Biomechanical studies on type B aortic dissection

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Summary

Samenvatting in het Nederlands

SUMMARY

The first part (Chapter 2) of this dissertation gives an introduction to Type B Aortic Dissection (TBAD). This overview shows several prognostic predictors of dissection related events (dissection related death or need for intervention) after initial medical management in acute uncomplicated TBAD. Predictors of complications in acute uTBAD during admission are aortic diameter ≥40mm, a primary entry tear >10mm, primary entry tear located on the concavity (undersurface) of the distal aortic arch, a FL diameter > 22mm, a peak CRP level >96mg/L and patency of the false lumen (defined as the concurrent presence of both flow and thrombus)..

The blood flow in the false lumen is highly variable due to morphological differences between various types of dissections. It is conceivable that patent branch vessels originating from the false lumen in an aortic dissection type B may contribute to persistent blood flow and patent false lumen, and thus to prognosis. Therefore, an in-vitro study was performed with a surgically-constructed false lumen and an adjustable outflow branch (Chapter 3.). This in-vitro study show that different outflow from branch vessels originating from the false lumen in TBAD result in expansion of cross-sectional false lumen area. This might have important consequences for patients with uTBAD when patent branch vessel(s) originating from the false lumen and partial thrombosis (occluding distal tears) or no distal tear are present, as these patients might be more at risk for developing complicated TBAD.

Haemodynamics, dissection morphology and aortic wall elasticity have a major influence on the pressure in the false lumen. The influence of haemodynamics and dissection morphology have been investigated often in multiple in-vitro and ex-vivo studies in contrast to aortic wall elasticity. In Chapter 4 the influence of aortic wall elasticity on the diameter and pressure of the false lumen in aortic dissection is studied in-vitro. It shows that aortic wall elasticity is an important parameter altering the false lumen. This in-vitro study showed that an aortic wall with reduced elasticity results in an increased false lumen diameter in the mid and distal part of the false lumen. False lumen expansion might result in higher stress of the aortic wall and at the ending of the dissection.

More insight in the hemodynamic changes during cardiac cycle in the true and false lumen of uncomplicated TBAD might result in prediction of adverse outcomes. Four-Dimensional flow Magnetic Resonance Imaging (4D flow MRI) compared to CTA provides insight into hemodynamic dimensions such as Wall Shear Stress. In arterial blood flow, the WSS expresses the viscous force per unit area applied by the fluid on the wall in a direction at the local interface. In Chapter 5. our ex-vivo research illustrates that an increase in heart rate (HR) from 60 to 80 bpm resulted in a significantly increase of the False Lumen Volume (FLV) and Wall Shear Stress (WSS) of the false lumen. Hereby we confirm that strict HR control is of major importance and reduces the mean and peak WSS in uncomplicated TBAD.

The first line therapy in TBAD with malperfusion syndrome is coverage of the proximal entry tear by Thoracic Endo-Vascular Aortic Repair (TEVAR). When this method is unfeasible, endovascular aortic fenestration has been proposed as an alternative technique. Fenestration is a

minimally invasive alternative for the treatment of acute symptomatic aortic dissections because it may quickly decrease the pressure gradient of the false lumen. It remains unclear where the optimal location of these fenestrations should be chosen. In Chapter 6. the false lumen volume after different fenestration strategies was studied. This in-vitro study showed that distal fenestration of the false lumen in aortic dissection will result in the largest false lumen reduction.