Modeling and Simulation of the Endovenous Laser Treatment with Diode Laser

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Great Saphenous vein reflux is the most common underlying cause of significant varicose veins. Traditional treatment of GSV reflux has been surgical removal of the GSV. Endovenous laser treatment (ELT) has been recently proposed as an alternative in the treatment of reflux of the Great Saphenous Vein and small Saphenous Vein. The doses of energy applied endovenously , induce an heating of the vein wall which is necessary to cause collagen contraction and destruction of endothelium. Successful ELT depends on the selection of optimal parameter required to achieve an optimal vein damage while avoiding side effects .Mathematical modeling of ELT could provide a better understanding of the ELT process and could determine the optimal dosage as a function of vein diameter .The model is based on calculations the light distribution using the Monte Carlo, the temperature rise using the bioheat equation and the Laser-induced injury using the Arrhenius damage model .the mathematical model was implemented in Matlab in combination with COMSOL MULTIPHYSICS software as an add-on for finite element modeling. thermal damage of the inner vein wall is required to achieve the tissue alternations necessary in order to lead the vein to permanent occlusion . the aim of this paper is to present a mathematical model using dynamic tissue changes based upon the Arrhenius damage model. The geometry used to simulate ELT was based on a 3D model consisting of a cylindrically symmetric blood vessel (diameter:3mm) including a vessel wall (Thickness:0.4mm) and surrounded by infinite and homogenous tissue. a 600 µm fiber was connected to a 980nm diode laser was inserted in the center of the vessel .At this wavelength , power is usually set between 10 and 15 W. calculations were performed at different distances from the center of the vein, in the tunica intima ,in the tunica externa and 3mm from the tunica externa. Results show that temperatures are lower inside the lumen , similar inside the wall and are higher in the perivenous tissue when using low power.