Scientific Paper

Two-Trocar Cholecystectomy by Strategic Laparoscopy for Improved Cosmesis (SLIC)

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ABSTRACT

Background and Objectives: Until the advent of single-incision laparoscopic surgery, few advances were aimed at improving cosmesis with laparoscopic cholecystectomy. Criticisms of the single-incision laparoscopic surgery technique include a larger incision and increased incidence of wound-related complications. We present our initial experience with a novel technique aimed at performing strategic laparoscopy for improved cosmesis (SLIC) for cholecystectomy.

Methods: Twenty-five patients with biliary symptoms were selected for SLIC cholecystectomy. Access to the abdomen was obtained with a 5-mm optical trocar in the left upper quadrant and a 5-mm trocar in the umbilicus. Retraction was performed by a transabdominal suture in the dome of the gallbladder and a needlescopic grasper. Age, American Society of Anesthesiologists score, body mass index, operative time, length of stay, pathology results, and short-term complications at follow-up were prospectively recorded.

Results: The 25 female patients had a mean age of 34.3 years and mean body mass index of 24 kg/m^2. American Society of Anesthesiologists scores ranged from 1 to 3. The mean operative time was 51.3 minutes. Pathology revealed chronic cholecystitis in all patients. All procedures were performed on an outpatient basis. The only complication was one ultrasonography-documented deep vein thrombosis. All 25 planned SLIC cholecystectomies were successfully completed.

Conclusions: SLIC cholecystectomy is feasible and safe. This technique decreases the cumulative incision length, as well as the number of incisions, leading to very desirable cosmetic results in patients with a favorable body habitus and surgical history.

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INTRODUCTION

Laparoscopic cholecystectomy (LC), described in 1985, was the first surgical procedure performed in minimally invasive fashion to gain wide acceptance and has become the gold standard for the treatment of gallbladder disease.[1,2] The success of this procedure has sparked the minimally invasive revolution, which has dramatically changed the face of general surgery over the past 20 years. Although the technique has been refined over the past 2 decades, it was not until recently that major advances were promoted to improve on the already excellent cosmetic results provided by LC.[3–5] Some of these major advances were made possible by the introduction of improved instrumentation such as mini-laparoscopic instruments, single-incision laparoscopic ports, flexible articulating devices, and high-quality optical equipment. In addition, the increasing popularity of fellowship training in minimally invasive surgery has fostered further innovation in technique and cosmesis of laparoscopy.

In 1991 Jako and Rozsos[6] reported a technique aimed at minimizing the invasiveness of cholecystectomy by using a single 25-mm vertical incision to introduce a device similar to the instrumentation used in laryngoscopy. LC performed through a single incision was first reported by Navarra et al[7] in 1995. Although single-incision laparoscopic surgery (SILS) cholecystectomy has reduced the number of visible incisions the 20-mm (on average) umbilical skin and fascial incisions made for the placement of the SILS port (Covidien, New Haven, Connecticut, USA) have been linked to increased wound-related complications including infection, fascial dehiscence, and incisional hernia.[8–10] Although only one incision is used, its increased size has not produced substantially less postoperative pain in patients undergoing such procedures when compared with conventional multiport LC.[9,11–16] In addition, the nature of SILS often requires crossing of instrumentation and compromises ergonomics as well as the dexterity afforded by the more natural multiport approach. The trajectory of the instrumentation at such acute angles prohibits the surgeon from using certain core principles of laparoscopic surgery.

Our goal was to strategically devise an alternative balanced approach to LC to improve cosmetic results while preserving the fundamentals of laparoscopy such as triangulation, operator ergonomics, surgical dexterity, and visualization of the surgical field. We also considered the costs of the necessary surgical instrumentation, as well as the learning curve and safety of the modified procedure. This study was undertaken to determine the feasibility, safety, and efficacy of cholecystectomy with two-trocar strategic laparoscopy for improved cosmesis (SLIC) in a series of patients who were selected based on a favorable body habitus and surgical history.

MATERIALS AND METHODS

This institutional review board–approved study was conducted at a university-affiliated tertiary medical center during the period from January 2011 through December 2012. Twenty-five female patients with biliary pathology, selected based on a favorable surgical history and body mass index (BMI), were offered two-trocar SLIC cholecystectomy. Written informed consent forms were provided to all of the patients regarding the SLIC technique. Two surgeons with advanced laparoscopic fellowship training performed all 25 cases.

