Application of CFD and Genetic Algorithm to Investigation of Determinants of Carotid Artery Bifurcation Shapes

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We studied which factors play an important role to determine the artery shapes by performing multi-objective optimization with CFD and genetic algorithms. First, we performed optimization that set objectives as assumed factors to obtain optimized shapes in the base of an actual carotid artery bifurcation shape. Next, the actual shape was compared with the results of the optimized one. By applying this process to other six shapes, common factors displaying actual shapes were selected. We assumed five factors: the max WSS, the min WSS, WSSG, WSSTG and the summation of the artery radius. As a result, in the case of minimizing both the max WSS and the artery radius, all actual shapes were optimized ones. This combination was the best in the six tested combinations. It became clear that the combination of those factors plays a more important role to determine normal artery shapes than the other tested combinations.

Keywords: carotid artery bifurcation, CFD, genetic algorithms, multi-objective optimization, WSS

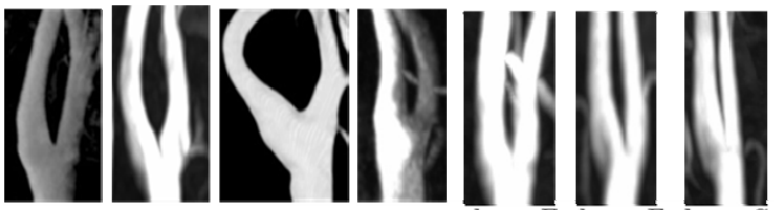

Figure 1: Actual shapes of carotid artery

Objectives	A	B	C	D	E	F	G	Summary
maxWSS, sum of radius	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	*Y*	7/7
maxWSS, minWSS	*n*	*n*	*Y*	*n*	*n*	*n*	*n*	1/7
WSSG, sum of radius	*n*	*Y*	*n*	*n*	*n*	*Y*	*Y*	3/7
WSSG, minWSS	*n*	*n*	*n*	*n*	*n*	*n*	*Y*	1/7
WSSTG, sum of radius	*n*	*n*	*n*	*Y*	*Y*	*n*	*Y*	3/7
WSSTG, minWSS	*n*	*n*	*n*	*n*	*Y*	*Y*	*Y*	3/7

Table 1: Results of optimizations; *Y*: actual shape is one of optimized one, *n*: not optimized one