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Robotics/Laparoscopy

Laparoendoscopic Single-Site Surgeries: A Single-Center Experience of 171 Consecutive Cases

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Purpose: We report our experience to date with 171 patients who underwent laparoendoscopic single-site surgery for diverse urologic diseases in a single institution.
Materials and Methods: Between December 2008 and August 2010, we performed 171 consecutive laparoendoscopic single-site surgeries. These included simple nephrectomy (n=18; robotic surgeries, n=1), radical nephrectomy (n=26; robotic surgeries, n=2), partial nephrectomy (n=59; robotic surgeries, n=56), nephroureterectomy (n=20; robotic surgeries, n=12), pyeloplasty (n=4), renal cyst decortications (n=22), adrenalectomy (n=4; robotic surgeries, n=2), ureterolithotomy (n=10), partial cystectomy (n=3), ureterectomy (n=1), urachal mass excision (n=1), orchiectomy (n=1), seminal vesiculectomy (n=1), and retroperitoneal mass excision (n=1). All procedures were performed by use of a homemade single-port device with a wound retractor and surgical gloves. A prospective study was performed to evaluate outcomes in 171 cases.
Results: Of the 171 patients, 98 underwent conventional laparoendoscopic single-site surgery and 73 underwent robotic laparoendoscopic single-site surgery. Mean patient age was 53 years, mean operative time was 190.8 minutes, and mean estimated blood loss was 204 ml. Intraoperative complications occurred in seven cases (4.1%), and postoperative complications in nine cases (5.3%). There were no complications classified as Grade IIIb or higher (Clavien-Dindo classification for surgical complications). Conversion to mini-incision open surgery occurred in seven (4.1%) cases. Regarding oncologic outcomes, no cancer-related events occurred during follow-up other than one aggressive progression of Ewing sarcoma.
Conclusions: Laparoendoscopic single-site surgery is technically feasible and safe for various urologic diseases; however, surgical experience and long-term follow-up are needed to test the superiority of laparoendoscopic single-site surgery.

Key Words: *Kidney; Laparoscopy; Minimally invasive surgical procedures; Robotics; Ureter*

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INTRODUCTION

The introduction of laparoscopic procedures has revolutionized surgery, paving the way for minimally invasive procedures. To improve safety, outcomes, and cosmesis, and to further reduce invasiveness, laparoendoscopic single-site surgery (LESS) has been developed for endourology. After Raman et al performed the first urologic LESS [1], this technique has been used for various urologic diseases [2-7] and has gradually been extended to pediatric cases [8-10]. Researchers have reported the feasibility and short-term outcomes of LESS with their own modifications; however, to our knowledge, there have been no reports on the large-scale use of LESS procedures in Asia [2-4,11]. Therefore, we present 171 consecutive cases of urologic LESS, including robotic procedures, in which our homemade port device was used.

MATERIALS AND METHODS

From December 2008 to August 2010, 171 cases of LESS were performed in our institution. Conventional LESS (C-LESS) and robotic LESS (R-LESS) were performed by three expert laparoscopic surgeons. The disease-specific inclusion and exclusion criteria for LESS were the same as for conventional laparoscopic surgery. Patients were given a choice of conventional laparoscopy, C-LESS, R-LESS, or open surgery. We described the expected surgical and postoperative outcomes, including pain and incisional wounds, with our own data and photographs. We also explained the advantages and disadvantages of LESS and its cost compared with other surgery types. We performed LESS only when the patients provided written consent. Patients were followed up with the appropriate studies. Cancer patients were evaluated by computed tomography (CT) or positron emission tomography-CT (PET-CT) at 3, 6, and 12 months after surgery, and then every 6 months if there was no evidence of recurrence or metastasis. Postoperative complications were classified according to the Clavien-Dindo classification for surgical complications [12]. We analyzed indications and perioperative outcomes. The present study was approved by the institutional review board at Yonsei Severance Hospital, Seoul, Korea.

Through the 2 to 5 cm umbilical incision, we placed the port device with a size 7 powder-free surgical glove and wound retractor for both C-LESS and R-LESS. For C-LESS, a total of three or four trocars (12 mm and 5 mm) were used (Fig. 1A). In C-LESS, a 10 mm 30° rigid laparoscope (Stryker, Kalamazoo, MI, USA) with integrated camera and right-angled light cable adaptor was used. In some cases, an additional 5 mm or 2 mm trocar was used for liver retraction or pelvic surgery [3]. We used conventional laparoscopic instruments and flexible articulating laparoscopic instruments depending on the type of procedure. Straight retractor devices were typically used for kidney and ureteral dissection without difficulty. Articulating devices such as hook cautery and scissors were used with the dominant hand only for renal vascular dissection, upper posterior kidney dissection, and adrenal dissection.

