

Three-Dimensional Virtual Reality Evaluation of the Aortic Root Configuration in Aortic Valve Leaflet Reconstruction with Same-Sized Autologous Pericardial Leaflets

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Aortic valve leaflet reconstruction using three same-sized autologous pericardium leaflets (ATLAS) has been performed for patients with narrow aortic annuls or contra-indication of valve prosthesis.

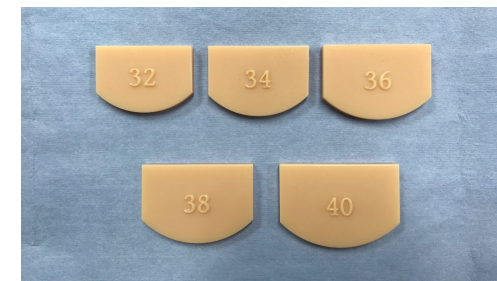
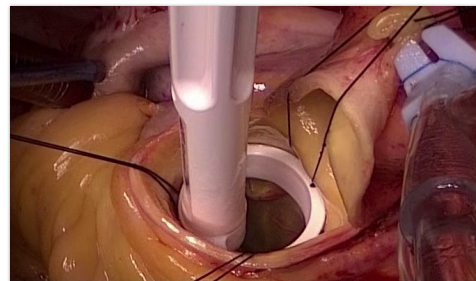
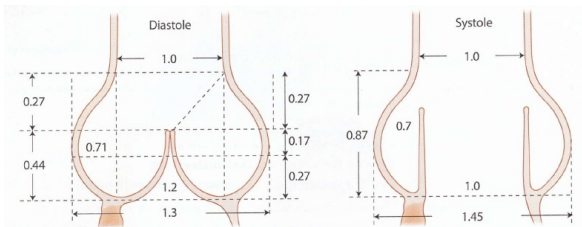
ATLAS requires precise information of the aortic root, which is not assessed adequately by ultrasound cardiography or 2D-3D CT, or even intraoperative evaluation or even intraoperative evaluation.

We introduced VR evaluation of the aortic root using novel 3D workstation, which has been useful for preoperative analysis of the aortic root and could establish our procedure as reproducible technique. Phisio-anatomical reconstruction based on STJ diameter.

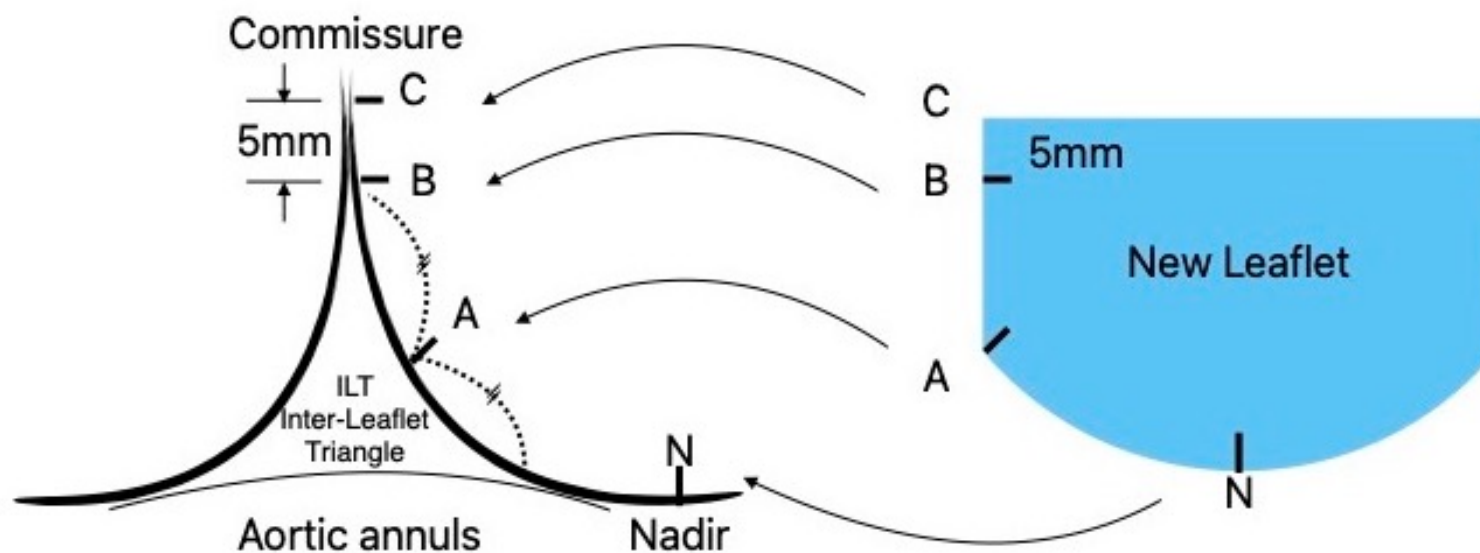
Aortic Tri-Leaflet Anatomical reconstruction Surgery (ATLAS)

