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Saint Petersburg, Russia

Can collateral flow index have an influence on restenosis growth dynamics?

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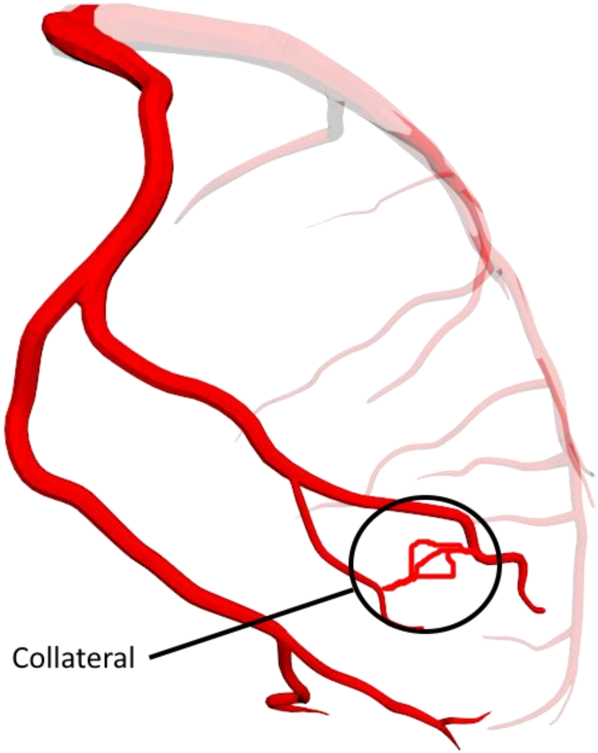
Introduction

Definitions

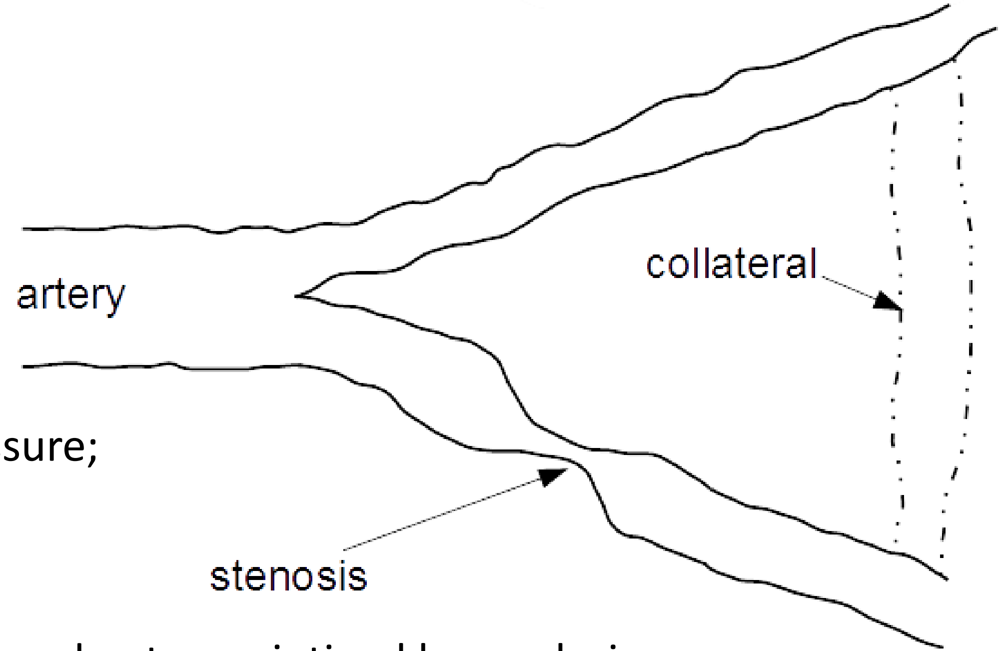
Collateral blood vessels – small capillary-like branches of an artery that grow over time in response to narrowed coronary arteries.



