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Application of pediatric expertise in adult recurrent pectus excavatum: Planned hybrid repair after childhood Ravitch de-escalated to minimally invasive repair of pectus excavatum (Nuss Procedure) – A case report

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Abstract

Recurrent pectus excavatum in adults after childhood Ravitch repair poses challenges for reoperative chest wall surgery due to chest wall rigidity, which is unusual in pediatric cases. When redo surgery is necessary, teams must be prepared to use hybrid techniques, combining open resection with a minimally invasive repair. As pediatric specialists managing such transition cases, we report a 52-year-old woman with symptomatic recurrence more than 40 years following a modified Ravitch operation. Preoperative planning anticipated a hybrid procedure with Nuss bars and limited open cartilage resection and osteotomy. Intraoperatively, favorable anterior chest wall pliability and thorough case preparation allowed the surgical team to de-escalate to a purely minimally invasive approach. Despite expectations of a more complicated procedure, the patient achieved excellent correction, minimal pain, and discharge after overnight observation. This case illustrates how pediatric teams' emphasis on preoperative preparation and flexible minimally invasive strategies can optimize outcomes in adult revisions.

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Keywords: Pectus excavatum recurrence; Nuss procedure; Ravitch; Pediatric expertise; Intraoperative decision; Hybrid repair.

Introduction

From a pediatric perspective, primary pectus excavatum repair favors the minimally invasive repair described by Dr. Nuss given the high chest-wall pliability in younger patients [1]. Recurrent cases after childhood Ravitch repairs often presenting in adulthood with rigidity, scar tissue, malunion, and partial ossification of parasternal cartilage challenge the use of a minimally invasive approach [2-4]. High-volume pediatric centers increasingly manage child-to-adult transitions, planning hybrid techniques (minimally invasive repair with thoracoscopy with targeted open elements) when a purely minimally invasive approach risks incomplete elevation of the chest wall [2,4]. We describe anesthetic and surgical management in a 52-year-old woman, who was prepared for a hybrid operation but successfully treated with pure minimally invasive repair using two bars after intraoperative pliability of the chest wall exceeded expectations. Our approach minimized risk by preparing for a more complex repair while de-escalation to a minimally invasive reconstruction facilitated rapid recovery and discharge without compromising operative success.

Case report

Case introduction

A 52-year-old woman (height 182 cm, weight 79 kg, BMI 24) presented after a mountain bike crash that resulted in fractures of her seventh through ninth left ribs with persistent and progressive dyspnea on exertion, atypical chest pain, and palpitations not noted prior to the injury. She underwent Ravitch repair at age 9. Preoperative CT showed a Haller index of 6.1 (Figure 1). Preoperative echocardiography identified trace mitral regurgitation without mitral valve prolapse or dilation of the aortic root or ascending aorta. Cardiopulmonary exercise testing showed a moderate reduction in exercise capacity with a peak VO_2 of 21.1 mL/kg/min (77% of predicted). A remote blood amphetamine level >15,000 ng/mL (4 months prior) normalized; cardiology clearance showed no residual issues on ECG and stress testing. Other past medical history is notable for attention deficit hyperactivity disorder, hypothyroidism, and migraines.

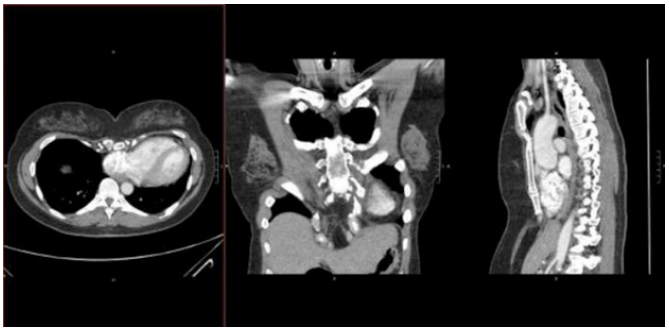

Figure 1: Preoperative CT images of the patient's pectus excavatum defect.

Anesthetic preparation and thought process

As pediatric anesthesiologists accustomed to minimally invasive repairs in children and adolescents, we anticipated adult rigidity and complexity following the previous pectus excavatum repair (e.g. intrapleural or retrosternal adhesions, bleeding risk) and prepared for a hybrid repair, using a modified Ravitch approach to lessen the rigidity of the chest wall and allow a minimally invasive reconstruction (Nuss repair) with chest wall support during the healing process:

- Invasive arterial line for sternal manipulation hemodynamics.
- 37-French double-lumen tube (per height/gender and Brodsky guidelines) for one-lung ventilation and thoracoscopy for a Nuss repair.
- Intraoperative intercostal cryoablation and intercostal nerve blocks (thoracoscopic, T3–T8 bilateral) to minimize opioids and length of stay.
- Transesophageal echocardiography availability for real-time cardiac compression relief and rare complications (e.g., pericardial injury, cardiovascular collapse).
- Type & screen, two 18-guage intravenous catheters, cell salvage for ~100-300 mL expected loss.

