Single Port Transumbilical Laparoscopic Surgery versus Conventional Laparoscopic Surgery for Benign Adnexal Masses: A Retrospective Study of Feasibility and Safety

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Abstract

Background: Single port laparoscopic surgery (SPLS) is an innovative approach that is rapidly gaining recognition worldwide. The aim of this study was to determine the feasibility and safety of SPLS compared to conventional laparoscopic surgery for the treatment of benign adnexal masses.

Methods: In total, 99 patients who underwent SPLS for benign adnexal masses between December 2013 and March 2015 were compared to a nonrandomized control group comprising 104 conventional laparoscopic adnexal surgeries that were performed during the same period. We retrospectively analyzed multiple clinical characteristics and operative outcomes of all the patients, including age, body mass index, size and pathological type of ovarian mass, operative time, estimated blood loss (EBL), duration of postoperative hospital stay, etc.

Results: No significant difference was observed between the two groups regarding preoperative baseline characteristics. However, the pathological results between the two groups were found to be slightly different. The most common pathological type in the SPLS group was mature cystic teratoma, whereas endometrioma was more commonly seen in the control group. Otherwise, the two groups had comparable surgical outcomes, including the median operation time (51 min vs. 52 min, \( P = 0.909 \)), the median decreased level of hemoglobin from preoperation to postoperation day 3 (10 g/L vs. 10 g/L, \( P = 0.795 \)), and the median duration of postoperative hospital stay (3 days vs. 3 days, \( P = 0.168 \)). In SPLS groups, the median EBL and the anal exsufflation time were significantly less than those of the conventional group (5 ml vs. 10 ml, \( P < 0.001 \); 10 h vs. 22 h, \( P < 0.001 \)).

Conclusions: SPLS is a feasible and safe approach for the treatment of benign adnexal masses. Further study is required to better determine whether SPLS has significant benefits compared to conventional techniques.

Key words: Benign Adnexal Masses; Single Port Laparoscopic Surgery; Surgical Outcomes

Introduction

Over recent years, laparoscopic surgeries have already been demonstrated as a better alternative to open abdominal surgery, especially when treating benign diseases. Intraoperative complications, pain, and length of postoperative hospital stay have all been found to be reduced.¹⁻² Conventional three ports laparoscopy has been widely applied to treat benign ovarian disease. Many attempts have been made to minimize the number of trocars by applying single port laparoscopic surgery (SPLS) to perform a cholecystectomy, appendectomy, and splenectomy.³⁻⁵ SPLS has also been applied to perform hysterectomies by several gynecologic groups with improving effects.⁶⁻⁷ However, few studies have evaluated the potential benefits of SPLS for the treatment of benign adnexal masses; therefore, in this study, our objective was to assess the feasible advantages of SPLS via a comparative study.
analysis between SPLS and conventional laparoscopy for adnexal masses.

**Methods**

This study was a case-control study that compared the outcomes of 99 cases of SPLS and 104 conventional laparoscopic adnexal procedures for adnexal masses between December 2013 and March 2015 performed by a single surgeon. The 99 patients who were chosen to undergo SPLS were those with the diagnosis of benign adnexal mass. The 104 patients in the control group who underwent conventional laparoscopic adnexal surgery, were age-matched and chosen during the same period. The inclusion criterion for both groups was as follow: patients who were diagnosed with the presence of adnexal masses on ultrasonography and without any severe complications. Patients who were under suspicion of malignant ovarian tumor on ultrasonography or with severe complications that cannot withstand surgery were excluded. The patients’ clinical data for both groups including history, routine preoperative workup, such as blood routine, biochemistry, coagulation tests, tumor markers, electrocardiogram, and chest X-ray were all collected retrospectively. The study protocol was approved by the Ethics Committee of Peking University First Hospital.

All surgeries were performed by a single surgeon (Ling Yin), with the assistance of two surgeons (Yan Zhang and Bing-Bing Xiao), at a single institution (Peking University First Hospital). The postoperative assessment was performed by a single investigator (Si-Yun Wang). The SPLS port with three access ports (one 12-mm port and two 5-mm ports) as well as a gas inlet, which was produced in Tonglu, Hangzhou, China, was used. After surgeries, intraoperative data including the operation time (from skin incision to closure), estimated blood loss (EBL) (by visual and experiential estimation), change in hemoglobin level after surgery (recorded at 3 days postoperatively), duration of postoperative hospital stay, intraoperative and postoperative complications were all collected until 1 month follow-up postoperatively.

