Technology Introduction: Robots in Urosurgery.

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Technology seems to be integral part of modern living and we live in exciting times and pace of change in medical and surgical technology has never been more rapid. As we embrace new technology and incorporate it into practice, traditional approaches will metamorphose into seemingly strange but incredibly useful paradigms. One such extraordinary transformation has been the incorporation of robot into the surgical practice, especially in urology. Urologists have over the years embraced new technological advances for patient benefit. On some occasions, however, the initial enthusiasm in something new has failed to endure rigorous scientific scrutiny.

The word 'robot' is derived from Czechoslovakian term robota, meaning force work. The word 'robot' was originally coined by Karel Capel in his play, Rossum's universal robots in 1921[1].

The first truly robotic flexible arm, known as the programmable universal Manipulation Arm (PUMA), was developed in 1978, by Victor Scheinman and quickly became the industry standard. The first surgical application of this technology was in 1985 when the PUMA 560 was used to orientate a needle for a radiologically guided brain biopsy[2]. Soon after robots were utilized in other surgeries including PROBOT, to perform trans urethral resection of prostate and the ROBODOC, for use in hip replacement[3-6].

The contemporary generation of surgical robot consists of "master-slave" system made by Intuitive Surgical Inc. (Sunnyval,CA).

The da Vinci is an advanced master-slave robotic system which involves control of three to four robotic arms by a surgeon sitting at a remote console. The basic component of the system is (a) a surgeon console (b) a surgical robot with three or four arms (c) an endoscopic stack. The console contains the master tool manipulators, the visual supply and foot pedals for camera and tool manipulation. The surgeon's hands are inserted in the free moving finger controls (masters). These controls convert the movements of the surgeons' finger tips and wrist into electrical signals. These signals are translated to computer commands that direct robot to replicate the movements with the robotic instruments in the operative field. The console is connected to the video and the surgical component of the robot via cables. The patient side surgical robot has an arm to control the camera and two or three arms to hold the operating instruments. These instruments are articulated at the wrist and have seven degrees of freedom and two degrees of axial rotation. The master-slave robotic system overcomes many of the limitations of the conventional laparoscopy. It provides the surgeons with 3D 10x magnified vision, wristed instrumentation, tremor filtration, and motion scaling. The system produces an immersive telerobotic environment ideally suited for surgical precision and reconstructive applications. To mention a few major robotic urosurgical undertakings are Robotic Assisted Radical Prostatectomy, Robotic assisted radical cystectomy, Robotic Pyeloplasty, Robotic Assisted Laparoscopic Partial Nephrectomy, and Robotic Sacral Colpopexy.

While in 1998, clinical robotic was introduced to the world of adult surgery[7], pediatric surgeons of Europe and USA introduced robotic in the field of pediatric surgery mainly in fundoplication and pyeloplasty[8-10]. since then increasing number of surgeons have reported the success of new techniques in growing range of pediatric surgical subspecialties, namely cervical and trans oral, thoracic, cardiovascular, gastrointestinal and urological.

There are many systems with enormous clinical potential in the pipeline that are likely to be further refined and developed in the coming years before being released into the clinical arena.

Urologists have been quick to embrace robotic surgery and other new technologies and Robotic Assisted Radical Prostatectomy (RALRP) is easily the most common of robotic procedures performed worldwide.

Direction of Robotic Surgery

The da Vinci S ™ is far lighter than the standard da Vinci system, but it remains a bulky piece of equipment that is difficult to maneuver and store in many standard operating theaters. Groups are looking at reducing these issues by installing ceiling mounted robotic devices.

Nanotechnology or nano tech is the emerging technology in every field and the robots are not exempt.

Nano robots are expected to permit significant new

capabilities for the diagnosis and treatment of diseases, for patient monitoring, and for minimally invasive surgeries.

Recent studies have revealed that the lack of tactile sensation during robot aided surgery can lead to an increase in tissue trauma and misjudgment leading to incomplete surgical resection Therefore a number of research institutes aim at equipping surgical robots with sensors and feedback mechanisms to reestablish the surgeons with tactile perception and feed back[11-12].

