Review

Medical Service of Robots

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Article history
Received: 13-04-2019
Revised: 20-04-2019
Accepted: 23-04-2019

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Abstract: Today, robots have not only penetrated to create microchips in electronics but also in medicine, where it helps to perform difficult operations, especially where precision is needed and the size is small and any human error could be fatal to the patient. Robots assist the doctor in heart, brain, kidney operations, not to mention bone implants and repair of damaged bones, cartilage and muscles. In this area, new materials adapted to the requirements of the human body also play an important role. The robotic systems used in today's operating blocks are very expensive and bulky and they need to be permanently adapted and prepared before a difficult operation, but in the end their help is unsurpassed because the operation takes place with the help of the machine and the computer, so they can perform a giant precision of hundredth of a millimeter, precision that stops the scalpel from cutting accidentally such as a nerve, a blood vessel, healthy tissue and anything else. Assisted operation brings infinitely more advantages than the disadvantage that the operator block is voluminous and costly. However, apart from the related space, the costs are amortized over time and the satisfaction of the successful operations is great for both the patients and the medical team. Surgery has taken advantage of this technology relatively late. Initial use of robots in surgery began in the late 1980s when an industrial robot was used to support instruments for stereotactic biopsy in neurosurgery. Also in the late 1980s, IBM built the first robot used in clinical practice, called Robo-doc. The first use of a robot in human surgery was for a transurethral prostate resection. In 1993, Computer Motion, Inc. introduced a voice-controlled arm, Automated Endoscopic System for Optimal Positioning (AESOPTM), used to support instruments, of optics in laparoscopic surgery. Its version, AESOPTM 2000 is the first human-controlled robot approved by the Food and Drug Administration of the United States. In 1998, Reichenspurner introduced the ZEUS Microsurgical Robotic System into Germany. Today, the most complex and efficient robot in use is the daVinci system. With the birth of laparoscopy and information technology, surgery went into a new era. The development of surgical robots is primarily motivated by their desire the need to increase the effectiveness of surgical medical interventions. Medical actions are chosen based on information from various sources, including patient-specific data (vital signs and images of human body tissues and organs), general medical knowledge (atlases of human anatomy) and medical experiences. First, a robot can usually do things much more accurate than a man. This provides the first motivation for using CAD/CAM systems. Robots can be used successfully if the patient has been radiated (e.g., with X-radiation), thus not endangering the health of the medical team. Since ancient times, the imagination of mankind has been concerned with the idea of making cars equipped with artificial intelligence to execute operations similar to those performed by man. Technicians have been used for many years in various fields other than medical, such as the automotive industry, the underwater environment, the alien space, or the areas at risk of nuclear radiation.

Keywords: Robots, Mechatronic Systems, Structure, Dynamics, Dynamics Systems, Machines, Medical Service of Robots, Medicine

Science Publications

Introduction

Today, robots have not only penetrated to create microchips in electronics but also in medicine, where it helps to perform difficult operations, especially where precision is needed and the size is small and any human error could be fatal to the patient.

Robots assist the doctor in heart, brain, kidney operations, not to mention bone implants and repair of damaged bones, cartilage and muscles. In this area, new materials adapted to the requirements of the human body also play an important role.

Sooner or later it was obligatory to happen and to have robots also penetrated in medical operations. We can no longer afford to play with the life and health or body integrity of a human when operative medical intervention is needed on it, which can be difficult without the assistance of specialized machines, medical robots.

The robotic systems used in today's operating blocks are very expensive and bulky and they need to be permanently adapted and prepared before a difficult operation, but in the end their help is unsurpassed because the operation takes place with the help of the machine and the computer, so they can perform a giant precision of hundredth of a millimeter, precision that stops the scalpel from cutting accidentally such as a nerve, a blood vessel, healthy tissue and anything else.

