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A Comparative Analysis of Three-Port vs Standard Four Port Technique of Laparoscopic Cholecystectomy

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ABSTRACT
The advancement of Laparoscopic Cholecystectomy (LC) techniques aims to reduce the size and number of ports used, with the goal of enhancing patient satisfaction and outcomes. This study was conducted to evaluate and compare the safety, outcomes and advantages of three-port versus four-port LC procedures. This prospective study involved 123 patients with symptomatic gallstone disease or gallbladder polyps larger than 1cm at the base. Patients with jaundice or choledocholithiasis were excluded. The patients were divided into two groups: Group T underwent three-port LC, while Group F underwent four-port LC. Various outcomes, including surgical duration, intra-operative and post-operative variables, were assessed and compared between the two groups. Statistically significant differences were observed between the two groups in terms of Visual Analogue Score for pain at 6 and 24 hours, analgesic requirement, duration of hospital stay and return to work, with all parameters favoring the three-port LC group. Patients in the three-port group also reported better cosmetic outcomes. Other variables showed comparable results between the two groups. The three-port LC procedure was found to be safe and potentially more cost-effective compared to the four-port LC procedure. Experienced surgeons can initiate LC with three ports and add a fourth port if necessary.

INTRODUCTION

Gallbladder-related diseases account for a significant proportion of gastrointestinal disorders, with gallstone disease being the predominant biliary condition observed. The population residing in India exhibits a pronounced predisposition to gallstone formation, to the extent that cholecystectomy ranks as the most frequently executed surgical intervention[1-5]. For individuals manifesting symptoms of gallstone disease, cholecystectomy remains the cornerstone of therapeutic intervention. The landscape of gallstone disease management has undergone a substantial transformation over recent years, following the advent of Laparoscopic Cholecystectomy[6]. Following the NIH Consensus Development Conference in September 1992, Laparoscopic Cholecystectomy gained recognition as the preferred treatment modality for cholelithiasis and has since been deemed the "Gold standard" in gallstone management. It is also favored for the treatment of a majority of other gallbladder conditions[7,8]. The inaugural laparoscopic cholecystectomy marked the beginning of a phase of ongoing refinement in the technique, aiming to enhance surgical outcomes, patient contentment, aesthetic results and to minimize post-surgical discomfort, duration of hospitalization and overall costs[9]. One strategy proposed to decrease post-operative pain and shorten hospital stays involves reducing the size and quantity of surgical ports, specifically by lowering the number of ports from four to three. The fourth port, typically positioned laterally, is employed in the American technique for grasping and laterally retracting the gallbladder fundus to unveil the Calot's triangle, thereby aiding the dissection in this area. Omitting this port in the three-port method has yielded promising outcomes in recent investigations[10,11]. This forward-looking comparative study aimed to assess and juxtapose the safety, benefits and outcomes of three-port versus four-port laparoscopic cholecystectomy, evaluating variables such as surgery duration, complication frequency, complication types, post-operative discomfort, length of hospital stay, recovery time and cosmetic results.

MATERIALS AND METHODS

This research was carried out involving a cohort of 123 patients who underwent laparoscopic cholecystectomy at an Indian medical college and hospital. The inclusion criteria encompassed patients with symptomatic gallstone disease and gall bladder polyps having a base diameter exceeding 1cm, as confirmed by ultrasound imaging. Exclusion criteria involved patients who declined participation, individuals with jaundice, radiographically detectable common bile duct stones, or those deemed unfit for laparoscopic procedures. Furthermore, patients unfit for general anesthesia (ASA-grade IV), individuals with substantial portal hypertension, liver cirrhosis, uncorrectable coagulopathies, acute pancreatitis, generalized peritonitis, or suspected/proven malignancy were excluded from the study. Patients were stratified into two groups-Group T and Group F. Group T underwent three-port laparoscopic cholecystectomy, while Group F underwent conventional four-port laparoscopic cholecystectomy. All surgeries were conducted by the same surgical team. Demographic data and ultrasound findings were recorded and pre-operative assessments were conducted with patients admitted a day before surgery For three-port Technique, Two 10mm trocars (epigastric and supra umbilical regions) and one 5mm trocar (right mid-clavicular subcostal region) were inserted. Dissection and extraction of the gall bladder were carried out through the epigastric port. In. four-port Technique, in addition to the three ports mentioned above, another 5mm port was inserted in the anterior axillary line in the right flank region to facilitate gall bladder dissection.

