Advanced Imaging in Percutaneous Valve Intervention: *Transcatheter Aortic Valve Replacement as a Test Case*

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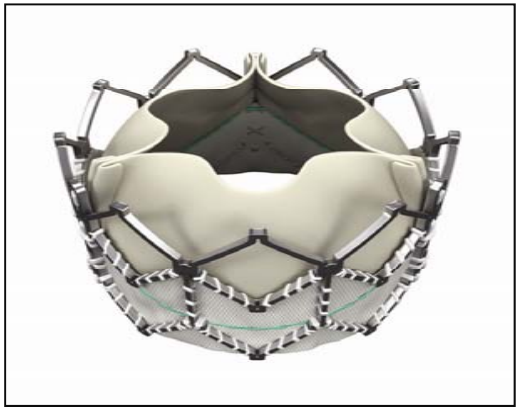
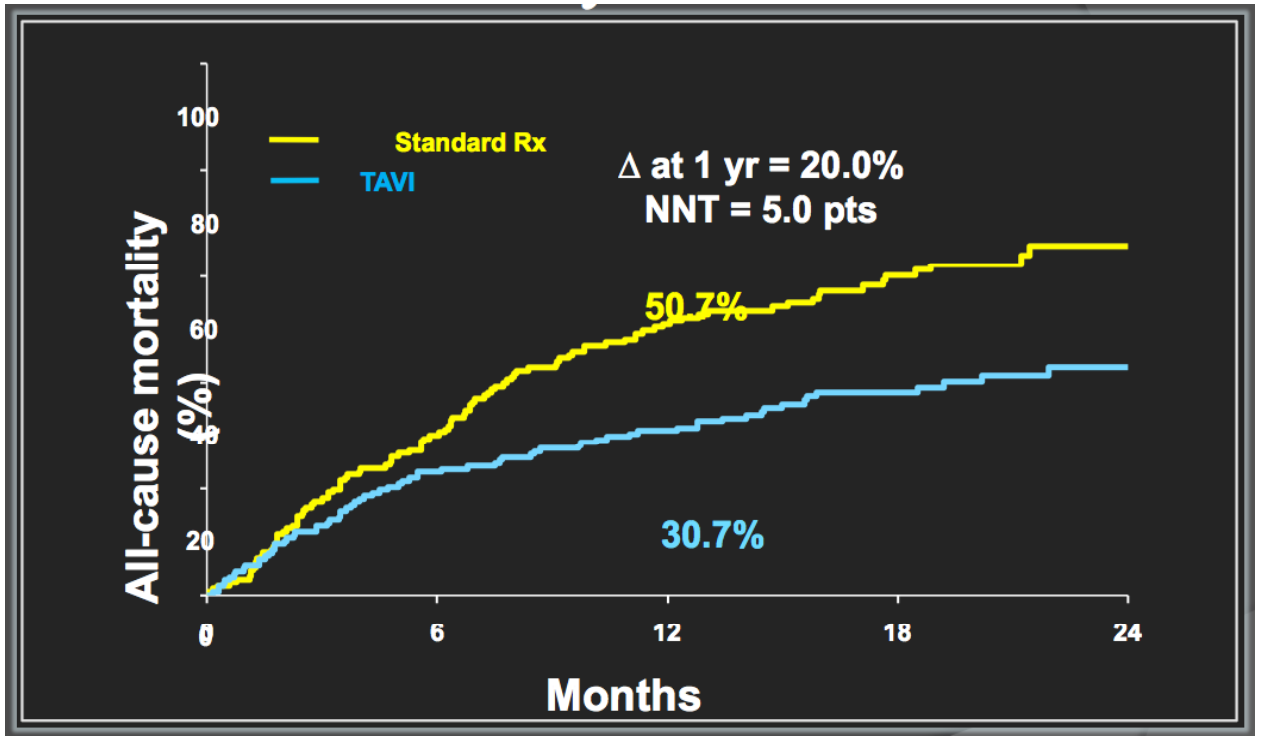
The NEW ENGLAND JOURNAL of MEDICINE



Transcatheter Aortic-Valve Implantation for Aortic Stenosis in Patients Who Cannot Undergo Surgery

Martin B. Leon, M.D., Craig R. Smith, M.D., Michael Mack, M.D., D. Craig Miller, M.D., Jeffrey W. Moses, M.D., Lars G. Svensson, M.D., Ph.D., E. Murat Tuzcu, M.D., John G. Webb, M.D., Gregory P. Fontana, M.D., Raj R. Makkar, M.D., David L. Brown, M.D., Peter C. Block, M.D., Robert A. Guyton, M.D.,



Leon MB, Smith CR, Mack M et al.
N Engl J Med 2010;363:1597-607

Multimodality Imaging in TAVR

- Multidisciplinary approach to optimizing TAVR related outcomes
- Optimal example of use of multimodality imaging –including transthoracic and transesophageal echocardiography; 3D echocardiography; multidetector CT (CT); and angiography – for optimizing TAVR related outcomes
- Pre-procedural performance of MDCT permits identification of patients who may qualify for **lower profile catheter delivery systems** and may **reduce the risk of TAVI-related complications**

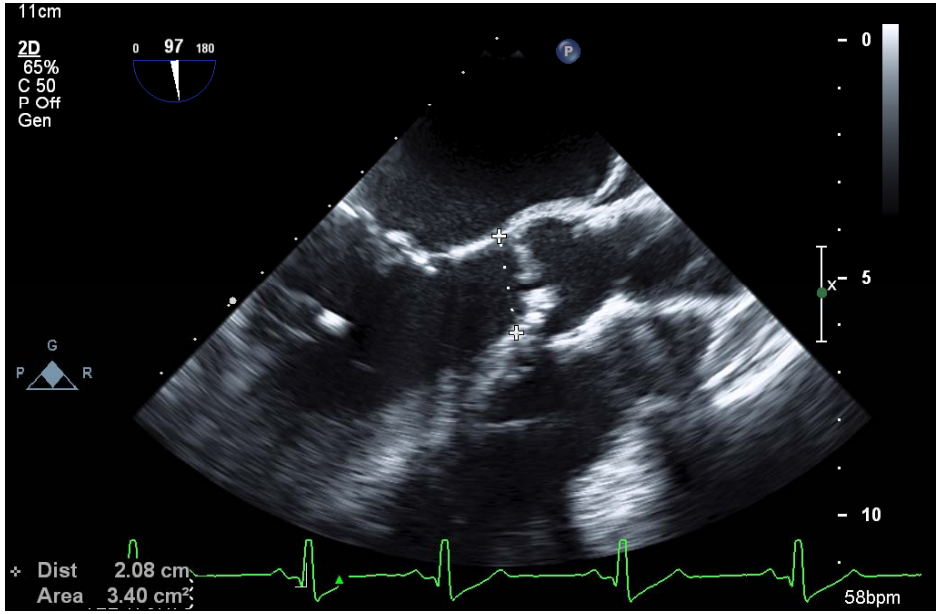
(1) 3D aortic annular and root morphology / dimension

Accurate measurement of the aortic annulus is essential for determining aortic prosthesis size

- Aortic valve prostheses for TAVR are designed for specific aortic annular sizes

- Aortic annular measurements for TAVI rely upon imaging, traditionally by:
  1. Transthoracic echocardiography (TTE)
  2. Transesophageal echocardiography (TEE)
  3. Aortic angiography

