The Nuss Procedure

Gregory Banever, M.D.

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Outline

• History
• Description of Procedure
• Physiologic Testing Data
• Recent Results
• Benefits/ Strengths
• Summary
History

- First Described - JPS 1998

A 10-Year Review of a Minimally Invasive Technique for the Correction of Pectus Excavatum

By Donald Nuss, Robert E. Kelly, Jr, Daniel P. Croitoru, and Michael E. Katz
Norfolk, Virginia

- Modification of the open procedure
  - Initially through central incision
  - Lateral incisions
History

• Since 1998
  - Several large series, many smaller
  - International
  - Numerous modifications
  - >130 papers published
Description

Nuss et al. JPS 1998.
Description

• 1-2. Supine, arms out

• 3. Marking

• 4. Bar length
Description

• 5. Bending bar

• 7-9. Introducer passed

Pectus Introducer

www.lorenzsurgical.com
Description

- Thoracoscopy
Description

• 11. Tape passed

• 12. Bar passed

• 13. Bar flipped
Description

• 17. Stabilizer
  Rib sutures

• 18. Closure
Description

• Important Modifications
  - Thoracoscopy*
  - Specialized introducer*
  - Lateral stabilizer*
  - Rib fixation
  - Patient age
  - 2-3 year bar duration

* Nuss et al. JPS 2002
Cardiopulmonary Function

• Does pectus excavatum cause impairment?
• Will correction improve this?
• Does the type of correction matter?
• Can this be documented?
Cardiopulmonary Function

- Conflicting results
- Confounding Variables
  - Procedure type
  - Type of testing
  - Timing of testing
  - Bar in/out?
  - Small numbers
  - Variability in physical conditioning
Cardiopulmonary Function

• Pectus Excavatum - pre-repair

  - Koumbourlis and Stolar. Ped Pulm 2004 (PFTs)
    • 51% normal, 41% obstructive, 5% restrictive

  - Malik et al. Chest 2003 (Exercise PFTs)
    • CV limitations, not respiratory

  - Rowland et al. Arch Ped Adolesc Med (Ex+Echo)
    • Reduced peak tidal vol, CI, endurance (watts/ kg)
Cardiopulmonary Function

- **Nuss**

<table>
<thead>
<tr>
<th></th>
<th>Bar IN</th>
<th>Bar OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>Borowitz</td>
<td>Aronson</td>
</tr>
<tr>
<td>CV better</td>
<td>Coln, Sigalet</td>
<td>Bawazir</td>
</tr>
<tr>
<td>Pulm better</td>
<td>Aronson</td>
<td>Kibiak, Lawson, Sigalet</td>
</tr>
<tr>
<td>Pulm worse</td>
<td>Borowitz, Sigalet</td>
<td>Borowitz</td>
</tr>
</tbody>
</table>
Cardiopulmonary Function

- Ravitch

  - No change: Lacquet, Morshuis, Wynn
  - Increased WOB: Lacquet, Morshuis
  - Pulm better: Cahill
  - Pulm/ CV better: Haller, Quigley (slight)
Cardiopulmonary Function

Pulmonary function following surgical repair of pectus excavatum: a meta-analysis

Moh H. Malek a,*, Dale E. Berger b, William D. Marelich c, Jared W. Coburn d, Travis W. Beck a, Terry J. Housh a

- 12 studies, 313 patients
- Both techniques - No effect
Cardiopulmonary Function

• Summary
  - Overall mixed results
  - Mild objective improvement
  - Significant subjective improvement
  - Further, controlled study needed
Pooled Results

• Larger series
  - Nuss (668) – Virginia
  - Pilegaard (383) – Denmark
  - Dzielicki (461) – Poland
  - Park (322) – South Korea
  - Hosie (172) – Europe
Pooled Results

