

# UPI Journal of Pharmaceutical Medical, and Health Sciences

Content Available at [www.uniquepubinternational.com](http://www.uniquepubinternational.com)

ISSN: 2581-4532

## Open Access

## Review Article

### Robotic surgery: innovation to an era of new treatment

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Article History	Abstract
Received: 11-05-2021 Revised: 24-05-2021 Accepted: 28-06-2022	We are going to enter the new era of robots-performing surgery with help of physician guidance, which runs automatically, also called Robot-assisted surgery which allows physicians to perform diverse types of surgical procedures without any hustles with control and conventional. Although this surgery isn't an option for everyone, by knowing about advantages and limitations by comparing with other techniques it can be performed. Most widely used robotic system includes camera arm also with mechanical arm with some other surgical instruments attached to them. Here surgeon controls those arms by seating at Console table gives his position. These surgical systems mostly used in various orthopaedic surgical procedures.
<b>Keywords</b> Robodoc, Robota, Programmable Universal machine, prostatectomy surgery, Knee arthroplasty.	
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DOI: <a href="https://doi.org/10.37022/jpmhs.v5i2.78">https://doi.org/10.37022/jpmhs.v5i2.78</a>	

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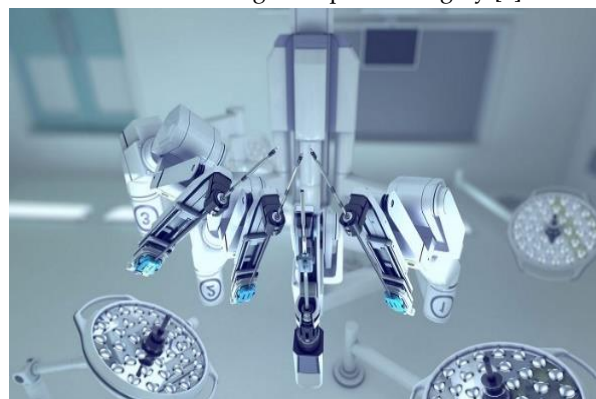
### Introduction

We are ready to enter a new era with greater knowledge and output with the capability for wider and more meaningful Robotic applications.

### History of robots

The general history of this surgery seems strange to talk about. When scientists started working towards it, the idea of robotics was already used more than 50 years ago itself, but main usage began in the late 1980's with Robodoc so called (Integrated Surgical systems) was developed by Hap Paul, DVM and William Bargar for use in surgical procedure "Prosthetic hip replacement. So, during this period of developing Paul and Bargar's Robodoc, Braian Davies and John Wickham was developed a urologic robot for Prostate surgery. During this time, itself, there was a number of computer -assisted systems being used in Neurosurgery (so called Stereotactic) and Otolaryngology [1]. This first robotic surgery platform was used on a human patient in year

1985 to perform a surgery "Neurosurgical biopsy" called Programmable Universal Machine for assembly 200 Puma. Further the machine was adapted and user for some of urologic and prostate surgical procedures in the robotics centre at Imperial College. Now the robodoc model surgical system is the one and only currently active robotic system cleared by Food and Drug administration for using orthopaedic surgery [2].



Neuromata, Probot, Robodoc, and Aerobat, precursors to Da Vinci & AESOP /, HERMES are the Robots that were developed in late 1980's and early 1990's. Some other Robotic systems developed during late 1980's through 1990's include ARTEMIS, MINERVA, CASPER & ENDOASSIST (Swamy, 2011). Robots have been used in Surgery since 1980's. Earlier this Orthopaedic surgery began to incorporate Robotic technology in 1992, within introduction of ROBODOC, in planning and performance of Total Hip Replacement. Now-a-days use of Robotic systems has increased subsequently compared with other traditional orthopaedic procedures [3]. Like surgeries of Hip & Knee replacement changes rapidly, these Robots has become more apart in our day-to-day lives. Some research writes down that 1st minimally invasion procedure of Surgery was 1st taken place in year 1985, then that robot was used in helping major performances. The neurological surgeries & biopsies and then by following robotic prostate procedures. As This procedure happens by removing of prostate tract in the body. This prostate surgery was first taken place in Montreal, Canada and then Hip Replacement surgeries are followed [4-5].

Some of the discoveries said that in the year 2012 in US, 85% of prostatectomy surgeries were majorly performed with presence of robots [6-9]. Since then, the implementation of surgical aid has increased quietly there. Also, they have estimated that the global market of medical Robot sciences would reach up to 1.5 billion dollars by the year 2018. In the year 2015, As per some medical records in England up to 98211 Hip surgeries & 104695 Knee Arthroplasties was recorded. Also, these happened in Wales, North Ireland & Isle of Man (Which is National joint registry, 2016) Annually in UK total knee arthroplasties by the year 2035 could reach up to 118666-1219326 cases. So, the cost for total knee arthroplasties may also increases on health care systems & also it is estimated to cost between £ 10893 & £ 21937. Here the cost mainly depends on indication of the disease and also complexity [10].

