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Advancements in Hysterectomy for Women›s Cancers: A Comprehensive Review of Emerging Surgical Techniques and Clinical Results

Hananeh Habib[1,*], **Samira Abdollahi**[1]

[1]Department of Obstetrics, Medical Faculty, Iran University of Medical Sciences, Tehran, Iran.

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Corresponding author:
Hananeh Habib, Department of Obstetrics, Medical Faculty, Iran University of Medical Sciences, Tehran, Iran. Email: Hana.habib.us@gmail.com.

ABSTRACT

Hysterectomy is a common treatment for endometrial, cervical, and ovarian tumors. Although open abdominal hysterectomy is successful, it can result in major recovery times, psychological and physical stress, and complications. Modern surgical methods and technologies have helped these treatments produce better clinical results, recovery times, and problem solving. This paper covers laparoscopic, robotic-assisted, and vaginal hysterectomy. The smaller incisions and better vision help to lower blood loss, hospital stays, and time to start regular activities. This review highlights the transforming results of some surgical and technological innovations in gynecologic cancer treatment driven by thorough research. By increasing the accuracy and outcomes of hysterectomies, these developments lower the long-term physical and psychological consequences of cancer treatment, and survival rates improve. Treatment for endometrial, cervical, and ovarian cancer mostly consists of hysterectomy—uterine excision. Requiring open abdominal surgery, traditional hysterectomy could lead to more problems, longer recovery times, and psychological and physical stress. Modern surgical techniques speed recovery, lower complications, and improve clinical outcomes. This thorough study reveals how technology and surgery have evolved gynecologic cancer treatment. These developments increase therapeutic results and survival rates, so lowering long-term physical and psychological consequences from cancer operations and improving hysterectomy accuracy and efficacy.

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INTRODUCTION

Gynecologic cancers including endometrial, cervical, and ovarian cancers—which impact the reproductive organs cause a major health concern for women everywhere (1). The American Cancer Society reports that uterine cancer is the most often occurring gynecologic cancer; followed by cervical and ovarian cancers. The frequency of gynecologic tumors depends on geography, risk factors, and healthcare availability; these tumors are a main cause of disease and death among women (2). Consequently, the treatment for many patients depends on hysterectomy excision of the uterus, thus the care of these tumors usually calls for surgical intervention (3).

Depending on the degree of the cancer, a hysterectomy may involve the excision of the uterus together with surrounding tissues including the cervix, ovaries, fallopian tubes, and lymph nodes. Apart from particular patient criteria including age, general health, and reproductive concerns, the degree of surgical resection is directly related with the type and stage of cancer as well as with general condition (4). Early-stage endometrial cancer may require a total hysterectomy that is, the excision of the uterus and cervix while invasive cervical cancer may call for a radical hysterectomy that is, the removal of adjacent tissues including the upper vagina, parametria, and pelvic lymph nodes (5).

Hysterectomy, sometimes known as an abdominal or laparotomy hysterectomy, has been performed historically with an open abdominal incision. Though historically thought of as the gold standard, this

approach has many drawbacks. Usually involving big abdominal incisions, open surgery can cause major postoperative pain, longer hospital stays, and longer recovery times (6). Moreover, open surgical operations could increase the possibility of issues including infections, thrombosis, damage to nearby organs, and others. These restrictions draw attention to the need of less invasive options that could generate equivalent or better oncological results while relieving patient physical and psychological load (7).

Gynecologic cancer surgery has experienced a significant transformation thanks to the evolution and broad implementation of minimally invasive techniques during the past twenty years. Laparoscopic and robotic-assisted surgeries are great alternatives for conventional open operation. Often referred to as "keyhole" surgery, laparoscopic hysterectomy is the process carried off using small incisions through which a camera (laparoscope) and specific surgical tools are introduced. Even in difficult cases, modern invention robotic-assisted hysterectomy uses robotic technologies such the da Vinci Surgical System to enable surgeons in performing extremely accurate and controlled motions (8). Among the several main benefits linked with minimally invasive operations are less blood loss, less postoperative complications, shorter hospital stays, and faster recovery times. Moreover, less scarring helps patients as well as enhances psychological well-being and general quality of life (8).

