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CURRENT STATUS AND PROSPECTS OF ROBOTIC TECHNOLOGY IN TREATING GYNECOLOGICAL DISEASES

Harold K. Ward
Johns Hopkins University School of Medicine, Baltimore, MD, USA.

Abstract: Robot-assisted surgery is a technological breakthrough in the field of minimally invasive surgery. It promotes the use of minimally invasive technology in complex gynecological surgeries. It is currently mainly used in gynecological diseases for three common malignant tumors in gynecology (endometrial cancer, Cervical cancer, ovarian cancer) and some complex benign gynecological diseases. This article reviews the relevant literature on the application of robot-assisted surgery to gynecological diseases, analyzes the current clinical evidence of robot-assisted surgery applied to gynecological diseases, and provides a realistic and reliable basis for clinical selection of robot-assisted gynecological surgery.
Keywords: Robotic surgery; Gynecological diseases; Minimally invasive technology

1 ENDOMETRIAL CANCER

In 1985, robotic technology was applied to medicine [1]. After decades of innovative development, the original HERMES voice control system to the first AESOP systems used in surgical procedures and in AESOP The Zeus system with two robotic arms was added to the system, and now it has The Finch surgical system moves open surgery toward minimally invasive surgery and even It is today's precision minimally invasive surgery. HD 3D of robotic systems Visual effects enable the operator to clearly identify blood vessels and nerves and other fine structures, making the surgery more precise and refined [2], and the robot can Filtering hand tremors makes surgery more precise and stable, and the robot arm can Telescopic and 360° rotation make the surgical operation more flexible and precise [3]. machine Robot-assisted surgery is more effective and safer than conventional laparoscopic surgery, especially in line with the concept of modern precision medicine.

In robot-assisted surgery, the surgeon sits in front of the console and remotely controls the robotic arm without direct contact with the patient. Perform surgery. Provides the operator with a comfortable, ergonomic posture Perform surgical operations, reduce operator fatigue, and be able to adapt to long-term operations Surgical operation[4]. Three-dimensional high-definition imaging system for robotic surgical systems It has extremely high resolution and clarity, and the robotic arm holding the mirror is stable, eliminating the tremor of human hands, presenting a high-definition and stable field of view, greatly reducing the No damage to adjacent surrounding tissues, and the manipulator is small and flexible The precision allows the surgeon to perform more precise cutting and suturing operations, resulting in less damage and bleeding during the operation, and less trauma to the patient. Patients recover faster and are discharged from hospital earlier [5]. However, robots are expensive and lack Shortcomings such as tactile feedback and bulky body limit the popularity of this system. At present, robotic technology is mainly used in the following gynecological diseases.

Staging surgeries for endometrial cancer include extrafascial total hysterectomy, bilateral adnexectomy, pelvic lymphadenectomy, and para-aortic lymphadenectomy. Compared with transabdominal surgery and conventional laparoscopic surgery, robot-assisted laparoscopic surgery is safer for the treatment of endometrial cancer and has wider applicable indications, such as obese patients, more severe patients, perioperative morbidity (The rate of moderate blood transfusion, intestinal injury, postoperative infection, etc.) is reduced and has little impact on short-term recurrence and survival outcomes, but the cost of surgery is higher.

BOUWMAN F et al.[6] believe that obesity makes patients with endometrial cancer The surgical risks are increased, which is more obvious in transabdominal surgery, while machine The minimally invasive technique of robotic-assisted laparoscopy can greatly reduce this risk. SEAMON LG[7]Compare robot-assisted laparoscopic surgery with conventional surgery Laparoscopic surgery for patients with stage I or occult stage II endometrial cancer Clinical Outcomes of Robotic Hysterectomy for Endometrial Cancer Surgery and lymphadenectomy can be done in sicker patients and can shorten Operation time, hospital stay, reduced blood transfusion rate and laparotomy Probability.

