Surg Today (2016) 46:1039–1044
DOI 10.1007/s00595-015-1273-5

ORIGINAL ARTICLE

Single-incision totally extraperitoneal inguinal hernia repair as a teaching procedure: one center's experience of more than 300 procedures

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Received: 25 August 2015 / Accepted: 20 October 2015 / Published online: 13 November 2015

Abstract
Purpose To evaluate resident doctors' proficiency in performing single-incision laparoscopic surgery for totally extraperitoneal inguinal hernia repair (SILS-TEP), and assess patient outcomes by comparing procedures performed by resident surgeons vs. those performed by staff surgeons.
Methods We analyzed retrospectively 301 patients who underwent SILS-TEP between January 2011 and May 2015 at Osaka Police Hospital.
Results The mean operative times for unilateral and bilateral hernia repairs in the resident-surgeon and the staff-surgeon groups were 99 vs. 88 min, respectively ($p < 0.05$), and 130 vs. 137 min, respectively. There was no significant difference in the incidence of conversion to a different procedure between the groups. The mean postoperative hospital stay was 2.0 days for patients from the resident-surgeon group vs. 2.8 days for those from the staff-surgeon group ($p < 0.05$). Seromas and wound infections developed in 8 % (12/148) of patients from the resident-surgeon group vs. 12 % (19/153) of those from the staff-surgeon group. No other major complications or hernia recurrence were noted in either group.
Conclusions SILS-TEP was performed safely, with low morbidity and no recurrence, by the resident surgeons under appropriate guidance by staff surgeons.

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Keywords Single-incision laparoscopic surgery (SILS) · Totally extraperitoneal repair (TEP) · Inguinal hernia · Resident training · Education

Introduction

Single-incision laparoscopic surgery (SILS) has been implemented as a procedure with better cosmetic outcomes than conventional laparoscopic surgery [1]. Based on its advantages, surgeons and patients tend to prefer this approach for various procedures. According to previous reports, resident surgeons could complete the SILS technique safely and with the same efficacy as they could perform traditional cholecystectomy [2], and they could perform laparoscopic appendectomy with results comparable to those of an experienced surgeon [3]. However, there have been few reports on resident-performed laparoscopic hernioplasty [4]. In our department, single-incision laparoscopic surgery for totally extraperitoneal repair (SILS-TEP) is a standard approach for adult inguinal hernias [5–7]. We conducted this study to evaluate resident competency in performing SILS-TEP, and assess patient outcomes, by comparing resident-surgeon-performed and staff-doctor-performed procedures.

Patients and methods

Clinical setting

We analyzed, retrospectively, 301 patients who underwent SILS-TEP between January 2011 and May 2015 at Osaka Police Hospital. Eleven resident surgeons and seven staff surgeons participated in this study. The residents in this

study were selected from among all postgraduate years (from year 3 to year 5) as they started surgical residency training in our hospital in their third year after graduation. They were involved in an average of approximately 150 SILS procedures per year. Each staff surgeon in this study had advanced, minimally invasive fellowship training and had performed SILS procedures routinely. The average number of years of experience of the seven staff surgeons was 14 years (range 10–32 years). An experienced laparoscopic surgeon (MW) who had already performed 37 conventional TEP hernia procedures and more than 500 SILS procedures, including appendectomy, cholecystectomy, acute abdomen, and colectomy, was the operator or the teaching assistant in all SILS-TEP procedures, in principle. All operations by the resident surgeons were performed under the guidance of the teaching assistant (MW).

Exclusion criteria

Single-incision laparoscopic surgery for totally extraperitoneal inguinal hernia repair was generally contraindicated for the following conditions: a history of radical prostatectomy; a small indirect inguinal hernia in a young patient; an irreducible hernia; and unsuitability for general anesthesia.

Surgical technique

Under general anesthesia with a transversus abdominis plane block, the patient was placed supine with both arms adducted. The patient was then placed in the Trendelenburg position with the side contralateral to the hernia site tilted down. A single, 25-mm, intraumbilical incision was made, followed by dissection of the subcutaneous tissue down to the rectus abdominis sheath. The anterior sheath was opened with an approximately 3 cm incision and blunt dissection using a finger or gauze was performed between the muscle and the posterior sheath, to create a preperitoneal space. After placing a Lap-Protector Mini (Hakko Co., Nagano, Japan) in this space, three 5-mm trocars (one for a 5-mm flexible scope and two for surgical devices) were inserted through a single-port access device (EZ Access; Hakko Co.) (Fig 1). The preperitoneal space was dissected gradually using conventional straight laparoscopic instruments without a dissection balloon. Polypropylene mesh was placed in this preperitoneal space, covering the inguinal floor, and fixed with three absorbable tacks at the pubic bone, Cooper's ligament, and above the iliopubic tract, respectively. After completion of the operation, the preperitoneal space was deflated carefully to avoid displacing the mesh. The anterior rectus sheath was closed with a 2-0 Vicryl suture, and the skin was closed with a 3-0 PDS suture (Fig. 2).