Moreover, advances in surgical technologies have considerably increased the accuracy and safety of hysterectomy operations. 3D imaging systems enable surgeons to view the surgical site in three dimensions, so improving depth perception and magnification that raises procedural accuracy. Using fluorescent markers to detect cancerous tumors in real-time, intraoperative molecular imaging has shown promise in guaranteeing total excision of malignant tissues, so possibly lowering the risk of recurrence. More individualized and successful treatment programs for women with gynecologic cancers have been made possible by the growing application of personalized medicine, which customizes treatment approaches depending on genetic and molecular profiling (9).

Emphasizing innovative surgical methods changing the course of gynecologic cancers, this paper aims to give a thorough overview of developments in hysterectomy techniques and technologies. This study will look at the present state of laparoscopic, robotic-assisted, and vaginal hysterectomies together with the effect of cutting-edge technologies including 3D imaging and intraoperative molecular imaging in enhancing the accuracy, safety, and outcomes of cancer operations. This paper will review the clinical outcomes of several operations together with their effects on surgical success rates, patient recovery, quality of life, and long-term survival rates. We want to make clear how these developments are changing the course of gynecologic cancer surgery and improving patient outcomes.

Evolution of Hysterectomy Techniques

The development of hysterectomy approaches in recent years is marked by notable changes meant to improve patient outcomes and lower the physical consequences of operations. While open abdominal surgery is still a good choice, many patients—especially those with early-stage malignancies are advised less invasive procedures more and more. In gynecologic oncology, the main hysterectomy techniques used are laparoscopic, robotic-assisted, and vaginal hysterectomy (10).

Laparoscopic Hysterectomy

Thought of as minimally invasive or "keyhole" surgery, laparoscopic hysterectomy passes specialized surgical tools through small abdominal incisions using a small camera called laparoscope. Real-time images of the pelvic area provided by the laparoscope help the surgeon to perform the operation with remarkable accuracy. Treating early-stage gynecologic malignancies including endometrial and cervical cancers (11) this approach is particularly useful if the neoplasm is limited to the uterus or cervix.

Among the advantages of laparoscopic hysterectomy are smaller incisions, less blood loss, less postoperative pain, and faster recovery than in open surgery. Studies comparing laparoscopic hysterectomy with traditional open abdominal surgery show that minimally invasive techniques produce less complications—including hernias and infections—along with a shorter hospital stay. Moreover, patients often find less scarring and can start their regular activities more quickly (12).

Though with many advantages, laparoscopic hysterectomy is not suitable for every patient. For those with advanced-stage cancer or bigger tumors, for example, it could be useless. The complexity of the surgery may demand specific knowledge, hence restricting its general use to facilities furnished with qualified surgical teams (13).

Robotic-Assisted Hysterectomy

Robotic-assisted hysterectomy is a sophisticated variation of minimally invasive surgery in which the surgeon is assisted all during the operation by robotic devices mostly the da Vinci Surgical System. The robotic system consists in robotic arms, a high-definition 3D camera, and specialized tools run by the surgeon from a console. Particularly in challenging locations like the pelvic sidewalls and lymph nodes,

the robotic arms offer better precision and a greater range of motion than traditional laparoscopic tools, so enabling more complex tissue dissection (14).

The better visibility provided by the high-density 3D camera which offers more magnification and depth awareness than traditional laparoscopy is a main advantage of robotic-assisted surgery. This helps doctors to more accurately identify and protect important tissues throughout treatment, including blood vessels and nerves. Robotic hysterectomy has shown good results in terms of minimizing blood loss, improving surgical accuracy, and lowering of recuperation times (15, 16). Moreover, robotic surgery fits with reduced rates of conversion to open surgery, which is typically required when laparoscopic operations encounter technical problems. Several studies (17) indicate that robotic-assisted hysterectomy is particularly helpful in complicated patients such as those involving large tumors, obesity, or past abdominal operations.

