Transcatheter Intervention for Heart Failure Reduced Ejection Fraction: Current and Future Trends

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Disclosure Statement of Financial Interest

- I am a full-time employee of the Cardiovascular Research Foundation, which organizes and operates Transcatheter Cardiovascular Therapeutics (TCT), which receives educational and research grants from several interventional heart failure companies.

Heart Failure is the EPICENTER of Interventional Cardiovascular Therapies

- HF is the ‘final common pathway’ of ALL CV diseases
  - Prevalence: ~ 4.3% of US population >65 years of age
  - ~70% of CCU admissions and ~50% mortality at 5 years
  - Most costly condition in CV medicine (pharma expenses ~$30 billion/year)
- HF hemodynamics well suited for analytic differential diagnosis and evidence-based therapy guidance (including AI-based)
- Primary causes easily targeted by catheter-based therapies!

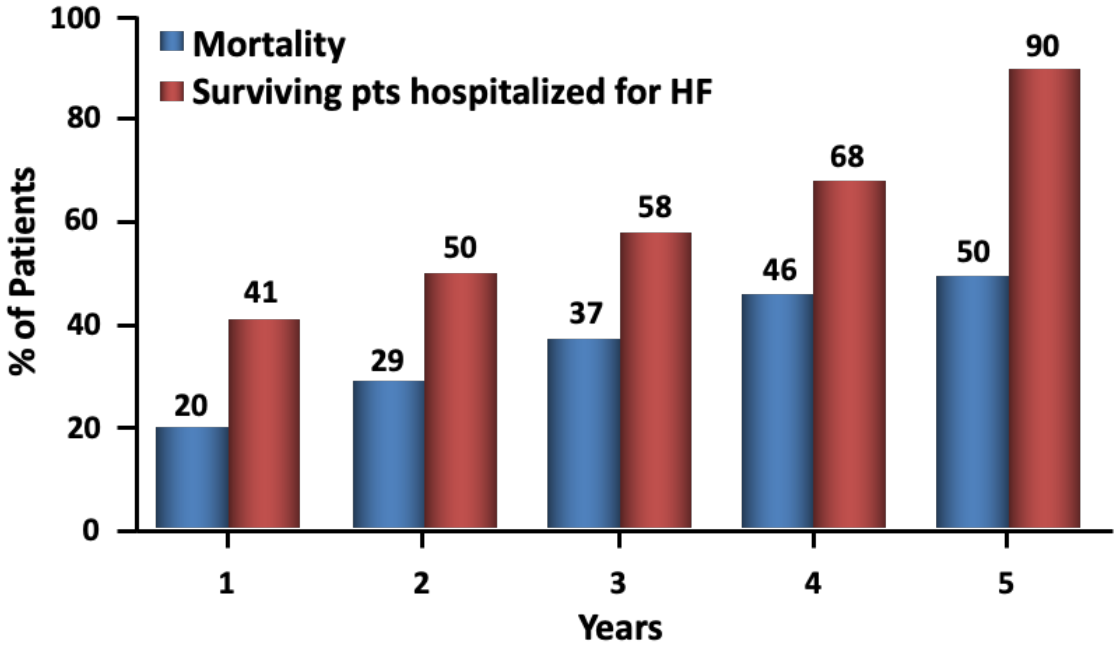
Heart Failure and the Percutaneous Treatment of Valvular Heart Disease

Natural History of Severe MR in the Real World

1,095 Pts* With 3+/4+ MR and HF (2000 to 2008)

- 74% FMR vs.21% DMR
- DMR Pts (N=226):
  - 84% SURGERY vs. 16% Med Rx
- FMR Pts (N=814):
  - 36% SURGERY vs. 64% Med Rx
- Un-Operated Med Rx Patients:
  - Lower LVEF
    Mean 27% Vs. 42%, P<0.0001
  - Higher STS Score
    Median 5.8 Vs. 4.0, P<0.001

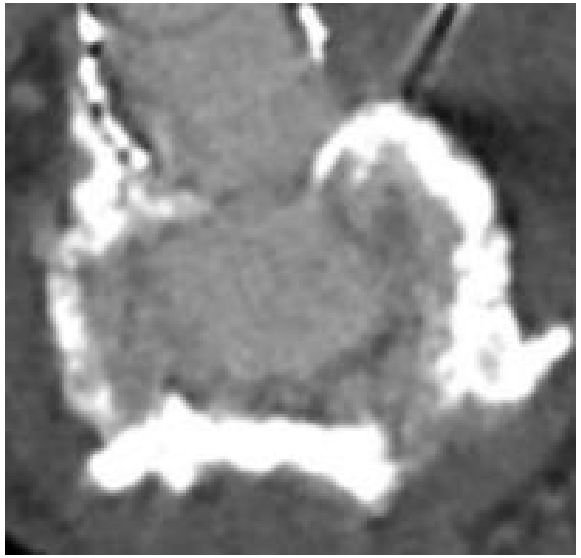
Prognosis of Unoperated Patients



* Excluded MVA ≤2 cm², AR ≥2+, aortic peak velocity ≥2.5 m/s, HCM, endocarditis, concomitant AV, Ao or pericardial surgeries, LVAD or OHT.

Goel SS et al. JACC 2014;63:185–90

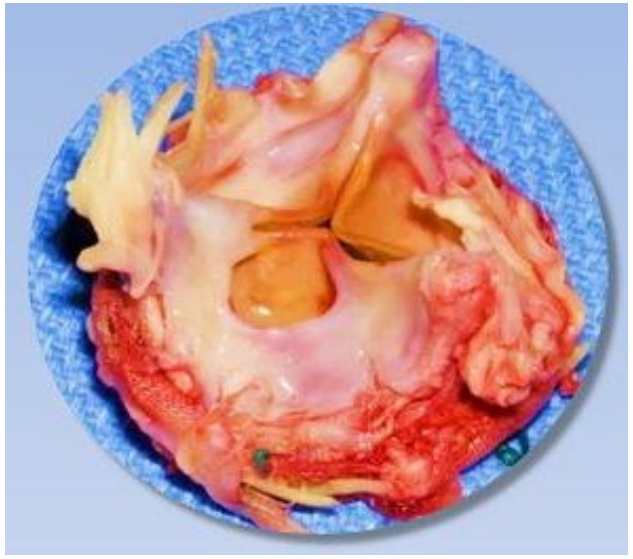
MR Patients Considered for TMVR Display Complex Mitral Valve Features



Severe MAC

Multiple Cleft Leaflets

Multiple MR Jets

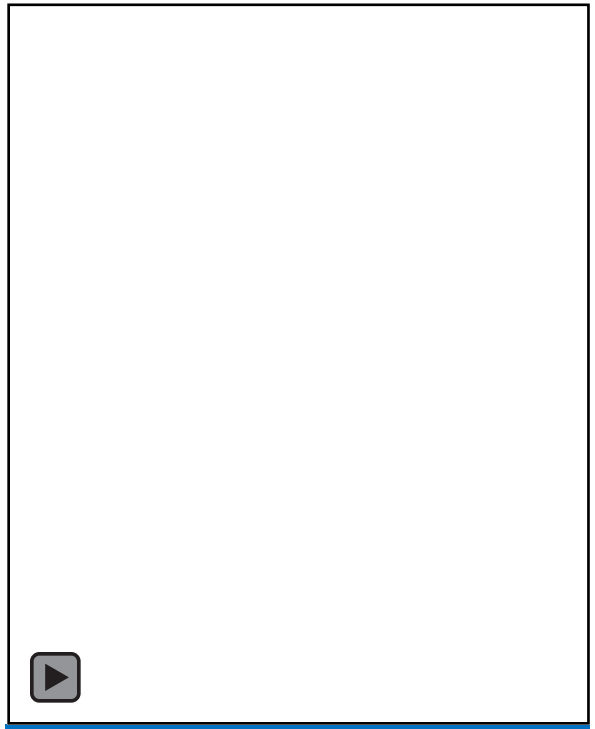


Bioprosthetic Failures

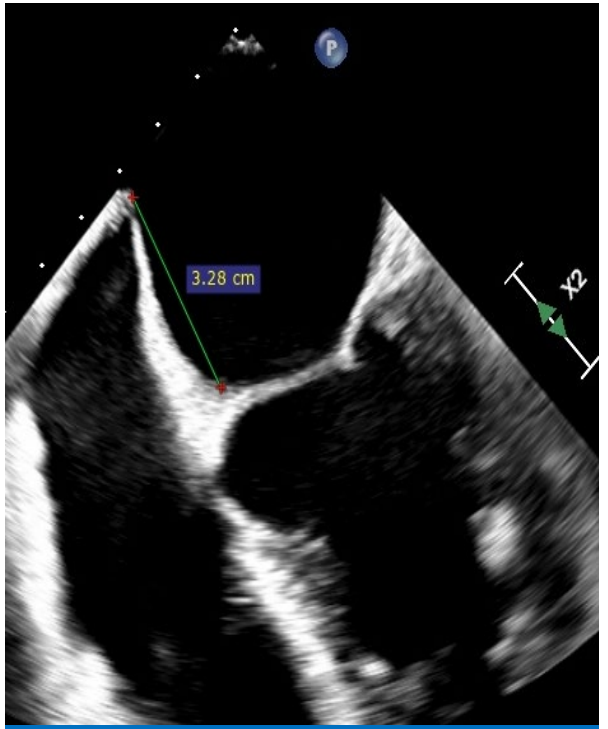
Special Device Design Considerations Are Needed!

Early Cephea™ Gen 3 Clinical Experience South America Feasibility Study

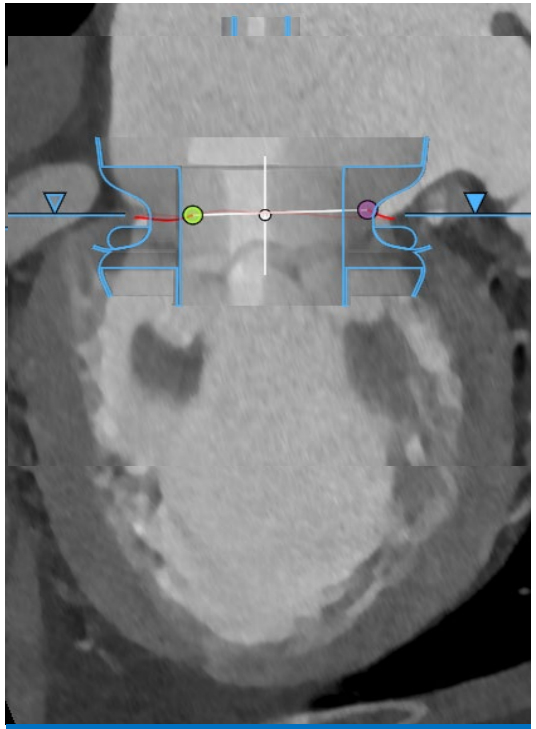
Age	80
Gender	F
MV Disease	4+ SMR
LVEF	32%
LVEDD	5.7 cm
MVA	2.5 cm^2
NYHA	II
STS-PROM	3.3



