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"The impact of using robots in surgical operations"

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Abstract:

Despite general surgeons being largely responsible for laparoscopic surgical advancements, robotics utilization in general surgery is shockingly low. Foregut, biliary, bariatric, colorectal, and endocrine surgeries are the most popular robotic-assisted operation areas. There is no significant difference in the results between laparoscopic and robotic Nissen fundoplication in foregut surgeries. assisted by robots Research on Heller moto-me for achalasia has similarly shown minimal perforation rates. Several writers have raised the possibility of robotic surgery for more complex patients; nevertheless, additional research is required before any definitive conclusions can be made. Robotically applying gastric banding during bariatric surgery has not proven as effective as laparoscopy. On the other hand, for more intricate bariatric treatments involving intracorporeal suturing, some have proposed that robotic surgery could enhance results. General surgeons' reluctance to fully adopt this new technology may have sprung from a combination of factors. The utilization of intricate robotics appears to be unnecessary for straightforward tasks. The robot's capabilities are severely hampered during more complicated procedures, especially those requiring it to traverse across many quadrants. It is also difficult to implement because there is no tool for stapling, sealing, and cutting the bowel, though this could be fixed in the future.

Keywords: surgery, robotic, importance, hospital, patient.

Introduction:

Patients' preferences for robotic-assisted surgeries have grown substantially since the turn of the millennium. Since robotics were first used in urology and gynecology for surgical procedures, several other branches of surgery have adopted the technology. This review delves deeply into many subjects, including robotic surgery's background, its advantages, and the various surgical procedures that make use of this technology. The lecture then moves on to discuss the financial benefits of robotic surgery and how patients feel about the operation. Especially in industrial operations, where robots execute tasks that are precise, repetitive, and potentially dangerous, robotics has grown at an exponential rate since then. Robotics is one area where this expansion has stood out. Recent years have seen a meteoric rise in technical advancements in the healthcare industry. Several essential surgical procedures are now increasingly incorporating robots as a result of this. (Zemmar, A., et al. 2020).

Engineering and technology are inextricably intertwined with the modern healthcare institution itself. There is a bewildering variety of technological gadgets hidden throughout a hospital, ranging from the operating room to the acute care unit, from the laboratory to the short-term care unit. In hospitals, the rate of technological innovation and the quality of medical care that is offered are inextricably linked to one another. In light of this, the hospital's plan places a significant emphasis on the importance of technical equipment from a range of strategic and economic reasons. Discussing the potential strategic and financial consequences of integrating robotic technology in healthcare settings is the objective of this article, which aims to accomplish that objective. The surgeon is now able to use robotic arms that are controlled remotely from a remote location, which has the potential to alter the way treatments are carried out. (Sheetz, K. H., et al. 2020).

One of the initial motivations for creating robotic surgical instruments was to increase the accuracy and precision of surgical procedures. Actually, the PUMA 200, a pioneering surgical robot developed in 1985, allowed neurosurgeons to attain more precise robot placement during stereotactic CT-guided brain procedures. Not long after, Integrated Surgical Systems used the popular CAD-CAM technique to develop ROBODOC, a surgical robot. During knee and hip arthroplasty procedures, orthopedists utilize this technology to improve upon the traditional method of prosthesis insertion using a mallet and broach by programming the robot with three-dimensional (3D) pictures that accurately shape the implant cavity. (Peters, B. S., et al. 2018).

Still, robotic systems couldn't comprehend surgeons' constant input and translate it into real-time movements until the 1990s, and then robotic surgery really took off. In an attempt to reduce casualties during conflicts, the Army funded research into technologies that would enable the remote operation of wounded soldiers in specially developed vehicles in the early 1990s. Many engineers and surgeons with prior Army experience created "telepresence" robotic systems for civilian populations. (Haidegger, T. 2019).

