Suspension Syndrome

S Rauch, K Schenk, G Strapazzon, T d Cappello, M Erckert, B Bliemsrieder, L Oberhuber, H Gatterer, H Brugger, P Paal
DEFINITION

- Pathophysiologic response of the human body being suspended motionless in a vertical position for an extended period of time.
- Symptoms include pre-syncope and can lead to a loss of consciousness.
- Potentially life-threatening disorder!

RELEVANCE

Climbing...

Courtesy of K. Grasegger
RELEVANCE

Workplace...
Since the 1970s the exact pathophysiological mechanism is debated...

**Hypovolemic shock??**

OBJECTIVE

To better understand the pathophysiological basis of suspension syndrome and to develop practical recommendations for prevention and treatment.
STUDY DESIGN

- Informed consent
- baseline parameters
  - Physical examination, anthropometric data, 12-lead ECG
- Randomisation
  - Climbing
  - Hanging
  - No climbing

13/10/17
Climbing...
...& hanging
...& hanging
...& hanging
STUDY DESIGN

**Continuous measurements:** HR, HRV, NIBP, CO, SpO2, NIRs (cerebral & somatic), RR

**Discontinuous measurements:** echocardiography (LVEDD, LVESD, VCI-diameter [max/min]), doppler sonography v. & a. fem. sup.

0 - 3 - 5 - 7 - 9 - 11 - 13 - 15 -- 20 -- 25 -- 30 -- 35 -- 40 -- 45 (-- 50 -- 55 -- 60)
HAEMODYNAMICS

1. Nexfin®:
   - Heart rate
   - Heart rate variability
   - Blood pressure (SAP, DAP, MAP)
   - Stroke volume
   - SpO2
HAEMODYNAMICS

2. Echocardiography:

LVEDD, LVESD
VENOUS POOLING

1. Ultrasound:
Superficial femoral vein (SFV)
VENOUS POOLING

2. Somatic NIRS
## RESULTS

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Number of participants</strong></td>
<td>20</td>
</tr>
<tr>
<td><strong>Number of tests</strong></td>
<td>40</td>
</tr>
<tr>
<td><strong>Mean age</strong></td>
<td>31.1</td>
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<tr>
<td><strong>Range of age</strong></td>
<td>21-46</td>
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<tr>
<td><strong>Mean BMI</strong></td>
<td>22.18</td>
</tr>
<tr>
<td><strong>Mean duration of hanging (min)</strong></td>
<td>46.45</td>
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<tr>
<td><strong>Minimal duration of hanging (min)</strong></td>
<td>14</td>
</tr>
<tr>
<td><strong>n presyncope</strong></td>
<td>12 (30%)</td>
</tr>
</tbody>
</table>
VENOUS POOLING?

...regional SO2

Start hanging

Presyncope

10 min

15 min
VENOUS POOLING?

SFV ultrasound
VENOUS POOLING?

SFV ultrasound
VENOUS POOLING?

SFV ultrasound
Haemodynamics

Heart rate
Haemodynamics

Blood pressure
Haemodynamics

Stroke volume

![Graphs showing haemodynamics](image)
CONCLUSION

Venous pooling (and orthostatic stress)

Neurally mediated loss of consciousness