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Three Port vs Four Port Laparoscopic Cholecystectomy: A Comparative Study in a Tertiary Care Centre

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Abstract

Introduction: Laparoscopic Cholecystectomy is now considered the Gold Standard for gall bladder stones. Gallstone disease remains one of the most prevalent digestive disorders worldwide, affecting an estimated 10–15 % of adults and accounting for more than 600,000 cholecystectomies each year.

Aims and Objectives

Aim

To determine whether three-port laparoscopic cholecystectomy delivers peri-operative outcomes that are at least equivalent to, or better than, the conventional four-port technique.

Objectives

Intra-operative comparison: Measure and contrast operative time, need for extra ports or conversion to open surgery, and incidence of common bile duct injury between three-port and four-port approaches.

- Post-operative recovery: Compare pain scores, analgesic requirements, length of hospital stay, and time to return to normal daily activities for both techniques.
- Literature benchmarking: Situate the study's results against published data on other reduced-port laparoscopic cholecystectomy methods.
- Port reduction impact: Assess how decreasing the number and size of ports influences overall patient morbidity and surgical efficiency.

Material and Method:

Study Design: A Prospective, Hospital-based Observational Study

Study Period: The study was conducted over a period of 18 months

Place of Study: The study was conducted at Department of General Surgery, Dr. Shankarrao Chavan Government Medical College and Hospital, Vishnupuri, Nanded,

Maharashtra

Sample Size: A total of 130 cases (65 in each group**)**

Result: The Three-Port Laparoscopic Cholecystectomy (3PLC) group includes a total of 65 patients. The breakdown across age groups is as follows: 21–30 years with 5 patients (7.69%), 31–40 years with 25 patients (38.46%), 41–50 years with 30 patients (46.15%), and 51–60 years with 5 patients (7.69%)

Discussion: Our study, which included a total of 130 cases (65 in each group), provided a breakdown of the primary indications for the procedure. The most common indication was gallstones, accounting for 65% of cases. This was followed by gall bladder polyps (23%), acalculous cholecystitis (8%), and other less frequent indications (4%).

Keywords: Cosmesis, Gallstone Disease, Laparoscopic Cholecystectomy, Minimally Invasive Surgery, Postoperative Pain

Introduction

Gallstone disease remains one of the most prevalent digestive disorders worldwide, affecting an estimated 10–15 % of adults and accounting for more than 600,000 cholecystectomies each year in the United States alone[1, 2] Since the first laparoscopic cholecystectomy was reported by Dubois and colleagues in 1987–1989 [3], minimally invasive surgery has supplanted the open approach as the treatment of choice for symptomatic cholelithiasis. The standard four-port laparoscopic cholecystectomy (LC), popularised in the early 1990s and widely hailed as the new "gold standard"[4], offers clear advantages over open surgery in terms of postoperative pain, convalescence and cosmesis, and is endorsed by systematic reviews and Cochrane analyses as the preferred technique for most patients[5]. While the four-port configuration revolutionised biliary surgery, continual refinement of access strategies has sought to lessen parietal trauma still further. In 1995 Slim et al. demonstrated the technical feasibility of a three-trocar LC, arguing that one working port could be safely omitted without compromising biliary dissection or ergonomics[6].

Three-port LC retains the familiar triangulation of instruments while eliminating the right sub-costal fourth port responsible for fundal retraction. Proponents contend that this modification reduces postoperative pain, shortens hospital stay and improves scar satisfaction without demanding new equipment or radical skill adaptation [9,10].

Randomised and non-randomised trials from diverse geographic regions have variably reported similar or slightly shorter operating times for three-port LC, with no significant differences in conversion, bile duct injury, or other major adverse events[12,13]. Meta-analytic syntheses and head-to-head comparative studies generally affirm equivalence between three- and four-port LC regarding intra-operative complications, conversion to open surgery and overall morbidity[14–16]. Many tertiary-care centres that serve large rural catchments face escalating surgical volumes under constraints of theatre time, personnel and equipment. If three-port LC can demonstrably shorten operative duration, decrease consumable use and expedite discharge without sacrificing safety, its adoption could yield significant health-system benefits[19,20].

Aim

To determine whether three-port laparoscopic cholecystectomy delivers peri-operative outcomes that are at least equivalent to, or better than, the conventional four-port technique.

Objectives

Intra-operative comparison: Measure and contrast operative time, need for extra ports or conversion to open surgery, and incidence of common bile duct injury between three-port and four-port approaches.

- Post-operative recovery: Compare pain scores, analgesic requirements, length of hospital stay, and time to return to normal daily activities for both techniques.
- Literature benchmarking: Situate the study's results against published data on other reduced-port laparoscopic cholecystectomy methods.
- Port reduction impact: Assess how decreasing the number and size of ports influences overall patient morbidity and surgical efficiency.

