Exercise capacity in patients with cystic fibrosis vs. non-cystic fibrosis bronchiectasis

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Evaluation

• Most tests performed in rest

• Real life – active, demanding, limitations?

• Questionnaire - reliability ↓

• Exercise tests – usually measure limited data (FEV\textsubscript{1}, ST segment, ECG abnormalities, etc.)

• Home sensors? (event recorder, accelerometer, holter)
Exercise Capacity

• **Definition** - the maximum amount of physical exertion that a patient can sustain

• **Measurement** - CPET – CardioPulmonary Exercise Testing

• **Variant measured** → **VO₂** (HR, Sat., BP, RR, VE/VCO₂, O₂ Pulse, ETCO₂, VE/MVV)
**Muscle Activity**

- Q_{CO_2}
- Q_{O_2}

**O_2 and CO_2 Delivery**

- Peripheral circulation
- Pulmonary circulation
- O_2 flow
- CO_2 flow

**Ventilation**

- V_A + V_D = V_E

**Expired**

- V_{CO_2}
- VO_2

**Inspired**

- H_2O

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MUSCLE ACTIVITY

O₂ and CO₂ DELIVERY

VENTILATION (VA + VD = VE)

Physiological responses:

Muscle

Heart

Blood

Lungs

Mitochondrion

QO₂

QCO₂

QO₂

QCO₂

O₂ flow

CO₂ flow

O₂ flow

CO₂ flow

Peripheral circulation

Pulmonary circulation

Expired

Inspired

↑ QCO₂

↑ QO₂

↑ SV

↑ HR

Recruit

↑ VT

↑ BF

↑ O₂

↑ O₂

↑ CO₂

↑ CO₂

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Exercise Capacity

- $\text{VO}_2 \rightarrow$ correlation with morbidity and mortality?

- COPD $\rightarrow$ $\text{VO}_2 \downarrow$
- Adult CF $\rightarrow$ $\text{VO}_2 \downarrow$
- Pediatric chronic lung disease $\rightarrow$ $\text{VO}_2 \downarrow$
- Pediatric CF $\rightarrow$ $\text{VO}_2 \downarrow$
- Pediatric non CF bronchiectasis $\rightarrow$ $\text{VO}_2 \downarrow$
- Pediatric + young adults PCD $\rightarrow$ $\text{VO}_2 \downarrow$

Vs. healthy
CF

• Genetic disease

• Typical vs. atypical

• High incidence of bronchial thickening and bronchiectasis

• Treatment: Inhalations (HS, abx, Dnase), Abx, genetic therapy, physio, vitamins,
Non CF bronchiectasis

Bag of diseases:

- Immune deficiencies
- Primary ciliary dyskinesia (PCD)
- Post infectious
- Post obstructive (FB, TB, etc.)
- Aspirations
- Tuberculosis (TB)
- Bronchiolitis obliterans (BO) associated
- Congenital defects
- Idiopathy
Mortality & morbidity in CF

Positive association with:
  ! QoL
  ! Risk of hospitalization

Figure 1. Survival among 109 Patients with Cystic Fibrosis, According to Fitness Level.

Thorax 2005;60:50–54
FIGURE 3. Relationship between forced expiratory volume in one second (FEV1) and a) peak oxygen uptake ($V_\text{O}_2$peak) and b) 6-min walking distance (6MWD) in healthy subjects (●, ▼) and patients with cystic fibrosis (○, ▲). ▲, ▼: male subjects; ○, ●: female subjects. % pred: % predicted.
Mortality & morbidity in non CF

- No data
  - Morbidity
  - Mortality
  - Correlation to pulmonary variables
CPET – CardioPulmonary Exercise Testing

• Clinical utility – Exercise capacity ($V_{O_{2peak}}$)

• Points the factor(s) limiting exercise capacity:
  – Motivation
  – Poor fitness
  – Disease pathophysiology:
    • Respiratory
    • Cardiovascular
    • Muscle
    • Combined

CPET de facto...
Aim

• To evaluate and compare exercise capacity in CF and non-CF bronchiectasis patients
Methods

