

Robotic Surgery in Healthcare Setting: Application, Current Advancements, and Future Perspectives of robotic surgery

Shivaraj Annigeri^{1*}, Vasant Dammali², Rajeswari P.³

Abstract

Robotic surgery, utilizing computer-controlled robots, has transformed minimally invasive procedures. This review delves into its evolution, applications, and future impact on healthcare. The Da Vinci system is globally employed, providing surgeons precision and flexibility. Originating in the late 1980s, robotic surgery has expanded across clinical domains. Specialized training is essential for surgeons entering this field. Various types of robotic surgeries offer benefits such as smaller incisions, quicker recovery, and improved outcomes. Preoperative planning, involving imaging studies, plays a crucial role. Advantages include increased accuracy, minimal invasiveness, and improved quality of life. Challenges include robotic malfunctions, limited availability, and financial constraints. Future advancements include miniaturization, single-port robotic surgery, AI integration, predictive analytics, Telesurgery, Nanorobots, haptic feedback, and regulatory considerations. Balancing technological progress with ethical standards is crucial for ensuring patient safety and accountability. In conclusion, robotic surgery presents significant benefits and challenges, with ongoing advancements and ethical considerations shaping its future impact on healthcare.

Keywords: Advantages, Challenges, Da Vinci system, future advancement, Health care Invasive, Robotic surgery, Telesurgery

INTRODUCTION

Now a day's robotic surgery is considered as the most advanced form of laparoscopic or minimally invasive surgical procedure. By using computer-controlled robot to aid the surgeons in some surgeries related to common traditional surgery or open surgery, the robotic surgery is less invasive with smaller incisions that results less scarring and pain to the patient. Through robotic surgery the surgeon can do most complicated surgeries by doing smaller incisions. The positioning and manipulation of robotic surgical instruments are computer-controlled and self-powered that helps the surgeons with better flexibility and accuracy of the surgery [1].

*Author for Correspondence

Shivaraj Annigeri
E-mail: ssannigeri85@gmail.com

^{1,3}Professor, HOD, Department of Medical Surgical Nursing, OP Jindal College of Nursing, Toranagallu, Dist. Bellary, Karnataka, India

²Professor, HOD, Department of Medical Surgical Nursing, Nanjappa Institute of Nursing Sciences, Shivamogga, Dist. Shivamogga, Karnataka, India

Received date: January 15, 2024

Accepted date: February 03, 2024

Published date: February 12, 2024

Citation: Shivaraj Annigeri, Vasant Dammali, Rajeswari P. Robotic Surgery in Healthcare Setting: Application, Current Advancements, and Future Perspectives of robotic surgery. International Journal of Medical Surgical Nursing. 2024; 7(1): 49-54p.

Currently general surgery has noticed remarkable changes in the application of robotic and other surgeries, offering uses like less incision sizes and getting good outcomes in surgical health care settings. So evolution of robotic surgery, mainly in terms of minimal invasiveness, has benefited advancements in surgical technologies. This review is taking look for impact of robotic surgery in future health care [2] Robotic surgery stands out as an inventive form of minimally invasive surgery where all health professionals make use of small surgical instruments used into a patient's body through a

series of small incisions. By using three robotic arms, providing surgeons with a various range of motion during the procedure. A fourth arm is for high-definition, three-dimensional camera for clear visualization of tissues and structure of the human body during the robotic surgery [3].

Robotic surgery minimally invasive surgery and it can be performed independently or sometime combined with open surgical methods depending upon the specific situations. Globally now a day's using Da Vinci system for robotic surgery which consists of three main parts, a surgeon cart, the surgeon's console, and a vision cart. All these parts work together, to help the surgeons to use and control robotic instruments accurately and effectively [4].

What is Robotic Surgery

Robotic surgery is a modern approach to minimally invasive procedures, using computer-controlled robots. Robotic surgery makes smoother and minimizing tissue injuries during the procedure even surgeons can perform surgeries in small area of the human body [5].

History of Robotic Surgery

Robotic surgery has become innovative area in the field of surgical research, developed step by step over several years. It was introduced in the late 1980s. Now it is applicable in different area in clinical settings like cardio-thoracic surgeries, pancreatic and laryngeal cancer surgeries including spine and urology, gynecology. The evolution of robotic technology has its own various advantages, like declining morbidity and enhance cosmesis [6].

Who Performs Robotic Surgery?

A Surgeon who desire to specialize in robotic-assisted surgery and wish to take training in this specific type of procedure by attending in fellowships involved in robotic and minimally invasive surgeries [7].

Types of Robotic Surgery

There are various types of robotic surgeries to enhance patient's surgical outcome.

Laparoscopic Surgery

Robot-assisted laparoscopic surgery uses computer based surgical robotic tools with least possible invasive procedures. This modified technique increase patient care and overall surgical end results by:

- Doing smaller incisions
- Minimizing postoperative pain including discomfort
- Speeding the process of recovery
- Less hospital stays
- Rapid shift to regular activities

Endoscopic Surgery

Using robotic assistance in endoscopic surgeries in various medical specialties, like urology, neurology, orthopedics gynecology, thoracic. This aims magnificent advantages, such as less blood loss with smaller incisions, speed recovery times, and overall enhancement of surgical outcomes.