Materials and Methods

Study Setting

This prospective, observational investigation will be carried out in the male and female General-Surgery wards of a large, government-funded tertiary-care teaching hospital. The centre caters to a heterogeneous referral population drawn predominantly from low- and middle-income districts, thereby providing a representative case-mix of surgical pathology seen in resource-constrained environments. All clinical care is delivered by a multidisciplinary team comprising consultant surgeons, surgical residents, anaesthesiologists, nursing officers and physiotherapists, with round-the-clock laboratory, imaging and critical-care support.

Study Period

Recruitment and follow-up will extend over 18 consecutive months beginning immediately after receipt of Institutional Ethics Committee (IEC) approval (anticipated start: August 2025; completion: January 2027). This duration accommodates seasonal variation in admission patterns and affords adequate time for post-intervention follow-up.

Study Design

This study is structured as a prospective, hospital-based, observational cohort study. No experimental intervention will be introduced, and patients will be managed strictly according to current department protocols. The design permits real-world assessment of outcomes while minimising ethical concerns associated with randomisation or placebo use.

Sample Size and Sampling Technique

Because prevalence data for the target condition in our specific catchment area are limited, a duration-based, convenience sampling strategy will be employed. All eligible patients presenting during the 18-month accrual window will be invited to participate, ensuring maximal capture of incident cases and enhancing external validity.

Inclusion criteria

- Adult patients (≥ 18 years) admitted under General Surgery with a confirmed clinical or radiological diagnosis relevant to the study objective.
- Ability to provide informed consent (or availability of a legally authorised representative).

Exclusion criteria

- Patients who decline participation.
- Individuals transferred from or to another department before baseline data collection is complete.
- Cases with missing critical laboratory results that cannot be retrieved within 48 h of admission.

Statistical Analysis

Data analysis will be performed using IBM SPSS Statistics v21 (IBM Corp., Armonk, NY).

- Descriptive statistics: Continuous variables will be summarised as mean ± SD or median (IQR) depending on normality; categorical variables as frequencies and percentages.
- Normality testing: Shapiro–Wilk test will guide choice of parametric vs non-parametric methods.
- Inferential analysis:
  - Student's *t*-test for comparison of normally distributed continuous variables.
  - Mann–Whitney *U* test for skewed data.
  - Chi-square or Fisher's exact test for categorical variables.
- Significance threshold: Two-tailed $p < 0.05$ will be considered statistically significant.
- Missing data: Analysed using complete-case analysis; sensitivity analyses with multiple imputation will be performed if > 10 % of data points are missing for a key variable.

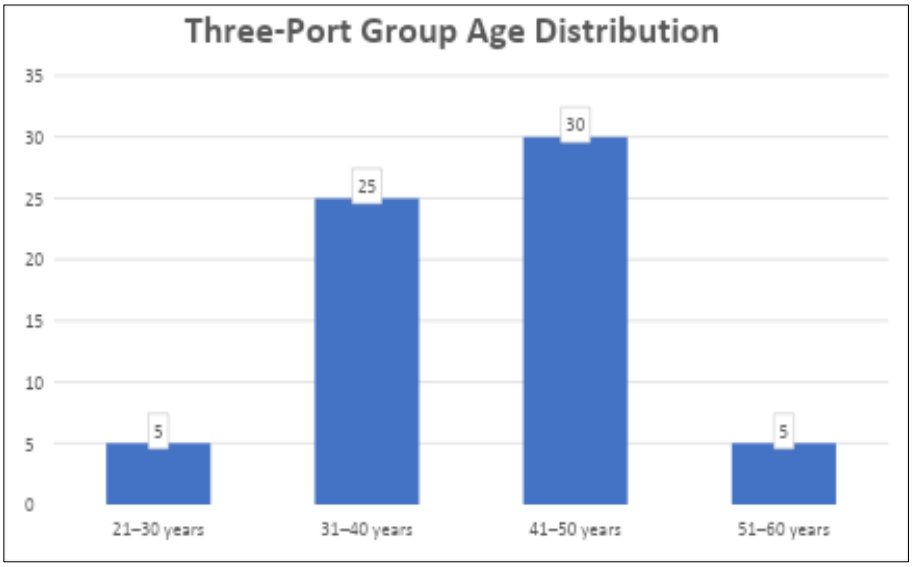
Result

Age & Gender Distribution

Table 1: Three-Port Group Age Distribution

Age Group	Frequency	Percentage
21–30 years	5	7.69
31–40 years	25	38.46
41–50 years	30	46.15
51–60 years	5	7.69
Total	65	100

Graph 1:



