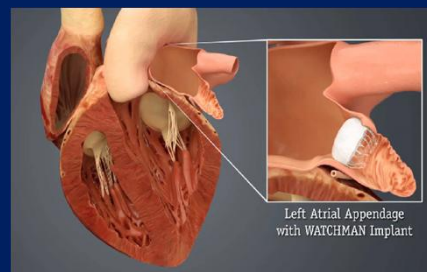


Morphology and Functional Characteristics of the Left Atrial Appendage

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Percutaneous Left Atrial Appendage Closure



Left Atrial Appendage

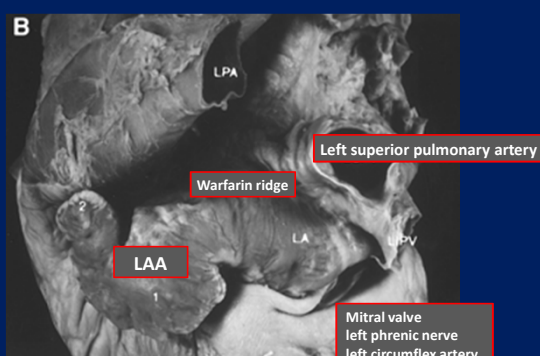
1. What are known?

2. Our Missions

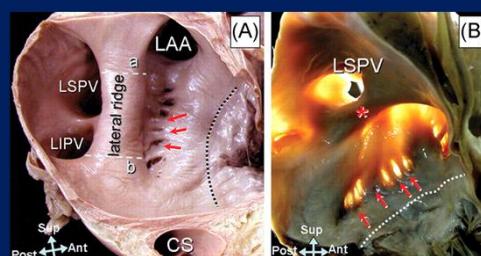
Left Atrial Appendage (LAA): What are known?

- Anatomy
- Embryology
- Function

Left Atrial Appendage Anatomy



Left Atrial Appendage Anatomy



- Elliptical ostium of the LAA: long axis 10-40mm, a short axis 5.2-19.5mm (5.7% round shape)
- Changes of ostium diameter: 1-2mm in sinus rhythm, no change during AF

A. Natale, Ed., In Tech Open Access Publishing, Vienna, Austria, 2012

Left Atrial Appendage Anatomy

A casts of the LAA by using synthetic resin

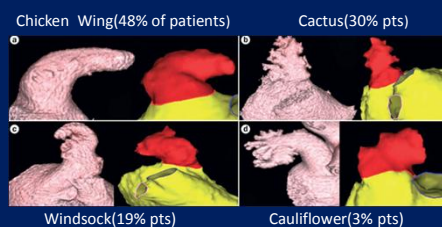


- The volume were 770-19270mm³(mean5220±3041).
- The LAA volume increase with aging, regardless of the gender.

Morphology of the left atrial appendage. 1995
Assessment of normal left atrial appendage anatomy and function over gender and ages by dynamic cardiac CT. 2015

Left Atrial Appendage Morphology

- CT and MRI allow us to recognize the Morphology easily.



The morphology of LAA associates with prevalence of stroke.

Does the left atrial appendage morphology correlate with the risk of stroke in patients with atrial fibrillation

Left Atrial Appendage Morphology



Morphology of the LAA is more complex, bizarre, and variable than previously thought....

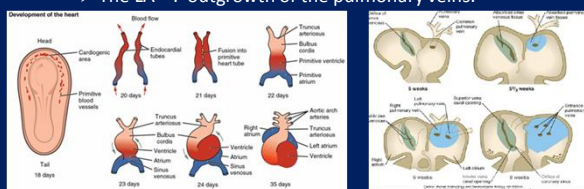
Morphology of the left atrial appendage. Ernst G 1995
The Morphology of the left atrial appendage Lobes: A Novel Characteristics Naming Scheme Derived through Three-Dimensional Cardiac Computed Tomography

Left Atrial Appendage (LAA): What are known?

- Anatomy
- Embryology
- Function

Left Atrial Appendage Embryology

- The LAA : primitive left atrial tissue.
: very well contracting, trabeculated tube
- The LA : outgrowth of the pulmonary veins.



