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Original Research Article

A Comparative Study of Single Port Laparoscopic Cholecystectomy Surgery versus Multiple Port Cholecystectomy Surgery

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Abstract: ***Background*:** Treatment of gall stones have evolved markedly since open cholecystectomy was first described by Langenbuch in 1881. Management has progressed through eras of nonsurgical management, laparotomy, minilaparotomy and now laparoscopic cholecystectomy which is the gold standard for the treatment of gall stone disease today. ***Methods:*** This comparative randomized study was conducted at Nimra Institute of Medical Sciences between November 2019 to October 2020. 100 consecutive patients who fit into the inclusion criteria were included in the study. 50 patients were included in the multiport cholecystectomy arm and 50 in the single port cholecystectomy arm. Random allocation of patients presenting with symptoms suggestive of gall bladder disease with confirmatory USG study was done to the two groups using the sealed envelope technique which was opened just before the skin incision. ***Results:*** Significant difference in the conversion rate was found in the two groups the conversion rate for single port cholecystectomy was 12%. No statistically significance rise in surgical complications occurred in the patients operated by single port technique as compared to multiport surgery. Median time required to complete cholecystectomy by single port technique was significantly higher than that required for multiport cholecystectomy. No difference was found in the duration of postoperative pain experienced in the two groups. Postoperative complaints of nausea and vomiting occurred in almost equal number of patients in the two groups. Patients operated by single port technique had a postoperative hospital stay of mean 2.12 days, almost same as for patients operated by multiport technique. ***Conclusion:*** Technical difficulty and inflammatory changes due to chronic cholecystitis are the leading causes of conversion from single port to multiport cholecystectomy. Time required for single port surgery is significantly higher than multiport cholecystectomy. Postoperative port site infection was significantly higher in single port cholecystectomy as compared to multiple port cholecystectomies. The sample size in our study is small to make solid conclusion. The procedure can be selectively and judiciously performed by surgeons trained in regular laparoscopic surgery. Also the threshold for conversion should be low in learning phase. Widespread application must await results obtained from level 1 trial.

Keywords: Single port laparoscopic Cholecystectomy. Multi-port laparoscopic Cholecystectomy.

INTRODUCTION

Gall stones are among the most common causes of gastrointestinal illness requiring hospitalization. Indeed, operations on biliary tract are among the most common abdominal procedure performed in the United States, with more than 6, 00, 000 cholecystectomies performed annually. Treatment of gall stones have evolved markedly since open cholecystectomy was first described by Langenbuch in 1881[1, 2]. Management has progressed through eras of nonsurgical management, laparotomy, minilaparotomy and now laparoscopic cholecystectomy which is the gold standard for the treatment of gall stone disease today [3, 4]. In 1992, the statement published by National Institute of Health (NIH) Consensus development conference stated that laparoscopic cholecystectomy provides a safe and effective treatment for most patients with symptomatic gall stones [5]. 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 post-operative pain, improved cosmesis, shorter length of hospital stay, earlier return to full activity, decreased overall cost were immediately appreciated.

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Soon after introduction of laparoscopic surgery the idea of no scar surgery has fascinated the surgeons all over the world. Various natural orifices like mouth (trans- gastric), umbilicus and vagina are being used as portals for surgery. Termed variously as Single Port Access (SPA) surgery, Single Incision Laparoscopic Surgery (SILS) or One Port Umbilical Surgery (OPUS) or Single Port Incision Less Conventional Equipment Utilizing Surgery (SPICES) or Natural Orifice Transumbilical Surgery (NOTUS) [6-8]. It is a novel technique which promises all advantages of minimally invasive surgery with additional advantages of reduced postoperative morbidity and improved cosmesis. One of the revolutionary methods of scarless surgery is the transumbilical single port laparoscopic technique, in which the surgical scar is virtually concealed within the umbilicus. In 1996, Kala and his colleagues [9] reported the first case of transumbilical single port laparoscopic appendectomies. The first case of transumbilical single port laparoscopic cholecystectomy was reported in 2007 by Podolsky *et al*. [10].

There are number of case series, studies and randomised control trials conducted for comparison of Single port cholecystectomy Vis a Vis Multiport cholecystectomy, however the benefit of Single Port cholecystectomy is still debatable.

In our study, we have made an attempt to evaluate the efficacy and effectiveness of single port laparoscopic cholecystectomy compared to the gold standard multiport laparoscopic cholecystectomy.

