P121: IDENTIFYING HAEMODYNAMIC DETERMINANTS OF PULSE PRESSURE: AN INTEGRATED NUMERICAL AND PHYSIOLOGICAL APPROACH

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hypertension, with investigators, however, not reaching a consensus on the relative importance of each wave component (1,2).

Objective: The aim of the current investigation was to examine the wave profile over time after developing an age-adapted, mathematical, one-dimensional model of the cardiovascular system.

Methods: Our state-of-the-art 1-D model (3,4) was extended to include turbulence and inertial effects of the flow exiting the left ventricle. Literature data on the age-associated changes in arterial stiffness, peripheral resistance and cardiac contractility were gathered and used as an input for the simulation.

Results: The predicted evolution of pressure and augmentation index with age followed accurately the curves obtained in a number of large-scale clinical studies. Analysis of the relative contribution of the forward and backward wave components showed that the forward wave becomes the major determinant of the increase in central and peripheral SBP and PP with advancing age.

Conclusions: The 1-D model of the ageing tree and heart captures faithfully and with great accuracy the central pressure evolution with ageing. The stiffening of the proximal aorta and the resulting augmentation of the forward wave pressure is the major contributor of the systolic pressure augmentation with age.

References

P121
IDENTIFYING HEMODYNAMIC DETERMINANTS OF PULSE PRESSURE: AN INTEGRATED NUMERICAL AND PHYSIOLOGICAL APPROACH

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Purpose: Hypertension, the single biggest killer worldwide1, arises mainly as a result of an increase in central pulse pressure (PP)2, yet hemodynamic basis of that increase is still disputed. We examined the ability of a simple “reduced” model comprising a proximal characteristic impedance linked to a Windkessel element to accurately predict PP from aortic blood flow simulation.

Methods: PP obtained from the model was compared with theoretical values calculated from physiological parameters. The statistical significance of the differences between methods was based on a paired t-test with * indicating p < 0.05.

Results: Estimated reservoir parameters are shown in Table 1. Algorithm (F) showed statistically significant differences in most of the parameters compared to (P1) and (P2), although, except time constant τ and asymptotic pressure P∞, there was a strong correlation between methods. Significant differences were observed in reservoir pulse pressure and area estimates between (P1) and (P2) despite their, in general, high correlation.

Table 1. Quantification of reservoir pressures p∞ obtained by methods (F), (P1) and (P2) at radial artery in the format of mean ± standard deviation based on 63 subjects whereby PP denotes the reservoir pulse pressure, A∞, the area of reservoir pressure above diastolic blood pressure, τ the time constant describing the diastolic pressure decay, P∞ the asymptotic blood pressure and a, b = 1/τ the rate constants. Peripheral (area) resistance and compliance, i.e. R and C, were estimated from the rate constants a and b for (P1) and (P2) using flow information. The correlation coefficient r was computed between relevant methods. The statistical significance of the differences between methods was based on a paired t-test with * indicating p < 0.05.

<table>
<thead>
<tr>
<th>Radial artery</th>
<th>p∞ (F)</th>
<th>p∞ (P1)</th>
<th>p∞ (P2)</th>
<th>r(F,P1)</th>
<th>r(F,P2)</th>
<th>r(P1,P2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP [mmHg]</td>
<td>41.5±10.0</td>
<td>36.3±7.2</td>
<td>35.7±7.0</td>
<td>0.82*</td>
<td>0.82*</td>
<td>0.96*</td>
</tr>
<tr>
<td>A∞ [mmHg/s]</td>
<td>17.5±4.3</td>
<td>15.6±3.7</td>
<td>15.5±3.7</td>
<td>0.94*</td>
<td>0.94*</td>
<td>1.00*</td>
</tr>
<tr>
<td>τ [s]</td>
<td>0.3±0.1</td>
<td>0.6±0.4</td>
<td>0.6±0.3</td>
<td>0.36*</td>
<td>0.42*</td>
<td>0.88</td>
</tr>
<tr>
<td>P∞ [mmHg]</td>
<td>65.7±10.3</td>
<td>63.9±15.2</td>
<td>64.8±12.6</td>
<td>0.45</td>
<td>0.53</td>
<td>0.79</td>
</tr>
<tr>
<td>a [1/s]</td>
<td>–</td>
<td>8.1±5.2</td>
<td>7.4±2.7</td>
<td>–</td>
<td>–</td>
<td>0.93</td>
</tr>
<tr>
<td>b [1/s]</td>
<td>–</td>
<td>2.2±1.1</td>
<td>2.1±0.8</td>
<td>–</td>
<td>–</td>
<td>0.84</td>
</tr>
<tr>
<td>R [mmHg s/m]</td>
<td>419.0±188.8</td>
<td>453.7±348.2</td>
<td>436.7±302.6</td>
<td>0.68</td>
<td>0.75</td>
<td>0.92</td>
</tr>
<tr>
<td>C [mm/mmmHg]</td>
<td>0.8±0.3</td>
<td>1.7±1.0</td>
<td>1.7±1.0</td>
<td>0.70*</td>
<td>0.70*</td>
<td>1.00</td>
</tr>
</tbody>
</table>

References