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A Look at the Different Types of Robotic Surgery

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Abstract

The purpose of this research is to investigate several aspects of robotic surgery. The history of robotic surgery, types of robots, and types of surgery done, as well as the benefits and drawbacks of robotic surgery, are all discussed throughout the article. Surgical robots are relatively new technology that has a lot of potential. Robotic surgery is the newest innovation and technology in surgery and it's getting a lot of attention right now. The market and the extent of their rising and developing uses are now driving the requirements for creating and purchasing robotic devices.

Keywords: *Robotics, Arduino, Self-decisioning robot, Artificial Intelligence, Edge Detection, Ultrasonic Sensor, Obstacle Avoidance*

INTRODUCTION

Robotic surgery is the practise of doing surgery with the assistance of robots and modern tools. Remote surgery, less invasive surgery, and unmanned surgery are three primary benefits of surgical robots.

Robotic surgery is a relatively recent phenomenon. Robots are employed to carry out sophisticated procedures and surgeries in this setting. The primary goal of this review article is to teach basic concepts in robotic surgery, beginning with its origins and progressing through the ages and stages of growth, through numerous procedures conducted, their benefits and drawbacks, and their future potential. Both doctors and surgeons who execute the surgeries and engineers who create robots with good features, technologies, and inexpensive budget are

responsible for the different challenges surrounding robotic surgery and its popularity.

THE BENEFITS OF ROBOTIC SURGERY

Less Personnel Required

To execute a more successful and safer surgery, fewer surgeons and people are required.

At a Distance Surgery

Robotic operations may now be conducted by surgeons even if they are in another city or even another country away from the patient, thanks to advances in telecommunications technology that allow for increased bandwidth and high-speed data transfer.

Patient Recovery is Faster and Trauma is reduced

Robotic surgery requires just minor incisions on the patient's body to operate, resulting in less pain during and after the procedure, as well as fewer risks and problems. Small incisions can aid in the patient's rehabilitation.

Doctors' Fatigue is reduced

When a surgeon's handshakes, robotic aides adjust for any tremors, and the computer ignores it, keeping the artificial arm firm. During protracted procedures, surgeons might get tremors as a result of exhaustion.

Hospitalization time is reduced

As a result of the shorter recovery period, patients can be discharged sooner, resulting in a shorter stay in the hospital.

Reduced Blood Loss and Transfusions

Because smaller incisions are used during surgery, there is less blood loss and fewer transfusions are necessary.

Greater Visualization, Enhanced Dexterity and Greater Precision by Surgeons using Robotic Surgery

The surgeon working on the patient feels and experiences increased strength, dexterity, flexibility, improved control, and a better vision of the patient's operated region. It's also more comfortable and easier to operate with enhanced attention and focus, and it can handle more intricate and difficult procedures that other techniques couldn't do.

DISADVANTAGES OF ROBOTIC SURGERY

Human Error by Surgeons

There is a risk of human (surgeon) mistake when operating the robotic system, as well as mechanical failure of robotic arms,

camera, robotic tower, binocular lenses, and equipment when surgery is supported by robots.

Frequently, the electrical current required by robotic instruments escapes the robotic arm and is administered incorrectly to nearby tissues, resulting in burn injuries. Due to severe body posture or direct nerve compression, surgery aided by robots can sometimes trigger nerve palsies in surgeons. It also takes longer to undertake robot-assisted surgery than it does to perform non-robotic surgery.

It's Expensive

Robot-assisted surgery costs an average of US$2678 (2272.67 euros) more than laparoscopic surgery, owing to longer operating periods and higher supply expenses.

ROBOTIC SURGERY'S HISTORY

The PUMA 560 robotic arm performed the first written and practical work on the design of robots, i.e. neurosurgical biopsy, a non-laparoscopic surgery, in 1985. Robotic surgery was the first laparoscopic surgery in 1987. (Called Cholecystectomy). The same PUMA 560 system performed a transurethral resection robotic operation in 1987.