LOW EF
Hemodynamic Stability

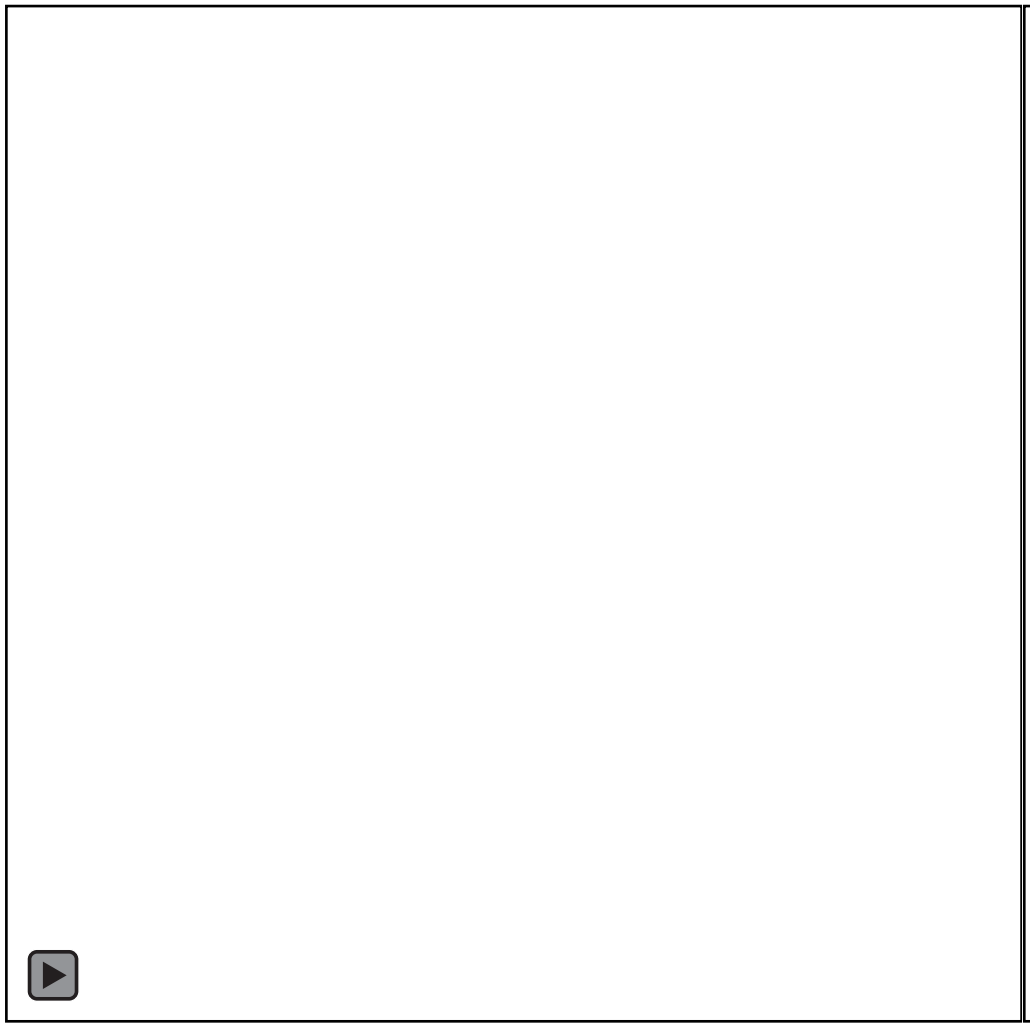


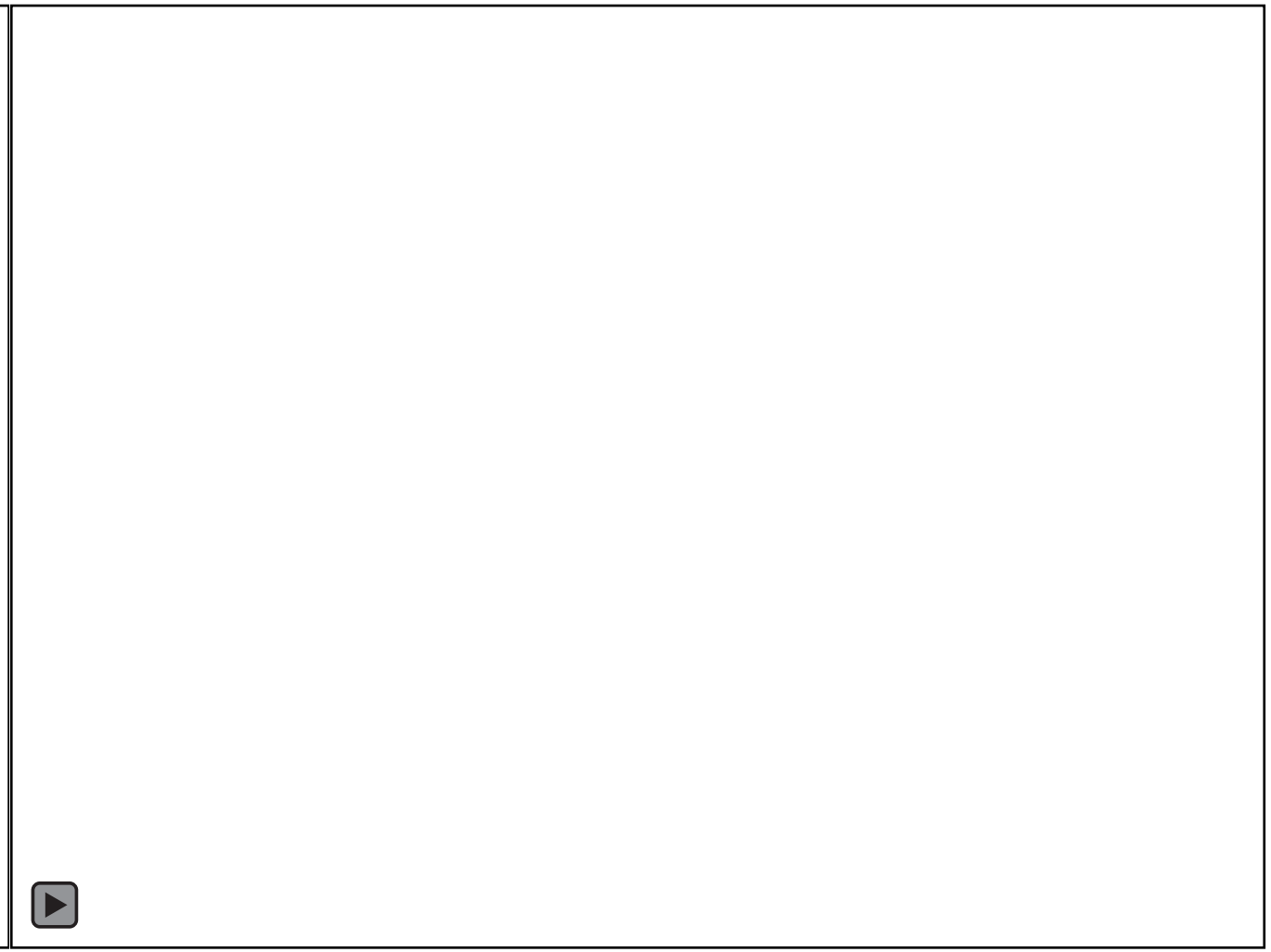
LOW SEPTAL HEIGHT
Depth Control



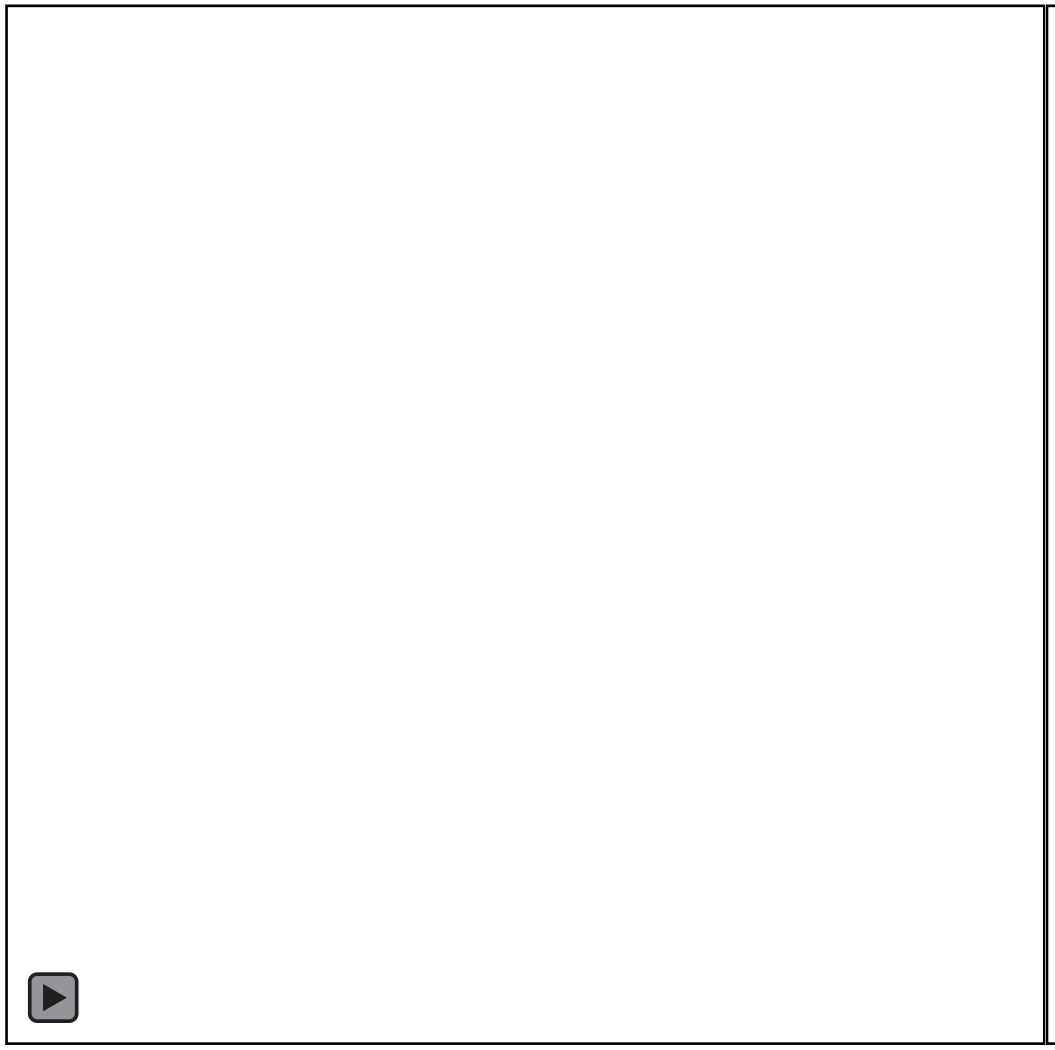
HIGH PAPILLARY
Precise Delivery

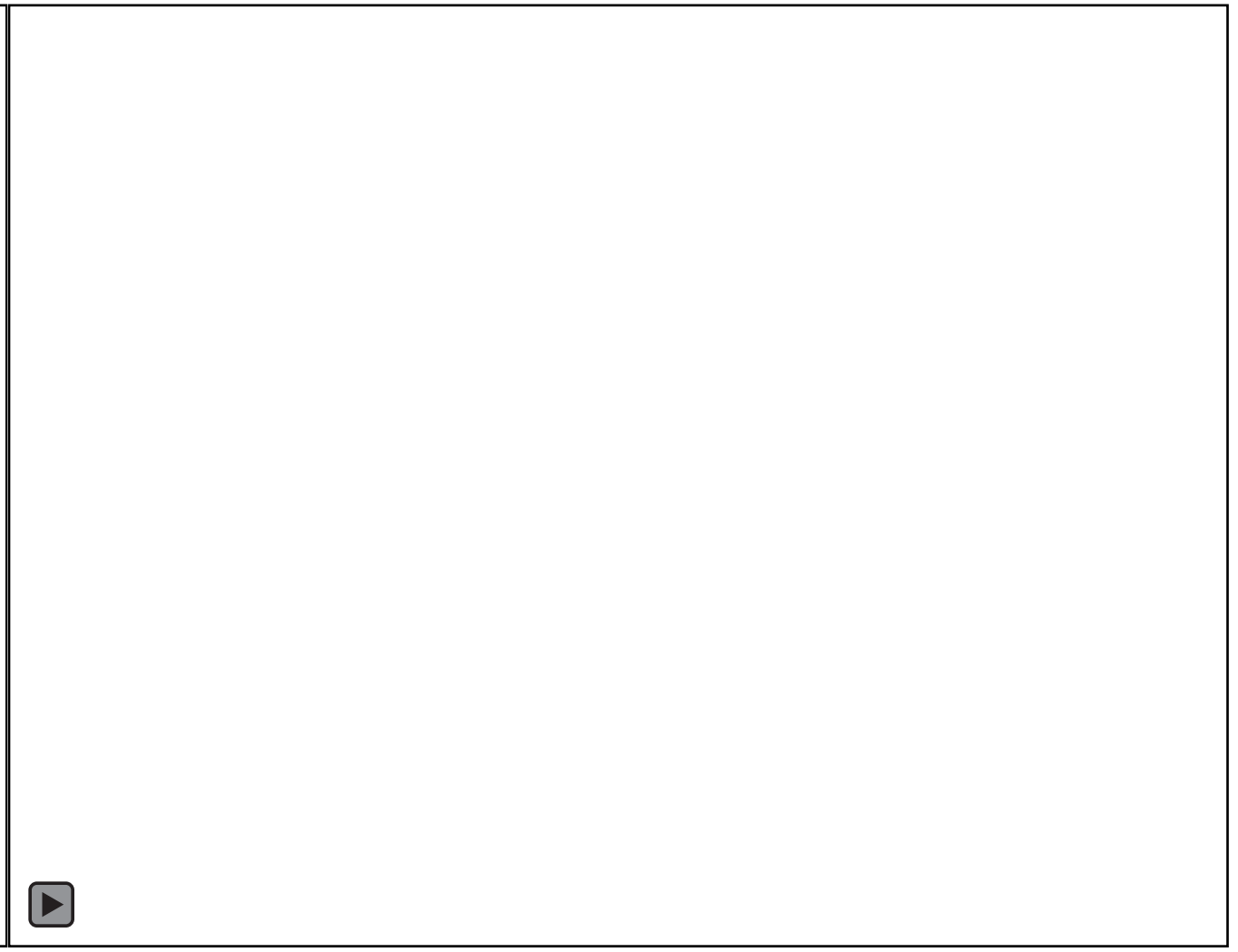
Cephea™ Gen 3: Second Position



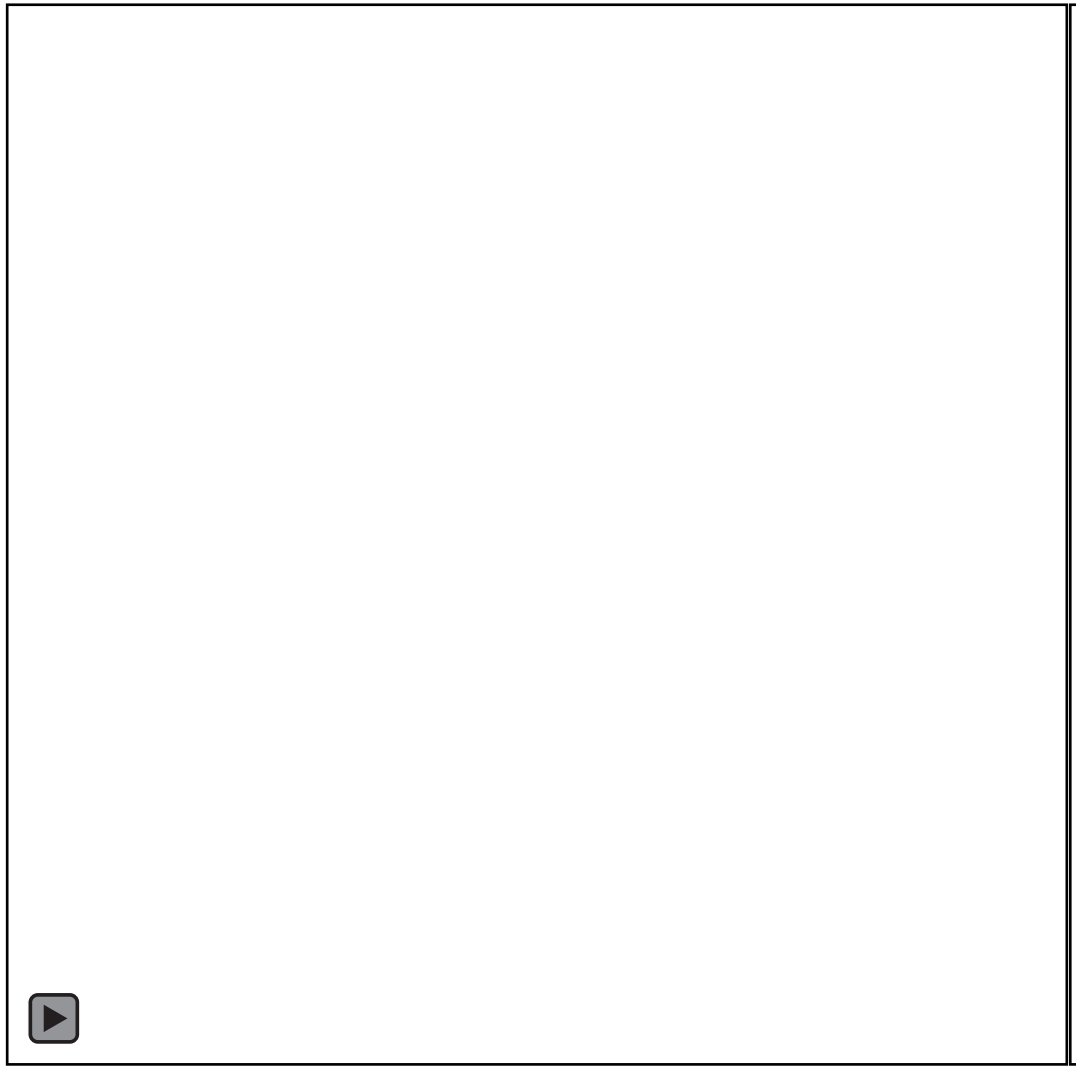


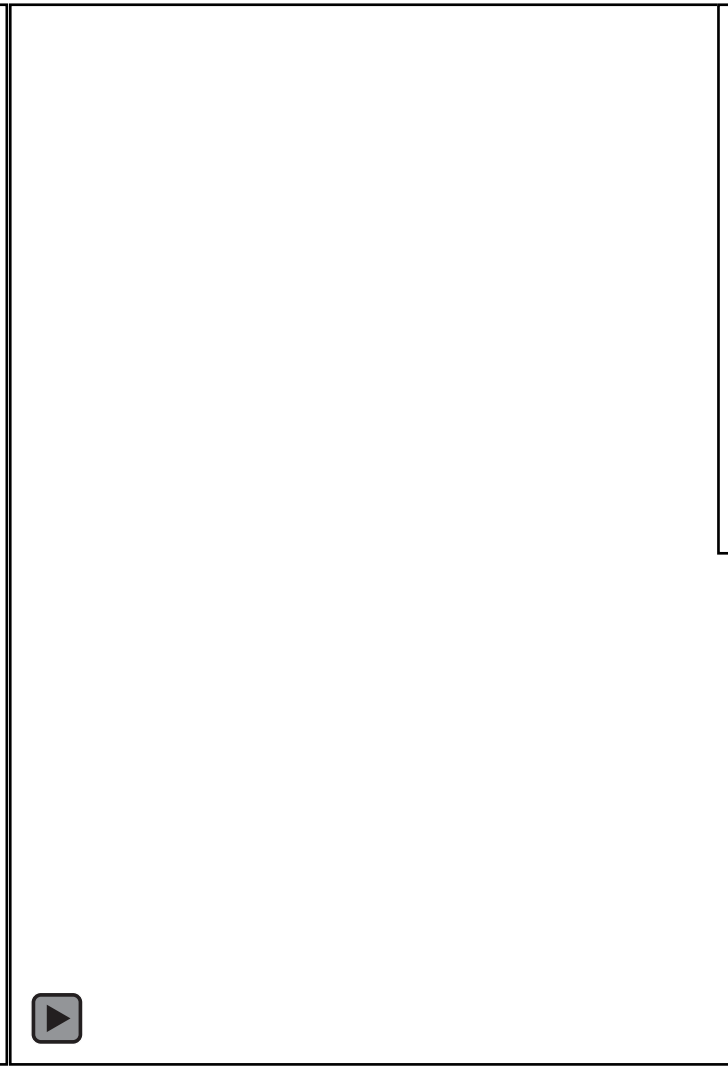
Cephea™ Gen 3: Valve Deployment

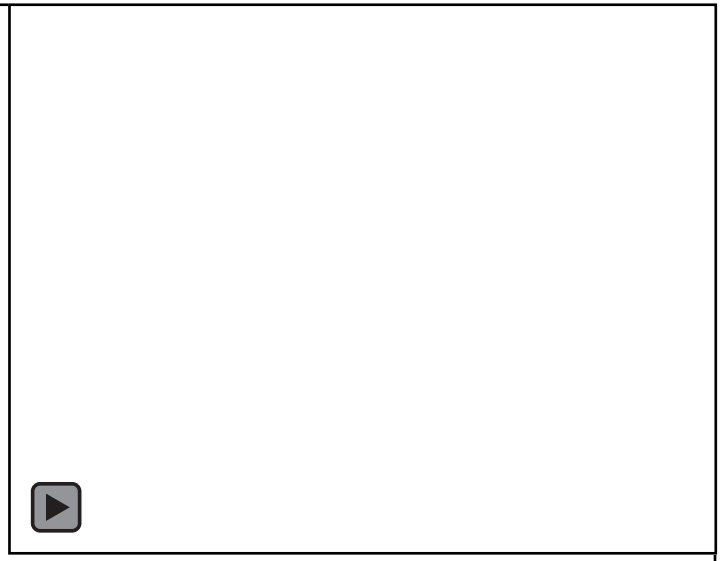




Cephea™ Gen 3: Final Result

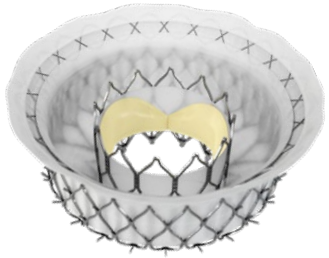






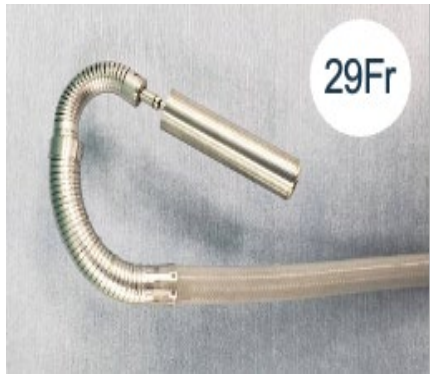
Next Generation TMVR Systems

SINGLE STEP (ANNULAR)

