Current Thoughts About Laparoscopic Fundoplication in Infants and Children

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What Do We Know Now That We Did Not Know in 2000?
Preoperative Evaluation

• 24 hr pH study – gold standard in many centers
• Impedance study– acid & alkaline reflux
• Upper GI contrast study - reflux seen in only 30%
• Endoscopy - visualization only not sensitive
• Endoscopy with biopsy – probably most sensitive
• Gastric emptying study ?
• Esophageal motility study - not needed in children?
Children’s Mercy Hospital

Jan 2000 – June 2007
843 fundoplications
(3.6% op. vol.)

UGI – 656 pts

pH study – 379 pts
Sensitivity UGI – 30.8%

AAP, 2009
J Pediatr Surg 4:1169-1172, 2010
Children’s Mercy Hospital

UGI – 656 pts

Abnormality (other than GER) – 30 pts (4.5%)

Suspected malrotation – 26 pts (4.0%)

Confirmed (16 pts)  No malrotation (6 pts)  Prev. Ladd (4 pts)

AAP, 2009
J Pediatr Surg 4:1169-1172, 2010
Children’s Mercy Hospital

UGI – 656 pts

Influences management - 4%

Malrotation is the most common finding

AAP, 2009

J Pediatr Surg 4:1169-1172, 2010
Preoperative Evaluation

Gastric Emptying Study

Fundoplication Enhances Gastric Emptying

GUY J. MADDERN, M.B., B.S.,* GLYN G. JAMIESON, M.S., F.R.A.C.S., F.A.C.S.†

Is a Gastric Drainage Procedure Necessary at the Time of Antireflux Surgery?


Delayed Gastric Emptying in Neurologically Impaired Children With Gastroesophageal Reflux: The Role of Pyloroplasty

By R. Todd Maxson, Susan Harp, Richard J. Jackson, Samuel D. Smith, and Charles W. Wagner

Little Rock, Arkansas
GERD
Fundoplication

Indications for operation

• Failure of medical therapy
• ALTE/weight loss in infants
• Refractory pulmonary symptoms
• Neurologically impaired child who needs gastrostomy
Options for Fundoplication

• Laparoscopic vs open

• Complete (Nissen) vs Partial (Thal, Boix-Ochoa, Toupet)
ISSUES/QUESTIONS
1) Effects of Pneumoperitoneum

- ↑ SVR
- ↑ PVR
- ↓ SV
- ↓ CI
- ↓ Venous Return
  (Head up)

- ↑ pCO₂
- ↓ FRC
- ↓ pH
- ↓ pO₂
Proceed With Caution

• Neonates (in general) with reactive or persistent pulmonary HTN

• Palliated defects with passive pulmonary blood flow (Glenn, Fontan procedures) – Risk is ↓ pulmonary flow, reversal of flow thru shunt and clotting of shunt

• Any defect adversely affected by ↑ SVR
  • HLHS
  • Unrepaired septal defects: VSD, CAVC
  • Risk is acute CHF 2° to ↑ afterload & ↑ shunting, unbalancing the defect
Laparoscopic Fundoplication

2. Is dysphagia a common problem following laparoscopic Nissen fundoplication in infants and children?
## Intraoperative Bougie Sizes

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Bougie Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5-4.0</td>
<td>20-24</td>
</tr>
<tr>
<td>4.0-5.5</td>
<td>24-28</td>
</tr>
<tr>
<td>5.5-7.0</td>
<td>28-32</td>
</tr>
<tr>
<td>7.0-8.5</td>
<td>32-34</td>
</tr>
<tr>
<td>8.5-10.0</td>
<td>34-36</td>
</tr>
<tr>
<td>10.0-15.0</td>
<td>36-40</td>
</tr>
</tbody>
</table>

Table 1. Recommended Bougie Size for Esophageal Calibration According to Patient Weight

