LOWER URINARY TRACT AND BOWEL RECONSTRUCTION IN CHILDREN

The Indiana Experience

With 500 Mitrofanoff and MACE Procedures

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THE PROBLEM
BLADDER RECONSTRUCTION

Where are we now?

Unacceptable
Spina Bifida - Urologic Management

**GOALS**

- Normal Renal Function
- Urinary/Fecal Continence
- Transition to Independent Care

Management of Neuropathic Bladder and Bowel

**Evolution of continence:**
- Intermittent catheterization
- Bladder outlet resistance
- Bladder augmentation
- Mitrofanoff procedure
- MACE procedure
HOW CAN OUTFLOW RESISTANCE BE ACHIEVED?

- Artificial sphincters
- Flap valve - Mitrofanoff
- Nipple valves
- Plication
- Hydrostatic mechanism
- Combination valves

NEW SURGICAL CONCEPTS
3 Trips Around the OR
(3 Papers over 5 Years)

- How we do it
- How we modified it
- Why we no longer do it

Bloom Principle: Triple digit number of patients
Double digit years of f/u
## MITROFANOFF
### Indiana Experience

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendicovesicostomy</td>
<td>110</td>
</tr>
<tr>
<td>Monti ileovesicostomy</td>
<td>199</td>
</tr>
<tr>
<td>Continent Vesicostomy</td>
<td>32</td>
</tr>
<tr>
<td><strong>Total Urinary Channels</strong></td>
<td><strong>341</strong></td>
</tr>
<tr>
<td>MACE</td>
<td>174</td>
</tr>
<tr>
<td><strong>Total Cath Channels</strong></td>
<td><strong>515</strong></td>
</tr>
</tbody>
</table>

Rink, Casale, Cain, Kaefer 2004
One of the most significant advances in Pediatric Urology

- allows us to achieve reliable continence
- preserve renal function
- freedom from recurrent symptomatic UTI
- CIC usually easily performed

Masson, Paris, 1980

Cystostomie continente trans-appendiculaire dans le traitement des vessies neurologiques

P. MITROFANOFF

Clinique Chirurgicale Infantile (Pr J. Borde), Hospital Charles-Nicolle, 1 rue de Germont, 76038 Rouen Cedex.
Cystostomie continente trans-appendiculaire dans le traitement des vessies neurologiques

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Mitrofanoff Principle

- Continence mechanism based on flap valve
- Reservoir pressure is transmitted against wall of conduit
MITROFANOFF (any supple tube)

- Appendix / Ureter 1980
- Fallopian tube
- Vas deferens
- Stomach 1991
- Bladder 1992
- Yang 1993
- Tapered ileum 1994
- Prepuce 1995
- Spiral Monti 1999

Mitrofanoff Procedure

Appendix as the catheterizable channel
Short, Straight, Supple

APPENDICOVESICOSTOMY
APPENDICOVESICOSTOMY

Mitrofanoff Procedure
Appendix as the catheterizable channel

**Advantages**

- readily available
- already tubular
- good blood supply
- no effect on bowel

Mitrofanoff Results

<table>
<thead>
<tr>
<th>Group(yr)</th>
<th>n</th>
<th>f/u</th>
<th>dry/ cath (%)</th>
<th>stomal/conduit stenosis (%)</th>
<th>Stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dykes (91)</td>
<td>28</td>
<td>13</td>
<td>86</td>
<td>4/2 (21)</td>
<td>n/a</td>
</tr>
<tr>
<td>Keating (93)</td>
<td>17</td>
<td>93</td>
<td>0/0</td>
<td>n/a</td>
<td></td>
</tr>
<tr>
<td>Duckett (93)</td>
<td>38</td>
<td>93</td>
<td>1/2 (7.3)</td>
<td>13(32)</td>
<td></td>
</tr>
<tr>
<td>Sumfert (93)</td>
<td>47</td>
<td>28</td>
<td>96</td>
<td>6/4 (23)</td>
<td>n/a</td>
</tr>
<tr>
<td>Woodhouse (94)</td>
<td>100</td>
<td>30</td>
<td>91</td>
<td>19/2 (21)</td>
<td>n/a</td>
</tr>
<tr>
<td>Jayanthi (95)</td>
<td>28</td>
<td>29</td>
<td>96</td>
<td>5/0 (18)</td>
<td>5(18)</td>
</tr>
<tr>
<td>Karfer (97)</td>
<td>44</td>
<td>96</td>
<td>5/1 (12)</td>
<td>6/12</td>
<td></td>
</tr>
<tr>
<td>Gonzalez (97)</td>
<td>43</td>
<td>36</td>
<td>98</td>
<td>3/6 (21)</td>
<td>2(5)</td>
</tr>
<tr>
<td>Cain (99)</td>
<td>57</td>
<td>24</td>
<td>98</td>
<td>6 (11)</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>408</td>
<td>33</td>
<td>94</td>
<td>14.7</td>
<td></td>
</tr>
</tbody>
</table>

