

Original Research Article

Three-port versus four-port laparoscopic cholecystectomy: a comparative study at a tertiary care centre in North India

Peeyush Kumar*, Anil K. S. Rana

Department of Surgery, PGIMER and Dr. Ram Manohar Lohia Hospital, New Delhi, India

Received: 19 December 2017

Accepted: 25 December 2017

***Correspondence:**

Dr. Peeyush Kumar,

E-mail: dr.peeyush.kr@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Improvement of Laparoscopic Cholecystectomy (LC) technique in terms of reduction in size and number of ports is being tried to improve patient satisfaction and outcome. Present study was conducted to evaluate and compare the safety outcome and advantages of three-port and four-port LC.

Methods: This prospective study included 90 patients presenting with symptomatic gall stone disease or gall bladder polyp more than 1cm at base. Patients with jaundice and choledocholithiasis were excluded. Patients were divided into two groups: A and B, who underwent three-port and four-port LC respectively. Outcomes of the two groups were assessed and compared in terms of duration of surgery, intra-operative and post-operative variables including rate and nature of complications, conversion rates, post-operative pain, duration of hospital stay, return to work and cosmetic outcome.

Results: Statistically significant difference was found 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; all being less in the three-port LC group. Cosmetic outcome as perceived by patients was also better in the three-port group. Results of other variables were comparable in the two groups.

Conclusions: Three-port procedure is safe and appears to be more cost effective than four-port LC. If LC is performed by an experienced surgeon, it can be started with three ports, if required, a fourth port can be inserted.

Keywords: Four-port, Laparoscopic cholecystectomy, Three-port

INTRODUCTION

Diseases of the Gallbladder constitute a majority of digestive tract disorders. Among these, gall stone disease is the most common biliary pathology.¹⁻³ It has been noted that people living in the Indo-Gangetic belt are highly susceptible to the formation of gall stones, so much so that cholecystectomy is the single most commonly performed surgical procedure in this part of the world.^{4,5}

Cholecystectomy is the mainstay of treatment for symptomatic gall stone disease. The management of

patients with gall stone disease has been revolutionized during the last several years with the introduction of Laparoscopic Cholecystectomy.⁶

Since National Institute of Health Consensus (NIH) Development Conference in September 1992, Laparoscopic Cholecystectomy was recognized as the most accepted method of treatment of cholelithiasis and is now considered as the “Gold standard” for treatment of gall stones. It is also the procedure of choice in most of the other gall bladder diseases.^{7,8}

Ever since the first laparoscopic cholecystectomy, there has been an evolution of the technique with attempts at continuous improvement in terms of better outcomes, patient satisfaction, cosmesis with reduced post-operative pain, hospital stay and cost.⁹

Reduction in the size and number of ports has been proposed as a method of reduced pain and duration of hospital stay post operatively. The most practical option is by reducing the number of the ports from four to three.¹⁰ The lateral fourth port is used to grasp the gall bladder funds and retract it laterally (American technique), so as to expose the Calot's triangle, facilitating dissection in this region. The use of this port was omitted in the three-port technique and results from recent studies have been encouraging.^{10,11}

This prospective comparative study was conducted to evaluate and compare the safety outcome and advantages three-port and four-port laparoscopic cholecystectomy, in terms of: duration of surgery, complication rates, nature of complications, post-operative pain, duration of hospital stay, return to work and cosmetic outcome.

METHODS

This study was conducted on a total of 90 patients who underwent laparoscopic cholecystectomy in our hospital from 2012 to 2013. All patients with symptomatic gall stone disease and gall bladder polyp with base more than 1cm in diameter, confirmed on ultrasound, were included in the study.

The patients who were unwilling to be a part of the study along with patients who were jaundiced, had radiologically demonstrable CBD stones or those who were unfit for laparoscopic procedure were excluded from the study. Those not fit for general anaesthesia (ASA-grade IV), patients with significant portal hypertension, cirrhosis of liver, uncorrectable coagulopathies, acute pancreatitis, generalized peritonitis, suspected or proven malignancy were also excluded.

A fully informed written consent was taken from all patients. All the patients were sequentially divided into two separate groups - A and B. Group A patients were subjected to three-port laparoscopic cholecystectomy and Group B patients were subjected to conventional four-port laparoscopic cholecystectomy. All the surgeries were performed by the same operating team. The demographic profile and ultrasound findings of the patients were noted. Pre-operative work up was done, and patients were admitted on the day prior to surgery.

