Current State Surgical Left Atrial Appendage Exclusion

Sebastian Iturra
Cardiac Surgery
Allina Health
March 2024
No conflict of interest

Objectives

• Understanding basis of LAAO for stroke risk reduction

• History of LAA exclusion / Surgical techniques

• LAAO trial / Future trials

• Conclusions
Introduction

• Atrial fibrillation is an important risk factor for stroke
  • 25% of ischemic strokes
  • Disability and death

• Anticoagulation has led to a decrease in stroke
  • Increase risk of bleeding
  • Poor adherence (Warfarin and DOAC)
    • 30% non-adherent with DOAC

Introduction

• Left atrial thrombi
  • 90% come from LAA
  • 57% in valvular AF
Techniques of Surgical LAAO

• Described since 1948

• Lack of standardization

• Confusing results:
  • Success?
  • Lack of flow
  • Stump < 1 cm.

Fig. 3. Surgical techniques of left atrial appendage closure. (A) Endoloop Suture. (B) Surgical stapler. (C) Epicardial excision. (D) Purse string excision.
Success of Surgical Left Atrial Appendage Closure
Assessment by Transesophageal Echocardiography

Anne S. Kanderian, MD,* A. Marc Gillinov, MD,† Gosta B. Pettersson, MD, PhD,†
Eugene Blackstone, MD,† Allan L. Klein, MD, FACC*  
Cleveland, Ohio

Table 2  Success of Different Techniques of LAA Closure

<table>
<thead>
<tr>
<th>Type of Closure</th>
<th>n</th>
<th>Patent LAA</th>
<th>Restent LAA</th>
<th>Excluded LAA With Persistent Flow</th>
<th>Successful LAA Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suture exclusion</td>
<td>73</td>
<td>6 (8)</td>
<td>6 (8)</td>
<td>44 (61)</td>
<td>17 (23)%*</td>
</tr>
<tr>
<td>Saphenous venous</td>
<td>12</td>
<td>2 (17)</td>
<td>7 (58)</td>
<td>2 (20)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>85</td>
<td>8 (9)</td>
<td>37 (43)</td>
<td>47 (56)</td>
<td>58 (68)</td>
</tr>
</tbody>
</table>

* p < 0.001.  † p < 0.002.

Abbreviations as in Table 1.
Outcomes of left atrial appendage occlusion using the AtriClip device: a systematic review


*Department of Vascular Surgery, Ninewells Hospital and Medical School, Dundee, United Kingdom
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Received 1 January 2013, revised 1 February 2013, accepted 19 May 2013

Key question:
What are the outcomes of surgical clipping of the left atrial appendage (LAA) using the AtriClip device?

Key finding(s):
LAA exclusion is achieved in 97.8% of patients. No device-related complications have been reported.

Take-home message:
The AtriClip™ device is safe and effective in the management of patients with arrhythmia.

- 93.9-100% LAA closure success
- No incidences of LAA flow or leak
- No device-related complications
- No incidence of bleeding
- No migrations

Epicardial LAA Exclusion Device

LOM
PA
LSPV
LAA
MV
L. Circ A
L. Circ V
LV
Clip Exclusion

- Animal 90 days
- Human
Left Atrial Appendage Occlusion Study (LAAOS): Results of a randomized controlled pilot study of left atrial appendage occlusion during coronary bypass surgery in patients at risk for stroke

Jeff S. Healey, MD, Eugene Crystal, MD, Andre Lamy, MD, Kevin Teoh, MD, Lloyd Semelhago, MD, Stefan H. Rohmler, MD, Irene Cybulsky, MD, Labib Abouzahr, MD, Corey Sawchuck, MD, Sandra Carrell, BSc, Carlos Morillo, MD, Peter Kleine, MD, Victor Chu, MD, Eva Lonon, MD, and Stuart J. Connolly, MD* Toronto and Hamilton, Ontario, Canada, and Frankfurt, Germany

LAAOS

- CABG
  - 77 (n) randomized 2:1 to LAAO:
    - Suture / stapling vs control
  - High risk for AF and stroke
    - Age >75
    - HTN and age >65
    - Previous stroke
    - History AF
  - TEE 8 weeks
    - Failure to occlude if stump >1 cm or flow seen into the LAA
  - Postop anticoagulation was left to discretion of physicians
LAAOS

