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FORM OCA 4-292

GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF CONTRACT ADMINISTRATION

<u>^</u>	SPONSORED PROJECT TERMI	NATION/CLOSEOUT SHEET			
•		Date11/25/8	6		
Project No. E-16-D05		School 2028	AE		
Includes Subproject No.(s)	•				
Project Director(s) Don P.	. Giddens				
Sponsor DHHS/PHS/Nation	hal Heart, Lung, and Bloo	d Institute			
TitleHemodynamics of	of Normal and Diseased Ca	rotid Arteries"			
Effective Completion Date: 1	1/30/84	(Performance) 2/2	8/85 (Reports)		
Grant/Contract Closeout Actions	Remaining:				
Nor	ne <u> KKN XXXX</u> Final Fiscal Report	- already submitted			
Closing Documents					
Final Report of Inventions - already submitted					
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FINAL PROGRESS REPORT

Hemodynamics of Normal and Diseased Carotid Arteries

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Grant No. HL22635 Period Covered: September 1, 1978 to November 30, 1984

> Don P. Giddens Georgia Institute of Technology

FINAL PROGRESS REPORT

The objectives of this study were to determine the nature of flow disturbances which occur distal to arterial stenoses and to employ this knowledge to aid in the detection and quantification of atherosclerotic plaques. Extensive experiments were performed to measure flow velocities in steady and pulsatile flows through models with axisymmetric constrictions and in a model of the human carotid bifurcation, as well as acute in vivo studies of coarctations in canines.

The stenosis experiments revealed three types of flow disturbances: (i) a coherent structure associated with the starting phase of each cycle; (ii) laminar oscillations of essentially discrete frequencies originating from the shear layer; and (iii) turbulence, characterized by random velocity fluctuations. These studies show that non-turbulent flow disturbances are the first to occur as the degree of stenosis increases, implying that coherent disturbance phenomena rather than turbulence may be an important key to improved detection of localized atherosclerosis.

The carotid artery model studies were performed only upon a model of the normal bifurcation since funding expired before the research had reached the stage of examining models with simulated plaques. The experiments showed that: (i) large regions of transient flow separation, reversal and helical patterns exist in the carotid bifurcation; (ii) turbulence (i.e., velocities with random behavior) does not occur under physiologic conditions in the carotid bifurcation; (iii) correlation with human disease demonstrated that atherosclerotic plaques localize in regions of low mean wall shear and oscillating shear, not in regions of high shear. Additionally, comparison of the model studies with data obtained from normal human subjects using ultrasonic duplex scanning methods showed convincingly that the model experiments correctly predicted the flow behavior found in vivo.

In companion studies of Doppler ultrasound techniques it was shown that: (i) tracking the Doppler signal with a phase lock loop frequency tracker gives very good velocity measurements for normal flows and for disturbed flows which are coherent or moderately turbulent (intense turbulence could not be followed accurately); (ii) the first moment approach to estimate velocity is accurate for pulsed Doppler systems with small sample volumes; (iii) autoregressive methods of spectrum estimation appear to be very promising as an improvement over Fourier methods.

Thus, the research identified those flow disturbances which first occur as a plaque develops and improvements in Doppler ultrasound signal processing were demonstrated which are necessary to measure flow velocity with sufficient accuracy that small disturbances can be detected. Unfortunately, funding for the project was discontinued so that these new basic findings have not been applied to actual human investigations.