Assisted operation brings infinitely more advantages than the disadvantage that the operator block is voluminous and costly. However, apart from the related space, the costs are amortized over time and the satisfaction of the successful operations is great for both the patients and the medical team (Rulkov *et al*., 2016; Agarwala, 2016; Babayemi, 2016; Gusti and Semin, 2016; Mohamed *et al*., 2016; Wessels and Raad, 2016; Maraveas *et al*., 2015; Khalil, 2015; Rhode-Barbarigos *et al*., 2015; Takeuchi *et al*., 2015; Li *et al*., 2015; Vernardos and Gantes, 2015; Bourahla and Blakeborough, 2015; Stavridou *et al*., 2015; Ong *et al*., 2015; Dixit and Pal, 2015; Rajput *et al*., 2016; Rea and Ottaviano, 2016; Zurfi and Zhang, 2016a; 2016b; Zheng and Li, 2016; Buonomano *et al*., 2016a; 2016b; Faizal *et al*., 2016; Ascione *et al*., 2016; Elmeddahi *et al*., 2016; Calise *et al*., 2016; Morse *et al*., 2016; Abouobaida, 2016; Rohit and Dixit, 2016; Kazakov *et al*., 2016; Alwetaishi, 2016; Riccio *et al*., 2016a; 2016b; Iqbal, 2016; Hasan and El-Naas, 2016; Al-Hasan and Al-Ghamdi, 2016; Jiang *et al*., 2016; 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He *et al*., 2013; Lee, 2013; Lin *et al*., 2013; Liu *et al*., 2013; Padula and Perdereau, 2013; Perumaal and Jawahar, 2013; Petrescu, 2011; 2015a; 2015b; Petrescu and Petrescu, 1995a; 1995b; 1997a; 1997b; 1997c; 2000a; 2000b; 2002a; 2002b; 2003; 2005a; 2005b; 2005c; 2005d; 2005e; 2011a; 2011b; 2012a; 2012b; 2013a; 2013b; 2013c; 2013d; 2013e; 2016a; 2016b; 2016c; Petrescu *et al*., 2009; 2016; 2017a; 2017b; 2017c; 2017d; 2017e; 2017f; 2017g; 2017h; 2017i; 2017j; 2017k; 2017l; 2017m; 2017n; 2017o; 2017p; 2017q; 2017r; 2017s; 2017t; 2017u; 2017v; 2017w; 2017x; 2017y; 2017z; 2017aa; 2017ab; 2017ac; 2017ad; 2017ae; 2018a; 2018b; 2018c; 2018d; 2018e; 2018f; 2018g; 2018h; 2018i; 2018j; 2018k; 2018l; 2018m; 2018n).

Materials and Methods

Since ancient times, the imagination of mankind has been concerned with the idea of making cars equipped with artificial intelligence to execute operations similar to those performed by man. Actually by robots in a broad sense, different authors understand different things. However, a robot can be defined as a device automatically capable of performing physical operations in conditions with some human attributes, such as adaptive faculty, self-determination, learning ability and, in particular, alumni representation, predictive and programming capability or a robot is defined as "a machine that can replace of the human being and mechanically fulfilling its tasks, lacking in emotions and sensibilities, or a machine that uses a human intelligence close to the human one. " Technicians have been used for many years in various fields other than medical, such as the automotive industry, the underwater environment, the alien space, or the areas at risk of nuclear radiation.

On the other hand, "robotics" is a broader notion, not limited to a concrete machine, but refers to a certain way of performing certain activities.

Physical or intellectual activities that can be explained by the program-robot, machine-robots or robot system.

The main features of the robots are:

They are designed to perform mainly handling, displacement and transport operations, which require speed and accuracy but for forces limited.

They are endowed with more degrees of freedom (between 2-6) so that the ship performs complex operations, each being controlled by the decontrol unit.

They are autonomous, functioning without the systematic intervention of man.

They are equipped with a reprogrammable memory capable of conducting equipment to perform operations that can be changed by modifying the initial program.

They are equipped with a very low logic capacity, with which they can perform tests and choose between two alternatives, as well as change approval signals with other devices. The robot's technical features include dimensions, displacement values, precision, repeatability, number of degrees of freedom, type of drive, robot weight, workspace volume, command and control system capability, speed, transportable load, working conditions, the possibility of having multiple working days, etc.