aortic valve leaflet reconstruction with same-sized three leaflet

- Same-sized three leaflets were provided from autologous pericardium (treated by 0.6% glutaraldehyde in 6 minutes) based on the STJ diameter
- New symmetric commissures and nadirs were determined, with nadir-adjustment procedures guided by VR analysis.
- Leaflets were sutured on cusp-suture-line in 3:2 ratio (leaflets : annulus) from the nadir to commissure height and in 1:1 in commissure part.
- Commissure coaptation stitches were placed between each leaflet to prevent from minor leakage of this region and coronary orifices occlusion.
- STJ fixation by a pericardial stripe by the size of STJ diameter.



The important guide-points for leaflet stitching

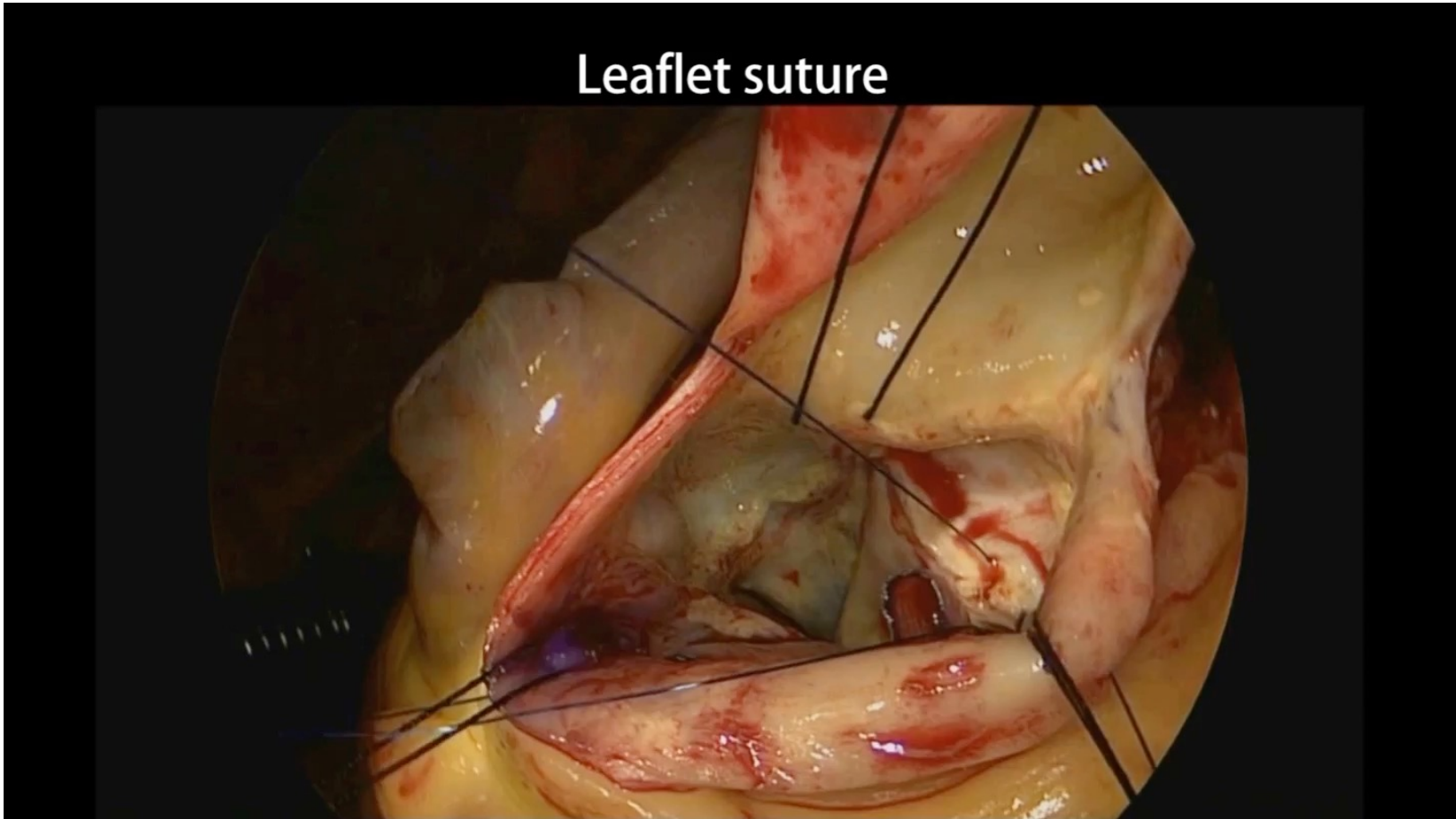


- Starting point in N (nadir)
- N to B : Suture the leaflet so that the aortic annulus to the leaflet is 2 to 3.
- The leaflet angle A should be positioned midway between the ILTs of the aortic annulus.
- Complete the suture so that commissure zone, set 5mm from the new commissure, is one to one.

