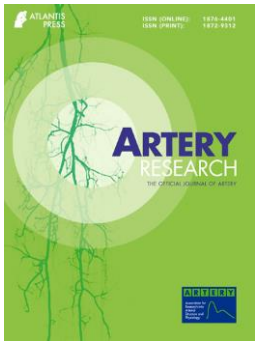

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FOCUS: FUNCTIONAL IMAGING - ULTRASOUND

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matrix degradation during aneurysm formation. Our current understanding of extracellular matrix remodeling during vascular diseases is limited to a few molecules of interest that are investigated intensively whilst others are not studied at all. Moreover, data on specificities or commonalities between the extracellular matrices of different vessels is sparse. It will be essential that high-quality vascular proteomic data investigating changes in the vessel wall with aging and diseaseare made publically accessible to advance the field (adapted from Mayr M. Vascular Proteomics — the forgotten blood vessels. *Proteomics Clin Appl.* 2013 Aug;7(7-8):463.).

FOCUS: FUNCTIONAL IMAGING – MRI AND PET

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The ground-breaking developments in non-invasive imaging over the last 50 years has provided a range of exciting new tools for physiologists and clinicians interested in large artery structure and function. The main focus of my lecture will be on MRI and PET/CT.
MRI can be used in a number of different ways to provide useful information about large arteries, including: arterial diameter, wall thickness, endothelial function, neovascularization, and the distribution of plaque. However, perhaps the most common is the assessment of vessel stiffness. This can be done by measuring distension waveforms or pulse wave velocity (PWV). Particular advantages of MRI are that measurement sites is not limited by anatomy, and accurate path lengths can be obtained for PWV estimation. However, temporal resolution is limited, which means that most waveforms are a composite average over several heartbeats or minutes. Nevertheless, MRI has provided useful information about regional age-related changes in structure and stiffness within the aorta.
A number of PET ligands are in clinical use, the most common being FDG. Uptake depends on metabolic activity, which is often used as a surrogate of inflammation. FDG PET/CT can aid the diagnosis of vasculitis and response to anti-inflammatory therapy. Emerging data suggests that chronic inflammatory diseases such as rheumatoid arthritis and COPD are associated with aortic inflammation, which may explain why they are also associated with increased, but reversible aortic stiffening. Other potentially interesting ligands are NaF (calcium), and FMISO (hypoxia).

FOCUS: FUNCTIONAL IMAGING - ULTRASOUND

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Introduction: Intravascular Elastography has proven to be a sensitive tool to identify vulnerable plaques in coronary arteries. It is a technique to assess the deformation (strain) due to the pulsatile blood pressure of the vessel wall and plaque. However, for screening asymptomatic patients, a noninvasive technique is required. Using linear array transducers, the carotid artery can be imaged noninvasively. However, in contrast to intravascular ultrasound catheters, the ultrasound field is not co-aligned with the radial strain in the arterial wall for cross-sectional imaging. We developed a compounding technique to circumvent this problem and to reconstruct radial strain images of the carotid artery and plaques.
Methods: Linear array transducers are capable of emitting the ultrasound field under different angles. By compounding strain images acquired under different angles, the radial strain can be determined for the full cross-section of the carotid artery. The method was validated using phantoms of arteries with and without plaque. In vivo data was acquired in patients before an endarterectomy procedure was performed allowing validation of the technique by histology.
Results: Using the noninvasive elastographic compounding technique, high quality elastograms of arterial tissues and plaque can be obtained. Phantom experiments revealed that the quality of these elastograms is similar to that of elastograms obtained with intravascular elastography. Receiver operating curves demonstrate high correlations with histologically determined vulnerable plaque features. For the detection of lipid content and superficial macrophages sensitivities and specificities were 80% & 70%, and 100% & 100%, respectively.
Conclusions: Noninvasive vascular elastography using compounding is a promising technique to assess vulnerable plaque features in patients.

Invited Lecture
CENTRAL AORTIC PRESSURE AND ARTERIAL STIFFNESS: ROLE IN ASSESSMENT OF BLOOD PRESSURE VARIABILITY AND BARORECEPTOR FUNCTION

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Blood pressure variability (BPV) is due to complex interaction of cardiac and vascular factors and is influenced significantly by baroreceptor control. The cardiovagal baroreflex sensitivity (BRS) has been shown to depend on vascular compliance and this may explain recent epidemiological association between BPV and arterial stiffness. Although baroreceptors are centrally located (in carotid arteries and aortic arch), BPV and BRS are generally assessed using arterial pressure measurement in a peripheral location (brachial artery or finger) However, the pressure pulse is amplified between the aorta and periphery, with amplification depending on heart rate due to the frequency dependency of the brachial transfer function. In addition, the degree of pulse amplification reduces with increased aortic stiffness as occurs with age. Thus, if BRS is determined by systolic BPV and concomitant changes in heart rate, the relationships will not be similar if assessed from a peripheral or central pressure measurement. The spontaneous sequence technique is used for computation of BRS from the slopes of linear relationships of systolic pressure (SBP) and pulse interval (PI) of contiguous cardiac cycles, where SBP and PI change in the same direction. With this method, BRS computed using central pressure has no consistent relationship to BRS computed using peripheral blood pressure measurements, with differences also being dependent on the lag between SBP and PI. With improvements in technology for continuous non-invasive measurements of central aortic pressure, characterisation of BPV and BRS will be enhanced by the inclusion of effects of arterial stiffness on the pressure waveform.

McDonald Lecture
WAVES, RESERVOIRS & ARTERIES

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It is commonly assumed that pressure and flow in the arteries are purely the result of forward and backward travelling waves. We will show that various observations of arterial behaviour are difficult to explain using this assumption. In particular we will look at what happens to arterial pressure under different conditions: during ectopic beats (or extended periods of cardiac arrest), in experimental studies of pressure and flow when the aorta is totally occluded at different locations, in a computational study of the input impedances of randomly generated networks of arteries and when pressure and velocity are measured at different distances along the aorta.
We show that all of these observations can be explained using wave intensity analysis, a method of analysis developed in gas dynamics which will be described very briefly. We further show that this analysis suggests that it is useful to separate arterial pressure into a reservoir pressure that accounts for the overall compliance of the arterial system and an excess pressure that is determined by local conditions.
Evidence has accumulated in the decade since the introduction of the reservoir-wave hypothesis that the reservoir/excess pressure separation can be useful in interpreting the results of vasoactive drugs on cardiovascular performance and that parameters based on the reservoir/excess pressure are significant predictors of cardiovascular events.
We argue that reservoir/excess pressure exists as a concept simply because it has been defined. The real question is the usefulness of the concept in the interpretation, physiologically and clinically, of the infinitely complex behaviour of the cardiovascular system. We conclude that the evidence suggests that it is a worthwhile topic for future research.