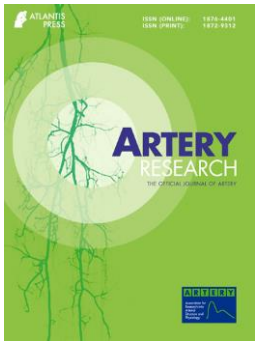

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P85: HIGH FRAME RATE DYNAMIC DISPLAY ULTRASOUND VECTOR FLOW IMAGING FOR QUANTITATIVE STUDIES OF HEMODYNAMICS OF CAROTID ARTERIES

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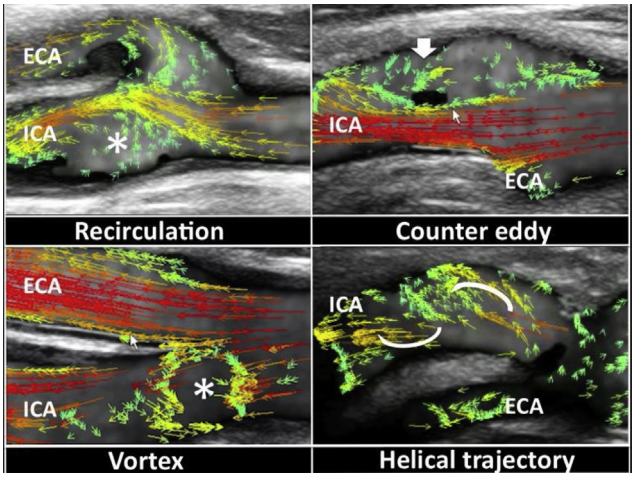
As a consequence of the local deceleration, the detachment of the boundary layer from the wall develops a disturbed flow, which impacts hemodynamics. It results in a non-uniform distribution of wall shear stress (WSS), which is responsible for atherosclerosis [1]. This phenomenon usually occurs in the carotid bifurcation (CB). Computational methods, MRI and conventional Doppler techniques have been used to establish the correlations between flow disturbance and plaque formation. We propose the use of a new method, called high-frame rate Vector Flow imaging (VFI), which dynamically visualises blood flow velocities in all directions, in the evaluation of the flow characteristics in the CB [2,3,4,5].

Methods: CB geometries and flow patterns in 30 healthy subjects of different age were evaluated using a commercial system equipped with high-frame rate VFI based on a frame rate of 600 Hz. The flow is represented by many coloured vectors, displayed as arrows, showing the different velocity, magnitude and direction at each site.

Results: The correlation between flow disturbances and carotid sinus diameter was confirmed: the more relevant the diameter, the more disturbed the flow. Different CB geometries, affecting the flow behaviours and generating complex flow, such as recirculation, counter eddy, vortex and helical trajectory, were identified (Fig 1).



Conclusions: High-frame rate VFI shows in detail the spatiotemporal characteristics of the flow and demonstrates the strong effect of vessel geometries on the flow patterns.

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P85

HIGH FRAME RATE DYNAMIC DISPLAY ULTRASOUND VECTOR FLOW IMAGING FOR QUANTITATIVE STUDIES OF HEMODYNAMICS OF CAROTID ARTERIES

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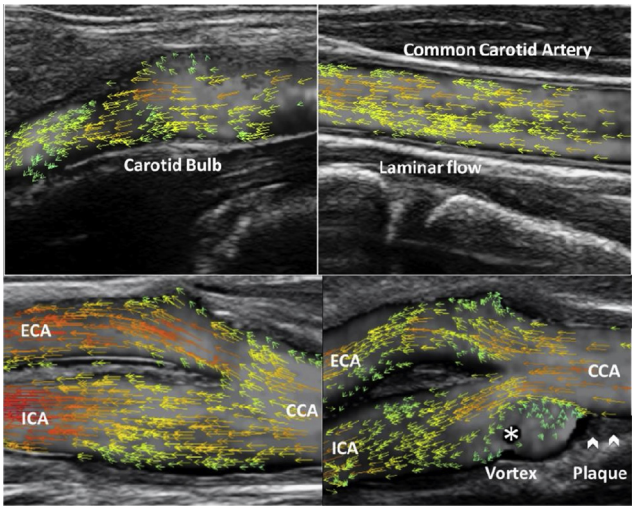
Advanced atherosclerotic patients are faced with significant risks of stroke, which are very likely to cause death or irreversible physical disability. However, the growth of artery stenosis usually needs a very long development. Early diagnosis is necessary and requires detailed and accurate quantitative hemodynamics to be supported. The paper proposes an angle-independent ultrasound flow imaging technique for carotid arteries, which allows true velocity vectors measurement, obtaining both value and direction of blood flow.

The proposed vector flow imaging is implemented based on multi-directional Doppler interleaved transmission [1,2], with high frame rate dynamic display [1] and zone sonography technology [3].

Hemodynamics becomes extremely complicated when plaques develop in the carotid bulb. The dynamic display with velocity vectors assesses flow patterns, e.g. laminar flow, vortex and turbulence (Examples are shown in the figure). The circular variance for the angles of vectors in a desired region of interest can be calculated, allowing disturbance quantification for the non-laminar flow. The method is capable of measuring volume flow (VF) and wall shear stress (WSS) at different locations. To ensure the accuracy both VF and WSS are calculated based on a frame rate of 400—600 Hz and vector velocities.



The high frame rate vector flow imaging has been implemented in a commercial ultrasound system. It provides various quantitative results such as circular variance, VF and WSS, which are useful for hemodynamics studies of complex flow. This could make the early prevention and diagnosis of carotid disease possible.

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Poster Session 1 — Models and Methodologies I

P120

A MODEL-BASED STUDY ON THE EVOLUTION OF BLOOD PRESSURE DURING AGEING

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Background: Hypertension being a major risk factor of cardiovascular mortality, there is a pressing need to understand the ageing mechanisms that lead to the continuous increase of pulse pressure and systolic blood pressure over time. Alterations in both forward and backward waves with age have been widely recognized as key features affecting the development of