MAYO CLINIC

Treatment of LVOT Obstruction

"Prevention and management in the context of TMVR"

Mayra Guerrero MD
Professor of Medicine
Department of Cardiovascular Medicine
Mayo Clinic Hospital

SOLACI-SOCIME 2025
Mexico City, Mexico.
Aug 6th, 2025

Disclosure Statement of Financial Interest

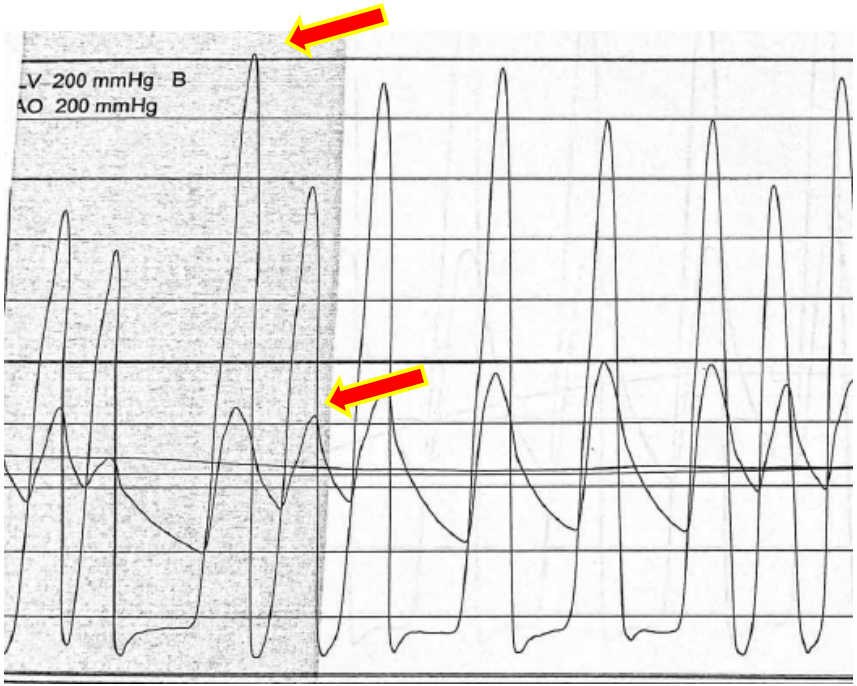
Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

Affiliation/Financial Relationship	Company
• Institutional Research Grant Support	• Edwards Lifesciences

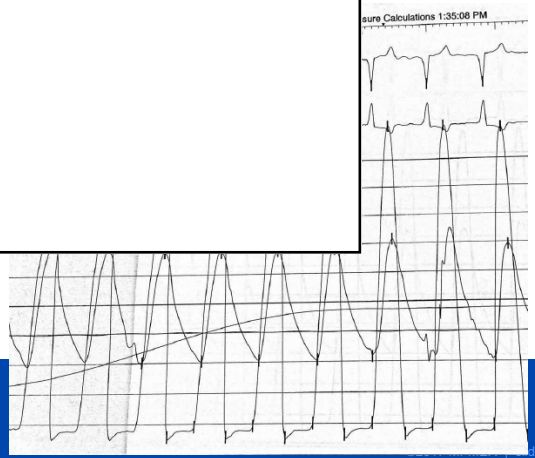
Off label use of products and investigational devices will be discussed in this presentation

