



From science fiction to operating room: Representations of surgery and AI in film and their ethical implications

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ABSTRACT

This paper examines the intricate relationship between surgical practice, artificial intelligence (AI), and science fiction movies, focusing on how imaginative storytelling has foreshadowed and influenced the development of modern medical technologies. Tracing the timeline from the Industrial Revolution to the digital era, it discusses key advancements such as robotic-assisted operations, virtual reality-based surgical education, augmented reality applications, and telehealth services. The analysis draws on well-known films—including *Prometheus*, *2001: A Space Odyssey*, *Star Wars*, and *Fantastic Voyage*—to examine how cinema has portrayed autonomous surgical tools, ethical challenges, and the evolving interaction between humans and machines. These fictional examples are compared with real-world innovations like the Da Vinci robotic system, mobile messaging for remote consultations, and AI-driven diagnostic methods. The article also addresses broader cultural shifts, including the rise of patient-focused care, greater inclusion of women in surgical roles, and the prioritization of empathy and ethical reasoning in clinical practice. Ultimately, the study asserts that while technology continues to transform surgery, the human touch remains essential. A harmonious integration of advanced tools and compassionate care is necessary to sustain the ethical and humane foundations of surgical medicine.

Keywords: Science, surgery, artificial intelligence, robotic surgery, augmented reality ethics

INTRODUCTION

The rate of social change and transformation is increasing. Futurist Toffler (1) envisioned human history as a series of three revolutionary ages—the information, the industrial, and the agricultural ages—in his 1980 book *The Third Wave*. He suggested that the information age would end in just one hundred years, whereas the agricultural and industrial revolutions lasted approximately one thousand and three hundred years, respectively (1).

The rapid technological development over the last forty years has raised the possibility that the information era will end even sooner than Toffler (1) predicted.

The healthcare industry is one of the fields most significantly impacted by these quick developments. In the past, the goal of medicine has been to improve the effectiveness, accessibility, and quality of its services.

This evolution has been supported by several important forces, such as;

- Changes in the demographics
- Modifications in illness futures and patient expectations,
- Constant developments in technology.

Scientific discoveries have made radical changes in medicine since the beginning of the industrial revolution.

Some of the noteworthy milestones are:

- The invention of the microscope, which made it possible to identify microorganisms as disease-causing agents,
- The introduction of anesthetics, which transformed the comfort and safety,
- The official founding of hospitals and specialties and subspecialties within the medical field.

Cite this article as: Cantürk NZ. From science fiction to operating room: representations of surgery and AI in film and their ethical implications. *Turk J Surg.* 2026;42(2):258-266

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Received: 12.08.2025

Accepted: 26.02.2026

Epub: 04.03.2026

Publication Date: 04.06.2026

DOI: 10.47717/turkjsurg.2026.2025-8-16

Available at www.turkjsurg.com



Even though progress has accelerated, not all innovations have been warmly received. The quote from the ancient philosopher Confucius that best captures humanity's persistent resistance to change is, "Life is simple, but we insist on making it complicated". Resistance to innovation has been a recurring phenomenon throughout history, as illustrated in Figure 1. However, a failure to understand and adjust to change may ultimately impede the progress of society.

A still from 1899's film, which is regarded as the first known cinematic representation of a surgical procedure, is seen in Figure 2. Alejandro Posadas (1870-1902), an Argentine surgeon, is shown operating with the assistance of medical students in this vintage video. Interestingly, Rodolfo Santiago Roccatagliata, an assistant, regularly drips anesthetic from a vial onto a mask. Although these scenes provide insight into the history of surgery, they also encourage contemplation of the limitations of the time and stimulate ideas about what surgery might be able to do in the future (2).

Science fiction has been a literary genre that pushes the boundaries of human imagination for over 200 years. In technologically advanced cultures, writers have always conjectured about what doctors and surgeons could be capable of. Surprisingly, science fiction has frequently been a prophetic medium, foreshadowing advancements in medicine. Robotic prosthetics and nanobots, two technologies that were previously only seen in science fiction books and movies, are increasingly finding real-world uses in contemporary healthcare.

