

Robotic laparoendoscopic single-site surgery for concurrent hysterectomy and cholecystectomy

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Summary

With the quality ergonomics and rapid learning curve of the robotic surgery system taken into consideration, robotic laparoendoscopic single-site surgery (R-LESS) appears to be the best integration for maximizing the benefits of single-site surgery. However, there are drawbacks of robot-assisted procedures which include longer operative time and higher cost, because of this, we hypothesized that the burden of robotic surgery would be reduced if two surgeries could be completed within one session in R-LESS. Three cases of R-LESS were performed for combined hysterectomy and cholecystectomy in patients with concomitant benign uterine disease and cholecystopathy. The combined surgeries were successfully conducted without additional port insertion or conversion and included the benefits of decreased hospital stay, anesthesia risk, and cost compared with the sum of two separate surgeries. Therefore, in cases in which concomitant pathologies are detected in the abdominopelvic cavity, R-LESS can be an option for selected patients with the benefit of minimally invasive surgery.

Key words: Cholecystectomy; Hysterectomy; Robotic laparoendoscopic single site surgery.

Contents

The feasibility of laparoendoscopic single-site surgery enables cholecystectomy and hysterectomy to be completed in one session with reduced perioperative burden.

Introduction

Laparoendoscopic single-site surgery (LESS) has enabled performance of complex surgeries with the added benefit of minimal invasiveness. Surgeons manipulate a camera, electrodes, and forceps in a coordinated fashion through a small space in the umbilical incision. Surgeons need advanced laparoscopic skills for LESS compared with multi-incision laparoendoscopic surgery.

Robotic LESS (R-LESS) comes with mechanical advantages to counter certain limitations of LESS, including improved ergonomics and triangulation among instruments [1]. The master controls automatically switch robot arms to be controlled intuitively by the ipsilateral hands. Further, the central position of the umbilical port enables distant organs in the abdominal cavity to be explored through a single incision. However, overall operative time and cost of robotic surgery are generally higher by 20%-30% than those of laparoendoscopic surgery in different fields [2]. Based on these features of R-LESS, we planned to combine two surgical types performed under a single anesthesia and reduce the number of incisions in the abdomen (Figure 1). The combination, if possible, would effectively reduce the burden caused by separate robotic procedures.

There were only a few case reports on concurrent hys-

terectomy and cholecystectomy using a single-site technique. Considering the prevalence of these two procedures, further information must be provided in order for this practice to be reproducible in clinical theater.

We present three cases of combined hysterectomy and cholecystectomy using the da Vinci SI system with a single-site platform (Intuitive Surgical Inc., Sunnyvale, CA) which were performed in patients with benign uterine disease and cholecystopathy concomitantly.

Case Reports

Case 1

A 63-year-old woman with persistent dysplasia and high-risk human papillomavirus (HPV) infection, since her previous conization, presented with nausea and vomiting (Table 1). Blood test results and abdominal computed tomography (CT) scans indicated cholecystitis. There were no specific findings apart from atrophic uterus and adnexa on transvaginal sonography (TVS). After extensive counseling with regards to the range of surgery and various techniques available, the patient decided to undergo concomitant total hysterectomy with adnexectomy and cholecystectomy using the R-LESS platform.

The surgical procedure began with a 2.5-cm-sized vertical incision at the umbilicus. Once the Single-Site[®] silicone port was installed, 12-mmHg pneumoperitoneum was established, and the robot cart was positioned at the right side of the patient. Monopolar hook of arm 2 and bipolar fenestrated grasper of arm 1 were inserted through the curved cannulae, and the laparoscopic grasper was intro-

