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Robotics and Ophthalmology

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Abstract

Robotic System is in initial stage of emergence in ophthalmology. But due to rapidly expanding technologies it will soon become an essential part of procedures especially vitero-retinal surgeries in near future. Smart surgical tools and steady hands are mainstay of this system. It not only reduces hospital stay but also cuts the cost and improves prognosis.

Introduction

Word 'ROBOT' was introduced by Czech writer Karel Capek in his play Rossum's Universal Robots [1,2]. published in 1920. Word Robot stands for Labour. Emerging application of Robotics in medicine and surgery is on peak in recent times. From last 20 years this system is being utilised in super specialities like urology, gastroenterology, gynaecology but use of robotics in ophthalmology is still at infant stage. New generation doctors need to be trained well in this budding field of robotics. Robots can be of various kinds like Surgical robots, Rehabilitation robots, Biorobots, Telepresence robots, pharmacy automation, companion robot, disinfection robot. Robots are mainly tele manipulators. Surgeon's activators are present on end to control the "effector" on the other end [3,4].

History of Robotics in Medicine

Probot was the first surgical robot developed by Mechatronics in Medicine Laboratory at Imperial College London, United Kingdom in 1980. In April 1991 first time a robot was used for transurethral resection in patient. This was followed by emergence of various other Robotic systems like Zeus (Computer Motion), the da Vinci (Intuitive Surgical Inc.) systems [4]. Down the lane Computer Motion was discontinued and the da Vinci became the most widely used robotic surgical system. The special needs of intraocular surgery have led to customization of robotic platforms in Ophthalmology.

Use of Robotics in Ophthalmology *vs.* Other Surgical Branches

Advantages of Robotics surgical system include minimal invasion, 3-D view with greater magnification, motion scaling to improve accuracy, reduced tremors, superior instrument articulation and maneuverability, technical precision [6]. These properties are of greater advantage in laparoscopic abdominal surgeries, cardiac valve replacement procedure where critical surgical sites are accessed without much collateral damage. Robotic tele surgical machines have already been used to perform transcontinental cholecystectomy [7,8]. This has led to popularity of Robotics in surgical branches other than ophthalmology [9]. Due to direct, non-invasive visualization of surgical site *via* transparent cornea, microsurgical techniques and minimally invasive instruments, the Robotics do not provide any relevant advantage to ophthalmic surgeon. Although number of procedures using robotic have grown exponentially in past 15 years but progress of robotics in ophthalmology is surprisingly low since ocular surgery is already minimally invasive microsurgery yielding excellent results. However, the ability of manipulating three surgical instruments at a time along with the cameras provides distinct advantage for Eye surgery. Due to its short learning curve, telemedicine can be provided in subspecialties like Ophthalmology in remote areas as well as developing and underdeveloped nations. International groups like the Robotic Assisted Microsurgical and Endoscopic Society (RAMES) have been organising basic skills training courses since 2009 to help surgeons develop and improve robotic surgery skills. However, Robotic tele manipulators are lacking tactile feedback. But in eye surgery visual feedback can be used to countercheck suture tightness and manipulation. Also, the placement of sutures is much slower than with standard ophthalmic microsurgical instruments leading to longer surgical times. However technical innovations are needed to improve visualization of the surgical field which are worse than normal operating ophthalmic microscope.