Robotic systems have been introduced into surgery, namely in microsurgery, which is a potential change in extending human abilities to the way surgery is performed. In the first phase, we can talk about a surgical application in an investigation of microscopic, navigational, precision operations. To provide surgery, surgeons performed bilateral nephrectomies, splenectomies on experimental animals. Two residents experienced only using the conventional technique: 8 rats were used in each of the 3 treatment groups. The two treated 4 rats in each group. Total surgery time, blood loss, vascular damage and animal survival were recorded and converted to a performance score. Then they worked slower using microsurgical instruments, but the result was the same as a classic surgery. Microsurgery has been well received by the entire medical setting and soon it has also been applied to humans, being a precise, non-risk technique by which any surgery achieves performance. The essential qualitative element that marks the transition from simple robots to intelligent robots is the transition from the robot's (robot's) set-up to the robot's goal setting, in other words, what is specific is not just the robot's movements but also the goals on which he has to accomplish. An important feature of intelligent robot systems (robot machines or robot programs) is that they interact with a known real-world or simulated-incomplete universe. Solving a problem by such a robot-system involves two main aspects:

1. Predetermination of the concrete operations to be performed to achieve the proposed objective, i.e., generation of plans
2. Command the robot action in the universe, so execute the plans

There is a great deal of redundancy between looking and touching objects. Man uses this redundancy by selecting the most comfortable sensors for executing a particular action. In the case of robots, the redundancy of sensory information is required to validate the accuracy of information and to increase system reliability (i.e., if a sensor category fails, the robot's action continues with the information provided by other sensor categories).

Medical robotics helps patients with prostheses, orthoses, hearing aids and visual prostheses for not making changes to the environment, but also helping disabled patients as well as helping practitioners (physicians) in microsurgery, endosurgery and telesurgery. Using robots to help people with disabilities.

Tasks: Nutrition, hygiene, housework, communication, hobby. Robot Requirements:

- Functional transparency: Fitting, disability learning, usage limits (mechanical, command and control, security), maintenance, addiction, biological, financial

Surgery has taken advantage of this technology relatively late. Initial use of robots in surgery began in the late 1980s when an industrial robot was used to support instruments for stereotactic biopsy in neurosurgery. Also in the late 1980s, IBM built the first robot used in clinical practice, called Robo-doc.

The first use of a robot in human surgery was for a transurethral prostate resection. In 1993, Computer Motion, Inc. introduced a voice-controlled arm, Automated Endoscopic System for Optimal Positioning (AESOPTM), used to support instruments, of optics in laparoscopic surgery.

Its version, AESOPTM 2000 is the first human-controlled robot approved by the Food and Drug Administration of the United States. In 1998, Reichenspurner introduced the ZEUS Microsurgical Robotic System into Germany.

Today, the most complex and efficient robot in use is the daVinci system.

With the birth of laparoscopy and information technology, surgery went into a new era.

The development of surgical robots is primarily motivated by their desire the need to increase the effectiveness of surgical medical interventions.

Medical actions are chosen based on information from various sources, including patient-specific data (vital signs and images of human body tissues and organs), general medical knowledge (atlases of human anatomy) and medical experiences.

First, a robot can usually do things much more accurate than a man. This provides the first motivation for using CAD/CAM systems.

Robots can be used successfully if the patient has been radiated (e.g., with X- radiation), thus not endangering the health of the medical team.

In contrast to industrial robots, surgical robots are rarely assigned to replace a member of the surgical or intervention team. They are intended to help the medical team through accurate or non-human interventions.

Surgical robotic systems are used today to apply invasive procedures in the surgical treatment of diseases in areas such as neurosurgery, cardiology, thoracic surgery, orthopedics, urology, gynecology, general surgery.

While cardiac and urologic surgery has boosted, general surgery is still in its infancy. Only a few operations are being done today using robots in the field of general surgery.

Robotic Surgery has demonstrated the following benefits: safety and reliability, better visualization of internal organs, healthy tissue destruction is minimal, hospitalization is in most cases less than 24 hours, dexterity and level of precision (the precision of the intervention is below one hundredth of a millimeter), the psychological impact on the patient is significantly reduced, the risk of wrong cuts (dissection of vessels, reaching of nerves) is minimal, the risk of infections is minimal, impossible interventions can be made by classical way.