Prostate Surgery

Robotic surgery helps to treat prostate related problems like prostate cancer with robot-assisted prostatectomy. The possible outcome with treatment is controlling cancer, declining prolonged hospital stay as well as minimal blood loss with speedy recovery.

Cardiovascular Surgery

Robot-assisted surgery used and implemented in various cardiovascular problems includes atrial septal defect repair, patent foramen ovale repair, cardiac tissue ablation, and cardiac tumor removal and

also treat coronary artery bypass, mitral valve repair, tricuspid valve repair.

Gynecological Surgery

In gynecology Robotic surgery innovated for treating conditions like hysterectomy, ovarian cystectomy, and myomectomy. uterine fibroids, pelvic prolapse repair, excessive menstrual bleeding as well as gynecological cancers such as uterine cancer like ovarian, cervical.

Neurosurgery

Robotics neurosurgery is assisting to treat brain tumors, seizures and other brain related problems with minimal invasive surgical robotic procedures.

Orthopedic Surgery

Robotic technology is being used to treat knee ligament reconstruction as well as knee and hip replacements, trauma, and spinal interventions successfully.

Others

Robot-assisted surgery engages in magnificent roles in multiple health care settings with advanced technology.

General Surgery

- Appendix related surgeries [Appendectomy]
- Hernia and its repair
- Problems of Gall bladder [Cholecystectomy]

Thoracic Surgery

- Lungs and Mediastinum Problems and reduction

Urologic Surgery

- *Cystectomy*: Removal of Urinary Bladder
- *Prostatectomy*: Removal of prostate gland
- *Nephrectomy*: Partial Removal of kidney

Gastrointestinal Surgery

- Surgical Removal of Pancreas, Stomach, Rectum, Colon [8]

PREOPERATIVE PLANNING AND PREPARATION ARE CRUCIAL COMPONENTS OF ROBOTIC SURGERY

Steps of Preoperative Planning Involves

- Make Use of imaging studies like MRI and CT to look for anatomy of the client and targeting the surgery effectively.
- Finding the proper surgical approach by developing surgical plan.
- Observe for potential complications.
- Medical and medication history of the patient should be reviewed.
- Make use of advanced imaging and software techniques for effective preoperative planning.
- Instruct the patient for fasting for several hours before the procedure to reduce the risk of anesthesia related problems.
- Administer antibiotics to prevent infection and anticoagulants to reduce the risk of blood clots in case needed.
- Bowel preparation should be done in case of organ visualization problem.
- Shifting Patient to the operating table with general anesthesia make sure for proper access to surgical site.

- Finally Surgical team and surgeon cross check the set up for the procedure [9].

ADVANTAGES OF ROBOTIC SURGERY

- *Increased Accuracy and clarity:* This robotic surgery provides surgeons to plan the procedures more safely and effectively.
- *Minimally Invasive Nature:* Surgeons can make fewer incisions while doing procedures with low blood loss including speed recovery of the patients.
- *3D Visualization:* for better surgical outcome these surgeries enables the surgeons for better visualization of the surgical site.
- *Improved Quality of Life and Reduced Complications:* This kind of newer technologies improves all round quality of life and decrease the risk of complications of the patients.
- *Increased Maneuverability:* There will be a reduced hospital stay, less postoperative pain and tissue damage is possible because of surgeons can operate challenging areas of the human body.
- Reduce surgeons tremor
- Reducing the risk of human error
- Enhancing the knowledge of surgeons to visualization of anatomical structure
- Declining risk of infection [10]

DISADVANTAGES OF ROBOTIC SURGERY

Robotic Malfunction

A careful examination during robotic surgery is very important because machines are made up of human beings so there is risk of mal function and which leads to tissue and nerve damage during the surgeries and results poor patient outcome.

Less Available Centers

Still there are less available facilities in our nearby hospitals and even most of the hospitals are not properly equipped to perform advanced robotic surgeries.

Expense

Robotic surgery is utilized by only selected patients because of financial problems and tools used in advanced robotic surgeries are more expensive so all patients are not affordable.

Latency during the Procedure

Robotic Machines consume more time to executing its work between the computer and robotic tool movements so sometimes surgeons are facing problems while operating emergency procedures [11].

IMPACT OF ROBOTIC SURGERY ON FUTURISTIC HEALTH CARE

Miniaturization of Robotic Systems

Micro-robotics is new innovations helps in modifying health care system. These micro robots plays very important role in delivering treatment in case if surgeons are not able reach the specific area for operating delicate structure of the human body.

Single-port Robotic Surgery

It is a minimally invasive treatment in which by doing single incision numerous robotic instruments are used to treat the problems that results less pain, scar as well as speed recovery.

AI and Machine Learning (ML) Integration

AI and Machine Learning integration is help the surgeons to make efficiency, data analysis and decision making as well as operating specific surgery with minimal human interventions that promotes optimize surgical outputs.

