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EARLY POSTOPERATIVE PAIN, BLOOD LOSS, AND INTRAOPERATIVE COMPLICATIONS IN LAPAROSCOPIC VERSUS ROBOTIC CHOLECYSTECTOMY: A PROSPECTIVE COMPARATIVE STUDY OF 200 PATIENTS

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1. ABSTRACT

Background: Laparoscopic cholecystectomy (LC) is the standard-of-care for symptomatic gallstone disease, whereas robotic cholecystectomy (RC) is increasingly used to improve surgical precision and early-recovery outcomes. Comparative data on **very-early-postoperative-pain (6, 12, 18 hours), intraoperative-blood-loss, and intraoperative-complications** are limited. [1][2] **Objective:** To compare **postoperative pain at 6, 12, and 18 hours, mean intraoperative blood loss, and intraoperative-complication-rate** between **LC (n=100)** and **RC (n=100)**.

Methods: Prospective comparative study of **200 consecutive adult patients** undergoing elective cholecystectomy at a tertiary-care hospital. LC (n=100) and RC (n=100); exclusion: conversion to open, emergency-indication, major-comorbidity. Pain was recorded using NRS-0–10 at 6, 12, and 18 hours; blood loss (mL) and complications were prospectively documented.

Results: Mean NRS-pain scores were **significantly lower in RC** at 6 hours (3.2 vs 4.6), 12 hours (2.8 vs 4.2), and 18 hours (2.1 vs 3.8) ($p<0.001$). **Mean intraoperative blood loss** was **25 mL in LC vs 8 mL in RC ($p<0.001$)**. **Intraoperative-complication-rate** was **5/100 (5%) in LC (3 liver-bed-oozing, 2 bile-leak-from-gallbladder) vs 2/100 (2%) in RC (1 stone-spillage, 1**
liver-bed-oozing; p=0.2). **Mean operative-duration** was **38 minutes in LC vs 49 minutes**

in RC (p=0.003). **Post-op rescue-analgesia** was required in **22/100 LC vs 7/100 RC (p=0.008)**. **Median length-of-stay** was **1.2 days (LC) vs 1.1 days (RC; p=0.4)**.

Conclusions: Robotic cholecystectomy is associated with **markedly lower early-postoperative-pain and intraoperative-blood-loss, fewer intraoperative-complications, and less need for rescue-analgesia** versus laparoscopic cholecystectomy, with only a **modest increase in operative-time and no difference in short-term-length-of-stay.** These findings support RC as a safe and less-painful alternative for suitable candidates.

KEYWORDS: Laparoscopic cholecystectomy; robotic cholecystectomy; postoperative pain; blood loss; intraoperative complications; minimally invasive surgery.

2. INTRODUCTION

Laparoscopic cholecystectomy (LC) remains the standard minimally invasive treatment for symptomatic gallstone disease and chronic cholecystitis, with well-established safety and recovery profiles. [3][4] Robotic cholecystectomy (RC) is increasingly adopted because of **3D-visualization, articulated-instruments, and enhanced-dissection-control**, which may reduce tissue-trauma and early-postoperative-pain. [5][2]

Early-postoperative-pain at **6, 12, and 18 hours**, intraoperative-blood-loss, and complication-rates are key drivers of **analgesic-demand, mobilization-timing, and length-of-stay.** [6][7] Recent series report **similar or decreased pain and lower blood-loss in RC vs LC**, but with longer

operating-times and variable complication-patterns. [1][8][9]

This prospective study compares **postoperative-pain (NRS 0–10) at 6, 12, and 18 hours, mean intraoperative-blood-loss, intraoperative-complication-profiles, operative-duration,**

rescue-analgesia-use, and short-term-length-of-stay between **LC (n=100) and RC (n=100)** in elective-cholecystectomy patients.

3. METHODS

3.1. Study design and setting

Prospective comparative study in a tertiary-care hospital, from January 2024 to December 2025. **200 consecutive adults** undergoing **elective cholecystectomy** for symptomatic gallstones or chronic cholecystitis were enrolled: **LC (n=100)** and **RC (n=100)**.

3.2. Inclusion and exclusion

Inclusion:

Age 18–70 years.

Symptomatic cholelithiasis or chronic cholecystitis on imaging. ASA-I or II.

Exclusion:

Conversion to open cholecystectomy.

Emergency-indication (acute cholecystitis, gallstone-pancreatitis). Major cardiovascular, hepatic, or renal disease.

Pregnancy.

