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TECHNIQUES AND INSTRUMENTATION

Low-cost total laparoscopic hysterectomy by single-incision laparoscopic surgery using only reusable standard laparoscopic instruments

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Abstract The purpose of this study was to demonstrate the feasibility and safety of total laparoscopic hysterectomy (TLH) by single-incision laparoscopic surgery (SILS) with conventional, reusable laparoscopic instruments, inserted through an inexpensive, self-constructed single-port device. Between June 2013 and April 2014, 15 TLHs by SILS were performed by a single surgeon (BJ). Only conventional, reusable laparoscopic instruments were used. The self-constructed single-port device was made by assembling a surgical glove, a wound protector, one reusable 10-mm trocar, and four reusable 5-mm trocars. The vaginal cuff was closed by intracorporeal suturing. Patient and perioperative data were analysed. Fifteen patients underwent TLH by SILS, and no conversion to standard laparoscopy or laparotomy was necessary. Mean operation time was 97 min (55–135 min), and mean drop in haemoglobin level was 1.2 g/dl (0–2.4 g/dl). There were no operative complications. Postoperative pain scores were low. The mean weight of the removed uterus was 118 g (50–208 g). TLH by SILS is feasible even when performed with reusable, conventional laparoscopic instruments. An inexpensive, self-constructed single-port device allows every surgeon worldwide to accomplish single-incision surgery without the need to invest in expensive ports, disposable instruments, sealing devices, or auto-locking sutures.

Keywords Laparoscopy · Single incision · Total hysterectomy · Standard reusable instruments · Frugal innovation · Self-constructed single-port device

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Background

The advantages of laparoscopy in gynaecological surgery, when compared with open surgery, have been accepted worldwide since the early 1980s [1]. Hysterectomies have thus been increasingly performed by laparoscopic approach. Even less invasive procedures, such as single-incision laparoscopic surgery (SILS), are now being introduced. This approach makes use of a single incision of skin and fascia, usually at the umbilicus, to introduce a trocar through which all instruments are inserted. This procedure produces a better cosmetic result and less port-related complications can be expected.

In this study, we aimed to demonstrate the feasibility of total laparoscopic hysterectomy (TLH) by SILS with the use of conventional, reusable laparoscopic instruments, and an inexpensive, self-constructed single-port device that can easily be assembled by every surgeon worldwide. We wanted to demonstrate that there is no need for expensive, commercially available disposable SILS ports, other disposable instruments, sealing devices or auto-locking sutures, to perform a safe and equally time efficient TLH by SILS.

Materials and methods

Patients

Between June 2013 and April 2014, a single surgeon (BJ) performed 15 total laparoscopic hysterectomies by SILS. All patients were selected for TLH because of benign or premalignant gynaecologic disease. The following patient and perioperative data were collected and retrospectively analysed: patient age, body mass index (BMI), general health status, total operating time, serum haemoglobin (Hb) drop (change between the

preoperative Hb and postoperative Hb 1 day after surgery), (peri-)operative complications, postoperative pain score, and weight of the removed uterus.

The duration of surgery was defined as the time from umbilical incision to the end of skin closure. Bowel, bladder, ureteral or vascular injuries, as well as blood loss >500 ml, were considered as intraoperative complications. Short-term postoperative complications were classified as urinary tract infection, postoperative ileus, wound infection, vaginal vault bleeding, or hematuria.

Postoperative pain was assessed using the visual analogue pain scale (VAS) (scoring from 0=no pain, to 10=worst imaginable pain). The VAS score was evaluated immediately after surgery in the recovery and at 6, 24, and 48 h postoperatively. All patients received the same intraoperative analgesia: intravenous paracetamol (1000 mg) and ketorolac trometamol (20 mg). Postoperative pain was managed by tramadol hydrochloride 300 mg and alizapride hydrochloride 100 mg, administered intravenously over the first 24 h, together with intramuscular diclofenac 2×75 mg the first day. Over the next 24 h, intravenous tramadol 200 mg and alizapride hydrochloride 100 mg was infused. As long as there was no oral diet intake, intravenous paracetamol 4×1000 mg was associated. When the patient started diet intake, oral analgesics (paracetamol 1000 mg) were administered on patient's demand.

Prophylactic intravenous antibiotic therapy, cefazolin 2 g and metronidazole 500 mg, was administrated during surgery (this was a standard protocol for TLH in our centre at the time of the study, and recently it has been altered to cefazolin 2 g) [2].

