Robotic surgery
- pushing the frontiers in minimally invasive surgery

Associate Professor Declan Murphy
Consultant Urologist
Director of Robotic Surgery
Outline
Changes in Training

Old Guy’s Theatre (1821)
Laparoscopic surgery – why?

Open radical nephrectomy

Laparoscopic nephrectomy
Open surgery

• See one
• Do one
• Teach one
Open ≠ Laparoscopic

• 2-D Image
  – Minimal tactile feedback
  – Remote image
  – Distance & lever effect

• Specific skills required
Why robotics?

• Minimally-invasive surgery benefits patients
• New technology essential
  – Information systems
  – Imaging systems
  – Mechatronics
Karol Capek, 1921

“robota” = forced work
Terminology & Definitions

• Robot
  – “computer-controlled manipulator with artificial sensing... preprogrammed to control tools to perform complex tasks”

• Automation
  – Robotic vs robotic-assisted
  – Truly autonomous
  Vs
  – Responds to instruction or control interface

• Most surgical “robots” don’t fulfill criteria
Laparoscopic access
1. LAPAROSCOPE MANIPULATORS
2. MASTER-SLAVE SYSTEMS
1. Laparoscopy manipulators

EndoAssist™

AESOP®
2. Master-slave systems

Stamford Research Institute (SRI) –
Green Telepresence System
2. Master-slave systems

- **Zeus™ surgical system**
  - Computer Motion/Intuitive Surgical

- **da Vinci® surgical system**
  - Intuitive Surgical
2. Master-slave systems

- **Zeus™ surgical system**
  - Computer Motion/Intuitive Surgical

- **da Vinci® surgical system**
  - Intuitive Surgical
DA VINCI & THE PROSTATE
Leonardo da Vinci – Father of Robotics (1452–1519)

- Sketched plans for a humanoid robot
- Mechanical knight now known as Leonardo's robot
- Anatomy probably based on Vitruvian Man
What is Robotic Surgery?
What is Robotic Surgery?

- da Vinci Surgical System®
- Advanced laparoscopic surgery device
  
  I. Patient-side robotic cart
  II. Surgeon console
  III. Vision cart
What is Robotic Surgery?
What is Robotic Surgery?
Robotic prostatectomy

Robotic-assisted laparoscopic radical prostatectomy
Technical considerations

Advantages
• EndoWrist™ vastly superior to conventional lap instruments
• 3D vision and 10x magnification
• Ergonomics

Disadvantages
• Expensive to buy – $3.5 million
• Expensive to run (monopoly)
• Excellent assistant required
Conventional laparoscopic suturing

Robot-assisted suturing

- Alaska
- Hawaii

- 1999
- 2000
- 2001
- 2002
- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009-through Q3 close
da Vinci® Australia/New Zealand
2003 – 2010
CLINICAL REVIEW

ROBOTIC TECHNOLOGY IN SURGERY: CURRENT STATUS IN 2008

DECLAN G. MURPHY,*† ROHAN HALL,*† RAYMOND TONG,*† RAJIV GOEL,*† AND ANTHONY J. COSTELLO*†

*Department of Urology, Epworth Hospital, Richmond, and †Department of Urology, Royal Melbourne Hospital, Melbourne, Victoria, Australia

Robotic procedures per annum in Australia & New Zealand

Robotic surgery volume by speciality

<table>
<thead>
<tr>
<th>Speciality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urology</td>
<td>91%</td>
</tr>
<tr>
<td>Cardiac</td>
<td>7%</td>
</tr>
<tr>
<td>Gynaecology</td>
<td>1%</td>
</tr>
<tr>
<td>General surgery</td>
<td>1%</td>
</tr>
</tbody>
</table>
PROSTATE CANCER

Most common male cancer
20,000 new cases per year
3,500 deaths
The goals of radical prostatectomy

1. Cancer control
2. Continence
3. Potency
   - “The trifecta”
   - Nerve-sparing dissection

Immunohistochemical studies of the NVB.
Costello, Murphy BJUi 2010 in press
Open radical prostatectomy

- Gold standard
Open radical prostatectomy

• Gold standard
• Is it MORBID??
  – Mortality <1%
  – Blood transfusion 20-30%
  – Complications 9-30%
  – Hospital stay 6.4 days
  – Incontinence <10%
  – Erectile dysfunction 14-44%

Judge et al. BJUi 2007
Catalona et al. J Urol 2004
Walsh et al. Urology 2000
Graefen et al Eur Urol 2006
Why should robotic-assisted be better?

• Minimally-invasive
  – Less pain etc

• Robot-specific
  – See better
  – Cut better
  – Easier than pure laparoscopy

• It’s a robot – it must be better!!
“THAT’S ALL FINE IN PRACTICE, BUT WILL IT WORK ON PAPER??”