- Successful closure LAA
  - 72% stapling device
  - 45% epicardial suture alone
- Safe procedure during CABG

<table>
<thead>
<tr>
<th>Table II. Perioperative events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Cross-clamp time (min)</td>
</tr>
<tr>
<td>Furosemide/72 h (mg)</td>
</tr>
<tr>
<td>Total chest tube output (mL)</td>
</tr>
<tr>
<td>Postoperative AF (%)</td>
</tr>
</tbody>
</table>

- Pilot trial of AF and increased risk of stroke
  - Randomized LAAOS 26 vs 25 no occlusion and anticoagulation
  - Procedure was safe
  - At 1 year:
    - 15.4% vs. 20.0%
    - Composite endpoint of death, MI, stroke, noncerebral systemic emboli, or major bleeding (RR, 0.71; 95% CI, 0.19-2.66; P = 0.61)
Surgical left atrial appendage occlusion during cardiac surgery for patients with atrial fibrillation: a meta-analysis

Yi-Chin Tsaiabc, Kevin Phancd, Stine Munkholm-Larsened, David H. Tianb, Mark La Meirc and Tristan D. Yanad**

* Department of Cardiothoracic Surgery, The Prince Charles Hospital, Chermside, Australia
** The Collaborative Research (CORE) Group, Macquarie University, Sydney, Australia
† Sydney Medical School, University of Sydney, Sydney, Australia
‡ Department of Cardiology, Hvidovre University Hospital, Copenhagen, Denmark
§ Department of Cardiothoracic Surgery and Cardiology, Academic Hospital Maastricht and Cardiovascular Research Institute Maastricht, Maastricht, Netherlands
¶ University Hospital Brussels, Brussels, Belgium

* Corresponding author. The Collaborative Research (CORE) Group, Macquarie University, 2 Technology Place, Sydney, Australia. E-mail: tristanyan@panalicts.com (T.D. Yan).

Received 26 March 2014; received in revised form 6 June 2014; accepted 12 June 2014

Figure 1: Forest plot of the odds ratio (OR) of embolic stroke incidence postoperatively on Day 30 and at the latest follow-up in the left atrial occlusion (LAA) group versus non-LAA group. The estimate of the OR of each trial corresponds to the middle of the squares, and the horizontal line shows the 95% confidence interval (CI). On each line, the number of events as a fraction of the total number is shown for both treatment groups. For each subgroup, the sum of the statistics, along with the summary OR, is represented by the middle of the solid diamonds. A test of heterogeneity between the trials within a subgroup is given below the summary statistics. M-H: Mantel-Haenszel.
FIGURE 2: PROTECT AF/PREVAIL Combined: Meta-Analysis Shows Comparable Primary Efficacy Results to Warfarin

<table>
<thead>
<tr>
<th>Event</th>
<th>HR</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>0.79</td>
<td>0.22</td>
</tr>
<tr>
<td>All stroke or SE</td>
<td>1.02</td>
<td>0.94</td>
</tr>
<tr>
<td>Ischemic stroke or SE</td>
<td>1.95</td>
<td>0.05</td>
</tr>
<tr>
<td>Hemorrhagic stroke</td>
<td>0.22</td>
<td>0.004</td>
</tr>
<tr>
<td>Ischemic stroke or SE &gt;7 days</td>
<td>1.56</td>
<td>0.21</td>
</tr>
<tr>
<td>CV/unexplained death</td>
<td>0.48</td>
<td>0.006</td>
</tr>
</tbody>
</table>

- All-cause death: HR 0.73, p = 0.07
- Major bleed, all: HR 1.00, p = 0.98
- Major bleeding, non-procedure-related: HR 0.51, p = 0.002

Hazard Ratio (95% CI)
Randomized LAAO vs. no LAAO:
- Cardiac surgery with the use CBP
- Atrial fibrillation
- CHA2DS2-VASc ≥2

Primary outcome:
- Ischemic stroke or systemic embolism

Guidelines directed stroke prevention therapy (OAC agents)
- Left to their local physicians

