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***Clinical Trials Study***

**Robotic gastrectomy with trans-vaginal specimen extraction for female gastric cancer patients**

Zhang S *et al*. Robotic gastrectomy with trans-vaginal specimen extraction

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**Author contributions:** Zhang S and Jiang ZW contributed equally to this work; Jiang ZW and Li JS designed research; Wang G, Feng XB and Liu J performed in data collection; Wang G, Feng XB and Zhao K analyzed data; and Zhang S wrote the paper.

**Institutional review board statement:** This clinical study is approved by the Ethic Committee of Jinling Hospital, Nanjing University.

**Informed consent statement:** All patients involved in this study gave their written informed consent authorizing use and disclosure of their protected health information.

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**Abstract**

**AIM:** To describe the application of complete robotic gastrectomy with trans-vaginal specimen extraction (TVSE) for gastric cancer patients.

**Methods:** Between July and Nov 2014, eight patients who were diagnosed with gastric adenocarcinoma underwent a TVSE following a full robot-sew gastrectomy. According the tumor location, the patients are allocated in different two groups, two patients received Robotic Total Gastrectomy with TVSE and the other six received Robotic Distal Gastrectomy with TVSE.

**Results:** All eight cases were successfully performed without conversion. The mean age was 55.3 (range, 42–69) years with the mean body mass index of 23.2 (range, 21.6–26.0) kg/m2. The mean total operative time, and blood loss were 224 (range, 200–298) min, and 62.5 (range, 50–150) ml, respectively. The mean post-operative hospital stay was 3.6 (range, 3-5) d. The mean lymph nodes resected was 23.6 (range, 17-27). None was readmitted within 30 d of post-operation. During the follow-up, no stricture was developed nor was any anastomotic leakage detected.

**Conclusion:** It is possible to perform a TVSE following a full robot-sew gastrectomy with Standard D2 Lymph nodes resection for gastric cancer patients.

**Key words:** Gastric cancer; Robotic surgery; Trans-vaginal; Natural orifice specimen extraction

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**Core tip:** It is widely recognized that the natural orifice specimen extraction (NOSE) could reduce postoperative pain, length of stay, and morbidity. Although NOSE has been performed in different institutions, there has not been any report of trans-vagina specimen extraction following full robot-sew gastrectomy for gastric cancer. This study describes the new application of complete robotic gastrectomy with trans-vaginal specimen extraction in eight patients with gastric cancer in Jinling Hospital. There were two different Surgeries performed, the Robotic total gastrectomy and robotic distal gastrectomy.

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**INTRODUCTION**

Gastric cancer is one of the top ranking and most prevalent cancer in the China[1]. Nearly a million new cases are diagnosed each year in the world, and it is the fourth most common type of cancer and the second leading cause of death worldwide[2]. For generations, surgeons have been contriving new surgical methods for the inner organs especially the stomach. These methods include: open gastrectomy, laparoscopic gastrectomy, robotic gastrectomy, and natural orifice specimen extraction (NOSE)[3,4].

It is widely recognized that the NOSE could reduce postoperative pain, length of stay, and morbidity. Although NOSE has been performed in a lot of institute, there has not been any report of trans-vagina specimen extraction following full robot-sew gastrectomy for gastric cancer. This article aims to report Robotic Gastrectomy following a trans-vaginal specimen extraction (TVSE) in eight patients with gastric cancer in Jinling Hospital. There were two different Surgeries performed, the Robotic total gastrectomy (RTG) and Robotic Distal Gastrectomy (RDG).

**MATERIALS AND METHODS**

***Patients***

Eight female patients with gastric cancer enrolled in this study between July and Nov 2014. All patients were newly diagnosed with gastric cancer pathologically. The study was approved by the Research Ethics Committee of Nanjing University. All eight Specimen extraction case series following full robot-sew gastrectomy were performed in Jinling Hospital. Patients with tumor that is too large or too difficult to resect were excluded in this study. Only multipara with no other underlying diseases was enrolled. Other organ (lung or renal) dysfunction, and abnormal clinic test results were not considered in this study. Patients, who had taken chemotherapy or radiotherapy preoperation, were also excluded. According the tumor location, the patients are primarily allocated in different two groups, two patients received Robotic Total Gastrectomy (RTG) with TVSE and the other six received Robotic Distal Gastrectomy (RDG) with TVSE.