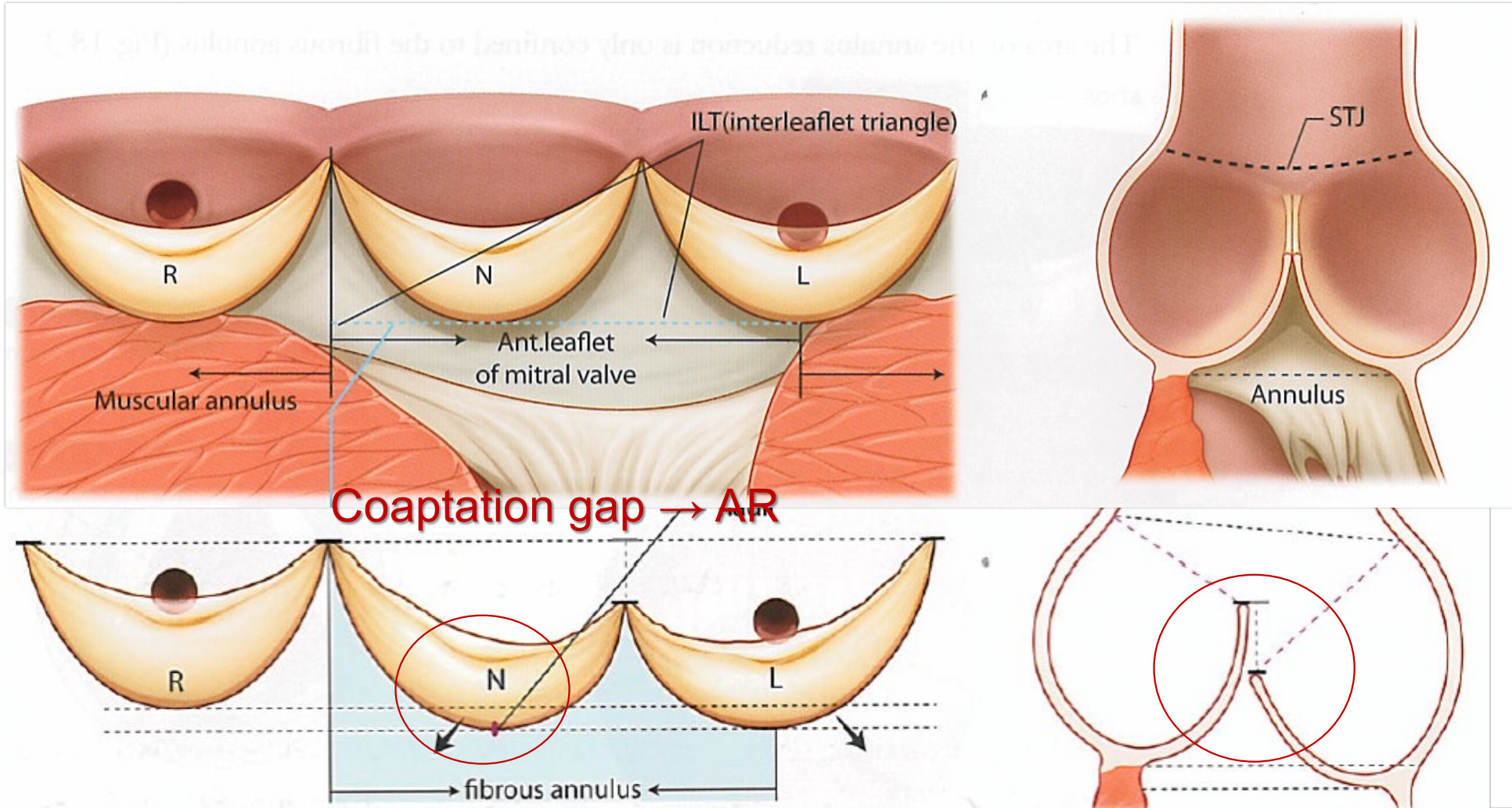
Basic surgical technique of ATLAS

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Leaflet suture



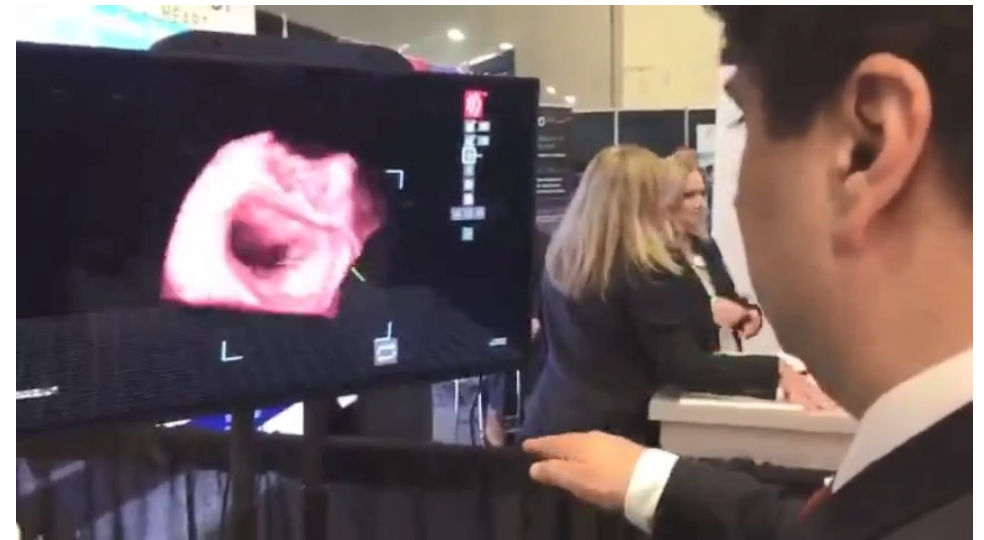
Pitfalls: nadir deviation



Totally different from 2D-2.5D images

3DVR brings important information that has not been available in ordinary image modalities such as CT, MRI or ultrasound analysis.

3DVR clarifies anatomical structures in physiologic condition, which we do not get even intraoperative findings.



