Journal of Surgery and Trauma 2020; 8(2):52-57.
jsurgery.bums.ac.ir

ORIGINAL ARTICLE

Comparison of 3-port with standard 4-port laparoscopic cholecystectomy: A clinical trial

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Received: December 30, 2019 ***Revised: May 17, 2020*** ***Accepted: May 17, 2020***

Abstract

Introduction: Since the laparoscopic cholecystectomy was introduced first in 1990, the 4-port laparoscopic cholecystectomy was the gold standard. The 4-port (lateral) is used to hold gallbladder fundus and observe Calot's triangle. It is discussed that the 4-port technique is not required in many patients. Therefore, this study aimed to make a comparison between 3-port and 4-port laparoscopic cholecystectomy methods in the treatment of gallstone disease.

Methods: A double-blind clinical trial was performed on patients admitted to Imam Reza Hospital, Birjand, Iran. The patients with gallstone disease (n=60) were randomly assigned into the case (3-port) and control (4-port) groups using balanced block randomization and underwent 3- or 4-port laparoscopic cholecystectomy. Postoperative pain was measured by a visual analog scale four h after surgery. The amount of pain-killer, duration of surgery, as well as length of stay and scars were measured in this study. Data were analyzed statistically in SPSS software (version 18) through the Chi-square test and t-test. A p-value less than 0.05 was considered statistically significant.

Results: The groups were compared in terms of demographic characteristics. There were 24 females (80%) and 6 males (20%) in the control group and 25 females (83.4%) and 5 males (16.7%) in the case group (P=0.739). Moreover, the mean ages of the control and case groups were 59.823±7.8 and 61.10±4.7, respectively, and there was no significant difference between the groups in this regard (P=0.348). Furthermore, length of operation (P=0.001) and analgesic consumption (P=0.001) in the 3-port laparoscopic cholecystectomy group were lower than those in the 4-port group; however, the hospital stay (P=0.896) was the same in both groups.

Conclusions: The 3-port laparoscopic cholecystectomy is a safe, reliable, and cost-effective method in patients who underwent laparoscopic cholecystectomy.

Key words: Cholecystectomy, Gallstones, Laparoscopy

Introduction

Gallstones are among the most important issues that involve the gastrointestinal tract (1, 2) with a prevalence of 3-20% (3). It is a common cause of hospitalization in America and other Western countries (4). The first successful open surgery of cholecystectomy was performed in 1882, and it was the standard treatment for symptomatic gallstone disease more than a hundred years (5). This surgery requires general anesthesia and a large incision with a length of 4-8 inches below the

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[DOI: 10.32592/jsurgery.2020.8.2.101]

inferior edge of the ribs on the right side or a longitudinal incision in the midline between the umbilicus and the xiphoid (6). Minimum hospitalization time is 2-3 days after surgery, and the patient needs weeks of rest to recover (7). Over the years, there have been attempts to change the mode of treatment to reduce scarring and postoperative pain (8). These methods lead to the reduction of muscle tissue damage during cutting and making incisions (9).

In 1987, laparoscopic cholecystectomy was introduced by Philippe Mort in France (5, 9-15) and later by Dubious and Parisat in 1990, and quickly it was used for the treatment of gallstones (5, 13-15). In this method, the abdominal wall is not opened by a wide surgical incision but 2, 5, and 10-mm trocars are placed through. Initially, it has a slightly longer duration than open surgery; however, time is reduced with increasing experience of the surgeon. Although the surgical morbidity is low (11), there is a risk of damage to the bile ducts so that it has been reported that the rupture is 0-7% in the biliary tree (6, 11).

Laparoscopic cholecystectomy is the standard treatment for cholelithiasis carried out by 4 ports (9, 14, 16); however, surgeons including Slim, Cala, Greeni, Kapizi, and Tagaya used 3 ports (13, 16, 17), and some have reduced it to 2 or even one port (17, 18). The 4-port method is used to collect the liver to observe the Calot's triangle in the French method and pull the gallbladder fundus superotemporally in the American method. As the surgeon's experience increases it can be performed using fewer ports (13-15, 19). In this method, it is of utmost importance to have the cooperative manipulation of surgical instruments for detecting the Calot's triangle and separating the gallbladder from its bed (14, 15).