Documented stones >5 mm and a diagnosis of acute cholecystitis met the exclusion criteria because these conditions would likely require enlargement of the fascial incision to >5 mm. Other exclusion criteria included BMI >35 kg/m^2, unfavorable surgical history, pregnant patients, planned intraoperative cholangiogram, or multiple comorbidities. Unfavorable surgical history included previous foregut and hepatobiliary operations that increased the likelihood for upper abdominal adhesions.

Patients were taken to the operating room, where general endotracheal anesthesia was administered. The abdomen was prepared and draped in standard surgical fashion. We then proceeded with the creation of a 5-mm incision in the left upper quadrant for access to the abdominal cavity under direct visualization using a videoscope and an optical trocar. Pneumoperitoneum was established, and the second 5-mm incision was hidden within an umbilical fold. After this, a 1.5-mm stab incision was placed in the mid right upper quadrant (RUQ) and a MiniLap grasper device (Stryker, San Jose, California, USA) was carefully advanced into the abdominal cavity (**Figure 1**). Lateral retraction of the gallbladder was performed by placing the camera in the umbilical port and advancing a needle with a No. 3–0 silk suture through the left upper quadrant 5-mm trocar. This suture was placed singlehandedly in a figure-of-8 fashion through the dome of the gallbladder and pulled through the anterior abdominal wall in the extreme RUQ by use of a transabdominal suture passer that did not require a stab incision. This lateral and slightly cephalad retraction tethered the dome of the gallbladder to the anterior abdominal wall near the ribcage, providing plenty of retraction to fully visualize the infundibulum and triangle of Calot. At this point, the needlescopic MiniLap grasper was used to retract the gallbladder laterally, fully exposing the triangle of Calot (**Figure 2**). An L-hook electrocautery instrument and a right-angle dissector were used to carefully dissect the triangle, isolating the cystic duct and artery. Hem-o-lok interlocking clips (Weck, Research Triangle Park, North Carolina, USA) were used to clip the two structures, twice on the patient side and once

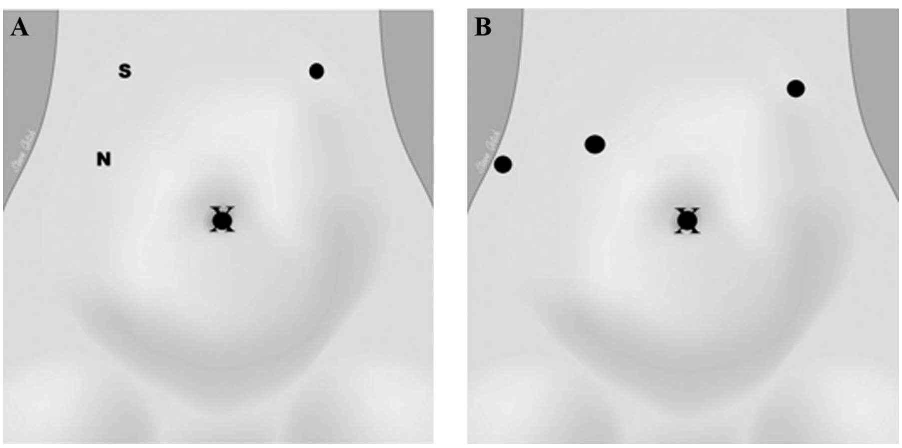

Figure 1. SLIC trocar placement (**A**) and 4-trocar multiport placement (**B**). N = needle; S = suture.

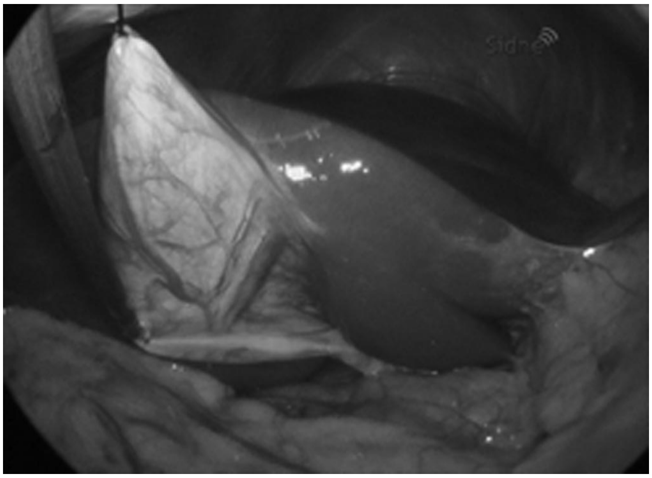

Figure 2. One-handed retraction suture and critical view of triangle of Calot.

