Course n°: (3)

ALI/ARDS after pulmonary resections: etiology and management

Session V
Date: 25-09-2014
Language: Romanian/English
City: Bucharest
Country: Romania
Speaker: DR. RADU T STOICA
ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)

Signs & Symptoms
- Tachypnea
- Dyspnea
- Retractions
- Hypoxia
- Tachycardia
- Pulmonary Compliance

Causes
- Trauma
- Pulmonary Infection/Aspiration
- Prolonged Cardiopulmonary Bypass
- Shock
- Fat Emboli
- Sepsis

ABGs
- $P_{O_2}$ ↓
- $P_{CO_2}$ ↑

My heart is racing and I can't catch my breath.
Postpneumonectomy ARDS


Postpneumonectomy pulmonary edema.

Zeldin RA, Normandin D, Landtwing D, Peters RM.
Revista Română de ANESTEZIE și TERAPIE INTENSIVĂ
1999 Vol. 7 nr. 1-2
Asociația Medicală Română

Sindromul de detresă respiratorie acută (Adult Respiratory Distress Syndrome - ARDS -) pe plămân unic

Rezumat:
Sindromul de Detresă Respiratorie Acută (Adult Respiratory Distress Syndrome - ARDS-) apare după pneumonectomie sau edemul pulmonar postpneumonectomie (PPE) este reconsidat ca o complicație a cărei apariție este împrejurătoare, statistic greu de apreciat și asociată cu o mortalitate mare. Sunt prezentate 2 cazuri (3,4%) de ARDS aparute după pneumonectomie stângă. Criteriile de diagnostic au fost clinice, paraciclinice și radiologice. Confirmarea fiind anatomic-patologică, într-un caz care a decesat, și în cel de-al doilea prin evoluția clinică, radiologică și prin tomografie computerizată. Pe marginea acestor cazuri și a datelor din literatură sunt discutate elementele comune și cele specifice patologiei ARDS după pneumonectomie.
Discuții

ARDS este o formă de insuficiență respiratorie acută în care modificările schimbărilor gazelor pulmonare duc la hipoxemie severă și sunt datorate edemului pulmonar necardiogen, rezultat al modificațiilor inflamaționale și de creștere a permeabilității capilarilor."
ARDS after pulmonary resections

How often
Etiology
Diagnosis
Prevention and treatment
Mortality
Incidence of ALI/ARDS postoperative 3.1% (44 from 1428 patients with curative lung resections for cancer (Jan 2001- June 2004). (Sloan-Kettering Cancer Center, NY)

CHEST 103 6 JUNE, 1993
W Sherman: Postpneumonectomy Pulmonary Edema. A Retrospective Analysis of Associated Variables

Incidence of 2.6%. 21 patients from 806 pneumonectomies from 1977-1988. (Mayo Clinic)

CHEST 2006; 130:73–78
Dulu A et al: Prevalence and Mortality of Acute Lung Injury and ARDS After Lung Resection

Prevalence ALI/ARDS: postpneumonectomy 2.45%, lobectomy 2.96%, sublobar resections 0.99% (2192 resections (2002-2004)
South-corean study:

Postpneumonectomy ALI / ARDS developed within the first postoperative week in 18 (12%) patients!!


British Study:


The incidence and mortality from ARDS had fallen significantly over the two study periods (incidence from 3.2% to 1.6%, p = 0.01; mortality from 72% to 45%, p = 0.05)

ARDS after pulmonary resections

How often
Etiology
Diagnosis
Prevention and treatment
Mortality
Etiology?

Excessive perioperative fluid administration


Previous treatment with radiotherapy


Duration of operation


Right-sided pneumonectomy


High intraoperative airway pressure (Paw)

Other risk factors for ALI after thoracothomy:

- COPD, postop FEV$_1$ < 45%, ppo lung perfusion < 55% vs preop,
- no previous physiotherapy, alcohol abuse, male sex, age > 60,
- intraoperative fluid administration > 2L, fresh frozen plasma administration

**FEV$_1$ in the multivariate analysis:**

- decreased postoperative predicted lung function and increased perioperative fluid administration remained independent predictors of postoperative lung injury.
- predicted decreased ppoDlco remained a significant, independent risk factor.


