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CURRENT APPLICATION OF ARTIFICIAL INTELLIGENCE FOR INTRAOPERATIVE DECISION SUPPORT IN SURGERY

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ABSTRACT:

In recent years, surgical uses of artificial intelligence (AI) in medicine have advanced significantly. In this scoping review, artificial intelligence-based decision support systems for intraoperative surgery were investigated. A wide range of technological solutions were found to be used across various surgical specialties. Three major types of motivations for developing such technologies were found in the twenty-one (n = 21) publications that were included: (1) enhancing the information available to surgeons, (2) speeding intraoperative pathology, and (3) advising surgical actions. The majority of the examined studies contained significant methodological flaws that made it challenging to evaluate the clinical significance of the provided performance statistics, even though many of the recommendations showed promise for improving patient outcomes. Despite restrictions, the state of this field at the moment indicates that a number of opportunities exist for future researchers and clinicians to work on AI for surgical decision support with exciting implications for improving surgical care.

Keywords: artificial intelligence; clinical decision support systems; computer vision; decision support; deep learning; intraoperative; machine learning; surgery.

UPCOMING DEVELOPMENTS OF AI:

The development of artificial intelligence (AI) has transformed current surgery toward more autonomous and precise intervention for treating both acute and chronic problems. By utilising these methods, significant advancements in surgical robotics,
intraoperative guidance, and preoperative planning have been made.

In light of this, our researchers provide a summary of the current situation, new developments, and significant obstacles that will likely arise in the development of artificial intelligence in surgery.
They also offer some potential solutions to these difficult problems.

An outlook on how surgery will develop in terms of preoperative planning,

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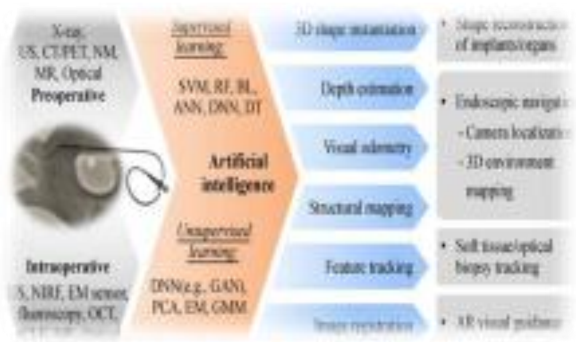
intraoperative guiding, surgical robotics, and potential ethical and legal difficulties.

AI FOR INTRAOPERATIVE GUIDENCE:

Minimally invasive surgery (MIS), which is increasingly paired with robotic aid, lowers surgical trauma. An essential component of MIS has always been computer-aided intra operative guidance.

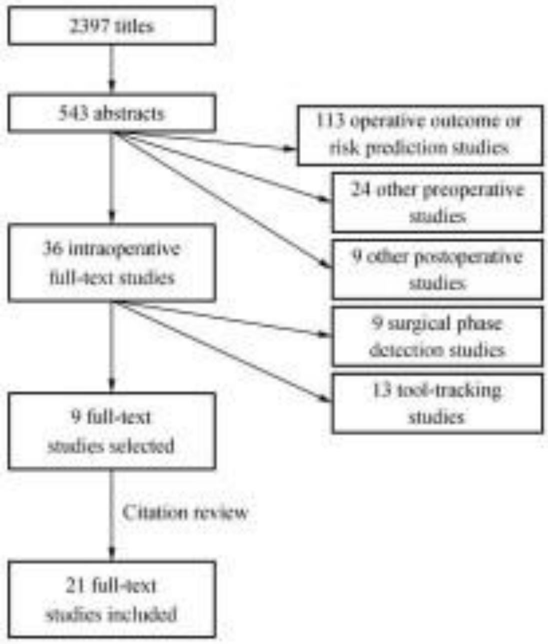
In order to improve localization and visualisation during surgery, learning methodologies have been deeply included into the creation of intra-operative guiding.

In MIS, computer-aided intra-operative assistance uses AI approaches primarily in four areas: Shape instantiation, endoscopic navigation, tissue tracking, and augmented reality are the first four (AR).



OUTCOMES OF AI IN SURGERY:

The database search yielded 2397 titles in total, and 543 abstracts were qualified for screening (included articles on preoperative and postoperative functional stages). Nine of these manuscripts—all of which addressed the perioperative stage—were chosen for inclusion. An extra 6 papers that qualified after the citations were reviewed, and an additional 6 papers that qualified when the citations in the additional papers were reviewed. The final analysis comprised 21 publications that had been reviewed in total (Fig. 1).



Gynecologic surgery, neurosurgery, general surgery, ophthalmologic surgery, and endocrine surgery were only a few of the surgical specialties included in the publications. These research used multimodal data that includes surgical videos, imaging modalities (such as optical coherence tomography and hyper-spectral imaging), and intraoperative variables including heart rate and blood pressure.The reasons indicated for the introduction of AI to the surgical context were the most common elements among the examined studies, given the variety of methodologies and themes.

The papers summarised here have been divided into three categories based on the three main drivers we identified: (1) giving surgeons additional information during operations, (2) accelerating intraoperative pathological diagnoses, and (3) direct recommendation of surgical steps in situations where experts who can make those determinations are scarce or unreliable (Fig. 2). We concentrate on four aspects of each study in the summaries: motivation, techniques, data set characteristics, and evaluation procedure.

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Reviewed applications of artificial intelligence for intraoperative decision support

1. Increasing the information available to surgeons
   - Replacing lost sensory input during minimally invasive surgery (n = 2)
   - Automated retrieval of similar cases (n = 7)
2. Accelerating intraoperative pathology
   - Tumor margin mapping (n = 3)
   - Tumor classification (n = 3)
   - Tissue identification (n = 4)
3. Recommending a surgical step
   - Improving spinal trauma alarm reliability (n = 1)
   - Mitigating surgery-specific expert shortages (n = 1)

Fig. 2 Motivations cited by reviewed papers for developing artificia intelligence-based intraoperative decision support systems.

CONCLUSION:

The enhancement of patient care should be the aim of intraoperative AI. In this review, we found a number of publications that performed a great job of locating an appropriate point of view.

Adding AI to the surgical workflow could result in an intervention that benefits the patient. The field is still young, therefore future research can be set up to have as much therapeutic relevance as possible. Future research should concentrate on making sure that data sets are representative of the target patient groups, have adequate and clinically relevant ground truth, and are validated in ways that are reflective of clinical use.

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