***Surgical techniques***

All eight robotic gastrectomies were carried out by the same surgeon (Jiang, ZW) with full intracorporeal robot-sew anastomosis produces[5]. The surgical procedure was carried out in four stages: (1) six of these patients were under robotic distal gastrectomy following Billroth Ⅱ reconstruction, and two were under robotic total gastrectomy following a Roux-en-Y reconstruction; (2) all the eight patients went through a standard D2 lymph node dissection (Distal Gastrectomy: 1, 3, 4Sb, 4d, 5, 6, 7, 8a, 9, 11p, 12a; Total Gastrectomy: 1, 2, 3, 4Sa, 4Sb, 4d, 5, 6, 7, 8a, 9, 10, 11, 12a )[6]; (3) partial omentectomy might be conducted if necessary; and (4) the TVSE and suture of wound was conducted.

***Positioning and settlement of robotic arms***

After general anesthesia, a 12-mm trocar was inserted into the abdomen through the sub-umbilical area, and a pneumoperitoneum was formed by insufflations of carbon dioxide. The intraperitoneal pressure was maintained at 11-13 mmHg. With Patient placed in reverse Trendelenburg position, distribution of trocars was as follows: A 12-mm camera port, three 8-mm robotic working ports, and 1 additional (12 mm) on-table assistant port were placed; (1, 2, 3, 4, 5; Figure 1). During the procedure, one ultrasonic scalpel, two Cadiere forceps, and one Mega needle driver were used.

***Surgical procedure***

The Da Vinci Robotic System was installed with its arms settled in position. Afterwards, the operator first inspected the abdominal cavity for any sign of tumor seeding or metastasis. The greater curvature of the stomach was mobilized by the ultrasonic scalpel. The gastrocolic ligament was cut with the ascending colon lifted by robotic arms. The left gastroepiploic artery was divided at its root after clipping. The dissection then proceeded towards the right gastroepiploic vessels as well as the left gastroepiploic vessels were ligated. The 4th set of lymph nodes along the greater curve of stomach were dissected with the 6th set of the infra pyloric lymph nodes. Then the right gastric artery was dissected, clipped, cut and ligated. And the 12a lymph nodes were resected with the 5th set of suprapyloric lymph node. The duodenal stump was mobilized using an endo-GIA 60 (Covidien, Mansfield, MA, United States) to allow clipping at the root of the left gastric Vessel. And the 7th lymph nodes were harvested. The 11p set of lymph nodes near the splenic artery were also resected with the 9th set of celiac trunk lymph nodes, and then, the 8th set of lymph nodes along the common hepatic artery. The 1st and 3rd set of perigastric lymph nodes along the lesser curvature were dissected up to the site of the right infra cardium and the lesser omentum. The proximal stomach was divided using an endo-GIA 60 (Covidien, Mansfield, MA, United States). A retrieval bag was introduced through the transabdominal trocar, and the specimen was transferred into it. The retrieval bag was then transferred into the pelvic cavity for trans-vaginal extraction (See Figure 2).

***Reconstruction***

According to the location of tumor, reconstructions were performed differently. Six patients who undergo RDG received a BillrothⅡ reconstruction while the other two patients undergo RTG received a Roux-en-Y reconstruction.