The homemade single-port system was placed for R-LESS (da Vinci S, Intuitive Surgical, Sunnyvale, USA) as it was for C-LESS. Two 12 mm trocars and two 5 mm trocars were used. The camera was inserted through the 12 mm trocar and the robot arms were inserted thorough the 8 mm port [13]. In most cases, an additional trocar was inserted alongside the port device to create a 12 mm hybrid port. To

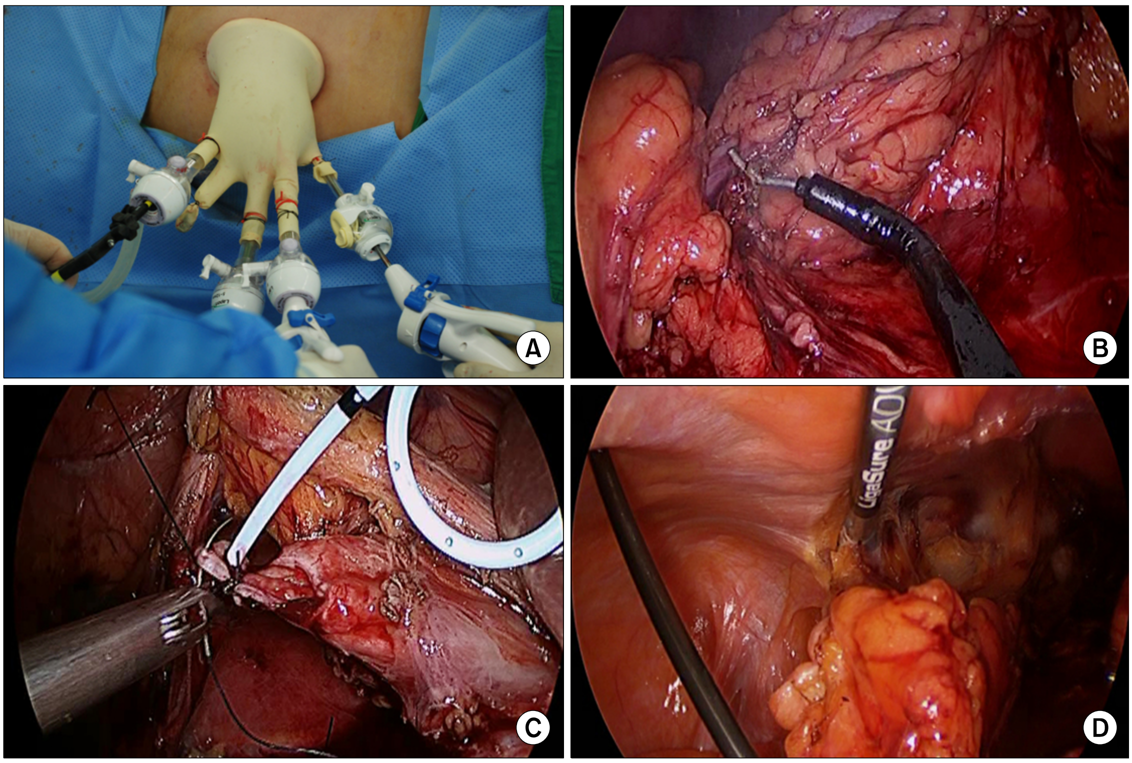

FIG. 1. Conventional laparoendoscopic single-site surgery. (A) A homemade single-port device and laparoscopic instruments for right radical nephrectomy. (B) Renal hilar dissection with articulating hook electrocautery. (C) Ureteropelvic reconstruction with a straight laparoscopic needle holder. We used the first stitch string for internal traction of the ureter. A double-J stent was inserted in the distal ureter; the proximal coil was not yet inserted. (D) Urachal mass excision using an additional 2 mm MiniLap Alligator clamp (Stryker, NY, USA, left).

