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Robotic Surgery in Gynaecologic Oncology- Where Do We Stand?

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Abstract

Robotics is a new upcoming surgical platform which has gained popularity because of its technical advantages, good patient outcomes and ease of surgery. Robotics has been applied to benign gynaecological patients with great success, and by adhering to stringent onco-surgical principles, it has been used in malignant gynaecological situations as well. Its use in early endometrial cancer has become very common in clinical practice. Robotics for sentinel lymph nodes (SLN) were found to be feasible and comparable to traditional laparoscopy. Application of robotics in ovarian cancer has been used but its application remains restricted to very well selected early-stage disease only. Its use in advanced-stage ovarian cancer and recurrent ovarian cancer is still remained experimental. After recent publication of LACC trial which is a well-designed randomized control trial- the role of minimally invasive surgery including robotics has become very constrained. Newer well-designed upcoming randomized controlled trials are ongoing to delve into the oncological non-inferiority of Robotics in cervical cancer (early-stage). In this review article recently published scientific evidence has been put forward to look into the current status of robotics in different gynaecological malignancies.

Keywords: Sentinel Lymph node, Video Endoscopic Inguinal Lymphadenectomy, Robotic-assisted laparoscopy, Conventional laparoscopy, Laparotomy, Minimally Invasive Surgery.

Introduction

Due to its advantages over traditional laparoscopy, such as high-definition 3D optics, wristed instrumentation, camera stability, tremor filtration, improved ergonomics, and fewer postoperative complications like less blood loss and quicker recovery time, robotics has emerged as one of the technologically advanced platforms. On the downside, initial cost, training, lack of availability, mechanical error, technically demanding and initial more operative time consumption - are a few of the disadvantages. Early clinical successes of robotics in benign gynaecological surgery have prompted gynaecologic oncologists to consider this platform to use in gynaecologic oncology cases without violating the oncological principles. In this review article more recently published good-quality studies are incorporated to support or refute the use of robotics in gynaecologic oncology in the present scenario.

Robotics in Ovarian Cancer

The application of robotics in patients with advanced-stage or relapsed ovarian cancer requires additional research, even in specific circumstances. The robotic technique can be employed in well-selected patients with early-stage ovarian cancer without violating the oncological safety rules. The exact function of robots in ovarian cancer remains unclear due to a dearth of compelling and convincing evidence. In cancer ovary robotics is feasible but has not shown any extra survival benefit If other than primary tumour removal and staging, patients requiring more than 2 additional procedures-- are best managed by open surgery (1, 2).

Recently published good-quality evidences are described in Table 1.

Continued By integrating robotic cytoreductive surgery into the ovarian cancer treatment pathway for women with a pelvic mass </=8 cm, the MIRRORS study (Minimally Invasive Robotic Surgery, Role in Optimal Debulking Ovarian Cancer, Recovery & Survival) aims to improve patients' surgical experience, access to surgery and speedy recovery, reduce morbidity, and shorten the time to initiation of chemotherapy.

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MIRRORS is a feasibility study that is being conducted at Royal Surrey County Hospital in Guildford, UK, on a single site. The research began in June 2020. The goal is to move on to the MIRRORS RCT (Randomised Controlled Trial) after this initial feasibility trial is finished in order to evaluate whether progression-free survival (PFS) and overall survival (OS) are comparable to open surgery (6).

Table 1: Robotics in early-stage ovarian cancer

Study	Study design	Comparison group	Findings
Facer Benjin et al. (3) 2019 AJOG	For clinical stage I epithelial ovarian cancer, 1901 individuals had robotic or traditional laparoscopic minimally invasive surgery between 2010 and 2014.	Robotic surgery Vs Traditional laparoscopy	7.2% of robots converted to open surgery, compared to 17.9% of laparoscopies (P <.001). There were no discernible changes in survival between the two arms in multivariate analysis.
Shi C et al. (4) 2019 World Journal of Surgical Oncology	8 studies included 647 patients Metanalysis	Robotic vs Laparoscopy And Robotic Vs Open	This meta-analysis found that while laparoscopy and robotic surgery had similar results in treating ovarian cancer, the former had a greater overall survival rate compared to laparotomy and reduced estimated blood loss, length of hospital stay, and post-operative complications.
Tang Q et al. (5) Meta analysis Journal of Oncology Volume 2022	There are 38 studies in the network meta-analysis.	Laparotomy Vs Robotic Vs Laparoscopy	Robotic and laparoscopic procedures resulted in less blood loss, fewer problems, shorter hospital stays, and the need for transfusions. There is no difference in the 5-year OS of patients with ovarian cancer between the robotics, laparoscopy, and laparotomy groups.

Eligibility criteria- Advanced ovarian/fallopian tube cancer (Stage IIIc-IVb), Interval debulking surgery setting, pelvic mass ≤8 cm, not requiring open surgery such as extensive disease requiring liver or upper gastro-intestinal surgical support.

