

Role of Lasers in Gynaecology: Current Applications and Future Prospects

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Abstract: Lasers have revolutionized the field of gynaecology by enabling precise, minimally invasive surgical interventions with enhanced patient outcomes. Their ability to selectively ablate, vaporize, or coagulate tissues has made them valuable tools in managing various gynecological conditions such as cervical intraepithelial neoplasia, endometriosis, uterine fibroids, and genital aesthetic procedures. This review explores the principles of laser technology, the types of lasers used in gynecology, and their current clinical applications. Additionally, it discusses the benefits, limitations, and future directions of laser-assisted procedures in women's health.

Keywords: Laser surgery, CO2 laser, Endometriosis, Vaginal rejuvenation, Hysteroscopy, minimally invasive gynecology, Nd:YAG laser

1. Introduction

The incorporation of laser technology into gynaecology has significantly expanded the therapeutic options available to clinicians. Lasers offer unparalleled precision and reduced tissue trauma, making them ideal for delicate gynecologic procedures. Since their first use in the 1970s for cervical pathology, laser systems have evolved to serve both diagnostic and therapeutic purposes in modern gynecologic practice. With growing interest in minimally invasive surgery and cosmetic gynecology, the role of lasers continues to gain prominence.

2. Principles of Laser Technology

Laser is an acronym for 'Light Amplification by Stimulated Emission of Radiation'. Lasers emit coherent, monochromatic, and collimated beams of light that interact with tissue based on absorption, reflection, transmission, and scattering. The interaction depends on wavelength, tissue composition, and power settings. Common laser-tissue effects include cutting, ablation, coagulation, and vaporization. These properties enable surgeons to perform highly controlled and targeted procedures with minimal damage to surrounding tissues.

3. Types of Lasers Used in Gynaecology

Several types of lasers are used in gynaecologic practice, each with specific characteristics:

Carbon Dioxide (CO2) Laser: Highly absorbed by water, ideal for superficial ablation and vaporization. Widely used in cervical dysplasia and vulvar lesions.

Nd:YAG Laser: Deeper tissue penetration; used for fibroid coagulation and endometrial ablation.

KTP Laser: Absorbed by hemoglobin; useful in vascular lesions.

Diode Lasers: Compact, cost-effective, and used in laparoscopy and hysteroscopy.

Er: YAG Laser: Used in aesthetic gynecology and minimally invasive procedures involving the vaginal mucosa.

4. Clinical Applications of Lasers in Gynaecology

4.1. Treatment of Cervical Intraepithelial Neoplasia (CIN)

CO2 laser vaporization is a standard treatment for CIN, offering precise ablation with minimal scarring and preservation of cervical integrity. It is particularly useful in women desiring fertility preservation.

4.2. Endometriosis

Laser ablation allows the destruction of superficial and deep endometriotic implants while minimizing adjacent tissue damage. It reduces postoperative adhesions and improves fertility outcomes in selected cases.

4.3. Uterine Fibroids

Nd:YAG and diode lasers are used to coagulate and reduce fibroid volume via hysteroscopy or laparoscopy. Laser-assisted myomectomy offers better hemostasis and faster recovery.

4.4. Genital Aesthetic and Functional Procedures

Er:YAG and CO2 lasers are used for vaginal rejuvenation, labiaplasty, and treatment of genitourinary syndrome of menopause (GSM). These procedures have gained popularity for improving sexual function, lubrication, and quality of life.

4.5. Hysteroscopic Procedures

Lasers enable precise excision of intrauterine adhesions, polyps, and septa under direct visualization. They offer minimal bleeding and reduced risk of uterine perforation compared to electrosurgery.

5. Advantages and Limitations

Advantages:

- Precise tissue targeting with minimal collateral damage
- Reduced bleeding and operative time
- Faster healing and reduced postoperative pain
- Suitable for outpatient procedures

Limitations:

- High equipment cost and need for specialized training
- Safety concerns including eye protection and smoke inhalation
- Limited availability in low-resource settings

6. Future Prospects

Emerging technologies such as fractional lasers, robotic-assisted laser surgery, and laser-integrated endoscopic platforms hold promise for enhancing precision and safety. Research is ongoing in regenerative applications of lasers, such as endometrial rejuvenation and stem cell activation. Wider adoption of laser-based procedures will depend on cost reduction, standardization, and robust evidence of long-term efficacy and safety.

7. Conclusion

Laser technology has emerged as a transformative tool in gynecology, enabling safe and effective management of a wide range of conditions. With continued advancements and evidence generation, lasers are likely to play an increasingly central role in both conventional and cosmetic gynecology. Investment in training, infrastructure, and research is essential to fully realize their potential, especially in low- and middle-income countries.

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