

Robot-assisted laparoendoscopic single site adrenalectomy

A comparison of 3 different port platforms with 3 case reports

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Abstract

Rationale: Laparoscopic adrenalectomy is currently the standard of care for adrenal lesion. Minimal invasive laparoscopic surgery such as laparoendoscopic single site surgery (LESS) and natural orifice transluminal endoscopic surgery (NOTES) have been developed to improve cosmetic outcomes and reduce postoperative pain. However, there are still some problems related to instruments and port limitation during LESS surgery. Robot-assisted laparoscopic surgery may help to overcome these problems, and port platforms selection is an important issue.

Patient concerns: Three cases received robot-assisted LESS adrenalectomy due to adrenal tumor were enrolled. Blood loss, hospital stay, and analgesia injection were compared.

Diagnoses: Preoperative evaluations were done in a usual manner. Benign tumors were suspect for two patients, while metastatic tumor could not be excluded for the other patient with prior malignancy history. The pathology reports were all benign adrenal cortical adenoma after operation.

Interventions: Three different port platforms, Da Vinci Single-Site Surgical Platform, GelPOINT, and homemade glove port were used. Trans-peritoneal approach was used for two patients, while the other one received trans-retroperitoneal approach. The advantage and disadvantage of different port platforms were discussed.

Outcomes: All patients underwent the operation smoothly without major complications or conversion to open surgery. Blood loss amount was small, hospital stay was short, and only one patient received one single dose of opioid analgesia injection after the surgery.

Lessons: The main problems of LESS are the loss of a working triangle and the limitations of the instruments. Robot-assisted LESS may help surgeons overcome part of these problems. Many different port platforms are available, and based on our initial experience, we believe that the GelPoint may be a more suitable platform, for it maintains the endo-wrist function of the Da Vinci instruments, and allows the surgeon to design the position of ports freely to minimize external and internal collision.

Abbreviations: ACTH = adrenocorticotropic hormone, IV/IM = intravenous/intramuscular, LESS = laparoendoscopic single site surgery, NOTES = natural orifice transluminal endoscopic surgery, RA-LESS = robot-assisted laparoendoscopic single site surgery, VMA = vanillylmandelic acid.

Keywords: adrenalectomy, LESS, port platform, robot-assisted surgery

1. Introduction

Since the first case was introduced in 1991 by Clayman et al,^[1] laparoscopic surgery in urology has been used more frequently because of the documented benefits of less postoperative pain,

better cosmetic result, and shorter hospital stay.^[2–5] Although laparoscopic surgery is less invasive compared to traditional open surgery, there still are some possible complications such as bleeding, internal organ injury, and port-site hernia.^[6,7] Therefore, new and less invasive surgical techniques have been developed along with progress in surgical instruments. Laparoendoscopic single site surgery (LESS) is a new technique, that organizes all instruments such that they enter the body cavity through a single incision.^[8,9] In the past decade, the number of urologic LESS has increased rapidly.^[10–13]

In 1992 Go et al^[14] reported the first case of laparoscopic adrenalectomy, and it became the standard of treatment for most benign and malignant adrenal lesions. Post the development of LESS, LESS adrenalectomy has also been performed widely using either transperitoneal or transretroperitoneal approaches. Studies reported comparable outcomes to conventional laparoscopic adrenalectomy with regard to blood loss, operation time, complication rate, and hospital stay length, as well as more favorable cosmetic results.^[15–18]

Since its approval by the US Food and Drug Administration in 2000, robotic surgery using the da Vinci system (Intuitive Surgical, Sunnyvale, CA) has garnered extensive interest from urologists. The minimal invasion and high degree of freedom of

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Table 1**Demographic information.**

