Robotic-Assisted Laparoscopic Surgery (RALS) in Pediatric Urology

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Robotics in Surgery
Robotic-Assisted Laparoscopic Surgery

• Advantages:
  – Quicker postoperative recovery
  – Fewer analgesic requirements
  – Shorter length of hospital stay
  – Conventional laparoscopic surgery
    • Technically demanding
    • Steep learning curve

Trevisani 2013, Tomaszewski 2012
Robotic-Assisted Laparoscopic Surgery

• Advantages:
  – Magnified three-dimensionality
  – Superior stereoscopic visualization
  – Enhanced dexterity
    • Wrist-like with 90 degrees of articulation
    • 7 degrees of freedom
  – Improved precision of movement
    • Tremor filtration
    • Ergonomic comfort
Robotics in Pediatric Urology

• Is Robotic Surgery feasible in children?
  – Considerations in RALS in Pediatrics

• Is Robotic Surgery applicable to Urologic surgery in children?

• Is Robotic Surgery successful in surgery?

• Is Robotic Surgery advantageous over open surgery in children?
RALS: Pediatric Urology

- Laparoscopy is effective in pediatrics

- RALS in Pediatrics is similar to RALS in Adults... with some exceptions
Considerations in Pediatric RALS

• Pneumoperitoneum:
  – 5-6 L in adults….1 L in a 1 year old
  – Working Pressure:
    – Infants (0–2 y)>>> 8 to 10 mm Hg
    – Children (2–10 y)>> 10 to 12 mm Hg
    – Adolescents (>10 y) >>> 15 mm Hg

• Small “working area”
  – Limits robotic mobility
    – Port site conflicts
    – Instrument collision
    – Potential increase risk of visceral injury

Casale 2010, Larobina 2005, Kutikov 2006
Considerations in Pediatric RALS

- Abdominal wall is thinner and more compliant
  - Increased risk of vascular injury
    - ~5 cm between abdominal wall and great vessels
    - Hasson open access technique for camera
    - All ports placed under direct vision
  - Increased risk of port expulsion
    - Rapid loss of insufflation and loss of vision
  - Difficulty maintaining insufflation during instrument exchange
    - Tie in trocars with heavy suture
  - Increased compliance
    - More “curved” abdomen
      » Triangular of ports will maximize exposure.

Casale 2008,
Considerations in Pediatric RALS

- Bladder is an abdominal organ in small children
  - Foley to decompress the bladder
    - Prevents bladder injury

- ↑ in inflation of stomach with anesthesia induction
  - NG for stomach decompression

Source: Casale 2008, Campbells Urology, 2016
Contraindications to Pediatric RALS

- Cardiopulmonary morbidity
- Incorrected coagulopathy
- Sepsis
Does Size Matter: Infant RALS

- Infants
  - No consensus on the appropriate infant candidate
  - No objective standards to guide decision making.
Does Size Matter: Infant RALS

• Casale et al.
  • 45 infants: 24 Female --- 21 Male
  • 3-12 months of age
  • Hypothesis: Smaller child = More robotic arm collisions
  • Methods:
    » ASIS: distance between both anterior superior iliac spines
    » PXD: puboaxypohid distance
      – Compared ASIS and PXD distance
    » Number of collisions/surgery
    » Time on the Robotic Console
Does Size Matter: Infant RALS

• Results:
  – Strong correlation: \(\uparrow\) number of collisions \(\uparrow\) console time
  – Strong inverse relationship
    • \(\downarrow\) ASIS distance \(\uparrow\) number of collisions
    • \(\downarrow\) PXD distance \(\uparrow\) number of collisions
  – Independent of age, gender or weight

• Conclusion:
  ASIS \(\leq\) 13 cm or PXD \(\leq\) 15 cm
    - May impair surgeon and restrict surgery due to collisions

