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The Comparison of Four-Port, Two-Port Without Suspension Suture and Single Port Laparoscopic Cholecystectomy Results

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A – research concept and design; **B** – collection and/or assembly of data; **C** – data analysis and interpretation; **D** – writing the article; **E** – critical revision of the article; **F** – final approval of article

Abstract

Background. Single-port surgery has recently become popular, however, many surgeons have to use additional ports during the surgery due to difficulties.

Objectives. We performed two-port MCAP (with an additional port using a multi-channel device through the umbilicus) without a suspension suture in a group of patients. We compared the results of this technique to the LC and SILC techniques.

Material and Methods. A total of 90 patients with gallbladder disease were included in the study. LC (n = 30) and SILC (n = 30) were performed in two groups. The other group underwent cholecystectomy (MCAP) by using an additional 5 mm port through the subxiphoid region with a multi-channel port through the transumblical. A transabdominal suspension suture was not used for the patients in this group. The surgery duration, estimated blood loss, length of hospitalization, visual analogue scale (VAS) score in the postoperative 1st and 7th day, need for analgesia in the postoperative period and complications, and the conversion rate were compared between the three methods.

Results. A total of 62 females (68.9%) and 28 males (31.1%) participated in the study. MCAP duration was significantly shorter than LC and SILC (38.1 ± 16.6, 49.4 ± 15.8, 77.8 ± 26.7 min respectively) ($p < 0.05$). The conversion rate was similar in all three groups. Hernia developed in the port area in two patients after SILC (6.7%). No significant difference was found between the groups for the other data we compared.

Conclusions. MCAP seems to be an easier technique with a shorter operation time compared to the other two techniques. However, there is a need for other studies to evaluate the cosmetic results (**Adv Clin Exp Med 2016, 25, 1, 101–109**).

Key words: single port, laparoscopic, cholecystectomy.

Single incision laparoscopic surgery (SILS) was first described in 1992 [1]. Pelosi reported this new technique to be an alternative, reliable and feasible method compared to conventional laparoscopy after performing 25 appendectomies, each through a single opening. The method was then used in gynecology, urology, general surgery and especially for cholecystectomy [2–4]. According to the results of the first experiences, this new method led to less pain and better cosmesis, and was more economical [4].

However, some recent studies have reported some disadvantages of this method (such as high hospital cost and high port-site hernia rate) [5]. According to Baik et al., the complex instruments and ports used in this method cause significant difficulties and restrictions during surgery [6]. Ma et al. had to use an additional port in 14 of 21 patients where they performed SILC (single-incision laparoscopic cholecystectomy) due to technical difficulties during surgery [7]. Such technical difficulties in rectal surgery have been overcome by using an additional port [8].

We found that surgery became easy and a suspension suture was not needed when we supported the SILC technique with an additional 5 mm

port in the subxiphoid region when we encountered difficulties in our clinical practice. We performed two-port MCAP (with an additional port using a multi-channel device through the umbilicus) without a suspension suture in a group of patients. We compared the results of this technique with the LC and SILC techniques.

Material and Methods

This study was conducted in the Department of General Surgery, Kafkas University School of Medicine. The records of patients undergoing cholecystectomy between December 2011 and July 2013 were retrospectively analyzed. All patients were provided information about the content of the study and consent was obtained from each participant for publication. The approval of the local ethics committee of Kafkas University School of Medicine was obtained and the Helsinki declaration was applied.

We have performed SILC and MCAP operations since 2011. In the study we included the first 30 cases of each operation and compared them with the first 30 cases of LC performed within the same time period.

The demographic data of all patients were analyzed. As regards the patient-related data, we evaluated the body mass index (BMI), American Society of Anesthesiologists (ASA) score, estimated blood loss (difference between the total amounts of suction and irrigation), surgery and inpatient duration, Visual Analogue Scale (VAS) score on the postoperative 1st and 7th day to measure the patient's pain, need for analgesia and any complications, and the conversion rate.

A surgical team from the department of general surgery experienced (with at least 100 laparoscopic surgeries) in minimal invasive technique practice performed the surgeries.

Exclusion criteria: Pregnant women, patients with clotting disorders, patients diagnosed with pre-operative choledocholithiasis and malignancy and those with abnormal cholestasis enzyme values, those who were undergoing peritoneal dialysis, patients with ASA ≥ IV and patients whose postoperative follow-up could not be performed were not included in the study.