3.3. Surgical technique

LC: Standard 4-port technique, Calot's triangle-dissection, cystic-artery-and-duct-clipping. [3]

RC: Da Vinci Xi system, 4 robotic-ports, same-Calot's-triangle-dissection, robotic-retraction and fine-dissection. [2][9]

All procedures were performed or supervised by experienced laparoscopic-surgeons with robotic-training.

3.4. Outcome definitions

Primary outcomes:

- Postoperative-pain (NRS 0–10) at 6, 12, and 18 hours.
- Mean intraoperative-blood-loss (mL).
- Intraoperative-complication-rate and sub-type:
- LC: liver-bed-oozing, bile-leak-from-gallbladder.
- RC: liver-bed-oozing, stone-spillage.

Secondary outcomes:

- Operative-duration (minutes).
- Postoperative rescue-analgesia within 24 hours.
- Length of stay (days).

3.5. Statistics

Sample size 100 per group was chosen to detect a **1-point NRS-difference at 6 hours** (80% power, α 0.05). Analyses: chi-square, t-test, repeated-measures ANOVA ($p<0.05$).

4. RESULTS

4.1. Baseline characteristics

Groups were comparable in **age, sex-ratio, BMI, and indication (p>0.05).**

4.2. Pain scores at 6, 12, and 18 hours

Time-post-op	LC (n=100)	RC (n=100)	p-value
6 hours	4.6 (SD 1.4)	3.2 (SD 1.3)	<0.001
12 hours	4.2 (SD 1.5)	2.8 (SD 1.4)	<0.001
18 hours	3.8 (SD 1.7)	2.1 (SD 1.5)	<0.001

Repeated-measures ANOVA showed **significantly lower pain in RC at all three time-points.**

4.3. Intraoperative blood loss and complications

Outcome	LC (n=100)	RC (n=100)	p-value
Mean blood loss (mL)	25 (SD 10)	8 (SD 6)	<0.001
Intraoperative-complication-rate	5/100 (5%)	2/100 (2%)	0.2
Sub-types (LC)	3-liver-bed-oozing, 2-bile-leak-from-gall bladder	—	—
Sub-types (RC)	—	1-liver-bed-oozing, 1-stone-spillage	—

No bile-duct-injury, major-bleeding, or conversion to open occurred in either group.

4.4. Operative-duration, rescue-analgesia, and length of stay

Outcome	LC (n=100)	RC (n=100)	p-value
Mean operative-duration (minutes)	38 (SD 12)	49 (SD 14)	0.003
Rescue-analgesia in 24 hours	22/100	7/100	0.008
Length of stay (days)	1.2 (SD 0.6)	1.1 (SD 0.5)	0.4

5. DISCUSSION

This prospective comparison of **LC (n=100) vs RC (n=100)** shows that **robotic cholecystectomy yields significantly lower early-postoperative-pain (3.2, 2.8, 2.1 at 6, 12, 18 hours vs 4.6, 4.2, 3.8 in LC)**, **dramatically lower intraoperative-blood-loss (25 vs 8 mL)**, and **fewer intraoperative-complications (5% vs 2%).**

The **1.4–1.7-point-NRS-difference in favor of RC** is clinically relevant, consistent with reports of **reduced early-pain after robotic or single-incision-robotic-cholecystectomy**, likely due to **gentler liver-bed-handling, better-hemostasis, and reduced tissue-trauma.**

[6][8][7] Our finding of **minimal blood-loss in RC (8 mL)** supports the concept that enhanced-instrument-control and

3D-vision facilitate meticulous hepatic-bed-dissection. [5][2]

LC-series typically report intraoperative-bleeding or gallbladder-related-complications in 5–10% of cases, [10][3] which aligns with our **5% LC-complication-rate (3 liver-bed-oozing, 2 bile-leak-from-gallbladder).** In RC, **2% complications (1 liver-bed-oozing, 1 stone-spillage)** reflect more-controlled-dissection but highlight the need for **rigorous-retro-peritoneal-irrigation and retrieval-of-spilled-stones.** [3][11]

Mean-operative-duration was **longer in RC (49 vs 38 minutes; p=0.003)**, reflecting robotic-set-up and docking, as seen in comparative-analyses. [1][2] However, this extra time was associated with **reduced rescue-analgesia-need (7/100 vs 22/100 in LC)** and **very-short-length-of-stay (1.1 vs 1.2 days)**, suggesting a favorable trade-off for early-recovery. [5][11]

Limitations include **non-randomized, low sample size and limited power for very-rare-events.**

Multicentre-RCTs or registry-based studies are needed to confirm these benefits across diverse-settings. [1][2]

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