Finkelstein 2015
Does Size Matter: Obesity and RALS

- **Cheng et al.**
  - 103 children
    - 66% healthy weight
    - 23% overweight
    - 10% obese
  - **Results**
    - Relative to healthy weigh children
      » 7 min increase in OR time in overweight children
      » 20 min increase in OR time in obese children
        - ? Time for port Placement
    - No differences in success rates
    - No surgical site infections
  - **Conclusion:**
    - Obesity is not a limitation for RALS in children
Pediatric RALS

• Conclusion:
  – There are special considerations in children
  – Smaller children may be challenging
    – Experience is important
  – Obesity is not a limiting factor
RALS Pediatric Pyeloplasty

Most common robotic procedure in pediatric urology
RALS Pediatric Pyeloplasty

Success Rates

<table>
<thead>
<tr>
<th>Authors, year</th>
<th>No. of cases</th>
<th>Operation time (min)</th>
<th>Follow-up (months)</th>
<th>Complication rate</th>
<th>Success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olsen, 2007</td>
<td>67</td>
<td>146</td>
<td>12</td>
<td>17.9</td>
<td>94</td>
</tr>
<tr>
<td>Sorensen, 2011</td>
<td>33</td>
<td>326</td>
<td>17</td>
<td>15.2</td>
<td>97</td>
</tr>
<tr>
<td>Minnillo, 2011</td>
<td>155</td>
<td>198</td>
<td>31</td>
<td>11</td>
<td>96</td>
</tr>
<tr>
<td>Singh, 2012</td>
<td>34</td>
<td>105</td>
<td>28</td>
<td>5.9</td>
<td>97</td>
</tr>
<tr>
<td>Avery, 2014</td>
<td>62</td>
<td>232</td>
<td>12</td>
<td>11.3</td>
<td>91</td>
</tr>
</tbody>
</table>

*Outcomes reported by Avery et al. are that of an infant cohort.

Complication Rates
RALS Pediatric Pyeloplasty

A

B

C

D

Song 2017
RALS Pediatric Pyeloplasty: HIIdES

Gargollo, 2011
RALS Pediatric Pyeloplasty: HIdES

A. Patient Scar Assessment Scale

B. Manchester Scar Scale

C. Wound Evaluation Scale

D. Trend for Access Time

E. Trends Over Time

Gargollo, 2011
RALS Pediatric Pyeloplasty: Stentless

- Excellent success rates
- Low complication rate
- Avoids second procedure
  - Avoids anesthesia
- Post operative morbidity
  - No complaints of post operative stent pain
  - No bladder spasms
  - No Ileus
  - No fever or UTI
### RALS Pediatric Pyeloplasty: Reoperative Outcomes

**Table 4** Clinical and imaging outcomes.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All patients (N = 23)</th>
<th>&gt;12 months follow-up (N = 18)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median length of follow-up in months (range)</td>
<td>26 (4–45)</td>
<td>31 (16–45)</td>
</tr>
<tr>
<td>Resolution of pain in children with pain prior to reoperative RALP (%)</td>
<td>6/7 (86%)</td>
<td>5/6 (83%)</td>
</tr>
<tr>
<td>Hydronephrosis on follow-up ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved</td>
<td>18 (81%)</td>
<td>13 (76%)</td>
</tr>
<tr>
<td>Stable</td>
<td>3 (14%)</td>
<td>3 (18%)</td>
</tr>
<tr>
<td>Worse</td>
<td>1 (5%)</td>
<td>1 (6%)</td>
</tr>
<tr>
<td>Follow-up MAG-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved/unobstructed</td>
<td>9 (82%)</td>
<td>7 (78%)</td>
</tr>
<tr>
<td>Stable/obstructed</td>
<td>2 (18%)</td>
<td>2 (22%)</td>
</tr>
<tr>
<td>Additional intervention</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temporary stent</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Balloon dilation of UPJ and multiple ureteral stents, ultimately underwent nephrectomy by outside surgeon</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

---

**a** Unable to obtain imaging in one patient (relocated out of state).

**b** Both patients without clinical evidence of obstruction but continued abnormal MAG-3. Further clinical details in text.
RALS Ureteral Reimplant (RALUR): Pediatrics

