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Original Research Article

Comparison of 3 Port vs 4 Port Laparoscopic Cholecystectomy for Gallstone Disease

Mahrukh Shafiq[1*], Rohit Kumar[2], Aun Ali[1], Muhammad Khurram Zia[3], Mansoor Iqbal[1], Yousuf Lakdawala[1]

[1]Department of General Surgery, FRPMC PAF Hospital Karachi, Pakistan
[2]Department of General Surgery, PNS Shifa Hospital Karachi, Pakistan
[3]Department of General Surgery, Liaquat College of Medicine and Dentistry and Darul Sehat Hospital Karachi, Pakistan
**Corresponding author`s email address:* mahrukhshafq92@gmail.com

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Abstract: *Laparoscopic cholecystectomy (LC) is the gold standard for treating symptomatic gallstones. Conventionally performed with four ports, the three-port modification has been proposed to reduce surgical trauma, postoperative pain, and recovery time. However, evidence comparing the safety and outcomes of three-port versus four-port LC in the Pakistani population remains limited.* ***Objective:*** *To evaluate and compare the clinical outcomes and perioperative risks of three-port LC with four-port LC.* ***Methods:*** *This randomised comparative study was conducted at F.R.P.M.C. PAF Hospital, Karachi, from 1 August 2023 to 1 July 2024, following ethical approval. A total of 60 patients aged 18–60 years of both genders, classified as ASA I or II, and scheduled for elective LC were recruited through non-probability consecutive sampling. Patients were randomised into two groups: three-port LC and four-port LC. Intraoperative complications, conversion to open surgery, length of hospital stay, postoperative pain (assessed by a standardised pain score), and recovery time were compared. Statistical analysis was performed using appropriate parametric and non-parametric tests, with $p<0.05$ considered significant.* ***Results:*** *Intraoperative complications were lower in the three-port group compared with the four-port group (17% vs. 40%, $p=0.09$). Conversion to open surgery occurred in 27% of three-port and 40% of four-port cases ($p=0.255$). The mean hospital stay was significantly shorter in the three-port group (2.8±0.6 days) than in the four-port group (3.5±0.7 days) ($p<0.0001$). Postoperative pain scores were also significantly lower in the three-port group (5.7±0.9) compared to the four-port group (6.5±0.9) ($p=0.001$). Furthermore, recovery time was faster in the three-port group (14.9±1.4 days) compared with the four-port group (17.2±1.5 days) ($p<0.0001$).* ***Conclusion:*** *Three-port LC is a safe and effective alternative to conventional four-port LC, offering shorter hospitalisation, reduced postoperative pain, faster recovery, and enhanced patient satisfaction, without increasing intraoperative risks.*

Keywords: Cholecystectomy, Laparoscopic; Gallstones; Pain Measurement; Postoperative Complications

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Introduction

Gallstone disease exists as one of the prevalent gastrointestinal conditions worldwide, affecting 10-15% of adults, yet it occurs most frequently in obese patients and women (1). Laparoscopic cholecystectomy (LC) stands as the established treatment for symptomatic gallstones because it provides better results compared to open surgery through its reduced pain level, shorter hospital stay, and faster recovery (2). Minimally invasive surgical advances have prompted healthcare providers to adopt three-port surgery, replacing the previously standard four-port procedure (3).

The three-port LC surgery reduces one lateral port, which improves patient pain outcomes in addition to decreasing scarring effects and accelerating patient recovery times (4). The surgeon faces ergonomic difficulties during this procedure, together with longer operative durations and potentially more complications. The evaluation of these two procedures centres on evaluating surgical period length, operating room problems, conversion rates to open procedures, post-surgical pain scores, hospital stay times, and patient comfort scores (5).

Studies analysing three-port versus four-port LC utilising randomised controlled trials demonstrate equivalent operative periods around 45-60 minutes without any considerable intraoperative problems, yet three-port procedures exhibited lower average pain scale ratings (6). A review of research data indicated that patients undergoing three-port LC only needed two and a half days in the hospital versus three and a half days for the four-port approach and required less postoperative pain medication (7). The data indicate conflicting results about open surgery rates, as research showed no difference in conversion rates, but additional studies revealed a minor increase with three-port procedures resulting from restricted instrument movements (8).

