ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 05, pp.16487-16489, May, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ROLE OF ROBOT-ASSISTED SURGERY FOR MAXILLOFACIAL SURGEON

Dr. Nageshwar Iyer, Dr. Amisha , *Dr. Girish Aggarwal, Dr. Bharatdeep Garg and Dr. Karan Gera

Department of Oral and Maxillofacial Surgery, M.M. College of Dental Sciences & Research, MMU, Mullana, India

ARTICLE INFO

Article History:
Received 10th February, 2015
Received in revised form
02nd March, 2015
Accepted 19th April, 2015
Published online 31st May, 2015

Key words:

Robot-assisted surgery,
Maxillofacial,
Craniofacial,
Minimally-invasive Surgery.

ABSTRACT

Surgical robots have revolutionized a number of surgical subspecialties, including laparoscopic surgery, urology, gynecology, and orthopedics. Robots offer a number of potential improvements over unassisted human hands, such as tremor filtration, scaling of motion, enhanced dexterity in confined spaces, and extremely high precision. Several designs and prototypes have recently been introduced for use in craniofacial surgery and they have been tested in animal models. Maxillofacial surgical robots have the potential to expand our treatment armamentarium, reduce complication rates, and hold future promise to treat surgical conditions that remain incurable today. Advances in the basic scientific research within the field of computer assisted oral and maxillofacial surgery have enabled us to introduce features of these techniques into routine clinical practice. One of the most significant developments in medical technology in the past decade is the advent of Robot-assisted maxillofacial surgery. Robotic surgery has distinct advantages over conventional open surgery, and most surgical procedures can now be performed by the robots. However, the popularity and acceptance of computer assisted surgery is far from universal, mainly due to the technical difficulties in the procedure. Robot assisted surgery requires training and skill, and has a long learning curve. Robot-assisted surgery may help overcome some of these problems.

Citation: Dr. Nageshwar Iyer, Dr. Amisha , Dr. Girish Aggarwal, Dr. Bharatdeep Garg and Dr. Karan Gera. 2015. "Role of Robot-Assisted Surgery for Maxillofacial Surgeon", *International Journal of Current Research,* 7, (5), 16487-16489.

INTRODUCTION

Robot-assisted surgery (RAS) using the da Vinci surgical system (dVSS; Intuitive Surgical, Sunnyvale, CA, USA) has led to a revolution in minimally invasive urological surgery. As of 30 June 2011, there have been 1933 dVSSs sold worldwide, 1411 in the USA, 342 in Europe and 180 in the rest of the world. (Intuitive Surgical, ?) The popularity of RAS has been partly due to the three main advantages it offers over conventional laparoscopy; magnified three-dimensional (3D) vision for precise vision, Endowrist instrument technology allowing exact excision and reconstruction, and a superior ergonomic environment for the operating surgeon. With the continued expansion of robotically assisted procedures, surgery residents continue to receive more exposure to this new technology as part of their training. There are currently no guidelines or standardized training requirements for robot-assisted procedures during residency program. Traditionally, surgical treatment of cancers of the head and neck has involved various external approaches to remove the primary tumour followed by open neck dissection.

***Corresponding author: Dr. Girish Aggarwal,**
Department of oral and maxillofacial surgery, M.M. College of Dental Sciences and Research, MMU, Mullana, India.

These techniques provided the surgeon with optimal surgical view and access, and fairly satisfactory oncological outcomes. However, they resulted in considerable postoperative morbidity, functional deterioration, and disfigurement. Many surgeons have therefore investigated other options for preservation of organs with comparable oncological outcomes. The Department of Veterans Affairs laryngeal trial and the 91-11 Radiation Therapy Oncology Group trial showed comparable survival after primary chemotherapy and radiotherapy and conventional surgery and adjuvant radiotherapy with preservation of the larynx. (The Department of Veterans Affairs Laryngeal Cancer Study Group, 1991)

Surgical Robot Advantages

The stunning growth rate of robot-assisted surgery is due to the number of advantages it offers over traditional surgical techniques. Tremor filtration can reduce or eliminate an inherent human flaw. Scaling of motion allows unprecedented precision that is not possible with unassisted human hands. Dexterity in confined anatomic spaces can be enhanced, as can maneuverability without direct visualization. (Palep, 2009) Robots can protect surgeons from hazardous exposures and tele-operation of robotic systems can afford patients access to specialized procedures without necessitating travel.