A study by GAIA G et al. [8] concluded that compared with transabdominal surgery and conventional abdominal surgery, Compared with laparoscopic surgery, robot-assisted endometrial cancer staging surgery has less intraoperative bleeding, faster patient recovery, and earlier discharge from the hospital. Phase 1 clinical outcomes (such as vascular, bowel and bladder injuries, etc.) are similar, but more The intraoperative conversion rate to laparotomy was low in the conventional laparoscopic group. PARK HK etc. [9] points Analysis comparing endometrial cancer patients undergoing robot-assisted surgery vs. Recurrence and survival in patients with endometrial cancer undergoing open surgery As a result, the estimated 3-year cumulative recurrence rate in the robotic group was found to be lower than that in the open group. Abdominal surgery group; 3-year progression-free survival rate and estimated 5-year survival rate of the robot group The overall survival time was higher than that of the open group. Xu Linli et al. [10] conducted a rigorous screening of A meta-analysis of 22 articles was performed, and the results showed that the more traditional laparoscopy Surgery, intraoperative staging of endometrial cancer assisted by da Vinci Organ damage, conversion to laparotomy, and intraoperative bleeding were all small and hospitalization The time is relatively short, but the cost of the operation is higher than that of traditional laparoscopic surgery. There was no significant difference in operation time and number of lymph nodes dissected.

2 CERVICAL CANCER

Over the past century, the standard surgical procedure for early-stage cervical cancer has been abdominal radical hysterectomy, and in recent decades, laparoscopic radical hysterectomy has been added to the surgical management of early -stage cervical cancer. Laparoscopic surgery creates the advantages of minimally invasive surgery without compromising surgical and tumor outcomes [11]. However, traditional laparoscopic surgery still has limitations such as lack of visual field stability, amplified tremor, poor ergonomics, long learning curve, and difficulty for operators to tolerate long operations [12]. In this era, Robotic technology has emerged, allowing surgeons to overcome some of the limitations of traditional laparoscopy, especially when performing complex surgical procedures such as extensive hysterectomy, nerve-sparing extensive hysterectomy, extensive cervix The advantages of resection are particularly obvious.

Since the successful implementation of the first robot in 2006, a wide range of Sexual total hysterectomy, followed by multiple studies confirming robot-assisted Extensive hysterectomy is safe and feasible to treat early-stage cervical cancer It is effective and more accurate than conventional laparoscopy [13-14]. Robot assistant Assisted extensive hysterectomy is compared with conventional laparoscopic surgery and open surgery. Compared with open surgery, intraoperative blood loss, operation time, and postoperative hospital stay are time was significantly reduced, and more refined lymph node dissection can be performed With the development and popularization of technology, the cost will become more reasonable. However, there are few reports on the long-term effects of tumor removal, and more large samples are still needed. Analysis of clinical randomized controlled studies.

CHEN L et al[15] found that robotic radical hysterectomy Surgery time of Robotic radical hysterectomy (RRH) and blood loss was significantly less than laparoscopic radical hysterectomy (Lapa- roscopic radical hysterectomy (LRH), but both procedures There was no significant difference in complication rate, overall survival and progression-free survival time. difference. KIM TH et al. [16] also concluded that RRH and LRH are used to early Complication rates of radical hysterectomy for early stage cervical cancer However, the operation time of RRH is longer, which may be related to the surgical experience of the surgeon. related. SHAZLY SA et al. [17] found that RRH may be effective in surgical treatment. The results are better than LRH, RRH has shorter hospitalization time and fewer complications. Heat and complications. Intraoperative and postoperative short-term outcomes of RRH and LRH Seems to be equivalent. It can be concluded that the current robot radical uterine Resection is more effective in the perioperative period than laparoscopic radical hysterectomy There are potential advantages in terms of prevalence, but the clinical value in other aspects (such as long-term prognosis) still lacks supporting evidence and requires more clinical big data. analyze.

