ORIGINAL ARTICLE

A comparative study of four port and three-port laparoscopic cholecystectomy

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Introduction: To compare four-port laparoscopic cholecystectomy with three-port laparoscopic cholecystectomy for calculus cholecystitis with respect to duration of surgery, conversion rates from three to four-port technique, complications, assessment of postoperative pain, hospital stay, and cosmesis according to Hollander wound score. **Materials and Methods:** One hundred patients who fulfilled the inclusion criteria and underwent laparoscopic cholecystectomy in the department of General Surgery, Rohilkhand Medical College and Hospital, Bareilly, between November 2018 and October 2019 for symptomatic cholelithiasis were evaluated and included in this study. They were divided into two Groups A and B of 50 each which underwent three-port and four-port laparoscopic cholecystectomy, respectively, and a comparison was done between the two groups. **Results:** Patients in the three-port group had a shorter operative time 22.70 ± 2.52 min. as compared to 43.80 ± 4.11 min. in the four-port group. The post-operative pain at <24 h and >24 h was less in the three-port group, as was the post-operative hospital stay (3.14 ± 0.73 in the three port and 4.04 ± 0.78 days in the four-port group). Cosmetic satisfaction was found to be better in the three-port group ($P > 0.001$) but the results were not statistically significant. **Conclusion:** Overall results of this study demonstrate that the use of three ports in laparoscopic cholecystectomy did not significantly affect the procedure's safety, conversion rate, and operating time. It had the advantages of lesser post-operative pain, shorter hospital stays, and fewer scars.

KEY WORDS: Hollander cosmetic score, laparoscopic cholecystectomy, visual analogue score

INTRODUCTION

Scarless surgery is the Holy Grail of surgery and the very reason for introducing Minimal Access Surgery was the reduction of scars and thereby pain and suffering of the patients.[1]

Laparoscopic surgery was introduced by Dimitri Ott, Georg Kelling, and Hans Christian Jacobeus. In 1901, the abdominal cavity of a pregnant woman was inspected by Von Ott and then procedure was performed by Georg Kelling, named "koelioscopie," as defined in modern laparoscopy. Furthermore, Jacobus in the same year published his first report of what he called "Laparothorakoskopie."[2]

In the 1950s, a publication on diagnostic laparoscopy was released by Raoul Palmer. In 1972, Henry Clarke published a laparoscopic procedure using instruments from the Ven Instrument Company in Buffalo, New York. This work was carried by J.C Tarasconi from the University of Passo Fundo using laparoscopy for performing organ resection for the 1st time, which was then reported at the Third AAGL Meeting in Atlanta, held in November 1976. In 1981, his work was published in The Journal of Reproductive Medicine, which was the 1st time that laparoscopic surgical resection had been recorded in the medical literature.[3]

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In the subsequent years, many authors in Europe and in the United States performed laparoscopic surgery for diagnostic purposes. With the use of the rod-lens optical system and of the cold light fiber-glass illumination the laparoscopy became more popular, especially in the department of gynecologist. By the time laparoscopy was mainly performed for the diagnosis of abdominal trauma and liver disorders, until Lukichev in 1983 and Muhe in 1985, who performed their technique of laparoscopic cholecystectomy in humans.[2]

Since the first laparoscopic surgery was performed by Muhe in 1985 and later published by Mouret, Perrisat, and Dubois in 1987 and 1988,[4-6] laparoscopic surgery has expanded broadly to become the standard procedure for many intra-abdominal surgeries. Cholelithiasis is the most common and important cause of biliary tract disease.[7] Today laparoscopic cholecystectomy is the most common treatment for gallstone disease and one of the most common operations performed worldwide with varied advantages.[8]

Gall stones are among the most common causes of gastrointestinal illness requiring hospitalization. Indeed operations on the biliary tract are among the most common abdominal procedure performed in the United States, with more than 600,000 cholecystectomies performed annually.[9] Treatment of gall stones has evolved markedly since open cholecystectomy was first described by Langenbuch in 1881.[10] Management has changed through time like that of nonsurgical management, laparotomy, mini-laparotomy, and now laparoscopic cholecystectomy which is the gold standard for the treatment of gall stone disease.