**Operative techniques**

After a 2–3 cm transverse transumbilical incision was made, an SPLS port wound retractor (30 mm), which was composed of a distal ring, a proximal ring, and a cylindrical connecting sleeve,[8] was then inserted to expand the edge of the incision laterally. The SPLS port has three access ports (one 12-mm port and two 5-mm ports) as well as a gas inlet. We used a rigid, 30°, 10-mm laparoscope, traditional rigid straight instruments, and prebent laparoscopic instruments to prevent the instruments from clashing and to optimize the operation space [Figure 1].

Once all equipment were in position, the following procedures were similar to the techniques in conventional laparoscopic approach [Figure 2]. The skin was closed using a 3-0 vicryl suture (Johnson & Johnson, USA), which provided for a good cosmetic outcome [Figure 3].

**Statistical analysis**

The SPSS version 20.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis using the Student’s t-test, Fisher’s exact test, Chi-square test, and Wilcoxon rank sum test. Quantitative data that satisfy a normal distribution were analyzed using Student’s t-test (data are shown as mean ± standard deviation [SD]). Quantitative data that did not satisfy a normal distribution were analyzed using Wilcoxon rank sum test (data are shown as median [min, max]). Qualitative data were analyzed using Fisher’s exact test and Chi-square test (frequency [%]). A value of P < 0.05 was considered as statistically significant.

**Results**

A total of 203 patients were enrolled in the study. The clinical characteristics between the two groups did not differ significantly, including the size of adnexal masses showed on ultrasonography and the proportion of unilateral masses [Table 1]. A cystectomy with or without concomitant surgeries such as myomectomy or hysteroscopy was performed in 76.7% of the SPLS group and in 77.9% of the conventional group, which was not a remarkable statistical discrepancy. The adhesiolysis ratio also showed no obvious difference between the two groups (SPLS: 65.7%; conventional: 67.3%; P = 0.803); however, the pathological findings between the two groups were slightly different. In the SPLS group, mature cystic teratoma made up the vast majority of pathological types while endometrioma was more commonly observed in the control group [Table 2].

The surgical outcomes between the two groups were comparable [Table 3]. No remarkable difference was shown between the two groups regarding the median operation time (51 min vs. 52 min, P = 0.909), median postoperative duration of hospital stay (3 days vs. 3 days, P = 0.168) and the median change in hemoglobin level (10 g/L vs. 10 g/L, P = 0.795) from preoperation to postoperation day 3. Notably, in SPLS groups, the median EBL and the anal exsufflation time were significantly less than those of the conventional group (5 ml vs. 10 ml, P < 0.001; 10 h vs. 22 h, P < 0.001). No case required a blood transfusion or conversion to laparotomy. There were no complications in either group, including peripheral visceral injury, incision hernia, or other postoperative morbidity. In addition, we successfully performed SPLS in an ovarian cyst torsion case. The size of the cyst was 70 mm × 56 mm × 51 mm. We performed a cystectomy and the operation time was 61 min. The EBL was 10 ml, and postoperative hospital stay was 3 days.

Based on visual inspection of the learning curve of the operation time from the 1st case to the 99th case in the SPLS group, the operative time gradually shortened as more cases were performed. A significant decrease in time was noted after 12 cases were done [Figure 4]. In the control group, the operative time remained steady [Figure 5].

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**Figure 1:**...


**Discussion**

SPLS is a highly innovative technique that has been introduced in the field of minimally invasive surgery in recent years.\(^9\) Although SPLS technique has been reported to perform tubal ligation for the 1\(^{st}\) time in the 1970s, and Ghezzi et al. succeeded in performing salpingectomy using SPLS in 2005, the use of SPLS technique has not been widespread because of its technical challenges.\(^10,11\) Fortunately, the innovation of operative techniques and design of new devices to overcome such difficulties have generalized the application of SPLS.\(^12\) Several gynecologist groups have reported successful experience in diverse gynecological procedures using SPLS approaches such as laparoscopic-assisted vaginal hysterectomy and total laparoscopic hysterectomy.\(^6,7\)

We performed a retrospective study to assess the use of SPLS versus conventional laparoscopy for the treatment of benign adnexal masses during the same period. Considering that the patients enrolled in our study were not randomly assigned, it was difficult to eliminate the selection bias in grouping. This might lead to the difference of the baseline characteristics and the variety of diseases between the two groups. According to our data, the clinical characteristics between the two groups did not diverge significantly. The median age of the patients from both groups were equal (32 years vs. 32 years, \(P = 0.055\)), but the variation in the SPLS group was slightly smaller than that of the conventional group ([11 years, 58 years] vs. [15 years, 73 years]).

