Study and Perspective on the Medical Robot: Healthcare with Technology

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Abstract. A robotic machine is an artificial intelligence machine that can perform semi-autonomous or fully autonomous work. It has basic characteristics such as perception, decision-making and execution, and can assist or even replace humans in completing dangerous, heavy, and complex tasks, improving work efficiency and quality, serving human life, expanding or extending the scope and capabilities of human activities. With the development of digital design and numerical control manufacturing, robot technology has rapidly expanded to all walks of life closely related to human life. From outer space, deep sea, industrial manufacturing to tiny molecules, robots are everywhere. A new generation of robots promises to create even more possibilities in home, workplace and community safety, supporting services, entertainment, education, healthcare, manufacturing and assistance. With the development of digital design and numerical control manufacturing, robot technology has rapidly expanded to all walks of life closely related to human life. From outer space, deep sea, industrial manufacturing to tiny molecules, robots are everywhere. The robot has the characteristics of precision, high efficiency and stability, and has been applied in all walks of life. At present, the application in treatment has achieved phased results. It not only reduces the work intensity of the clinician, but also improves the accuracy of the treatment. This paper reviews the application and research status of robot in medical field.Aic is an artificial intelligence machine which can be used to perform semi-autonomous or fully autonomous work. It has the most basic characteristics .For example perception, decision-making and execution, and can assist or even replace human beings to complete dangerous, heavy and complex work, improve work efficiency and quality, serve human life, expand or extend the scope of human activities and capabilities. This paper reviews the contribution of robots in the field of medicine. The main point of this paper is the help and development of robots to the medical industry.

Keywords: Safety, accuracy, treatment, medical.

1. Introduction

Since a Company called Intuitive Surgical launched the Da Vinci surgical robot system in the year of 1996, the progress of robotic technology in the medical field has been nothing short of revolutionary. From the initial groundbreaking innovation to its widespread application in precise operations across various fields, including oral implant surgery, robots have not only become indispensable assistants to doctors but have also shown great potential in enhancing surgical precision and shortening recovery periods.

On the long journey of medical exploration, robots have gradually taken up an important position with their unique advantages. It is well known that long surgical procedures often pose a physical and mental challenge to doctors, and the increased risk of surgery due to attention lapses and diminished judgment from fatigue is undeniable. At this point, the introduction of robotic-assisted technology is like bringing fresh air into the operating room. Their tireless and precise operations greatly alleviate the pressure on doctors and ensure the safety and efficiency of surgery. Taking neurosurgery as an example, Li and his team successfully applied the NeuroMate robotic system to image-guided and stereotactic targeting of anatomical structures [1]. This innovation not only achieved precise planning of surgical paths but also, through the stable operation of the robotic arm, effectively reduced human error and significantly shortened the time for biopsy surgeries involving multiple targets. Even more commendably, the introduction of the NeuroMate robotic system has made neurosurgery more controllable and predictable, bringing hope for life to countless patients.

Furthermore, the research by Minchev G et al. has further confirmed the superiority of robot-assisted stereotactic surgery [2]. They found that compared to traditional surgical methods, surgery assisted by robots can significantly improve the accuracy of positioning, reduce the time for positioning, and help young doctors master surgical skills more quickly and shorten the learning curve. This discovery undoubtedly provides new insights and methods for medical education and talent cultivation.

With the rapid development of technology, medical robots are gradually moving from the laboratory to the clinical front line. They not only excel in fine surgeries such as neurosurgery and dental implantation but also show a wide range of application prospects in rehabilitation therapy and drug delivery. In the future, with the continuous integration of advanced the purpose of the technology is to enhance the quality of life,facilitate human activities ,and broaden the range og capabilities, medical robots will serve patients more intelligently and personally, contributing even more to human health.

In summary, the widespread the way of using robotic technology in the In medical research and practical applications is an inevitable outcome of technological progress and an important trend in the development of medicine. With their unique advantages and potential, they are gradually changing the face and future of the medical industry. We have reason to believe that in the near future, medical robots will become an indispensable part of the healthcare system, creating a more splendid chapter for the cause of human health.

2. Current Study on the Medical Robot

Da Vinci robot, known as the "King of Surgery", is currently the world's leading minimally invasive surgical system. The robot system is mainly dependent on three important parts: The first part is the doctor's operating part,then is the bedside robotic manipulator part, the third one is the video processing part.

In routine surgery, a group of doctors are often surrounded by a group of doctors in front of the patient's bed and perform the operation throughout the whole process. The surgeon who operates the Da Vinci robot can sit on the operating table and control the robotic arm to complete the operation like a game controller by observing the high-resolution 3D lens that is magnified by 20 times.

2.1. Da Vinci Robot

Laparoscopic surgery is less invasive than traditional open surgery, less blood loss, mild pain and faster recovery for postoperative patients, so it has been rapidly popularized [3]. However, laparoscopic surgery also has its limitations. For example, the instrument does not fully conform to the ergonomic characteristics, which restricts the operation of the surgeon; the small field of view of the operation leads to a long operation time; the surgeon's attention is highly concentrated for a long time and prone to fatigue; at the same time, the learning curve is also long, which cannot completely replace traditional surgery [4].