• Setting: Out patients clinic, physical exercise clinic, pediatric pulmonary institute

• Design: Retrospective/prospective study
Inclusion criteria

- Children and adults aged 7-45 years
- Bronchiectasis upon chest CT
- CPET – maximal performance
- Cycle ergometry
Exclusion criteria

• CPET – submaximal performance

• Technical
Outcome parameters

Primary end point:
• \( \text{VO}_2 \) (oxygen consumption)

Secondary end points:
• Spirometry
• Vital signs (HR, Sat)
• \( \text{O}_2 \text{pulse} \) (cardiac)
• \( \text{VE}/\text{VCO}_2 \)
Visit

✓ Life style questionnaires

✓ Spirometry

✓ MVV

✓ Cycle ergometry CPET

✓ Post exercise spirometry
Sample size

✓ A sample size of 119 patients in each group is necessary to detect a difference of 10% in VO₂ between both groups.

✓ A sample size of 37 patients in each group is necessary to detect a difference of 20% in VO₂ between both groups.
Statistics

SPSS for windows, version 21, (IBM, SPSS Chicago, Illinois)

✓ t-test (differences between the two groups (CF vs. Non CF))
✓ Mann-Whitney U (quantitative parameters were not normally distributed)
✓ Fisher exact test (differences in the categorical parameters)
✓ Pearson correlation test (relationship between VO$_2$ and FVC or FEV$_1$)
✓ Repeated measure model was used for differences in the Sat. O$_2$ before and after CPET
✓ p<0.05 was considered as statistical significance
Results - demographics

<table>
<thead>
<tr>
<th></th>
<th>CF (N=46)</th>
<th>Non CF (N=48)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>21.1±10.05</td>
<td>18.4±10.3</td>
<td>p=0.2</td>
</tr>
<tr>
<td>Gender –Male</td>
<td>29 (63.0%)</td>
<td>29 (60.4%)</td>
<td>p=0.55</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>159.7±16.3</td>
<td>155.8±15.7</td>
<td>p=0.25</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>56.2±18.5</td>
<td>51.1±18.4</td>
<td>p=0.15</td>
</tr>
<tr>
<td>BMI</td>
<td>21.5±4.3</td>
<td>20.4±5.2</td>
<td>p=0.31</td>
</tr>
<tr>
<td>Religion -Jews</td>
<td>13 (28.3%)</td>
<td>19 (39.6%)</td>
<td>p=0.27</td>
</tr>
</tbody>
</table>

NON CF:  Idiopathy - 12  
         PCD   - 11  
         Post BO - 8
## Results

<table>
<thead>
<tr>
<th></th>
<th>CF (N=46)</th>
<th>Non CF (N=48)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEV 1.0 (L/Sec)</strong></td>
<td>2.14±0.84</td>
<td>1.99±0.88</td>
<td>p=0.39</td>
</tr>
<tr>
<td><strong>FEV 1.0 (% Pred)</strong></td>
<td>69.7±21.9</td>
<td>67.6±20.4</td>
<td>p=0.64</td>
</tr>
<tr>
<td><strong>FVC (L)</strong></td>
<td>2.84±1.0</td>
<td>2.64±1.1</td>
<td>p=0.36</td>
</tr>
<tr>
<td><strong>FVC (% Pred)</strong></td>
<td>81.8±19.4</td>
<td>78.6±19.8</td>
<td>p=0.42</td>
</tr>
<tr>
<td><strong>VO₂ Absolute (ml/min)</strong></td>
<td>1949.3±699.0</td>
<td>1736.4±548.7</td>
<td>p=0.10</td>
</tr>
<tr>
<td><strong>VO₂ (%)Pred</strong></td>
<td>91.6±22.9</td>
<td>88.06±19.3</td>
<td>p=0.42</td>
</tr>
<tr>
<td><strong>VO₂ Specific (ml/kg/min)</strong></td>
<td>36.9±10.8</td>
<td>34.9±10.6</td>
<td>p=0.35</td>
</tr>
<tr>
<td><strong>VE/VCO₂</strong></td>
<td>31.3±4.2</td>
<td>32.02±4.0</td>
<td>p=0.42</td>
</tr>
<tr>
<td><strong>O₂ pulse (%)Pred</strong></td>
<td>99.9±24.6</td>
<td>91.4±18.9</td>
<td>p=0.096</td>
</tr>
<tr>
<td><strong>BR (L) median 25%-75%</strong></td>
<td>14.1 (5.75-27.05)</td>
<td>12.6 (1.00-35.75)</td>
<td>P=0.91</td>
</tr>
<tr>
<td><strong>VE (L/min)</strong></td>
<td>69.7±27.9</td>
<td>60.6±22.1</td>
<td>p=0.083</td>
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<tr>
<td><strong>MVV (L/min)</strong></td>
<td>87.4±36.1</td>
<td>80.8±34.5</td>
<td>p=0.36</td>
</tr>
<tr>
<td><strong>Sat. O₂ (pre)</strong></td>
<td>98.1±2.6</td>
<td>98.97±1.5</td>
<td>p=0.045</td>
</tr>
<tr>
<td><strong>Sat. O₂ (post)</strong></td>
<td>96.8±5.1</td>
<td>98.1±4.2</td>
<td>p=0.19</td>
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</tbody>
</table>
## Results - saturation

