IJPSR (2020), Volume 11, Issue 10 (Review Article)

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH

Received on 14 August 2019; received in revised form, 27 May 2020; accepted, 18 September 2020; published 01 October 2020

AN OVERVIEW ON THE TRENDS, FEATURES AND APPLICATIONS OF ROBOTIC SURGERY

Shruti Shettigar, Vishwavibhushitam Yadav and Vanita G. Kanase *

Department of Pharmacology, Oriental College of Pharmacy, Sector 2, Behind Sanpada Railway Station, Sanpada West, Navi Mumbai - 400705, Maharashtra, India.

Keywords:

Transoral, Robotic surgery, Laparoscopic, Cranium, Microbot

Correspondence to Author:
Dr. (Mrs.) Vanita G. Kanase

Head of Department,
Department of Pharmacology,
Oriental College of Pharmacy, Sector 2, Behind Sanpada Railway Station,
Sanpada West, Navi Mumbai - 400705, Maharashtra, India.

E-mail: vanita.kanase@gmail.com

ABSTRACT: In the era of recent technology, robotic surgery will be the ruler of the medical world with its attributes, its journey from a mere idea to today's world's surgical epitome. Using the methods of telerobotic visualization and controlling systems, this technology works towards improvement in all the fields of medicine and patient care. Robotic surgery dwells on the functionality of the most widely known models of Da Vinci and Zeus. It has benefited the patients by combining with minimally invasive, transoral, and laparoscopic techniques working better in synergism. It has been to date employed in the surgeries in the fields of the eyes, cranium, bone, thyroid, heart, liver, obesity, gastrointestinal, obstetrics as well as carcinomas. Its future potential is bright based on the types of technologies that are being linked with normal robotic surgery. One such endeavour is the microbot, which makes reaching the smallest nooks and corners of the internal physiology of the human body possible as well as more efficient.

INTRODUCTION: A robot is defined by the Robot Institute of the United States (U.S.) as ' A reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions to perform a variety of tasks [1]. Over the past few years or so, the advancement of robotic surgery seems to have become active. Many clinical robots have been created in the 1980s while few have been examined in human testing [2]. Clinical robots, over time developed into telerobotic instruments for an operation that enables practitioners to work on individuals from distant places using automated tools.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.11(10).4794-04

This article can be accessed online on www.ijpsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.11(10).4794-04

Telepresence builds a digital picture of the medical sector to a distant place. Utilization of telerobot to transmit their hand movements to the distant operating theatre, practitioners conduct procedures without truly having to watch their patients.

Tele-monitoring allows an experienced surgeon who stays in his/her own clinic to advise a trainee on how to conduct a fresh procedure or use a fresh medical technique in a distant place [3]. Surgery is becoming automated," suggests Krummel, "Blood and guts are no longer involved, but bits and binary digits. I don't believe surgical robotics is the final advancement, but a move on the path into something greater [4]. A substantial decrease in Assignment Run time (T) after introductory courses was indicated in trainee users in this survey. Furthermore, there was rapid progress in the first two or three coaching trials [5]. Surgeons were informed about pain and tiredness in the extreme upper end and neck muscles.

This is thought to be related to the weak efficiency pattern of laparoscopic tools and inappropriate body posture. These are likely the factors why many laparoscopic surgeons are unwilling to conduct complicated processes that might take time [6].

Spatial restrictions owing to the voluminous machinery are a widespread problem in machine-assisted procedures. The anesthetists aren't able to observe and work after the robot has been placed and involved [7]. Most reports of adverse events are linked to Obstetrics (30.1%), Urology (14.7%), Cardiac and Thoracic (3.7%), such as Uterus removal in 2.331%, removal of the Prostate in 1.291%, and Thoracic issues in 110% patients respectively. The greater proportion of adverse events in Gynecological and Urological operation could be clarified by the greater amount of these processes conducted as opposed to other medical specialties in the U.S. [8]

History: The term robot is derived from the Slavonic word ' robota' which means' labor.' While the word "robot" and "robotics" are comparatively recent, the concept of self-operating devices could be traced back in 400 BC when Arentum Archytas created a hydro-driven, self-propelled wooden bird capable of flying 200 m. With the first invention known to mankind, the new bird of Archytas contributed significantly to the comprehension of machines by man; it was not till 1495 that the metal-plated fighter of Leonardo Da Vinci became the first robot to imitate human motions of the Jaws, Arms and Neck. Gianello Toriano, who produced a robotic Mandolin-playing woman in 1540, was inspired by Da Vinci's invention. Further, there was a leap in robotic surgery in 1994 when the Automated Endoscopic System for Optimal Positioning 1000 (AESOP 1000) became the first Food and Drug Administration (FDA) – approved laparoscopic camera carrier, and when it was officially accessible in 1998, ZEUS brought the concept of telerobotics or telepresence to robotics.

The ZEUS robot comprised of three arms, each connected to the operation table separately that is one AESOP arm and 2 four-degree surgical arms. A tele-monitor and 2 handles were used to control the telerobot's 2 surgical arms. There were three arms for the initial Da Vinci robot, one for the camera and two for the surgical tools, but the newer model has one additional arm for tools for operation. Unlike the ZEUS, instead of the operation table, the Da Vinci robot is connected to the operative trocar system. The instruments for operation mimic the human forearm with 7 degrees of liberty and two degrees of motion around the axis. The Da Vinci acquired FDA approval for all over laparoscopic processes in 2000 and became the first operational robot in the United States [9].

The use of robots in operation is the result of modern society's need to attain two objectives: teleconferencing and performing repeated and precise duties. In 1951, the first objective was reached. Raymond Goertz intended the first remotely controlled mechanical arm to manage dangerous nuclear material when serving for the Atomic Energy Commission (U.S.). The second was accomplished in 1961, once the first industrial robot called Unimate for General Motors was created by George Devol and Joseph Engelberger [10]. They are employed because operation theatres are generally combined around the main scrub room, manpower will be reduced, which is in our benefit [11]. An outbreak in minimally invasive robotic surgery is probable to occur during the next few years as more surgeries are outlined and released with medical advantages [12].