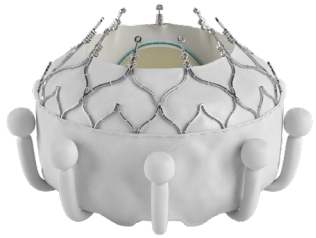


INTREPID

CEPHEA

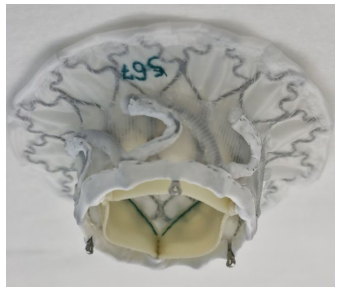


SINGLE STEP (SUB-ANNULAR)



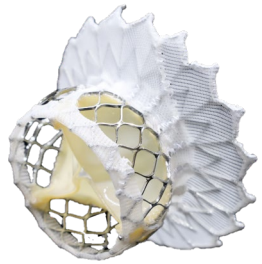
EVOQUE

REVALVE



INNOVALVE

MULTIPLE STEP (SUB-ANNULAR)



HIGHLIFE

SAPIEN M3

TIOGA

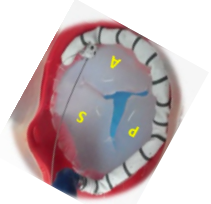
INNOVHEART

Transcatheter Tricuspid Valve Technologies

Annuloplasty

Trialign

Cardioband

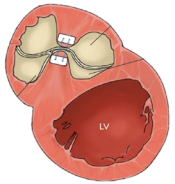


TriCinch

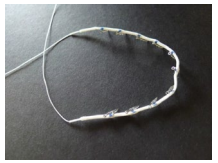
Millipede

MIA

PASTA



DaVingi



Coaptation Enhancement

Edge-to-Edge

TriClip

Pascal

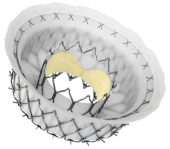
Dragonfly

Mitralix

Orthotopic Replacement

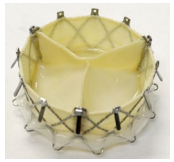
Evoque

Intrepid



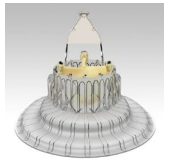
V-Dyne

Navigate

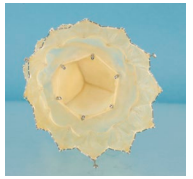


Trisol

Lux

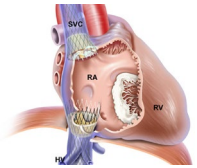


Topaz

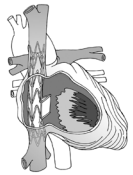


Heterotopic Replacement

TricValve

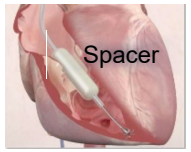


TriCento

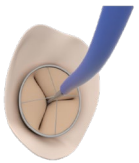


Trillium

Forma



Croi



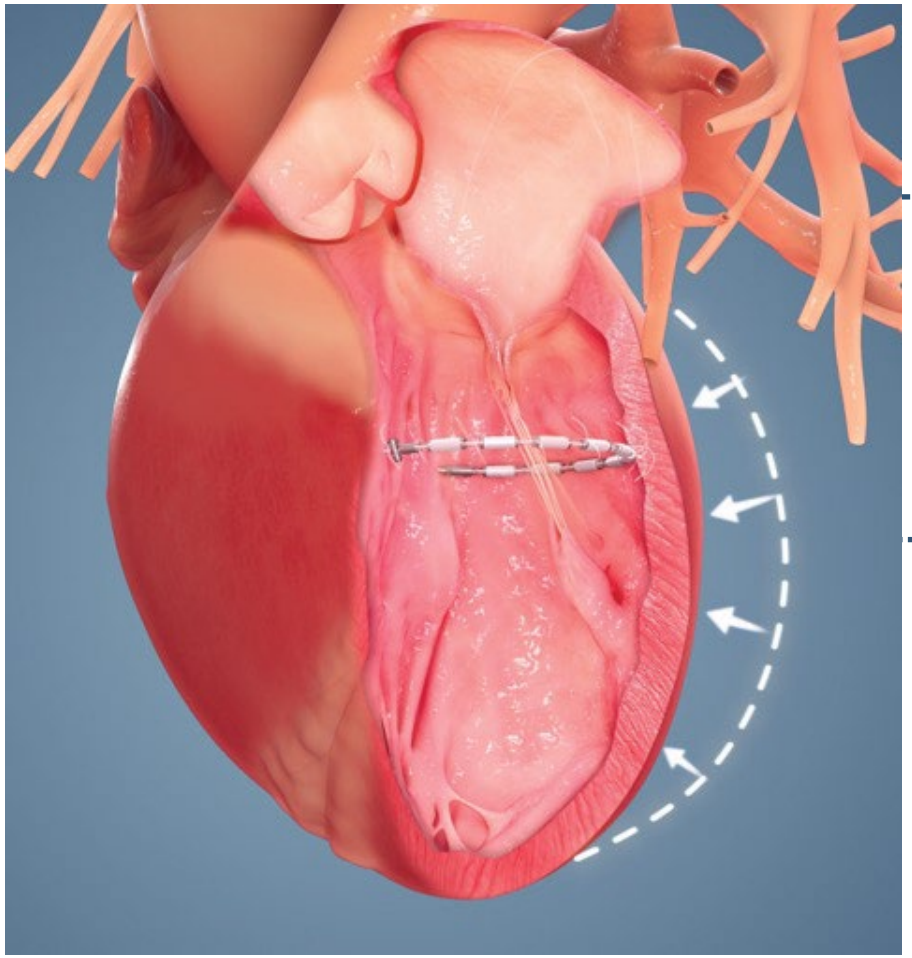
Coramaze

Tri-Flow

Spacers

Reshaping the Left Ventricle: Catheter-Based Ventricular Remodeling

Transcatheter Direct Sub-Annular Annuloplasty System for FMR (AccuCinch)



APPROACH:

Transcatheter device to treat the dilated left ventricle (LV)

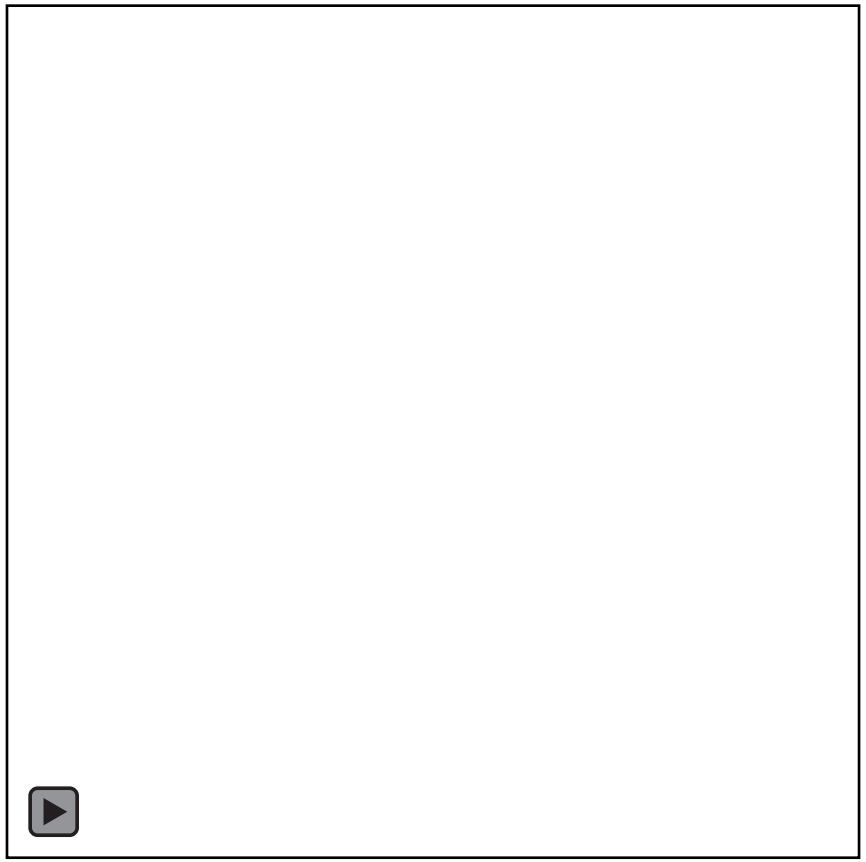
MECHANISM:

LV size reduction → LV wall stress reduction → Initiation of biological reverse remodeling

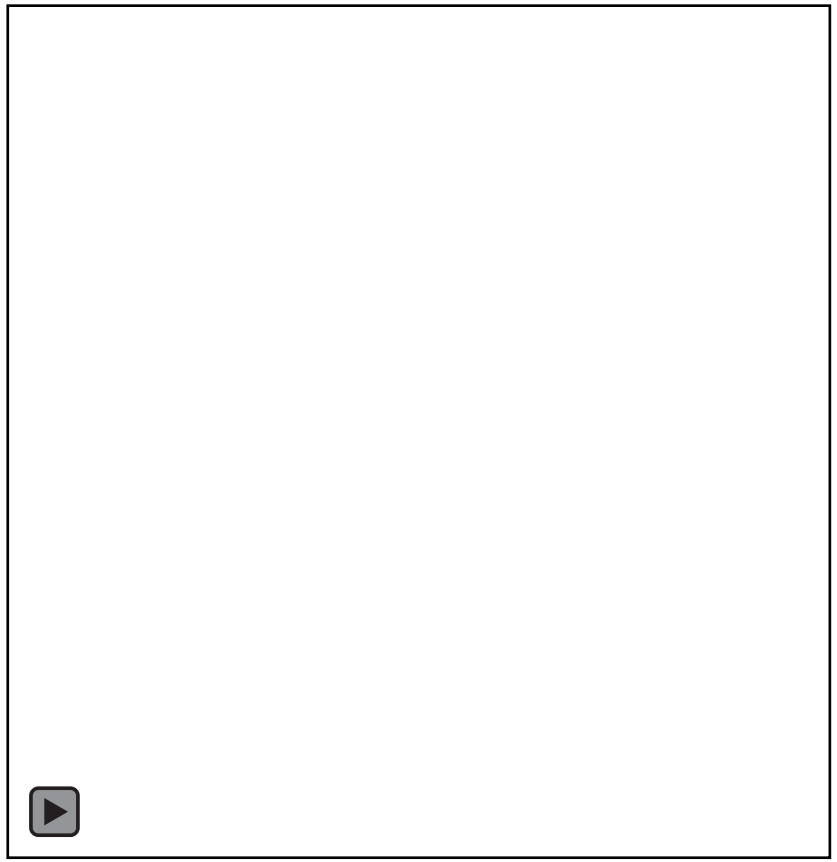
GOAL:

Improve quality of life, functional capacity, HF hospitalization rate, and life expectancy

