Oro-Nasal Mask versus Two-Way Non-Rebreathing Valves for Maximal Aerobic Capacity Testing in Astronauts

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Abstract
INTRODUCTION: Astronauts complete maximal aerobic capacity (VO2pk) testing as part of their annual fitness assessment (AFA). A mouthpiece (mouthpiece) has been used in these tests. This is also the configuration that is used on the International Space Station. (ParvoMedics, Sandy, UT).

METHODS: The VO2pk tests are conducted on a cycle ergometer with a TrueOne2400 metabolic cart (ParvoMedics, Sandy, UT). The mask was accepted for use in all tests.

RESULTS: In 6 of 17 comparisons (34%), the time was 30 seconds less during the mask test. In one case, the time was 30 seconds more during the mask test. The results of this data mining effort were presented to the Medical Operations Group (MOG), which is a group of doctors from all over Johnson Space Center who decided on items pertaining to crew health.

CONCLUSIONS: The measured differences in VO2 at high workloads were seen in data from two of the subjects separated the two tests. In one case, the time was 30 seconds less during the mask test. In one case, the time was 30 seconds more during the mask test. An Astronaut Strength & Conditioning Rehabilitation specialist confirmed that the measured differences in VO2 at high workloads (>300W) were lower (-10.8±2.0%) with the mask. The submaximal data did not indicate a leak in either apparatus during these tests.

Table 3 – Summary of the variables compared between the mouthpiece and mask for each astronaut. The * indicates the extreme under-estimates of VO2 at high workloads. The + indicates the extreme over-estimates of VO2 at high workloads.

<table>
<thead>
<tr>
<th>Astronaut</th>
<th>VO2pk (L/min)</th>
<th>Peak RR</th>
<th>Peak VO2</th>
<th>Peak VE</th>
<th>Time (min)</th>
<th>VO2.Lmin (L/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.55±1.46</td>
<td>53.03</td>
<td>4.25</td>
<td>182.57</td>
<td>12.5±2.69</td>
<td>117.15±27.41</td>
</tr>
<tr>
<td>B</td>
<td>3.97±1.69</td>
<td>46.09</td>
<td>3.68</td>
<td>163.28</td>
<td>12.0±2.93</td>
<td>113.72±13.06</td>
</tr>
<tr>
<td>C</td>
<td>4.25±1.69</td>
<td>46.76</td>
<td>3.68</td>
<td>149.87</td>
<td>12.0±3.28</td>
<td>142.42±14.25</td>
</tr>
</tbody>
</table>

Discussion:
A maximal aerobic capacity (VO2pk) test is part of an astronaut’s annual fitness assessment (AFA). Once assigned to a mission, the International Space Station (ISS) astronaut will complete several VO2pk tests pre-flight, in-flight and post-flight.

The VO2pk test is used for in-flight exercise prescriptions as a function of workload (W).

An Astronaut Strength & Conditioning Rehabilitation specialist confirmed that the measured differences in VO2 at high workloads were lower (-10.8±2.0%) with the mask. The submaximal data did not indicate a leak in either apparatus during these tests.

The mask will be checked for leaks prior to test start. The astronaut will seal the open of the mask and blow out the lungs. If a leak is detected without resolve, the test will be repeated (if schedule allows and remaining tests will be completed with the mouthpiece).

Purpose:
To assess the reliability and validity of mask vs. mouthpiece by comparing submaximal VO2 and VO2pk data collected on the same astronauts within 1 year.