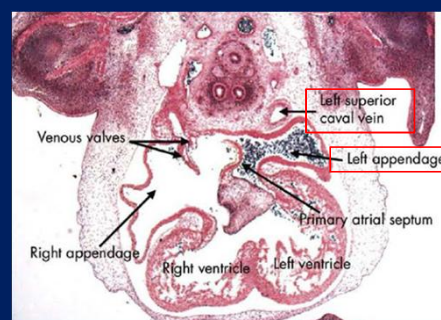
- Intussusception of left pulmonary vein into the LA

Smooth wall LA

Trabeculated LAA

Abdulla R, Blew GA, Holterman MJ. Pediatr Cardiol 2004
Martinsen B, Lohr J. 2005

Left Atrial Appendage Embryology

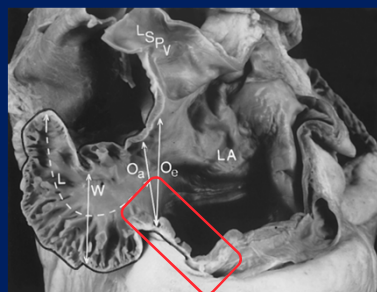


The left superior caval vein possesses its own walls outside the developing left atrium.

Moorman A, Webb S, Brown NA, et al. Heart 2003

Left Atrial Appendage Embryology

Area of the Pectinate muscle = primitive left atrial



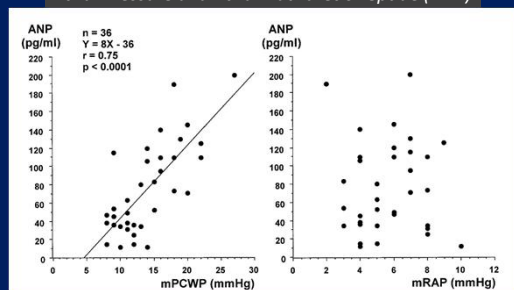
Left Atrial Appendage (LAA): What are known?

- Anatomy
- Embryology
- Function

Left Atrial Appendage function

: Secretion of Atrial natriuretic peptide(ANP)

Atrial Pressure and Atrial Natriuretic Peptide (ANP)



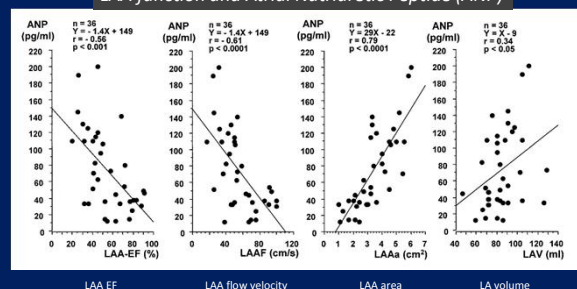
LA Pressure

RA Pressure

Tabata et al. Eur J Echocardiography 2000

Left Atrial Appendage function

LAA function and Atrial Natriuretic Peptide (ANP)



LAA EF

LAA flow velocity

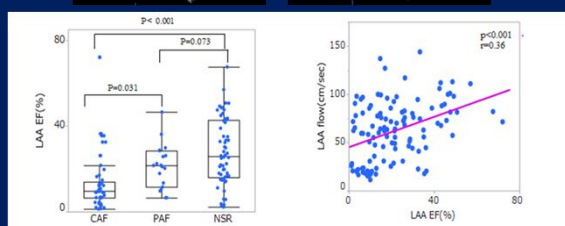
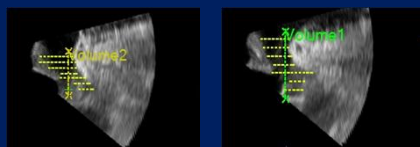
LAA area