The AESOP robot software, developed by Computer Motion (an American robot business), performed the first surgical surgery in 1990 after receiving permission from the Food and Drug Administration (FDA).

In the year 2000, the operating system robotic da Vinci was approved by the FDA, and for the first time, laparoscopic surgery was conducted. For the first time, the FDA has approved the da Vinci surgical robot system, which contains all surgical veins and cameras. The surgeons were able to examine, access, and operate on the region with exceptional clarity and high resolution thanks to the da Vinci robotic surgical system's movements and screen magnification.

In comparison to large-armed devices like the PUMA 560, it featured surgical arms with a diameter of one centimetre. This breakthrough resulted in less interaction between the patient's exposed inner tissue and the surgical gadget, lowering the risk of infection on a larger scale.

Some of the robotic surgeries performed successfully in world are [4]:

- The performance of the 1997 reconnection in the Fallopian tubes in Cleveland using the Zeus Robotic.

- Passing the initial heart bypass operation of the heart in May 1998 by Dr Friedrich-Wilhelm Mohr at the Leipzig in Germany by means of surgery Da Vinci robot.
- Reconstruction of the first surgical robots for heart coronary artery bypass graft (CABG) in Canada using the ZEUS surgical robot in October 1999.
- Cholecystectomy on a pig in Strasbourg, France and New York in 2001 by Prof. Marescaux using the robot surgery Zeus.
- Performing the first unmanned robotic surgery in May 2006 in Italy.
- A study conducted by Dr Todd Tillmanns by use of surgery da Vinci Robotic system for gynaecologic oncology and including the current and new users learning skills test as detected by using the tool in January 2009. [4]

In 2003, robotic-assisted surgeries comprised 1.5 percent of all operations. According to 2015, it comprised 27 percent of all surgeries performed.[2]

Nearly 400,000 robotic surgeries were performed on all types of surgery in the United States in 2012. The rate of robotic surgery was up 25 percent a year. (According to Jul 23, 2015) [5]

In 2017, Intuitive surgical (a company founded in 1995 for commercial robot-assisted surgery in conjunction with the U.S. Army) reported a 32% year-over-year growth in operating its robotic surgical systems among standard surgeries. [6]

WORKING OF ROBOTIC SURGERY

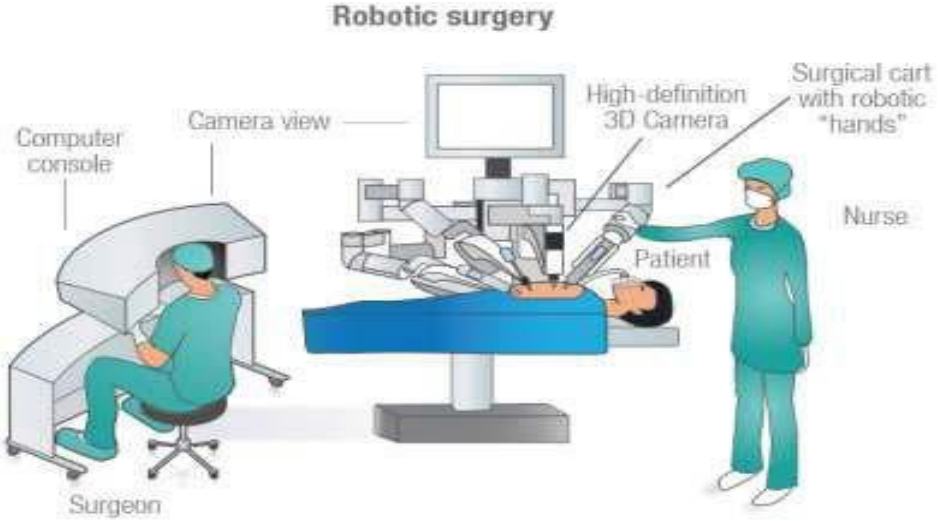

Fig.1:-Overall set up of robotic surgery [8]

LITERATURE REVIEW

To compare robotic management and cost-effectiveness to open-source and laparoscopic procedures, Ho et al [9] employed the Health Technology Assessment (HTA) test. The authors conducted a systematic analysis of surgical evaluations of robotic surgery vs open and laparoscopic procedures, followed by a study of economic research. The authors also looked at a basic economic study of robotic surgery from a Canadian perspective, as well as an assessment of robotic surgery's prospective influence on Canadian health care (both human and fiscal impact).

