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Intercostal Hernia and Costochondral Disruption Repair

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Background	A 70-year-old male patient presented with debilitating left-sided chest wall pain, which began a year prior when bearing down for a bowel movement. Since that event, he had experienced constant tearing pain at rest and during movement with progressive dyspnea, requiring a walker. He had seen numerous providers and been unsuccessfully diagnosed and treated. Prior attempts to address this pain included narcotic and non-narcotic pain medication, locoregional anesthesia, and psychiatry referral, and were unsuccessful in providing sustainable, long-term relief. After a clinical exam and imaging, the patient's diagnosis was confirmed as having disruption of his left costal margin with an intercostal hernia between ribs seven and eight.
Summary	At intake, the patient underwent a clinical exam and CT scan that identified a costal margin rupture and intercostal hernia at the left seventh and eighth ribs. He also had significant comorbidities, including atrial fibrillation, type 2 diabetes, hypertension, hypothyroidism, gout, obesity (body mass index [BMI) 31), asthma, 25 pack-year smoking history, and chronic obstructive pulmonary disease (COPD), history of remote polysubstance abuse, and chronic pain. Intraoperatively, the patient was diagnosed with a costal margin rupture and an associated intercostal hernia between ribs seven and eight. He underwent video-assisted thoracoscopic surgery (VATS) cryoneurolysis of intercostal nerves five to nine for long-term pain control, manual reduction of the costochondral disruption, and a bi-level "Edward's quilt" mesh repair, a complex technique to provide additional stability beyond suture-only repair—this technique was first reported in 2019 and has shown successful repair of similar injuries, and thus was chosen for this patient, particularly with his significant comorbidities. Postoperatively, the patient recovered without major complications, demonstrating increased activity and reduced pain. However, he continued to have some residual left-sided chest wall pain at five months follow-up. He has had no evidence of hernia or costal margin rupture recurrence.
Conclusion	Evidence suggests that patients who do not undergo surgical repair suffer from chronic pain, which supports operative intervention as a standard treatment option. Given the chronicity of these injuries, the benefit gained with the involvement of a dedicated pain management team cannot be understated. Considering the multitude of repair options and varying degrees of success in postoperative outcomes, a consensus statement regarding the management of intercostal hernia and costochondral disruption is needed.
Key Words	intercostal hernia; costochondral disruption; Edward's Quilt; mesh repair; cryoneurolysis; video-assisted thoracic surgery (VATS)

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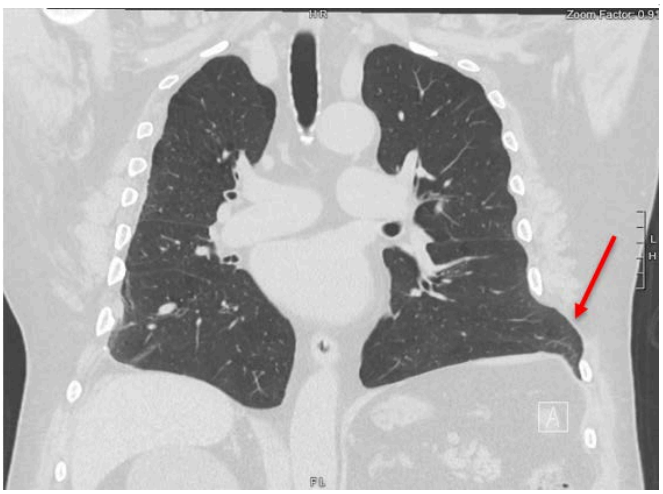
Case Description

A 70-year-old male patient presented with debilitating left-sided chest wall pain. The pain began a year prior when bearing down for a bowel movement. He described feeling a pop with subsequent tearing of his chest wall. Since that event, the patient described constant tearing pain at rest and during movement with associated dyspnea. He required a walker because of his severe pain. He had seen numerous providers and was diagnosed with chronic left-sided chest wall pain but without underlying etiology. Prior attempts to address this pain included narcotic and non-narcotic pain medication, locoregional anesthesia, and referral to psychiatry.

The patient had significant comorbidities, including atri-al fibrillation, type 2 diabetes, hypertension, hypothyroidism, gout, obesity (BMI 31),[1] asthma, 25 pack-year smoking history, COPD, history of remote polysubstance abuse, and chronic pain. On clinical exam, the patient had evident disruption of his costal margin with respiration and at rest upon palpation. Manipulation of his costal margin rupture aggravated his pain. During his intake vis-it, the patient underwent a CT scan, from which he was diagnosed with a costal margin rupture with an associated intercostal hernia between ribs 7 and 8 (Figure 1).