As a disadvantage, we can list: System ergonomics is low and requires a large number of training hours, the surgeon does not feel the tissues (no tactile feedback), the space occupied by such a system in the operating room is high and the price of a system is very picked up.

In the research, it was useful to classify surgical robots as medical care systems (so-called CAD surgery). The best example of CAD/CAM surgery is the ROBODOC system. It was developed for total hip and knee replacement (Fig. 1).

In this surgery, the patient's joint is replaced by an artificial prosthesis. For the hip, a prosthesis is mounted in the femur and the other in the pelvis, creating a spherical joint cavity. For the knee, a prosthesis is mounted in the femur and another in the tibia, thus creating a hinge joint.

Research on the ROBODOC system began in the mid-1980s as part of a project between IBM and Davis University in California. At that time, the conventional technique for hip and knee replacement surgery consisted of 2D planning (using X-rays) and manual methods for bone planning.

The motivation for introducing the robot was to improve the precision of the procedure (fitting the prostheses in the right places and adjusting the bones correctly). The technique of the system is to use Computerized Tomography (CT) for 3D planning and a robot for automatic bone cutting. Planning (CAD surgery) is performed with the ORTHODOC workstation. This allows the surgeon to graphically position the 3D model of the denture with the help of tomography images.

Therefore, the surgical plan can be transferred from the computed tomography coordinate system to the robot coordinate system.

The robot will process the bones in accordance with the plane using a very fast and silent milling tool.