In 1992, the statement published by the National Institute of Health Consensus development conference stated that laparoscopic cholecystectomy provides a safe and effective treatment for most patients with symptomatic gall stones.[11] In fact, laparoscopic surgery is the procedure of choice for most benign gall bladder diseases unless obvious contraindication exists. The advantages of earlier return of bowel function, less pain, shorter hospital stay, early return to daily normal activity, improved cosmesis, and cost-effectiveness are appreciated in laparoscopic surgeries.[12]

The term laparoscopy was coined by Hans Christian – Jacobaeus of Sweden in 1911.[13] Alfred Cushieri and George Berciin 1983 suggested the utility of laparoscopic exploration to minimize non-therapeutic laparotomy and applied laparoscopy in the evaluation of penetrating abdominal trauma.[14] They also promoted interventional general surgical laparoscopy, notably, lysis of intra-abdominal adhesion and laparoscopic guided cholecystectomy.

The apparent advantages of less pain, saving hospitalization were incentive enough to pursue this novel technique despite early controversies regarding surgeon training and complication related to lack of experience with this new technique.

Various techniques are used in doing laparoscopic cholecystectomy of which three port and four-port laparoscopic cholecystectomy techniques are widely used. Since the initial days, laparoscopic cholecystectomy has employed four trocars.

With increasing surgeon experience, laparoscopic cholecystectomy has undergone many refinements with reduction in port size. It has been discussed that the fourth trocar may not be necessary, and laparoscopic cholecystectomy can be performed safely without using it. The use of varied surgical instruments is very important for this procedure, for exposing Calot's triangle and dissecting the gallbladder from the gallbladder bed when using the three-port techniques. Further, in the era of laparoscopic surgery, less postoperative pain and early recovery are major goals to achieve better patient care and cost-effectiveness. Several studies have demonstrated that less postoperative pain is associated with a reduction in either size or number of ports.[15]

We investigated the technical feasibility, safety, and benefit of three-port laparoscopic cholecystectomy versus standard four-port laparoscopic cholecystectomy in our setup.

Technical feasibility was defined as the performance of the laparoscopic cholecystectomy without much difficulty using the three-port technique.

This was a prospective randomized controlled clinical study to see the feasibility of reducing port number without compromising the safety in cases of laparoscopic cholecystectomy and evaluated the real benefit associated with it in terms of pain, recovery, and patient satisfaction. Safety was defined as the performance of the procedure without any major complications like bleeding and injury to the bile duct or any viscera. Comparison was done using various parameters like operative time, days of hospital stay, postoperative recovery time after discharge, days taken to return to work, cosmetic satisfaction, quantitative requirement of analgesia after surgery, and assessment of postoperative pain score using a 10cm unscaled visual analog score (VAS) [Figures 1 and 2].

Procedure

The present study was carried out in the Department of Surgery at Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh between November 2018 and October 2019. In our study, a total of 100 patients were included which were statistically calculated using the software Power and sample size program.

Nature of study

A randomized control study (double-blinded).

Preoperative Workup Includes

1. A complete history and physical examination
2. Standard laboratory tests including liver function tests
3. Radiological examinations including abdominal ultrasound which confirmed the presence of gall bladder stones but CECT abdomen scan was done when there was suspicion for any malignancy.

Inclusion Criteria

1. All patients with calculus cholecystitis
2. Age >18 years and <80 years.

Exclusion Criteria

1. Choledocholithiasis
2. Carcinoma of the gall bladder
3. Perforated gall bladder
4. American Society of Anesthesiologists Grade 3 or 4
5. Coagulation disorders
6. Clinical and radiological findings of empyema gall bladder
7. The patients who were started with a three-port laparoscopic cholecystectomy but had to be converted to four-port laparoscopic cholecystectomy.