Minimally Invasive Techniques: With the exception of standard operation in which the operator directly views the region of concern and handles operating tools with an unhindered strategy, Minimally Invasive Surgery (MIS), needs the operator to monitor the region of an operation *via* an endoscope or display unit and to control complicated tools for an operation whose movements are restricted by the tool's entry points into the body. Robot-assisted MIS can eradicate the hand trembling, introduce speed reduction variables between the surgeon's hand movements and the robotic tools, and give extra compliant joints at the tooltips. The subsequently improved operation agility can lead to better patient results and facilitate more challenging processes. The utilization of present industrial robotic surgical devices is restricted by their significant size, difficulty, price as well as their time-consuming configuration, repair, and sterilizing process.

To completely eradicate the requirement for a human helper to maintain the endoscope in MIS, a compact endoscope controlling the robot called the Light Endoscope Robot (LER) was created. The entirely teleoperated robotic structure for MIS must have one endoscope controller, two master tele-operation software to be handled by the operator, a computer CPU to pinpoint the movement of the teleoperation software at a sufficiently high rate and produce movement controls to be sent to the robot motor manipulators, an electronic manipulator for each motor, and the two tool controllers with their articulated tools [13]. The latest technology applications include operation related help, improvement of skill, communication of systems, and picture-guided treatment. Positioning a microprocessor between both the side of the operator and the tip of the operational tool enhances skill. Noninvasive methods may be used for plaque ablation in Arteries, revascularization of Myocyte, treatment of tennis elbow, Bone injuries, and non-union Bone injuries [14].

Trans-oral Method: Trans-oral robotic surgery (TORS) has been revealed to be viable at multiple upper respiratory and digestive system locations, along with Nasal, Oropharyngeal most often for basal cell cancer resection. Neither of the patients needed a continuous gastrostomy pipe, with all patients accepting a 2-year follow-up oral diet. Robotic optics enable the great visual representation of Oropharynx and Laryngopharynx mucosa. This visual enables the Oropharynx and Laryngo-pharynx lesions to be thoroughly inspected and transorally resected. This led to TORS being authorized for its application in mild and selected malignancies by the U.S. FDA in 2009 [15]. The TORS operation has the benefit of being very near to cancer with the tip of the double video endoscope in the patient's mouth. Since combined with the alternative of a 30° range, this inner mouth perspective is handy to resolve the constraints put by the conventional trans-oral methods. Moreover, when combined with an amplified three dimensional (3D) perspective, the enhanced directional view enables the operator to recognize tiny and big vessels for either surgical excision or conservation.

An extra advantage of the main operation strategy has been that nearly half of the patients in this sequence were able to prevent Cancer treatment by medication, and two were able to prevent radiation exposure and medication fully [16].

Robotic Surgery *vs*. Laparoscopic Surgery: In our organization, mainstream laparoscopy was lesser costly than robotic-assisted Uterine tissue and Cervix Cancer therapy. The cost of robotic surgery excess could be decreased by optimizing the floor occupancy period and decreasing the operating period. The advantages of robotic surgery for the patient can help counter any of their extra expenses by reducing difficulties and the duration of hospitalization [17]. The drawbacks have included the price of installing and maintaining the absence of haptic feedback to the operator, the existence of heavy robotic arms, lengthy and dense cables, and the failure to transfer the operating table when the robot arms are connected and function simultaneously in separate segments. As earlier mentioned, robotic surgery is a type of endoscopic surgery, and comparing robotic surgery with Colon resection instead of laparoscopy will be more suitable for future research [18].

Robotic-Assisted Laparoscopic Surgery: Tools are lengthy and painful in laparoscopic surgery as they are controlled with restricted degrees of liberty through set entry locations [19]. Inevitably, as an operator who has done laparoscopy before is able to verify the slightest motions of the tool-holding attendant or tremble from a heartbeat when heavy optical zoom is utilized caused movement-linked nausea amongst the medical team [20]. It has been have thus found, after analyzing their first 34 cases, that robotically assisted operation could be achieved with a similar degree of security as the more conventional laparoscopic method. They also thought that robotic surgery, with its capacity to improve the hand-eye coordination and 3D perspective lost in laparoscopic surgery, enables us to conduct such sophisticated laparoscopic processes more accurately and with finer granularity [21]. Urological laparoscopic processes could efficiently be conducted utilizing either the robotic machine Da Vinci or the robotic operation system Zeus. The learning process and operating time were narrower in this restricted research, and the inner operative tactical motions emerged more naturally expressive with the Da Vinci System [22]. Pancreatic ablation continues among the most difficult fields of Gastro-Intestinal Tract (GIT) operation and is linked with forty percent of perioperative morbidity and about five percent of mortality when all processes were conducted utilizing the Da Vinci robotic model. The post-surgery morbidity rate was twenty-six percent, and the mortality rate was 2.23 percent [23]. The primary benefits of robot-assisted laparoscopic operation were 3D vision accessibility and simpler device handling than conventional laparoscopy could be obtained [24].