• Indications for surgical treatment
  – Breakthrough UTI while on Antibiotic prophylaxis
  – Acquired Renal Scarring
  – Worsening or Severe Urinary Reflux

• Between 2000-2012
  – Total number of Reimplants decreased by 14%
  – Minimally Invasive Ureteral Reimplant
    • 0.3% in 2000 to 6.3% in 2012
      – 80% performed robotically

Bowen, 2016
RALS Ureteral Reimplant: Intravesical

• Intravesical Ureteral Reimplant
  – 2005 by Dr. Craig Peters
    • 6 patients 5-15 years
    • Cohen (Cross Trigonal)
  – Complications
    • 1 post-operative urine leak
  – Success Rate
    • 83% VUR resolution on post-operative VCUG.

Peters, 2005
RALS Ureteral Reimplant: Intravesical

Marchini et al 2011:
- 92% success rate
- less bladder spasms and less hematuria
- shorter hospital stay and shorter duration of urethral catheter drainage

Courtesy of Patricio Gargollo, MD  Pediatric Urology Mayo Clinic
RALS Ureteral Reimplant: Extravesical

• Extravesical Reimplant
  – 2004 by Dr. Craig Peters
    • Lich-Gregor procedure

• Be aware of the neurovascular bundle (bilateral)
  – dorsomedial at the distal 2.5 cm of the ureter
  – dorsocranial to the trigone
    » 10% transient urinary retention for open extravesicals
### RALS Ureteral Reimplant: Extravesical

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of patients</th>
<th>Mean age years</th>
<th>Method of defining procedural success</th>
<th>Success rate</th>
<th>Reported complications</th>
<th>Follow up (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akhavan et al. 2014 [17**]</td>
<td>N = 50 (28 bilateral)</td>
<td>6.2</td>
<td>Radiographic</td>
<td>92%</td>
<td>Ureteral obstruction [2], ureteral injury [1], febrile UTI [5*], ileus [2], perinephric fluid collection [1], urinary retention [1], contralateral de-novo VUR [5*]</td>
<td>41</td>
</tr>
<tr>
<td>Dangle et al. 2014 [18]</td>
<td>N = 29 (11 bilateral)</td>
<td>5.3</td>
<td>Radiographic</td>
<td>80%</td>
<td>None reported</td>
<td>16</td>
</tr>
<tr>
<td>Grimsby et al. 2015 [19*]</td>
<td>N = 61 (32 bilateral)</td>
<td>6.7</td>
<td>Radiographic and clinical</td>
<td>72%</td>
<td>Ureteral obstruction [3], urine leak [2], nonsurgical readmission [1]</td>
<td>51</td>
</tr>
<tr>
<td>Herz et al. 2016 [20]</td>
<td>N = 54 (18 bilateral)</td>
<td>5.2</td>
<td>Radiographic</td>
<td>92%, unilateral 72% bilateral</td>
<td>Ureteral obstruction [4], urine leak [2], urinary retention [4], total reoperation [10], worsening postoperative BBD [12], postoperative UTI [6], nonsurgical readmission [2]</td>
<td>12</td>
</tr>
<tr>
<td>Arlen, 2016 [21]</td>
<td>N = 17 (3 bilateral)</td>
<td>9.3</td>
<td>Clinical</td>
<td>94%</td>
<td>Ureteral stricture with obstruction requiring reoperation [1], ileus [1], febrile UTI [1]</td>
<td>66</td>
</tr>
</tbody>
</table>
# RALS Ureteral Reimplant: Extravesical