Benefits of Ablation and Left Atrial Appendage Management in Atrial Fibrillation

<table>
<thead>
<tr>
<th>Operative Safety Outcomes</th>
<th>LAAO n=2379</th>
<th>No LAAO n=2391</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bypass time, mean (SD)</td>
<td>119 min (48)</td>
<td>113 min (47)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Crossing time, mean (SD)</td>
<td>86 min (37)</td>
<td>83 min (37)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Catheter output, median (IQR)</td>
<td>520 ml (350-790)</td>
<td>500 ml (340-760)</td>
<td>0.06</td>
</tr>
<tr>
<td>Re-operation for bleeding</td>
<td>94 (4.0%)</td>
<td>95 (4.0%)</td>
<td>0.97</td>
</tr>
<tr>
<td>Prolongation of hospitalization due to heart failure</td>
<td>5 (0.2%)</td>
<td>14 (0.6%)</td>
<td>0.04</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>89 (3.7%)</td>
<td>95 (4.0%)</td>
<td>0.68</td>
</tr>
</tbody>
</table>

*Not adjusted for multiplicity
LAAOS III did not compare LAAO with anticoagulation
Oral Anticoagulation Use and Left Atrial Appendage Occlusion in LAAOS III

Circulation. 2023;148:1298–1304. DOI: 10.1161/CIRCULATIONAHA.122.060315

Table 4. Adjusted Cox Proportional Hazard Analyses With Oral Anticoagulant Use as a Time-Dependent Covariate for the Outcome of Ischemic Stroke or Systemic Embolism

<table>
<thead>
<tr>
<th>Group</th>
<th>Events</th>
<th>Incidence/100 person-years</th>
<th>Hazard ratio 99% CI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>On oral anticoagulant</td>
<td>56</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Not on oral anticoagulant</td>
<td>14</td>
<td>0.8</td>
<td>1.3</td>
</tr>
</tbody>
</table>

*Hazard ratios were adjusted for use of oral anticoagulants as a time-dependent covariate.
Sub-analysis LAAOS III
Data Medicare reimbursement
Increase of cost is driven by stroke
Overall, cost saving in LAAOS

Guidelines recommendations
Table 2  2010 AHA/ACC/AHRF focused update of the 2006 AHA/ACC/AHRF guidelines for the management of patients with atrial fibrillation.  

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Class of recommendation</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>After surgical occlusion or exclusion of the LAA</td>
<td>IIb</td>
<td>B</td>
</tr>
<tr>
<td>LAA embolization</td>
<td>IIb</td>
<td>C</td>
</tr>
<tr>
<td>Surgical occlusion or exclusion</td>
<td>IIb</td>
<td>B</td>
</tr>
</tbody>
</table>

Table 3  2020 European Society of Cardiology Guidelines for the management of atrial fibrillation.  

<table>
<thead>
<tr>
<th>Recommendations for occlusion or exclusion of the LAA</th>
<th>Class of recommendation</th>
<th>Level of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAA occlusion may be considered for stroke prevention in patients with AF and contraindications for long-term anticoagulant treatment (eg, intracranial bleeding without a reversible cause)</td>
<td>IIb</td>
<td>B</td>
</tr>
<tr>
<td>Surgical occlusion or exclusion of the LAA may be considered for stroke prevention in patients with AF undergoing cardiac surgery</td>
<td>IIb</td>
<td>C</td>
</tr>
</tbody>
</table>

AF — atrial fibrillation, LAA — left atrial appendage.  
Adapted from Hindricks et al.  

Journal Pre-proof

The Society of Thoracic Surgeons 2023 Clinical Practice Guidelines for the Surgical Treatment of Atrial Fibrillation

Moritz C. Wyler von Bal Koce, MD, PhD, Dawn S. Hui, MD, J. Hunter Muhaffey, MD, MSc, S. Chris Malaisrie, MD, Panos N. Vardas, MD, A. Marc Gillinov, MD, Thoralf M. Sundt, MD, Vinay Badhwar, MD

PII: S0003-4975(24)00057-2
DOI: https://doi.org/10.1016/j.athoracsur.2024.01.007
Reference: ATS 37181


Received Date: 10 November 2023
Revised Date: 8 January 2024
Accepted Date: 13 January 2024
### Recommendations for concomitant left atrial appendage management