Both techniques present comparable risks of post-operative complications, which include bile duct injury and bleeding complications. The reduced number of incisions in three-port LC leads to improved patient satisfaction because patients experience less discomfort from incisions (9). Additional research needs to assess mid-term results regarding symptom recurrence and complete patient welfare after surgical procedures. This research aims to evaluate the clinical outcomes and risks of three-port LC against four-port LC among 60 patients to assess the feasibility of reduced-port methods as an alternative to conventional practice.

Methodology

After the ethical approval from the institutional review board, this randomised comparative study was conducted at FRPMC PAF hospital, Karachi, from 1st July 2023 to 1st August 2024. Through non-probability consecutive sampling, 60 patients aged 18-60 years, both genders, ASA Class I or II, having an elective laparoscopic cholecystectomy were included in the present study. Patients with acute cholecystitis, as well as common bile duct stones and upper abdominal surgery history, together with severe comorbidities (ASA grade III and above), and pregnant women were excluded from the present study. After the informed consent from the recruited participants, they were equally divided into two groups: 3-Port (n=30) and 4-Port (n=30). The three-port LC employed an umbilical camera port and subxiphoid working port, along with a right lateral working port, whereas the four-port LC required an additional

epigastric working port to enhance instrument triangulation. The entire surgical team executed all procedures using standard laparoscopic techniques under the leadership of experienced surgeons to maintain consistent surgical practices. Operative time, intraoperative complications, and surgical conversion to open procedures were the primary outcome measures of the study. Additionally, postoperative pain was assessed using VAS scores, and analgesic medication requirements, hospital stay duration, postoperative complications, and patient satisfaction ratings were also evaluated, with ratings ranging from 1 to 10. Postoperative testing took place at three time points post-surgery: both on hours 6 and 24, and day 48, then again on day 7 and week 4. SPSS version 26 was used to analyse the data. Continuous variables were presented as mean and standard deviation, while categorical variables were presented as frequency and percentage. T-test and chi-square were used to compare the primary and secondary outcomes between the groups. A p-value ≤0.05 was considered significant.

Results

The demographic and clinical history of patients showed that the mean age of patients in the three-port group was 47.7±7.4 years, whereas in the four-port group, it was 50.1±6.2 years (p=0.257). Gender distribution was similar, with 47% males and 53% females in the three-port group compared to 57% males and 43% females in the four-port group (p=0.311). The mean BMI was significantly lower in the three-port group (28.6±2.4) compared to the four-port group (31.5±2.2) (p<0.0001). Regarding comorbidities, diabetes was present in 10% of three-port patients and 30% of four-port patients (p=0.601), while hypertension was observed in 27% and 30% of patients, respectively (p=0.5). Other comorbidities were present in 30% of three-port patients and 33% of four-port patients (p=0.43) (Table 1).

Preoperative parameters showed that pre-op pain levels were comparable between the groups (5.6±0.9 vs. 5.7±1.2, p=0.85) (Table 2). Imaging modalities included ultrasound (43% vs. 33%), MRI (30% vs. 30%), and CT (27% vs. 37%) with no significant differences (p=0.712). The mean gallstone size was significantly smaller in the three-port group (14.5±2.4 mm) compared to the four-port group (17.5±2.1 mm) (p<0.0001). Surgery duration was significantly shorter in the three-port group (48.7±4.3 min) than in the four-port group (57.5±3.9 min) (p<0.0001). Intraoperative complications were lower in the three-port group (17% vs. 40%, p=0.09), and conversion to open surgery was required in 27% of three-port cases and 40% of four-port cases (p=0.255).