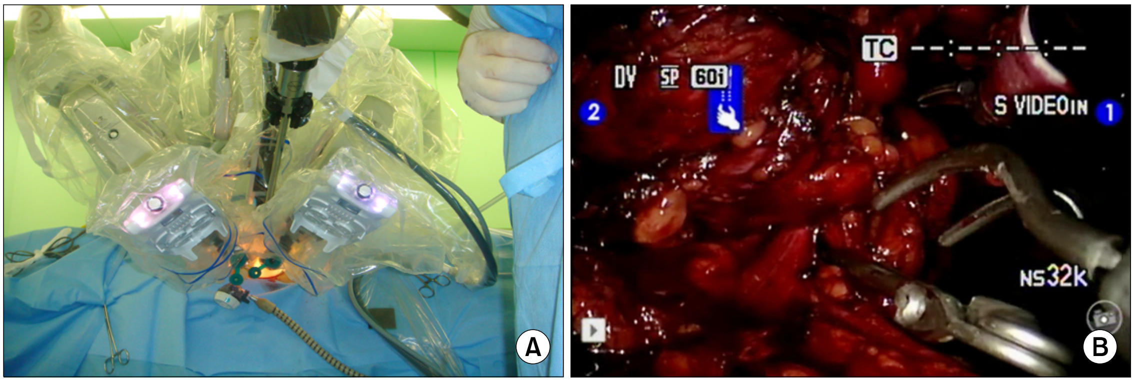

FIG. 2. Robotic laparoendoscopic single-site partial nephrectomy. (A) A homemade single-port device was established by inserting two 12 mm trocars and two 8 mm trocars through the fingers of the surgical gloves. The scope was placed at a 30° upward angle to the robotic arms. (B) Renal vessel clamping.

prevent the outer clashing of robotic arms, the scope was placed at a 30° upward angle to the robotic arms (Fig. 2A) [13]. We maintained intra-abdominal pressure under 12 mmHg and checked the glove to ensure that it did not inflate. All surgical procedures were performed with the homemade single-port device (Fig. 1B-D, 2B).

RESULTS

Between 2008 and 2010, 171 patients underwent C-LESS (n=98) or R-LESS (n=73) for various urologic diseases (male, n=94 [55%]; female, n=77 [45%]). Mean patient age was 53 years (range, 1-86 years), and mean body mass index was 23.7 kg/m^2 (range, 14.3-32.9 kg/m^2). Thirty-three patients (19.3%) had undergone previous abdominal surgery, and seven cases were converted to mini-incision open surgery owing to severe adhesions from previous surgery (C-LESS, n=3; R-LESS n=2), failure to identify endophytic renal mass even by intraoperative ultrasonogram (R-LESS n=1), or inferior vena cava injury (C-LESS n=1). Mean operative time was 190.8 min (range, 20-440 min), and mean ischemic time for partial nephrectomy was 26 min (range, 11-65 min). Mean estimated blood loss (EBL) was 204 ml (range, $<$10-2,700 ml), and the total transfusion rate was 9%. The mean hospital stay was 4.5 days (range, 1-19 days). Intraoperative complications occurred in seven cases (4.1%): diaphragm injury during C-LESS radical nephrectomy (n=2), bowel injury during C-LESS partial nephrectomy and R-LESS simple nephrectomy (n=2), inferior vena cava injury during C-LESS simple nephrectomy (n=1), renal vein injury (n=1), and ureter injury during R-LESS partial nephrectomy (n=1).

An additional port was used for seven right renal surgeries and one pelvic surgery during C-LESS (4.7%). Most R-LESS procedures used an additional hybrid port except for simple and radical nephrectomies. Postoperative complications occurred in nine patients (5.3%). Wound dehiscence (Clavien-Dindo Grade I) occurred in three patients; however, they did not require secondary closure. One patient suffered from prolonged ileus after C-LESS (Grade I), but recovered and was discharged according to schedule. Acute renal failure (Grade I) developed immediately after R-LESS nephroureterectomy, but patients recovered with hydration and diuretics. One patient required a transfusion for postoperative bleeding (Grade II). After C-LESS nephroureterectomy, one patient developed a retroperitoneal abscess on postoperative day 8 and was treated with antibiotics (Grade II). One retroperitoneal abscess (Grade IIIa) was detected on postoperative day 11 after R-LESS nephroureterectomy and was treated with antibiotics and pigtail drainage for 8 days. In one C-LESS pyeloplasty, the ureteral catheter migrated downward on postoperative day 4 (Grade IIIa); the patient reported flank pain, so we exchanged the ureteral catheter. No grade IIIb, IV, or V (death) complications were reported. Surgical scars were almost undetectable within a few months after surgery (Fig. 3).

