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Robotic Surgery and Robotic Tele-Surgery and Covid-19 Pandemic

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Summary

Background: *Covid-19 virus sweeps the whole world with millions of people infected and a hundred thousand dead. This pandemic does not affect normal people only but affects the surgeons also. The number of surgeons worldwide is limited, especially experienced ones at risk of infection and die. Patients pay the pill of surgical shutdown by postponing their scheduled surgical procedure that may affect their health and render them more morbid. Surgery is limited during the pandemic to emergent cases. There is a need to establish a way to provide surgical service from experienced surgeons without the possibility of virus transmission to these experienced surgical staff.*

Robotic and robotic Tele-surgery is an emerging, very recent diagnostic and therapeutic tool that offers excellent surgical service without affecting the surgical staff. Robotic surgery can be used in different fields of surgery in emergent and non-emergent cases during the pandemic and after the pandemic settles down.

The aim: *is to evaluate the role of robotic surgery and Tele-surgery in offering global surgical services for emergent and non-emergent cases during the pandemic and after the pandemic fades away and its way for facing future pandemics without affecting higher senior surgical staff, especially during the lockdown period. Evaluate the role of Tele-surgery as a way of continuous training for younger surgeons during the pandemic.*

Conclusion: *robotic and robotic Tele-surgery is an excellent method for providing surgical services by experienced surgeons to patients.*

Keywords: *Telesurgery, security, globalization, robotic surgery.*

Research question: is robotic surgery and robotic Tele-surgery are effective during the pandemic?
Hypothesis: robotic surgery and robotic Tele-surgery are effective during the pandemic

Introduction

Covid-19 pandemic

At the end of 2019, a mysterious virus discovered later to be coronavirus two started in Wuhan, China, and spread worldwide, infecting millions of people [1].

Surgical fields exposed to more infection

The respiratory airway has a high concentration of Covid-19 and is transmitted mainly by droplet infection. So, anesthesiologists, otolaryngologists, and laparoscopic surgeons are at significant risk to contact infection. Laparoscopic surgeons are at risk because the virus contaminates the aerosol from leakage in Co2 used in laparoscopic surgery [2].

Role of the surgeon during the pandemic

The role of surgeons during a pandemic is the least among other front-line doctors; hence there is a need to create a new way of how surgeons share effectively in the subsequent pandemics by providing excellent surgical support to patients without much risk to contact infection with the virus. This pandemic will fade away, but its effects will stay insides all of us. We must understand the lessons and prepare ourselves efficiently. Tele-surgery allows elective surgical lists to continue with no affection for patients' health, no risk of infection, and not exposing the hospital to massive loading of cases after the pandemic ends [3].

Telemedicine is the brilliant idea of contacting doctors and patients during the pandemic, so why not use Tele-surgery to operate the patients during the pandemic?

Surgical shutdown effects

Surgical shutdown during pandemic let many patients without care. The delaying of elective endoscopy and surgery has many disadvantages, like delayed diagnosis, changing the patients from operable to inoperable cases, and hence increasing mortality and non-emergent cases changed to emergent ones. This pandemic has changed our methods of thinking. the surgical communities advised the surgeons to stop elective surgery, transfer the surgical patients to hospitals less infected with Covid-19, open surgery than laparoscopy, radiotherapy for cancer as an alternative to surgery, and postpone diagnostic endoscopy. [4].

Robotic surgery and Robotic Tele-surgery

Definition

Robotic surgery is a very excellent advanced step in surgery and helped in the evolution of robotic Tele-surgery. Robotic surgery entitles surgery on patients while the surgeon is near the patient in the same room or next room, while tele-surgery enables surgeries while the surgeons may be a thousand miles away from the patients [5].

The usual trend of surgery is that the surgeon is to be a distance away from the patient. The open surgery, the surgeon, is a few millimeters or centimeters from the patient. In laparoscopic surgery, this distance is increased with better surgical outcomes. Finally, Tele-surgery emerged with more distance and with the best outcome [6].

The start points of robotic Tele-surgery

The first robotic Tele-surgery performed in 2001 is called operation Lindbergh by Marescaux and his team. They were in New York, USA.and, and performed laparoscopic cholecystectomy in a 68-years old female patient in a hospital in Strasbourg, France, using the ZEUS surgical robot. France's government supported this step by providing excellent high, secure, and low-latency asynchronous transfer mode networks. This is the starting point after which many robotic Tele-surgeries are performed [5, 7-8].

Parts of robotic Tele-surgery

A robotic Tele-surgery system consists of the surgical part called the surgeon console and a robotic part with its arms visualized and controlled by the surgeons through video feedback that transmits full high-definition pictures to the operating surgeons [5].