***TVSE***

The trocars were reallocated; the holes trocar, (1, 2; Figure 1) left on the costal arch were sutured in case of air leakage. Additional trocar (6.7; Figure 1) was inserted. After the intraperitoneal pressure had been maintained back to 12 mmHg, the robotic arms were introduced into the abdominal cavity. By purse-string sutured, the uterus was lifted by a robotic arm. A 4-cm posterior colpotomy was performed with additional trans-vagina port inserted about 2 cm posterior to this junction. Like others, we use a two-layer retrieval bag to deposit the specimen[7-9]. Then the retrieval bag containing the specimen was gently withdrawn until it reached the intra-abdominal tip of the trans-vaginal port. The withdrawal of retrieval bag specimen was assisted by a tenaculum placed on the anterior lip of the cervix (3; Figure 2). After the removal of trans-vagina port, the posterior incisions were closed with an intra-vaginal 2-0 Vicryl (Ethicon A division of J and J Medical Limited, Livingston, United Kingdom) suture (4; Figure 2). Then over 1000 ml warm water was poured into the abdominal cavity through one of the trocar port to clean the cavity. It was carefully examined to ensure that no spot was left untreated. One drain was placed in the abdominal cavity through the ancillary port. Closure of the port incisions with subcuticular suture completed the operation.

**RESULTS**

Eight patients participated in the study. The mean age of the women was 55.3 (range, 42–69) years (See Table 1), and the mean body mass index (BMI) was 23.2 (range, 21.6–26.0) kg/m2. Histopathology confirmed poorly differentiated adenocarcinoma in all cases. The mean number of retrieved lymph nodes was 23.6 (range, 17-27). In case 1, 16 of 17 lymph nodes were found positive. Nevertheless, no metastatic lymph nodes were found in the other seven patients. Only the node-positive patients (case1) underwent six cycles of postoperative chemotherapy.

Because the length of the incision were adapted to the size of the specimen and the tumor, with all tumors under 4cm in diameter, the incision on the vagina is no larger than 4cm. The mean operating time was 224 (range, 200–298) min, and the average blood loss was 62.5 (range, 50–150) ml and none of them needed blood transfusion. No intraoperative complications were noticed in any of the eight patients during the follow up. The mean postoperative stay was 3.6 (range, 3-5) d. The first flatus of patient’s occurred on mean 28.5 (range, 24-33) h after surgery (See Table 1).

There are no anastomotic leakages reported both within the hospital stay and 30 days after discharge from the hospital. During the follow up, neither is there a sign of surgical site infection (SSI) nor lung infection (LI). No other complications were reported during the hospital stay. Thus, there is no one needed to re-admission in hospital. That is to say that both the mortality and morbidity was zero in 30 d (See Table 2). The average VAS of six patients in the TVSE-RDG group decrease from 2.8 in POD1 to 1.7 in POD2, and then 1.0 in POD3 while the average VAS of 2 patients in the TVSE-RTG group is 2, 1 and 1 on the POD1, POD2 and POD3 respectively. The trend of postoperative mobility is also related to the VAS score.

All eight patients showed great progress in postoperative activity; their steps increased greatly for TVSE-RDG group patients from 62 (range, 40-75) steps on POD1, to 336 (range, 116-465) on POD2, and then maybe with pain relief, the activity steps took a great leap to 1078 (range, 985-1200) steps on POD3, nearing a normal daily level. The statistics from TVSE-RTG group also show the same trend (See Table 2). There are 55 steps on POD1, 342 on POD2 and 1100 on POD3 in the TVSE-RTG group. The sleep time measured by Fitbit Flex indicates an improvement in POD2 to POD3 by 0.5 hour in the TVSE-RTG group and 1.1 h in the TVSE-RDG group.

During the perioperative course, both the SpO2 showed a slight fluctuation (See Table 3). The SpO2 decreased from preoperative 100% to 98.3% (range, 96%-99%) on POD1, and then 99.3% (range, 98%-100%) on POD3 in TVSE-RDG group while the SpO2 is 100, 98.5% (range, 98%-99%) and 99% (range, 98%-100%) on Pre-operation day, POD1 and POD3 respectively. Similarly, the Heart Rate (HR) also fluctuated from preoperative 66.2 (range, 58-69) to 77.5 (range, 62-102) on POD1, and then down back to 72.5 (range, 60-85) on POD3 in TVSE-RDG group. However, we noticed that the Grip Strength strangely increased in 7 of the 8 patients, causing the average strength to increase from 25.6/25 kg to 27.8/26.3 kg in the TVSE-RTG group and 23.3/21.7 kg to 25.6/24.5 kg in the TVSE-RDG group. We also measured the body mass with a body machine (Inbody 230, South Korea) The body machine detected nearly no change in the bone (10.3%-10.2%), body fat (30.5%-30.2%), water (47.9%-48.1%) and muscle (32.0%-31.4%),which also an indication for stability in keeping weight.

