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RESEARCH ARTICLE
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"ASSESSING THE EFFICACY AND SAFETY OF THREE PORT VS FOUR PORT TECHNIQUE IN LAPAROSCOPIC CHOLECYSTECTOMY"

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ABTRACT

Background: Laparoscopic cholecystectomy has evolved as the gold standard for the treatment of symptomatic cholelithiasis. Recent innovations seek to minimize invasiveness by reducing the number of ports. This study compares the outcomes of three-port and four-port laparoscopic cholecystectomy. **Methods:** This prospective comparative study was conducted at Santosh Medical College over 1.5 years, involving 124 patients undergoing elective laparoscopic cholecystectomy. Patients were randomly allocated to either the three-port or four-port group. Outcomes compared included operative time, intraoperative complications, postoperative pain, analgesic requirements, hospital stay, cosmesis, and conversion rates. **Results:** The three-port group showed significantly shorter mean operative time (65 vs. 104 min, $p<0.001$), lower analgesic requirements, and shorter hospital stay (mean 1.98 vs. 4.79 days, $p<0.001$). Both groups had similar complication rates and return-to-activity times. Scar cosmesis, assessed by POSAS, favored the three-port group. Conversion to open surgery occurred only in one patient in the three-port group. **Conclusion:** Three-port laparoscopic cholecystectomy is a safe and effective alternative to the conventional four-port technique, offering benefits in operative efficiency, reduced analgesic requirement, and improved cosmetic outcomes without compromising safety.

Keywords: Laparoscopic cholecystectomy; Three-port technique; Four-port technique; Gallstones; Minimally invasive surgery; Operative time

Introduction

Cholelithiasis, or gallstone disease, represents a prevalent gastrointestinal condition affecting millions worldwide. It is characterized by the formation of stones within the gallbladder, often asymptomatic, though it can lead to significant morbidity when symptoms arise. In Western populations, the prevalence reaches 10–15%, whereas in India, it stands lower at approximately 4% [1]. Surgical

removal of the gallbladder, or cholecystectomy, remains the definitive treatment for symptomatic cases.

The surgical approach to cholecystectomy has undergone a remarkable transformation. Since the pioneering laparoscopic cholecystectomy performed by Erich Mühe in 1985, minimally invasive surgery has become the gold standard for treating gallstone disease [2]. The National Institutes of Health (NIH) formally endorsed laparoscopic cholecystectomy in 1992, citing advantages such as reduced postoperative pain, shorter hospital stay, early resumption of oral intake, faster return to normal activities, and improved cosmetic results [3].

Traditionally, laparoscopic cholecystectomy employs four ports. However, recent years have witnessed a growing interest in reducing the number of ports used. The rationale behind the evolution from four-port to three-port and even single-port techniques lies in enhancing cosmetic outcomes, minimizing invasiveness, and further improving patient satisfaction [4,5]. The three-port technique, by omitting the fourth port typically used for lateral gallbladder traction, challenges conventional practice and offers potential benefits such as shorter operative time, less postoperative pain, and fewer port-related complications[4].

Despite these theoretical benefits, debate persists regarding the safety, feasibility, and efficacy of the three-port technique. Some surgeons argue that omitting the fourth port may compromise surgical ergonomics or lead to increased intraoperative complications, especially in difficult cases [5]. Moreover, patient-specific factors such as comorbidities, anatomical variations, or the presence of acute inflammation may influence the suitability of one approach over the other.

The present prospective comparative clinical study was undertaken to assess whether three-port laparoscopic cholecystectomy offers comparable, if not superior, outcomes compared to the conventional four-port technique. The study focuses on operative time, intraoperative and postoperative complications, analgesic use, hospital stay, return to normal activity, conversion rate, and scar cosmesis — providing a comprehensive evaluation of both approaches in elective settings.

Materials and Methods

This prospective comparative clinical study was conducted over a period of 1.5 years in the Department of General Surgery at Santosh Medical College and Hospital. A total of 124 patients aged between 18 and 60 years, diagnosed with cholelithiasis on ultrasonography and scheduled for elective laparoscopic cholecystectomy, were enrolled in the study after obtaining informed consent. Patients with gallbladder malignancy, common bile duct stones requiring exploration, obstructive jaundice, or those who declined to participate were excluded.