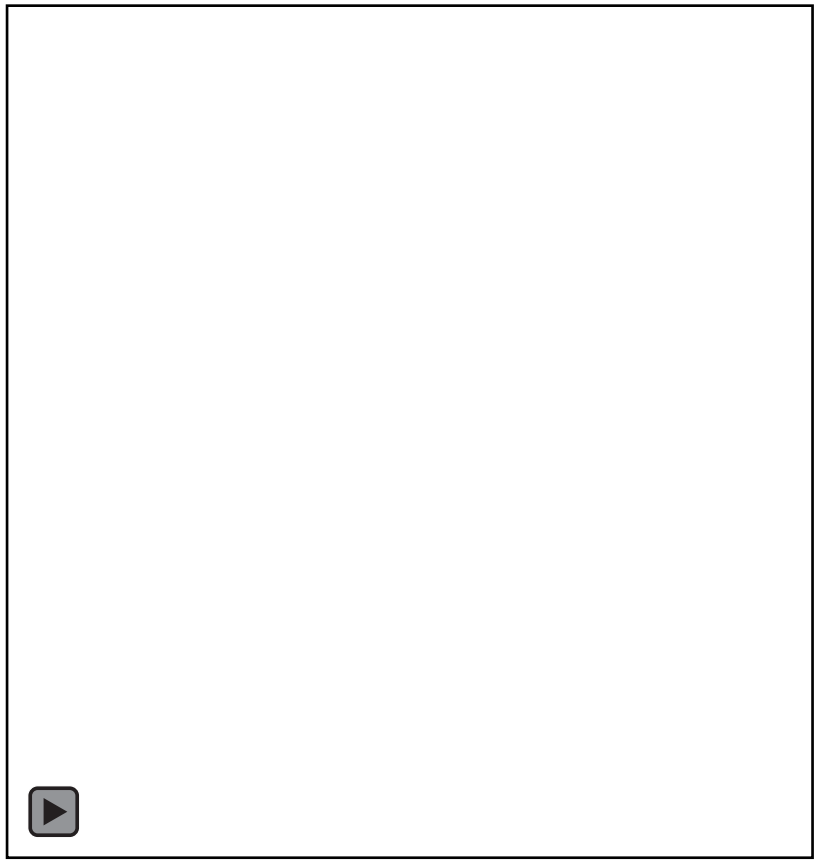
Retrograde Access to Mitral Valve



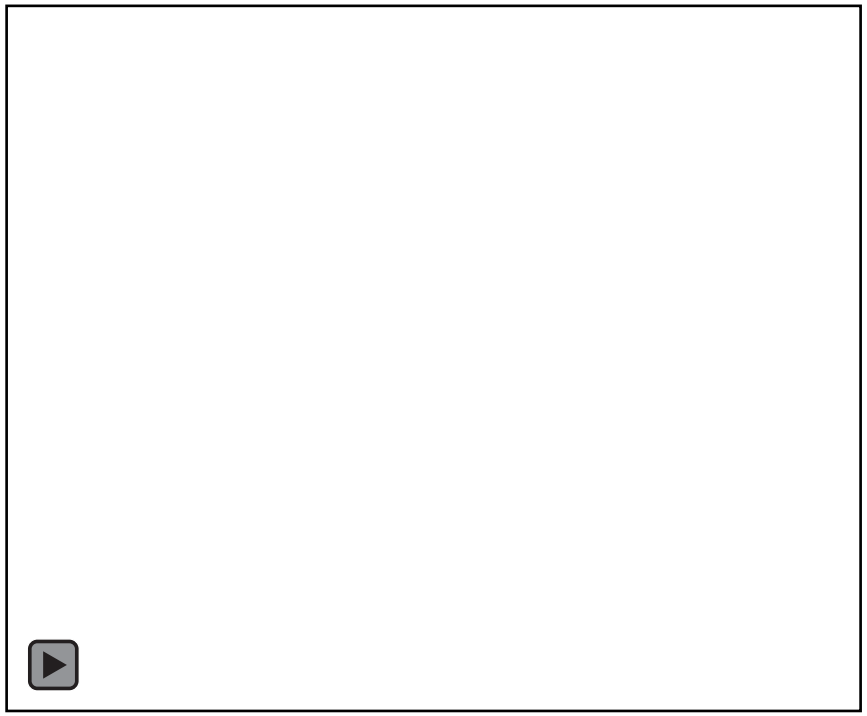
Sub-Annular Catheter Delivery



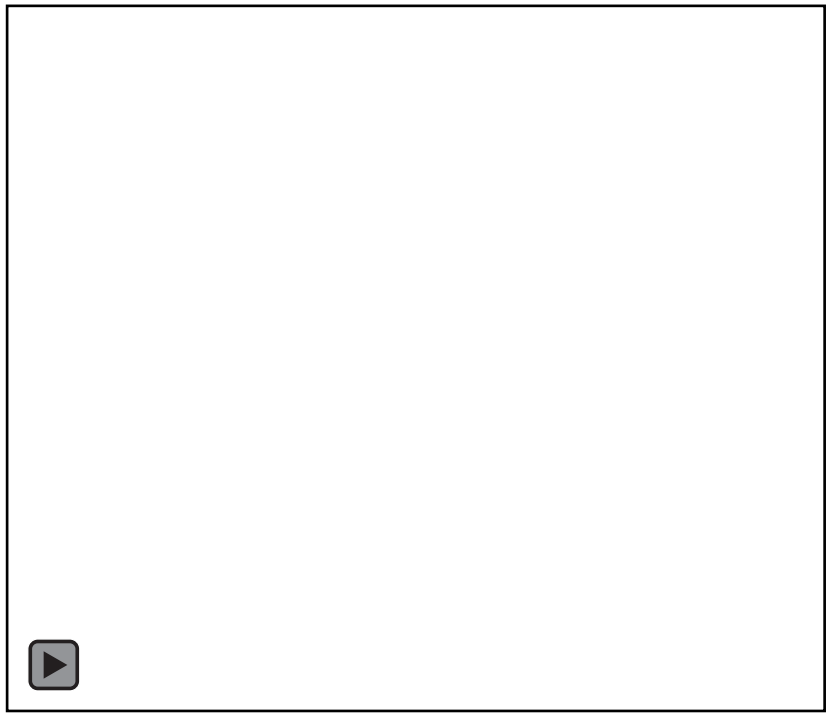
Anchor Delivery Along LV Wall



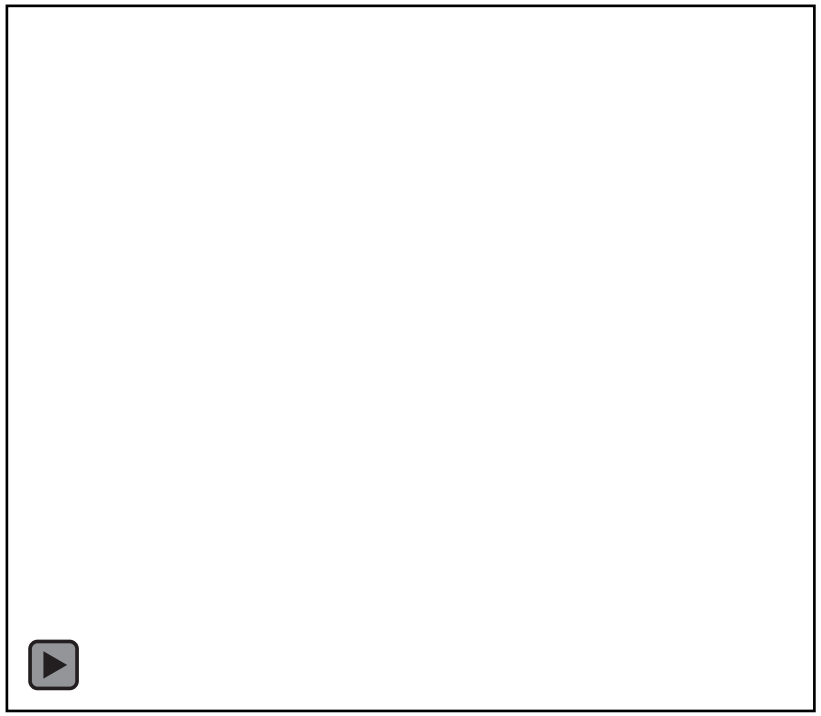
Anchor/Spacer Delivery



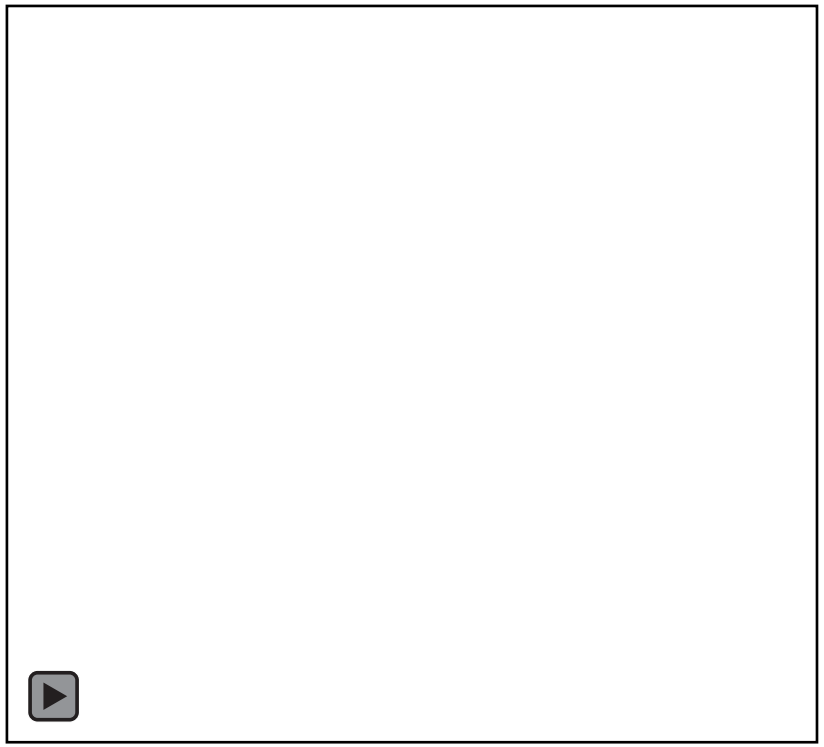
Removing the Trac Catheter

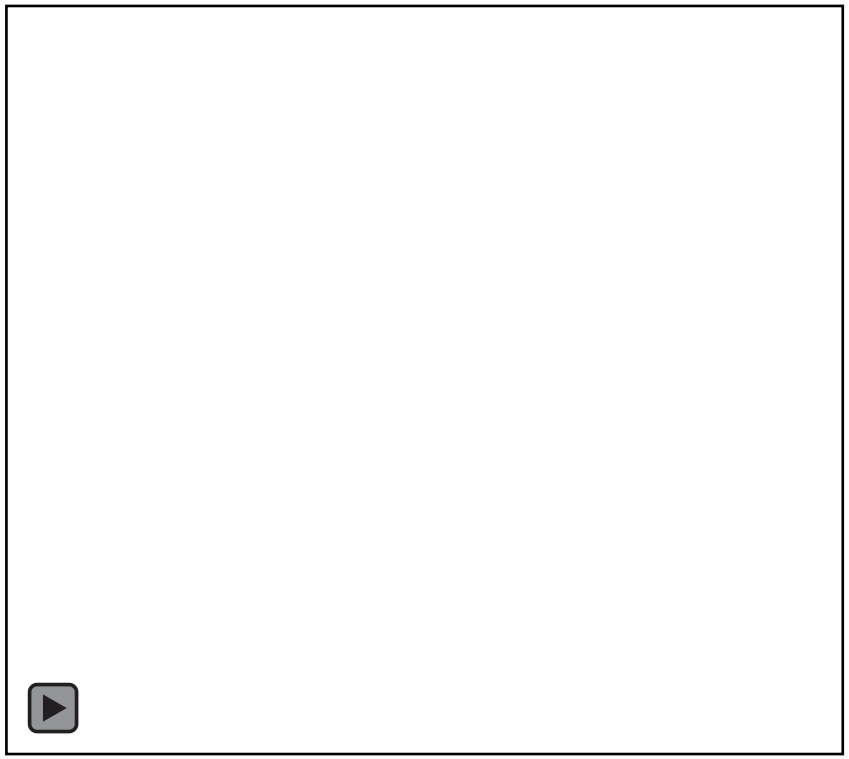


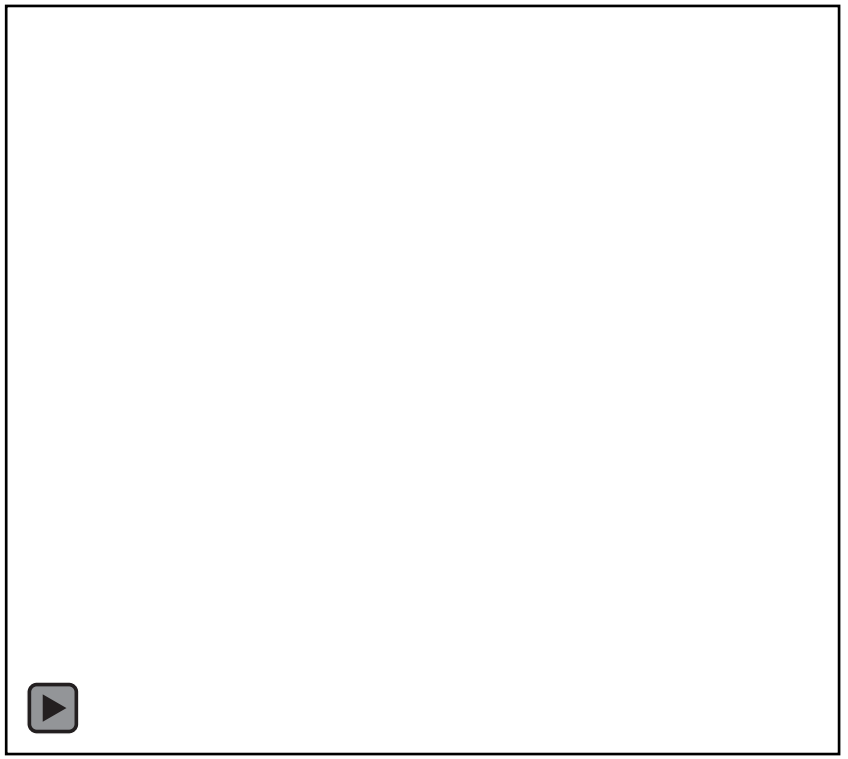
Trac Cath Removal



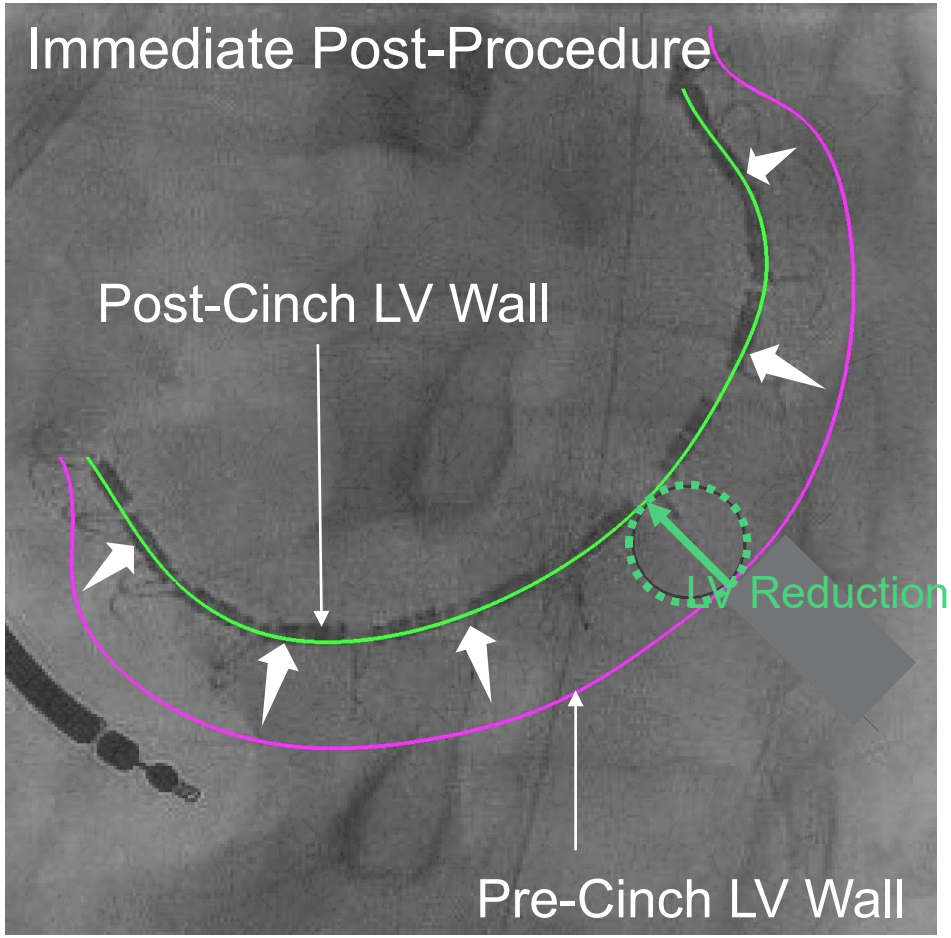
Adjusting Cinching and Locking







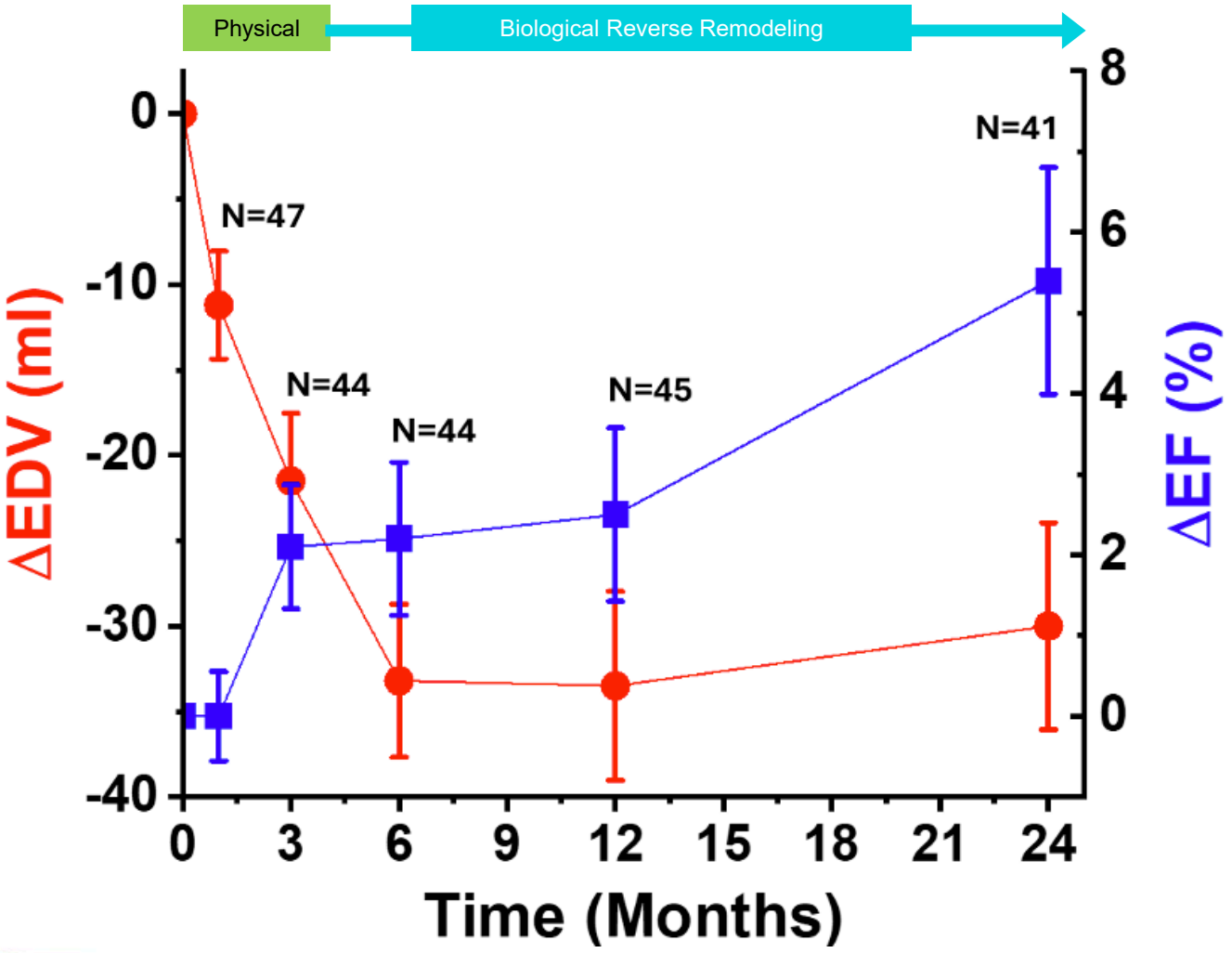
Accucinch Clinical Experience: Acute Procedural Results (n=51)