(Marescaux *et al.,* 2002). In fact, all of these advantages have already been achieved. The da Vinci Surgical System (Intuitive Surgical, Sunnyvale, Calif.) is currently the most commonly utilized surgical robot). Surgeons are seated at a console (master) where they can stereoscopically visualize the operative field. Hand manipulators and foot pedals control the instruments and the endoscopic camera. Movements are translated by the computer to scale motion and to filter or eliminate tremor in real time without any detectable lag to the surgical instruments. The surgical cart, containing up to 4 robotic arms, docks to laparoscopic robotic tools and a 12 mm endoscopic camera provides a 3-dimensional view. A number of modular surgical instruments are available for a wide variety of applications. (da Vinci Surgical System, 2010) There are also other commercial robots available for specialized purposes. Examples include the Sansei X Robotic Catheter System (Hansen Medical, Mountain View, Calif.) which allows cardiac electrophysiologists to guide a catheter based robot with great dexterity and without exposure to fluoroscopy, (Saliba *et al.,* 2008) and the Robotic Arm Interactive Orthopedic System (Mako Surgical Corp, Ft. Lauderdale, Fla.), which is capable of high-precision joint replacement and resurfacing based on pre-operative CT scans. (Pearle *et al.,* 2009)

Surgical Robot Disadvantages

There are a number of drawbacks to robots in the operating room. Not surprisingly, expense is a major limiting factor. The da Vinci Surgical System carries a price tag that exceeds US$1 million. Annual maintenance and service contracts, combined with the cost of disposables, can add well over $100 000 to the annual cost of operating the device. Operating room setup time can be significantly longer with da Vinci assisted cases, over 20 minutes have been documented in some studies. (Iranmanesh *et al.,* 2010) Predominantly outpatient surgical sub-specialties, such as ophthalmology, are trending toward shorter duration procedures, faster room turnover, and overall increased efficiency. These trends may be at odds with the introduction of robotic assistance. Lastly, there exists a learning curve associated with using new surgical tools, and the complexity of surgical robots often presents a challenge both for physicians and operating room support staff alike.

Clinical application in craniofacial surgery

There are several ways to classify the use of robots in medicine. One scheme, as developed by Taylor et al. in 1997, is to classify robots by the role they play in medical applications. Taylor stresses the role of robots as tools that can work cooperatively with physicians to carry out surgical interventions, and identifies five classes of systems: (1) intern replacements, (2) telesurgical systems, (3) navigational aids, (4) precise positioning systems, and (5) precise path systems. Although this classification is technology oriented. Clinical applications are more interesting to the end-user, and a list of seven clinical areas where robotics has been applied these including: neurosurgery, orthopedic, urology, maxillofacial, radiosurgery, ophthalmology, and cardiac surgery. (Hemal *et al.,* 2004)

Maxillofacial surgery

Maxillofacial surgery is a branch of surgery that is concerned primarily with operations on the jaws, face and surrounding soft tissues. In many maxillofacial surgery cases, it is necessary to manipulate the skull bone by drilling, cutting, shaping, and repositioning operations. Accuracy is at a premium, because the shape of the bone and the aesthetic appearance of the skull and face are extremely important to patients. The current procedures are done manually using tools such as pliers, chisels, electric saws, and drills. As primarily bony structures are involved and accuracy is so important, maxillofacial surgery may be a good application area for robotics. (Hassfeld and Muhling, 2001)

