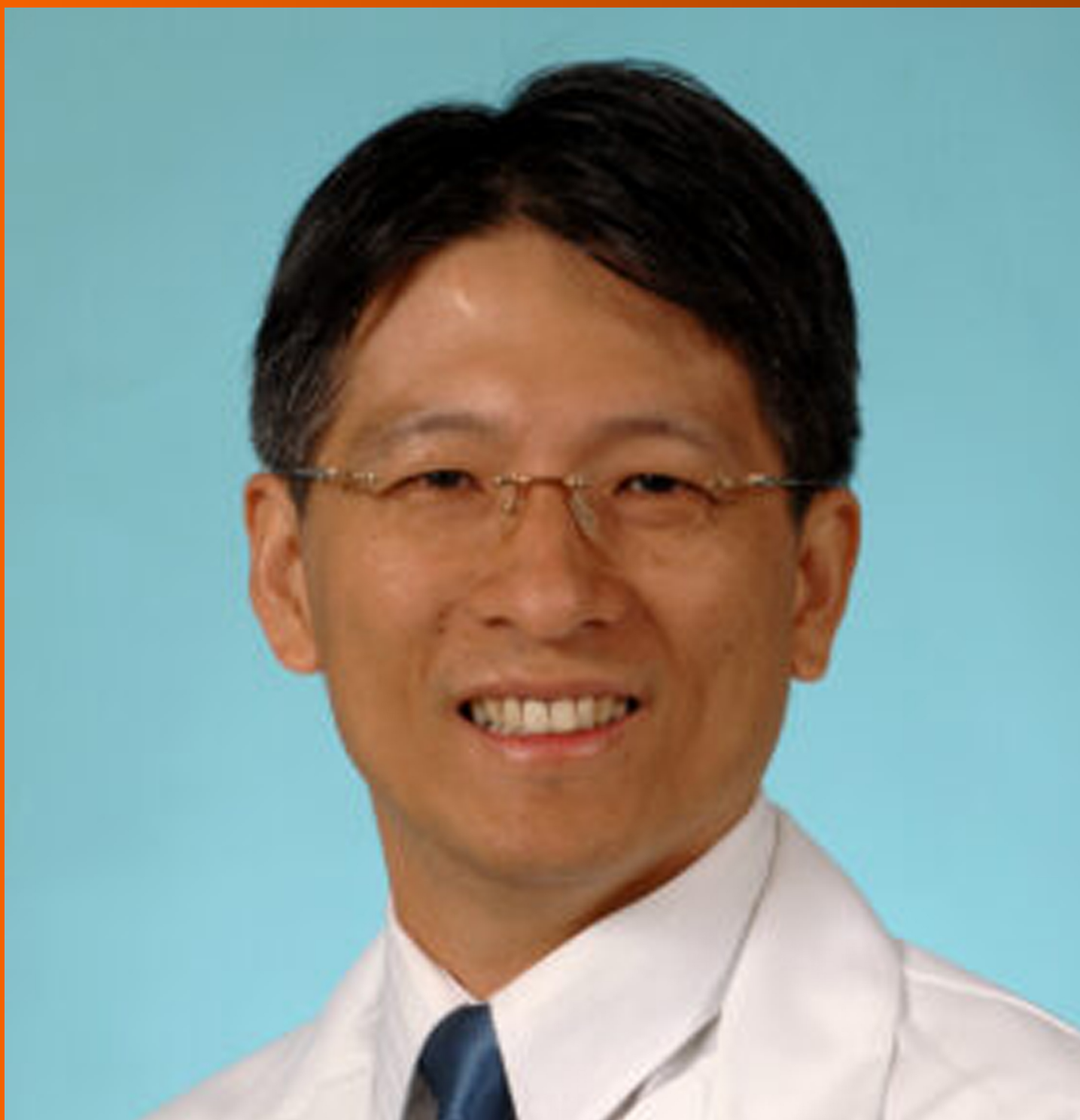


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Observational Study

Our initial single port robotic cholecystectomy experience: A feasible and safe option for benign gallbladder diseases

Huseyin Kemal Rasa, Ayhan Erdemir

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Abstract

BACKGROUND

Although single-port laparoscopic cholecystectomy has been performed for over 25 years, it is still not popular. The narrow working space used in this surgery limits the movement of instruments and causes ergonomic challenges. Robotic surgery not only resolves the ergonomic challenges of single-port laparoscopic surgery but is also considered a good option with its additional technical advantages, like a three-dimensional display and not being affected by tremors. However, the extent to which these technical and ergonomic advantages positively affect the surgical outcomes and how safe the single-port robotic surgeries need to be assessed for each particular surgery.