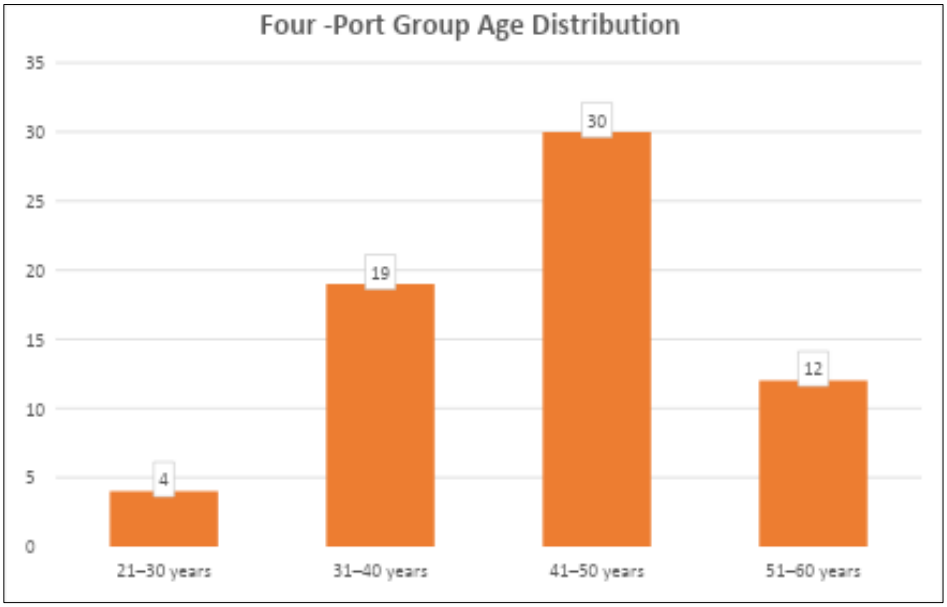
The age distribution table for the Three-Port Laparoscopic Cholecystectomy (3PLC) group includes a total of 65 patients. The breakdown across age groups is as follows: 21–30 years with 5 patients (7.69%), 31–40 years with 25 patients (38.46%), 41–50 years with 30 patients (46.15%), and 51–60 years with 5 patients (7.69%)

- Mean ($\bar{x}$) = 40.9 years
- Standard Deviation (s) = 7.5 years

Table 2: Four-Port Group Age Distribution

Age Group	Frequency	Percentage
21–30 years	4	6.15%
31–40 years	19	29.23%
41–50 years	30	46.15%
51–60 years	12	18.46%
Total	65	100.00

Graph 2:



The age distribution table for the Four-Port Laparoscopic Cholecystectomy (4PLC) group includes a total of 65 patients. The breakdown is as follows: 21–30 years with 4 patients (6.15%), 31–40 years with 19 patients (29.23%), 41–50 years with 30 patients (46.15%), and 51–60 years with 12 patients (18.46%).

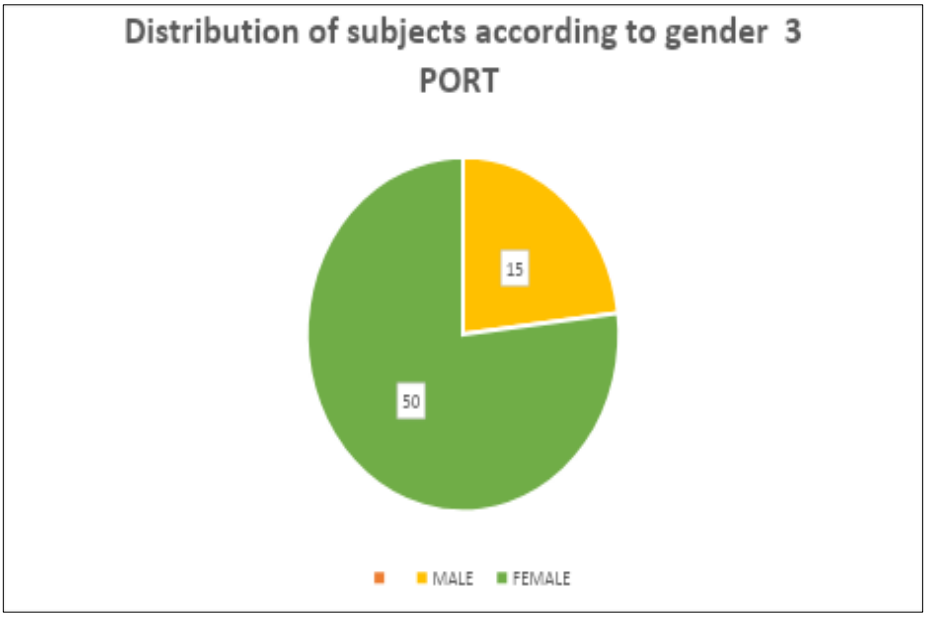
The mean age for this group is 40.12 years, with a standard deviation of 10.24 years.