Cost-Effectiveness: When there are contrasting operation processes, the primary economic factors involve surgery expenses, the hospital remains, and injuries. Operating costs are motivated mainly by machinery and equipment and operating time. Robotic surgery's primary limitation is the high cost of obtaining and keeping a robot together with the cost of tools. The primary point controlling operating costs, apart from machinery, relies on the operating moment. A genre-analysis of contrast studies discovered that during the learning process, operating times were similar for larger robotic series. In order for robotic surgery to be price-effective, cuts will be needed [25]. Hospital expenses included the funds needed to carry out an operation and post-surgery care immediately. Hospitals have patient-related expenses along with operating costs, medicines, nursing, operating and hospital rooms, board, and servicing, *etc*. Informal expenses such as administration of hospitals and intrinsic building expenses also exist. Furthermore, there are expenses not linked to hospital stay but paid for post-surgery care and check-up. In addition, successive processes may be necessary and will be carried out by doctors and/or nursing staff, putting expenses to the illness. If a method is more expensive but in the longer term more efficient, then comparing hospital admission expenses may not depict the actual cost reductions which may happen in the future [26].

Applications:

Ocular Surgery: A. Tsirbas and E. Dutson were the first to report the first instance of Ocular robotic microsurgery. A handheld injection of saline into the five Porcine eye's vitreous sac was the first phase in the operation process. The operation was intended to keep eye amount and eye tone to imitate *in-vivo* eye patterns. A standard eight mm long corneal laceration was performed with a 2.7 mm keratome across the cornea apex in each eye to imitate a cornea puncture wound at a depth of ninety percent of the cornea volume. Every operator used a hundred micro-filament nylons to perform puncture wound surgery with three distinct disrupted incisions. The closing working time was evaluated with an analog clock. Post-surgical assessment of the eyes utilizing conventional operational microscopy, each eye was exposed to the subjective and microscopic assessment of puncture wound closure and incision positioning. Also, it was observed that stronger surgical tools would enhance incision monitoring. There is a limited possibility of serious bleeding in this exercise, and therefore, there is a more regulated atmosphere. In conventional eye surgery, the advantages of enhanced build quality, movement masteries, shake filters and comprehensive device specificity are essential. The eye is a closed environment, and the other surgeon's areas in which the robot is utilized that can be considered as a mini-sized. Major downsides are the expensive treatment and slower installation of sutures [27].

Skull Surgery: Utilizing the accessible robotic instruments, it was still unable to properly connect to the midline Cranium base and the frontal Cranium base in the corpse or an alive dog. The 30-degree high-zoom endoscope camera didn’t provide the necessary visualization of these cranium base areas. In the continuing potential in a human clinical study, the conventional TORS method has enabled outstanding visual representation and connection to the para-pharyngeal room and infratemporal fossa, as illustrated in animal models and Cranium base operation on two human patients to date. Though, TORS only offers restricted access to the base of the midline Cranium with maximum access to the reduced Nasopharynx stage. Thus, we created a new clinical strategy in human bodies, a mixed Cranial TORS (C-TORS) that allowed us to resolve regular TORS' angulation of the device and control constraints and effectively conduct clinical examinations in the frontal Sphenoid, Clivus, Sella, and Suprasellar fossa [28].

Orthopedic Surgery: The Robotic Arm Interactive Orthopedic System (RIO) is an illustration of a widely accessible, haptic robotic model requiring the operator's active involvement in completing a one-part Knee replacement.

The operator utilizes this system to schedule the size and positioning of the parts pre-surgically. Intra-surgically, the operator will link the Femur and Tibia's bony exteriors, enabling the pre-surgical system to fuse with the Knee's real physiology. The flexion-extension spaces can be evaluated after bringing the Knee *via* a range of motion, and the operational scheme can be finalized in the principle of element positioning, making a perfect cutting zone for the robot. These devices are utilized peri- operatively for evaluating joint abnormalities and joint kinesiology for making suggestions about how to proceed with the operation, for example, if evaluating ligament balance and for monitoring the precision of bone reductions. The extensive use of robotics in orthopedic operations is limited by economic obstacles. For many organizations, beginning-up costs for buying or acquiring a robotic system are sometimes unaffordable. Also, these devices involve ongoing operating systems updates configuration, causing extra expenses. Institutions should carry out a complicated economic sustainability assessment, taking into consideration operating quantity and future profit, when exploring the use of robotics [29]. Certain types of pelvic operation may combine some of the advantages of enhanced degrees of liberty, even though they are not yet demonstrated. Robotic pelvic operation definitely eliminates the barriers connected with the reduction of degrees of liberty while operating in a tightly closed area when suturing is required [30].

Thyroid Surgery: A percentage of distant thyroid removal surgery methods have propagated even without the help of robotic technological advances. They have created and defined a logical strategy using acquainted examination planes and avoiding the need for breast perforations and collarbone traversing [31]. Endoscopic benefits over open Thyroid disorder operation include lower levels of hyperesthesia and Neck muscle twitching and extremely enhanced aesthetic results. Outstanding beauty findings and decreases in throat sensory alterations, speech, and swallowing pain after surgery is amongst the efficiency-of-life advantages of robotic surgery. The first robotic Thyroidectomy was conducted in 2007 with the outcomes of the first hundred patients undergoing robotic Thyroid removal surgery reported in 2009 by a lone operator. Studies linking robotic Thyroid removal surgery with endoscopy or standard open operation showed comparable post-surgical complexity rates for the previous, indicating that robotic Thyroid removal surgery is viable and secure and therefore, can resolve some of the constraints met with endoscopic techniques. Since open endoscopic and robotic Thyroid removal surgeries, three methods comprising distinct physical duties and variable kinds and severity of muscle and skeletal pressure, surgeons finished a study of the throat, shoulder, and back muscle pain. Results of the survey indicated that muscle and skeletal pain throughout robotics was smaller than it was during Thyroid removal surgery open or endoscopic. Robotic processes involve three phases that are creating a workspace, a loading point, and a dashboard level. Unlike robotic surgery of the Stomach, there is no conducted room in the Neck region, and there is always a need for flap cutting. Therefore, robotic Thyroid removal surgery with or without cutting of the throat generally takes longer than an open operation. Once the operator gets to know the robotic technique more intimately, the time required decreases [32].