Inclusion criteria: Patients with symptomatic stones and polyps in the gall bladder and patients with biliary dyskinesia were included.

Statistics

The SPSS 16.0 for Windows package program was used for the statistical analysis. The Shapiro-Wilk test was used for the distribution analysis of the parameters; data with normal distribution were expressed with mean ± standard deviation and data with abnormal distribution were expressed with the median values. Parameters with a normal distribution were compared with one-way variance analysis (ANOVA) and parameters with an abnormal distribution were compared with the Kruskal-Wallis test for the comparison of study groups. The Bonferroni correlation test was used for parameters with a normal distribution and the Mann-Whitney *U* test for parameters without a normal distribution in *post hoc* analysis. A p-value < 0.05 was accepted as significant.

Surgical Technique

We entered the abdomen with a Veress needle just below the umbilicus with the patient in the supine position for the LC method. Pneumoperitoneum was created with a mean intra-abdominal pressure of 12 to 15 mm Hg with CO_2 after connecting the insufflator to the Veress needle. The Veress needle was then removed, a 10 mm trocar introduced from the same place, and the camera inserted. Following this process, a total of three more trocars were placed with one under the xiphoid process in the midline, one under the costal arc at the anterior axillary line and one under the costal arc at the midclavicular line. We entered the abdomen with an approximately 1.5 cm transverse incision through the umbilicus for SILC while the patient was in the supine position under general anesthesia. The fascia was passed and the abdomen entered. A flexible SILC port (Covidien, ABD) was pushed forward to the abdomen from the incision with the help of a clamp. Cannulas were inserted into the holes in the port. CO_2 was given from the insufflation cannula into the abdominal cavity, and pneumoperitoneum was created with an average pressure of 12 to 15 mm Hg. A 5 mm optic camera was inserted through a cannula into the abdominal cavity and the abdomen was explored. A 4/0 polypropylene fiber with a straight needle was entered to the abdomen from the right upper quadrant under the costal curve. The needle was passed through the fundus of the gallbladder and was exited from the skin adjacent to the entry site. Tension was applied to the suture and the gallbladder was suspended on the abdominal wall. Calot's triangle was dissected with standard laparoscopic instruments and the cystic duct and cystic artery were revealed. The cystic duct and cystic artery were clipped with a 5 mm clip. Following the completion of the sac dissection, the suspension suture was cut and the sac taken out of the abdomen together with the port.

No suspension sutures to suspend the gallbladder were placed in the MCAP method unlike