- Mean: 43.19 years
- Standard Deviation: 8.25years

Table 3: Distribution of subjects according to gender (Three Port)

Sex	Number of patients	Percentage
Male	15	23.08%
Female	50	76.92%
Total	65	100.00%

Graph 3:

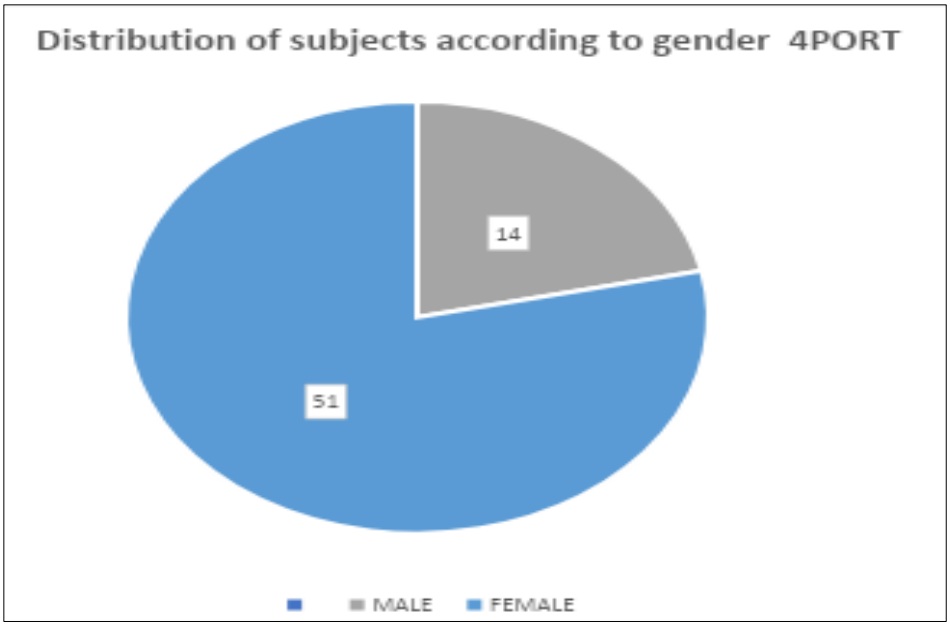


The gender distribution table for the 3-Port Laparoscopic Cholecystectomy group includes a total of 65 patients. It indicates male patients numbering 15 (23.08%) and female patients numbering 50 (76.92%).

Table 4: Distribution of subjects according to gender (Four Port)

Sex	Number of patients	Percentage
Male	14	21.54%
Female	51	78.46%
Total	65	100%

Graph 4:

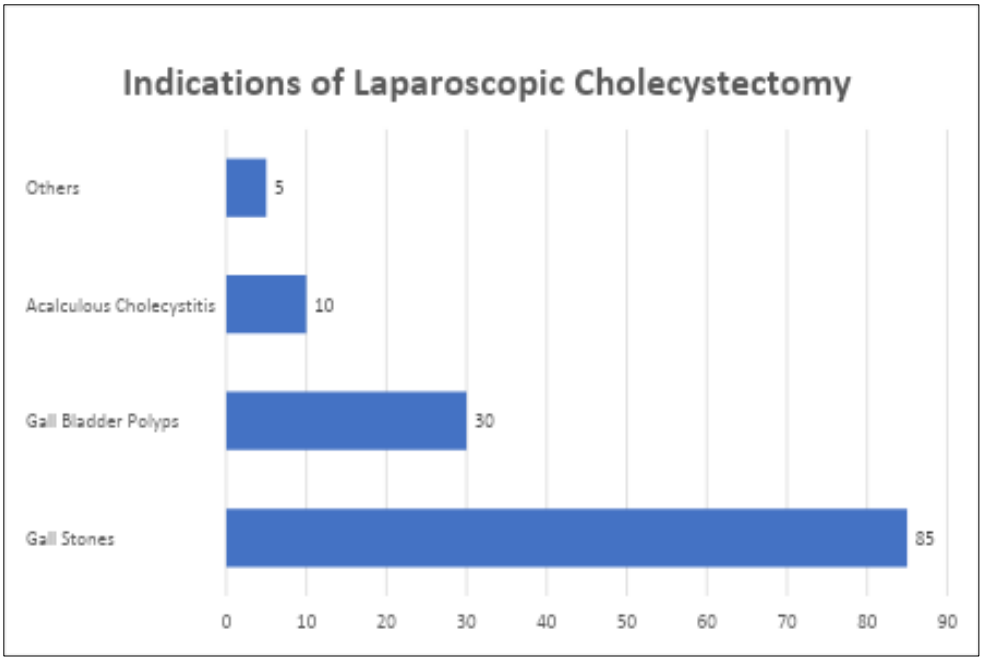


The gender distribution table for the 4-Port Laparoscopic Cholecystectomy group includes a total of 65 patients. It shows male patients numbering 14 (21.54%) and female patients numbering 51 (78.46%).

