

Novel Method for Simultaneous Measurement of Left Ventricular and Aortic Pressure Gradient in the Era of Langston Catheter Recall

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Abstract

Invasive hemodynamics are often necessary for the evaluation of aortic stenosis and dynamic left ventricular outflow obstruction in order to measure intracavitary gradients and gradients across the aortic valve, particularly when noninvasive testing is inconclusive, when there are discrepancies between the clinical presentation and noninvasive imaging, to assess response or necessity of pharmacologic or surgical and nonsurgical treatments, and whenever there is a need for definitive hemodynamic measurements for decision making. After the recall of the Langston catheter (Teleflex), which was widely used to measure simultaneous left ventricular and aortic pressures, we and others sought out alternative methods to simply and expediently measure these pressures. Here, we present the use of a mother in daughter-style technique that involves placing a Twin-Pass microcatheter (Teleflex) and an .014-inch coronary guide-wire within the left ventricle via a standard 5 or 6 French coronary guiding catheter, which is then withdrawn into the aortic root in order to accurately and if necessary, easily and repetitively, measure the appropriate gradients.

Aortic stenosis and hypertrophic obstructive cardiomyopathy are characterized by an increased gradient across the aortic valve.¹ By measuring peak velocities and pressures across the aortic valve, echocardiography is often the first-line imaging modality to diagnose the severity of aortic valve stenosis and left ventricular outflow obstruction.²⁻⁴ Yet sometimes there is a discrepancy between the clinical presentation and noninvasive findings, or the echocardiogram is limited or deemed technically unreliable. As a result, invasive hemodynamics may be necessary to diagnose and classify the disease severity.⁵ For more than a decade, the Langston dual lumen catheter (Teleflex), with a 6 French (Fr) outer catheter and 4 Fr inner lumen, has been used to simultaneously measure aortic and LV pressures.⁶ In 2020, the Langston catheter was recalled by the Food and Drug Administration due to issues related to separation of the inner catheter during power injection.⁷ We report our experience with

the simultaneous measurement of aortic and LV pressures with the use of a Twin-Pass microcatheter (Teleflex), a standard .014-inch angioplasty work-horse wire, and standard 5 or 6 Fr interventional guiding catheters.

Case Presentation

Femoral access was gained with a 6.0 Fr, 24 cm Arrow-Flex sheath (Teleflex) (note longer sheaths can be used if desired). After routine coronary angiography, the aortic valve was crossed with a 5 Fr Judkin right 4.0 (JR4) catheter over a standard .014-inch J wire. Alternatively, to save a step, Amplatz left guiding catheters and moveable or fixed core straight wires can be directly placed in the LV. Simultaneous LV and aortic pressures were measured using the femoral long sheath pressure as a surrogate for the ascending aortic pressure, after verifying that aortic root and long sheath pressures were identical and superimposable, which is another technique useful for quickly measuring LV-aortic gradients. The use of this gradient as a surrogate for aortic root-to-LV gradients has been controversial; however, we find it to be suitable for most routine clinical decision making. Subsequently, the 5 Fr JR4 catheter was exchanged for a 6 Fr JR4 guide catheter over a standard .035-inch exchange-length J wire and the aortic valve was crossed with a JR4 guide