Figure 1. CT Scan Showing Patient's Left Intercostal Hernia (arrow indicates defect). Published with Permission



Given his existing comorbidities, the patient underwent a comprehensive preoperative evaluation to ensure suitability for surgery. Pulmonary function tests (PFTs) were notable for a significantly diminished forced vital capacity (FVC) (38% of predicted) and forced expiratory volume in 1 second (FEV_1) (48% of predicted) and were interpreted as being consistent with interstitial lung disease and reactive airways.

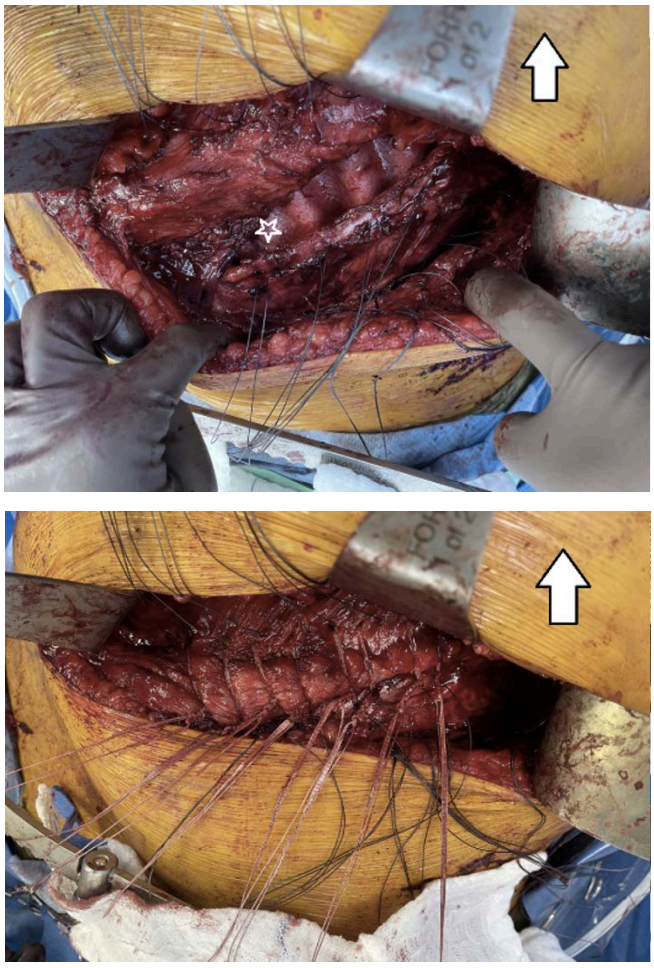
Echocardiogram revealed borderline left ventricular hypertrophy and a normal left ventricular ejection fraction (57%).

The patient was positioned in the right lateral decubitus position, and a muscle-sparing incision was used to expose the intercostal hernia. Intraoperative findings were notable for an intercostal hernia between left ribs seven and eight with grossly disrupted costochondral junction. After the transition to single lung ventilation, the hernia sac was entered, providing exposure to the thoracic space. Video-assisted thoracoscopic surgery (VATS) cryoneurolysis of intercostal nerves five to nine was performed (Atricure, Cincinnati, OH).

The costochondral disruption was manually reduced, and the chest wall disruption was evaluated. The defect measured 18 cm (cranial to caudal) by 15 cm (anterior to posterior). A 20 cm Strattice mesh (Allergan, Maddison, NJ) was trimmed, and 18 Ethibond (Ethicon, Somerville, NJ, USA) sutures were secured in the mesh. The Strattice mesh was chosen for the internal layer based on reports of this bi-level mesh repair method by Dr. John Edwards, who developed and described this novel technique in 2019.[2] Additionally, the Strattice mesh is smooth and absorbable, ideal for internally buttressing the repair, complemented by the permanent mesh secured outside to stabilize the injury further. The double-level mesh layering optimally distributes forces across the intercostal defect.[2] Bicortical holes were drilled through ribs eight, nine, and ten with 1 cm spacing over the span of the chest wall defect. The ribs were "drilled for suture placement, rather than using intercostal horizontal mattress pledgeted sutures, to spare the intercostal nerves" from possible compression.[2]

