Reducing lung volume in emphysema

Surgical Aspects

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Surgical aspects of LVR

- Why we should NOT perform LVRS
- Physiology behind LVRS
- Role of the MDT
- Spiracle trial
- Patient selection for LVRS
- Surgical approach
- Outcome
Why we should **NOT** perform LVRS

- From a surgical perspective.....
- High risk population
  - ? High risk procedure
- Surgeon specific mortality reporting
- Increase in Thoracic surgeons
- Complications -
Why we should NOT perform LVRS
Physiology behind LVRS

- Alveolar destruction
- Loss of elastic recoil
- Gas trapping
- Dynamic hyperinflation
- Chest wall and diaphragm function
Physiology behind LVRS

- Brantigan 1957
- Joel Cooper 1990s
- Geddes and Goldstraw NEJM 2000
- NETT
Role of the MDT

- Better patient selection
- Increase in patients being treated
- Peri-operative management
- Consideration for all available treatments

“The outcomes of a successful LVRS programme are not only dependent on good surgical technique and post-operative care. Case selection and work-up by a dedicated multidisciplinary approach for emphysema patients plays an invaluable and integral part in an LVRS programme”

Rathinatham S. Eur J Cardiothoracic Surg 2014
Role of the MDT

- Better patient selection
- Increase in patients being treated
- Peri-operrative management
- Consideration for all available treatments

“The outcomes of a successful LVRS programme are not only dependent on good surgical technique and post-operative care. Case selection and work-up by a dedicated multidisciplinary approach for emphysema patients plays an invaluable and integral part in an LVRS programme”

Rathinatham S.  Eur J Cardiothoracic Surg 2014
Spiracle trial

- Homogenous Emphysema
- Extra-pulmonary bypass
Effect Of A Single Extra-Pulmonary Pathway

**After Inflation**

**After Deflation**
Effect Of A Single Extra-Pulmonary Pathway

After Inflation

26 Fr Urinary catheter

After Deflation
Effect Of A Single Extra-Pulmonary Pathway

No Effect In Pulmonary Fibrosis

Moore A.  Annals of Thoracic Surgery. 2010
Effect Of A Single Extra-Pulmonary Pathway

Increased Air Flow in Emphysema

Moore A. Annals of Thoracic Surgery. 2010
Open Label Pilot of Extrapulmonary Bypass

• **Entry Criteria**
  • Homogenous emphysema
  • FEV₁ 20-40% predicted
  • Hyperinflation
  • RV:TLC ratio >0.6

• **Exclusion criteria**
  • >2 exacerbations requiring admission /year
  • Other significant disease
  • Pulmonary hypertension (PAP>35 mmHg if measured)
  • TLCO<20% predicted and FEV₁<20% predicted SWT <150m
  • PaO₂<8kPa or use of NIV
  • BMI<20 kg/m²

This point is the cohort with the greatest mortality in our cohort: approximately 30% at 4 years with no treatment.
Spiracle Trial

- Homogenous emphysema
- Completed PR
- Maximal medical therapy
- N=5

- 2 Baseline visits 1 month apart
  - Routine PFT,
  - 6MW
  - VO2 max
  - Collateral ventilation

- Insertion Size 9 armoured ET tube

- FU 1 & 3 Mo
  (primary end point)
Spiracle Trial

- Mini Axillary Thoracotomy
- Short segment rib resection
- ET tube inserted into Upper Lobe
- Talc Pleurodesis
- Single Drain
Spiracle Trial
Spiracle Trial
Spiracle Trial
### b) FEV1 (as % predicted)

