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CASE REPORT

Single-incision laparoscopic cholecystectomy: Single institution experience and literature review

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Abstract

Single-incision laparoscopic surgery is a rapidly evolving field as a bridge between traditional laparoscopic surgery and natural orifice transluminal endoscopic surgery. We report one of the initial clinical experiences in Japan with this new technique. Four cases of gallbladder diseases were selected for this new technique. A single curved intra-umbilical 25-mm incision was made by pulling out the umbilicus. A 12-mm trocar was placed through an open approach, and the abdominal cavity was explored with a 10-mm semi-flexible laparoscope. Two 5-mm ports were inserted laterally from the laparoscope port. A 2-mm mini-loop retractor was inserted to retract the fundus of the gallbladder. Dissection was performed using an electric cautery hook and an Endograsper roticulator. There were two women and two men with a mean age of 50.5 years (range: 40-61 years). All procedures were completed successfully without any perioperative complications. In all cases, there was no need to extend the skin incision. Average operative time was 88.8 min. Postoperative follow-up didnot reveal any umbilical wound complication. Single-incision laparoscopic cholecystectomy is feasible and a promising alternative method as scarless abdominal surgery for the treatment of some patients with gallbladder disease.

Key words: Laparoscopic Cholecystectomy; Incision; Single-incision laparoscopic cholecystectomy; Single-incision laparoscopic surgery; Single-incision endoscopic surgery; Minimally invasive surgery

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INTRODUCTION

Since the introduction of laparoscopic cholecystectomy as the gold standard procedure to remove the gallbladder, many surgeons have attempted to reduce the number and size of ports in laparoscopic cholecystectomy to decrease parietal trauma and improve cosmetic results.

These efforts are some of the fundamentals of the natural orifice transluminal endoscopic surgery (NOTES) approach[1-4], which removes transabdominal incisions completely, but NOTES is technically challenging and current instruments need to be further improved. As a bridge between traditional laparoscopic surgery and NOTES, the recent focus has been on the development of single-incision laparoscopic surgery (SILS) to further

minimize the invasiveness of laparoscopic surgery by reducing the number of incisions.

SILS was described as early as 1992 by Pelosi *et al*[5] who performed a single-puncture laparoscopic appendectomy, and in 1997, by Navarra *et al*[6] who performed a laparoscopic cholecystectomy *via* two transumbilical trocars and three transabdominal gallbladder stay sutures. SILS can be performed using refinements of existing technology, and surgeons can perform SILS without any new instruments, specific competence, or training. SILS may offer the advantages of reducing postoperative pain, and virtually scarless surgery.

We report our initial experience with four patients who underwent single-incision laparoscopic cholecystectomy, and review the previous literature.

CASE REPORT

Four cases of gallbladder disease were selected for this new technique from June to July 2009. Indications included chronic cholecystitis and symptomatic cholelithiasis. There were two women and two men with a mean age of 50.5 years (range: 40-61 years). One patient had previously undergone appendectomy for acute appendicitis. Body mass index was 19.4-26.6 (mean: 23.0). All procedures were completed successfully without any perioperative complications. In all cases, there was no need to extend the skin incision. Average operative time was 88.8 min. Characteristics of patients and operative data are included in Table 1. The procedures were performed by the same surgeon.

Surgical technique

A single curved, intra-umbilical, 25-mm incision was made by pulling out the umbilicus. After exposing the fascia, a 12-mm trocar was placed through an open approach, and the abdominal cavity was explored with a 10-mm semi-flexible laparoscope (LTFVH; Olympus). Pneumoperitoneum was induced and maintained at 8 mmHg with carbon dioxide. Two 5-mm ports were inserted through the anterior sheet of the abdominal rectus muscle, each placed 1 cm laterally from the laparoscope port. The patient was put in an anti-Trendelenburg position and rotated to the left, as in standard laparoscopic cholecystectomy. A 2-mm mini-loop retractor (Mini-loop retractor Ⅱ; Hakkou-shoji) was inserted through an extra incision in the right subcostal space to retract the fundus of the gallbladder (Figures 1 and 2). Dissection was performed as a normal retrograde cholecystectomy using an electric cautery hook in the left trocar and an Endograsper roticulator (Roticulator Endograsp Ⅱ, 5 mm; Autosuture) in the other trocar. On the occasion when the optimal exposure of the Triangle of Calot was inadequate, we inserted the hook and the grasper for traction. The cystic artery and duct were first exposed, then separately clipped with a standard 5-mm clip applier (Endoclip Ⅲ 5-mm clip applier; Autosuture) and excised using an endoshear roticulator (Roticulator Endo Mini-Shears; Autosuture). The gallbladder was extracted with a standard endocatch (Endocatch Gold, 10 mm; Autosuture) through the umbilical site. Careful control of homeostasis was achieved, and a Penrose drain was placed in the cholecystectomy lodge through the 2-mm incision for the mini-loop retractor Ⅱ. Finally the 25-mm trocar site was closed with an absorbable suture, and the umbilicus was restored to its physiological position.