MITROFANOFF 23 pts 180 mos 70% dry 39% stenosis
MITROFANOFF PROCEDURE
Early Indiana Experience

- 100 patients between 1990 - 1998
- Appendicovesicostomy 57
  Monti ileovesicostomy 21
  Continent vesicostomy 21
  Tapered ileum 1
- Overall continence rate 98%

Cain et al J.Urol. 162: 1749, 1999

APPENDICOVESICOSTOMY
Current Indiana Results (110 pts.)

- Continence: 107/110 (97.3%)
- Complications:
  - Stomal revision: 7/110 (6.4%)
  - Channel revision 7/110 (6.4%)
  - Difficult cath conserv. Rx 6/110 (5%)
- 104/110 (94.5%) still in use
  - 3 replaced with Monti
  - 3 incontinent diversion (non compliant)

Dussinger, Cain et al 2004
APPENDICOVESICOSTOMY

Disadvantages

- Fatty mesentery
- Short mesentery
- Used for MACE
- Prior appendectomy

What do you do if there is no appendix available?
URETERAL URETHRA

Adams, Rink, Mitchell

Long tapered ileal tube

Rink, Adams 1991
CONTIENT ILEAL STOMA

Results
- 18/19 (95%) dry on ICC
- No stomal problems

Complications
- 1 reservoir perforation
- 1 wound infection
- 1 failure - stopped ICC

Rink, et al, 1991

GASTRIC TUBE

Bihrlle et al 1992
CONTINENT VESICOSTOMY
CONTINENT VESICOSTOMY

continence 100%

Stomal stenosis 45%
CONTINENT VESICOSTOMY

31 patients
- 17 RLQ, 7 umboum, 7 neoumbo
- 31/31 (100%) continent
- 14/31 (45%) stomal stenosis
- 20/31 (65%) still using CV

Cain, Rink et al
J Urol, 2002
NEW TECHNIQUES FOR CONSTRUCTION OF EFFERENT CONDUITS BASED ON THE MITROFANOFF PRINCIPLE

PAULO RICARDO MONTI, ROLF CARVALHO LARA, MARCOS ANTONIO DUTRA, AND JÉSUS REZENDE DE CARVALHO

Urol. 1997

YANG NEEDLE TUNNELLING TECHNIQUE IN CREATING ANTIREFLUX AND CONTINENT MECHANISMS

Yang, WH J.Urol. 150:830, 1993

Reconfigured ileum

MONTI - YANG

Yang 1993
Monti et al, 1997
Variability in Position of Mesentery (Monti Ileovesicostomy)
MONTI ILEOVESICOSTOMY
Implant into bladder

MONTI- YANG
## Early Data – Monti Procedure

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>F/U</th>
<th>Continent</th>
<th>Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gerharz</td>
<td>16</td>
<td>4.1</td>
<td>81%</td>
<td>n/a</td>
</tr>
<tr>
<td>Cain</td>
<td>21</td>
<td>8.5</td>
<td>95%</td>
<td>4%</td>
</tr>
<tr>
<td>Castellan</td>
<td>25</td>
<td>13</td>
<td>93%</td>
<td>0%</td>
</tr>
<tr>
<td>Mcandrew</td>
<td>21</td>
<td>34</td>
<td>n/a</td>
<td>24%</td>
</tr>
<tr>
<td>Narayanaswamy</td>
<td>25</td>
<td>25</td>
<td>88%</td>
<td>16%</td>
</tr>
</tbody>
</table>

*BJU, J Urol, Urol 1998-2001*
"The Yang – Monti ileovesicostomy: a problematic channel?" 92 pts. Great Ormond Street

- 69 Appendicovesicostomy, 25 Monti ileovesicostomy

<table>
<thead>
<tr>
<th>Cath.</th>
<th>Revised</th>
<th>Stomal stenosis</th>
<th>Bladder stenosis</th>
<th>Pouch dilation</th>
<th>Prolapse</th>
</tr>
</thead>
<tbody>
<tr>
<td>App.</td>
<td>18(27%)</td>
<td>10(15%)</td>
<td>10(15%)</td>
<td>4(6%)</td>
<td>0</td>
</tr>
<tr>
<td>Monti</td>
<td>15(60%)</td>
<td>5(20%)</td>
<td>4(16%)</td>
<td>2(8%)</td>
<td>7(28%)*</td>
</tr>
</tbody>
</table>