Introduction

Definitions

$$CFI = \frac{P_{occl} - CVP}{P_{ao} - CVP}$$

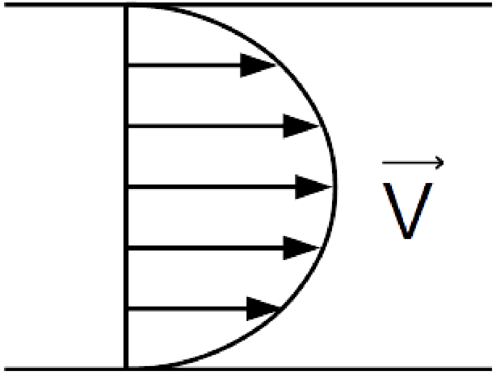


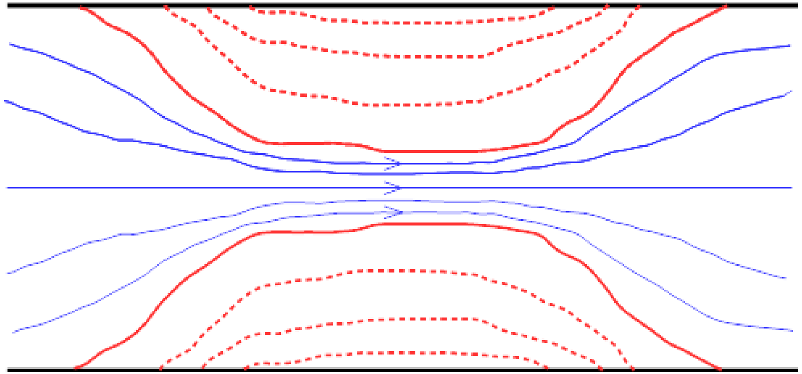
CFI – collateral flow index;
P_{occl} – coronary occlusive or wedge pressure;
P_{ao} – aortic pressure;
CVP – central venous pressure.

Restenosis – clinically significant lumen loss due to neointimal hyperplasia after stenting or angioplasty

WSS and restenosis growth

WSS – wall shear stress





$$\langle WSS\rangle = \frac{32\nu\langle q\rangle}{\pi d^3}$$

v – blood viscosity

q – flux

d – vessel diameter

$$WSS_{thr} \approx 0.5\ Pa$$

Numerical model

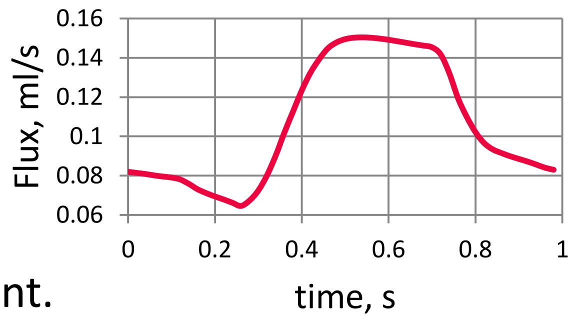
Output data:

p – pressure in the point;

v – flow velocity in the point;

lumen_sq – vessel lumen area in the point.