PAPS, 2002
JPS 37:1664-1666, 2002
Laparoscopic Fundoplication

3. Should the esophagus be extensively mobilized in laparoscopic fundoplication?

Video
1. Less mobilization of esophagus

2. Keep peritoneal barrier b/w esophagus & crura
3. Secure esophagus to crura at 8, 11, 1 and 4 o’clock
Technique Changed 2002

Video
Why The Change in Technique?
Personal Series - CMH
Jan 2000 – March 2002
130 Pts
No Esophagus – Crural Sutures
Extensive Esophageal Mobilization

Mean age/weight 21 mo/10 kg
Mean operative time 93 minutes
Transmigration wrap 15 (12%)
Postoperative dilation 0

APSA, 2006
Personal Series - CMH
April 2002 – December 2004

119 Pts
Esophagus – Crural Sutures
Minimal Esophageal Mobilization

Mean age/weight 27 mo/11 kg
Mean operative time 102 minutes
Transmigration wrap 6 (5%)
Postoperative dilation 1

APSA 2006
Prospective, Randomized Trial

- 2 Institutions: CMH, CH-Alabama
- Power analysis using retrospective data (12% vs 5%): 360 patients
- Primary endpoint - transmigration rate
- 2 groups: minimal vs. extensive esophageal dissection
- Both groups received esophago-crural sutures
- Stratified for neurological status
- UGI contrast study one year post-op
- APSA, 2010
### Preoperative Demographics

<table>
<thead>
<tr>
<th></th>
<th>Extensive Esophageal Mobilization (N=87)</th>
<th>Minimal Esophageal Mobilization (N=90)</th>
<th>(P)-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>1.9 +/- 3.3</td>
<td>2.5 +/- 3.5</td>
<td>0.30</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>10.7 +/- 11.9</td>
<td>12.6 +/- 18.2</td>
<td>0.44</td>
</tr>
<tr>
<td>Neurologically Impaired (%)</td>
<td>51.7</td>
<td>54.4</td>
<td>0.76</td>
</tr>
<tr>
<td>Operating Time (Minutes)</td>
<td>100 +/- 34</td>
<td>95 +/- 37</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Minimal vs Extensive Esophageal Mobilization During Laparoscopic Fundoplication

## Results

<table>
<thead>
<tr>
<th></th>
<th>Extensive Esophageal Mobilization (N=87)</th>
<th>Minimal Esophageal Mobilization (N=90)</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative Wrap Transmigration (%)</td>
<td>30.0%</td>
<td>7.8%</td>
<td>0.002</td>
</tr>
<tr>
<td>Need for Re-do Fundoplication (%)</td>
<td>18.4%</td>
<td>3.3%</td>
<td>0.006</td>
</tr>
</tbody>
</table>

APSA, 2010
Minimal vs. maximal esophageal dissection and mobilization during laparoscopic fundoplication: Long-term follow-up from a prospective, randomized trial

Amita A. Desai, Hanna Alemayehu, G.W. Holcomb III, Shawn D. St. Peter *

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ARTICLE INFO

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ABSTRACT

Purpose: We have previously conducted a prospective randomized trial (PRT) comparing circumferential phrenoesophageal dissection and esophageal mobilization (MAX) to minimal dissection/mobilization (MIN). The MIN group had a decreased incidence of postoperative wrap herniation and need for reoperation. This study provides long-term follow-up of the patients from our center who participated in the PRT.

Methods: Parents of patients in the PRT were queried regarding symptoms, medication use, postoperative complications, and additional procedures. Medical records were reviewed. Student's t-test was used for continuous variables. Fisher's exact and chi-square with Yates correction were used where appropriate.

Results: Of patients from our center, 75.4% MAX and 72.5% MIN patients were contacted. Median time to follow-up was 6.5 years. A rise in the incidence of herniation was noted in both groups (22.7% to 36.5% MAX vs 2.8% to 12.2% MIN). Time to diagnosis of hernia was significantly longer in the MIN group (14.7 ± 9.5 months MAX vs 30.2 ± 23.6 months MIN, P = 0.04). There was no significant difference between MIN and MAX group in reflux symptoms or medication use.