<table>
<thead>
<tr>
<th></th>
<th>Screening</th>
<th>Baseline</th>
<th>1 Month</th>
<th>3 Months</th>
<th>6 Months</th>
<th>% increase Baseline-3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>22.0</td>
<td>31.0</td>
<td>23.0</td>
<td>33.0</td>
<td></td>
<td>6.5</td>
</tr>
<tr>
<td>Patient 2</td>
<td>34.0</td>
<td>35.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient 3</td>
<td>30.0</td>
<td>28.4</td>
<td>30.8</td>
<td>35.0</td>
<td>32.7</td>
<td>23.2</td>
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<tr>
<td>Patient 4</td>
<td>20.0</td>
<td>18.0</td>
<td>22.0</td>
<td>22.0</td>
<td>23.0</td>
<td>22.2</td>
</tr>
<tr>
<td>Patient 5</td>
<td>15.0</td>
<td>20.0</td>
<td>22.0</td>
<td>28.0</td>
<td>25.0</td>
<td>40.0</td>
</tr>
<tr>
<td>Average</td>
<td><strong>21.8</strong></td>
<td><strong>24.4</strong></td>
<td><strong>24.5</strong></td>
<td><strong>29.5</strong></td>
<td><strong>26.9</strong></td>
<td><strong>23.0</strong></td>
</tr>
<tr>
<td>(of Pt 1,3-5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
## RV / TLC Ratio

### a) RV TLC Ratio

<table>
<thead>
<tr>
<th></th>
<th>Screening</th>
<th>Baseline</th>
<th>1 Month</th>
<th>3 Months</th>
<th>6 Months</th>
<th>% Reduction Baseline-3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>63.4</td>
<td>58.4</td>
<td>63.5</td>
<td>53.7</td>
<td></td>
<td>8.0</td>
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<tr>
<td>Patient 2</td>
<td>69.0</td>
<td>66.0</td>
<td>68.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient 3</td>
<td>62.8</td>
<td>64.8</td>
<td>61.0</td>
<td>57.0</td>
<td>60.7</td>
<td>12.0</td>
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<tr>
<td>Patient 4</td>
<td>68.0</td>
<td>73.4</td>
<td>71.4</td>
<td>72.2</td>
<td>69.3</td>
<td>1.6</td>
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<tr>
<td>Patient 5</td>
<td>79.1</td>
<td>74.8</td>
<td>70.0</td>
<td>71.6</td>
<td>69.6</td>
<td>4.3</td>
</tr>
<tr>
<td><strong>Average (of Pt 1,3-5)</strong></td>
<td><strong>68.3</strong></td>
<td><strong>67.9</strong></td>
<td><strong>66.5</strong></td>
<td><strong>63.6</strong></td>
<td><strong>66.5</strong></td>
<td><strong>6.5</strong></td>
</tr>
</tbody>
</table>
d) Incremental Shuttle Walk Distance (metres)

|                | Screening | Baseline | 1 Month | 3 Months | 6 Months | % increase
|----------------|-----------|----------|---------|----------|----------|-------------
| Patient 1      | 170       | 220      | 3       | 270      |          | 22.7        |
| Patient 2      | 280       | 270      | 210     |          |          |             |
| Patient 3      | 530       | 510      | 430     | 440      | 380      | -13.7       |
| Patient 4      | 240       | 250      | 130     | 130      | 240      | -48.0       |
| Patient 5      | 150       | 130      | 120     | 110      | 180      | -15.4       |
| Average (of Pt 1,3-5) | **273** | **278** | **171** | **238** | **267** | **-13.6** |
Spiracle Trial
Spiracle trial

• Extra-Pulmonary Bypass is possible
  (one patient still had “air leak” after 18 months)

• TLC and RV/TLC can be reduced

• FEV1 can be increased
  (by 23% in 4 patients)

Very Small number of cases performed worldwide
Spiracle trial

- Homogenous Emphysema
  - Transplant

- Heterogeneous Emphysema
  - LVRS
    - Bullectomy
    - Intra-cavity drainage
    - Endobronchial LVRS
Patient selection for LVRS

- **Bullectomy**
  - Breathless / Single large bulla on CT / FEV1 < 50%

- **LVRS**
  - Severe COPD with marked restriction of ADL despite max med therapy
  - Pulm rehab
  - FEV1 > 20%
  - TLCO > 20%
  - PaCO2 < 7.3
  - Upper lobe predominant emphysema

NICE guidelines [CG101]. 2010
Patient selection for LVRS

- 1.1 million patients with COPD in UK  
  (Quality Outcomes Framework data, www.gpcontract.co.uk)
- If 10% have severe or very severe disease
- If only 15% of these meet LVRS criteria  
  (US database study)