MATERIAL AND METHODS

This comparative and randomized study was conducted at Nimra Institute of Medical Sciences between November 2019 to October 2020, 100 consecutive patients who fit into the inclusion criteria were included in the study. 50 patients were included in the multiport cholecystectomy arm and 50 in the single port cholecystectomy arm

The inclusion criteria were

- Age of patient between 18 and 65 years
- Diagnosis of chronic cholecystitis, symptomatic cholelithiasis, recurrent biliary pancreatitis, Gall Bladder (GB) polyp

The exclusion criteria were

- Severe co-morbid conditions (uncontrolled diabetes, hypertension or presence of IHD)
- Diagnosis of acute cholecystitis, Mirizzi syndrome, suspicion of GB cancer
- ASA Grade-4

Random allocation of patients presenting with symptoms suggestive of gall bladder disease with confirmatory USG study was done to the two groups using the sealed envelope technique which was opened just before the skin incision.

The two groups were as follows
Group1: Single port umbilical surgery
Group2: Multiple Port Laparoscopic Surgery

The details of preoperative assessment, intraoperative observation, postoperative course and postoperative follow up with reference to following points were recorded in a proforma.

Preoperative observations

Such as age, sex, investigations

Intraoperative observations

Duration of surgery, anatomy of extrahepatic billiary system, presence of adhesions, complications such to Injury to vessels, Injury to CBD, Injury to liver including GB fossa injury, Injury to GB, Injury to other organs (bowel etc).

Conversion of single port surgery to: 2 port surgery, Multi-port surgery, Open surgery.
Conversion of multiport surgery to open surgery:
Requirement of drain.
Complication due to pneumoperitoneum

Postoperative observations

Pain on VAS scale at following time points 6 hrs after operation, Morning of postoperative day 1.

Technical steps

General Anaesthesia was used in all patients.

Multiport cholecystectomy

Patient position: The patient was placed in supine position with surgeon standing on patients left side during port insertion. The position was changed later to 30 degree reverse Trendelenburg with the table rotated to left by 15 degree during surgery.

Port placement: A 10 mm port was inserted through supraumbilical or umbilical incision by open technique. Pneumoperitoneum was created. Another 10mm port in the epigastric region, a 5mm port in right subcostal area in midclavicular line and a 5mm port in right flank in anterior axillary line were placed under vision.

Dissection: The gall bladder was grasped at fundus and retracted over the liver edge. With a second grasper the gall bladder infundibulum was retracted laterally to expose the triangle of Calot. Dissection was done with dissecting forceps inserted through the epigastric port. The peritoneum, fat and loose areolar tissue around the gall bladder and cystic duct were dissected off towards the bile duct. After the cystic duct was identified and dissected free, dissection and

identification of cystic artery was done. Three titanium clips were placed on the cystic duct and the duct was divided between the clips. Cystic artery was similarly clipped and divided. Dissection of gallbladder off the liver bed was performed in the retrograde fashion.

GB fossa was checked for any bleeding and secure placement of clips on cystic duct and artery. Any blood or bile accumulated during the procedure was removed with the suction irrigation cannula. If any bile or blood was expected to accumulate, a suction drain (18F) was placed in Morrison's pouch through the 5mm flank port. The gall bladder was removed through the epigastric port. Under vision the accessory ports were removed after checking for haemostasis. The abdomen was deflated and the 10 mm ports closed with sutures.

Single port cholecystectomy

Patient position: The patient was placed in supine position with surgeon standing at patients left side during port insertion. The position was changed later to 30 degree reverse Trendelenburg with the table rotated to left by 15 degree during surgery.

Port placement: About 2.5 cm incision was taken through the umbilicus and deepened in layers to gain open access to peritoneal cavity. A double barrel (cylinder) multi-channel single port was inserted in the abdomen. Pneumoperitoneum was created by attaching carbon dioxide tubing to the right angled insufflation channel in outer cylinder. The cylinder was so adjusted that three working channel were placed two in superior and one in inferior position.

Dissection: A 30 degree telescope was inserted through the lower or inferior hole. A grasper was inserted through the upper right hole to grasp the gall bladder at the infundibulum. A dissecting forcep was inserted through upper left hole. A combination of straight and angulated instruments was used. Calot's triangle was dissected identifying the cystic duct and artery.

30 and zero degree telescopes were used as and when required to improve visualisation and reduce clashing of instrument with optic cable. Whenever required an infundibular stitch was taken to anchor the infundibulum to anterior abdominal wall. The pulling up of infundibulum helps expose the Calot's triangle in long and floppy GB. After the dissection was completed a modified vascular clip applicator with 10 mm jaws and 5 mm shaft loaded with clip was inserted through upper left hole. The cystic duct and artery were clipped and divided between clips. GB was dissected from the liver bed with the help of hook and electrocautery.