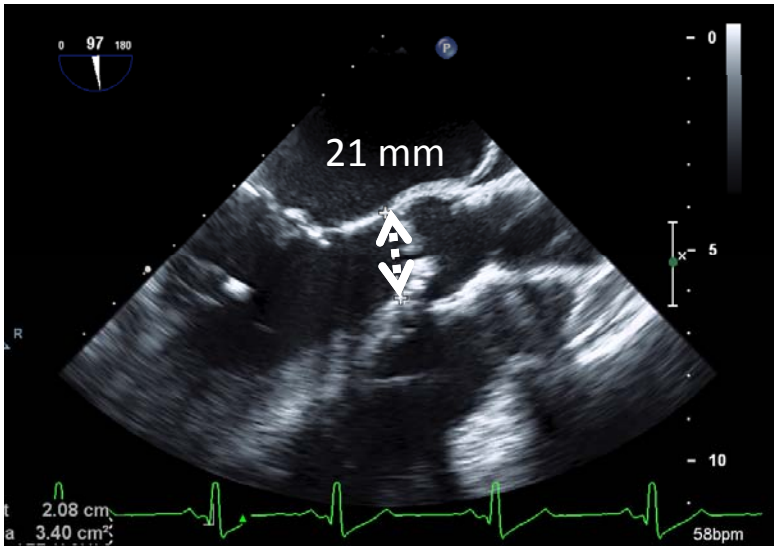
THERE IS OFTEN DISCORDANCE BETWEEN ANNULAR DIMENSIONS BY MDCT VERSUS ECHO

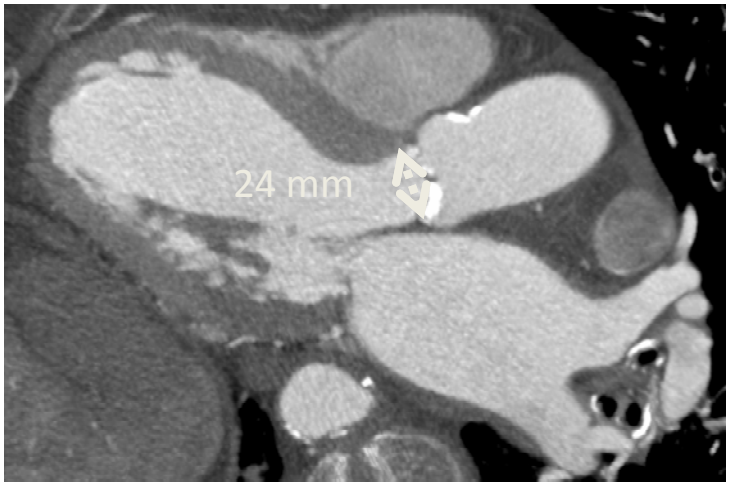


- ECG-gated MDCT observes generally **larger annular sizes** than either TTE or TEE

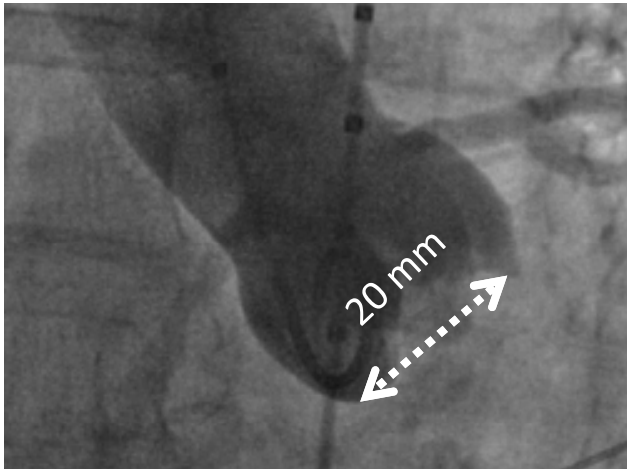
Example: Pre-procedural and peri-procedural annular measurements vary between 17-24 mm

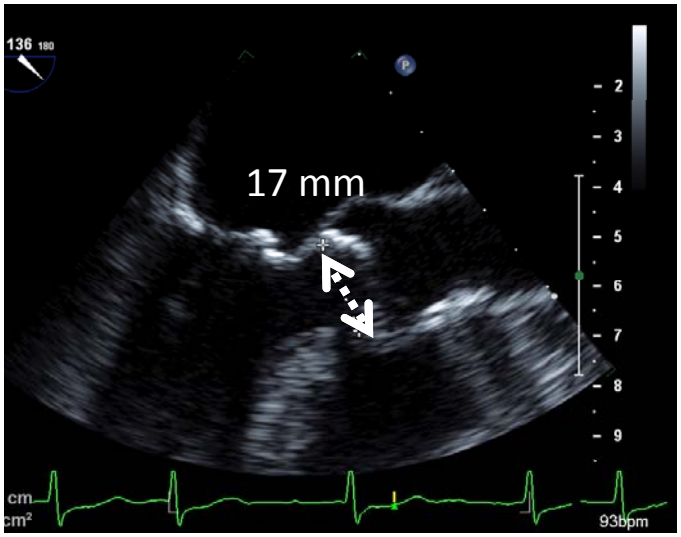
PRE-PROCEDURAL EVALUATION



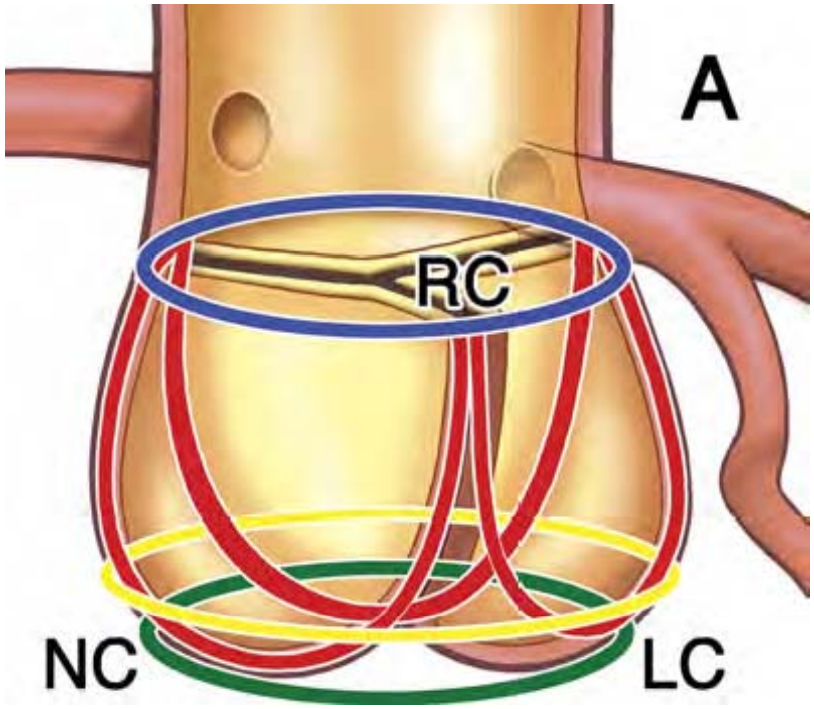


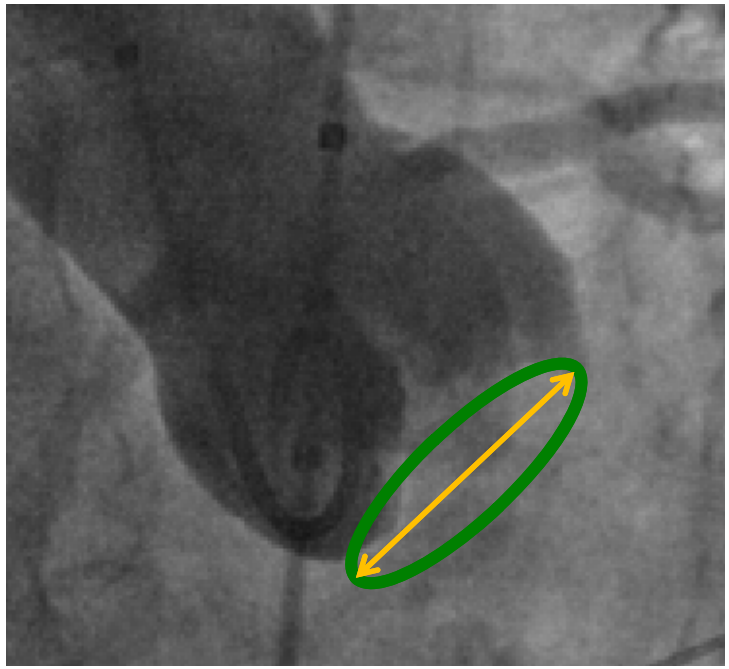
PERI-PROCEDURAL EVALUATION





The Virtual Basal Ring: What are we trying to measure?