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Figure 1. Throughout history, people have worked for change, yet they have also shown resistance to it. (<https://www.google.com/url?sa=i&url=https%3A%2F%2Ftr.pinterest.com%2Fouido%2F&psig=AOvVaw2eJXLV1zZ6ih7Z8dmM8Jhz&ust=1753787763837000&source=images&cd=vfe&opi=89978449&ved=0CBEQjRxqFwoTCjK4Nq2344DFQAAAAA dAAAAABAz>)

prosthetics and nanobots, two technologies that were previously only seen in science fiction books and movies, are increasingly finding real-world uses in contemporary healthcare. Science fiction is a conceptual roadmap for future innovation as well as a mirror of human aspirations. Once merely theoretical ideas, robotic technologies have quickly developed into instruments in the field of surgery. These technologies, which were first sparked by the fantastical worlds of science fiction, have since been integrated into actual industrial and medical systems. In addition to being commercially available, robotic surgical platforms are now often used in clinical settings. We can now do several procedures that were previously done laparoscopically because of our institution's recent adoption of the Da Vinci robotic surgical equipment (3,4).

Hugo Gernsback, a pioneer in early radio broadcasting and print publishing, was one of the first to imagine remote medical engagement. This technology integration has improved surgical precision and expanded the range of minimally invasive interventions (Figure 3). Long before the telemedicine era, he proposed the "teledactyl" (Figure 4), a novel device with mechanical arms and a display that would allow doctors to physically interact and visually assess patients from a distance. The teledactyl was envisioned as a futuristic tool that would allow doctors to perform remote physical examinations with tactile feedback. Its prospective uses extended beyond remote real-time diagnostics to in-room patient monitoring. In order to make accurate and thorough diagnoses in the future, the device was designed to detect thermal and aural clues (5,6). These forward-thinking ideas foresaw a paradigm shift in the doctor-patient interaction, one that was becoming more and more mediated by technology.

This pattern has been confirmed by developments since the 1970s. Notably, telehealth became an essential tool for sustaining medical care during the coronavirus disease-2019 (COVID-19) epidemic, much like virtual education did in terms of maintaining continuity in the face of worldwide upheaval (7).



Figure 2. A scene from what is believed to be the oldest film depicting a surgical procedure, dated 1899 (2).

An important turning point in the delivery of digital healthcare was reached when our hospital was the first in Türkiye to employ WhatsApp for video-based medical consultations, reviewing their data through our hospital's electronic records and software



Figure 3. Robotic surgery in our operating room.



H. Gernsback, Editor of RADIO NEWS, receiving the television broadcast from WRNY at his home in New York City, with the simple apparatus described in this article. For purposes of the test, the neon tube and loud speaker were connected in series temporarily, with successful operation simultaneously.

Figure 4. Hugo Gernsback and the "teledactyl" (https://tr.m.wikipedia.org/wiki/Dosya:Gernsback_Television_1928.png).

systems, and offering diagnoses and recommendations accordingly (Figure 5). Physicians could remotely access patient data and provide diagnostic assessments and suggestions by integrating with our institution's clinical software and electronic health records (EHRs). Despite being new at first, these methods are now widely used, especially in disciplines like psychiatry. In Türkiye, one such professional application now implemented by many private and public health institutions is called "E-vital" (8). The practice of prescribing drugs remotely has grown in popularity, and advances in telepresence applications have also been made in the surgical field. Notably, the first-time robotic assistance was used for a brain biopsy was in 1985 (9). The first robot-assisted laparoscopic cholecystectomy was carried out two years later (10). The potential for cross-continental surgical treatment was shown in 2001 when a surgical team in New York used cutting-edge robotic technology to successfully perform a tele-surgical procedure on a patient in Strasbourg (11). The strategic significance of tele-surgical capabilities in military and remote contexts is highlighted by the potential of such breakthroughs, especially for situations where urgent surgical competence is absent, such as emergency surgeries onboard naval vessels stationed at sea. But can people truly entrust their bodies to a machine, allowing it to alter their physical integrity? As a surgeon, I may be speaking emotionally, but I am among those who doubt this will become widely acceptable.

