratio	8:28	10:26	-
Body Mass Index	26.71 ± 2.08	27.02 ± 1.76	0.31
Direct Bilirubin	0.36 ± 0.13	0.31 ± 0.14	0.54
Indirect Bilirubin	0.44 ± 0.20	0.34 ± 0.16	0.08
Alkaline Phosphatase (IU/L)	58.20 ± 7.12	57.48 ± 5.61	0.68
AST (IU/L)	34.10 ± 5.44	33.65 ± 4.82	0.72
ALT (IU/L)	41.30 ± 5.80	40.55 ± 6.10	0.58
GB Wall Thickness (mm)	3.58 ± 0.24	3.54 ± 0.27	0.89
Port Dilator Required	09/36	03/36	0.06

AST = Aspartate Aminotransferase; ALT = Alanine Aminotransferase; GB = Gall Bladder; SD = Standard Deviation

Table 2: Operative and Postoperative Comparative Outcomes

Operative / Postoperative Variable	Epigastric Group (Mean ± SD)	Umbilical Group (Mean ± SD)	P-Value
Ease of Retrieval (VAS 0 –10)	7.88 ± 0.31	7.32 ± 0.88	0.0015*
GB Retrieval Time (seconds)	30.12 ± 10.95	52.40 ± 14.87	< 0.0001*
Port-Site Pain at 6 h / 12 h (VAS)	8.52 ± 1.41 / 7.18 ± 1.02	7.40 ± 2.18 / 6.24 ± 1.15	0.0092* / 0.0011*
Mean Postoperative Port -Site Pain (VAS)	7.74 ± 0.61	7.20 ± 0.80	0.0019*
Port-Site Infection	Nil	Nil	-
Port-Site Hernia	Nil	Nil	-

VAS = Visual Analogue Scale; GB = Gall Bladder; * = Statistically significant ($P < 0.05$)

DISCUSSION

The findings of this randomized controlled trial corroborate the hypothesis that the umbilical port constitutes a superior site for gall bladder extraction during laparoscopic cholecystectomy when patient-centred pain outcomes are prioritized. The significant reduction in mean port-site pain in the umbilical arm is consistent with physiological reasoning: the umbilical region is inherently less innervated than the epigastric zone, and the natural fibrous concavity of the umbilicus accommodates the passage of a bulky endobag with less fascial and dermal stretch, thereby mitigating mechanical nociception.

Postoperative pain following LC is a composite phenomenon encompassing incisional, visceral, and referred shoulder pain. Studies examining pain trajectory after LC have consistently documented that incisional discomfort predominates in both incidence and magnitude relative to visceral pain during the first 48–72 postoperative hours, and that peak pain intensity occurs within the initial 8 hours. This temporal pattern renders the early postoperative period (6–12 hours) the most clinically meaningful window for pain assessment, and our data confirm that the umbilical approach delivers the greatest analgesic benefit precisely during this critical interval.

The superiority of the umbilical port in facilitating gall bladder delivery reflected in significantly better surgeon-rated ease scores is an important secondary finding. Despite initial apprehension about the feasibility of delivering the gall bladder downward toward the umbilicus rather than in the more traditional cephalad direction, surgeons in our unit reported greater ease with the umbilical method once familiarization was achieved. This finding aligns with anatomical studies demonstrating that the angle of approach through the umbilical port better

accommodates the natural trajectory of the gall bladder fundus during traction. The most conspicuous disadvantage of umbilical retrieval in our series and indeed in prior comparative investigations - is the significantly prolonged extraction time. The mean difference of approximately 22 seconds identified in our data is partly an artefact of a learning curve inherent to any technique modification. As documented elsewhere, this time penalty diminishes substantially with increasing surgeon experience and case volume, and does not confer any measurable adverse physiological consequence on the patient. Regarding port-site infection and hernia, our series recorded zero events in either group, likely reflecting the protective effect of universal endobag use, meticulous fascial closure, and perioperative antibiotic prophylaxis. Published incidence figures for port-site infection after LC range broadly from below 2% to over 6%, depending on case selection, endobag utilization, and wound care protocols. The use of an endobag appears to be the single most effective deterrent against port-site contamination, and its routine deployment is strongly advocated regardless of the chosen extraction site.

