Table 1. Variables recorded during the cardiac preload maneuvers

|  |  |
| --- | --- |
|  | **Cardiac preloading maneuvers** |
| **Orthostatic challenge** | **Passive leg raise** |
| **SVI****(ml/m2)** |  | T1Pre | T2Post | T3Pre | T4Post |
| mean | 47.6 | 55.5 | 46.6 | 63.3 |
| SD | 7.9 | 7.8 | 5.6 | 6 |
| %∆ | 16.5% | 35.8% |
| *P*\* | 0.008 | 0.002 |
| **CI****(l/min/m2)** | mean | 2.9 | 3.4 | 2.7 | 3.7 |
| SD | 0.7 | 0.6 | 0.7 | 0.6 |
| %∆ | 16.8% | 36.9% |
| *P*\* | 0.006 | 0.001 |
| **HR (BPM)** | mean | 63.5 | 61.1 | 60.7 | 59.4 |
| SD | 7.2 | 8.1 | 6.9 | 7.2 |
| %∆ | 3.7% | 2.1% |
| *P*\* | 0.16 | 0.67 |
| **TPRI****(mmHg/l/min/m2)** | mean | 2266 | 1972 | 2259 | 1905 |
| SD | 478 | 436 | 481 | 373 |
| %∆ | 12.09% | 15.6% |
| *P*\* | 0.0001 | 0.0001 |
| **MAP****(mmHg)** | mean | 84.8 | 77 | 80.2 | 79.5 |
| SD | 14 | 7.9 | 12.6 | 12.9 |
| %∆ | 9.5% | 0.8% |
| *P*\* | 0.001 | 0.67 |
| **rSO2 right hemisphere (%)** | mean | 68.2 | 70.2 | 68.1 | 69.4 |
| SD | 8.6 | 7.3 | 8 | 7.2 |
| %∆ | 2% | 1.9% |
| *P*\* | 0.5 | 0.5 |
| **rSO2 left hemisphere (%)** | mean | 64.9 | 67.3 | 64.7 | 66.5 |
| SD | 10.6 | 10 | 10.3 | 9.6 |
| %∆ | 3.6% | 2.7% |
| *P*\* | 0.54 | 0.52 |
| **Vmax (cm/s)** | mean | 69.1 | 70 | 72.1 | 72.3 |
| SD | 16.5 | 16.4 | 17.8 | 15.1 |
| %∆ | 1.3% | 0.2% |
| *P*\* | 0.64 | 0.52 |
| **Vmean (cm/s)** | mean | 49.4 | 49.1 | 50.2 | 52.1 |
| SD | 12.6 | 11.1 | 13.2 | 10.7 |
| %∆ | 0.6% | 3.8% |
| *P*\* | 0.68 | 0.70 |

Values are expressed as mean (SD) and percent change (%∆) up () or down () before and after the test.

\* *P* values from the generalized estimating equation including time point (pre or post) and baseline value as covariables.

*SVI* stroke volume index, *CI* cardiac index, *HR* heart rate, *BPM* beats per min, *TPRI* total peripheral resistance index, MAP systemic mean arterial pressure, *rSO2* regional hemoglobin oxygen saturation, *Vmax* maximum blood flow velocity in the middle cerebral arteries, *Vmean* mean blood flow velocity in the middle cerebral arteries

Table 2. Responses recorded at baseline in supine decubitus, seated, and standing positions and percent change between positions