Experimental operating room for developing an interactive robot system for maxillofacial surgery, an experimental operating room has been set up at the Charite´ Hospital of Humboldt University in Berlin, Germany, in 1998. This operating room includes a unique robotic system, the SurgiScope. While most robotic systems described are based on a serial kinematic structure in which the links are attached one after the other as in the human arm, at least one company has developed a medical robot based on a parallel kinematic structure. The SurgiScope is a general-purpose 6DOF robotic device consisting of a fixed base, three parallel links, and a movable end-effector. The system is designed to be fixed on the ceiling, and provides a large workspace while not cluttering the operating room floor. The parallel kinematic structure also provides a very stable structure for precision operations. The robot was originally sold by Elekta, but is now being marketed by Jojumarie Intelligente Instrumente in Berlin. The use of this system for placement of the radiation source in brachytherapy in animal studies is described by Heissler *et al.* in 1998. (Korb *et al.,* 2004)

Craniofacial osteotomy

Another system for maxillofacial surgery has been developed at the Institute of Process Control and Robotics in Karlsruhe, Germany, in cooperation with the Clinic of Craniofacial Surgery at the University of Heidelberg. Animal studies were carried out to perform osteotomies where an RX 90 surgical robot (ortoMaquet, Staubli) was used to guide a surgical cutting saw; Burghart *et al.* in 1999, in his studies were carried out as follows. Twelve titanium screws were implanted into the head of a pig to be used as landmarks. A CT scan with 1.5 mm slice spacing was done, and the resulting images were used to create a surface model for surgical planning. A haptic interface was used to trace the cutting lines on the surface of the skull. Once the planning was completed, the robot was registered with the pig in the operating room, and the surgeon manually guided the Robot Arm along the trajectory where his movements perpendicular to the cutting line were restricted. This system has also been evaluated; using sheep, for the autonomous milling of a cavity in the skull needed for customized titanium implant. (McBeth *et al.,* 2004)

Neurosurgery

Neurosurgical stereotactic applications require spatial accuracy and precision targeting to reach the anatomy of interest while minimizing collateral damage. This section presents three neurosurgical robotic systems:
(1) Minerva from the University of Lausanne in Switzerland, (2) NeuroMate from Integrated Surgical Systems in the United States, and (3) An MRI-compatible robot developed by Dohi et al. in Japan. Minerva One of the earliest robotic systems

developed for precise needle placement was the neurosurgical robot Minerva (Burckart, 1995) designed for stereotactic brain biopsy. The mechanical design of this system was presented by Glauser et al. (1993); the system consists of a five-degree-of-freedom structure with two linear axes. NeuroMate is a six-axis robot for neurosurgical applications that evolved from work done by Benabid (1987) and Lavalle´e (1996) in University Hospital in France. The images can be in digital form (DSA, CT, or MRI images) or can be digitized (radiographs, for example) using a digitizing table or scanner. MRI-Compatible Robot in Japan, in the Mechatronics Laboratory at the University of Tokyo, Dohi et al. (1995) developed an MRI-compatible needle insertion manipulator intended for use in stereotactic neurosurgery. The manipulator frame was manufactured using polyethylene terephthalate (PET), and ultrasonic motors were used for the actuators Researchers in Germany (Kaiser et al., 2000) have developed an MRI compatible robotic biopsy system, focusing on breast cancer as an initial application. (Byeona *et al.,* 2015)

Oncosurgery

The use of the robotic surgical system for treatment of cancers of the head and neck is currently upcoming in many countries, and the number of patients operated on is steadily rising over time. Initially, Robot-assisted neck dissection **(**RAND) was done through a transaxillary retroauricular approach to remove the necknodes confidently and comfortably. However, as surgeons gained in experience they realised that the operation can successfully be done through a retroauricular or modified facelift approach alone. RAND should not be used in every case in which neck dissection is indicated though, because the oncological safety could be violated in cases of nodal metastases in the neck with overt extranodal extension including encasement of the carotid artery. Its use should be limited to necks that are cN0 or cN+ with no obvious extranodal extension on preoperative examination. Likewise, Transoral robotic surgery (TORS) should not be used in patients with poor oral exposure or tumours with extensive local invasion. TORS, which is a minimally invasive technique for organ preservation with equally acceptable oncological outcomes, is now emerging as a standard of surgical care in cancers of the head and neck where it is indicated.