Irish Professor of Surgery - 1994
Surgery in Motion

Operative Details and Oncological and Functional Outcome of Robotic-Assisted Laparoscopic Radical Prostatectomy: 400 Cases with a Minimum of 12 Months Follow-up

Declan G. Murphy¹, Michael Kerger, Helen Crowe, Justin S. Peters, Anthony J. Costello
Department of Urology, Epworth Hospital, Richmond, & Royal Melbourne Hospital, Australia

Table 1 – Peri-operative characteristics (n = 400)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age ± SD (yr) (range)</td>
<td>60.2 ± 6.0 (43–75)</td>
</tr>
<tr>
<td>Mean BMI ± SD (kg/m²) (range)</td>
<td>27.2 ± 3.3 (20.2–39.8)</td>
</tr>
<tr>
<td>Clinical stage</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>279 (69.7%)</td>
</tr>
<tr>
<td>T2</td>
<td>111 (27.7%)</td>
</tr>
<tr>
<td>T3</td>
<td>10 (2.6%)</td>
</tr>
<tr>
<td>Median PSA (ng/mL) (interquartile range)</td>
<td>7.0 (5.3–9.6)</td>
</tr>
<tr>
<td>D’Amico risk category</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>146 (36.5%)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>201 (50.25%)</td>
</tr>
<tr>
<td>High</td>
<td>53 (13.25%)</td>
</tr>
<tr>
<td>Mean total operative time ± SD (min) (range)</td>
<td>186 ± 49 (94–435)</td>
</tr>
<tr>
<td>Number of blood transfusions</td>
<td>10 (2.5%)</td>
</tr>
<tr>
<td>Conversion to open surgery</td>
<td>1 (0.25%)</td>
</tr>
<tr>
<td>Complication rate – overall</td>
<td>63 (15.75%)</td>
</tr>
<tr>
<td>Clavien I-II</td>
<td>42 (10.5%)</td>
</tr>
<tr>
<td>Clavien III</td>
<td>21 (5.25%)</td>
</tr>
<tr>
<td>Clavien IV</td>
<td>0</td>
</tr>
<tr>
<td>Clavien V</td>
<td>0</td>
</tr>
<tr>
<td>Final pathological outcome (%)</td>
<td></td>
</tr>
<tr>
<td>T2a/b/c</td>
<td>70</td>
</tr>
<tr>
<td>T3a</td>
<td>25</td>
</tr>
<tr>
<td>T3b</td>
<td>4.75</td>
</tr>
<tr>
<td>T4</td>
<td>0.2</td>
</tr>
<tr>
<td>Positive surgical margins – overall (%)</td>
<td>19.2</td>
</tr>
<tr>
<td>T2</td>
<td>9.6</td>
</tr>
<tr>
<td>T3</td>
<td>42.3</td>
</tr>
<tr>
<td>Mean prostate weight ± SD (g) (range)</td>
<td>48.9 ±20.2 (18–182)</td>
</tr>
<tr>
<td>Numbers undergoing</td>
<td>38 (6)</td>
</tr>
<tr>
<td>PLND (positive for cancer)</td>
<td></td>
</tr>
<tr>
<td>Mean hospital stay ± SD (d) (range)</td>
<td>3.1 ±1.4 (1–12)</td>
</tr>
<tr>
<td>Mean duration of catheterisation ± SD (d) (range)</td>
<td>8.2 ±3.1 (4–33)</td>
</tr>
</tbody>
</table>

SD = standard deviation; BMI = Body Mass Index; PSA = prostate-specific antigen; PLND = pelvic lymph node dissection.
So what’s next??
Current robotic simulators 1

- dV Trainer
- Mimic Technologies
Current robotic simulators
Beyond simulation....
Beyond simulation....
Beyond simulation....
Beyond simulation....
What if....
Natural Orifice Transluminal Endosurgery - NOTES
NOTES – urology applications

Rapid Communication

Transvaginal Single-Port NOTES Nephrectomy: Initial Laboratory Experience

Ralph V. Clayman, M.D., Geoffrey N. Box, M.D., Jose Benito A. Abraham, M.D., Hak J. Lee, M.D., Leslie A. Deane, M.D., Eric R. Sargent, M.D., Ninh T. Nguyen, M.D., Kenneth Chang, M.D., Amy K. Tan, B.A., Lee E. Ponsky, M.D., and Elspeth M. McDougall, M.D.

will no doubt be possible clinically. Given the precision with which the instruments must be manipulated and the complexity associated with positioning the TP system, the endoscope, and the instruments, this could be a tremendous opportunity for robotic applications.
What next?

- Dual console system
- Roof-mounted robotic arms
- Single-port robotic surgery
- Image-guided surgery
- Simulation

- Multispeciality

- Competition (please)
The Operating Room of the Future
Single port surgery

• Through umbilicus or small single incision
• Technically challenging
• Inadequate optics and instrumentation
• Robotic platforms required

“A triumph of technical ability over common sense”
Conclusions

• Minimally-invasive surgery is evolving rapidly
• Robotic platforms will enable further advance
• Increasing integration with a digital environment:
  – Imaging
  – Information systems
  – Simulation/Virtual reality
• Almost limitless potential!
Thank you

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www.petermac.org/roboticsurgery