Robotics Surgery: the new Challenge for the Medical and Nursing Staff at the 21st century

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ABSTRACT

The aim of the present research work is to study the utilisation of robotics in surgical science. We discuss the functionality of the daVinci robotic system , its advantages and disadvantages, as well as the specialities in which robotics surgery is applied. The daVinci robotic system is worldwide the first and unique system of robotics surgery so far used for performing surgical operations. Its advantages are multiple, including endoscopic execution of microsurgical operations, stability and detail in execution of surgical movements etc. Nevertheless, there are important disadvantages as well, including high cost, which are further examined in the present work. Indeed, robotics surgery is applied in a lot of specialities of medical science. An essential requirement for the correct application of robotics surgery is the continuous education and training of medical and nursing staff.

Keywords: laparoscopic surgery, daVinci robotic system , robotics surgery, surgical console, surgical field, technology Endo-Wrist.

INTRODUCTION

Twenty years ago, an experiment started. Its aim was the execution of surgical operations without injury, namely with a laparoscope. Its success was so great that it changed the course of contemporary medicine and created a new speciality, the one of minimally invasive surgery. With the laparoscopic surgery, incisions of the abdomen were not necessary and the hospitalisation of a surgical patient dramatically changed. Complete surgical operations are performed through small apertures not exceeding in size one centimetre. Postsurgical pain, loss of blood and complications almost vanished. Operations requiring in the past many days of hospitalisation, now can be performed in one day (Susan C. deWit, 2009).

Laparoscopic surgery was an enormous technological and medical innovation, but in the attempts of generalising its utilisation, certain weaknesses emerged, limiting its development. During the laparoscopic operation, the surgeon is guided by video-image without directly contacting the patient. The limited operating space and optical field and the downgrading of surgeon's natural senses create serious obstacles in the development of technological applications. Some laparoscopic

Picture 1: Depiction of the daVinci robotic system.

operations, like the one for the inflammation of the gall-bladder, developed easily and fast. However, this was not the case with some most demanding operations, like removal of the spleen, intestine, stomach, etc. All studies agreed in the conclusion that advanced laparoscopic surgery requires time-consuming education and certain surgical abilities. Two solutions were proposed in order to overcome these difficulties: technological assistance of surgeons in order to improve their abilities or replacing them for an automatic machine free of the human weaknesses. Research has been done to both directions (Sejal P., 2008).

As a result, after numerous studies and much research, we now observe a revolution in the domain of surgery, with the approval of robotics surgery, which led to the use of robotics systems within human body under the guidance of computers. These robotic systems require operation and control by a surgeon. They are remotely controlled and they are activated by voice (Chatzidimitriou S., 2008).

In the present report, we examine the operation of robotics surgery, the surgical system daVinci, its advantages and disadvantages, as well as the specialities in which it can be applied. Continuous education and training of the medical and nursing staff is essential for the correct application of robotics surgery science.

HISTORICAL RETROSPECTION

Robotics surgery is a reality thanks to the robotic technology and tele-surgery. The development of digital analysis provides the possibility to transfer information in distance, promoting tele-surgery. Until recently, it was unimaginable to perform an operation from a distance, especially without having the patient and the surgeon in the same room. This restriction led NASA to begin research, in order to create a medical method for operating astronauts by doctors working on the ground. The same concept is investigated for its applicability in soldiers, whose life is in danger in the field of battle, operated by doctors remaining in safe and distance (Konstantinidis K. et. al., 2009).

In 1985, the robotic system PUMA 560 was used to perform a brain biopsy under guidance with computed tomography. In 1988, the system PROBOT, which was developed in the Imperial College of London, was used in urological operations of the prostate. The system ROBODOC of Integrated Surgical Systems was launched in 1992 for precise resurfacing during arthroplasty and replacement of the hip. Further development of robotic systems took place from Intuitive Surgical with the manufacturing of daVinci system and from Computer Motion with the AESOP robot and ZEUS robot. Intuitive Surgical bought Computer Motion in 1994 and they interrupted development of ZEUS. At the same time, the daVinci system was getting approval from FDA for a broad range of surgical operations including complete operation for prostate cancer, hysterectomy and restoration of mitral valve, and it is used in more than 800 hospitals in America and Europe. In May 1988, Dr. Friedrich-Wilhelm Mohr performed the first robotic aorto-coronary by-pass in Leipzig Heart Centre, Germany, using the daVinci system. In 2001, J. Marescaux performed from New York an operation for inflammation of the gall-bladder, on a patient in Strasbourg, France (Howe RD. et. al., 1999).

