Technical Aspects of The Minimally Invasive Pectus Repair

Robert J. Obermeyer, MD, FACS, FAAP
Assistant Professor of Clinical Surgery and Pediatrics
Department of Pediatric Surgery
Eastern Virginia Medical School
Children’s Hospital of The King’s Daughters
Norfolk, Virginia

Conflict of Interest

- Consulting, Biomet Microfixation, LLC

Objectives

- At the conclusion of this course, participants will be able to:
  - Select and shape a Pectus bar
  - Determine bar position
  - Stabilize the bar

Is the Grass Greener?
Early Results of the Nuss Procedure

Scott Engum, Fred Rescorla, Karen West, Thomas Rouse, L.R. “Tres” Scherer, Jay Grosfeld

Conclusions:
The Nuss Procedure is a quick, minimally invasive, and technically easy method to learn; however, our data indicate there is a significant learning curve.

Goal of this course:
Reduce the learning curve

Preoperative Preparation

- Give ICS to patient preoperatively
- Teach them to use it now rather than postop
- Instruct them to use it frequently up until the time of their surgery (20+/day)
- Chlorhexidine skin cloths

Intraoperative Preparation

- Chlorhexidine vs Betadine skin prep
- Antibiotic prophylaxis
- Judicious fluids at start of case
MINIMALLY INVASIVE PECTUS REPAIR

Technical Details
Positioning
Measuring
Bar selection and configuration
Skin Preparation and Antibiotics
Marking the patient
Thoracoscopy
Subcutaneous tunnel
Substernal tunnel
Sternal elevation
Bar insertion and rotation
Bar fixation
Pneumothorax evacuation
Chest Xray

Positioning the Patient
Arms are abducted
70-deg at the shoulder
90-deg at the elbow

“THE NEW POSITION ON SURGICAL TABLE”

Minimizes the possibility of a brachial plexus lesion
Due to the placement of the arms of the patient along the body

MINIMALLY INVASIVE PECTUS REPAIR

Technical Details
Positioning
Measuring
Bar selection and configuration
Skin Preparation and Antibiotics
Marking the patient
Thoracoscopy
Subcutaneous tunnel
Substernal tunnel
Sternal elevation
Bar insertion and rotation
Bar fixation
Pneumothorax evacuation
Chest Xray

Measuring After Induction
Corrective Pressure = Pain
Nerve Contact = Pain
MINIMALLY INVASIVE PECTUS REPAIR

Technical Details
Positioning
Measuring
Bar selection and configuration
Marking the patient
Thoracoscopy
Subcutaneous tunnel
Substernal tunnel
Sternal elevation
Bar insertion and rotation
Bar fixation
Pneumothorax evacuation
Chest Xray

Nuss Bar should be ~1 inch shorter than external measurement

Bending the bar
Avoid excessive bending at the ends of the bar

Correct Configuration of Pectus Bar
Pectus Bar should fit against chest

MINIMALLY INVASIVE PECTUS REPAIR

Skin Preparation and Antibiotics
Chlorhexidine may be superior to Betadine
Place towels around prep site and remove (FIRE & BURN RISK)
Cefazolin 30mg/kg (Peds)
2 gm (Adults <120kg)
Within 30 min
Re-dose q 4 hours
MINIMALLY INVASIVE PECTUS REPAIR

Technical Details
- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics

Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray

Marking the Chest

1) Deepest point of the depression
2) Intercostal spaces in the same horizontal plane

Marking Bar Insertion Site

Skin Incision, Entry and Exit Sites, Sternum, and Deepest Point of Excavatum are IDEALLY all in the Same Horizontal Plane

Deepest Point is often lower than end of Sternum
If two bars are needed you can plan incision so both bars can be placed through one incision

Skin Incision – Female Patient

Identify the Inframammary Crease

MINIMALLY INVASIVE PECTUS REPAIR

Technical Details
- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics

Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray

Why is there a need for thoracoscopy?

During difficult visualization consider placing a port on both sides
Thoracoscopy
At least one bar should be under the sternum for structural support.

Consider additional bars in the following circumstances:
- Incomplete repair ⇒ residual depression
- Unstable correction ⇒ bar tries to flip
- Excessive pressure ⇒ subjective assessment

MINIMALLY INVASIVE PECTUS REPAIR
Technical Details
- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics
- Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray

Technical Details
- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics
- Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray

Tunnel – Subpectoral or Subcutaneous
* Bilateral *

Subpectoral
Cephalad
Finger
Sweep

Subpectoral or Subcutaneous

Subpectoral
Subcutaneous

MINIMALLY INVASIVE PECTUS REPAIR

Original “Introducer”
Consider starting with a smaller introducer first then use a larger one if needed.