Sampling Method

The data collected was analyzed using descriptive statistical principles (i.e., mean, proportions, and percentages).

Randomization

Random allocation of patients was done to the two groups by "www.random.org."

The two groups of 50 each were as follows.

- Group A: Three-port laparoscopic cholecystectomy
- Group B: Four-port laparoscopic cholecystectomy.

Ethical Considerations

Informed consent was obtained from all the participants. Ethical approval for the study was obtained from the Institutional Ethical Committee.

Data Collection

All participants were explained about the objectives of the study and an informed written consent was obtained. Face-to-face interviews, history, and physical examination were conducted. The purpose, benefits, risks, anonymity, and confidentiality of the study were clearly explained to the patients. Data were entered in specially prepared case record form for this purpose. The details of preoperative assessment, intra-operative observation, postoperative course, and postoperative follow-up were analyzed by Unpaired-*t*-test. Descriptive statics of numerical variables such as age, conversion of three port to four-port laparoscopic cholecystectomy and mean operative time were computed as Mean ± standard deviation.[12] Frequency and percentage of categorical variables such as gender, conversion factors, perioperative complications, and cosmetic score were computed by Chi-square test.[13] Unpaired *t*-test was used for Continuous variables between the groups[14] such as mean of duration of hospital stay, mean number of days for return to normal daily activities, and VAS pain score [Figure 1].

Statistical Analysis

The results are presented in frequencies, percentages and mean ± SD. The Chi-square test was used to compare the categorical variables. The unpaired *t*-test was used to compare continuous variables between the groups. $P < 0.05$ was considered significant. All data analysis was carried out on the SPSS version 23.0.

METHODOLOGY

After screening of patients as per the inclusion criterias, appropriate patients were enrolled in the study after obtaining written informed consent. Patient details were entered in a pre-structured case record form. Patients presenting to Rohilkhand Medical College and Hospital in the Department of General Surgery, between November 2018 and October 2019 with symptomatic cholelithiasis were evaluated and included.

Operative Technique

The laparoscopic cholecystectomy was carried out according to the standard technique described.

Patient Positioning

The patient was placed in the supine position with the table given a 30-degree head up and 15-degree right side up tilt to allow the colon and duodenum to fall away from the liver edge with the surgeon on the left and assistant on the right of the patient.[16]

Access to the Peritoneal Cavity

Closed peritoneal insufflation using veress needle followed by insertion of the blind port. This technique entails the initial creation of pneumoperitoneum using a veress needle and electric insufflators. The veress needle was inserted at the supra-umbilical site where the port was introduced. After the safe and free penetration of the peritoneal cavity, the insufflation of the peritoneal cavity was continued at an initial inflow rate of about 1 L/min. The insufflator was then switched to high flow to allow complete filling of the peritoneal cavity to a pressure of approximately 10–15 mm Hg. At this point, the veress needle was withdrawn. During the insufflation process, all quadrants of the abdomen were percussed to confirm uniform as distinct from localized distension.[16]

The Three-port Laparoscopic Cholecystectomy Technique

After successful pneumoperitoneum creation, primary 10mm trocar was inserted in the midline towards the pelvis, through the umbilical incision. The pyramidal trocar was held in such a manner that the index fingertip acted as a guard to avoid sudden entry. The trocar was inserted with a screwing motion and its safe entry was confirmed by "hiss of escaping gas." After inserting the telescope, a quick inspection of the peritoneal cavity was performed. In some cases where the umbilical region was scarred because of previous surgery, then veress' needle was inserted at the "Palmar's point" (below the left sub-coastal margin in the mid-clavicular line) after checking that there was no splenomegaly and with nasogastric tube in place followed by insertion of 10mm trocar. Umbilical trocar was now inserted

