Artificial Intelligence in Surgery

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Abstract

To discuss the advantages of transition from laparoscopy to robotic surgery and next generation autonomous robots that will be introduced when integrated with artificial intelligence in surgery.

After the usage of the technological products that started with laparoscopic systems in surgery and the advantages it provided, a transition towards robotic surgery was realized, but the desired point could not be reached in robotic surgery. The robots are used as laparoscopic instruments with increased mobility in today. The desired point is the autonomous robots that have the ability to auto-function or independently. Existing robots will be transformed into robots with superior technical features and predictability when integrated with artificial intelligence technology that can perceive the surroundings, recognize problems, implement appropriate action plans and produce solutions for new problems. The practical points that can bring the surgical techniques together with the ethical problems that will be brought together are a matter of discussion. In the near future, it can be foreseen that autonomous robots may be the assistant or rival of surgeons in the operating rooms thanks to the rapid developments in engineering, computer and robotics. The use of artificial intelligence in surgery can save time, decrease medical errors, and achieve better surgical outcomes. However, there is a need for multidimensional algorithms that are still not developed for the production of robots that can undertake the task of the surgeon in order to make critical and ethical decisions.

Keywords: Laparoscopic surgery, robotic surgery, artificial intelligence

INTRODUCTION

Laparoscopic video systems are introduced as the first precursor of the technology in surgery. The use of laparoscopic surgery (LS) began at the beginning of the twentieth century, and it has rapidly developed in the last two decades. In recent years, almost all operations have been performed by laparoscopic technique (1). Lately, robotic surgery (RS) has become widespread, and it has been applied worldwide. The starting point of the RS was the limit of the LS, making the surgeries applicable in a similar way to open surgery. The robots used in surgery are actually used as laparoscopic instruments with increased mobility. We desire to obtain the automatic robots that can be programmed or can independently function (2). The artificial intelligence (AI) technology, which was introduced by Gunn for the diagnostic evaluation of abdominal pain in 1976, is nowadays in use with the algorithms developed in RC with numerous data (3-5).

Artificial intelligence has become more popular in different industrial areas. Five million dollars have been spent on AI in 2016 (6). The goal of the AI technology is to design programs that can make their own decisions and carry out the desired task with better efficiency and fewer errors. With the studies that will be conducted by surgeons and data scientists together, it will be possible to see in near future the prototypes of the products using the AI technology in RS.

The aim of this review is to explore the use of advanced technology products in surgery and the points that future-generation RS systems can achieve.

REVIEW

Laparoscopic surgery was first performed by Hans Jacobaeus in Sweden in 1901. However, after unsuccessful experiences, the first successful LS was the laparoscopic cholecystectomy performed

by the German surgeon Erich Müche in 1985 (1). Since then, LS has made great progress. Nowadays, although all operations can be performed laparoscopically, RS has started to come to the forefront. The term "robot" comes from the Czech word "robota", which means the non-living entity that is forced labored. The development of robots is inspired by the drawing book of Leonardo Da Vinci, which is why the first surgical robot was named after him (2).

Today, even though the most important subject of discussion for RS is cost, increasing the surgical practice by defining the digital data and integrating AI into robots will gain importance in future (7). The place of AI in science seems to be dependent on its ability to perform the tasks as good as people can or better than they can. Owing to its present applications and its self-improvement ability, it can eliminate human errors in some areas, and can even achieve better results by going beyond human intelligence. However, on the other hand, there are also opposing views suggesting that it will never catch up with human intelligence and analytical thinking (8, 9).

Today, AI is used in many different industrial fields to give machines learning ability by developing data algorithms and to develop artificial neural networks, internet-based learning, and computational skills. It is used in health sector by being included in electronic medical records, clinical algorithms, and analyses of image data in pathology and radiology. Moreover, nowadays, we see that AI is used in the ECG analysis, interpretation of arterial blood gas, interpretation of some radiological images such as mammography, and many other medical fields (10). The use of AI in surgery can mainly be listed as the abilities of decision-making and applying surgical techniques during the surgical procedure, but complex surgical procedures, instantaneous complications, and the personal solutions offered by the surgeons to patients prevent the use of AI in surgery (11).

The first widespread use of AI is likely to be the strengthening of human performance by computer. In pathology, which is an area that utilizes AI in this way, the error rate in the detection of cancer-positive lymph node has reduced from 3.4% to 0.5% (12).

A robot, which is widely used in surgery nowadays, is not fully integrated with AI. It is a high-tech product commanded by surgeons. Three-dimensional high-quality image with robotic technology, increased freedom of movement with articulating hand tools, elimination of vibration, and the possibility of safe suturing in the narrow spaces as in open surgery are among the advantages of RS.

The smart tissue autonomous robot, which is the first example of robots assisting surgeon by using the AI technology, can perform intestinal anastomoses more precisely and faster than experienced surgeons can, although it works under surgeon's control (13). Apart from the robots that assist the surgeon, in autonomous robots equipped with AI, it is aimed to reach a device that monitors all vital signs at the same time during the operation and gives verbal warnings when necessary, analyzes all the current information needed for the moment, performs pathological examination, and determines surgical margins in solid organ tumors, applies appropriate surgical technique with zero margin of error, and calculates the possible postoperative complications, beside only increasing the vision and eliminating hand shivering (14).

One of the most different ideas on this subject is that soft, fully deformable, and small-sized robots that will be produced with three-dimensional printers can perform the operation by entering into the surgical site from a small incision line (15). With the rapid developments in engineering, computer, and robotics, this technology, which currently seems distant, will go beyond a dream as a groundbreaking method in future.

Because existing systems only arrange for the construction and use of medical devices, it will be necessary to decide on the autonomy of the robot and when the robot goes beyond being a device. Considering that there will be improvements in the relationship among the patient, the surgeon, and the robot in future and that there will be cooperation between the surgeon and autonomous robots on the patient, the evaluation of the ethical rules in the scope of the responsibility toward the patient will also be discussed (11).

CONCLUSION

The use of AI in surgery can lead to time saving, decrease in medical errors, and better surgical outcomes. However, there is a need for multi-directional algorithms, which have still not been developed, to produce robots that can completely undertake the task of the surgeon because of the necessity of critical and ethical decisions in surgery.

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