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Original Research Article

A comparative study of single incision laparoscopic cholecystectomy versus four port laparoscopic cholecystectomy

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ABSTRACT

Background: Since Langenbuch's pioneering open cholecystectomy in 1882, surgical approaches to gall bladder diseases have seen continual evolution. Laparoscopic surgery has emerged as the preferred method for treating benign gall bladder conditions, offering benefits like decreased postoperative discomfort and enhanced cosmetic outcomes. Variations to the traditional four-port laparoscopic cholecystectomy have been developed to further refine the procedure.
Methods: A comparative randomized study was carried out at the Department of Surgery, Govt. Medical College and Hospital Jammu, spanning from November 1, 2018, to October 31, 2019. Thirty eligible patients were recruited, with 15 assigned to undergo single-incision laparoscopic cholecystectomy (SILC - Group A) and 15 assigned to undergo four-port laparoscopic cholecystectomy (Group B).
Results: The study comprised patients aged between 20 and 60 years, with mean ages of 41.9 years for Group A and 40.3 years for Group B. Substantial variances were noted between the two groups concerning surgery duration, conversion rates, postoperative pain scores, and hospital stay.
Conclusions: Based on our findings, single-incision laparoscopic cholecystectomy (SILC) cannot be deemed a standard operative procedure, mainly due to its cost implications and the necessity for specialized instruments. At present, SILC does not serve as a substitute for four-port laparoscopic cholecystectomy. Continued research and advancements are warranted to solidify SILC as a feasible alternative.

Keywords: Cholecystectomy, Multiport vs single port cholecystectomy, SILC

INTRODUCTION

Gallbladder diseases, encompassing both benign and malignant conditions, pose significant morbidity and mortality risks. Among benign conditions, gallbladder stones stand out prominently. Carl Langenbuch's successful cholecystectomy in 1882 established the standard treatment for symptomatic gallbladder stones for over a century (Traverso et al).[1]

The landscape changed in 1985 when Eric Muhe in Boblingen, Germany, conducted the world's first laparoscopic cholecystectomies (LC) (Reynolds).[2] Following this milestone, Phillipe Mouret of Lyon, France, performed his inaugural laparoscopic cholecystectomy in 1987, followed closely by Francois Dubois of Paris, France, in 1988 (Reynolds).[2] Over time, with increasing surgeon expertise, laparoscopic cholecystectomy has seen numerous refinements, including the reduction in port size and number. There is ongoing debate regarding the necessity of the fourth

trocar used for gallbladder retraction, with arguments suggesting that laparoscopic cholecystectomy can be safely performed without it (Kumar et al).[3]

In 1992, the National Institute of Health (NIH) Consensus Development Conference released a statement affirming laparoscopic cholecystectomy as a safe and effective treatment for most patients with symptomatic gallstones (NIH consensus statement, n.d.).[4] Laparoscopic surgery has become the preferred approach for the majority of benign gall bladder diseases unless a clear contraindication is present, and it ranks among the most common procedures performed by general surgeons worldwide.

Since 2007, numerous authors have reported their experiences with cholecystectomy performed via alternative routes such as transvaginal or transgastric approaches, also known as natural orifice transluminal endoscopic surgery (NOTES) (Arulampalam et al).[5] Despite numerous reports in the literature over the past decade, NOTES continues to face several ongoing challenges.

Single incision laparoscopic surgery (SILS) was described as early as 1992 by Pelosi et al, who performed a single puncture laparoscopic appendectomy (Pelosi and Pelosi, 1992).[6] Minimization of surgical trauma is a major goal of minimally invasive surgery. Single-incision surgery is often attempted for the putative benefits that fewer surgical wounds will result in faster recovery by reducing surgical stress and pain and will lead to better cosmesis (Jeong et al).[7] This study aimed to investigate the advantages and disadvantages of single-incision laparoscopic cholecystectomy compared to multiport laparoscopic cholecystectomy, focusing on operative time, incision length, total intraoperative complications, conversion rates, postoperative pain, and duration of hospital stay.