Hemostasis and secure placement of clips checked. Any blood or bile accumulated during the procedure was removed with the suction irrigation cannula. If any bile or blood was expected to accumulate, suction drain 18 F was placed in Morrison's pouch through separate incision in right flank. The gall bladder was delivered out with the port. Rectus sheath was sutured with ethilon no 1. Skin sutured with monocryl 3-0 (subcuticular suture).

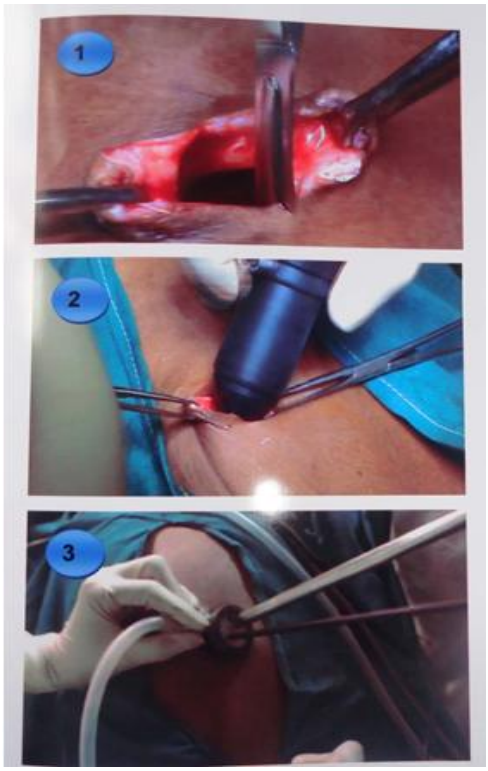

Fig-1: Steps in Single port cholecystectomy; 1-3: Steps of port insertion

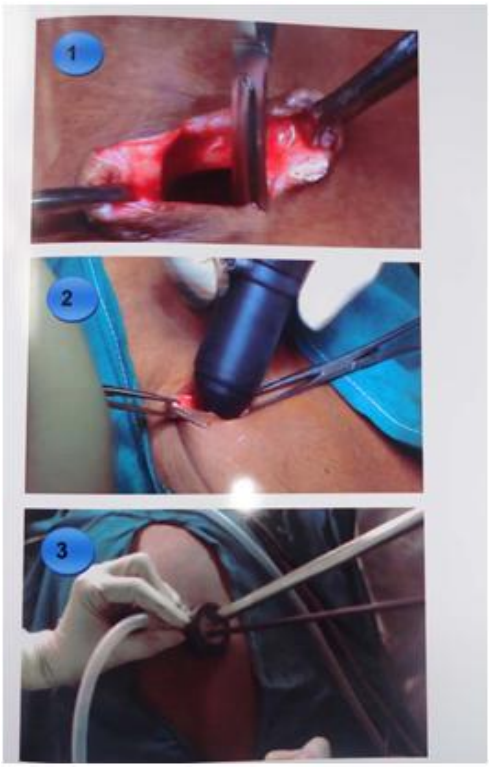

Fig-2: Steps in Single port Cholecystectomy; 4-dissection of Calot's triangle, 5-Clipping of Cystic duct

Fig-3: Postoperative sutured incisions

STATISTICAL ANALYSIS

The collected data was entered prospectively in Microsoft Excel 2000 and analyzed using SPSS 20 software. The results were tabulated for statistical analyses to identify significant differences between the two groups. Categorical variables were compared using chi-square test or Fisher's exact test. Continuous variables were analyzed using Student's t test or Mann–Whitney U test. A p value of <0.05 was considered significant.

RESULTS

Trial design

118 patients were considered for inclusion in the study. Of these 18 patients were excluded due to multiple reasons.

50 patients presenting with benign gallbladder disease were operated upon with the general intent of performing single port cholecystectomy surgery. Outcomes of these patients were recorded along with outcomes of 50 other patients operated by multiport technique for benign gallbladder disease.

6 patients in the single port were converted to the multiport group due to various reasons. They were excluded from the final analysis.

Majority of presenting patients were in age group 40-50 years. There was no significant difference in the mean age of patients operated by the two techniques.

Table-1: Age wise distribution of cases in study groups

Age(yrs)	Single port	Multi-port	Total
30-40	11	17	28
40-50	23	19	42
50-60	13	07	20
60-70	03	07	10
Total	**50**	**50**	**100**

Table-2: Comparison of age in study groups

Parameter	Single Port	Multi-Port	P Value
	Mean±SD(n=50)	Mean±SD(n=50)	
Age(yrs)	46.4±8.53	45.24±10.34	>0.05 (NS)

64% of the operated patients were males and 36% females and there was no significant difference among the two groups (Table 3).