Robotic technology has significant advantages in joint movement and image magnification. It can perform three-dimensional visualization of the blood vessels and autonomic nerve supply of the bladder and rectum, thereby making nerve preservation procedures safe and feasible and significantly reducing the risk of surgical sequelae. Therefore, robots assist in nerve preservation. Extensive hysterectomy is a safe, effective and more attractive method of treating cervical cancer.

For young women with early-stage cervical cancer who want to preserve their fertility Sex, radical trachelectomy is safe and effective, with good pregnancy outcomes. RAMIREZ PT et al.[18] retrospectively analyzed 520 patients who underwent radical 70% of patients with early-stage cervical cancer who undergo trachelectomy have a successful pregnancy. JOHANSEN G et al[19] studied 49 patients who underwent robotic radical cervical surgery. An analysis of the efficacy of resection in patients with early-stage cervical cancer found that 2 Local recurrence occurred in 21 cases, and 21 cases had successful pregnancies during reproductive follow-up. The high fertility rate and acceptable recurrence rate support the effectiveness and feasibility of robotic radical trachelectomy to preserve fertility in women with early-stage cervical cancer. VIEIRA MA et al [20] believed that radical trachelectomy performed through minimally invasive techniques (laparoscopy and robot-assisted laparoscopy) can reduce blood loss and shorten hospitalization time, indicating that this technology is highly safe.

3 OVARIAN CANCER

Standard treatment for ovarian cancer includes upfront surgery to accurately diagnose and stage the disease, as well as maximum cytoreduction, followed by standardized postoperative chemotherapy and, if necessary, radiotherapy. Surgical staging for ovarian cancer has traditionally included exploratory laparotomy with peritoneal washing, hysterectomy, biadnexectomy, omentectomy, multisite peritoneal biopsy, and pelvic and abdominal lymph node dissection. As the use of minimally invasive techniques in gynecological oncology expands, laparoscopic and robot-assisted techniques are used to evaluate and treat cervical and endometrial cancers. The role of minimally invasive surgery in the treatment of ovarian cancer includes: (1) assessment, diagnosis and staging of overt early ovarian cancer; (2) assessment of the feasibility of early -stage cytoreductive surgery without visible disease; (3) tumor debulking treatment of advanced ovarian cancer; (4) Review of patients with complete response to initial therapy; evaluation of recurrent disease and cytoreduction. However, the role of minimally invasive surgery in the treatment of ovarian cancer still needs further study.

Clinically, early ovarian cancer mainly refers to patients whose surgical and pathological staging is in stages I-II. Robot-assisted surgery has similar surgical outcomes as conventional laparoscopic surgery in patients with definite early-stage ovarian cancer, and current data supporting the role of robotic surgery in ovarian cancer are limited to case reports and case series in early-stage patients and surgical debulking in patients with late-stage recurrence. MAGRINA JF et al. [20] compared the perioperative outcomes and survival rates of patients undergoing primary surgical treatment of epithelial ovarian cancer using robot-assisted surgery, laparoscopic surgery and laparotomy. The average blood loss and average hospital stay were compared with the robot-assisted surgery. The least auxiliary surgery was performed, and the most was laparotomy. There was no significant difference in the overall survival rate of patients with the three surgical methods.

Segmenting and comparing patients based on extent of surgery, primary type of surgery, and number of surgeries, perioperative outcomes for stage I and II patients with cytoreduction using robotic and laparoscopic surgery improved compared with open surgery. For stage III patients undergoing tumor removal surgery, robotic surgery is no better than open surgery. It is also believed that laparoscopy and robotic techniques are preferable to laparotomy for ovarian cancer patients who require simple primary tumor resection or who require additional surgery. Laparotomy is preferable for patients requiring two or more surgeries, and the type of surgical approach does not affect survival.