|  |  |  |
| --- | --- | --- |
|  | **Baseline values** | **%∆** |
| **Supine T5** | **Seated T13** | **Standing T21** | **Supine–****seated** | **Supine–****standing** | **Seated–****standing** |
| **SVI****(ml/m2)** | mean | 56.5 | 40.9 | 31.8 | 27.6% | 43.7% | 22.2% |
| SD | 6.9 | 9.5 | 7.6 |
| *P*\* | 0.001 | 0.001 | 0.001 | 0.036 |
| **CI****(l/min/m2)** | mean | 3.4 | 2.6 | 2.3 | 23.5% | 32.5% | 11.5% |
| SD | 0.6 | 0.6 | 0.6 |
| *P*\* | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| **HR (BPM)** | mean | 59.1 | 63.1 | 78 | 6.7% | 31.9% | 23.6% |
| SD | 8.2 | 9.1 | 10.1 |
| *P*\* | 0.0001 | 0.035 | 0.0001 | 0.0001 |
| **TPRI****(mmHg/l/min/m2)** | mean | 1853.6 | 2944.9 | 3248.9 | 58.8% | 75.2% | 10.3% |
| SD | 319.4 | 668.6 | 833.2 |
| *P*\* | 0.0001 | 0.0001 | 0.001 | 0.296 |
| **MAP****(mmHg)** | mean | 76.9 | 88.5 | 89.4 | 15.1% | 16.2% | 1.09% |
| SD | 5.3 | 8.5 | 8.3 |
| *P*\* | 0.0001 | 0.001 | 0.0001 | 0.31 |
| **rSO2, right hemisphere (%)** | mean | 69.6 | 68.2 | 68 | 2% | 2.2% | 0.2% |
| SD | 8 | 10 | 8.2 |
| *P*\* | 0.002 | 0.033 | 0.0001 | 0.64 |
| **rSO2, left hemisphere (%)** | mean | 66.9 | 65.8 | 65.3 | 1.6% | 2.3% | 0.7% |
| SD | 10.4 | 10 | 8.2 |
| *P*\* | 0.091 | 0.167 | 0.029 | 0.417 |
| **Vmax (cm/s)** | mean | 70 | 68.1 | 70.5 | 2.7% | 0.7% | 3.5% |
| SD | 16.3 | 18.6 | 28.5 |
| *P*\* | 0.610 | 0.388 | 0.870 | 0.463 |
| **Vmean (cm/s)** | mean | 50.7 | 47.1 | 48.7 | 7.1% | 3% | 3.3% |
| SD | 12.2 | 13 | 19.3 |
| *P*\* | 0.042 | 0.012 | 0.495 | 0.567 |
| **rSO2, deltoid (%)** | mean | 79.8 | 77.6 | 73.5 | 2.7% | 7.8% | 5.2% |
| SD | 5.9 | 4.4 | 3.9 |
| *P*\* | 0.0001 | 0.002 | 0.0001 | 0.0001 |
| **rSO2, quadriceps (%)** | mean | 85.5 | 81.7 | 71 | 4.4% | 16.9% | 13% |
| SD | 7.7 | 10.5 | 15.6 |
| *P*\* | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| **TcPCO2****(mmHg)** | mean | 36.6 | 36.2 | 36.1 | 1.1% | 0.3% | 1.3% |
| SD | 4.1 | 3.9 | 2.8 |
| *P*\* | 0.809 | 0.515 | 0.785 | 0.692 |

Values are expressed as mean (SD) and percent change (%∆) up () or down () between the different positions.

*\* P* values from the generalized estimating equation.

*SVI* stroke volume index, *CI* cardiac index, *HR* heart rate, BPM beats per minute, *TPRI* total peripheral resistance index, *MAP* systemic mean arterial pressure, *rSO2* regional hemoglobin oxygen saturation, *Vmax* maximum blood flow velocities in the middle cerebral arteries, *Vmean* mean blood flow velocities in the middle cerebral arteries, *TcPCO2* transcutaneous partial pressure of carbon dioxide

Table 3. Hemodynamic, rSO2, middle cerebral artery blood flow velocity and TcPCO1 responses during vasoconstriction or vasodilation models in supine decubitus, seated and standing positions