Table 5: Indications of Laparoscopic Cholecystectomy (Total Cases: 130)

Indication	Number of Cases	Percentage
Gall Stones	85	65%
Gall Bladder Polyps	30	23%
Acalculous Cholecystitis	10	8%
others	5	4%

Graph 5:

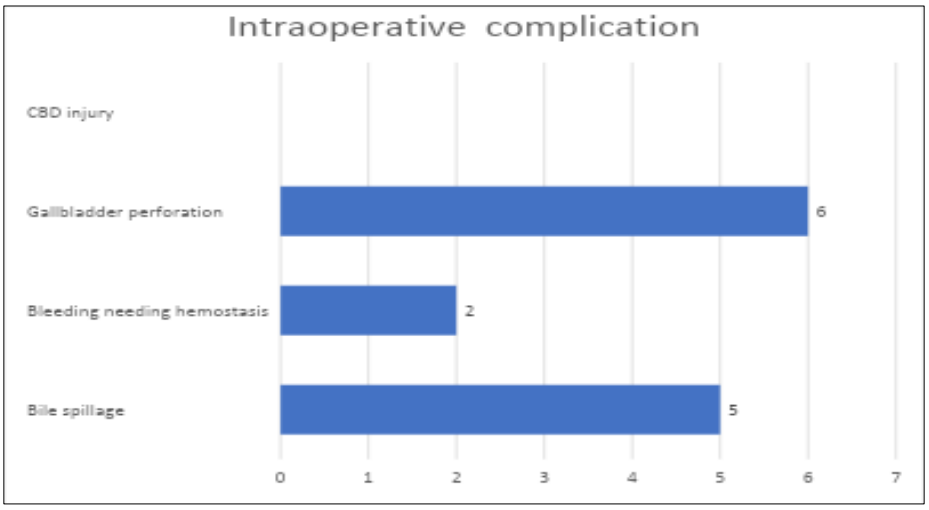


The indications table for Laparoscopic Cholecystectomy across a total of 130 cases lists: gall stones with 85 cases (65%), gall bladder polyps with 30 cases (23%), acalculous cholecystitis with 10 cases (8%), and others with 5 cases (4%)

Table 6: Distribution of subjects according to Intraoperative Complication Port Laparoscopic Cholecystectomy (3PLC, n = 65)

Complication	Count	Percentage (%)
Bile spillage	5	7.7%
Bleeding needing hemostasis	2	3.1%
Gallbladder perforation	6	9.2%
CBD injury	0	0%

Graph 6:



The intraoperative complications table for the Three-Port Laparoscopic Cholecystectomy (3PLC, n=65) specifies: bile spillage with 5 occurrences (7.7%), bleeding needing hemostasis with 2 occurrences (3.1%), gallbladder perforation with 6 occurrences (9.2%), and CBD injury with 0 occurrences (0%).

Table 7: Association of Intraoperative complication between 3 and 4 Port Laparoscopic Cholecystectomy

Complication	3PLC (n=65)	4PLC (n=65)	p-value
Bile spillage	5 (7.7%)	8 (12.3%)	0.38
Bleeding needing hemostasis	2 (3.1%)	4 (6.2%)	0.68
Gallbladder perforation	6 (9.2%)	9 (13.8%)	0.43
CBD injury	0 (0%)	1 (1.5%)	—

The intraoperative complications table for the 4-Port Laparoscopic Cholecystectomy (4PLC, n=65) details: bile spillage with 8 occurrences (12.3%), bleeding needing hemostasis with 4 occurrences (6.2%), gallbladder perforation with 9 occurrences (13.8%),

Graph 7:

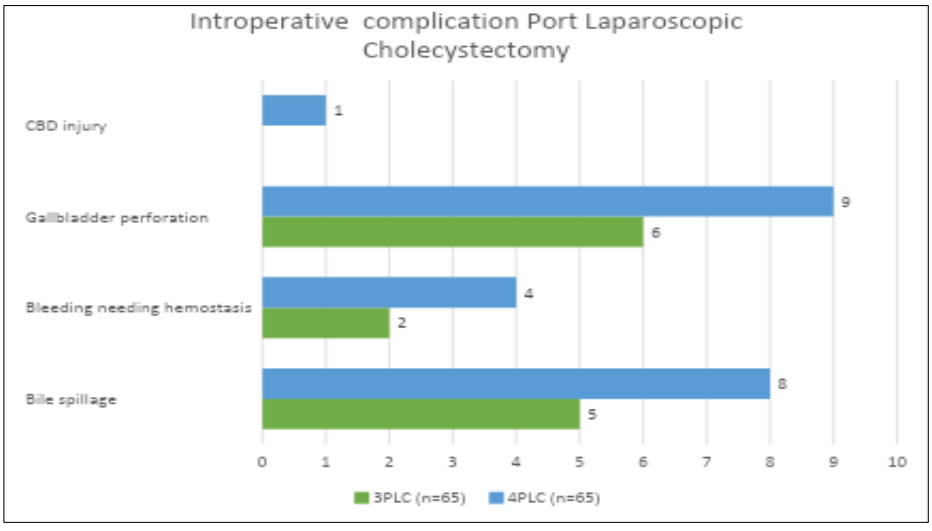
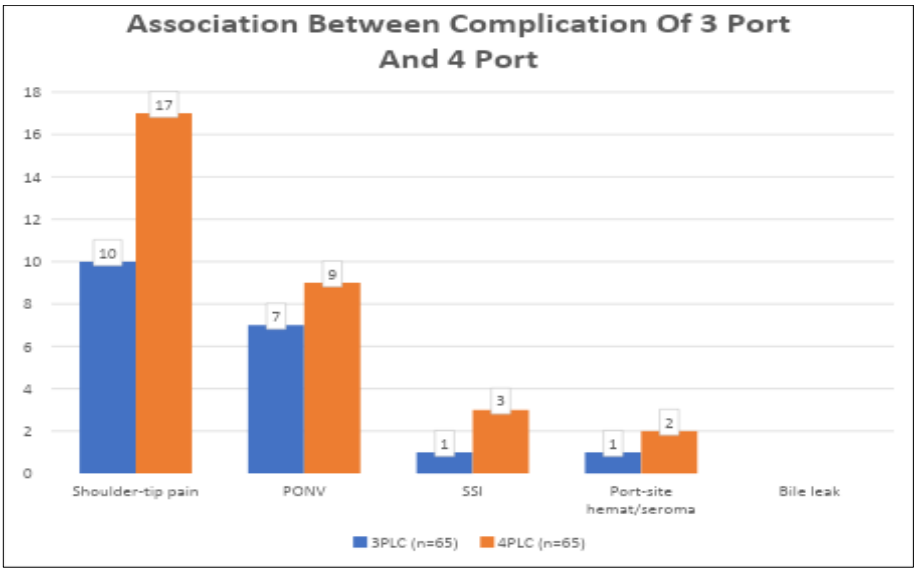


