Artificial intelligence: Implication in obstetrics and gynecology

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ABSTRACT

Over the past decades, digitalization and research rapidly evolved and also the use of artificial intelligence to solve system gaps and automate tasks to optimize services. Through data organization synthesis and analysis, AI (artificial intelligence) – has the ability to complete tasks that would take hundreds of hours for a person in just a few milliseconds. Artificial intelligence is a multi-disciplinary field with important implications for medicine, such as the electronic health record (HER) or it is necessary to be implemented in clinical practice. We elaborated a narrative review to show the role of AI in obstetrics and gynecology. It is important for clinicians to understand how AI works, improve its impact on healthcare, and prepare ourselves to utilize it.

Keywords: artificial intelligence, obstetrics, gynecology, machine learning, deep learning

INTRODUCTION

Artificial intelligence (AI) is a multi-disciplinary field that simulates human intelligence by machines such as computers. It can assist physicians and replace administrative tasks.

Machine learning (ML) is a method for AI; it is the process in which machines ingest data, identify its pattern, and can predict relationships based on the patterns learned.

Deep learning (DL) is an ML technique to process input, make an assumption about data and analyze them. On the other hand, Artificial Neural Network is designed by programming computers to behave as interconnected brain cells, able to perform tasks by being exposed to various datasets and examples without any task-specific rules.

The questions nowadays are: can artificial intelligence monitor a pregnancy correctly? Could it predict correctly the onset of labor? What are the benefits of using AI in IVF? Is AI useful in training and simulation? How can AI help in benign and malignant gynecological conditions?

ROLE OF AI IN PREGNANCY HEALTH SURVEILLANCE

Pregnancy surveillance is mandatory during the early stages of pregnancy. In a systematic review, Davidson et al. (1) described the benefits of AI in pregnancy health surveillance, varrying from disease screening, pharmacologic support, predicting the mode of delivery, and postpartum diseases.

Fergus et al. (2) elaborate an algorithm using Electrohysterography (EHG) to provide a viable way of diagnosing true labor.

Cardiotocography (CTG) is a reliable and very effective method to diagnose fetal health during labor, but the interpretation could be very subjective from one physician to another. Algorithms are able to accurately analyze and identify CTG fundamental patterns; thus, it could improve the effectiveness of the interpretation and improve the physician's decision-making. Lu et al. (3) suggested that AI analysis of CTG signals could support obstetricians' function more effectively.

Other algorithms are studied like Computer Aide Foetal Evaluator (4) (CAFE), INFANT study protocol

(5) and System 8000 (6), they have all proven their efficiency. Finally, Davidson et al. (1) proved that the future of AI in pregnancy health surveillance permits better and more informed decision making, and ML is a tool that enables improving science but requires validation for a wider population.

ROLE OF AI PREDICTING THE ONSET OF LABOR

For obstetricians, predicting the exact time of labor could be a challenging task; for the patient it is a considerable emotional cost. The use of algorithms could provide a valuable solution. Software to self-report conditions and other methods like diaries could help gather more useful data and use them for wide use and better understanding. On the other hand, Fergus et al. (2) studied the uterine electric signal - EHG and suggested a viable diagnosis of true labor and the ability to predict preterm deliveries and was proven to be an effective and reliable tool. Future work will permit the discovery of more accurate patterns.

Idowu et al. (7) investigated various algorithms to classify their performance. The results are insufficient to predict preterm birth accurately, but further research could significantly help predict it and thus offer better health care for the patients. In conclusion, an ML classification algorithm could provide a robust method to predict. AI has the potential to act as a tool to determine the precise viability among a wider range of population

BENEFITS OF AI IN ASSISTED REPRODUCTIVE TECHNOLOGY

In assisted reproductive technology (ART), the development of AI imported many opportunities; AI permits high-quality embryos choosing by identifying the chromosomally abnormal ones, giving precision in interpreting more data in less time than a human using the time-lapse microscopy (8,9). Moreover, AI is very useful in sperm morphology identification and automatic follicle counts (10). It also permits automation in predicting the stage of embryo cells and their evaluation. The application of the inception-V1 algorithm showed 97.6% accuracy in differentiating good and bad embryo cells (10). AI also gives improved simulation protocols and can predict precisely certain diseases.