Surgical technique

The procedure began with the patient in lithotomy position and placement of a reusable Hohl uterine manipulator (Karl Storz, Tuttlingen, Germany). A single intra-umbilical skin incision of 1–2 cm and a 2- to 3-cm fasciotomy was performed to insert the self-constructed single port device (Fig. 1). The device was constructed using an Alexis Wound Protector/Retractor (Applied Medical, Rancho Santa Margarita, CA, USA) attached to a size 8 surgical glove. One finger of the surgical glove was incised to place a 10-mm reusable trocar for CO_2 insufflation and laparoscope insertion. A maximum of 15 mmHg intra-abdominal CO_2 pressure was achieved to prevent the glove from overdistending. Four 5-mm reusable trocars were placed through the other fingers for insertion of the reusable laparoscopic instruments. We used a standard rigid 0° 10-mm laparoscope. The reusable conventional laparoscopic instruments were a bipolar forceps, a pair of cold scissors, an atraumatic forceps, a monopolar hook, a laparoscopic needle holder, and a suction-irrigation cannula. The

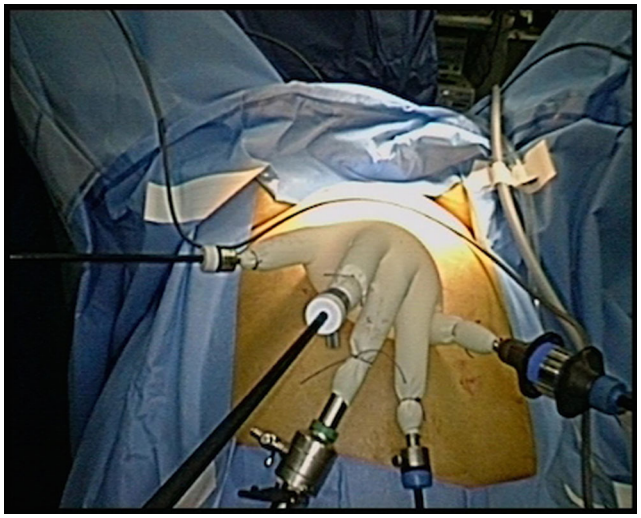

Fig. 1 Low cost self-constructed single port device

laparoscope and two laparoscopic instruments were inserted through the trocars, into the abdomen, together at one time. One or two additional laparoscopic instruments were inserted through the trocars but left outside the abdomen. Alternating instruments was done without the need to insert or withdraw them through the trocars.

The colpotomy was made using a reusable monopolar hook to incise the vagina circumferentially onto the vaginal cup of the uterine manipulator. After laparoscopic resection of the uterus, the uterus was extracted transvaginally. The vaginal vault was closed laparoscopically by three interrupted and intracorporeally knotted figure of eight sutures using a Vicryl-1 V-34 with 36-mm round-bodied needle (Ethicon, Piscataway, NJ, USA). After haemostasis, the abdomen was desufflated, the single-port device was removed, and the umbilical fascia and subcutaneous tissue were closed respectively with 1 Vicryl V-34 and 3–0 Monocryl PS-2 sutures (Ethicon, Piscataway, NJ, USA).

Table 1 Overview of patient and perioperative characteristics

Data	Mean	Range
Age (years)	52	42–64
BMI (kg/m^2)	25.0	16.8–37.1
Total operating time (min)	97	55–135
Serum haemoglobin drop (g/dl)	1.2	0–2.4
Postoperative pain score		
Immediate postoperative	1.8	0–4
6 h	2.5	2–4
24 h	2	1–5
48 h	2.2	1–6
Weight of removed uterus	118	50–208

Table 2 Patient and perioperative characteristics of consecutive patients

Patient no.	Age	BMI (kg/m^2)	Parity	Previous abdominal surgery	Type of surgery	Total operating time (min)	Serum haemoglobin drop	(Peri-)operative complications	Postoperative pain score		Uterus weight (g)
									6 h	48 h	
1	54	24.8	P2	–	TLH+BSO	135	2	–	2	2	146
2	52	24.7	P2	CE	TLH	110	1	–	4	4	157
3	52	26.4	P1	CS, LS	TLH+BSO	130	1.2	–	2	6	139
4	60	21.6	P2	LS	TLH+BSO	105	0.7	–	3	1	130
5	44	24.5	P2	CCE, CS	TLH	90	1.4	–	2	2	119
6	45	16.8	P0	Diagnostic laparoscopy	TLH	80	0	–	2	1	57
7	53	23.4	P1	Adhesiolysis	TLH	85	1.3	–	2	1	75
8	64	30.5	P3	CS, LS	TLH+BSO	110	0.7	–	3	1	152
9	42	24.8	P0	–	TLH	85	2.2	Cystitis	3	2	143
10	53	29.1	P3	–	TLH+BSO	105	0.8	–	2	3	153
11	50	24.2	P3	–	TLH	90	2.4	–	2	2	118
12	63	37.1	P2	–	TLH+BSO	100	0.6	–	2	2	50
13	50	26.1	P1	LS, AE	TLH	100	1.3	–	2	1	208
14	53	20.5	P3	CS, AE	TLH	55	1.2	–	2	2	51
15	43	21.2	P1	–	TLH	70	1.3	–	4	3	77

CE cystectomy, *CS* caesarean section, *LS* laparoscopic sterilisation, *CCE* cholecystectomy, *AE* appendectomy, *TLH* total laparoscopic hysterectomy, *BSO* bilateral salpingo-oophorectomy

Results

Between June 2013 and April 2014, 15 procedures were successfully performed by single-incision laparoscopic surgery using conventional, reusable laparoscopic instruments. No conversion to standard multi-incision laparoscopy or laparotomy was necessary. Nine patients underwent only a hysterectomy. In six patients, a simultaneous prophylactic bilateral salpingo-oophorectomy was performed.