Sinotubular junction

Aortic leaflets

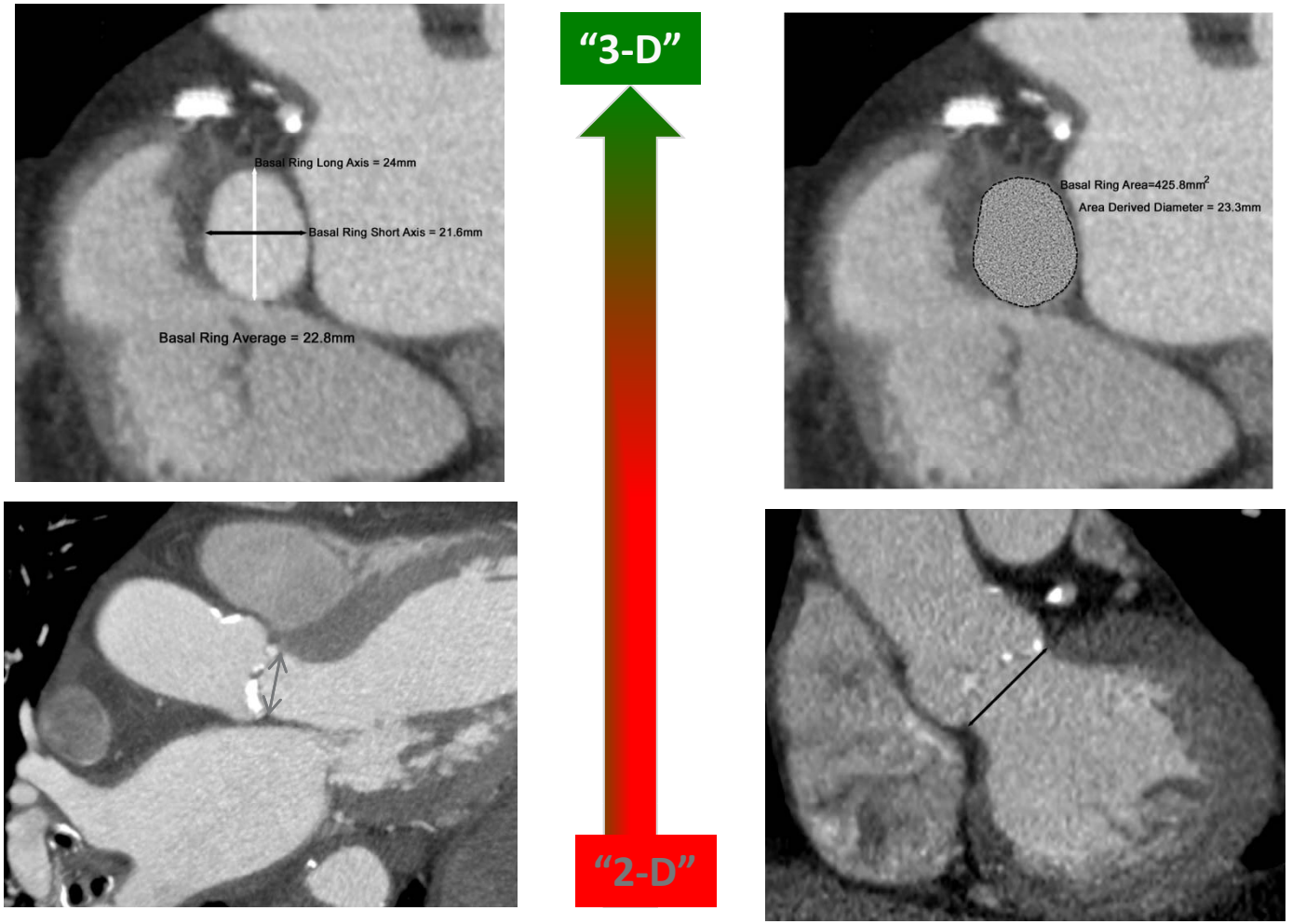
Aortic Annulus

Aortic Annular Diameter

RC = Right coronary cusp; NC = Non-coronary cusp; LC = Left coronary cusp

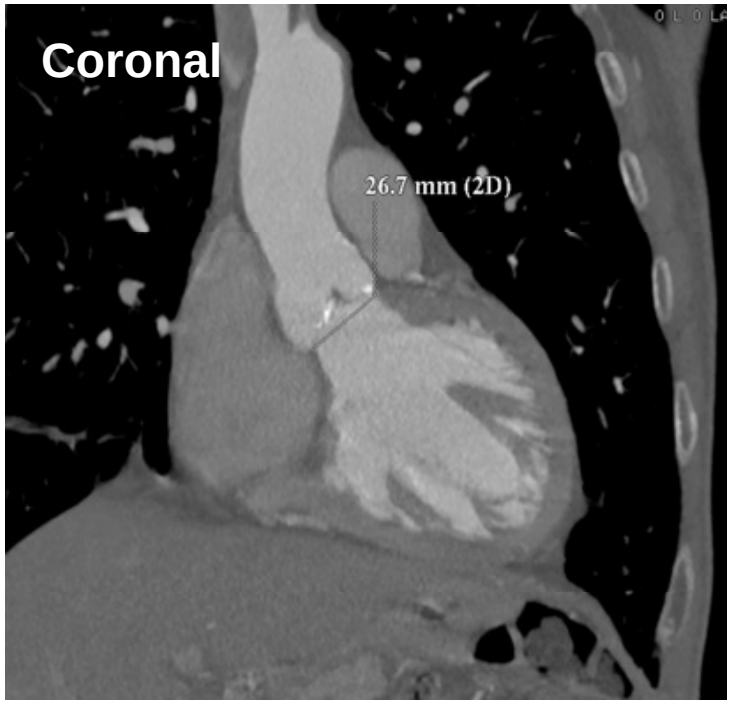
Source: Leipsic et al JACC Img April 2011

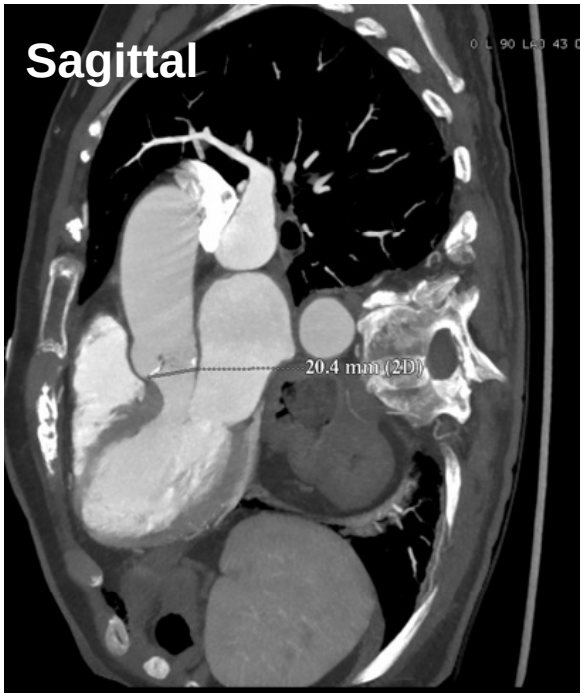
Advantages *to MDCT methods*



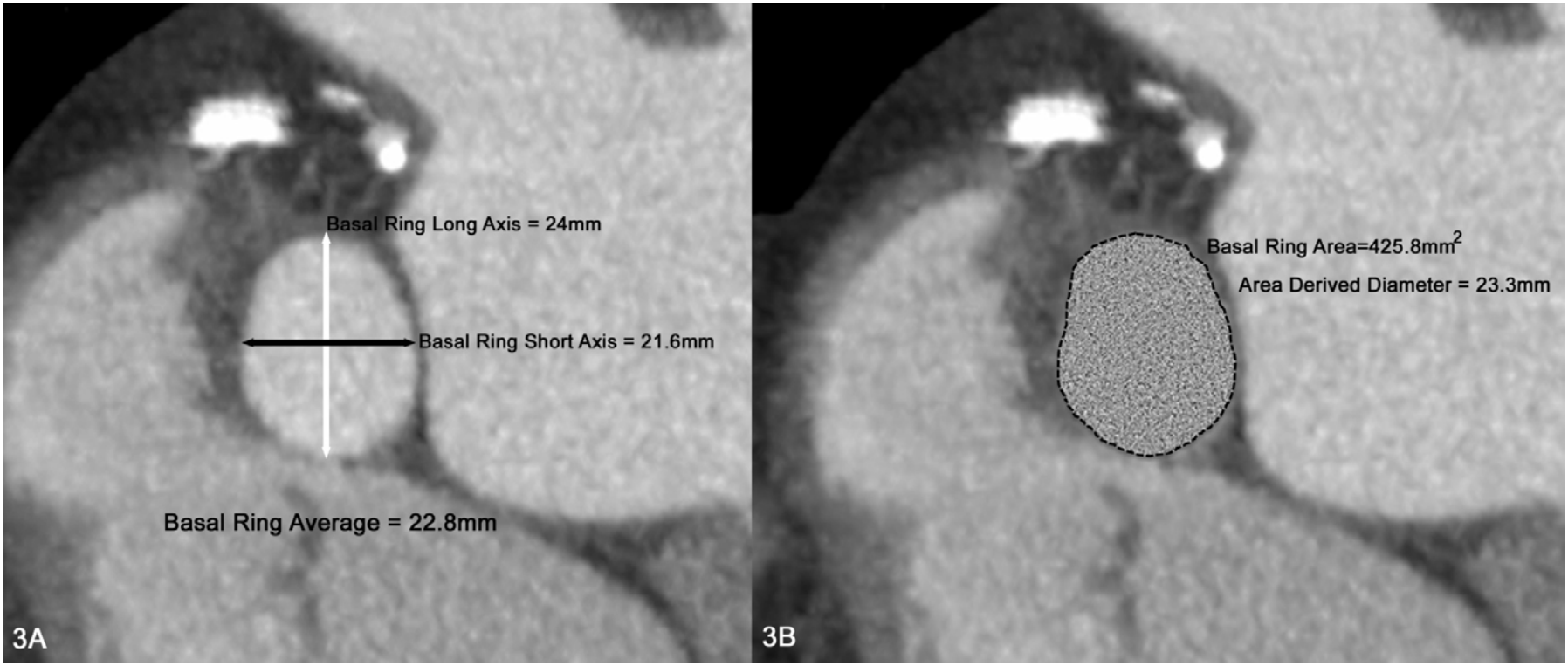
Numerous methods for measurement of the aortic annulus