The Strattice mesh was parachuted into the intrathoracic space and trimmed to fit the space. The Ethibond sutures were brought up through the bicortical bore holes and secured (Figure 2A). The intercostal hernia was then reduced with 8 Tiger Tape sutures (Arthrex, Inc., Naples, FL) that encircled the seventh rib and were passed through the holes in the eighth rib (Figure 2B). An additional Ethibond suture was placed at the costal margin between ribs seven and eight to further stabilize the chest wall in a manner similar to the Hansen slipped rib repair.[3] Final intra-thoracic inspection of the underlay mesh revealed adequate coverage (Figure 3A). Following irrigation of the wound, a 15 × 20 cm Symbotex overlay mesh (Medtronic, Minneapolis, MN) was secured in place with transcostal Ethibond sutures to complete the robust repair of the intercostal hernia and costochondral defect using the bi-level "Edward's quilt" technique (Figure 3B).[2] A 24 French (24F) Blake drain was left in the thoracic cavity, and a 19F drain was left in the posterior subcutaneous dissection bed.

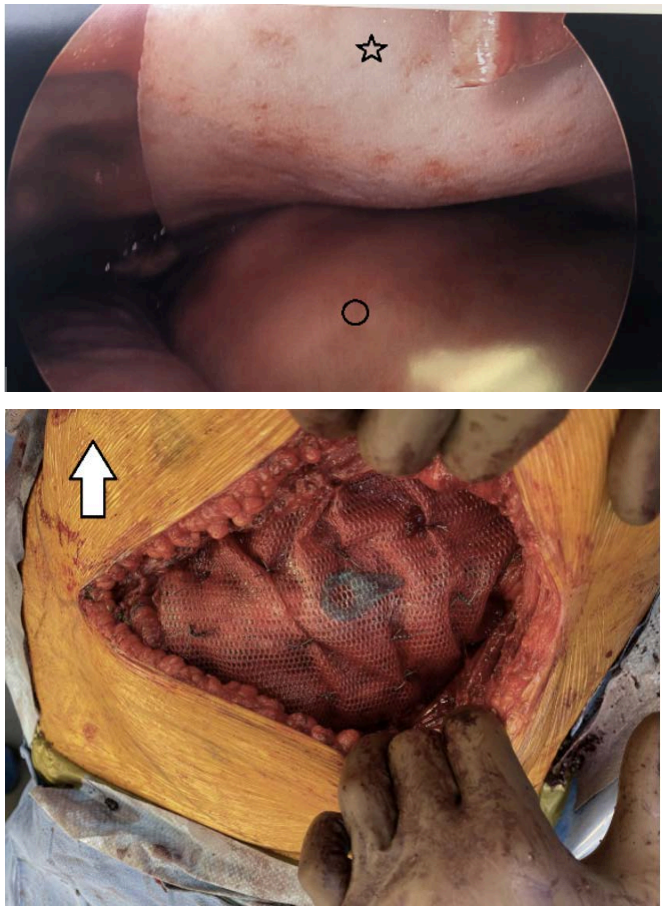
Figure 2. Intraoperative Photos. Published with Permission



A) Placement of underlay mesh (star marks intercostal hernia defect, arrow points cranial); and B) closure of intercostal hernia with Tiger Tape (arrow points cranial)

Postoperatively, the patient recovered without any major complications. The patient's baseline pain score was 9/10 and then reduced to 6/10 by postoperative day (POD) 2. On POD 2, he began working with physical and occupational therapy daily until discharge. Oral analgesia was initiated on POD 1, and the patient was fully transitioned off intravenous narcotics by POD 7. The patient was discharged from the hospital on POD 8. On follow-up at five months, he continues to have left-sided chest wall pain, although it improved from before surgery. He has had no evidence of hernia or costal margin rupture recurrence.

