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PWV Measurement Influenced by Distance Between Two Recording Sites

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To the Editor: We have read the recent letter by Hermeling *et al.* entitled "Potentials and Pitfalls of Local PWV Measurements,"[1] discussing the advantages and challenges for local pulse wave velocity (PWV) measurements. The letter was in reference to an article by Vappou *et al.* regarding pulse wave imaging measurement of arterial stiffness *in vivo*.[2] In the common carotid artery, due to the susceptibility of the systolic foot in the local PWV measurement, the authors suggest the dicrotic notch as a new time reference point. However, how strong the interference influence on the foot-to-foot PWV and how the distance of the recording sites affects the PWV remain unknown.

Therefore, we tested the reliability of the foot-to-foot PWV when the periodic water input was pumped into simulated T-tubes. The frequency of the input was set to match the fundamental natural frequency of the T-tube to simulate the *in vivo* condition.[3] The simulation system has evolved from our previous study[4] in 1991 and has been improved according to the theoretical model in 2008.[5] We chose five uniform latex tubes all with the length of 180 cm and similar physical dimensions, but different Peterson's elastic modulus. The PWV measurements were performed to study the correlation with the arterial stiffness (**Table 1**).

Table 1 | PWV measured by foot-to-foot method with the various distances of two transducers

			Pulse wave velocity (m/s)			
			Distance between two recording sites (cm)			
Tube	E_p (10^5 N/m^2)	f_0 (Hz)	30	60	90	120
Latex 1	0.61 ± 0.02	1.9	4.20 ± 0.14	3.99 ± 0.05	4.84 ± 0.07	6.02 ± 0.10
Latex 2	1.46 ± 0.06	2.3	6.92 ± 0.26	6.10 ± 0.10	5.16 ± 0.22	8.57 ± 0.10
Latex 3	1.83 ± 0.05	3.7	4.40 ± 0.15	7.50 ± 0.30	11.8 ± 0.1	13.0 ± 0.2
Latex 4	3.13 ± 0.06	4.1	15.5 ± 0.7	12.5 ± 0.7	11.1 ± 0.3	13.9 ± 0.4
Latex 5	3.26 ± 0.07	4.2	15.0 ± 1.0	12.4 ± 0.6	11.6 ± 0.3	15.3 ± 0.3
Linear correlation coefficient between PWV and $\sqrt{E_p}$			0.72 ($P = 0.08$)	0.91 ($P = 0.02$)	0.93 ($P = 0.01$)	0.99 ($P < 0.001$)

PWV, pulse wave velocity.

We found that the linear correlation between the foot-to-foot PWV and the tube stiffness is significant ($r > 0.7$, $P < 0.1$) for all regions. However, the longer the region of the measurement is, the higher the correlation between the foot-to-foot PWV and the elasticity of the tube is shown. The result confirms the *in vivo* observation by Hermeling *et al.*[1] The simulation experiment also reveals that long-distance PWV, such as carotid-femoral PWV, can reflect the arterial stiffness well in spite of the change in the waveform.

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1. Hermeling E, Reesink KD, Hoeks AP, Reneman RS. Potentials and pitfalls of local PWV measurements. *Am J Hypertens* 2010; 23:934; author reply 935.
2. Vappou J, Luo J, Konofagou EE. Pulse wave imaging for noninvasive and quantitative measurement of arterial stiffness *in vivo*. *Am J Hypertens* 2010; 23:393–398.
3. Wang YYL, Hsu TL, Jan MY, Wang WK. Review: theory and applications of the harmonic analysis of arterial pressure pulse waves. *J Med Biol Eng* 2010; 30:125–131.
4. Wang YY, Chang SL, Wu YE, Hsu TL, Wang WK. Resonance. The missing phenomenon in hemodynamics. *Circ Res* 1991; 69:246–249.
5. Wang YYL, Sze WK, Bau JG, Wang SH, Jan MY, Hsu TL, Wang WK. The ventricular-arterial coupling system can be analyzed by the eigenwave modes of the whole arterial system. *Appl Phys Lett* 2008; 92.

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