Postoperative parameters revealed that post-op complications occurred in 40% of three-port patients and 53% of four-port patients (p=0.423). The length of hospital stay was significantly shorter in the three-port group (2.8±0.6 days) compared to the four-port group (3.5±0.7 days) (p<0.0001). Post-op pain was significantly lower in the three-port group (5.7±0.9) compared to the four-port group (6.5±0.9) (p=0.001). Recovery time was also faster in the three-port group (14.9±1.4 days vs. 17.2±1.5 days, p<0.0001). Follow-up duration was slightly shorter in the three-port group (6.8±0.76 weeks vs. 7.3±0.7 weeks, p=0.003). Recurrent gallstones were observed in 20% of three-port patients and 33% of four-port patients (p=0.211). Patient satisfaction scores were significantly higher in the three-port group (8.3±0.7) compared to the four-port group (7.6±0.75) (p=0.002) (Table 3).

Table 1: Demographic and clinical history of the patients

Variables	3-Port (n=30)	4-Port (n=30)	P value
Age (years)	47.7±7.4	50.1±6.2	0.257
Gender			0.311
Male	14 (47%)	17 (57%)	
Female	16 (53%)	13 (43%)	
BMI	28.6±2.4	31.5±2.2	<0.0001
Comorbidities			
Diabetes	3 (10%)	9 (30%)	0.601
Hypertension	8 (27%)	9 (30%)	0.5
Others	9 (30%)	10 (33%)	0.43

Table 2: Preoperative parameters of the patients in both groups

Variables	3-Port (n=30)	4-Port (n=30)	P value
Pre-op Pain Level	5.6±0.9	5.7±1.2	0.85
Pre-op Imaging			0.712
Ultrasound	13 (43%)	10 (33%)	
MRI	9 (30%)	9 (30%)	
CT	8 (27%)	11 (37%)	
Gallstone Size (mm)	14.5±2.4	17.5±2.1	<0.0001
Duration of Surgery (minutes)	48.7±4.3	57.5±3.9	<0.0001
Intraoperative Complications	5 (17%)	12 (40%)	0.09
Conversion to Open Surgery	8 (27%)	12 (40%)	0.255

Table 3: Post-operative parameters of the patients in both groups

Variables	3-Port (n=30)	4-Port (n=30)	P value
Post-op Complications	12 (40%)	16 (53%)	0.423
Length of Hospital Stay(days)	2.8±0.6	3.5±0.7	<0.0001
Post-op Pain Level	5.7±0.9	6.5±0.9	0.001
Recovery Time (days)	14.9±1.4	17.2±1.5	<0.0001
Follow-up (Weeks)	6.8±0.76	7.3±0.7	0.003
Recurrent Gallstones	6 (20%)	10 (33%)	0.211

Patient Satisfaction	8.3±0.7	7.6±0.75	0.002

Discussion

A large body of research exists about the demographic features and clinical characteristics of patients who receive three-port and four-port laparoscopic cholecystectomy (LC) to measure their effectiveness and safety rates (10). The research established no significant relationship ($p = 0.257$) between demographic groups of patients undergoing three-port (47.7 ± 7.4 years' age) and four-port (50.1 ± 6.2 years' age) procedures. Among the patients, the distribution of both genders was similar for both procedures since the three-port group included 47% males with 53% females, while the four-port group consisted of 57% males combined with 43% females ($p = 0.311$). Previous studies confirmed that demographics do not differ significantly between patients receiving treatment with three-port and four-port LC (11). Our research demonstrated a statistically significant difference in the mean body mass index (BMI) between both groups, where the three-port group had a BMI of 28.6 ± 2.4, but the four-port group had a BMI of 31.5 ± 2.2 ($p < 0.0001$). Our findings differ from research that discovered minimal BMI variations between the two groups. The systematic review and meta-analysis done by Nip et al. (2022) discovered no meaningful BMI variation between three-port and four-port LC patients (12). Our research data indicate higher BMI values in patients who received four-port procedures, possibly because surgeons tend to choose this approach for subjects with higher BMI due to technical reasons (13).