Table-3: Sex wise distribution of cases in study groups

Sex	Single port	Multi-port	Total	p value
Male	33	31	64	p = NS
Female	17	19	36	
Total	50	50	100	

Due to the specific group of clients coming to our hospital we had more male patients than females.

Table-4: Intraoperative findings of anatomical variations, adhesions

Intraoperative observations	Singleport group (n=50)	Multiport group (n=50)	Total(n=100)	P value
Anatomical variation	1(2)	0(0)	1(1)	NS
Adhesions	13(26)	11(22)	24(24)	NS

Table-5: Conversion rates in both groups

Parameter	Single port(n=50)	Multi-port(n=50)	P Value
Conversion of surgery	**6**	**0**	**< 0.05**

Table-6: Reason for conversion in study groups

Reason for conversion	Single port(n=50)	Multi-port(n=50)
Technical difficulty	**3**	**0**
Anatomical variation	**1**	**0**
Haemorrhage	**1**	**0**
Structure Injury	**1**	**0**
Total	**6**	**0**

Significant difference in the conversion rate was found in the two groups (Table 5 and 6). 6 patients in the single port were converted to the multiport group due to various reasons. They were excluded from the final analysis. Out of these 6 patients, technical difficulty was encountered in three patients Intra operatively and in one patient; anatomical variation in form of long and low inserting duct was noticed due to which these cases were converted to multiport technique.

No statistically significant rise in surgical complications occurred in the patients operated by single port technique as compared to multiport surgery. One of the patients who underwent single port cholecystectomy had Liver injury while one patient who underwent multiport cholecystectomy had vessel injury and liver injury (Table 7).

Table-7: Comparison of complication in study groups

Complications	Single Port (n=44)	Multi-Port(n=50)
Vessel injury	**0**	**1**
CBD injury	**0**	**0**
Liver injury	**1**	**1**
GB injury	**0**	**0**
Others injury	**0**	**0**
Total	**1**	**2**

Median time required to complete cholecystectomy by single port technique was significantly higher than that required for multiport cholecystectomy (Table 8).

Table-8: Comparison of duration of surgery in study groups

Parameters	Single Port	Multi-Port	p value
	Mean±SD(n=44)	Mean±SD(n=50)	
Duration(min)	73.75±20.68	40.1±7.52	<0.05
Range(min)	35-120	25-55	<0.05

No difference was found in the duration of postoperative pain experienced in the two groups. Average duration of postoperative pain as deduced from requirement of analgesic was 48-72 hours (Table 9).

Table-9: Comparison of postoperative pain score in study groups at 6 hrs after surgery and on postoperative day 1

Parameter	Single port	Multi-port	P value
	Mean±SD(n=44)	Mean±SD(n=50)	
VAS Score at 6 hrs post surgery	5.46 ± 0.51	4.37 ± 0.49	>0.05
VAS Score on postoperative day 1	3.39 ± 0.53	3.10 ± 0.43	>0.05

Postoperative complaints of nausea and vomiting occurred in almost equal number of patients in the two groups.3 patients who underwent Single Port Cholecystectomy and 2 patients who underwent Multiport Cholecystectomy experienced shoulder pain. Other complaints like urinary retention, headache occurred in 2 cases that underwent Single Port Cholecystectomy and 1 case who underwent Multiport Cholecystectomy (Table 10).

Table-10: Postoperative complaints in study groups

Complaints	Single port(n=44)	Multi-port(n=50)	P value
Nausea	2	4	>0.05
Vomiting	3	3	>0.05
Shoulder pain	3	2	>0.05
Others	2	1	>0.05

Patients operated by single port technique had a postoperative hospital stay of mean 2.12 days, almost same as for patients operated by multiport technique (Table 11).

Table-11: Comparison of hospital stays in study groups

Hospital	Single port	Multiport	p value
	Mean±SD(n=44)	Mean±SD(n=50)	
Stay(days)	2.12±0.34	2.13±0.35	>0.05

Significant postoperative port site infections were observed with the Single Port Cholecystectomy (Table 12).

Table-12: Port site infection at first follow up in study groups

Port site infection	Single port(n=44)	Multiport(n=50)	P value
Present	**6**	**0**	**<0.05**

DISCUSSION

Out of 50 patients operated by single port surgery 33 were males and 17 were females. In the multiport group distribution was 31 males and 19 females. Majority patients were in 40-50 age groups. The mean age of patients in single port group was 46.4± 8.53 years and in multi-port group were 45.24±10.34 years.