Conclusion: Long-term follow-up demonstrates an increase in incidence of herniation in both groups. Previously demonstrated higher risk of wrap herniation with maximal esophageal dissection during laparoscopic fundoplication remains supporting original findings.

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Table 1
Demographics at the time of original surgery of those with long-term follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Minimal esophageal dissection (n = 43)</th>
<th>Maximal Esophageal Dissection (n = 39)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at original surgery (months)</td>
<td>21.0 ± 31.2</td>
<td>22.7 ± 38.7</td>
<td>P = 0.8</td>
</tr>
<tr>
<td>Weight at original surgery (kg)</td>
<td>8.8 ± 8.4</td>
<td>12.9 ± 14.1</td>
<td>P = 0.2</td>
</tr>
<tr>
<td>Neurologic impairment at original surgery</td>
<td>16</td>
<td>21</td>
<td>P = 0.6</td>
</tr>
<tr>
<td>Gender (male)</td>
<td>19</td>
<td>28</td>
<td>P = 0.2</td>
</tr>
<tr>
<td>Contacted (%)</td>
<td>70.5</td>
<td>63.4</td>
<td>P = 0.8</td>
</tr>
<tr>
<td></td>
<td>Minimal esophageal dissection (n = 3)</td>
<td>Maximal esophageal dissection (n = 13)</td>
<td>P value</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>--------------------------------------</td>
<td>---------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Average time to postoperative wrap transmigration by UGI (months)</td>
<td>30.2 ± 23.6</td>
<td>14.7 ± 9.5</td>
<td>P = 0.04</td>
</tr>
<tr>
<td>Average time to 1st reoperation of symptomatic patients (months)</td>
<td>32.4 ± 22.0</td>
<td>15.2 ± 11.0</td>
<td>P = 0.06</td>
</tr>
<tr>
<td>Average time between 1st and 2nd reoperation</td>
<td>16.8 ± 17.9</td>
<td>8.2 ± 4.9</td>
<td>P = 0.4</td>
</tr>
</tbody>
</table>
Study Just Completed

- Analysis (80% power, $\alpha - 0.05$) – 110 patients
- Minimal esophageal dissection in all patients
- 4 esophago-crural sutures vs. no sutures
- UGI study at one year postoperatively
No Esophago-crural Sutures

Video
Review of the Experience with Re-operation After Laparoscopic Nissen Fundoplication

Amita A. Desai, MD; Hanna Alemayehu, MD; Brian G. Dalton, MD; Katherine W. Gonzalez, MD; Brian Biggerstaff, MD; George W. Holcomb III, MD, MBA; and Shawn D. St. Peter, MD

Abstract

Introduction: The risk of redo fundoplication has been demonstrated to be significantly higher in patients of younger age, those with ongoing retching, and those who underwent more extensive dissection of the esophageal hiatus at the initial operation. The purpose of this study was to review the management and outcomes of patients who required one or more re-operations for recurrence after laparoscopic fundoplication.

Materials and Methods: After obtaining Institutional Review Board approval, we performed a retrospective review of all patients who underwent laparoscopic Nissen fundoplication from 2000 to 2013 and subsequently required a redo operation for recurrence. Patient demographics, neurologic impairment, interval time between re-operations, operative approach, use of mesh, and length of follow-up were analyzed. Two-tailed independent Student’s t test was used to compare continuous variables, and two-tailed chi-squared test with Yates’s correction (Fisher’s exact test where appropriate) was used for discrete variables.

Results: Eighty-two patients (10.3% of the sample) required re-operation during the study period. The mean age at initial surgery was 1.8 ± 3.6 years. Fifteen patients (18.3%) required more than one re-operation. Of the 102 re-operations performed, 68 were successfully managed laparoscopically, 3 required conversion to an open procedure, and 31 were performed open from the outset. Of those patients requiring more than one re-operation, there was no difference in age, weight, use of mesh, or time to subsequent re-operations compared with patients that only required one redo fundoplication.