Types of available robotic

Two forms of robotic systems are available, The ZEUS surgical robotic system and the da Vinci system. Although The ZEUS surgical robotic system was the form used in the first operation known as operation Lindbergh, the da Vinci system became more widely used because of its efficiency than the ZEUS surgical robotic system [9].

Parts of the robot

Surgeon's Console: The master console consists of a high-definition video camera that transmits the intraoperative view from the endoscope. A touch screen is present and supplied with multiple sensors that transmit orders from the surgeons to the robot and control it properly.

Robots: Robotic arms are controlled by sensors present in the surgeon console. The servo control unit controls each arm, and there are multiple servo control units for the instruments and endoscopic camera [10].

Transformation for Tele-surgery

The two parts of robotic surgery necessitate telecommunication computers that ensure the excellent connection between the surgeon console and the robot.

Consent of robotic surgery and robotic Tele-surgery:

Specific consent for Tele-surgery is designed, and it is a contract between the patient and the surgeons about the acceptance of performing the process. The patients have the right by law to restitute their rights in different countries involved in this type of surgery [11].

Doctor code

Every country has a code that declares the essential duties of a doctor. These codes are based on the ethical principles and ability to protect life as well as the ability of the doctor to integrate with patients physically and psychologically regarding the geographical distance between the two parties.

Robotic Tele-surgery and security

Dowler and Hall's provided a classification of the Tele-surgery security frame. In the preoperative station, secure connection between the surgeon console and the robot by particular digitalized identity. The surgeon has to authenticate appropriately to get the secret parameters. They are using a SecureSurgiNET system that helps data encryption in all phases of surgery. In the intraoperative station, multiple framework systems are used as Transmission Control Protocol (TCP) and User Datagram Protocol (UDP), and Advanced Encryption Standard (AES). In the postoperative station, data are collected and stored at the central Tele-surgical authority (TSA) database server (DBS) for future reference and legal inquiry, if needed [12].

Surgical field where robotic and robotic Tele-surgery can help

Robotic surgery showed significant and successful advancement in different fields of surgery like general, gynecological, urological, and cardiothoracic surgery [13]. Tele-surgery is a new diagnostic and therapeutic branch of telemedicine [14].

A study was conducted on 146 Da Vinci robotic surgeries to evaluate the efficacy of robotic surgery. Robotic surgeries included: 39 procedures for reflux esophagitis, 48 cholecystectomies, 28 uterine tubal anastomoses, ten bariatric surgeries for obesity, three inguinal hernia repairs, three intra-rectal operations, two hysterectomies, two cardiac procedures, two prostatectomies, 2 Artio-venous shunts, one lumbar sympathectomy, one appendectomy, one laryngeal exploration, one varicocelectomy, one endometriosis cure, and one neosalpingostomy .this study proved very effective surgeries with no morbidity. These studies evaluated the

efficiency of robotic surgery in a very narrow space and microsurgery operation [15]. Another study evaluates the efficacy of robotic surgery in Fallopian tube micro anastomosis after the previous sterilization process. They stated that this technique is precious and compelling [16].

A study was performed on the effect of robotic Tele-surgery performed on 25 patients with cholecystitis. Cholecystectomy was performed in 24 cases successfully, and one converted to traditional laparoscopic surgery. This study concluded that Tele-surgery is a very effective and safe technique [17]. Another study was performed using robotic Tele-surgery on radical prostatectomy and concluded its safety and efficacy [18].

Advantages of robotic surgery and robotic Tele-surgery

Covid-19 pandemic put us on a side that we must think about putting robotic and robotic Tele-surgery in the front of our interest. Tele-surgery provides excellent surgical services by away experienced surgeons without doctor-patients direct contact.no need for patient or doctor traveling to each other, hence decreasing the cost. This pandemic caused the surgical shutdown, and the waiting list of surgical patients is increasing; this has a cost, and the hospital's burden on treating waiting list patients is costly.

Robotic Tele-surgery allows physical control of the robot and provides other interaction methods between the principal surgeon and the assistant surgeons. This interaction is provided maybe through telephone (verbal action), fax (written interaction), and video conference (visual interaction).

Robotic Tele-surgery is not used only in civilian surgery but also in military surgery. The Department of NATO used Tele-surgery to provide soldiers an excellent surgical service through the robot in the field of war [6][13][19].

Tele-surgery is not limited only to provide surgical services to faraway patients but also to train other surgeons to perform certain operations. This process is called Telementoring [6] [20].