Cardiac & Endovascular Surgery: There are several publications on robotic coronary surgery, robotic valve surgery, robotic Pericardium removal surgery, robotic duct surgical excision, robotic lead positioning, and so on. More than two hundred papers on the topic have been printed over the past six years, though the biggest downside in robotic Heart surgery is the problem of Coronary procedures. It was discovered just a few extremely chosen cases that were "completely robotic," and many of them were "robot-assisted," *i.e.*, standard circumvents with Thoracic artery robotic cutting. The second one typically took approximately twice as long, and price as standard methods did [33]. The main benefit of robotically aided Heart surgery over standard methods is the capacity to reduce the incision size, thereby restricting operational injury to patients. This resulted in less post-surgical pain and enhanced aesthetic outcomes, which are the key factors underneath the growing popularity of robotic surgery among professionals and patients.

This research was the first to make a comparison of in-hospital expenses with robotic and standard surgeries. In the assessment, robotic technique has not increased overall hospital costs considerably.

However, the price of robotic procedures was considerably greater when considering the original capital expenditure for the robotic surgical scheme by amortizing institutional expenses which reduced with familiarity due to reduced time requirement [34]. Minimally invasive methods for valve activities have been created recently. With the introduction of shaking filtration, narrow intra-heart spaces enhance accuracy. In addition, for all operators, kinesthetic awareness can become a certainty. These instruments can be used to mix leaflet resections, chordal shifts, and sliding plastics with an annuloplasty band or ring to conduct absolute repairs. The findings recorded herein constitute a multicenter robotic Mitral valve operation authorized by the Food and Drug Administration (FDA) [35]. Two primary kinds of endo-vasculature interventional robots were developed with distinct methods of operation: electromechanical-based systems like the robotic tracking scheme Sensei and magnetically regulated systems such as the magnetic positioning system Niobe. In 2002, the first research on robot-assisted laparoscopic Aorta operation was released, where it was suggested that robotic surgical methods permit higher simulation and promote the aortic cutting and this would encourage a step towards completely laparoscopic robotic Aorta operations [36].

Hepatic & Pancreatic Surgery: The procedures performed on hepatic organs include robotic Hepatectomy, Pancreaticoduodenectomy, distal Pancreas removal for spleen preservation, robotic Bile duct exploring, and biliary enteron restoration [37]. The robotic system provides many technological benefits from an analytical point of perspective that render the ablation of the hepatic organ possible through a minimally invasive method. This involves a continuous 3D perspective that offers outstanding visibility, peripheral vision and optical zoom, a fourth arm who can function as a secure hose clamp under the immediate operator's control throughout all stages of hepatic resection and wrist tools that enhance laparoscopy suturing and knot tying capacities that are useful for vascular handling and hemostasis. In contrast, surgical therapy is justified in instances of advanced abdomen symptoms, increased size, or trouble to exclude Cancers, especially in tiny benign growths of the hepatic organ. In instances of gigantic injuries that inhabit most of one lobe, main Hepatectomies may be necessary, as was essential in two patients [38].

Surgery for Morbid Obesity: Minimally Invasive Surgery Center, the University of Illinois at Chicago Medical Center was the one who performed the first-ever robotically assisted Gastric bypass in September of 2000 and created the technique of robotic Gastrojejunostomy for others to follow. The procedures performed are robotically assisted Gastric bypass and adjustable gastric banding. Gastric bypass is an efficient method of treating morbid obesity by surgery. The Da Vinci model also gives hyper-obese patients with such a Body Mass Index (BMI) of more than 60 kg/m^2 a performance advantage during operation. The operating intervals were initially considerably longer than with an open and conventional laparoscopic bypass. At first, this institution's median start-up time for the robot was thirty-five minutes. Their operating squad has considerably decreased the robotic installation time with growing experience. Their setup time contributes roughly seven minutes to each case after further than two hundred robotic instances [39].

Surgeries Relating to GIT & Urology: Anti-reflux operation is the only particular robotics operation to which proof is accessible for class 1 (randomized monitored clinical study). Bariatric surgery is where writers observed the subsequent gains while using a robot in contrast to standard laparoscopic Bariatric surgery that is hand-crafted Gastrojejunostomy is considerably simpler with a robot, robot stapling device prevention, that avoids problems as a result of the nasal linked gastric flow of an anvil, lack of an intra-lumen stapler promoting the use of a robot stapling devices and that the robot has two benefits over enhanced abdomen wall thickness that is stiffer tools and mechanical energy. Other procedures performed under this category are on the Spleen, Gallbladder, Small Intestine, Colon, and Adrenal glands [40]. The patient is ready and dressed in the ordinary way, and the traditional method insufflates the belly. The lens is positioned a bit to the left of the centerline.

Drawbacks of the procedure include anesthesia factors for upper abdominal surgery, restricted field of operation, tactile stimulus, and benefits include high-resolution 3D visual representation, control of instruments, the electronic transition of data, movement scaling, and decrease of shaking [41]. To date, the Colon-linked rectal literature has depicted that robotic methods have equal oncological results and comparable restoration to bowel function as compared to conventional laparoscopy and the only statistically meaningful distinction being greater operating time. This distinction can be resolved with expertise and a lot of skill, as depicted in many small case series. This includes the procedures for the right semi-colon removal operation and complete removal of the Mesorectum [42]. The procedure is carried out in two steps for complete colon removal operations. The first is similar to the ablation of the left colon; the second is similar to the ablation of the correct Colon, along with the placement of the channel. The robotic arms are originally on the left side of the patient as they were for left autopsies of the Colon. Upon completion of this part of the surgery, the surgery table will rotate 180°, and the robotic arm will pivot to the correct side of the patient [43].

