EDITORIAL

Robotic Surgery Advantages and Challenges

Alireza Mirbagheri [1*], Mehrnaz Aghanouri [2]

[1] *Research Center for Biomedical Technologies and Robotics, Advanced Medical Technologies and Equipment Institute, Tehran University of Medical Sciences, Tehran, Iran*

[2] *Department of Medical Physics and Biomedical Engineering, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran*

*Corresponding Author: Alireza Mirbagheri
Email: a-mirbagheri@ tums.ac.ir

Received: 24 October 2021 / Accepted: 03 November 2021

Abstract

The interest in using robotic surgery especially for gynecology, gastroenterology, and urology is increasing every day as this technology is expected to be the first line of surgery in many medical fields in the near future. This attentiveness is due to the unique features of this method and its advantages over open surgery and laparoscopy technique. Knowing curiously about robotic surgery, its components, characteristics, advantages, and challenges is crucial to be prepared for such huge evolution and to be engaged in the advancement of this new technology.

Keywords: Robotic Surgery; Minimally Invasive Surgery; Open Surgery; Robotic-Assisted Laparoscopic Surgery; Master-Slave.

DOI: https://doi.org/10.18502/fbt.v9i1.8138

Day by day advancement of technology and engineering has drastically affected the field of medicine and surgery where the Minimally Invasive Surgery (MIS) technique has replaced open surgery in many fields of surgery such as Gynecology, Gastroenterology, and Urology. Although employing MIS has obviated a bunch of open surgery difficulties and challenges by providing a shorter hospital stay, outpatient treatment, less pain, less trauma, less bleeding, lower infection rates, and faster patient recovery; some other challenges have been born. Among them is maneuvering the Laparoscopic handles in the inverse direction and with a variable scale based on the insertion length of the Laparoscopic instruments, which comes due to the fulcrum effect. Another challenge that surgeons complain about is the back, neck, wrist, and lumbar pain after a few years of Laparoscopic surgery experience arising from the long stem of conventional Laparoscopic instruments and non-ergonomic position of surgeons during Laparoscopic surgeries. Moreover, the conventional Laparoscopic surgery method cannot fulfill the need for high dexterity and maneuverability of surgical instruments inside the patient's abdomen for many advanced and complex surgeries such as Radical Prostatectomy which poses significant problems.

To get around these challenges, again technology has come to the aid of medicine and robotic surgery systems have been emerged. These systems have two key components: the "surgeon console" located at the surgeon side and the "surgical robots" exploited at the patient side. This structure introduces a master-slave manner in which the positions and gestures of the surgical robots are controlled in real time by mimicking the surgeon's hand movements sitting behind the surgeon's console. The surgeon uses the real time intra-abdominal images taken by the camera. Thanks to the network and communication, the "surgeon console" and the "surgical robots" can be either in the same room or far away from each other. The statistics as performing more than 10% of abdominal surgeries in the USA and Europe through the Robotic Assisted Laparoscopic Surgery (RALS) [1, 2] and more than 90% of Radical Prostatectomy method in the USA [3], indicate the robotic surgery method is admitted more and more by the surgeons because of its specific characteristics.

Several advantages of using robotic surgery systems over the Laparoscopy method and open surgery can be enumerated. The primary one is the ability to direct and intuitive control of the surgical instrument's tip. Performing advanced and complex operations such as Esophagostomy by employing a high dexterous and maneuverable robotic surgery instruments inside the patient's body as mentioned by Ray K. Chihara *et al.* [4] is one of the important successes of robotic surgery. The benefit of providing a remote surgery which at first glance reduces the risk of infections, radiation, and anesthesia gas for the surgeon is revealed more than ever in the COVID-19 pandemic as expressed by Gaby N. Moawad *et al.* [5]. Besides, this feature facilitates the surgeon's ergonomic posture, leading to the reduction of surgeon fatigue and errors. Another foremost advantage of robotic surgery systems is satisfying the demand for high-quality health services to undeveloped or less-developed locations while reducing long-distance medically-related transportations. The downscaling movement function is one of the most important advantages of robotic surgery systems which help surgeons to do miniature surgeries with more accuracy and fewer errors. This function mimics the surgeon's hand movements but performs them at the patient side with a reduced scaling ratio of up to ten times. Also, tremor filtration function is one of the other advantages, which helps surgeons during miniature surgeries.

Despite the undeniable superiority of robotic surgery over Laparoscopic and open surgeries, there are still various challenges ahead of this technique. Lack of Force feedback capability from the patient side to the surgeon's hand is one of the most tangible problems which can affect the surgery quality and accuracy. The high cost of robotic surgeries coming from the high initial, maintenance, and consumable cost and the expensive instruments is another indubitable challenge preventing robotic surgery to be popularized. Providing straight and flexible instruments for simple and complex surgeries, respectively, by the companies in this field, can be thought of as a possible solution. Less improvement in some areas of general surgeries especially on the small intestine and other deformable intra-abdominal organs reveals some other challenges. The first difficulty is the patient reorientation during the surgery, which is crucial at most parts of the general intra-abdominal surgeries. As the second one, we can mention the lack of tactile sensing to grasp delicate soft tissues and injuries which may be damaged during the robotic surgery process without tactile sensation.

The next challenge can be expressed as the lack of proper instruments to grasp large and delicate intra-abdominal organs such as the bladder and spleen.

There are also some limitations for, if addressed, this technology will be admitted and employed more by the surgeons. To this end, some developments are desirable. Some instances include the availability of both sitting and standing postures for the surgeon during the surgery to provide more ergonomic postures, high configuration flexibility for surgery robot placements at both sides of the surgery bed, availability of non-interruptive docking and reorienting of the surgical bed during the surgery which is very essential in most of the general surgeries, selectable handles for surgeon's side for each special task and comfortless of surgeons.

References

1- K. H. Sheetz, J. Claflin, and J. B. J. J. n. o. Dimick, "Trends in the adoption of robotic surgery for common surgical procedures.", JAMA Netw Open, vol. 3, no. 1, pp. e1918911-e1918911, (2020).

2- INTUITIVE, "Investor Presentation Q3 2019", (2019).

3- C. Arenas-Gallo, J. E. Shoag, and J. C. J. U. C. Hu, "Optimizing Surgical Techniques in Robot-Assisted Radical Prostatectomy.", *Urol Clin North Am*, vol. 48, no. 1, pp. 1-9, (2021).

4- R. K. Chihara, M. P. Kim, and E. Y. J. J. o. T. D. Chan, "Robotic surgery facilitates complex minimally invasive operations.", *J Thorac Dis*, vol. 12, no. 9, p. 4606, (2020).

5- G. N. Moawad, S. Rahman, M. A. Martino, and J. S. J. J. o. R. S. Klebanoff, "Robotic surgery during the COVID pandemic: why now and why for the future.", *J Robot Surg*, vol. 14, no. 6, pp. 917-920, (2020).