One of the earliest tele surgical robots to obtain FDA clearance in 1994 was AESOP (Automated Endoscopic System for Optimal Positioning), created by Computer Motion Inc. with financing from the US Army. A foot pedal or vocal command system would be available to surgeons for operating the endoscope. Afterwards, Computer Motion Inc. (once again) developed the ZEUS robotic system, which incorporated AESOP technology along with other innovations. This was the first "master-slave" system where the surgeon could control the robot's manipulator arms remotely from a specialized panel. Competing manufacturers did not spend any time suing each other for patent infringement, despite robotic surgery being in its infancy. After two of its most serious rivals, Computer Motion Inc. and Intuitive Surgical Inc., merged in 2003, the ZEUS robot was no longer produced. The companies banded together to market their "da Vinci" system. (Azadi, S., et al. 2021).

The starting of using robotic system (The da Vinci surgical system):

One of the most popular tele-surgical systems nowadays is the da Vinci Surgical System, a complex master-slave surgical robot. The device has four arms: three for holding surgical tools and a fourth for an endoscopic camera with two lenses that provide the doctor a stereoscopic three-dimensional vision. Thanks to Endo Wrist Technology, the device can mimic the exact hand movements of the operating surgeon with the use of console controls. (Zemmar, A., et al. 2020).

The FDA gave the da Vinci system the green light for general laparoscopic surgery in 2000, radical prostatectomy in 2001, and urological therapies in 2005. Subsequently, it gained approval for use in general thoracoscopic surgeries, gynecological laparoscopic surgeries, and thoracoscopically assisted cardiotomy procedures. There were a total of 27,99 da Vinci systems deployed by June 2013, with 2001 in the US, 442 in Europe, and 356 on the other side of the planet. Roughly 350,000 of the procedures were in the fields of gynecology and urology in 2012, out of almost 500,000. (Andras, I., et al. (2020).

Surgical robotic systems, like the da Vinci, offer a truly "immersive" patient experience. The operating room provides a fully immersive three-dimensional experience for the surgeon. Nowadays, most robotic systems don't include haptics, which is short for force feedback. Because of the dramatic improvement in visual quality brought about by advances in three-dimensional vision, magnification, and high-contrast, high-fidelity imaging, many robotic surgeons fail to notice the absence of tactile input when operating on these devices. (Haidegger, T. 2019).

Even though the surgeon may find "immersion" alluring, he or she is isolated from the rest of the surgical team. To bridge the gap between the operating room and the tableside (or supervising teaching) surgeon, Intuitive Surgical debuted the "John Madden teleprompter" device last year. Both the ease of remote, real-time surgical consultations and the potential reduction of isolation might result from this. But there are still certain scientific hurdles to overcome before surgical robotics can be fully utilized. One such hurdle is the lack of haptics. (Sheetz, K. H., et al. 2020).

The computer-assisted surgery:

To fully grasp the implications and potential of surgical robotics, or better expressed, "computer-assisted surgery," one must delve into the insights gained from the groundbreaking practice of laparoscopic surgery. Modern minimally invasive surgery has its roots in Mouret's 1987 laparoscopic cholecystectomy, which revolutionized the practice of general surgery and the surgical specialty as a whole. Only five years after its inception, laparoscopic cholecystectomy was acknowledged by the medical community as the "standard of care" in 1992. Surgery for ant reflux, colon, urologic, thoracic, and trauma cases had previously made use of laparoscopic methods that same year. The removal of solid organs was another successful procedure. (Peters, B. S., et al. 2018).

All modern surgical subspecialties are impacted by minimally invasive surgery. In many ways, modern operating rooms (ORs) are not drastically different from their hundreds of years-old counterparts. Although we live in an era of "high technology" minimally invasive surgery, the tools used in the operation are nevertheless quite stiff, unyielding, and uncomfortable to the touch. Although they are operating on patients, surgeons usually keep themselves physically secluded from "the rest of the world" One way to think about laparoscopic instruments is as new "chop sticks." Poor ergonomics, a limited range of motion, and a lack of precision are common complaints about these instruments. The three-dimensional operating field can only be shown in two dimensions through visualization. Given the limitations of current laparoscopic surgical equipment and instruments, it is incredible that skilled laparoscopic surgeons can perform such a broad range of difficult treatments. (Azadi, S., et al. 2021).