Leung et al. (11) developed an automated sperm immobilization that enables considerable time saving and training as it was conventionally performed manually; the algorithm demonstrated an 88.2% success rate. Moreover, it can visually track a sperm cell and immobilize it using a micropipette. Although more research is ongoing in order to establish an algorithm able to predict the likelihood of successful pregnancy based on the quality of embryos and clinical parameters, AI could probably detect patterns of morphology invisible to human eyes in the near future.

ROLE OF AI IN DIAGNOSIS AND DECISION MAKING IN GYNECOLOGY

AI has proven its efficacy in gynecology, algorithms can predict clinical outcomes in order to determine response to medical treatment. Luo et al. (12) succeeded in predicting fibroid volume reduction after treatment using a Residual Convolutional Neural Network (ResNet). In the studies, all AI models have higher accuracy in predicting outcomes compared to the trained radiologist. Although Luo et al. was limited in their study by relying on data from a single institution, further research will determine more pathways and develop stronger algorithms. This will lead to an improvement in diagnosing the benign condition and predicting their prognosis.

On the other hand, Lawlor et al. (13) introduced AI in screening uterine masses to study leiomyosarcoma that accounts for 8% of uterine malignancies. It appears that AI is very useful in the diagnosis and screening (14,15). Malek et al. (16) developed ML to differentiate leiomyosarcomas from benign fibroids; the Random Forest classifier developed has a 100% sensitivity and 90 specificities in his cohort of 42 patients. This result is very promising, AI should be developed more to achieve its best performance.

In oncology, AI has the potential to develop in the field of early cancer diagnosis. Although Elias et al. (17) attempted using an RNA for the early detection of ovarian cancer, it appears to have huge biologic relevance, and he suggested that miRNAs could be developed for a non-invasive diagnostic test.

Endometrial cancer is the most common cancer encountered in gynecology, Takahashi et al. (18) developed an automated system that uses deep learning technology for diagnosing endometrial cancer using hysteroscopy. His algorithm processes image collected for the uterine cavity through hysteroscopy and categorize them in groups that proved a 91% accuracy in diagnosing endometrial cancer and improves the survival rate of woman.

ROLE OF AI IN TRAINING AND SIMULATION

For medical students, AI should be empowering, it can help understand better the anatomy through software and 3d representation. On one hand, it allows them to train on simulators, different scenarios varying from basic medical knowledge to ad-

vanced surgical techniques using laparoscopy or robotic surgery simulators (19), on the other hand, emerging technologies as head-mounted display or holograms are the next big step (20). AI should be incorporated more in teaching and clinical practice.

Considering the high cost of these new techniques, developing low-cost virtual reality simulators should be mandatory, Bing et al. (21) showed in Africa, with limited access to surgical oncological training, that participation to the simulation generated confidence, knowledge, and also skills.

ROLE OF AI IN ENHANCING SURGICAL SKILLS

Virtual reality is used for simulation and training, and the concept of a machine-augmented surgeon seems to be a futuristic idea, but it is currently developed and used by different teams around the world, it is known as Augmented Reality (AR). For example, it can be used to overlay anatomical landmarks during surgery to increase efficacy and decrease the risk of errors. In addition, it can allow the surgeon to superimpose preoperative imaging on the surgical fields and highlight structures using markersl; it has been proved to increase surgeon accuracy during surgery.

Bourdel et al. performed a prospective study on the porcine model to evaluate the potential of AR in tumor resection using the laparoscopic view augmented with pre-operative data (22). Nine tumors were resected in this study that showed the accuracy of surgical resection while visualizing vascularization and resection margin.

Bourdel developed an algorithm that projects hidden subsurface structures by endoscopic imaging (23,24) using adenomyomas as a model (Figure 1). The software can recognize uterus mobility and the transmitted image is very accurate. The principles rely on using preoperative imaging to be overlaid and fused with endoscopic imagery in real-time. With further development, this method could be used in various gynecologic surgeries, facilitating the localization of anatomical markers and increasing performance and the procedure's safety.