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Hyperoxia** | **Hypocapnia** | **Hypercapnia** |
| **Supine** | **Seated** | **Standing** | **Supine** | **Seated** | **Standing** | **Supine** | **Seated** | **Standing** |
| T5Pre | T6Post | T13Pre | T14Post | T21Pre | T22Post | T7Pre | T8Post | T15Pre | T16Post | T23Pre | T24Post | T9Pre | T10Post | T17Pre | T18Post | T25Pre | T26Post |
| **CI****(l/min/m2)** | mean | 3.4 | 3.1 | 2.6 | 2.5 | 2.3 | 2.2 | 3.4 | 3.7 | 2.4 | 2.9 | 2.3 | 2.8 | 3.4 | 3.4 | 2.5 | 2.6 | 2.5 | 2.5 |
| SD | 0.6 | 0.5 | 0.6 | 0.5 | 0.7 | 0.7 | 0.5 | 0.4 | 0.5 | 0.7 | 0.7 | 0.7 | 0.6 | 0.7 | 0.6 | 0.6 | 0.6 | 0.5 |
| %∆ | 8.8% | 3.8% | 4.3% | 8.8% | 20.8% | 21.7% | 0% | 4% | 0% |
| *P\** | 0.001 | 0.0001 | 0.755 |
| **HR (BPM)** | mean | 59.1 | 55.8 | 63.1 | 60 | 78 | 72.6 | 59.6 | 87.2 | 64 | 93.5 | 80 | 110.6 | 63.5 | 72.1 | 60.3 | 69.7 | 77.2 | 75 |
| SD | 8.2 | 7.1 | 9.1 | 9.7 | 10.1 | 12.2 | 5.9 | 14.3 | 9.4 | 21.2 | 12.2 | 21.1 | 8.2 | 10.5 | 6.1 | 9.9 | 8.7 | 13.2 |
| %∆ | 5.5% | 4.9% | 6.9% | 46.3% | 43.8% | 38% | 13.5% | 15.5% | 2.8% |
| *P\** | 0.004 | 0.024 | 0.029 |
| **MAP****(mmHg)** | mean | 76.9 | 79.2 | 88.5 | 89 | 89.4 | 93.6 | 80.8 | 85.4 | 87.1 | 89.7 | 91.3 | 95.3 | 79 | 90.1 | 89.1 | 95.7 | 91.5 | 98.5 |
| SD | 5.3 | 6.3 | 8.5 | 8.2 | 8.3 | 8.3 | 6.2 | 11.6 | 6 | 11.2 | 6.6 | 10.5 | 10.8 | 10.1 | 7.2 | 10 | 7 | 8.4 |
| %∆ | 2.9% | 0.5% | 4.6% | 5.6% | 2.9% | 4.3% | 14% | 7.4% | 7.6% |
| *P\** | 0.001 | 0.001 | 0.045 |
| **rSO2, right hemisphere (%)** | mean | 68.7 | 74.5 | 66.1 | 70.3 | 64.9 | 72.3 | 69.4 | 66.6 | 66.7 | 63.7 | 67.3 | 65.1 | 65.8 | 78.1 | 65.1 | 76.2 | 65.3 | 77.1 |
| SD | 8 | 8.3 | 8 | 7.9 | 8.2 | 8.6 | 8.5 | 10.2 | 9.1 | 11.4 | 7.7 | 9 | 8.2 | 9 | 8.8 | 7 | 9.7 | 7.2 |
| %∆ | 8.4% | 6.3% | 11.4% | 4% | 4.4% | 3.2% | 18.6% | 17% | 18% |
| *P\** | 0.0001 | 0.001 | 0.001 |
| **rSO2, left hemisphere (%)** | mean | 65.8 | 71.3 | 63.2 | 67.7 | 62.4 | 68.7 | 66.6 | 65.2 | 64.5 | 62.1 | 64.5 | 62.7 | 62.8 | 74.8 | 62.6 | 74.4 | 62.6 | 74 |
| SD | 10.4 | 10.9 | 12.1 | 10.5 | 10.1 | 9.3 | 11.1 | 12 | 10.9 | 12.9 | 10.3 | 10.6 | 10.2 | 11.6 | 10.6 | 9 | 11.1 | 9.2 |
