CAN LASER DOPPLER VIBROMETRY DETECT STENOSIS FROM SKIN VIBRATIONS?

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1. INTRODUCTION

Carotid artery stenosis is a major cause of stroke and has a prevalence of 4.2 % [1] but it is often asymptomatic, hence creating a need for a quick screening method. We computationally investigated how the high-frequent flow fluctuations vary with the degree of stenosis, the inlet flux, and the flow split between the carotid branches. These findings could potentially support the use of Laser Doppler Vibrometer (LDV) for screening of carotid artery stenosis.

2. MATERIALS AND METHODS

A patient-specific carotid bifurcation with severe internal artery (ICA) stenosis was segmented and then geometrically altered to obtain a total of five stenosis degrees, ranging from mild to extremely severe [Fig1A]. The flow rates and splits were varied within physiologically plausible ranges[2,3]. 13 simulations [Fig1B-D] with dt=5e-05 s, were run for 3 cardiac cycles with blood as Newtonian fluid with viscosity $\nu = 3.3 \cdot 10^{-6}\, m^2/s$, by means of our finite-element solver *Oasis*.

3. RESULTS AND DISCUSSION

We can observe that only the geometries with a mild stenosis (<70%) harbored high-frequent fluctuations when using physiology based flows in the common carotid artery and flow splits [Fig1E]. When changing the boundary conditions to increase the flow rate in the ICA, the high-frequent fluctuations increase. Our simulations suggest that a severe stenosis as such does not necessarily lead to flow instabilities and high frequency oscillations in pressure and velocity. It is only in combination with a sufficiently high flow level through the stenosed vessel that instabilities are generated, explaining the absence of instabilities in the most severe stenosis case. It remains to be demonstrated that the same fluctuations can be observed in-vivo. If so, LDV is promising for detecting early-stage stenosis,

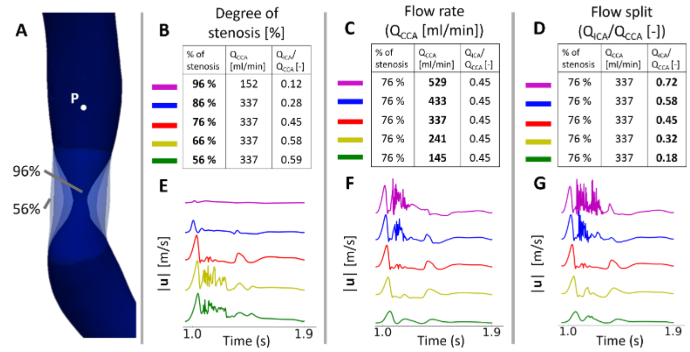

Fig1 **A**: Variable degree of stenoses in the internal carotid artery, and a point P located 1 diameter downstream of the stenosis. **B**, **C**, and **D**: List of simulations, with varying degree of stenosis, flow rate, and flow split, respectively. **E**, **F**, and **G**: Velocity magnitude (|**u**|) in point P of the corresponding list simulations in **B**, **C**, and **D**, respectively.

while more severe stenosis might be missed, depending on the flow rate in the stenosis. Future work will focus on flow fluctuations in healthy subjects to understand the risk of false positives.

References

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