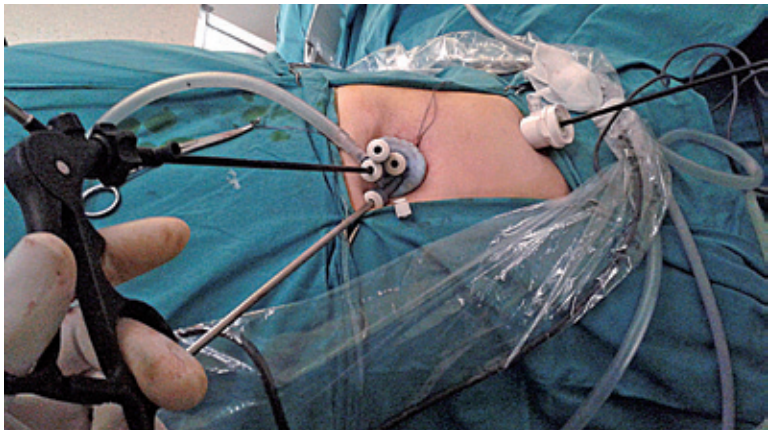


Fig. 1. The entry sites of the ports in the MCAP method

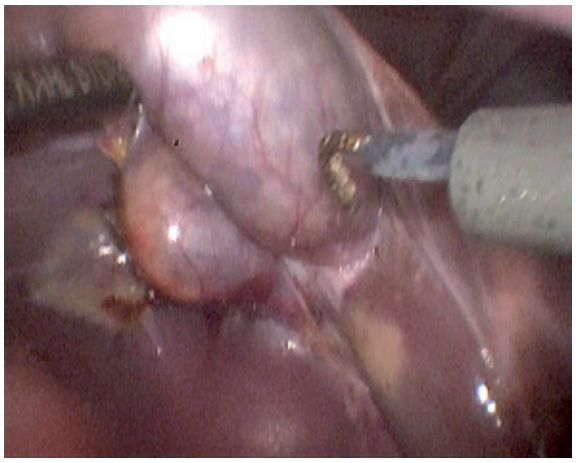
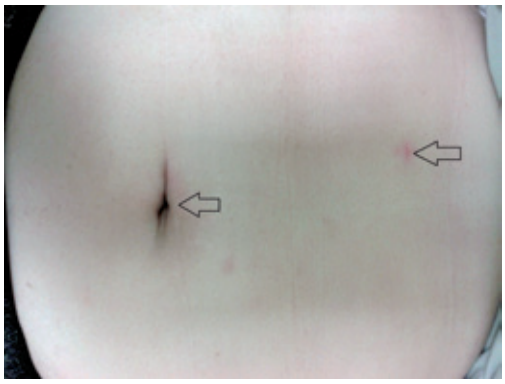


Fig. 2. Gallbladder dissection with two instruments in the MCAP technique

the SILC method. After the SILC port was inserted through the umbilical incision, a 5 mm trocar was placed through a 0.5 cm incision at the second port (Fig. 1). Laparoscopic instruments such as a grasper, clip shooter, dissector and irrigation instrument were inserted from this point as required during the surgery. The gallbladder was suspended with a grasper inserted through the umbilical port. The second grasper was entered through this port as required during the procedure and the gallbladder was retracted. Cholecystectomy was performed as in the SILC method (Fig. 2).

The umbilical fascial defect was closed with a Prolene™ (Ethicon) loop and the skin with Vicryl™ (Ethicon) in all three methods. All patients were administered two doses of antibiotics (1 g intravenous ampicillin-sulbactam during and after surgery). The pain control program in the post-operative period was as follows: All patients were administered pethidine 50–100 mg *i.m.* (according to the patients' age and body mass) after surgery and 4 mL *i.v.* metamizole sodium at follow-up. Metamizole sodium was repeated at the same dose as required for analgesia. These repeated doses were accepted as the post-operative analgesic need of the patients.



a

b

Fig. 3a, b. Postoperative incision images of the patients. 3a: post-operative 1st month image in a female patient; 3b: image after the MCAP in a female patient with midline incision

The patients were followed up with for an average of 12 months. Interviews by phone or face-to-face were periodically conducted in order to detect early and late postoperative complications and for general evaluations. The data of the patients was archived (Fig. 3a, b).

Results

A total of 90 patients (62 females and 28 males) between the ages of 23 and 77 years (mean 47.5 ± 10.9 years) were included in the study. The demographic and preoperative characteristics of the patients are presented in Table 1 and 2. We found no significant difference between the three groups in terms of age, gender, BMI and ASA values in our study ($p < 0.05$). Preoperative diagnoses and past abdominal surgery rates were similar.

Analysis of the intra-operative and post-operative data revealed no difference between the groups in terms of estimated blood loss, postoperative analgesia requirement, VAS scores of the 1st and 7th days, postoperative inpatient duration and total complication rate ($p > 0.05$). However, there was a significant difference between the three groups in terms of surgery duration. The mean duration was the shortest with the MCAP method (38.1 ± 16.6 min) and the longest with the SILC method (77.8 ± 26.7 min) ($p < 0.05$) (Table 3).

We performed retraction of the gall bladder through the transumbilical multichannel port using two graspers in 22 patients (73.3%) and a single grasper in 8 patients (26.7%). The characteristics of these 8 patients are presented in Table 4.

We evaluated the postoperative pain characteristics of our patients. Shoulder pain was defined in 28 patients and abdominal pain in 2 patients in the LC group. Periumbilical pain was commonly described in the SILC and MCAP groups (SILC: periumbilical 28, shoulder 1, whole abdomen 1, MCAP: periumbilical 26, shoulder 1, whole abdomen 3).

No significant difference was found between the groups for postoperative complications. However, hernia at the port site was detected in 2 patients (6.7%) in the SILC group who presented to our clinic on the postoperative 10th and 16th days (Table 5). One of these patients was obese (BMI: 34.5 kg/m^2), and the other was a diabetic patient. These patients immediately underwent surgery and their fascia defects were repaired with prolene mesh.