| %∆ | 8.3% | 7.1% | 10% | 2.1% | 3.7% | 2.7% | 19.1% | 18.8% | 18.2% |
| *P\** | 0.0001 | 0.001 | 0.001 |
| **Vmax (cm/s)** | mean | 71.1 | 68.9 | 65.4 | 65.5 | 71.9 | 71 | 70.5 | 48.3 | 71.4 | 53.8 | 68.8 | 52.2 | 71.8 | 102.9 | 73.7 | 98.7 | 69.9 | 97.5 |
| SD | 16.3 | 17 | 18.6 | 22.3 | 28.5 | 24.6 | 17.8 | 16.3 | 21.2 | 18.5 | 26.3 | 20.7 | 20.7 | 23.7 | 23.1 | 26.5 | 27.5 | 36 |
| %∆ | 3% | 0.1% | 1.2% | 31.4% | 24.6% | 24.1% | 43.3% | 33.9% | 39.4% |
| *P\** | 0.001 | 0.001 | 0.001 |
| **Vmean (cm/s)** | mean | 51.1 | 47.7 | 46.8 | 45.6 | 53.2 | 51.1 | 51.2 | 28.9 | 49.6 | 27.2 | 48.8 | 28.3 | 53.7 | 80.1 | 53.6 | 71.7 | 47.9 | 68.8 |
| SD | 12.2 | 12.5 | 13 | 17.3 | 19.3 | 18.3 | 13.5 | 9.1 | 15.4 | 9.4 | 21.2 | 16.5 | 16.6 | 22.2 | 18.3 | 21.7 | 21.1 | 26.8 |
| %∆ | 6.6% | 2.5% | 3.9% | 43.5% | 45.1% | 42% | 43.3% | 33.7% | 43.6% |
| *P\** | 0.022 | 0.001 | 0.001 |
| **rSO2, deltoid****(%)** | mean | 78.3 | 79.7 | 75.7 | 77 | 71 | 72 | 79 | 91.2 | 76.4 | 88.8 | 71.8 | 82.7 | 75.3 | 78.3 | 73.4 | 76.8 | 71.2 | 73.7 |
| SD | 5.9 | 7.6 | 4.4 | 5.7 | 3.9 | 4.1 | 5.9 | 5.1 | 4.8 | 7.3 | 5.1 | 7.9 | 4 | 5 | 3.9 | 4.5 | 3.9 | 5.6 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | %∆ | 1.7% | 1.7% | 1.4% | 15.4% | 16.2% | 15.1% | 3.9% | 4.6% | 3.5% |
| *P\** | 0.0001 | 0.001 | 0.001 |
| **rSO2, quadriceps (%)** | mean | 85.6 | 87.5 | 83.2 | 85.2 | 73.7 | 71.6 | 86.3 | 88.6 | 83.4 | 87.9 | 69.5 | 72.7 | 85.4 | 86.1 | 81.9 | 82.5 | 67.2 | 66.8 |
| SD | 7.7 | 6.8 | 10.5 | 10.7 | 15.6 | 16.3 | 7.6 | 6.1 | 10.5 | 7.5 | 3 | 4.5 | 8.3 | 8.9 | 11.7 | 9.8 | 13.3 | 14.3 |
| %∆ | 2.2% | 2.4% | 0.1% | 2.6% | 5.3% | 4.6% | 0.8% | 0.7% | 0.5% |
| *P\** | 0.0001 | 0.001 | 0.001 |
| **TcPCO2****(mmHg)** | mean | 36.6 | 36.8 | 36.2 | 34.9 | 36.1 | 36.1 | 36.4 | 25 | 35.6 | 26.1 | 36.3 | 25.4 | 34.8 | 44.9 | 35.4 | 43.3 | 35 | 43.6 |
| SD | 4.1 | 3.9 | 3.1 | 3.3 | 2.8 | 2.8 | 3.2 | 2.2 | 3.5 | 4.2 | 3 | 4.5 | 4.2 | 5.6 | 3.2 | 4.5 | 3.4 | 5.2 |
| %∆ | 0.5% | 3.5% | 0% | 31.1% | 26.6% | 30.6% | 26.8% | 22.3% | 24.5% |
| *P\** | 0.517 | 0.01 | 0.001 |