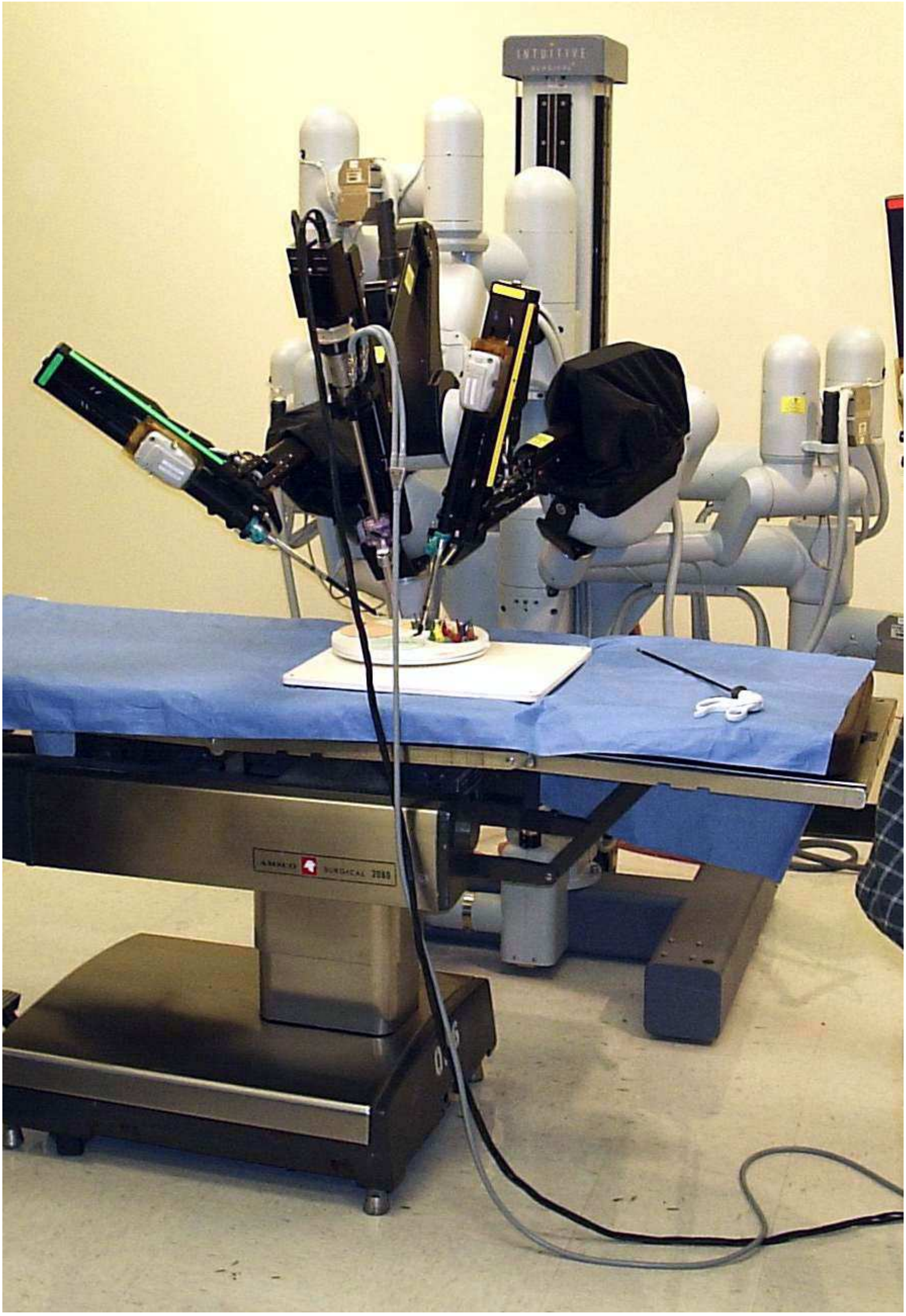

Fig. 1: The ROBODOC system used in surgery orthopedic

Results and Discussion

The da Vinci telesurgical system was developed by Intuitive Surgical, Inc. This is thanks to 3D HD (High Definition) viewing, high control and precision, one of the most advanced surgical platforms currently available. It was named so because Leonardo da Vinci invented the first robot (Fig. 2 and 3). With the DaVinci system in 1998, Carpentier made the first robot-assisted cardiac intervention in Paris, a mitral valve replacement.

It consists of 3 interconnected components through a network:

- Surgical ergonomic bracket
- Surgical mass with 4 interactive robotic arms
- 3D HD system viewing system da Vinci was designed to increase efficacy

Surgical operations and perform as complex procedures as possible. It can not be programmed, it can not make decisions. He conveys the movement from the console to the surgeon in a corresponding micromachine instruments inside the patient. Practically, the system is a prolongation of the surgeon's arm, like a medical interface, a prolongation able to transform the surgeon's wide motion into a smaller movement at the micro level, being also a kind of mechanical motion reducer capable to adapting a wider movement to the need a lower displacement at the operator's level for the obvious purpose of allowing the doctor a high precision operation, without the cut affecting healthy tissue, good blood vessels, nerves...

The system allows the surgeon to operate under comfortable conditions, thereby reducing operator stress and fatigue. He is no longer required to sit for hours standing up, sweating above the patient who is operated, but sitting comfortably in front of the console, a few meters away from the patient, observing through the viewing system the real image of the surgical field, while operating in real time through small and accurate incisions, using specialized electromechanical tools.

A variety of control modes can be selected from the console using the pedals and the joysticks and used to determine the movement of the robot arms.

An important part of the installations find their application in the surgical environment and are aimed at servicing technological processes. In this category are the manipulators, the "master" installations:

- Slaves, pedophiles, etc.

Robots "master-slave" have applications similar to those of manipulators. They are made up of two open kinematic chains, the first "master" chain, the second "slave" copying this movement, carrying out manipulation operations. The connection between "master" and "slave" can be achieved cinematically - for example, through shafts and gears:

- Or by remote control - for example through radio waves

The system consists of a master part and one slave. The slave is the one next to the operating table. It has 3 or 4 robotic arms that can handle the stereo endoscope or surgical instruments such as scissors, scalpel, pliers, etc. The master part is represented by the control console.

The first surgical robot called da Vinci, in honor of Leonardo da Vinci, was developed in Silicon Valley by Intuitive Surgical and in 2000 he obtained the authorization of the American Food and Drug Administration (FDA) for use in laparoscopic surgery.