When focused on the tip, pay attention to the "elbow".

Creating Substernal Tunnel

Right entry site marked with an X.
This site is typically at or medial to the top of the pectus ridge.

Substernal Tunnel Creation

The introducer is inserted through the tunnel. The pleura and pericardium are carefully dissected off the undersurface of the sternum under direct thoracoscopic visualization.

Inserting Two Bars - Options

Option #1: Place one bar at a time (easier repair).
Option #2: Place both introducers then place the bars (difficult repair).

Tunneling

Inserting Two Bars - Options
**Inserting Two Bars**

*When to Consider*

- **Preoperative:** Long deformity, deep defect, rigid chest, older patients
- **Intraoperative:** Unstable bar, suboptimal elevation, excess pressure
- **Postoperative:** “If it doesn’t look good on the table, it won’t look good in the recovery room. I have never regretted placing two bars” (multiple personal communications with Dr. Nuss)

**Insertion Site**

Variable based on sternum relative to defect

- Larger intercostal spaces higher up on sternum
- Placement close to the sternum causes more over-correction than under-correction
- One bar should be under the sternum
- Consider creating the easier (higher) tunnel first

**MINIMALLY INVASIVE PECTUS REPAIR**

**Technical Details**

- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics
- Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray

**Sternal Elevation**

10-15 seconds 3+ times

- More Stretching = Less Corrective Force
- Two Bars = Same Force but Less Pressure (psi or Pa)
- Less Pressure = Less Pain

**p** = Force/Area

**MINIMALLY INVASIVE PECTUS REPAIR**

**Technical Details**

- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics
- Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray
**Umbilical Tape Attached to Introducer**

The introducer is slowly withdrawn from the chest.
Umbilical tape is pulled through the substernal tunnel.

**Bar Insertion**

Thoracoscopic visualization
The bar is inserted into the right subcutaneous tunnel.
Gentle traction is applied on the umbilical tape to guide the bar.
Bar is guided through the substernal tunnel upside down.
Index finger can be inserted into tunnel on left side helps guide the bar and avoid potential injury to the pericardium.

**Bar Flippers**

**Bar Rotation**

Rotation clockwise or counter-clockwise under thoracoscopic visualization.
Try not to pull outward on the Bar Flipper during rotation because this will straighten bars.

**MINIMALLY INVASIVE PECTUS REPAIR**

**Technical Details**
- Positioning
- Measuring
- Bar selection and configuration
- Skin Preparation and Antibiotics
- Marking the patient
- Thoracoscopy
- Subcutaneous tunnel
- Substernal tunnel
- Sternal elevation
- Bar insertion and rotation
- Bar fixation
- Pneumothorax evacuation
- Chest Xray
Bar Stabilization is essential

Stabilizer typically secured to one end with Fiberwire #0 or #1 looped PDS pericostal sutures to at least two separate ribs

Pericostal Suture

Fixation to TWO separate ribs Decreases degrees of rotational freedom

Two stabilizers should be used with caution in growing patients but a reasonable option in certain older patients

Stabilizer

Bar fixation to Stabilizer

#3 SS Wire, Fiberwire, Prolene
Evacuation of Pneumothorax

Pneumothorax is evacuated by placing insufflation tubing under water & giving positive pressure ventilation (30mmHg max)
May need an occlusive dressing over port
Durant position – “head down and to the left”
Bar Switch Technique

Step One
Chest tube of limited benefit for this step – maybe harder, but…

Multiple Silk Suture

Step Two
Attach chest tube to NEW pectus bar

New Pectus Bar

Step Three
Pull NEW pectus bar through with chest tube
Acts as a guide through scar tissue and calcification
Chest tube maybe safer for this step

Relaxing Incisions

Operative innovation to the “Nuss” procedure for pectus excavatum: operative and functional effects
Ali Al-Azizi, Maggie MacGregor, Victor Meng, Ryan Drizen, Erin Macran, and David L. Sigurgeirsson
Department of Pediatric Surgery, Alberta Children’s Hospital, University of Calgary, Calgary, Alberta, Canada T2N 4N9
Accepted in February 2004; accepted in revised form 7 January 2005

Relaxing Incisions

Fig. 3. The relaxing incisions reduce the force required to insert the pectus bar.

A

B
Relaxing Incisions

Rib
Cartilage

Relaxing Incisions

Relaxing Incisions

Questions