The ability to accurately place a needle into the target area of deep seated organs for various medical purposes like percutaneous nephrolitotomy,radioactive seed placement in prostate brachytherapy, cryotherapy and radiofrequency ablation have been highly facilitated by robotic assistance. Percutaneous access to the kidney robot (PAXY) was used first at John Hopkins University for PCNL patients[13].

Future of Robotic Surgery

The da Vinci robotics is highly unlikely to represent the ultimate robotic surgical system as a result of the stepwise progression of robotic developments. The devices are expected to be smaller, lighter, and integrated into tele surgical system.

The future robotic developments include the snake like or serpentine robots, which are now being targeted toward the field of natural orifice surgery, NOTES ™ (Natural orifice trans luminal endoscopic surgery), and these robots have multiple degrees of freedom[14] such devices include Cardio ARM, Laparo ARM, Gastro ARM, and Arthro ARM which will provide various platforms for various single port endoscopic and laparoscopic procedures. These devices open door for incision or external woundless/ scar less surgery and procedures including cholecystectomies, appendicectomies, tubal ligations etc.

The field of surgical robotics continues to move in rapid pace and many of these concepts that we find difficult to grasp at present will rapidly become standard surgical practice throughout the globe.

REFERENCES:

1. Capek K. Rossum's universal srobots [Playfair N, selver p, trans. Landes WA, ed. New York: Doubleday; 1923.

2. Kwoh YS, Hou J, Jonckheere EA, Hayati S. A robot with improved absolute positioning accuracy for CT guided stereotactic brain surgery. IEEE Trans Biomed Eng. 1988;35:153-60.

3. Davies B. A review of robotics in surgery. Proc Inst Mech Eng. 2000;214:129-40.

4. Davies BL, Hibbered RD, Coptcoat MJ, Wickman JEA. A surgeon robot prostatectomy - a laboratory evaluation. J Med Eng Technol. 1989 ;13:273-7.

5. Bann S, Khan M, Hernandez j, et al Robotics in Surgery. J Am Coll Surg. 2003;196:784 -95.

6. Bauer A, Borner M, Lahmer A. Clinical experience with a medical robotic system for total hip replacement In: Nolte LP, Ganz R, eds. Computer Assisted Orthopedic Surgery. Bern, Switzerland: Hogrefe & Huber; 1999:12– 133.

7. Cadierre GB, Himpens J. Feasibility of robotic laparoscopic surgery: 146 cases. World J Surg. 2001;25:1467 – 77.

8. Heller K. Gutt CN, Schaeff B, et al. Use of the robot sustem da Vinci for laparoscopic repair of gastro-iesophageal reflus in children. Eur J Pediatr Surg. 2002;12:239- 42.

9. Olsen LH, Jorgeusen TM. Robotic vs standard retroperitonescopic pyeloplasty in children. BJU Int. 2003;91:73.

10. Lee RS, Retik AB, Borer JG, Peters CA. Paediatric robot assisted laparoscopic dismembered pyeloplasty: comparison with a cohort of open surgery. J Urol. 2006;175:683-7.

11. Wagner C, Stylopoulos N, Howe R. The role of force feedback in surgery: analysis of blunt dissection. In: Proceedings of the IEEE 10th Symposium on Haptic Interfaces for Virtual Environmental & Teleoperator system; 2002.

12. Deml B, Ortmaier T, Seibold U. The touch, and feel in minimally invasive surgery. In: IEEE International Workshop on Haptic Audio Visual Environment, and Their Applications, Ottawa, ON; 2005:33-8.

13. Challacombe B, Patriciu A, Glass J, et al A randomized controlled trial of human versus robotic and telerobotic access to the kidney as the first step in percutaneous nephrolithotomy. Comput Aided Surg. 2005;10(3):165-71.

14. Hochberger J, Lamade W. Transgastric surgery in the abdomen: the dawn of a new era? Gastrointest Endosc. 2005;62(2):293-6.