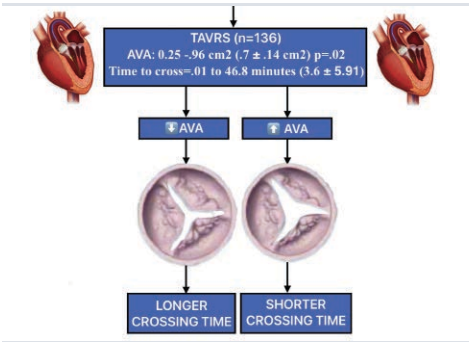
Cath Lab Digest

A product, news & clinical update for the cardiac catheterization laboratory specialist



TAVR

Aortic Valve Area and Time to Cross the Aortic Valve in Severe Aortic Stenosis During Transfemoral Transcatheter Aortic Valve Replacement

Richard Casazza, MAS; Joshua Fogel, PhD; Jacob Shani, MD

Abstract

Objective: Aortic valve area (AVA) may delay time to cross the aortic valve (AV) during transcatheter aortic valve replacement (TAVR). We study the association of AVA with time to cross stenotic AVs during TAVR.

Methods: We studied 136 patients at a single center with severe aortic stenosis undergoing TAVR. Time to cross the AV was defined as the amount of time the operator was on fluoroscopy from the beginning of trying to cross the AV to the actual crossing of the AV with the catheter. Covariates included age, sex, body mass index, body surface area, valve orientation, and operator specialization.

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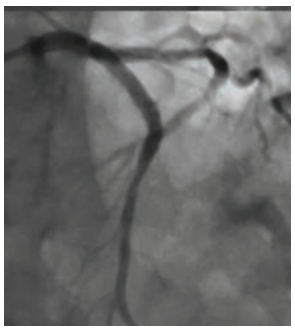
CORONARY IVL

Cracking Calcium on a Cliff-Hanger: Intravascular Lithotripsy for High-Risk Left Main PCI in STEMI



CLD talks with Dr. Kalaivani Mahadevan, MD, and Prof. James C. Spratt, BSc, MB ChB, MD.

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LEFT ATRIAL APPENDAGE CLOSURE

Delayed Pericardial Effusion Following Left Atrial Appendage Closure: A 5-Year Single-Center Experience

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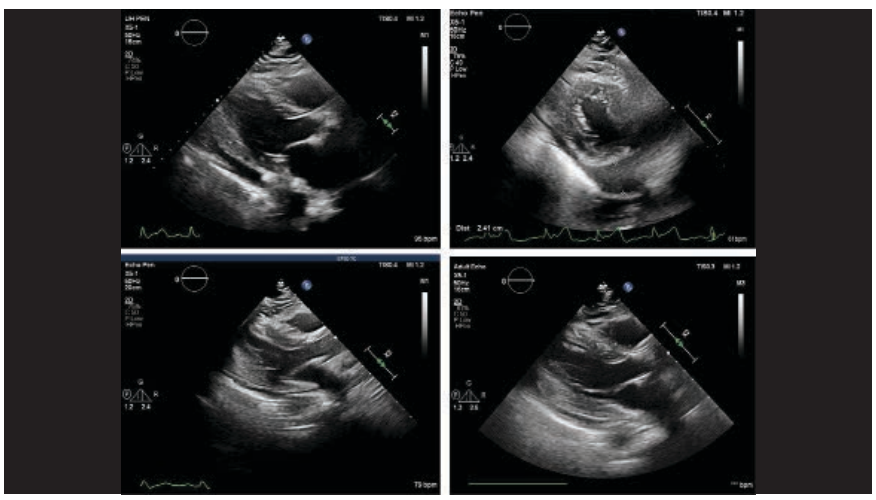