Figure 3. Published with Permission



A) Intrathoracic image of underlay mesh (star marks mesh, circle marks diaphragm); and B) overlay mesh (arrow points cranial)

Discussion

Costochondral disruptions are a type of costal cartilage fracture originating from damage to or weakening of the costal cartilage or costochondral joint between cartilage and sternum. Other types include disruption at the chondrosternal or interchondral joints.[4] Costochondral injuries are commonly caused by trauma but also can occur spontaneously, such as with coughing or sneezing, performing Valsalva maneuvers, playing wind instruments, strenuous lifting, or contact sports.[2,4–6] Potential etiologies for a weakened costochondral joint may include several cartilaginous disorders, such as costochondritis, enchondroma, or chondrosarcoma.[7]

Intercostal hernias are frequently associated with costochondral disruption, as costochondral damage weakens the stability and support of the intercostal muscles.[8] They are characterized by lung tissue protruding through the intercostal space.[8] Approximately one-third of intercostal hernias are spontaneous; other etiologies include congenital and traumatic defects.[9,10] Spontaneous hernias typically result from a sharp increase in intrathoracic pressure.[11–13] Predisposing factors include COPD (most likely due to chronic bouts of violent coughing), lung hyperinflation, chronic steroid use, tobacco use, and obesity.[1,8,9,11] Costochondral disruptions are rare, though their incidence may be underreported owing to underappreciation of the injury pattern.[2] While chest radiographs can identify some degree of lung tissue protrusion, this imaging modality alone is insufficient to diagnose costochondral damage. The gold standard for diagnosing intercostal hernia and costochondral injury is a physical exam with a concomitant CT scan.[14,15] Intercostal hernias are also rarely documented but may be underreported as their clinical course is often asymptomatic.[13,16] When costal margin ruptures are present, evaluating the concomitant presence of intercostal hernia is prudent as these two pathologies can occur concurrently due to the weakened thoracic musculoskeletal infrastructure, especially in the presence of other risk factors such as obesity.[1]

Unfortunately, there are currently no consensus guidelines on managing these injuries, and the literature is limited to case series and studies.[2] Current repair techniques for costochondral disruption and intercostal hernia include primary repair with autologous tissue, periosteal flaps or direct muscle re-approximation for smaller defects, and pericostal suture, sternal wires, rib plates, and bi-level mesh repair for more significant injuries.[14,17,18] Previous case reports have shown that fixation of the ribs, in addition to patch repair of the hernia site, is an effective surgical treatment for concurrent lung herniation and rib fracture.[8] The Edward's quilt mesh repair was first reported in 2019 by Gooseman et al.[2] and has shown success in costal margin rupture and intercostal hernia and was the method of repair chosen for our patient.[19,20] A case study documenting a traumatic lung herniation and rib fracture repaired by rib open reduction and internal fixation (ORIF) alone without mesh placement yielded a successful postoperative condition and quality of life improvement for the patient.[19] Another case report utilized a different technique for chest wall stabilization, including sternal zip ties and plates.[21] What is clear is that suture-only repair is unlikely to provide durable long-term success.[21] Given the multitude of treatment options utilized, a consensus regarding managing these injuries is needed.

Conclusion

The patient was a 70-year-old male diagnosed with grossly disrupted costal margin with an associated intercostal hernia between ribs 7 and 8. Repair of his injury included bi-level Edward's quilt mesh, a complex repair that provides additional stability beyond suture-only repair. Despite procedural complexities and longer operative time, evidence suggests that patients with costochondral disruptions and intercostal hernias who do not undergo surgical repair suffer from chronic pain, suggesting that operative intervention should be pursued.[12] Like other patients with similar pathology, our patient had a positive outcome, evidenced by progressively reduced pain, increased activity, and no recurrence.[7,19,20,22] However, the benefit gained with the involvement of a dedicated pain management team cannot be understated. Given the chronicity of this injury, anatomic repair alone is unlikely to alleviate pain in the immediate perioperative period completely, and long-term pain management is often required.

Lessons Learned

Successful repair and patient recovery will likely require not only standardized operative protocol but also long-term postoperative support and pain management regimens. Stabilizing operative techniques such as mesh placement have shown longer-term success in repairing costochondral ruptures, intercostal hernias, and similar injuries in the literature, particularly for patients with significant comorbidities, as seen in our case. Because there is no consensus on screening for and repairing these complex injuries, setting guidelines to detect and manage these injuries effectively would significantly benefit the healthcare team and patients in guiding care delivery to optimize patient outcomes and quality of life. Patients with extensive comorbidities are at higher risk of worse outcomes, lower quality of life, and unresolved long-term chronic pain.[21,23–25] There is an even greater imperative to establish a management protocol that accounts for the multifactorial patient factors that impact their perioperative risk and outcomes.

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