Table 1 presents an overview of patient and perioperative data. Individual patient details are presented in Table 2. Mean operation time was 97 min. Nine patients had had previous abdominal surgery. There were no intraoperative complications, and only one patient had a postoperative cystitis for which oral antibiotic therapy was administered. The mean drop in haemoglobin level was 1.2 g/dl. Most patients scored a low postoperative pain score (range 0–4). Only one patient mentioned a score of 6/10 48 h after surgery. This was due to referred shoulder pain caused by intra-abdominal CO_2. Mean weight of the removed uterus was 118 g.

Each patient was examined 6 weeks after surgery. They were all in a good health, the umbilical scar was almost invisible due to its intra-umbilical position (Fig. 2), and there were no patients with port-site hernias.

Discussion

In this study, TLH by SILS with intracorporeal suturing of the vaginal vault was performed with conventional, reusable laparoscopic instruments, within a reasonable operation time and with a low complication rate.

We used an inexpensive, self-constructed single-port device that can be made by every surgeon worldwide. This port device has been proven to be safe and effective previously [3–9]. Combining this poor man's single-port device with easily available, conventional, and reusable laparoscopic instruments, this study shows that TLH by SILS can be performed worldwide without increasing the cost of laparoscopic surgery. Even in a third-world setting, where only standard basic laparoscopic equipment is available, TLH can be performed with this SILS technique.

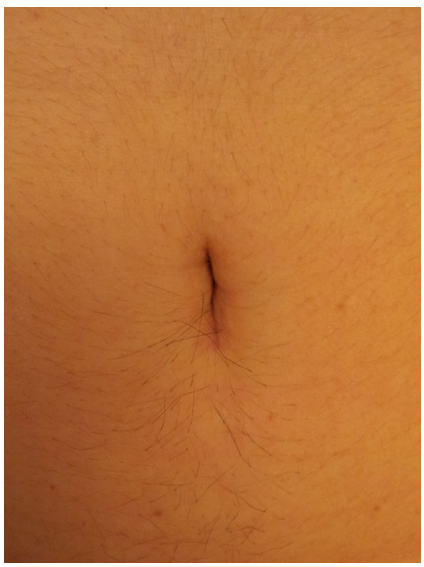

Fig. 2 Umbilical scar six weeks after surgery

A self-constructed port using a surgical glove has advantages when compared to commercial ports. It is less costly, it has flexible material that enables greater manipulation of instruments, and a greater number and size of instruments can be passed through the incision. Assembling five trocars into the glove before starting the procedure allows to leave all instruments inserted through the trocars during surgery. This makes alternating between instruments less time consuming.

Suturing and knot tying for closure of the vaginal vault can be the most difficult part of TLH by SILS due to problems of collision between instruments, laparoscope, and trocars, and because of limited triangulation and traction of tissue [10, 11]. This study demonstrates that intracorporeal suturing and knot tying are feasible via SILS. The technical challenge of suturing via SILS can be reduced by practising on an endotrainer.

Our data on surgical outcomes and perioperative complications seem to be in line with those of other larger studies that evaluated the feasibility and safety of TLH by SILS [11–16].

There are several limitations of our study. To evaluate the feasibility of TLH by SILS with the use of a low cost single-port device and conventional, reusable laparoscopic instruments, this study was designed as a case series with no control group. Other limitations are its small sample size, its lack of generalizability, limited follow-up, and all procedures being performed by one surgeon.

A meta-analysis by Murji et al. [17] showed that there is no significant difference in overall complications between single-incision versus conventional laparoscopy. Operation time was significantly longer for adnexal surgery by SILS, but no significant difference in operation time for hysterectomy by SILS could be demonstrated. However, current evidence is not strong enough to make any conclusion on surgical approach based on operation time. A meta-analysis for postoperative pain, change in haemoglobin, length of hospital stay, and cosmetics was not possible because of inconsistent data in literature [17].

A review of the literature showed that there is no difference in length of hospitalization [17]. One randomized controlled trial reported no difference in postoperative pain scores; however, two other RCTs found statistically lower postoperative pain with SILS compared to conventional laparoscopy [18–20]. Regarding cosmetic results, patients who underwent SILS seem to be more satisfied compared to patients after conventional laparoscopy or open surgery [21].

Single-incision surgery is feasible in selected cases and may provide benefits when compared with conventional laparoscopy; however, one should be cautious by interpreting conclusions as the current evidence is derived from a limited number of small studies.

Conclusion

TLH by SILS with intracorporeal suturing and knot tying is feasible and can be performed by surgeons worldwide with the use of a low-cost single-port device and conventional, reusable laparoscopic instruments. Less postoperative pain and better cosmesis seem to be an advantage of SILS; however, larger cohort studies are necessary to encourage or discourage this minimally invasive procedure.

Conflict of interest Anneleen Reynders and Jan Baekelandt declare that they have no conflict of interest.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This article does not contain any studies with animals performed by any of the authors.

For this type of study formal consent is not required.

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