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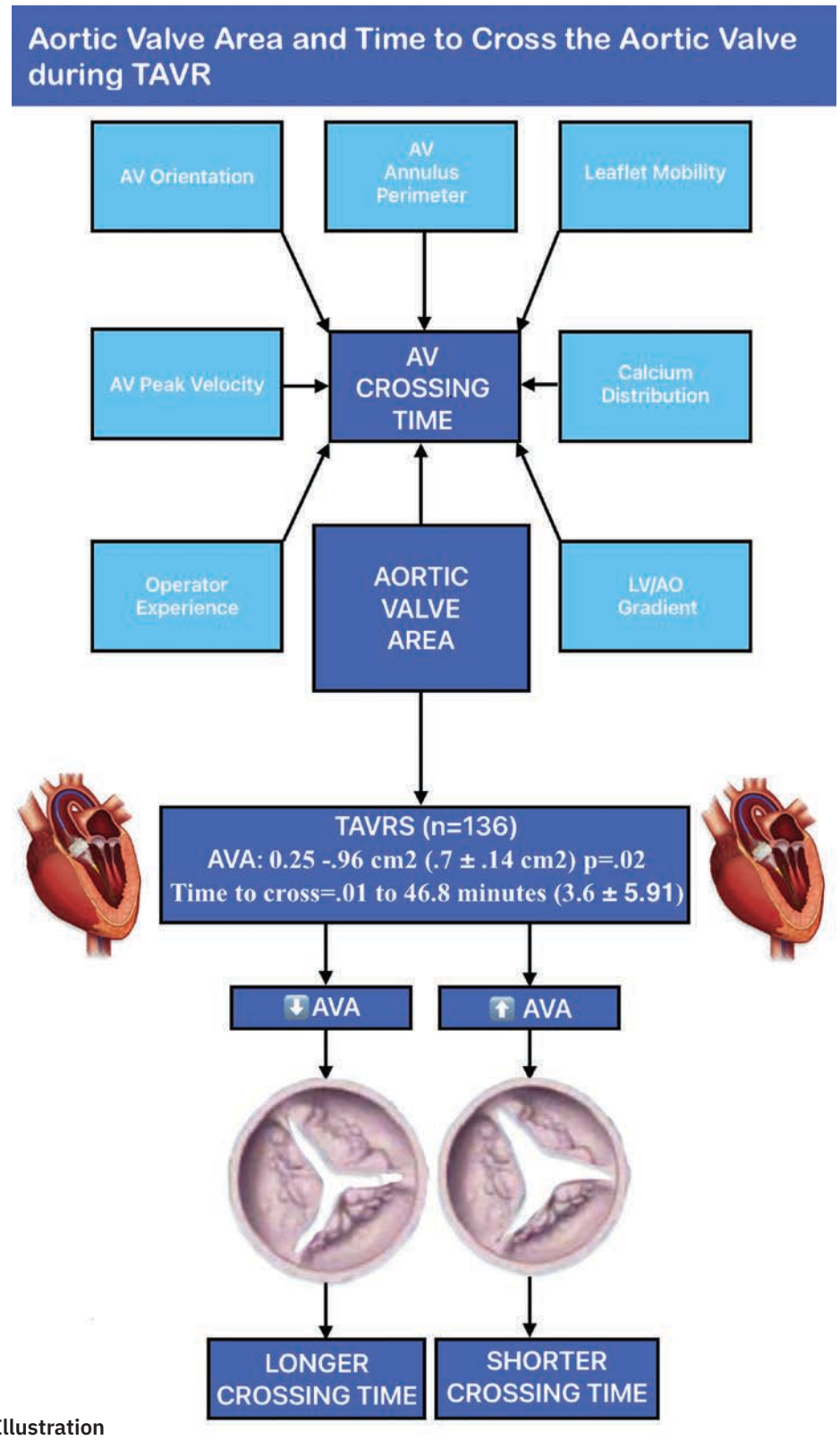
Aortic Valve Area and Time to Cross the Aortic Valve in Severe Aortic Stenosis During Transfemoral Transcatheter Aortic Valve Replacement

Richard Casazza, MAS; Joshua Fogel, PhD; Jacob Shani, MD



Central Illustration

Results: Time to cross the AV ranged from 0.01 to 46.8 minutes (M=3.6, SD=5.91 minutes). AVA ranged 0.25 cm^2-0.96 cm^2 (M=0.7, SD=0.14 cm^2). A multivariate partial correlation analysis found that increased AVA was significantly associated with decreased time to cross the AV (r=-0.22, *P*=.01).

Conclusion: Smaller AVA in patients with aortic stenosis are significantly associated with increased time to cross the AV. We recommend operators be aware that in patients with smaller AVA, TAVR procedures may be prolonged and lead to assorted catheter selection and unconventional approaches to cross stenotic AVs.

