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Review Article

Robotic Surgery in Africa: History, Contemporary, and Thereafter.

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Abstract

Background: Since its introduction in the late 1980s, robotic surgery has become a less invasive procedure, offering advantages such as increased dexterity, mobility, 3D visualization, and reduced fatigue for surgeons. Although the procedure is still not widely used in Africa, it is fast growing and can potentially minimize surgical inequities in low- and middle-income nations. This narrative review aims to explore the advantages of robotic surgery, its history in Africa, the current level of application of this surgical technique in the continent, the limitations, and how the healthcare system in the region stands to benefit from its use in the future.

Methodology: In this narrative review, extensive literature research was conducted using the Google search engine and databases: 'Google Scholar', 'Cochrane Library', 'PubMed', 'ScienceDirect', and African Journals Online (AJOL), spanning 6 months. The search phrases used included: robotic surgery, robotic surgery in Africa, history of robotic surgery in Africa, robotic surgery in low- and middle-income countries, potential advantages of robotic surgery, robotic surgery limitations, benefits of robotic surgery, demerits of robotic surgery, artificial Intelligence in surgical care, and the future of robotic surgery.

A total of 405 articles were found. An advanced search that limited the search to titles revealed only 20 results. Two discussed the possibility of embracing robotic surgery in low- and middle-income countries, one talked about the potential benefits, challenges, and scope of robotic surgery in the future. Also, one talked about the origin of robotic surgery, one delved into artificial Intelligence and its role in surgical care, then discussed the roles of robotic surgery in surgical care, and the rest discussed the few recorded applications of robotic surgery in surgical care in Africa.

Results: Even though the concept of robotics in surgery dates back more than fifty years, its practical application began in the late 1980s. Its enormous potential notwithstanding, the application of robotic surgery on the African continent is still highly underwhelming.

Admittedly the utilization of robotic surgery in Africa faces many challenges such as the high cost of its acquisition, maintenance, and training needed to use the machine, the upskilling of surgeons to specialize in robotic surgery in each field of expertise, the need to alter the size and layout of pre-existing operating rooms to accommodate the components of the robots and to also increase patient load for the use of the robot to make it effective for the cost price, it can potentially reduce cost of healthcare, nosocomial infections, antibiotics abuse and surgical inequalities in the Mother Continent.

Conclusion: Our research showed that robotic surgery, despite offering multiple benefits and having the capability to lessen surgical inequalities in resource-poor nations, is still underutilized in the African continent. The study also showed that even though the utilization of robotic surgery faces challenges in middle and low-income parts of the world, like Africa, due to high costs, limited facilities, patient burden, and the need for specialized training. It, however, holds enormous potential in the continent, such as reductions of infections, antibiotic resistance, and hospital stays, and even possibly reduce the costs of healthcare.

Keywords: Robotic Surgery; History; Africa; Advantages; Limitations; Benefits.

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Introduction

Robotic surgery, also known as robot-assisted surgery, is a game-changing technology that has allowed for more minimally invasive and precise approaches, resulting in fewer wound abscesses, trauma, shorter hospital stays, improved surgical visualization, greater surgical precision, and fewer postoperative wound complications(1). Robotics in surgery is an exciting new technology that is revolutionizing the surgical field.

Although the concept of robotics in surgery dates back more than fifty years, its practical application began in the late 1980s with Robodoc (Integrated Surgical Systems, Sacramento, California), an orthopedic image-guided system created by William Bargar, MD, and Hap Paul, DVM, for prosthetic hip replacement (2). The first surgical robot approved by the FDA to help surgeons do laparoscopic surgery was the da Vinci system from Intuitive Surgical Inc., located in Sunnyvale, California, which was introduced in 2000.(1)

The market, however, has been the main force behind the rush to buy and integrate this cutting-edge equipment. Despite their lack of practical significance, surgical robots have become an admission price in facilities seeking to be known for proficiency in minimally invasive surgery.(3)

Among the benefits of robots in surgery are improved dexterity and increased degree of freedom, 3D visualization allowing improved hand-eye coordination, and position that reduces fatigue. Significantly, it enhances the quality of life of patients and lessens blood loss, intraoperative and postoperative complications.(1)