**DISCUSSION**

Thanks to the development of new technology and the enterprise of generations of surgeons in minimally invasive surgery. Innovations and progresses have evolved to another level in the field of NOSE surgery.

There are four potential routes, for example, trans-esophagus, trans-rectal, trans-vaginal, and trans-urethral. The robotic Surgery makes it possible for NOSE to become more and more feasible and thereby the optimal way of approaching gastric cancer.

Although NOSE is now relatively widely performed, it does not give any importance to gastric resection with specimen extraction through the trans-vaginal route for gastric cancer, especially robotic gastrectomy.

Trans-vaginal NOSE (TVSE) using a posterior colpotomy has extensively been reported during gynecologic procedures[10,11]. In 1993, Delvaux *et al*[12] performed the first trans-vaginal extraction. The gallbladder containing a stone was extracted through the trans-vaginal route following laparoscopic cholecystectomy in female patients. In 1996, Redwine *et al*[13] first described a segmental colectomy with trans-vaginal extraction for bowel endometriosis. Kim *et al*[14] in 1996 reported trans-vaginal extraction of the rectum in four patients following low anterior resection. In 2002, Gill *et al*[15] described vaginal extraction of the intact specimen following laparoscopic radical nephrectomy. And Ghezzi *et al*[10] reported 60 Vaginal extraction of pelvic masses following operative laparoscopy in the same year. In 2007, a Chinese Surgeon, Yuan *et al*[16] presented a 65-year-old female with invasive urothelial carcinoma of the urinary bladder and end-stage renal disease who underwent laparoscopic radical cystectomy combined with bilateral nephroureterectomy, where the specimen was extracted transvaginally. And, in 2008, Palanivelu *et al*[17] reported extraction of total colon and rectum following totally laparoscopic proctocolectomy. Also in 2008, a swine model for trans-vagina specimen extraction following total gastrectomy was successfully constructed by Nakajima, who later also succeeded in human the following year[18,19]. Despite the difficulty of trans-vagina laparoscopic/endoscopic gastrectomy described by Lacy *et al*[20] in 2009, Jeong *et al*[21] succeeded in repeating the laparoscopic trans-vaginal extraction of gastric cancer in 2011.

Nevertheless, there have not been previous reports of robotic trans-vaginal extraction following gastrectomy, nor any trans-vaginal NOSE following gastrectomy with standard D2 lymphnodes-resection for gastric cancer (Table 4). It was not until June 2014 that the first NOSE following gastrectomy was performed by Dostalik *et al*[22]. However the natural orifice specimen was extracted through the oral-esophageal route. Even when carefully washed with water, the bad smell of blood mixed with stomach contents could not be disserved within a couple of weeks. Damages to the esophageal wall during extraction occurred in our previous experience. Moreover, in the single port laparoscopic gastrectomy, the lymph nodes resection was not as easy as the robotic surgery or the open abdomen surgery, nor was the specimen extraction. Colpotomy is considered safe and does not lead to surgical site infections or dyspareunia[23,24]. Trans-vaginal NOSE using a posterior colpotomy is considered a mature procedure used in gynecology. Not only is the robotic gastrectomy valued in the surgical safety but also in oncological performance as it is a safe way to perform the Standard D2 Lymphnodes harvest in gastric cancer[25,26].

In 2013, we have succeeded in publishing an investigation on robotic procedure which provides us a safe and feasible approach to robotic gastrectomy[5]. This new procedure for gastrectomy is performed daily in our hospital with the anastomosis sewn fully by robot intracorporeally. This daily training provides us a possibility to perform the trans-vagina specimen extraction following full robot-sew gastrectomy.

We are glad to see a decrease in the morbidity and mortality in patients with trans-vagina specimen extraction following full intracorporeal robot-sew gastrectomy. This study shows the safety of eight trans-vagina specimen extraction following gastrectomy indicating that it could be a more feasible way of approaching the gastric cancer.