The use of self-operating robotic equipment, the "MEDPOD", by Elizabeth Shaw to execute an open abdominal treatment and remove an alien organism is a noteworthy cinematic example of autonomous surgical intervention in the film Prometheus



Figure 5. A first in Türkiye: video consultations with patients via WhatsApp in our hospital.

(12). Speculative narratives about the possible autonomy of surgical systems—concepts that were originally purely fictional but are now being discussed more and more in real-world technical discourse—are reflected in this dramatization. In the United States, a fully autonomous robot completed a whole surgical procedure, marking a significant advancement in surgical robotics (13). Even though these incidents are still unusual, they represent a significant change in the ethical issues and technological capabilities related to machine-led medical interventions. Today, advancing technology allows doctors and patients to remain connected even when in-person visits are impossible. In our era, both doctors and patients can access and download their medical records; doctors can consult with one another without institutional limitations. Soon, even lab tests may be conducted from home. Türkiye's "E-Nabız" platform is a notable illustration of digital health innovation, offering consumers immediate, secure access to a variety of healthcare services, including their medical information. This approach is a prime example of how technology can empower patients by promoting openness, independence, and involvement in their treatment (14). Virtual consultations have attracted a lot of attention in the face of a global physician shortage and restricted access to healthcare in underprivileged areas.

Telemedicine does not mean that the doctor-patient connection is ending, even while it encourages patient self-management and convenience. Instead, it reinterprets this relationship in a digital context, utilizing technology efficiency while maintaining interpersonal engagement. As mentioned earlier, Hollywood often envisions the future of technology before it materializes. Table 1 lists the top 10 best-known fictional surgeons from classic science fiction works (15). This study is based on a qualitative analysis of selected Hollywood films produced between 1950 and 2023, focusing on surgery, robotics, artificial intelligence (AI), or medical technology, and influencing public perception. Each film was examined for its representation of surgical practices,

Table 1. The ten iconic characters in the role of surgeons from science fiction classics
Victor Frankenstein
Miles Bennell
Doctor Blair
Helena Russel
White uniform men
Three doctors who slept cryogen sleep
Leonard McCoy
Robotic surgeon
Dr. Ash
Peter Duval

the presentation of AI and robotic technologies, and ethical and educational implications. The study is limited to the selected films and does not encompass all popular culture products. The findings from the films were compared and evaluated with existing literature (including systematic reviews and meta-analyses obtained through PubMed searches).

The protagonist in the film adaptation of Mary Shelley's novel, "Frankenstein", personifies the stereotypical figure of the overreaching surgeon motivated by a warped pursuit of perfection. He creates a monster out of cadaveric remains and eventually succumbs to the life he made. The historical background of surgical practice in the 20th century, where patients were routinely subjected to medical judgments without sufficient explanation or participation, is paralleled in this fictitious story. Physicians frequently made unilateral decisions about treatment plans, which reflected a paternalistic paradigm with little patient autonomy. Patient empowerment is becoming more and more accepted in modern surgical practice. Patients today want open communication about their medical options, actively seek out information, and engage in support groups. As a result, surgeons are now more dedicated than ever to obtaining informed consent and offering thorough explanations. This change is indicative of a more morally based doctor-patient relationship and a larger trend toward shared decision-making (15,16).

In the last 5 decades: Significant improvements in communication between surgeons and patients have significantly made. Yet, we still struggle with mutual trust. Modern patients increasingly seek second opinions, which leads to more medical procedures and diagnostic tests, requiring shared responsibility between doctors, patients, and their families. Dr. Miles Bennell is a prophetic character in "Invasion of the Body Snatchers" who sees an increasing danger but is disregarded by his community. He is the only one who ignores his warnings as extraterrestrial replicas gradually replace his patients (17).

This fictional representation reflects contemporary obligations on the part of doctors, who are required by law and ethics to notify public health authorities about unusual cases, outbreaks, or systemic failures.