- Initial published reports: ***Coronal and sagittal measurements differ substantially depending on the obliquity of the aortic root plane***
- ❖ Theoretical or Actual?: Greater reproducibility; Less sensitive to minor changes in obliquity'





Aortic Annular Sizing:
Basal Ring Area-Derived Diameter

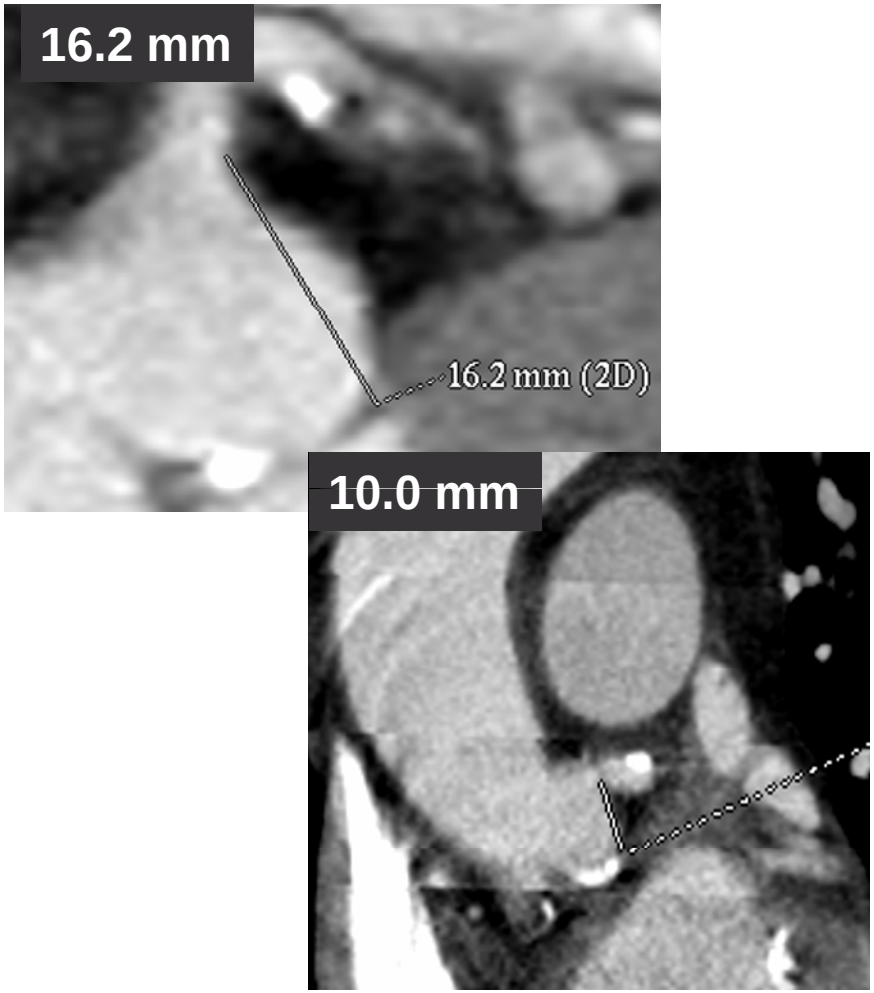


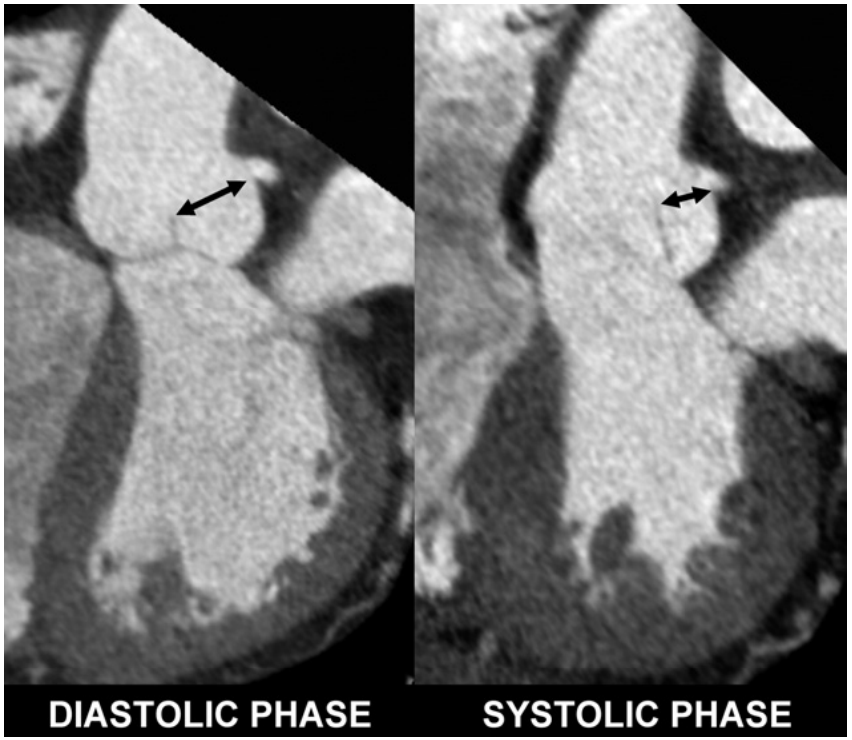
Calculation for the Area Derived Diameter