In comparison with Trans-rectal extraction, the trans-vaginal extraction is feasible, and also carries a low risk of infection and postoperative leakage[27]. Despite the potential advantages, there are still potential risks in trans-vaginal NOSE, for example, infertility or dyspareunia to some extent. And the complicated surgical procedure requires more technique and consume more time to perform the trans-vagina NOSE. The mean time of trans-vagina specimen extraction following robotic gastrectomy is 224 min in average in the eight patient. The mean operative times were 229 min and 212 min for Awad and McKenzie even though they are laparoscopic colectomy which seems easier than those in gastrectomy[28,29]. However, there were no significant side effects clinically detected in the post-vaginal-sensation patients[30,31]

Robotic TVSE in Gastric Cancer might be a feasible and alternative operative procedure for patients with gastric cancer. It showed minimal post-operative pain with small incisions; minimal invasiveness as well as less severe post-operative complications such as anastomotic fistulae, stenosis, and bleeding.

This innovation with robotic surgery provides a new approach to gastric cancer with pure NOSE approach. However, we must realize that this trans-vagina specimen extraction following standard D2 gastric surgery study with eight patients is small. And the following up of six months is a little too short for the judgement of oncological safety. Extensive studies with larger sample size (patients) focusing on the oncologic safety with long-term surveillance are needed for adequate confirmation.

**comments**

***Background***

Despite the advantages of robotic gastrectomy, the need for an incision in the abdominal wall to remove the surgical specimen is a morbid factor.

***Research frontiers***

The development of natural orifice translumenal robotic surgery and natural orifice specimen extraction (NOSE) appears to be the next major frontier in robotic surgery.

***Innovations and breakthroughs***

Present research showed that robotic gastrectomy with transvaginal extraction is a safe and effective procedure. This technique is feasible and simple to perform, avoids the abdominal wall incision and its potential complications.

***Applications***

NOSE may provide both an attractive way to reduce abdominal wall morbidity and a bridge to pure natural orifice transluminal endoscopic surgery for robotic gastrectomy.

***Terminology***

NOSE in robotic gastrectomy prevents the need for an enlarged port site or minilaparotomy to extract the surgical specimen. The current trend to develop less invasive techniques by reducing the number and size of abdominal incisions has spurred new interest in practice.

***Peer- review***

Authors conducted the case series analysis about the robotic trans-vaginal specimen extraction following total or partial gastrectomy for gastric cancer. Authors concluded that this surgical procedure is safe and feasible for patients with gastric cancer. This paper is very interesting and well written.

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| Table 1 Basic information of robotic trans-vaginal specimen extraction patients |
|  | **Case 1** | **Case 2** | **Case 3** | **Case 4** | **Case 5** | **Case 6** | **Case 7** | **Case 8** | **Mean** |
| Age/yr | 42 | 54 | 49 | 59 | 65 | 69 | 54 | 50 | 55.3 |
| BMI | 23.25 | 23.1 | 20.8 | 25.7 | 26 | 21.6 | 22.2 | 23.25 | 23.2 |
| Approach | RTG | RTG | RDG | RDG | RDG | RDG | RDG | RDG |  |
| Reconstruction | Roux-en-Y | Roux-en-Y | Billroth II | Billroth II | Billroth II | Billroth II | Billroth II | Billroth II |  |
| Number of retrieved LNs | 16/17 | 0/22 | 0/27 | 0/24 | 0/27 | 0/25 | 0/22 | 0/25 |  2/23.6 |
| WHO classification | PD | PD | PD | PD | PD | PD | PD | PD |  |
| Lauren classification | Less curvature Antrum | Less curvature Antrum | Less curvature Body | Less curvature Body | Less curvature Body | Less curvature Body | Less curvature Body | Less curvature Body |  |
| Histopathology | adenoma | adenoma | adenoma | adenoma | adenoma | adenoma | adenoma | adenoma |  |
| History | Null | Null | Hemorrhoids 4 years ago | Appendectomy 10 years ago | Null | Null | Null | Caesarean section 22 years ago |  |
| Postoperation stay/d | 5 | 4 | 3 | 3 | 3 | 4 | 3 | 4 | 3.6 |
| Stage | **TNM** | T4bN3M0 | T1N0M0 | T1N0M0 | T4bN0M0 | T1N0M0 | T1N0M0 | T1N0M0 | T1N0M0 |  |
| **Gross type** | IIIC | IA | IA | IIIB | IA | IA | IA | IA |  |
| During Operation | **Blood loss/ml** | 50 | 50 | 100 | 100 | 50 | 50 | 50 | 50 | 62.5 |
| **Blood Transfusion/ml** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Urine/ml** | 600 | 400 | 500 | 300 | 300 | 400 | 300 | 450 | 406.3 |
| **Operation time/min** | 225 | 215 | 298 | 200 | 230 | 200 | 185 | 235 | 224 |
| Time to first flatus/h | 30 | 32 | 27 | 33 | 36 | 35 | 28 | 33 | 31.8 |