Even unlikely or infrequent presentations are taken seriously and dealt with effectively thanks to today's emphasis on responsibility, openness, and documentation. Although patient complaints may sometimes be exaggerated, doctors now must provide clearer explanations and maintain more thorough documentation to avoid malpractice claims. No matter how strange complaints may seem, doctors and patients are obligated to take one another seriously today (15). An extraterrestrial being infiltrates a scientific research station in Antarctica, taking over and mimicking the researchers in John

Carpenter's 1982 novel *The Thing*. When Dr. Blair disregards fundamental safety procedures during an autopsy, he becomes a vector of infection and eventually falls victim to the alien entity.

This story emphasizes how crucial infection control procedures are in contemporary surgical settings (18). To reduce occupational risks, surgeons now follow stringent safety procedures, such as wearing gloves, masks, and goggles, and getting regular vaccinations against communicable infections. Risks like needlestick injuries and virus exposure still exist despite these safeguards, highlighting the ongoing importance of surgical safety regulations and informed patient consent, particularly concerning bloodborne infections like human immunodeficiency virus (HIV) and hepatitis C (15). During the COVID-19 pandemic, many healthcare workers, including surgeons, contracted the virus. In surgeries, infection with HIV and other viruses remains an occupational hazard. Over the past 50 years, protective equipment and screening tests have greatly improved surgeons' ability to avoid infections.

During a time when women were mainly underrepresented in the medical sector, Dr. Helena Russell, who was portrayed in the BBC series *Space: 1999*, became a trailblazing example of female surgical ability. Her persona defied accepted gender stereotypes by exhibiting emotional intelligence, leadership, and clinical knowledge. Less than 8% of surgeons were women by the end of the 20th century (19). But things have changed much since then, and women are now highly skilled in all areas of surgery. International luminaries like Prof. Dr. Monica Morrow and Prof. Dr. Giuseppe Galimberti, as well as notable individuals like Prof. Dr. Güldeniz K. Çakmak, Prof. Dr. Yeşim Erbil and Prof. Dr. Seher Demirel in Türkiye, demonstrate the crucial role that women today play in improving surgical knowledge and practice. Government officials, disguised as anonymous medical professionals, break into a little boy's house in Steven Spielberg's *E.T.* and brutally and dehumanizingly experiment on the extraterrestrial creature. Their disregard for the emotional root of *E.T.*'s disease (homesickness) is indicative of a larger criticism of impersonal, cold medicine (20).

On the other hand, contemporary medical and surgical ethics place equal emphasis on patient-centered care and clinical efficacy. Today's treatment choices necessitate a careful balancing act between quality of life, procedural risks, and survival outcomes. This development highlights a crucial change away from intrusive paternalism and toward compassionate, cooperative doctor-patient decision-making. The cryogenic preservation of doctors on board the spaceship *Discovery One* in Stanley Kubrick's *2001: A Space Odyssey* represents both reliance on AI and faith in future medical needs. Concerns about an over-reliance on autonomous technologies are reflected when the onboard AI system HAL-9000 takes over human command

and kills the frozen crew (21). Clinical practice in modern medicine has been significantly impacted by the digitization of healthcare, especially EHRs. These systems enhance legal protection, accessibility, and data preservation, but they have also introduced additional paperwork constraints that impact medical workflow and medico-legal defense strategies (15,22).

As the chief medical officer of the *USS Enterprise* in *Star Trek*, Dr. Leonard McCoy is a figure of paradox—a doctor in a technologically advanced future yet with a strong foundation in orthodox medical beliefs. Despite having state-of-the-art diagnostic tools that enabled non-invasive, real-time assessments, his postoperative care strategy was still outdated. This comparison highlights the difficulty of adjusting established clinical practices to contemporary, evidence-based norms. For example, surgical care used to lack early postoperative mobilization, which is now a standard practice. Thus, McCoy's character serves as an example of how paradigm shifts in clinical thought and behavior must coexist with technical innovation (23).

During the battle between the Light Side and the Dark Side, a young hero loses his arm. In the movie *Star Wars: The Empire Strikes Back*. A robotic surgeon—the autonomous humanoid 2-1B surgical robot—replaces it with a bionic arm effortlessly (24).