## Table 2

<table>
<thead>
<tr>
<th>Area</th>
<th>Open (n = 97)</th>
<th>Robotic (n = 21)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Genitourinary</strong></td>
<td>Urinary retention (5), postoperative hydronephrosis (5), obstruction of ureter or kidney (5), oliguria/anuria (2), acute kidney injury, hematuria (8), urinary extravasation, other urinary complications</td>
<td>Urinary retention (2), postoperative hydronephrosis (4), other ureteral abnormalities, oliguria/anuria, urinary frequency, complications of cystotomy, hematuria</td>
</tr>
<tr>
<td><strong>Infection</strong></td>
<td>Urinary tract infection (9), wound infection (4), other</td>
<td>Urinary tract infection (2)</td>
</tr>
<tr>
<td><strong>Cardiovascular and respiratory</strong></td>
<td>Tachycardia, dysrhythmias (2), pneumonia (4), asthma flare (3), bronchospasm, other</td>
<td>Tachycardia, pulmonary collapse, hypoxemia, asthma flare (2)</td>
</tr>
<tr>
<td><strong>Hematologic</strong></td>
<td>Anemia (2), hemorrhage complicating a procedure</td>
<td></td>
</tr>
<tr>
<td><strong>Gastrointestinal</strong></td>
<td>Nausea/vomiting (14), paralytic ileus (5), constipation (7), abdominal pain (2), intestinal perforation</td>
<td>Constipation, abdominal pain</td>
</tr>
</tbody>
</table>

*Some patients in each group experienced multiple complications.*

**Conclusion:** Statistically more complication in the RAL Ureteral Reimplants

Kurtz 2016
RALS Ureteral Reimplant: Complex Ureters

• Defined:
  – Megaureters >> Tapering and/or dismemberment
  – Duplicated collecting system
  – Ureteral Diverticulum

• Clinical Success
  – Absence of Febrile UTI at 16 mths follow-up
    • 94% RALS
    • 93% OUR

* OUR = open ureteral reimplant

Arlen, 2016
RALS Ureteral Reimplant: Complex Ureters

Courtesy of Patricio Gargollo, MD  Pediatric Urology Mayo Clinic
RALUR was associated with a significantly higher direct costs even when adjusted for demographic and regional factors.

RALUR is associated with shorter hospital stay which offsets cost to some degree.

Kurtz 2016
RALIMA: Robotic-Assisted Laparoscopic Augmentation Ileocystoplasty and Mitrofanoff appendicovesicostomy

Pedraza, 2004
Gundeti, 2008
Cohen, 2015
RALIMA: Robotic-Assisted Laparoscopic Augmentation Ileocystoplasty and Mitrofanoff appendicovesicostomy
RALIMA: Robotic-Assisted Laparoscopic Augmentation Ileocystoplasty and Mitrofanoff appendicovesicostomy

### Table 1 - Patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Robotic (n = 15)</th>
<th>Open (n = 13)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr (IQR)</td>
<td>11.7 (8.1-13.8)</td>
<td>4.6 (3.5-6.6)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>9 (60)</td>
<td>6 (46)</td>
<td>0.71</td>
</tr>
<tr>
<td>Weight, kg (IQR)</td>
<td>37 (34-54)</td>
<td>23.5 (12.1-34.9)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Body mass index, kg/m² (IQR)</td>
<td>18 (16-27)</td>
<td>19 (16-22)</td>
<td>0.56</td>
</tr>
<tr>
<td>Wheelchair bound, n (%)</td>
<td>5 (33)</td>
<td>1 (8)</td>
<td>0.17</td>
</tr>
<tr>
<td>VP shunt, n (%)</td>
<td>7 (47)</td>
<td>4 (31)</td>
<td>0.46</td>
</tr>
<tr>
<td>Prior abdominal surgery, n (%)</td>
<td>2 (13)</td>
<td>8 (62)</td>
<td>0.02</td>
</tr>
<tr>
<td>Urinary incontinence, n (%)</td>
<td>13 (87)</td>
<td>10 (77)</td>
<td>0.64</td>
</tr>
</tbody>
</table>

IQR = interquartile range; OAI = open augmentation ileocystoplasty; RALI = robot-assisted laparoscopic augmentation ileocystoplasty; VP, ventriculoperitoneal.
Indications for surgery included RALI: myelomeningocele (9 patients), sacral agenesis (3), tethered cord (2), posterior urethral valves (1); OAI: myelomeningocele (6), cloacal anomaly (4), posterior urethral valves (2), nonneurogenic neurogenic bladder (1).