In Greece, daVinci surgical system is used since 2006 in Medical Centre of Athens, while in 2008, a second system was placed in "Ygeia" Hospital. The use of daVinci robotic system began in September 2006, and during the first year, more than 250 absolutely successful surgical operations have been performed. The person behind this initiative is Mr. Konstantinos Konstantinidis, Assistant Professor, who successfully performed the first robotic surgical operations in collaboration with other doctors (Konstantinidis K. et. al., 2009). The surgical operations that have been performed include:

- Surgical operation Heller-Dorr for the management of achalasia of the oesophagus.
- Restoration of diaphragm's hernia at Nisssen.
- Appendicectomies and operations for the inflammation of the gall-bladder.
- Ectoperitonial excision of inguinal hernia and abdominal hernia with the insertion of a plexus.
- Insertion and removal of gastric balloon for pathogenic obesity.
- Excision of pancreatic tumours and renal cysts.
- Excision of the adrenal glands.
- Excision of the ovaries and hysterectomy.

At the same time, A. Ploumidis, N. Pardalidis, V. Poulakis and E. Panagiotou, urologists, performed a broad range of complete prostate surgeries using the daVinci robotic system, sparing the nerves of the area and erectile function, as well as nephrectomies, pelvic operations and total excision of cysts (Diamantes Th., 2009).

OPERATION OF THE SYSTEM OF ROBOTICS SURGERY DA VINCI

Robotic surgery is the most recent and revolutionary development in the field of minimally invasive surgery. It is performed by the daVinci robotic system, which is worldwide the first and unique system of its kind at the moment, and it was approved by the Food and Drug Administration (FDA) for performing surgical operations. It is a product of Intuitive Surgical, combining the surgeon's skills with robotic technology, enhanced by a computer (Muhlmann G. et. al., 2003).

It consists of three compartments: the robot with the special arms, the endoscopic tower and the surgical console (Picture 1).

The surgeon controls the system through the surgical console, having in front an enlarged three-dimensional image of the surgical field. The surgical console includes handles, where the surgeon places his fingers and moves the levers as if he uses his hands. Each surgeon's movement is reproduced with absolute precision and stability in the surgical field from the surgical arms of the robot, which is usually placed to the left of the patient, with the surgical team. The robot's surgical arms use the Endo-Wrist technology, which involves flexible wrists, bendable by the surgeon like his own, but with even more flexibility. The endoscopic control tower includes two video cameras, a system of automatic picture adjustment, a high definition video recorder and other necessary components (Morino M. et. al., 2006).

Designing of the daVinci surgical system began in 1995 and since 2000 it is used in more than 350 hospitals worldwide. Its use has expanded rapidly during the past years, due to its important advantages, such as the ability of endoscopic microsurgical operations, its big stability and its precision in surgical movements execution, the three-dimensional views and the availability of more degrees of freedom in comparison to laparoscopic tools.

However, the daVinci robotic system presents the following disadvantages:

- High cost (one million US dollars).
- Big weight resulting in a slow moving ability.
- Time for preparation before the surgical operation requiring at least 30 minutes.
- Necessity of assembling all the tools before their usage.
- Regulation of the system (Link RE. et. al., 2006).

ADVANTAGES OF ROBOTICS SURGERY

There are multiple advantages of robotic surgery in comparison to the conventional surgical operations (Rocco B. et. al., 2006):

- It is a minimally invasive and minimally traumatic method, due to the precision of the surgical movements.
- It provides for a minimum loss of blood.

Picture 2: Depiction of execution of surgical movements by the surgical tools of robotic arms.

- It minimizes pain and malaise after the surgical operation.
- It minimizes the probability of complications during and after the surgery.
- It considerably decreases the time and cost of hospitalisation.
- It provides rapid recovery and return in daily activities.
- It provides better aesthetic result, with the absence of scars.
- It provides the surgeon with three-dimensional (3D) view of surgical field in high enlargement.
- It ensures higher precision of surgical movements. While the surgeon's operations on the console are transformed to movements of the surgical arms, the physiologic hand tremor is eliminated and as a result, an unprecedented surgical dexterity is achieved.
- It provides the opportunity to perform difficult surgical operations. The surgical tools of robotic arms can perform all movements of the human hand (7 degrees of freedom for movement), with greater dexterity and precision, and they can turn almost at 360o in the surgical field (Picture 2).
- It provides greater comfort for the surgeon during the operation. Contrary to the conventional surgical method, robotic surgery allows the surgeon to perform operations while seated, in a carefully designed and ergonomically excellent environment. By this way, the surgeon's tiredness is decreased, with very important benefits, particularly for the cases of challenging and long-lasting operations.
- It provides the opportunity to prepare the operation on the computer, using images of internal organs of the patient derived from their laboratory work-up. The surgeon can also recall these images during the operation and be supplied with useful images.
- The surgeon derives the sense that his eyes and hands are into the patient's body. He is able to see perfectly in places with poor optical accessibility until recently.
- It provides for less duration of anaesthesia and decreased risk of infection.