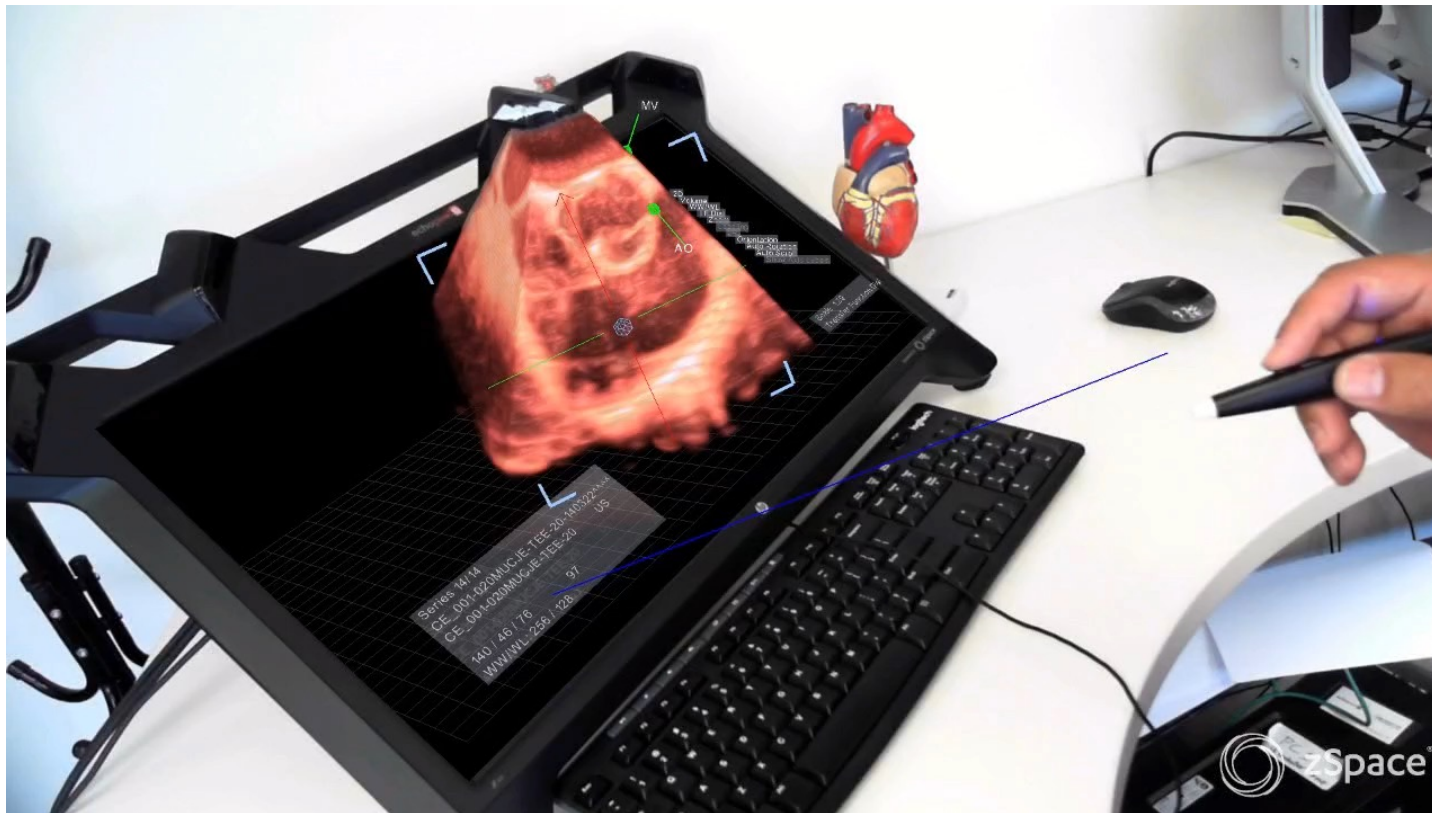
True 3D Visualization Platform

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<https://vimeo.com/291181373>

Why? – Focus on the Clinical Challenge



- Stereoscopic Parallax
- Motion Parallax
- Direct Interaction



- **Reduces cognitive load**
- **Leverages intuition**
- **Completes human perception**