Over the past 30-40 years, surgery has made incredible strides: Complex operations can now be performed through small incisions. Laparoscopic or minimally invasive procedures, Robotic surgery (e.g., Da Vinci systems), navigation tools, and virtual reality (VR) technologies are available. Still, such interventions must be led by human surgeons. Although robotic systems offer great possibilities, these surgeries can still be performed manually today. Interestingly, films like *The Matrix* (1999) and *Total Recall* (1990) present more realistic scenarios than *Star Wars* when it comes to future medicine (25,26). In *Alien*, the doctor on board the *Nostromo*, Dr. Ash, is eventually shown to be an android whose primary purpose is to protect alien life ahead of human life. His disdain for crew safety and disengagement from ethical standards serve as an example of the dangers associated with removing morality and human empathy from medical decision-making (27).

On the other hand, modern healthcare places a strong emphasis on patients and surgeons working together to make decisions. Work together to decide on the treatment plan. In order to maintain ethically sound and patient-centered care, doctors—especially surgeons—must continue to play a key role in clinical decision-making processes, even while healthcare administrators may push for cost-cutting or protocol adherence (15).

Dr. Peter Duval is portrayed in *Fantastic Voyage* (1966) as a

metaphorical forerunner of contemporary minimally invasive surgery. On board the miniature submarine Proteus, he uses a laser instrument to remove a cerebral clot from an ill scientist's vascular system. This creative depiction figuratively foreshadows current surgical objectives, which include maximizing therapeutic impact with the least amount of invasiveness. The aspirations first envisioned in such speculative narratives are reflected in the rising number of technologies used in operating rooms today that are intended to minimize incision size, maximize precision, and speed recovery (15,28,29). Science fiction books and films have proliferated during the last 20 years, challenging and stimulating medical imagination (Figure 6) (30).

These artistic endeavors frequently function as conceptual labs where new technologies and moral conundrums are explored through story testing. As mentioned, intellectual curiosity is still necessary for innovation, especially in the medical field. A doctor who stops being curious runs the risk of losing interest in the direction of advancement and losing the chance to influence how healthcare is developed in the future. There are significant technological developments in healthcare from the early 2000s to the present, with AI being highlighted as a key development (31).

These advancements highlight how digital tools and clinical

practice are increasingly overlapping. In light of this change, it is critical to proactively assess both established and new technologies to make sure that their application continues to be morally righteous and therapeutically advantageous.

VR in Surgery and Medical Education

In surgical practice and teaching, VR has become a game-changing instrument. Using immersive 360-degree camera systems, surgeon Shafi Ahmed carried out the first VR-assisted treatment in history at Royal London Hospital in April 2016 (32,33). Students, reporters, and family members could see the treatment in real time using the Medical Realities platform because it was streamed worldwide. This milestone marked the start of a new age in surgical training, where students can watch, practice, and hone their abilities in simulated operating rooms thanks to immersive technologies (34,35).

For surgical education, VR technology provides immersive, scalable, and internationally accessible platforms. Trainees can now experience operations from the surgeon's point of view instead of just watching them passively from behind the operating table. With the use of VR-based technologies, surgeries can be streamed in real time across international borders, allowing students wearing headsets to virtually experience the operating room. In order to improve radiological interpretation, procedural planning, and the educational experience of surgical