The intra operative observations of anatomy were made. Peri gall bladder adhesions were present in 26% patients in single port and 22% patients in multiport group. One patient had anatomical variation in the form of long and low inserting cystic duct. Majority conversions in single port group occurred in gall bladders with adhesion suggesting chances of conversion are high if a patient had acute or chronic cholecystitis.

The conversion rate for single port cholecystectomy was 12%. In a study conducted by P.P Rao *et al*. [20] single port surgery using Triport a conversion rate of 15% was seen in another study done by Sang Kuon Lee *et al*. [21] a conversion rate of 13% was observed. While the conversion rate of single port surgery in our study was significantly higher than that of multiport surgery it matches fairly with the conversion rates in other studies.

Almost all conversions occurred during the first 15 cases. Technical difficulty was the leading causes of conversion in our study.

Intraoperative complication of liver injury to GB fossa occurred in one patient of the 44 operated by single port technique. No rise in intraoperative complication as compared to multiport surgery was observed in our study.

In the study conducted by Sang Kuon Lee *et al*. [21] one case of right hepatic duct injury, 11 GB perforations, 2 mesenteric injuries are mentioned. In most of the other study no intraoperative complications occurred. In the case series by Sinan Ersin *et al*. [24] one case was converted due to failure of Trocar insertion. The results in our study are in agreement with those of other studies. Complication due to pneumoperitoneum did not occur in either group.

The median time required for single port cholecystectomy in our study was 60 min which is significantly high when compared to median time of 40 min required for multiport cholecystectomy.

In the case series by Sinan Ersin *et al*. [24] the duration of surgery for single port cholecystectomy ranges from 105-110 min with a mean of 94 min, another study done by Rao PP, *et al*. [20] showed a mean duration of surgery of 40 min. The duration of surgery for single port cholecystectomy in our study compared satisfactorily with that in other studies.

In study published by Abd Ellatif ME *et al*. [27] found significantly improved pain profile in patients who underwent Single port cholecystectomy. In a study conducted by Bucher P *et al*. [30] significantly less pain was observed in patient who underwent LESS. In another study done by Prsasad a *et al*. [33] there was significant difference in postoperative pain between the two groups who underwent single port cholecystectomy and multiport cholecystectomy. In our study, we also got no significant difference in postoperative pain between the two groups.

In our study common postoperative complaints were nausea (singleport group 4.54%, multiport group 8%) vomiting (single port group 6.81%, multiport group 6%) and shoulder pain (single port group 6.8%, multiport group 4%).Urinary retention in one patient in postoperative period was reported in study conducted by Hodgett *et al*. [23]. No postoperative complication like bleeding or bile leak occurred in either group in our study. In study conducted by Chow *et al*. [25] bile leak from accessory duct of Luschka was noted in one case.

Mortality was 0% in both the groups

Length of postoperative stay in our study for singleport group (2.12±0.34 days) was almost same as postoperative stay required by multiport surgery patients (2.13±0.35 days). In the converted cases the

multiport surgery patients with gall bladder perforation on 3rd day after drain removal on 2nd day, other patients were discharged on day 2 or 3, same as single port operated cases. In study conducted by Kravetz *et al*. [22]. Post-operative stay range was 1-4 days for patients who underwent single port cholecystectomy, another study done by Ersin, *et al*. [24] hospital stay for single port group was one day. Postoperative hospital stays in our study ranged from 2-3 days in patients who underwent single port cholecystectomy which is compared fairly with that in other studies.

6 Cases of port site infection occurred in the single port group whereas patients who underwent multiport cholecystectomy had no port site infection which is statistically significant (13.63%).

In one patient operated by single port technique blackening of skin around incision occurred. Three patients complained of continued pain in epigastric region at first follow up in single port group, none of the patients in multiport group complained of same. The difference is statistically insignificant. Pain in epigastric region post cholecystectomy is mostly attributed to pre-existing gastritis in which case the pain in epigastric region is not relieved after cholecystectomy and is generally not procedure related.

At second follow up none of the patients in the two groups had any complaints.

CONCLUSIONS

1. Technical difficulty and inflammatory changes due to chronic cholecystectomy are the leading causes of conversion from single port to multiport cholecystectomy
2. No rise in intra and post-operative complications occurred in the single port surgery even with the technical drawbacks of the procedure
3. Time required for single port surgery is significantly higher than multiport cholecystectomy.
4. Degree of postoperative pain is same in both groups.
5. Length of postoperative hospital stay for single port cholecystectomy is same as for multiport cholecystectomy.
6. Postoperative port site infection was significantly higher in single port cholecystectomy as compared to multiple port cholecystectomies.
7. Mortality was nil in the present study

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