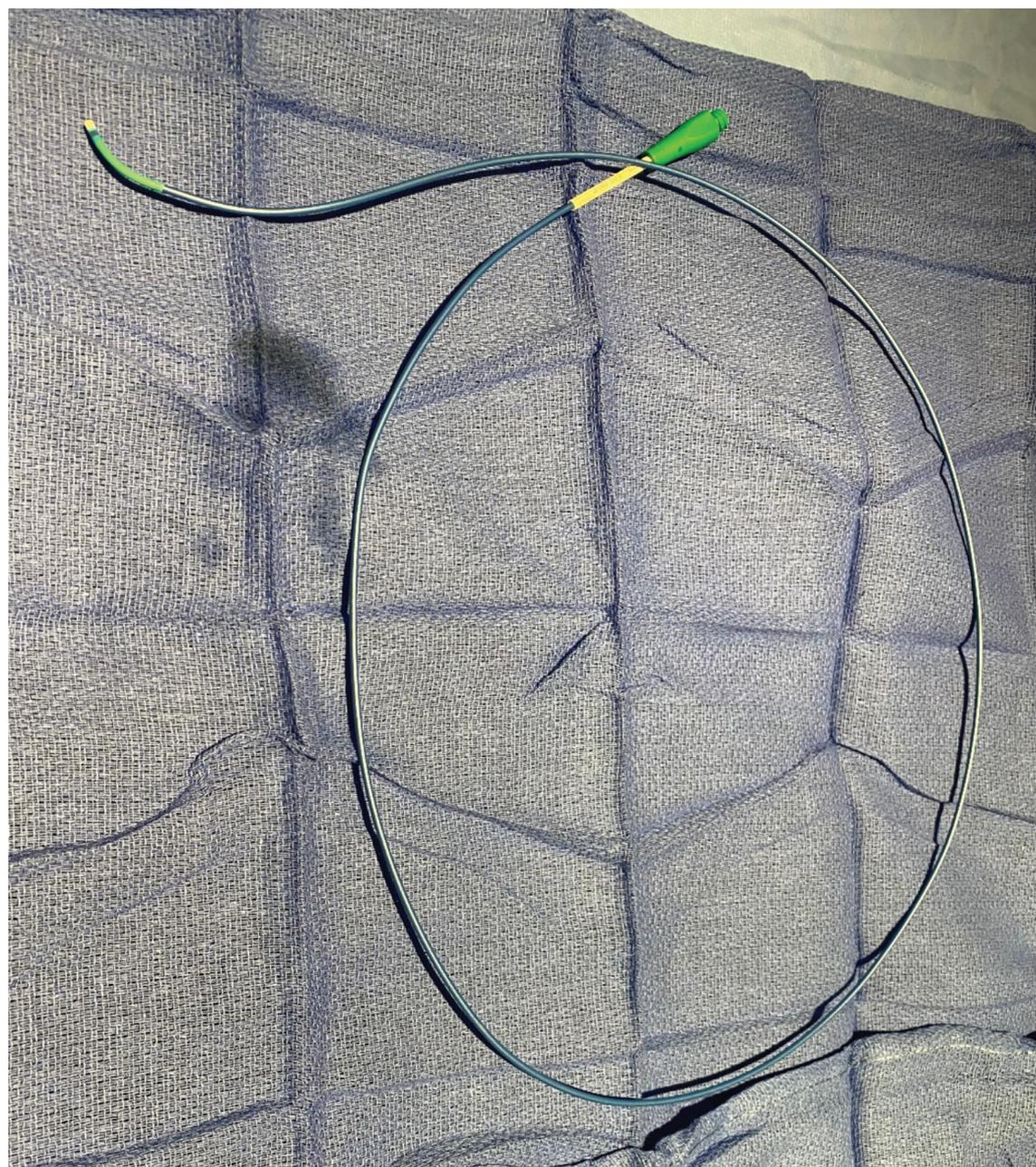


Figure 1. A Judkins right 4.0 (JR4) guide catheter.

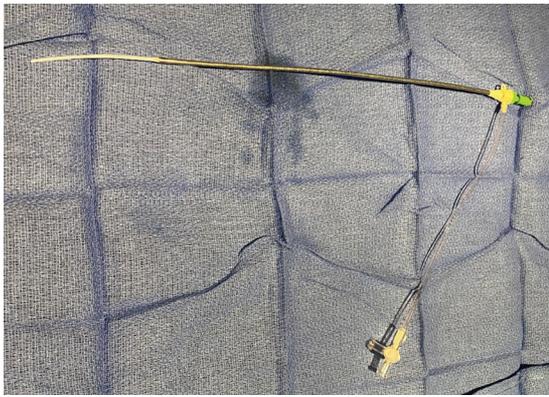


Figure 2. A long 6 French Arrow-Flex sheath (Teleflex).

