

# Comparison of Laparoscopic Single-Incision Surgery with Hangt-Port Approach and Multiport Approach for Ovary Mature Cystic Teratoma

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## Research Article

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# Abstract

## Objective

To compare the safety and clinical outcomes of transumbilical laparoscopic single-incision Hangt-port approach with multiport approach surgery for mature cystic teratoma of ovary.

## Methods

A total of 94 patients with unilateral ovarian maturity cystic teratoma underwent cystectomy in our hospital from February 2018 to December 2019 were retrospectively analysed. All the patients were treated with single incision surgery by Hangt-port approach (n = 45) and multiport approach (n = 49). Baseline characteristics were presented, and perioperative outcomes were followed-up and compared. Primary outcome measures were incision related complications.

## Results

Baseline characteristics were comparable within the groups. During 1 year follow-up, the incidence of incision related complications of Hangt-port approach were more than that in the multiport group ( 8/45 v.s.1/49, P = 0.013). A total of 2 cases suffered postoperative umbilical hernia and 7 case was delayed incision wound healing. Compared with multiport group, post-operative VAS scores during 12 hours were significantly increased in Hangt-port group ( $3.62 \pm 0.91$  v.s.  $2.92 \pm 1.13$ , P = 0.001). Also, the Hangt-port group had significantly shorter operative time for patients with cyst size > 6cm ( $77.77 \pm 16.31$  v.s.  $92.33 \pm 25.65$ , P = 0.031), while showed significantly prolonged post-operative hospital stay for patients with cyst size  $\leq$  6cm ( $4.13 \pm 1.01$  v.s.  $3.32 \pm 0.82$ , P = 0.003).

## Conclusions

Both multiport and Hangt-port approach were safe in laparoscopic single incision surgery. Hangt-port approach was likely to be recommended for patients with cyst size > 6 cm, but incision-related follow-up complications should be concerned.while this finding still need to be explored by further large-scale study.

## Introduction

In recent years, with great progress in minimally invasive surgery, laparoscopic single-incision surgery has been developed rapidly and praised broadly in clinical practice. Especially in the gynecological field targeting young female patients, single-incision surgery was more and more popular due to its hidden incision and good cosmetic effect. At present, the most widely used single-incision surgery was through transumbilical laparoscopic single incision approach. The transumbilical incision for single-incision approach included single skin incision in combination with multiple fascial incisions <sup>(1)</sup>.

Currently, there were two commonly used approaches for single-incision surgery named multiport approach and newly developed Hangt-port (Beijing HangTian KaDi Technology R&D Institute)<sup>™</sup> approach. Considering different incision methods for umbilical region, this study was aimed to the safety and clinical outcomes of transumbilical laparoscopic single-incision Hangt-port approach with multiport approach surgery for mature cystic teratoma of ovary.

## **Materials And Methods**

### **Patients**

We retrospectively collected the patients visited Chengdu Women's and Children's Central Hospital with diagnosis of unilateral ovarian maturity cystic teratoma from February 2018 to December 2019. All patients adopted elective surgery with preoperative primary diagnosis of unilateral ovarian teratoma by transvaginal color doppler ultrasonography and/or pelvic CT examination. For patients with tumor marker test at normal level was commonly not submitted for intraoperative frozen section, while the other patients with suspected malignant tumor during operative observation would further waiting for intraoperative frozen section. Besides, emergency patients, elder patients (> 60 years old) and patients suffered with other severe systematic disorders were excluded. Patients with bilateral ovarian cyst and pathologicay confirmed malignant tumor were also excluded. Finally, there were 94 patients underwent ovarian cystectomy by laparoscopic single-incision surgery between February 2018 and December 2019. According to different incision approaches, the patients were divided into newly developed Hangt-port group (n = 45) and conventional multiport group (n = 49). All the baseline characteristics of the patients were recorded and presented to ensure the comparability of the two group.