With the help of precise positioning and navigation, doctors can complete complex surgical operations through tiny surgical incisions. This surgical method, which is characterized by small trauma, rapid recovery and excellent effect, has become more and more popular in hospital, which not only brings better treatment effect and medical experience to patients, but also injects new impetus into the development of the hospital.

Intravascular interventional surgery should be operated under continuous X-ray irradiation, and long-term radiation accumulation will cause irreversible damage to the surgeon. During the operation, the surgeon cannot directly control the end of the guide wire or catheter, so he needs to change the equipment frequently and operate repeatedly, resulting in an increase in the operation time and an increase in the possibility of vascular damage [5, 6].

When applying the intracavitary intervention robot, the surgeon can directly control the direction of the guide wire or the end of the catheter, and reach the target site accurately and quickly, shortening

the operation time and reducing the cost of surgery. And the magician will not be exposed to X-ray radiation.

2.2. Robots in Tumor Removal

In the traditional resection of head and neck tumors, the incision is often large in order to meet the needs of visual field. This not only causes serious aesthetic problems, but also has psychological impact on the postoperative patients lives. In another way, areas such as the base of the tongue are particularly difficult to operate with traditional surgical methods. Compared with traditional surgical techniques, surgical robots have the advantages of three-dimensional visualization, good hemostasis, and better operational freedom (about 360), which is expected to overcome the advantages of traditional surgery. In the year of 2011, Kayhan F. et al bring about the first surgery robot-assisted resection of adenoid cystic carcinoma of the base of the tongue which is called Da Vinci [7]. The oral approach avoids tracheotomy, skin incisions and mandibular fractures, thereby avoiding postoperative neck scarring. Therefore, in recent years, Da Vinci surgical robots have been used for the surgical treatment of tumors in the parapharyngeal space, such as pleomorphic adenomas [8], lipomas and schwannomas [9, 10]. However, due to the lack of force feedback system, it is easy to rupture the tumor envelope during surgery. Therefore, if necessary, manual blunt separation is required. Compared to traditional surgery, the robotic incision is smaller and can be hidden in the patient's hairline behind the ear. Therefore, postoperative aesthetic satisfaction was significantly higher than traditional surgery, but the average operation time was slightly longer. In the traditional resection of head and neck tumors, the incision is often large in order to meet the needs of visual field. This not only causes serious aesthetic problems, but also has psychological impact on the postoperative patients lives.On the other side , areas such as the base of the tongue are particularly difficult to operate with traditional surgical methods. Compared with traditional surgical techniques, surgical robots have the advantages of three-dimensional visualization, good hemostasis, and better operational freedom (about 360), which is expected to overcome the advantages of traditional surgery. In 2011, Kayhan F. et al. performed the first Da Vinci surgery robot-assisted resection of adenoid cystic carcinoma of the base of the tongue [11]. The oral approach avoids tracheotomy, skin incisions and mandibular fractures, thereby avoiding postoperative neck scarring. Therefore, in recent years, Da Vinci surgical robots have been used for the surgical treatment of tumors in the parapharyngeal space, such as pleomorphic adenomas, lipomas and schwannomas. However, due to the lack of force feedback system, it is easy to rupture the tumor envelope during surgery. Therefore, if necessary, manual blunt separation is required. Compared to traditional surgery, the robotic incision is smaller and can be hidden in the patient's hairline behind the ear. Therefore, postoperative aesthetic satisfaction was significantly higher than traditional surgery, but the average operation time was slightly longer.

2.3. Application of Surgical Robot in Oral Implant Field

In traditional oral implantation technology, the accuracy of implantation site and the strength of drilling are difficult to control, and the possibility of success of implantation depends on the skill and experience of doctors. Surgical robots, which have been widely used in clinical practice, have become an important direction to further improve the accuracy of oral implant surgery due to their characteristics of precision, minimally invasive, safety and efficiency.

At the year of 2017, robot system which is used in a dental implant navigation which is called Yomi [12], designed by Neocis, USA, was approved by the FDA. The system is controlled by tactile navigation technology to provide physical parameters of drill bit position, direction and depth, and can limit the direction and depth of the drill needle. The Yomi robot visualizes the surgical site and enables the doctor to change the implantation protocol in real time according to the specific situation during the operation. In 2021, Bolding S L et al. used Yomi robot to implant a total of 38 implants in 5 patients [13]. The finally consequence expresses that the Angle deviation was (2.56±1.48), the

shoulder deviation was (1.040±0.700) mm, the deviation of the root was (0.950±0.730) mm, and the deviation of the depth was (0.420±0.460) mm.