TTE Measurements	
LVEF, %	29.8 ± 5.1 [20.7 – 39.4]
LVESD, cm	5.6 ± 0.7 [3.7 - 7.1]
LVEDD, cm	6.6 ± 0.6 [5.0 - 7.9]

Procedural Results	Median
Procedure Time (min)	131 min
Anchors Placed (#)	13 anchors
LV Reduction (mm)	9.3 mm

Improvement in LVEDV and LVEF at 2 Years



Improvement in End Diastolic Volume (LVEDV)

-30mL

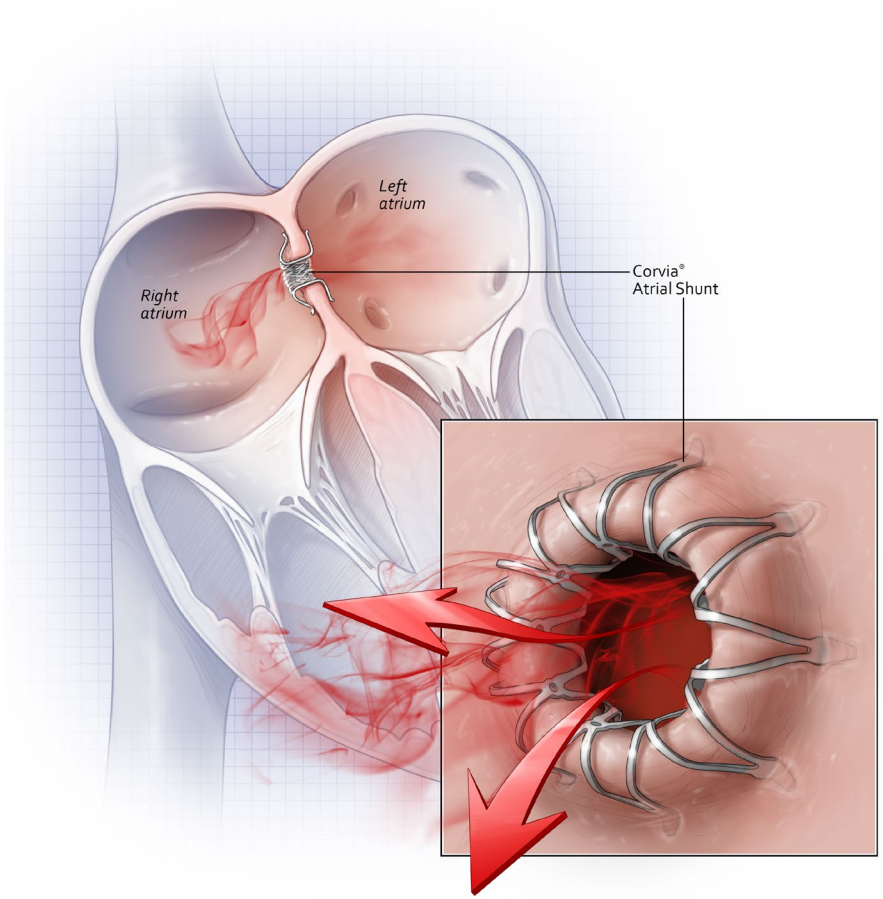
Improvement in Ejection Fraction (LVEF)

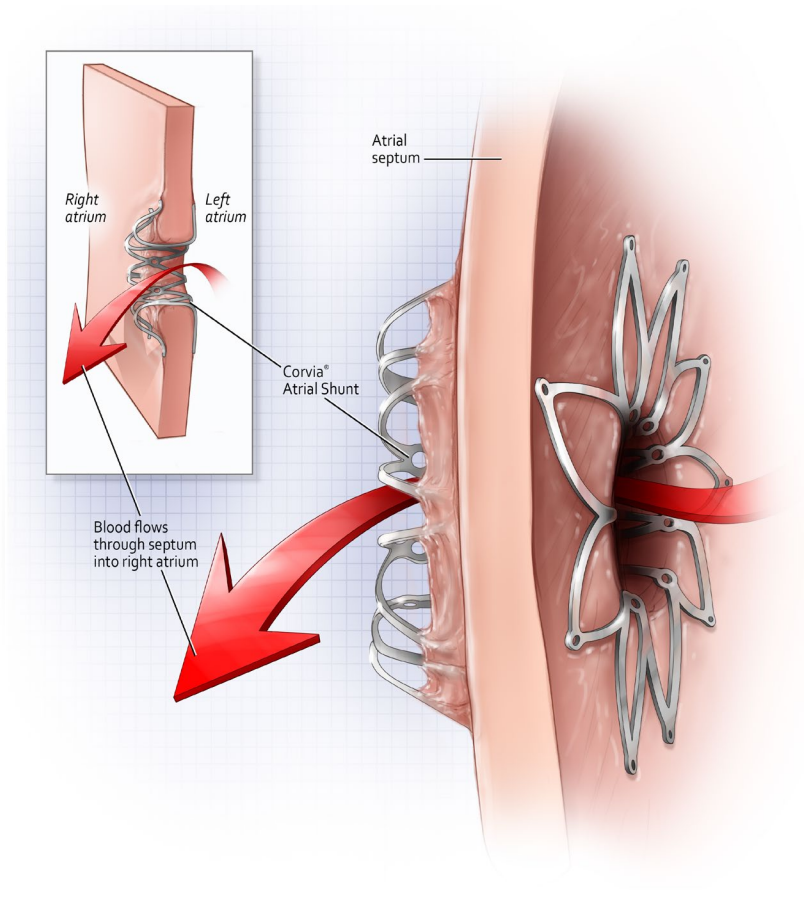
+5.4%

M. Reisman. TCT2024.

Dynamic Decompression of the LA: Percutaneous Intra-Cardiac Shunts

Percutaneous Inter-Atrial Shunts: Corvia

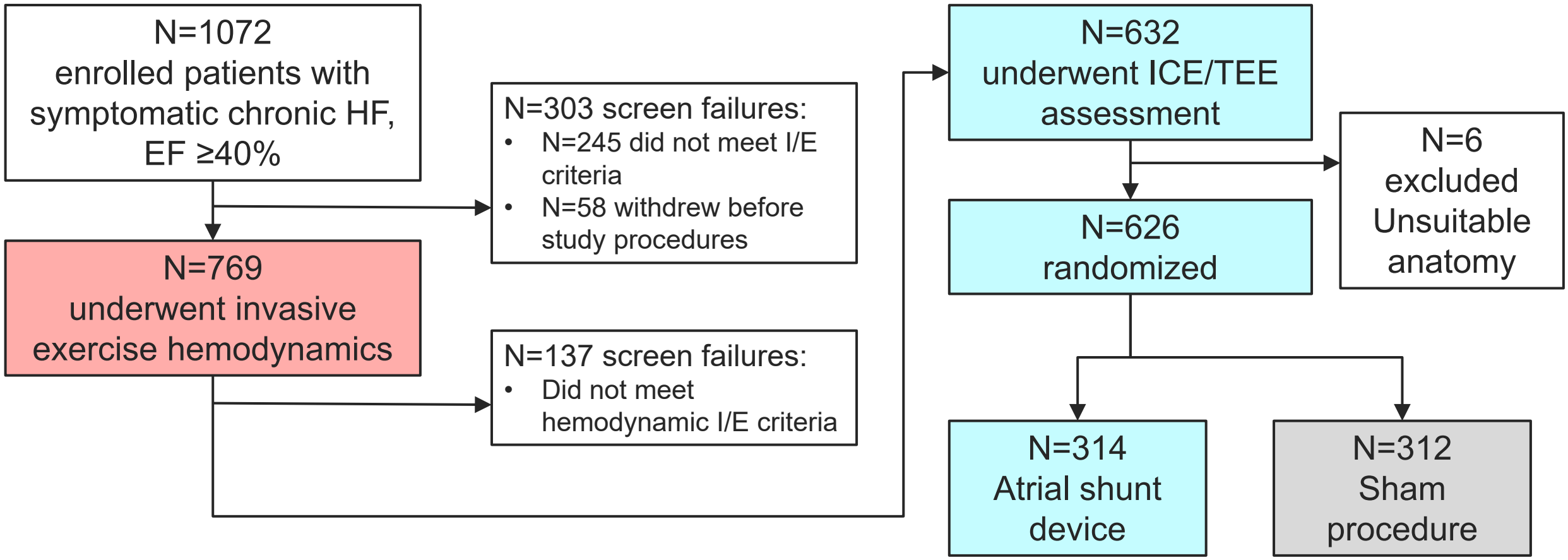




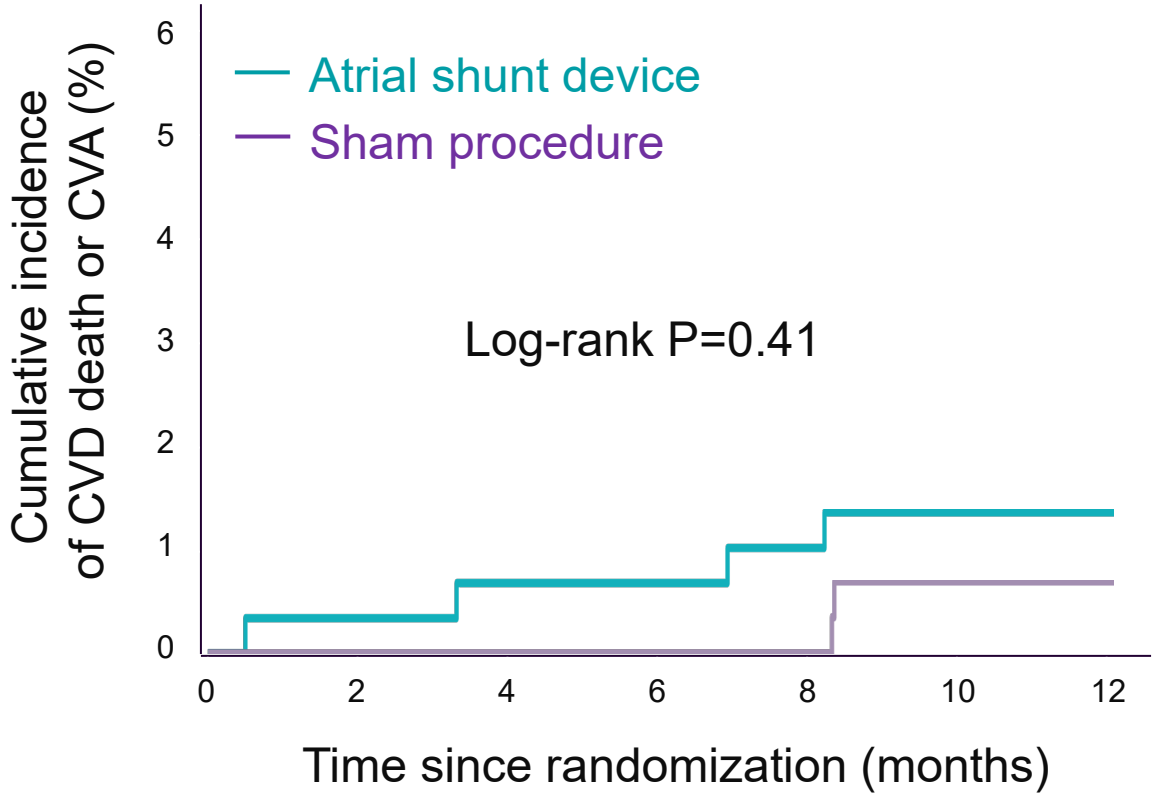
- Self-expanding nitinol cage
- Double-disc, flush with LA septum
- Single, 8-mm shunt diameter

Proposed mode of action: dynamic decompression of overloaded LA chamber by shunting blood from LA → RA (Qp:Qs 1.2-1.3)

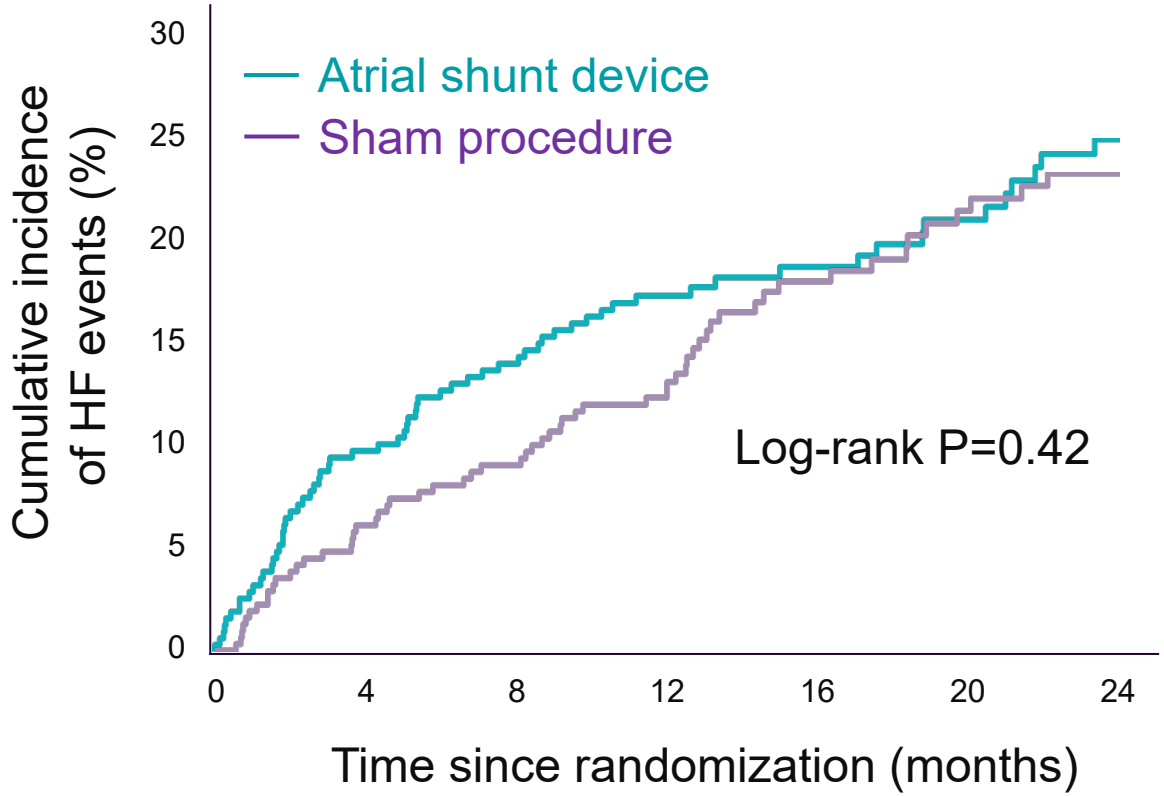
REDUCE LAP-HF II: Study Design



REDUCE LAP-HF II: Primary Endpoint



Finkelstein-Schoenfeld p-value=0.85
Win ratio: 1.0 (95% 0.8-1.2)

