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### 9.9: FLOW-MEDIATED SLOWING AS A NOVEL METHOD FOR THE NON-INVASIVE ASSESSMENT OF ENDOTHELIAL FUNCTION

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## 9.7

## THORACIC AORTA PWV ASSESSMENT BY USING 4D FLOW IN MRI

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**Purpose:** In MRI, thoracic aorta pulse wave velocity (TAPWV) is usually estimated by 2D phase contrast (PC) with either in plane or through plane velocity acquisition. Thanks to technological improvement, 4D PC with full coverage of the TA and 3 dimension velocity encoding thought time can be now achievable in 10min. Our aim was to compare estimation of TAPWV using 4DPC or 2DPC on healthy volunteer.

**Methods:** Acquisitions were performed on a 3 Tesla scanner (GEHC, 750w). 2DPC was done with through plane velocity encoding on an axial oblique slice perpendicular to ascending and descending TA. 4D acquisition covered the full TA volume from the aortic valve to diaphragm. Segmentation and velocity estimates were done by using cloud computing (Arterys). Optimal data view sharing was applied to obtain 8ms and 16ms temporal resolution for 2DPC and 4DPC, respectively. Flow data curves were further computed on homemade software (artfun) to assess PWV for both 2D and 4D acquisition.

**Results:** 31 healthy volunteers (13 male, age 50.9y ±18.6) were included. Correlation coefficient between 4DPC and 2DPC PWV was 0.69 (p<0.001) with small underestimation of 4D vs 2D (-0.17m/s limits of agreement [-3.85 ; 3.50]). A strong correlation with aging was obtained for both 4D and 2D PWV (r=0.75 p<0.001 and r=0.74 p<0.001 respectively)

**Conclusions:** TAPWV can be accurately estimated by 4D flow MRI, since close relation with 2DPC and aging have been obtained. By using the same data set, TAPWV should be estimates in association to other stiffness and geometrical parameters of the TA.

## 9.8

## NEAR INFRARED SPECTROSCOPY (NIRS) CAN DETECT IMPROVEMENTS IN ARTERIAL FUNCTION FOLLOWING 6-MONTHS OF MARATHON TRAINING

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**Background:** Endurance training improves vascular function and skeletal muscle perfusion. NIRS can measure changes in oxygenated haemoglobin (oxy-Hb) in the skeletal muscle microvascular bed. Therefore, combined with arterial occlusion, NIRS has the potential to assess microvascular function within skeletal muscle. However, NIRS measurements are strongly influenced by adipose tissue thickness (ATT) at the measurement site.

**Methods:** Vascular function was tested in healthy individuals prior to marathon training oxy-Hb changes were measured by NIRS (Portamon, Artinis) during a 30-second arterial occlusion and the subsequent hyperemic response. ATT was assessed at the site of measurement using ultrasound (Vivid I, GE).

Participants underwent the same test after completing the marathon. Post-occlusive time-to-peak oxy-Hb response and Δoxy-Hb concentration were compared pre- and post-marathon and the effect of ATT on each parameter was assessed. Results are meanSD a paired t-test was used for comparison and β-coefficients used to compare the ATT relationships.

**Results:** 34 participants (18=male, 30±3 years old) completed vascular testing and ATT measurements. The Δoxy-Hb value was more strongly attenuated by ATT than time-to-peak oxy-Hb (β-coefficients: -0.58, p<0.0001 and -0.14, p=0.45, respectively). 27 participants (15=male, 313 years old) completed the marathon and underwent testing at both time points. Time-to-peak hyperemic response was significantly faster post-marathon (Δ1.95±4.07seconds, p=0.01) but there was no difference in Δoxy-Hb(0.83±6.23 μM, p=0.5).

**Conclusions:** Endurance training has a positive effect on reperfusion rates following short duration ischemia. Improvements can be detected using NIRS to measure oxy-Hb changes. Comparing the time-to-peak response overcomes some of the limitations of ATT on the NIRS measurements.

## 9.9

## FLOW-MEDIATED SLOWING AS A NOVEL METHOD FOR THE NON-INVASIVE ASSESSMENT OF ENDOTHELIAL FUNCTION

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**Background:** Flow-mediated slowing (FMS) assesses the slowing of pulse wave velocity (PWV) in response to reactive hyperaemia, to provide a measure of endothelial function. We assessed the reproducibility of FMS and whether the technique is sensitive to the influence of age. FMS was compared to the commonly used, but technically demanding, alternative measure of endothelial function, flow-mediated dilatation (FMD).

**Methods:** PWV was measured using the Vicorder device, with cuffs placed around the upper arm and wrist. FMD was assessed in the contralateral arm. The reproducibility of FMS was assessed in 23 subjects on two separate occasions. FMS and FMD were also assessed concurrently in 23 younger subjects (mean age 22±2years, 11 males) and 13 older subjects (mean age 69±6years, 7 males), all of whom were normotensive and not taking vasoactive medication. Response to glyceryl trinitrate (GTN, 25 μg administered sublingually) was also assessed with both techniques.

**Results:** FMS was reproducible, with positive correlations between repeat visits (r =0.56, P=0.003). FMS and FMD did not correlate (r=0.23, P=0.18) whereas GTN mediated responses did (rho=0.42, P=0.01). Comparisons between younger and older groups demonstrated that FMS, FMD and GTN-mediated slowing were all significantly attenuated in older subjects (P<0.01 for all) but there was no age-related difference in GTN-mediated dilatation (p=0.7).

**Conclusions:** FMS is a reproducible technique that is sensitive to the influence of age, but does not correlate with FMD. The extent to which FMS represents endothelial function is worthy of further investigation.

## 9.10

## STRUCTURAL AND FUNCTIONAL ARTERIAL ABNORMALITIES IN FIBROMUSCULAR DYSPLASIA ARE IN THE CONTINUUM OF HYPERTENSION: AN IMAGING AND BIOMECHANICAL STUDY

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Fibromuscular dysplasia (FMD) is a non-atherosclerotic non-inflammatory arterial disease of unknown origin. We previously showed the presence of triple signal (TS) at ultrasound within common carotid artery (CCA) wall. We aimed at coupling TS presence with microconstituents of the vessel wall.

We included 50 patients with multifocal FMD, 50 essential hypertensive (HT) patients and 50 healthy subjects (HS) matched for age, sex, ethnicity and BP (HT and FMD). TS score from the right and left CCA were assessed from 15-MHz echotracking system coupled with aplanation tonometry. 14 microconstituents of the CCA, representing geometry, perivascular tethering, and wall material coefficients were derived from fitting of the pressure-diameter curve.

In multivariate analysis, age, hypercholesterolemia and IMT were significantly associated with TS, explaining 9.5% of its variance. TS was more frequent in FMD than HS (49% vs 16%, p<0.01), and HT (32%, p=0.08). When considering the whole population (n=150), several microconstituents appeared correlated with age and BP: particularly, residual stress was higher, and collagen fibers were stiffer with increasing age and BP (p<0.01). TS was positively associated with circular collagen mediated-stiffness (p<0.01), independently of age and BP.

We confirmed that FMD is associated with higher frequency of TS, but with overlap with matched HT and HS. The strong association between TS and