$$diameter = 2\sqrt{\frac{area}{\pi}}$$

(2) Relationship of AoV to coronary artery ostia

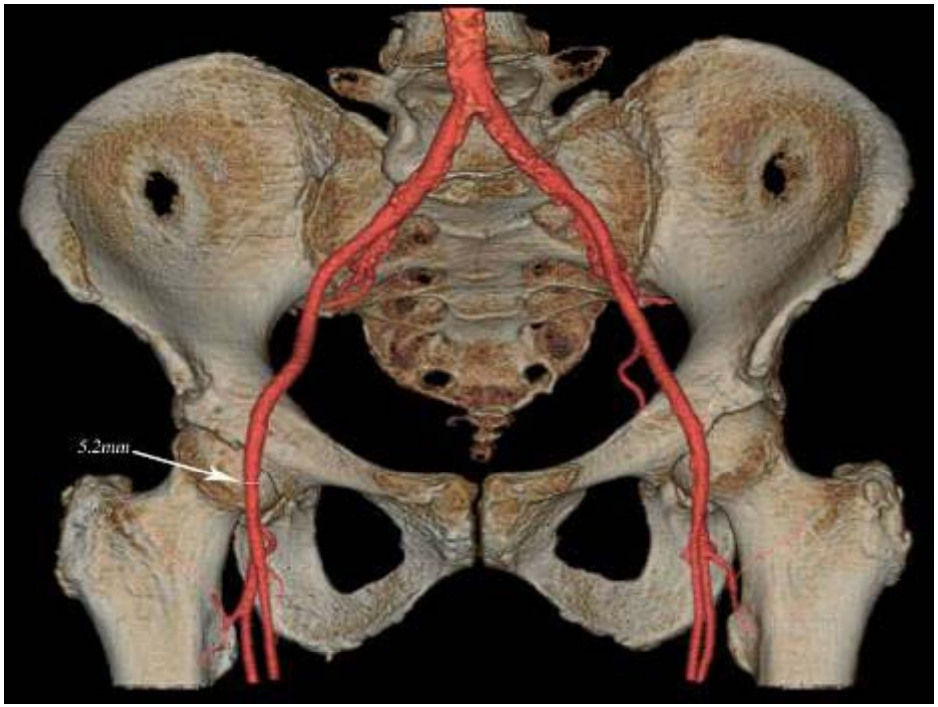
Left main height





(3) Aortoiliofemoral Arterial Assessment

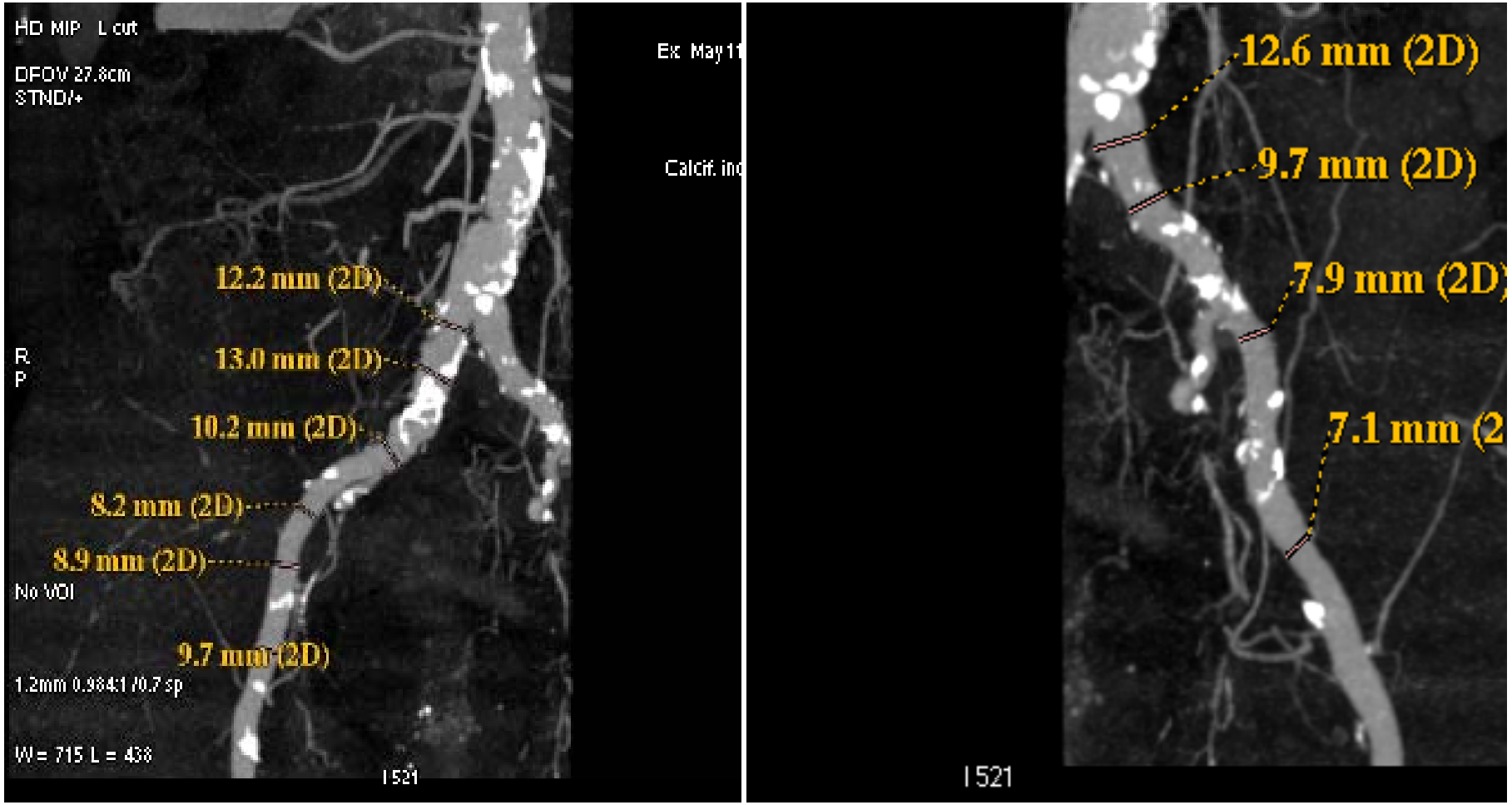
ILEOFEMORAL ASSESSMENT



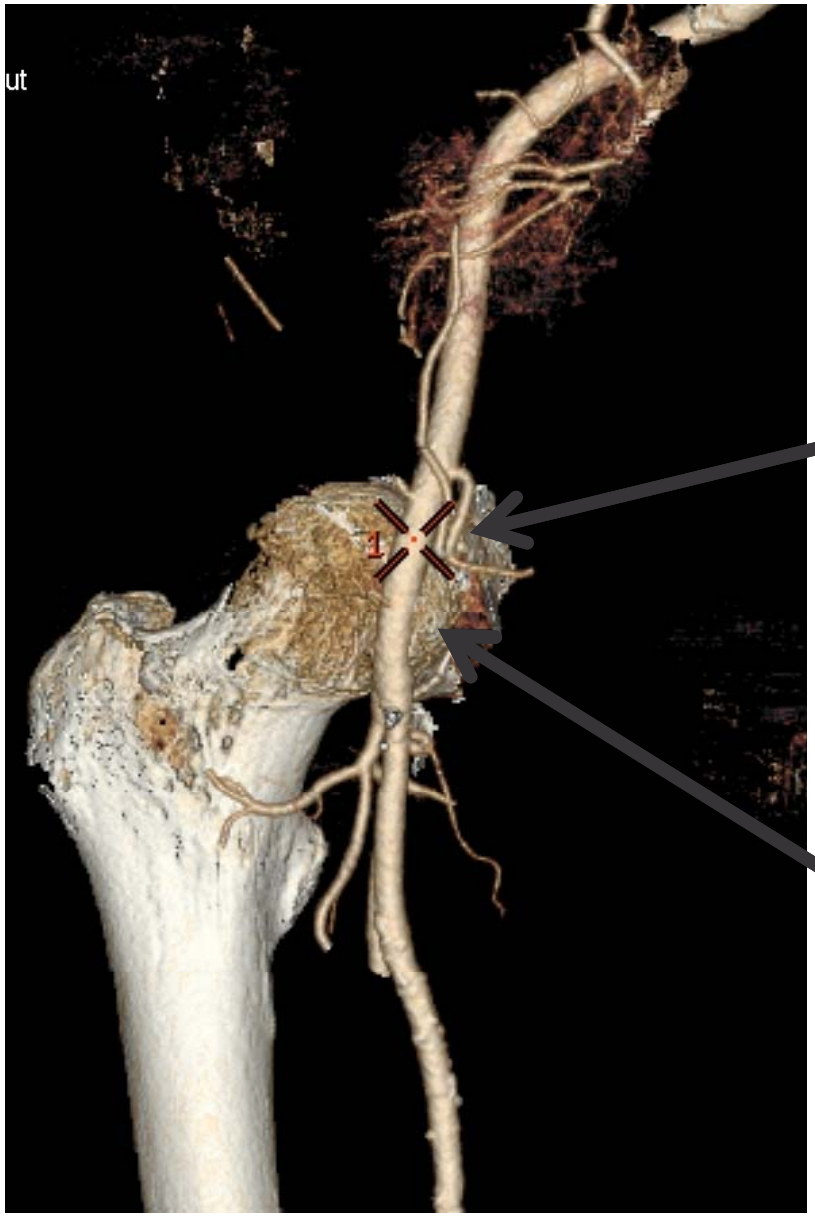
MDCT allows assessment of a greater breadth of pathologies and anatomical structures:

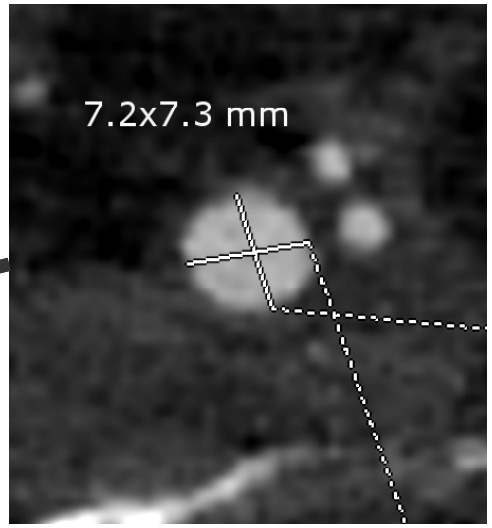
1. Complete 3D iliofemoral system (incl. DOSA MLD)
2. Tortuosity
3. Calcification
4. Atherosclerosis / stenosis
5. High-risk features (e.g., dissections and complex atheromas)