### **Outcome Measurements**

Primary outcome measurement was defined as incision-related complications, which mainly included postoperative umbilical hernia and delayed incision wound healing. All the patients were followed up by 1 year. Both of the diagnosis of the incision-related complications can be easily completed after necessary physical examination. Secondary outcome measurements included postoperative pain scores during 12 hours and 24 hours, and the pain scores were judged by visual analogue scale (VAS) method. And other clinical outcome measurements included operation time, postoperative hemoglobin change, postoperative hospital stay and postoperative anal exhaust time.

### **Surgeons**

The operations were performed by four different gynecologists in a same treatment group. All of them were experts with experience of more than 50 cases of single-incision surgery, and work in the hospital more than 5 years.

### **Hangt-port approach**

*(1) Approach:* The left and right side sutures of umbilical region were lifted for exposure. upper and lower longitudinal incision for the umbilical region was made to accommodate about 2 fingers (about 4cm after the folds at the umbilical region were opened), the umbilical centrum tendineum was opened, the fat, fascia and peritoneum were cut for access to the abdominal cavity, where the Hangt-Port was placed. After the operation, the Endo-Pouch was placed into the abdominal cavity. The specimen could be easily removed from the large incision. *(2) Suture:* the peritoneum was clamped with Allis clamp for continuous absorbable suture of peritoneum and fascia layer. The center of umbilical wheel was sutured and the umbilical depression was formed. Interrupted suture was adopted for the subcutaneous tissues at the upper and lower margins of hilar depression, and continuous suture for intradermal tissue. Detailed information can be find in Fig. 1.

## Multiport approach

*(1) Approach:* A longitudinal incision about 2.0cm above one side of the umbilical region (not opened at the center), with a 10mm trocar at the fascia and two 5mm trocars at the left and right sides respectively. After the operation, the Endo-Pouch was placed from 10mm trocar. *(2) Collection of Endo-Pouch and suture of incision:* the inserted Endo-Pouch was closed with thread, which was drawn out from 10mm trocar. After sampling, tighten the mouth of Endo-Pouch, and take out the 10mm trocar and Endo-Pouch mouth. The specimen was routinely removed in pieces with Endo-Pouch taken out. *(3) Suture:* the fascia was nipped by Allis clamp (whether the peritoneum would be sutured or not dependent on the exposure, if the peritoneum was difficult to expose, it would not be sutured, or it would be sutured). The fascia layer of three incisions could be sutured in the shape of 8 with absorbable suture. Interrupted suture was adopted for the subcutaneous tissue, and continuous suture for intradermal tissue. Detailed information can be find in Fig. 2.

## Postoperative Management

All the patients were encouraged to be early ambulation. And all the other recommendations based on enhanced recovery after surgery were fully followed. Liquid infusion was gradually reduced when the patients recovery to normal feed.

## Statistical analysis

SPSS 24.0 statistical software was used for statistical analysis. Considering the influence of important factor, subgroup analysis according to cyst size was performed for the analysis of other clinical outcomes. The Fisher exact test or  $\chi^2$  test was used for the comparison of dichotomous variable, and T-test was used to compare the difference of continuous variable between the group. The difference was defined as statistically significant when  $P < 0.05$ .

## Results

## Baseline characteristics

A total of 94 patients were retrospectively analyzed in the study. The baseline characteristics of the patients in Hangt-port group (n = 45) and multiport group (n = 49) were presented in Table 1. The average age in the two groups was comparable ( $30.24 \pm 8.80$  v.s.  $29.39 \pm 7.64$ ,  $P > 0.05$ ). The average body mass index (BMI) was without significant difference ( $20.67 \pm 2.87$  v.s.  $21.72 \pm 3.65$ ,  $P > 0.05$ ), while the percentage of overweight patients was higher in the Hangt-port group than that in the multiport group ( $10/45$  v.s.  $2/49$ ,  $P = 0.008$ ). Also, we collected the data of preoperatively reported cyst size and previously operative history as clinically important factors. The average cyst size was  $6.63 \pm 2.38$  cm and  $6.00 \pm 3.1$  cm ( $P > 0.05$ ), and 22 (48.89%) and 21 (42.86%) of them were  $> 6$  cm ( $P > 0.05$ ), in the Hangt-port group and in the multiport group, respectively. Besides, 35 (77.8%) of them and 37 (75.5%) of them in each group did not receive any other surgery. In the Hangt-port group, there were 6 patients who received cesarean section, 1 patient received twice cesarean section, 2 patients received appendectomy and 1 patient received laparoscopic adnexal surgery. In the multiport group, there were 7 patients who received cesarean section, 1 patient received twice cesarean section, 3 patients received appendectomy and 1 patient received laparoscopic cholecystectomy. (Table 1)