### Table 1: Comparison of preoperative characteristics of the single port laparoscopic surgery group and the conventional group

| Preoperative characteristics                  | SPLS (\(n = 99\)) | Conventional (\(n = 104\)) | Statistic value | \(P\)  |
|----------------------------------------------|-------------------|-----------------------------|-----------------|-------|
| Age (years), median (min, max)               | 32 (11, 58)       | 32 (15, 73)                 | \(-1.920^\dagger\) | 0.055 |
| BMI (kg/m\(^2\)), mean ± SD                 | 22.1 ± 3.2        | 22.2 ± 3.1                  | \(-0.416^\dagger\) | 0.678 |
| History of previous abdominal surgery, \(n\) (\%) | 17 (17.2)         | 21 (20.2)                   | 0.304\(^1\)     | 0.581 |
| Proportion of unilateral tumors, \(n\) (\%)  | 85 (86.7)         | 85 (85.5)                   |                 | 0.328 |
| Size of ovarian tumor* (long diameter, mm), median (min, max) | 49.0 (14.0, 226.0) | 55.5 (5.0, 181.0)         | \(-1.853^\dagger\) | 0.064 |
| Size of ovarian tumor* (short diameter, mm), median (min, max) | 34.0 (9.0, 95.0) | 39.5 (5.0, 111.0) | \(-1.422^\dagger\) | 0.155 |

*The size of ovarian tumors was measured by transvaginal ultrasonography; \(^U\) value; \(^t\) value; \(^\chi^2\) value; SPLS: Single port laparoscopic surgery; BMI: Body mass index; SD: Standard deviation; –: No data.

**Figure 1:** Port placement for the single three-channel port system (external view). (a) Inserting the SPLS port through a 2–3 cm transverse transumbilical incision. (b) The SPLS port has one 12-mm port and two 5-mm ports as well as a gas inlet. (c) Using a rigid, 30\(^\circ\), 10-mm laparoscope, traditional rigid straight instruments, and prebent laparoscopic instruments to optimize the operation space. SPLS: Single port laparoscopic surgery.

**Figure 2:** Intraoperative view of a single port laparoscopic surgery for the treatment of an adnexal mass. (a) Image of a right ovarian cyst. (b and c) Resected and peeled the cyst off the right ovary. (d) Postoperative image.

**Figure 3:** A representative image of the 2–3 cm incision for the single three-channel port system prior to the final skin closure.
Moreover, the size of the ovarian tumor in the SPLS group was slightly smaller (49.0 mm vs. 55.5 mm, \( P = 0.064 \)). However, there was no statistically significant difference between the two groups regarding these two indicators. Besides, from clinical experience, factors including body mass index, history of previous abdominal surgery and severity of pelvic adhesion were considered more relevant than age itself to the surgical outcomes and complications. Furthermore, we believe the insignificant difference between the ovarian tumor size of the two groups was quite insignificant for experienced surgeons in clinical practice and would not have a dramatic influence on the main surgical outcomes. We concluded that no significant differences were observed regarding the operation time, perioperative decrease in hemoglobin level and postoperative hospital stay between the two groups. In the SPLS group, the median EBL was 5 ml and the median exsufflation time was 10 h. Both outcomes were superior to those of the conventional group \( (P < 0.001) \). There were no cases of peripheral visceral injury or conversion to conventional laparoscopic surgery or laparotomy. Additionally, there was a notable difference in the pathological types between the two groups \( (P = 0.002) \). In the SPLS group, mature cystic teratoma was the majority pathology type, comprising 27.8% of all cases. Meanwhile, endometrioma made up 40.4% of the cases in the control group. This significant difference might have some influence on the surgical outcomes between the two groups, such as operation time and EBL due to pelvic adhesions that endometriomas commonly cause. However, there were no assumed differences in either the ratio of adhesiolysis performed during surgery or the operation time in both groups according to our study. The EBL in SPLS group was significantly less than that in the conventional group (5 ml vs. 10 ml, \( P < 0.001 \)), but it did not have any dramatic impact on the median changes in hemoglobin levels postoperatively (SPLS: 10 g/L; conventional: 10 g/L, \( P = 0.795 \)). Therefore, we consider the difference in the pathology types between the two groups to be minor as it did not influence the operative outcomes in our study. No operative complications were observed in either group. However, our short-term follow-up was not able to validate