Also, here the most common cause for any failure of surgery procedures is loosening of aseptic technique, with monstrosity of components [11]. This is a major causing factor; so, at that time Robot-assisted Knee replacements may reduce these types of incidents of the major failures.

Today there is a great demand for assorted services of robots like rehabilitation, surgical & hospital Robots etc. Because they will continue for developing by reducing cost of production of robots. While these see major

greatest & developed growth in medical and mainly in Surgical Field while coming to non-invasive-radio-surgical systems, there's also rise in the significant growth. Some other areas of developing and their development includes Emergency response systems, prosthetic and endoskeleton usage, assistive, also immediate rehabilitation systems & also they have been used in non-medical hospital systems. Now coming to Orthopaedic era, Robots and their usage was 1st ever started before 30 years ago, but their adoption has been limited until now itself. While today if we see the processing & using instruments that also causes many the challenges which are been facing by many of orthopaedic surgeon's which results in use of manual instruments that cause inconsistencies while placing and removing of certain bones and also tissues, introduction of human errors &, it's very less predictable outcomes sometimes due to lack of reproducible averages. So, this allows for many advanced plannings, machining of bones with decreased errors that results in improved implant bone contact & also optimization of placing of components & it's mechanical alignment. So, all these factors will have stimulated and then finally we can see that there may be increase in interest in Robots [12-13].

### **Robot**

Robot, it is named as any automatically operated machine that replaces human efforts though it may not resemble humans in appearance or perform functions in human like manner.

### **Surgery**

It often deals with branch of medicine that is concerned with treatment of injuries, diseases and other disorders by manual and instrument. It involves in management, Therapy to treat acute injuries, illness which are differentiated from chronic.



In general, the word "ROBOT" is derived from word of polish "ROBOTA" it means forced labour, also describes a machine that carries a wide variety of tasks automatically. The Robotic systems can be classified into 2 main types.

- Haptic and Autonomous surgical
- Passive surgical systems.

Recently 3rd type of surgical system has implemented.

Today, use of Robotic systems has gained latterly compared with other traditional procedures in orthopaedics.

#### **Robotic Surgery – Used in Different Systems**

Robotic surgery can be used in almost all organ systems such as Orthopaedics, paediatrics, otolaryngology, urology, paediatric urology, gynaecology, neurosurgery etc.

Let's see some of the organ systems by using robotic surgery.

#### **Robotic surgery in gynaecology**

- In gynaecology, laparoscopic surgery has very rapid evolvement in various specialities. So, in this field, robot-assisted surgery is used in different procedures, mainly involves in hysterectomies for any benign diseases and myomectomy procedures also in endometriosis etc.,
- So, some of surgeons who practices these benign gynaecological conditions agree that in some cases blood loss and need for transfusions are decreased, also duration of hospital stay is less. As it's all depends upon learning of each procedure.
- In almost all the techniques, its major important for surgeon to get well trained and certified according to each hospital guidelines of practicing robotic surgery, also should be constantly updates with every aspect along with tools provided by robotic surgery to make sure to use correctly of this technology to maintain patient safety.

#### **Robotic surgery in paediatrics**

- The first use of paediatric robotic surgery in child was occurred in 2001.paediatric robotic assisted surgery is increasing its prevalence.
- From small abdominal and thoracic cavities there is limit working space also the operative indications differ to that of adult population.

#### **Robotic surgery in urology**

- Urology has been at forefront of modern robotic surgery since in 1990s. Currently almost all urologic procedures are performed robotically only.
- This urology has always been leaders in advancing surgical technologies, including endoscopic transurethral surgery.
- Also, robotic surgery in urology is quickly becoming a gold standard in United states and

world is expanding significantly throughout developed world. Yes, the future is very excited.

#### **Current Status of Robotic Surgery**

- The field of computer-aided surgery is expanding day to day with new device developments with multiple centres throughout worldwide. In addition, societies and journals are devoted to the use of computers and surgical robots are emerging everywhere.
- This burst of interest in the cyber technology for medical use has a spawned a surplus of acronyms, including the CAOS (computer-assisted orthopaedic surgery), MRCAS (medical robotics and computer assisted surgery), MICCAI (medical image computing and computer-assisted intervention), and CARS (computer-aided robotic surgery) among other surgical systems.
- Use of this robotics will lower instrument and inventory costs to manufactures, also it helps to keep down the implant costs. Also, these Robotic devices do not need expensive saw guides, broaches. The other materials such as end effectors (burr or saw blade) are relatively cheap and disposable to use.

