Society for Pediatric Anesthesia
education • research • patient safety

RAVITCH PROCEDURE

Surgical Specialty:	Thoracic Surgery
Authors:	Carly Smith, MD; Senthil Packiasabapathy Riley Hospital for Children, Indianapolis, IN

Background:

- General Considerations
    - Pectus excavatum (funnel chest) and the less common pectus carinatum (pigeon chest) deformities are congenital abnormalities of the sternum, ribs, and costal cartilage. These deformities are usually minimal at birth but progress with age.
    - The Ravitch procedure for pectus carinatum involves extra-pleural excision of the sternocostal cartilages and mobilization of the sternum and ribs. It is generally reserved for the more severe cases of pectus excavatum.
    - For the majority of patients, a minimally invasive technique (the Nuss procedure) is used for pectus excavatum. In this procedure, the costal cartilages are preserved, and the sternum is elevated with a bar used to correct the deformity.
- Patient Considerations
    - While being common in males, a higher incidence of both deformities occurs in children with Marfan syndrome, congenital heart disease, and in families in which other children have the defect.
    - Scoliosis is often associated.
    - Adolescents often request to be operated upon for cosmetic or functional reasons (shortness of breath during exercise, etc.)
    - These children often appear asymptomatic but occasionally have cardiac or pulmonary abnormalities related to the deformity, including:
        - Pulmonary: normal or modestly reduced FVC and TLC, and in severe cases, V/Q mismatch
        - Cardiac: left heart displacement and compression, leading to arrhythmias, right axis deviation on EKG, reduced stroke volume, and functional murmur that is most noticeable in the standing position and with exercise. There is also an increased incidence of mitral valve prolapse.

Anesthetic Planning:

- Preoperative Assessment
    - Focuses on exercise tolerance and other signs of cardiopulmonary compromise, such as the presence of lung infections

        - Echocardiograms are performed to detect the presence of mitral valve prolapse (MVP) and right ventricular outflow tract obstruction (RVOTO). In patients with Marfan syndrome, the aortic valve and the diameter of the thoracic aorta should also be evaluated.
        - Chest X-ray, pulmonary function tests, arterial blood gases, and EKG are obtained only if there is clinical evidence of significant underlying disease.
        - Labs: baseline hemoglobin and hematocrit.
- Specific or Unique Room Set-up Requirements
    - Airway
        - Oral endotracheal tube (ETT)
            - One-lung ventilation (OLV) with a Double-Lumen Tube (DLT) is usually not required unless requested by the surgeon.
    - Drugs/Infusions
        - No specific infusions are indicated unless there are co-morbid conditions or cardiopulmonary compromise.
    - Monitors
        - Standard American Society of Anesthesiologists monitors
        - Arterial line and central venous catheter are only needed for close monitoring in patients with significant cardiopulmonary compromise
    - Blood Availability (if indicated)
        - Blood loss is usually minimal to moderate (100-500cc)
        - Consider type and screen or type and cross-match.
    - PICU Bed Availability (if indicated)
        - Not mandatory
        - Discuss case-specific concerns with the surgeon

Intraoperative Considerations:

- Induction
    - Standard intravenous (IV) or inhalational induction can be performed. In the setting of RVOTO, avoid myocardial depressants, hypovolemia, and short diastolic filling time (tachycardia)
    - Single-lumen oral ETT placement (lung isolation with DLT typically not needed)
- Positioning
    - Supine
- Maintenance
    - Maintenance of Anesthesia
        - General anesthesia with controlled ventilation is the preferred method, and no agents are specifically indicated or contraindicated for the procedure.
        - Non-depolarizing muscle relaxation
        - Opioids
    - Fluid Requirements and Hemodynamics
        - Access: 18-16g IV x1
        - Maintenance Fluids: Normal Saline/Lactated Ringers/Plasmalyte @ 1-2 mL/kg/hr
        - Fluid restriction is unnecessary as this is an extrapulmonary operation

- Surgical Considerations
    - Typically, 2-3hr surgical time
    - Patients will receive surgical prophylactic antibiotics
    - Midline incision
    - Pleural and wound drainage are common
- Emergence/Disposition
    - Extubate in the OR. Awake vs. deep extubation may be considered
    - Ensure spontaneous ventilation and adequate reversal of neuromuscular blockade before extubation
- Post-Op Pain Management
    - Post-op pain is intense and generally lasts days to weeks, posing a particular challenge for post-op management.
    - Patient-controlled analgesia (PCA) is often used in these patients. However, intercostal nerve blocks, erector spinae plane blocks, paravertebral blocks, and thoracic epidural analgesia have become increasingly popular.
    - Thoracic epidural analgesia (with local anesthetic and opioids) for 2-3 days, followed by oral opioids and non-steroidal anti-inflammatory drugs, is a frequently used technique.
    - Thoracic epidural analgesia may be difficult in cases of scoliosis or impossible after previous scoliosis surgery. In patients with Marfan syndrome, the presence of dural ectasias may increase the risk of dural tap.

Case-Specific Complications/Pitfalls

- Pneumothorax (5-10%): caused by unintentional pleural tear, intra-op deterioration presents as increased ventilatory pressure, hypotension, and hypoxemia
- Flail chest and post-operative atelectasis are also possible
- Wound infection, sternum necrosis, and migration of strut/hardware can also occur

References

1. Jaffe, R. A., Schmiesing, C. A., & Golianu, B. (2014). *Anesthesiologist's manual of surgical procedures* (5th ed.). *Chapter 5: Thoracic Surgery.* Wolters Kluwer. 295-298.
2. Davis, P. J., & Cladis, F. P. (2022). *Smith's anesthesia for infants and children*. *Chapter 32: Anesthesia for Thoracic Surgery*. Elsevier. 868-870.

Reviewed by:

Reviewer #1: Arundathi Reddy, M.D., University of Arkansas

Reviewer #2: Srinivasa R. Govindarajan, MD, Arkansas Children's Hospital

Reviewer #3: Francis Veyckemans, MD (Retired)

Senior Editor: Debnath Chatterjee, MD, FAAP, Children's Hospital Colorado

---

Created: Date; Last revised: 10.29.24