Residual Post-Thrombotic Iliofemoral Vein Occlusion as a Cause of Exercise Limitation

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Post-Thrombotic Syndrome
From: Up to Date®

• Post-thrombotic syndrome (PTS) is the development of chronic venous symptoms and/or signs secondary to deep venous thrombosis (DVT).

• Injury to the venous valvular system produces symptoms of chronic venous insufficiency that can include pain, venous dilation, edema, pigmentation, skin changes, and venous ulcers.

What about exercise capacity?
Exercise Capacity in Residual Post-DVT Venous Occlusion

• Colleagues from coagulopathy clinic note that some post-DVT patients have seemingly unexplained effort intolerance.

• Most clinicians assume venous collaterals are sufficient to enable normal exercise performance even in post-DVT patients with residual venous occlusion.
In 1997, Ben-Dov et al reported a case of lower limb venous obstruction causing severe exercise limitation.
Exercise Capacity in Residual Post-DVT Venous Occlusion

- Kuo et al (J Vasc Interv Radiol 2013) report a case of symptomatic IVC occlusion from a chronically thrombosed IVC filter resulting in exercise intolerance (inc. dizziness and palpitation when running). After removal of the obstructing filter exercise capacity was restored, allowing the patient to resume long-distance running!
Hypothesis & Objective

• **Hypothesis:** Chronic residual venous occlusion after deep vein thrombosis (DVT) may result in reduced exercise capacity.

• **Objective:** To study exercise physiology in post-DVT patients complaining of effort intolerance.
Methods

• Multimodality incremental symptom-limited maximal cardiopulmonary exercise testing (including gas exchange)

• Subjects:
  – 6 post-DVT patients c/o effort intolerance with no cause identified by standard workup; all had residual iliofemoral occlusion
  – 8 health volunteers as controls
## Subject Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Controls</th>
<th>PTS</th>
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<tbody>
<tr>
<td>N (female)</td>
<td>8 (2)</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>45±12</td>
<td>38±15</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>71±15</td>
<td>80±19</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>174±11</td>
<td>172±8</td>
</tr>
<tr>
<td>FEV$_1$ (% predicted)</td>
<td></td>
<td>91±17</td>
</tr>
<tr>
<td>FVC (% predicted)</td>
<td></td>
<td>92±15</td>
</tr>
<tr>
<td>FEV$_1$/FVC</td>
<td></td>
<td>0.84±0.9</td>
</tr>
<tr>
<td>TLC (% predicted)</td>
<td></td>
<td>97±10</td>
</tr>
<tr>
<td>DLCO (% predicted)</td>
<td></td>
<td>76±10</td>
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Exercise Capacity is Reduced in Iliofemoral Vein Occlusion

![Graph showing peak VO2 (% predicted) for control and PTS groups with p=0.007](image)
Exercise Capacity is Reduced in Iliofemoral Vein Occlusion

<table>
<thead>
<tr>
<th></th>
<th>range</th>
<th>% predicted</th>
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<tbody>
<tr>
<td>$\dot{V}O_2$ peak (ml.min$^{-1}$)</td>
<td>680-1672</td>
<td>36-67%</td>
</tr>
<tr>
<td>$\dot{V}O_2$:HR peak (ml.beat$^{-1}$)</td>
<td>5-12.4</td>
<td>50-83%</td>
</tr>
<tr>
<td>$\dot{V}O_2$ @ AT (ml.min$^{-1}$)</td>
<td>466-1049</td>
<td>25-40%*</td>
</tr>
<tr>
<td>Peak HR (min$^{-1}$)</td>
<td>122-140</td>
<td>62-80%</td>
</tr>
<tr>
<td>RER @ peak ex.</td>
<td>1-1.37</td>
<td></td>
</tr>
<tr>
<td>Breathing reserve (L/min)</td>
<td>57-101</td>
<td></td>
</tr>
<tr>
<td>$\dot{V}E/\dot{V}CO_2$ @ AT</td>
<td>28-64</td>
<td></td>
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* % predicted VO2 peak; >40% is normal
All Cardiovascular Parameters are Reduced in Iliofemoral Vein Occlusion
What is the mechanism of reduced exercise tolerance in chronic iliofemoral vein occlusion?
Leg exercise capacity is more severely affected than arms in patients with iliofemoral vein occlusion.

* % predicted V'O2 is for leg exercise; red dashed line denotes predicted peak V'O2 for arms = 70% of leg value
Modeling Iliofemoral Vein Occlusion

• We attempted to model the physiological effects of post-thrombotic iliofemoral occlusion by applying tourniquets to the thighs of healthy volunteers
• Tourniquets were inflated to 30 mmHg
• 4 CPETs were performed in random order:
  1. Standard lower limb exercise (no tourniquet)
  2. Lower limb exercise with 1 tourniquet
  3. Lower limb exercise with 2 tourniquets
  4. Upper limb exercise (no tourniquet)
Blocking venous flow in the legs using tourniquets reduces exercise capacity in healthy volunteers.
Summary & Conclusions

- Exercise capacity is reduced in post-thrombotic iliofemoral occlusion.
- Leg exercise capacity is more severely affected than arm exercise capacity.
- Venous obstruction in the legs by application of tourniquets to the thighs reduces exercise capacity in healthy volunteers.
- **Conclusion**: reduced exercise capacity in post-thrombotic iliofemoral occlusion is probably caused by reduced venous return.
Thank you for your attention!

Questions?