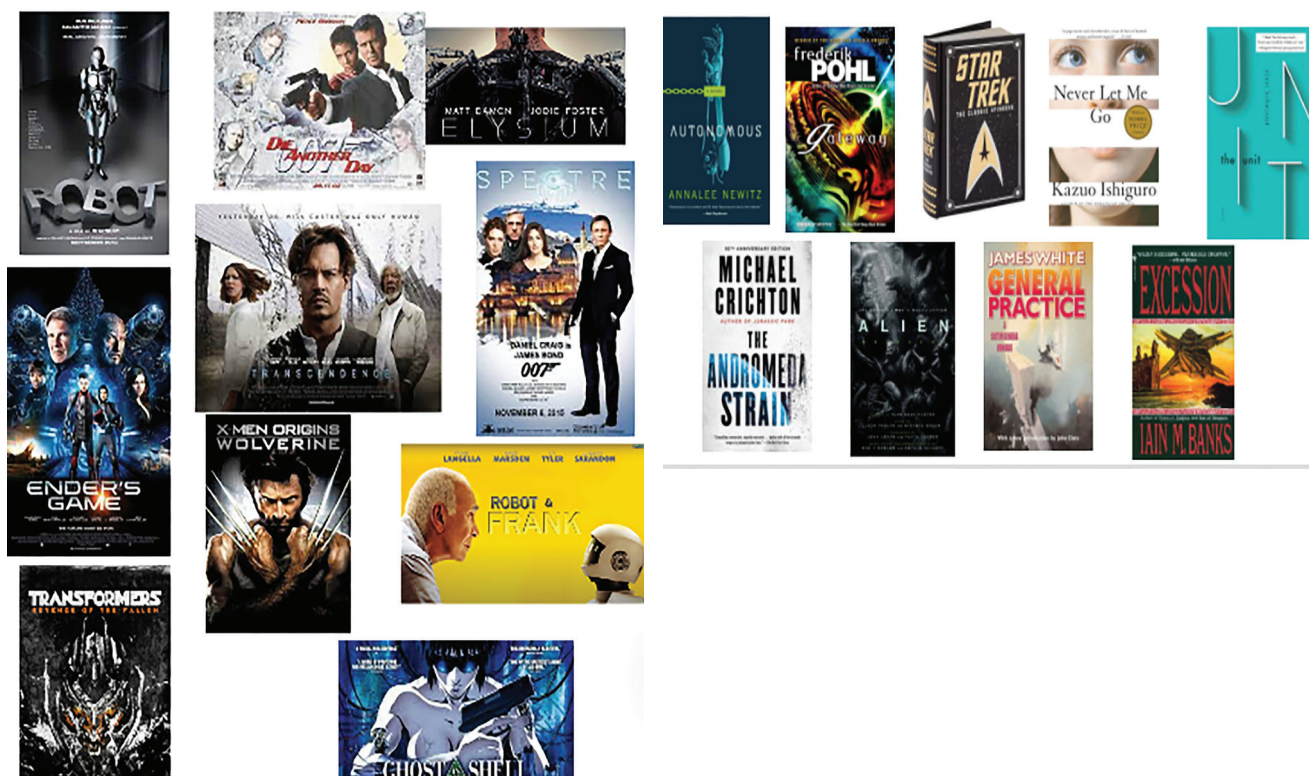


Figure 6. Some notable science fiction books and films from the last 10-20 years.

trainees, teams like The body VR are actively creating simulation tools and interactive material (Figure 7) (36,37).

Augmented Reality (AR) in Surgical Precision

By directly superimposing important anatomical and procedural information into the surgeon's field of vision, AR enhances the surgical environment. In contrast to VR, AR enhances perception rather than replaces it by preserving the user's link to the real world (38). This capacity is particularly helpful for intricate processes like tumor localization or minimally invasive surgery (MIS) navigation. AR is being used to maximize intraoperative precision and enhance patient outcomes, as demonstrated by cutting-edge systems like Medsights Tech's tumor modeling software and Atheer's wearable interface (39,40).

An example of the cutting edge of interactive medical visualization is the "True 3D" system from EchoPixel (41). With the help of this platform, physicians may work in real time with three-dimensional (3D) models of a patient's anatomy, generating an open virtual environment that allows organs and tissues to be examined from various perspectives. Such technology could improve surgical planning, boost the safety and effectiveness of complex treatments, and improve the accuracy of diagnostics.

Surgical Robots: Engineering Marvels in Modern Surgery

The extensive use and confidence in these cutting-edge devices are demonstrated by the fact that the global surgical robotics market had grown to over \$6.4 billion by 2020. For more than 15 years, the da Vinci Surgical System in particular

has been the industry standard. With the use of high-definition, 3D imagery and articulated tools that are more accurate than human hands, the technology allows for small incisions and precision surgeries. Surgeons retain complete control over these sophisticated instruments, guaranteeing patient safety and clinical responsibility (42).

The development of next-generation robotic systems has been hastened by recent partnerships with major pharmaceutical and technology companies. The area of robotic application in microsurgery is expanded by these more recent systems, which have precision-driven components and small, flexible arms designed to execute complex procedures involving delicate tissues (43,44).