METHODS

This comparative randomized study took place at the Department of Surgery, Government Medical College and Hospital Jammu, spanning from November 1st, 2018, to October 31st, 2019 after ethical clearance from the institutional committee. A total of 30 patients were enrolled, with 15 undergoing multiport cholecystectomy and 15 undergoing single-port cholecystectomy.

Inclusion criteria

The inclusion criteria for this study encompassed all patients, regardless of gender, aged 15 years and above, with ultrasound-documented cholelithiasis.

Exclusion criteria

Exclusion criteria included patients who declined laparoscopic cholecystectomy, individuals below 15 years of age, cases of cholelithiasis associated with choledocholithiasis, a history of jaundice within the preceding 3 months, patients deemed unfit for general anesthesia, diagnosed cases of gallbladder carcinoma, and instances of complicated cholelithiasis such as mucocele, pyocele, or empyema.

Patients presenting with symptoms indicative of gall bladder disease and confirmed by ultrasound study were randomly allocated to two groups using the sealed envelope technique. The allocation was disclosed just before the skin incision. Group A underwent single-incision laparoscopic cholecystectomy, while Group B received four-port laparoscopic surgery.

Statistical analysis

Statistical analysis of data was done in MS Xcel and SPSS software.

RESULTS

This prospective study spanned one year and involved 30 patients diagnosed with cholelithiasis who were admitted to the Postgraduate Department of Surgery at Government Medical College Hospital Jammu. Patients were randomized into two groups, with 15 individuals each. In Group A, single-incision laparoscopic cholecystectomy was attempted. However, successful completion was achieved in only 5 patients, while conversion to either the three or four-port method was required in the remaining 10 patients. In contrast, Group B underwent successful completion of four-port laparoscopic cholecystectomy. The study made the following observations:

In this study, the majority of patients fell within the age range of 41-50 years, constituting 40% of the total in both groups. The mean age in Group A was 41.9 years and in Group B was 40.3 years, with the age range spanning from 20 to 60 years in both groups (Table 1).

In this study, among the 15 patients analyzed in each group, Group A consisted of 5 males (33.3%) and 10 females (66.7%), resulting in a male-to-female ratio of 1:2. In Group B, there were 6 males (40%) and 9 females (60%), yielding a male-to-female ratio of 1:1.5. Notably, female predominance was observed in both groups. While the male-to-female ratio was significant in intragroup comparisons, it was not significant in intergroup comparisons (Table 1).

The mean time taken for surgery in Group A was 61 minutes (45-75 min), whereas; in Group B, it was 43.3 minutes (30-60 min). The intergroup comparisons as far as time to complete surgery were statistically signification with $p<0.001$(Mean of 61 minutes versus 43.3 minutes) (Table 1).

Table 1: Various findings in group A and B.

Features /characteristics	Group A	Group B
Mean age (years)	41.9	40.3
Gender (%)		
Male	33.3	40
Female	66.7	60
Time taken to complete surgery in minutes (mean)	61.0	43.3
Intra-operative complications (%)	33.5	13.33
Post-operative analgesia needs (%)	66.7	26.7
Abdominal drains used (%)	66.7	26.7
Post-operative ileus (%)	20	6.7
Return to routine activities in days (mean)	8.3	5.4
Incision length in cm (mean)	3.89	2.43
Cosmetic score	4.93	6.31
Pain score at 6 hours	4.7	3.1
Duration of hospital stay in days (mean)	2.7	2.1

The mean time taken for Calot's triangle and liver bed dissection in Group A was 25-50 minutes with a mean value 36.9 minutes, whereas; in Group B it was 14-36 minutes with a mean value of 21.8 minutes. The intergroup comparison of time taken for Calot's triangle and liver dissection was statistically significant with a p <0.001 (36.9 minutes vs 21.8 minutes). An important observation in the study was that more time was consumed when conventional laparoscopic instruments were used for the dissection of Calot's triangle and liver bed, there was a great disturbance in agronomics and instrument handling was difficult and cumbersome. Both Maryland and Hook Dissectors were used for the purpose. With angulated instruments, the time taken for dissection was less as compared to conventional instruments in SILC.