Values are expressed as mean (SD) and percent change (%∆) up () or down () before and after the adoption of each position in each ventilatory condition.

*\* P* values from the generalized estimating equation including position, time point (pre or post) and baseline value as covariables.

*CI* cardiac index, *HR* heart rate, *BPM* beats per minute, *MAP* systemic mean arterial pressure, *rSO2* regional hemoglobin oxygen saturation, *Vmax* maximum blood flow velocity in the middle cerebral arteries, *Vmean* mean blood flow velocity in the middle cerebral arteries, *TcPCO*2 transcutaneous carbon dioxide

Table 4. Respiratory responses during vasoconstriction or vasodilation models in supine decubitus, seated and standing positions

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Hyperoxia** | **Hypocapnia** | **Hypercapnia** |
| **Supine** | **Seated** | **Standing** | **Supine** | **Seated** | **Standing** | **Supine** | **Seated** | **Standing** |
| **T5****Pre** | **T6****Post** | **T13****Pre** | **T14****Post** | **T21****Pre** | **T22****Post** | **T7****Pre** | **T8****Post** | **T15****Pre** | **T16****Post** | **T23****Pre** | **T24****Post** | **T9****Pre** | **T10****Post** | **T17****Pre** | **T18****Post** | **T25****Pre** | **T26****Post** |
| **ETCO2****(mmHg)** | Media | 38 | 37.4 | 36.3 | 33.7 | 34.7 | 33.1 | 37 | 20.7 | 35.6 | 19.5 | 33.5 | 16.5 | 34.7 | 73.1 | 36 | 71 | 34.8 | 79.7 |
| SD | 2.3 | 2.9 | 3.7 | 3 | 3.7 | 3 | 2.1 | 2.8 | 2.7 | 3.4 | 3.7 | 3 | 3.2 | 12.7 | 2.5 | 12.4 | 4.6 | 13 |
| ∆ | 0.6 | 2.6 | 1.6 | 16.3 | 16.1 | 17 | 38.4 | 35 | 44.9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **TcPCO2****(mmHg)** | Media | 36.6 | 36.8 | 36.2 | 34.9 | 36.1 | 36.1 | 36.4 | 25 | 35.6 | 26.1 | 36.3 | 25.4 | 34.2 | 44.9 | 35.4 | 43.3 | 35 | 43.6 |
| SD | 4.1 | 3.9 | 3.1 | 3.3 | 2.8 | 2.8 | 3.2 | 2.2 | 3.5 | 4.2 | 3 | 4.5 | 4.2 | 5.6 | 3.2 | 4.5 | 3.4 | 5.2 |
| ∆ | 0.2 | 1.3 | 0 | 11.4 | 9.5 | 10.9 | 10.7 | 7.9 | 8.6 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **SpO2 (%)** | Media | 98.7 | 99.9 | 98.1 | 99.9 | 98.4 | 99.9 | 98.8 | 99.7 | 98.8 | 99.5 | 98.1 | 99.3 | 97.7 | 99.3 | 98.3 | 99.2 | 98.4 | 99.2 |
| SD | 0.9 | 0.3 | 0.9 | 0.5 | 0.7 | 0.3 | 0.8 | 0.5 | 0.9 | 0.5 | 1.4 | 0.9 | 1.2 | 0.7 | 1.2 | 0.9 | 1 | 0.8 |
| ∆ | 1.2 | 1.8 | 1.5 | 0.9 | 0.7 | 1.2 | 1.6 | 0.9 | 0.8 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **FeO2** |  | 94% |  |  |  |  |  |  |  |  |  |  |  |  |

Values are expressed as mean (SD) and percent change (%∆) up () or down () between pre and post readings under each condition and in each position