AIM

To evaluate the feasibility and safety of single-port robotic cholecystectomy for patients with cholelithiasis.

METHODS

The electronic records of the first 40 consecutive patients with gallbladder lithiasis who underwent single-port robotic cholecystectomy from 2013 to 2021 were analyzed retrospectively. In addition to the demographic characteristics of the patients, we analyzed American Society of Anesthesiologists (ASA) scores and body mass index. The presence of an accompanying umbilical hernia was also noted. The amount of blood loss during the operation, the necessity to place a drain in the subhepatic area, and the need to use grafts during the closure of the fascia of the port site were determined. Hospital stay, readmission rates, perioperative and postoperative complications, the Clavien-Dindo complication scores and postoperative analgesia requirements were also evaluated.

RESULTS

The mean age of the 40 patients included in the study was 49.5 ± 11.6 years, and 26 were female (65.0%). The umbilical hernia was present in 24 (60.0%) patients,

with a body mass index median of 29.3 kg/m² and a mean of 29.7 ± 5.2 kg/m². Fifteen (37.5%) of the patients were evaluated as ASA I, 18 (45.0%) as ASA II, and 7 (17.5%) as ASA III. The mean bleeding amount during the operation was 58.4 ± 55.8 mL, and drain placement was required in 12 patients (30.0%). After port removal, graft reinforcement during fascia closure was preferred in 14 patients (35.0%). The median operation time was 93.5 min and the mean was 101.2 ± 27.0 min. The mean hospital stay was 1.4 ± 0.6 d, and 1 patient was readmitted to the hospital due to pain (2.5%). Clavien-Dindo I complications were seen in 14 patients (35.0%), and five (12.5%) complications were wound site problems.

CONCLUSION

In addition to the technological and ergonomic advantages robotic surgery provides surgeons, our study strongly supports that single-port robotic cholecystectomy is a feasible and safe option for treating patients with gallstones.

Key Words: Cholecystectomy; Laparoscopic cholecystectomy; Robotic surgery; Single-port surgery; Single-port laparoscopic cholecystectomy; Single-port robotic cholecystectomy

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Core Tip: We retrospectively analyzed 40 consecutive patients with cholelithiasis who underwent single-port robotic cholecystectomy from 2013 to 2021. We believe that the learning curve for single-port robotic cholecystectomy surgery is not long, and after a particular experience, the operation times are significantly shortened. Our data suggest that it is a safe surgery with acceptable intraoperative blood loss, no conversion, and no bile duct injury or postoperative bile leak. Our data also support more liberal graft use during the fascia closure. Single-port robotic cholecystectomy is a feasible and safe option that should be considered when treating patients with gallstones.

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INTRODUCTION

The first successful laparoscopic cholecystectomy (LC) was performed in 1985 and quickly became the preferred method for all benign gallbladder diseases. The laparoscopic approach was also favored for different surgeries and initiated the evolution of “single-port” and “robotic” surgeries. Single-port laparoscopic cholecystectomy (SPLC) was first introduced in 1995[1] and was shown to be a reasonable option for various surgeries like appendectomy[2] and colectomy[3].

The narrow working space in SPLC limits the movement of instruments and causes ergonomic challenges like crowding and collision between instruments. These technical difficulties have prevented SPLC from becoming the gold standard approach[4]. Robotic surgery gained popularity after 2010 and resolved the ergonomic challenges of single-port surgeries. Its additional technical advantages, like a three-dimensional display and not being affected by tremors, enable robotic surgery to be a good option for surgeries with single-port use. On the other hand, the extent to which these technical and ergonomic advantages positively affect surgical outcomes and how safe robotic surgeries are performed with a single port still need to be assessed.

To evaluate the feasibility and safety of single-port robotic cholecystectomy (SPRC) surgery, we analyzed the results of our first 40 consecutive SPRC operations for cholelithiasis from 2013 to 2021.

MATERIALS AND METHODS

The electronic patient records of the first 40 consecutive patients who underwent SPRC using the “da Vinci SI” platform (Intuitive Surgical, Sunnyvale, CA, United States) in our hospital between 2013 and 2021 were reviewed retrospectively. The indication for surgery in all patients was gallbladder lithiasis. No distinction was made between patients with or without symptoms, and patients with acute cholecystitis or suspected malignancy were not included in the group.

