Modelling Of An Innovative Directional Ultrasonic Atherosclerosis Treatment Device

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Abstract

Atherosclerosis prevalence keeps increasing worldwide because of the sedentary lifestyle and aging of the population. It is a pathology which is characterized by the build-up of plaque on the artery walls. While it has no incidence at the beginning, the blood flow can be severely altered in the most advanced cases. Atherosclerosis can lead to lethal consequences.
Several methods can be used to allow for a normal blood flow recovery; they are known as angioplasty. Whereas some of them rely on the flattening of the plaque, many atherosclerosis require to be properly removed. The removal can be made by different methods including ultrasonic waves.
The present article introduces a modelling of the latter method and focuses on the generation of the ultrasonic waves which produces cavitation. Whereas existing angioplasty ultrasonic devices producing cavitation have a single degree of freedom and generate a cavitation field only in one direction, the present device is driven not by only one piezoelectric actuator but by three independent piezoelectric actuators (patented concept). Therefore, the generated cavitation field can be oriented and focused on specific areas of the artery wall and better target the plaque.
The model includes a coupling between the ultrasonic tip mechanical movement and the acoustical behaviour of the aqueous environment surrounding the tip. The acoustical field allows for a precise prediction of the cavitation generation and the Rayleigh-Plesset equation provides predictions of the bubble's dynamic.
Thanks to the simulation results, a proof of concept was established and the directional abilities of the device have been optimised.

Figures used in the abstract

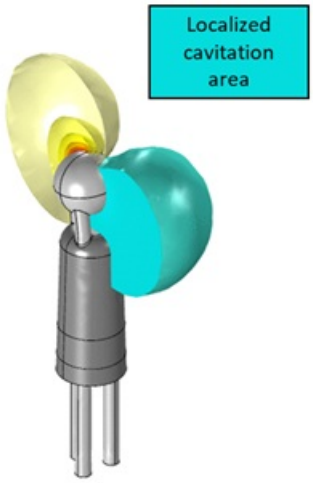

Figure 1 : Pressure distribution and cavitation area at the device tip