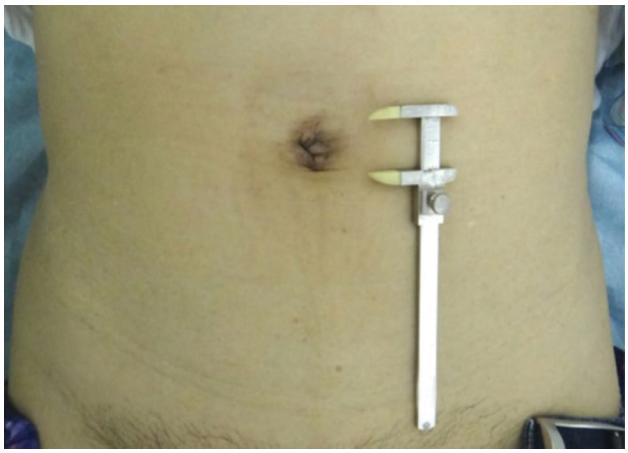

Fig. 2 The postoperative scar 3 months after single-incision laparoscopic surgery for totally extraperitoneal inguinal hernia repair (SILS-TEP) repair for bilateral inguinal hernias

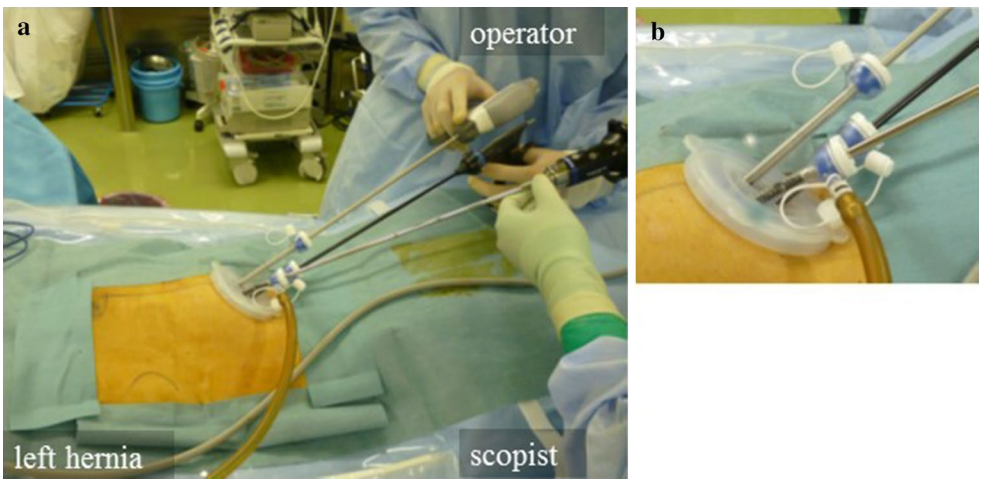

Fig. 1 The three ports secured to the EZ Access for the operation

Data collection

The patients' age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, site and type of hernia, operative time, bleeding volume, conversion to a different procedure, postoperative hospital stay, follow-up duration, postoperative complications, and hernia recurrence were recorded. Some patients were followed-up by phone calls, but for patients not able to be contacted by phone, the last follow-up findings were used in the analysis. Results are expressed as mean ± SD or numbers (percentages).

Statistical analysis

Student's *t* test, Fisher's exact probability test, and the Mann–Whitney *U* test were used for the analysis of parametric and non-parametric data, as appropriate. Differences at $p < 0.05$ were considered significant. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The Foundation for Statistical Computing). More precisely, it is a modified version of R commander, designed to add statistical functions and frequently used in biostatistics [8].

Results

Table 1 lists the patient characteristics for each group. There were no significant differences between the groups with regard to patient age, sex, BMI, ASA score, and type of hernia. The staff surgeons operated on significantly more patients with bilateral hernias than did the residents ($p < 0.05$).