**Table 2: Comparison of operative characteristics of the single port laparoscopic surgery group and the conventional group, \( n \) (%)**

| Operative characteristics | SPLS (\( n = 99 \)) | Conventional (\( n = 104 \)) | Statistic value | \( P \) |
|---------------------------|---------------------|-----------------------------|---------------|-----|
| Operation type            |                     |                             |               |     |
| Cystectomy only           | 53 (53.5)           | 49 (47.1)                   |               | 0.322|
| Oophorectomy only         | 13 (13.1)           | 8 (7.7)                     |               |     |
| Cystectomy + other procedures* | 23 (23.2)       | 32 (30.8)                   |               |     |
| Oophorectomy + other procedures* | 6 (6.1)          | 6 (5.8)                     |               |     |
| Cystectomy + oophorectomy (with or without other procedures*) | 2 (2.0) | 7 (6.7) |     |     |
| Other procedures*         | 2 (2.0)             | 2 (1.9)                     |               |     |
| Adhesiolysis              | 65 (65.7)           | 70 (67.3)                   | 0.062\( ^{\dagger} \) | 0.803|
| Pathologic findings       |                     |                             |               |     |
| Mature cystic teratoma    | 27 (27.8)           | 19 (18.3)                   |               |     |
| Endometrioma              | 25 (25.8)           | 42 (40.4)                   |               |     |
| Serous/mucinous cystadenoma | 14 (14.4)        | 24 (23.1)                   |               |     |
| Ectopic pregnancy         | 15 (15.5)           | 4 (3.9)                     |               |     |
| Other benign tumors†      | 16 (15.0)           | 15 (14.4)                   |               |     |

*Other procedures included myomectomy, hysteroscopy + fractional curettage, hysterectomy and appendectomy; †Other benign tumors included hydrosalpinx, ovarian corpus luteum cyst, mesosalpinx cyst, myoma, ovarian steroid cell tumor, ovarian thecoma, ovarian granulosa cell tumor, tubal serous glands fibroma; \( ^{\dagger} \chi^2 \) value; SPLS: Single port laparoscopic surgery; –: No data.

**Figure 4:** Operative time from the first case to 99th case in the single port laparoscopic surgery group. SPLS: Single port laparoscopic surgery.

**Figure 5:** Operative time from the 1st case to 104th case in the control group.
have reached similar conclusions that the surgical outcomes in benign adnexal surgeries did not differ significantly between SPLS and conventional laparoscopy. In our study, we also managed to perform a cystectomy in an ovarian cyst torsion case. The size of the ovarian mass was 70 mm × 56 mm × 51 mm. The operating time was 61 min. The EBL during surgery was 10 ml and postoperative hospital stay was 3 days. These positive results suggest that even in emergency cases like ovarian cyst torsion, SPLS might also have comparable surgical outcomes compared to conventional laparoscopic surgery. Therefore, we would like to share our successful experience to draw more attention to single port procedures to manage benign adnexal masses.

It is fundamental to maintain triangulation during SPLS procedures to avoid excessive instrument clashing and provide sufficient surgical field exposure. However, it is challenging because all of the laparoscopic working ports are placed through the same incision. In our experience, we used a 10-mm, 30-cm endoscope with a 30° angle to provide a wider range of vision and avoid collisions between surgical instruments compared with 0° endoscopes. We further used small trocars and prebent laparoscopic instruments to avoid collisions between instruments and to provide a wider range of motion. In spite of the above challenges, adnexal surgery is relatively simpler than other gynecological procedures. Therefore, we believe these aforementioned difficulties can be overcome with accumulated experience.