It is predictable and expected that reducing the size and the number of incisions gives better results although some surgeons believe that reducing size and number may be unnecessary. However, some others have reached positive results by reducing the number and size of the ports (9, 18). In a study, it has been found that reducing the amount of postoperative pain is associated with reducing the number and size of the ports (14). According to the results of other studies, the benefits of 3-port laparoscopic cholecystectomy can be summarized as low invasiveness, expedited recovery and return to work, more beauty, increased satisfaction, and reduced postoperative pain, length of stay, costs, rates of wound infection, and cardio-pulmonary complications (5, 6, 9, 13, 14, 16, 19). Therefore, this study aimed to make a comparison between 3-port and 4-port laparoscopic cholecystectomy methods in the treatment of gallstone disease.

Methods

The study protocol was approved by the Ethics Committee of Birjand University of Medical Sciences, Birjand, Iran, and registered in Clinical Trial System (IRCT ID: IRCT201202098375N5) (ethical code: 2-3-1391).

This study is a double-blind clinical trial using a case-control design. The sampling was performed using the census method by a single surgeon who was blinded to the patients' group. The study was conducted in the general surgery ward of Imam Reza Hospital, Birjand, Iran, on patients who met the criteria for laparoscopic cholecystectomy. The inclusion criteria were 1) the age of between 30 and 49 years, 2) presence of gallstone, 3) absence of acute or chronic cholecystitis, 4) and body mass index (BMI) <35.

On the other hand, the patients with gangrenous cholecystitis and cardiovascular diseases, and those who needed the 4-port, drain, and longer operation time more than the mean total operation time were excluded from the study.

Initially, the patients (n=60) were randomly assigned to the case (n=30) (3-port) and control (n=30) (4-port) groups using the balanced block randomization. After obtaining informed consent from the patients, they were asked to complete the questionnaire containing demographic characteristics such as age, gender, underlying disease, and the consumed medications. The patients were hospitalized electively, and they were advised not to eat or drink in the morning of the surgery performed in the ward of Imam Reza Hospital, Birjand, Iran. Moreover, the preoperative measures were taken from patients and the intravenous line was taken on the right arm of the patient. The patients in both groups underwent the same general anesthesia and the reverse Trendelenburg position slightly to the left side (the patient's right shoulder slightly above). In addition, the surgeon and the surgeon assistant carrying a camera were on the left side of the patient, and the television monitor was on the right side of the patient. After preparation and draping of the surgical site, the control group underwent the 4-port laparoscopy as follows:

Initially, two 10-mm ports were placed, of which one was above the umbilicus (camera) and the other in the epigastrium (the main port for dissection). Subsequently, another two 5-mm ports were placed, of which one was at the edge of the ribs 7 or 8 interiorly on mid-clavicular line and the

[DOI: 10.32592/jsurgery.2020.8.2.101]

Figure1: Port placement in 3-port cholecystectomy

other around the umbilicus or slightly higher (depending on the patient).

On the other hand, the case group was subjected to two 10-mm ports using the same procedure as the control group; however, the third port that was placed at the edge of rib 7 in the control group was eliminated. Due to technical issues to improve the dissection, a 5-mm port (the third port) was placed slightly lower than the umbilicus, compared to the control group, which gave the surgeon a better exposure (Figure 1).

In the 4-port method, port 3 is used to hold fundus of the gallbladder body, and the fourth port is employed to expose the Calot's triangle and for lateral maneuver and inferior traction of the gallbladder neck at Hartman pouch. In the 3-port method, the third port is initially used to free trunk and gallbladder fundus, and then, the port is utilized for lateral and inferior traction (Calot's triangle exposure).

Other surgical procedures included the dissection of Calot's triangle and ligation of the duct, and the cystic artery was performed through the second port in the same manner in two methods. Finally, the surgeon separated the gallbladder from the bed and removed it through the umbilical trocar. At the end of the surgery, the 10-mm trocar fascia and skin on the entry sites of trocars were repaired by monocryl suture using the subcuticular method.

The data were collected by a nursing expert who was blinded to the patients' study groups. Subsequently, they were analyzed statistically in SPSS software (version 18). Moreover, the Chi-square test and t-test were used to analyze central parameters and assumptions. A p-value less than 0.05 was considered statistically significant.