	Case 1	Case 2	Case 3
Age	34	76	49
Sex	Male	Male	Female
Preoperation diagnosis	adrenal functional adenoma	Nod-functional adenoma	Nod-functional adenoma
Postoperation diagnosis	adrenal cortical adenoma	adrenal cortical adenoma	adrenal cortical adenoma
Port	Da Vinci Single-Site Surgical Platform	GelPOINT (Applied Medical)	Homemade glove port
Approach method	transperitoneal	transperitoneal	trans-retroperitoneal
Console time, min	130	180	160
Blood loss (ml)	50	50	30
IV or IM form analgesic	Morphine 10 mg once	Non	Non
Hospital stay (day)	4	3	4

IM = intramuscular, IV = intravenous.

instruments allow for it to replace surgeons during many open or conventional laparoscopic surgeries in different operation fields. After LESS became popular, robot-assisted LESS urologic surgery was reported for the first time by Kaouk et al in 2009.^[19] Several case series were presented thereafter.^[20–22]

Here we introduced 3 cases series (Table 1) of robot-assisted LESS adrenalectomy using the da Vinci system (Intuitive Surgical). We compared 2 approaches (lateral transperitoneal and lateral trans-retroperitoneal approach), and 3 port platforms: single-site port (Intuitive Surgical), GelPoint (Applied Medical, Rancho Santa Margarita, CA), and homemade glove port, which were used in the 3 cases. This is a surgical experience summary study, and not involved in the decision of treatments for patients. In addition, no private or identical information of patients was revealed. No ethical approval or informed consent is necessary.

2. Case description

2.1. Case 1

This 34-year-old man has diabetes mellitus, which was managed using regular medications. He had hypertension 1 year before the operation. Headache, palpitation, edema, or muscle weakness was absent. Laboratory data were checked and showed that aldosterone, renin, potassium, adrenocorticotropic hormone (ACTH), cortisol level, vanillylmandelic acid (VMA), and urine catecholamine levels were all within the normal range. Abdominal computed tomography revealed a 2.0-cm nodule arising from the left adrenal gland. An adrenal scan with NP-59 showed possible left adrenal functional adenoma. For suspected secondary hypertension related to left adrenal functional adenoma, robot-assisted laparoendoscopic left adrenalectomy was performed. We used the Da Vinci Single-Site Surgical Platform with a transperitoneal approach.

The console time was 130 minutes and essential blood loss was 50 mL. The patient received only 1 dose of an opioid analgesic with 10 mg of morphine after operation and was discharged on the fourth day after operation. The pathology report indicated adrenal cortical adenoma.

2.2. Case 2

This 76-year-old man had a history of hypertension that was under medical control for 6 years. He had left renal cell carcinoma and received left radical nephrectomy approximately 1 year before this operation. The pathology results revealed renal cell carcinoma and, clear cell type, pT1a. During the outpatient department follow-up for left renal cancer, a left adrenal tumor was found using abdominal computed tomography. The tumor was 2.5 cm in size.

The patient denied headache, palpitation, or sweating. Meanwhile, laboratory data revealed renin, potassium, ACTH, cortisol level, VMA, and urine catecholamine levels to be within the normal range. For suspected left adrenal tumor, robot-assisted laparoendoscopic left adrenalectomy was performed. We used GelPoint (Applied Medical) with the transperitoneal approach.

The console time was 180 minutes and essential blood loss was 50 mL. The patient did not receive any intravenous/intramuscular (IV/IM) painkillers after operation and was discharged on the third day after operation. The pathology report indicated adrenal cortical adenoma.

2.3. Case 3

This 49-year-old woman has a history of left ureteral stone, for which she received left ureterorenoscopy with stone manipulation twice in 2006 and 2010. She was followed at our outpatient department regularly. During the follow-up, intravenous urography revealed rigid appearance of left ureteropelvic junction with relative lumen narrowing. Abdominal computed tomography revealed no significant filling defect in collecting, but a 3-cm nodule in the left adrenal gland was found. She denied headache, palpitation, or sweating. Laboratory data revealed renin, potassium, ACTH, VMA, and urine catecholamine levels to be within the normal range. Slightly elevated cortisol level was noted. For suspected left adrenal tumor, robot-assisted laparoendoscopic left adrenalectomy was performed. We used a homemade glove port with transretroperitoneal approach.