under vision and then telescope shifted to umbilical port. After insertion of trocar, table was tilted in reverse Trendelenberg position at 20° and right side of table was tilted up. A 10 mm second trocar (the working port) was inserted just below the xiphisternum to the right of the midline, entering the abdomen to the right of falciform ligament. All operating instruments such as Maryland dissector, scissors, hook dissector, suction cannula, and clip applicator were introduced through this port. A 5 mm third trocar was inserted below the right sub-costal margin in the mid-clavicular line. This port was used for inserting an atraumatic grasper to hold the Hartman's pouch. The trocars were inserted through the abdominal wall and directed toward the gall bladder. The abdominal wall was transilluminated using the tip of the telescope so that blood vessels in the wall could be avoided, especially the superior epigastric vessels. The gallbladder fossa was visualized and retraction of the gallbladder done showing Rouviere's sulcus. After identifying the cystic duct, posterior dissection was done just above the gallbladder neck and complimentary anterior dissection was also done. Cystic duct and cystic artery were dissected using Maryland dissector with cautery and a wide window was created showing the liver at the back and junction of cystic duct and gallbladder giving elephant head appearance. Cystic duct was clipped using LT300 titanium clips. The cystic duct was then cut. Now the cystic artery was clipped and cut and gall bladder was dissected off the gall bladder fossa. Gall bladder was then extracted by gall bladder extractor through the epigastric port. An abdominal drain 18F suction catheter was placed in the Hepatorenal pouch in all patients. The closure of 10 mm ports with Polyglactin (910) 1-0 and [Figures 3 and 4] Nylon 3-0 and 5 mm port was closed with Nylon 3-0.[16]

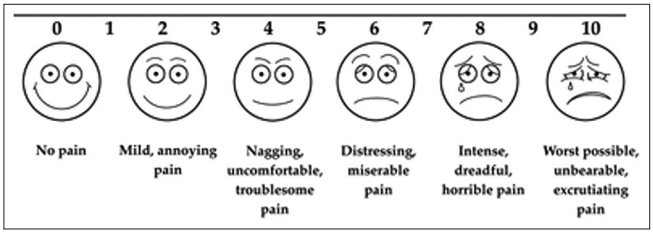

Figure 1: Visual analogue pain score

Incision attribute	Score if absent	Score if present
Step-off borders	0	1
Contour Irregularities	0	1
Margin Separation	0	1
Edge inversion	0	1
Excessive Distortion	0	1
Overall appearance	0 (satisfactory)	1 (unsatisfactory)
Total Hollander score	**0 (best)**	**6 (worse)**

