The value of thoracoscopic surgery for congenital pulmonary malformations

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Classification

“A rare developmental abnormality of the lung, characterized by cystic masses of disordered pulmonary parenchyma”.

- BPS = Bronchopulmonary sequestration
- CPAM = Congenital pulmonary adenomatoid malformation
  (CCAM = Congenital cystic adenomatoid malformation)
- CLE = Congenital lobar emphysema
- Hybrids, bronchogenic cysts

### Histology - CPAM

| 1977 Stocker - Klassifikation (CCAM) |
| 1995 Adzick - Klassifikation (pränataler Ultraschall) |
| 1997 Histopathologische Klassifikation nach Cha |
| 2006 Klassifikation nach Kreiger (3 histopathol.Subtypen) |

Macrocystic (>5mm) versus microcystic (<5mm) versus solid

Postnatal management

- Clinical status
- Associated anomalies
- Diagnostic imaging (also fetal)
  - US
  - CT
  - MRI
- Confirmation of diagnosis
- Recommendation to the parents….
Chronic inflammation in CCAM: an underestimated risk factor.

- Early (postnatal) or late resection (3 months) ??
- 18 in perinatal group (PG), required operation for respiratory distress
- 6 in the late group (LG) with elective surgery
- PG: 100% of type II (n=8) and 50% of type I were inflamed
- LG: 50% were chronically inflamed

Conclusion: Overall incidence of pulmonary inflammation 79%. Thus early postnatal treatment should be considered even in asymptomatic patients
Is CPAM a premalignant lesion for pleuropulmonary blastoma?


- Retrospektive Studie (Toronto) 1999-2008
- 129 Kinder mit CPAM, wovon 74 reseziert wurden
- 5 Kinder hatten ein PPB
- 3 Kinder wurden präoperativ als CPAM diagnostiziert

Anhand ihrer eigenen Daten berechneten die Autoren das Risiko eines PPB bei 2% aller diagnostizierten CPAM und bei 4% aller resezierten Formen

1. LaBerge JM et al. Asymptomatic CPAM. Semin Pediatr Surg 2005;14:16-33
Principles of thoracoscopy

- Positioning allows either anterior or posterior access
- Ergonomic placement of 3-5-ports (3-12mm, soft or rigid)
- Scope (3-5mm, 30°)
- Insufflation Pressure 6-8 mmHg
- Vessel sealing: Clip, Ligasure, suture
- Bronchus ligation: Clip, endostapler, Endoloop
- Specimen bag

Boubnova J. Surg Endosc 2011;25:593-596
Kaneko K. Ped Surg Int 2010;26:361-365
Surgical strategy

- You must be (very) familiar with the anatomy of the lung

- Laparoscopic resection usually works by the „open book principle“

- You tackle:
  - pulmonary arteries first,
  - bronchus
  - pulmonary veins last
Extralobar sequestration (BPS)

<table>
<thead>
<tr>
<th></th>
<th>Extralobar</th>
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</thead>
<tbody>
<tr>
<td>Anatomy</td>
<td>Covered by own pleura, separated from lung parenchyma</td>
</tr>
<tr>
<td>Frequency</td>
<td>25%</td>
</tr>
<tr>
<td>Localisation</td>
<td>Paravertebral (supra- and infradiaphragmatic), most left sided</td>
</tr>
<tr>
<td>Blood supply</td>
<td>Variable</td>
</tr>
<tr>
<td>Blood drainage</td>
<td>V. cava, V. azygos, V. portae</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Mostly asymptomatic</td>
</tr>
<tr>
<td>Therapy</td>
<td>Resection</td>
</tr>
<tr>
<td>Male / Female</td>
<td>4:1</td>
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</tbody>
</table>
Thoracoscopic resection BPS

- Lateral decubitus position
- 3(4) ports (3-5mm)
- Ligation with clips, LigaSure
- Careful: Retraction of the vessels after dissection
- Extraction of tissue in specimen bag of fragments (morcellation)
Thoracoscopy
Resection & results
Bronchogeneic cyst
...but what about the more complex lesions...
### Intralobar BPS

