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Meta-analysis on the effect of uncertainties in inflow boundary condition, blood rheology, and vascular wall compliance

Data extracted from reference studies and meta-analysis computations are presented in this supplementary material. Three meta-analyses were performed to measure the effect of uncertainties in inflow boundary condition, blood rheology, and vascular wall compliance on the wall shear stress (WSS) predictions made by virtual endovascular treatment models of aneurysms. Random-effects meta-analyses performed on reference studies within each group and computations are presented in tables 1, 2, 3. For each reference study, matched group standardized mean differences (Hedges’ g) were computed. The basic and summary data for the reference studies used in each meta-analysis are presented in tables 4, 5, and 6.

Table 1. Random-effects computations on the effect of inflow boundary condition on CFD-predicted aneurysmal WSS.

<table>
<thead>
<tr>
<th>Reference First Author (Year)</th>
<th>N</th>
<th>Effect Size (g)</th>
<th>Study Variance (Vg)</th>
<th>Adjusted Variance (T² + Vg)</th>
<th>Adjusted Weight</th>
<th>Percentage Weight</th>
<th>95%-CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jansen (2014)</td>
<td>36</td>
<td>0.37</td>
<td>0.011</td>
<td>0.027</td>
<td>36.78</td>
<td>45.5%</td>
<td>0.16 - 0.57</td>
</tr>
<tr>
<td>Karmonik (2010)</td>
<td>10</td>
<td>0.07</td>
<td>0.024</td>
<td>0.040</td>
<td>24.91</td>
<td>30.8%</td>
<td>-0.23 - 0.37</td>
</tr>
<tr>
<td>McGah (2014)</td>
<td>4</td>
<td>0.48</td>
<td>0.036</td>
<td>0.052</td>
<td>19.11</td>
<td>23.7%</td>
<td>0.11 - 0.85</td>
</tr>
<tr>
<td>Pooled</td>
<td>50</td>
<td>0.30</td>
<td></td>
<td>0.012</td>
<td></td>
<td></td>
<td>0.08 - 0.52</td>
</tr>
<tr>
<td>p-value</td>
<td></td>
<td></td>
<td></td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between-studies Variance (T²)</td>
<td>0.016</td>
<td></td>
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Table 2. Random-effects computations on the effect of blood rheological model on CFD-predicted aneurysmal WSS. Between-studies variance is set to zero (fixed-effect meta-analysis) as DerSimonian and Laird method of computing between-studies variance resulted in a negative value (DerSimonian and Kacker, 2007)

<table>
<thead>
<tr>
<th>Reference First Author (Year)</th>
<th>N</th>
<th>Effect Size (g)</th>
<th>Study Variance (Vg)</th>
<th>Adjusted Variance (T² + Vg)</th>
<th>Adjusted Weight</th>
<th>Percentage Weight</th>
<th>95%-CI</th>
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</thead>
<tbody>
<tr>
<td>Castro (2014)</td>
<td>10</td>
<td>0.02</td>
<td>0.002</td>
<td>0.002</td>
<td>597.95</td>
<td>52.8%</td>
<td>-0.06 - 0.10</td>
</tr>
<tr>
<td>Fisher (2009)</td>
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<td>0.04</td>
<td>0.013</td>
<td>0.013</td>
<td>75.52</td>
<td>6.7%</td>
<td>-0.26 - 0.19</td>
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<tr>
<td>Morales (2013)</td>
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<td>0.02</td>
<td>0.002</td>
<td>0.002</td>
<td>459.19</td>
<td>40.5%</td>
<td>-0.07 - 0.11</td>
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<tr>
<td>Pooled</td>
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<td>0.001</td>
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<td>-0.04 - 0.07</td>
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Table 3. Random-effects computations on the effect of wall compliance model on CFD-predicted aneurysmal WSS.