Results

This study was performed on 60 patients with gallstone of which 30 cases underwent laparoscopic surgery using a 3-port method, and the other 30 subjects underwent surgery using the conventional method with 4 ports. Gender frequency distribution was similar in the case and control groups (P=0.348). There was no statistically significant difference between the case and control groups regarding BMI (P=0.211). Moreover, the mean operation time in both groups showed no significant differences between the two groups in this regard (P=0.001). Furthermore, there was no significant difference between the groups in terms of age, length of stay, and pain (age: P=0.348, length of stay: P=0.896, pain: P=0.326) (Table 1).

Table 1: Demographic and medical characteristics of the patients (n=60) participated in the study

		Control group	Case group	P-value
Age		59.823±7.8	61.10±4.7	P=0.348
Gender	Female	(80%) 24	(83.3%)25	P=0.739
	Male	(20%) 6	(16.7%) 5	
Body mass index		27.57± 1.93	27.66±1.45	P=0.211
Surgery duration (min)		29.56±4.987	22.1±4.37	P=0.001
Length of stay (h)		24.81±0.96	24.85±0.99	P=0.896
Pain (visual analog scale)		8.2±15.1	7.8 ±1.39	P=0.326
Pain-killer injection (ml)		150.55±19.31	90.33±13.12	P=0.001

Discussion

Nowadays, laparoscopic cholecystectomy is widely used as the gold standard for the treatment of symptomatic gallstone (8, 13, 16). Standard laparoscopic cholecystectomy is performed with four ports (14, 16). In this study, several changes have been made for improvements, including reducing the number of ports. In the American 4-port laparoscopic method, the fourth port is typically used to hold gallbladder fundus; however,

[DOI: 10.32592/jsurgery.2020.8.2.101]

it is unnecessary in some cases, and it can be performed with fewer ports as the experience of the surgeon broadens (8, 16, 17). In this study, a 3-port laparoscopic cholecystectomy technique was compared with the standard 4-port method to evaluate satisfaction, duration of surgery, complications, and postoperative pain.

The results indicated that the duration of the surgery in 3-port laparoscopic surgery is shorter than that of the standard 4-port technique. This success can be observed in other studies (14, 18). However, some argue that the duration of the 3-port and 4-port surgery is similar (9, 10, 13, 19). One of the reasons for the reduction in the duration of the surgery using the 3-port is the time required for the placement of the ports in the abdominal wall, compared to the 4-port technique (14). Another reason could be the increased experience of the surgeon in laparoscopic surgeries (11). Reduction in the duration of the surgery can reduce the incidence of surgical complications and the need for painkiller consumption since the complications are associated with the duration of the surgery.

Diclofenac and pethidine are routine painkillers for laparoscopic surgeries. In this study, the 3-port laparoscopic group received lower amounts of intravenous analgesia (i.e., pethidine), and the difference was statistically significant between the groups in this regard ($P<0.001$) (90.33±13.12 vs. 150.55±19.31). In some studies, such as a study conducted by Trichac, it was revealed that the amount of postoperative pain had no decrease in the 3-port method (13, 14). This can be due to the multi-factorial cause of the pain; however, fewer incisions cause less pain. Even reduced size in 3-port laparoscopic cholecystectomy procedures can reduce pain. Similarly, Cheah has stated that the use of 2-mm ports instead of the 5-mm ports reduced postoperative pain and the need for painkillers. The results of a study performed by Bisgaard were in line with these findings.

In a study, it was stated that the total pain scores reduced in the first week after surgery; however, the mean pain score did not decrease clearly. Reducing the need for anesthesia is associated with the duration of the surgery and pneumoperitoneum. In a study conducted by Moncure on animals, increased central venous and pulmonary pressure was found followed by pneumoperitoneum that led to increased thoracic and intracranial pressure. This resulted in decreased cardiac output and venous return, transient impaired renal function, weakened immune system, and increased susceptibility to deep venous thrombosis, which could increase the need for painkillers.

No complications were reported in both groups; however, some surgeons have questioned the safety of the technique and stated that the method increased the risk of biliary tract injury during the surgery. Nonetheless, in some studies, it has been stated that the incidence of biliary tract injury was not affected by the 3-port laparoscopic technique (13). Biliary tract damage could be prevented if the gallbladder is not under tension and is held from infundibulum and moved aside, and dissection is performed between the infundibulum and cystic duct junction (13).