Conclusions: The incidence of patients requiring another operation after a redo operation after an initial laparoscopic fundoplication is 18%. Patient demographics and time to re-operation have not been found to be predictive of which patient will require multiple re-operations for recurrence. However, younger patients and those with a shorter time to re-operation may increase the likelihood of failure.
<table>
<thead>
<tr>
<th>Table 3. Comparison of Patients Prior to and After Change in Surgical Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial surgery</strong></td>
</tr>
<tr>
<td><strong>Prior to 2009</strong></td>
</tr>
<tr>
<td>(n=512)</td>
</tr>
<tr>
<td><strong>After 2009</strong></td>
</tr>
<tr>
<td>(n=284)</td>
</tr>
<tr>
<td><strong>P value</strong></td>
</tr>
<tr>
<td><strong>Patients requiring re-operation</strong></td>
</tr>
<tr>
<td>70 (13.7%)</td>
</tr>
<tr>
<td>12 (4.2%)</td>
</tr>
<tr>
<td>&lt;.01</td>
</tr>
<tr>
<td><strong>Indications for re-operation</strong></td>
</tr>
<tr>
<td><strong>Wrap transmigration</strong></td>
</tr>
<tr>
<td>55 (78.5%)</td>
</tr>
<tr>
<td>4 (33.3%)</td>
</tr>
<tr>
<td>&lt;.01</td>
</tr>
<tr>
<td><strong>Wrap disruption</strong></td>
</tr>
<tr>
<td>4 (5.7%)</td>
</tr>
<tr>
<td>6 (50%)</td>
</tr>
<tr>
<td>&lt;.01</td>
</tr>
<tr>
<td><strong>Recurrent reflux symptoms</strong></td>
</tr>
<tr>
<td>1 (1.4%)</td>
</tr>
<tr>
<td>2 (16.6%)</td>
</tr>
<tr>
<td>.06</td>
</tr>
<tr>
<td><strong>Emergency conditions</strong></td>
</tr>
<tr>
<td>4 (5.7%)</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>1.0</td>
</tr>
<tr>
<td><strong>Time (years) to first re-operation</strong></td>
</tr>
<tr>
<td>2.5±2.6</td>
</tr>
<tr>
<td>1.7±1.4</td>
</tr>
<tr>
<td>.3</td>
</tr>
<tr>
<td><strong>Patients with &gt;1 re-operation</strong></td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td><strong>Mesh at first re-operation</strong></td>
</tr>
<tr>
<td>33</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>.5</td>
</tr>
</tbody>
</table>
Laparoscopic Nissen fundoplication mainly reduces the volume of acid reflux and potentially improves mucosal integrity up to the middle esophagus in neurologically impaired children detected by esophageal combined pH–multichannel intraluminal impedance measurements

Suguru Fukahori a,*, Minoru Yagi a, Shinji Ishii a, Kimio Asagiri a, Nobuyuki Saikusa a, Naoki Hashizume a, Motomu Yoshida a, Daisuke Masui a, Saki Sakamoto a, Shihori Tsuruhisa a, Tomohiro Kurahachi a, Yoshiaki Tanaka a,b

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ABSTRACT

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Background: The aim of this study was to evaluate detailed changes of gastroesophageal reflux disease (GERD) in children before and after laparoscopic Nissen fundoplication (LNF) utilizing esophageal combined pH–multichannel

• 13 patients
• 8 mos - 20 yrs
• All neurologically impaired
• All underwent LNF
• Impedance/pH studies before and 1 year after LNF
• LNF prevents high-volume refluxate, mainly acid reflux episodes, from rising to the proximal esophagus and is expected to improve the mucosal integrity up to the middle esophagus.

QUESTIONS

www.cmhclinicaltrials.com

www.cmhmis.com