Operative details

Three-port method

Two 10mm trocars (in the epigastrium for working port and supraumbilical region for camera port) and one 5mm

trocar (right mid clavicular subcostal region) was inserted. A grasping forceps was then inserted through the third port to hold the infundibulum, moving it right and left or back and forth to display the Calot's triangle.

The instruments used to perform dissection were passed through the epigastric port. This was followed by dissection of the Calot's triangle and the gall bladder from liver bed. Special maneuvering of the grasping forceps was done, in which the shaft of the forceps was moved in opposite direction to the movement of the jaw to retract the liver. This maneuver practically achieved similar exposure in the region of Calot's triangle as is done by fundal grasper. Finally, cystic duct and cystic artery were clipped, and gall bladder was extracted through the epigastric port. In case of bile spillage, irrigation was done and a drain (Romovac) No.14/16 was placed in the sub-hepatic pouch of Morrison's, inserted through the 5mm port and was positioned under vision. Skin incisions were closed by 2-0 ethilon. Incision sites were subcutaneously infiltrated with 0.5% Bupivacaine in all cases.

Four port technique

In addition to the above-mentioned ports, another 5mm port was inserted in the anterior axillary line in right flank region. This was used to grasp the fundus of the gall bladder to facilitate the dissection of the Calot's triangle and provide traction to the gall bladder. Rest of the procedure was the same as that mentioned for the three-port technique. Patients were discharged either on the same evening or next morning. The outcome of the two groups viz. A and B were assessed by the following parameters:

Duration of surgery

It was calculated from the time when initial skin incision was given upto the time of skin closure.

Conversion of three-port to four-port technique and its reasons.

Conversion to open cholecystectomy and its reasons.

Intra-operative variables

- Intra-operative complications
- Intra-operative bleed
- Bile spillage
- Drain placement

Postoperative variables

Port site pain

It was assessed after the effect of anaesthesia drugs were over, at end of six hours and at the end of 24 hours, using the Visual Analog Scale for pain.

Requirement of analgesics

It was calculated as the number of Diclofenac ampoules required post operatively for pain relief

Postoperative complications

Post-operative hospital stay

Taken from the day of surgery to the day of discharge from the hospital.

Early ambulation/return to work

Cosmesis

This was assessed by asking leading questions to the patients about the outcome of the scar at follow up clinic at the end of one month. It was defined in terms of patient satisfaction and graded as patient satisfied, partially satisfied or not- satisfied.

Statistical analysis

For descriptive statistics, continuous variables were presented as mean, standard deviation and range, and ordinal variables were presented as percentages. Comparison of parameters between three-port and four-port laparoscopic cholecystectomy was done using “chi square test” or “Fisher exact test” for categorical

variables and “independent sample t-test” for continuous variables. Software used for statistical analysis was SPSS version 16.0 and p value of less than 0.05 was taken as significant.

RESULTS

Demographic results

Demographic details of the patients are shown in table 1 and are comparable in the two groups. A total of 90 patients were included in the study, of which 45 (50%) patients underwent three-port and the remaining 45 underwent four-port laparoscopic cholecystectomy. Female to male ratio was 7.2:1. The mean age of patients in the study group was 42.59±8.2 years with an age range of 26-65 years.

Majority of patients in the total study population as well as both the study groups were in the age range of 40-50 years. In the three-port group, the mean weight of the patients was 64.4±10.4kg (range 44-95kg). In the four-port group, the mean weight of the patients was 68.5±13.84kg (range 46-110 kg).

On ultrasound, most of the patients had multiple calculi in the gall bladder, described as three or more calculi. 19 patients in the Group A and 20 patients in group B had single calculus. 1 patient in each group had gall bladder polyp. Of the patients with cholelithiasis, majority had chronic symptoms.

Table 1: Demographic details of the study population.

Variables	Three-port (Group A)	Four-port (Group B)	Total
Mean age (Age range) In years	42.2 (26-62)	42.98 (28-65)	42.6 (26-65)
Gender	Males n (%)	6 (13.3%)	5 (11.1%)
	Females n (%)	39 (86.7%)	40 (88.9%)
Mean weight (Weight range) In kg	64.4 (44-95)	68.5 (46-110)	66.4 (44-110)
Ultrasound	Single calculus n (%)	19 (42.2)	20 (44.5)
	Multiple calculi n (%)	25 (55.6)	24 (53.3)
	Polyp n (%)	1 (2.2)	1 (2.2)
Acute symptoms n (%)	2 (4.5)	3 (6.8)	5 (5.7)
Chronic symptoms n (%)	42 (95.4)	41 (93.2)	83 (94.3)

Per-operative findings

Conversion rate

In the three-port group, 41 cases were completed successfully without any need for conversion. 3 patients were converted to four-port procedure and 1 patient was converted to open cholecystectomy. In the four-port group, 3 cases were converted to open cholecystectomy for completion (Table 2). This result was not statistically significant.