The ability to do minimally invasive surgeries can be categorized into two levels: basic and advanced. Almost any surgeon is capable to successfully performing basic laparoscopic skills, which include the ability to remove organs with one hand, manage vascular issues to a limited extent, and avoid reconstruction. The fast and safe adoption of laparoscopic cholecystectomy, which started the revolution in laparoscopic surgery, is largely attributable to the fact that it met these criteria. Expert videoendoscopic procedures necessitate the use of both hands, such as when suturing, knotting, or performing bimanual manipulation. For example, there aren't many "simple" laparoscopic therapies in urology. Nevertheless, patient-driven demands are increasing to offer limited access surgery options for more complex procedures including prostatectomy, nephrectomy, and donor nephrectomy. (Zemmar, A., et al. 2020).

These operations call for challenging reconstruction or, in the case of nephrectomy, the dissection and care of vessels adjacent to the body's biggest. Having said that, only a select few of urologists possess the training necessary to do complex laparoscopic procedures. Although advanced laparoscopic urological treatments are becoming increasingly common, experts in the field claim that only 2% of urologists actually do them. It is even more astonishing to see such low numbers in other branches of surgery. Basic laparoscopic procedures, including cholecystectomy, are within the skill set of any general surgeon. Less frequently used, though, are advanced laparoscopic methods. To make matters worse, most hospitals only have a handful of general surgeons who perform all the complex laparoscopic procedures. (Peters, B. S., et al. 2018).

The advantage and disadvantage of using robots in surgical healthcare:

The advantages:

1. Surgical Precision.

The benefits of surgical robots, such as the da Vinci Surgical System, are massive. These devices combine 3D high-definition vision systems with miniature surgical instruments, allowing for hitherto inconceivable surgical precision. By 2019, the da Vinci Surgical System had been used in over 6 million surgeries worldwide, demonstrating its broad acceptance and effectiveness. (Andras, I., et al. (2020).

2. Consistency and Quality.

Humans tire easily; however, robots never do. Robots can execute with unparalleled regularity in activities requiring repetitive motions or steady concentration, making them beneficial in many healthcare contexts.

3.Long-term cost efficiency

While robots require a significant initial investment, their long-term cost-effectiveness is a persuasive argument in their favor. Robots can work continually without requiring rest, vacation, or healthcare benefits. Over a lengthy time period, these advantages can help to offset the initial costs. (Sheetz, K. H., et al. 2020).

4.Enhanced Data Analysis

Artificial intelligence systems can examine massive and complex datasets significantly more quickly and efficiently than any human. When robots are endowed with AI capabilities, they can help healthcare workers make more educated, data-driven decisions. (Azadi, S., et al. 2021).

5. Reception. Robots in hospitals.

Reception robots such as Pepper and Temi demonstrate the benefits of incorporating technology into healthcare. They improve patients' experiences by giving information, directions, and minimizing wait times. These intelligent assistants free up human resources for more difficult jobs, increasing productivity. By reducing errors and engaging patients, reception robots demonstrate how technology improves healthcare interactions and operations.

6.Lower risk of infection.

Robots can be sanitized significantly more thoroughly than human hands or traditional medical devices. Robots cannot host diseases or act as viral vectors. Some hospitals even use robots with UV light capabilities built expressly for sterilizing rooms, lowering the risk of hospital-acquired diseases. (Haidegger, T. 2019).

The disadvantages:

1. Expensive initial costs

While the long-term benefits are encouraging, the initial expenditures of deploying robotic systems in healthcare can be prohibitively expensive, sometimes in the millions of dollars.

2. Skill gap and training

To operate these complex robotic devices, medical professionals must undertake extensive training, which is not only costly but also time consuming. These training sessions might last several months, if not years, delaying the final deployment of these devices. (Zemmar, A., et al. 2020).

3. Ethical and legal considerations

The lack of a strong legal framework to address potential malpractice or faults in robotic treatments is causing considerable worry. The questions of liability and accountability in the event of a robotic malfunction during a medical operation remain largely unaddressed.