- **General Data**
  - LOS: 4-6 days
  - OR Duration: 37-80 mins
  - Good-Excellent: 82-99%
  - Complications: 9-20%
  - Bar displacement: 2-9% (Nuss - 0.8%)
Comparative Results

- Interpret carefully

**Pectus Excavatum Repair: Experience With Standard and Minimal Invasive Techniques**

By Kim A. Molik, Scott A. Engum, Frederick J. Rescorla, Karen W. West, L.R. Scherer, and Jay L. Grosfeld

*Indianapolis, Indiana*

- 2001
- N=25 Nuss pts., 68 open
- Nuss reoperation rate = 29%
- Similar cost and complication rates

Molik et al. JPS 2001
Comparative Results

Minimally invasive repair of pectus excavatum: A single institution’s experience

K. A. Miller, MD, R. K. Woods, MD, R. J. Sharp, MD, G. K. Gittes, MD, K. Wade, RN, CS, PNP, K. W. Ashcraft, MD, C. L. Snyder, MD, W. M. Andrews, MD, J. P. Murphy, MD, and G. W. Holcomb III, MD, Kansas City, Mo

- 2001
- N=80 Nuss pts.  32 open
- “Encouraging”

Table I. Short-term results for open versus MIS bar repair of pectus excavatum

<table>
<thead>
<tr>
<th></th>
<th>Open repair (n = 32)</th>
<th>MIS repair (n = 80)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time</td>
<td>143</td>
<td>53</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>(mean, min)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Blood loss</td>
<td>6</td>
<td>0.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>(mean, mL/kg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of stay (days)</td>
<td>3.2</td>
<td>3.7</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

Miller et al. Surgery 2001
Comparative Results

Comparison of Minimally Invasive and Modified Ravitch Pectus Excavatum Repair

By Eric W. Fonkalsrud, Steven Bean, Andre Hebra, William Adamson, and Edward Tagge
Los Angeles, California and Charleston, South Carolina

- 2002
- N=68 Nuss pts., 139 open
- Nuss: longer LOS, narcotic use, more complications
- 9% bars flipped
- 90% of complications occurred in first 25 cases

Fonkalsrud et al. JPS 2002
Comparative Results

Reduced hospitalization cost for patients with pectus excavatum treated using minimally invasive surgery

T. H. Inge,¹ E. Owings,² C. J. Blewett,³ C. E. Baldwin,² W. S. Cain,² W. Hardin,² K. E. Georgeson²

- 2003
- N = 43 Nuss pts., 23 open
- Nuss: Shorter LOS (2.4d vs 4.4d)
- Nuss: Less cost ($6324 vs $8633)
- Higher compl: bar disloc’n prior to fixation

Inge et al. Surg Endosc 2003
Nuss - Versatility

• Adults
  • Hebra et al. Am Surg 2006
  • Schalamon et al. J Thor CV Surg 2006
  • Aronson et al. World J Surg 2006

• Failed or Recurrent
  • Croitoru et al. JPS 2005
  • Miller et al. JPS 2002
Nuss – Quality of Life

- Improved self-esteem and satisfaction
  - Krasopoulos et al. Eu J CT Surg 2005

- Improved physical symptoms, self-image
  - Lawson et al. JPS 2003
  - Roberts et al. JPS 2003
Unusual Complications

• **Bar infection, Pericarditis**
  - Most respond to medical treatment

• **Nickel allergy**
  - Preventable - H+P, skin testing, titanium bar
    » Rushing et al. JPS 2007

• **Recurrence/ Reoperation**
  - Improved fixation, bar duration 3 years

• **Cardiac injury/ death**
  - Rare, thoracoscopy
Complications

• Ravitch
  - Wound infections
  - Recurrence
  - Floating sternum
  - Chest wall constriction
Summary

• Nuss procedure
  - New (9 years vs >50 years)
  - Data is early
  - Technical variability
  - ? learning curve
  - Rare serious complications
    • Analysis of technique
  - Excellent results and satisfaction
Questions?