Gel port or SILS port was used in surgeries. The port was placed through an open technique, and a 3 cm incision was made from the umbilicus. After port placement, the patient was placed in a partial reverse Trendelenburg and right tilt position. The port was positioned with the camera trocar at the bottom and the working trocars at the top. After the camera trocar was inserted, the docking was done. Monopolar scissors and bipolar fenestrated forceps were placed in the study arms. A technique similar to LC was used in the surgeries. To reduce the risk of bile duct injuries and to avoid complications due to anatomical alterations, we used the "Critical View of Safety" technique introduced by Strasberg in all our SPRC surgeries[5]. Admittedly, the view achieved by SPRC is usually better than that of laparoscopy.

Similar care with laparoscopic surgeries in the postoperative period was applied. Patients were allowed to take fluids in the 2nd hour, mobilized at the 6th hour, and discharged within 1 d to 3 d post-surgery.

In addition to the demographic characteristics of the patients, we analyzed American Society of Anesthesiologists (ASA) scores and body mass indexes. The presence of an accompanying umbilical hernia was also noted. The amount of blood loss during the operation, the necessity to place a drain in the subhepatic area and the need to use grafts during the closure of the fascia of the port site were determined. Hospital stay, readmission rates, perioperative and postoperative complications, the Clavien-Dindo complication scores, and postoperative analgesia requirements were also evaluated.

Ertan Koç reviewed the calculations and statistical methods of this study.

RESULTS

The mean age of the 40 patients included in the study was 49.5 ± 11.6 years, and 26 patients were female (65.0%). The umbilical hernia was present in 24 (60.0%) patients with a body mass index median of 29.3 kg/m^2 and mean of $29.7 \pm 5.2 \text{ kg/m}^2$. Fifteen (37.5%) of the patients were evaluated as ASA I, 18 (45.0%) as ASA II, and 7 (17.5%) as ASA III. The mean blood loss during the operation was $58.4 \pm 55.8 \text{ mL}$, and drain placement was required in 12 patients (30.0%). After port removal, graft reinforcement for fascia closure was preferred in 14 patients (35.0%). We used a prolene graft for fascia closure reinforcement. After the fascial defect was primarily closed, a properly sized prolene graft was placed as an on-lay, and the graft was fixed with interrupted non-absorbable sutures.

The median operative time was 93.5 min and the mean time was 101.2 ± 27.0 min. The mean hospital stay was 1.4 ± 0.6 d, and 1 patient was readmitted to the hospital due to pain (2.5%). Clavien-Dindo I complications were seen in 14 patients (35.0%), and five complications (12.5%) were wound site problems (Table 1).

We also evaluated our 40 consecutive multi-port laparoscopic cholecystectomies performed in the last 6 mo to guide us in evaluating the results of our study. The average age of the patient in this group was 45.5. Fifteen of the patients were female and twenty-five were male. The mean BMI was 28.7 kg/m^2 . For ASA scores, 14 patients were ASA 1, 23 were ASA 2, and 3 were ASA 3. One patient had an umbilical hernia. Thirteen patients were operated on for acute cholecystitis. Perioperative bleeding was minimal and drains were used in 4 patients; no grafts were used in any of the patients. The mean operative time was 54 min, and the average length of stay in the hospital was 1 d. A single dose of paracetamol was used as an analgesic postoperatively in 23 of the patients. Complications at the level of Clavien-Dindo 1 (2 of diarrhea, 1 of pain) developed in 3 patients postoperatively, but no patient required re-hospitalization (Table 2).

DISCUSSION

A systematic review published in 2021 evaluating the intraoperative and postoperative results of robotic cholecystectomy showed that the operating room time for robotic cholecystectomy is longer than its laparoscopic equivalent[6]. When the studies included in this review were evaluated, it was shown that the most critical factor that extended the operation time was the learning curve. While the time difference between the robotic and laparoscopic surgeries was more distinct in the studies before 2010, it was seen that there was less or no difference in the studies published in the following years. SPRC surgeries in our study lasted 60 to 207 min, with a median time of 93.5 min and an average of 101.2 ± 27 min. When we reviewed our data, we saw a similar trend in our study; the surgeries performed at the beginning of our learning curve took longer, and the operating times shortened over time. The increase in the operating room team's experience in preparing the robotic arrangement and the rapid replacement of hand tools shortened the surgery and operation times.