<table>
<thead>
<tr>
<th></th>
<th><strong>Intralobar</strong></th>
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<tbody>
<tr>
<td><strong>Anatomy</strong></td>
<td>Covered by visceral pleura</td>
</tr>
<tr>
<td><strong>Frequency</strong></td>
<td>75%</td>
</tr>
<tr>
<td><strong>Localisation</strong></td>
<td>Posterobasal segment, most left sided</td>
</tr>
<tr>
<td><strong>Blood supply</strong></td>
<td>Large arteriel supply branching from the aorta and ist large branches</td>
</tr>
<tr>
<td><strong>Blood drainage</strong></td>
<td>Pulmonal venes</td>
</tr>
<tr>
<td><strong>Symptoms</strong></td>
<td>Mostly asymptomatic, Infections, bleeding</td>
</tr>
<tr>
<td><strong>Therapy</strong></td>
<td>Lobectomy</td>
</tr>
<tr>
<td><strong>Male / Female</strong></td>
<td>1:1</td>
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</tbody>
</table>
CPAM

- Incidence: 1.2 / 10,000 newborn
- Classification*:
  - microcystic (< 5mm)
  - macrocystic (> 5mm)
- Often hybrid lesions (CPAM)
- Anatomical lobectomy mandatory
- Timing: - asymptomatic at 3-6 months
  - symptomatic at any age

CPAM-lobectomy

- Lateral position
- Single lung ventilation preferred
- 3(4) ports 3-5mm
- Energy sources on board:
  - Electrocautery hook (fissure)
  - Ligasure
  - Clips
  - Endo-GIA (> 6 months of age, without a trocar)
CPAM lower lobe

- Decompression of the CPAM?
- Mobilization of inf. pulmonary lig
- Dissection of incomplete fissure
  - Monocautery hook
- Ligation of pulmonary arteries
  - Ligasure
  - Clips
  - Suture ligations
- Dissection of bronchus
  - Clips (PDS) or GIA or suture
- Ligation of pulmonary veins
- Extraction of tissue
  - Specimen bag
  - Morcellation
Results

- **Experience with 144 consecutive pediatric thoracoscopic lobectomies**
  - Albanese CT, Rothenberg SS. J Laparoendosc Avd Tech 2007

- 144 thoracoscopic lobectomies (1995 to 2005)
- CCAM/sequestrations(112), bronchiektases(19), CLE(10), malignancy(3)
- Age 2 days to 18 years
- Single lung ventilation in all cases
- All but 3 successful (1 bleeding, 1 bronchus of UL, 1 inadequate margin)
- 110 LL, 24 UL, 10 ML
- Operating time 35 to 220 min.
- No reoperations, median LOHS 2.8 days

- Conclusion: The current techniques and equipment allow for the complete thoracoscopic resection of pulmonary lobes in any age or size of the child
Thoracoscopy improves midterm musculo-skeletal status and cosmesis

Lawal TA, Ure BM Ann Thorac Surg 2009

- Video-assisted thoracoscopic (VATS) versus conventional thoracic surgery (CTS)
- 62 children, FU of 1-7 years (mean 3.8 years)
- Underwent clinical assessment of skeletal function, intercostal spaces were investigated for rib fusion by US
- Chest asymmetry was significantly less after VATS, p<0.001
- Incidence of scoliosis was lower after VATS (9% vs 54%, p<0.001)
- Intercostal spaces were narrower after CTS (p<0.001)

- Conclusion: VATS is associated with significant less midterm muscoloskeletal sequelae and better cosmesis
Thoracoscopic lobectomies in infants less than 10kg with prenatally diagnosed cystic lung lesions


- 75 patients under 1 year or 10kg (2001 to 2009)
- 52 CCAM, 20 BPS 3 CLE
- Age at operation 4 days to 11 months (3.1 – 10kg)
- 75 thoracoscopic lobectomies
- Operation time 45-225 minutes

- Conclusion: Thoracoscopic lobectomy is safe in infants < 10kg and avoids the morbidity associated with thoracotomy
Prior thoracic surgery has limited impact on the feasibility of consecutive thoracoscopy. 


- 228 thoracic procedures in 190 children (mean age 5.1 years)
- 137 thoracoscoopies, 91 conventional operations
- 32 (14%) had previous ipsilateral thoracic surgery
- 20 underwent subsequent thoracoscopy
- No significant impact on conversion rate
- However higher number of reconstructive surgery in patients without prior surgery

Conclusion: Thoracoscopic surgery is feasible even after prior thoracic operations
Thoracoscopy improves midterm musculoskeletal status and cosmesis

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Conclusion: VATS is associated with significant less midterm musculoskeletal sequelae and better cosmesis
Increasing acceptance for most indications and most age groups
No prospective multi-center studies available
High variability of pathologies
Highest technical standard even in complex pathologies
Significant learning curve
Decrease in iatrogenic morbidity
Less trauma and late musculo-skeletal deformities
Good functional and cosmetic results
Limits: Individual experience and technology
Future: Development will continue (e.g. Single port laparoscopy)