* Height available in 11 of 15 robotic surgery patients.

Murthy, 2015
TABLE 2 – Perioperative and hospital data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Robotic (n = 15)</th>
<th>Open (n = 13)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concomitant procedures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appendicovesicostomy, n (%)</td>
<td>11 (73)</td>
<td>10 (77)</td>
<td>1.0</td>
</tr>
<tr>
<td>Antegrade colonic enema, n (%)</td>
<td>6 (40); 3 with cecal flap</td>
<td>2 (15)</td>
<td>0.22</td>
</tr>
<tr>
<td>Bladder neck closure, n (%)</td>
<td>4 (27)</td>
<td>2 (15)</td>
<td>0.66</td>
</tr>
<tr>
<td>Operative time, min (IQR)</td>
<td>623 (532–659)</td>
<td>287 (269–339)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Estimated blood loss, ml (IQR)</td>
<td>100 (50–100)</td>
<td>50 (60–200)</td>
<td>0.89</td>
</tr>
<tr>
<td>IV morphine equivalents, mg/kg (IQR)</td>
<td>0.49 (0.21–0.78)</td>
<td>0.70 (0.34–1.33)</td>
<td>0.33</td>
</tr>
<tr>
<td>Return to regular diet, d (IQR)</td>
<td>4 (2–5)</td>
<td>4 (4–6)</td>
<td>0.07</td>
</tr>
<tr>
<td>Length of stay, d (IQR)</td>
<td>6 (5–7)</td>
<td>8 (7–11)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

CI = confidence interval; IQR = interquartile range; IV = intravenous.

TABLE 3 – Subprocedure operative times for robot-assisted laparoscopic augmentation ileocystoplasty with Mitrofanoff appendicovesicostomy

<table>
<thead>
<tr>
<th>Procedure, patients reviewed</th>
<th>Time, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendiceal harvest</td>
<td>28 (21–48; 7)</td>
</tr>
<tr>
<td>Ileal loop isolation and anastomosis</td>
<td>74 (68–107)</td>
</tr>
<tr>
<td>Cystotomy</td>
<td>30 (26–42)</td>
</tr>
<tr>
<td>Ileal detubularization</td>
<td>6 (4–10)</td>
</tr>
<tr>
<td>Appendicovesicostomy</td>
<td>82 (66–88)</td>
</tr>
<tr>
<td>Ileovesical anastomosis</td>
<td>121 (101–167)</td>
</tr>
<tr>
<td>Bladder neck closure</td>
<td>32 (22–54)</td>
</tr>
</tbody>
</table>

All procedure times are described as median (interquartile range).
RALIMA: Robotic-Assisted Laparoscopic Augmentation Ileocystoplasty and Mitrofanoff appendicovesicostomy

<table>
<thead>
<tr>
<th>Complications</th>
<th>Robotic</th>
<th>Open</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30-d</td>
<td>7 (47)</td>
<td>8 (62)</td>
<td>0.48</td>
</tr>
<tr>
<td>30–90 d</td>
<td>4 (27)</td>
<td>6 (46)</td>
<td>0.43</td>
</tr>
<tr>
<td>Highest grade, 30 d, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>8 (53)</td>
<td>5 (38)</td>
<td>0.26</td>
</tr>
<tr>
<td>Grade 1</td>
<td>5 (33)</td>
<td>4 (31)</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>1 (7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>1 (7)</td>
<td>4 (31)</td>
<td></td>
</tr>
<tr>
<td>Highest grade, 30–90 d, n (%)</td>
<td></td>
<td></td>
<td>0.39</td>
</tr>
<tr>
<td>None</td>
<td>11 (73)</td>
<td>7 (54)</td>
<td></td>
</tr>
<tr>
<td>Grade 1</td>
<td>1 (7)</td>
<td>3 (23)</td>
<td></td>
</tr>
<tr>
<td>Grade 2</td>
<td>1 (7)</td>
<td>1 (8)</td>
<td></td>
</tr>
<tr>
<td>Grade 3</td>
<td>2 (13)</td>
<td>2 (15)</td>
<td></td>
</tr>
</tbody>
</table>

IQR = interquartile range.
Median follow-up: robotic, 43 mo (IQR: 19–69); open, 45 mo (IQR: 32–56); p = 0.8.
Complications reported by the day after surgery when the complication was diagnosed.