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<th>Effect Size (g)</th>
<th>Study Variance (Vg)</th>
<th>Adjusted Variance (T² + Vg)</th>
<th>Adjusted Weight</th>
<th>Percentage Weight</th>
<th>95%-CI</th>
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<td>0.011</td>
<td>0.012</td>
<td>80.02</td>
<td>26.6%</td>
<td>-0.02 - 0.40</td>
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<tr>
<td>Takizawa (2012)</td>
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<td>0.009</td>
<td>0.010</td>
<td>101.44</td>
<td>33.8%</td>
<td>0.13 - 0.50</td>
</tr>
<tr>
<td>Bazilevs (2010a)</td>
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<td>0.42</td>
<td>0.015</td>
<td>0.016</td>
<td>60.77</td>
<td>20.2%</td>
<td>0.18 - 0.67</td>
</tr>
<tr>
<td>Bazilevs (2010b)</td>
<td>4</td>
<td>0.49</td>
<td>0.016</td>
<td>0.017</td>
<td>58.10</td>
<td>19.3%</td>
<td>0.24 - 0.74</td>
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<td>0.003</td>
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<td>0.22 - 0.45</td>
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<td>&lt; 0.001</td>
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<tr>
<td>Between-studies Variance (T²)</td>
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Table 4. Basic data from three studies performed on the effect of inflow boundary condition on CFD-predicted aneurysm WSS. Matched group standardized mean differences are reported as Hedges’ g for each study.

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<th></th>
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<tbody>
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<td></td>
<td>WSS (Pa)</td>
<td>WSS (Pa)</td>
<td>Absolute Difference (Pa)</td>
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<td>P1</td>
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<td>0.60</td>
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<tr>
<td>P2</td>
<td>1.6</td>
<td>2.20</td>
<td>0.40</td>
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<td>P3</td>
<td>1.2</td>
<td>1.80</td>
<td>-0.60</td>
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<td>P4</td>
<td>1.5</td>
<td>1.90</td>
<td>-0.40</td>
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<td>P5</td>
<td>1.2</td>
<td>1.80</td>
<td>-0.60</td>
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<td>SD</td>
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**PSIBC** Patient-specific inflow boundary condition  
**GIBC** Generalized inflow boundary condition  
**r** Pearson’s correlation coefficient  
**N** Sample size  
**S_within** Within-study standard deviation  
**g** Hedges’ g  
**V_g** Variance of the Hedges’ g  
**SD_g** Standard deviation of the Hedges’ g  

* Only mean and SD values of WSS magnitude were reported by this study, therefore the correlation coefficient was assumed to be equal to that of the most populated study in the meta-analysis, i.e., Jansen et al. (2014).
Table 5. Basic data from three studies performed on the effect of blood rheological model on CFD-predicted aneurysmal WSS. Matched group standardized mean differences are reported as Hedges’ g for each study.

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<th>WSS (Pa)</th>
<th>WSS (Pa)</th>
<th>Absolute Difference (Pa)</th>
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<td>CRM</td>
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<td>P4</td>
<td>0.95</td>
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<td>0.13</td>
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<td>P5</td>
<td>1.19</td>
<td>1.18</td>
<td>-0.01</td>
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<td>P6</td>
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<td>-0.01</td>
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<td>0.91</td>
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<td>SD</td>
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<table>
<thead>
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<th></th>
<th>r</th>
<th>N</th>
<th>S_within</th>
<th>g</th>
<th>V_g</th>
<th>SD_g</th>
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</table>
Table 6. Basic data from three studies performed on the effect of wall compliance model on CFD-predicted aneurysmal WSS. Matched group standardized mean differences are reported as Hedges’ g for each study.

<table>
<thead>
<tr>
<th>Study</th>
<th>WSS (Pa)</th>
<th>WSS (Pa)</th>
<th>Absolute Difference (Pa)</th>
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<td></td>
<td>RWM</td>
<td>CWM</td>
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<th>WSS (Pa)</th>
<th>Absolute Difference (Pa)</th>
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<td>RWM</td>
<td>CWM</td>
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<tr>
<td>Bazilevs et al. (2010b)</td>
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RWM = Rigid wall model  
CWM = Compliant wall model  
r = Pearson’s correlation coefficient  
N = Sample size  
S_within = Within-study standard deviation  
g = Hedges’ g  
V_g = Variance of the Hedges’ g  
SD_g = Standard deviation of the Hedges’ g

*Obtaining a correlation for the studies by Torii et al. (2009) and Bazilevs et al. (2010a) was not possible; so all the studies were pooled together and the correlation coefficient was computed.
References