PD: Poorly differentiated; RTG: Robotic total gastrectomy; RDG: Robotic distal gastrectomy.

**Table 2 Clinical features of robotic trans-vaginal specimen extraction patients**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Adverse event | Pain/ VAS | activity/ step | Sleep/h |
| anastomotic leakage | 30 d re-admission | SSI or LI | POD1 | POD2 | POD3 | POD1 | POD2 | POD3 | POD1 | POD2 | POD3 |
| TVSE-RTG | 0/2 | 0/2 | 0/2 | 2 | 1 | 1 | 55 | 342 | 1100 | 7 | 6 | 6.5 |
| TVSE-RDG | 0/6 | 0/6 | 0/6 | 2.8 | 1.7 | 1 | 62 | 336 | 1078 | 7.1 | 6.8 | 7.9 |

SSI: Surgical site infection; LI: Lung infection; TVSE: trans-vaginal specimen extraction.

**Table 3** D**uring the perioperative course, both the SpO2 showed a slight fluctuation**

|  |  |  |  |
| --- | --- | --- | --- |
|  | SpO2/% | HR/min-1 | Hand grip strength/ (left/right) kg |
| **Pre-** | **POD1** | **POD3** | **Pre-** | **POD1** | **POD3** | **Admission**  | **Discharge** |
| TVSE-RTG | 100 | 98.5 | 99 | 60 | 62 | 60 | 25.6/25 | 27.8/26.3 |
| TVSE-RDG | 100 | 98.3 | 99.3 | 66.2 | 77.5 | 72.5 | 23.3/21.7 | 25.6/24.5 |

Pre-: Pre-operation; POD: Post-operation day; CRP: C-reactive protein; HB: Haemoglobin; ALB: Albumin; PAB: Prealbumin; TFN: Transferrin; HR: Heart rate; TVSE: trans-vaginal specimen extraction.

**Table 4 Labratory features of robotic trans-vaginal specimen extraction patients**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | CRP | HB | ALB | PAB | TFN |
| Pre- | POD1 | POD3 | Pre- | POD1 | POD3 | Pre- | POD1 | POD3 | Pre- | POD1 | POD3 | Pre- | POD1 | POD3 |
| TVSE-RTG | 0.4 | 1.8 | 32.2 | 132 | 131 | 123 | 41.6 | 34.8 | 28.4 | 321 | 227 | 200 | 2.7 | 2.6 | 2.2 |
| TVSE-RDG | 0.5 | 19.4 | 35 | 133 | 124 | 116.3 | 41.4 | 33.5 | 29.6 | 273.7 | 236.8 | 205.8 | 2.8 | 2.5 | 2.3 |

POD: Post-operation day; CRP: C-reactive protein; HB: Haemoglobin; ALB: Albumin; PAB: Prealbumin; TFN: Transferrin; HR: Heart rate; TVSE: trans-vaginal specimen extraction.



**Figure 1 placement of trocars.**



**Figure 2 procedure of robotic trans-vagina specimen extraction.**