The console time was 160 minutes and essential blood loss was 30 mL. The patient did not receive any IV/IM painkillers after operation and was discharged on the fourth day after operation. The pathology report indicated adrenal cortical adenoma.

3. Discussion

There are 3 possible problems in using LESS. These include the external collision of ports and instruments, internal collision of instruments, and loss of working triangle (Fig. 1). In our experience, external collision was mostly encountered because of port collision. Second, internal collision was mostly encountered at the transabdominal wall portion, which was caused because of trocar sheath fighting. This may limit the relative position of camera and instruments. Finally, crossing of the instruments could occur at the single site, thereby preventing the working triangle from being maintained. This may cause left to right side shift. However, even though the instruments were maintained at each side, the working space could be small.

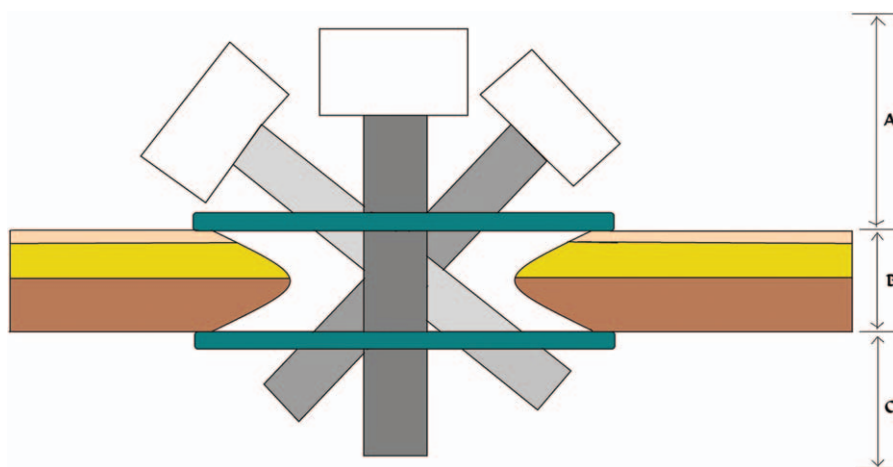


Figure 1. Possible problems encountered during LESS surgery. (A) External collision. (B) Internal collision. (C) Loss of working triangle. LESS=laparoendoscopic single-site surgery.

3.1. Comparing port platforms

3.1.1. Da Vinci single-site. The Da Vinci Single-Site Surgical Platform was a solid port with built-in channel (Fig. 2). There was