Table 2 lists the perioperative data for each group. The mean operative times for a unilateral hernia in the resident and staff-surgeon groups were 99 ± 25 min (range 53–160 min) and 88 ± 26 min (range 41–204 min), respectively ($p < 0.05$). The mean operative times for bilateral hernias in the resident and staff-surgeon groups were 130 ± 23 min (range 97–177 min) and 137 ± 28 min (range 77–194 min), respectively ($p = 0.4$). The mean blood loss was minimal in each group. There was no significant difference in conversion to a different procedure between the groups ($p = 0.5$). Six patients in the resident group required conversion of the SILS: two to multi-port TEP repair and four to open surgery. The reasons for conversion in the resident group were adhesion of the preperitoneal space caused by previous inguinal hernia or lower abdominal surgery in two; adhesion between the hernia sac and vessels in one; and pneumoperitoneum caused by injury of the peritoneum in two. Four patients in the staff-surgeon group required conversion of SILS: one to multi-port TEP repair and three to open surgery. The reasons for conversion in the staff-surgeon group were adhesion of the preperitoneal space caused by previous inguinal hernia or lower abdominal surgery in one; adhesion between the hernia sac and vessels in two; and pneumoperitoneum caused by injury of the peritoneum in one. There were no significant differences in the reasons for conversion. The mean postoperative hospital stay was 2.0 ± 1.2 days (range 1–7 days) for the resident group and 2.8 ± 1.2 days (range 0–6 days) for the staff-surgeon group, being significantly shorter for the resident group ($p < 0.05$). The mean follow-up duration was 16 ± 12 months (range 2–46 months) for the resident group

Table 1 Clinical characteristics of the patients and inguinal hernias

Characteristics	Resident surgeons ($n = 148$)	Staff surgeons ($n = 153$)	*p* value
Age (years)	66 ± 11	68 ± 11	0.3
Male sex	129 (87)	137 (90)	0.5
BMI (kg/m^2)	23 ± 3	23 ± 3	0.1
ASA score ≥3	14 (9)	12 (8)	0.6
Site of hernia			
Unilateral	130 (88)	121 (79)	–
Bilateral	18 (12)	32 (21)	<0.05
Type of hernia			
Direct hernia	51 (31)	49 (26)	0.4
Indirect hernia	95 (57)	111 (60)	0.6
Femoral hernia	5 (3)	3 (2)	0.4
Mixed type hernia	5 (3)	11 (6)	0.2
Recurrent hernia	10 (6)	9 (5)	0.6
Obturator hernia	0	2 (1)	0.2

Data are expressed as mean ± SD or number (%), unless otherwise specified

SD standard deviation, *BMI* body mass index, *ASA* American Society of Anesthesiologists

Table 2 Perioperative data

Variable	Resident surgeons ($n = 148$)	Staff surgeons ($n = 153$)	p value
Operative time			
Unilateral (min)	99 ± 25	88 ± 26	<0.05
Bilateral (min)	130 ± 23	137 ± 28	0.4
Bleeding volume (ml)	Minimal	Minimal	1
Conversion	6 (4)	4 (3)	0.5
Multiple port surgery	2 (1)	1 (1)	0.5
Open surgery	4 (3)	3 (2)	0.7
Postoperative hospital stay (days)	2.0 ± 1.2	2.8 ± 1.2	<0.05
Follow up duration (months)	16 ± 12	24 ± 11	<0.05
Complications	12 (8)	19 (12)	0.2
Seroma	9 (6)	19 (12)	0.1
Wound infection	3 (2)	0	0.1
Recurrence	0	0	1

Data are expressed as mean ± SD or number (%), unless otherwise specified

SD standard deviation

and 24 ± 11 months (range 2–46 months) for the staff-surgeon group, being significantly shorter for the resident group ($p < 0.05$). The mean follow-up duration of all of the patients was 20 ± 12 months (range 2–46 months). Postoperative complications developed in 8 % (12/148) of the patients in the resident group and 12 % (19/153) of those in the staff surgeon group ($p = 0.2$). A seroma developed in 6 % (9/148) of the patients in the resident group and 12 % (19/153) of those in the staff-surgeon group ($p = 0.1$). A wound infection developed in 2 % (3/148) of the patients in the resident group and 0 % (0/153) of those in the staff-surgeon group ($p = 0.1$). These seromas and wound infections were managed conservatively. No other major complications, such as mesh infections, incisional hernia of the umbilical wound, or other organ injury, were noted during the follow-up period in either group. There were no recurrences in either group.

