Retained Hemothorax

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Objectives: At the completion of this module fellows will be able to:

1. **Describe the modalities used to diagnose a retained hemothorax.**
2. **Compare and contrast the non-operative and operative treatment options for a retained hemothorax.**
3. **Describe the operative techniques for evacuation of a retained hemothorax.**

Background

- The most common injuries from both blunt and penetrating thoracic trauma are rib fractures, hemothorax and pneumothorax. More than 85% of patients can be definitively treated with a chest tube.
- The true incidence of retained hemothorax (RH) is unknown; observational studies suggest RH rates up to 10%.
- Classic teaching is that a RH predisposes the patient to developing a fibrothorax and trapped lung. This causal link has not definitely been demonstrated.
- Infection can complicate up to 25% of cases of RH.

Evaluation/Diagnostics

- Physical exam suggestive of thoracic trauma (ecchymosis, crepitus, chest wall instability, dullness to percussion, penetrating wound) with concurrent tachycardia or anemia may herald a RH but imaging is definitive.
- Following placement of a tube thoracostomy for a post-injury hemothorax, patients must have a chest radiograph documenting evacuation of the chest.
- Malpositioned chest tubes occur in up to 25% of patients undergoing tube thoracostomy; this may result in an inadequately drained hemithorax.
- Bedside ultrasound may reveal undrained pleural fluid.
- CT scan more accurately diagnoses RH compared to chest radiographs as it allows one to discern between collapsed/contused lung and the fluid/clot components.
- On CT imaging, RH is typified by a heterogeneous collection with Houndsfield units ranging from 35-70.
- Size quantification by the equation: volume in cc = greatest depth of the hemothorax from chest wall to lung in cm (squared) x craniocaudal length in cm (which equates to number of slices x the thickness of the CT cuts) = d^2 x L.

Management

- Non-operative Management:
  - Tube thoracostomy with observation: Tube thoracostomy alone as treatment for RH may be considered in patients with small volume hemothorax (< 300 cc) or in whom surgical risk is prohibitive.
  - Tube thoracostomy with fibrinolytics: Intrapleural thrombolytic therapy may be used as an adjunct to tube thoracostomy. A significant number of patients may require additional drainage procedures.

- Image-guided percutaneous drainage (IGPD): IGPD can be utilized alone or as an adjunct to tube thoracostomy. Advantages include that it is less invasive and has a more precise placement, although a significant number of patients may require additional drainage procedures.

- Indications for Surgery:
  - RH volume > 300 - 500 cc.
  - Failure of drainage adjuncts, including lytic agents and/or IGPD.
- Preoperative Preparation:
  - CT scan of the chest:
    - Location of RH.
    - Degree of loculation.
    - Volume of RH.
    - Associated injuries.
  - Standard preoperative preparation, focusing on:
    - Cardiac status and reserve.
    - Pulmonary status and potential for intraoperative deterioration/ability to tolerate single lung ventilation.
    - Hemoglobin/coagulation status.

Operative Technique

- Minimally Invasive Procedure: Video-assisted Thoracoscopic Surgery (VATS) is an accepted first line approach for RH.
  - Timing:
    - Level I data do not exist regarding the optimal timing of VATS.
    - With an up to 33% incidence of empyema after tube thoracostomy with radiographically determined RH, VATS within 72 hours of identification of RH may be beneficial.
    - Although VATS may be successful up to 14 days after RH, the need for thoracotomy increases after day 5.
  - Advantages:
    - Reduced postoperative pain compared to thoracotomy.
    - Fewer pulmonary complications compared to thoracotomy.
    - Rapid recovery.
  - Contraindications:
    - Hemodynamic instability.
- Open Procedure: Thoracotomy remains the gold standard treatment for RH, although VATS is increasing in both frequency of application and success of drainage.
  - Positioning:
    - Posterolateral approach.
    - Lateral decubitus position.
  - Application:
    - Failed VATS.
    - Concomitant diaphragm injury.