Robotic surgery has certain restrictions even if it offers many advantages. While the significant learning curve for surgeons requires great training and practice, the great cost of robotic systems is a major barrier to more general use. As technology gets more reasonably priced and training programs more reachable, robotic-assisted surgery is expected to become a progressively common approach for gynecologic oncologic surgery (18).

Vaginal Hysterectomy

An other minimally invasive approach for hysterectomy is vaginal hysterectomy, in which the uterus is excuted through the vaginal canal. For those with early-stage cervical or endometrial cancer, especially when the uterus is not enlarged, vaginal hysterectomy is a perfect substitute even if it is not appropriate for every patient. This approach does away with abdominal incisions, so reducing pain, hastening recovery, and lowering risk of wound infections (19).

A more direct access path to the uterus allows a vaginal hysterectomy to reduce the risk of damage to nearby structures including the bladder and rectum. Still, its effectiveness depends mostly on the anatomical structure of the patient and the surgeon's experience. Vaginal hysterectomy may not be feasible when the uterus is larger or cancer has spread outside the uterus; laparoscopic or robotic-assisted procedures may be preferred (20).

Technological Innovations in Hysterectomy

In recent years, numerous technological breakthroughs have significantly enhanced the safety, precision, and efficacy of hysterectomy surgeries. These improvements have facilitated surgeons in executing more precise procedures with minimum disturbance to adjacent tissues, ultimately resulting in improved patient outcomes (21).

3D Imaging and Navigation Systems

In gynecologic oncology, 3D imaging and navigation technologies taken together have greatly increased the accuracy and efficacy of surgical treatments for female cancers (22). Modern technology's real-time, high-resolution, three-dimensional pelvic area imaging helps surgeons to perform challenging operations with less risk and more accuracy. While historically surgeons have relied on 2D imaging or visual inspection during operations; the switch to 3D imaging offers a more complete and thorough view of anatomical structures, which is especially important in oncological operations where accuracy is absolutely vital (23). In gynecologic oncology, combining 3D imaging with navigation technologies has drastically raised the potency and accuracy of surgical treatments for women's cancers (22). Modern technologies enable doctors to do challenging surgical operations with more accuracy and less risk by offering real-time, high-resolution, three-dimensional images of the pelvic area. Although surgeons have always used 2D imaging or visual inspection for operations, the change to 3D imaging provides a more complete and detailed view of anatomical structures, which is especially important in cancer operations where accuracy is vital (23).

Enhanced Visualization and Anatomical Understanding

Great caution is required when moving around in the surgical area during gynecologic oncology procedures, which includes the uterus, ovaries, bladder, rectum, and nearby blood vessels, because there are many tissues close together and we want to avoid harming important organs. Unlike the flat, two-dimensional images generated by earlier imaging technologies, 3D imaging systems allow surgeons to view structures in three-dimensional space (24). 3D imaging helps us to better grasp the anatomical diversity and complexity unique to every patient by offering a more exact representation of the relative locations and connections among significant components (25).

Improved visibility is absolutely vital when working on malignancies in the pelvic cavity or other areas near sensitive or inaccessible organs. Surgeons can more easily identify sensitive areas—such as blood vessels or nerve pathways—that might call for extra attention during surgery using 3D imaging. Moreover, 3D imaging helps one better view tumors partially hidden by surrounding tissues, so facilitating more complete tumor removal (26).

Increased Surgical Precision

Although navigation systems and 3D imaging have several benefits, their accuracy during surgical