on the specimen side. The cystic duct and artery were then divided with 5-mm laparoscopic hook scissors. The remainder of the gallbladder was carefully taken off the liver bed by use of hook electrocautery. The direction of the dissection was medial to lateral rather than from the infundibulum to the dome because of the nature of the retraction. Once the dissection was complete, the gallbladder remained tethered to the anterior abdominal wall. It was carefully pulled partially out of the body through one of the 5-mm trocar incisions. As the specimen was pulled through this incision, a Frazier-tip suction device was introduced into the gallbladder to release bile and the specimen was easily removed. Enlargement of the incisions was not necessary in any of the patients because most patients did not have stones. After this, the operative field was carefully inspected, irrigated, and suctioned as needed. Local anesthetic (0.25% bupivacaine hydrochloride) was injected into both trocar sites. The two skin incisions were closed in a subcuticular manner with a No. 4–0 Vicryl suture (Ethicon, Somerville, NJ, USA) followed by placement of sterile adhesive strips.

Alternatively, in our last 15 patients, we used a V-loc No. 3–0 interlocking barbed suture (Covidien) placed through the dome of the gallbladder and the diaphragmatic peritoneum to tether the gallbladder and provide retraction. After tightening the loop, the suture was pulled through the same 1.5-mm stab incision through which the mini-grasper was placed. This eliminated the need for a second stab incision and obviated the cost of the transabdominal suture passer.

Upon discharge, patients were provided with a prescription for oral narcotic pain medication. Patients were discharged home on a regular diet and instructed to follow up within 1 to 2 weeks with the operating surgeon.

Prospectively gathered information included age, American Society of Anesthesiologists (ASA) score, BMI, length of stay (LOS), and operative time. Other information obtained included gender, symptoms at presentation, medical and surgical history, preoperative workup performed, indications for procedure performed, pathology results, and presentation at follow-up including any short-term complications.

A cost analysis of instrumentation for the various cholecystectomy techniques was performed based on prices at our institution. Data were obtained regarding the costs of the SILS port, MiniLap grasper device, and trocars.

RESULTS

Twenty-five female patients presenting with symptoms consistent with biliary etiology were selected to undergo SLIC cholecystectomy. Twenty-four of these patients were evaluated on an outpatient basis, and one patient presented as an inpatient. Patients had a mean age of 34.3 years (range, 20–56 years) and a mean BMI of 24 kg/m^2 (range, 18.8–30.9 kg/m^2). Medical history included gastroesophageal reflux disease, hypertension, peptic ulcer disease, rheumatoid arthritis, cardiac murmur, hypothyroidism, carcinoid tumor, and asthma. Surgical history included cesarean section, abdominoplasty, salpingo-oophorectomy, dilation and curettage, sigmoidectomy, small bowel resection, appendectomy, and diagnostic laparoscopy.

The most common biliary symptom reported was RUQ pain. Other symptoms included indigestion, nausea, vomiting, and bloating related to biliary dyskinesia and cholelithiasis. Patients underwent an extensive workup before presenting to the surgeon's office, which included RUQ ultrasonography and a hepatobiliary iminodiacetic acid scan, because most patients were diagnosed with biliary dyskinesia. Some also underwent an esophagogastroduodenoscopy and/or abdominal computed tomography scan. Four patients had a diagnosis of cholelithiasis on ultrasonography before surgery. Two patients had ultrasonographic findings consistent with gallbladder polyps. Of the 25 patients, 24 were selected for elective outpatient SLIC cholecystectomy based on body habitus, number of comorbidities, and desire for improved cosmetic outcome. One patient was selected to undergo inpatient SLIC cholecystectomy based on the same criteria. She initially presented with gallstone pancreatitis and was selected for the SLIC technique after her pancreatitis had resolved and endoscopic retrograde cholangiopancreatography showed clearance of the common bile duct.

The ASA scores ranged from 1 to 3, with most patients having an ASA score of 2. There were no immediate intraoperative complications noted, and the mean estimated blood loss was <10 mL in all cases. The mean operative time was 51.3 minutes. All SLIC cholecystectomies were performed by two general surgeons with fellowship training in advanced laparoscopic surgery.

