Aortic Pulse Wave Velocity, Reflection Site Distance, and Augmentation Index

To the Editor:

The article by Westerhof et al1 readdresses issues raised by McDonald and Taylor 50 years ago.2 Unfortunately, the article does not refer to the elegant modeling studies undertaken by Taylor3,4 nor their application to data obtained from different arteries of different animals, where the primary approach was directed toward pulse wave analysis in the frequency domain. These studies established that the major reflection sites are located at arterial junctions and arteriolar terminations where reflection is strong and positive, and the distance to a functionally discrete reflecting site depends on physical dispersion of reflection sites in a vascular bed rather than any single anatomic site.3,5

Taylor3,4 and McDonald2 considered that pulse wave velocity (PWV) of a forward-traveling wave is identical to PWV of the reflected wave, and both are directly related to the properties of the arterial wall.2,5 Reflection at branching points appears to be minimized by the size of the daughter to parent branches; although phases of this could vary, it was not considered to significantly affect amplitude or timing of the reflected wave.3,5

Westerhof et al1 concluded that PWV cannot be determined from timing of wave reflection in the proximal aorta. We dispute the theory applied on the basis of positive wave reflection from major reflection sites, as established by Taylor3,4 and McDonald,2 although we concede that it is often difficult to separate the foot of the reflected wave from the shoulder of the pressure pulse in older humans with stiffened arteries.5 We also note that it can be equally difficult separating the foot of the reflected wave from the cardiac incisura when the aorta is normal and PWV is low.5 During aging from 20 to 60 years in humans, PWV doubles and Δt decreases ~40%, causing reflection site distance to increase; however, augmentation index does not decrease as the authors state, it increases.5

We are uncomfortable with the analogy of the tennis ball in the article by Westerhof et al.1 As Roger Federer dispatches the ball at a given speed, Andy Roddick needs to hit the ball hard to maintain the same speed in the opposite direction. If the racquet is held still, the velocity of the ball will decrease as a consequence of frictional energy loss. A better analogy is speed of sound waves in fluid, where, as in arteries, velocity depends on physical properties of the medium over which the wave travels.2,3,5

We agree that location of reflection sites is elusive, although not for the reasons described by Westerhof et al.1 The explanations given by Taylor3,4 and McDonald2 remain the most elegant and logical. It is a disappointment to see them overlooked.

Disclosures

None.

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