The research revealed that diabetes affects 10% of three-port patients, whereas 30% of four-port patients ($p = 0.601$). Similarly, hypertension was detected in 27% of three-port patients and 30% of four-port patients ($p = 0.5$). Patients undergoing a three-port approach had the same rate (30%) of comorbidities compared to four-port patients (33%) without significant differences ($p = 0.43$). Health conditions between the patient groups remained equivalent based on statistical analysis. Previous literature has demonstrated that patients undergoing three-port or four-port LC display analogous coexisting medical conditions (14). Both groups showed no significant difference in their reported preoperative pain intensity (5.6 ± 0.9 vs. 5.7 ± 1.2, $p = 0.85$). Studies explored the same imaging techniques between groups yet revealed no meaningful statistical variations ($p = 0.712$). The mean size of gallstones treated with three-port access (14.5 ± 2.4 mm) proved lower when compared to four-port access (17.5 ± 2.1 mm; $p < 0.0001$). The discovery indicates that bigger gallstones create operational difficulties during three-port LC, so surgeons choose four-port methods for these cases. The scientific research conducted by Akay et al. (2019) determined that the four-port approach delivered superior exposure during surgical procedures involving larger gallstones (15). The operative time was significantly shorter in patients undergoing three-port laparoscopic surgery (48.7 ± 4.3 min) than in patients undergoing four-port laparoscopic surgery (57.5 ± 3.9 min), with a p-value less than 0.0001. The research by Beltzer et al. (2023) through their meta-analysis revealed that three-port LC results in shorter operative duration. Fewer port insertions, along with reduced instrument handling, lead to the shorter operative time of the three-port technique (16).

Intraoperative complications were less common among patients who received three-port access to the gallbladder compared to patients who received four-port access (17% vs. 40%, $p = 0.09$). Surgical conversions to open procedures required treatment of 27% of three-port patients and 40% of four-port patients ($p = 0.255$). The results suggest that three-port surgery may result in fewer surgical complications and fewer procedure conversions, although the statistical significance was not achieved. Similar data from Lin et al. (2024) show that intraoperative difficulties, along with surgical conversions, occurred at comparable rates between the two methods (17).

The postoperative examination showed that 40% of patients underwent complications through the three-port approach and 53% via the four-port method ($p = 0.423$). The research established that patients undergoing three-port surgery needed only 2.8 ± 0.6 days of hospital admission, whereas patients with four-port surgery needed 3.5 ± 0.7 days before hospital discharge ($p < 0.0001$). The three-port access method resulted in lower postoperative pain levels, which patients reported as 5.7 ± 0.9 compared to the four-port method with 6.5 ± 0.9 ($p = 0.001$). Wang et al. (2025) in their systematic review confirmed that both postoperative pain and hospital stay duration were improved by the three-port technique (18). The three-port approach led to faster recovery times (14.9 ± 1.4 days compared to 17.2 ± 1.5 days) along with improved patient satisfaction scores (8.3 ± 0.7 versus 7.6 ± 0.75) according to statistical analysis ($p < 0.0001$ and $p = 0.002$). The data reveal that three-port laparoscopic cholecystectomy delivers better recovery rates, together with enhanced patient contentment. The selection between three-port and four-port LC requires individual consideration because factors such as patient conditions, together with surgeon expertise and treatment conditions, influence the choice process (19).

Conclusion

Current evidence shows that three-port LC presents itself as a safe surgical approach substitute for four-port LC by delivering lower operative duration and shorter hospitalisation, along with less pain and elevated patient satisfaction. The approval of these findings requires additional full-scale randomised controlled trials that will enable definitive decisions about suitable operative techniques.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

MS (FCPS Trainee)
Manuscript drafting, Study Design,
RK (FCPS trainee)
Review of Literature, Data entry, Data analysis, and drafting articles.
AA (Associate professor)
Conception of Study, Development of Research Methodology Design,
MKZ (Associate Professor of Surgery)
Study Design, manuscript review, critical input.
MI (Assistant professor),
Manuscript drafting, Study Design,
YL (Professor)
Conception of Study, Development of Research Methodology Design,

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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