Learning Objectives

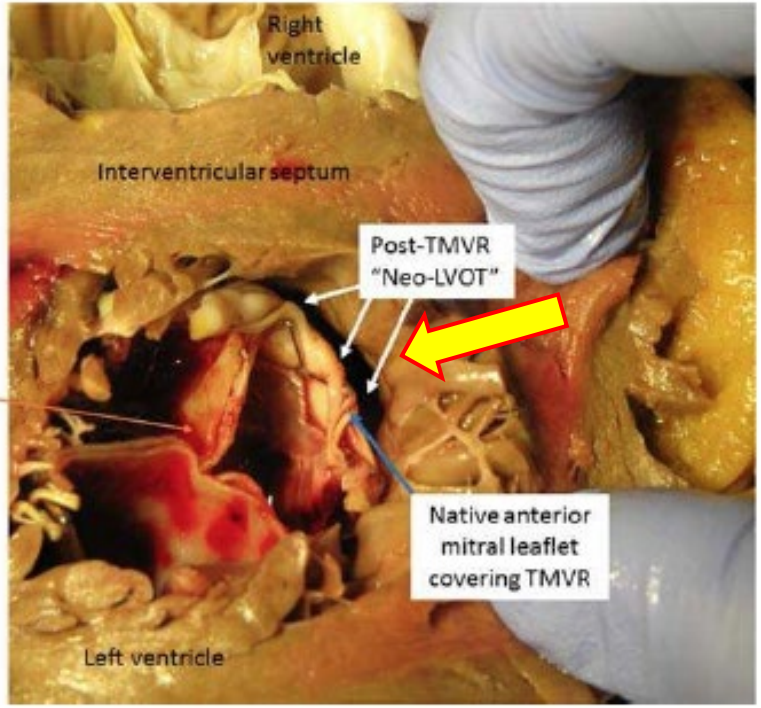
- To illustrate the mechanism of TMVR-induced LVOT obstruction.
- To review outcomes of preemptive septal modification to enable TMVR.
- To describe contemporary strategies to prevent TMVR-induced LVOT obstruction.

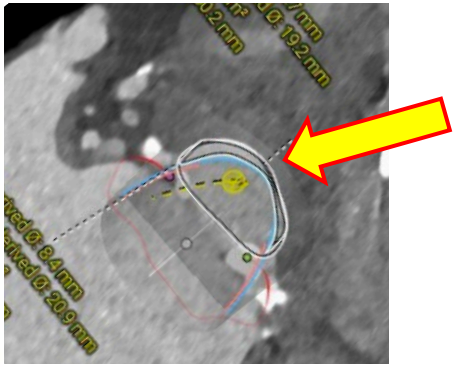


8-7-2014


sure Calculations 1:35:08 PM

LVOT Obstruction





We learned the concept of Neo-LVOT after TMVR the hard way in 2014, before it was defined by CT

Wang et al, *CCI* 2017 Dec 11. doi: 10.1001/ccd.27447

TMVR in MAC Global Registry (n=116)

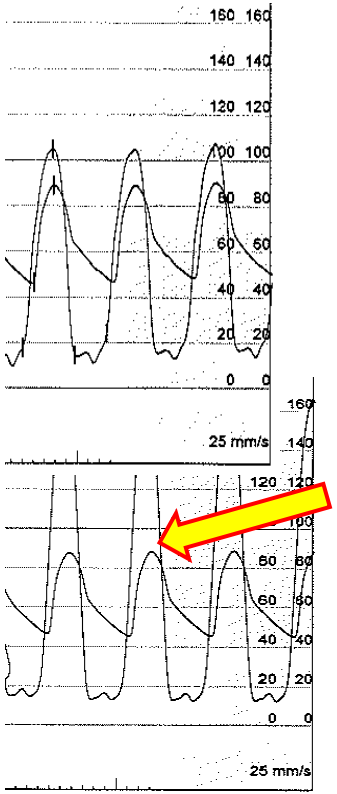
Multivariate Cox Regression Analysis

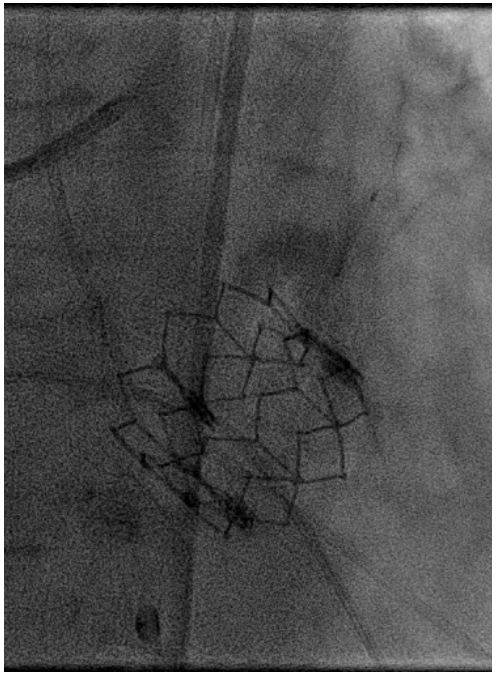
Independent Predictors of 1-Year Mortality