Table 1  
Baseline characteristics between Hangt-port and multiport approach

	Hangt-port group (n = 45)	Multiport group (n = 49)	P
Age (years)	30.24 ± 8.80	29.39 ± 7.64	0.615
BMI (kg/m <sup>2</sup> )	20.67 ± 2.87	21.72 ± 3.65	0.128
Overweight	10(22.2%)	2(4.1%)	0.008
Obese	0	1(2.0%)	N/A
T2DM (%)	2(4.4%)	1(2.0%)	0.94
Cyst size (cm)	6.63 ± 2.38	6.00 ± 3.1	0.272
>6 cm	22(48.89%)	21(42.86%)	0.558
≤6 cm	23(51.11%)	28(57.14%)	
Previously operative history	35(77.8%)	37(75.5%)	0.795
None	6(13.3%)	7(14.2%)	0.894
Cesarian section once	1(2.2%)	1(2.0%)	0.949
Cesarian section twice	2(4.4%)	3(6.1%)	0.717
Appendectomy	0	1(2.0%)	0.335
CMPL cholecystectomy	1(2.2%)	0	0.294
CMPL adnexal surgery			
Continous data was presented as mean and standard deviation.			
BMI, body mass index. CMPL, conventional multiport laparoscopy			
Overweight BMI 25-29.9			
Obese BM ≥30			
T2DM: Type 2 diabetes			

## Incision-related Complications

All the patients were followed up during postoperative 1 year for the status of the incision, as shown in Table 2. There were 8 cases and 1 cases of incision-related complications, and the difference was statistically significant (P = 0.013). 2 cases of patients were diagnosed as umbilical hernia in the Hangt-port group. One case was 38 years old, with a BMI of 29.1 kg/m<sup>2</sup> and also complicated with T2DM. The incidence of hernia was reported in postoperative 3 months with aggravated clinical symptoms, and required surgery repairment was in postoperative 4 months. The other case was 45 years old, with a BMI

of 26.7 kg/m<sup>2</sup>, reported in postoperative 1 months, and refused surgery repairment because of very mild symptom. Besides, 6 case in the Hangt-port group and 1 case in the multiport group were reported to be with delayed wound healing ( $P > 0.05$ ), and all of them recovered by locally simple wound care. No significant infection, redness and induration were reported.

Table 2  
Comparison of incision-related complications and pain scores between Hangt-port and multiport approach

	Hangt-port group (n = 45)	Multiport group (n = 49)	P
Incision-related follow-up complications			
Umbilical hernia	2(4.4%)	0	0.226
Umbilical hernia required surgery	1(2.2%)	0	0.479
Delayed wound healing	6(13.3%)	1(2.0%)	0.052
Overall incidence	8(17.8%)	1(2.0%)	0.013
Incision-related postoperative pain	2.76 ± 0.67	2.28 ± 0.83	0.003
Postoperative 12h VAS	3.62 ± 0.91	2.92 ± 1.13	0.001
Postoperative 24h VAS	1.89 ± 0.91	1.63 ± 0.76	0.14
Continuous data was presented as mean and standard deviation.			
VAS, visual analogue scale.			

## Postoperative Pain Scores

Postoperative pain score in 12 and 24 hours were judged separately (Table 2). There was statistically significant difference in the score of 12 hours, patients in Hangt-port group reported average higher VAS scores than that in the multiport group ( $3.62 \pm 0.91$  v.s.  $2.92 \pm 1.13$ ,  $P = 0.001$ ). While, the VAS scores in 24 hours were relieved in both groups, and without significant difference ( $1.89 \pm 0.91$  v.s.  $1.63 \pm 0.76$ ,  $P > 0.05$ ).