4. Environmental Impact

Manufacturing, running, and finally disposing of medical robots requires the usage of rare earth minerals, which can contribute significantly to electronic waste, increasing environmental concerns. (Peters, B. S., et al. 2018).

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5.The Issue of Patient Trust

Although robots can do jobs with high accuracy, patients' belief in robotic surgeries varies greatly. Age, cultural background, and previous experience with technology can all have a substantial impact on a patient's willingness to undergo a robotic surgery. (Sheetz, K. H., et al. 2020).

Robotic surgery in different fields:

The field of urology:

it has been the first to embrace robot-assisted surgery, and soon, robots will be standard equipment for radical prostatectomies. Since its initial use in 2000, robot-assisted laparoscopic prostatectomy (RALP) has rapidly surpassed all other robotic procedures in terms of utilization. So, many procedures were carried out, taking into account factors such as age, levels of prostate-specific antigen, and pathological features. The researchers found that RALP has many benefits over open and LRP procedures, such as a shorter LOS and less blood loss than was previously thought. (Azadi, S., et al. 2021).

The use of robotics in gynecological surgery:

in 2005, five years after its initial licencing for use in urology, the FDA authorized robotic-assisted radical hysterectomy for endometrial and cervical cancer. The use of robots to help in surgical procedures has now gained widespread acceptance in the US. Despite radical hysterectomy being the second most prevalent robot-assisted procedure in the US, there has been a notable lack of randomized controlled trials, in contrast to RALP.Using data mostly from individual case series, Kruijdenberg et al. compared robot-assisted radical hysterectomy (RRH) with total laparoscopic hysterectomy (TLRH). Despite the fact that RRH patients needed fewer blood transfusions (5.4% vs. 9.7%, $p<0.05$) and had a considerably shorter LOS (3.3 vs. 6.2 days, $p<0.05$), RRH patients were more likely to experience major postoperative complications (9.6% vs. 5.5%, respectively, $p<0.05$) compared to TLRH patients. (Zemmar, A., et al. 2020).

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General surgery:

Despite general surgeons' dominance in laparoscopic surgery advancements, robotics have seen limited application in general surgery. Foregut, biliary, bariatric, colorectal, and endocrine surgeries are robotic-assisted procedures that surgeons are particularly interested in. Clinical investigations comparing robotic Nissen fundoplication to laparoscopic procedures have shown comparable outcomes in foregut surgeries. Research on robot-assisted Heller myotomy for achalasia has likewise demonstrated remarkably low rates of perforation. More study is needed before definitive conclusions can be drawn; however, some authors have touched on the possibility of robotic surgery being used in more complex cases. Robotic gastric banding has not improved bariatric surgery over laparoscopy. Robotic surgery, according to some specialists, has the potential to improve results for more complex bariatric surgeries involving intracorporeal suturing. (Sheetz, K. H., et al. 2020).

Several reasons may be contributing to the general surgeons' cautious attitude in adopting this new technology. It seems that complicated robots are unnecessary for basic operations. More complex processes, especially those involving movement into many quadrants, are beyond the robot's capability. Also, it's hard to adopt because there isn't a tool for stapling, sealing, and cutting the intestines; however, this could be fixed in the future. (Azadi, S., et al. 2021).

The future of robotic system in surgical operations:

Further improvement is necessary before robotic technology can be used widely in clinical settings due to its high cost. Robotic technology is costly to implement, but it has shown to be incredibly reliable and accurate in manufacturing, particularly for tool exchange and precise, repetitive tasks, with rates of accuracy and reliability surpassing 99.9 percent. Of course, robots used for automated activities are very different from robots used to improve human performance. Nonetheless, any technology that can reduce medical errors is attractive because of the 1999 research by the Institute of Medicine (IOM) that detailed 44,000 to 98,000 deaths each year in the US due to these mistakes. Improvements in haptics, instrumentation, and the size and portability of surgical robotic systems are crucial, but so are the connections to information systems and telemedicine. (Peters, B. S., et al. 2018).