Starting in 2013, Professor Irimin Zhao's team developed a highly robotic system used in autonomous dental implant for clinical application purposes [14]. The system consists of high precision UR5 manipulator, FusionTrack 250 optical tracking system, Gamma six-axis force/moment sensor, computer and other hardware systems, and software control system based on application development framework Qt and visualization toolkit. Under the supervision of doctors, the oral implant robot can independently complete the preparation of implant holes and implant implantation according to the planned implantation plan and doctor's instructions, and the implantation accuracy is higher than that of traditional free hand implantation, guide implantation or navigation-guided implantation, ensuring the postoperative repair effect and long-term success rate of implants. Under the mixed control of visual servo and force servo, the robot end effector can carry out accurate movement and compensate the systematic error caused by the deformation of the end effector when it is forced, so that the robot can have "doctor's hand" in the planting process. The robot has a follow-up function, which can track the involuntary tremor of the mandible of patients under local anesthesia in real time, so as to make sure the accuracy of implant implantation and the patients personal safety. The team used the dental implant robot system to conduct animal experiments [15]. The tested animals were 9 3-year-old Chinese pastoral dogs, and the results showed that the overall accuracy was (0.269±0.152) mm at the neck, (0.254±0.218) mm at the root, and (0.989±0.517) at the Angle. In September 2017, three patients with missing teeth underwent autonomous oral implant robot surgery, and the immediate restoration of missing teeth was successfully completed.

2.4. Application of Da Vinci Robot in Stomatology

Nadjmi N et al. also studied the feasibility of Da Vinci surgical robot to repair cleft palate, as well as the optimal surgical posture of man-machine (patient-robot) on cadaver [15], and then used the robot in clinical practice to complete 10 cases of cleft palate repair without complications during and after surgery. Although the length of hospital stay was shorter than that of traditional surgery with 1.4 days, the operation time was 35 minutes longer on average. Nadjmi believes that oral robotic repair of cleft palates can reduce damage to blood vessels, palatal muscles, nerves and mucous membranes. After repair, the function of posterior palate and eustachian tube was improved. In addition, high-resolution three-dimensional images provide good spatial perception, improve surgical accuracy, facilitate intra-oral suture, and improve surgical safety. Compared with traditional surgery, the posture of robotic surgery is more reasonable.

3. Discussion

This paper mainly analyzes the limitations of the contributions made by robots in certain fields. In the medical field, the limitations of robotics research include the high cost of the technology, the reliance on professionals, and the uneven acceptance of patients In this paper, the contribution of robots to medicine is analyzed in combination with actual data and in this direction. The benefits are surgical accuracy, reduced recovery time and reduced human error With the continuous development of robots, more robots will be applied to the in medical research and practical applications in the future to promote the improvement of medicine. Improving human-machine collaboration can be achieved by developing more intuitive user interfaces and training medical staff to communicate effectively. The technical barrier can be lowered by simplifying operational processes and providing more training resources. Increasing patient education can increase acceptance of robotic surgery through the use of easy-to-understand materials and interactive demonstrations that educate patients about the benefits and safety of robotic surgery.

The current extent of intelligence and automation of robots used in medical science needs to be improved, and most of the medical robots at this stage are non-automated or task automation, and can not achieve complete automation. Medical robots in the new stage of development will get more

"autonomous" permissions, but all this must be based on safety. In the future, through data accumulation and machine learning, the deep integration of robots and artificial intelligence technology will further improve the level of medical treatment. Robots will make up more for the shortcomings of human abilities, provide more help to humans, and allow doctors to focus on highly intelligent judgment.

At the same time as the improvement of technology which is used in Medical Science is on the rise, we also have to think about the ethical issues that robot technology may encounter. Especially when the robot develops to the stage of high intelligence in the future, it is more necessary to pay attention to complying with ethical norms, and adhere to the positive help of intelligent technology for medicine, rather than the pursuit of replacing doctors. It is necessary to avoid conflicts that may arise in medical ethics, health law, health economics, medical sociology and other aspects of medical robots while intelligent technology is helping the development of medicine. Robots will surpass some human skills, but the creative ability will always be controlled by humans, and the future will be deep cooperation between humans and machines.

4. Conclusion

The advantages of medical robot are high surgical precision, good stability, intelligence, standardization, and remote surgery. With the continuous development of medical robots in the field of stomatology, it will certainly promote the standardization, standardization, precision and intelligent process of the entire medical industry.

Although the current research on robots in the medical field has made great progress, it is still far from perfect, and there are many shortcomings: such as the lack of adequate human-computer interaction, the level of intelligence is not enough to completely liberate clinicians, and the perception and control system of surgical instrument forces needs to be established. Although the current research on robots in the medical field has made great progress, it is still far from perfect, and there are many shortcomings: such as the lack of adequate human-computer interaction, the level of intelligence is not enough to completely liberate clinicians, and the perception and control system of surgical instrument forces needs to be established. As the result, with the development continuance and improvement of artificial intelligence technology, nanorobot technology and robot control theory, the problems whichare above showed before will be solved in the future. This means that robots will be more widely used in the medical field and will make great contributions to human health. However, with the continuance development and big improve in the artificial intelligence technology, nanorobot technology and robot control technology, the above problems will be solved in the future. This means that robots will be more widely used in the medical field and will make greater.

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