During the COVID-19 pandemic, robotic and robotic Tele-surgery can help so much. First, the number of surgeons around the patient in the operating theatre is zero with only the operating surgeon in the surgical console, and the robotic arms replace the assistance surgeons, which decreases the incidence of transmission of the virus. Second, the surgeon is away from the patients, so virus transmission from aerosol due to Co2 leak is nil compared to laparoscopic surgery. Third, the postoperative complications as conversion rates and wound infection are the least, so hospital stay is shortened, so the burden on hospital and incidence of contact viral infection is minimized [21-22].

Robotic surgery and robotic Tele-surgery have significant advantages over conventional open surgery as short hospital stay, decreased pain and analgesic intake, and lower incidence of postoperative complications as wound infections. Regarding cost, robotic surgery, and robotic Tele-surgery, although expensive, decrease the incidence of complications that may cost much more, especially during the pandemic. However, it is essential to notice that robotic surgery and robotic Tele-surgery may not be available all the time due to the unavailability of experienced surgeons all the time and this push us for expanding the Telementoring program, so that increase the number of experienced surgeons dealing with this recent type of surgery [23-24].

By using robotic surgery, we can keep COVID-19-negative individuals away from the highly infected area. Then robotic surgery offers the most rapid and most efficient way to perform non-emergent surgery with the lowest risk of complication and rapid return to home.

Robotic and robotic Tele-surgery can be done with pneumoperitoneum pressure less than ten mmHg, contrary to the traditional laparoscopic pressure of 12-15 mmHg. This low pressure decreases the risk of virus transmission [25].

In traditional laparoscopy, many persons are significant, including the surgeon, one or two assistants, scrub nurse, circulating nurse, and technician. All are very close to each other, so if one is infected and shows no symptoms, he or she may infect the others. In robotic surgery and robotic Tele-surgery, this number is much decreased as the surgeon operates away from the patient and one assistant surgeon is present in the room. These wide separations decrease the incidence of infection between medical and paramedical staff.

Disadvantages of robotic surgery and robotic Tele-surgery

A disadvantage of robotic Tele-surgery is the absence of face–to–face contact between patient and doctor that many transmit infection between both sides [13]. In Tele-surgery, it is better to establish direct contact between the operated surgeon and the patients. However, unfortunately, it is not available in all cases [26].

Complications of malfunctioning the robotic part may cause intraoperative problems, or even death may occur. The owner of the robot is responsible, and this should be investigated [26].

Tele-surgery provides an excellent diagnosis and treatment method, especially in war areas or areas with limited experienced surgeons. However, the high cost of this robotics and unavailability in most hospitals is an obstacle [11].

Robotic and robotic Tele-surgery break barriers between countries and lead to globalization of the surgery, but many economic, legal and ethical questions arise [13].

Another issue is that highly specialist surgeons can migrate to wealthy countries and operate on patients in their original countries without being physically present. [19].

Privacy of patient data and instrument safety is a matter of concern [6]. Justice and health ministers in many countries

have to put a law that regulates these processes and insurance against complications of the procedures [27].

A controversy is that the insurance companies are numerous and have variable policies covering specific aspects of medical problems. Each hospital chooses the insurance companies suitable for their policy and need that cover intraoperative and postoperative complications [20].

Timing and Synchronization: one of the most annoying parts to surgeons facing in robotic and robotic Tele-surgery is communication latency. It may affect perfect surgical performance. Many studies stated that latencies of up to 700 ms could be accepted [28].

One of the disadvantages of Tele-surgery is the absence of tactile sensation, hence failure to determine tension on the tissue and depend on visual assessment. Recently, a technology that transmits tactile sensation to the surgeon. It is called haptic feedback. This adds trust to the surgeon regarding feeling the tissue's consistency, the tension on the sutures line and avoiding tearing of friable tissues [29].

Limitations

Different limitation prevents broad globalization of the usage of robotic surgery and robotic Tele-surgery. We are providing an adequate telecommunication secure system. Unavailability of the robotic system. Communication between countries as regards medico-legal aspect for the procedure. Availability of insurance companies for the procedures.

Future perspective

Globalization of robotic and robotic Tele-surgery. Surgery may be done in the space

Conclusion

Covid-19 is a global pandemic that affects both doctors and patients. The waiting list for non-emergent cases is postponed adding more morbidity and mortality to the patient. The surgeon got infected, and many died. Surgical shutdown and countries closed their borders.

Robotic surgery and robotic Tele-surgery are recent advances in surgery that help provide surgical services to the patients without direct face-to-face contact between patients and doctors. Tele-surgery and robotic surgery are helpful during the pandemic and after the pandemic ends. The waiting list is polished by using this surgery without loading on the hospital. Robotic surgery has the best outcome after surgery with minor complications than conventional open or laparoscopic surgery. Robotic Tele-surgery is helpful in civilian operations and military situations. Different obstacles face the globalization of Tele-surgery and may be overcome by collaboration between countries for the sake of humanity.

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