Q



$$\sigma = \frac{8\nu}{2\pi R^3} Q$$

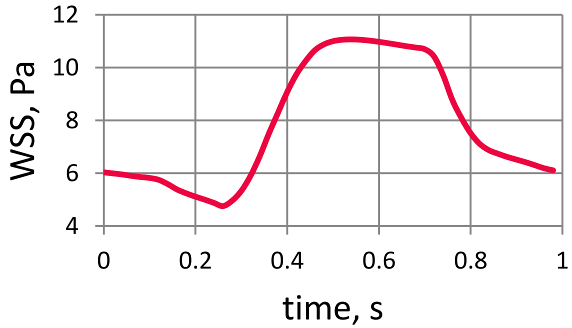
σ – wall shear stress

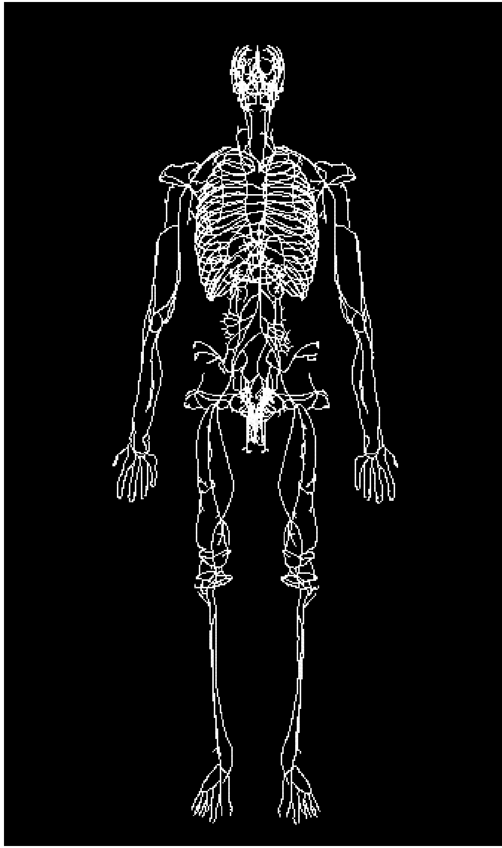
ν – blood viscosity

R – vessel radius

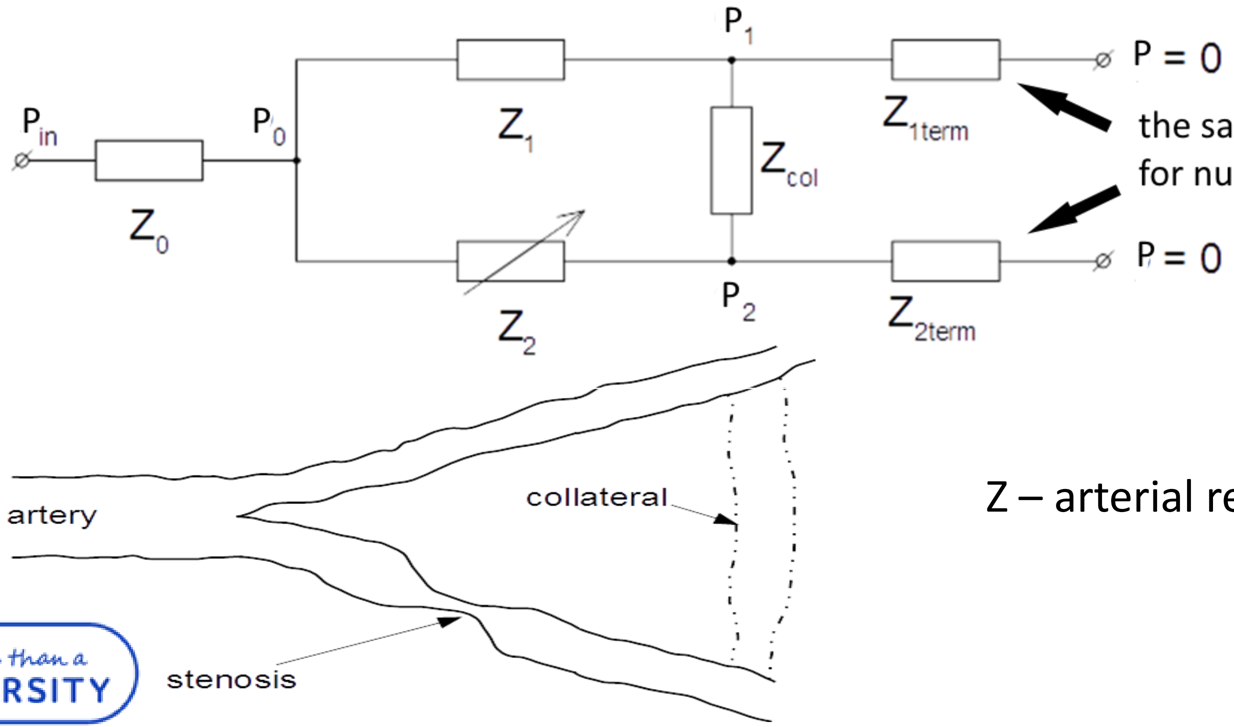
Q – flux

σ





Lumped parameters model



the same boundary conditions for numerical model

Z – arterial resistance

Analytical solution

$$Q = \frac{P_2 - P_0}{Z_2}$$

Q – flux in branch 2

Z_2 – resistance of vessel 2 (with stenosis)