Lack of adequate knowledge about the Calot's triangle anatomy can cause other damage to the bile ducts. Over-detection of the Calot's triangle makes bile duct (CBD) and other extrahepatic ducts including accessory bile ducts appear. In a study, it was pointed out that the ability to identify anatomical structures is experience-dependent (11), and it is known that the major CBD damages may be due to the lack of detection of an incorrect understanding of the anatomical structures rather than the experience and knowledge of the surgeon.

Cosmetics can be considered a desirable outcome, especially in young women, because the patients take advantage of 5-mm invisible incisions and 10-mm incisions hidden in the folds of the umbilicus. Moreover, the umbilical scar is not distinguished from umbilical structures after healing. It will also keep the umbilical structure.

Another advantage of the 3-port laparoscopic technique is the lower cost which could be due to less use of surgical instruments and ports. However, in this study, the costs of both methods were similar due to the use of multiple-use metal objects and global calculation of the surgery cost. In some studies, the economic aspect is considered to be controversial since reducing one port does not lead to such economic results; however, it is precious when we are faced with a shortage of equipment in the operating room.

The lengths of stay in the control and case groups were 24.81±0.96 and 24.85±0.99 h, respectively, which showed no significant difference between the groups in this regard ($P=0.89$). This result is in line with the findings of other studies (19, 14,13,9 and 20), and Trichac has mentioned the safety and benefits of 3-port laparoscopic procedures including reduced need for painkiller; however, he showed no difference in the number of hospitalization days after surgery. This theory has been proposed in the literature that the reduced length of stay may be due to the reduced postoperative painkiller consumption. Moreover, reduced consumption and the need for

[DOI: 10.32592/jsurgery.2020.8.2.101]

painkillers correlated significantly with reduced postoperative hospital stay (10).

In this study, 2 out of 30 patients were treated with 3-port laparoscopic cholecystectomy (6.66%), and the 4-port method was used due to the special anatomical location. The 3-port laparoscopic cholecystectomy is difficult in long gallbladder with a lot of peritoneal folds since the long fundus is located at the dissection site. With all these problems, it has been proposed that the 3-port laparoscopic approach is not technically difficult and can be performed safely by experienced surgeons.

No case of laparoscopic surgery ended with open surgery were reported in the current study. However, other studies have reported conversion rates varying from 0 to 16%, and the differences may be related to the selection of patients and equipment (9). The risk factors for conversion to open surgery include old age, large stone, gangrenous cholecystitis, fluid accumulation around the gallbladder, difficulty in separating the Calot's triangle from high adhesions (11), gallbladder wall thickness, reduced skill and experience of the surgeon, bleeding and damage to the bile tract (11, 14), males with acute cholecystitis, lack of knowledge about the anatomical structure, improper means employed, gallstone identified during surgery (11), adhesion (9), scleroatrophic gallbladder, and stones in the papilla. Moreover, increased BMI (32 kg / m2) causes increased blood loss and time that could also be considered a risk factor. Some others have considered diabetes as a risk factor for conversion to open surgery. On the other hand, some have found no correlation between diabetes and open surgery.

The mortality rate was zero in both groups of the study, which is also observed in other studies (9 and 10). Several studies revealed no evidence on mortality rate; however, the cause of mortality is expected to be mostly due to myocardial infarction and sepsis. It is worth mentioning that these causes have also been confirmed in the studies conducted by Brunt and Malik.

Conclusions

The 3-port laparoscopic technique is a feasible and safe method with advantages, such as reduced postoperative pain and the need for analgesics.

Acknowledgments

The authors thank the participating patients and the staff working in the general surgery ward at Imam Reza Hospital, Birjand, Iran, for their contribution to this study.

Funding

The authors express their gratitude to the Research Deputy of Birjand University of Medical Sciences, Birjand, Iran, for supporting this project.

Conflict of Interest

There are no conflicts of interest associated with this study.

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[DOI: 10.32592/jsurgery.2020.8.2.101]

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[DOI: 10.32592/jsurgery.2020.8.2.101]