Approximately 1.5 million people in the United States have aortic stenosis (AS). Within that population, approximately 500,000 have severe AS, and approximately 250,000 people with severe AS are symptomatic.[1] Transcatheter aortic valve replacement (TAVR) use exceeds all other types of surgical aortic valve replacement.[2] Furthermore, a clinical trial showed that TAVR is noninferior and may be superior to surgical aortic valve replacement for mortality, stroke, and rehospitalization.[3]

Crossing the aortic valve (AV) is an essential part of the TAVR procedure.[4] One study using a Judkins catheter (JR4) reported the vast majority of the AVs were crossed in less than two minutes.[5] Another study using a pigtail catheter had an 86% success rate and AV mean crossing time was 48.2 seconds.[6] Others found that a diastolic phenomenon approach had 100% success for crossing the AV.[7] Although the typical approach is to use the pigtail or Amplatz 1 catheter and an .035 straight wire for AV crossing,[8] some valves are extremely difficult to cross and operators have even used coronary guide catheters and .014 wires as a last-ditch effort to cross stenotic AVs.[9]

One small study reported that AV peak velocity and a larger aortic annulus perimeter are associated with shorter AV crossing times, while aortic valve area (AVA) was not associated with AV crossing time.8 This study included 35 patients and its two groups had one group with 6 patients and the other with 29 patients, possibly underpowered for analyzing AVA and time to cross the AV. Problems crossing the AV can increase procedural times and lead to complications.[10] We study the association of AVA with time to cross the AV during TAVR for patients with severe AS.

Methods

Setting. This is a retrospective, observational, single-center study conducted at Maimonides Medical Center, located in Brooklyn, New York, United States. All consecutive transfemoral TAVR procedures for those with severe aortic stenosis (<1.0 cm^2) from September 2017 through October 2019 were included. The study protocol was approved by the hospital institutional review board.

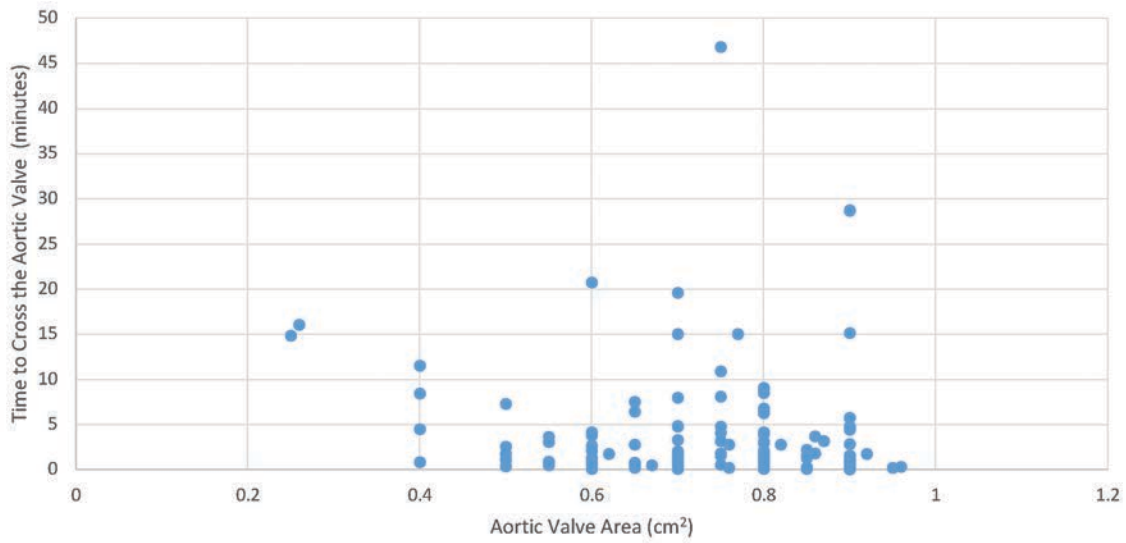


Figure 1. Scatter plot of aortic valve area and time to cross the aortic valve.
Note: Non-logarithmic values for time are shown for ease of understanding.

A waiver for informed consent was obtained due to the retrospective nature of the study.