Figure 2: Modified Hollander wound score

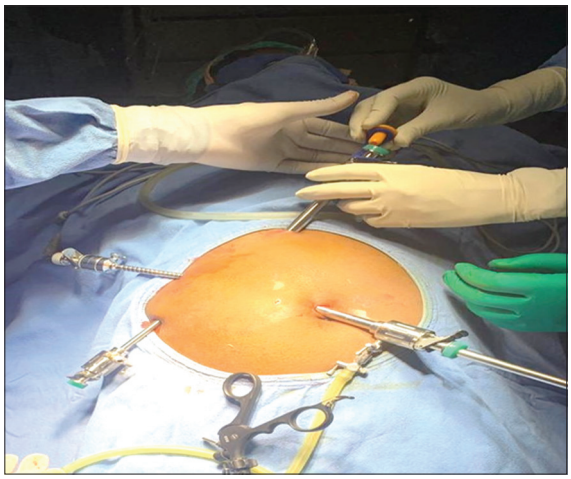

Figure 3: Position of ports in four port laparoscopic cholecystectomy

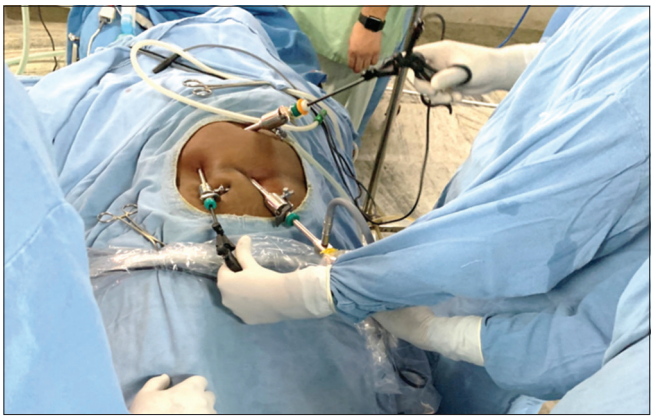

Figure 4: Position of ports in three port laparoscopic cholecystectomy

The Four-Port Laparoscopic Cholecystectomy Technique

In Four-port lap cholecystectomy, the first three ports were identical to three-port laparoscopic cholecystectomy but an additional 5 mm 4th port was put in the right anterior axillary line 4 cm below the right subcostal margin. The completion of procedure was identical using clips for cystic artery and cystic duct and closure of ports were identical to the three-port technique[Figures 3 and 4].

RESULTS

Age

Table 1 and Figure 5 shows the distribution of age between the groups. The mean age of patients of three port and four-port Laparoscopic cholecystectomy was 41.76 ± 13.54 years and 40.12 ± 16.03 years respectively. There was no significant ($P > 0.05$) difference in age between the groups showing comparability of the groups in terms of age.

Operative Time

Table 2 and Figure 6 shows the comparison of operative time between the groups. Operation time was significantly ($P < 0.001$) less among patients of three-port laparoscopic cholecystectomy (22.70 ± 2.52 min) than four-port laparoscopic cholecystectomy (43.80 ± 4.11 min).

Post-operative Pain

Table 3 and Figure 7 shows the comparison of post-operative pain according to VAS between the groups. Mean pain score was

Table 1: Distribution of age between the groups

Age (in years)	Three port (*n*=50)		Four port (*n*=50)		*P*-value[1]
	No of Patients	Percentage	No of Patients	Percentage	
18–30	11	22.0	17	34.0	0.248[#]
31–50	28	56.0	20	40.0	
>50	11	22.0	13	26.0	
Total (*n*)	50	100	50	100	

[1]Unpaired *t*-test. [#]Statistically not significant

Table 2: Comparison of operative time between the groups

Groups (*n*=100)	Time Up to Removal of GB (min.) (Mean±S.D)	*P*-value[1]
Three port (*n*=50)	22.70±2.52	<0.001*
Four port (n=50)	43.80±4.11	

[1]Unpaired *t*-test. *Significant

Table 3: Assessment of post-operative pain (visual analog score) between the groups

Groups (*n*=100)	Pain score<24 h (Mean±S.D)	Pain score>24 h (Mean±S.D)	*P*-value[1]
Three port (*n*=50)	2.86±1.10	2.06±0.82	<0.001*
Four port (*n*=50)	4.88±1.12	3.02±0.80	<0.001*

[1]Unpaired *t*-test, *significant

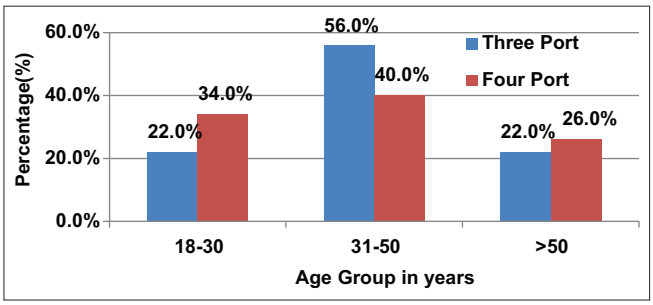

Figure 5: Distribution of age between the groups

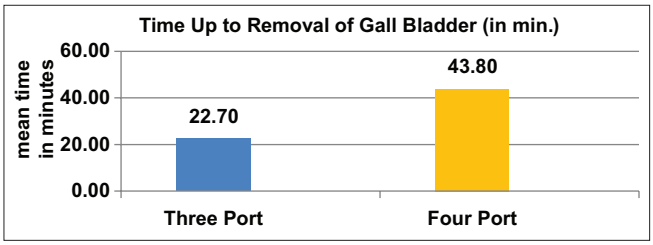

Figure 6: Comparison of operative time between the groups

lower among patients of three-port laparoscopic cholecystectomy than four-port laparoscopic cholecystectomy at <24 h and >24 h and the difference was statistically significant.