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left atrial appendage obliteration for atrial fibrillation is recommended for all first-time non-emergent cardiac surgery procedures, with or without concomitant surgical ablation, to reduce morbidity from thromboembolic complications.</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>It is reasonable to perform left atrial appendage excision or exclusion in conjunction with surgical ablation for AF for longitudinal thromboembolic morbidity prevention.</td>
<td>Ila</td>
<td>C</td>
</tr>
</tbody>
</table>

**Observational data documenting safety & effectiveness**
- Limited comparisons with percutaneous LAAO (procedural risk, bleeding, TE complications)
- SALAMANDER (prospective registry)
- **no RCTs comparing percutaneous vs surgical LAAO vs OMT**

### Recommendations regarding stand-alone left atrial appendage management

<table>
<thead>
<tr>
<th></th>
<th>2017</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated surgical left atrial appendage obliteration may be considered in patients with longstanding persistent atrial fibrillation, a high stroke risk, and contraindications for or failure of long-term oral anticoagulation.</td>
<td>Iib</td>
<td>B-NR</td>
</tr>
</tbody>
</table>
AHA/ACC 2023 CPG

6.5.2. Cardiac Surgery–LAA Exclusion/Excision

Recommendations for Cardiac Surgery–LAA Exclusion/Excision

Referenced studies that support the recommendations are summarized in the Online Data Supplement.

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>1. In patients with AF undergoing cardiac surgery with a CHA2DS2-VASc score ≥2 or equivalent stroke risk, surgical LAA exclusion, in addition to continued anticoagulation, is indicated to reduce the risk of stroke and systemic embolism.1,18</td>
</tr>
<tr>
<td>1</td>
<td>A</td>
<td>2. In patients with AF undergoing cardiac surgery and LAA exclusion, a surgical technique resulting in absence of flow across the suture line and a stump of &lt;1 cm as determined by intraoperative transesophageal echocardiography should be used.14,5</td>
</tr>
</tbody>
</table>

References:


Circulation. 2024;149:e1–e156. DOI: 10.1161/CIR.0000000000001193

18 of 37
Hemodynamics of LAA

• LAA has a role:
  - Complementary reservoir
  - Producing atrial and brain natriuretic peptide

• Unknown effect of LAAO on healthy atrium:
  - Increase of diuretics treatment on LAAO?
Future Trials

Should every patient cardiac patient be considered for LAAO?

• 50% cardiac patients risk factors for AF / Stroke:
  • Atrial cardiomyopathy
  • HTN / age >75 / HF / valve disease / LA enlargement
  • Only one surgical chance of LAAO
LEAAPS Trial

Intracardiac Echos

Follow-up Visits:
- Discharge, After cardiac surgery procedure
- 3 months
- 12 months
- Every 2 months thereafter until a common end date

Patients enrolled were classified as:
- AHA/ACC LAAE
- No LAAE

30-day OAC = patient on oral anticoagulation.

Risk Stratification in Cardiac Surgery Patients

Low Risk
- No Afib
- CHA2DS2-VASC = 2
- Age <65 yrs
- No Atrial Cardiomyopathy

Elevated Risk
- No Afib
- CHA2DS2-VASC = 2
- Age >65 yrs
- Atrial Cardiomyopathy
  (1 LAA, 1 LAD, 1 pro-BNP)

Pre-Op Afib
- Afib History

LeAAPS Trial
- 13% of CS Patients

LAOSS III Trial
- 59% of CS Patients

- 28% of CS Patients
- 33% reduction in ischemic stroke and systemic embolism (at 3.8 yrs)
- No evidence of adverse events
- Benefit is additive to anti-platelet therapy
Conclusion

• Atrial fibrillation / LAA clot is an important risk factor for stroke

• LAAO is safe and effective in decreasing risk of stroke

• There is a need to increase surgical LAAO in AF all patients
Conclusion

• LAAO will be indicated on all high-risk surgical patients?

• In LAAO, will anticoagulation be needed?