Procedure. Access site and valve type were decided by the structural heart team based on imaging studies and patient clinical factors. All AVs were evaluated prior to TAVR with transthoracic echocardiography. Interventional cardiologists, cardiac surgeons, and imaging specialists were part of the structural heart team. The operator standing in the first position and performing most of the procedure was considered the primary operator. All procedures were performed in a standard fashion in a hybrid operating room under fluoroscopic and echocardiography imaging guidance. Edwards Sapien 3 valves and Medtronic Evolut R/Evolut Pro valves were used.

All primary operators crossed the AV. Time to cross the AV was defined as the amount of time the operator was on fluoroscopy from the beginning of trying to cross the AV to the actual crossing of the AV with the catheter. Operators used various catheters according to individual preference. Catheter choices were the Cordis 110 cm pigtail catheter, Amplatz-shaped catheters (AL1, AL2, AL3, AR1), Judkins-shaped catheters (JL4, JR4), and the multipurpose 1 shaped catheter. All operators used an Argon .035 straight-tip wire. The standard technique involved a crossing timer that would start when fluoroscopy was on, beginning at the initial attempt to cross. If operators attempted to cross with a catheter and a .035 J-wire from initial catheter introduction into a femoral sheath, the timer would start when catheter and wire were positioned just above the aortic valve and crossing attempts commenced. Any time operators switched catheters or wires that required stepping off the fluoroscopic pedal, the timer would stop. The timer would restart when the operator stepped back on the fluoroscopic pedal to commence crossing the AV. The timer would stop and complete the crossing time when the shuttling catheter crossed the AV into the left ventricle.

Variables. The main predictor variable was AVA (cm^2) measured by transesophageal echocardiogram. Demographic variables included age (years), sex (male/female), body mass index (kg/m^2), and body surface area (m^2). We recorded horizontal valve orientation (no / yes) and operator specialization (interventional cardiologist or cardiothoracic surgeon). The outcome variable of time to cross the AV was measured in minutes.

Statistical Analysis. Mean and standard deviation were used to describe the continuous variables. Frequency and percentage were used to describe the categorical variables. Pearson correlation analysis, multivariate partial correlation analysis, and multivariate linear regression analysis were performed. Time to cross the AV was logarithmic transformed due to presence of skewness. All p-values were two tailed with alpha level for significance at $P<.05$. IBM SPSS Statistics version 29 was used for all analyses (IBM Corporation, 2022).

Results

We studied 136 patients undergoing TAVR. Mean age was 81.0 years, with greater than half of participants female. Mean AVA was 0.8 cm^2 (range: 0.25 cm^2 – 1.7 cm^2). Mean time to cross the AV was 3.6 minutes (range: 0.01 to 46.8 minutes). Interventional cardiologists crossed almost all the valves (91.9%). The most common catheter type used was pigtail (70.6%). Less than 10% of patients had horizontal valve orientation. Body mass index mean was 29.3 kg/m^2 and body surface area mean was 1.8 m^2. Sample characteristics are displayed on Table 1.

Figure 1 shows the scatter plot of AVA with time to cross the AV. A Pearson correlation analysis of AVA with time to cross the AV had a statistically significant negative correlation (r=-0.22, P=.01). Multivariate linear regression analysis (Table 2) was performed for the time to cross the AV. A larger AVA was statistically significantly associated with decreased time to cross the AV (P=.02). None of the demographic variables, valve orientation, or operator specialization were significantly associated with time to cross the AV. However, the overall analysis of variance was not statistically significant, which precluded interpretation of the regression coefficient output. A multivariate partial correlation analysis of AVA with time to cross the AV that adjusted for the covariates included in the linear regression analysis also had a statistically significant negative correlation (r=-0.22, P=.01).

TABLE 1. Sample characteristics of aortic stenosis patients receiving transcatheter aortic valve replacement.

Variables	M (SD) or # (%) (n=136)
Age (years)	81.0 (7.50)
Sex (female)	80 (58.8)
Body mass index (kg/m^2)	29.3 (6.89)
Body surface area (m^2)	1.8 (0.23)
Horizontal valve orientation (yes)	13 (9.6)
Surgeon	
Interventional	125 (91.9)
Cardiothoracic	11 (8.1)
Aortic valve area (cm^2)	0.7 (0.14)
Time to cross the aortic valve (minutes)	3.6 (5.91)
Catheter type	
AL1, AL2, AL3, AR1	29 (21.3)
JL4	2 (1.5)
JR4	9 (6.6)
PIG	96 (70.6)

M = mean, SD = standard deviation.
PIG = Cordis 110 cm pigtail catheter,
AL1, AL2, AL3, AR1 = Amplatz-shaped catheters,
JL4, JR4 = Judkins-shaped catheters.