Discussion

Robotics in Ophthalmology

Various challenges in robotics surgical system have limited this technology's applicability in ophthalmology. A microsurgical robotic system for intraocular use must satisfy few requirements like ease of manoeuvrability within a defined workspace, capability to exhibit motion of seven degrees of freedom, must have Remote Centre of Motion (RCM), or pivot joint which must be located at entry wound, stereoscopic view, efficient separation of sterile instrumentation from the unsterile, and compatibility with the surgical environment. The da Vinci surgical robot has been tried for various surgeries in porcine and cadaver eyes. Robotics has been tried for corneal perforation repair, capsulorhexis, corneal transplantation, petrygium surgery. It has also been tried for pars plana vitrectomy and intraocular foreign body removal. The da Vinci system include a console for the surgeon to control, an imaging cart and four arms attached to a mobile instrument cart. Three articulated arms of instrument cart carry surgical instruments while fourth manipulate the digital stereoscopic camera to visualize the surgical field. The multiple joints of the instruments provide a full 360 degree of intracorporeal movement called "EndoWrist" technology. Tools include scissors, dissecting forceps, scalpel, spreaders and few more. Three-dimensional view magnified up to 12 times to 15 times is provided by the fourth arm of the robot which has stereoscopic camera with two light sources. Four articulate of the robotic arms can be manipulated by two telemanipulation handles. Stereo viewer is the optical system present in surgeon's console which provide the three-dimensional view of operating field. Newer version of this system has two surgeon consoles for simultaneous use with two operators. Thus, both surgeons can use the three robotic arms. Limitations of this system include high RCM which makes intraocular movements less controllable and intra-operative visualization. These motions are different from movement of surgeon's arms with restricted range of motion. Thus, procedures like capsulorhexis are difficult to perform. Secondly video capture system does not yield details of a sophisticated optical microscope. This results in longer surgical time compared to manual surgery. Newer modifications like Si HD model are developed to solely for purpose of intraocular surgery where RCM is located near entry wound. Also, Human hand is mimicked by micro hand of Robot. Surgeon's accuracy increased by 5 times to 10 times with robotic assistance. However, no system has been capable of performing a complete ocular surgical procedure, including both anterior and posterior intraocular surgeries. IRISS (Intraocular Robotic Interventional and Surgical System), A joint effort of Jules Stein Eye Institute and UCLA department of Mechanical and Aerospace Engineering, is designed to perform both anterior and posterior segment intraocular surgery. It can be used for continuous curvilinear capsulorhexis; infusion-aspiration of cortex, core vitrectomy, induction of PVD along with micro cannulation of a temporal retinal vein. Compared to da Vinci, IRISS has increased range of motion, dexterity and accuracy. However, with the IRISS, the surgical manipulator RCM needs to be manually aligned to the incision made in the porcine eye which takes lot of time and energy to overcome movements between eye and manipulator. Clinical application of IRISS is restricted as patient is not under general anaesthesia and slightest head movement can cause severe damage. The use of Femtosecond (FS) laser a in cataract and refractive surgery is also considered to be a type of robotic system. Nagy et al first reported use of FS lasers for cataract surgery in 2009. The LenSx (Alcon, California, USA) was approved by FDA in September 2009 for anterior capsulotomies in cataract surgeries. Thereafter it also got approved for creation of corneal incisions and fragmentation of cataracts. FS laser systems got FDA clearance for cataract surgery in 2010. The currently available machines for cataract surgery are LenSx, LenSar (Lensar, Inc., FL, USA), Optimedica (Abbott Medical Optics Inc., CA, USA) FS laser can be used to perform four groups of incisions: capsulotomy, lens fragmentation, astigmatic relaxing incisions, and clear corneal incisions. As laser cataract and refractive surgery has dramatically evolved towards becoming a nearly automated process, requiring minimal intra-operative manipulation by the surgeon, future adaptations may contribute to the inevitable shift towards automation of other anterior segment procedures. This can be achieved by combining robotic platforms with a FS laser device. In addition, assimilation of robotic platforms like the IRISS with intraoperative visual recognition technology, OCT, and laser technology could help facilitate creation of a 'no-fly zone', whereby certain vital intraocular structures (for example, the posterior capsule) can be delineated and restricted from instrumentation. Robotics may be advantage in surgeries like vitreoretinal by providing surgeon dexterity, improving accuracy, decreasing complications by eliminating tremors especially in dealing with delicate fine detail manipulations.

Conclusion

Robotic systems in ophthalmology are still in its infant stages. Although there is immense scope of research, technological development. Various unique challenges include steep learning curve for new surgeons, high cost, and trust of patient. However, its precision, accuracy, complete automation are positive attractive properties of this technology. Robotic Eye surgery is going to become a norm very soon.

References

1. Capek K. R.U.R. (Rossum's Universal Robots): A play in introductory scene and three acts-translated into English by David Wyllie [e-book]. South Australia: eBooks@Adelaide; 2014 [cited 2015 Oct 10].
2. Felger JE, Nifong L, Chitwood WR. The evolution of and early experience with robot assisted mitral valve surgery. Surg Laparosc Endosc Percutan Tech. 2002;12(1):58-63.
3. Beasley RA. Medical Robots: Current Systems and Research Directions. Journal of Robotics. 2012.
4. Achim Schweikard, Floris Ernst. Medical Robotics. Springer Science Business Media. 2015;22891-4.
5. Arezzo A, Ulmer F, Weiss O, Schurr MO, Hamad M, Buess GF. Experimental trial on solo surgery for minimally invasive therapy. Surg Endosc. 2000;14(10):955-9.
6. Douglas R. Robotic surgery in ophthalmology: reality or fantasy? Br J Ophthalmol. 2007;91(1):1.
7. Marescaux J, Leroy J, Rubino F, Smith M, Vix M, Simone M, et al. Transcontinental robot-assisted remote telesurgery: feasibility and potential applications. Ann Surg. 2002;235(4):487-92.
8. Cheah WK, Lee B, Lenzi JE, Goh PM. Telesurgical laparoscopic cholecystectomy between two countries. Surg Endosc. 2000;14(11):1085.
9. Kim VB, Chapman WH, Albrecht RJ, Bailey BM, Young JA, Nifong LW, et al. Early experience with telemanipulative robot-assisted laparoscopic cholecystectomy using Da Vinci. Surg Laparosc Endosc Percutan Tech. 2002;12(1):33-40.