Neural Networks Implemented on Aorta with Abdominal Aneurism

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Introduction – Aneurysm, as already being said, is a degenerative disease that mainly affects the aorta and some arteries. Due to the loss of elasticity of the aortic wall tissue in the abdominal part, as well as due to the age and other factors, a suitable area for creating an AAA is created. Aneurysm on the abdominal aorta represents an increase in the diameter of the aorta more than 50% of its normal diameter.

Aim –The aim of this paper was to predict critical wall shear stress, and its location, which represent the indicators of the place where aorta may rupture.

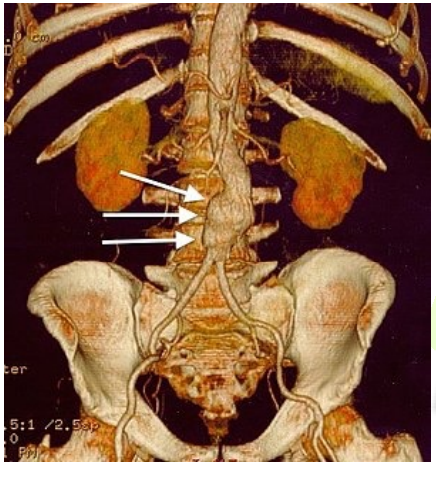
Predicted X [mm]	Calculated X [mm]	Absolute error	Precentiual error %
5.05702391860896	4.911602165	0.145421753335488	2.96078
3.56996105663862	3.199862236	0.370098820910124	11.56608
3.11362250138229	2.035908408	1.07771409386094	52.93529
4.37386320943301	4.21301296	0.160850249343815	3.81793
2.99167087750271	3.21065906	0.218988182113046	6.82066
6.75130725326340	6.679597918	0.0717093348416933	1.07355
4.39412282257390	4.4372484012	0.0216388109267571	0.49488
4.40957002769607	4.302451244	0.107118783402969	2.48971
3.68588259503149	3.040601208	0.645281387507403	21.22216
4.63659085417484	4.329055816	0.307535037696574	7.10397
3.53584259876819	2.730649526	0.805193073212204	29.48723
2.93817438039671	2.32188484	0.616289540790548	26.54264
3.85820063957610	3.594669207	0.26353143298325	7.33117

Materials and methods – 3D models of AAA are generated in the PAC - CAD software, that is using a PAKF solver, which generates an .unv file that contains the model data including the distribution of shear stress on wall of aorta over the nodes of the network that has been generated inside the software.

After generation of models, artificial neural networks (ANN) are being created with aim to predict critical wall shear stress, and its location. Inputs of the ANN were 5 dimensional parameters of AAA while output was calculated wall shear stress.

Predicted Stress [Pa]	Calculated Stress [Pa]	Absolute error	Precentiual error %
0.118582658248576	0.118457715643	0.000124942614575823	0.10547
0.126053374796077	0.125251037786	0.000802337010076926	0.64058
0.104710557887551	0.104636680310	0.00007387757744938	0.07060
0.109285484613271	0.109013180448	0.000272304165271325	0.24979
0.116250370385474	0.116005023751	0.000245346634525814	0.21149
0.120222810717955	0.119261353404	0.000961457313955194	0.80617
0.119803323092908	0.114833026333	0.00497029676009182	4.32828
0.117197206667634	0.116310767936	0.000886438731634062	0.76212
0.116806708817945	0.116727998926	0.0000787098919449725	0.00674
0.118829787865676	0.117946343945	0.000883443920324231	0.74902
0.131960053871137	0.131867417580	0.0000926362911372325	0.07024
0.145123903941121	0.145056988874	0.0000669150668790586	0.04613

Results – The results show that mean absolute error of detecting maximum wall shear stress is 0.0011, while mean absolute errors of detecting coordinates are 0.603, 0.625 and 0.168 for x, y, and z coordinate respectively.



Conclusion – A small number, or a lack of data in neural networks, can cause major training errors, which can be seen in X and Y coordinates. Also, existing neural networks can further be trained and optimized to obtain more precise results, or less errors in coordinate monitoring, since the prediction of a shear stress on the wall of the aorta with abdominal aneurysm is relatively precise. For a more precise prediction of the coordinates it is desirable to use a larger number of input data as well as the AAA model.

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