The pathogenesis of post-pneumonectomy ALI/ARDS is not fully understood.
# ARDS after pulmonary surgery: risk factors

<table>
<thead>
<tr>
<th>Risk factors: peri-operative</th>
<th>Direct surgical pulmonary tissue injury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transfusion of blood products (TRALI)</td>
</tr>
<tr>
<td></td>
<td>Ischemia-reperfusion lesions</td>
</tr>
<tr>
<td></td>
<td>Volutrauma during one lung anesthesia</td>
</tr>
<tr>
<td></td>
<td>Slowing the lymphatic drainage</td>
</tr>
<tr>
<td></td>
<td>Inappropriate thoracic drainage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other risk factors</th>
<th>Pulmonary capillary bed reduction with edema and increased alveolo-capillary permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chronic acooolism</td>
</tr>
<tr>
<td></td>
<td>Pulmonary disfunction (moderate –severe)</td>
</tr>
<tr>
<td></td>
<td>Advanced age</td>
</tr>
<tr>
<td></td>
<td>Oncologic therapy</td>
</tr>
<tr>
<td></td>
<td>High ASA score</td>
</tr>
</tbody>
</table>

Others...
An increase in blood flow through the remaining lung in some patients may promote disruption of the capillary endothelial cell-alveolar cell barrier, allowing protein-rich fluid to flood the alveolus.


Mediators of inflammation, such as leukotrienes, platelet-activating factor, and various other cytokines, cause an increase in pulmonary capillary pressure without a change in capillary permeability. …Even though inflammation and increased permeability may be prominent features of ARDS, the formation of edema fluid is increased by increases in pulmonary capillary hydrostatic pressure.

DR NAVEED ALAM (Memorial Sloan-Kettering Cancer Center, NY): Certainly in the initial experiments by Dr Zeldin he thought that it was related to some form of increased permeability of the capillaries and increased hydrostatic effects. And some physiologic studies with animals have been done. But I do not think we really know. I think the consensus now is that this is really just another form of ARDS (acute respiratory distress syndrome) with the inciting factor being surgical lung trauma.

So.....
ALI/ARDS after pulmonary resections

The conceptual model of ARDS

- ARDS is the type of acute lung injury associated with recognized risk factors characterized by inflammation leading to increased pulmonary vascular permeability and loss of aerated lung tissues.

- The hallmarks of clinical syndrome are hypoxemia and bilateral radiographic opacities on standard chest X-ray or CT scan. ARDS is associated with recognized risk factors characterized by inflammation.

- Physiological derangements include: increased pulmonary venous admixture, increased physiological dead space, decreased pulmonary compliance.

- Morphological hallmarks are: lung edema, inflammation, hyaline membrane and alveolar hemorrhage.

(Dr Andrei Schwartz, ARDS Berlin Definition.2011. Is more usefully ? ppt)
ARDS after pulmonary resections

How often
Etiology
Diagnosis
Prevention
Mortality
Update
Diagnosis

Post-pneumonectomy ALI/ARDS begins a few days after surgery:

The mean time from operation to presentation with ALI was $5.2 \pm 1.7$ days and for ARDS $4.2 \pm 1.1$ days (Kutlu et al)

Diagnosis criteria for ALI/ARDS:

- American-European Consensus Conference on ARDS (1994)
- Berlin Definition 2011

Sometimes difficult to appreciate the PAWP after pneumonectomy

Pumonary Hypertension and Congestive heart disease may co-exist

356 With ALI/ARDS Berlin definition and necroptic examination: 159 (45%) with histopathological lesions of DAD (diffuse alveolar damage) compatible with ALI/ARDS.

Histopathological confirmation is proportional with severity of the illness

14% of cases had normal lungs

Regarding histopathological confirmation sensitivity and specificity of ALI/ARDS diagnosis (Berlin criteria) was 89%, respectively 63%

ARDS after pulmonary resections

How often
Etiology
Diagnosis
Prevention and treatment
Mortality
Prevention and treatment

Early admission in ICU

Prevention: risk factors!
- Excessive preoperative fluid administration (Zeldin) *(increasing fluid administration causes injury or is an effect of the injury itself!?)*
- Should the patients be kept “dry”? 