There are numerous advantages of SPLS for the treatment of adnexal masses. First, a single incision at the umbilicus might offer superior cosmetic outcomes by taking advantage of the concealing location of the umbilicus to hide the scar. Second, it was easier to extract the specimen through a larger umbilical incision expanded by the SPLS wound retractor compared to the conventional 5-mm or 11-mm trocar incisions. Third, by eliminating the trocars inserted in the bilateral lower quadrant the risks of complications including injury to the inferior epigastric vessels, subcutaneous hematoma as well as postoperative wound infection might be reduced. Fourth, SPLS might be associated with less postoperative pain and the reduction of narcotic use due to fewer trocars being inserted. Controversially, a larger umbilical incision may also cause a greater amount of postoperative pain. Kim et al. demonstrated less postoperative pain score in the SPLS group for hysterectomy than that of the conventional group with comparable surgical outcomes. Nevertheless, studies that compare levels of postoperative pain between the two groups are warranted.

However, SPLS procedures do have several disadvantages. One is limited instrument movement and possible consequent hand and instrument collisions. Others include the costs of certain instruments, increased risk of complications including a hernia and possible increased postoperative pain associated with the larger size of the incision. However, the risk of a hernia does not appear to increase with the SPLS approach when the fascia is closed in a running, mass closure fashion. There were foreign researches reported that additional SPLS instruments would raise surgical costs. However, the SPLS ports we used were domestic products which hardly increased the surgical costs. Cost-effectiveness analysis would be deliberated in our future study.

Still, the generalizability of SPLS technique requires additional effort and time to learn the operative skills. Escobar et al. have demonstrated a remarkable decrease in operative time after 10–15 SPLS were performed. According to our experience, proficiency in the learning curve was reached after about 12 cases. Moreover, the operative time shortened gradually. As our surgeon is very experienced and has performed laparoscopic surgeries for more than 20 years, adopting SPLS technique for her was not as much of a challenge compared to junior physicians. Thus, we did not expect a significantly prolonged operation time in the SPLS group. As a matter of fact, the operative time shortened as more cases were performed, compared to the control group, in which the operative time remained steady. In addition, the operative time in SPLS might also be shortened due to the easier extraction of the specimen as we mentioned earlier. Therefore, the aforementioned aspects might contribute to the shortening of the learning curve. As surgeons gain experience, the difference between the two groups regarding necessary operation time becomes insignificant.

Although we have concluded that SPLS approach has comparable surgical outcomes compared to conventional laparoscopic surgery regarding treating benign adnexal masses, as the operation type gets more complicated, SPLS approach might be confined by its complex technical challenge. Therefore, despite that SPLS technique might have several advantages, it cannot replace conventional laparoscopic approach in complex cases.

SPLS is an innovative approach that is rapidly gaining recognition around the world. Studies that evaluate the feasibility and safety of SPLS for adnexal masses are not

### Table 3: Comparison of operative outcomes of the single port laparoscopic surgery group and the conventional group

| Operative outcomes | SPLS (n = 99) | Conventional (n = 104) | U | P  |
|--------------------|--------------|-----------------------|---|----|
| Operation time (min) | 51 (22, 148) | 52 (18, 153) | -0.115 | 0.909 |
| EBL (ml) | 5 (0, 30) | 10 (0, 100) | -4.552 | <0.001 |
| Change in hemoglobin (g/L) | 10 (–2, 38) | 10 (–16, 38) | -0.259 | 0.795 |
| POD (days) | 3 (1, 12) | 3 (1, 8) | 1.380 | 0.168 |
| Anal exsufflation time (h) | 10 (5, 48) | 22 (5, 85) | -7.127 | <0.001 |

Data are shown as median (min, max). SPLS: Single port laparoscopic surgery; EBL: Estimated blood loss; POD: Postoperative duration of hospital stay.
adequate. Most of the previous studies have been limited to retrospective data and small samples of patients. In spite of the limitations of the study, including a retrospective data comparison with inevitable case selection bias and lack of postoperative pain score measurement and long-term follow-up, we have concluded that SPLS is a safe and feasible approach to treat benign adnexal masses. Prospective studies with postoperative pain score measurement and long-term follow-up are needed to further assess the potential benefits and defects of SPLS.

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Conflicts of interest
There are no conflicts of interest.

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