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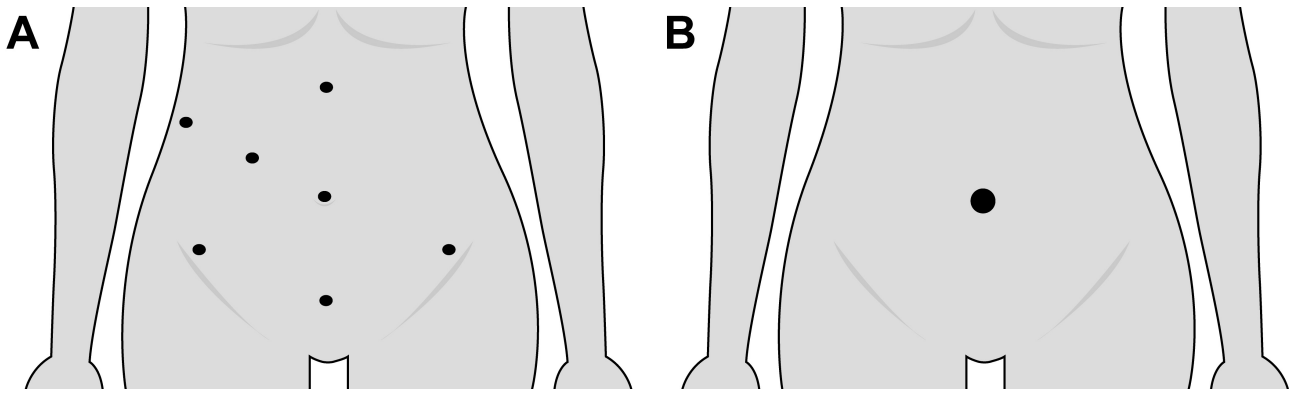


Figure 1. — (A) Conventional laparoscopic port sites. (B) Robotic laparoendoscopic single-site surgery (R-LESS) central port site in the concurrent operation.

duced through an assistant cannula for cephalic traction of the gallbladder. The gallbladder infundibulum was retracted to the right side with the grasper of arm 2 to open the Calot's triangle. The peritoneum was incised with a monopolar hook to expose the cystic duct and artery. Following ligation and transection, the gall bladder was dissected from the liver bed. The gallbladder was placed in an endobag and pulled out through the single-site incision.

Thereafter, the robotic arms were undocked, and the patient was rotated approximately 140°. Medial docking between the patient legs was performed, which enabled access to both the right and left pelvic organs. In this case, a uterine manipulator could not be inserted into the endometrial cavity due to a cervical os stricture; hence, an assistant grasper was used to handle the uterus. Hysterectomy was initiated with coagulation and cutting of infundibulopelvic ligaments. After the cervix was incised circumferentially, the monopolar hook was replaced with a needle holder in arm 2. The vaginal vault was closed with a barbed suture. At the end of the procedure, the uterus and adnexa, placed in an endobag, were extracted via the single-site incision. The entire procedure lasted 3.5 hours without any noteworthy incidents. The patient was discharged at postoperative day 2 with no evidence of grade II or higher complication (Clavien-Dindo Classification).

Case 2

A 56-year-old woman presented with right flank pain with bacteriuria. Right hydronephrosis was noted on abdominopelvic CT, where the right ureter was compressed at the ureterovesical junction by a 5.1-cm-sized calcified uterine leiomyoma growing from the right wall of the uterus. Additionally, calcified stones were identified in the gall bladder, which were believed to be the cause of chronic abdominal discomfort after meals. Following counseling, the patient opted for concomitant R-LESS.

Hysterectomy was performed for rapid release of the ureteral obstruction. Upon exploration after medial docking between the legs the leiomyoma abutted the ureter to the right pelvic wall, the ureter was identified after peritoneal incision at the pelvic brim with the monopolar hook

of arm 2. Further dissection of the pelvic wall was gently performed with the monopolar hook, while the peritoneum was held with the fenestrated grasper of arm 1. The right ureteral course could be secured down to the ureterovesical junction. The skeletonized uterine vessel was coagulated and resected with electrodes. The vaginal vault was sutured to prevent peritoneal gas leakage and the detached uterus was morcellated with a scalpel.

Transition (undocking-redocking) and cholecystectomy were performed as previously described. The total completion time for the surgeries was 2 hours and 45 minutes.

No grade II or higher grade complications were associated with the surgery until 15 months postoperatively. Although the symptom of hydronephrosis disappeared at postoperative day 1, hospital stay was prolonged for 5 days due to the patient being unprepared for discharge.