Robotics in Uterine Surgery

Multiple retrospective clinical studies with low numbers of patients have shown the feasibility of robotics in endometrial cancer surgery. Recently published systematic review and clinical meta-analysis and one randomized control trial in early-stage endometrial cancer have been depicted in Table 2. Evidence of Sentinel lymph node dissection in early-stage endometrial cancer is depicted in Table 3.

Robotics in Obese Patient

Performing robotic surgery to obese patients with endometrial cancer is safe and clinically feasible even in a super morbid patient (BMI of >50 kg/m2). A study conducted by Stephan J M et al published in 2015 has shown robotic in obese early cancer endometrium is a valid surgical management option with similar outcomes, duration of hospital stays, estimated blood loss, perioperative complications, and total numbers of lymph nodes retrieved (12).

Table 2: Robotics in early-stage Endometrial cancer

Study	Study design	Comparison group	Findings
Mäenpää M M et al. (7) AJOG 2016	Randomized controlled trial. 2010 to 2013 101 endometrial cancer patients. The total operation time served as the primary outcome measure. The amount of time spent in the operating room overall and the surgical result (amount of lymph nodes removed, problems, and recuperation) were the secondary outcomes.	Robotic surgery (n=50) Vs Laparoscopic surgery (n=51)	Comparing median times for robotic surgery and conventional laparoscopy, the former took 139 minutes (P<.001) less. The robotic surgery group spent less time in the operating room overall (197 vs 228 minutes, P <.001). 5 conversions from laparoscopy to laparotomy vs to 0 in the robotic group (P<.027). The surgical outcomes for each group were comparable. Conclusion: For the surgical treatment of endometrial cancer in its early stages, robotic surgery provides a reliable and secure substitute.
Fu H et al. (8) Zhengzhou University China 2023 Gynecologic Oncology Journal	A comprehensive examination and meta-research. Overall survival (OS), disease-specific survival (DSS), recurrence-free survival (RFS), and disease-free survival (DFS) were the key outcomes for 21 papers.	Comparing laparotomy (LT) and conventional laparoscopy (CLS) with robotic-assisted laparoscopy (RALS)	When compared to LT, RALS was substantially linked with favourable OS (HR = 0.682), RFS (HR = 0.793), and DSS (HR = 0.441); however, there was no difference in OS (HR = 0.962), RFS (HR = 1.096), and DSS (HR = 1.489) between RALS and CLS for endometrial cancer. RALS's subgroup analysis revealed comparable or better RFS/OS than that of CLS and LT. RALS had a worse RFS than CLS in patients with early-stage endometrial cancer, but a similar OS. Conclusions. When it comes to long-term oncological outcomes, RALS is safer than LT when managing endometrial cancer. Its outcomes are comparable to those of CLS.
Salehi S et al. (9) European Journal of cancer Sweden	controlled trial conducted at random. Ca Endometrium at High Risk, Stages I and II The paraaortic lymph node count was the main result.	Robot-assisted laparoscopic surgery (RALS)(n=48) Vs Laparotomy (LT) (n=48)	For RALS, the mean paraaortic lymph node count was 20.9, whereas for LT, it was 22 (p = 0.45). After RALS, there was a decrease in the mean pelvic node count (LT 28 +/-10 versus RALS 22 +/- 8, p < 0.001).

2017	Perioperative events, postoperative complications, and overall health care costs were secondary outcomes.		There was no difference in readmissions or perioperative problems between the groups. The RALS group had a longer operation time ($p < 0.001$) than the LT group, although there was less overall blood loss (<0.001) and a shorter hospital stay (<0.001). RALS had substantially lower medical expenses. Conclusion: RALS is superior to laparotomy in terms of non-inferiority in paraaortic lymph node count, comparable complication rates, shorter hospital stays, and lower overall costs. RALS is a useful therapy option for uterine endometrial carcinoma at high risk.

Table 3: Robotics in early-stage Endometrial cancer sentinel node assessment

Study	Study design	Comparison group	Findings
Bizzari N et al. (10) 2021 Italy	Retrospective, single-center, observational cohort study conducted between January 2015 and 2019 that included patients treated with minimally invasive primary surgery for endometrial cancer (FIGO stage IA–IVB) and receiving injections of indocyanine green (ICG) to identify SLN.	Out of the 549 patients who were included, 286 (52.1%) and 263 (47.9%) had the laparoscopic procedure, respectively. Of the patients, 387 (70.5%) had bilateral SLN mapping, 102 (18.6%) had unilateral mapping, and 60 (10.9%) had no mapping.	In conclusion, even though the patients having robotics were older and more obese, SLN mapping and bilateral SLN identification with ICG in endometrial cancer were not different in the laparoscopic and robotic arms.
Roy A et al. (11) 2023 ASCO- JCO Global Oncol	Prospective observational study conducted on a single centre with EC patients having robotic staging.	Of the 105 female patients in the research, 71 had both SLN and a complete lymphadenectomy, while 34 had just SLN. Ninety-two patients (87.61%) had bilateral mapping, and one patient had no mapping.	The SLN-ICG had a 92.3% sensitivity and a 98.3% negative predictive value. In 8.57% of patients, ultra-staging results in upstaging. Conclusion: SLN mapping with ICG dye has a good diagnostic accuracy in detecting lymph node metastases

			in early endometrial cancer, with a strong negative predictive value.