* Pouch like dilations in 7pts:
  - 6/7 two-segment (double) Monti
  - 4/7 post op catheter expulsion or occlusion, difficult replace
  - 5/7 treated conservatively

Narayanaswamy et al, BJU 87: 861, 2001

THE INDIANA EXPERIENCE
Monti-Yang Procedure

- 199 patients
- Most neuropathic bladders
- Most concomitant augmentation

Dussinger, Cain et al 2004
MITROFANOFF PROCEDURE
Monti Ileovesicostomy

- **4/199 (98%)** continent stoma
- **7/199 (7%)** early surg. complications
  - 3/7 small bowel obstruction
  - 1/7 VP shunt infection
  - 1/7 enterocutaneous fistula
  - 1/7 pelvic abscess
  - 1/7 empyema

MONTI ILEOVESICOSTOMY
Revisions

- **16/199 (8%)** stomal revisions
  - 10/16 stomal stenosis
  - 3/16 prolapse
  - 3/16 other stomal problems
- **19/199 (9.5%)** channel revisions
  - 7/19 elongation, angulation
  - 6/19 deficient tunnel
  - 6/19 other: stenosis, divertic., fistula
Comparison of Data
Appendicovesicostomy vs. Monti

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>F/U</th>
<th>Continent</th>
<th>Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple</td>
<td>408</td>
<td>33mo</td>
<td>94%</td>
<td>14.7% (revised + conserv.)</td>
</tr>
<tr>
<td>Authors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Appendix)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>199</td>
<td>28mo</td>
<td>98%</td>
<td>8% (revised)</td>
</tr>
<tr>
<td>Monti</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indiana</td>
<td>110</td>
<td>40mo</td>
<td>97.3%</td>
<td>8.2% (revised)</td>
</tr>
<tr>
<td>Appendix</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monti Technical Considerations

- 2 Layer running closure over 14/16 fr catheter
- Long intravesical tunnel
- Wide V-flap for stoma
- Secure bladder to abd. wall at muscular hiatus
- Catheterize channel several times during case
Continent Ileovesicostomy

Spiral Monti
Casale’s Spiral Monti

- 25/26 (96%) continent
  - 1 leak after implantation into gastric augment

- 22/25 (85%) catheterize without problems
  - 3 patients with intermittent difficulty, managed medically

- 1/26 (4%) stomal stenosis
  - Patient had developed a peristomal abscess
History and the Mitrofanoff

What is Next?

- Appendix / Ureter 1980
- Fallopian tube
- Vas deferens
- Stomach 1991
- Bladder 1992
- Yang 1993
- Tapered ileum 1994
- Prepuce 1995
- Monti 1997
- Spiral Monti 1999
Mitrofanoff = excellent urinary continence

What about the stool incontinence?
What about fecal continence?

Initial Bowel Clean Out:
- Magic Mousse (ice cream, pudding, mineral oil)
- Fleets enemas x 3 days
- Senokot (10-20 mg/kg QHS)
- Go-Lytely (50-100cc/kg)
- Increased Fiber and Fluids
Management of Neuropathic Bowel: Overcoming Chronic Constipation

Routine Maintenance Program:
- High Fiber and Fluid Intake
- Daily Suppository (glycerin, dulcolax)
- Digital Stimulation/Disimpaction
- Stool Softeners (colace, lactulose, mineral oil)
- Laxatives (Miralax, MOM)

Miralax dose 0.8 g/kg/day (17 gms/capful)

MACE Catheterizable Channel

- 1990- P. Malone
- Neuropathic bowel
- Antegrade enema
- May use tap water
- >90% fecal continence
MACE and Quality of Life

The MACE procedure can be easily performed and improves the quality of life in patients with neuropathic bowel.