Intra-operative complications

The various intra-operative complications encountered in the two groups are listed in Table 3. No statistically significant difference was seen in the two groups (p value - 0.694).

Intra operative bleed

The amount of intra-operative bleed in the two groups is shown in Table 3. Most of the patients had intraoperative

bleed of less than 10ml. The difference was not statistically significant. Overall, bleeding was slightly more in the four-port group.

Table 2: Conversion rate in three-port and four-port LC group.

Conversion	Three-port (Group A)	Four-port (Group B)	p value
Open n (%)	1 (2.2)	3 (6.7)	0.135
4 port n (%)	3 (6.7)	NA	
None n (%)	41 (91.1)	42 (93.3)	

Intra operative adhesions

Gall bladder adhesions with omentum, small bowel or duodenum were seen in 21 patients in the three-port group and 25 patients in the four-port group (Table 3).

Table 3: Comparison of intra-operative variables in patients of three-port and four-port LC groups.

Variable	Three-port n (%)	Four-port n (%)	p value
Complications:			
Bleeding from cystic/ major artery	1 (2.2)	2 (4.4)	0.694
Bile duct injury	1 (2.2)	0 (0)	
Visceral organ injury	0 (0)	1 (2.2)	
Others	1 (2.2)	1 (2.2)	
None	42 (93.4)	41 (91.2)	
Amount of bleeding: <10ml	32 (78)	22 (52.4)	0.41
10-20ml	9 (22)	19 (45.2)	
>20ml	0	1 (2.4)	
Intraoperative adhesions	21 (46.7)	25 (55.6)	0.68
Bile leak	12 (29.3)	7 (16.7)	0.17

Bile Spillage

Bile leak was seen in 12 patients in the three-port group and 7 patients in the four-port group (Table 3). The result is, however, not statistically significant.

Table 4: Comparison of operative time and postoperative variables in patients of three-port and four-port LC groups.

Variable	Three-port (Group A)		Four-port (Group B)		p value
	Mean±SD	Range	Mean±SD	Range	
Operative time (mins)	46.07±11.93	25-75	42.1±15.12	20-100	0.188
VAS 6 hrs	5.71±0.84	4-8	6.60±0.83	5-8	0.000
VAS 24 hrs	2.80±0.81	1-5	3.60±0.80	2-5	0.000
Diclofenac ampoules (n)	3.76±1.02	3-7	4.36±0.76	3-8	0.003
Duration of hospital stay (hrs)	37.61±11.42	24-72	38.05±4.93	30-50	0.820
Return to normal activity (days)	5.44±0.50	5-6	5.90±0.82	4 - 7	0.003

Drain placement

Two patients in each group had a drain placed in the subhepatic region. The drains were removed on the first post-operative day in both groups of patients.

Operative time

The average operative time was slightly more in the three- port LC group as compared to the four-port group. It was 46.0±11.9 minutes for three-port cholecystectomy, ranging from 25 to 75 minutes.

In the four-port cholecystectomy group, it was 42.1±15.1 minutes, ranging from 20 to 100 minutes (Table 4). The difference however was found to be statistically insignificant.

Post-operative variables

Comparison of various postoperative variables in the two groups is shown in Table 4.

Post-operative pain

Pain at 6 hours and 24 hours post operatively was found to be less in the three-port group than the four-port group and the results were statistically significant. The mean Visual Analog Score was 5.71±0.84 and 6.60±0.83 at 6 hours; and 2.80±0.81 and 3.60±0.80 at 24 hours in the three-port and four-port groups respectively.

Diclofenac ampoules

The average number of diclofenac ampoules required in the three-port group was significantly less than that of the four-port group.

Duration of hospital stay

The average number of hours of hospital stay was slightly less in the three-port group (37.6±11.4 hours) as compared to the four-port cholecystectomy group (38.1±4.9 hours). However, the difference was not statistically significant.

