



THE ROLE OF ARTIFICIAL INTELLIGENCE AND ROBOTIC TECHNOLOGIES IN SURGICAL PRACTICE

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ABSTRACT

Artificial intelligence (AI) and robotic technologies play an important role in improving diagnostic accuracy and optimizing surgical planning, although their overall impact has not yet been fully explored. This study aims to systematically analyze the role of AI and robotic technologies in surgery. The research was conducted using a systematic literature review methodology based on 14 scientific articles published between 2020 and 2024. The results indicate that AI significantly improves disease-detection accuracy and helps predict surgical outcomes, while robotic technologies expand the possibilities of minimally invasive surgery, improve patient safety, and reduce surgical errors. These technologies are transforming modern surgery and offering patients more effective and safer treatment options; however, their integration also raises ethical and legal concerns.

Introduction

Surgical practice is undergoing significant changes through the use of artificial intelligence (AI) and robotic technologies, which play an important role in improving diagnostic accuracy, optimizing surgical planning, and ensuring greater precision during operations [1, 2, 4, 5, 7]. However, the overall impact of these technologies on surgical practice, including their benefits, challenges, and prospects, has not yet been fully explored. This study aims to systematically analyze the role of artificial intelligence and robotic technologies in surgery.

RQ1: What are the main applications of artificial intelligence in surgical diagnosis and planning?



RQ2: How do robotic technologies improve surgical precision and minimally invasive procedures?

RQ3: What are the main challenges and ethical issues involved in integrating these technologies into surgery?

Main Body

Literature Review: Recent studies have extensively examined the role of artificial intelligence (AI) in surgical diagnosis and planning [1, 4]. In particular, AI is important for improving disease-detection accuracy through image analysis [7] and predicting surgical outcomes [8]. Robotic technologies, meanwhile, have supported the development of minimally invasive surgical procedures and significantly improved surgical precision and patient safety [2, 5, 6]. These technologies also offer opportunities to reduce surgical errors [14]. In addition, the literature discusses ethical and legal challenges associated with integrating AI and robotic technologies into surgery [10, 11], as well as educational approaches based on virtual and augmented reality [12, 13].

Research Methodology: The study was based on a systematic literature review. PubMed, Scopus, Web of Science, Google Scholar, and scientific journals published in Uzbekistan were searched for the period 2020–2024 using the keywords “artificial intelligence surgery” and “robotic technology surgery” [1, 2, 4, 5].

Inclusion Criteria: Articles published after 2020 that examined AI and robotic technologies in surgery were included [3, 10, 11].

Exclusion Criteria: Conference abstracts and sources not directly related to the topic were excluded.

Of the initial 120 sources, 45 remained after duplicates were removed; 14 articles met the criteria and were included in the final analysis [8, 9, 14].

Analysis and Results: The analysis indicates that artificial intelligence (AI) is playing a central role in surgical diagnosis and planning. By analyzing images, AI significantly improves the accuracy of disease detection [7] and helps predict surgical outcomes, making it possible to develop personalized treatment plans [8]. Its role in optimizing surgical planning, including preoperative mapping, is also highly valued [1, 4]. Robotic technologies support the expansion of minimally invasive procedures and may help shorten recovery time and reduce pain for patients [2, 5]. They can improve surgical precision and patient safety while helping to reduce surgical errors [6, 14]. Ethical and legal challenges associated with integrating these technologies into surgery have also been identified, including issues of data privacy and accountability [10, 11]. Virtual- and augmented-reality-based educational methods serve as useful tools for surgical training [12, 13]. Table 1 summarizes the main areas in which AI and robotic technologies affect surgical practice.



Table 1. Main areas of impact of AI and robotic technologies in surgical practice

Technology	Application area	Outcome / impact
Artificial intelligence	Diagnostics	More accurate disease detection [7]
Artificial intelligence	Planning	Prediction of surgical outcomes [8]
Artificial intelligence	Image analysis	Optimization of preoperative mapping [1, 4]
Robotic technologies	Minimally invasive surgery	Shorter recovery time [2, 5]
Robotic technologies	Surgical precision	Improved patient safety [6]
Robotic technologies	Error reduction	Minimization of surgical errors [14]
General	Integration	Ethical and legal challenges [10, 11]
General	Education	Applications of virtual and augmented reality [12, 13]

Discussion: The findings of this study confirm the important role of AI and robotic technologies in improving diagnostic accuracy [7, 8], optimizing surgical planning [1, 4], and supporting minimally invasive procedures and greater precision [2, 6]. These findings are consistent with the conclusions of international researchers such as Hashimoto et al. [1] and Mylonas and Darzi [2], reinforcing the transformative potential of these technologies in surgery. Nevertheless, the ethical and legal issues that arise during their integration require further investigation [10, 11]. The study is limited by the number of selected literature sources and the scarcity of empirical data in the context of Uzbekistan. Future research should evaluate the long-term clinical outcomes and cost-effectiveness of these technologies.

Conclusion

This study has shown that artificial intelligence and robotic technologies play an important role in improving diagnostic accuracy, optimizing surgical planning, and enabling minimally invasive procedures. These technologies can improve patient safety, accelerate recovery, and reduce surgical errors. In the future, it will be important to expand their integration, address ethical and legal issues, and provide surgeons with continuous training using virtual-reality-based methods.



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