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Letter to the Editor

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Ethical approval: Not required

48 Dear Editor,

49 We have read the research article “Computing pulsatile blood flow of coronary artery
50 under incomplete boundary conditions” by WenJun Pu et al. published in *Medical*
51 *Engineering and Physics*, with interest. The authors compute pulsatile coronary
52 blood flow using a 3D reconstruction in diseased arteries (1). They conclude that
53 ignoring the effect of inertia may significantly affect the accuracy of computed flow,
54 providing important new evidence for the development of computational tools aimed
55 at improving diagnosis and treatment of ischaemic heart disease. This finding is
56 consistent with work conducted by our own group using 1 dimensional models of
57 coronary flow (2).

58 We would however, dispute the authors’ claim that virtuQ, a 3D model of absolute
59 coronary flow (3), necessitates exclusion of side branch flow due to the absence of
60 distal pressure boundary conditions at side branches. While the original description
61 of the virtuQ technique did not include side branch flow, morphometric scaling laws
62 have now been leveraged to include this in simulations. Murray’s law of branching
63 mass transport networks dictates that single lumen geometries of coronary arteries
64 will contain taper localised to bifurcation points (4), at which, proportional flow (Q)
65 splitting (or terminal vessel resistance (R)) may be given by:

66
$$D \propto Q^c \quad D \propto \frac{1}{R^c}$$

67 Where D denotes vessel diameter. C denotes the flow diameter scaling exponent,
68 this was 3.0 in Murrays original law, but challenged by the Huo-Kassab law which
69 suggested a value of 2.33 (5). A recent meta-analysis in mammalian coronary
70 arteries supported the Huo-Kassab law, deriving an exponent of 2.39 (6). This
71 exponential law allows for flow splitting at bifurcation points, without the need for an
72 invasively measured side branch pressure boundary condition (7) and can also be
73 localised to points of vessel bifurcation (8). While it may be an interesting question to
74 determine whether an invasively measured distal boundary at side branches
75 improves model accuracy, techniques currently exist to allow side branch flow
76 quantification without such invasive measurements. Furthermore, these pressure
77 measurements in coronary side branches would likely be prohibitively time-
78 consuming and too technically challenging for widespread uptake.

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