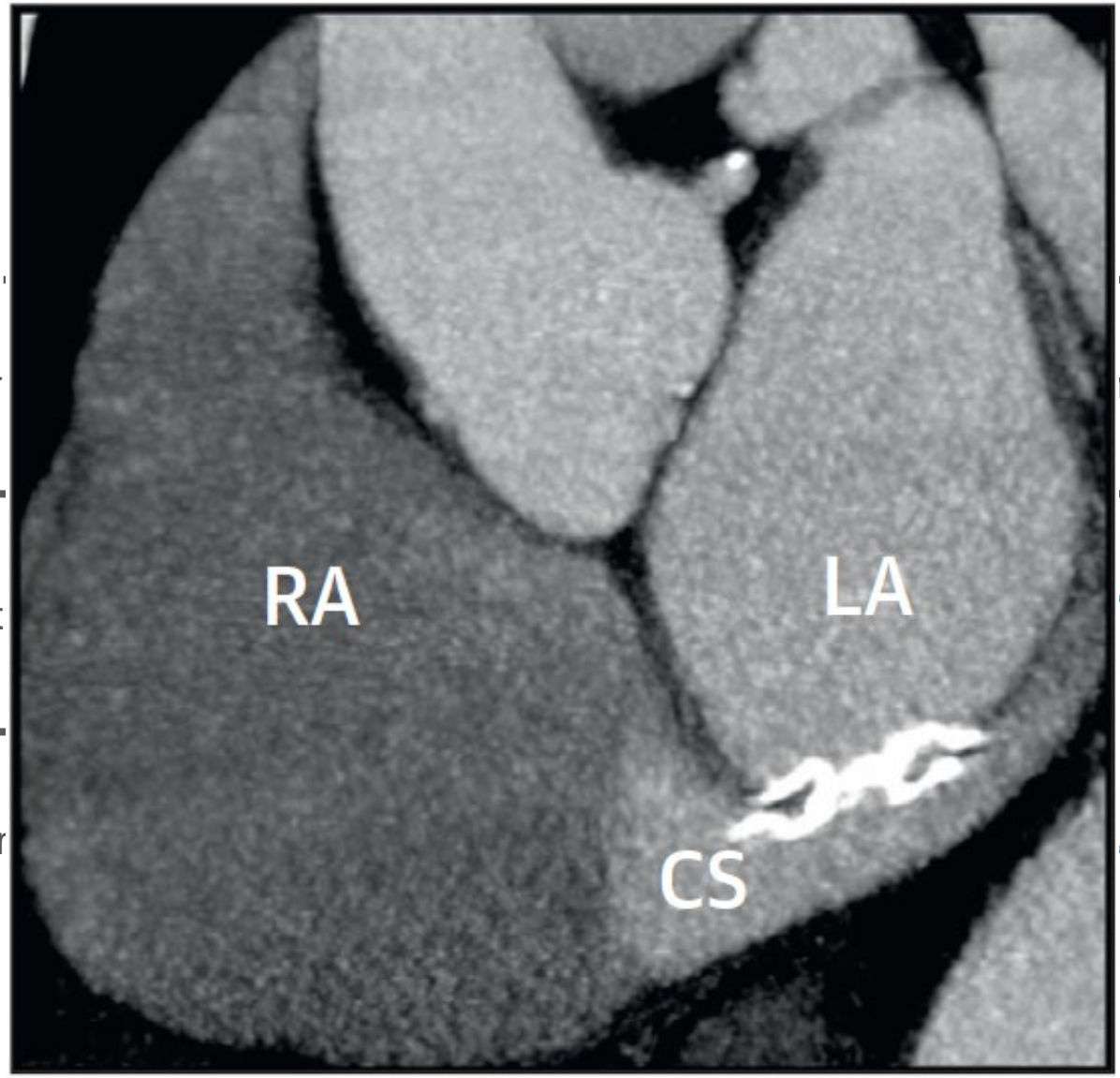


Edwards APTURE Transcatheter Shunt System

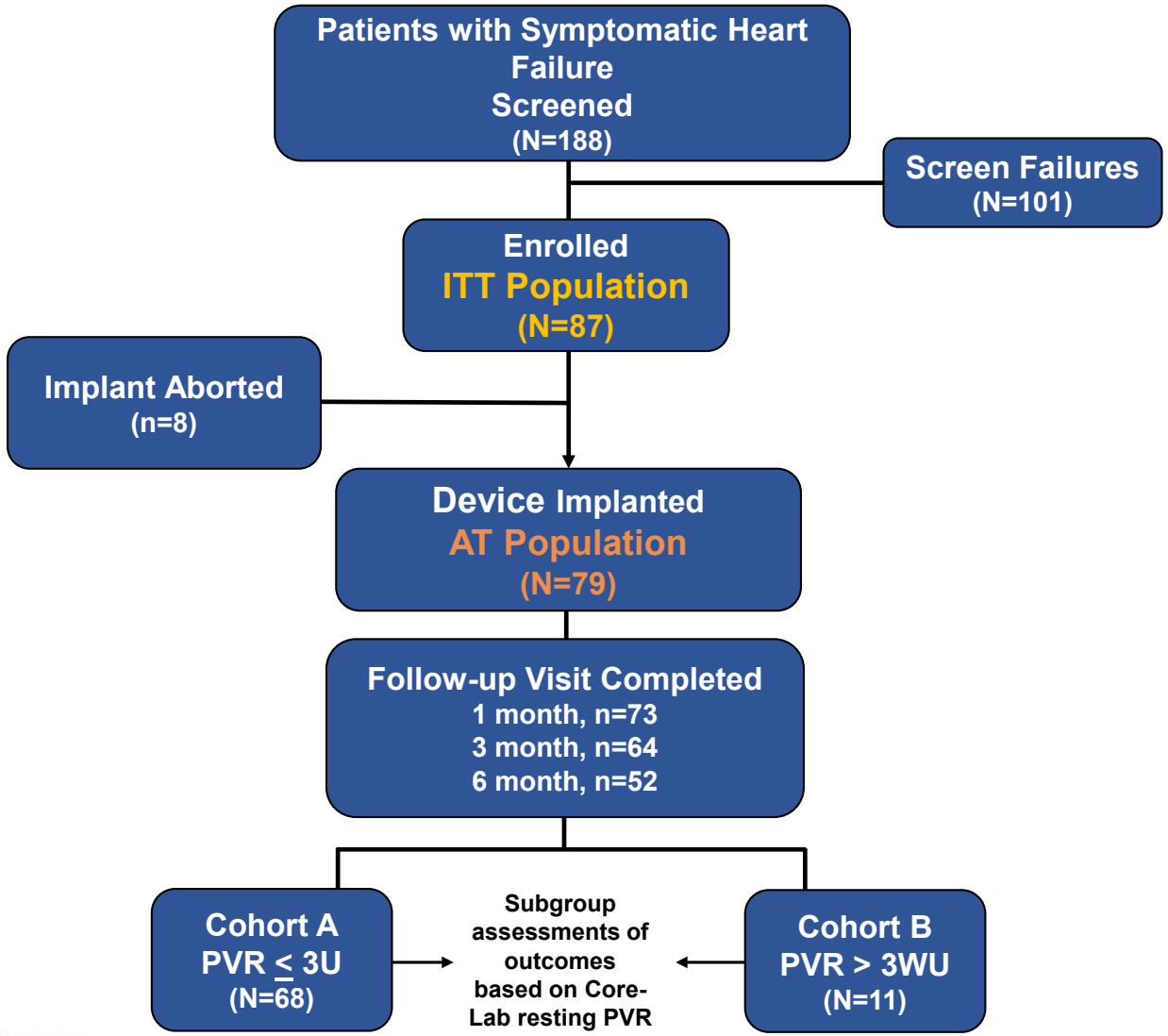
Edwards Stabilizer

Guidewire Delivery Cat

Atrial Shunt Deliver Catheter



ALT-FLOW EFS: Study Flow and Endpoints



Pre-Specified Endpoint Assessments

ITT Population (N=87)

- Safety and Reintervention (30d)
- Performance: Device, Procedure, and Clinical Success

- AT Population (N=79)
- Outcomes Assessment up to 6 months Total Implant population and subgroups
  - Patency
  - Clinical
  - Hemodynamic
  - Functional
  - Quality of Life

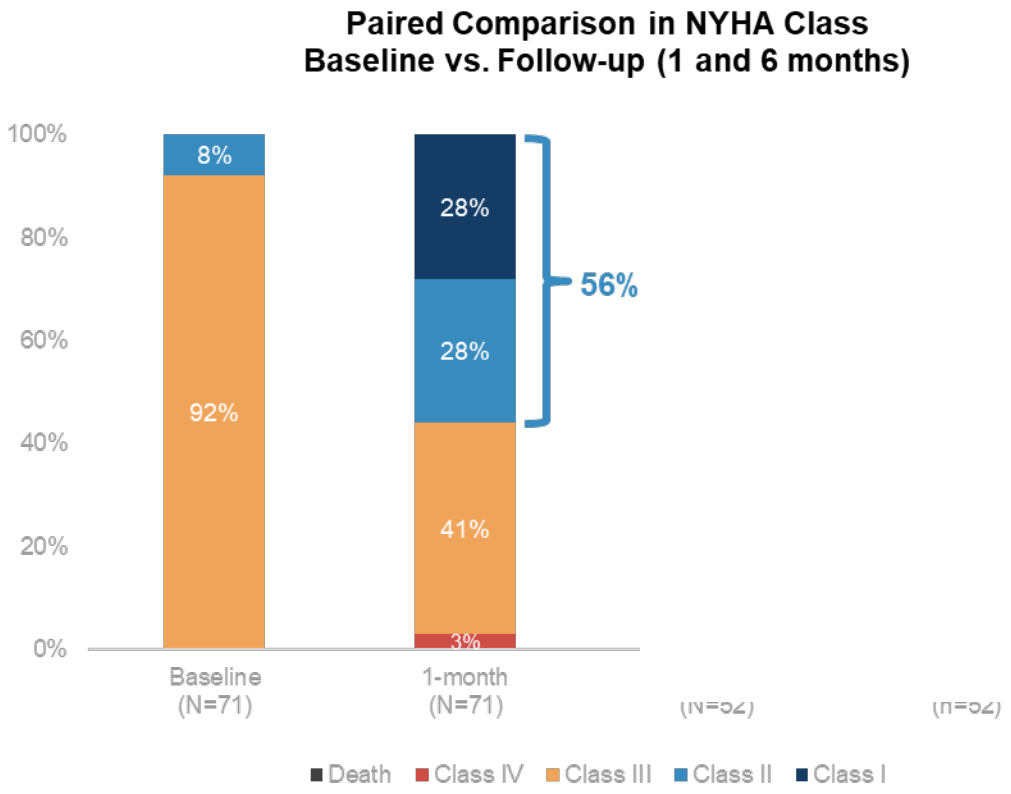
ALT-FLOW EFS: Procedural Outcomes Total Enrolled Cohort (N=87)

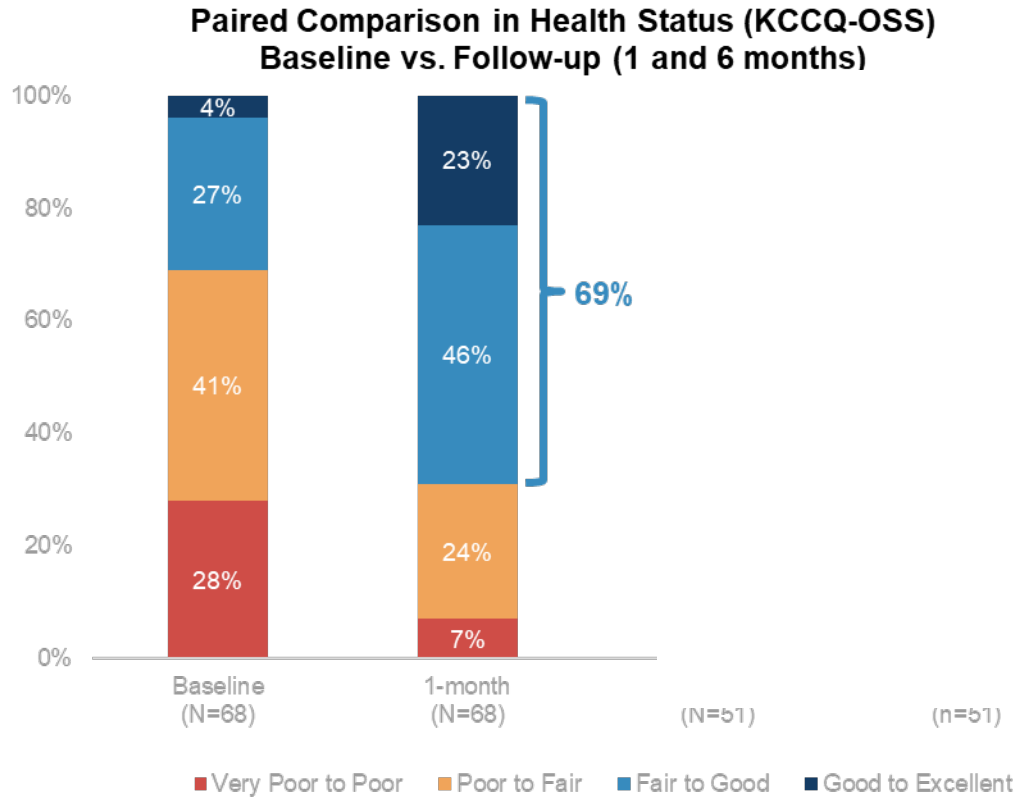
Procedural Outcomes	
Device Success	89.7% (78/87)
Procedural Success	88.5% (77/87)
Clinical Success	88.5% (77/87)
Procedural Complications	
Device Embolization	1.1% (1/87)
Pericardial Effusion*	3.4% (3/87)
Cardiac Surgery	2.3% (2/87)
Shunt Patency at 6 months	100% (44/44)

*One patient required cardiac surgery for CS injury, one patient drained percutaneously, one patient observed without sequelae

ALT-FLOW EFS: NYHA Class and Health Status Improvement at 1 and 6 Months

Total Implant Population (AT)



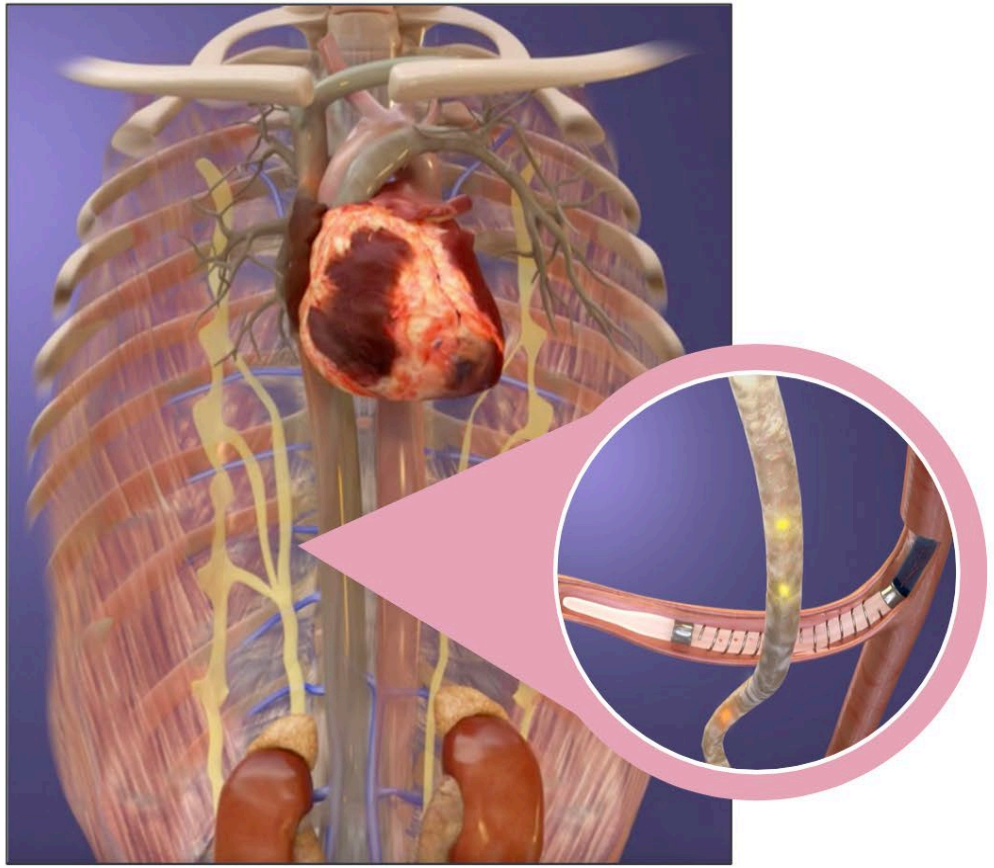


Volume Overload Management: Splanchnic Nerve Denervation

Chronic Decompensated Heart Failure
Splanchnic Ablation for Volume Management (SAVM)