IMPLEMENTATION OF ROBOTIC SURGERY

Robotics is implemented in various surgical specialities, including general surgery, bariatric surgery, cardiac surgery, thoracic surgery, vascular surgery, paediatric surgery, urological surgery, pelvic surgery, kidney's transplantation for graft taking and endocrine surgery (Vassiliades, 2006).

Presently, most frequently performed robotic laparoscopic operations, include bariatric indications, inflammation of the gall-bladder, management of diseases of the small intestine, management of gastro-oesophageal reflux disease, surgical management of pelvic disease, prostate's surgery, kidney excision, endocrine surgery etc., thus providing important benefits to the patient (Nikiteas N., 2008).

CONCLUSION

According to the present discussion, it is obvious that robotic surgery is an innovation of the 21st century, with multiple benefits for patients, and medical and nursing staff. The speed of the continuous development in robotic surgery requires continuing training and education of the medical and nursing staff. Important factors for the development of a robotic surgery unit include the experience of the surgical team in laparoscopic operations, as well as the institution's infrastructure (Patel VR., 2006).

On the other hand, nursing is in front of a new challenge. Nurses are charged with new responsibilities, targeting to provide a high quality clinical care to the patients that will be subjected to this new surgical technique. Importantly, nursing staff will still be irreplaceable for the patient, because nurses bridge the gap between technology and science, confronting human pain with human hope.

BIBLIOGRAPHY

1. Howe RD. and Matsuoka Y., 1999. Robotics for Surgery, Annual Review Biomedical Engineering, 01:213.
2. Link RE., Bhayani SB. and Kavoussi LR., 2006. A prospective comparison of robotic and laparoscopic pyeloplasty, Ann Surg., 243(4):486-491.
3. Morino M., Pellegrino L., Giaccone C., Garrone C. and Bebecchi F., 2006. Randomized clinical trial of robot-assisted versus laparoscopic Nissen fundoplication, Br J Surg., 93(5): 553-558.
4. Muhlmann G., Klauss A., Kirchmayer W., Wykypiel H., Unger A., Holler E., Nehoda H., Aigner F. and Weiss HG., 2003. DaVinci robotic-assisted laparoscopic bariatric surgery: is it justified in a routine setting?, Obes Surg., 13(6): 848-854.
5. Patel VR., March 2006. Essential elements to the establishment and design of a successful robotic surgery programme, International Journal of Medical Robotics, 2(1): 28-35.
6. Rocco B., Matei DV., Melegari S., Ospina JC., Mazzoleni F., Errico G., Mastropasqua M., Santoro L., Detti S. and deCobellio, 2009. Robotic vs open prostatectomy in a laparoscopically naïve centre: a matched-pair analysis, Division of Urology, European Institute of Oncology, Milan, Italy.
7. Sejal P. Dharia and Tommasco F., April 2008. Robotics in reproductive medicine, Department of Obstetrics and Gynecology, University of Alabama at Birmingham, Birmingham, Alabama.
8. Susan C. deWit, 2009. Medical-Surgical Nursing: Concepts and Practice, 95.
9. Vassiliades TA Jr., March 2006. Robotics in cardiac surgery, International Journal of Medical Robotics, 2(1): 4-6.
10. Diamantes Th.., 21-23 May 2009. Robotics Bariatric Surgery. Congress of Laparoendoscopic Surgery and International Symposium: 'Collaboration for the development of Surgery', Athens.
11. Konstantinidis K., Chiridis S., Jiarchos A., Anastasakou K., Sampalis G.., Borias M., Georgiou M. and Thomas D.., 23-24 February 2009. The surgical robot DAVINCI at the General Surgery: Two years later from the beginning of the first programme of robotics surgery in Greece. 1o Pan-Hellenic Congress of Robotics, Athens.
12. Nikiteas N., 17-19 April 2008. Robotics Surgery of abdomen – Present and Future. 3o Pan-Hellenic Congress & International Forum of the Hellenic College of Surgeons, Athens.
13. Chatzidimitriou S., 17-19 April 2008. The digital communication and computer science at the service of surgery today and at the future. 3o Pan-Hellenic Congress & International Forum of the Hellenic College of Surgeons, Athens.