Integrating information systems with surgical robotic platforms is essential so that the surgeon can access imaging data, including 3D reconstructions of the patient's anatomy, in real-time. According to Ron Merrill, "telesurgery" can be defined as the practice of consulting an expert during surgery through telemedicine. However, in order to broaden Jacques Marescaux's definition of telesurgery to include telemanipulation, we must address the following: the need to resolve limitations in bandwidth and compression algorithms; the need to expand telecommunication connectivity from short-distance cables to nonproprietary long-distance cables; and the investigation of wireless capability for use on ships, in space, or on the battlefield. When it comes to minimally invasive surgery, it's obvious that surgical robots can improve human strength, precision, visibility, and range of motion. There are more than 250 surgical robotic systems in use across the globe, but with a price tag of $1 million each, the da Vinci and Zeus systems are currently in a niche market. (Haidegger, T. 2019).

The understanding that surgical robots signify a change in our technology utilization is crucial to this conversation. One technology that is extending the relics of the industrial era is the laparoscopic revolution, which is a transitional one. The information age will be represented by surgical robotics. Robots are more accurately described as information systems with arms rather than machinery. Instead of imaging systems, computed tomography (CT) and magnetic resonance imaging (MR) scanners are information systems that look like eyes. Our present capacity allows us to create three-dimensional models of our patients' anatomy from digital computed tomography or magnetic resonance scans. Despite their underutilization, modern technology allows us to edit these reconstructions in order to model optimal surgical approaches prior to actual treatments. (Zemmar, A., et al. 2020).

The case for enhanced preoperative planning and its positive effects on patient care is strong. In addition, compared to the present, frequently rudimentary, surgical simulators, surgical education that makes use of three-dimensional reconstructions of modern patient anatomy for preoperative instruction and rehearsal provides a considerable improvement. You may recall that the da Vinci surgical robotic system constantly "knows" the exact location of its arms along the "x," "y," and "z" axes. This kind of surgical device has the potential to revolutionize the way we practice and prepare for our patients' surgeries. (Andras, I., et al. (2020).

By registering their three-dimensional anatomy with its three-dimensional functional platform, we can not only practice and simulate the procedures in advance, but also program the robot to execute the surgery autonomously once we've determined the "best" approach through multiple trials. What about virtual surgery? Although this scenario is still beyond the realm of possibility, the necessary technological components are already at our disposal. Research on technological systems often includes ethical considerations. Eighty percent of the world's unmet healthcare needs beg the question: why should we invest one million dollars on robots? The current generation of surgical robots is obviously paving the way for the telerobotic technology that will enable underprivileged communities to access much-needed surgical services. There is no positive or bad side to technology; it is just neutral. (Sheetz, K. H., et al. 2020).

Opportunities abound, but we need to be prudent with its usage. For instance, developing nations have been able to "leap-frog" over the difficulties of establishing a telephone network because to mobile phone technology, which was once out of reach for everyone but the wealthiest and largest enterprises. A comparable paradigm change in the delivery of surgical care could be triggered by surgical robotics. (Peters, B. S., et al. 2018).

Conclusion:

Robots have proven themselves in industries as varied as space exploration and vehicle manufacture, and their ability to execute extremely precise operations has sparked a great interest in incorporating them into surgical procedures. Robotic surgery is following in the footsteps of other healthcare breakthroughs that have encountered opposition. Robotic surgery has been plagued by doubts regarding its efficacy, patient safety, and expenditure. Many patients are nevertheless enthusiastic about laparoscopic surgery because of its status as a transitional technology. Consequently, the information age and the industrial era will be bridged by contemporary laparoscopic equipment. The inclusion of "smart" technologies in computer-assisted minimally invasive surgery is already here, even if laparoscopic surgery will inevitably grow in popularity. Current laparoscopic surgery "wizards" are competent using "chop stick" instruments and two-dimensional vision, but with three-dimensional vision and precisely built, articulated robotic instruments, we may achieve far more. The next iteration of surgical platforms will integrate this "smart" technology with imaging systems to enhance patient safety and medical care.

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