Vascular access surgery for hemodialysis: postoperative flow prediction with a patient specific lumped parameter model

Vascular access surgery for hemodialysis: Postoperative flow prediction with a patient specific lumped parameter model

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Introduction

A good functioning arteriovenous fistula (AVF) is essential for dialysis patients. Successful AVF function is mainly determined by the immediate postoperative flow-volume (pFV)[1]. However, pFV is hard to predict. In this study, it is hypothesized that a patient-specific computer model can give more insight. Ultimately, this model can be used to simulate the outcome of AVF creation by an adequate pFV prediction.

Material and methods

Vascular hemodynamics was simulated using a lumped parameter model[2] of the arteries and veins. This model was made patient specific by using data (cardiac output, arterial and venous diameters, flow-volumes and local arterial pressures) obtained from preoperative Duplex, Magnetic Resonance Angiography and arterial pressure measurements. Simulation outcomes were compared with clinical pFV measurements. The construction of an AVF was simulated for six patients (3x radiocephalic-AVF (RC-AVF), 3x brachiobasilic-AVF (BB-AVF).

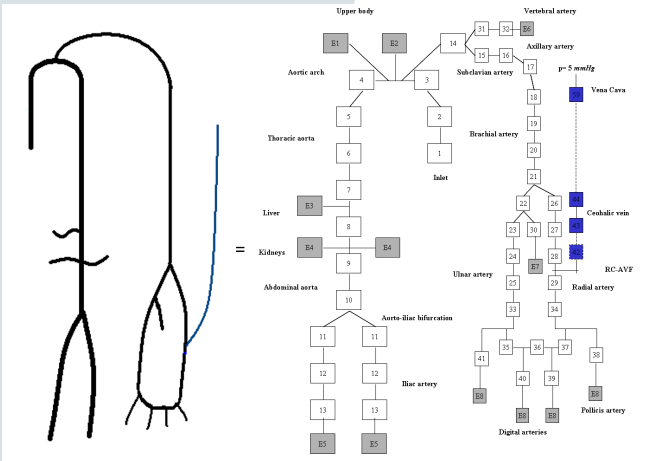

Figure 1 *Anatomy of aorta, major side-branches and the arm with RC-AVF (left) and the lumped parameter model (right).*

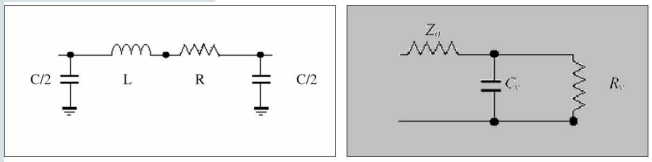

Figure 2 *Vascular (left) and end-segment (right).*

Results

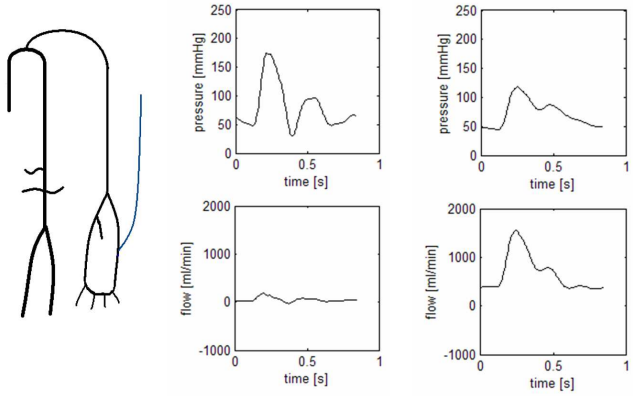

Figure 3 *An example of the simulated radial artery pressure (up) and flow (down) versus time; before (left) and after (right) AVF construction.*

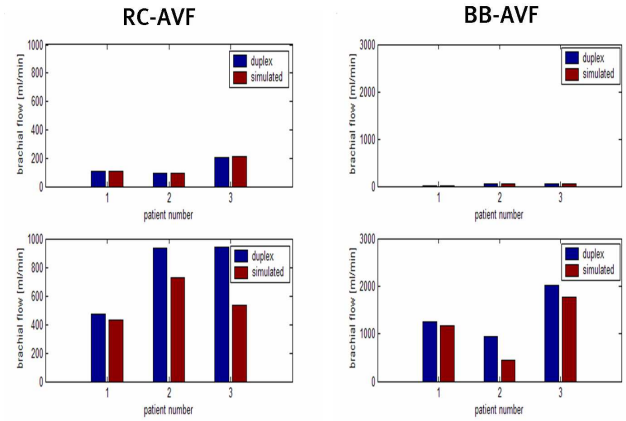

Figure 4 *Simulated and measured flow-volume before (up) and after (down) AVF construction.*

Conclusions

There is reasonable correspondence between simulations and the clinical outcome. Differences between simulated pFV and clinical measurements are mainly due to the inaccuracy of the patient data. The model should be further improved by taken into account vascular adaptation.

References:

[1] TORDOIR JHM: *Nephrol Dial Transplant 18: 378-383* (2003)
[2] WESTERHOF N: *J of Biomechanics 2:121-143* (1969)

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