catheter. An .014-inch Runthrough coronary wire (Terumo) was advanced into the LV. The guide catheter was pulled back into the ascending aorta, leaving the Runthrough in the LV. Next, a Twin-Pass microcatheter was advanced into the LV over the Runthrough wire. Simultaneous LV and aortic pressures were measured using the Twin-Pass and guide catheter. During pullback, premature ventricular contractions (PVCs) were induced when

necessary with the Runthrough wire, and resting and provoked gradients were measured precisely, easily, and repetitively at various locations within the LV using LV-aortic pullbacks of the Twin-Pass over the guidewire. The pressure gradient, when measured by using the femoral sheath as a surrogate for the ascending aortic pressure and by directly measuring the ascending aortic pressure with the JR4 catheter, correlated well between the two techniques. The absence of a transvalvular pressure gradient and the presence of a LV outflow gradient with Brockenbrough-Braunwald-Morrow sign were evident, and these dynamic obstructive hemodynamics were easily measured and demonstrated with guidewire-provoked PVCs. Once measurements were complete, all catheters and wires were removed. Hemostasis was achieved with the use of an Angio-Seal (Terumo). Figures 1-5 show the instruments that were used and the waveforms that were obtained in this case.

Discussion

The use of the Twin-Pass catheter within a standard guiding catheter is helpful for the simultaneous measurements of aortic and LV pressures and LV

outflow tract gradient measurements. In our experience, this technique also correlates well with the use of the femoral arterial sheath as a surrogate for the ascending aortic pressure. In the era of the Langston catheter recall, this technique may be used for the measurement of aortic stenosis and left ventricular outflow tract obstruction. An .014-inch Runthrough wire can induce PVCs to elicit the Brockenbrough-Braunwald-Morrow sign and further differentiate valvular aortic stenosis from hypertrophic obstructive cardiomyopathy.

In an era with both transcatheter and surgical approaches to the treatment of structural heart disease, invasive cardiac hemodynamics are increasingly being utilized for further evaluation of valve disease. Accurate measurement of pressure gradients and valve area will aid in optimal patient management.⁵

In the presence of the Langston catheter recall, we suggest this alternative method to measure the necessary pressures quickly and reliably, but other approaches have also been reported in the literature.⁸ Each technique offers its own advantages and disadvantages, described below.

A single catheter pullback from the LV to the aorta may be helpful, but only when there is normal regular heart rate with sinus rhythm. An increase in the aortic pressure is observed in critical aortic stenosis on pullback due to relief of the obstruction by the catheter, named the Carabello sign or effect.⁹

The requirement of two separate arterial accesses and two catheters placed centrally in the ascending aorta and left ventricle may be considered for simultaneous measurements, but increases risk for vascular complications and is more time consuming.

The femoral artery pressure may be an option for use as a surrogate for the ascending aortic pressure. Limitations in using femoral artery pressure as a surrogate can result from peripheral amplifications of the pressure or large vessel occlusion, leading to underestimation or overestimation of the aortic valve gradient. While this approach should not be routinely used, it may be useful as a check on the centrally measured gradients.¹⁰

The feasibility of pressure wire use for the measurement of LV pressure and 5 Fr catheters for measurement of the aortic pressure was studied and found to be safe, feasible, and accurate in 18 patients when compared to Doppler-derived measurements;¹¹ however, in the setting of severe aortic stenosis, the stenotic jet causes direct valve crossing with any .014-inch wire to be unreliable and challenging to accomplish in a timely manner. Use of the Navvus microcatheter (ACIST Medical) has been reported as an alternative strategy for simultaneous pressure measurement, but its availability and cost may be an issue for widespread utility.¹²

A standard mother-daughter technique may also be considered for simultaneous aortic-LV pressure measurements. In this technique, a 110 cm to 120 cm 4 Fr catheter can be advanced within a 90 cm 6 Fr guide catheter to measure LV and aortic pressures, respectively.¹³



Figure 3. Twin-Pass microcatheter (Teleflex).



Figure 4. Simultaneous aortic-left ventricular pressure measurement waveform.



Figure 5. Simultaneous aortic-left ventricular pressure measurement waveform with premature ventricular contractions.

Use of a Swan-Ganz catheter to measure simultaneous LV and aortic pressures has also been reported. In this approach, a Swan-Ganz catheter is exchanged for the JR 4.0 catheter into the LV. Measurements are made from the distal port in the LV and proximal port in the ascending aorta;¹⁴ however, difficulties can arise when passing this catheter into the LV and the fidelity of the pressure tracings may be inferior.