- 16,000 potentially eligible individuals

- SCTS UK data
  - 96 LVRS cases in 2009/10
  - 90 LVRS cases in 2010/11
  - >1/3 of these cases were performed by thoracotomy
Patient selection for LVRS

- Clinical review
- PFT  \( (\text{FEV}_1 \ / \ \text{TLCO} \ / \ \text{RV-TLC ratio}) \)
- ABG
- Pattern of disease on CT  \( \text{(Heterogenous} \ / \ ?\text{just COPD}) \)
- VQ scan with lobar quantification
- Consideration of all treatment modalities / trials
- Clinical review and consent
Patient selection for LVRS
Patient selection for LVRS

Ventilation:

Results:

<table>
<thead>
<tr>
<th>Perfusion (%)</th>
<th>Ventilation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>Upper</td>
<td>7.68</td>
</tr>
<tr>
<td>Middle</td>
<td>9.95</td>
</tr>
<tr>
<td>Lower</td>
<td>22.3</td>
</tr>
<tr>
<td>Total</td>
<td>39.9</td>
</tr>
</tbody>
</table>
Surgical approach – Unilateral vs Bilateral

- NETT studied Bilateral LVRS
- ? Reduced benefit with Unilateral
- Reduced morbidity / more rapid recovery with Unilateral LVRS
- Longer lasting benefit with staged Bilateral LVRS

Oey I. Eur J Cardiothorac Surg. 2010
Surgical approach – Lobar resection

- Unilateral Lobe Resection by Video-Assisted Thoracoscopic Surgery Leads to the Most Optimal Functional Improvement in Severe Emphysema
  - 0% mortality
  - Similar effect on PFT
  - Similar recovery
  - Improved Exercise Capacity

Di Chiara F. SCTS Manchester 2015
Beckers F. Thorac Cardiovasc Surg. 2014
Surgical approach – Lobar resection

- 19 / 99 patients
- Similar pt characteristics
- Prolonged air leak (>7 days) reduced from 50% (40 cases) to 21% (4 cases) (P<0.05)
- Complications reduced (P<0.05)
- Length of stay similar

Di Chiara F. SCTS Manchester 2015
Outcomes - NETT

- 3777 pts assessed at 17 centres
- 1218 randomised
- 29 month follow up
- Mortality in 2 groups same overall
- Survival benefit in het, upper lobe with poor Ex capacity - 15% at 5 years

- High risk group:
  - FEV1 <20% and
  - Homogenous or TLCO <20%

- LVRS improves Spirometry / RV / TLCO / O2 & CO2 / QoL / Ex capacity
Peri-operative Survival

- NETT 5.5% at 90 days
- Better pt. selection and peri-operative care
- Unilateral approach
- ? Exclusion of high risk cases
- Many authors reporting mortality rates 1-2%
- Our own series of 115 unilateral procedures – 0% mortality at 90 days

Median Length of stay 12 days
Future

- BTS Survey in 2013
- 65 responses (82% resp physicians)
- ½ were unsure or overestimated mortality
- 30% did not have access to COPD MDT

<table>
<thead>
<tr>
<th></th>
<th>Jan 2014</th>
<th>Jan 2015</th>
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<tbody>
<tr>
<td>FEV1</td>
<td>0.55</td>
<td><strong>0.96</strong> (37%)</td>
</tr>
<tr>
<td>FVC</td>
<td>2.08</td>
<td>2.61</td>
</tr>
<tr>
<td>TLCO</td>
<td>2.51</td>
<td><strong>3.99</strong> (42%)</td>
</tr>
<tr>
<td>RV/TLC</td>
<td>71%</td>
<td>65%</td>
</tr>
</tbody>
</table>
Frank
FRANK

NSCLC / Chest Wall Invasion

FEV1  23%
TLCO  25%

Right Upper Lobectomy & Chest wall resection (ribs 1-2)
Post-op

FEV1  32%
TLCO  35%
Future
Surgery for N2 Disease

Peri-operative mortality has fallen from 3.8 to 2.1 % over the past decade

Number of resections are increasing year on year

60 % increase in 4 years to 5265 resections