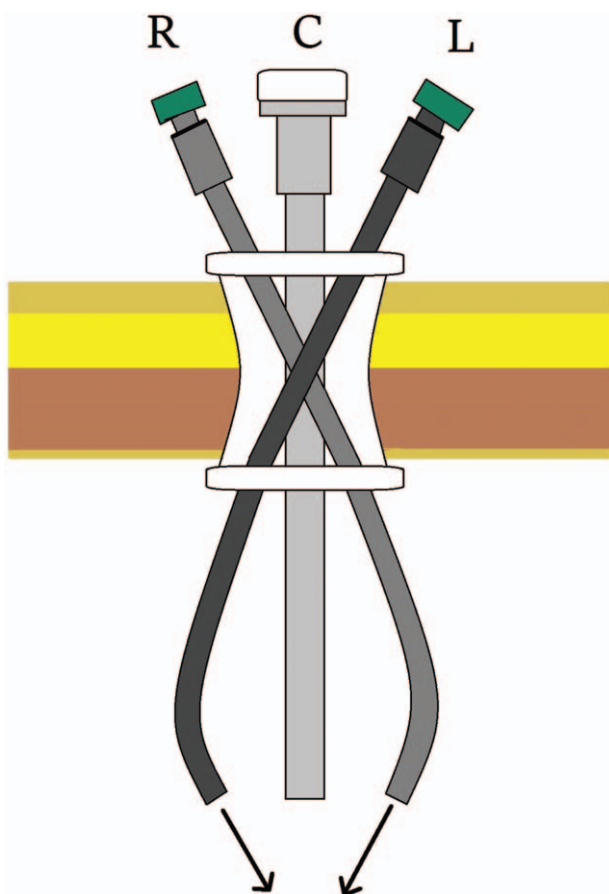


Figure 2. Illustration demonstrated the inner structure of a Da Vinci Single-Site Surgical Platform multichannel port. The assistant port and inflation port are not shown. Two working sheaths are crossed inside the port and a left-right switch was performed by a built-in computer program. "C" indicated the camera port. "L" indicated the arm controlled by surgeon's left hand, and "R" indicated the arm controlled by surgeon's right hand. The arrow head indicated restored working triangulation.

1 camera port, 2 working ports, and 1 assistant port within it. The working port was designed to be crossed, and the instruments were semi-rigid. Hence, when the instruments were inserted through the ports, the left side outside the body would be right side inside the body cavity. By combining the Da Vinci system, a left to right switch could be set up and the surgeon could perform the surgery in an intuitive way.

With this port, extracorporeal robotic arm clashing is minimized externally owing to the curved cannulas angling the robotic arms away from each other. Internal collisions with the camera are avoided because the camera is designed to be placed in the middle

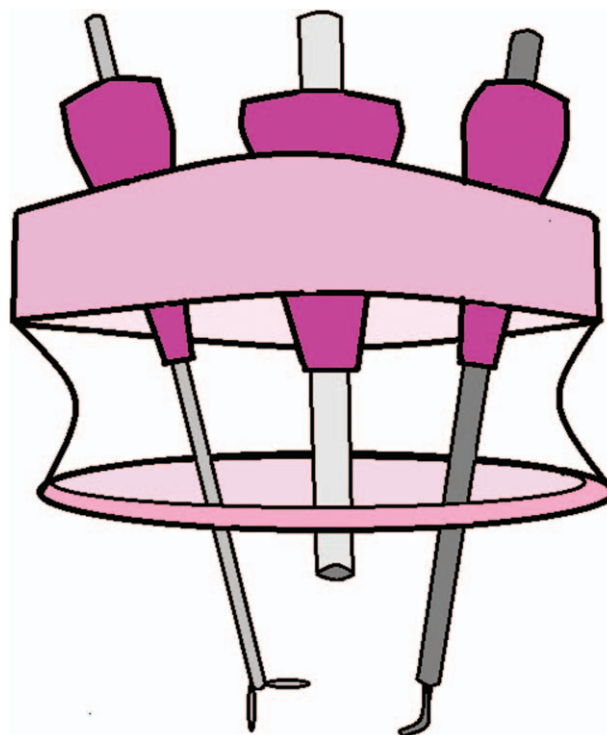


Figure 3. GelPoint. The GelPoint was a port with a gel cap that could be penetrated by trocar. The advantage include that it could be adapted to different trocar configurations (less limited number and size of trocars).

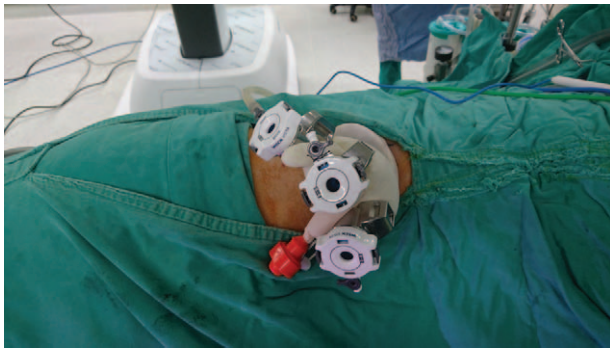


Figure 4. Homemade glove port with Alexis wound retractor and glove.

of the curved cannula zone. However, the single-site instruments were nonwristed, and the working space is small.

3.1.2. GelPoint. The GelPoint is a port with a gel cap that could be penetrated by a trocar (Fig. 3). Compared to those of other platforms, the GelPoint's advantage may include its adaption to different trocar configurations (less limited number and size of trocars) and a more limitless outer working space for assistant. The surgeon could design the position of the ports, and minimize internal collision. Given the flexibility through which ports can be placed, we could obtain better triangulation with greater spacing of ports. Furthermore, by using GelPoint, conventional Da Vinci instruments with endo-wrist could be used to increase working space and maximize the working triangle.