FIG. 3. Abdomen 1 month after surgery.

Regarding oncologic outcomes, two cases with focal positive margins underwent R-LESS partial nephrectomy. In these cases, intraoperative analysis of frozen sections was negative, and no evidence of recurrence was found at the 1-month or 6-month follow-up CT evaluations of either patient. One patient who underwent C-LESS radical neph-

TABLE 1. Procedures, surgical indication or diagnosis, and perioperative results for LESS (n=171)

Procedures	n	Surgical indication or diagnosis	Mean size (cm)	Mean OR time (min)	Mean EBL (ml)	Mean HS (day)	Trans-fusion rate (%)	Comments
Simple nephrectomy								
2008 Desai et al [4]	14	Benign nonfunctioning kidney	-	145	109	2	0	All cases morcellated and extracted Additional port (5; 41%)
2008 White et al [2]	7	Nonfunctional renal unit	-	156	121	2.3	0	No complications
2009 Raybourn et al [16]	11	Atrophic nonfunctioning kidney	-	151	51	32	0	Port site bruising (1), pyrexia (1)
2010 Present study C-LESS	17	Benign nonfunctioning kidney	-	221	328	5.5	18	IVC injury: mini-incision open conversion (1) Additional port for liver traction (2) Ileus (1)
R-LESS	1	Benign nonfunctioning kidney	-	128	100	7.0	0	Bowel injury (1), no additional port
Radical nephrectomy								
2008 Desai et al [4]	3	RCC	-	208	200	3.5	0	Gonadal vein avulsion (1) Transvaginal extraction (1) Additional port
2008 White et al [2] C-LESS (5) R-LESS (1)	6	Enhanced renal mass suggesting malignancy	4.6	206	146	2.3	17	Intensive care unit admission for post-operative bleeding and embolization (1)
2009 Stolzenburg et al [17]	10	RCC	5.2	146.4	202	-	10	Bleeding requiring transfusion (1)
2010 Present study C-LESS	24	RCC (21) Urothelial carcinoma, pelvis (1) Ewing sarcoma (1), Mixed epithelial and stromal tumor (1)	4.8	209	289	5.7	17	Diaphragm injury (2) Mini-incision open conversion (1) Wound dehiscence (1) Additional port for liver traction (2)
R-LESS	2	RCC (1) Leiomyosarcoma (1)	9.0	248	225	4.7	0	Mini-incision open conversion (1) No additional port
Partial nephrectomy								
2008 Desai et al [4]	6	RCC (2) AML (1) Oncocytoma (1)	-	271	475	7.2	0	Laparoscopic conversion (1) Postoperative bleeding - angioembolization (1) Additional port, negative margins
2008 White et al [2] C-LESS (11) R-LESS (4)	15	Enhancing renal mass suggesting malignancy	3.01	196	422	4.5	27	Conversion (2), Positive margins (1)
2008 Aron et al [18]	5	RCC (3) Oncocytoma (2)	3	270	150	3	0	Postoperative hemorrhage and pulmonary embolism (1), negative margins
2008 Kaouk et al [19] C-LESS	5	RCC (6) Benign cyst (1)	2.1	160	420	3.2	-	Focally positive margin (1) Conversion to laparoscopy (1) No additional port
R-LESS	2		2.0	170	100	3.5	0	No complications, negative margins No additional port
2010 Present study C-LESS	3	RCC (1) AML(1) Metanephric adenoma in a child (1)	2.5	226	70	4.3	0	Bowel injury (1) Mini-incision open conversion (1) Margins negative, Mean ischemic time 29 min Additional port for liver traction (1)
R-LESS	56	RCC (49) AML (3) Oncocytoma (1) Other (3)[a]	2.8	198	273	4.7	13	Mini-incision open conversion (2) Renal vein injury (1), ureter injury (1) Postoperative bleeding (1) Positive margins (2)[b] Mean ischemic time 26 min, Hybrid port

