

ORIGINAL ARTICLE

A Randomized Controlled Trial Comparing Three-Port and Four-Port Laparoscopic Cholecystectomy for Acute Cholecystitis

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ABSTRACT

Objective: To compare the efficacy, safety, and postoperative outcomes of three-port versus four-port laparoscopic cholecystectomy (LC) in patients with acute cholecystitis.

Methods: A prospective, randomized controlled trial was conducted involving 170 patients diagnosed with acute cholecystitis. Patients were randomly assigned to undergo either three-port or four-port LC. Demographic data, operative time, postoperative pain (measured by Visual Analog Scale), analgesic requirements, hospital stay duration, and complication rates were recorded and analyzed.

Results: The three-port group (n=85) had a mean age of 42.5 years, while the four-port group (n=85) had a mean age of 43.2 years. The male-to-female ratio was 1:2 in both groups. Operative times were comparable between the two groups (mean 45 minutes for three-port vs. 47 minutes for four-port, $p=0.35$). Postoperative pain scores were significantly lower in the three-port group (mean VAS score 2.1 vs. 3.4, $p<0.001$). Analgesic requirements were also reduced in the three-port group (mean 120 mg pethidine vs. 180 mg, $p<0.01$). Hospital stay was shorter in the three-port group (mean 2.3 days vs. 3.1 days, $p<0.05$). No significant differences were observed in complication rates or conversion to open surgery between the two groups.

Conclusion: Three-port laparoscopic cholecystectomy is a safe and effective alternative to the traditional four-port approach for acute cholecystitis, offering benefits in terms of reduced postoperative pain, lower analgesic requirements, and shorter hospital stays without compromising safety or efficacy.

Keywords: Three-port laparoscopic cholecystectomy, four-port laparoscopic cholecystectomy, acute cholecystitis, postoperative pain, hospital stay, surgical outcomes.

INTRODUCTION

Laparoscopic cholecystectomy (LC) is the gold standard for the management of symptomatic gallstones and acute cholecystitis. Initially, the procedure was performed using a four-port approach, which provides optimal visualization and allows for efficient manipulation of instruments. However, the evolution of laparoscopic techniques has prompted the introduction of the three-port approach, which is suggested to reduce postoperative pain, improve cosmetic outcomes, and reduce recovery time¹.

Several studies have compared the advantages of the three-port technique over the traditional four-port method. Sun et al. (2009) conducted a meta-analysis comparing the two approaches and found that the three-port method resulted in less postoperative pain and a faster recovery, with no difference in operative time or complication rates². Similarly, Al-Azawi et al. (2007) demonstrated that the three-port approach was safe and effective for both acute and chronic cholecystitis, with patients experiencing shorter hospital stays and reduced analgesic consumption³. Trichak et al. (2004) found that the three-port technique was associated with reduced postoperative pain, fewer complications, and a shorter recovery period compared to the traditional four-port approach⁴.

However, some concerns remain about the three-port technique, particularly in patients with complex cases or anatomical variations. For example, studies by Ruggiero et al. (2012) and Zuckerman et al. (2009) emphasized that while the three-port method works well for uncomplicated cases, it may not be as effective in patients with significant anatomical variations or advanced cholecystitis^{5,6}. This study aims to compare the outcomes of the three-port and four-port approaches in 170 patients with acute cholecystitis, focusing on operative time, postoperative pain, analgesic requirements, hospital stay, and complications.

METHODOLOGY

This study was a prospective, randomized controlled trial (RCT) was conducted at Department of General Surgery Indus Hospital Manawan, Lahore and CMH Lahore over 12 months, from June 2022 to May 2023. Ethical approval for the study was obtained from the Institutional Review Board (IRB), and written informed consent was taken from all patients prior to their participation in the study.

A total of 170 patients aged between 18 and 75 years with acute cholecystitis were enrolled. Inclusion criteria included clinically diagnosed acute cholecystitis confirmed by biochemical and radiological tests (such as ultrasonography showing gallbladder wall thickening, gallstones, and pericholecystic fluid). Patients were excluded if they had a history of previous abdominal surgeries, were pregnant, or had contraindications to laparoscopy. Additionally, patients with severe comorbidities that contraindicated anesthesia or surgery were also excluded.

After enrollment, patients were randomly assigned to either the three-port or four-port group using a computer-generated randomization sequence. The randomization process was concealed, and the allocation was done by the clinical research coordinator. The three-port technique involved one port placed in the umbilicus for the camera, one in the midclavicular line for the working instrument, and another in the anterior axillary line for retraction. In contrast, the four-port technique followed the standard procedure with one port in the umbilicus for the camera, two ports in the midclavicular and anterior axillary lines for the working instruments, and a fourth port placed subxiphoid for retraction.

The primary outcomes measured in the study were operative time, postoperative pain (measured using the Visual Analog Scale [VAS] at 6, 12, and 24 hours post-surgery), postoperative analgesic requirements (measured in mg of pethidine used in the first 24 hours), and the duration of the hospital stay. Secondary outcomes included complication rates (such as bile duct injury, bleeding, infection, and port-site hernias), as well as any conversions to open surgery.

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All patients who completed the surgery without major intraoperative complications were included in the final analysis. Data were collected on all outcomes by trained research personnel, and any missing or incomplete data were excluded from analysis. For statistical analysis, continuous variables, such as operative time, pain scores, and hospital stay duration, were compared between the two groups using independent t-tests, while categorical variables (such as complication rates) were analyzed using chi-square tests or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

The demographic characteristics of patients in both groups were comparable. The mean age of the three-port group was 42.5 years (range 18-75), and the mean age of the four-port group was 43.2 years (range 20-74). The male-to-female ratio was 1:2 in both groups. The body mass index (BMI) in the three-port group was 27.4 ± 4.1 , while in the four-port group, it was 28.1 ± 3.9 . The majority of patients in both groups had an ASA score of II (35/85 for three-port and 33/85 for four-port).

