

Aortic Compliance Evaluation in 291 Normal Studies

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Studies have shown that aortic compliance (AC) is a strong independent predictor of cardiovascular events, both in normals and people with risk factors. It can be evaluated noninvasively and its reduction with age in normals has been demonstrated with both MRI and Doppler echo methods. Aortic pulse wave velocity (PWV), a measurement of the flow pulse traveling along aorta as a surrogate of AC, can be assessed using a single breath-hold phase contrast (PC) imaging technique. Repeated study in the same age group can provide us valuable information on the evolution of normal aortic stiffness with ageing. We repeated our studies at 5-year intervals on normal volunteers and evaluated the relationship of aortic PWV to age over time.

Methods 225 healthy volunteers gave informed consent (115 male, age: 58.2 ± 14.5) and were screened to exclude hypertension, hyperlipidemia and cardiovascular disease. Among those 225 volunteers, 64 of them were participated in 5 year follow up and 2 were in 10 year follow up. Using the 'candy cane' view of aorta, an axial plane through the ascending and descending aorta at the pulmonary artery level was prescribed and a through-plane velocity encoded PC cine imaging was acquired with VENC of 150 cm/s, TR/TE/FA = 98ms/2.9ms/15° and voxel spatial resolution $1.3 \times 2 \times 6 \text{ mm}^3$ on a 1.5T MRI scanner. The distance traveled by the aortic pulse wave, ΔD , was determined as the distance along the central line between the sections imaged in the ascending and descending aorta in the 'candy cane' image. For flow pulse onset, the cross correlation between the first halves of the ascending and descending aortic flow curves was calculated by varying the relative time shift between them. The Δt was the time shift at the maximal correlation. We then calculated $\text{PWV} = \Delta D / \Delta t$. The cardiac volumetric measurements were performed on all studies for correlation. 2D breath hold SSFP cine imaging of the heart was acquired with 8 mm slice thickness and no gap in between slices. Logarithm PWV was correlated with volunteer's age, left ventricle (LV) volume, LV ejection fraction, LV mass, right ventricle (RV) volume, RV ejection fraction, RV mass, systolic blood pressure (SBP), diastolic blood pressure, and heart rate. The blood pressure and heart rate were measured when the PC sequence just finished while volunteer was in the scanner. Linear regression was used to determine the relationships between PWV and age at each visit.

RESULTS: The linear regression between PWV versus age yielded $\text{Log}(\text{PWV}) = 0.1728 + 0.0121 * \text{Age}$, with $R^2 = 0.32$, $p < 0.001$ as shown in **Figure 1**. The relationship between SBP and PWV was found as $\text{SBP} = 109.1 + 17.14 * \text{Log PWV}$, with $R^2 = 0.19$, $p < 0.001$ as shown in **Figure 2**. The RV mass also correlates with PWV with $R^2 = 0.11$, $p < 0.001$. PWV doesn't show close correlations with the other parameters measured. From those 66 studies enrolled in 5 year follow up, the mean and std of PWV, changed little between visits, but showed a stronger correlation with age at 5 years ($8.6 \pm 5.5 \text{ m/s}$) than at intake ($7.9 \pm 5.5 \text{ m/s}$).

CONCLUSIONS: Aortic compliance can be easily evaluated in MRI with a single breath hold phase contrast cine imaging. PWV is correlated with age, systolic blood pressure and RV mass in normal volunteers.

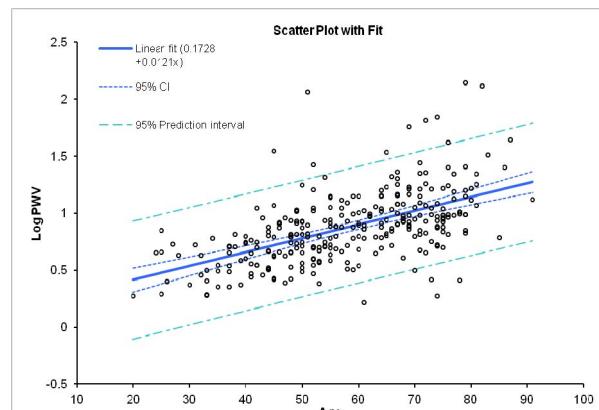


Figure 1. The scatter plot of the fitting curve between PWV and age $R^2 = 0.32$, $p < 0.001$, $n = 291$.

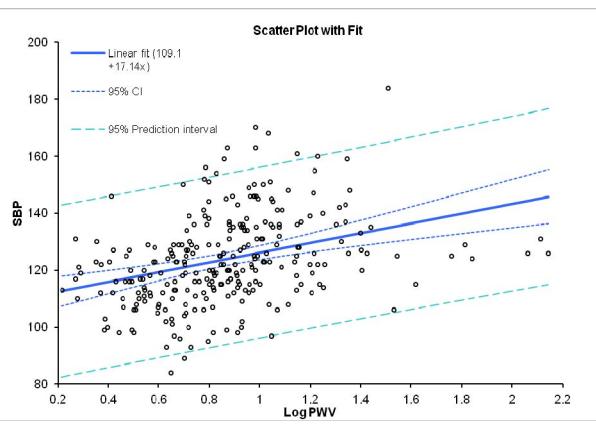


Figure 2. The scatter plot of the fitting curve between PWV and SBP $R^2 = 0.19$, $p < 0.001$, $n = 291$.