All patients were discharged within 23 hours after surgery. One patient, with a diagnosis of gallstone pancreatitis, had been admitted as an inpatient before proceeding with surgery and thus was kept for overnight observation and discharged home on postoperative day 1.

Patients were given a prescription for oral pain medication and discharge instructions to follow up within 1 to 2 weeks with the surgeon. Of the 20 patients, 17 presented for their follow-up appointment whereas 3 did not present because they had no reported complaints. These patients were contacted to ensure they were doing well. The mean time to follow-up was 13.4 days. The most common postoperative complaint was residual pain; however, none of the patients required additional prescriptions for pain medication. The only complication noted on follow-up was one ultrasonography-documented below-the-knee deep vein thrombosis, which was followed with serial ultrasonography.

It is important to consider the economic implications of SLIC cholecystectomy. As described earlier, the first approach to SLIC cholecystectomy implements the use of the transabdominal suture passer to retract the dome of the gallbladder. The use of the needlescopic grasper adds a cost of $195. However, there is a $42 savings in using two fewer trocars in the SLIC technique. (Each trocar comes at a price of approximately $21.) The net additional cost of the SLIC cholecystectomy approaches $153 in comparison with the conventional multiport LC (**Table 1**). Half of the patients underwent SLIC cholecystectomy without the use of the transabdominal suture passer. These patients had retraction of their gallbladder with the use of a single No. 3–0 V-loc barbed suture that was passed through the dome of the gallbladder and brought out through the same needlescopic incision in the RUQ used for the grasper device. This approach eliminated an additional needlescopic stab incision. When we consider SILS cholecystectomy at our institution, there are additional costs of the SILS port ($533) as well as the needlescopic grasper ($195). The net additional cost is $644 when compared with conventional multiport LC. Ultimately, SLIC cholecystectomy becomes a more cost-effective procedure than SILS (**Table 1**).

DISCUSSION

Recent technological advances and focused fellowship training have led to the refinement of many minimally invasive techniques brought on by the laparoscopic revolution of the past 2 decades. Two-trocar SLIC cholecystectomy is safe and feasible and decreases cumulative incision length, as well as the total number of incisions, leading to very desirable cosmetic results in patients with a favorable body habitus and surgical history. The technique is highly reproducible, with successful completion in all patients who were offered the procedure.

Single-incision LC has been the most notable development in the evolution of the procedure over the past few years. Although the cosmetic result of a well-performed intraumbilical incision is quite appealing, several aspects of the procedure have been criticized. The results of several studies evaluating postoperative pain when compared with conventional multiport LC have been mixed, showing no clear advantage.[9,11–17] Theoretically, the postoperative discomfort is highly related to the longest fascial incision, which is considered the "weakest link" with regard to postoperative pain. Although an intraumbilical incision may not be visible, the increased fascial length may render it more painful than the much smaller trocar incisions. The longest trocar incision with the SLIC tech-

Table 1.
Cost Comparisons for 4-Trocar, SILS, and 2-Trocar Cholecystectomy

	4-Trocar Cholecystectomy	SILS Cholecystectomy	2-Trocar Cholecystectomy
Additional expenses	Standard	$533 (SILS port) and $195 (grasper)	$195 (grasper)
Savings	Standard	$84 (4 trocars)	$42 (2 trocars)
Net change	Standard	$644	$153

nique is 0.5 cm, whereas—on average—the SILS intraumbilical skin and fascial incisions that hold the SILS port are about 2.0 cm (4 times as long). It can also be theorized that cumulative incision length at the level of the fascia, more so than at the skin, may correlate with postoperative pain. Similarly, our technique has a cumulative incision length of 1.0 cm compared with 2.0 cm for SILS.

The larger incision used in SILS is also likely to be the weakest link with regard to wound-related complications, such as dehiscence, infection, and hernia formation. Publications have evaluated the rate of increased wound-related complications related to the single-incision technique.[9] Our technique uses trocars that separate the fascial fibers with no actual incision of the fascia, as is required with the umbilical placement of the SILS port. This feature should lead to lower rates of fascial dehiscence and eventual hernia occurrence. We do not consider the needle holes used for the suture passer or needlescopic grasper (which may be used during SLIC or SILS) as incisions because they tend to completely disappear within several weeks after surgery in our patients (**Figure 3**).