Hanly [12] had completed a review and discussion of the information contained in the MEDLINE (Medical Literature Analysis and Retrieval System Online databases, which is a database of health sciences and biomedical databases and includes bibliographic databases from educational journals, medicine, nursing, pharmacy, and so on) databases, which are written in English and include the following key words:'surgical robots,' 'robot surgery,' 'robots,' 'computer-assisted surgery,' 'da Vinci,' 'Zeus,' 'da Vinci,' 'Zeus,' 'da Vinci,' 'Zeus,' 'da Vinci,' 'da Vinci,' ' 'Obesity,' 'Fundoplication,' 'Hepatectomy,' 'pancreatectomy,'' small intestine,' splenectomy,' 'colectomy,' 'adrenalectomy,' and 'baby surgery.' To assess subject compatibility and surgery for the abdomen, a study of 387 publications was conducted. Reports that have sparked debates concerning human applicability and surgical results have received a lot of attention and pressure.

Haasteren et al [13] conducted an assessment of the data on the feasibility, safety, advantages, limits, and costs of robot aided surgery in children, as well as a comparison of the technology to existing paediatric surgical procedures and predictions for the technology's immediate and long-term future.

Antoniou et al [14] conducted a review on the current status of clinical robot applications in relation to vascular surgery.

Hockstein et al. [15] described the technological capabilities of transoral robotic surgery (TORS) using the da Vinci surgical system, including radical tonsillectomy, granule, and laryngeal applications and operations such as tongue amputation, supraglottic laryngectomy, and postoperative surgery.

Alternative placement of robotic endoscopes and devices, on the other hand,

has yet to be proven to be safe. Finally, it is presumed, and the study finds, that the hazards of robotic surgery are comparable to those of traditional surgery.

Bike [16] discusses the early worries about robotic colorectal surgery utilising the da Vinci robotic system, presents preliminary clinical data from the current series, and discusses not just the safety and practicality of robotic colorectal surgery but also robotic colorectal surgery.

Also discussed are the da Vinci robotic system's prospective clinical advantages and limits in robotic colorectal surgery.

APPLICATIONS OF ROBOTIC SURGERY

- General surgery
- Cardiothoracic surgery
- Cardiology and electrophysiology
- Gastrointestinal surgery
- Gynaecology
- Gynaecologic Oncology
- Neurosurgery
- Orthopaedics
- Paediatrics
- Radiosurgery
- Urology

Robotic surgery is not allowed for cancer surgery as of 2019 as safety and efficacy are unclear.

TYPES OF ROBOTS USED IN ROBOTIC SURGERY

Zeus

Fig.2:-ZEUS Robotic System [18]

Computer Motion's ZEUS Robotic Surgical System (ZRSS) was a medical robot developed in the United States. The Food and Drug Administration (FDA) authorised AESOP, a ZEUS predecessor, for minimally invasive surgery in 1994.

The FDA approved ZRSS in 2001. The first arm of the ZEUS robot, the AESOP (Automated Endoscopic System for Optimal Positioning), included a voice activator, allowing the surgeon to gaze inside the patient's body.

The robots' other two arms imitated the surgeon's motions, making direct and detailed observations. The merging of Computer Motion (an American robot firm) with its Intuitive surgical company resulted in the formation of ZEUS in 2003, which led to the development of the Da Vinci Surgical System.

It was a tele manipulator robot with a master and slave. General, cardiothoracic, and gynaecological surgery were all performed using it.

Da Vinci

The da Vinci Surgery System is an American business Intuitive Surgical's robot-based surgical programme that was created for surgical preparation utilising a randomised controlled approach by a surgeon from the console and began operating after receiving permission from the FDA.