Table 8: Association between Complication Of 3 Port And 4 Port

Complication	3PLC (n=65)	4PLC (n=65)	p-value
Shoulder-tip pain	10 (15.4%)	17 (26.2%)	0.13
Post-op nausea/vomiting (PONV)	7 (10.8%)	9 (13.8%)	0.79
Wound infection (SSI)	1 (1.5%)	3 (4.6%)	0.62
Port-site hematoma/seroma	1 (1.5%)	2 (3.1%)	1.00
Bile leak	0 (0%)	0 (0%)	—

Graph 8:



The comparison table for postoperative complications between 3PLC (n=65) and 4PLC (n=65), including p-values, indicates: shoulder-tip pain with 10 (15.4%) in 3PLC and 17 (26.2%) in 4PLC (p=0.13), post-op nausea/vomiting (PONV) with 7 (10.8%) in 3PLC and 9 (13.8%) in 4PLC (p=0.79), wound infection (SSI) with 1 (1.5%) in 3PLC and 3 (4.6%) in 4PLC (p=0.62), port-site hematoma/seroma with 1 (1.5%) in 3PLC and 2 (3.1%) in 4PLC (p=1.00), and bile leak with 0 (0%) in both groups.

Table 9: VAS Score Distribution at 6HR 3 PORT

Vas score	Frequency	Percentage
1-3	50	76.9%
4-6	12	18.5%
7-9	3	4.6%
Total	65	100.00

The VAS score distribution table for the Three-Port group (mean = 2.92) shows: 1-3 with 50 patients (76.9%), 4-6 with 12 patients (18.5%), and 7-9 with 3 patients (4.6%). Mean is 2.92

Graph 9:

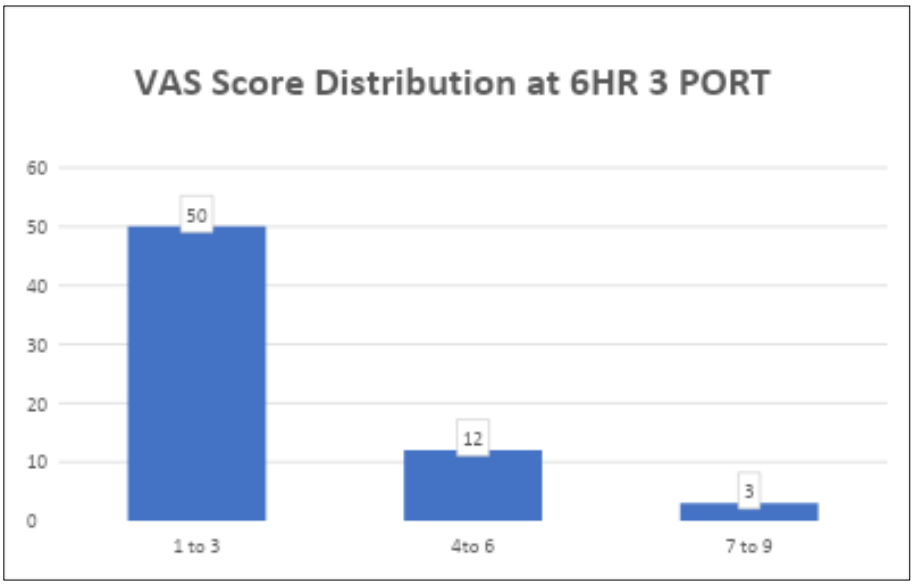


Table 10: VAS Score Distribution at 6HR 4 PORT

Vas score	Frequency	Percentage
1-3	42	64.6%
4-6	18	27.7%
7-9	5	5%
Total	65	100.00