LA volume

Tabata et al. Eur J Echocardiography 2000

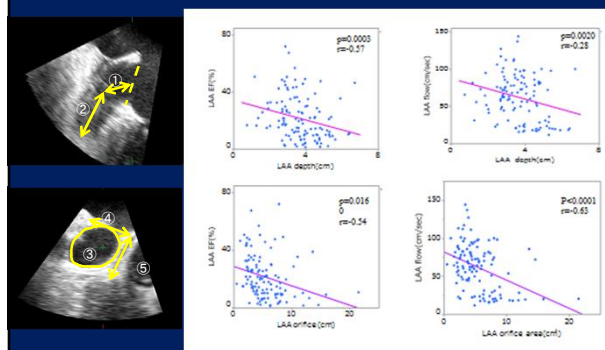
Left Atrial Appendage function

3D-TEE Analysis (n=194 with history of stroke)



Matsumoto et al, submitted

Relationships between 3D-TEE Anatomical Parameters and Function of LAA



Matsumoto et al, submitted

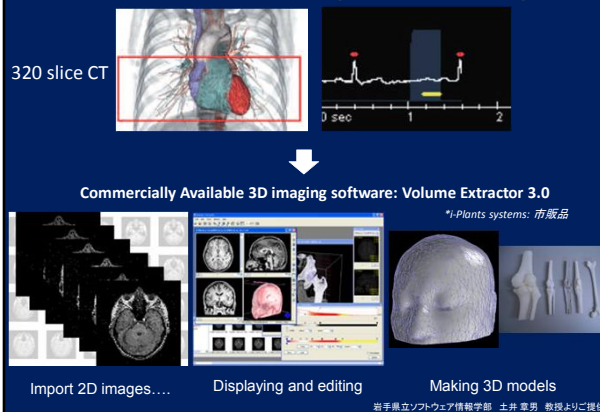
Our Missions: Left Atrial Appendage (LAA)

CT based 3D Reconstruction (for Free Measurements)
and 3D Printing

Iwate Medical University, Iwate Prefectural University
Combined Teams of LAA Project