$$\sigma = \sqrt[4]{\frac{\nu}{2\pi}\left(\frac{Z_{st}}{L_{st}}\right)^3 Q}$$

σ – wall shear stress of the stenosis segment

ν – blood viscosity

L_{st} – length of the stenosis segment

Z_{st} – resistance of the stenosis segment

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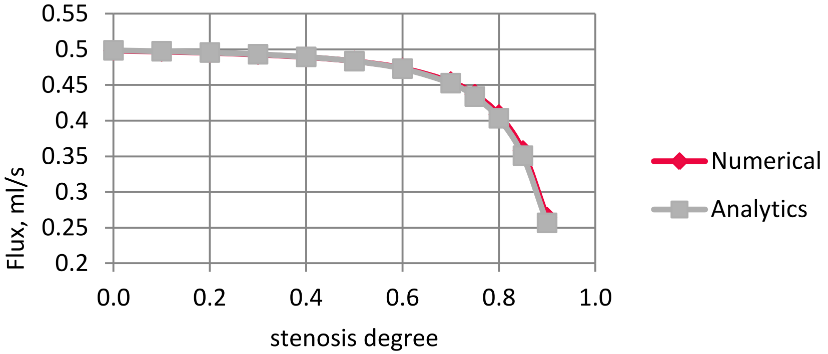
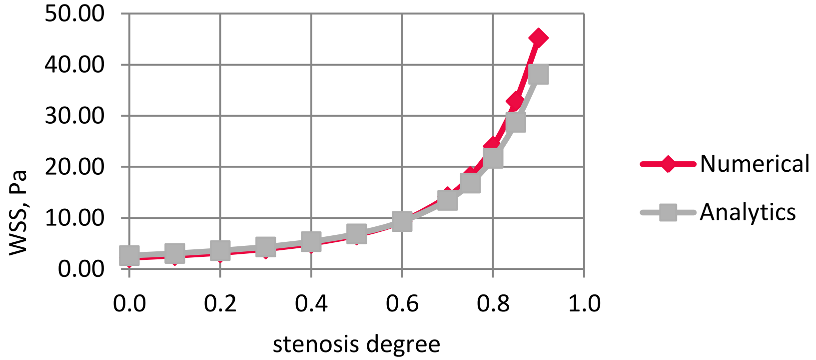
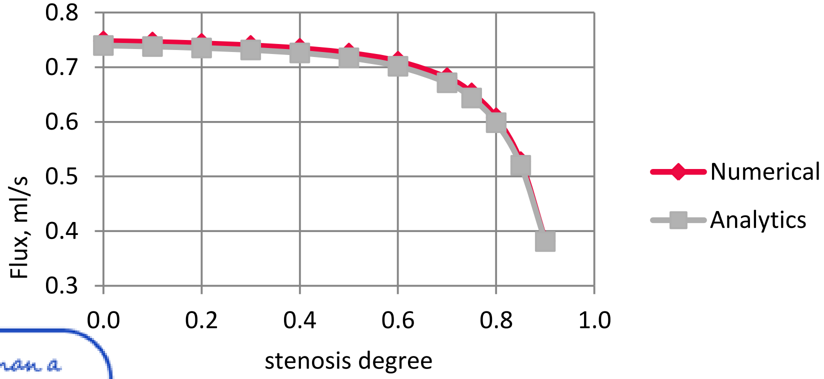
Comparison of analytics and model