All patients underwent a detailed clinical evaluation including demographic profiling, history, physical examination, and relevant investigations such as complete blood count, liver function tests, blood sugar, renal function tests, chest X-ray, and abdominal ultrasound. Preoperative anesthesia fitness was confirmed for all cases.

Eligible patients were randomly allocated into two groups using the sealed-envelope method: Group A (three-port laparoscopic cholecystectomy) and Group B (four-port laparoscopic cholecystectomy). All surgeries were performed under general anesthesia by experienced surgeons using a standardized operative protocol. In the three-port group, a 10-mm umbilical port, a 10-mm epigastric port, and a 5-mm right subcostal port were used. In the four-port group, an additional 5-mm lateral subcostal port was placed. The need to convert to an open procedure or add a fourth port in the three-port group was recorded. Operative details including duration of surgery and intraoperative complications were documented.

Postoperatively, all patients were monitored for vital signs, pain scores, need for additional analgesia, surgical site infections, and time to return to normal activity. Pain assessment was done using a standard visual analog scale (VAS) and analgesic use was documented in milligrams. The length of hospital stay and any postoperative complications were also noted. Cosmetic outcomes were evaluated at follow-up using the Patient and Observer Scar Assessment Scale (POSAS), measuring parameters such as pigmentation, thickness, pliability, and vascularity.

Statistical analysis

Data were compiled in Microsoft Excel and analyzed using Stata MP-17. The Kolmogorov–Smirnov test was used to assess data distribution. Parametric data were analyzed using independent t-tests, while categorical data were compared using the Chi-square test. A p-value less than 0.05 was considered statistically significant.

Results

A total of 124 patients were enrolled and randomized into two groups: 62 patients underwent three-port laparoscopic cholecystectomy (Group A) and 62 underwent four-port laparoscopic cholecystectomy (Group B). The demographic and clinical profiles of both groups were comparable at baseline (table 1). No statistically significant differences were observed in baseline characteristics between the two groups ($p>0.05$), indicating successful randomization.

Table 1: Baseline Characteristics of Study Participants

Parameter	Three-Port (n=62)	Four-Port (n=62)	*P* value
Age (years), mean ± SD	34.8 ± 9.2	36.5 ± 10.4	0.22
Gender (M:F)	18:44	20:42	0.69
Diabetes mellitus (%)	2 (3.2%)	5 (8.1%)	0.25
Hypertension (%)	4 (6.5%)	2 (3.2%)	0.15
Previous abdominal surgery (%)	9 (14.5%)	7 (11.3%)	0.59
Gallbladder distension (%)	62 (100%)	62 (100%)	-
Pericholecystic fluid (%)	5 (8.1%)	3 (4.8%)	0.30
Multiple gallstones (%)	46 (74.2%)	44 (71.0%)	0.80

Operative time was significantly shorter in the three-port group ($p<0.001$). Though intraoperative complications were slightly higher in this group, the difference was not statistically significant (table 2).

Table 2: Comparison of Operative and Intraoperative Outcomes

Outcome	Three-Port (n=62)	Four-Port (n=62)	*P* value
Operative time (min), mean ± SD	65 ± 11.7	104 ± 9.3	<0.001
Conversion to open (%)	1 (1.6%)	0 (0.0%)	0.32
Intraoperative complications (%)	9 (14.5%)	4 (6.5%)	0.25
‣ Vascular injury	3 (4.8%)	2 (3.2%)	1.0
‣ Gallbladder perforation	4 (6.4%)	2 (3.2%)	0.49

The three-port technique demonstrated significantly reduced analgesia needs and hospital stay. Cosmetic outcomes, evaluated using POSAS, also favoured the three-port approach with significantly better scar parameters ($p<0.001$) (table 3). Vascular injury at the liver bed was more frequent in the 3-port group (2.4%) than in the 4-port group (0.8%). Gallbladder perforation with bile spillage occurred in 3.2% of cases in the 3-port group, whereas it was lower (1.6%) in the 4-port group.