Table 4: Robotics in vulval cancer (R-VEIL Surgery)

Study	Study design	Comparison group	Findings
Jain V, Sekhon R et al. (13) 2016 RGCIRC, Delhi India	Retrospective study	22 R-VEIL operations were performed on 12 patients with vulva squamous cell carcinoma between February 2011 and February 2015.	Mean blood loss was 30 millilitres, and the operation took 69.3 minutes on average. No complications during surgery were seen. Drains were cleared on average in 13.9 days. There were an average of eleven superficial and deep inguinofemoral lymph nodes recovered, along with six cases of lymphocele, six cases of chronic lower limb lymphedema, one case of persistent lymphorrhea, and two cases of cellulitis. Just one patient experienced a recurrence. Conclusions: Robotics has the potential to lower the surgical morbidity associated with the open operation, and the R-VEIL permits the removal of inguinal lymph nodes within the same bounds as open surgery for inguinofemoral lymph node dissection.

Robotics in Vulval Cancer Surgery

Two subcutaneous routes are used for Video Endoscopic Inguinal Lymphadenectomy (VEIL) surgery: VEIL-L, which goes via the lower limbs, and VEIL-H, which goes through the lower belly. Robotic-VEIL (R-VEIL) is also known as Robotic-Assisted Inguinal Lymphadenectomy (RAIL). Recently published scientific evidence on R-VEIL surgery in vulval cancer is shown in Table 4.

Robotics in Cancer Cervix Surgery

After the publication of negative results of the LACC Trial (14) on DFS and OS in the minimally invasive surgery (MIS) arm the numbers of MIS has drastically reduced. Although this trial is highly criticised as it was not statistically powered enough to evaluate the oncologic outcomes per se it is undeniable that at present LACC trial is the only randomized controlled trial—which has explored the oncologic safety of minimally invasive surgery (MIS) in cervical cancer (early-stage).

Interestingly in MIS arm only 15.6% were robotics in LACC Trial. Recently ongoing 2 well-designed randomized control trials in robotic surgery in early-stage cancer cervix may be practice-reforming and it will either support or refute the oncological significant findings of the LACC trial in future. These 2 ongoing trial objectives and schema have been described in Table 5.

Table 5: Robotics in cervical cancer

Study	Study design	Eligibility criteria	Objectives
RACC Trial Falconer H et al. (15) Randomized control trial	Randomised 1:1 for laparotomy or robot-assisted laparoscopic surgery for radical	FIGO (2018) stages IB1, IB2, and IIA1 squamous, adenocarcinoma, or adeno-squamous	Primary: Survival without recurrence Secondary: Overall survival, health-related

	hysterectomy with bilateral pelvic node dissection. 768 patients in all	histology in women over the age of 18.	quality of life, problems during and after surgery, cost of healthcare, and pelvic SNL concept diagnostic accuracy
ROCC /GOG -3043 Trial Bixel K L et al. (16) Randomized control non inferiority trial	There will be 840 patient enrolments. 90% power to rule out an absolute drop in DFS by 7% (HR < = 1.375) in a randomised 1:1 way (420 per arm, total 89 events), using a log-rank test for non-inferiority with a one-sided alpha of 0.05.	Squamous cell, adenocarcinoma, and adeno-squamous cell carcinoma of FIGO 2018 stage IA2-IB2 confirmed. An MRI shows that the cervical tumour is less than 4 cm in size. Absence of overt cervical extension is seen. No further regional metastases, not even nodal. Transcervical uterine manipulator not used. Precise and intricate surgical methods are necessary to ensure appropriate containment of the tumour. It is required to have photographic proof of the specimen with the tumour contained.	First, ascertain whether the 3-year disease-free survival (DFS) of an abdominal (OPEN) technique is inferior to that of a robotic-assisted (RBT) radical hysterectomy. Recurrence patterns, long-term morbidity, peri- and postoperative complications, influence on patient-reported outcome (PRO) measures, and development of lower extremity lymphedema (LEL) are some of the factors that contribute to secondary OS.

Discussion and Conclusion

Robotics will undoubtedly change the onco-surgical treatment of gynaecological cancer, despite continuous debate and discussion about practicality, cost, standardised training, patient safety, and clinical oncologic outcomes. Unlike traditional laparoscopic surgery, robotic surgery has a huge potential for telemonitoring and telesurgery. It is envisaged that in the near future, robotics will replace open surgery as the primary method for treating gynecologic cancers, as fresh, high-quality scientific evidence continues to emerge and technology advances.

Abbreviations

SLN-Sentinel Lymph node, VEIL- Video Endoscopic Inguinal Lymphadenectomy, RALS-Robotic-assisted laparoscopy, CLS-Conventional laparoscopy, LT-Laparotomy, MIS- Minimally Invasive Surgery

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Author Contributions

The author contributed to the study conception and design.

Conflict of Interest

The author declares no conflict of interest.

Ethics Approval

Not applicable

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