The VAS score distribution table for the Four-Port group (mean = 3.22) details: 1-3 with 42 patients (64.6%), 4-6 with 18 patients (27.7%), and 7-9 with 5 patients (5%). Mean is 3.22

Graph 10:

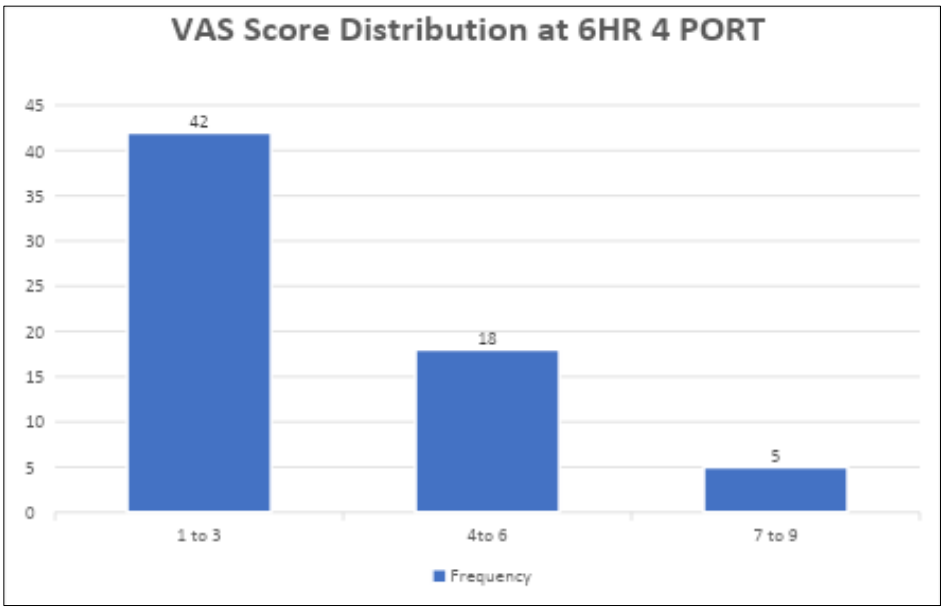


Table 11: Hospital Stay for 3PLC

Hospital Stay	Frequency	Percentage
1–3	53	81.54%
>3 DAYS	12	18.46%
Total	65	100.0%

The hospital stay table for the Three-Port Laparoscopic Cholecystectomy (3PLC) group, based on a total of 65 patients, shows the duration of hospital stay as follows: 1–3 days with 53 patients (81.54%) and more than 3 days with 12 patients (18.46%).

Graph 11:

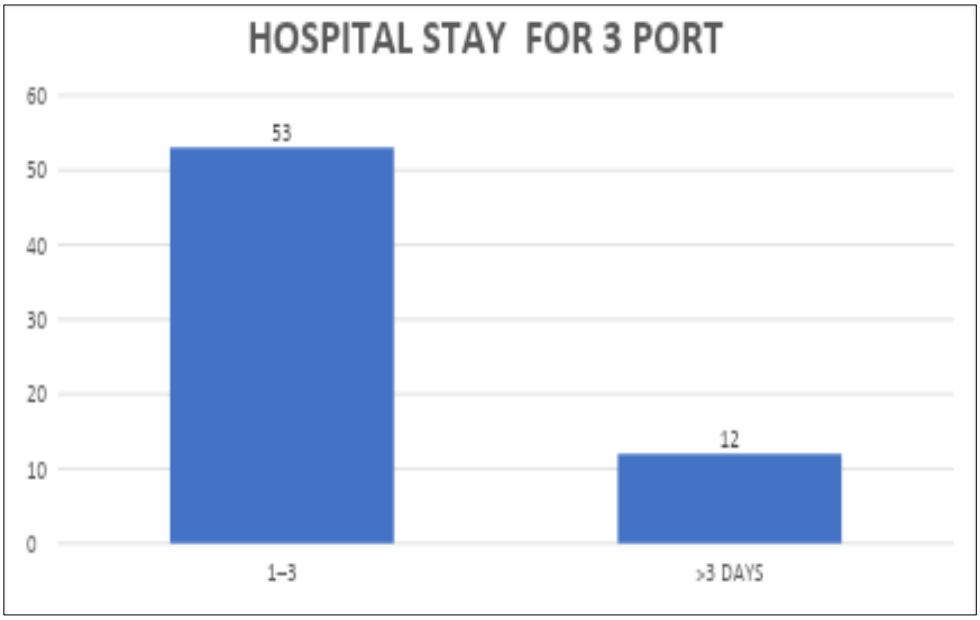
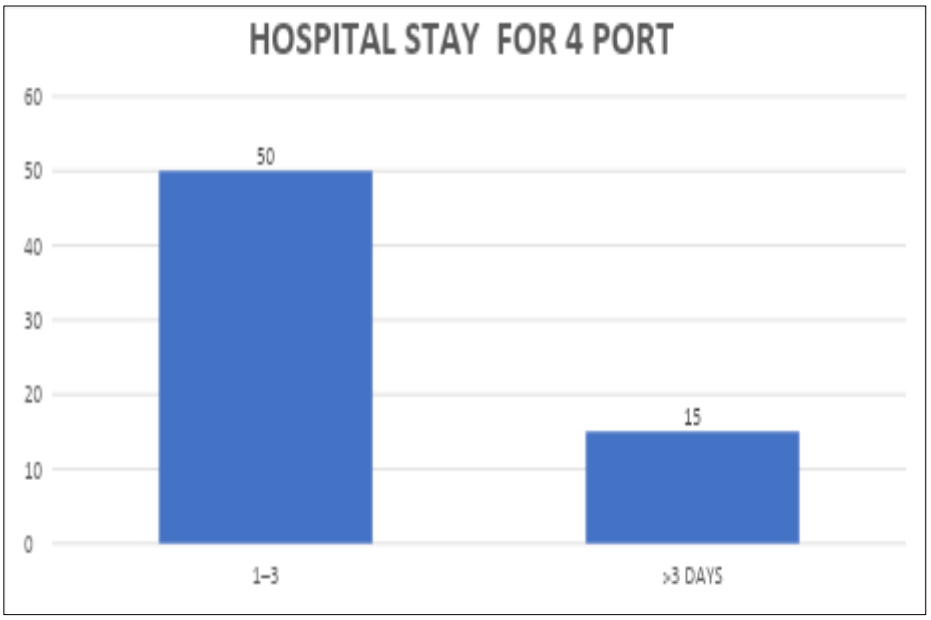


