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Abstract

A fluid dynamic study of blood flow within the umbilical vessels of the human maternal-fetal circulatory system is considered. It is found that the umbilical coiling index (UCI) is unable to distinguish between cords of significantly varying pressure and flow characteristics, which are typically determined by the vessel curvature, torsion and length. Larger scale geometric non-uniformities superposed over the inherent coiling, including cords exhibiting width and/or local UCI variations as well as loose true knots, typically produce a small effect on the total pressure drop. Crucially, this implies that a helical geometry of mean coiling may be used to determine the steady vessel pressure drop through a more complex cord. The presence of vessel constriction, however, drastically increases the steady pressure drop and alters the flow profile. For pulsatile-flow within the arteries, the steady pressure approximates the time-averaged value with high accuracy over a wide range of cords. Furthermore, the relative peak systolic pressure measured over the period is virtually constant and approximately 25% below the equivalent straight-pipe value for a large range of non-straight vessels. Interestingly, this suggests that the presence of vessel helicity dampens extreme pressures within the arterial cycle and may provide another possible evolutionary benefit to the coiled structure of the cord.

Word count: 3559

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