New Aproach for Treating HFpEF

- Unilateral ablation of the right greater splanchnic nerve (GSN)
- Designed to interrupt sympathetic nervous activity to the splanchnic bed, reducing congestion
- Transvenous femoral, implant-free procedure
- < 1 hour procedure time (skin-to-skin)
- Patients typically go home the same day



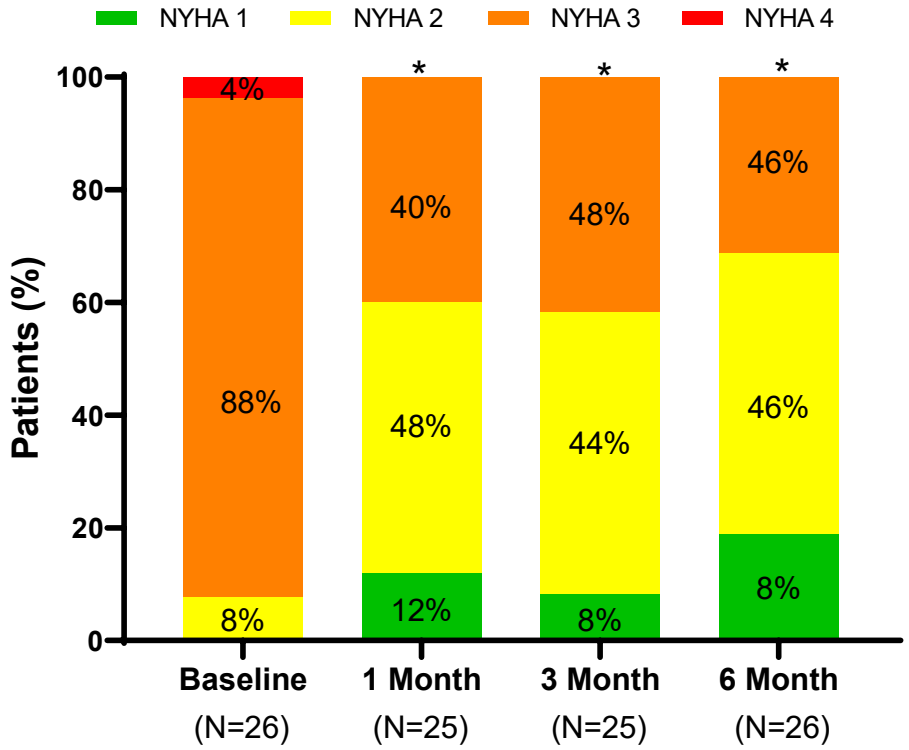
REBALANCE-HF Roll-in Cohort (n=26) Hemodynamics – PCWP

	Baseline	1-Month	1M - BL	p-value*
Resting				
Mean ± SD (N)	18.5 ± 7.13 (26)	17.6 ± 7.17 (23)	-0.9	0.24
Median (Min, Max)	17.0 (4.0, 34.0)	20.0 (5.0, 31.0)	-3	
Legs-Up				
Mean ± SD (N)	23.6 ± 6.20 (25)	21.2 ± 7.37 (24)	-2.4	0.03
Median (Min, Max)	24.0 (11.0, 34.0)	22.5 (3.0, 32.0)	-1.5	
20W				
Mean ± SD (N)	36.6 ± 8.02 (24)	30.8 ± 8.12 (21)	-5.8	0.003
Median (Min, Max)	35.0 (22.0, 50.0)	30.0 (15.0, 47.0)	-5	
Peak				
Mean ± SD (N)	39.2 ± 7.05 (23)	33.10 ± 8.40 (21)	-6.1	0.016
Median (Min, Max)	37.0 (26.0, 50.0)	35.0 (15.0, 47.0)	-2	

*P-value is derived from a mixed effects repeated measures model with an unstructured correlation structure.

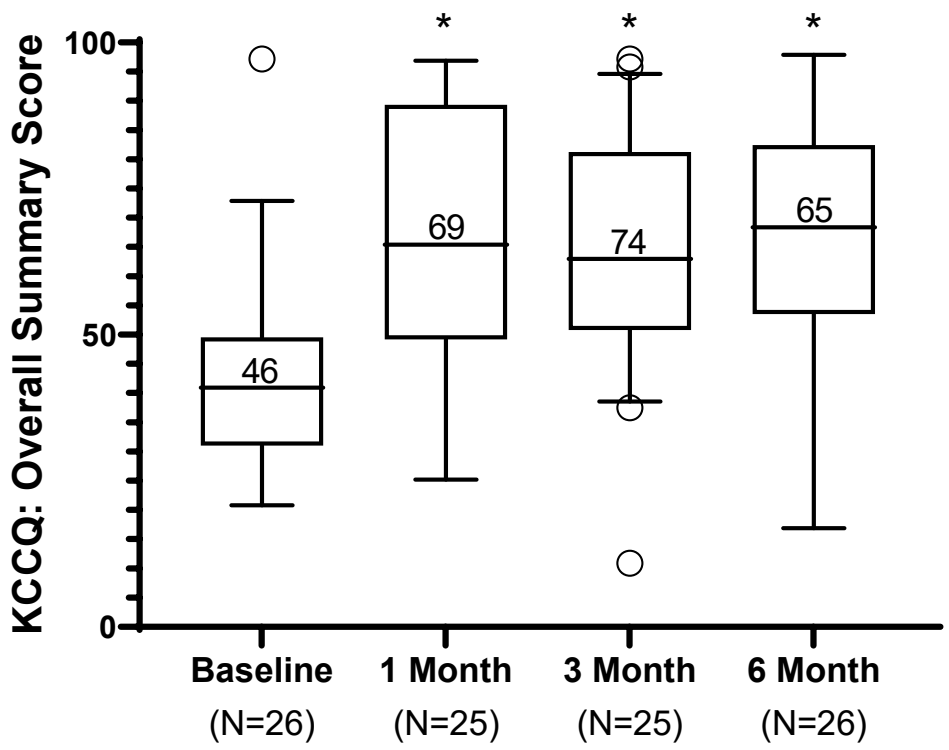
REBALANCE-HF Roll-in Cohort (n=26) Functional Status and KCCQ Score

NYHA Functional Class



More patients in NYHA 1&2 class at follow-up visits (*p<0.001)

KCCQ Overall Score



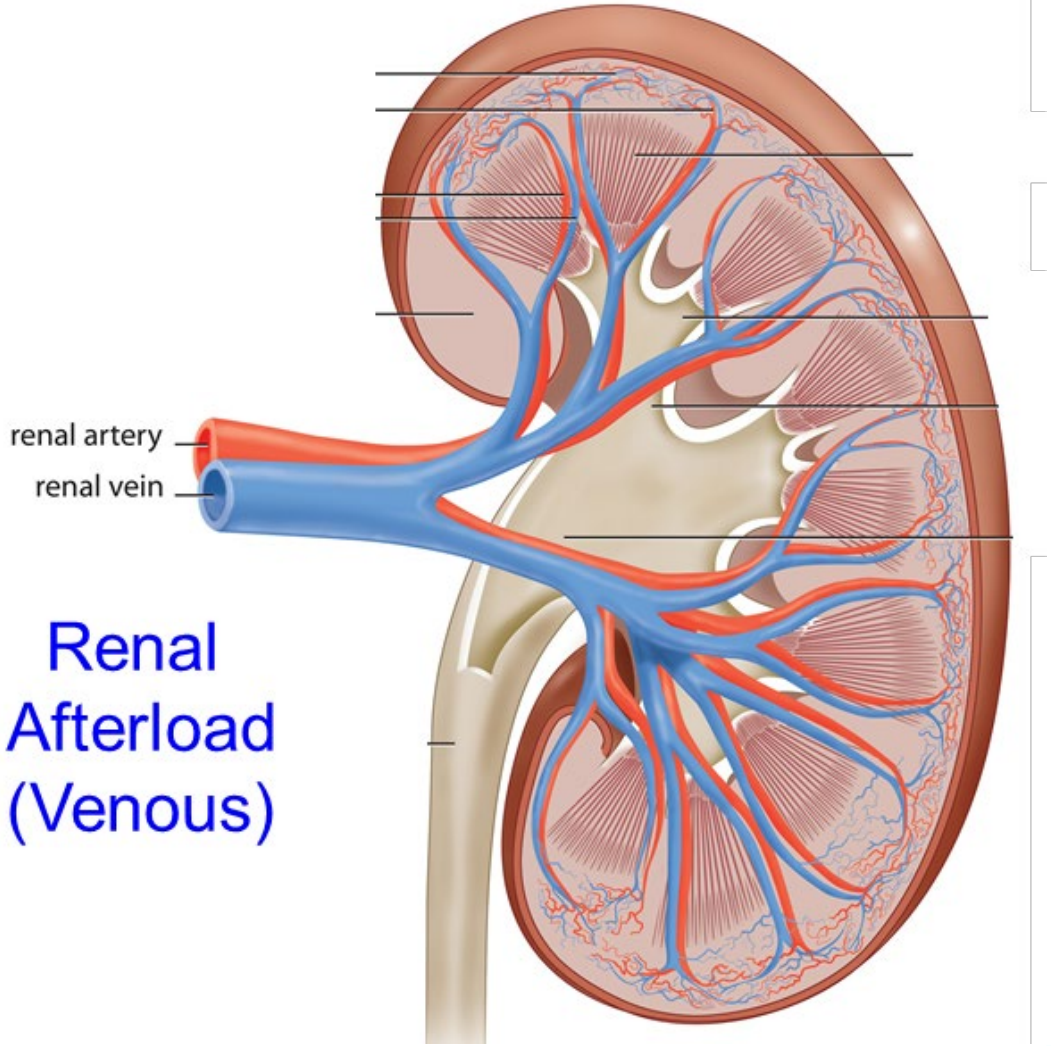
Sustained improvements in KCCQ Overall Summary Score through 6-months (*p<0.05)

Improvement of Renal Perfusion in Cardio-Renal Syndrome

Renal Afterload Reducers (Venous Pressure)

Passive Systems:
PTCR (IVC)
Doraya (IVC)
Nephronyx (IVC)

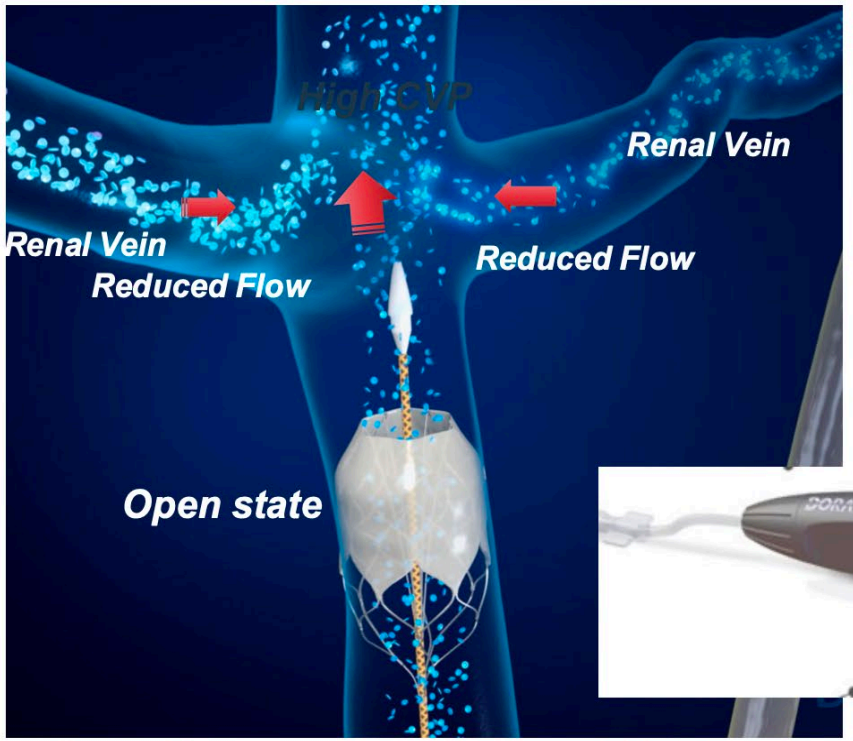
Active Systems:
preCARDIA (SVC)

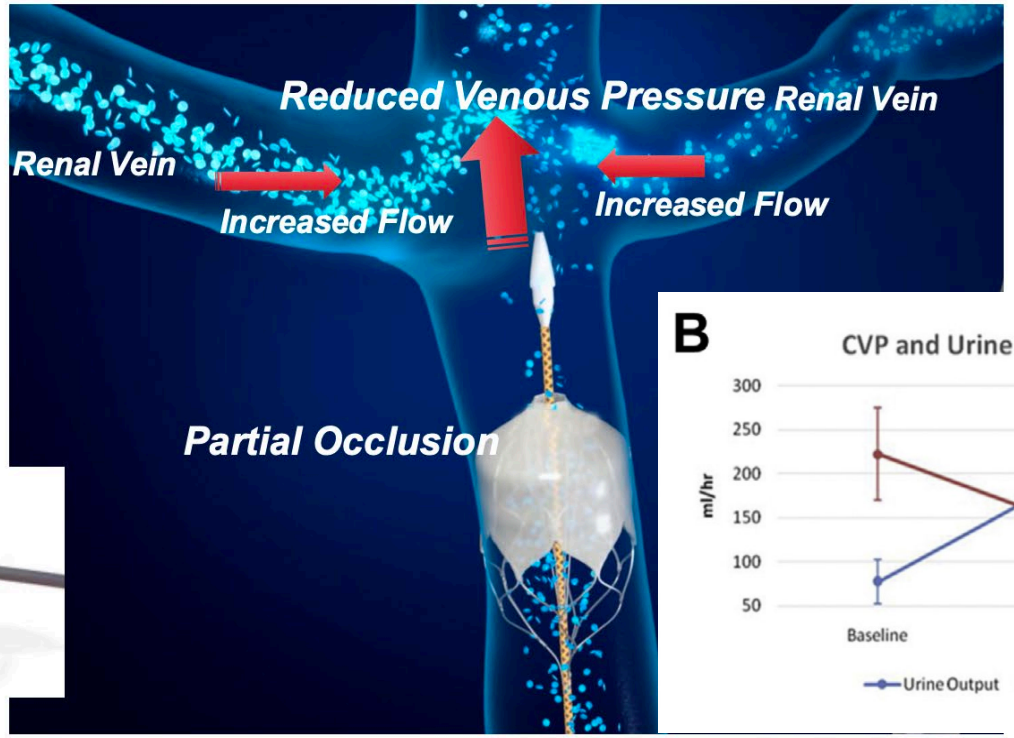


Acute Decompensated Heart Failure

Enhancing Diuresis by Reducing Venous Congestion

Doraya **–** a temporary partial obstruction of the IVC, below the renal veins.
Decreased renal venous pressure resulting in “Pulling” blood from the renal veins outlet