The cumbersome nature of the SILS approach is also cited as one of its limitations.[11] The ergonomic sacrifice because of the crossing nature of the trocars increases surgeon fatigue and decreases dexterity and meticulous tissue dissection when compared with a conventional multiport approach. The use of a needlescopic instrument in the surgeon's left hand to retract the neck of the gallbladder and the dissection with the right hand allow for the surgeon to be in a more natural position. This mimics the customary triangulation of the multiport technique with minimal trauma to the abdominal wall.

Figure 3. One year after 2-trocar cholecystectomy, only 1 small 5-mm incision is visible in the left upper quadrant.

With regard to cost, the two-trocar SLIC approach compares favorably with the SILS approach because the cost of the single-incision port can add significantly to the overall cost of the procedure. At our institution, SILS requires the SILS port, costing approximately $533, as well as a $195 grasper. Certainly, there is a savings in not using the 4 trocars ($84); however, the net additional cost is still $644. This factor put together with the longer operative times makes SILS a costly and time-consuming procedure.

In a meta-analysis from 2012 comparing clinical outcomes of SILS versus conventional multiport cholecystectomy, the mean operative times were 70.7 minutes versus 51.1 minutes.[11] Additional studies support these findings.[18,19] The SLIC cholecystectomy appears to be almost 20 minutes shorter in duration compared with SILS and has an operative time similar to the mean operative time for 4-trocar multiport cholecystectomy.

In comparing the costs of SLIC with the standard multiport approach, savings are incurred because two fewer ports are used in the two-trocar technique ($42). Those savings, however, are negated by the cost of the single MiniLap alligator grasper used to retract the gallbladder ($195) (**Table 1**).

The ergonomic instrument placement of the SLIC technique very much mimics that of the standard multiport technique, which is most familiar to laparoscopic surgeons. This similarity of the technique to one of the most commonly performed laparoscopic procedures is a major advantage when compared with the cumbersome nature of the SILS technique. The learning curve and feasibility of the technique are therefore ideal as evidenced by the completion of all the cases that were intended to be treated with SLIC. Although all of the triangulation, visualization, and dissection objectives of the multiport technique were delivered with SLIC, the advantage lies in the decreased number of incisions (2 vs 4), decreased cumulative incision length (1 cm vs 2.5 cm), and decreased size of the largest incision (0.5 cm vs 1.0 cm) (**Table 2**). As a result of the decreased incision length, there has been an observed (but not measured) decrease in postoperative pain and an increase in cosmetic advantage.

This retrospective review of prospectively gathered data shows the feasibility of a novel and advantageous technique; however, some weaknesses are evident. Because of the small sample size and the absence of randomized controls, statistically significant conclusions could not be drawn. Second, patients were chosen for this technique based on highly selective exclusion criteria. These included BMI >35 kg/m^2, extensive surgical history, preg-

Table 2.
Comparison of Incisional Lengths with Various Techniques

	4 Trocars, Multiport	SILS	2 Trocars
No. of incisions	4	1	2
Cumulative skin incision	2.5 cm	2.0 cm	1.0 cm
Visible incisions	1.5 cm	0	0.5 cm
Cumulative fascial incision	2.5 cm	2.0 cm	1.0 cm
Longest incision	1.0 cm	2.0 cm	0.5 cm

nant patients, requirement for intraoperative cholangiogram, or multiple comorbidities. The BMI requirement was established to avoid operating in patients with thick abdominal walls and large livers, making retraction by suture difficult. Although we used multiple comorbidities as an exclusion criterion, this was not exclusively used in patient selection and it was used more as a relative contraindication. Third, stones >5 mm, a diagnosis of acute cholecystitis, and the need for intraoperative cholangiography greatly limited patient selection for this technique because these would all require larger ports or an increased number of ports. Finally, this study assumes that postoperative pain is directly related to fascial wound length. Objective assessment of postoperative pain with a patient survey was not completed. Further studies examining the postoperative assessment of pain and patient satisfaction, as well as increased sample size, are warranted.

CONCLUSION

Overall, the 2-trocar SLIC cholecystectomy technique has a very favorable learning curve, given the similarities between the positioning of instruments in this technique and the conventional 4-trocar multiport LC. In addition, it provides the patient with improved cosmesis (0.5-cm visible incision) and decreased pain (1.0-cm total fascial incision) while maintaining the principles of laparoscopic triangulation, excellent visualization, operating ergonomics, and a low procedure cost. Although 4-trocar multiport cholecystectomy remains the standard of care, 2-trocar SLIC cholecystectomy should be offered to patients with a favorable body habitus and favorable surgical abdominal history who are interested in improved cosmetic results.