	HR	95% CI	p
Technical success (yes vs no)	0.22	0.09-0.51	**0.0005**
LVOT obstruction	2.63	1.14-6.06	**0.0227**

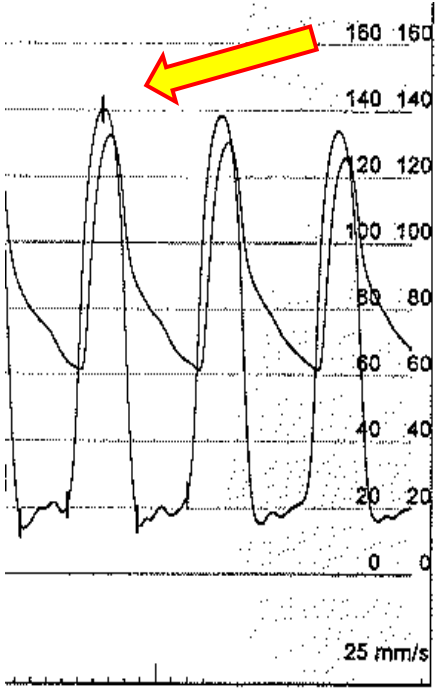
Guerrero, Urena et al, *JACC* May 1st. 2018;71:1841-53.

Alcohol Septal Ablation to treat acute LVOTO after ViMAC





Courtesy of Dr. William O'Neill

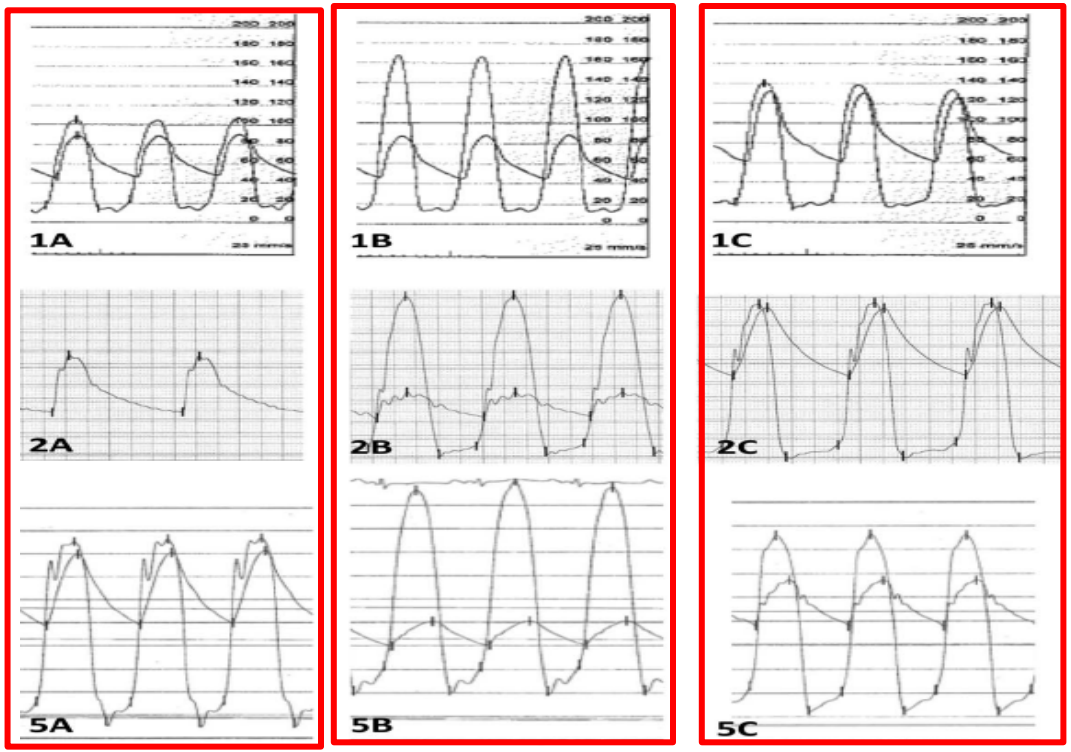


After Alcohol Ablation

Guerrero et al, *CCI 2016 July 5*. doi:10.1002/ccd.26649.