High dose steroids? No!! (ARDS Clinical Trial Network)

*Cerfolio et al. reported on the administration of steroids before ligation of the pulmonary artery in patients undergoing pneumonectomy, suggesting that this strategy reduced the incidence of post-pneumonectomy ARDS!*

What about protective ventilation?

Protective ventilatory strategy during OLV decreases the proinflammatory response, improves lung function and results in earlier extubation.


32 patients who underwent lung resection: the levels of inflammatory markers in bronchoalveolar lavage fluid were higher after OLV with a $V_T$ of 10 ml/kg vs. 5 ml/kg.


Recruitement manoeuvres: at the beginning of the intervention or when starting OLV!
ARDS after pulmonary resections

How often
Etiology
Diagnosis
Prevention and treatment
Prognosis and Mortality
Mortality

Mortality rate 40% (20 patients/50), 50% after pneumonectomy, 42% after lobectomy and 22% after sublobar resections (A. Dulu, Chest, 2006)

Increased age associated with higher mortality

Marginally significant association between mortality and time of presentation to the ICU after surgery (p  0.06).

To prevent stump fistula (high pressure) it may be necessary HFJV or DLT intubation

(S. Turnage, Chest 1993)

Mortality 64.4% ALI/ARDS after pulmonary resections.

(Kutlu 2000)

Berlin ALI/ARDS definition: mortality of any ALI/ARDS etiology is in mild forms 27%, 32% and respectively și 45% in moderate and severe forms

Conclusions

ALI/ARDS post pulmonary resection: severe condition with high mortality

Rapid ICU admission and treatment on mechanical ventilation

Prevention strategies?
Identifying patients with risk factors
Surgical sparing strategies?
Protective ventilation during OLA

Before Recruitment Man

After RM with 7cm H2O PEEP

Patient ID: COMANECE
Birthdate: 12/02/2009
Age: 52

Syringe Sample

ACID/BASE 37°C

- pH: 7.3401
- pCO2: 41.5 mmHg
- pO2: 67.2 mmHg
- HCO3-act: 21.9 mmol/L
- HCO3-std: 21.4 mmol/L
- ctCO2: 23.2 mmol/L
- BE(B): -3.6 mmol/L
- BE(ecf): -3.9 mmol/L

Oxygen Status 37°C

- ctHb: 6.8 g/dL
- Hct: 20%
- ctO2(a): 8.91 ml/dL
- BO2: 9.11 ml/dL
- pO2: 67.21 mmHg
- sO2: 95.4%
- F02Hb: 92.11%
- FC02Hb: 3.31 align%
- FMetaHb: 0.2%
- FHHb: 4.4%

Patient ID: COMANECE
Birthdate: 12/02/2009
Age: 52

Syringe Sample

ACID/BASE 37°C

- pH: 7.3491
- pCO2: 39.1 mmHg
- pO2: 299.51 mmHg
- HCO3-act: 21.1 mmol/L
- HCO3-std: 21.0 mmol/L
- ctCO2: 22.3 mmol/L
- BE(B): -4.2 mmol/L
- BE(ecf): -4.6 mmol/L

Oxygen Status 37°C

- ctHb: 6.31 g/dL
- Hct: 19%
- ctO2(a): 9.41 ml/dL
- BO2: 8.51 ml/dL
- pO2: 299.51 mmHg
- sO2: 99.71%
- F02Hb: 2.21%
- FC02Hb: 0.3%
- FMetaHb: 0.3%
- FHHb: 0.3%

28/10/2009
Descending trend of ALI/ARDS after pulmonary resections:

- reducing the number of pneumonectomies (better cancer staging and oncologic therapy)

- Protective strategies of ventilation during OLA and MV in ALI ARDS patients
ARDS post left
Pneumonectomy
DM. F, 55 y
C.V, 64 y, ARDS after left pneumonectomy