3.1.3. Homemade glove port. In Case 3, we used homemade Glove port as a working port (Fig. 4). The access port was 7.5 surgical gloves in size and contained an Alexis wound retractor (Applied Medical). The port was placed below the 12th rib, and the retroperitoneal space was dissected by a balloon dilator. Trocars were then inserted through the fingers of the glove and fixed in place. Unlike commercially available single-port access system, this homemade single port requires time to set up. Several steps, such as designing the surgical glove, glove trimming, and trocar securing ligature, are required. As expected, there was a noticeable limited range of motion among the robotic arms, which required timely adjustment and angulation by the assistant to proceed with the surgery. Similar to GelPoint, conventional Da Vinci instruments with endowrists could be used for better working triangle. The cost is much lower than that of commercially available single-port system. It may be an alternative to the costly, commercially available single-port system, especially in countries with a low payment from Bureau of National Health Insurance, like Taiwan.

3.1.4. Transperitoneal and retroperitoneal approach. Among the 3 cases, we compared the transperitoneal and retroperitoneal robotic assisted laparoendoscopic single-site adrenalectomy. All patients were placed in the decubitus position with the side of the tumor facing up, allowing the abdominal contents to retract owing to the force of gravity.

In case 1 and case 2, we used a transperitoneal approach, and found that the blood loss and operation time were similar to that observed with the retroperitoneal approach (case 3). Although it is easier to identify the land marks, maintaining orientation and finding the adrenal tumor via the transperitoneal approach require more time to take down the colon and spleen. Indeed, in

Table 2

Comparison of 3 port platforms.

	Less external and internal collision	Maintains the endowrist function	Less time to set up	Less cost
Da Vinci Single-Site	Fair	Poor	Good	Poor
GelPoint	Good	Good	Fair	Fair
Homemade Glove port	Poor	Good	Poor	Good

our experience, this method requires retraction of the spleen and pancreas (or liver for the right adrenalectomy). Furthermore, we found that if patients did not have previous major abdominal surgery, the time to take down the colon and spleen was usually <20 minutes.

In case 3, we used a retroperitoneal approach. Theoretically, it provided more direct access to the adrenal gland, but this did not save time because of the loss of landmarks to guide the direction to the adrenal gland. In addition to restricted working space, the retroperitoneal approach is limited by restricted movements. The advantages of retroperitoneal approach are that it is less likely to injure the intra-abdominal organs. For patients who have undergone abdominal surgery in the past, it could prevent intraperitoneal adhesions. Morbidly obese patients and those with an enlarged liver are good candidates for the retroperitoneal approach.^[2,3]

In our 3 cases, we found no postoperative ileus. Furthermore, no case required conversion to open surgery.

The main benefits of minimal invasive surgery are less wound pain, shorter hospital stay, and better cosmetic result. Patient 1 had received only one dose of opioid analgesic via injection, whereas patients 2 and 3 patients did not receive any IV/IM painkillers after operation.

These are our first 3 cases of robot-assisted LESS adrenalectomy. Nevertheless, the sample size is too small to make a generalizable comparison. Our operation time is still longer than that of an experienced surgeon, and requires a learning curve to overcome. Nevertheless, based on our initial experience, we believe that the GelPoint may be a more suitable platform because it maintains the endowrist function of the Da Vinci instruments, but allows the surgeon to design the position of ports freely to minimize external and internal collision (Table 2).

In conclusion, robot-assisted laparoendoscopic adrenalectomy is a feasible approach with less postoperative pain, better cosmetic result, and shorter hospital stay. There are still several factors that should be taken into consideration while comparing LESS surgery with conventional laparoscopic surgery, such as patient selection, conversion and complication rate, and surgical outcome, which is similar to what suggested for surgery by an experienced surgeon.

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