TABLE 1. Continued

Procedures	n	Surgical indication or diagnosis	Mean size (cm)	Mean OR time (min)	Mean EBL (ml)	Mean HS (day)	Trans-fusion rate (%)	Comments
Nephroureterectomy								
2008 Desai et al [4]	2	Urothelial carcinoma (1) Reflux+recurrent pyelonephritis (1)	-	90	75	5	0	Distal ureter: cystoscopic resection+laparoscopic EndoGIA No complications, additional port (2)
2008 White et al [2] C-LESS (6) R-LESS (1)	7	Urothelial carcinoma	2.73	198	396	3.9	14	Conversion (1)
2010 Present study C-LESS	8	Urothelial carcinoma (5) Vesicoureteral reflux in a child (2) Ectopic ureter in a child (1)	3.3	315	103	7.4	0	Retroperitoneal abscess (1) Additional port for liver traction (2)
R-LESS	12	Urothelial carcinoma (10) RCC (2)	2.5	227	248	4.1	17	Acute renal failure (1) Retroperitoneal abscess (1), hybrid port
Pyeloplasty								
2008 Desai et al [4] C-LESS (15) R-LESS (2)	17	Primary ureteropelvic junction obstruction	-	236	79	2	0	Laparoscopic conversion (1) Additional port success rate: 15/16 93.5%; follow-up data available for 16/19
2008 White et al [2] C-LESS (7) R-LESS (1)	8	Ureteropelvic junction obstruction	-	233	62.5	3.4	0	Hernia (1)
2009 Tracy et al [20]	15	Ureteropelvic junction obstruction and delayed urinary excretion based on functional imaging	-	202	35	77	5	Hematuria, urine leak, clot obstruction (5)
2010 Present study C-LESS	4	Ureteropelvic junction obstruction	-	196	80	4.5	0	Stent migration (1)
Renal cyst decortications								
2008 Desai et al [4]	1	Extrinsic compression and ureteropelvic junction obstruction	-	60	<50	1	0	No complications Additional port
2008 White et al [2]	2	Symptomatic renal cyst	-	135	50	1.5	0	No complications
2009 Ryu et al [21]	5	Large renal cyst	-	56	178.8	5.2	0	Wound dehiscence (1)
2010 Present study C-LESS	22	Symptomatic renal cyst	6.0	93	20	2.2	0	No complications Transperitoneal (19), Retroperitoneal (3)
Adrenalectomy								
2008 Desai et al [4]	1	Adrenal mass	-	150	650	3	0	Laparoscopic conversion (1) Renal vein injury (1) Additional port
2009 Jeong et al [22]	9	Pheochromocytoma (5) Nonfunctioning adenoma (3) Cushing's syndrome (1)	2.8	169.2	177.8	77	0	Small bowel injury (1)
2010 Present study C-LESS	2	Pheochromocytoma (1) Leiomyosarcoma (1)	5.7	260	125	3.0	0	No complications
R-LESS	2	Pheochromocytoma (1) Nonfunctioning adenoma (1)	2.5	167	250	3.5	0	No complications Hybrid port

TABLE 1. Continued

Procedures	n	Surgical indication or diagnosis	Mean size (cm)	Mean OR time (min)	Mean EBL (ml)	Mean HS (day)	Trans-fusion rate (%)	Comments
Other C-LESS procedures in the present study								
Ureterolithotomy	10	Ureter stone	1.8	162	70	3	0	Wound dehiscence (1) Mini-incision open conversion (1)
Partial cystectomy	3	Urachal remnant (2) Leiomyoma (1)	3.5	171	50	3.3	0	No complications
Ureterectomy	1	Duplication of ureter (ectopic ureter)	-	80	150	3	0	Wound dehiscence (1)
Urachal mass excision	1	Urachal remnant	1.5	100	<10	3	0	Additional 2 mm port (1)
Orchiectomy	1	Cryptorchidism	-	20	<10	2	0	No complications
Seminal vesiculotomy	1	Seminal vesicle cyst	4.4	110	<10	2	0	No complications
Retroperitoneal mass excision	1	Cystic lymphangioma	6.4	99	30	6	0	No complications

LESS: laparoendoscopic single-site surgery, OR: operating room, EBL: estimated blood loss. HS: hospital stay, IVC: inferior vena cava, RCC: renal cell carcinoma, AML: angiomyolipoma, [a]: xanthomatous pyelonephritis (n=1), metanephric adenoma (n=1), hemorrhagic cyst (n=1), [b]: focally positive on final pathology. Intraoperative analysis of frozen section was negative.

rectomy eventually received a diagnosis of Ewing sarcoma; multiple lymph node metastasis and bone metastasis were detected within 2 months. Other than this case, no recurrence or metastasis was reported during follow-up (mean follow-up, 9.4 months). Even leiomyosarcoma, which was treated by C-LESS adrenalectomy, had not recurred by the 15-month follow-up. Perioperative outcomes and specific comments regarding each type of surgery are shown in Table 1.