In the year 2000, the Food and Drug Administration (FDA) issued a statement. The da Vinci system includes a surgeon in the same room as the patient, as well as a patient's side cart with three arms of robots that interact and are controlled by a model from the console.

Fig.3:-Da Vinci Robotic System

The arms contain tools and accessories including scales, scarves, saws, and armrests, with the final arm controlling three cameras.

The surgeon utilises the console's controls to send the arms to a vast region that can be monitored by three or four robotic arms on the patient's cart. The da Vinci method necessitates the presence of a leader at all times.

INCH WORM

Inchworm is a mobile robot that takes its inspiration from the inchworm worm and moves in a similar manner to the inchworm worm. The primary assembly's composition, which includes a centre that opens and shuts and supplies itself, as well as electromagnets at both ends of the body that provide adhesive power to each moving part.

The Inchworm robot may work in any location that appears in any vexing posture, such as vertical placement of the patient's body and movement of the complete body using electromagnets to attach themselves to the patient's body. Inchworm can also switch between several appearances, allowing it to explore freely in unfamiliar areas.

It's an active, self-contained kind that's employed for colonoscopy.

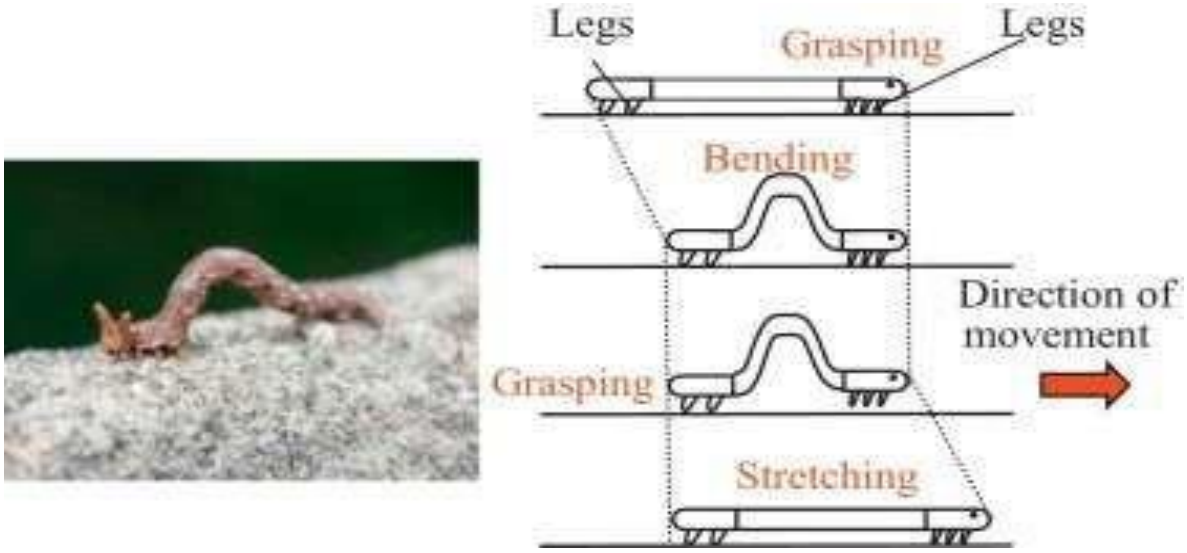

Fig.4:-Inch Worm Robot [23]

