The Use of Robot in Urology

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Minimally invasive surgery by laparoscopic means expanded tremendously in 1990s. Laparoscopic surgery is performed with similar surgical techniques as in open surgery but through small cut wounds. The obvious advantages of less wound pain, short hospital stay, short convalescent period, small external scars and similar surgical results to open surgery, make many types of laparoscopic surgery the new standard of treatment. Most of the nephrectomies were quickly taken over by laparoscopic means in 1990s. The laparoscopic urological surgery was then extended from destructive surgery to surgery that required some reconstructive procedures like pyeloplasty and partial nephrectomy. Problems arose when laparoscopic surgery was used to perform radical prostatectomy which required fine dissection and complex reconstruction. Schuessler1 from USA commented in 1997 that laparoscopic radical prostatectomy had no advantages as compared to open surgery because of the difficulties and long hours of operation. On the other side of the Atlantic Ocean, Vallancien2 in 1999 and Abbou3 in 2000, both from France, reported that laparoscopic radical prostatectomy was feasible. However, in order to achieve similar results to open surgery, experience in operating 150 laparoscopic radical prostatectomy was required. Even with skilled laparoscopic techniques, experience in operating 40 to 80 laparoscopic radical prostatectomy was required, a number that is difficult to be achieved by most urology centres in Asia because of the low incidence of prostate cancer.

The dexterous human hands have six degrees of freedom and can be fully utilised in open surgery. Long and small instruments are used in laparoscopic surgery. The instruments are confined by small cut wounds and allow only four degrees of freedom. The long and small instruments also have chopstick and fulcrum effects which further decrease the dexterity. The surgeons have to operate with a 2-dimensional image from the monitor. The surgeons have also to perform the laparoscopic radical prostatectomy with twisted postures which bring fatigue and tiredness. All these drawbacks make many of the experienced American urologists with skilled open surgical techniques finding laparoscopic radical prostatectomy very difficult to learn. The da Vinci Surgical System, a surgical robot, allows the direct transfer of open surgical techniques to perform radical prostatectomy through small cut wounds. Many of the American urologists have been using robots in performing radical prostatectomy. Comments have been made that in the foreseeable future, all complex laparoscopic surgery will be performed by robots.

The prototype of the da Vinci Surgical System was developed by the Stanford Research Institute in 1980's and was funded by the US Army who planned to develop a robotic system to perform battlefield surgery remotely by surgeons in the safe rear. The da Vinci Surgical System was first used in human surgery in 1997 in Europe. FDA approved the use of the da Vinci Surgical System in 2000. The first robotic radical prostatectomy was performed in Europe in 2000. By the end of 2006, 559 da Vinci Surgical Systems have been installed worldwide, mostly in America. Over 70,000 robotic surgeries have been performed in 2006. Less than 1% of the radical prostatectomy was performed by robots in 2001 in America. In 2006, it rose to over 40% that meant over 30,000 robotic radical prostatectomies. The da Vinci Surgical System was initially designed for coronary arterial bypass surgery through small cut wounds. American Urologists quickly used the robots to perform radical prostatectomy.

The da Vinci Surgical System consists of a surgeon console, a patient cart with three or four robotic arms, and a vision cart. The surgical robot belongs to the master and slave system. The surgeon directly initiates all movements of the robotic instruments in real time. The laparoscope of the da Vinci Surgical System has a two lens system which produces a high definition and 3-dimensional binocular vision. The image can be magnified ten to fifteen times. The endowrist instruments have two joints at the distal 2cm tip and produce two more degrees of freedom. The dexterity of the human hands has returned in operating with endowrist instruments. The robot can filter off hand tremors and scale down the movements five times. The special features translate into improved dexterity, better control and precision in operating movements. The surgeon can also sit comfortably at the console to operate on the patient through the patient cart a few feet away. Menon from America claimed himself as untrainable in...
laparoscopic radical prostatectomy. He has performed over 3,000 robotic radical prostatectomy and commented that surgeons with minimal laparoscopic experience could directly transfer the open surgical techniques to perform laparoscopic radical prostatectomy with the help of the robot. After operating 20 robotic radical prostatectomy, the surgical results would be similar to those of open radical prostatectomy. Ahlering from America even commented that surgeons with experience in open surgery, robotic radical prostatectomy has the advantages of shorter hospital stay, shorter convalescent period, less blood loss, shorter urethral catheterisation time. Menon and others also claimed that robotic radical prostatectomy had a better cancer control, faster return of urinary continence and erectile function.

The da Vinci Surgical System is an expensive equipment and has costly consumables. It is mainly used for complex laparoscopic surgery on a cost-effectiveness basis. The robot was first installed in a public hospital in Hong Kong in November 2005. In the first year, the urology team used the robot to perform 17 radical prostatectomy, 3 radical cystectomy, 3 partial nephrectomy, 2 ureterocalycostomy, 1 pyeloplasty, and 1 ureteroureterostomy. In performing radical prostatectomy, the robot has advantages in dissecting and preserving the neurovascular bundles from the prostate, in dissecting and dividing the urethra from the apex of the prostate, in joining the bladder to the urethra with a water-tight anastomosis. After performing a radical cystectomy on a female patient, an intracorporeal ileal conduit was done. The operation required anastomosing of the small bowel and anastomosing of the ureters to the small bowel. Without the robot, it would be extremely difficult for me to perform such operation with conventional laparoscopic instruments. The da Vinci S Surgical System, an upgrade model, was installed in a private hospital in Hong Kong in March 2007. In the first month, 11 robotic urological surgeries, 9 radical prostatectomy, 1 pyeloplasty, 1 partial nephrectomy, have been done. The upgrade model has the advantages of faster setup, more rapid exchange of instruments and wider infra-abdominal access.

Most of the robots have been used in urological surgery. The robots can also be used in many complex laparoscopic surgery in other surgical specialties. The company manufacturing the robots targeted at prostatectomy, hysterectomy, cardiac surgery and gastric surgery. Many Asian centres have installed or are going to install the robots for clinical use, including two centres in Mainland China. A revolution has already been started and robotic surgery will soon become the new standard for complex laparoscopic surgery.

References