Three-dimensional unsteady Navier-Stokes equations of an incompressible Navier–Stokes fluid in tube containing a sinusoidal extension is used for modelling the flow in the aortic root. Firstly, the proof of the existence of the weak solution is provided. The main aim of this thesis is to understand the formation of vortices and other flow characteristics such as dissipation, vorticity, wall shear stress and pressure drop. We extend the results presented in Chabionik et al. (2022) International Journal of Engineering Science, 180(103749) by focusing on three following aspects. The first is to use the extension with three sinuses describing a more realistic aortic root geometry. The second aspect is to approximate the boundary of the discretised computational domain by piecewise higher order polynomials to better capture the imposed boundary conditions. Thirdly, we discuss the choice of the finite element discretisations such as Taylor-Hood element and Brezzi-Douglas-Marini element. For all these aspects we investigate the character of the solutions and how the flow characteristics changes with the allowed slip at the wall.