3.2 Fluid Structure Interaction

As previously discussed the arterial wall shows a complex elastic behaviour, if the fluid is driven by an oscillating pressure gradient. Negligence of material nonlinearities and viscoelasticity simplifies the discription, but nonetheless the equations are geometrically nonlinear – the diameter of the vessel varies with the pulsating pressure. In large vessels, such as the aorta, the carotid or the radial arteries a maximum change of 10% in the vessel diameter is expected. This results in the same change in the Womersley and Reynolds numbers. Even though a linearisation about a equilibrium cross-section is cogitable under these conditions the cyclic deformation of the arterial wall in myocardial bridges is geometrically nonlinear, thus we resign these simplified notation.

This section starts from a simplified geometry found in most myocardial bridges and subsequently derives an analytical expression for the relation between the pressure and area of a non-circular tube. Finally the elastic properties and the wall thickness of vessels are related to their diameter by experimental findings.

3.2.1 Geometrical Model

Our first geometrical simplification for modelling blood flow in arteries is that the curvature of the tube is assumed to be small everywhere so that the problem can be defined in one space dimension along the $x$-axis. According to this we have simplified the anatomy of the myocardial bridge as shown in figure 3.1.

![Figure 3.1: Schematic anatomy of a double myocardial bridge. The control segments $\Omega_n$ are equally spaced. Observation locations for hemodynamic properties are in the centre of each segment at $x_{sn}$, transitions between the segments are at $x_{tn}$.](image)

The two arrows in figure 3.1 denote the location of either circular ($B - B$) or oval ($C - C$) cross-section of the tube. Due to the fact that the wall thickness is