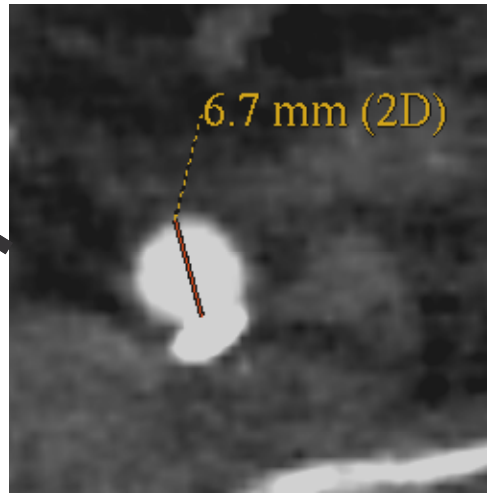
Iliofemoral Sizing



Artery Size







CT Screening Can Reduce your Vascular Access Complications

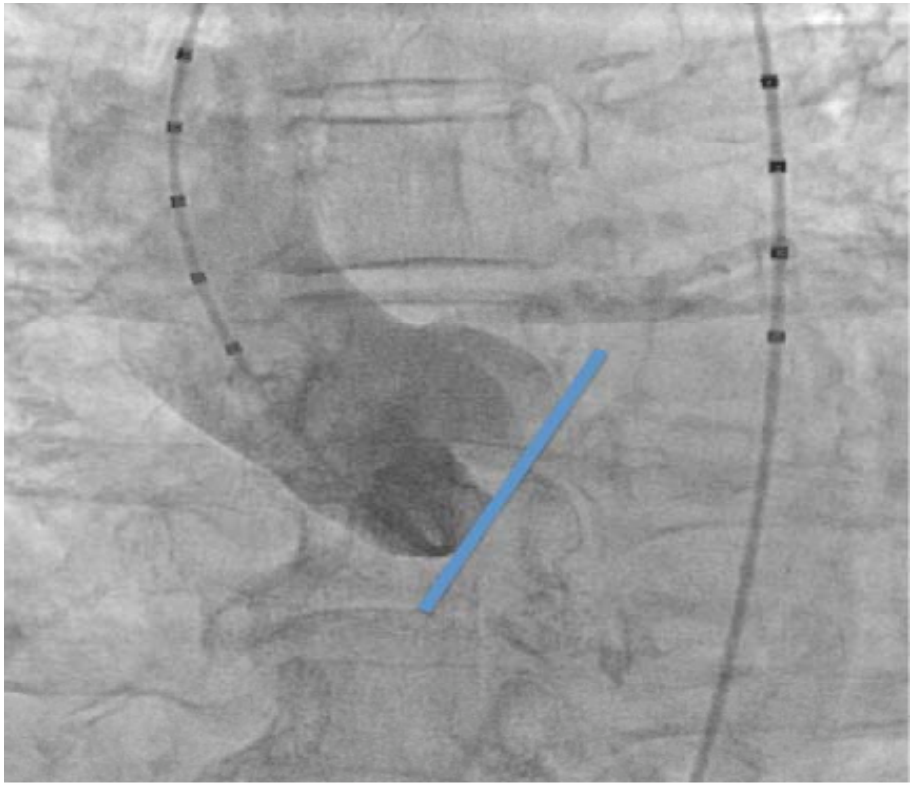
CT Screened Patients

Variable	No vascular complication n = 58	Vascular complication n = 8	P Value
Minimal lumen diameter (mean)	7.0	6.2	
Minimal diameter < sheath diameter, n (%)	23 (40%)	7 (83%)	0.02
Moderate or severe calcification, n (%)	9 (15%)	5 (42%)	0.04

Toggweiler S, Gurvitch R, Leipsic J et al . JACC Jan 2012

(4) Optimal angle for aortic valve deployment

Predict Co-axial Angle of Deployment

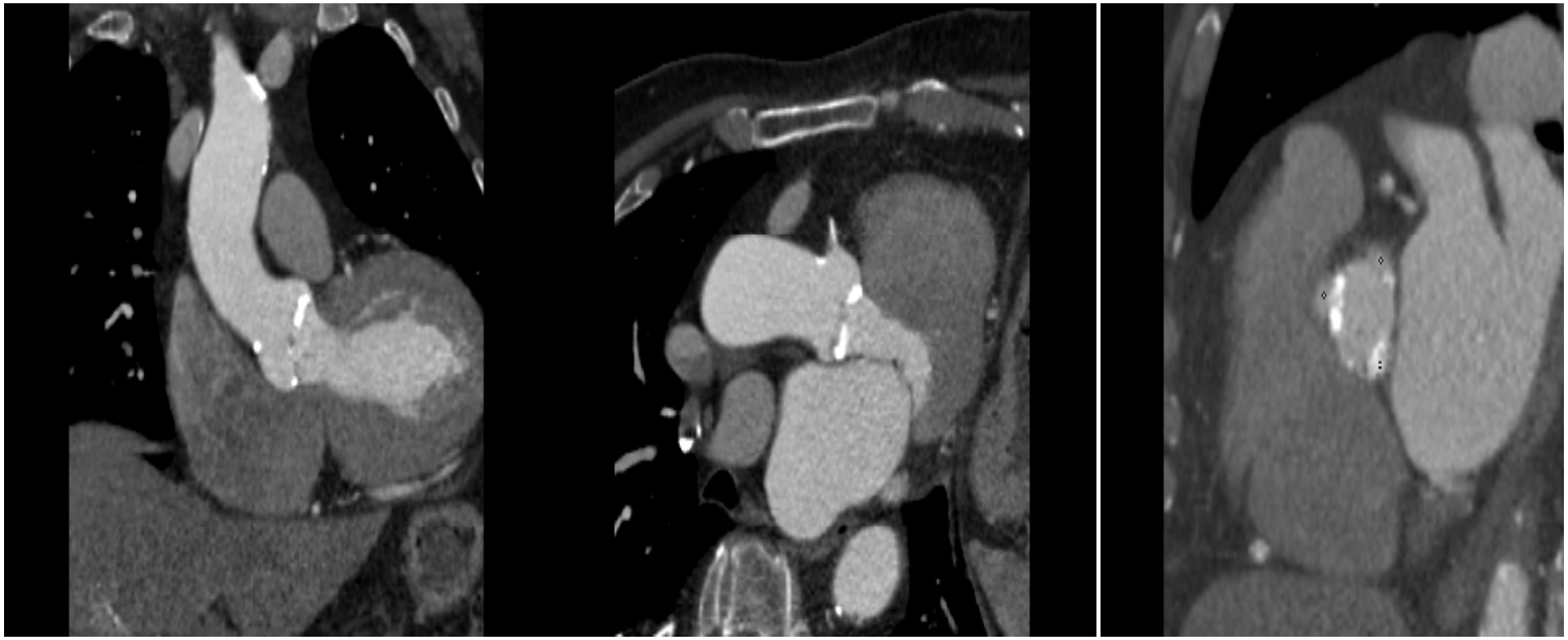


Find angiographic projections representing perpendicularity to the native valve plane in 3 axes:

1) AP cranial-caudal without RAO or LAO angulation
2) straight RAO to LAO as needed without cranial or caudal angulation
3) LAO 30^0 with cranial or caudal angulation as needed.

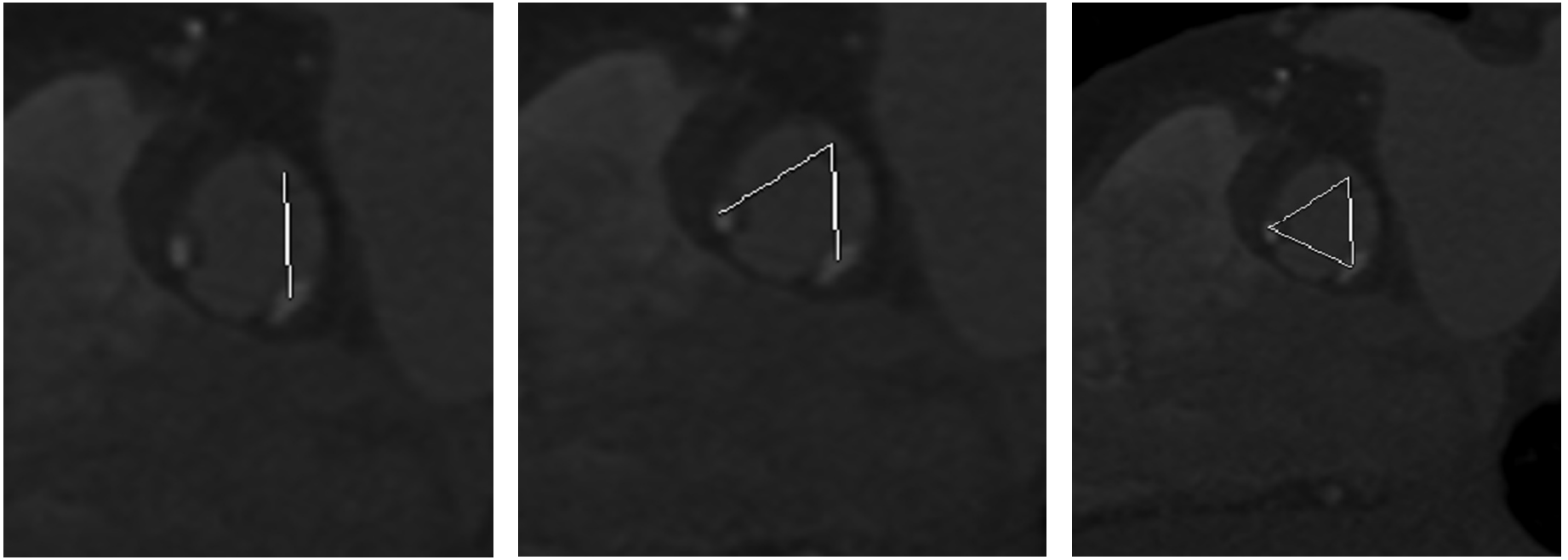
Axes chosen based on the preferred working angles in the catheterization lab