Murthy, 2015
RALIMA: Robotic-Assisted Laparoscopic Augmentation Ileocystoplasty and Mitrofanoff appendicovesicostomy

Table 6 – Troubleshooting and tips for proficiency

<table>
<thead>
<tr>
<th>Difficulty</th>
<th>Troubleshooting</th>
</tr>
</thead>
<tbody>
<tr>
<td>High BMI</td>
<td>Use bariatric ports after initial proficiency has been established</td>
</tr>
<tr>
<td>Kyphoscoliosis</td>
<td>Move camera port supraumbilically if pubo-umbilical distance is short to reach small bowel</td>
</tr>
<tr>
<td>Appendix isolation in patients with a VP shunt</td>
<td>Perform diagnostic peritoneoscopy</td>
</tr>
<tr>
<td></td>
<td>Anticipate adhesions and adhesiolysis</td>
</tr>
<tr>
<td></td>
<td>Appendix often found in subhepatic space</td>
</tr>
<tr>
<td>Short appendix requiring dual channels (MAPV or ACE)</td>
<td>Utilize a cecal flap for creation of ACE channel</td>
</tr>
<tr>
<td>Presence of VP shunt</td>
<td>Place lower end in Endopouch bag and keep in subhepatic space for duration of procedure</td>
</tr>
<tr>
<td>Short ileal mesenteric vessels</td>
<td>Reducing Trendelenburg can help bring the loop into pelvis</td>
</tr>
<tr>
<td>Fatty mesentery</td>
<td>First, resect bowel from antimesenteric side, and then take down mesentery for better identification of vessels</td>
</tr>
<tr>
<td></td>
<td>Consider Firefly if available</td>
</tr>
<tr>
<td>Mesenteric orientation and twisting</td>
<td>Place stay sutures at proximal and distal ends of division segment, and maintain diligence for entire procedure</td>
</tr>
<tr>
<td></td>
<td>For appendix, place a stay suture on the mesenteric side of stomal end</td>
</tr>
<tr>
<td>Bladder neck closure</td>
<td>Mobilize omentum and bring into pelvis with laparoscopy prior to robot docking to be used later to cover the repair to prevent dehiscence</td>
</tr>
</tbody>
</table>

ACE = antegrade colonic enema; BMI = body mass index; MAPV = Mitrofanoff appendicovesicostomy; VP = ventriculoperitoneal.

Required Conversion to open procedure

Murthy, 2015
Robotic Assisted Surgery in Pediatric Urology at UNC

- RAL Pyeloplasty
- RAL Nephrectomy
  - Poorly functioning scarred kidney
  - Ectopic ureter with chronic urinary incontinence
- RAL Nephroureterectomy
- RAL Renal Cysto Decortication
  - Excision of Calyceal Diverticulum
Robotic Assisted Surgery in Pediatric Urology at UNC
Robotic Assisted Surgery in Pediatric Urology at UNC

15 yo male with ESRD with a history of a failed renal transplant who is on Peritoneal Dialysis

Scheduled for a RAL Retroperitoneal Nephrectomy in July
Pediatric Robotic Prostatectomy and Pelvic Lymphadenectomy for Embryonal Rhabdomyosarcoma

Deepak K. Agarwal, Tanner S. Miest, Candace F. Granberg, Igor Frank, Patricio C. Gargollo
Thank You!

The Worlds Most Human Like Robot.....What’s Next?
References

References