Ellsworth et al. J Urol 1996
Yerkes and Cain et al. J Urol 2003

“A MACE A Day Keeps The Diapers Away..”
• **Medical management**
  – Mean: 5.7 years
  – Mean # methods attempted: 3.7
    • Most helpful: ‘nothing’, timed toileting
    • Least helpful: suppository, enema, senekot

• **All reported MACE as superior to medical management**
  – 91% ’significantly better’

**SATISFACTION**

• **89% reported the highest level of satisfaction**
  – 1.5% (1 pt) gave an unsatisfactory rating

• **88% would have the MACE again or recommend to friend**
  – 1.5% (1pt) definitely would not
SOCIAL CONFIDENCE / HYGIENE

N=65

- 88% SIGNIFICANTLY BETTER
- 9% BETTER
- 3% NO CHANGE

MACE CLINICAL OUTCOME

- 77% have complete or nearly complete fecal continence
  - the other 23% report improved continence
  - 12% still had weekly incontinence
- 91% require no other bowel program
  - 9% take oral meds regularly
  - 28% have used medication through MACE
MACE
Tap Water

71 pts 101 sets electrolytes
- No significant Na change related to MACE
- 13 moderate hyperchloremia (77% ileal augmentation)
- ↑Na, ↑Cl⁻ (softened water)
- Avg 550 cc (300 to 1000 cc)

Yerkes, et al, 2000

MACE SPECIFICS

- Irrigation time:
  - 79% require > 30 minutes
  - 44% require > 45 minutes
- 77% irrigate daily
- 78.5% catheterize stoma only daily
IN-SITU IMBRICATED APPENDIX:
Experience with a Simple MACE Technique
Rink RC, Casale AJ, Cain MP, King SJ
Indiana University School of Medicine
Indianapolis, Indiana

MACE

Rink et al 1998
MACE

Rink et al 1998
Mean Follow Up = 2 yrs
Fecal Continence = 91%
Complications: (13%)
Major = 6 pts (volvulus, SBO, shunt, leak)
Minor = 11 pts (stomal stenosis, prolapse)

Indiana Univ. MACE Experience

168 MACE Procedures 127 in-situ

Herndon, Rink, Cain et al, J Urol 2004
CONCLUSIONS

• MACE ≠ Perfection
  – Significant improvement is realistic
  – Intermittent constipation
  – Trade-off: time and effort

MACE Alternatives

When the appendix is not available, the Monti-MACE is an effective alternative to the in-situ appendix.

Liloku et al J Ped Surg 2002
Yerkes and Rink et al J Urol 2002
Tackett and Sheldon et al J Urol 2002
MONTI - MACE

13 PATIENTS
- F/U 21.7 mos.
- all continent at abd. Wall
- 2 stomal revisions

Yerkes et al 2001
However, the Monti-MACE:

- Small bowel anastamosis
- May be tethered by shortened mesentery
- Requires reimplantation into colon

**MACE Alternatives**

In 1993, Squire introduced the colon flap MACE.

- Avoids small bowel anastamosis.
- Time efficient

Squire et al 1993 BJU
MACE Alternatives

- 1997-2003: 168 MACE procedures
- 12 Colon flap procedures (7 cecal, 5 other)
- 9/12 successful (3 stenosis)

Herndon, Cain, Rink et al, 2003
WHAT DO YOU DO IF YOU NEED A CATH CHANNEL FOR BLADDER AND BOWEL?

Split the Appendix

Appendicocecostomy

Appendicovesicostomy
MITROFANOFF
Limit complications

Conclusions

• It allows us to aggressively achieve dryness
• Improves independence and social well being
• It provides privacy from care givers
• It is preferred by the patients
  Horowitz et al
• It may decrease bladder perforation
  Metcalfe et al
• Stomal complications not uncommon but easily treated
  DeGanck et al BJU,2002
Everyone who cares for the child must be able to catheterize
MPC Mitrofanoff/MACE

- 1996-2004 - 99 patients
- Bladder Augment = 56
- Mitrofanoff = 74
  (Monti 48, Appendix 20, CV 6)
- MACE = 58
  (Appendix 52, Monti 3, Cecal flap 3)

MPC Mitrofanoff/MACE
Results – Secondary Revision

Mitrofanoff Procedure

7/74 (9.5%) revision
  - exclude CV 3/68 (4.4%)
Leakage – 2 pts with Monti
Angulation – 1 Monti
Stomal stenosis – 4 CV, 1 Monti
MPC Mitrofanoff/MACE
Results – Secondary Revision

MACE Procedure
6/58 (10%) revision
Stomal stenosis – 4 pts
Obliteration/False Passage – 2 pts
(1 cecal flap, 1 Monti-MACE)

“But there is still so much to do, so much to live for”
Hugh Hampton Young, 1940
Urologic Problems And Spina Bifida-
Lesion Does Not Predict Bladder Outcome