Patients received food orally at 24 h postoperatively, and were mobilized. Drains were removed on the first postoperative day. All cases were discharged between the third and fifth postoperative day. Postoperative follow-up didnot reveal any umbilical wound complications.

Table 1 Patient characteristics and operative data

	Age (yr)	Sex	BMI	Previous history	History of cholecystitis	Operation time (min)
1	61	M	22.2	Appendectomy, HT	+	105
2	40	M	26.6	DM	+	102
3	41	F	19.4	None	-	64
4	60	F	23.7	DM	-	82

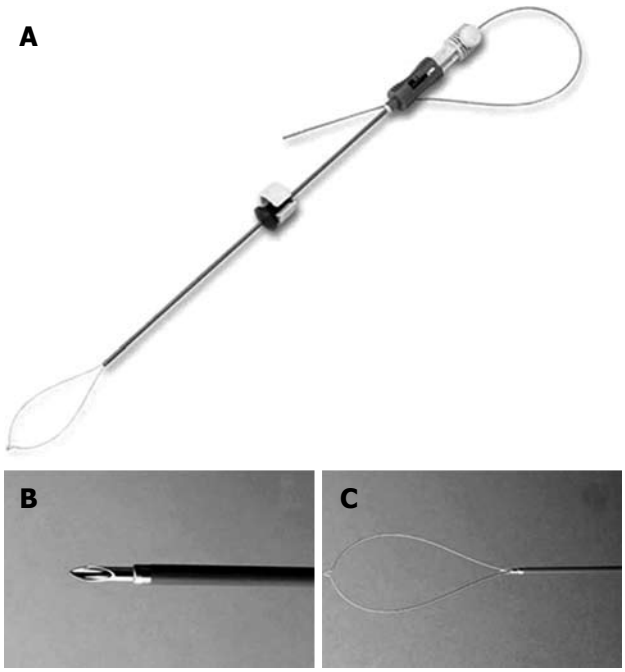

Figure 1 Mini-loop retractor Ⅱ (Hakkou-shoji). A: Mini-loop retractor Ⅱ; B: Needle for puncture; C: Loop wire.

DISCUSSION

Laparoscopic surgery is a well-established alternative to open surgery across disciplines. Although the magnitude of impact varies by procedure, generally the benefits of laparoscopy on postoperative pain, cosmetics, hospital stay, and convalescence are recognized widely.

Many surgeons have attempted to reduce the number

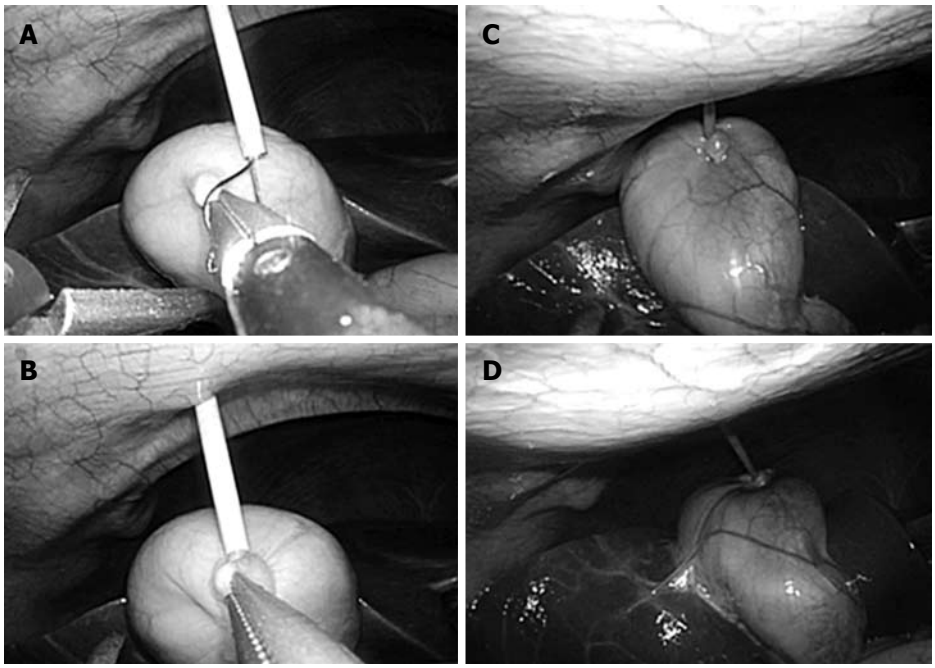

Figure 2 Gallbladder suspension using the Mini-loop retractor Ⅱ. The fundus of the gallbladder was suspended with this retractor (C and D), which was only tightened with a looped wire (A and B).

