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RECENT ADVANCES IN ROBOTIC AND MINIMALLY INVASIVE SURGERY IN OBSTETRICS AND GYNECOLOGY

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Abstract: Robotic and minimally invasive surgical techniques have transformed the field of obstetrics and gynaecology by improving surgical precision, reducing recovery time, and minimising complications. This review examines the technological advancements, clinical applications, benefits, limitations, and prospects in robotic and minimally invasive gynecologic surgery. With a growing emphasis on patient-centred and technology-driven care, robotic platforms such as the da Vinci system have become integral in procedures like hysterectomy, myomectomy, and oncologic surgery. Despite the advantages, challenges such as high costs and access disparities remain. This review highlights the importance of ongoing innovation and training to enhance access to these advanced surgical techniques.

Keywords: Robotic surgery, Minimally invasive surgery, Obstetrics and gynaecology, Laparoscopy, da Vinci system, Women's health, Surgical innovation

Introduction

Minimally invasive surgical (MIS) techniques have significantly advanced gynaecologic care, offering patients quicker recovery, less pain, and reduced postoperative complications compared to traditional open surgeries. Robotic-assisted surgery represents a major leap forward, especially in complex gynaecological procedures, since the introduction of robotic systems such as the da Vinci Surgical System, the landscape of gynaecologic surgery has experienced a notable transformation.

Technological Background

The evolution of gynaecologic surgery from open procedures to laparoscopy, and now to robotic-assisted surgery, marks a significant advancement in surgical care. Robotic platforms offer three-dimensional high-definition visualisation, tremor filtration, and instrument articulation that enhances surgical precision. The da Vinci system, in particular, provides ergonomic benefits for the surgeon and facilitates delicate tissue dissection and suturing.

Clinical Applications

Robotic and MIS techniques are now widely used in:

- **Hysterectomy:** Including both benign and malignant indications
- **Myomectomy:** Especially in fertility-preserving surgeries
- **Endometriosis excision:** For complex and deeply infiltrating lesions
- **Pelvic organ prolapse repair:** Such as sacrocolpopexy
- **Gynecologic oncology:** Including radical hysterectomy and lymphadenectomy

Advantages of Robotic & Minimally Invasive Surgery

- Smaller incisions and better cosmetic outcomes
- Reduced blood loss and need for transfusions
- Shorter hospital stays and quicker recovery
- Enhanced surgical precision and dexterity
- Improved visualization in confined pelvic spaces

Limitations and Challenges

Despite the benefits, there are notable challenges:

- High initial and maintenance costs of robotic systems
- Prolonged operative times during the learning curve
- Limited availability in rural and resource-poor settings
- Need for specialized training and credentialing

Recent Trends and Innovations

- **Single-port robotic surgery:** Reduced invasiveness and scarring
- **Augmented reality (AR) and artificial intelligence (AI):** For preoperative planning and intraoperative guidance
- **Tele-surgery:** Exploring remote robotic procedures in real-time
- **Enhanced recovery protocols (ERAS):** Integration with MIS for improved outcomes

Comparative Outcomes

Parameter	Open Surgery	Laparoscopic Surgery	Robotic Surgery
Blood Loss	High	Moderate	Low
Hospital Stay	4–7 days	1–3 days	1–2 days
Recovery Time	4–6 weeks	2–3 weeks	1–2 weeks
Complication Rate	Moderate	Low	Low
Cost	Low	Moderate	High

Future Directions

Future developments may include more cost-effective robotic platforms, greater integration of AI for surgical decision-making, and widespread training programs to ensure equitable access. Emphasis will also grow on developing systems that combine minimal invasiveness with personalised care approaches.

Case Studies:

- **Scenario 1:** Total Robotic Myomectomy in a Complex Case (India)

A 30-year-old woman with morbid obesity (BMI 42 kg/m²), uterine size equivalent to 22 weeks, multiple large fibroids (total weight ≈ 750 g), and coexisting endometriosis underwent total robotic myomectomy and endometriosis clearance**.** Surgery lasted ~160 minutes, she lost minimal hemoglobin, and recovery was uneventful—demonstrating feasibility well beyond traditional case limits.

- **Scenario 2:** Minimally Invasive Surgery in a Low-Resource Setting (Pakistan)

A quasi-experimental study compared minimally invasive (laparoscopic/robotic) versus open gynecologic surgeries in women with benign conditions. The MIS group showed significantly lower operative times**,** shorter hospital stays**,** and fewer postoperative complications**,** substantiating MIS benefits even in resource-limited environments**.**

Conclusion

Robotic and minimally invasive surgery in obstetrics and gynaecology has redefined modern surgical standards, enhancing both patient outcomes and surgeon capabilities. While the advantages are clear, broader implementation requires addressing cost, training, and access barriers. Continued innovation and policy support are essential for making these advanced techniques universally available.

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