operations defines most of them. Particularly in cases of very complex gynecologic oncology, traditional surgical operations often depend on the tactile sense of the surgeon. Not always are visual cues present. Using 3D imaging allows surgeons to plan and execute millimeter-level accuracy, so helping to restrict the margin of error (27) in surgical operations. For operations including hysterectomy or tumor resections, the 3D scans, for instance, enable the surgeon to precisely cut incisions and remove malignant tissue. This is achieved by helping the surgeon ascertain, ahead of time the precise size, location, and margins of the tumor (25). Furthermore, real-time monitoring of surgical tools is made possible by the junction of three-dimensional imaging technologies and navigation systems. Using the three-dimensional screen, the surgeons can check their tools to make sure they are pointed correctly within the operative area. Particularly important when dealing with vital organs like blood vessels or ureters, which are vulnerable to damage during gynecologic operations, this live tracking improves the surgeon's ability to execute motions with the highest possible degree of accuracy (27). This accuracy not only reduces the unintentional damage to the surrounding tissues but also increases the general general safety of the operation (28). Though their accuracy during surgical operations defines most of their advantages, both 3D imaging and navigation systems have several advantages. Particularly in cases of gynecologic oncology that are especially complex, conventional surgery usually depends on the tactile sense of the surgeon and offers only limited visual cues. 3D imaging gives surgeons the ability to plan and execute operations with millimeter-level accuracy (27), so helping to lower the margin for error. For example, when performing hysterectomies or tumor resections, the 3D scans can help the surgeon identify the tumor's exact size, position, and borders, allowing for more precise incisions and better removal of malignant tissue. Moreover, the amalgamation of navigation systems with 3D imaging facilitates real-time monitoring of surgical instruments (26). Surgeons could check their instruments on a 3D screen to make sure they are positioned and pointed correctly inside the surgical area. Particularly important when dealing with vital organs like blood vessels or ureters, which are prone to damage during gynecologic operations, this live tracking improves the surgeon's capacity to execute motions with the highest possible degree of accuracy. This degree of accuracy not only reduces the possibility of inadvertent damage to the nearby tissues but also makes the operation more safe generally (28).

Improved Outcomes in Complex Cases

Three-dimensional imaging and navigation tools have proven quite helpful in difficult gynecologic oncology operations. Usually related to advanced-stage cancer, these circumstances call for extra operations, such as lymph node dissection. Under these conditions, structural distortion may cause the tumor to have penetrated surrounding structures, so impeding surgical access (27, 28). Conventional 2D imaging or blind dissection techniques may not be sufficient in these complex conditions to give enough direction; hence, either partial resections, more complications, or worse surgical results (29).

With a thorough, three-dimensional view of the operating area, 3D imaging enhances the surgeon's ability to painstakingly negotiate complex anatomical features. In cases of advanced cervical or endometrial cancer, 3D imaging guarantees precise identification and dissection of these tissues, allowing the tumor to have spread to adjacent lymph nodes or the pelvic wall (30). By precisely locating affected nodes and analyzing the lymphatic network, 3D imaging assists surgeons with lymph node dissection to lower the risk of residual malignant tissue and raise the possibility of total excision.

Moreover, three-dimensional drawings allow surgeons to view the structures from multiple angles and perspectives, thereby helping them avoid inadvertently damaging surrounding tissues. Reduction of the possibility of consequences relevant in advanced gynecologic cancer treatments depends on this ability: lymphedema, bladder or intestinal damage, and hemorrhage (31).

Real-Time Surgical Planning and Decision-Making

Including 3D imaging into the surgical operation enhances procedural execution, intraoperative decision-making, and preoperative planning. Before operation, doctors can develop comprehensive treatment plans using 3D imaging data. This helps to fully grasp the features of the tumor, including its size, form, and proximity to important tissues, so enabling the prediction of possible outcomes (32).

Moreover, real-time, high-resolution images help dynamic decision-making during the surgical operation. Should unanticipated outcomes, such the tumor's interaction with nearby tissues or the discovery of other masses, the surgeon can quickly change their approach depending on the real-time, three-dimensional visual data. Depending on the changing visual data, ensuring the use of the most efficient and least invasive technique during the operation will help to enable real-time change in the surgical plan, so improving the outcomes (33).

Minimizing Surgical Risk and Complications

Often used in gynecologic oncology surgeries, three-dimensional imaging and navigation technologies help to reduce the risks and challenges related with surgical

operations. Modern technologies, which are marked by enhanced visibility and accuracy, greatly lower the possibility of inadvertently destroying important structures (34). Finding and conserving the ureters the tubes that transport urine from the kidneys to the bladder is absolutely critical during a hysterectomy for cervical or endometrial cancer. Two most often occurring results of urinary tract damage are urinary incontinence and renal failure. By skillful traversing and identification of challenging 3D imaging structures, surgeons can reduce the risk of ureteral complications (35).