Intraoperative Considerations

- Order of priorities:
  - Achieve hemostasis.
  - Complete evacuation of hematoma (liquid and clot components).
  - Ensure full expansion of lung.
  - If the lung is trapped by fibrin deposits or exudate, more aggressive decortication may be required.
  - Chest tube placement is required prior to closure; the size, number, and position of the tubes are based on the intraoperative findings.

Postoperative Management and Potential Complications

- Postoperative chest radiograph must be performed to confirm:
  - Appropriate chest tube placement.
  - Complete lung expansion.
  - Evacuation of RH.
- Maintain chest tube to suction until any air leaks have stopped.
- Reverse coagulopathy.
- Use a restrictive fluid resuscitation strategy.
- Maintain head of bed elevated ≥ 30° if not contraindicated.
- Ensure chest tube is draining properly.
- Ensure adequate respiratory support; non-invasive positive pressure ventilation may be necessary in the first 24 hours to recruit pulmonary segments.
- Monitor hemoglobin level and chest tube output to ensure no ongoing bleeding.
- If chest radiograph appearance worsens after first 48 hours, perform chest CT scan to evaluate for any re-accumulation of blood versus lung consolidation.
- Antibiotics should not be used routinely, aside from pre-operative single dose.
- Physical therapy and incentive spirometry are important adjuncts to mobilize the patient and clear airway of secretions.

Long-term Outcomes

- Appears more dependent on the number of rib fractures, presence of a flail segment, extent of the pulmonary contusion, and type of operation rather than the RH component.
- Most patients continue to show significant improvement over time, getting close to baseline pulmonary function.
- Competitive athletes may notice reduced lung function that prevents similar levels of competition.

Special Populations

1. Pediatric
   - Compliance of thoracic cage allows for significant bending of the ribs and sternum resulting in transmission of high energy force to the internal structures without fracture of the ribs.

- There are no established criteria for intervention or validated volumetric calculation for RH in the child.
- Management is similar to adults.

2. Geriatric
    - No specific data available for this patient population related to outcomes after RH.
    - Special consideration for those on anti-coagulation therapy -- more aggressive radiographic follow up may be warranted.

3. Immunocompromised
    - No specific data available for this patient population related to RH outcomes.
    - As retained blood is a nidus for infection, aggressive evacuation should be pursued to minimize risk of empyema.

Pearls from the Experts: Drs. Ernest E. Moore, J. David Richardson, and Matthew J. Wall

- Classic teaching involves placement of the chest tube at the 4-5th intercostal space to avoid injury to the diaphragm, but many tubes subsequently are identified in the fissure on the CT scan. Tube thoracostomy, therefore, should be performed lower on the chest wall, at the 6th intercostal space. Digital palpation of the lung parenchymal surface should ensure the major pulmonary fissure is not evident at the insertion sight. Additional care should be used to direct the tube posteriorly toward the apex.
- Although there are little published data in acute trauma patients, for those with a small-moderate sized RH, instillation of fibrinolytics into the pleural space at 48-72 hours may obviate need for operative evacuation:
    - Two suggested protocols:
        - tPA 6mg in 50cc sterile saline every 12 hours x 48 hours. Have patient roll from side to side immediately after infusion to distribute the tPA and unclamp chest tube after an hour. Monitor for bleeding complications with serial hemoglobin levels.
        - tPA 10mg/30 mL sterile saline, dwell x1 hour then drain. 2 hours after tPA, dornase 5 mg/30 mL, dwell x1 hour then drain. Doses are repeated q12h x 3 days as necessary.
- Air leak increases the risk for infection of a RH.
- Subcutaneous tunneling of tubes is unnecessary - simply cut on the rib and tunnel over the top.
- Avoid an intercostal arterial injury – (i.e. avoid tube position under then rib); if an intercostal artery injury occurs, advance a Foley catheter with a 30cc balloon into the chest tube tract, inflate the balloon, pull back so the balloon is snug against the inside of the chest wall, and maintain traction with a Kelley clamp on the chest wall.
- Consider the diagnosis: While RH following penetrating trauma is usually not missed, it is often not appropriately considered after blunt trauma, especially with multiple rib fractures. Obscuration of the diaphragm can be due to a variety of causes but one of them

may be RH. If that is the case and the lung is entrapped, it may significantly alter long-term pulmonary function.

