Mathematical formulation and solution technique of Biomagnetic Fluid flow in an aneurism

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We will present the mathematical formulation and a corresponding methodology for the numerical investigation of the biomagnetic fluid flow in an aneurismal geometry under the influence of a steady localized magnetic field [1].

The mathematical model used for the formulation of the problem is consistent with the principles of ferrohydrodynamics (FHD). Blood is considered as a homogeneous non isothermal Newtonian fluid and is treated as an electrically non conducting magnetic fluid. The physical problem is described by a coupled, non–linear system of PDEs, with appropriate boundary conditions [2].

For the numerical solution of the problem, an effective numerical methodology using finite differences and the stream function–vorticity formulation was implemented. The essential elements of this methodology are the following four:

- First, the "parabolization" of the problem by using a pseudotransient algorithm where the time derivatives appear in the equations but the time t plays the role of iterations. This parabolization enable us to use simpler numerical techniques to attain solution.
- Second, the use of grid transformations in such a way so that the grid is configured to be dense at the area where the major disturbances of the flow field are expected and the calculations are taking place in a simple orthogonal computational domain rather that the more complicated physical domain.
- Third, the construction of a boundary condition for the vorticity equation on the solid walls in a way that will not cause numerical instabilities during the numerical solution procedure
- and fourth, the development of a semi—implicit numerical technique for the estimation of the solution at the next time step (iteration) so as to estimate the steady state solution [3].

Results concerning the physical problem variables i.e. the velocity and temperature field, skin friction and rate of heat transfer indicate that the presence of the magnetic field influences the flow field considerably especially in the region of the aneurism.

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References

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