Discussion

Based on the findings of this study, we made two important conclusions: first, SILS-TEP could be performed safely by resident surgeons under the guidance of a fully trained teaching assistant; and second, SILS-TEP seems to be an effective and safe technique with a low recurrence rate. In the present study, the rates of conversion and postoperative complications in patients operated on by the resident surgeons were similar to those in the patients operated on by the staff surgeons, although the operative time was slightly longer in teaching operations performed by the resident surgeons. In our department, the first SILS procedure for colectomy [9–11] was performed in May 2009, and the indications for SILS have been expanded to include cholecystectomy, appendectomy, gastrectomy [12–14], and hernioplasty. SILS-TEP is now the standard procedure for adult inguinal hernia in our department [5–7]. Since SILS is the standard laparoscopic approach for various procedures in our department, the resident surgeons have developed their specific skills for the SILS procedure, such as manipulation of the laparoscopic coagulation shears, forceps, and flexible laparoscope, and have overcome the many difficulties associated with a confined operating space, in-line positioning of the laparoscope, close proximity of the working instruments with limited triangulation, and limited range of motion of the laparoscope and instruments. This could explain why our residents could complete SILS-TEP safely and efficiently, under the guidance of an experienced teaching assistant, whereas the surgical field of TEP is not familiar to some general surgeons.

The operative time was significantly shorter in the staff surgeon group because these surgeons had performed more laparoscopic surgery, including SILS. Sufficient experience with SILS-TEP would shorten the operative time for the resident group. The mean postoperative hospital stay was significantly shorter in the resident group than in the staff surgeon group. We introduced a 3-day admission clinical pathway for inguinal hernia patients in May 2014 with the aim of shortening the postoperative hospital stay. Furthermore, the teaching assistant (MW) gradually entrusted SILS-TEP to each resident surgeon after they passed the learning curve for SILS-TEP, which is thought to be about 40 cases [15]. The introduction of the 3-day admission clinical pathway and the recent increase in the number of patients operated on by the resident doctors probably contributed to the shorter postoperative hospital stay in the resident group in this study.

SILS-TEP seems to offer a good operative outcome, including a low recurrence rate. There are no significant differences in postoperative complications, particularly recurrence rates, between conventional multi-port TEP and transabdominal preperitoneal repair (TAPP) [16], although we were unable to find any reports comparing the outcomes of SILS-TEP and SILS-TAPP. There are significant differences in ergonomics between SILS and conventional multi-port laparoscopic surgery [17], but probably less difference between SILS-TEP and conventional multi-port TEP because TEP does not involve complicated manipulation such as suturing the peritoneum, which is required in the TAPP procedure. The indirect hernia sac must be ligated from the single access port, but it might be easier than suturing the peritoneum using straight laparoscopic instruments. Dulucq et al. [18] reported that the complication rate and recurrence rate after conventional multi-port TEP were 5.4 % (167/3100) and 0.35 % (14/3100), respectively, and concluded that TEP was the better approach for most types of inguinal hernia. In our analysis of SILS-TEP, the complication rate and the recurrence rate were 10 % (31/301) and 0 % (0/301), respectively, which was comparable with previous reports on conventional TEP and open inguinal hernia surgery [19, 20].

Sufficient operative experience and standardization of the SILS procedure will improve its operative outcomes and the operative skills of the resident surgeons. At our institution, which is a high-volume center for SILS in Japan, resident surgeons routinely perform single-incision laparoscopic appendectomy, cholecystectomy, and SILS-TEP under the guidance of a staff surgeon. They also gradually begin to perform parts of SILS colectomy and gastrectomy, although it is difficult to complete colectomy and gastrectomy from the beginning to the end. As demand for SILS grows, the importance of surgical residents training to incorporate these advanced techniques under appropriate supervision without negatively affecting patient outcomes will be important.

The present study has several limitations. First, it was performed retrospectively without randomization for resident or staff surgeon treatment or by surgical experience. Thus, there was a selection bias between the groups treated by the resident surgeons and those treated by the staff surgeons. Although the staff surgeons always operated on patients with bilateral hernias or a large indirect hernia for safety, the present trial showed no significant difference in the ASA scores between the groups. Second, the follow-up duration was short. Thus, the long-term outcome of SILS-TEP, especially the incidence of incisional hernia of the umbilical wound, was not evaluated [21]. Despite these limitations, the present analysis demonstrates clearly that SILS-TEP is safe and feasible as a teaching procedure in the hands of resident surgeons.

In conclusion, this series of SILS-TEP procedures performed in Osaka Police Hospital demonstrates that SILS-TEP can be performed safely, with low morbidity and no recurrence, by resident surgeons under appropriate supervision by a staff surgeon.

Compliance with ethical standards

Conflict of interest The authors (MW, MT, KA, TM, RT, MK, KF, YS, TM, KK, MT, HA) declare that they have no potential conflicts of interest.

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