Table 2 All published reports of single-incision laparoscopic cholecystectomies

Authors	Publication year	*n*	Conversion to standard LC (%)	Complication (%)	Average operating time (min)
Piskun *et al*[8]	1999	10	0	0	NR
Tacchino *et al*[7]	2009	12	0	2 (16.7)	55
Cuesta *et al*[9]	2008	10	0	0	70
Rao *et al*[10]	2008	20	3 (15)	0	40
Romanelli *et al*[11]	2008	1	0	0	68
Merchant *et al*[13]	2009	21	1 (4.8)	0	45-90
Palanivelu *et al*[14]	2008	10	4 (40)	1 (10)	148
Navarra *et al*[15]	2008	30	0	0	123
Cugura *et al*[17]	2008	1	0	0	NR
Bucher *et al*[16]	2009	11	0	0	52
Ersin *et al*[18]	2009	20	1 (5)	0	94
Nguyen *et al*[19]	2009	1	0	0	70
Langwieler *et al*[20]	2009	14	0	0	53-115
Podolsky *et al*[21]	2009	5	0	0	121
Zhu *et al*[12]	2009	26	0	0	62
Guo *et al*[22]	2008	1	0	0	158
Gumbs *et al*[23]	2009	2	0	0	< 60
Hong *et al*[24]	2009	15	0	0	79
Kuon Lee *et al*[25]	2009	37	5 (13.5)	2 (5.4)	83.6
Our cases	2009	4	0	0	83

and size of ports in laparoscopic surgery to decrease parietal trauma and improve cosmetic results, and recently two innovations have been developed: NOTES, which removes transabdominal incisions completely and SILS, which completes laparoscopic procedures by trocars located at one umbilical incision.

SILS, however, is not a new concept, and was described as early as 1992 by Pelosi *et al*[5] who performed a single-puncture laparoscopic appendectomy. In recent years, SILS has been focused upon as a bridge between NOTES and traditional laparoscopic surgery, because NOTES is technically challenging and current instruments need to be further improved. SILS, on the other hand, enables the application of a wide range of already existing instruments. The main point for reducing the number of incisions is not only the cosmetic advantage but also lowered incision risks, morbidity of bleeding, incisional hernia, and organ damage.

Table 2 provides an overview of comparative features of single-incision laparoscopic cholecystectomy[6-25]. Out of 252 reported cases, 14 (5.6%) were converted to standard laparoscopic cholecystectomy. The reasons to convert were difficult dissection in nine cases, bleeding from the cystic artery in two, choledochoscopy for common bile duct exploration in two, and failure in trocar insertion in one case. There were five complications in

252 reported cases: one subcutaneous hematoma, one hepatic injury, one bile leakage, one mesenteric injury, and one injury of the right hepatic duct. Operative times in some series have been reported to be on a par with conventional laparoscopic surgery, but a majority of the procedures are lengthy, which may only be justified in patients who have a special cosmetic interest (Table 2).

The real challenge of SILS is to avoid conflict between the operative instruments and the camera, to maintain the pneumoperitoneum and reduce operative stress. As a result of the limited space with using only a single incision, it is difficult for both the surgeon and the assistant to work in the area. For that reason, we propose that using a semi-flexible endoscopic camera system would make the procedure more comfortable. Especially, the visualization and dissection of Calot's triangle would be easier and safer. Although the use of this semi-flexible endoscopic camera system with a cable connection on the posterior and crossed-over articulating instruments enables the procedure to be performed without interference, the use of crossed-over articulating instruments requires a longer operative time for achievement of careful and precise dissection, and some adjustments in the strategy of exposure are necessary, particularly because less strength is applied to the tissue than with the standard laparoscopic technique.

Some authors have suggested percutaneous puncture of the gallbladder for drainage or introduction of suspension hooks for better visualization of Calot's triangle[7,18]. These maneuvers, however, may inadvertently increase the chances of bactobilia and lead to perforation of the gallbladder, which leads to an increased risk of bile peritonitis, particularly in the setting of acute cholecystitis. To avoid these complications, we introduced the mini-loop retractor Ⅱ to achieve optimal visual exposure. The fundus of the gallbladder was suspended with this retractor, which was only tightened with a looped wire. The use of this retractor enables the surgeon to grasp the gallbladder without injury for visualizing Calot's triangle, without increasing the risk of perforation of the gallbladder.

This report documents the feasibility of single-incision laparoscopic cholecystectomy. The clinical advantages of this approach may eventually require a randomized controlled trial to compare it with conventional laparoscopic cholecystectomy. The major advantage of this method is improved cosmetics, without any visible abdominal scars. Disadvantages of SILS include the conflict between the operative instruments, and the camera and the smaller degree of instrument triangulation compared to that of conventional laparoscopic surgery. Some of these disadvantages may be overcome with the use of the semi-flexible endoscopic camera system and crossed-over articulating instruments. Despite the limitations of SILS, we were able to perform our operation in four cases. All procedures were completed successfully within a reasonable time.

In conclusion, we documented the feasibility of single-incision laparoscopic cholecystectomy. This procedure is a promising alternative method, with scarless abdominal surgery, for the treatment of some patients with gallbladder disease. Further advantages of single-incision laparoscopic cholecystectomy compared to conventional laparoscopic cholecystectomy will ultimately require a clinical trial.

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