Alcohol Septal Ablation as bail out for LVOTO

6 patients treated with alcohol ablation as bail out for LVOTO post TMVR
Reduction in LVOT gradient in all 6 patients
4 were discharged from the hospital after successful rescue

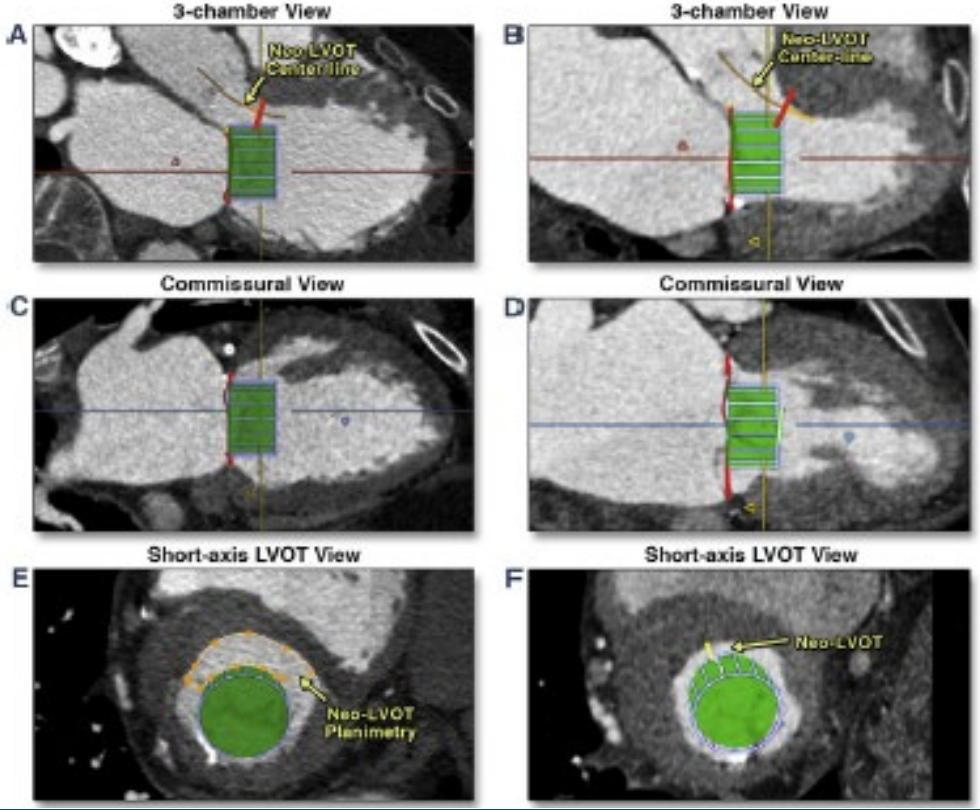


*LVOT gradient recurred the following day due to suspected septal edema

Guerrero et al, *CCI* 2017, March 7 doi: 10.1002/ccd.26975.