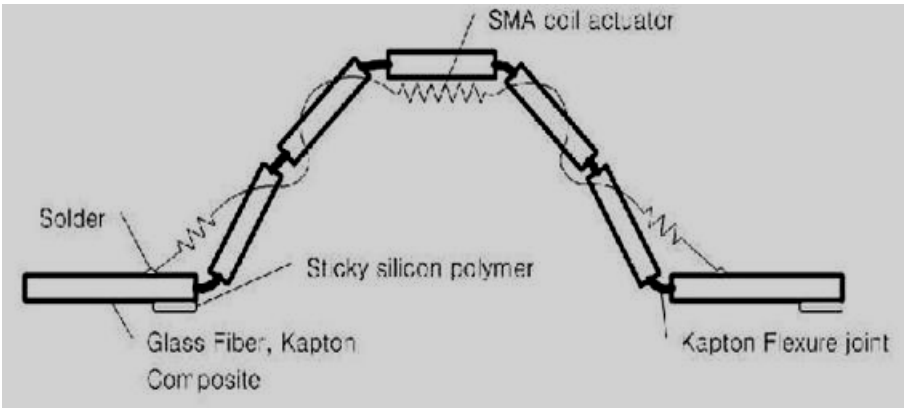

Fig.5:-Schematic view of inch worm robot [24]

PROBOT

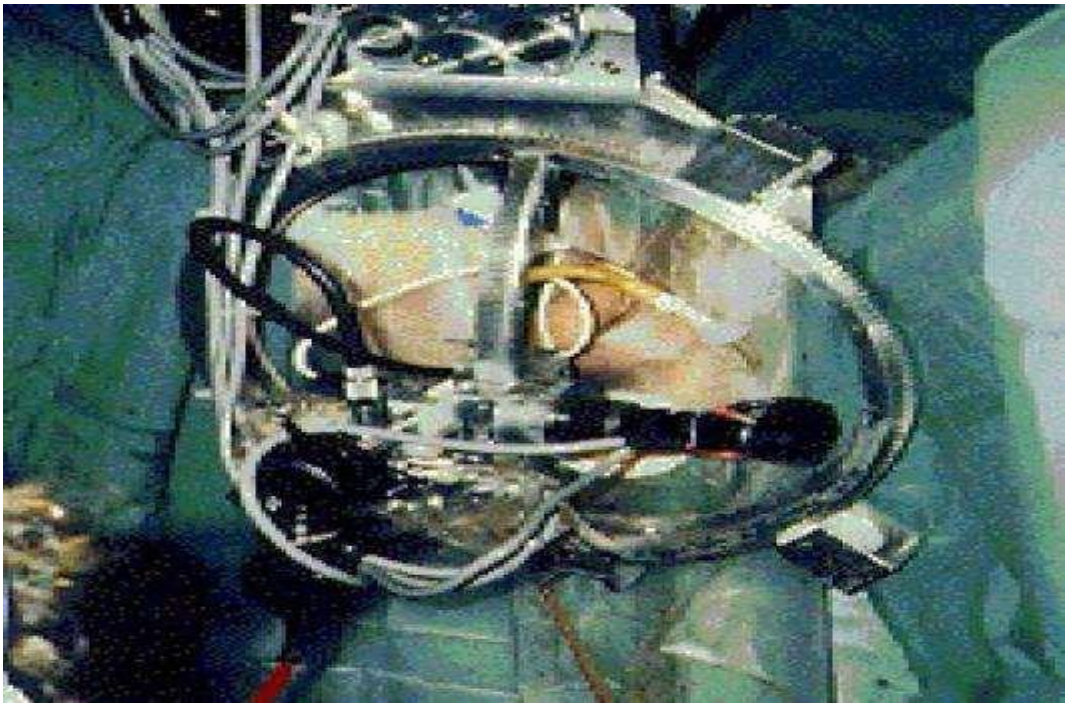

Fig.6:-A Typical Probot In Use [25]

The PROBOT is a prostate resection active robot. It was created to let a surgeon to define a volume within the prostate to be sliced, and then to automatically cut that amount without the surgeon's assistance. A Probot is an active surgical procedure that is mostly used to remove benign prostatic hyperplasia.

ROBODOC

ROBODOC is active surgical type and mainly used for prosthetic hip/knee implantation.