In the present study, minor complications were present in 5 (33.67%) patients of Group A, whereas; it was present in 02 (13.33%) cases of Group B. The intergroup comparison of minor complications was statistically not significant (p value=0.388).

In Group A, umbilical port site bleeding was encountered in 02 patients, liver sinuses were opened in 02 patients, and in 01 patient avulsion of the posterior branch of the cystic artery while Gall bladder perforation and spillage of bile in 04 (26.67%). In Group B, GB Perforation and spillage of stones occurred in 01 patient (6.67%) and in 01 patient umbilical port bleed and liver sinus bleed were noticed.

Total 10 out of 15 patients underwent conversion (66.6%) in Group A. In 04 patients (26.67%), technical difficulties concerning agronomics, instrument handling vis a vis anatomy of the biliary tract and abdominal contour of the patient led to conversion to either the three or four-port method. The technical difficulties were encountered much more with direct entry of the lateral instruments as well as conventional instruments. In 03 patients (20%), dense adhesion and difficult calot's triangle anatomy led to the conversion. In 01 patient each posterior branch of the cystic artery bleed, liver sinus bleed and GB perforation with spilt gallstones, we had to convert to the four-port method. However, in Group B none of the patients were converted to open cholecystectomy. Given the experience of the operating surgeon, we could handle difficult calot's triangle anatomy and sinus bleed from the liver bed (Table 2).

Table 2: Types of intraoperative complications and reasons for conversion in group A.

	Group A (%)	Group B (%)
Intraoperative complications		
Port site bleeding	13.3	6.7
Intraoperative bleeding	13.3	6.7
Posterior branch of cystic artery avulsion	6.7	0
Reasons for conversion in group A		
GB perforation and bile spillage due to adhesions	6.7	
Difficult callot’s triangle dissection	20	
Difficult GB handling (technical difficulty	26.7	
Intraoperative haemorrhage	13.3	

The pain was higher in group A with a mean Pain score at 6 hours being 4.7 and in group B being 3.1 which was statistically significant. Similarly, pain at Postoperative day 1 was more in group A than B which was also statistically significant (Table 1).

The need for postoperative analgesia was less in Group B with a mean of 3 days while the mean need for analgesia in days was 5.2 days in Group A which was statistically significant in each group.

The requirement of the intra-abdominal drain was more in group A in comparison to group B with 66.7% requiring it in group A while only 26.7% requiring it in group B which was statistically significant with a p-value of 0.028 (Table 1).

Postoperative ileus was present in 3 cases of group A while only in 1 case of group B which was found to be statistically non-significant (Table 1).

Duration of hospital stay postoperatively was more in group A than B with a mean of 2.7 days and 2.1 days

respectively. These findings are statistically significant with a p-value of 0.005 (Table 1).

In Group A, the return to routine activity ranged from 6 to 10 days, with a mean of 8.3 days, while in Group B, it ranged from 3 to 8 days, with a mean of 5.4 days. The intergroup comparison regarding return to routine activities showed statistical significance with a p-value of <0.001 (8.3 days vs 5.4 days). The comparatively larger umbilical scar and associated pain in Group A contributed to the delay in returning to routine activities (Table 1).

In Group A, the mean length of incision was significantly greater at 3.89cm compared to Group B, where the mean length of incision was 2.43cm. These differences were statistically significant with a p-value of <0.001 (Table 1).

Cosmetic score was more in Group B with mean of 6.31 based on cosmesis as compared to group A with mean of 4.93 (Table 1).

DISCUSSION

Laparoscopic cholecystectomy for gallstone disease has evolved since 1985. Surgeons have contemplated cholecystectomy with four, three and even two ports and ultimately single incision laparoscopic cholecystectomy (SILC) too. There are few studies available in the literature comparing four ports versus three ports and four ports versus single port/incision. The present study was a comparative study of four-port versus single-incision laparoscopic cholecystectomy.