There have been many benefits recorded over conventional methods, along with little pain, shorter hospitalizations, faster transition to ordinary operations, limited bruising, decreased recovery period, and lessened tissue damage [44]. There are broad, varying, and not continuous operation complexities. Thirty-one studies demonstrate the range and difficulties of distinct kinds. Different issues are leakage, invasion, technique related, Central Nervous System (CNS) related, Muscule and Skeletal system related, Cardiac, Respiratory, Urogenital, GIT issues, and miscellaneous. The most prevalent potential problem found in sixty-three instances was distal leakage accompanied by GIT and infection instances. Technological problems (generally when we say "technical robotic surgery difficulties", we apply to risks associated with robotic system defect) [45]. In its current state, robotic Colon restoration involves long operating periods and greater expenses compared to laparoscopic Colon removal procedures [46]. Although urological processes are carried out mainly on soft tissues, a creative study has enabled much separate robotic equipment to be developed used in Urology at various stages of progression [47]. Robotic contributor in radical Nephron removal operation follows the following steps where step one includes patient placement; step two is port positioning, step three is robot setup, step four is Peritoneoscopy, step five is Toldt line cut and Colon movement, step six is Pulmonary artery and vein monitoring, step seven is Kidney movement and step eight is retrieving of sample [48]. Major procedures for Urology are Dismembered Robot-Assisted Pyeloplasty and Radical Cystectomy [49].

Gynaecological & Paediatric Surgery: As with any particular robotic surgery, machine build-up involves two stages before beginning, which is the robotic set-up and optic system set-up [50]. One of the earliest successors and first robotic-assisted obstetrics apps was a speech-activated robotic arm known as AESOP. During laparoscopic surgery, AESOP's main function was to function the camera. One research conducted by Mettler et al. contrasted the scheme with an operation assistant who held the laparoscope during gynecological operation [51]. In obstetrics, Myomectomies and Sacrocolpopexies were performed using the Da Vinci robotic model [52]. While it has been proven pregnancy rates after laparoscopic Myomectomy are comparable to those since open Myomectomy, laparoscopic Myomectomies have comparable constraints with those of laparoscopic removal of Uterus procedures, with the extra problem of insufficient Uterus closure genetic susceptibility to potential uterus rupture. For this operation, robotic methods have also been proposed [53]. The use of endoscopic surgery for kids goes all the way back to 1971 when Gans and Berci researched and published MIS for babies and kids [54]. Motion balancing, enhanced optical zoom, stereoscopic visibility, enhanced tooltip acuity, vibration filters, device archiving, user-controlled shaky cam, and pivot eradication are benefits [55].

Abdomen processes and thoracic operations are generally conducted. Procedures for small patients can be performed with several distinct processes with outstanding outcomes, even patients less than five kg. However, in kids less than 3 kg, especially in the chest, mobility becomes an important problem [56]. With the big diameter of the camera, thoracic processes in tiny kids were not possible. A two-dimensional camera particular to the Da Vinci robot was published in September 2004, soon after last year's launch of the tools. Apart from a Kasai method, they rapidly started to embrace this camera as their camera of choice for all processes in kids under ten kg [57].

Robotic surgery appears to be viable and secure in kids utilizing the Da Vinci model. The primary benefits seem to be enhanced to increase visibility by utilization of a stereo-optic camera and facilitating accurate examination by a micromechanical tool aimed at a remote console by master slaves. Because tools tailored to the size of tiny kids are not yet accessible, the method is restricted [58].

Surgery for Treating Cancer: This type of robotic surgery dabbles in operating carcinomas in categories offering surgeries as follows, *i.e.,* Brain surgery, Cardiac surgery, the Mediastinum, Respiratory system, Abdominal surgeries, Urology, Obstetrics, Dermal surgeries [59]. Transoral Robotic Surgery (TORS) shows promise for human medical use and can be useful as a minimally invasive and low morbidity main treatment for tongue-based carcinomas [60]. Conventionally, Head and Neck operation processes were conducted by big perforations requiring large quantities of ordinary examination of body [61]. But, in the case of the application of TORS for the management of carcinomas of the upper aeration linked digestive system, clinical methods in Head and Neck operation have drastically developed over the previous two centuries as the surgical theatre employees and doctors have acquired expertise with the Da Vinci Surgical Framework. It took one hundred and forty minutes to set up the first case. In many other cases, the configuration time gradually reduced over the study period of twenty to twenty-five minutes configuration time [62]. Using the current main TORS therapeutic routine and simulated Neck examination with adjunctive Chemoradiotherapy as stated, we accomplished local illness control in forty-six patients, regional control in forty-five patients and remote control in forty-three patients at least 18 months of the check-up [63]. In robot-assisted radical prostatectomy (RARP), there is 40 percent increase in healthcare spending on Prostate Cancer operation is definitely connected with the surge in the annual amount of robotic procedures during the duration of the research. Though, the enhanced spending was also ancillary to an increase of $2,000 for every case in the average price of procedures over the same duration [64].

Future Prospects of Robotic Surgery: With robotic systems, the modern world of surgical robots started using constant feedback from operators to alter their motions in live time as per feedback. Further progress is being made to improve clinical sight beyond even the operating robot's zoomed eye. It can be accomplished through two ways by combining the operating field with the adjuvant live-time image analysis or enhancing visual pixel density further than the physiology of the exterior to envision physiological systems or small complex tumors to see this with the unaided eye. Amid the prospective benefits, robotic arm crashes, restricted projection despite Edowrist model capabilities, and counter-productive camera angles are still to be tackled in technical difficulties. Utilizing presently accessible robotic models, new methods like ‘chopstick surgery’ are being evaluated to assist resolve these constraints. The configuration of the chopstick passes the devices within the abdomen wall so that the correct tool is on the left side of the goal and the left tool on the correct side. This handling counterintuition is then fixed utilizing the robotic controller to drive the ‘left tool’ with the right effect and vice versa, this handling counter-intuitive is then fixed. The latest inventions are microrobots which, once integrated, give visuality and operational duties with a separately monitored system. These micro-robots, installed on two axial tires and powered by power transmission engines, showed adequate momentum to drive over slick, deformable innards without creating injury damages. A fixed-base pan-and-tilt camera microrobot, consisting of tripod legs, was engineered to include a 360 ° pan and 45 ° tilt perspective of the operator's microrobots and operating the field illuminated by lightening diodes. Semi-autonomous mini robots were also evolved for basic operation tasks if the connection between both the operator and the patient was established with low or really high connectivity processing power.