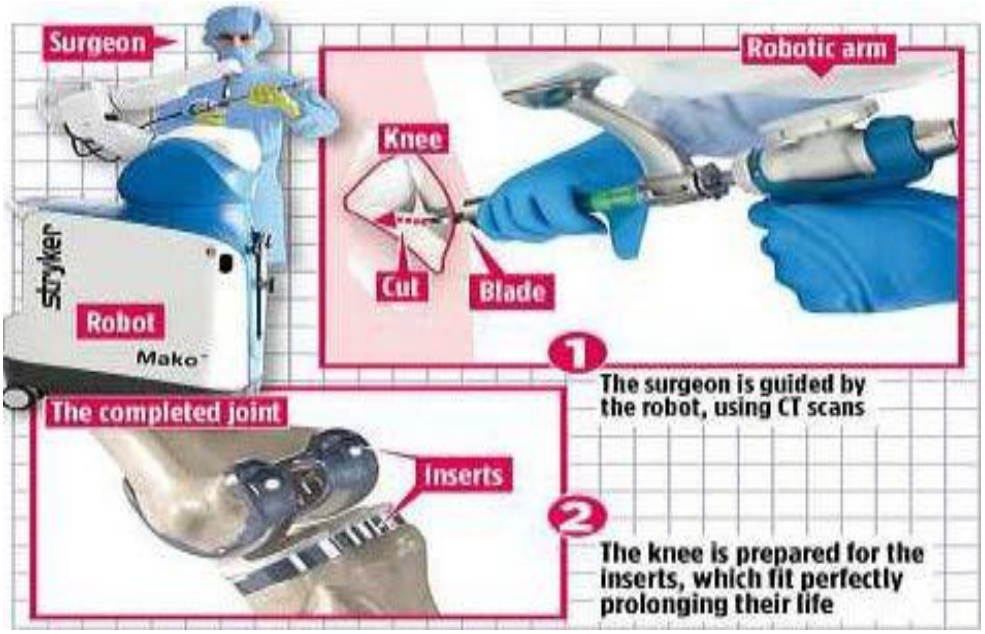

Fig.7:-Robodoc Robot In Use [26]

CASPAR

CASPAR is used for prosthetic knee implantation and is of active surgical type.

ACROBOT

Fig.8:-CASPAR Robot in Use [27]

Acrobat is semi active surgical type and is used for prosthetic knee implantation.

Fig.9:-Acrobat Robot in Use [28]

MINERVA

Minerva is used for stereotactic neuro surgery and is of active surgical type.

AESOP

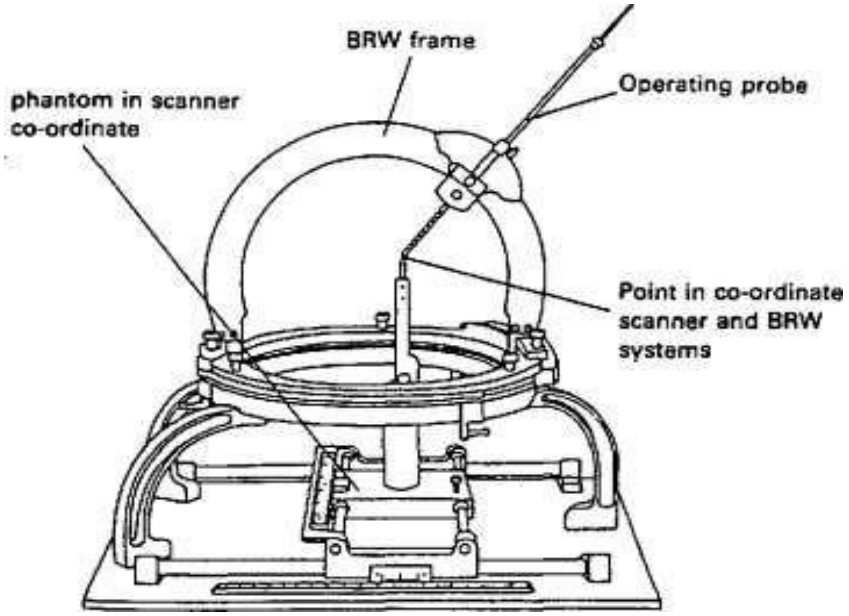

Fig.10:-Mechanical Parts of Minerva Robot [29]

AESOP is a single voice-controlled robotic arm that understands basic orders such as "move up," "right," and "left."