Robotic surgery is rapidly spreading across various specialties, with an annual increase of around 15%. By 2020, the global volume was 1.24 million, with the United States (US) accounting for 70.6%.(1) Data on robotic surgery use in low- and middle-income nations is, however, scarce. Robotic surgery integration in low- and middle-income countries (LMIC) holds promise.(4)

Discussion

Pros of robotic surgery

In addition to the generally acknowledged overall advantages of robotic surgery, its incorporation holds substantial potential advantages. For patients to have access to safe surgical care, surgical site infection must be decreased, and robotic surgery may be the answer. Compared to open surgery, robotic surgery involves smaller surgical incisions, which reduces the danger of surgical site infection. This, in turn, indirectly lowers the need for antibiotics and delays the emergence of antibiotic resistance.(4)Additionally, robotic surgery lowers the risk of infection transmission by allowing health personnel and surgeons to be physically apart from the patient.(1)

Reducing surgical disparities worldwide may be facilitated by the integration of robotic surgery into the healthcare system. The field of robotics is still in development but has seen a lot of research and practical applications. Robotic surgery will result in less pain and discomfort, quicker recovery, and shorter hospital stays.(1)

History and status quo of robotic surgery in Africa

There is a paucity of history and heritage of robotic surgery in Africa due to soon-to-be-discussed challenges and hindrances. Nevertheless, here are smatters of literature where the use of robotics was employed in the field of surgery has been documented and served as a silver lining in the dark void of robotic surgery on the continent.

In Africa, Etienne Nel, who was a semiprofessional electronic sports gamer, was the first patient to undergo a robotic-assisted thoracic procedure. Also, Zaghloul et al, published a preliminary report on the results of colorectal surgery at the National Cancer Institute, Cairo University.(8)

Furthermore, the first laparoscopic cholecystectomy in South Africa, and probably in Africa, was done in Groote Schuur Hospital by Professor Bornman in 1990. (6) Additionally, the da Vinci robot was used for the first radical prostatectomy in South Africa in 2014; currently, nine such robots are in use in the private sector in South Africa. Groote Schuur Hospital has conducted 240 procedures, whereas Tygerberg Hospital has performed 260 surgeries since the acquisition in 2021. Rigid training methods have been used to accomplish these. Formal training has been provided to prospective surgeons, nurses, and their anesthetic colleagues. Simulator, dry lab, and abroad wet lab training were provided to the surgeons and their trainees.(6)

Similarly, Debakey et al did the first randomized control trial on Robotic-Assisted versus Conventional Laparoscopic Approach for Rectal Cancer Surgery in northern Africa and the Middle East even as the first Cardiothoracic robotic-assisted surgery program in the continent has been set up at Netcare Christiaan Barnard Hospital to proffer techniques that are less invasive for surgeries involving the chest cavity, such as lung cancer and cardiac surgeries(5, 7)

Indeed, the handful of academic publications and reports on robotic-assisted surgeries in Africa emphasize the underwhelming number of centers that employ robotic-assisted procedures in surgery. It is grossly underutilized at the moment in the African continent.

Limitation to robotic surgery in Africa

Despite the nearly two decades since the introduction of the revolutionary surgical robotic system for more effective, improved surgical precision, safety, and reliability of surgeries (3)(12), there are still numerous obstacles and limitations to the use of robotic surgery around the world and in middle and low-income countries like in Africa.

First is the sheer magnitude of the cost of purchase, maintenance, and training to use the machine alone already greatly limits the number of facilities capable of operating with the machine,(12) and the burden placed on patients and health insurance companies because of the need to make a profit off the purchase and use of the robot. (1)There is also a challenge regarding the need to alter the size and layout of pre-existing operating rooms to accommodate data cables(13), robotic arms, control console, and computer towers(14) for the basic operation of the machine to perform procedures and surgeries it is purposed for.