Table 2. The pre-operative characteristics of patients who underwent LC, SILC and MCAP

	LC (n: 30)	SILC (n: 30)	MCAP (n: 30)
Previous abd. surg.			
upper	0	1	1
lower	6	9	8
both	0	0	0
no	24	20	21
İndications for cholecystectomy			
chronic cholecystitis	22	24	22
acute cholecystitis	3	2	3
gallstone pancreatitis	2	1	1
choledocholithiasis	0	0	0
biliary dyskinesia	1	2	2
polyp	2	1	2

The rate of changing to another technique due to the lack of technical adequacy during the surgery was similar. Conversion to open surgery from the LC method was required in 2 patients for hydropic gallbladder and bleeding control (6.7%). Conversion to open surgery was required in 2 patients (6.7%) for acute cholecystitis findings and bleeding control and an additional port was required in two patients (6.7%) due to acute cholecystitis with the SILC method. Two patients (6.7%) were converted to open surgery for cystic arterial injury and the presence of porcelain sac with the MCAP method. Another port was added as the intra-abdominal fat was preventing visibility in the obese patient (3.3%).

Discussion

Laparoscopic cholecystectomy is currently the gold standard. However, surgeons have begun seeking less invasive methods in recent years. The SILS method was first described in 1997 and has been used as an alternative method for the surgical

Table 1. The demographic characteristics of the patients who underwent LC, SILC and MCAP

	LC (n: 30)	SILC (n: 30)	MCAP (n: 30)	P-value
Age (years)	45.7 ± 1.1	48.3 ± 9.1	48.4 ± 1.2	0.591
Female/male	17/13	23/7	22/8	0.204
BMI (kg/m^2)	28.5 ± 5.7	30.9 ± 4.0	29.7 ± 5.8	0.051
ASA (I/II/III)	15/14/1	14/15/1	18/11/1	0.267

BMI – body mass index; ASA – American Society of Anesthesiologists.

Table 3. The pre-operative and post-operative data of patients who underwent LC, SILC and MCAP

	LC (n: 30)	**SILC (n: 30)**	**MCAP (n: 30)**	**P-value**
Operating time	49.4 ± 15.8	77.8 ± 26.7	38.1 ± 16.6	< 0.05
Estimated blood loss (mL)	10.7 ± 6.9	10.0 ± 6.1	11.5 ± 10.7	0.934
Conversions to another surgery	2 (6.7%)	4 (13.3%)	2 (6.7%)	0.695
VAS.1 (1–10)	4.1 ± 1.1	4.1 ± 1.3	4.2 ± 1.3	0.990
VAS.2 (1–10)	2.0 ± 1.2	2.2 ± 1.0	1.9 ± 0.7	0.683
Analgesic	3.4 ± 1.8	3.6 ± 1.6	3.3 ± 1.5	0.871
Hospital stay (d)	2.0 ± 0.9	2.0 ± 1.0	1.9 ± 0.8	0.967
Post-op complications	3 (10.0%)	5 (16.6%)	4 (13.3%)	0.693

VAS – visual analogue scale.

Table 4. The post-operative complication features of patients who underwent LC, SILC and MCAP

Post-op. complications	**LC (n: 30)**	**SILC (n: 30)**	**MCAP (n: 30)**
Wound infection not requiring oral antibiotics requiring oral antibiotics	 1 0	 1 0	 1 0
Port side hernia	0	2	0
Port side hemorrhage	1	0	0
Port side seroma	1	2	2
Postoperative bile leak	0	0	1

Table 5. The characteristics of patients applied traction to the gallbladder with a single grasper entered through the transumbilical port in the MCAP method

Patients	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Gender	F	F	F	F	F	F	F	F
Age	64	39	22	65	47	39	27	42
BMI	24.4	30.9	31.6	29.3	35.9	22.6	28.7	23.2
ASA	II	II	II	I	II	II	I	II
O. time	14	26	15	21	36	30	9	20
EBL (mL)	5	5	0	0	0	10	0	0
Conversion	–	–	–	–	–	–	–	–
VAS1	4	7	4	3	3	7	5	3
VAS2	1	2	1	1	1	3	1	0
Analgesic	2	5	1	1	2	3	3	1
Hospital stay (d)	1	3	1	1	1	2	1	1
Post-op. complications	–	–	–	–	–	–	–	–

F – female; BMI – body mass index; ASA – American Society of Anesthesiologists;
VAS – visual analogue scale; EBL – estimated blood loss.

treatment of many organs. The first results of this method, performed transabdominally through a port inserted from a 1.5–2 cm incision in the umbilical region, were positive. Yilmaz et al. reported that these positive results were due to the newly-developed specific ports, cameras providing better visibility and devices with improved motion [9].