In our study, 15 patients each in the two groups were studied, wherein; 05 were males (33.3%) & 10 were females (66.7%) in Group A and 6 (40%) males 9 (60%) females in Group B showing female predominance in both. (Hajong et al), (Tyagi et al) and (Cinar et al) in their comparative study between the single incision and four-port laparoscopic cholecystectomy showed a female predominance with 87.5%, 75% and 67%; respectively.[8-10]

Table 3: Comparison of age group and sex distribution with other studies.

	Males (%)	Females (%)	Age in years
Present study	36.66	63.34	20-60 (range)
Hajong et al[8]	12.5	87.5	18-70 (range)
Tyagi et al[9]	25	75	60-70 (range)
Cinar et al[10]	33	67	20-60 (range)

In our study, the majority of patients were present in the age group of 41-50 years (40%) in both groups. The mean age in Group A was 41.9 years (20-60 years) and in Group B was 40.3 years (20- 60 years) which was in concordance with the studies conducted by (Hajong et al).[8] However, it was in contrast to the study conducted by (Tyagi et al, 2017) in which the majority of patients were in the age group of 60-70 years.[9]

Table 4: Age groups in various studies.

Studies	Time required for surgery in minutes (mean/median)
Present study	61 (Mean)
Hajong et al[8]	69±4.00
van der Linden et al[11]	45 (Mean)
Malladad et al[12]	109.23±25.37

The mean time taken for surgery in Group A was 61 minutes while in Group B it was 43.3 minutes which was statistically significant with p value <0.001. (Hajong et al) concluded that single-incision laparoscopic cholecystectomy was more time-consuming than conventional laparoscopic cholecystectomy, whereas; (Malladad et al) in their study observed no statistically significant difference in the mean duration in both groups.[8,12] Furthermore (van der Linden et al) reported fewer laparoscopic cholecystectomy groups.[11] The observation of (van der Linden et al) is in sharp contrast to the present study, as well as other similar studies in the literature with mean operating time (45 min) in the single incision group as compared to 59 min in the four-ports group.[11]

In our study, the average time taken for Calot's triangle and liver bed dissection was more in Group A (52.5 min) as compared to the mean time of 37.5 min in Group B. However, no such comparative data was found in the review of the literature. So, this parameter and observation in the present study have added a new dimension to the literature as far as comparisons between these two surgical techniques are concerned.

In the present study, minor intra-operative complications in the form of umbilical port and liver sinus bleeding were present in 2 (13.3%) patients of Group B, whereas; in Group A, umbilical port site bleeding was encountered in 02 patients, in 02 patient liver sinuses was opened while separating GB from the liver bed and in 01 patient, posterior branch of cystic artery was avulsed leading to torrential bleeding. The intergroup comparison of minor complications was statistically significant and was higher in Group A.

Similarly, gall bladder perforation and spillage of bile were encountered in 04 (26.67%) patients in Group A including spillage of stones in 01 patient. In Group B, GB Perforation and spilt stones occurred in 01 patient (6.67%). In 01 patient each umbilical port bleed and liver sinus bleed was also noticed in Group B which dealt with adequate stitch and bipolar cauterization respectively.

Culp et al and Malladad et al in their study found no statistical significance in terms of procedure-related

complications.[13.12] Lee et al reported 11 GB perforation, one right hepatic duct injury and 2 mesenteric injuries.[14] Goyal et al in their study reported that the incidence of intraoperative complications was higher in single incision group.[15] Among 25 cases, 3(12%) had intraoperative complications i.e., bleeding from gallbladder bed in 1 case (overcome by electrocautery), gall bladder puncture (1 case) which was managed by conversion to standard LC and bile leak (1 case) due to slippage of clip intraoperatively managed by conversion to four-port laparoscopic cholecystectomy and by reapplication of Liga clip. Suh et al, 2019 in their study found a high incidence of minor complications like intraoperative gallbladder perforation (17%).[16]

Table 5: Reasons for conversion of single port surgery to multiport.

Reason for conversion	No. of cases
Technical difficulties	04
Difficult calot's triangle anatomy	03
Liver sinus bleed	01
Perforate GB	01

Table 6: Comparison of conversion rate with other studies.

