Future & New Developments in Robotic Surgery

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“The only thing that is permanent, is change”

1930, Dr. Mayo
History of
Urological Surgery

Open surgery
History of Surgery

3. Robotic surgery

“Modern Times”, Charlie Chaplin, 1932
Robot-assisted Surgery

Definition

= Computer-steered Master-Slave Telemanipulator, that can perform one single task under direct control of the operator. It allows manipulation of the instruments in the operation field.
Answer:
This device offers us the possibility of doing laparoscopy in a natural “intuitive” way, with 3D vision & with instruments that are movable at their tips, allowing very precise handling.
3-D HD for everybody
Evolution of MIS Technology

1910-1999

Traditional Laparoscopy

1999

da Vinci®

• Eliminates lap compromises
• Introduction of 4th arm (2003)
• Simple instruments

2006

da Vinci® S™

• 3D HD Vision (720p)
• Visual Inputs – TilePro
• Multi-quadrant access
• Streamlined set-up
• Procedure-specific and energy instruments

2009

da Vinci® Si™

• Dual Console option
• Enhanced HD Vision (1080i)
• Scalable architecture
• Advanced instruments
• OR Integration
Robotic Surgery

1999: da Vinci standard system

3 arms
Robotic Surgery
2009: da Vinci Si system
4 arms
Robotic Surgery
2014: da Vinci Xi system

- erus
- ORSI

Olav Vattikuti Robotic Surgery Institute
Indications for robot-assisted surgery in Urology
Robot-assisted Surgery

Indications

- all procedures
- especially in **reconstructive surgery & meticulous exeresis**:
  - radical prostatectomy:
    - nerve-sparing
    - anastomosis
  - partial nephrectomy
  - nephr(oureter)ectomy
  - Pyeloplasty
  - ureterreimplantation
  - Colpopromontofixation
  - cystectomy & urinary diversion
  - vaso-vasostomy
  - ...

- ...
Major indication: 

*radical prostatectomy*

Surgery is in constant motion
Looking for perfection to reach the “**TRIFECTA**”

1. **Cure** the patient from his cancer
2. Obtaining early **continence**
3. Preserving **erectile function**
Thanks to robotic surgery, more insights in microanatomy
Surgical anatomy of the prostate
Robotic Prostatectomy
New Developments in Robotic Surgery
1. Tissue recognition
2. Augmented reality
3. Miniaturisation
Image guided surgery
Tilepro
Image guided surgery
Tilepro
Fluorescence Imaging on da Vinci

New camera head can pass fluorescence signal

Laser Excites IndoCyanine-Green and Fluoresces

Fluorescing signal overlaid with green hue in surgeon console

Renal arteries - fluorescence mode (NIR)
Clinical Background: indocyanine green

- ICG binds to plasma proteins in blood after iv injection
- ICG is excited at \( \sim 806 \text{ nm} \) and emits light at 830 nm
  - ideally suited for penetrating tissue, blood, and fat
- Fast uptake allows for multiple injections (2-5 min half life)

<table>
<thead>
<tr>
<th>IV injection</th>
<th>Blood Vessels (artery then vein)</th>
<th>Kidney</th>
<th>Liver Bile (ducts to duodenum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>See within:</td>
<td>5-50 seconds</td>
<td>&lt; 1 min</td>
<td>&lt; 2 min</td>
</tr>
<tr>
<td>Time lasts:</td>
<td>seconds</td>
<td>~20 mins</td>
<td>1-2 hours</td>
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<td>1-2 hours</td>
<td>1-2 hours</td>
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</tbody>
</table>
Fluorescence in Robotic Surgery

- **Kidney:**
  - Selective clamping
  - Effective clamping
  - Check vascularisation after partial

- **Bowel:**
  - proper vascularisation
  - Lymphnodes

- **Gallbladder:**
  - Choledochography.
Robotic Surgery
Fluorescence

Multiple Branches Renal Artery
Upper tract Endoscopy

Console based robotic device

- Avicenna Robot (ELMED, Turkey)

Console with fine movements (joy-stick, wheel) and footpedal for laser (N=28 cases)

Dusting the stone
Advanced Single Port or NOTES

Single Port

- Natural orifice / trans-umbilical
- *da Vinci*-like capability
- Large range of motion (multi-quadrant capability)

Flexible Systems
Robotic Surgery
2015?: da Vinci SP system
(Surgical Snake)
Researchers from Singapore have developed a small robot designed to remove stomach cancer in its early stages. The mini robot resembles a crab, because it incorporates a pincer and a hook to do the job. The robot is mounted on an endoscope which reaches the stomach via the patient’s mouth. Next to its size, another advantage of the robot is that it doesn’t leave an external scar. The crab-like robot has a pincer to grab the tissue to be removed, and the hook can cut the tissue and cauterize it to stop the bleeding. The operating surgeon can see what’s happening through the little camera in the endoscope and control the robot’s movements. These movements are very precise and accurate compared to movements made directly with human hands. The robot has already been used to remove early-stage stomach cancer in as many as five patients in India and Hong Kong.
Japan’s Ritsumeikan University researchers unveil a prototype model of the micro medical robot, measuring \textbf{1cm in diameter, 2cm in length and weighing only 5-grammes}, which enables it to stay and move inside a human body to remove or treat the affected part of disease, especially cancer.

The tiny robot incorporates various medical devices including a \textbf{small camera, sensors and a drug delivery injector}, which could reduce the need for surgery.

Data is sent to a computer through a slim cable although researchers hope to develop a transmitter.

Previously miniature robots for inside the body have been designed to be swallowed and can only take pictures, although US researchers are also working on a small robot that enters through an incision to treat heart problems.
Mini-robot swims through bloodstream

by Joshua Topolsky posted Jun 27th, 2007 at 9:57 AM

Two Israeli scientists may have created the catalyst for a medical revolution with their new project: a tiny, 1-millimeter-diameter robot which is capable of crawling through human veins and arteries. The bot can cling to vessel walls using small, powerful arms which protrude from a hub in its center. Manned control is accomplished by using a magnetic field outside of the body, and the robot is able to swim against the flow of blood, as well as squeeze through a variety of arterial openings. Right now the doctors don't know what the medical applications might be, though they speculate that a large number of the bots could be used to fight certain types of cancer.
O.L.V. Vattikuti

Robotic Surgery Institute

(ORSI)

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O.L.V. Clinic Aalst
OLV Vattikuti Robotic Surgery Institute
Aalst
Belgium
Non profit society
(created 2010)

Mission:
Offer high quality training, exposure and R&D in minimal invasive therapies
ORSI wants to offer:

1. Training platform

2. Clinical platform

3. Technology platform
ORSI Society wants to do to ‘Partners & Industry’ a unique proposal:

ORSI will:
- offer broad European platform (“inclusive”)
- Offer the unique concept of 3 platforms.
- Unique team of clinical multispecialty KOL’s
  > top case observations
- Link technical innovation to clinical expertise
- Diversification to other minimal invasive innovative techniques

➢ today, collaboration with LMTC (KU Leuven), U Ghent, CREAAX,...
New Developments in Robotics

This is only the beginning...

“The future of surgery is not about blood and guts, it is about bytes and bits”
(R. Satava)