However, some studies published about 5 years after the initial treatment have mentioned some deficiencies and disadvantages of this method. According to Alptekin et al., SILC was not superior to traditional laparoscopic cholecystectomy. Technical difficulties such as the inability to work comfortably in the limited anatomical area, the proximity of the trocars, superposition of the instruments, and poor ergonomics were the main reasons stated [5, 10]. The results of some clinical studies have also supported this conclusion. The meta-analysis results of 9 randomized studies including 362 patients who underwent SILC were recently reported [11]. Additional ports were required due to the difficulty of the method in 4 of these studies. Additional port implementation rates were between 3% and 67%.

Operation Duration

Studies conducted to date have reported a shorter surgery duration with LC than with SILC. The operation duration with the SILC method was significantly longer than with the LC method in the meta-analysis of Trastulli et al., which included 13 studies and 923 patients [12]. There was a significant difference between the methods only in terms of operation duration and cosmetic result in meta-analysis studies by Wang et al. and the operation duration results favored LC [13].

The surgery duration was shorter with LC than with SILC in our study as well ($p < 0.05$). However, we found a significantly shorter time in patients where an additional port was used compared to the patients undergoing LC or SILC. The most important factor affecting this result was using an additional port. There were many factors causing the surgery duration to be shorter in patients where an additional port was used. First, the number of instruments inserted into the abdomen through the umbilical port decreased with the use of the additional port. We entered the grasper together with the camera through the umbilical port and other devices through the additional trocar site. In this way, the superposition of the instruments was prevented and the instruments could be moved more freely in the abdomen. Retraction was applied to the gallbladder with the grasper and procedures such as cholecystectomy, hemostasis and irrigation of the surgical field were performed with the instruments entered from the other port. The second factor was overcoming the hand superposition encountered frequently due to the surgeon's hands being close to each other while holding the instruments. While one of the surgeon's hands is on the umbilicus, the other is on the epigastric region. However, we had to use the second grasper through a single port in some patients. The characteristics of these patients were usually a hydropic gallbladder with a large stone in Hartmann's pouch and increased wall thickness, with the gallbladder preventing visibility in Calot's triangle. In this case, the help of the assistant was needed to hold the camera.

The third factor is the use of a thin and angled camera. Better visibility was obtained due to the angled feature. Being thin reduced the possibility of colliding with adjacent instruments.

We did not apply the technique of suspending the gallbladder with suspension sutures in the MCAP group in contrast to the SILC group. This was the fourth factor providing a time advantage. Suspension sutures are usually placed to the fundus in order to expose Calot's triangle. Some surgeons place a second suspension suture in Hartmann's pouch [14]. Data on the duration of suspension suture implementation are inadequate in the literature. However, Tian et al. report the mean time spent for the gallbladder retraction suture as 4 min [15]. The duration of this process was associated with the experience of the surgeon in our cases. However, the process may need to be repeated and the duration prolonged as a result of factors such as the needle being short, bending or breaking in some cases due to a thick subcutaneous fat layer or incorrect fixation through the gallbladder or skin. We shortened the surgery duration significantly by applying traction with one or two graspers we entered through the umbilical port in the additional port method we used.

Another advantage was minimizing the time loss occurring during the frequent irrigation of the surgical field. The irrigation instrument inserted through an additional port in this technique does not collide with other instruments and the irrigation is easier and quicker as the umbilicus is entered with a straighter angle.

A significant advantage affecting the operation duration in additional port usage is the possibility of a steeper learning curve. The learning curve for the SILC technique was reported by Tay et al. to be nineteen patients [16]. The number of ports is smaller in the MCAP technique we used and it is similar to the conventional technique, so it can be used without difficulty by any surgeon using the LC technique. The surgeons using this method in our clinic are experienced in the classic

laparoscopic technique. Despite this experience, the first SILC surgery took 160 min while the first surgery with the additional ports technique on the same date took only 35 min.

Postoperative Pain and the Need for Analgesia

Shoulder pain after laparoscopy can be due to pneumoperitoneum, parietal stretching, diaphragmatic irritation or intraoperative shoulder abduction, and is seen in at least one-third of these patients [17]. Methods such as the administration of local anesthesia to the port area, saline infusion with a ropivacaine solution to the right sub-diagraphmatic area during surgery and Transcutaneous Electrical Nerve Stimulation have been recommended to reduce postoperative pain [18, 19].