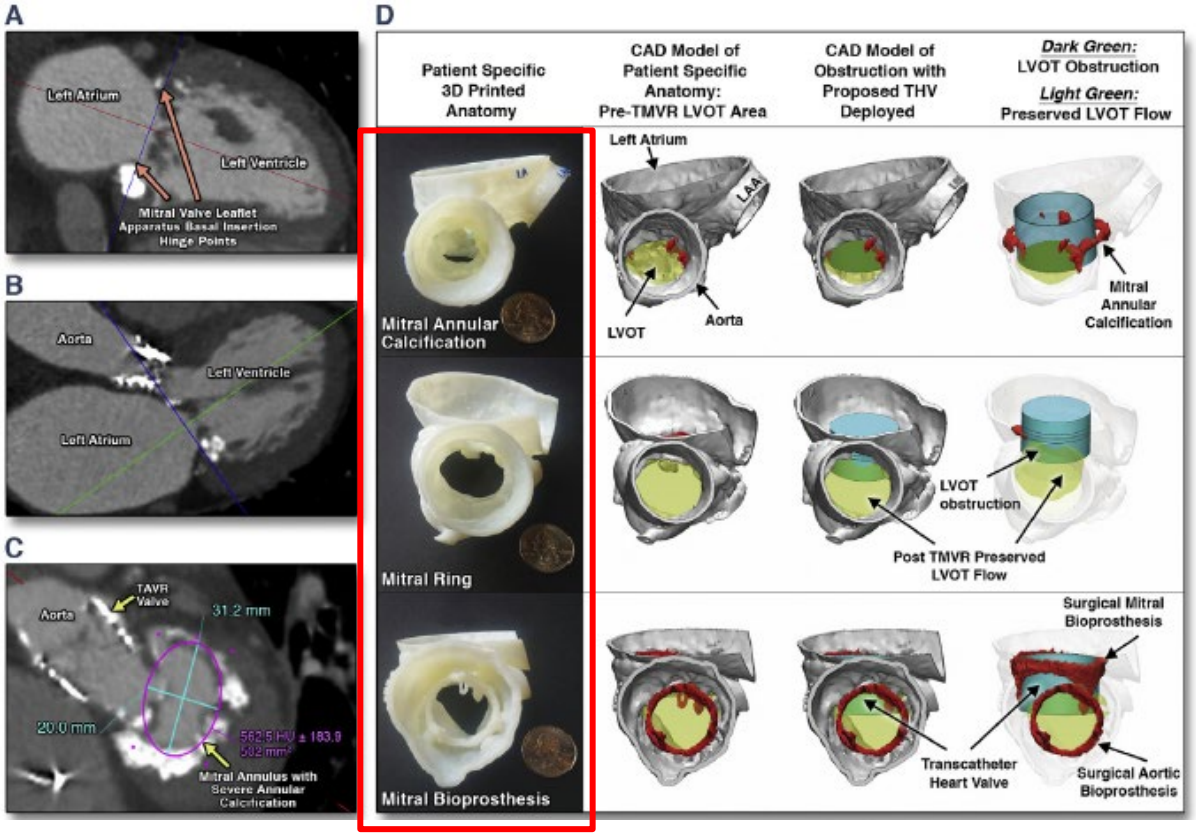
Predicting LVOT Dimensions

"Neo-LVOT concept"



Blanke et al, *JACC Cardiovasc Imaging* 2015;8(10):1191-208.

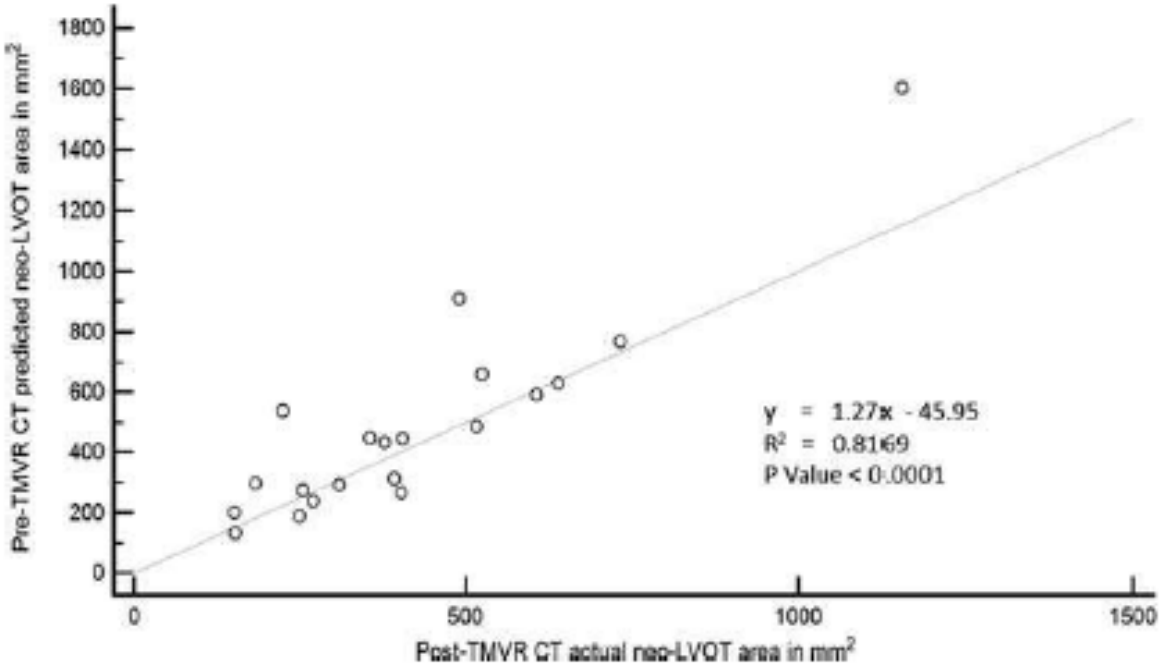
Predicting LVOT Obstruction with Computer-Aided Design & 3D-printing