CT to Assist Valve Deployment

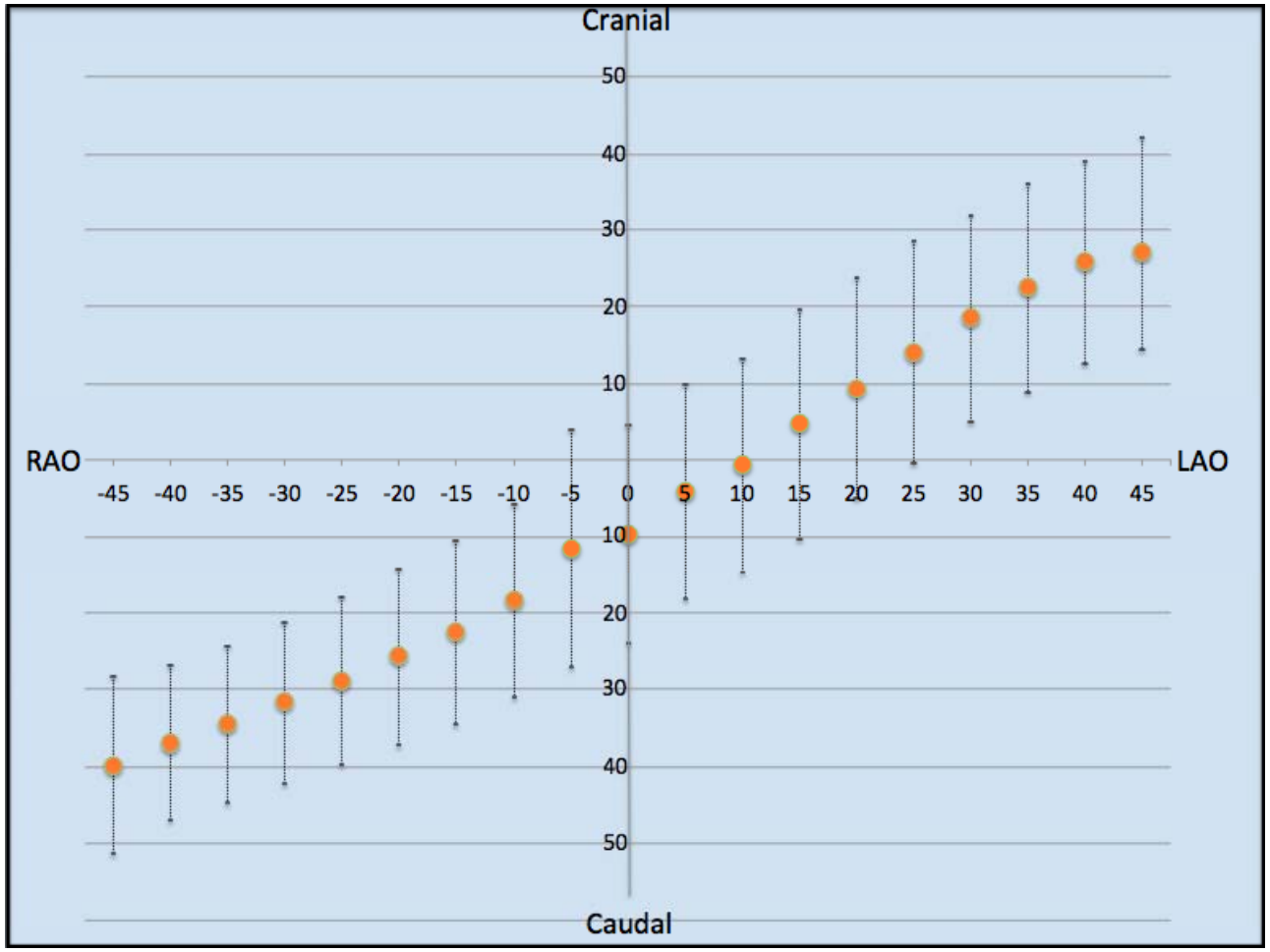


Gurvitch R, Wood D, Leipsic J et al. MSCT for the Determination of the Angle of Deployment for TAVR. JACC Interventions. Nov 2010

Connect the Dots



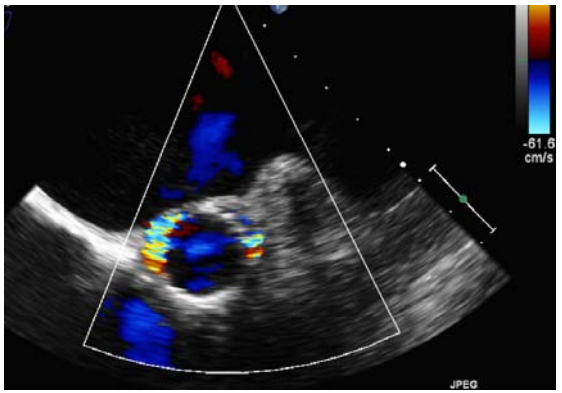
Line of Perpendicularity- Predicted Angles



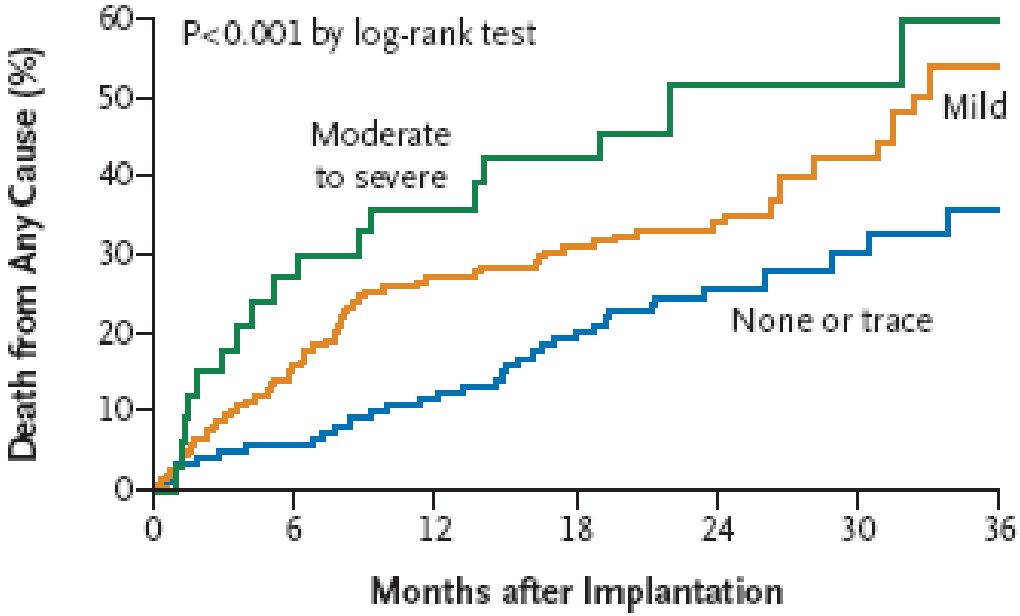
(5) Prediction of Post-TAVR Complications