4 OTHER COMPLEX BENIGN GYNECOLOGICAL DISEASES

4.1 Uterine Fibroids

The introduction of robotic technology has expanded surgical options According to the certificate, it is suitable for minimally invasive myomectomy for more complex cases such as large Removal of fibroids (fibroids >10 cm in diameter as measured by ultrasound). LEE CY et al[21] studied the effectiveness of robot-assisted surgery for removal of large uterine fibroids. Clinical Outcome, Compared with Surgery Time in Patients with Fibroids <10 cm Long-term and less perioperative complications, and there is no difference in blood loss between the two. Youyan The study found that compared with conventional laparoscopy, robotic surgery takes longer and loses There is no obvious advantage in terms of blood volume and postoperative complications. Abdominal myomectomy Compared with surgery, fibroid removal under the robotic system results in less blood loss and risk of blood transfusion. The complication rate is low, but the operation time is long and the cost is high. ARAUJO SE et al[20] compared robot-assisted, conventional laparoscopy, open Clinical results of three abdominal surgical approaches, finding that the robotic group recovered The abdominal group had higher blood loss and relatively slow recovery.

4.2 Endometriosis

Endometriosis based on ectopic Different locations can be divided into superficial, ovarian (ovarian chocolate cyst), and deep (defined as invasive depth >5 mm). deep infiltration type Endometriosis (DIE) is a nodule that invades the peritoneal surface and often occurs in the sacral ligament, Douglas fossa, vagina, intestine, bladder and ureter.

Endometriosis often causes dense adhesions in tissue to dissolve Abnormal anatomical structure, which is a thorn in the side of traditional laparoscopic surgery Hand problems, and the unique high-definition 3D video effect of the robot system can Make tissues, blood vessels, nerves, etc. clearly displayed, especially suitable for some special Resection of endometriosis lesions at specific locations. Many retrospective analysis tables It has been shown that the use of robot-assisted laparoscopic surgery (RAS) to treat endometriosis is safe and feasible. Yes, especially for the treatment of DIE. Robotic surgery versus conventional abdominal surgery Compared with mirrors, the flexibility of robotic instruments and the three-dimensional magnified imaging system May improve endometriosis prognosis. This was confirmed in the case report of AUR- LANE DN et al. [22]. Robot-assisted Surgical treatment of uterus in fossa of Douglas and uterovaginal diaphragm: a case Endometriosis completely infiltrates bilaterally and caudally, up to the base of the bilateral sacral ligaments The patient had no intraoperative and postoperative complications. However, the Meta-analysis conducted by RESTAINOS et al. [23] pointed out that RAS is effective in treating endometrium. Heterotopia requires a longer average operating time than laparoscopic surgery (LAS), but the amount of blood loss, complications and hospitalization are There was no significant difference in hospital stay. A meta-analysis by CHEN SH et al. [24] that included 4 studies also reached a similar conclusion. For mild to moderate endometriosis, robot-assisted surgery does not show obvious advantages, and because it is an emerging technology and the surgeon is not proficient enough, the average operation time is long and the cost is high; for DIE, it can Consider using a robotic surgical system.

5 CONCLUSION

Robotic surgery overcomes some limitations of traditional laparoscopic surgery and is safe, feasible and effective for complex gynecological surgeries. Compared with traditional laparoscopy, it highlights certain advantages in performing complex surgeries. However, the long operation time is mainly due to the Pre-installation and debugging are related to the operator's proficiency in new technologies. For long-term prognosis (such as five-year survival rate, recurrence rate, etc.) and patients' quality of life, big data from multiple institutions and prospective randomized clinical trials are needed to explore.

With the development of science and technology, robot technology through continuous innovation and development, robots in the new era will surely move toward smarter, smaller, and more affordable Improvements and improvements in reasonable price and other aspects may provide novel and unique functions. capabilities, such as tactile gloves or cell image navigation; integrating fluorescence imaging techniques The introduction of robotic surgery can assist doctors in determining key anatomical structures, determining tumor boundaries in solid organs, and assessing blood flow in target tissues. perfusion, etc.; the introduction of a flexible conveying system (Flex system) can achieve Advance surgical instruments through non-linear paths to the surgical site, thereby increasing

Increase the flexibility of operation and break through the limitations of the scope of surgery.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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