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References:

1. Reynolds W. The first laparoscopic cholecystectomy. *JSLS.* 2001;5:89–94.

2. Sopper NJ, Stockmann PT, Dunnegan DL, Ashley SW. Laparoscopic cholecystectomy. The new ‘gold standard.’ *Arch Surg.* 1992;127(8):917–921.

3. Tacchino R, Greco F, Matera D. Single-incision laparoscopic cholecystectomy: surgery without a visible scar. *Surg Endosc.* 2008;23:896–899.

4. MacDonald E, Alkari B, Ahmed I. Single port laparoscopic cholecystectomy-overcoming technical problems. *Ann R Coll Surg Engl.* 2010;92:67–172.

5. Kehagias I, Karamanakos S, Markopoulos G, Kalfarentzos F. Benefits and drawbacks of SILS cholecystectomy: a report of 60 SILS cholecystectomies with conventional instrumentation from an academic center. *Surg Innov.* 2012;19(4):438–445.

6. Jako GJ, Rozsos S. Preliminary report: endoscopic laser-microsurgical removal of human gallbladder. *J Laparoendosc Surg.* 1991;1(4):227–234.

7. Navarra G, Pozza E, Occhionorelli S, Carcofor P, Donini I. One-wound laparoscopic cholecystectomy. *Br J Surg.* 1997;84:695.

8. Krajinovic K, Ickrath P, Germer CT, Reibetanz J. Trocar-site hernia after single-port cholecystectomy: not an exceptional complication? *J Laparoendosc Adv Surg Tech A.* 2011;21:919–921.

9. Phillips MA, Marks JM, Roberts K, et al. Intermediate results of a prospective randomized controlled trial of traditional four-port laparoscopic cholecystectomy versus single-incision laparoscopic cholecystectomy. *Surg Endoscopy.* 2012;26(5):1296–1303.

10. Raakow R, Jacob DA. Single-incision cholecystectomy in about 200 patients. *Minim Invasive Surg.* 2011;1–5.

11. Markar SR, Karthikesalingam A, Thrumurthy S, Muirhead L, Kinross J, Paraskeva P. Single-incision laparoscopic surgery (SILS) vs. conventional multiport cholecystectomy: systematic review and meta-analysis. *Surg Endosc.* 2012;26:1205–1213.

12. Marks J, Tacchino R, Roberts K, et al. Prospective randomized controlled trial of traditional laparoscopic cholecystectomy versus single-incision laparoscopic cholecystectomy: report of preliminary data. *Am J Surg.* 2011;201(3):369–372.

13. Chang SK, Tay CW, Bicol RA, Lee YY, Madhavan K. A case-control study of single-incision versus standard laparoscopic cholecystectomy. *World J Surg.* 2011;35(2):289–293.

14. Lirici MM, Califano AD, Angelini P, Corcione F. Laparoendoscopic single site cholecystectomy versus standard laparoscopic cholecystectomy: results of a pilot randomized trial. *Am J Surg*. 2011;202:45–52.

15. Phillipp SR, Miedema BW, Thaler K. Single-incision laparoscopic cholecystectomy using conventional instruments: early experience in comparison with the gold standard. *J Am Coll Surg*. 2009;209(5):632–637.

16. Prasad A, Mukherjee KA, Kaul S, Kaur M. Postoperative pain after cholecystectomy: conventional laparoscopy versus single-incision laparoscopic surgery. *J Minim Access Surg*. 2011;7(1):24–27.

17. Tsimoyiannis EC, Tsimogiannis KE, Pappas-Gogos G, et al. Different pain scores in single transumbilical incision laparoscopic cholecystectomy versus classic laparoscopic cholecystectomy: a randomized controlled trial. *Surg Endosc*. 2010;24(8):1842–1848.

18. Asakuma M, Hayashi M, Komeda K, et al. Impact of single-port cholecystectomy on postoperative pain. *Br J Surg*. 2011;98(7):991–995.

19. Koo EJ, Youn SH, Baek YH, et al. Review of 100 cases of single port laparoscopic cholecystectomy. *J Korean Surg Soc*. 2012;82:179–184.