Perhaps the most significant limitation of our study was that the number of included surgeries was only 40. With this total number, it was impossible to perform subgroup analyses such as early and late periods, in which statistically significant differences could be revealed. On the other hand, our observation was similar to the results of a systematic review published in 2018 by Migliore *et al*[7] that showed the learning curve for SPRC surgery to not be long. After a particular experience, the operation

Table 1 Demographic and perioperative data of the patients

Characteristic	Parameter		
Age, yr	Min-Max: 26-73	Median: 48	mean \pm SD: 49.5 \pm 11.6
BMI, kg/m ²	Min-Max: 20.2–40.9	Median: 29.3	mean \pm SD: 29.7 \pm 5.2
Operation time, min	Min-Max: 60-207	Median: 93.5	mean \pm SD: 101.2 \pm 27.0
Amount of bleeding, mL	Min-Max: 15-250	Median: 50	mean \pm SD: 58.4 \pm 55.8
Length of hospital stay, d	Min-Max: 1-3	Median: 1	mean \pm SD: 1.4 \pm 0.6
Sex	Female	26	65
	Male	14	35
ASA score	I	15	37.5
	II	18	45
	III	7	17.5
Umbilical hernia	Present	24	60
	Absent	16	40
Drain	Present	12	30
	Absent	28	70
Graft	Present	14	35
	Absent	26	65
Postoperative complication	Present	14	35
	Absent	26	65
Readmission	Present	1	2.5
	Absent	39	97.5

Parameter data are presented as *n* and %, unless otherwise indicated. ASA: American Society of Anesthesiologists; BMI: Body mass index; SD: Standard deviation.

times were shortened significantly.

The same systematic review analyzed the conversion rates of SPRC surgeries. According to the results of the 13 studies included in the review, it was found that this rate was 4.2%, of which 2.2% were converted to multi-port laparoscopic surgery and 2% to open surgery[7]. We had no conversion among the 40 operations, probably due to our inclusion criteria. We did not prefer SPRC operations for patients with acute cholecystitis and its complications, such as perforation, or patients with malignant pathologies.

As a result of increasing experience and developing technological possibilities, the risk of complications in operations performed for benign gallbladder diseases has decreased significantly. Problems such as bile duct injuries and postoperative bile leaks decreased to 0.1%-0.3%. In our study, there were no patients with intraoperative bile duct injury or postoperative bile leakage. These data were again attributed to our patient selection criteria and our limited number of surgeries. We anticipate that this technique will also become one of our options in non-elective gallbladder surgeries and malignant diseases soon. We plan to evaluate whether SPRC surgeries performed for these more complicated aetiologies will affect our complication rates.

The mean perioperative blood loss in our SPRC surgeries was 58 mL. This loss was similar to the blood loss in other cholecystectomy operations where we use different techniques like LC or SPLC and is also comparable with literature data. Our “learning curve” discussion about the operation time may also be valid for our generous drain preference in this cohort (12 surgeries – 30.0%), and we hypothesize that we will have a decreasing trend in the coming years.

An umbilical hernia was present in 24 patients (60.0%). This rate is higher than expected, likely due to the addition of patients with fascia defects detected by ultrasonography to patients with clinically significant hernia. At the end of the surgery, graft reinforcement was preferred in 14 patients (35.0%) during the closure of the port site. In the follow-up, an incisional hernia was observed in 1 patient (2.5%) in whom we did not use a graft. A meta-analysis by Jensen *et al*[8] showed that the risk of incisional hernia development in patients who underwent robotic cholecystectomy ranged from 0% to 16.7%. We also know that prophylactic graft use in the laparoscopic method reduces the risk of incisional hernia

Table 2 Demographic and perioperative data of our last 40 consecutive laparoscopic cholecystectomy patients

Feature		Value
Average age, yr		45.5
BMI, kg/m ²		28.7
Operation time, min		54
Amount of bleeding, mL		10
Length of hospital stay, d		1
Sex	Female	15
	Male	25
ASA score	I	14
	II	23
	III	3
Umbilical hernia	Absent	39
	Present	1
Drain	Absent	36
	Present	4
Graft	Absent	40
	Present	0
Postoperative complication	Absent	37
	Present	3
Readmission	Absent	40
	Present	0

ASA: American Society of Anesthesiologists; BMI: Body mass index.

development[9]. Our study had only 1 patient with an incisional hernia, and we did not use a graft for that patient. All those facts support more liberal graft use during the fascia closure. Graft reinforcement should be considered more frequently, especially in patients with a body mass index > 30 kg/m², over 65 years of age, who are diabetic, and who have a chronic obstructive pulmonary disease with impaired wound healing and a high risk of incisional hernia.

It is known that wound site problems are more significant in laparoscopic and robotic cholecystectomy operations performed *via* a single port when compared with multiple ports[10,11]. While the general wound site problems reported for SPRC surgeries accounted for 5%, it was found that this problem was seen in 5 patients (12.5%) in our study. The difference between the literature and the results of our study may be due to the definition of 'wound problem'. While in most series only patients with surgical site infection and significant seroma were included in this group, we added patients with surgical site dehiscence and incision healing problems to the list.