Wang et al, *JACC Cardiovasc Imaging* 2016;9(11):1349-52.

Predicted vs Actual Neo-LVOT post-TMVR

n=38 pts (MViV= 17 ,MViR= 12, ViMAC= 9), 7 had LVOTO.



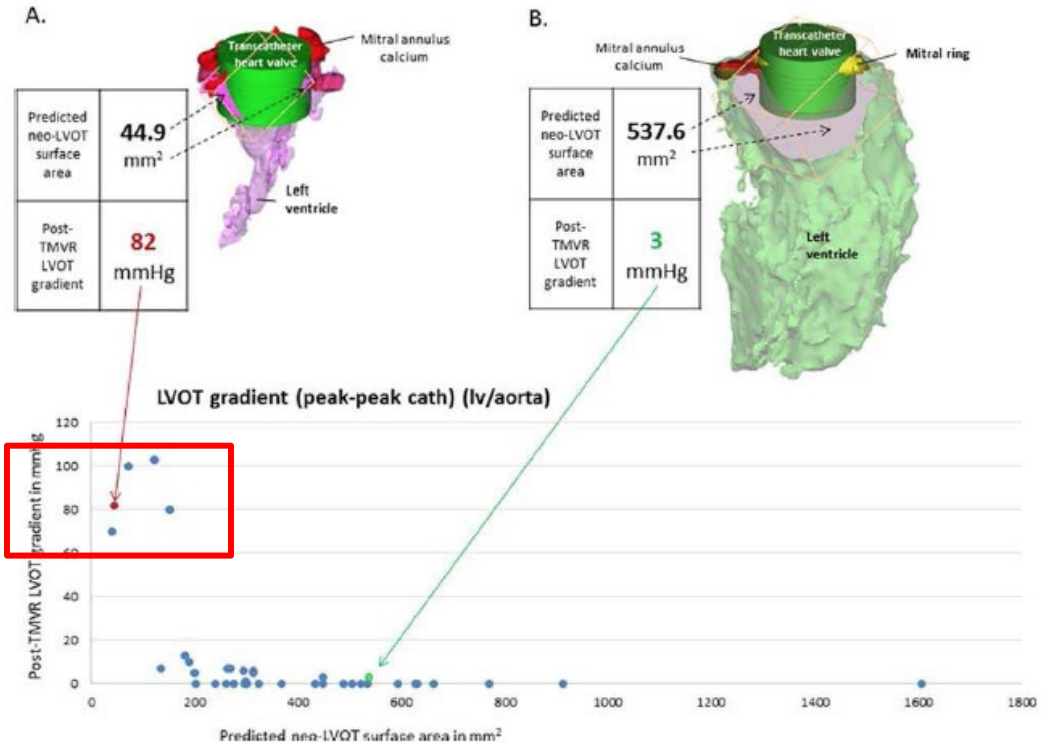
Depth of implantation and angle may affect actual Neo-LVOT

Wang et al, *CCI* 2017 Dec 11. doi: 10.1001/ccd.27447

A Neo-LVOT <189.4 mm2 had 100% sensitivity and 96.8% specificity to predict increase in LVOT gradient of ≥10 mmHg

n=38 pts (MViV= 17 ,MViR= 12, ViMAC= 9), 7 had LVOTO.