Table 1: Baseline details of all the included patients

Variable	Three-Port Group (n=85)	Four-Port Group (n=85)
Mean Age (years)	42.5 ± 10.2	43.2 ± 9.8
Gender (M:F)	28:57	30:55
BMI (kg/m ²)	27.4 ± 4.1	28.1 ± 3.9
ASA Score (I/II/III)	40/35/10	42/33/10

Operative time was similar between the two groups, with the three-port group having a mean operative time of 45 minutes, compared to 47 minutes for the four-port group ($p=0.35$). There were no conversions to open surgery in either group. Table 2

Table 2: Operative outcomes between both groups

Outcome	Three-Port Group (n=85)	Four-Port Group (n=85)
Operative Time (minutes)	45.0 ± 8.3	47.0 ± 7.1
Conversion to Open Surgery	0	0
Drain Placement	5	6

Postoperative pain, measured by the Visual Analog Scale (VAS), was significantly lower in the three-port group (mean VAS score 2.1 vs. 3.4 in the four-port group, $p<0.001$). The three-port group also required fewer analgesics, with a mean of 120 mg pethidine compared to 180 mg in the four-port group ($p<0.01$). Hospital stay was shorter in the three-port group (mean 2.3 days vs. 3.1 days, $p<0.05$). Table 3

Table 3: Post-operative outcomes between both groups

Outcome	Three-Port Group (n=85)	Four-Port Group (n=85)	p-value
Postoperative Pain (VAS Score)	2.1 ± 0.9	3.4 ± 1.1	<0.001
Analgesic Requirements (mg pethidine)	120 ± 40	180 ± 50	<0.01
Hospital Stay (days)	2.3 ± 0.6	3.1 ± 0.7	<0.05

There were no significant differences in complications between the two groups. Minor complications, such as bleeding and infection, were observed but were not statistically significant. Table 4

Table 4: Complication between both groups

Complication	Three-Port Group (n=85)	Four-Port Group (n=85)
Bile Duct Injury	0	0
Bleeding	1	2
Infection	2	3
Port Site Hernia	1	1

DISCUSSION

This study demonstrates that three-port laparoscopic cholecystectomy (LC) is a safe and effective alternative to the traditional four-port approach for the management of acute cholecystitis. Our findings align with those of previous studies, which indicate that the three-port technique offers significant advantages in terms of reduced postoperative pain and faster recovery without compromising operative outcomes.

The significant reduction in postoperative pain observed in the three-port group is consistent with the findings of Sun et al. (2009), who reported that the three-port approach resulted in less postoperative discomfort compared to the four-port technique¹. This can be attributed to the fewer incisions and less tissue trauma in the three-port approach, which likely leads to a more comfortable postoperative course. Similarly, Al-Azawi et al. (2007) and Trichak et al. (2004) observed that the three-port technique was associated with reduced analgesic requirements and shorter recovery times, further supporting the results of our study^{2,3}.

In terms of operative time, our study found no significant difference between the three-port and four-port groups, which is consistent with other studies, such as those by Zuckerman et al. (2009) and Ruggiero et al. (2012)^{4,5}. This suggests that the three-port technique does not increase the complexity of the procedure, making it a viable alternative to the traditional approach. Furthermore, there were no conversions to open surgery in either group, which aligns with findings from studies by Ruggiero et al. (2012) and Yousuf et al. (2016), who also reported a low conversion rate in both groups^{5,6}.

Postoperative analgesic requirements were significantly lower in the three-port group, which is consistent with the study by Lee et al. (2014), who reported reduced use of analgesics in patients undergoing three-port LC⁷. This reduction in analgesic use can be attributed to less incisional trauma, which reduces the need for pain relief after surgery.

Our study also observed a shorter hospital stay in the three-port group, which supports findings from several other studies, including those by Zha et al. (2011) and Jadhav et al. (2014), who reported a similar reduction in hospital stay in the three-port group compared to the four-port group^{8,9}. The shorter hospital stay can be explained by the faster recovery associated with the three-port technique, which is attributed to less pain, fewer complications, and a quicker return to normal function.

Regarding complications, our study found no significant differences in complication rates between the two groups. This finding is consistent with other studies, including those by Morino et al. (2002) and Kelly et al. (2005), who reported similar complication rates in both groups^{10,11}. The low complication rates observed in our study suggest that the three-port technique is equally safe as the four-port technique when performed by experienced surgeons.

However, it is important to note that the three-port technique may not be suitable for all patients, particularly those with complex gallbladder anatomy, severe inflammation, or other complicating factors. Several studies, including those by Kitano et al. (2002) and La Regina et al. (2012), have emphasized that the four-port technique may still be preferred in such cases to provide better access to the gallbladder^{12,13}. Therefore, careful patient selection is crucial for the success of the three-port approach.

Additionally, the three-port technique may offer cosmetic benefits, as fewer incisions are made, leading to improved aesthetic outcomes. Studies such as those by Rosi et al. (2010) and Sahu et al. (2018) have highlighted the aesthetic advantages of the three-port technique, especially in terms of postoperative scarring^{14,15}. The smaller incisions may also reduce the risk of port-site hernias, a complication often associated with laparoscopic surgeries.

CONCLUSION

Overall, the three-port technique appears to be a safe and effective option for patients with acute cholecystitis. The advantages of reduced postoperative pain, quicker recovery, and shorter hospital stays make it an attractive alternative to the four-port technique, especially in centers aiming to reduce healthcare costs and improve patient outcomes.

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