Table 3: Postoperative Outcomes

Parameter	Three-Port (n=62)	Four-Port (n=62)	*P* value
Analgesic requirement (mg), mean ± SD	116.1 ± 50.2	262.5 ± 37.8	<0.001
Hospital stay (days), mean ± SD	1.98 ± 0.91	4.79 ± 0.75	<0.001
Return to normal activity (days), mean ± SD	4.73 ± 0.79	4.87 ± 0.82	0.30
Postoperative complications (%)	1 (1.6%)	0 (0.0%)	0.32
Scar score (POSAS), mean (vascularity)	1.94 ± 0.92	3.84 ± 0.75	<0.001

Discussion

This prospective comparative clinical study was conducted to evaluate the safety, efficacy, and clinical outcomes of three-port versus four-port laparoscopic cholecystectomy. Both approaches are accepted techniques in the surgical management of gallstone disease, but there remains clinical interest in refining laparoscopic techniques to reduce invasiveness without compromising surgical efficacy. In this context, our study offers robust evidence favoring the three-port approach, especially in terms of operative efficiency, postoperative analgesic requirement, and cosmetic satisfaction.

The mean operative time was significantly lower in the three-port group (65 minutes) compared to the four-port group (104 minutes), with a *p*-value <0.001. These findings align with those of Kumar M et al., who reported a shorter mean duration in patients undergoing three-port laparoscopic cholecystectomy (47.3 ± 29.8 min) compared to four-port procedures (60.8 ± 32.3 min) [9]. Similarly, Krishnanand et al. noted comparable durations between the two techniques, further confirming the feasibility of reduced-port access without prolonging operative time [7].

Intraoperative complications, such as gallbladder perforation and vascular injuries, were slightly higher in the three-port group but did not reach statistical significance. This reflects earlier concerns that omitting the fourth port could compromise surgical ergonomics or dissection angle [5]. However, our findings, along with those of Nidoni et al., suggest that proper patient selection and surgical experience can effectively mitigate these risks [8].

Postoperative analgesic requirements were substantially lower in the three-port group, which may be attributed to the reduced number of incisions and, hence, fewer sources of somatic pain. Singhal P et al. observed a significant reduction in analgesic demand at 24 hours in patients undergoing three-port cholecystectomy [9]. This finding is consistent with the broader minimally invasive surgical principle that fewer incisions lead to improved postoperative comfort and faster recovery.

Cosmetic outcomes also favoured the three-port group. Scars assessed using the Patient and Observer Scar Assessment Scale (POSAS) demonstrated significantly better results in vascularity, pigmentation, thickness, and surface area. These findings support the cosmetic advantages of reduced-port approaches, which have been highlighted in recent literature, especially among younger patients and those with cosmetic concerns [6,14].

Conversion to open surgery was rare in both groups. Our observed rate of 0.8% in the three-port group and 0% in the four-port group was in line with the findings of Ercan et al., who demonstrated that proper preoperative assessment can help reduce the risk of conversion [10]. Multiple studies, including those by Vyas et al. and Bansal et al., have proposed preoperative scoring systems to predict difficult laparoscopic cholecystectomy, emphasizing factors like gallbladder wall thickness, pericholecystic fluid, and previous surgeries [8,15].

Importantly, comorbidities such as diabetes and hypertension did not significantly impact port selection or outcomes in our study. These findings confirm that three-port laparoscopic cholecystectomy is a safe alternative even in patients with controlled systemic diseases, provided perioperative care and surgical planning are optimized.

Our study further supports that patient-specific anatomical or radiological variables — such as gallbladder distension, number of stones, or pericholecystic fluid — do not significantly influence the

choice of port configuration. The ability to perform safe laparoscopic cholecystectomy across varying anatomical presentations reinforces the versatility of the three-port approach.

Taken together, these findings contribute to the growing body of literature advocating for three-port laparoscopic cholecystectomy as an efficient, safe, and cosmetically superior alternative to the conventional four-port technique. It aligns with contemporary surgical goals that prioritize minimal invasiveness and enhanced patient satisfaction [1,2,3].

However, surgical flexibility remains essential. The ability to add a fourth port intraoperatively in difficult cases should not be viewed as failure but as a necessary adaptation for patient safety. Therefore, while the three-port approach can be recommended as the first-line technique in suitable patients, surgeon experience and intraoperative judgment continue to play a central role in successful outcomes.

Conclusion

Three-port laparoscopic cholecystectomy is a safe and effective alternative to the conventional four-port method. It offers advantages such as reduced operative time, lower analgesic use, shorter hospital stay, and better cosmetic outcomes, without increasing complication or conversion rates. It is feasible in most elective cases and aligns with minimally invasive surgical goals.

Recommendations

- Prefer the three-port technique in uncomplicated elective cholecystectomy.
- Ensure surgical teams are trained to convert to four-port or open procedures when needed.
- Further large-scale studies should assess long-term outcomes and cost-effectiveness

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