ΔΙΟΙΣΟΦΑΓΕΙΑ ΥΠΕΡΗΧΟΚΑΡΔΙΟΓΡΑΦΙΑ 3 ΔΙΑΣΤΑΣΕΩΝ

ΣΤΗΝ ΕΚΤΙΜΗΣΗ ΤΗΣ ΑΟΡΤΙΚΗΣ ΣΤΕΝΩΣΗΣ ΓΙΑ ΔΙΑΔΕΡΜΙΚΗ ΑΝΤΙΚΑΤΑΣΤΑΣΗ (TAVI)

Αγγελική Ζαχαράκη
Καρδιολόγος
Ηράκλειο
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3D TEE

in patients with contraindications to computed tomography (CT) such as renal dysfunction and known iodinated contrast allergies

Multi-slice detector computed tomography reconstruction of the aortic root and ascending aorta
The aortic root contains at least 3 **circular rings** and 1 **crown-like ring**

1. **Virtual annulus** formed by the joining basal attachments of the AV leaflets.
2. **Anatomic annulus** formed by the ventriculoarterial junction
3. **Sinotubular junction**.
4. **Crown-like ring** formed by the insertion of the leaflets.
Multidisciplinary approach to transcatheter aortic valve implantation

Selection of patients occurs on the basis of their surgical risk and anatomic suitability

![Figure 1. Choice of TAVR Versus Surgical AVR in the Patient With Severe Symptomatic AS](image)

<table>
<thead>
<tr>
<th>Clinical characteristics</th>
<th>Favour TAVI</th>
<th>Favour SAVR</th>
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<tbody>
<tr>
<td>STS/EuroSCORE &gt; 9%</td>
<td>+</td>
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<tr>
<td>Logistics EuroSCORE &gt; 15%</td>
<td>+</td>
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<tr>
<td>Presence of severe comorbidity (not adequately reflected by scores)</td>
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<td>Age &gt; 75 years</td>
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<tr>
<td>Previous coronary surgery</td>
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<td>+</td>
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<tr>
<td>Poor LV function</td>
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<td>Restricted mobility and conditions that may affect the rehabilitation process after the procedure</td>
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<tr>
<td>Presence of atrioventricular valve anomalies</td>
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**Anatomical and technical aspects**

- **Unfavorable access area for TAVI**
- **Sinus of Valsalva anomalies**
- **Presence of intact coronary bypass grafts at risk when interventional is performed**
- **Expected prosthesis mismatch**
- **Severe chest deformations or scoliosis**
- **Short distance between coronary sinus and aortic valve annulus**
- **Size of aortic valve annulus out of range for TAVI**
- **Aortic root morphology unfavorable for TAVI**
- **Valve morphology (tricuspid, degree of calcification, occlusion pattern) unfavorable for TAVI**
- **Presence of dissections or LV remodelling**
- **Critical coronary stenoses in relation to aortic stenosis that require consideration for concomitant intervention**
- **Severe CAD requiring revascularization by CAGB**
- **Severe primary mitral valve disease, which could be treated surgically**
- **Severe tricuspid valve disease**
- **Anomalies of the ascending aorta**
- **Septal hypertrophy requiring resection**
Imaging for TAVR

Transthoracic echocardiography (TTE)

- Severity and assessment of aortic valve morphology,
- Concomitant valve lesions such as mitral regurgitation,
- Left and right ventricular function,
- Pulmonary artery pressure.
Assess the severity of stenosis
Types of aortic stenosis

- high gradient (velocity > 4 m/s or mean gradient > 40 mmHg) vs. low gradient (mean gradient < 40 mmHg)
- normal flow (SVi > 35mL/m²) vs. low flow (SVi < 35mL/m²)
- preserved ejection fraction (> 50%) vs. reduced ejection fraction (< 50%)
25% patients reclassified from severe to moderate AS when using 3D TEE planimetered annulus area

- 2D: Geometric assumption that LVOT is circular
- 3D: LVOT assumes an elliptical configuration

Errors in the measurement of the diameter are squared in the process of calculating AVA, leading to an underestimation of up to 13% for LVOT and 26.3% for AVA.
3D ECHO for aortic stenosis severity assessment

Accurate planimetry of AVA

In 2D methods, it is often difficult to capture the tip of the aortic valve leaflets at the moment of maximal systolic opening; this may lead to overestimation of AVA because of a “funnel” configuration.

Affected by valvular calcification.

3DTEE underestimates the measurement.
TAVI has been cited as a ‘blind’ procedure.
2D/3D TEE evaluation prior to TAVI

- Valve anatomy
  - number of cusps
  - degree of calcification
  - symmetry of calcification

- Aortic annulus diameters, perimeter and area (3D)
- LVOT diameters (3D)
- Distance to coronary arteries (3D)
- Aortic root dimensions (sinus of Valsalva / sinotubular junction / ascending aorta)
- Presence of aortic plaques
- Septal hypertrophy
The annulus size determines the size of the THV that should be used.

Aortic annulus perimeter or cross sectional area is superior to annulus diameter.

The intentional oversizing of implants is a recognized strategy to reduce the risk of PVR.

Unintentional oversizing increases the risk of rupture of the root, significant conduction disturbances and device underexpansion.