*ETCO2* end-tidal carbon dioxide, *TcCO2* transcutaneous carbon dioxide, *SpO2* blood oxygen saturation by pulse oximetry, FeO*2* expired oxygen fraction, *TcPCO2*

transcutaneous partial pressure of carbon dioxide

Table 5. Hemodynamic, rSO2, middle cerebral artery blood flow velocity, and TcPCO2 responses during the Valsalva maneuver in supine, seated and standing positions

|  |  |
| --- | --- |
|  | **Valsalva maneuver** |
| **Supine** | **Seated** | **Standing** |
|  | **T11****Pre** | **T12****Post** | **T19****Pre** | **T20****Post** | **T27****Pre** | **T28****Post** |
| **CI****(l/min/m2)** |  |  |  |  |  |  |  |
| mean | 3.3 | 3.2 | 2.6 | 2.5 | 2.5 | 2.5 |
| SD | 0.5 | 0.25 | 0.3 | 0.25 | 0.6 | 0.5 |
| %∆ | 3% | 3.8% | 0% |
| *P\** | 0.847 |
| **HR (BPM)** | mean | 62.7 | 70.3 | 64.2 | 83.3 | 80.2 | 99.7 |
| SD | 4.7 | 6.7 | 6.2 | 13.7 | 9.2 | 14.7 |
| %∆ | 12.1% | 29.7% | 24.3% |
| *P\** | 0.211 |
| **MAP****(mmHg)** | mean | 82.9 | 88.6 | 87.4 | 88.9 | 94.8 | 97 |
| SD | 3.9 | 9.6 | 4.6 | 3.9 | 3.8 | 3 |
| %∆ | 6.8% | 1.7% | 16.3% |
| *P\** | 0.484 |
| **rSO2, right hemisphere (%)** | mean | 68.2 | 67.6 | 68 | 67.7 | 67.7 | 65.6 |
| SD | 1.8 | 2.3 | 2.3 | 3.4 | 1.6 | 2.5 |
| %∆ | 0.8% | 0.4% | 3.1% |
| *P\** | 0.001 |
| **rSO2, left hemisphere (%)** | mean | 65.4 | 65.1 | 65.3 | 65.6 | 64.4 | 63.9 |
| SD | 2.1 | 2.3 | 2.4 | 3.9 | 1.6 | 2.8 |
| %∆/ | 0.4% | 0.4% | 0.7% |
| *P\** | 0.001 |
| **Vmax (cm/s)** | mean | 68.3 | 62.2 | 67.2 | 56.7 | 71.4 | 57.1 |
| SD | 6.1 | 8.2 | 7.2 | 9 | 13.1 | 8.1 |
| %∆ | 8.9% | 15.6% | 20% |
| *P\** | 0.001 |
| **Vmean (cm/s)** | mean | 50.4 | 44.9 | 48.2 | 39.3 | 50.6 | 38.1 |
| SD | 5.8 | 6.1 | 7.7 | 9.3 | 10.7 | 6.5 |
| %∆ | 10.9% | 18.14% | 24.7% |
| *P\** | 0.087 |
| **rSO2, deltoid (%)** | mean | 78.7 | 79.8 | 74.6 | 77.5 | 71.1 | 73.7 |
| SD | 3.4 | 3.7 | 1.9 | 2.4 | 3.1 | 4 |
| %∆ | 1.3% | 3.8% | 3.6% |
| *P\** | 0.087 |
| **rSO2, quadriceps (%)** | mean | 87 | 86.6 | 83.3 | 81.9 | 66.1 | 66 |
| SD | 1.9 | 2.1 | 2.9 | 4.5 | 6 | 7.1 |
| %∆ | 0.4% | 1.6% | 0.1% |
| *P\** | 0.001 |
| **TcPCO2****(mmHg)** | mean | 35.2 | 34.9 | 35.2 | 34.6 | 35.7 | 35.6 |
| SD | 3.5 | 3.1 | 3.6 | 3.7 | 3.4 | 3.2 |
| %∆ | 0.3 | 0.6 | 0.1 |
| *P\** | 0.01 |

Values are expressed as mean (SD) and percent change (%∆) up () or down () before and after the adoption of each position in each ventilatory condition.

*\*P* values from generalized estimating equation including position, time point (pre or post) and baseline value as covariables.

*CI* cardiac index, *HR* heart rate, *BPM* beats per minute, *MAP* systemic mean arterial pressure, *rSO2* regional hemoglobin oxygen saturation, *Vmax* maximum blood flow velocity in the middle cerebral arteries, *Vmean* mean blood flow velocity in the middle cerebral arteries, *TcPCO*2 transcutaneous partial pressure of carbon dioxide.