Table 12: Hospital Stay For 4PLC

Hospital Stay	Frequency	Percentage
1–3	50	78.57%
>3 DAYS	15	21.43%
Total	65	100.0%

The hospital stay table for the Four-Port Laparoscopic Cholecystectomy (4PLC) group, also based on a total of 65 patients, details the duration of hospital stay as follows: 1–3 days with 50 patients (78.57%) and more than 3 days with 15 patients (21.43%).

Graph 12:



Discussion

Our study, encompassing 65 patients in both the three-port and four-port groups, revealed distinct age profiles. In the three-port group, the mean age was 40.9 years (SD = 7.5 years), with the highest concentration of patients (46.15%) falling within the 41–50 years age bracket. The four-port group had a slightly higher mean age of 43.19 years (SD = 8.25 years), with a similar peak in the 41–50 years age group (46.15%), but a notable increase in patients aged 51–60 years (18.46%) compared to the three-port group (7.69%).

In our study, the gender distribution showed a clear female preponderance in both the three-port and four-port groups. For the three-port group, 23.08% were male and 76.92% were female. Similarly, in the four-port group, 21.54% were male and 78.46% were female.

The indications for laparoscopic cholecystectomy are generally consistent across surgical practices, primarily driven by symptomatic gallstone disease. Our study, which included a total of 130 cases (65 in each group), provided a breakdown of the primary indications for the procedure.

Postoperative complications are crucial indicators of patient morbidity and recovery quality. Our study meticulously tracked these complications within 30 days for both the three-port and four-port groups. In the 3PLC group (n=65), shoulder-tip pain was observed in 15.4% of patients, post-operative nausea/vomiting (PONV) in 10.8%, wound infection (SSI) in 1.5%, and port-site hematoma/seroma in 1.5%.

Postoperative pain, often assessed using the Visual Analog Scale (VAS), is a critical factor influencing patient comfort and recovery. Our study provided a detailed analysis of VAS scores at various time points. At 6 hours post-operation, the mean VAS score for the 3PLC group was 2.92, while for the 4PLC group, it was 3.22.

Our study examined the duration of hospital stay for both three-port and four-port laparoscopic cholecystectomy groups. In the 3PLC group (n=65), 81.54% of patients had a hospital stay of 1–3 days, while 18.46% stayed for more than 3 days. For the 4PLC group (n=65), 78.57% had a hospital stay of 1–3 days, and 21.43% stayed for more than 3 days.

Conclusion

This comparative study of 3PLC and 4PLC in 130 patients demonstrates that both techniques are viable for laparoscopic cholecystectomy, with similar demographic profiles, indications, and overall safety outcomes, as evidenced by non-significant p-values in complication rates and operative time associations. While 3PLC showed slightly lower intraoperative and postoperative complication rates, reduced conversion needs (albeit with some conversions), shorter operative times in distribution trends, consistently lower mean VAS pain scores across most postoperative intervals, and a modest advantage in shorter hospital stays, these differences did not reach statistical significance, indicating equivalence in efficacy and patient recovery. However, the potential for fewer ports in 3PLC may offer benefits in terms of reduced invasiveness, lower pain, and resource efficiency, warranting further large-scale randomized trials to confirm these observations and explore long-term outcomes.

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