Several previous investigators have contributed to this debate. Studies supporting the umbilical approach have documented reduced VAS scores for postoperative pain and shorter hospital stay, whereas studies favouring the epigastric approach have emphasized faster intraoperative retrieval. A minority of trials have reported equivalent pain profiles between the two methods, differing from our results possibly due to variations in surgical technique, anaesthesia protocols, or analgesic regimens. One prospective study specifically observed that the epigastric site was associated with lower pain scores on postoperative days 1 and 30, a discordant finding that highlights the importance of population specific and technique-specific variables in interpreting results.

Limitations of the present study include the single-centre design, which may restrict generalizability, and the inability to blind the operating surgeon. The relatively short follow-up period of six weeks means that late herniation beyond this window cannot be excluded. Future multicentre randomized trials with longer follow-up and including assessment of health-economic outcomes (e.g., earlier return to work, reduced analgesic consumption costs) would provide stronger evidence to guide practice standardization.

CONCLUSION

This prospective randomized controlled trial demonstrates that extraction of the gall bladder via the umbilical port during laparoscopic cholecystectomy results in statistically and clinically significant reductions in postoperative port-site pain and a more favourable ease-of-retrieval profile when compared with the epigastric port. Although umbilical extraction demands more operative time for GB removal, this disadvantage is expected to attenuate with increasing surgical familiarity. On balance, the umbilical port is recommended as the preferred route for gall bladder retrieval in four-port laparoscopic cholecystectomy.

LIMITATIONS & FUTURE PERSPECTIVES

The study's limitations include a single-centre setting, a relatively small sample size, and a short study duration, which may limit the broader applicability of the results. Future studies should incorporate multi-centre designs with larger populations to enhance validity, assess long-term outcomes, and investigate advanced diagnostic & management approaches. Such efforts will improve overall patient care & help minimize complications.

CLINICAL SIGNIFICANCE

The clinical significance of this study lies in its potential to bridge the gap between research findings and practical health-care, diagnosis, and treatment outcomes. By highlighting real-care applications. It emphasizes the importance of translating scientific observations into meaningful improvements in patient world relevance, the study contributes to evidence based medical practice and supports informed clinical decision making. Ultimately, the findings aim to enhance patient quality of life, optimize therapeutic strategies, and promote better disease management in clinical settings.

ABBREVIATIONS

LC: Laparoscopic Cholecystectomy

GB: Gallbladder

VAS: Visual Analogue Scale

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AUTHOR CONTRIBUTIONS

All authors significantly contributed to the study conception and design, data acquisition, or data analysis and interpretation. They participated in drafting the manuscript or critically revising it for important intellectual content, consented to its submission to the current journal, provided final approval for the version to be published, and accepted responsibility for all aspects of the work. Additionally, all authors meet the authorship criteria outlined by the International Committee of Medical Journal Editors (ICMJE) guidelines.

ACKNOWLEDGEMENT

The authors sincerely acknowledge the seniors of the Department of General Surgery, Government Medical College, Orai, Jalaun, India. We are grateful to our college for providing the necessary resources to carry out this work. We also extend our heartfelt thanks to our colleagues and technical staff for their valuable assistance during the study.

CONFLICT OF INTEREST

Authors declared that there is no conflict of interest.

FUNDING

None

ETHICAL APPROVAL & CONSENT TO PARTICIPATE

All necessary consent & approval was obtained by authors.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

DATA AVAILABILITY

All data generated and analyzed are included within this research article. The datasets utilized and/or analyzed in this study can be obtained from the corresponding author upon a reasonable request.

USE OF ARTIFICIAL INTELLIGENCE (AI) & LARGE LANGUAGE MODEL (LLM)

The authors confirm that no AI & LLM tools were used in the writing or editing of the manuscript, and no images were altered or manipulated using AI & LLM.

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Cite this article: Sudhanshu Sharma & Satyam Kumar Kesharwani. Comparative Evaluation of Liver Function Tests in Patients with Refractory Psoriasis Treated with Tofacitinib & Apremilast: A Retrospective Cohort Study. *JSRR : Journal of Surgical Research & Reviews*. 2026;3(1):1-6.