DISCUSSION

In recent decades, laparoscopic surgery has undergone rapid technical development and advances in laparoscopic instruments. The aims of laparoscopic surgery include minimal invasiveness, safety, and cost-effectiveness; thus, laparoscopic surgeons have worked to continuously improve the surgical techniques. A result of these efforts is the nearly scarless technique, LESS [1]. The last 3 years have witnessed a rapid expansion of LESS for various urologic diseases. To evaluate LESS, worldwide experiences have been reported [14], including large-scale studies conducted in a single institution. Table 1 compares the outcomes of previous studies with our data [2,15-22]. Desai et al performed a total of 100 LESS procedures including simple prostatectomy (32%), donor nephrectomy (17%), pyeloplasty (17%), simple nephrectomy (14%), and partial nephrectomy (6%) [4]. White et al reported the same number of LESS procedures including donor nephrectomy (19%), partial nephrectomy (15%), sacral colpopexy (13%), and renal cryotherapy (8%) [2]. Indications for LESS in the present study differed somewhat from those of the previous studies. In our study, more than half of the LESS procedures were performed for malignancies, 59 (34.5%) of the LESS cases were performed for partial nephrectomy, and 26 (15.2%) for radical nephrectomy. However, this difference may be due to different patient populations rather than the surgeons' preferences.

The ideal indications for LESS may be pediatric urologic diseases and benign diseases for which cosmetic outcomes are important. Park et al and Marietti et al have reported outcomes for C-LESS in simple nephrectomies for pediatric cases of nonfunctioning kidney [8,10]. In the present study, four pediatric patients underwent C-LESS: two nephroureterectomies for nonfunctioning kidney, one partial nephrectomy for metanephric adenoma, and one ureterectomy for ectopic ureter were successfully performed without complications. Anecdotally, their parents seemed extremely satisfied with the postoperative cosmetic results. Similarly, surgeries that require smaller incisions for specimen extraction appear to be good indications for LESS. Patients are more concerned with cosmesis in non-life-threatening diseases such as ureteropelvic junction obstruction, renal cyst, or ureteral stone. In addition, these surgical procedures do not require a wide surgical field, and the specimens are smaller than the single-port device. Ryu et al achieved favorable results using LESS for renal cyst decortications [21]. We have expanded the use of LESS to pyeloplasty, ureterolithotomy, and other benign surgeries such as urachal mass excision, orchiectomy, seminal vesiculotomy, and retroperitoneal mass excision, as shown in Table 1. Comparing the indications for C-LESS and R-LESS, R-LESS was more suitable for technically demanding procedures requiring meticulous intracorporeal suturing such as partial nephrectomy and bladder cuff resection. On the other hand, C-LESS is relatively suitable for simple and radical nephrectomy, renal cyst decortications, ureterolithotomy, and pediatric surgery because these can be comfortably performed without the expensive robot assistance even with standard laparoscopic instruments. For partial nephrectomy, we preferred to use R-LESS (94%), because the robotic EndoWrist and hybrid port technique was more convenient and safe for upper posterior renal dissection and hilar management. With this system, we could also perform the meticulous suturing for renorrhaphy without difficulty [3,9,13]. In the first C-LESS nephroureterectomy, we used the Endo-GIA stapler for bladder repair. Even with stay sutures, deep bladder cuff resection using the laparoscopic endoshears (including detrusor muscle as previously reported) was somewhat difficult in C-LESS [23]. In contrast, robotic assistance could make a deep bladder cuff resection and convenient suturing of the bladder defect. However, lymph node dissection was not performed in all nephroureterectomy cases, because only low-grade tumors were selected.

The operative outcomes of the present study were comparable to those of previous studies (Table 1). However, in partial nephrectomy, the mean EBL of our C-LESS procedures (70 ml) was noticeably less than that of other studies (150-475 ml) [2,4,18,19]. In contrast, the mean EBL of R-LESS procedures (273 ml) was greater than that reported by a previous study (100 ml) [19], but was still smaller than that of C-LESS procedures in other studies. These differences may not be due to differences in technical skill, but may be the result of different surgical indications. When we began treating partial nephrectomies with C-LESS, we limited the procedure to exophytic anterior lower pole masses. After the transition to R-LESS, we gradually expanded the indication to endophytic and upper posterior masses, because R-LESS enables more accurate suturing and safer hilar and upper pole management. The mean EBL for C-LESS simple nephrectomy was larger than that reported in other studies, and larger than that of radical nephrectomy and even partial nephrectomy in our study, because of three cases: the surgeon's first LESS case, inferior vena cava injury in one case, and multiple renal vessels in one case. Apart from these three cases, the EBL was comparable (159 ml).