Discussion

Our study demonstrated that larger AVA in patients with AS was statistically significantly associated with decreased time to cross the AV. Patient demographic variables were not significantly associated with time to cross the AV. Valve orientation or operator specialization were not significantly associated with time to cross the AV. A previous very small sample size study reported no association of AVA with time to cross the AV.[9] Our larger sample size study differs from this pattern. We suggest that mechanistically our findings make

TABLE 2. Multivariate linear regression analysis for time to cross the aortic valve.

Variables	B (SE)	*p*-value
Age (years)	-0.002 (0.01)	0.85
Sex (female)	0.03 (0.15)	0.87
Body mass index (kg/m^2)	-0.002 (0.01)	0.88
Body surface area (m^2)	-0.32 (0.41)	0.44
Horizontal valve orientation (yes)	0.38 (0.21)	0.07
Surgeon		
Interventional	Reference	
Cardiothoracic	0.01 (0.22)	0.97
Aortic valve area (cm^2)	-1.07 (0.43)	0.01
Intercept	1.64 (1.16)	0.16

M = mean, SD = standard deviation. PIG = Cordis 110 cm pigtail catheter, AL1, AL2, AL3, AR1 = Amplatz-shaped catheters, JL4, JR4 = Judkins-shaped catheters.

sense, as a larger valve orifice should provide a larger "window" for operators to pass wires and catheters into the left ventricle, which should reduce the procedural time.

It is important to minimize AV crossing times. An exceedingly long AV crossing time can lead to longer procedural times and poor turnover. It is also possible that in institutions with only one hybrid operating room or cardiac catheterization laboratory dedicated for TAVR, this may lead to subsequent patients being scheduled later into the afternoon/night and possibly to a later date, based on room availability. Longer AV crossing times may also lead to increased risk of procedural complications such as coronary artery dissection, cerebral embolism, left ventricular perforation, aortic dissection, or hemopericardium.[10]

Crossing AVs is a critical skill set required for TAVR procedures. Several factors can come into play when crossing an AV. Aortic valve area, type of catheter, valve orientation, degree of calcification, operator experience, AV gradient, and systolic duration all can factor in to how long it may take to cross a stenotic AV. Conventional and unconventional techniques for crossing the AV have been described and utilized during clinical practice. However, crossing the AV in the cardiac catheterization laboratory (CCL) has diminished due to modern echocardiography techniques, while simultaneously, TAVR volumes have steadily increased. Although crossing AVs isn't a "lost art", crossing times, particularly for neophyte structural/TAVR operators may be affected due to the of lack of everyday practice in the CCL. It is essential that senior operators impart the requisite skills to junior operators as a result of the decline in the routine practice of crossing stenotic AVs. These methods can potentially increase efficiency and safety of TAVRs by allowing for improved AV crossing time and reducing patient complications.

Limitations. A strength of this study is that we are the first to find an association of AVA with time to cross the AV. This study has several limitations. First, the study originated from a single center and may not generalize to other centers. Second, almost all valves were crossed by experienced interventional cardiologists; the techniques performed may differ slightly from operator to operator, which may affect AV crossing times. Future research should consider evaluating the specific crossing techniques of each operator and resulting impact on time to cross the AV. Third, we did not measure aortic root size or aortic tortuosity. Future research should consider adjusting for these variables in a multivariate linear regression analysis. Fifth, we calculated overall time which includes time to cross with the wire and time to bring the catheter across the aortic valve. Future research could consider separate analyses for each of these timeframes in addition to overall time.

Conclusion

Smaller AVA in patients with aortic stenosis are significantly associated with increased time to cross the AV. We recommend operators be aware that in patients with a smaller AVA, TAVR procedures may be prolonged and lead to assorted catheter selection and unconventional approaches to cross stenotic AVs. ■

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Disclosures: The authors report no conflicts of interest regarding the content herein.

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