Even though premature pilot projects were shown in a dog model, technical issues include the tied layout for the constant strength of the robot and the absence of an auto-cleaning system for the lens of the camera. The robotic catheter Sensei TM is another master-slave monitoring system where the operator on the dashboard remotely controls the tip of the catheter by instinctively miming the hand of the operator. Risk assessments have been recorded in ureterorenoscopy for the Sensei robotic catheter.

The potential of robotic procedures is probable to be provided by a mixture of such robotic systems, including smooth operating robots and remotely operated intra-corporative miniature robots [65].

CONCLUSION: Robotic surgery is not a component of the near future, but today, it has become a reality in the healthcare and the medical sector. With time, there will be further advances and betterment in the skill set required in the operations by the human force, making the process smooth and less error-prone. Hence, this field is ever-growing and has great scope to be explored even further in the future.

ACKNOWLEDGEMENT: We, the authors, are pleasured to thank the Management of Oriental College of Pharmacy, Sanpada, Navi Mumbai-400705, our Principal Dr. (Mrs.) Sudha Rathod and our Guide Dr. (Mrs.) Vanita G. Kanase.

CONFLICTS OF INTEREST: There are no conflicts of interest among any of the authors of this paper.

REFERENCES:

1. Troccaz J, Dagnino G and Yang GZ: Frontiers of Medical Robotics: From concept to systems to clinical translation. Ann Rev of Biomedical Engineering 2019; 21: 193-218.
2. Ng WS, David BL, Hibberd RD and Timoney AG: Robotic Surgery A first-hand experience in transurethral resection of the Prostate. IEEE Engineering in Medicine and Biology 1993; 120-25.
3. Mégevand JL, Amboldi M, Lillo E, Lenisa L, Ganio E, Ambrosi A and Rusconi A: Right colectomy: consecutive 100 patients treated with laparoscopic and robotic technique for malignancy. Cumulative experience in a single centre. Updates in Surgery 2019; 71: 151-56.
4. Chen DX, Wang SJ, Jiang YN, Yu MC, Fan JZ and Wang XQ: Robot-assisted gallbladder-preserving hepatectomy for treating S5 hepatoblastoma in a child: A case report and review of the literature. World Journal of Clinical Cases 2019; 7: 872-80.
5. Coulson R, Robinson M, Kirkpatrick M and Berg DR: Design and preliminary testing of a Continuum Assistive Robotic Manipulator. Robotics 2019; 8: 84.
6. Van Boxel GI, Ruurda JP and Van Hillegersberg R: Robotic-assisted gastrectomy for gastric cancer: a European perspective. Gastric Cancer 2019; 22: 909-19.
7. Lee JR: Anesthetic considerations for robotic surgery. Korean Journal of Anesthesiology 2014; 66: 3-11.
8. Alemzadeh H, Raman J, Leveson N, Kalbarczyk Z and Iyer R: Adverse events in robotic surgery: A retrospective study of 14 years of FDA data. PLoS ONE 2016; 11: 1-20.
9. Goldenberg S, Nir G and Salcudean SE: A new era: Artificial intelligence and machine learning in Prostate Cancer. Natural Reviews Urology 2019; 16: 391-403.
10. Ghezzi LT and Corleta CO: 30 Years of robotic surgery. World Journal of Surgery 2016; 40: 2550-57.
11. Guo T, Zhou H, Yang J, Wu P, Liu P, Liu Z and Li Z: Identifying the superior surgical procedure for Endometrial Polypectomy: A network meta-analysis. International Journal of Surgery 2019; 62: 28-33.
12. Russell JO, Razavi CR, Garstka ME, Chen LW, Vasiliou E, Kang SW, Tufano RP and Kandil E: Remote-Access Thyroidectomy: A multi-institutional North American experience with transaxillary, robotic facelift, and transoral endoscopic vestibular approaches. Journal of American College of Surgeons 2019; 228: 516-22.
13. Maddahi Y, Zareinia K, Tomanek B and Sutherland GR: Challenges in developing a magnetic resonance–compatible haptic hand-controller for neurosurgical training. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine 2018; 232: 1148-67.
14. Trochimczuk R, Łukaszewicz A, Mikołajczyk T, Aggogeri F and Borboni A: Finite element method stiffness analysis of a novel telemanipulator for minimally invasive surgery. Medical Simulation 2019; 95: 1015-25.
15. Gallitto M, Sindhu K, Wasserman I, De B, Gupta V, Miles BA, Genden EM, Posner M, Misiukiewicz K and Bakst RL: Trimodality therapy for oropharyngeal cancer in the TORS era: Is there a cohort that may benefit? Journal of the Sciences and Specialities of the Head & Neck 2019; 41: 3009-22.
16. White J and Sharma A: Development and assessment of a transoral robotic surgery curriculum to train Otolaryngology residents. Oto-Rhino-Laryngology, Head and Neck Surgery 2018; 80: 69-76.
17. Park DA, Lee DH, Kim SW and Lee SH: Comparative safety and effectiveness of robot-assisted laparoscopic hysterectomy versus conventional laparoscopy and laparotomy for Endometrial Cancer: A systematic review and meta-analysis. European Journal of Surgical Oncology 2016; 42: 1303-14.
18. Araujo SE, Seid VE, Marques RM and Gomes MT: Advantages of the robotic approach to deep infiltrating Rectal Endometriosis: Because less is more. Journal of Robotic Surgery 2016; 10: 165-69.
19. Sun Y, Xu H, Li Z, Han J, Song W, Wang J and Xu Z: Robotic versus laparoscopic low anterior resection for Rectal Cancer: A meta-analysis. World Journal of Surgical Oncology 2016; 14: 61.
20. Huang Y, Burdet E, Cao L, Phan PT, Tiong AM, Zheng P and Phee SJ: Performance evaluation of a foot interface to operate a robot arm. IEEE Robotics and Automation Letters 2019; 4: 3302-09.
21. Ma X, Song C, Chiu PW and Li Z: Autonomous, flexible endoscope for minimally invasive surgery with enhanced safety. IEEE Robotics and Automation Letters 2019; 4: 2607-13.
22. Tan X, Chng C, Su Y, Lim K and Chui C: Robot-assisted training in laparoscopy using deep reinforcement learning. IEEE Robotics and Automation Letters 2019; 4: 485-92.
23. Niu X, Yu B, Yao L, Tian J, Guo T, Ma S and Cai H: Comparison of surgical outcomes of robot-assisted laparoscopic distal Pancreatectomy versus laparoscopic