AtriCure Study

Atsushi Okada, MD, PhD
Vinayak N. Bapat, MD

Minneapolis Heart Institute Foundation
Minneapolis Heart Institute at Abbott Northwestern Hospital
Devices to isolate the left atrial appendage

**Transcatheter devices**
- **Watchman®**
- **Amulet®**

**Surgical device**
- **AtriClip®**

Available in 4 sizes (35, 40, 45, 50 mm)

Device sizing is performed in different ways

**Transcatheter devices**
- Device sizing by preprocedural imaging
  - Transesophageal echo
  - Computed tomography (CT)

**Surgical devices (AtriClip)**

Usefulness of preprocedural imaging (CT) for AtriClip sizing is unknown
Appropriate device sizing is crucial

- If the Clip is too small, may result in incomplete closure
- If large, Clips may interfere with the surrounding structures
  - Coronary arteries
  - Pulmonary veins

Aim of this study

We sought to investigate

1. Association between theoretical CT-predicted size and implanted size during surgery

2. Their association with imaging outcomes
   - findings on prospectively conducted post-AtriClip CTs

in patients undergoing AtriClip placement
Methods

Study population

- Prospectively enrolled patients undergoing open heart surgery @ ANW and clinically indicated for LAA ligation with the AtriClip device

Consented for the study
N=30

Exclusion

Study population
Completed 30-day follow-up CT
N=24
Methods

Evaluations

- Baseline characteristics

- Pre-AtriClip CT

- AtriClip sizing during surgery (on-table sizing)

- Post-AtriClip CT
  - at 90 days after surgery

---

Pre-AtriClip CT 1

“Clip Plane”
- Parallel to the LAA ostium
- Above (distal to) the left circumflex artery
- Area and perimeter in short axis view

LAA Ostium
- At the base of LAA
- Area and perimeter in short axis view
**CT-predicted AtriClip size**

<table>
<thead>
<tr>
<th>Perimeter at Clip plane</th>
<th>Perimeter/2</th>
<th>CT suggested AtriClip® Flex-V® size</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.0 mm or smaller</td>
<td>35.0 mm or smaller</td>
<td>35 (smallest available)</td>
</tr>
<tr>
<td>70.1 - 80.0 mm</td>
<td>35.1 - 40.0 mm</td>
<td>40</td>
</tr>
<tr>
<td>80.1 - 90.0 mm</td>
<td>40.1 - 45.0 mm</td>
<td>45</td>
</tr>
<tr>
<td>90.1 mm or larger</td>
<td>45.1 mm or larger</td>
<td>50 (largest available)</td>
</tr>
</tbody>
</table>

**Methods**

**Pre-AtriClip CT 2**

- Trabeculation/lobe near Clip plane (<5 mm)
AtriClip size during surgery

- On-table sizing by sizers: implanted Clip (IMClip)

- Comparison with CT-predicted size
  - IMClip < CTClip: on-table size was smaller than CT-predicted size
  - IMClip = CTClip: on-table size was same as CT-predicted size
  - IMClip > CTClip: on-table size was larger than CT-predicted size

Post-AtriClip CT 1

- Complete occlusion of LAA (No Contrast in LAA)

- Thrombus formation at atrial side of Clip
### Methods

**Post-AtriClip CT 2**

<table>
<thead>
<tr>
<th>Stump depth &lt;10 mm</th>
<th>Stump depth &gt;10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trabeculation/lobe in stump (-)</td>
<td><img src="Image1.png" alt="Images" /></td>
</tr>
<tr>
<td>Trabeculation/lobe in stump (+)</td>
<td><img src="Image4.png" alt="Images" /></td>
</tr>
</tbody>
</table>

### Methods

**Post-AtriClip CT 3**

- Clip interference with surrounding structures
  - coronary arteries (left main trunk, left circumflex artery)
  - left superior pulmonary vein

- AoV: aortic valve
- LA: left atrium
- LV: left ventricle
- LSPV: left superior pulmonary vein
## Results

### Patient Characteristics

<table>
<thead>
<tr>
<th></th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>69 (61-77)</td>
</tr>
<tr>
<td>Male</td>
<td>15 (63%)</td>
</tr>
<tr>
<td>Body surface area, m²</td>
<td>2.02 (1.81-2.17)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>9 (38%)</td>
</tr>
</tbody>
</table>