Conclusion

Various methods to simultaneously measure aortic and left ventricular pressures have been described. The use of a Twin-Pass catheter with a 6 Fr coronary guiding catheter over an .014-inch coronary wire is a feasible, accurate, and elegant approach, allowing for precisely positioned, invasive evaluation of aortic valve stenosis and left ventricular outflow pressure gradients, as well as intracavitary obstructive gradients. ■

References

1. Vanichsarn C, Siegel RJ. Fool me once, fool me twice: hypertrophic cardiomyopathy with aortic stenosis. *Am J Med.* 2015; 128(10): 1076-1079. doi: 10.1016/j.amjmed.2015.05.003
2. Gersh BJ, Maron BJ, Bonow RO, et al. 2011 ACCF/AHA guideline for the diagnosis and treatment of hypertrophic cardiomyopathy: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation.* 2011;124(24): 2761-2796. doi: 10.1161/CIR.0b013e318223e230
3. Ommen SR, Mital S, Burke MA, et al. 2020 AHA/ACC guideline for the diagnosis and treatment of patients with hypertrophic cardiomyopathy: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *J Thorac Cardiovasc Surg.* 2021; 162(1): e23-e106. doi: 10.1161/CIR.0000000000000938
4. Baumgartner H, Hung J, Bermejo J, et al. Recommendations on the echocardiographic assessment of aortic valve stenosis: a Focused update from the European Association of Cardiovascular Imaging and the American Society of Echocardiography. *J Am Soc Echocardiogr.* 2017; 30(4): 372-392. doi: 10.1016/j.echo.2017.02.009
5. Saikrishnan N, Kumar G, Sawaya FJ, et al. Accurate assessment of aortic stenosis: a review of diagnostic modalities and hemodynamics. *Circulation.* 2014; 129(2): 244-253. doi: 10.1161/CIRCULATIONAHA.113.002310
6. Bradaric C. Simultaneous measurement of differential pressures with a dual lumen catheter. *Cardiac Interventions Today.* 2019; (3): 25-27. <https://citoday.com/articles/2019-mar-apr/simultaneous-measurement-of-differential-pressures-with-a-dual-lumen-catheter>
7. U.S. FDA. Vascular Solutions, Inc. recalls Langston dual lumen catheter due to risk of separation during use. April 30, 2020. <https://www.fda.gov/medical-devices/medical-device-recalls/vascular-solutions-inc-recalls-langston-dual-lumen-catheter-due-risk-separation-during-use>
8. Kern MJ. The Langston is gone for now (no more dual lumen pigtail for aortic valve assessment). Now what? *Cath Lab Digest.* 2021 Apr; 29(4): 6-10. <https://www.hmpgloballearningnetwork.com/site/cathlab/content/langston-gone-now-no-more-dual-lumen-pigtail-aortic-valve-assessment-now-what-includes-video-discussion>
9. Carabello BA, Barry WH, Grossman W. Changes in arterial pressure during left heart pullback in patients with aortic stenosis: a sign of severe aortic stenosis. *Am J Cardiol.* 1979; 44(3): 424-427. doi: 10.1016/0002-9149(79)90391-6
10. Nishimura RA, Carabello BA. Hemodynamics in the cardiac catheterization laboratory of the 21st century. *Circulation.* 2012; 125(17): 2138-2150. doi: 10.1161/CIRCULATIONAHA.111.060319
11. Bae JH, Lerman A, Yang E, et al. Feasibility of a pressure wire and single arterial puncture for assessing aortic valve area in patients with aortic stenosis. *J Invasive Cardiol.* 2006; 18(8): 359-362.
12. Satuluri P, Makam K, Sabatini MJ, et al. Life without Langston! Simultaneous LV and aortic pressure measurements with single arterial access. *Cath Lab Digest.* 2021; 29(3): 1, 23. <https://www.hmp-globallearningnetwork.com/site/cathlab/content/life-without-langston-simultaneous-lv-and-aortic-pressure-measurements-single-arterial-access>
13. Katz S, Bush MC, Tereso LS, et al. Mother-and-child technique for aortic stenosis. *Cath Lab Digest.* 2021; 29(12): 38-39. <https://www.hmpgloballearningnetwork.com/site/cathlab/suggested-technique/mother-and-child-technique-aortic-stenosis>
14. Garg J, Tyagi S, Allana S. Assessing transvalvular aortic gradient with Swan-Ganz catheter. *JACC Cardiovasc Interv.* 2021; 14(11): e123-e124. doi: 10.1016/j.jcin.2021.03.014

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