Conclusion

In conclusion, robotic surgery, and particularly the dVSS, have expanded surgical skills, thanks to increased surgical accuracy and precision, movements beyond the manipulation that can be achieved by the human hand, tremor reduction, 3D magnification of the operative field, motion scaling, ergonomic advantages and remote operations. Phantom, cadaver as well as clinical studies showed the increasing surgical accuracy and precision of different robotic devices. So for best results, those exposed to RAS training in their residency or fellowship must provide evidence of experience with a minimum of 20 robotic cases. However, two important principles must be followed if RAS is to be successfully practised and taught [12]. First, care must be provided in the context of a close-knit surgical team. Second, there is no substitute for practice.

The use of a surgical robot and its overall role in health care in the current era of cost containment are controversial. What is clear is that the robot has made its way into many hospitals across the United States and around the world. We cannot turn back the clock on robotic surgery. The application of a surgical robot to procedures is here to stay. Robotic assistance for maxillofacial surgery has the potential to expand our treatment armamentarium, reduce complication rates, and treat conditions that remain incurable today.

REFERENCES

Byeona, H. K., Holsingerb, F. C., Kima, D. H., Kimc, J. W., Parkd, J. H. and Koha, Y. W. 2015. Feasibility of robot-assisted neck dissection followed by transoral robotic surgery. *Br. J. Oral. Maxillofac. Surg.,* Jan; 53(1):68-73.

da Vinci Surgical System. Intuitive Surgical, Sunnyvale, Calif. www.davincisurgery.com. Accessed October 1, 2010.

Hassfeld, S. and Muhling, J. 2001. Computer assisted oral and maxillofacial surgery – a review and an assessment of technology. *Int. J. Oral Maxillofac. Surg.,* 30, 2–13.

Hemal, A. K. and Menon, M. 2004. Robotics in urology. *Curr. Opin. Urol.,* 14, 89–93.

Intuitive Surgical. How many units have we sold? http://investor. intuitivesurgical.com/phoenix.zhtml?c=122359&p.=irol-faq #22324; 2011 [last accessed 18.09.11].

Iranmanesh, P., Morel, P., Wagner, O. J., Inan, I., Pugin, F. and Hagen, M. E. 2010. Set-up and docking of the da Vinci surgical system: prospective analysis of initial experience. *Int. J. Med. Robot,* 6:57–60.

Korb, W., Marmulla, R., Raczkowsky, J., Muhling, J. and Hassfeld, S. 2004. Robots in the operating theatre – chances and challenges. *Int. J. Oral Maxillofac. Surg.,* 33, 721–732.

Marescaux, J., Leroy, J., Rubino, F., Smith, M., Vix, M., Simone, M. and Mutter, D. 2002. Transcontinental robot-assisted remote telesurgery: feasibility and potential applications. *Ann. Surg.,* 235:487–92.

McBeth, P. B., Louw, D. F., Rizun, P. R. and Sutherland, G.R. 2004. Robotics in neurosurgery. *Am. J. Surg.,* 188, 68S–75S.

Palep, J. H. 2009. Robotic assisted minimally invasive surgery. *J. Minim. Access Surg.,* 5:1–7.

Pearle, A.D., Kendoff, D., Stueber, V., Musahl, V. and Repicci, J. A. 2009. Perioperative management of unicompartmental knee arthroplasty using the MAKO robotic arm system (MAKOplasty). *Am. J. Orthop.,* 38:16–9.

Saliba, W., Reddy, V.Y., Wazni, O., *et al.* 2008. Atrial fibrillation ablation using a robotic catheter remote control system: initial human experience and long-term follow-up results. *J. Am. Coll. Cardiol.,* 51:2407–11.

The Department of Veterans Affairs Laryngeal Cancer Study Group. Induction chemotherapy plus radiation compared with surgery plusradiation in patients with advanced laryngeal cancer. *N. Engl. J. Med.,*1991; 324:1685–90.

****