Can AI Support Surgical Training and Education?

Rasit Dinc

Rasit Dinc Digital Health & AI Research

Published: December 27, 2018 | AI in Surgery and Robotics

DOI: 10.5281/zenodo.17998871

Abstract

Artificial intelligence (AI) is no longer a concept confined to science fiction; it has become an integral part of our modern technological landscape, with a...

Can AI Support Surgical Training and Education?

Author: Rasit Dinc

Introduction

Artificial intelligence (AI) is no longer a concept confined to science fiction; it has become an integral part of our modern technological landscape, with applications spanning across various industries. The medical field, and particularly surgery, is no exception to this transformation. As surgical procedures become more complex and data-driven, AI presents unique opportunities to revolutionize how surgical skills are taught and practiced [1]. This article explores the potential of AI to support surgical training and education, delving into the opportunities, challenges, and ethical considerations associated with its integration.

The Evolution of Surgical Training

The traditional model of surgical training, based on the apprenticeship-style mentorship, has been the standard for centuries. However, this model faces challenges in the modern era, including variability in the quality of mentorship, limited exposure to rare surgical cases, and constraints on hands-on opportunities due to patient safety concerns [2]. The evolution of surgical techniques, from open to minimally invasive and robotic-assisted procedures, further necessitates a shift in training methodologies. This has led to the development of competency-based training models, which focus on ensuring that trainees acquire a specific set of skills and knowledge before they can practice independently. AI is poised to play a pivotal role in this new paradigm of surgical education.

AI's Role in Surgical Education

AI offers a multitude of tools and techniques that can enhance surgical education and training. These can be broadly categorized into personalized learning, simulation-based training, and intraoperative guidance and assessment.

Personalized Learning

AI algorithms can analyze a trainee's performance data to identify their strengths and weaknesses, allowing for the creation of personalized learning paths. This tailored approach can help trainees focus on areas where they need the most improvement, potentially reducing training time and increasing the efficiency of surgical education [3]. AI-powered platforms can also provide trainees with curated educational materials, such as articles, videos, and quizzes, based on their individual learning needs.

Simulation-Based Training

One of the most significant contributions of AI to surgical education is in the realm of simulation. Virtual reality (VR) and augmented reality (AR) simulators, powered by AI, can create highly realistic and immersive training environments. These simulators allow trainees to practice surgical procedures in a safe and controlled setting, without any risk to patients [1]. AI can also provide real-time feedback during simulations, helping trainees to refine their techniques and correct their mistakes. This is akin to having a virtual mentor available at all times.

Intraoperative Guidance and Assessment

AI is not limited to the training lab; it can also provide valuable support in the operating room. AI-powered systems can analyze real-time data from surgical instruments and cameras to provide intraoperative guidance to surgeons. For example, an AI system could highlight critical anatomical structures or provide warnings about potential complications. Furthermore, AI can be used for objective and automated assessment of surgical skills. By analyzing video recordings of surgeries, AI algorithms can evaluate a surgeon's performance based on a variety of metrics, such as efficiency of movement, tissue handling, and adherence to best practices [2]. This provides a more objective and standardized method of assessment compared to traditional, subjective evaluations by human observers.

Opportunities and Challenges

The integration of AI into surgical education presents a wide range of opportunities, but it also comes with its own set of challenges.

| Opportunities | Challenges | | --- | --- | | Personalized learning experiences | Lack of standardization in surgical procedures | | Realistic simulation-based training | Data privacy and security concerns | | Predictive modeling for complication avoidance | Potential for bias and discrimination in AI algorithms | | Augmented reality for real-time guidance | Lack of a clear regulatory framework | | Remote training and telementoring | Risk of overreliance on technology | | Objective and automated skills assessment | High cost of implementation |

Ethical Considerations

The use of AI in surgical education also raises several important ethical questions that need to be addressed. These include:

Informed Consent: *Patients must be informed if their data is being used to train AI algorithms, and their consent must be obtained.* **Privacy and Confidentiality:** Patient data is highly sensitive and must be protected from unauthorized access and misuse. ***Bias:*** *AI algorithms are only as good as the data they are trained on. If the training data is biased, the AI system may perpetuate and even amplify existing disparities in healthcare.* **Responsibility:** Who is responsible if an AI system makes a mistake that leads to a negative outcome? This is a complex question that needs to be addressed through clear legal and ethical guidelines.

Conclusion

AI has the potential to be a transformative force in surgical training and education. By providing personalized learning experiences, realistic simulations, and objective assessments, AI can help to create a new generation of highly skilled and competent surgeons. However, it is crucial to address the challenges and ethical considerations associated with this technology to ensure that it is used in a responsible and beneficial manner. The future of surgical education will likely involve a close collaboration between human educators and AI-powered tools, working together to improve patient outcomes and advance the field of surgery.

References

[1] Valente, D. S., Brasil, L. J., Spinelli, L. de F., Vilela, M. A. P., & Rhoden, E. L. (2025). A narrative review of transforming surgical education with artificial intelligence: opportunities and challenges. *AME Surgical Journal*, *5*. https://asj.amegroups.com/article/view/97081/html

[2] Rubalcava, N. S., Guetter, C. R., Kapani, N., & Quiñones, P. M. (2023, August 9). How Artificial Intelligence Is Expected to Transform Surgical Training. *American College of Surgeons*. https://www.facs.org/for-medical-professionals/news-publications/news-and-articles/bulletin/2023/august-2023-volume-108-issue-8/how-artificial-intelligence-is-expected-to-transform-surgical-training/

[3] Satapathy, P., Hermis, A. H., Rustagi, S., Pradhan, K. B., Padhi, B. K., & Sah, R. (2023). Artificial intelligence in surgical education and training: opportunities, challenges, and ethical considerations – correspondence. *International Journal of Surgery*, *109*(5), 1543–1544. https://pmc.ncbi.nlm.nih.gov/articles/PMC10389387/