Studies	Rate of conversion (%)
Present study	66
Rao et al[17]	0
Lee et al[14]	13
Kim et al[18]	3.4
Deolekar et al[19]	10
Malladad et al [12]	13.33

In our study 10 out of 15 patients of group A were converted to either three or four-port laparoscopic cholecystectomy (66%) with the most number of conversions being due to technical difficulties (n=04) and difficult calot's triangle anatomy (n=03). Other reasons for conversion were liver sinus bleeding in 01 patient, perforated GB with spilt stones and bleeding from the posterior branch of the cystic artery in another patient. Among the conversion from SILC to Three or Four Port laparoscopic cholecystectomy, conversion was maximum where conventional instruments were used (4/4); whereas with single umbilical port and angulated forceps, there were 2 conversions out of 6 patients subjected to SILC. In a study by (Rao et al) no conversions were reported.[17] Lee et al reported a 13% conversion rate (the majority being due to inadequate visualisation of the hepatocystic triangle).[14] Kim et al reported a 3.4% conversion rate with 9 patients requiring conversion due to inadequate exposure of Calot's triangle due to adhesions and inflammation, in 7 patients due to uncontrolled bleeding of cystic artery and 1 conversion due to CBD injury.[18] Deolekar et al reported a conversion rate of 10% (3 cases) all due to the use of conventional laparoscopic instruments.[19] Furthermore, Malladad et al also reported a 13.33% conversion rate and maximum conversions being due to adhesions (1 case due to technical difficulty, 1 case due to GB adhesion and 2 cases due to anatomical variation.[12]

In our study, pain was higher in Group A with the mean pain score at 6 hours being 4.7 and in Group B it was 3.1. The intergroup comparison was statistically significant. Similarly, pain on the first postoperative day was more in Group A than in Group B which was also statistically significant. This finding was in concordance with the study conducted by Solhjou et al, who reported a higher pain score for the SILS group with a p value of 0.034.[20] Similarly, Pan reported that the pain score at 8 hours was significantly higher in the SILS group (p value 0.000).[21]

However, Casaccia et al, in their study compared pain at 4 hours and 24 hours in the SPLC and 4PLC groups and found no statistical difference between the two groups with p values of 0.967 and 0.413 respectively.[22]

Table 7: Comparison of postoperative pain between the two groups.

Studies	Pain score compared on VAS at 6hrs and on day 1 postoperatively
Present study	Significant
Solhjou et al[20]	Significant
Pan[21]	Significant
Casaccia et al[22]	Non-significant

Duration of postoperative hospital stay in Group A was >2 days with a mean of 2.7 days in 10 patients, whereas; in Group B, postoperative stay was <2 days in 12 patients with a mean of 2.1 days. These findings were found to be statistically significant with a p-value of 0.005 which was similar to the study conducted by Kuon Lee et al, 2009 and Culp et al, 2012 who reported mean postoperative stay of 2.7 and 2.8 days respectively.[14,13] In a study by Chow et al, mean postoperative hospital stay was one day in both groups and intergroup comparison was statistically not significant.[23] Systemic review and meta-analysis by Pereira and Gururaj, 2022 showed more complications compared to conventional 4 port laparoscopic cholecystectomy.[24]

Table 8: Comparison of post op hospital stay with other studies.

Studies	Hospital stay in days (post op)
Present study	>2
Lee et al[14]	2.7 (mean)
Culp et al[13]	2.8 (mean)
Chow et al[23]	1

Limitation of study was sample size.

CONCLUSION

Given comparative data available from the present study and retrospective analysis of similarly situated studies in

the literature it is concluded that SILC cannot be considered as a standard operative procedure for symptomatic cholelithiasis, nor it is cost-effective because of special instruments required for the procedure. Furthermore, as of date, SILC cannot replace four-port laparoscopic cholecystectomy as the "Gold Standard" method for the management of symptomatic cholelithiasis. The surgeons desirous of doing SILC must have sufficient experience of four/three-port laparoscopic and open cholecystectomy as well as resources in hand for getting specially designed gadgets before embarking upon SILC.

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