## Other Clinical Outcome Measurements

The average operative time ( $77.49 \pm 20.66$  v.s.  $79.73 \pm 25.35$ ,  $P > 0.05$ ) and postoperative hemoglobin change changes ( $11.29 \pm 6.79$  v.s.  $9.71 \pm 9.25$ ,  $P > 0.05$ ) was found to be comparable between Hangt-port and multiport group. For postoperative outcomes, the hospital stay ( $3.71 \pm 0.59$  v.s.  $3.49 \pm 0.96$ ,  $P > 0.05$ ) and anal exhaust time ( $36.64 \pm 13.55$  v.s.  $35.63 \pm 11.70$ ,  $P > 0.05$ ) after surgery was also similar without significant difference.

Subgroup analysis was performed according to the cyst size.(Table 3) When the patients were divided into cyst size > 6cm and ≤ 6cm. For patients with cyst size > 6cm, the Hangt-port group had significantly shorter operative time than the multiport group (77.77 ± 16.13 v.s. 92.33 ± 25.65, P = 0.031). While, for patients with cyst size ≤ 6cm, the Hangt-port group showed significantly prolonged post-operative hospital stay than the multiport group (4.13 ± 1.01 v.s. 3.32 ± 0.82, P = 0.003). Postoperative hemoglobin change and post-operative anal exhaust time were not statistically difference across all the subgroups.

Table 3  
Comparison of other clinical outcomes between Hangt-port and multiport approach according to cyst size

	Hangt-port group	Multiport group	P
Operative time ( min)	77.49 ± 20.66	79.73 ± 25.35	0.641
>6 cm (n = 22/21)	77.77 ± 16.31	92.33 ± 25.65	0.031
≤6 cm (n = 23/28)	77.22 ± 24.50	70.29 ± 20.95	0.281
Hb changes (g/l)	11.29 ± 6.79	9.71 ± 9.25	0.353
>6 cm (n = 22/21)	12.64 ± 7.37	9.90 ± 9.07	0.284
≤6 cm (n = 23/28)	10.00 ± 6.07	9.57 ± 9.54	0.853
Post-operative hospital stay, (d)	3.71 ± 0.59	3.49 ± 0.96	0.186
>6 cm (n = 22/21)	3.86 ± 0.77	3.71 ± 1.10	0.608
≤6 cm (n = 23/28)	4.13 ± 1.01	3.32 ± 0.82	0.003
Postoperative anal exhaust time, (h)	36.64 ± 13.55	35.63 ± 11.70	0.699
>6 cm (n = 22/21)	36.09 ± 15.16	36.38 ± 10.40	0.942
≤6 cm (n = 23/28)	37.17 ± 12.13	35.07 ± 12.75	0.552
Continous data was presented as mean and standard deviation.			

## Other Operation Related Complicaitons

None of them switched to laparotomy. Any other operation related complications such as perforation and organ injury was not occurred.

## Discussion

Up to now, for gynecological surgery, single-incision surgery has well developed after large incision, small incision and multiple small incisions. Mature cystic teratoma of the ovary is one of the most common benign tumors among women. As the umbilical region is a natural scar of human congenital residual, laparoscopic single-incision surgery is performed simply through this natural scar, with less postoperative

pain, faster recovery, and better cosmetic effect as compared with traditional laparotomy and the laparoscopic surgery.