Two-Year Outcomes after Transcatheter or Surgical Aortic-Valve Replacement

Susheel K. Kodali, M.D., Mathew R. Williams, M.D., Craig R. Smith, M.D., Lars G. Svensson, M.D., Ph.D., John G. Webb, M.D., Raj R. Makkar, M.D., Gregory P. Fontana, M.D., Todd M. Dewey, M.D., Vinod H. Thourani, M.D., Augusto D. Pichard, M.D., Michael Fischbein, M.D., Ph.D., Wilson Y. Szeto, M.D., Scott Lim, M.D., Kevin L. Greason, M.D., Paul S. Teirstein, M.D., S. Chris Malaisrie, M.D., Pamela S. Douglas, M.D., Rebecca T. Hahn, M.D., Brian Whisenant, M.D., Alan Zajarias, M.D., Duolao Wang, Ph.D., Jodi J. Akin, M.S., William N. Anderson, Ph.D., and Martin B. Leon, M.D., for the PARTNER Trial Investigators*

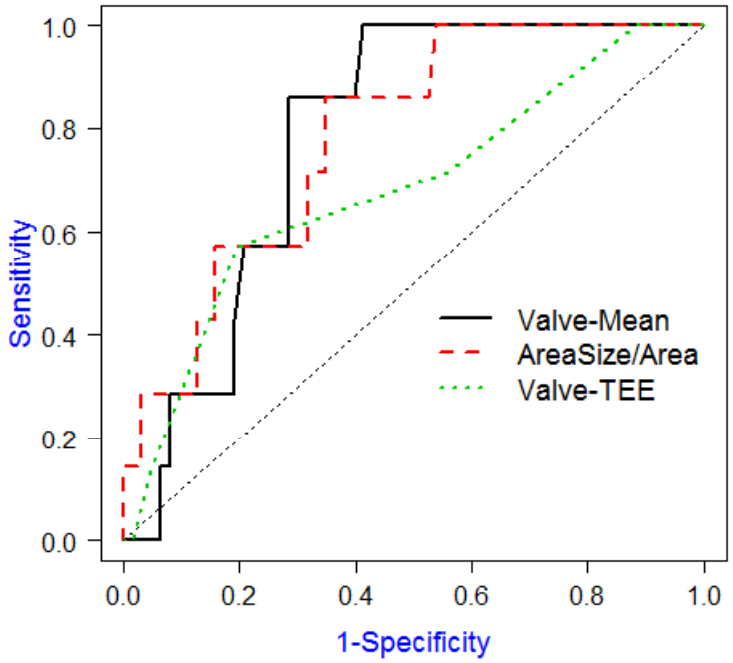


D Severity of Total Aortic Regurgitation: None or Trace, Mild, or Moderate to Severe

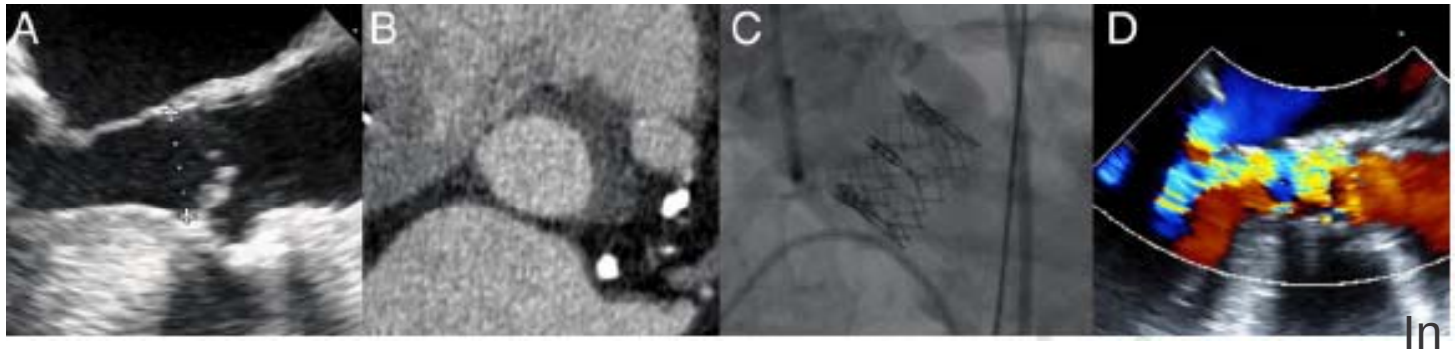


No. at Risk							
None or trace	125	117	108	95	64	29	10
Mild	162	136	118	109	70	31	15
Moderate to severe	34	25	22	19	15	6	2

CT Annular Measures Can Predict PV Leak

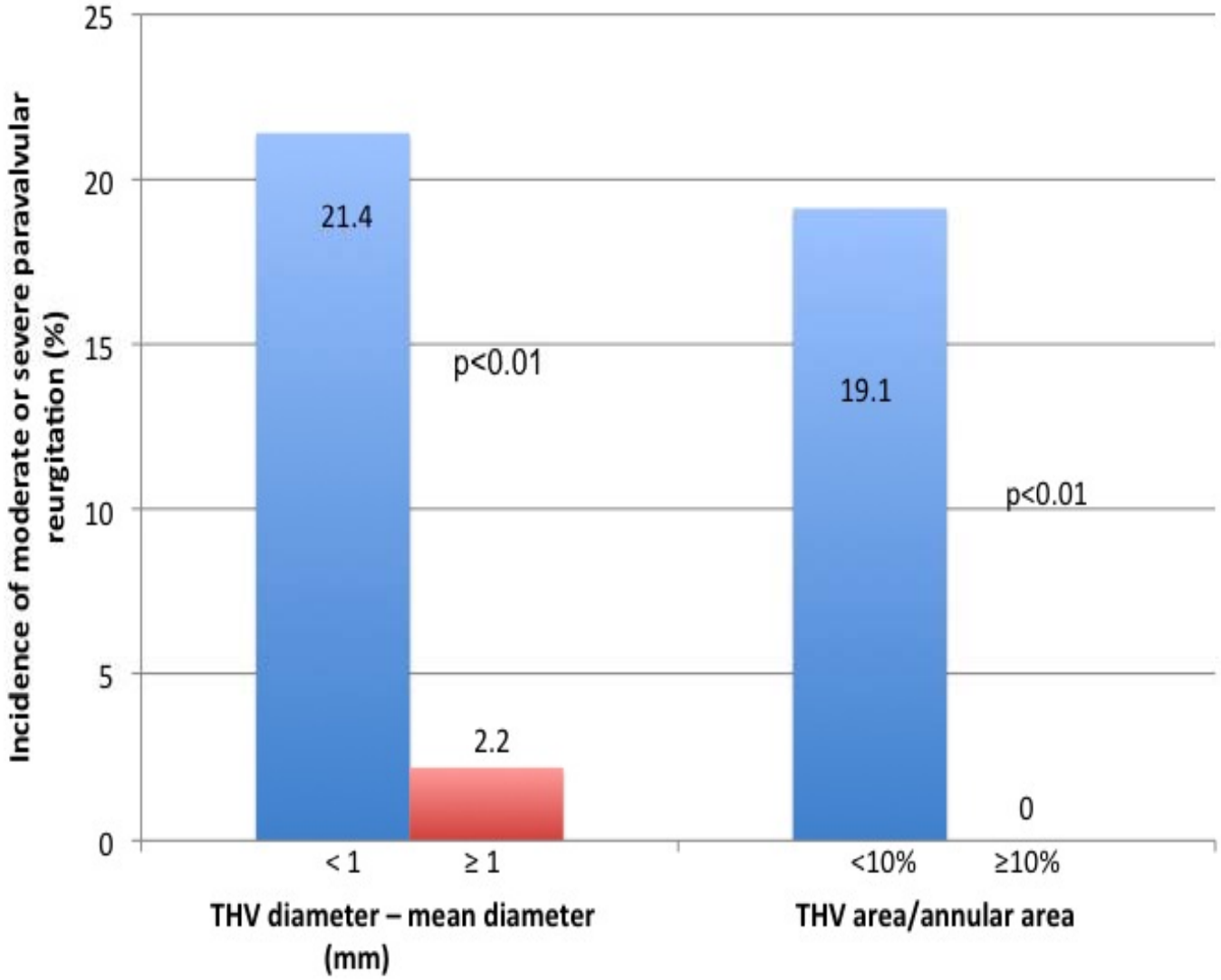


- Valve stent diameter – Mean annular diameter$_{MDCT}$ AUC 0.84
- Valve stent diameter – Area-derived annular diameter$_{MDCT}$ AUC 0.86
- Valve stent area/ Annular area$_{MDCT}$ AUC 0.87



In press JACC

Incidence of PV Leak



CONCLUSIONS

1. 3D aortic annular and root morphology / dimension
2. Aortic valve to coronary ostia relationship
3. Aortoiliofemoral arterial assessment
4. Prediction of co-axial angle of deployment
5. Prediction of PVR