**Surgical data**

<table>
<thead>
<tr>
<th>AtriClip size, mm</th>
<th>35</th>
<th>6 (25%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>9 (38%)</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>4 (17%)</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>5 (21%)</td>
</tr>
</tbody>
</table>

**Procedures***

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic valve surgery</td>
<td>11</td>
<td>46%</td>
</tr>
<tr>
<td>Mitral valve surgery</td>
<td>10</td>
<td>42%</td>
</tr>
<tr>
<td>Tricuspid valve surgery</td>
<td>3</td>
<td>13%</td>
</tr>
<tr>
<td>Coronary artery bypass grafting</td>
<td>7</td>
<td>29%</td>
</tr>
<tr>
<td>Ascending aorta replacement</td>
<td>1</td>
<td>4%</td>
</tr>
</tbody>
</table>
### Pre-AtriClip CT

<table>
<thead>
<tr>
<th>LAA shapes</th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken wing</td>
<td>9 (38%)</td>
</tr>
<tr>
<td>Cactus</td>
<td>3 (13%)</td>
</tr>
<tr>
<td>Windsock</td>
<td>9 (38%)</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>3 (13%)</td>
</tr>
</tbody>
</table>

**Ostium**

<table>
<thead>
<tr>
<th>Area, mm²</th>
<th>519 (423-676)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter, mm</td>
<td>87 (79-103)</td>
</tr>
</tbody>
</table>

**Clip plane**

<table>
<thead>
<tr>
<th>Area, mm²</th>
<th>449 (384-613)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perimeter, mm</td>
<td>80 (72-92)</td>
</tr>
</tbody>
</table>

| Trabeculation/lobe near Clip plane | 12 (50%) |

---

### Post CT 1

<table>
<thead>
<tr>
<th>Complete occlusion of LAA</th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

| Thrombus formation at Clip | 0 (0%) |

<table>
<thead>
<tr>
<th>Residual stump</th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>depth &gt;10mm</td>
<td>6 (25%)</td>
</tr>
<tr>
<td>depth &lt;10mm</td>
<td>18 (75%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trabeculation/lobe in stump</th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12 (50%)</td>
</tr>
<tr>
<td>No</td>
<td>12 (50%)</td>
</tr>
</tbody>
</table>

---

**Stump depth**

<table>
<thead>
<tr>
<th>Stump depth</th>
<th>N=6</th>
<th>Stump depth</th>
<th>N=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;10 mm</td>
<td>3 (50%)</td>
<td>&lt;10 mm</td>
<td>9 (50%)</td>
</tr>
<tr>
<td>Trabeculation/lobe in stump (-)</td>
<td>3 (50%)</td>
<td>Trabeculation/lobe in stump (+)</td>
<td>3 (50%)</td>
</tr>
<tr>
<td>Trabeculation/lobe in stump (+)</td>
<td>9 (50%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Results

Post CT 2

<table>
<thead>
<tr>
<th>Clip interference with surrounding anatomy</th>
<th>N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximity with Left main trunk</td>
<td>1 (4%)</td>
</tr>
<tr>
<td>Proximity with Left circumflex artery (LCx)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Proximity with Left superior pulmonary vein</td>
<td>4 (17%)</td>
</tr>
</tbody>
</table>

Results

AtriClip size during surgery vs. CT-predicted size

![Graph showing AtriClip size comparison](image)

Cases with residual stump >10 mm

Theoretical range
Results
Factors associated with size discrepancy

<table>
<thead>
<tr>
<th>Rates of residual stump (&gt;10 mm)</th>
<th>Proximity with left superior pulmonary vein</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Graph" /></td>
<td><img src="image2" alt="Graph" /></td>
</tr>
</tbody>
</table>

Results
Can we predict imaging outcomes from pre-AtriClip CT?

<table>
<thead>
<tr>
<th>Rates of residual stump (&gt;10 mm)</th>
<th>Residual trabeculation/lobe in stump</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Graph" /></td>
<td><img src="image4" alt="Graph" /></td>
</tr>
</tbody>
</table>

On Pre-AtriClip CT
Conclusions

• AtriCure study is a prospective evaluation of pre- and post-CTs in patients undergoing LAA elimination using AtriClip device

• Both pre- and post-CTs can provide important information which could contribute to better outcomes

Thank you for your attention