Return to normal activity

The mean duration for return to normal activity was significantly less in the three-port LC group. In the three-port group, it was 5.4 ± 0.5 days with a range of 5-6 days. In the four-port group, it was 5.9 ± 0.8 days with a range of 4-7 days.

Post-operative complications

In the three-port group, 2 patients had wound infection, 1 patient had abdominal pain post operatively and 38 patients had no complications. In the four-port group, 2 patients had wound infection, 2 patients had wound hematoma and 38 patients had no complications postoperatively. None of the patients had port site hernia at one month follow up (Table 5). The difference in the two groups was statistically insignificant.

Table 5: Post-operative complications in patients in three-port and four-port LC group.

Complications	Three-port (Group A) n (%)	Four-port (Group B) n(%)	p value
Wound infection	2 (4.9)	2 (4.8)	0.39
Wound hematoma	0 (0)	2 (4.8)	
Abdominal pain	1 (2.4)	0 (0)	
Port site hernia (1 month)	0 (0)	0 (0)	
None	38 (92.7)	38 (90.5)	

Cosmetic outcome

In the three-port group, 32 (78%) patients were completely satisfied with the scar and cosmetic outcome, 8 (19.6%) patients were partially satisfied, whereas 1 (2.4%) patient was unsatisfied due to poor scar and cosmetic result.

In the four-port group, 21 (50%) patients were completely satisfied with the cosmic outcome, 20 (47.6%) were partially satisfied and one patient was unsatisfied. Thus, overall patient satisfaction regarding scar outcome was significantly better in the three-port group (Table 6).

Table 6: Cosmetic outcome in patients in three-port and four-port LC group.

Outcome	Three-port (Group A) n (%)	Four-port (Group B) n (%)	p value
Good	32 (78)	21 (50)	0.025
Average	8 (19.6)	20 (47.6)	
Poor	1 (2.4)	1 (2.4)	

DISCUSSION

Laparoscopic Cholecystectomy is the treatment of choice for gall stone disease.^{7,8} The classical four port method uses the fourth right flank port to retract the gall bladder funds (American technique) or liver (French technique) for better exposure of Calot's triangle.^{12,13} Reduction in post-operative pain with better cosmesis and early return to work have been the goals to improve cost effectiveness and patient satisfaction. Reduction in the number and size of ports has been advocated as a means to achieve the same. Recent published data has shown positive results in this regard.¹⁴⁻¹⁸ Reduction of the ports to three, by omitting the aforementioned fourth port has shown positive results in present study, without compromising procedure safety.

In present study group of 90 patients, most of the patients were females (77.8%) in the age group of 40-50 years. The overall female to male ratio was 7.2:1. Age and gender distribution was almost similar in the two groups. Gall stone disease is a female preponderant disease, mostly affecting middle aged females. Few studies have linked the etiology to estrogen hormone.¹⁹ Most of the patients in either groups had multiple calculi with chronic symptoms.

Naso-gastric suction was carried out only during the procedure to deflate the stomach and duodenum to facilitate laparoscopic visualization of the abdominal viscera, similar to a few previous authors.²⁰⁻²³ Intraoperatively, adhesions were found in 55.6% patients in four-port and 46.7% patients in the three-port group, which were seen at as fundus of the gall bladder and near the Calot's triangle. These were mostly with omentum, small gut, stomach, transverse colon and anterior abdominal wall. All but two could be separated successfully using monopolar electrocautery, fundal pressure, irrigation and suction.

There were 3 conversions to four-port and 1 conversion to open cholecystectomy in the Group A patients. A fourth port had to be introduced for various reasons like, difficult anatomy of the Calot's triangle with aberrant relations of the cystic duct and cystic artery in one case and distended Hartman's pouch obscuring the anatomy of the Calot's triangle in another. Third case had a long right hepatic artery which had to be traced high up in the gall bladder fossa, along with a long cystic duct before joining the common hepatic duct. The case which was converted to open cholecystectomy had injury to common bile duct which underwent primary repair and was managed successfully. There were 3 conversions to open cholecystectomy in the four-port group. Two cases had dense adhesions of the gall bladder with surrounding structures. Third case was an hour glass type of gall bladder with a long cystic duct in which there was a cystic artery bleed due to the slippage of the clips applied on the stump of cystic artery, which could not be controlled laparoscopically. Further evaluation of these

patients was not done in the study as the variables assessed were disproportionate to those included in the study. Other authors have reported similar causes of conversion. Few other causes reported include cholecysto-digestive fistula, choledocholithiasis, intrahepatic adhesions and equipment failure.²⁴⁻²⁶

We found no significant difference in the number of complications in the two groups. However, number of bleeds in the four-port group was slightly more than the three-port group. The reason could be that more patients in the four-port group were found to have adhesions in the Calot's triangle.