In this study, the operations were completed successfully without switching to laparotomy, and without serious intraoperative and postoperative incision and operation related complications. For both Hangt-port and multiport group, postoperative umbilical hernia has always been the focus of all kinds of laparoscopic single-site surgery (LESS). In this study, there was a case of delayed umbilical hernia undergoing repair: rectus sheath ruptured, with continuous peritoneum, protruding into hernia sac, most of which occurred within 12 months after surgery<sup>(2, 3)</sup>. The incidence rate of umbilical hernia was also related to the follow-up duration, and most of umbilical hernia occurred within one year. The main differences between LESS approaches include the incision mode and size at the umbilical region. Whether to open the umbilical centrum tendineum or not is important for incision suture and the healing. Postoperative umbilical hernia is one of the main long-term complications. In a study of 109 patients for surgery (using SILS™ Port or TriPort™), the incidence rate of incisional hernia for average 38 months of follow-up was 5.5%, in which 67% was confirmed in the first year of follow-up<sup>(4)</sup>. Another laparoscopic single-site surgery (LESS) study of 211 patients, 113 cases were conducted by PORT, reported 4 umbilical hernia within 30–36 months of follow-up<sup>(5)</sup>. According to a report of single-site laparoscopic cholecystectomy, the incidence rate of postoperative incisional hernia was 5.8%<sup>(6)</sup>, which was at a high level. Because in multiport surgery, the umbilical centrum tendineum was not opened, the fascia damage of the surgery was almost the same as that of traditional laparoscopic umbilical incision. In a report of 5541 patients who underwent traditional laparoscopic surgery, the incidence rate of incisional hernia during a 43-month follow-up was 0.41%<sup>(7)</sup>. According to the statistics of American Association of Gynecologic Laparoscopists, the incidence rate of incisional hernia was 0.021% among 4385,000 patients who were performed laparoscopic surgery<sup>(8)</sup>, which was significantly lower than that for LESS. Most physicians especially emphasized that good closure of fascia layer was beneficial to incisional hernia incidence reduction<sup>(9)</sup>. For transumbilical laparoscopic single incision multiport surgery, the Hangt-port was not used, and the umbilical centrum tendineum was not opened, and so through suturing a single skin incision on one side of the navel, the fascia might be closed better<sup>(10, 11)</sup>, and the risk of umbilical hernia or umbilical hernia during pregnancy might be lower in the future. In addition, the use of non-absorbent and delayed absorbent materials was also one of the effective suture methods. Although the incidence of delayed wound healing in the Hangt-port group was higher than that in the multiport group, the difference was not reached statistically significance. This might be caused by that parts of patients with higher BMI located in the Hangt-port group, and the risk of incisional hernia and incisional infection in overweight patients, obese and diabetic patients would be higher. The skin incision was hidden in the folds of the umbilical cord and so there was little difference in appearance between the two groups. By clinical observation, most patients were not serious, and recovered after simple dressing change. It may be related to less exposure and poor involution, and we advised to strengthen the observation and nursing, and fill a small gauze block in the hilar depression to keep the incision dry, so as

to promote the healing. Strengthening preoperative notification and postoperative complication control were also effective for relevant improvement<sup>(12)</sup>.

There was no statistically significant difference between the two groups in operation time, postoperative hemoglobin change, postoperative hospitalization time, postoperative anal exhaust time. However, further subgroup analysis by distinguishing important clinical factor including VAS measuring timing, cyst size and previously operative history. The most important finding was that for patients with cyst size > 6cm, the Hangt-port group had significantly shorten the operative time than the multiport group. The possible explanations were: ①. The abdomen-entering and abdomen-closing time of the multiport group was smaller than that of the Hangt-port group; ②. Because of the small incision in multiport group, the sample taking time was longer than that in Hangt-port group, which offset the advantage of short abdomenentering and closing time; ③. Some teratomas contain solid components such as hair and cephalic nodes, especially for larger teratomas. The specimen time of multiport is long, while that of Hangt-port is short. Meanwhile, in clinical practice, we also found other potential advantage of Hangt-port approach: ④. The tumor tissues can be completely removed to the maximum extent, and the tumor tissues are not easy to be broken in the abdominal cavity, which is conducive to the principle of tumor-free and pathological examination; ⑤. For myomectomy, subtotal hysterectomy and other operations not suitable for the use of crushing device, Hangt-port approach has an absolute advantage in the removal of tissue; ⑥. Because hangt-port approach is a general surgical approach to the abdomen, compared with the blind puncture of the first trocar in the laparoscopy, it is not suitable to damage the abdominal organs. However, the results on the other hand revealed that patients in the Hangt-port group showed significantly higher VAS scores in 12 hours and delayed postoperative hospital stay in patients with cyst size less than 6 cm than in the multiport group. This would be simply related to the size of the umbilical region incision that the size of the fascial incision in the multiport group was about 1 cm, while in the Hangt-port group was about 4 cm.

