JACC VOL. 66, NO. 5, 2015
AUGUST 4, 2015:592–7

because all were calculated from the same aortic pressure waveform, which had been reduced and distorted when pressure was measured side-on to the direction of flow, by a Venturi effect at peak flow velocity.

The authors appear not to have considered this issue (which was illustrated in the previous paper [3]) (**Figure 1**); it does explain different features of waveforms, including the slow rising (<400 mm Hg/s) anacrotic pressure pulse, the grossly abnormal values of peripheral resistance, and central impedance prior to TAVR (the authors' Figure 1 and Central Illustration).

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http://dx.doi.org/10.1016/j.jacc.2015.04.077

Please note: Dr. O'Rourke is a founding director of AtCor Medical P/L, manufacturer of pulse wave analysis system, SphygmoCor, and of Aortic Wrap P/L, developer of methods to reduce aortic stiffness. Dr. Nichols has reported that he has no relationships relevant to the contents of this paper to disclose.

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REPLY: High Flow Velocity and Low Systolic Pressure

Compliance of the Aortic Wall or Venturi Effect Within

We have read with great interest the letter by Drs. O'Rourke and Nichols, and we appreciate his valuable comments. The issue of conversion of potential (static pressure) to kinetic (dynamic pressure) energy is a very well taken point, and needs to be considered when assessing vascular properties at high flow-velocity rates. As elegantly pointed out by Drs. O'Rourke and Nichols, impact pressure should be preferred over lateral pressure to accurately characterize the arterial load in the scenario of aortic stenosis. Unfortunately, because there are no clinically approved micromanometer catheters capable of measuring impact pressure, lateral pressure has been used in all previous work on arterial hemodynamics of aortic stenosis (1-3). Moreover, notice that in our study we balanced the pressure micromanometer against the impact pressure measured by a fluid-filled guiding catheter aligned facing the flow direction. Because we were aware of non-negligible dynamic pressure, we performed this balancing procedure *in situ* in the ascending aorta at the measurement point (see the Central Illustration from Yotti et al. [4]). Although the mean pressure matching method we used for balancing may introduce some small time-dependent errors from the fluid-filled system, it grants an accurate measurement of both static and dynamic components.

We have confirmed that dynamic pressure was properly captured by our calibration procedure. In most cases, peak-systolic micromanometer pressure after balancing was in fact slightly higher than guiding catheter impact pressure (**Figure 1**)—probably due to overdamping in the fluid-filled system. This error did not change after transcatheter aortic valve replacement (TAVR) and did not correlate with peak flow velocity ($R = 0.01$). Thus, although there may have been some subtle impact on the morphology of the pressure tracings, there was no significant Venturi effect on our data. Additionally, TAVR modified vascular resistance and pressure-decay compliance, indices that are insensitive to the systolic morphology of the pressure waveform. Finally, we would like to emphasize that the slow upstroke and other features of aortic pressure waveforms attributed by Drs. O'Rourke and Nichols to measurement artifacts are universally accepted signs of aortic stenosis.

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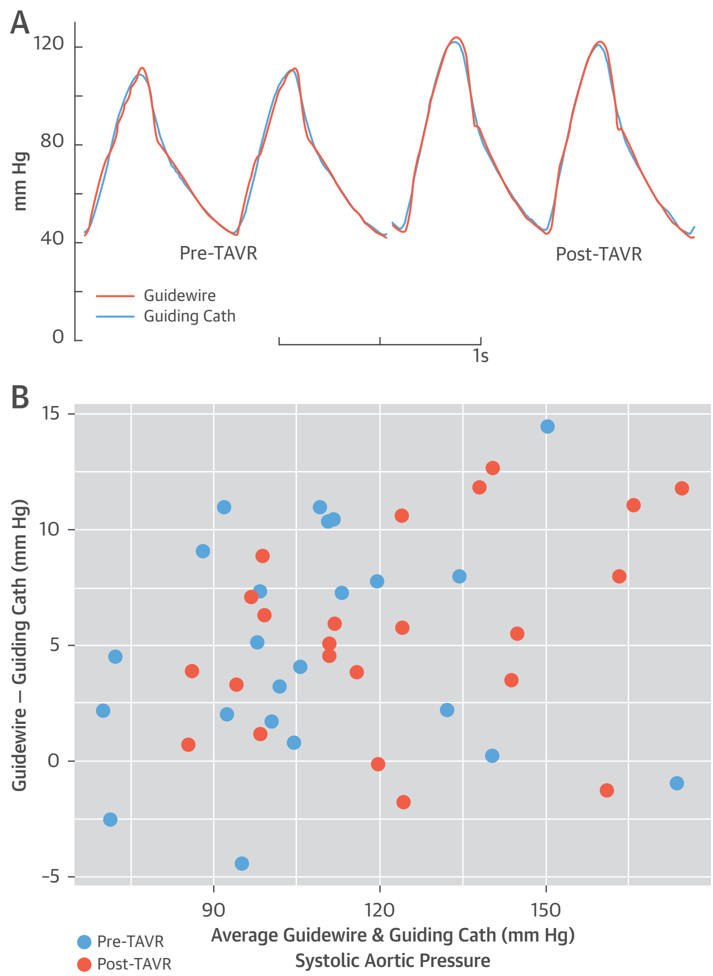
FIGURE 1 **Comparison of Aortic Pressure Tracings Obtained With the Micromanometer and the Guiding Catheter**



(A) Simultaneous pressure signals obtained with the micromanometer **(salmon)** and the guiding catheter (Cath) **(blue)** in a representative example. **(B)** Bland-Altman plot showing the agreement between the peak systolic aortic pressures measured with the guiding catheter and the micromanometer before and after transcatheter aortic valve replacement (TAVR).

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http://dx.doi.org/10.1016/j.jacc.2015.05.059

Please note: The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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