# A Comparative Study of Normal and High-Fidelity Approaches to Predict Flow Physics of Left Atrium

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Computer-aided models of left atrial blood flows have accomplished to an acceptable level of sophistication and in principle can non-invasively predict blood clot formation and stroke, however, numerical aspects in which uncertainties can arise have obtained less attention. The primary aim of the present study is to investigate normal-resolution (NR) simulations in the context of the vast majority of published literature against high-resolution (HR) ones based on numerical aspects of mesh resolution, time-step refinement and numerical solution strategy. To accomplish our objective, the study is conducted by comparing normal-fidelity approach combining 400k grid size mesh, 100 time-steps per cycle and normal solution strategy which is commonly employed as default settings in commercial CFD solvers, i.e. overall first order accurate with stabilization methods by high-fidelity approach combining 26M grid size mesh, 10k time-steps per cycle and our high resolution CFD solver, i.e., overall second order accurate and minimally dissipative. A representative cohort consisting of 9 patients is selected in the current study. A generic pulsatile flow corresponding to cardiac output 5.5 L/min for two cardiac cycles is simulated to ensure that initial numerical transients are washed out from first cycle simulation. The results of the study NR versus HR for one case show that HR simulation can lead to substantial qualitative differences in dynamical behaviour of flow in the left atrium and subsequently quantitative differences in hemodynamic indices of TAWSS, TWSSG and OSI as can be seen in Figure 1 and Table 1, respectively.

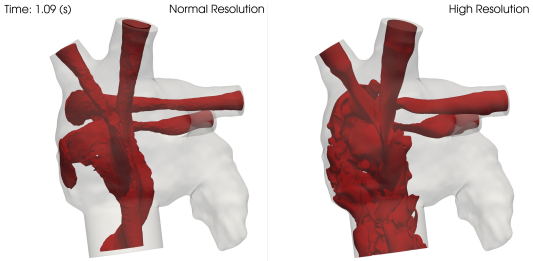


Figure 1: Qualitative differences in HR versus NR velocity.

Our study shows that it is essential to consider numerical aspects as important as modelling assumptions such as flow rates, non-Newtonian rheology and patient-specific boundary conditions in determining the quality of flow physics underlying the left atrium.

Table 1: Quantitative differences in HR versus NR hemodynamic indices.

| | NR | HR | |
|---|---|---|---|
| HI | Mean $\pm$ SD | Mean $\pm$ SD | Error (%) |
| TAWSS | $0.11 \pm 0.13$ | $0.15 \pm 0.19$ | 23.54 |
| TWSSG | $0.009 \pm 0.01$ | $0.023 \pm 0.031$ | 57.43 |
| OSI | $0.26 \pm 0.14$ | $0.34 \pm 0.15$ | 21.62 |