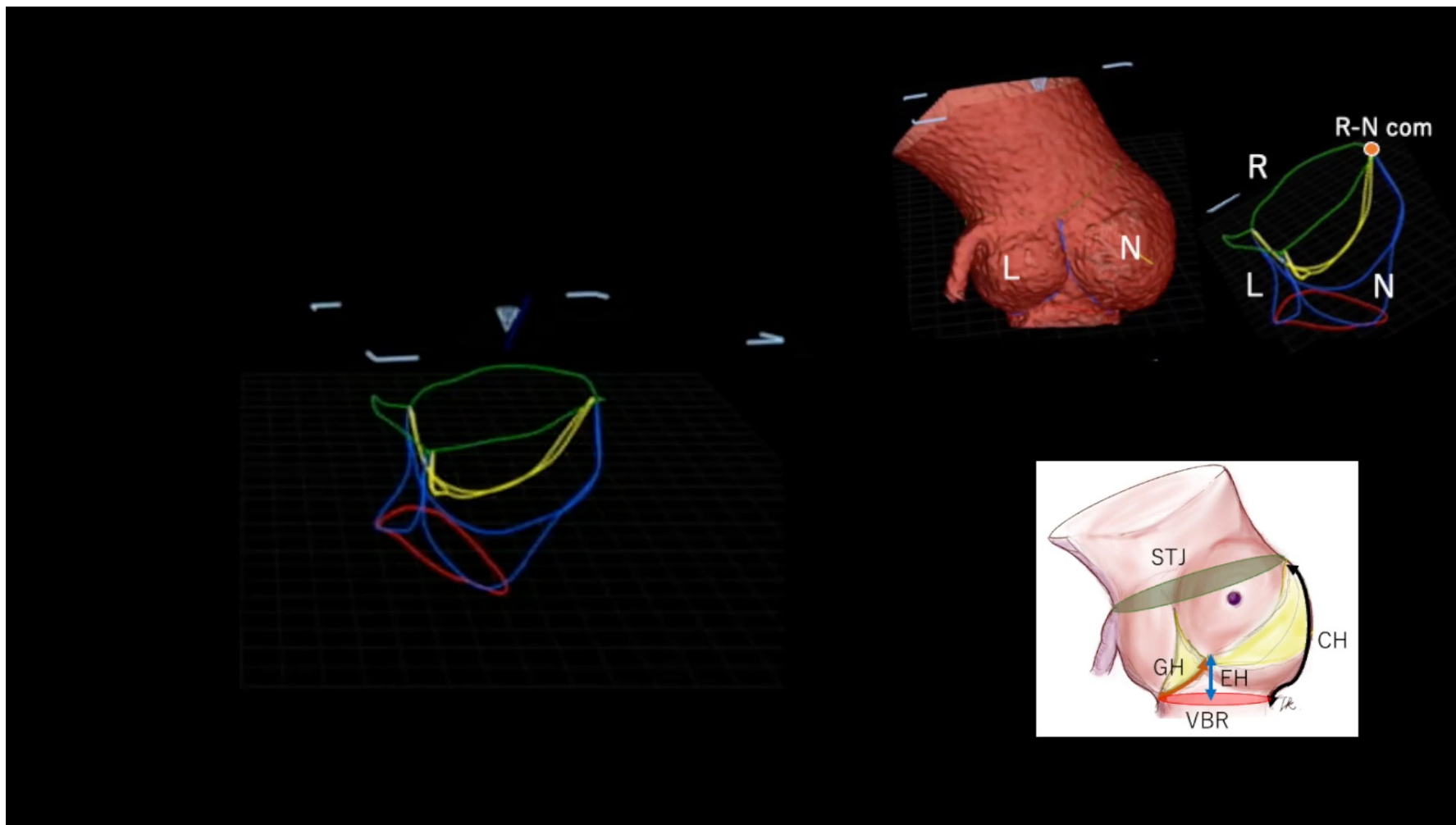
EchoPixel

<https://vimeo.com/291187719>

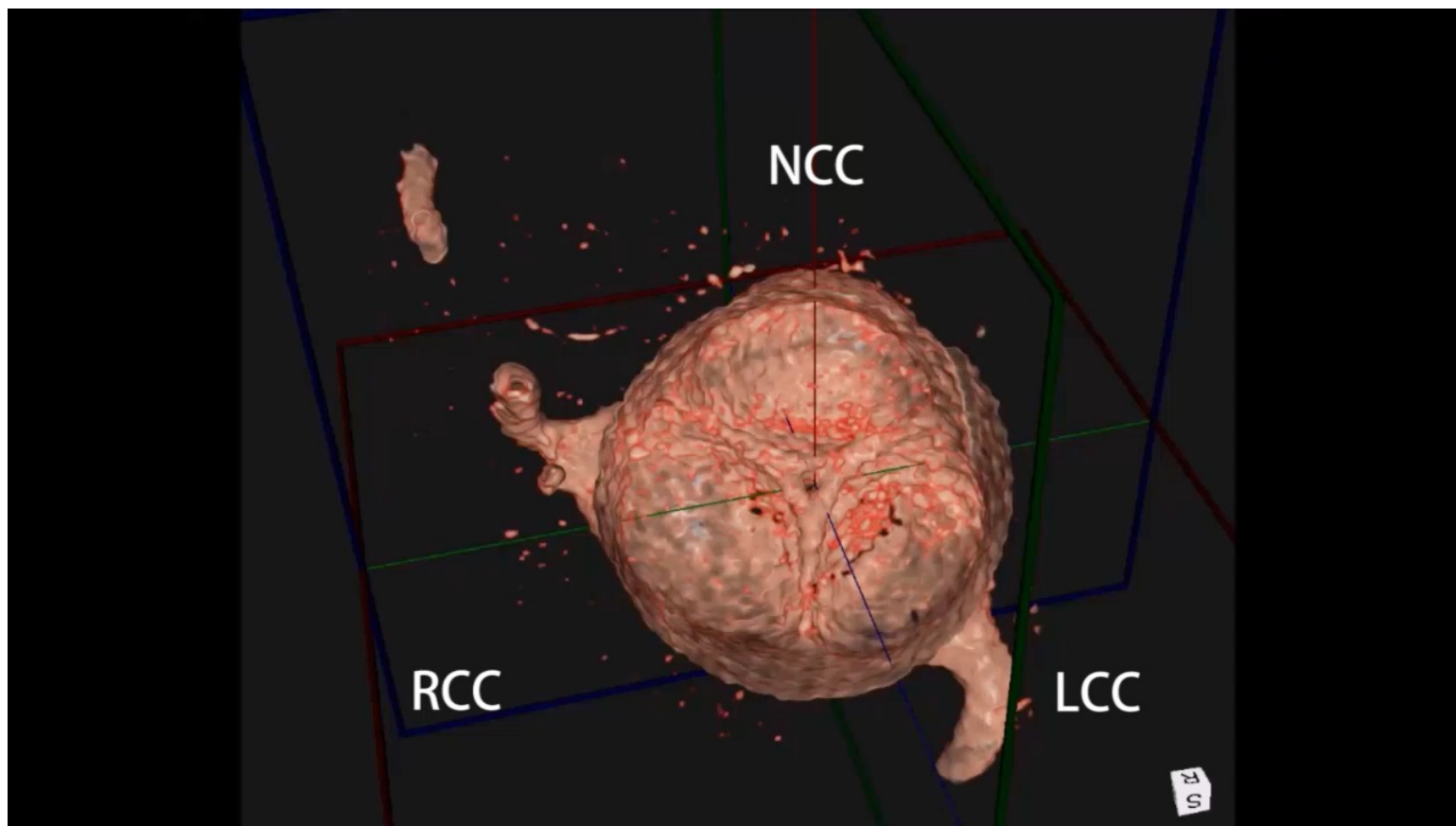
- Medical VR is not a future technology – It is already here!
- Allows precise measurements and natural interactions using standard imaging datasets
- Enables sharing the treatment plan with staff and patients
- Allows operators to understand complex anatomy – enhances procedural efficiency and patient safety

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Valve sparing aortic root surgery