Post-operative Hospital Stay

Table 4 and Figure 8 shows the comparison of post-operative hospital stay between the groups. The mean duration of stay of patients of three-port laparoscopic cholecystectomy and of four-port laparoscopic cholecystectomy was3.14 ± 0.73 days and 4.04 ± 0.78 days respectively. There was a significant ($P < 0.001$) difference in duration of stay between the groups.

Cosmetic Satisfaction

Table 5 and Figure 9 shows the comparison of cosmesis in between the groups based on the modified Hollander scale. Cosmetic satisfaction was more in three ports as compared to four-port group but the difference was statistically not significant ($P = 0.0704$).

Correlation between Number of Ports and Cosmesis

Correlations	Score	Third port
Modified Hollander wound score		
Pearson correlation	1	0.053
Sig. (2-tailed)		0.6
n	102	102
Patient satisfaction in three port patients		
Pearson correlation	0.053	1
Sig. (2-tailed)	0.6	
n	102	102
Correlations	**Fourth port**	**Score**
Patient satisfaction in Four Port patients		
Pearson correlation	1	-0.064
Sig. (2-tailed)		0.523
n	102	102
Modified Hollander Wound Score		
Pearson correlation	–0.064	1
Sig. (2-tailed)	0.523	
n	102	102

In the present study, correlation between three port, four-port laparoscopic cholecystectomy, and cosmesis was done among the study subjects. The mean score of three port was 1.480 ± 0.502 and the mean score of modified Hollander wound score was found to be 1.774 ± 0.769. The mean score of four port was

Table 4: Comparison of post-operative hospital stay between the groups

Groups (*n*=100)	Duration of stay in days (Mean±S.D)	*P*-value[1]
Three port (*n*=50)	3.14±0.73	<0.001*
Four port (*n*=50)	4.04±0.78	

[1]Unpaired *t*-test. *Significant

Table 5: Comparison of cosmesis according to modified Hollander scale between the groups

Groups (*n*=100)	Cosmesis (Mean±S.D)	*P*-value[1]
Three port (*n*=50)	1.66±0.48	0.0704[#]
Four port (*n*=50)	1.82±0.39	

[1]Unpaired *t*-test. [#]Statistically not significant

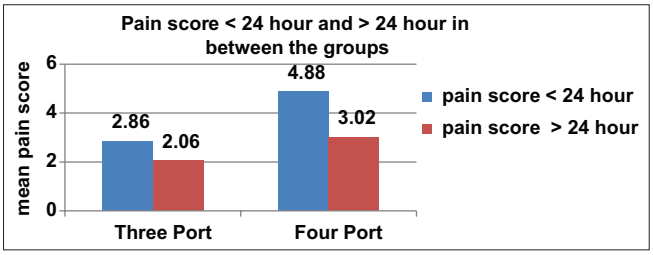

Figure 7: Assessment of post-operative pain (visual analogue score) between the groups