Mean operative time in the four-port group was found to be slightly less than the three-port group. This is probably because the addition of the fourth port facilitates dissection of the Calot's triangle as it is better exposed due to laterally retracted gall bladder. Mixed results have been found in literature in this regard. While some authors have reported similar findings, some have reported three port procedure to be shorter than four-port.^{16,18,25,27-29} They have explained this on the basis of less time required to create an additional port. We believe that three port cholecystectomy is a relatively new technique and with increasing experience, mean procedural time is likely to reduce.

Authors have used the epigastric port for extraction of gall bladder in a technique similar to that.^{22,30} Various other authors have used the umbilical port for extraction.^{20,29,31}

Three-port cholecystectomy scores over the four-port technique in terms of various post-operative outcomes. Post-operative pain at 6 and 24 hours and use of analgesics were statistically less in the three-port group and so was the duration of return to work and normal activity. Mean duration of hospital stay was also slightly less in the three-port group. The cosmetic effect of the surgery in both groups was evaluated one month after surgery and patient satisfaction was overall found to be better in the three-port group. The main reason for partial satisfaction was that the patients in four-port group were aware of the fact that the number of scars could have been reduced.

Based on our experience with the two procedures and after analysis of results, we would recommend that three-port laparoscopic cholecystectomy can be done in patients of benign gall bladder disease. Even though the duration of surgery was slightly longer in the three-port technique, post-operative pain, recovery, time of discharge, return to work and cosmetic outcome was superior in three-port laparoscopic cholecystectomy. Thus, overall three-port procedure appears to be more cost effective than four-port, in terms of reduced cost of an additional port, lesser analgesic use and less number of work days lost. Intraoperative complication rates and

factors leading to conversion to open technique were comparable in both techniques.

The difficulty level in three-port laparoscopic cholecystectomy was higher as compared to four-port laparoscopic cholecystectomy in the following situations: thick walled gall bladder, gall bladder packed with stones, large stone impacted at Hartman's pouch, empyema of gall bladder, severe pericholecystic adhesions, frozen Calot's triangle and acute cholecystitis. If laparoscopic cholecystectomy is performed by an experienced surgeon, it can be started with three ports. In the face of above-mentioned situations, intraoperative difficulty or a large heavy and fatty liver, a fourth port can be inserted.

The study was conducted on a small group of patients at a single centre. Similar studies conducted on a larger study population at different centres can further be done to validate our results.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Shahedi WH. The biliary system through the ages. *Int Surg.* 1979;64(6):63-78.
2. Gadacz TR. US experience with laparoscopic cholecystectomy. *Am J Surg.* 1993;165(4):450-4.
3. Shea JA, Berlin JA. Indications and outcome of cholecystectomy: A comparison of pre and post-laparoscopic era. *Ann Surg.* 1998;227(3):343-50.
4. Nahrwold DL. Biliary System. In: Sabiston DS, Lyerly HK, eds. *Textbook of Surgery: The Biological Basis of Modern Surgical Practice.* 15th Ed. WB Saunders Company, USA; 1997:1117-1148.
5. Hunter JG, Oddsdottir M. Gallbladder and the extrahepatic biliary system. In: Brunicaardi FC, Andersen DK, Billiar TR, Dunn DL, Hunter JG, Pollock RE, eds. *Schwartz's Principles of Surgery.* 8th Ed. Mc Graw Hill, New York; 2005:1187-1218.
6. Soper NJ, Dunnegan DL. Laparoscopic cholecystectomy: experience of a single surgeon. *World J Surg.* 1993;17(1):16-20.
7. Soper NJ, Brunt LM, Kerbl K. Laparoscopic General Surgery. *N Engl J Med.* 1994;330(6):409-19.
8. Soper NJ, Stockmann PT, Dunnegan DL. Laparoscopic cholecystectomy. The new 'gold standard'? *Arch Surg.* 1992 Aug;127(8):917-21.
9. Mouret P. From the first laparoscopic cholecystectomy to frontiers of laparoscopic surgery; the future perspective. *Dig Surg.* 1991;8:124-5.
10. Palanivelu C. History of Laproscopic Surgery. *Palanivelu's Text Book of Surgical Laproscopy.* 1st