Case 3

A 49-year-old peri-menopausal woman, who had experienced postprandial upper abdominal discomfort, visited our clinic due to hypermenorrhea with anemia. Preoperative abdominopelvic CT displayed multiple stones in the gall bladder and multiple leiomyomas in the uterus, with the largest one having a diameter of 7 cm, which was consistent with the findings of TVS. Upon hearing an explanation about the possibility of conversion to laparotomy because of the uterine size, she still opted for concomitant total hysterectomy with adnexectomy and cholecystectomy using the R-LESS platform.

Robot arms were first docked from the caudal side to decide whether to abort R-LESS or convert to other approaches at the beginning of the pelvic phase. The uterus was set aside using a uterine manipulator, and the suspensory ligaments were pulled to the counter direction using the laparoscopic grasper of the assistant. The infundibulopelvic, broad, and round ligaments were coagulated with the bipolar penetrated grasper of arm 1 and resected with the monopolar hook in arm 2 or laparoscopic scissors in the assistant trocar. For right uterine vessel ligation, the instrument of the medial side (arm 1) was used to further push the uterus to the left to clearly expose the uterine isthmus

Table 1. — *Characteristics and perioperative findings of patients.*

Age (y)	BMI (kg/m ²)	Clinical information	Final histopathologies of specimens	Operative finding	Operative duration (h)	Blood loss (mL)	Postoperative hospital stay (d)
63	23.2	Previous conization with persistent HPV infection Nausea and vomiting	Mild dysplasia and chronic cholecystitis	Atrophic uterus with cervical os stricture	3.5	100	2
56	21.3	Acute right flank pain with hydronephrosis and chronic abdominal discomfort	Uterine leiomyomas (120 g) and chronic cholecystitis with stones	Leiomyoma of right uterine wall compressing the ureter	2.75	Minimal	5
49	24.1	Hypermenorrhea and postprandial discomfort	Uterine leiomyomas (550 g) and chronic cholecystitis with stones	Multiple leiomyomas, with the largest one having a diameter of 7 cm	3.42	250	4

BMI: body mass index, HPV: human papillomavirus.

to the instruments in arm 2. The procedures were repeated for left uterine vessel ligation. The uterine specimen was morcellated in an endobag for extraction.

Transition to right-side docking was followed by an upper abdominal phase. During the dissection of the peritoneum covering the gallbladder neck, two cystic arteries were identified and secured using a clip through arm 2. The detached gallbladder was placed in an endobag and removed through the umbilical incision.

The surgical procedure was completed after 3 hours and 25 minutes. Estimated blood loss was 250 mL, which mainly developed from the hysterectomy phase without any noteworthy incidents. The patient was discharged at 4 days postoperatively and reported no complications until the last follow-up at 3 months.

Discussion

Although promising results have been published in literature of cholecystectomy since the introduction of LESS by Navarra [3], there still remain mechanical hurdles in the procedure to be overcome (such as pulling the gallbladder, precise and exquisite dissection, and elaborate visualization). Our general surgeons reported favorable outcomes in the form of short operative time and no grade II or higher complication in 108 consecutive LESS-cholecystectomies [4]. However, seven cases still required additional ports to expose the Calot's triangle, with rates similar to those (2.8% to 28.3%) of other studies on LESS. According to a systemic review of 9 randomized clinical trials (RCTs), significantly more adverse events developed in the LESS group than in the multi-port group [5].

Over the five years since the first robotic surgery in 1999, the robotic system has evolved to a single-site platform, enabling single-incision surgeries to be practiced in multiple departments. Initial studies have demonstrated that robotic single-site technique is safe and has potential to resolve the technical limitations of conventional laparoscopy [6]. A recent RCT described benefits of R-LESS over LESS in terms of patients' outcome and surgeons' stress load [7].

In gynecology, since LESS and R-LESS hysterectomies were first reported in 2009, single-site surgery has been regarded to have advantages over laparotomy and multi-incision laparoscopy. However, LESS has limitations in controlling collateral vessels of a bulky uterus or its distorted cornea. R-LESS techniques have been developed to overcome these challenges and have been reported to be feasible and reproducible even in gynecological malignancies, although high para-aortic lymphadenectomy to the left renal vein was still unattainable [8, 9]. R-LESS hysterectomy is being accepted by more surgeons and is becoming a more standardized alternative for patients.