(a) (b)

Fig. 2: (FDA) for use in laparoscopic surgery (a) Da Vinci patient-side component (left) and surgeon console (right) (b) a surgeon console at the treatment centre of Addenbrooke's Hospital

Fig. 3: Robotic surgery DaVinci system

The da Vinci Surgical System (sic) is a robotic surgical system made by the American company Intuitive Surgical. Approved by the Food and Drug Administration (FDA) in 2000, it is designed to facilitate complex surgery using a minimally invasive approach and is controlled by a surgeon from a console (Fig. 2a and 2b), (Da Vinci Surgical System, From Wikipedia). The system is commonly used for prostatectomies and increasingly for cardiac valve repair and gynecologic surgical procedures. According to the manufacturer, the da Vinci System is called "da Vinci" in part because Leonardo da Vinci's "study of human anatomy eventually led to the design of the first known robot in history", (Akubue, 2011).

The "da Vinci" robot is provided with a high- resolution camera that magnifies 12 times the image; 4 robotic arms with the possibility of rotation up to 540 degrees, thus allowing complex movements in an extremely small space, impossible to do by any surgeon. The device can be operated even by an older, experienced surgeon, but whose hands tremble, these unwanted additional movements being automatically eliminated by the system.

Manipulation of the "da Vinci" robot can be done remotely using a console that controls the surgical instruments attached to the robot arms. In the case of heart interventions, such as changing a valve, the robot arms are inserted through approximately 2 cm incisions made under the sternum.

Thus, while operating the "da Vinci" robotic system, the surgeon should not be in the operating room and more than that, he may be at distant continents.

Most surgeons operating with the da Vinci robot in ACIBADEM hospitals have trained in Germany and France.

Here is the moment of important clarifications. Besides the fact that the Da Vinci surgical robot allows the surgery to be done by an older doctor who can sit quietly on a chair during the operation and even if they start to shake hands the device automatically eliminates the influence of this trembling and the surgeon can accomplish his quiet purpose, so besides this important aspect, another important aspect is that the system allows the surgery to be made by several surgeons simultaneously and they can help each other and intervene when one another if necessary, even more, they can be positioned at very large distances, one being even at a great distance from the operating block working from another city, the transmission in both directions being automatically done by electromagnetic waves. Thus, a younger doctor can be assisted by his boss during the operation, the chief doctor being able to intervene when the assistant fails to cope with an unforeseen situation.

In ACIBADEM hospitals, there is the possibility of performing cardiac or vascular surgery by laparoscopic methods, using robots coordinated by surgical specialists. The advantage of the method is that the incision made is very small compared to the one made in the case of a classic surgery. In this type of surgery, after the intervention, there are traces of very small three holes through which the robot's arms were inserted. At the same time, the intervention is much less traumatic, requiring a considerably shorter recovery time.

This type of interventions have been done in ACIBADEM hospitals since 1999. By 2012, more than 6000 patients have been successfully operated using this kind of interventions.

Advantages of using the "da Vinci" robotic system in cardiac surgery:

- In traditional cardiac surgery, the sternum is open. Performing surgical intervention through the small incisions that the da Vinci system needs, significantly reduces recovery and post-operative pain

- Blood transfusions are not required due to very low bleeding
- The patient can sit sideways only one day after surgery
- Stay in the hospital is shortened, the patient staying in hospital for only a few days
- The patient can make an effort shortly after surgery
- For example, he can ride a bicycle after just one week

Conclusion

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Acknowledgement

This text was acknowledged and appreciated by Dr. Veturia CHIROIU Honorific member of Technical Sciences Academy of Romania (ASTR) PhD supervisor in Mechanical Engineering.

Funding Information

Research contract: 1-Research contract: Contract number 36-5-4D/1986 from 24IV1985, beneficiary CNST RO (Romanian National Center for Science and Technology) Improving dynamic mechanisms.

Contract research integration. 19-91-3 from 29.03.1991; Beneficiary: MIS; TOPIC: Research on designing mechanisms with bars, cams and gears, with application in industrial robots.

Contract research. GR 69/10.05.2007: NURC in 2762; theme 8: Dynamic analysis of mechanisms and manipulators with bars and gears.

Labor contract, no. 35/22.01.2013, the UPB, "Stand for reading performance parameters of kinematics and dynamic mechanisms, using inductive and incremental encoders, to a Mitsubishi Mechatronic System" "PN-II-IN-CI-2012-1-0389".

Ethics

This article is original and contains unpublished material. Authors declare that are not ethical issues and no conflict of interest that may arise after the publication of this manuscript.

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