Moreover, the precision of tumor removal made possible by 3D imaging guarantees the complete elimination of malignant tissue, so lowering the possibility of the tumor resurfacing. Studies using three-dimensional navigation during surgical operations have shown a rise in the percentage of whole tumor excision. This is especially true in cases when the tumor has a complex form or sits in difficult angles (36).

Future Potential and Integration with Other Technologies

As 3D imaging advances and interacts with other innovative technologies, we anticipate improved outcomes for gynecologic cancer surgeries. Three-dimensional imaging, intraoperative molecular imaging (IMI), and real-time lighting of tumor areas together could help doctors perform surgeries more accurately. Three-dimensional anatomical structure research, tissue differentiation between benign and malignant, and a higher probability of total tumor excision (37) would all be made possible by this convergence of technology.

Furthermore, on the brink of significantly improving navigation and 3D imaging systems are algorithms for artificial intelligence (AI) and machine learning. Important anatomical features could be automatically found or possible problems could be predicted using artificial intelligence and real-time imaging data. These advancements could result in more easily available, quick, and user-friendly 3D imaging and navigation systems, so improving surgical outcomes and patient safety (38).

Intraoperative Molecular Imaging

Modern and quickly developing method that can greatly increase surgical oncology's accuracy is intraoperative molecular imaging (IMI). During surgery, it provides real-time, extremely sensitive imaging that helps doctors find malignant areas invisible using more traditional imaging techniques. This sophisticated approach releases observable signals gathered by specialized cameras or imaging devices by using molecular tracers either fluorescent dyes or radioactive materials that are most preferably absorbed by cancer cells. In the management of gynecologic tumors, where the difficulty of obtaining complete tumor excision is sometimes exacerbated by the threat of residual disease, IMI's ability to identify hidden or microscopic cancer cells during surgery is especially important (37).

Principles and Technology Behind IMI

IMI's efficacy derives from the particular biological features of cancer cells. Tumor cells vary from normal tissue in many respects on the metabolic and molecular levels, including the expression of some proteins, enzymes, and receptors. IMI uses tracers able to specifically link to cancer cells to leverage these differences. Specialized imaging tools can see these tracers, usually attached with a radioactive element or a fluorescent dye. Fluorescent dyes, unlike radioactive tracers, emit light when excited by a specific wavelength (39).

Cancerous cells absorb the tracers once the tracers are injected into the patient either locally at the tumor site or systemically via the veins and arteries. Using specific imaging methods, the surgeon can view the surgical area and spot cancerous tissue depending on tracer signals. This process helps to identify tumor margins at a microscopic level, thereby improving the chances of total resection and reducing the possibility of residual malignant cells (40). When IMI is combined with more conventional imaging techniques such as MRI, CT, or ultrasonic waves, its advantages become most apparent. These methods may overlook small, subclinical cancer cell deposits or differentiate between benign and malignant tissues even if they do a great job of illuminating structures and anatomy. Using functional molecular data, IMI assists the surgeon in real time to ensure the complete removal of cancer cells, thereby preserving healthy tissue (41).

Applications in Gynecologic Oncology

In the field of gynecologic malignancies, I MI has shown great promise in improving surgical outcomes, particularly in cancers including ovarian, endometrial, and cervical ones with increased risk of residual disease. Many cancer types are associated with the microscopic spread of malignant cells that might go unnoticed to the unaided eye even in advanced disease stages (42).