MIS

Reducing patient trauma while maintaining or regaining physiological function has continuously been at the forefront of surgical innovation. The post-Edison era saw the emergence of early endoscopic instruments, which developed in the late 20th century with the introduction of fiber optics and microcameras. These innovations made it possible to visualize and manipulate internal processes with never-before-seen clarity. More recently, innovations like FlexDex's mechanical wrist-extension tools and Levita's magnetic surgical system have increased the potential of MIS and provided affordable, ergonomic substitutes for fully robotic systems (45,46).

3D Printing and Simulation for Preoperative Planning and Training

Preoperative planning and surgical education have both benefited greatly from the use of 3D printing. A congenital abnormality was successfully corrected in 2016 by Chinese surgeons using a full-scale 3D printed model of a newborn's heart (47). Similar technology was used later that year by a team in the United Arab Emirates to precisely direct the excision of a kidney tumor. These instances demonstrate how useful patient-specific anatomical models are for increasing surgical accuracy. Additionally, 3D printing is becoming more and more popular in classrooms, providing students with tactile organ models for simulation and procedural practice (48). The simulation platform Touch Surgery has developed systems for practicing various procedures, from cardiac surgery to carpal tunnel release (49).

Live Diagnostic: The Smart Scalpel

Zoltan Takats of Imperial College London created the intelligent surgical knife (iKnife), which combines real-time mass spectrometry and electro-surgical dissection. The chemical makeup of the tissue that is vaporized during incision is instantly examined, enabling the surgeon to make an immediate distinction between benign and cancerous tissue. By converting



Figure 7. An example of a surgical application using a VR headset.

VR: Virtual reality

surgery into a dynamic, intraoperative detection process, this breakthrough offers a fresh diagnostic paradigm that holds promise for earlier, more precise cancer therapies (50).

AI and Surgical Robotics

Many people believe that the future of operative medicine lies in the fusion of surgical robotics and AI. AI programs like Google's DeepMind and IBM's Watson are already showcasing their powers in clinical decision assistance (51).

Deep learning algorithms based on clinical and radiologic datasets are used by platforms such as Enlitic to accurately identify pathological anomalies (52). It is anticipated that surgical treatments will become more individualized, safer, and faster as AI technologies are incorporated into robotic and minimally invasive devices (53,54).

Despite the experimental demonstration of fully autonomous surgical systems, it seems doubtful that human surgeons will become obsolete (Figure 8) (13). Patient care still requires empathy, clinical insight, and ethical judgment—elements that no machine or algorithm can replace. Even in the age of AI and robotics, there will always be a need for a skilled human—man or woman—holding the scalpel, making critical decisions, and connecting with the patient. So, the human aspect must be maintained as automation and AI become more and more integrated into surgical practice. In order to ensure that patient welfare always comes first, the future of medicine will need a symbiotic interaction between clinical competence and technological innovation. Despite rapid technological progress, robots and machines cannot replace the human element of care. Surgeons must retain their presence and voice in the decision-making processes of healthcare. Empathy, ethical reasoning, and human intuition are qualities no algorithm can replicate.

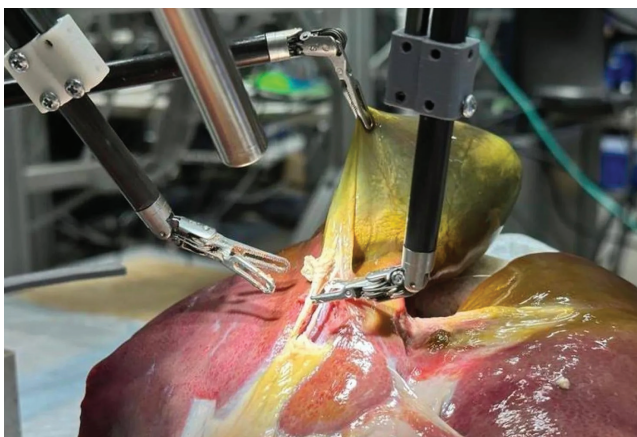


Figure 8. A historic image of the world's first fully autonomous robot-performed surgery.

Footnotes

Financial Disclosure: The author declared that this study received no financial support.

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