Unintentional undersizing
Elevated risk of clinically significant PVR and device embolization.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Aortic measurements for transcatheter aortic valve prosthesis</th>
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<tbody>
<tr>
<td></td>
<td>Prosthesis size</td>
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<tr>
<td>CoreValve evolut (mm)</td>
<td>23</td>
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<tr>
<td>CoreValve (mm)</td>
<td>26</td>
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<tr>
<td></td>
<td>29</td>
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<td></td>
<td>31</td>
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<tr>
<td>Edwards SAPIEN (mm)</td>
<td>23</td>
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<td></td>
<td>26</td>
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<td>Edwards SAPIEN XT (mm)</td>
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<td>26</td>
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<td></td>
<td>29</td>
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<tr>
<td>Edwards SAPIEN 3 (mm)</td>
<td>23</td>
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<td>29</td>
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➢ Biplane imaging or three dimensional reconstruction can be used to obtain measurements in the sagittal and coronal planes simultaneously and has become the echocardiographic gold standard for preimplantation assessment of the aortic root.
Aortic annulus measurement

- Ability to measure both the long and short dimensions of the elliptical annulus.
- Measurements are made during mid-systole when root dimensions are maximal and most circular.
- The diameter of the annulus must be measured with disregard for the calcification.

LVOT measurement

LVOT$_{diam} = 2.54$ cm
LVOT$_{area} = 5.1$ cm$^2$

LVOT$_{diam} = 2.62$ cm
LVOT$_{area} = 5.4$ cm$^2$

LVOT$_{diam} = 2.62$ cm
LVOT$_{area} = 5.6$ cm$^2$

LVOT$_{diam} = 2.70$ cm
LVOT$_{area} = 5.6$ cm$^2
Coronary artery height

- It is crucial to know the distance from the basal aortic annulus to the ostia of the left and right coronary arteries and to compare this with the length of the cusps.

- Coronary artery compromise occurring in <1 % of patients in clinical trials.

- Coronary occlusion most commonly affected the left coronary (88.6 %) more commonly in women.

- In 2D-TEE examinations, the distance from the RCA ostium to the annulus can be evaluated.

- There are no 2D planes in which both the left coronary ostium and the leaflet’s hinge line can be visualized.
Coronary artery height

- Height of the leaflets with respect to the coronary ostia

Risk factors for coronary ostial obstruction

- A low lying coronary ostium $<10$ to $12$ mm from the basal leaflet insertion to the coronary ostium
- Mean sinus of Valsalva diameter of $<30$ mm
- Sinus of Valsalva diameter / annular diameter ratio of $<1.25$
Potential mechanisms for coronary ostial obstruction

- Displacement of native bulky aortic leaflets over the coronary ostium.
- Impingement of the coronary ostia by the THV support structure.
- Inappropriately high positioning of the sealing cuff of the THV.
- Embolization of atheroma, calcium, thrombus, air, or vegetation.
- A significantly oversized THV.
- Aortic root dissection.
The role of TAVI in bicuspid aortic valve (BAV) is uncertain since data on efficacy and safety are limited.

BAV: contraindication to TAVI - poor seating, asymmetrical stent expansion, and/or PAR due to severe distortion of the native valve leaflets.

Growing data from large multicenter registries suggest that outcomes following TAVI in BAV stenosis appear to be quite good.
Aortic leaflets

- **Degree of leaflet calcification**

In a 3D TEE the two nodules are less easily distinguishable because their texture is similar to the surrounding structures.

Calcifications may be recognized with 3D imaging, when they **protrude** into the left ventricular outflow tract or into the aorta.
Concomitant cardiac pathology

Mitral valve leaflets

- Anterior mitral valve morphology is important to characterized in order to avoid unintentional impingement of the anterior leaflet with placement of the THV too low within the ventricle.

- Dense calcification within the aortomitral curtain or mitral annular calcification may increase the risk of paravalvular regurgitation due to asymmetric expansion of the THV.

- Moderate or severe MR is seen in 15 to 48% of patients undergoing TAVI.
Sinotubular junction and proximal aorta

- Small and heavily calcified STJs
- Balloon migration
- Prosthesis patient mismatch
- THV embolization
- Aortic root rupture

Left ventricular outflow tract and septum

- Prominent septal hypertrophy
- Challenge to the proper seating of the THV
- Spontaneous repositioning
- Atrioventricular block

Ventricular thrombus

- Contraindication to TAVI
Peri-procedural transesophageal echocardiography during TAVI
Peri-procedural transesophageal echocardiography during TAVI

- Appreciation of how a known balloon size fits into the valve annulus
- Determination of space within the sinuses to accommodate calcified leaflets
- Imaging of coronary ostia to determine risk of obstruction
- Detection of severe regurgitation post-valvuloplasty
Peri-procedural transesophageal echocardiography during TAVI
Aortic regurgitation

Incorrect prosthesis positioning may lead to embolization

Myocardial ischaemia- new wall motion abnormality

Mitral regurgitation
Damage to the valve leaflets or subvalvar apparatus
Myocardial ischaemia
Dyssynchrony secondary to pacing

Pericardial effusion
LV or RV perforation

Unmasked LV dynamic obstruction
SAM related
Midventricular

Aortic dissection or root rupture
Its Completed!!!
What does the future hold?

Echo Navigator screen image showing a 3D echocardiography image of the aortic valve and a fusion image of echocardiography in 3D and fluoroscopy of the aortic valve during a TAVR procedure
Conclusion

- Aortic annulus diameters, perimeter and area (3D)
- LVOT diameters (3D)
- Distance to coronary arteries (3D)

So, going back to our famous archer, we believe William Tell would advise us to trust our MSCT accuracy while keeping a second 3D-TEE arrow to give us alternative options. Both accuracy today and advancement in future options are important, but safety is essential.
ΕΥΧΑΡΙΣΤΩ ΠΟΛΥ!!!