While this method required an extremely trained surgeon able to understand the concept and manually mark the occluding contours of the uterus during surgery, further research by Francois et al. (25) developed a program permitting the use of AR with an automatic setting, this is a huge step toward the generalization use of AR in endoscopic surgery.
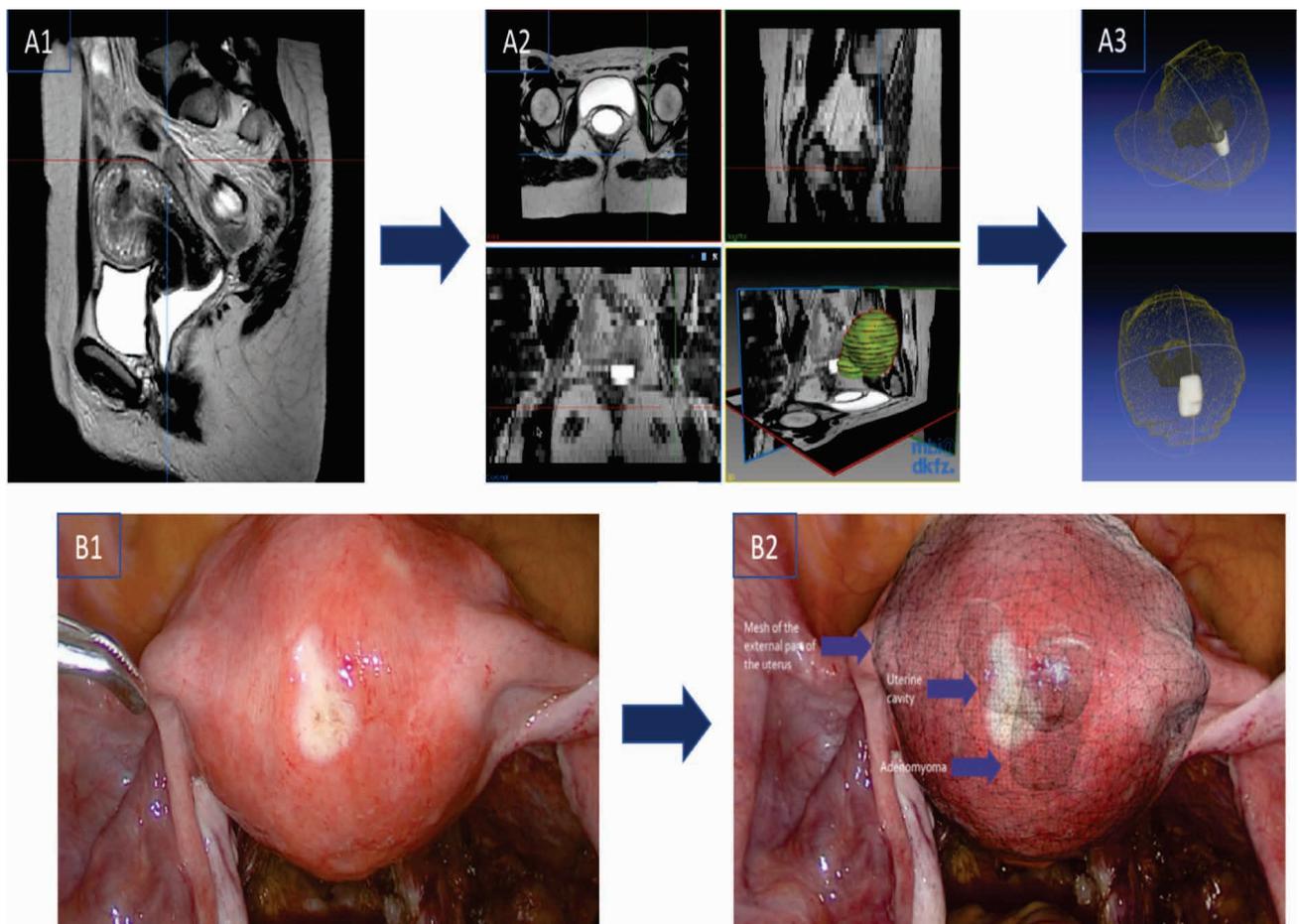

FIGURE 1. Use of augmented reality in a gynecologic surgery to visualize adenomyomas, with permission from Bourdel (23)

Other teams are ongoing in this field, and the future is promising, Akladios et al. (26) developed on animal models an algorithm based on AR to visualize the ureters. It experimented on 2 pigs, and the technique proved to be feasible, the reconstruction was accurate.

CONCLUSIONS

It is important for clinicians to understand how AI works, improve its impact on healthcare, and prepare themselves to utilize it. However, we must respect the patient-physician relationship and work to improve the future.

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