1. Ovarian cancer

Usually resulting from its asymptomatic features in the first phases, ovarian cancer is often found at advanced stages. Small aggregates of cancer cells can be difficult to separate from surrounding healthy tissue once the tumor is found since the disease may have already spread to other areas of the abdomen or pelvis (43). In helping surgeons find peritoneal implants or

minor metastases otherwise missed, IMI has shown great promise. More thorough debulking which is necessary to improve patient outcomes is made possible by the ability to identify microscopic spread. Studies have shown that the use of fluorescent dyes, such indocyanine green (ICG), in ovarian cancer operations can help identify even minute deposits of cancer, so lowering the possibility of partial resection (44).

2. Endometrial Cancer

The most common gynecologic cancer is endometrial cancer, thus even if it is usually found early on, advanced cases may show difficult to detect lymphatic metastases or peritoneal dissemination. Particularly useful in spotting lymph node metastases—a common site for endometrial cancer's spread—is IMI (45). Radiolabeled tracers or fluorescent compounds allow surgeons to identify and remove affected lymph nodes during operation, so improving staging accuracy and lowering the risk of recurrence. Furthermore, IMI helps to confirm that the tumor margins are free of residual cancer cells, so reducing the local recurrence risk (46).

3. Cancer of the Colon

Often times, cervical cancer results in the tumor spreading to lymph nodes and parametrial tissues. Advanced stages may see the tumor permeating nearby tissues, so complicating the surgeon's ability to differentiate between malignant and normal structures. IMI offers a very successful approach for spotting tiny clusters of cancer cells that might have spread outside of the main tumor (47). In particular, IMI applied during a radical hysterectomy in cervical cancer can help to dissection affected lymph nodes and surrounding tissues, so enabling a more complete excision of malignant cells. Additionally under research is IMI's ability to identify pelvic lymph node metastases, a vital factor influencing treatment plan and cervical cancer patient prognosis (48).

Benefits of IMI in Gynecologic Cancer Surgery

Including IMI in gynecologic cancer operations has a number of advantages that would greatly affect patient outcomes:

1. Enhanced Tumor Excision Accuracy:

I MI can identify cancerous tissue unlike more conventional methods. Among its main benefits are these ones. By means of even small or microscopic cancerous cluster identification, the surgeon can remove all malignant tissue. This reduces the possibility of disease continuation, which might cause recurrence and negative effects down the road. In cases of diseases like ovarian and endometrial malignancies, which often spread microscopically, it is especially important to remove the tumor in whole. Improving survival rates depends on removing all malignant tissue during surgery (49).

2. Stopping Next Occurrences

Increasing the degree of tumor excision helps MI reduce the possibility of cancer returning. This is especially crucial for gynecologic tumors because local recurrence or metastases raise serious concerns. In ovarian cancer, for instance, sophisticated imaging might not be able to show the spread of small cancer cells to lymph nodes or the peritoneum. Minimizing the possibility of postoperative recurrence helps me, MI, to guarantee thorough investigations of these areas and, if necessary, biopsies or resections during surgery (50).

3. Drop in the postoperative problem incidence.

By helping doctors avoid needless dissecting of healthy tissues, IMI helps to lower the risk of damage to vital organs, including the bladder, bowel, and blood vessels. By accurately distinguishing cancerous tissue from healthy tissue, IMI lessens the need to remove healthy parts and helps avoid problems like bleeding, organ harm, and infections after surgery. In pelvic region surgeries, where vital organs are nearby (51), such identification is especially crucial.

4. Improved Treatment schedules and Staging

Excellent cancer treatment depends critically on accurate staging. I MI can increase staging accuracy by spotting malignant lymph nodes or metastatic tumors that might escape conventional imaging modalities. This improved capacity to evaluate the spread of disease guides choices on adjuvant treatments, including targeted therapies, radiation, or chemotherapy. More exact staging helps IMI to improve tailored treatment plans and increase general survival rates (52).

Challenges and Limitations of IMI

Though MI has tremendous promise, its general application in clinical practice is hampered. One great restriction is the need for specific tools and knowledge. Integrating IMI into regular surgical operations still requires a major infrastructure, equipment, and training investment even if technology is becoming more user-friendly. Using molecular tracers allows one to thoroughly evaluate the pharmacokinetics and safety aspects of the chosen drugs. A short half-life, poor tissue penetration, or inability to link to cancer cells while avoiding healthy tissue could make some radioactive tracers or fluorescent dyes useless (53).