## Limitation

There are also difficulties and limitations for multiport, especially in mutual interference of devices. All of the devices for laparoscopic operation enter the abdominal cavity through the umbilical region, which violates the principle of triangular distribution for puncture devices, and so causes a unique "chopstick effect" in single-incision surgery<sup>(13)</sup>, and makes the operation difficult for the surgeons. In addition, the surgeons for Hangt-port operation have a small space for motion in the Hangt-port, and for multiport operation, the fascial layer among the three Trocars is not cut, the surgeons' left and right hands are fixed, which can effectively prevent air leakage<sup>(14)</sup>, but the operation is greatly limited for the chopsticks effect, which increases the difficulty of operation. Besides, the incision size would significantly influence the difficulty to remove hysteromyoma larger than 3 cm and perform subtotal hysterectomy<sup>(15)</sup>. Also, the experience of surgeons could not be ensured to be same, and also the suture procedure may be sometimes not completely done by the experts. At last, cost analysis was always essential for clinical

application. The price of Hangt-port is only for single use, and its financial cost is relative higher than repeated multiport.

Otherwise, benign gynecological ovarian tumors were mostly found in the population of childbearing age, but presently, there is still no report concerning umbilical conditions during and after pregnancy after transumbilical laparoscopic single-incision surgery. With the development of pregnancy, the depressed umbilical region may gradually become shallow as being expanded and stretched, and the center of umbilical region may become weak with great tension. During pregnancy after Hangt-port surgery, whether the umbilical scar can withstand the huge tension or not and whether the probability of pregnancy complicated with umbilical hernia may be increased or not are still to be studied. A systematic evaluation and meta-analysis on ventral hernia recurrence among women of child-bearing age indicated that the combined recurrence rate of ventral hernia among women of child-bearing age was 12%, and pregnancy might be considered as a risk factor for ventral hernia recurrence<sup>(16)</sup>. In this study, among all the patients who underwent laparoscopic single-incision surgery, the postoperative follow-up was 1 year, and there were 5 cases of pregnancy 1 to 6 months after surgery (4 cases after multiport surgery, and 1 case after Hangt-port surgery), 3 cases of full-term delivery, and 2 cases in pregnancy, 15–25 weeks of gestation as of the date for preparing this paper. At present, there is still no pregnancy complicated with umbilical hernia. As the time is short and the sample size is small, there is still no basis for conclusion, and further observation is needed. In particular, gynecologists should pay more attention to the follow-up for umbilical conditions during pregnancy after Hangt-port.

## Conclusion

Both multiport and Hangt-port approach were safe in laparoscopic single incision surgery. Hangt-port approach was likely to be recommended for patients with cyst size > 6 cm, but incision-related follow-up complications should be concerned.while this finding still need to be explored by further large-scale study.

## List Of Abbreviations

Hangt-port

Beijing HangTian KaDi Technology R&D Institute™

VAS

visual analogue scale

BMI

body mass index

T2DM

Type 2 diabetes

LESS

laparoscopic single-site surgery

## Declarations

## **Ethics approval and consent to participate**

I confirm that all methods were carried out in accordance with relevant guidelines and regulations.

