History of Robotic Surgery and Current Applications of Robotics

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The revolutionary industrialisation took place after the end of II world war and the major turn-around was introduction of Robotics in engineering. However, it took another half century for medics to identify and explore its usage in the field of surgery.

Dr Cloud Abbou, a French urologist performed the first ever Robotic Prostatectomy. Dr Mani Menon, another urologist from Detroit pioneered and popularized this technique.

'Robota ' is a Czech word which means "forced labour" coined by a playwright, Capek.

Asimov's three laws-

1. 1. A robot may not injure a human being, or through inaction, allow a human being to come to harm (Zeroth Law).

2. 2. A robot must obey the orders given to it by human beings except where such orders would conflict with the First Law.

3. 3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Though Leonardo DaVinci has been credited in conceptualising and fine printing the first ever scientific sketch, the idea of having a mechanical labourer was thought well before that by Chinese and Indians.

Worldwide to-date, over 5000 daVinci systems have been installed and the total number of robot-assisted procedures performed worldwide are approaching over 2 million.

Current Scenario and Clinical Applications
Advantages of surgical robots-

- Superior visualisation including 3-dimensional imaging of the operative field
- Stabilisation of instruments within the surgical field
- Mechanical advantages over traditional laparoscopy
- Improved ergonomics for the operating surgeon

Across multiple surgical specialties, robotic surgery was felt to offer the greatest advantage in complex reconstructive and oncological processes.

The potential advantages of robotic surgery extend across many different surgical subspecialties.

Urology: While the most mature outcomes data in the field of robotics are for radical prostatectomy, robotics may also offer advantages for cystectomy, pyeloplasty, nephrectomy (partial, complete and donor) and ureteral reimplantation. Robotic surgery may ultimately replace open surgery for some complex urological procedures.

Gynecology: Robotic surgery has shown promise in hysterectomy for both benign and malignant disease, as well as myomectomy. In myomectomy, the robot may provide substantial benefit by allowing minimally invasive fertility sparing options. It is also beneficial for tubal reconstruction. The robot may provide potential advantages for pelvic reconstructive surgery.

General Surgery: Procedures where it may be of particular value include Heller myotomy, paraesophageal hernia repair, gastric bypass, gastric resection for neoplasm, biliary reconstructive surgery, transhiatal esophagectomy, transthoracic esophageal surgery, distal pancreatectomy with splenic preservation, and selected colorectal procedures.

Thoracic Surgery: Robotic surgery offers clear benefits in the resection of solid thoracic tumors, particularly those located in the apex of the chest. Benign or malignant esophageal tumors may also be resected robotically. Other surgeries which could be benefited in reducing the morbidity by using the daVinci system are thymectomy, LIMA/ RIMA retrieval, MVR etc.

Otorhinolaryngology/Head and Neck Surgery: Preliminary data of transoral robotic surgery indicate its utility for resections of benign and malignant lesions of the pharynx and larynx. Oncologic resections of the supraglottis, tonsil and tongue base have been shown to be feasible with potential advantages compared to traditional approaches. Preliminary evidence indicates that these advantages may include avoidance of mandibulotomy, avoidance of tracheostomy, decreased operative time, reduced requirements for complex reconstructions, and avoidance of external excisions. Transaxillary thyroidectomy has been proven to be an effective method in patients who remain conscious of having a neck scar.

Pediatric Surgery: Over 50 different types of abdominal and thoracic procedures have been performed in pediatric patients.

Leonardo da Vinci and Dissection

Overall benefits to patients-

1. Minimal scarring
2. Less pain, requiring less analgesia
3. Less wound related issues
4. Less hospitalisation
5. Less blood loss
6. Early ambulation and return to work

Benefits to Surgeons-

1. **Improved 3D vision-**
2. Magnified view- 10x HD magnified view
3. Superior **manoeuvrability** of instruments with "Endowrist"
4. **Ergonomically** far superior than standard laparoscopy
5. Excellent **educational tool-** Dual console allows the main surgeon to control the robotic arms of training console.
6. **Tile-pro imaging-** allows the surgeon to simultaneously visualise real time intraoperative USG whilst operating.
7. **Firefly technology-** Allows to identify vascularity or vascular territory of the feeding vessel. A built in infrared camera allows the tissue to discriminate the vascular territory after injecting ICG dye.
8. **Bipolar diathermy-** built in.
9. **Airseal technology-** keeps the intra-abdominal pressure maintained throughout the surgery without impacting vision due to cautery smoke or risk of losing the pneumoperitoneum with constant suction.

Airseal technology, especially during Covid time has been a boon to facilitate concealing potentially trapped Coronavirus contaminated plume and its safe discard through a dedicated suction system.

Future developments-

Haptics in Robotics- Ability to get the feel of the tissue

Virtual reality Vs Augmented reality- Such technology is already been used outside clinical trials.

Remote (Tele) surgery- inter-continental surgery has taken place, but due to potential medico-legal issues and some lag in instrument movement it has not gained acceptance.

Single Port Surgery- The new daVinci SP system has been launched recently.

Surgical assist- will enable the surgeon to get a roadmap and didactic guidance of surgery as he/she continues to operate

Fusion imaging- Superimposing the radiological images (CT/ MRI) with real time operative view.

Micro-bots- The crude example is "capsule endoscopy". Once we achieve technology to navigate such miniature/micro capsules to enter the body system, it would open another dimension to diagnose and treat several medical conditions.

The "Productivity Paradox" holds true - it takes on average 20 years for an innovation to reap its productivity benefits. First robotic surgery was performed in year 2000 and robotic surgery; in the last 20 years it has managed to establish its place in the field of surgery. It has been predicted that by year 2050, 90% of surgeries will be using a robot in some or other way either to diagnose or treat the ailments.

It is high time we embrace these technological advancements which complement medical field. ❑

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