- A chest radiograph is not reliable for this diagnosis; use of a CT scan with an attempt at a volumetric approximation of the amount of RH is essential for the diagnosis.
- Beware of "halfway" measures: The use of lytic agents (while espoused by some literature) is a very expensive and an indirect way to solve a surgical problem. Experience is limited to date.
- The ease of the operation is inversely proportional to length of time between the injury and the operation. Therefore, if it is obvious that a tube thoracostomy is not accomplishing its goal of hemothorax evacuation, move promptly to a VATS.
- VATS is the current management technique of choice. However, hemothoraces that have been in place for several days are on occasion quite tenacious. If a secondary infection has occurred there may be a thick peel present around the lung which is difficult to remove thoracoscopically. In this instance, this could usually be determined by careful thoracoscopic evaluation. A small incision may be necessary (particularly with empyema) for a hand assisted technique to augment the thoracoscopic procedure. A patient should be aware of this possibility preoperatively and a surgeon should never hesitate to add a mini thoracotomy if that is necessary to completely evacuate the hemothorax and/or empyema, and to facilitate full expansion of the lung.
- The lung is usually trapped inferiorly and posteriorly since that is the way blood tends to layer. Beginning the procedure superiorly and anteriorly to define the anatomy is a good technique.
- The use of a double lumen tube greatly facilitates the ability to complete the operation but a careful dialog with the anesthesiologist is crucial. One can do some work with the lung deflated followed by re-inflation which then allows the planes to become clearer and more easily delineated. This stop-and-start technique between inflation and deflation allows for a safer and better operation.
- One should obviously try to avoid air leaks as much as possible but if the hemothorax has not been treated early there are often air leaks that will occur. One should not become timid and stop the operation because of air leaks as that will likely only worsen the problem if the lung is not fully free from the its fibrinous encasement. Insuring complete freedom by total extirpation of the hemothorax or surrounding rind will allow for much better expansion and sealed air leaks.
- The use of tissue sealant can be helpful in the treatment of air leaks. This can be done by placing a needle through the thorax itself and bathing the area of air leak with a tissue sealant.
- It is imperative that the lung is fully expanded before leaving the operating room. Several vigorous hyperinflated breaths are given after placing chest tubes and withdrawing all instruments.
- Postoperative pain control may be aided by performing rib blocks inferiorly and posteriorly to the area of chest tube insertion or any incisions that are made; Bupivacaine (0.25%) is used for this maneuver. If done appropriately it may help and should not be a problem. The only caution is to aspirate before injecting to ensure that an intravascular injection of the anesthetic agent does not occur.

- The use of abrasive agents such as talc may be indicated for recurrent pneumothoraces but should be judiciously avoided in treatment of the hemothorax.
- VATS can be performed in rare cases in the supine position in patients with unstable spine fractures.
- A sterile Yankauer sucker may be used to evacuate blood from the chest prior to placing a chest tube at bedside.
- If the chest radiograph is not clear, obtain a CT scan on day 2, so a decision can be made and VATS performed by day 3.
- VATS beyond day 4-5 can be much more challenging and become a decortication.
- Operate early so you do not need to deal with a rind.
- If you leave a rind, the lung will collapse.
- Two tubes are suggested, one antero-apical and one posterior for drainage.
- Consider bronchoscopy in the OR to assure no mucous plugs.
- Avoidance of pain that causes a great amount of splinting is crucial. One does not want the lung to drop.

References

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