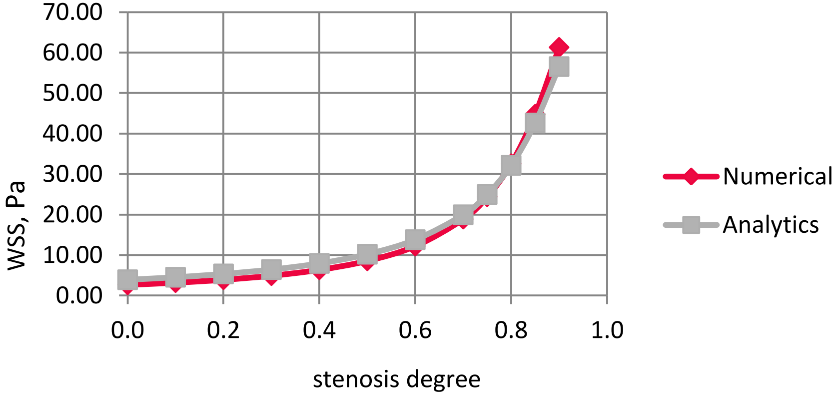
constant flow





pulsatile flow





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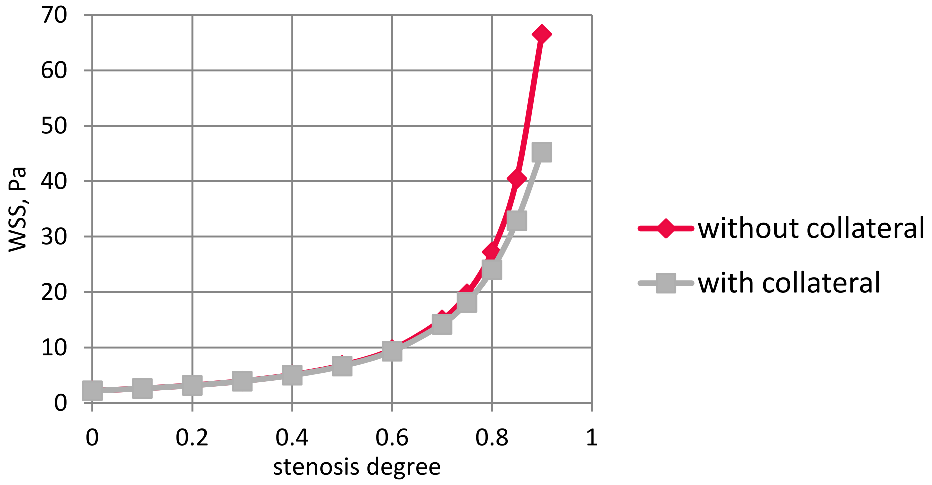
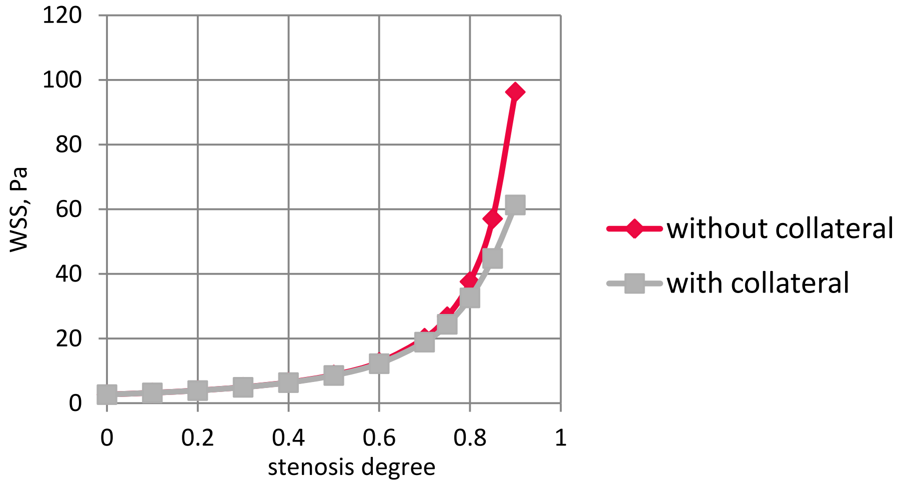
Influence of a collateral

Test Y-topology



constant flow



pulsatile flow

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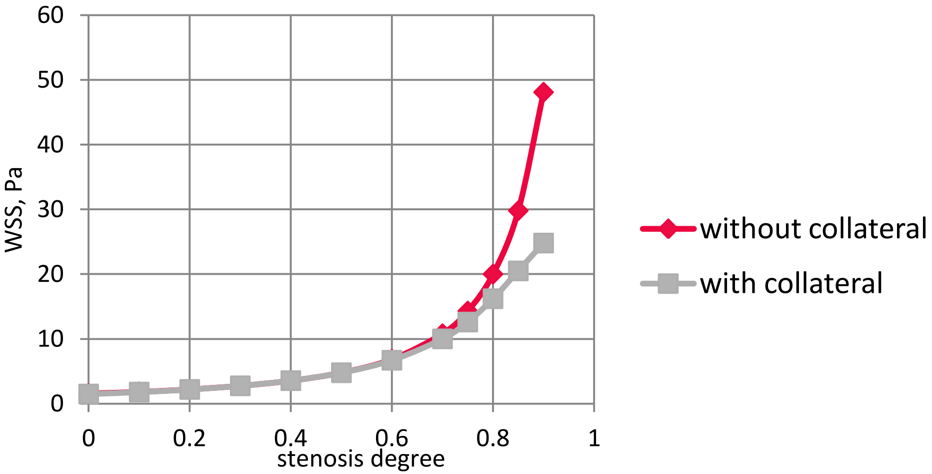
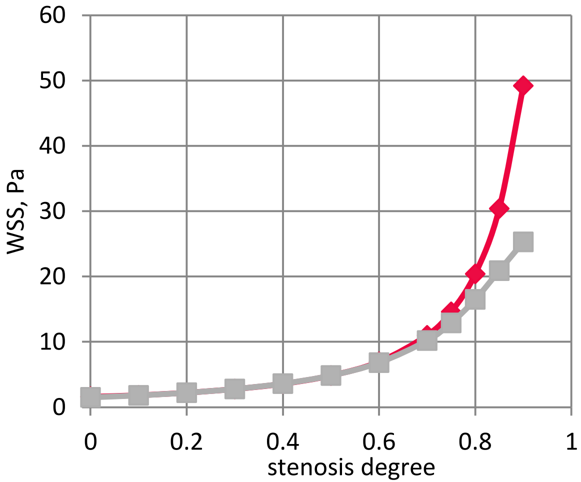
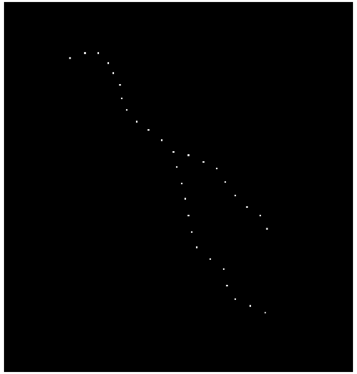
Influence of a collateral