In addition, another constraint lies with the training of surgeons to specialize in robotic surgery in each field of expertise(13). Also, due to the intricacies of the surgeries in each field, multiple surgeons of each specialty will need to be trained per facility for robot use to be effective. This will be needed to increase patient load for the use of the robot to make it effective for the cost price. Additionally, by virtue of the distance of the surgeon from the assistants, there are disruptions in communication and coordination as well as equipment malfunctions such as fogging up the camera lens, suturing issues, malfunctions, over-heating causing heat damage to organs in addition to surgeon inexperience in using the machine or the surgery itself. (13)

There is further impediment to the training of specialists either as existing scrub nurses and circulating nurses, or specialized technicians who would need to assist the surgeon during operations by: Docking the robot to laparoscopic ports; Switching instruments as required by the surgeon and operating room turnover for the next case (13)
Another restraint is the possibility of outdating commonly used ancillary equipment of open and laparoscopic surgeries such as stapling guns, scissors, and hemostatic devices for the fact that they are not inherently designed to fit into the robotic devices requiring the robotic companies to create their specific devices to fulfill these functions or for the device companies to create those usable by the various models of the device. This in itself creates additional financial concern where either company would have to invest millions into restructuring their robotic machines or devices. (12)

Future of robotic surgery in Africa

Globally, the technology of robotic surgery has revolutionized surgical practice through a perfect blend of minimally invasive approaches, improved surgical visualization, fewer wound abscesses and trauma, greater surgical precision, and fewer post-operative complications.(1) The use of robotic care in high-income countries is increasing exponentially across all specialties, precisely at a rate of 15% annually. In the year 2020, about 71% of all robotic surgeries (1.2 million) happened in the United States. Yearly, 900 robotic surgery consoles are installed around the world.(15)In England, 32% of acute National Health Service (NHS) trusts have at least one surgical robot. In the same country, 12, 000 surgeries were done in 2018 with 83% of them being urology cases.(16) Nonetheless, the evolution of robotic surgery is far from over with multiple potentials to be achieved via the development of novel procedures, adaptation of existing ones, and production of more sophisticated surgical robots.(2)

Currently, Africa lags behind in the timeline of robotic surgery and its application in health care but the prospect of robotic surgery in the continent of vast potential with the possibility of being the standard of care.(3) The disparity of access to robotic surgery between high-income countries and low-income ones stems from a multifaceted problem.(1)These problems include lack of financial infrastructure to cater for colossal fees of procurement and maintenance of surgical robots, dearth of local innovation and manufacturing of surgical robots, shortage of surgeons with knowledge and technical know-how of surgical robot and unavailability of training to increase the number of these surgeons and poor internet services.(1)

Mehta et al said before robotic surgery can reach its full potential in Africa and other low-income countries, regional and local research addressing its challenges in the region must be done.(1)The envisaged potential of robotic surgery in Africa includes reducing surgical site infection and consequently reducing antibiotic resistance via minimal access wound, reduced intraoperative contact between surgical staff, and short hospital stay.(1) Overcrowding in hospitals of low-income countries is the status quo with these facilities operating at a capacity of 200-300% or more,(17)Here, robotics is perfectly poised to solve this problem as it shortens hospital stay and optimizes surgical care(1).

Also worthy of note is that Africa and other low-income countries are home to about half of the world's population and only boast of 19% of all the surgeons in the world(18). Indeed, robotic surgery comes in handy here and remains the future as its incorporation with tele mentoring and telesurgery allows surgeons from other countries to perform surgeries in these regions while active effort is put into increasing the surgical workforce.(1)

Lastly, carefully selected robotic surgical cases could potentially reduce surgically related healthcare costs in Africa. In a retrospective cohort study by Okhawere et al, it was noted that the overall cost of robotic-assisted prostatic is almost cheaper than the open approach after a year post-op, as the post-discharge cost was small, and it offsets the expensive robotic procedure.(19)(20)

Conclusion

Robotic surgery, a minimally invasive technology since the late 1980s, offers benefits like improved dexterity, freedom, 3D visualization, and reduced fatigue. The technique is spreading rapidly, with the potential to reduce surgical disparities in low- and middle-income countries but remains underutilized in Africa.

Robotic surgery faces challenges in middle and low-income countries like Africa due to high costs, limited facilities, patient burden, and the need for specialized training. The need to alter operating rooms, train surgeons, and create devices for ancillary equipment further complicates the process. Additionally, communication disruptions and equipment malfunctions can occur due to the distance between surgeons and assistants. It, however, holds enormous potential in Africa, such as reductions in infections, antibiotic resistance, and hospital stays, and even potentially lower healthcare costs.

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