It is based on an active camera and is used for camera manipulation during minimum access surgery (by voice controlled).

Fig.11:-AESOP Surgical Robotic System [30]

FIPSENDOARM

It is an active camera that is used for camera manipulation during minimum access surgery (finger ring joystick operated). See Figure 12

ENDOASSIST

ENDOASSIST is a self-contained gadget that holds the laparoscope and allows an assistant surgeon to control the procedure.

It all starts with the surgeon's footing and head control. It's intended to help surgeons do laparoscopic surgery with better imagery while they operate. The cholecystectomy was done laparoscopic ally. It is an active camera that can be manipulated during minimum access surgery (by synchronising with the surgeon's head motions). See Figure 13

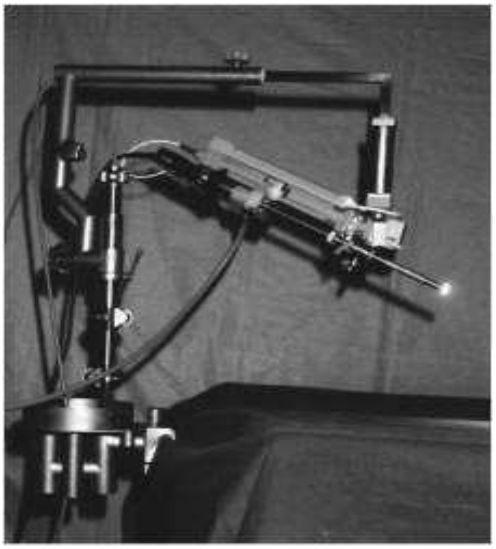

Fig.12:-Fipsendoarm Guiding System [31]

Fig.13:-End assist Robotic System [33]

RECENT DEVELOPMENTS IN ROBOTIC SURGERY

The following are some of the most notable recent robotic surgical developments:

The Renaissance Guidance System from Mazor Robotics is a comprehensive surgical solution for spine treatments such spinal fusion, Kyphoplasty, Biopsies, and Scoliosis surgery, with better precision, decreased complication rates, and quicker recovery periods.

Smart Tissue Autonomous Robot (STAR)

This robot uses infrared lights to highlight the regions of the patient's body and uses a preoptic approach to create a three-dimensional model of the body using pictures from many cameras. It can also work in small, inaccessible areas of the body.

Virtual Incision Corp's Miniature Robot

People with Crohn's disease, colon cancer, diverticulitis, and ulcerative colitis can use this sort of robot to undertake invasive colon screening treatments. It has the benefit of completely encircling the patient's stomach while causing minimal pain.

FUTURE OF ROBOTIC SURGERY

The future of robotic surgery is bright, and scientists and engineers must devise new ways to undertake and complete delicate medical procedures. In the next generation of medical robots, the present benefits should be enhanced. The existing drawbacks of robotic surgery should also be reduced.

With systems capable of operating at longer distances between the surgeon's control console and the patient side table robotics, the isolation of patient from human interaction (surgeons, nurses, and attendants) during surgery, with reduced infection risks, might be advanced to the next level.

This might allow surgeons to operate on patients in a nearby sterilised and sterile environment, virtually eliminating infection throughout the procedure. Medical robots of the future may enable surgical preparation to be done remotely as well. However, it will take some time for robotic surgery to reach its full potential.

The robotic surgery business generates almost $3 billion in annual revenue, which is predicted to increase by nearly 15% every year until 2022.

CONCLUSION

Robotic surgery is still in its infancy, and there is still much advancement to be made. Its functional domains and applications are primarily centred on a surgical technique that necessitates the use of tiny surgical holes. Both marketing and a practical function is required for robotic devices, but the marketing role should be prioritised.

If robotic technology is pushed to its full potential, it has the potential to transform the creation and growth of laparoscopic operations, surgical technological advancements, and surgical methods that beyond human skill boundaries, bringing contemporary surgery to life. However, the cost of robotic surgery should be emphasised so that ordinary people can afford it.

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