Articles have reported contradictory results regarding the level of postoperative pain occurring after LC and SILC [20, 21]. The difference is due to reasons such as the subjective perception of pain and the emotional state. The post-operative 1st and 7th day pain scores were similar in all three groups in our study. Accordingly, there was no significant difference between the postoperative analgesic requirements of the patients. However, we found a difference in the localization of the pain between the LC group and the other two groups. Almost all pain in the LC group patients was localized in the right shoulder while most of the patients in the other two groups described periumbilical pain. This may be due to the size of the incisions and more trauma to the umbilical incision with the longer operation duration. In conclusion, we found the use of an additional port did not increase pain and thus analgesia usage when compared to the other two techniques.

Post-Operative Complications

Discharge was present at the incision site in some patients we included in our study. However, these were serous discharges. They were treated with daily wound care. The closed environment of the umbilicus region increases the risk of secretion and infection around the incision in patient groups operated with multi-channel devices. Bunting reports that hernia development is most common in the umbilicus among the trocar insertion sites (88.9%) [5, 22–24]. Although actual rates are not known, Alptekin et al. found the frequency of port site hernia development after the SILC technique to be about 3.2 times higher than the LC technique [5]. Two incisional hernias developed in the SILC group in our study. No hernia was observed in the patients where an additional port was used. It is interesting that hernias only developed with the SILC method although both the SILC and MCAP methods use an umbilical entry site. The operation duration and incision size have been reported to be important factors in hernia development after laparoscopic procedures [22, 23]. The longer trauma duration to the umbilicus in the single port method can affect the blood circulation in the area. This may compromise postoperative wound healing.

Although the same closure technique was used as for the other patients in our study, we found hernia development in the SILC group with a longer surgery duration. The MCAP technique can decrease the possibility of hernias, seen with the SILC technique.

Changing to Another Procedure Due to the Inadequate Surgical Technique

The main reasons of inadequate surgical technique are the inadequacy or uncertainty in the anatomic image of the Callot's triangle, inadequacy of pneumoperitoneum creation and the failure to control bleeding [25]. While the rate of changing from the laparoscopic method to open surgery is about 10%, the rate of intervention in the surgical technique increases up to 67% due to the more difficult method with a single port [7, 26]. We found gallbladder-related reasons (hydropic gallbladder, increased wall thickness or infection) and inadequate bleeding control to play a role in changing to another technique (open, multiport or additional port) in our study. We changed to the multiport method due to gallbladder-related reasons in patients undergoing MCAP, unlike patients who were undergoing SILC. However, changing to the additional port or multiport methods due to gallbladder pathology as well as technical difficulties were seen with SILC.

The rate of technical inadequacy in our cases were within the rates reported in the literature. The rate in surgeries performed with an additional port was the same as seen with LC.

Hospitalization Duration

No significant difference was found between the LC and SILC groups in terms of post-operative hospitalization duration in recent meta-analysis studies [11, 25]. However, the hospitalization duration after 4-port cholecystectomy was reported to be significantly longer than with SILC in certain groups [27, 28]. Kurpiewski et al. found more postoperative complications (pneumothorax in

2 patients, choleperitonitis in 1 patient, and unfavorable wound healing in 4 patients) in the SILC group than in the LC group (7 versus 2). However, the VAS score at the 6th and 24th hour was lower in the SILC group. In conclusion, the patient's pain is more decisive in hospitalization duration unless there is a major complication. According to our clinical observations, surgery that does not restrict daily activities does not affect the patient's discharge even if there is pain.

Bile leakage occurred in a patient in the MCAP group. However, it did not create a significant difference between this technique and the other two methods in terms of postoperative pain scores and hospitalization duration.

Study Limitations

The lack of evaluation of the cosmetic expectations can be suggested as a significant limitation of our study. However, we preoperatively questioned the patients whether an incision and scar tissue about 0.5 cm in size would create a cosmetic problem. We then chose patients for SILC and MCAP among the patients who did not have a cosmetic expectation or who did not consider such a scar a problem. We therefore created a homogeneous group among the patients. Studies in larger series and those that evaluate the cosmetic expectation are also needed.

The authors concluded that MCAP is easier than classic 4-port and single incision laparoscopic cholecystectomy and has no postoperative disadvantages. However, it needs to be evaluated in terms of cosmetic results.

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