LC operations performed using a single port have better cosmetic results than LC operations performed using multiple ports and provide higher patient satisfaction[10,11]. However, in robotic surgery, there is no study evaluating the impact of the port number on cosmetic results and patient satisfaction. The general belief is that patients are happier with a single incision, and our observations support this data.

There is no robust data that support that any of the surgical options for cholecystectomy have an impact on postoperative pain. A systematic review published in 2021 analyzed 15 studies for postoperative pain. It was concluded that it is impossible to say whether there is a difference between patients who underwent robotic surgery or LC due to different study methodologies and pain assessment methods[6]. In a recently published study, it was found that the pain scores of patients who underwent SPRC were lower than the scores of patients who underwent LC *via* a single port[12]. It was observed that the pain scores of the patients included in our study were low, and pain control could be achieved effectively using single (paracetamol) or dual (paracetamol and nonsteroidal anti-inflammatory) painkillers. In 1 patient included in the study, post-discharge pain scores remained high, and he was re-hospitalized to maintain pain control.

Sun *et al*[13] published a systematic review and meta-analysis in 2018, which compared SPRC and multi-port laparoscopic cholecystectomy surgeries. They concluded that the risk of incisional hernia and the high cost of the procedure should be considered when performing SPRC. However, their main conclusion was that, so far, the advantages and disadvantages of SPRC still have not been studied extensively and we need more high-quality studies and data to be able to comment on robot-assisted cholecystectomy operations. Indeed, there is also a lack of concrete evidence from comparisons of the advantages and disadvantages of the single-port *vs* multi-port robotic cholecystectomy operations, with the exceptions of features related to ergonomics and technical components. More high-quality studies are also needed for applicability in more complex gallbladder diseases.

Another limitation of our study was the inability to evaluate whether SPRC increased the cost of treating benign gallbladder diseases. The cost of the operations showed a significant difference during the study period (2013-2021) due to a number of reasons. According to current calculations, the mean cost for SPRC is \$6659 and for multi-port laparoscopic cholecystectomy is \$2439.

CONCLUSION

The findings from this study, which we performed on 40 consecutive patients, strongly support the view that SPRC is a feasible and safe surgery. Considering the technological and ergonomic advantages it provides to the surgeon, SPRC seems to be an excellent option that should be considered for all benign gallbladder pathologies. It would be appropriate to confirm this inference with randomized controlled studies with a large number of patients in the near future.

ARTICLE HIGHLIGHTS

Research background

Single-port laparoscopic cholecystectomy has been performed for over 25 years but is not popular. The narrow working space in this surgery limits the movement of instruments and causes ergonomic challenges. Robotic surgery resolves the ergonomic challenges. However, the extent to which these technical and ergonomic advantages positively affect the surgical outcomes and the safety of the single-port robotic surgeries need to be assessed.

Research motivation

Our first motivation for the study was to determine the feasibility and safety of single-port laparoscopic cholecystectomy. We also evaluated patient outcomes after robotic surgery.

Research objectives

Our main objective was to evaluate the safety of single-port laparoscopic cholecystectomy by determining intraoperative blood loss, conversion rate, and risk of bile duct injury or postoperative bile leak. We also determined the necessity of grafts during fascia closure.

Research methods

Our research methodology was retrospective electronic patient record evaluation.

Research results

We observed that the mean blood loss during the operation was 58.4 mL, and drain placement was required in 12 patients (30.0%). The median operative time was 93.5 min. We hypothesize that experience of the surgeon will have a positive effect on those numbers, and future studies will have better results. After port removal, graft reinforcement for fascia closure was preferred in 14 patients (35.0%). One patient was readmitted to the hospital due to pain (2.5%). Clavien-Dindo I complications were seen in 14 patients (35.0%), and 5 complications (12.5%) were wound site problems. These data support the safety of single-port robotic cholecystectomy.

Research conclusions

The findings of this study, which we performed on 40 consecutive patients, strongly supported the view that single-port robotic cholecystectomy is a feasible and safe surgery. Considering the technological and ergonomic advantages it provides to the surgeon, single-port robotic cholecystectomy seems an excellent option that should be considered for all benign gallbladder pathologies.

Research perspectives

It would be appropriate to confirm our results with randomized controlled studies to be conducted with more patients in the near future. Also, comparing single-port laparoscopic cholecystectomy and single-

port robotic cholecystectomy will be helpful.

FOOTNOTES

Author contributions: Rasa HK contributed to conceptualization of the study, methodology, writing, review and editing of the manuscript, and project administration; Erdemir A contributed to conceptualization of the study, methodology, formal analysis of the data, investigation into the literature and writing of the original draft of the manuscript; both authors read and approved the final manuscript.

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