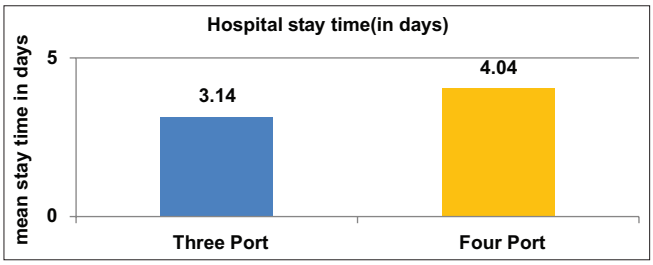

Figure 8: Comparison of post-operative hospital stay between the groups

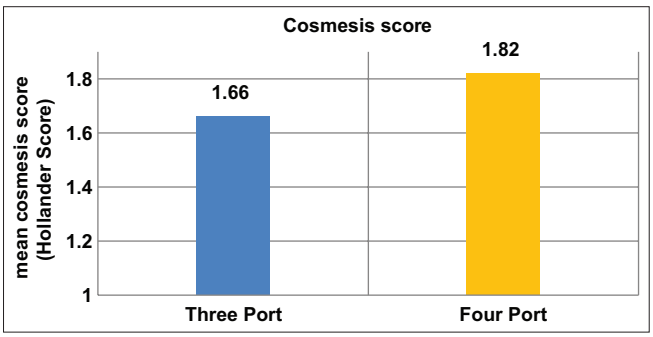

Figure 9: Comparison of Cosmesis according to modified Hollander scale between the groups

found to be 1.500 ± 0.502. Pearson Correlation coefficient (r) for three port was found to be 0.053 which is not statistically significant at p value 0.600. Pearson Correlation coefficient (r) for four port was found to be –0.064 which is statistically not significant at $P = 0.523$. There is negative correlation between the three port, four port, and the Hollander score which indicates that as the number of port increases, the wound score value is decreased which is suggestive of the fact that less the number of ports, higher will be the cosmetic level.

DISCUSSION

Laparoscopic surgery is a well-established alternative to open surgery across all disciplines and is considered the gold standard in cholecystectomy. Although positive magnitude of impact varies by the procedure, generally the benefits of laparoscopic cholecystectomy on post-operative pain, cosmesis, hospital stay, and convalescence are recognized widely. Laparoscopic cholecystectomy is the treatment of choice for gall stone disease. The classical four-port method included the fourth right flank port to retract the gall bladder funds (American technique) or liver (French technique) for better exposure of Calot's triangle. Good results in Laparoscopic Cholecystectomy depend on many factors and the most important one is the experience of the surgeon in laparoscopy.[17] Laparoscopic cholecystectomy using three ports mandate good experience in Laparoscopy for not to threaten the benefits of this procedure. The standard four-port approach is followed by the majority of surgeons. The use of the fourth trocar which is generally used for fundus retraction seemed unnecessary by some surgeons.

In the era of laparoscopic surgery, less post-operative pain and early recovery are major goals to achieve better patient care and cost-effectiveness. The results of the study conducted were compiled and analyzed to determine the efficiency, safety and benefits of the three and four-port laparoscopic cholecystectomy in terms of primary and secondary patient outcomes.[18]

The most important aspect of any surgical procedure is its safety and complications. Some surgeons have expressed concerns about the safety of the three-port technique, arguing that it may lead to a higher percentage of bile duct injuries. However, bile duct injury can be avoided if the gallbladder is gripped at the infundibulum, retracted laterally, and beginning the dissection at infundibulum-cystic duct junction rather than cystic duct-common bile duct junction.[19]

Furthermore, the early removal of the abdominal drain was also considered an important factor for early ambulation and discharge of the patient. In this study, the abdominal drain was removed 24 hours post-operatively in both the study group.

CONCLUSION

Overall results of this study demonstrate that the use of three ports in laparoscopic cholecystectomy did not significantly affect the:

- Procedure's safety
- Conversion rate
- Operating time.

The introduction of the three-port technique, which is still in routine practice in our institute, has the following advantages:

- Need for lesser post-operative analgesics
- Shorter hospital stays
- Fewer scars.

Three-port laparoscopic cholecystectomy resulted in less individual port-site pain, fewer surgical scars with similar clinical outcomes, and without any increased risk of complications when compared with four-port laparoscopic cholecystectomy.

The three-port method of laparoscopic cholecystectomy is a safe procedure with no extra complications in the hands of an experienced surgeon.

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