In this case series, we incorporated two procedures in the upper abdomen and lower pelvis to make the best use of the benefits of R-LESS. Under multidisciplinary cooperation, concomitant pathologies were resolved through one umbilical incision rather than through multiple incisions over the whole abdomen (Figure 1). We avoided the risk of anesthesia and complications and the overall cost of a second surgery, which might have occurred if the combined R-LESS had not been selected by patients and surgeons at the initial exam.

Each of the three cases had features that could enhance the difficulty of pelvic surgery, including atrophic uterus, pelvic wall compression, and large uterine size (> 500 g) (Table 1). Operative time and blood loss were comparable to the sum of measures expected by separate surgeries. This study demonstrated that complex concomitant procedures can be safely and feasibly performed using an R-LESS approach.

To the best of our knowledge, there have been few reports of combined LESS with hysterectomy and cholecystectomy. One study used a conventional laparoendoscopic system [10] and the other used a robotic system [11]. They presented no problems during the perioperative periods and took approximately 3 hours to complete in LESS and one additional hour in R-LESS.

For extension of combined R-LESS, the operating team members should be experienced in R-LESS. Hysterectomy

and cholecystectomy would be most frequently involved in each of their fields and the robotic versions would have been attempted early on. Our gynecology and general surgery teams could replace each other at robotic theater and share surgical instruments with proficiency. Also the operating teams should be cooperative to select the appropriate patients for the concurrent R-LESS. When it comes to the conversion due to bleeding or inaccessibility, the advantages of concurrent R-LESS will diminish including the minimal invasiveness and the reduced cost of robot operation. Although the rate of open conversion is low in R-LESS for cholecystectomy and hysterectomy [12, 13], extra time is needed for undocking of robotic arms which is critical in emergency setting.

The order of operations should be determined with care to ensure the safety of the patient and the success of combination. It is reasonable to perform more symptomatic or contaminated condition first [14]. The condition has a high probability to be complex and lead to use of additional instruments or conversion. The carefully defined sequence can enable more surgical resources to be made available for the following procedure. In our last two cases suffering from hydronephrosis-inducing leiomyoma and huge uterus respectively, the surgery was initiated with hysterectomy to relieve the renal and pelvic symptoms quickly. They were assessed that the condition could be cleared through a single-site incision without further instrumental supports.

So far case series have presented the potential of LESS for the combination of abdominal procedures such as liver resection, splenectomy, intestinal surgery and nephrectomy in addition to cholecystectomy and hysterectomy [15]. As R-LESS is being widely accepted in general surgery, urology and gynecology [1, 2], the experience from performing hysterectomy or cholecystectomy will accumulate and contribute to the feasibility of performing a various combination of complex procedures with R-LESS.

However, the transition between the two procedures during R-LESS was more laborious compared to that of conventional laparoscopy. To prepare for the second procedure, a significant amount of time was spent on implementing a double docking procedure. This limitation is in line with the time-consuming feature of robot-assisted laparoendoscopic surgery.

The next generation robotic platforms are known to be advanced with an endoscope suitable to any arms or a 2.5-cm portal incorporating a camera and all armaments. These can omit patient repositioning or arm re-docking and enable abdominal quadrants to be more accessible for combined cholecystectomy and hysterectomy.

Robotic technologies may facilitate the widespread acceptance of single-incision surgery, overcoming the limitations associated with conventional laparoscopic and LESS. In our series, hysterectomy and cholecystectomy were concurrently performed without adverse events using the R-LESS platform. Therefore, we concluded that in cases with multidisciplinary pathologies detected in the ab-

dominopelvic cavity, R-LESS has proven to be a feasible alternative for selected patients.

Ethics Approval and Consent to Participate

All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of CHA Bundang Medical Center (approval number: 2018-05-048-010).

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Conflict of Interest

The authors declare no conflict of interest.

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