- Ed. Gem digestive disease foundation, Coimbatore; 2002:3-6.
11. Udwardia TE. Laparoscopy in India a personal perspective. *J Minim Access Surg*. 2005;1(2):51-2.
 12. Haribhakti SP, Mistry JH. Techniques of laparoscopic cholecystectomy: Nomenclature and selection. *J Minim Access Surg*. 2015;11(2):113-8.
 13. Dubois F. Laparoscopic Cholecystectomy: The French Technique. In: Phillips EH, Rosenthal RJ, eds. *Operative Strategies in Laparoscopic Surgery*. Springer, Heidelberg; 1995.
 14. Harsha HS, Gunjiganvi M, Singh C, Moirangthem GS. A study of three-port versus four-port laparoscopic cholecystectomy. *J Med Soc*. 2013;27(3):208-11.
 15. Wilkinson TRV, Mehrotra P, Bansod P, Akhtar M. Three-port versus four-port laparoscopic cholecystectomy- a prospective study. *Int J Med Res Rev*. 2017;5(3):235-41.
 16. Kumar M, Agrawal CS, Gupta RK. Three-port Versus Standard Four-Port Laparoscopic Cholecystectomy: a randomized controlled clinical trial in a community-based teaching hospital in Eastern Nepal. *JLS*. 2007;11(3):358-62.
 17. Mayir B, Dogan U, Koc U. Safety and effectiveness of three-port laparoscopic cholecystectomy. *Int J Clin Exp Med*. 2014;7(8):2339-42.
 18. Al-Azawi D, Houssein N, Rayis AB, McMahon D, Hehir DJ. Three-port versus four-port laparoscopic cholecystectomy in acute and chronic cholecystitis. *BMC Surg*. 2007;7:8.
 19. Novacek G. Gender and gallstone disease. *Wien Med Wochenschr*. 2006;156:527-33.
 20. Dubois F, Icard P, Berthelot G. Coelioscopic cholecystectomy. Preliminary report of 36 cases. *Ann Surg*. 1990;211(1):60-2.
 21. Schirmer BD, Edge SB, Dix J. Laparoscopic cholecystectomy. Treatment of choice for symptomatic cholelithiasis. *Ann Surg*. 1991;213(6):665-76.
 22. Peters JH, Ellison EC, Innes JT. Safety and efficacy of laparoscopic cholecystectomy. A prospective analysis of 100 initial patients. *Ann Surg*. 1991;213(1):3-12.
 23. Grace PA, Quereshi A, Coleman J. Reduced postoperative hospitalization after laparoscopic cholecystectomy. *Br J Surg*. 1991;78(2):160-2.
 24. Slim K, Pezet D, Stencl J. Laparoscopic cholecystectomy: an original three-trocar technique. *World J Surg*. 1995;19(3):394-7.
 25. Lee SH, Burhenne HJ. Gallbladder surgery following cholecystolithotripsy: suggested guidelines for treatment. *Br J Surg*. 1990;77(11):1268-71.
 26. Koscak D, Lovric J. Laparoscopic three trocar cholecystectomy at Bjelovar General Hospital. *Acta Clin Croat*. 2005;45:51-6.
 27. Rashed A, Nassar A, Ashkar K. Three Vs Four Ports in Laparoscopic Cholecystectomy. *Br J Surg*. 1995;82:15.
 28. Gupta A, Shrivastava UK, Kumar P. Minilaparoscopic versus laparoscopic cholecystectomy: a randomised controlled trial. *Trop Gastroenterol*. 2005;26(3):149-51.
 29. Trichak S. Three-port vs standard four-port laparoscopic cholecystectomy. *Surg Endosc*. 2003;17(9):1434-6.
 30. Zucker KA, Bailey RW, Gadacz TR. Laparoscopic guided cholecystectomy. *Am J Surg*. 1991;161(1):36-42.
 31. Perissat J, Collet D, Belliard R. Laparoscopic cholecystectomy: the state of the art. A report on 700 consecutive cases. *World J Surg*. 1992;16(6):1074-82.

Cite this article as: Kumar P, Rana AKS. Three-port versus four-port laparoscopic cholecystectomy: a comparative study at a tertiary care centre in North India. *Int Surg J* 2018;5:426-32.