Real coronary arteries



constant flow





pulsatile flow

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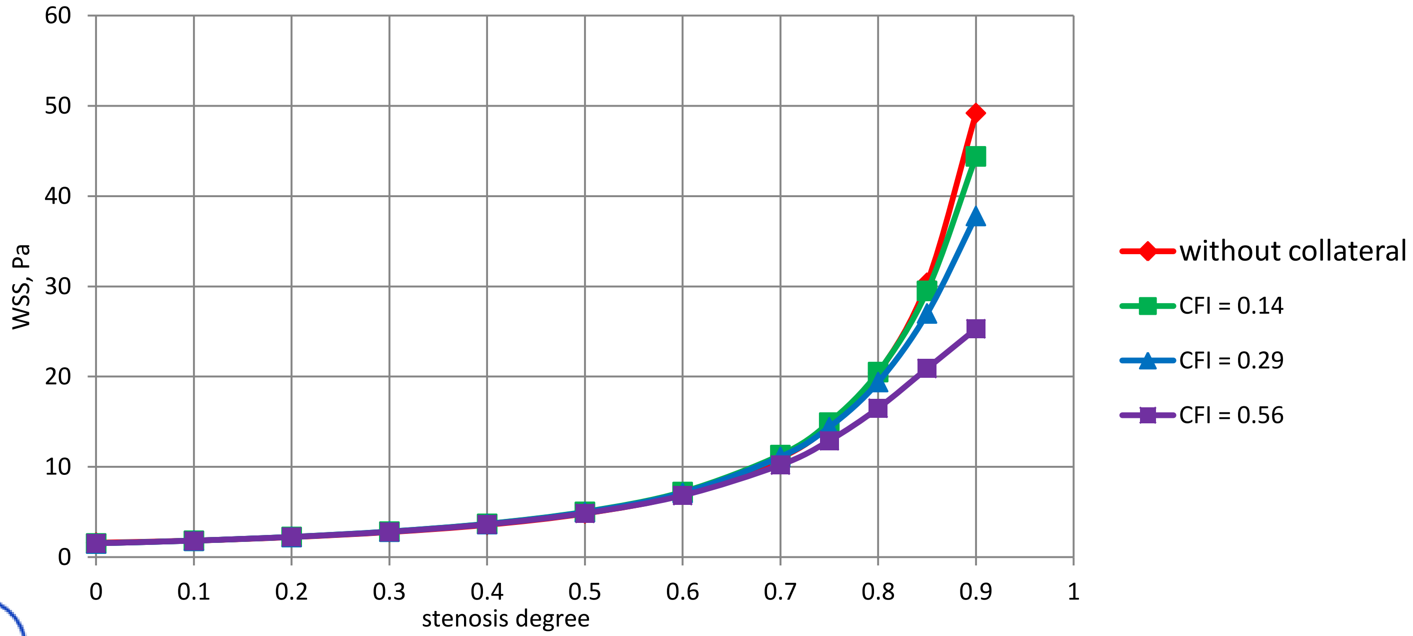
WSS and CFI



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Conclusion

Collateral flow index influence on restenosis growth dynamics was investigated on test Y-topology and real coronary arteries topology. Results were confirmed by analytical calculations. Collateral flow index influence on restenosis growth dynamics was not found.

Presence of collateral unlikely can have an influence on restenosis growth dynamics, because WSS significantly changes only in cases of high WSS.

Thank you!

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