and open resections: A systematic review and meta-analysis. Asian Journal of Surgery 2019; 42: 32-45.

24. Samreen S, Fluck M, Hunsinger M, Wild J, Shabahang M and Blansfield JA: Laparoscopic versus robotic Adrenalectomy: A review of the national inpatient sample. Journal of Robotic Surgery 2019; 13: 69-75.
25. Henry LE, Haugen TW, Rassekh CH, Adappa ND, Weinstein GS and O'Malley Jr BW: A novel transpalatal-transoral robotic surgery approach to clival chordomas extending into the nasopharynx. Journal of the Sciences and Specialities of the Head & Neck 2019; 41: 133-40.
26. Hampp EL, Chughtai M, Scholl LY, Sodhi N, Bhowmik-Stoker M, Jacofsky DJ and Mont MA: Robotic-arm assisted total Knee Arthroplasty demonstrated greater accuracy and precision to plan compared with manual techniques. Journal of Knee Surgery 2019; 3: 239-50.
27. Pandey SK and Sharma V: Robotics and Ophthalmology: Are we there yet? Indian Journal of Ophthalmology 2019; 67: 988-94.
28. Bekeny JR and Ozer E: Transoral robotic surgery frontiers. World Journal of Otorhinolaryngology - Head and Neck surgery 2016; 2: 130-35.
29. Jacofsky DJ and Allen M: Robotics in Arthroplasty: A comprehensive review. Journal of Arthroplasty 2016; 31: 2353-63.
30. Zhang X, Wei Z, Bie M, Peng X and Chen C: Robot-assisted versus laparoscopic-assisted surgery for Colorectal Cancer: A meta-analysis. Surgical Endoscopy 2016; 30: 5601-14.
31. Byeon HK, Kim DH, Chang JW, Ban MJ, Park JH, Kim WS, Choi EC and Koh YW: Comprehensive application of robotic Retroauricular Thyroidectomy: The evolution of robotic Thyroidectomy. The Laryngoscope 2015; 126: 1952-57.
32. Sephton BM: Extracervical approaches to Thyroid surgery: Evolution and review. Minimally Invasive Surgery 2019; 2019: 1-14.
33. Pettinari M, Navarra E, Noirhomme P and Gutermann H: The state of robotic Cardiac surgery in Europe. Annals of Cardiothoracic Surgery 2017; 6: 1-8.
34. Harky A and Hussain SM: Robotic Cardiac surgery: The future gold standard or an unnecessary extravagance? Brazilian J of Cardiovascular Surgery 2019; 34: XII-XIII.
35. Su CS, Shen CH, Chang KH, Lai CH, Liu TJ, Chen KJ, Lin TH, Chen YW and Lee WL: Clinical outcomes of patients with multivessel coronary artery disease treated with robot-assisted Coronary artery bypass graft surgery versus one-stage percutaneous Coronary intervention using drug-eluting stents. Medicine Baltimore 2019; 98: e17202.
36. Wang K, Lu Q, Chen B, Shen Y, Li H, Liu M and Xu Z: Endovascular intervention robot with multi-manipulators for surgical procedures: Dexterity, adaptability, and practicability. Robotics and Computer-Integrated Manufacturing 2019; 56: 75-84.
37. Qiu J, Chen S and Chengyou D: A systematic review of robotic-assisted Liver resection and meta-analysis of robotic versus laparoscopic Hepatectomy for Hepatic neoplasms. Surgical Endoscopy 2016; 30: 862-75.
38. Morel P, Jung M, Cornateanu S, Buehler L, Majno P, Toso C, Buchs NC, Rubbia-Brandt L and Hagen ME: Robotic versus open Liver resections: A case-matched comparison. International Journal of Medical Robotics and Computer Assisted Surgeries 2017; 13: e1800.
39. Rodríguez-Sanjuán JC, Gómez-Ruiz M, Trugeda-Carrera S, Manuel-Palazuelos C, López-Useros A and Gómez-Fleitas M. Laparoscopic and robot-assisted laparoscopic digestive surgery: Present and future directions. World Journal of Gastroenterology 2016; 22: 1975-2004.
40. Peters BS, Armijo PR, Krause C, Choudhury SA and Oleynikov D. Review of emerging surgical robotic technology. Surgical Endoscopy 2018; 32(4): 1636-55.
41. Zhou T, Cabrera ME, Wachs JP, Low T and Sundaram CP: a comparative study for telerobotic surgery using free hand gestures. Journal of Human-Robot Interaction 2016; 5: 1-27.
42. Yeo HL, Isaacs AJ, Abelson JS, Milsom JW and Sedrakyan A: Comparison of open, laparoscopic, and robotic Colectomies using a large national database: Outcomes and trends related to surgery center volume. Diseases of the Colon and Rectum 2016; 59: 535-42.
43. Pascual M, Salvans S and Pera M: Laparoscopic Colorectal surgery: Current status and implementation of the latest technological innovations. World Journal of Gastroenterology 2016; 22: 704-17.
44. Tam MS, Kaoutzanis C, Mullard AJ, Regenbogen SE, Franz MG, Hendren S, Krapohl G, Vandewarker JF, Lampman RM and Cleary RK: A population-based study comparing laparoscopic and robotic outcomes in colorectal surgery. Surgical Endoscopy 2016; 30: 455-63.
45. Randell R, Honey S, Alvarado N, Greenhalgh J, Hindmarsh J, Pearman A, Jayne D, Gardner P, Gill A, Kotze A and Dowding D: Factors supporting and constraining the implementation of robot-assisted surgery: a realist interview study. BMJ Open 2019; 9: e028635.
46. Hoshino N, Sakamoto T, Hida K and Sakai Y: Robotic versus laparoscopic surgery for Rectal Cancer: An overview of systematic reviews with quality assessment of current evidence. Surgery Today 2019; 49: 556-70.
47. Cadeddu JA, Stoianovici D and Kavoussi LR: Robotic surgery In Urology. Technologic advances in Urology. Implications for the twenty first century. Urological Clinics of North America 1998; 25: 75-85.
48. Sairam K, Elhage O, Murphy D, Challacombe B, Hegarty N and Dasgupta P: Robotic Renal surgery. Minerva Urologica e Nefrologica 2008; 60: 185-96.
49. Devos G, Muilwijk T, Raskin Y, Calderon V, Moris L, Van Den Broeck T, Berghen C, Meerleer GD, Albersen M, Van Poppel H, Everaerts W and Joniau S: Comparison of peri-operative and early Oncological outcomes of robot-assisted *vs.* open salvage Lymph Node dissection in recurrent Prostate Cancer. Frontiers in Oncol 2019; 9: 781.
50. Liu H, Kinoshita T, Tonouchi A, Kaito A and Tokunaga M: What are the reasons for a longer operation time in robotic Gastrectomy than in laparoscopic Gastrectomy for Stomach Cancer? Surgical Endoscopy 2019; 33: 192-98.
51. Doo DW, Kirkland CT, Griswold LH, McGwin G, Huh WK, Leath CA, Kim KH: Comparative outcomes between robotic and abdominal radical hysterectomy for IB1 cervical cancer: Results from a single high volume institution. Gynecologic Oncology 2019; 153: 242-47.
52. Fanning J, Hojat R, Johnson J and Fenton B: Robotic radical Hysterectomy. Minerva Ginecologica 2009; 61: 53-55.
53. Papalekas E and Fisher J: Trends in route of Hysterectomy after the implementation of a comprehensive robotic training program. Minimally Invasive Surgery 2018; 7362489.
54. Pelizzo G, Nakib G and Calcaterra V: Pediatric and adolescent Gynecology: Treatment perspectives in minimally invasive surgery. Pediatric Reports 2019; 11: 8029.
55. Steyaert H, Van Der Veken E and Joyeux L: Implementation of robotic surgery in a Pediatric Hospital:

Lessons learned. Journal of Laparoendoscopic and Advanced Surgical Techniques 2019; 29: 136-40.
56. Meehan J and Sandler A: Pediatric robotic surgery: A single-institutional review of the first 100 consecutive cases. Surgical Endoscopy and Other Interventional Techniques 2008; 22: 177-82.
57. Meehan J: Robotic Surgery in Small Children: Is there room for this? Journal of Laparoendoscopic & Advanced Surgical Techniques 2009; 19: 707-12.
58. Gutt C, Markus B, Kim Z, Meininger D, Brinkmann L and Heller K: Early experiences of robotic surgery in children. Surgical Endoscopy and Other Interventional Techniques 2002; 16: 1083-86.
59. Hashizume M and Tsugawa K: Robotic surgery and Cancer: The present state, problems and future vision. Japanese Journal of Clinical Oncology 2004; 34: 227-37.
60. O'Malley B, Weinstein G, Snyder W and Hockstein N: TransOral Robotic Surgery (TORS) for base of tongue neoplasms. Laryngoscope 2006; 116: 1465-72.
61. Garg A, Dwivedi R, Sayed S, Katna R, Komorowski A, Pathak K, Rhys-Evans P and Kazi R: Robotic surgery in Head and Neck Cancer: A review. Oral Oncology 2010; 46: 571-76.
62. Genden E, Desai S and Sung C: Transoral robotic surgery for the management of Head and Neck Cancer: A preliminary experience. Journal of the Sciences and Specialities of the Head and Neck 2009; 31: 283-89.
63. Weinstein G, O'Malley B, Cohen M and Quon H: Transoral robotic surgery for advanced Oropharyngeal Carcinoma. Archives of Otolaryngology-Head and Neck Surgery 2010; 136: 1079-85.
64. Chang S, Kibel A, Brooks J and Chung B: The impact of robotic surgery on the surgical management of Prostate Cancer in the USA. BJU International 2015; 115: 929-36.
65. Wedmid A, Llukani E and Lee D: Future perspectives in robotic surgery. BJU International 2011; 108: 1028-36.

How to cite this article:
Shettigar S, Yadav V and Kanase VG: An overview on the trends, features and applications of robotic surgery. Int J Pharm Sci & Res 2020; 11(10): 4794-04. doi: 10.13040/IJPSR.0975-8232.11(10).4794-04.