Intraoperative safety is the most important concern in laparoscopic surgery. White et al reported that no intraoperative complications occurred in 100 cases [2]. Another study of renal and ureteral LESS reported the same outcome [21]. However, Desai et al reported 4/100 (4%) intraoperative complications that included gonadal vein avulsion, bowel injury, bleeding requiring sutures, and renal vein injury [4]. In the present study, seven intraoperative complications (4.1%) occurred, and one case (inferior vena cava injury) was converted to mini-laparotomy (6 cm). The total conversion rate (7/171 [4.1%]) was lower than that of the two previous studies with 100 cases (conversion rates, 6% and 7%) [2,4]. Intraoperative accidents were not the most common reason for conversion. We were able to successfully manage intraoperative accidents without conversion by effective internal retractions through our homemade port device. This was possible because the glove used for the port device provided a wide range of motion, and various trocar sizes could be used. In addition, the residual finger space in the gloves, which replaced a retrieval bag for sealing the small specimen, provided more room for important procedures. In the present study, most of the intraoperative accidents occurred in our first 30 cases and during partial nephrectomy. This finding suggests that even experienced surgeons experience some difficulty adapting to the single port. In addition, partial nephrectomy, which requires meticulous parenchymal suturing and careful vascular control, is as challenging a technique in LESS as it has been in conventional laparoscopy and robotic surgery.

We compared our postoperative complications with those of two other studies. Desai et al reported five cases (5%) of postoperative complications including urinary tract infection (Clavien-Dindo Grade II); postoperative bleeding requiring transfusion (Grade II), angioembolization (Grade IIIa), and exploration (Grade IIIb); and one mortality (Grade IV) [4]. White et al reported 10 cases (10%) of postoperative complications with seven cases of blood transfusion (Grade II), urinary tract infection (Grade II), rectovesical fistula requiring operation (Grade IIIb), and readmission to the intensive care unit and angioembolization due to postoperative bleeding in partial nephrectomy cases (Grade IVa) [2]. Although it is difficult to compare outcomes from different types of surgery, the postoperative complication rate of the present study (5.3%) was similar to or lower than the rates of previous studies, and the complications in the present study were less severe.

The duration of follow-up in the present study was not sufficient to evaluate oncologic outcomes (9.4 months). However, no cancer-related events were observed other than progression of Ewing sarcoma in one case. Long-term follow-up data must be analyzed and compared with results from conventional laparoscopic surgery and open surgery.

LESS is an attractive surgical modality that has advanced the ultimate aim of minimally invasive surgery; however, aspects of LESS can be improved. First, a suturing technique is needed that allows meticulous suturing of renal parenchyma and various anastomoses. The conventional triangular arrangement of instruments is not used in LESS; therefore, some conventional laparoscopic suture techniques cannot be performed. Second, because LESS is increasing continuously, standard indications are needed for each LESS procedure. LESS is still a challenging technique; accordingly, leading laparoscopic surgeons should be responsible for establishing indications. Finally, a robotic system specialized for single-port surgery is needed. The currently available robotic systems were not developed for LESS procedures. For this reason, instrumental clashing was unavoidable, and we used a hybrid port technique. With these changes, the LESS procedure will become safer and more convenient for surgeons.

There were several limitations to this study. We did not attempt to evaluate the superiority of LESS over conventional laparoscopy or robotic surgery. In addition, cosmetic outcomes and quality of life data were not evaluated. To overcome these limitations, additional surgical experience, longer follow-up, and large-scale randomized controlled trials are needed.

CONCLUSIONS

We presented 171 cases of urologic LESS procedures performed with the use of a homemade single-port device. We have demonstrated that LESS is feasible and can be safely applied to a variety of urologic operations, although LESS is still a challenging technique for urologic conditions. Long-term follow-up will be needed to prove the safety, cosmesis, and cost-effectiveness of LESS and provide a comparative analysis with other procedures to confirm the significant benefits of LESS.

Conflicts of Interest

The authors have nothing to disclose.

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