This balanced pediatric emphasis on safe, minimally invasive techniques while preparing for adult worst-case scenarios (e.g., sternal forced elevation failure, open conversion, complications requiring cardiopulmonary bypass) allowed for de-escalation if chest wall pliancy was adequate and permitted minimally invasive reconstruction.

Surgical technique and intraoperative course

Small bilateral lateral chest wall incisions enabled thoracoscopy. Using a sternal elevator (PectusAssist, Thompson Surgical Instruments, Traverse City, MI), the sternum was elevated sufficiently to visualize the pericardial junction with the posterior sternum without evidence of malunion, floating segments, or excessive resistance.

The pericardium was separated from the sternum with blunt dissection, widely exposing the anterior mediastinum. No anterior chest wall incision, cartilage resection, or osteotomy was required. Proceeding with the minimally invasive repair, two custom-bent anodized titanium pectus bars (Pure Pectus, KLS Martin, Jacksonville, FL) were placed retrosternally with thoracoscopic guidance, rotated, and secured with bridges to prevent bar rotation. Hammock sutures were placed lateral to the pectus bars to prevent tearing of the intercostal muscles with dorsal displacement of the pectus support bars from the downward force of the more rigid chest wall [4,5]. Intraoperative cryoablation (cryoSPHERE+, AtriCure Inc, Mason, OH) and intercostal nerve blocks with 0.25% bupivacaine with epinephrine plus 0.5% lidocaine solution were performed as planned. The patient was extubated in the OR and transferred to the post-anesthesia care unit with a Visual Analog Scale (VAS) score of 1-2/10. Estimated blood loss for the 165-minute case was minimal (50 mL), and no transfusion was needed.

Postoperative course

Postoperatively, the patient's pain was well controlled (VAS 4–6/10) using multimodal analgesia (perioperative gabapentin, cryotherapy, acetaminophen, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs), and low-dose hydromorphone patient-controlled analgesia transitioned to oral opioids on the first postoperative day). Postoperative x-ray showed bars in place (Figure 2). The patient ambulated, tolerated a regular diet, and was discharged home on the first postoperative day. At one-week follow-up, the patient noted marked improvement in exercise tolerance and chest contour. Pain was well controlled (VAS 4-5/10) with minimal oral opioids, NSAIDs, and cyclobenzaprine. There were no complications.

Figure 2: Chest XR on first postoperative day.

Discussion

Adult post-Ravitch recurrences often require hybrid repair due to reduced pliability of the chest wall (e.g., Johnson series: >85% hybrid for malunion or inadequate lift [4]). A purely minimally invasive repair (Nuss procedure) is successful in select cases, often with multiple bars in adults to achieve better correction and stability [2,4,6,7]. Intraoperative forced elevation of the sternum helps to guide decisions as teams can de-escalate when chest wall pliability exceeds expectations [4]. The experience and expertise of pediatric specialists in chest wall reconstruction with comprehensive anesthetic and surgical preparations can improve the outcomes following minimally invasive repairs, even in adult revisions. Furthermore, perioperative multimodal pain control enables rapid recovery, not typically seen in adult redo cases that typically average a 4-day postoperative hospital stay even with minimally invasive repairs [4,6].

In our case, bilateral intercostal cryoablation was chosen to support early mobilization and discharge. Across chest wall surgery, postoperative analgesia strategies vary widely: thoracic epidural, paravertebral catheters, intercostal blocks, and multimodal systemic regimens are all used, with no single technique proving universally superior [8]. Thoracic epidural can provide excellent analgesia but has nontrivial failure and side-effect rates; paravertebral techniques offer comparable pain control with fewer adverse effects in some series [8]. Cryoablation—temporary injury of multiple intercostal nerves—has been associated (especially in pediatric Nuss cohorts) with reduced perioperative opioid use and shorter length of stay after a single intraoperative treatment, though long-term outcomes and chronic pain risk require continued follow-up [8]. Large revision programs also report either thoracic epidural or subcutaneous local anesthetic infusion catheters (On-Q) as part of multimodal pathways in adult revisions [4].

Conclusion

Pediatric specialists' preparation for hybrid repair in adult patients with recurrent pectus excavatum after a Ravitch procedure facilitates a safe de-escalation to a purely minimally invasive repair when intraoperative chest wall pliability allows. This optimizes the benefits of a minimally invasive chest wall repair while mitigating risks in reoperative procedures. In those reoperative cases, intraoperative assessment may favor a minimally invasive repair or argue for a more complex hybrid operation as anatomical factors may lead to inadequate chest wall elevation that may increase the risk of cardiac injury and prevent safe placement of the pectus hardware.

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