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
<th>Range</th>
<th>p</th>
<th>p</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td><strong>Sat. O₂ (pre)</strong></td>
<td>CF</td>
<td>98.087</td>
<td>2.5977</td>
<td>46</td>
<td>86-100</td>
<td>p=0.045</td>
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<tr>
<td></td>
<td>Non CF</td>
<td>98.979</td>
<td>1.5366</td>
<td>48</td>
<td>93-100</td>
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<tr>
<td></td>
<td>Total</td>
<td>98.543</td>
<td>2.1586</td>
<td>94</td>
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<tr>
<td><strong>Sat. O₂ (post)</strong></td>
<td>CF</td>
<td>96.848</td>
<td>5.1032</td>
<td>46</td>
<td>77-100</td>
<td>p=0.19</td>
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<tr>
<td></td>
<td>Non CF</td>
<td>98.104</td>
<td>4.1832</td>
<td>48</td>
<td>78-100</td>
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<tr>
<td></td>
<td>Total</td>
<td>97.489</td>
<td>4.6738</td>
<td>94</td>
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<tr>
<td><strong>p</strong></td>
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<td>P=0.012</td>
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<td>P=0.065</td>
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</tbody>
</table>
$\text{VO}_2 \text{ vs FEV}_1$

CF

$\text{Non CF}$

$r = 0.65, p < 0.0001$

$r = 0.193, p = 0.188$
$\text{VO}_2 \text{ vs FVC}$

CF

$r = 0.692, p < 0.0001$
Discussion

✓ Retrospective/prospective trial evaluating exercise capacity in CF vs. non CF bronchiectasis

✓ No difference was observed in oxygen consumption between groups

✓ Saturation deteriorated in the CF patients (96% vs 98%) compared to non CF (no change)

✓ $O_2$ pulse was reduced in non CF group vs. CF
Discussion

• Oxygen consumption was preserved in both groups (mean FEV$_1$~68%)

• CF correlation probably due to relative homogenous group with standard care in CF centers

• Non CF – heterogeneous group, no standard care
Discussion

• One study in 44 PCD patients (6-29 yr)
CPET

• Safe even in severe patients.

• Provide personal guidelines for exercise.

• Reassurance for patients to perform exercise.

• Provide valuable prognostic factors.

• May provide functional outcome measure for follow up.
Limitations

✓ Small sample size
✓ Wide range (7-45 years)
✓ Non CF – variety of diseases
✓ % Pred...
A glance to the future

✓ Larger cohort of children/adults

✓ Disease specificity

✓ Mild-moderate disease vs. severe disease

✓ Training and reevaluation - can physical activity change the slope?
Thanks!

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– Dr. Michal gur
– Dr. Moshe Rotschild
– Dr. Vered Nir
– Dr. Zeev shnapp

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– Physical exercise clinic – Hadas, Ehab, Roman, Haya, Violetta
שלום, אני נסע...
תודה רבה על המקשבה!!!