#### **Total hip arthroplasty**

Various systems of computer-aided orthopaedic surgery (CAOS) in total hip arthroplasty (THA) have been developed since the early 1990s. These include computer aided preoperative planning, robotic devices, navigation, and patient specific surgical templates. The author reviews the scientific literature on these CAOS systems in THA and describes the history, safety, and effectiveness issues to help readers to evaluate and compare the pros and cons of these CAOS applications.

#### **Knee arthroplasty**

A number of groups are exploring the potential role of semiactive robots in knee arthroplasty, the systems that are commercially active now for knee surgery are active robots.<sup>18</sup> Such active robots obviously require a high degree of safety and reliability and should give the surgeon adequate feedback about the ongoing process such as the cutting path with respect to preoperative planning, cutting process, bone motion, and so on, to allow the surgeon to appropriately detect if something is going wrong and subsequently allow him or her to intervene if necessary.

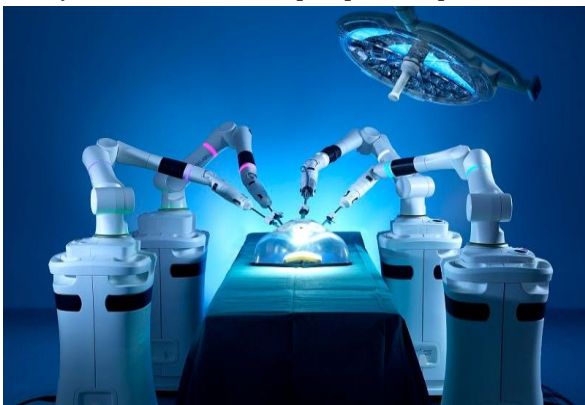
#### **Orthopaedics**

It's a field in medicine and is often concerned with study and treatment of musculoskeletal system, particularly spine, joints, muscles. It mainly deals with correction of disorders, deformities related to Musculoskeletal system.

Hence this branch of orthopaedics is central to treatment of back pain.

#### Advantages

- By using this robotic technology in orthopaedics may include the possibility of improving implant placement (e.g., reducing outliers), accessing certain anatomic areas, reducing the complications, decreasing the fluoroscopy use, and performing remote surgery.
- They are more exact than the humans in performing certain tasks.
- They can achieve the reproducible results, which should lead to less variation in patient outcomes.
- They also can execute the preoperative plans.



#### Disadvantages

By using this robotics in orthopaedics may increase the costs, the need for updated software's, the surgeon learning curve and Increased time, imaging for preoperative templating, and possibly there are no differences in long-term outcomes.

#### Types of Robots used in Orthopaedic surgery

There are many different categorisations of robotic systems used throughout the surgery. But mainly historical categorisation of robots includes the following: So, there are 3 historical classifications here in this:

1. Passive systems-which guides surgeons  
Examples - Omnilbotics and Da Vinci surgical systems
2. Semi active systems-used by surgical manipulation and feedback to what can be done surgically  
Examples - ACROBAT (Active constraint robot, Stanmore implants worldwide, although these types of systems are not more in use in this era.
3. Active systems-so finally these active systems can perform tasks independently without direct human interaction/manipulation  
Example-ROBODOC surgical systems  
Here surgeons start and stops a robot's activity, but surgeon doesn't have continuous control of robot and robot's actions.

Some Newer systems, such as TSolution One (Think surgical), maybe fully autonomous, this allows robots to autonomously mill bone without physical guidance of the surgeon.

#### Use of Surgical Robotic Platforms

This Robotics were also applied to surgery in 1970's as a Military project which was endorsed by National Aeronautics and space administration (NASA) which is funded by Defence advanced research project administration (DARPA), in which main aim of replacing surgeon's physical presence and also by providing some care to astronauts in space crafts or also to the soldiers in the battlefields.

#### Conclusion

Robot, it is named as any automatically operated machine that replaces human efforts though it may not resemble humans in appearance or perform functions in human like manner. There are many different categorisations of robotic systems used throughout the surgery. Most widely used robotic system includes camera arm also with mechanical arm with some other surgical instruments attached to them. The field of computer-aided surgery is expanding day to day with new device developments with multiple centres throughout worldwide. Robotically performed surgery is most expensive than laparoscopic and open surgeries. Finally, we conclude the future market of Robotics may exceed \$7 billion.

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