Predictive analytics

This predicts patients safety as well as decision-making, medical history, finding potential complications and real-time surgical information including overall surgical success.

Telesurgery and Remote Surgery

Telesurgery or remote surgery technology is helpful while delivering critical intervention during emergency because of utilizing high speed internet with robotics makes the surgeons or operate procedures remotely.

Nanorobots in Surgery

Nanorobots in surgery refers to nanomedicine helps to detection of early cancer, enhance tissue repair, and medicine delivery to target area with minimal side effects. Here surgeon can expect accuracy.

Haptic Feedback and Sensory Augmentation

This technology is more safer and effective surgeries, because here surgeons make skills and control on hands while operating delicate procedures like detection of tissues as well as suturing by simulates tactile sensations, enables the surgeons to "feel" tissue resistance and texture.

Regulatory and Ethical Considerations

These regulations and ethical considerations are important to reduce risks, making accountability, and enhance high standards of safety and quality in robotic surgery. Follow guidelines while designing, process of manufacturing, and training of robotic surgeons and certification of equipments during future use of robotic surgeries [12].

CONCLUSION

Robotic surgery has emerged as a leading minimally invasive approach, transforming traditional surgical methods. This review explores the current state, applications, and future impact of robotic surgery in healthcare. Utilizing computer-controlled robots, surgeons can perform intricate procedures with smaller incisions, reducing scarring and postoperative pain. The Da Vinci system, widely used globally, showcases the versatility of robotic surgery in various medical specialties. Advantages include increased accuracy, minimal invasiveness, 3D visualization, and improved patient outcomes. Challenges such as malfunctions, limited accessibility, expenses, and procedural latency require consideration. Future prospects involve miniaturization, single-port surgery, AI integration, predictive analytics, telesurgery, nanorobots, and enhanced sensory feedback. The review emphasizes the evolving role of robotic surgery, combining technological advancements with ethical and regulatory considerations for a promising future in healthcare.

REFERENCES

1. Vaibhavi Lokare, Branding Associate at Wockhardt Hospitals, Published Jan 25, 2021. [Available from - <https://www.linkedin.com/pulse/impact-robotic-surgeries-healthcare-vaibhavi-lokare>]
2. Sakshi Bramhe, Swanand S Pathak, Robotic Surgery: A Narrative Review, Published online 2022 Sep 15. doi:10.7759/cureus.29179. [Available from - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9573327>]
3. What is robotic surgery, nyulangone health. [Available from - <https://nyulangone.org/care-services/robotic-surgery-center/what-is-robotic-surgery>]
4. What is robotic surgery, Narayana Health, robotic surgery, understanding the procedures. [Available from - <https://www.narayanahealth.org/robotic-surgery>]
5. Raynetta Stansil, Clinical Educator, What Is Robotic Surgery and How Does It Work, Surgical Solutions, Jul. 31 2019. [Available from - <https://surgical-solutions.com/blog/what-is-robotic-surgery-and-how-does-it-work>]
6. Debra Dunn MSN, MBA, RN, CNOR, Robotic-Assisted Surgery: A Brief History to Understand

-
- Today's Practices, 25 February 2022,<https://doi.org/10.1002/aorn.13629> [Available from - <https://aornjournal.onlinelibrary.wiley.com/doi/10.1002/aorn.13629>]
7. Robotic surgery, Cleveland clinic. [Available from - <https://my.clevelandclinic.org/health/treatments/22178-robotic-surgery>]
 8. Dr. Gayatri Deshpande in Robotic Surgery Program , Robotic Surgery: An Overview and its Advantages, Oct 06, 2023.[Available from - <https://www.nanavatimaxhospital.org/blogs/robotic-surgery-advantages>]
 9. Sung Hyun Park, Ki-Yoon Kim, Yoo Min Kim,et,al. Patient-specific virtual three-dimensional surgical navigation for gastric cancer surgery: A prospective study for preoperative planning and intraoperative guidance.[Available from - <https://www.frontiersin.org/journals/oncology/articles/10.3389/fonc.2023.1140175/full>]
 10. Paola Picozzi, Umberto Nocco, Greta Puleo, et,al. Telemedicine and Robotic Surgery: A Narrative Review to Analyze Advantages, Limitations and Future Developments . Published: 28 December 2023. [Available from -<https://www.mdpi.com/2079-9292/13/1/124>]
 11. Pros and Cons of Robotic Surgery, Narayana Health, March 29, 2023.[Available from - <https://www.narayanahealth.org/blog/pros-and-cons-of-robotic-surgery/>]
 12. Kavyanjali Reddy , Pankaj Gharde, Harshal Tayade,at,al. Advancements in Robotic Surgery: A Comprehensive Overview of Current Utilizations and Upcoming Frontiers, December 12, 2023.[Available from - <https://www.cureus.com/articles/191019-advancements-in-robotic-surgery-a-comprehensive-overview-of-current-utilizations-and-upcoming-frontiers#!/>]