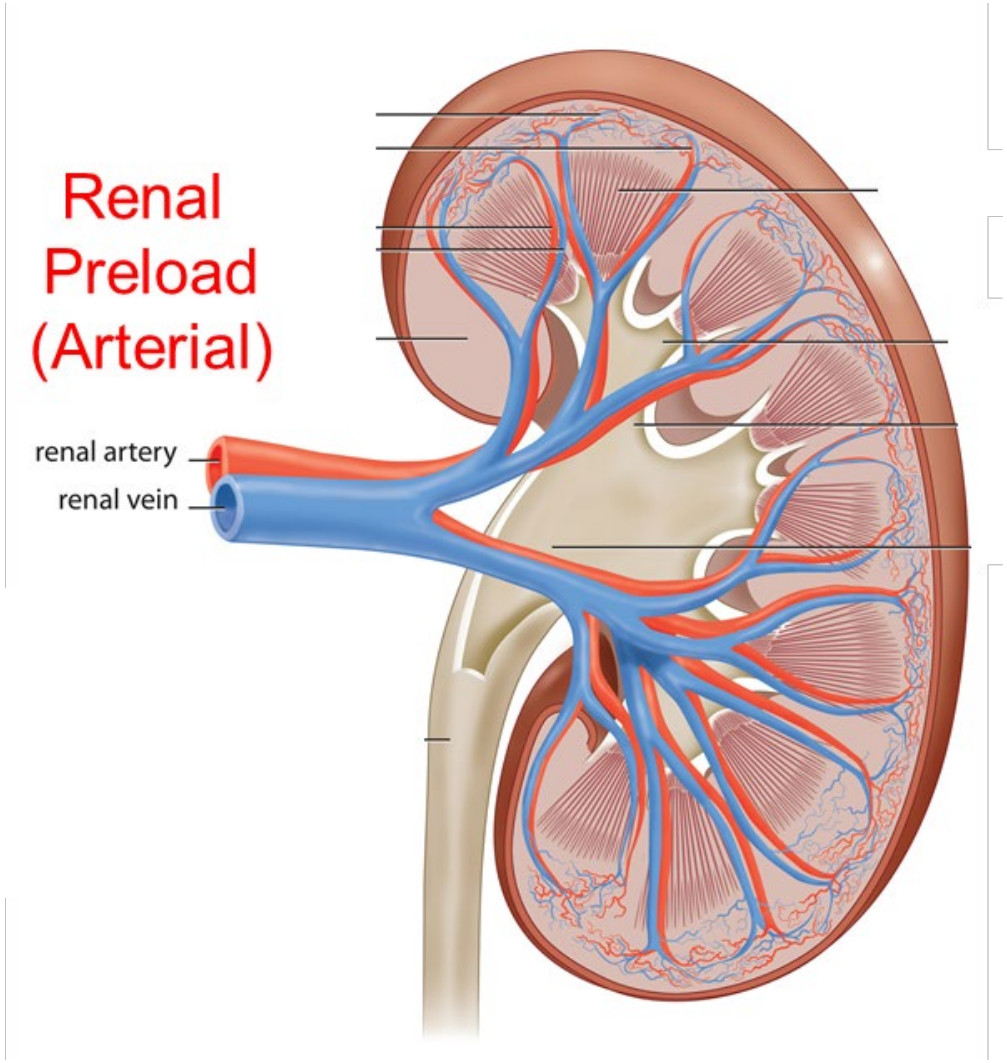


Normally open, after deployment

Adjustment using an external handle

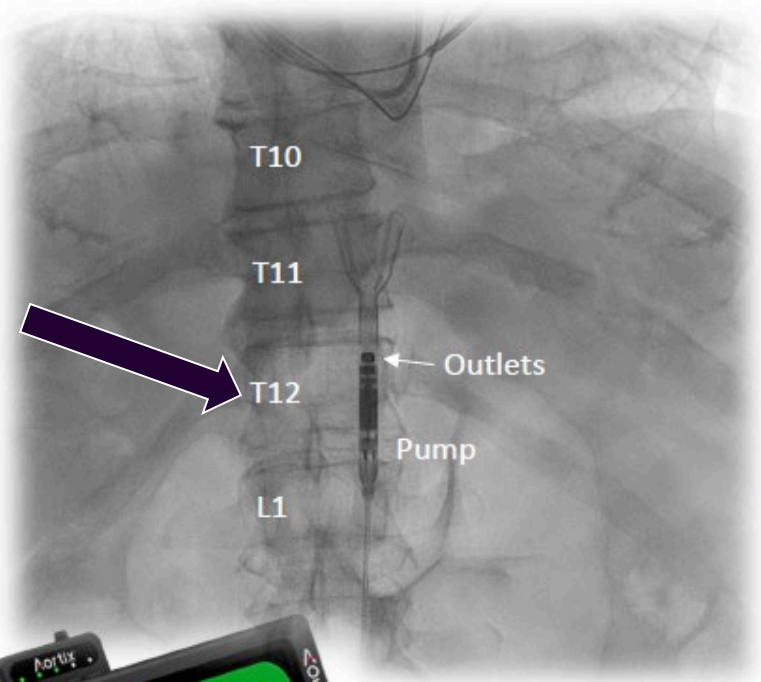
After adjustment, modulating flow through central passage, thus effecting hemodynamics

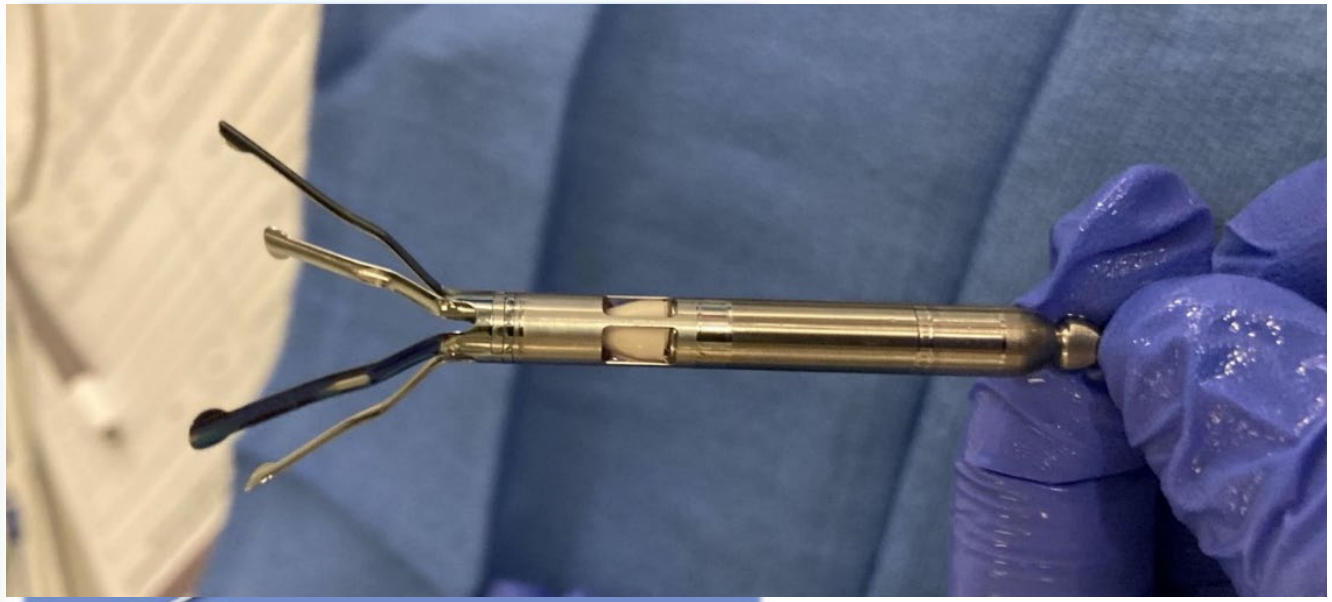
Renal Preload Augmentation (Arterial Pressure)



The Aortix System in Patients with Decompensated Heart Failure and Cardiorenal Syndrome

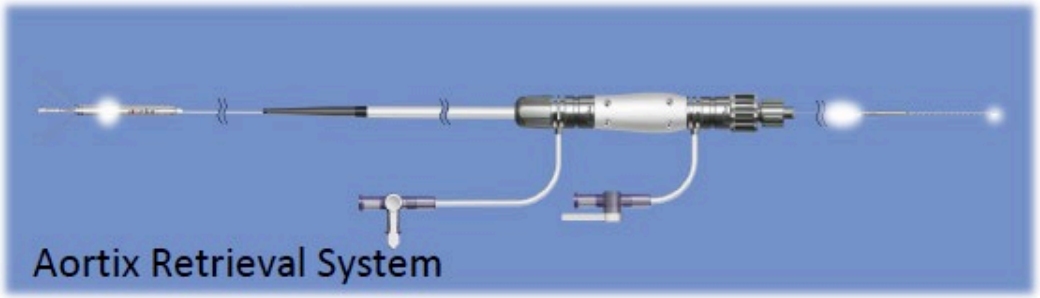
Placed at T10 to T12, perirenal





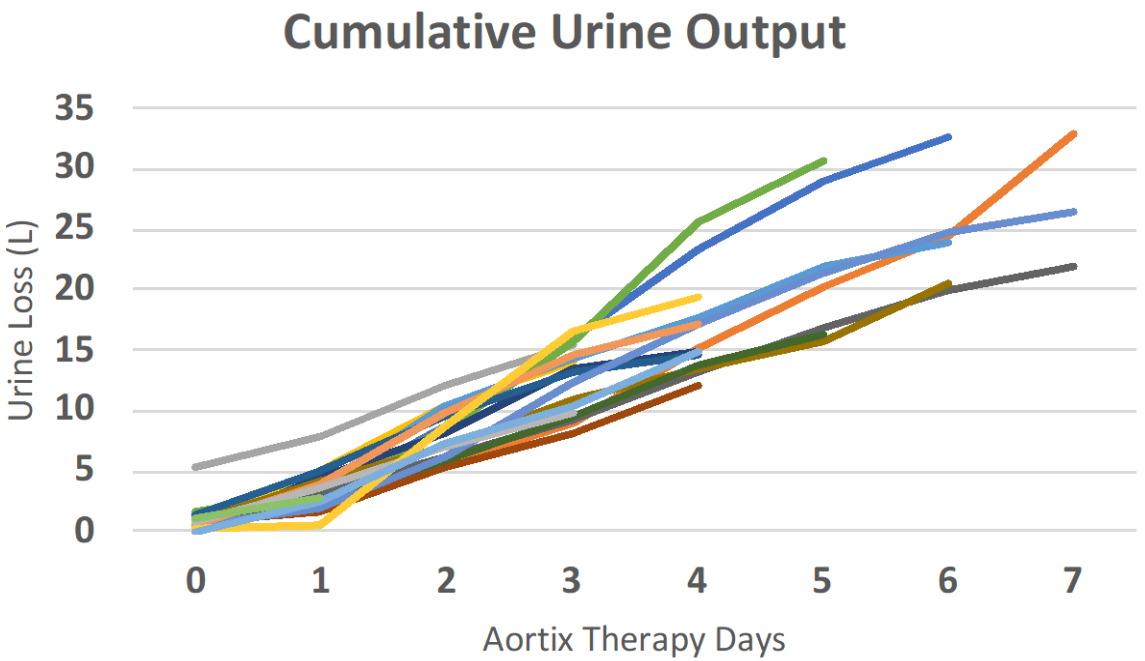
Aortix Delivery System

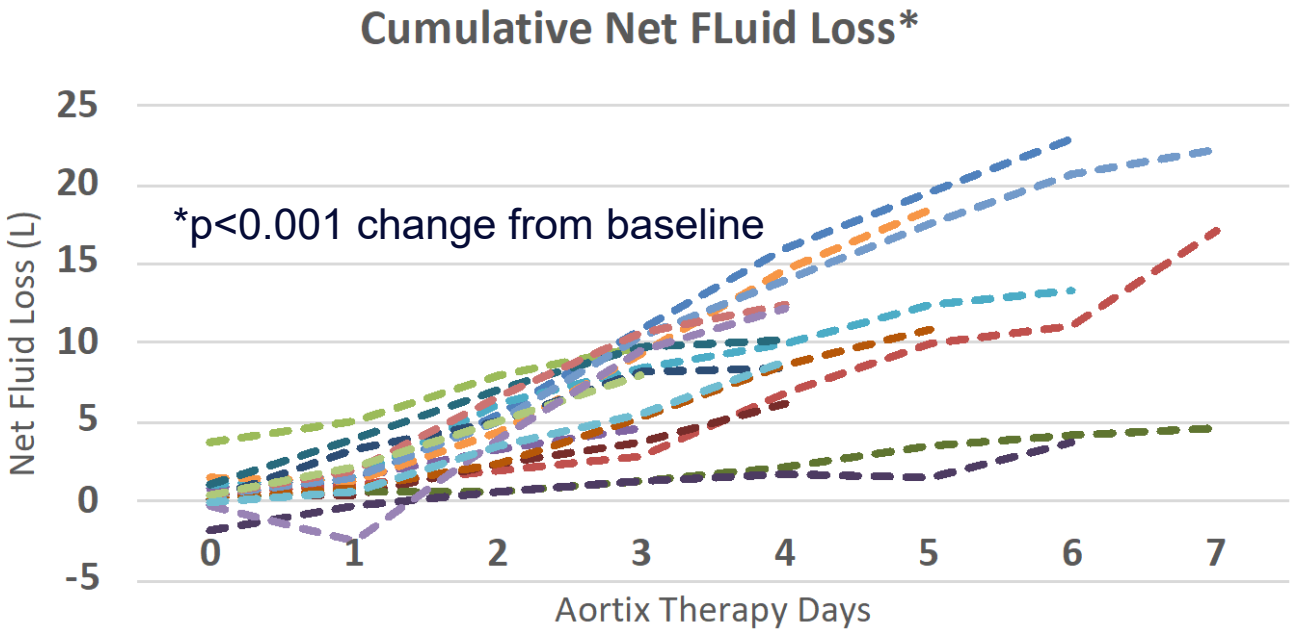
Aortix Control System

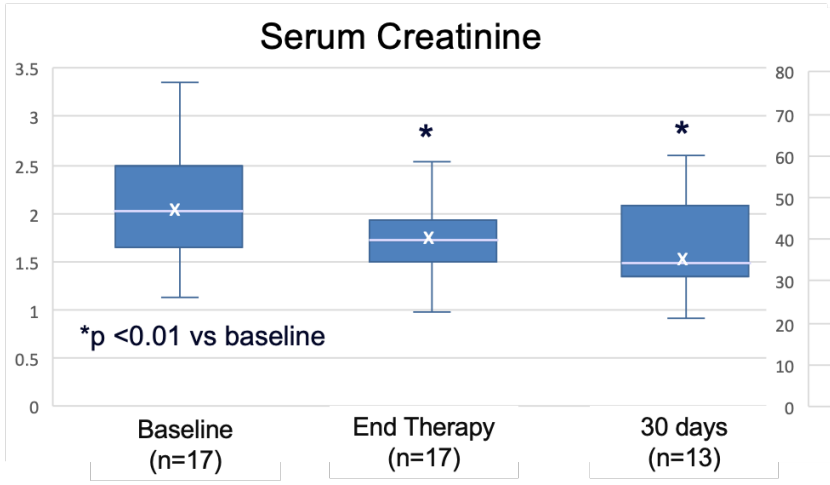


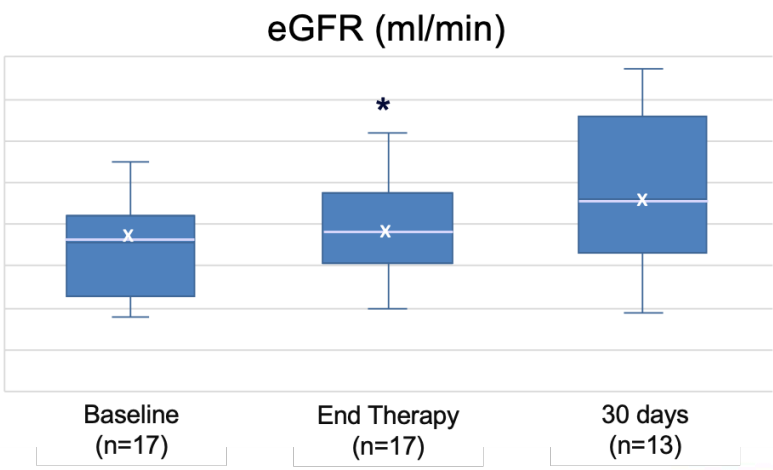
Aortix Retrieval System

Early Human Experience: Impact on Renal Function









Total net fluid loss during Aortix therapy = 10.7 L ± 6.5

Conclusions: Interventional Heart Failure

- Heart failure is the largest unmet need in cardiovascular medicine and a natural target for transcatheter innovation.
- New therapies go beyond valves, addressing ventricular remodeling, volume overload, and pressure management.
- Early clinical data are promising, but long-term outcomes and patient selection remain key challenges.
- Interventional heart failure is emerging as a new subspecialty and the next major frontier in structural heart disease