The need for thorough clinical studies to show the safety and efficacy of new imaging agents and tracers as part of regulatory licensing adds still another level of challenge. Given their great cost, access to molecular imaging agents and specialized equipment

may be difficult when resources are limited.

Clinical Outcomes and Patient-Centered Considerations

Alongside the technical components of surgery, patient outcomes are a vital factor in assessing various hysterectomy methods. These outcomes encompass oncological findings (e.g., survival rates, recurrence rates), postoperative complications, recuperation durations, and the effect on a patient's quality of life (54).

Oncologic Outcomes

Any surgical intervention aimed at cancer has as its main goal improving survival rates. Studies on oncologic results using laparoscopic, robotic, and open hysterectomy methods abound. Especially for patients with early-stage cancers, these studies show that minimally invasive methods like robotic and laparoscopic hysterectomy have similar cancer outcomes to traditional open surgery (55). Equivalent survival results have been shown from robotic-assisted surgery; some studies suggest it may improve accuracy during lymph node dissection, which is essential for staging and prognosis (56).

Patient-Reported Outcomes

Crucially important markers of surgical success are patient-reported outcomes (PRRs), which include psychological well-being, quality of life, and pain levels. Particularly laparoscopic and robotic-assisted hysterectomy, minimally invasive procedures have shown to dramatically lower PROs when compared to open surgery (57). Those undergoing minimally invasive surgeries have less postoperative pain, fewer complications, and a faster return to normal activity. These advantages help patients to recover emotionally and psychologically since they often have less worry about the surgical treatment and recovery (54).

Since minimally invasive hysterectomy usually results in fewer scars, less pain, and a faster return to normal function, studies have also shown that it may result in better long-term quality of life for patients. It is important not to undervalue the psychological effects of surgery, since fewer problems and a shorter recovery time could help reduce the emotional load related to cancer treatment (58).

Personalized Treatment Approaches

Recent interest in the possible benefits of customized medicine in the therapy of diseases afflicting women has been rather active. Individual characteristics of patients age, tumor type, cancer stage, comorbidities, genetic composition, and molecular background—all help to direct the tailoring of hysterectomy treatments. These factors affect choices about the optimal surgical technique and the necessity of adjuvant treatments, such as radiation or chemotherapy (59).

For patients with advanced-stage malignancies, strict open surgical operations combined with chemotherapy or radiation may be necessary; for those with early-stage cancers, minimally invasive treatments may be successful. In addition to estimating the probability of recurrence, molecular markers and genetic profiles guide targeted treatment (60).

Challenges and Future Directions

Modern hysterectomy techniques have resolved many issues, but some still persist. One of the main problems is that, considering its substantial cost, robotic surgery is not offered in all nations or healthcare systems. Furthermore, not every surgeon will possess the required skills to execute robotic-assisted surgery even if, under the direction of qualified professionals, it has shown remarkable success (61).

Future research should focus on developments in robotic systems, cost reductions, and training courses allowing this technology to be more generally available. Furthermore, necessary for evaluation of the long-term effects of minimally invasive operations for advanced-stage cancer are continuous research and clinical trials. Applied in surgical planning and decision-making, artificial intelligence and machine learning can improve surgical results and change treatment strategies.

CONCLUSION

Minimally invasive and robotic-assisted methods for hysterectomy have revolutionized the treatment of tumor- invading women. Faster recovery times, fewer postoperative problems, and improved surgical accuracy are a few advantages of these improvements. Still unaddressed are issues with access, money, and specialized knowledge. Thanks to advancements in molecular profiling and technology, patients can now have customized treatment programs that are highly likely to improve their outcomes. Future hysterectomies for gynecologic cancers will definitely vary depending on continuous clinical research and improvements in surgical equipment, so optimizing patient outcomes and quality of life.

Authors's Contribution

Hananeh Habib: Conceptualization and writing. The authors read and confirmed the final manuscript.

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Consent for publication

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