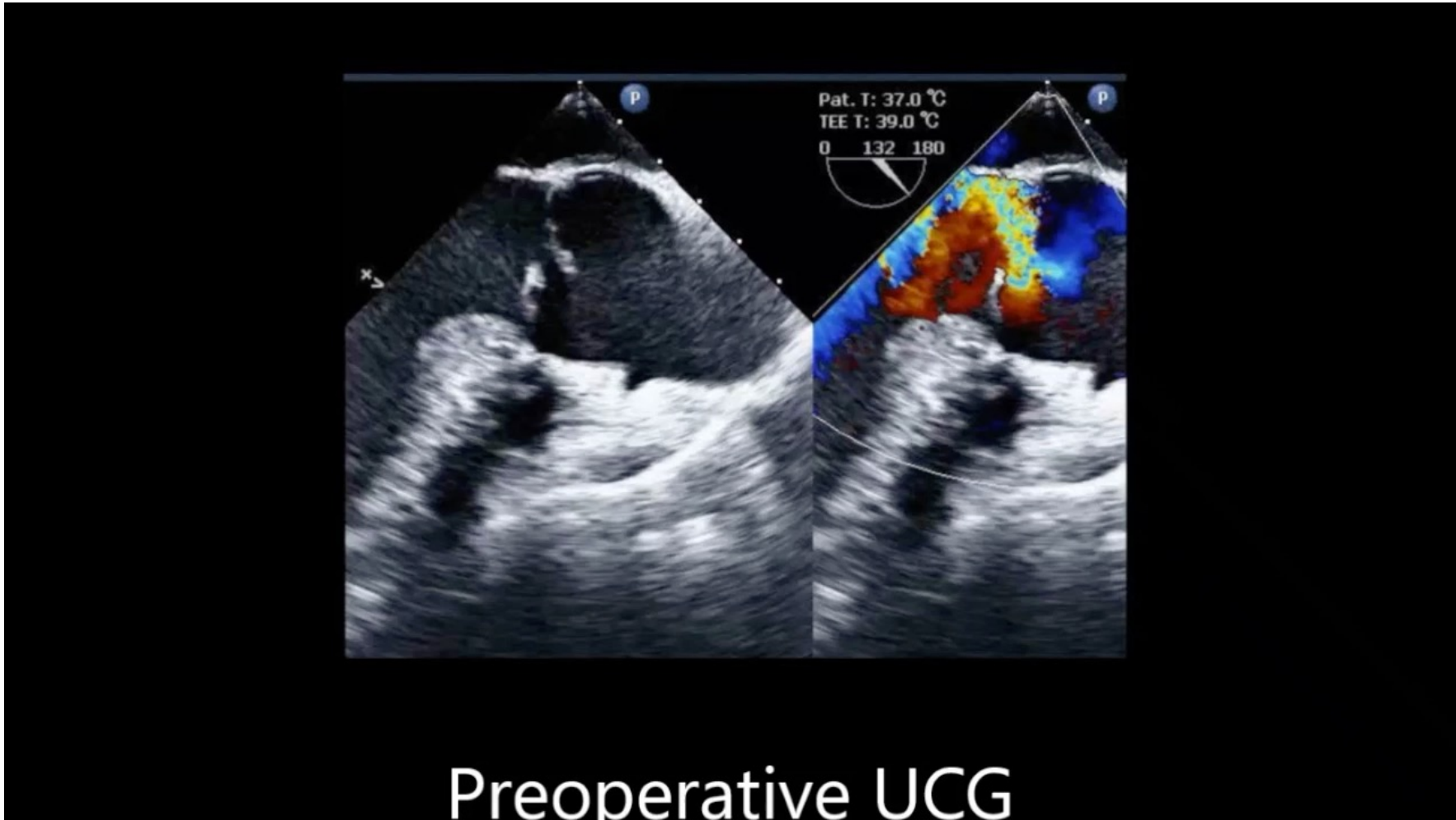
Investigation of the aortic root



Crescent Plication of Valsalva sinus
adjustment for leaflet reconstruction

- > 46 y.o. male, Severe AR
- > Bicuspid (Sievers type 1, L-R), LCC shortened

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Patient: 53-year-old male with bicuspid AS
(type 0, L-R)



52 cases (AS=17, AR=28: active IE=7), age, 58 +/- 19)

- **Additional Valsalva Procedures in 12 cases**
- **Type 0 BA = 3**
- **Type I BA = 2**
- **Pure AR = 7**
- **Mortality: 1 by MOF in active IE with preoperative multiple embolization.**
- **Morbidity: 1 by mediastinitis required revision of SSI.**

- **52 cases (AS=17, AR=28: active IE=7), age, 58 +/- 19)**
- **One redo AVR due to perforation of pericardium (technical failure, no degenerative change)**
- **One late mortality due to renal failure 1 year after surgery. (non cardiac related)**
- **Follow up (max 8.3 years) by UCG (46 cases/49)**
 - **IE=0**
 - **no AR greater than mild**
 - **mean PG 9.1 mmHg.**

ATLAS technique described herein can provide a simple and reproducible procedure that allows anatomical physiologic correction of the aortic valve.

This technique might be available for anatomically unbalanced aortic root including bicuspid aortic valve.

VR image analysis was useful and helpful to decide surgical plan for difficult cases like Type 0 bicuspid aortic valve.

This technique absolutely should be strictly followed up to clarify mid-term and long-term outcomes.