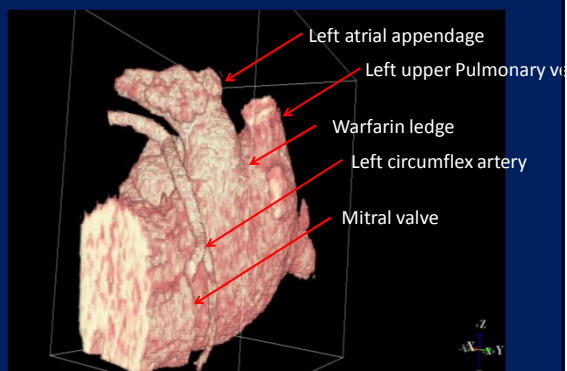


Reconstruction of 3D images from 2D images

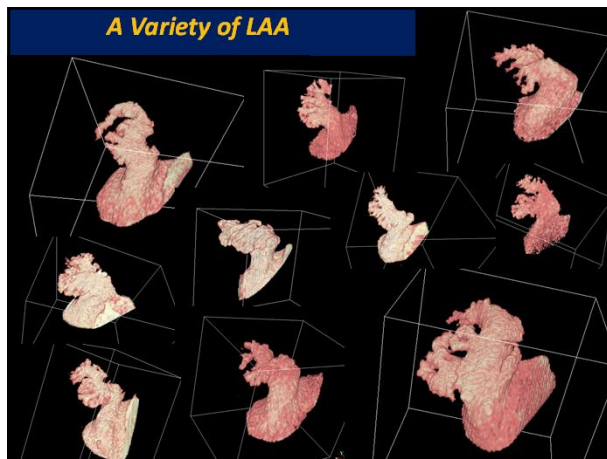


Visualization/ Segmentation of LAA

➤ Volume Rendering of LAA

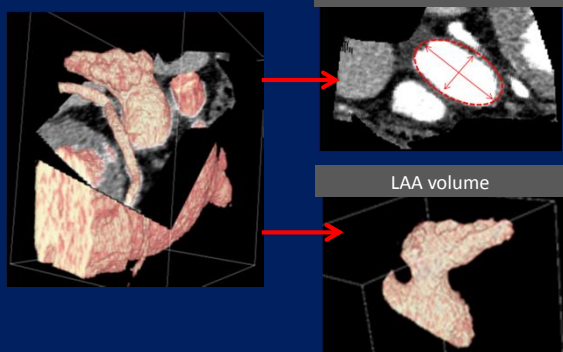


A Variety of LAA



Measurement of any parameters

By using Measure Manager



Process of making the LAA 3D models

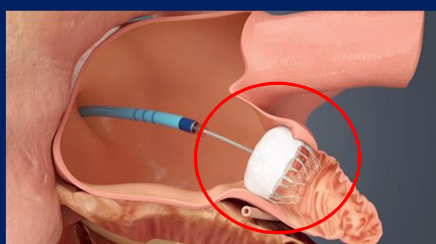
1. CT→VE→STL→FreeForm
2. Correction and Editing
3. Smoothnig
4. Boolean operations
5. Making of opening space
6. Processing
7. Output the 3D models

Project of Left Atrial Appendage



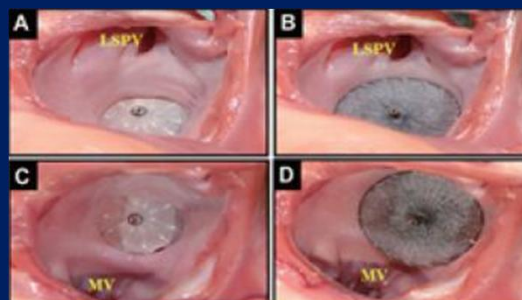
What we need to know is...

Precise measurement of orifice of LAA.



Correct sizing allows us to perform implantation safely.

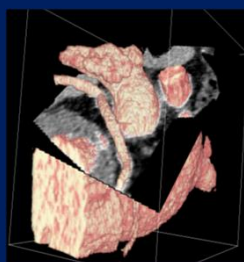
Where is the orifice of LAA ?



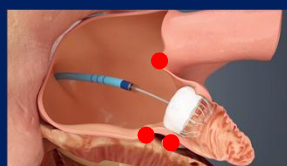
Is there the Landmarks of the LAA orifice ?

Somewhat arbitrary definition of the LAA orifice is needed.

- Hypothesis :
LAA orifice planes could be determined by combinations of the following anatomical landmarks.

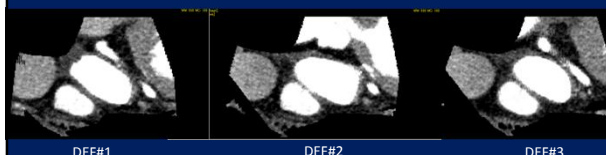


Warfarin ridge
Left circumflex artery
Mitral valve



Comparison for each definitions

- DEF#1: center of warfarin ridge, orifice of LCx, and bifurcation of LCx and obtuse marginal branch.
- DEF#2: a plane of warfarin ridge and mitral valve annulus.
- DEF#3: that by observers' discretion by progressive rotation of LAA geometry.



- OA measured by DEF#2 was 1.39 times greater than DEF#1 ($537 \pm 186 \text{ mm}^2$ vs $387 \pm 128 \text{ mm}^2$, $p=0.0007$) and 1.21 times greater than DEF#3 ($537 \pm 186 \text{ mm}^2$ vs $445 \pm 161 \text{ mm}^2$, $p=0.034$).
- Significant positive correlations were appreciated between DEF #1 and DEF#3.

Comparison for each definitions



- Brandt-Altman plots of each comparison were shown in the Figure, demonstrating that systematic bias between DEF#1 and DEF#3 was the smallest.

For the Future



- Precise measurement is needed.
- There is the possibility that we have the individual definition of the LAA orifice.
- Progressive rotation of 3D-CT imaging makes it easy to think the protocols of procedure for each individuals.

Our Goals: Development of Simulation Software

- The Virtual view like TEE by using CT images
- Procedure guidance ; Trans septal puncture, catheter guidance
- Appropriate sizing of LAA and choice device size
- Pre operation simulation