The study was a retrospective study that did no harm to participants and was reviewed and approved by the hospital ethics committee, see [the Ethics Committee of Hospital.PDF](#)

## **Consent for publication**

Not applicable

## **Availability of data and materials**

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

## **Competing interests**

The authors declare that they have no competing interests

## **Funding**

None

## **Authors' contributions**

DG and LH were responsible for design, data analysis and interpretation

DG, LH and XW were responsible for administrative support, provision of study patients, collection and assembly of data, manuscript writing

All authors read and approved the final manuscript

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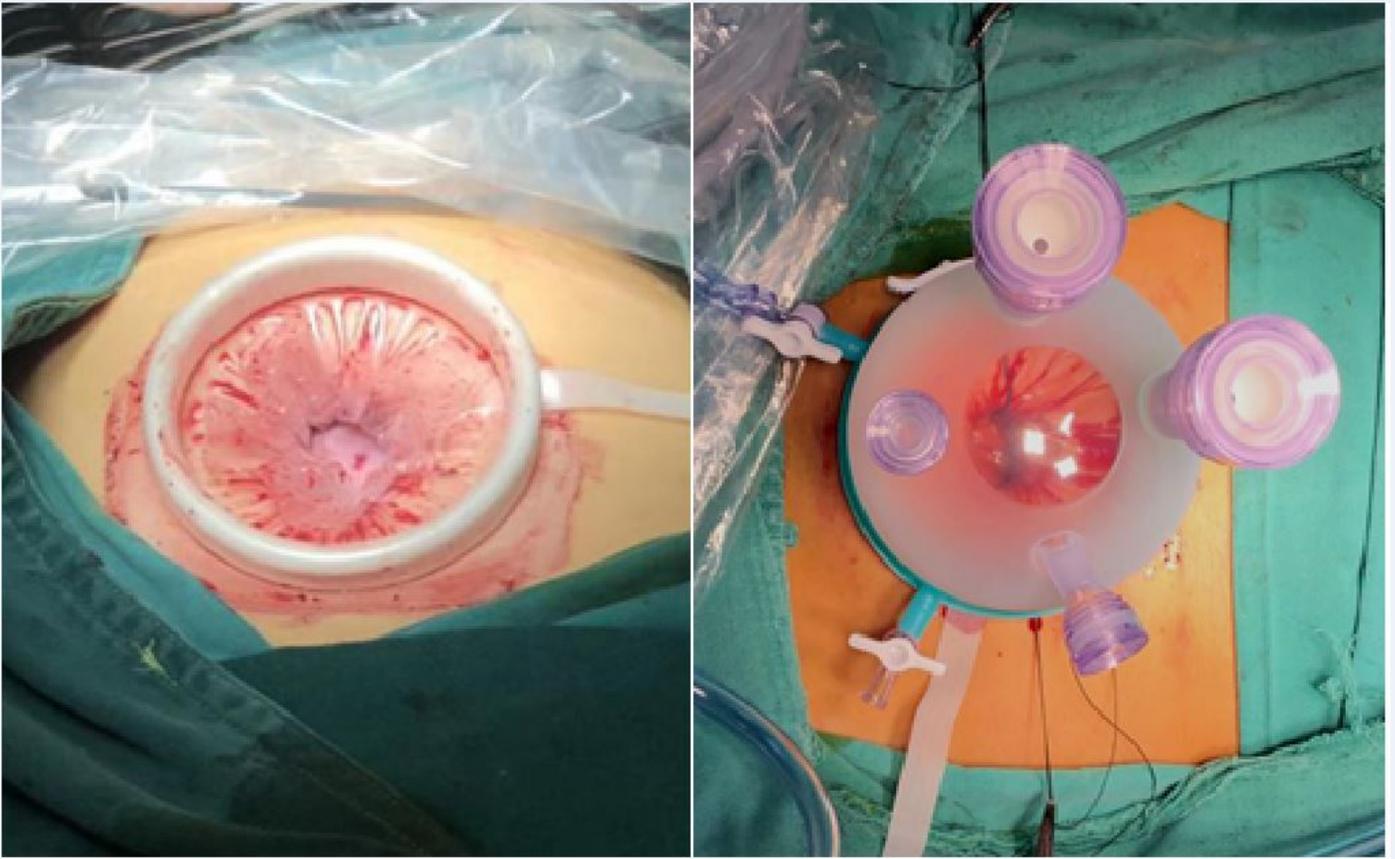
Not applicable

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## Figures



**Figure 1**

The procedure of Hangt-port approach for surgery.



**Figure 2**

The procedure of Multiport approach for surgery and homemade specimen bag.