Parameters such as duration of surgery, conversion rates between three-port and four-port techniques, reasons for conversion to open cholecystectomy, intra operative variables including complications, bleed, bile spillage, drain placement, postoperative variables like port site pain assessed using the Visual Analog Scale, postoperative complications, hospital stay, early ambulation/return to work and cosmesis were evaluated for Postoperative Assessment. Descriptive statistics were employed, presenting continuous variables as mean, standard deviation and range and ordinal variables as percentages. Comparison between three-port and four-port laparoscopic cholecystectomy was conducted using appropriate statistical tests (chi-square test, Fisher exact test, independent sample t-test) with significance set at a p-value less than 0.05. Statistical analysis was performed using SPSS version 19.0.

RESULTS AND DISCUSSIONS

The demographic characteristics of the patients are summarized in (Table 1), indicating comparable distributions across the two study groups. A total of 123 patients participated in the study, with 61 (50%) patients undergoing three-port laparoscopic cholecystectomy and the remaining 62 undergoing four-port laparoscopic cholecystectomy. The female-to-male ratio was 7.20:1. The mean age of the study participants was 42.90±9.1 years, with ages ranging from 27-66 years. Ultrasound assessments revealed that the majority of patients presented with multiple calculi in the gallbladder. In the three-port group, 55 cases were successfully completed without requiring any conversion. Four patients necessitated conversion to the four-port procedure, while two patients underwent conversion to open

Table 1: Clinico-demographic variables in study participants

Variable	Group T	Group F	Total
Age in years; mean (range)	42.8 (27-63)	42.12 (29-66)	42.9 (27-66)
Weight in kg, mean (range)	63.8 (43-96)	68.1 (47-109)	66.0 (43-109)
Males, n(%)	8 (6.50)	7 (5.69)	15 (12.20)
Females, n(%)	53 (43.09)	55 (44.72)	108 (87.80)
Single calculus on USG, n(%)	26 (21.14)	27 (21.95)	53 (43.09)
Multiple calculi on USG, n(%)	34 (27.64)	33 (26.83)	67 (54.47)
Polyp on USG, n(%)	1 (0.81)	2 (1.63)	3 (2.44)
Acute symptoms, n(%)	4 (3.25)	4 (3.25)	8 (6.50)
Chronic symptoms, n(%)	58 (47.15)	57 (46.34)	115 (93.50)

Table 2: Comparison of conversion rate and intra-operative complications

Variable	Group T	Group F	p-value
Conversion to Open, n (%)	2 (1.63)	3 (2.44)	0.15
Conversion to 4 port, n (%)	4 (3.25)	NA	
No conversion, n (%)	55 (44.72)	59 (47.97)	
Bleeding from cystic/major artery	1 (0.81)	3 (2.44)	
Bile duct injury	1 (0.81)	0 (0.00)	
Visceral organ injury	0 (0.00)	1 (0.81)	0.65
Others	1 (0.81)	1 (0.81)	
None	58 (47.15)	57 (46.34)	
Bleeding <10ml	46 (37.40)	33 (26.83)	0.45
Bleeding 10-20ml	15 (12.20)	28 (22.76)	
Bleeding >20ml	0 (0.00)	1 (0.81)	
Intraoperative adhesions	29 (23.58)	34 (27.64)	0.71
Bile leak	16 (13.01)	10 (8.13)	0.21

Table 3: Comparison of operation time and postoperative parameters

Variable	Group T	Group F	p-value
Operative time, minutes	46.43±11.68	41.76±15.23	0.21
VAS at 6 hours	5.68±0.87	6.63±0.79	<0.05
VAS at 24 hours	2.76±0.84	3.62±0.77	<0.05
Diclofenac ampoules required (n)	3.82±1.05	4.31±0.79	<0.05
Duration of hospital stay, in hours	37.83±11.23	37.96±5.01	0.85
Return to normal activity, in days	5.48±0.48	5.93±0.79	<0.05

Table 4: Comparison of operation time and postoperative parameters

Complications	Group T	Group F	p-value
Wound infection	4 (3.25)	1 (0.81)	0.14
Wound hematoma	1 (0.81)	3 (2.44)	
Abdominal pain	0 (0.00)	1 (0.81)	
Port site hernia at 1 month	0 (0.00)	0 (0.00)	
None	56 (45.53)	57 (46.34)	

Table 5: Patient satisfaction about cosmetic outcome

Outcome	Group T	Group F	p-value
Good	48 (39.02)	31 (25.20)	<0.05
Average	12 (9.76)	30 (24.39)	
Poor	1 (0.81)	1 (0.81)	

cholecystectomy. Conversely, in the four-port group, three cases were converted to open cholecystectomy for completion (Table 2). However, this outcome did not exhibit statistical significance. In (Table 2), various intra operative complications encountered in both groups are outlined, with no statistically significant differences noted between them. The amount of intra operative bleeding in the two groups is also detailed in (Table 2), indicating that most patients experienced intra operative bleeding of less than 10ml. Notably, the disparity in bleeding between the groups was not statistically significant, albeit slightly higher in the four-port group. Gallbladder adhesions with the omentum, small bowel, or duodenum were observed in 29 patients in the three-port group and 34 patients in the four-port group (Table 2).

The comparative analysis of various postoperative variables between the two groups is presented in (Table 3). Pain levels at 6 hours and 24 hours post-operation were notably lower in the three-port group compared to the four-port group, with statistically significant results. Additionally, the average requirement of diclofenac ampoules in the three-port group was significantly lower than that in the four-port group. While the average duration of hospital stay was slightly shorter in the three-port group compared to the four-port cholecystectomy group, this difference did not reach statistical significance. However, the mean time for returning to normal activities was significantly shorter in the three-port group. Regarding postoperative complications, there was no statistically significant difference observed between the two groups, as indicated in (Table 4). Overall, patient satisfaction concerning cosmetic outcomes, particularly scar appearance, was significantly higher in the three-port group, as detailed in (Table 5). In the current investigation involving 123 participants, a predominant number of patients were females within the age bracket of 40-50 years. The demographic distribution concerning age and sex was notably

consistent across both study groups. Gallstone disease predominantly affects middle-aged women, with some research attributing its etiology to estrogen[12]. The majority of subjects in both cohorts presented with multiple stones and chronic symptomatology.

Naso-gastric intubation was utilized solely during the surgical procedure to deflate the stomach and duodenum, thereby enhancing laparoscopic visualization of the abdominal organs, in alignment with methodologies reported by prior studies[13-16]. Intra operative observations revealed a higher incidence of adhesions in the four-port group compared to the three-port group, particularly around the gallbladder fundus and Calot's triangle, predominantly involving the omentum, small intestine, stomach, transverse colon and anterior abdominal wall. Except for three instances, these adhesions were successfully managed using techniques such as monopolar electro cautery, application of fundal pressure, and irrigation and suction. Within the Group T participants, there were 4 instances requiring conversion to the four-port technique and 2 instances necessitating conversion to open cholecystectomy. The introduction of a fourth port was necessitated under various circumstances, such as challenging anatomical configurations of Calot's triangle, aberrant relationships between the cystic duct and cystic artery, a distended Hartman's pouch complicating the anatomical clarity of Calot's triangle, or a prolonged right hepatic artery necessitating tracing to the gallbladder fossa alongside an extended cystic duct before its convergence with the common hepatic duct. Additional conversion factors included cholecysto-digestive fistula, choledocholithiasis, intra hepatic adhesions and equipment malfunction[17-19].

The comparative analysis of complications between the two groups revealed no significant disparity. Nonetheless, the incidence of hemorrhagic complications was marginally higher in the four-port cohort, possibly attributable to the greater prevalence of adhesions within Calot's triangle in this group. Interestingly, the mean duration of surgery was marginally shorter in the four-port group. This reduction in operative time may be ascribed to the enhanced exposure of Calot's triangle facilitated by the additional port enabling lateral retraction of the gallbladder. This observation is corroborated by mixed outcomes in the literature, with some studies aligning with our findings while others report shorter operative times for the three-port technique[19,20-24]. The rationale provided includes the reduced time required for creating an additional port. It is postulated that as the three-port cholecystectomy method gains traction and experience accumulates, the average procedural duration may decrease. Extraction of the gallbladder through the epigastric port, akin to techniques described in other studies[13,25] and the umbilical port as utilized by various researchers[16,21,26], has been documented. In terms of post-operative outcomes, the three-port cholecystectomy demonstrated superior performance over the four-port approach. Post-operative pain at 6 and 24 hours post-operation, analgesic usage, duration until return to work and routine activities and the average length of hospital stay were all statistically lower in the three-port group. The cosmetic outcomes assessed one month post-surgery indicated higher patient satisfaction in the three-port group, primarily due to the reduced number of incisions. The level of difficulty encountered in the three-port laparoscopic cholecystectomy was greater compared to the four-port method, particularly in complex cases. This study's limitations include its small sample size and the fact that it was conducted at a single institution. Future research involving larger cohorts across multiple centers could provide further validation of these findings.

CONCLUSION

Despite a slightly longer surgical duration associated with the three-port technique, several key post-operative benefits were observed, including reduced post-operative pain, quicker recovery, shorter hospital stay, faster return to work and improved cosmetic results compared to the four-port approach. Consequently, the overall cost-effectiveness of the three-port procedure appears favorable due to lower costs associated with an additional port, reduced analgesic requirements and fewer workdays lost. moreover, the rates of intra operative complications and factors necessitating conversion to an open surgical technique were found to be comparable between both procedures. Therefore, based on our findings, we advocate for the adoption of the three-port laparoscopic cholecystectomy as a preferred approach for managing benign gall bladder disease, considering its favorable outcomes and cost-effectiveness.

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