Neo-LVOT <189.4 mm2

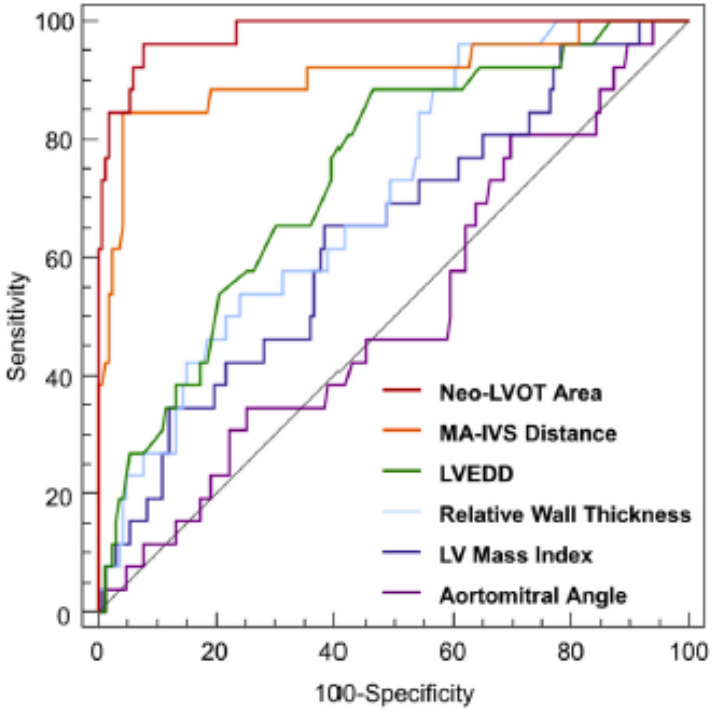


Wang et al, *CCI* 2017 Dec 11. doi: 10.1001/ccd.27447

Predictors of LVOT Obstruction after MViV, MViR and ViMAC

194 patients in the TMVR Registry (MViV=107, MViR=50, ViMAC=37)

Median age 76.(IQR 69-81) years, 54.1% female, 26 of 194 (13.4%) developed LVOTO.



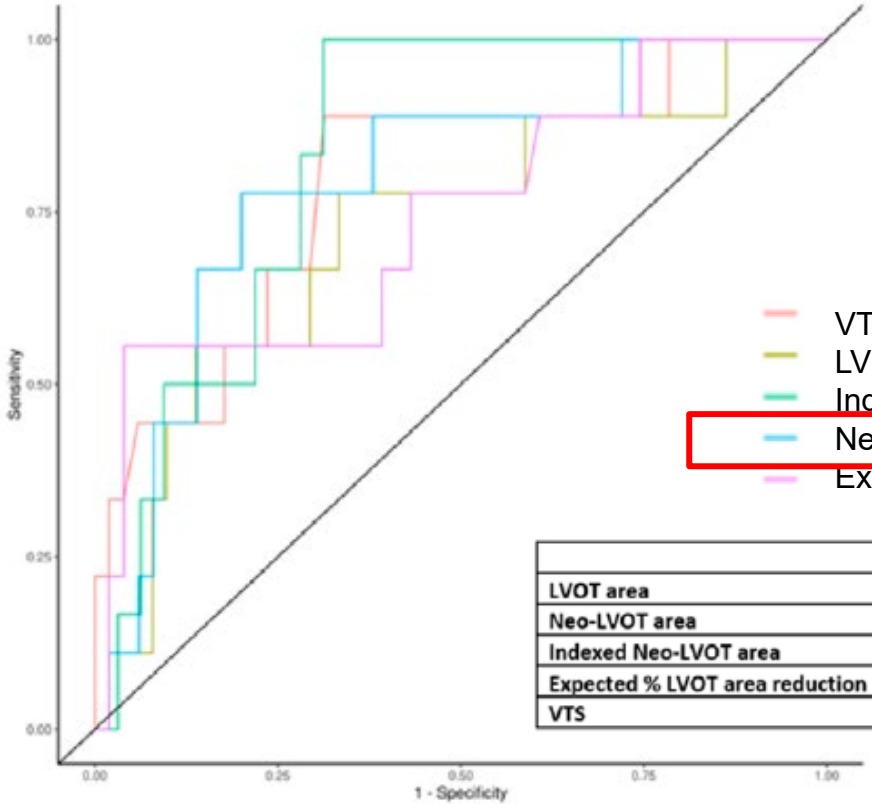
Neo-LVOT Cutoff <170 mm^2

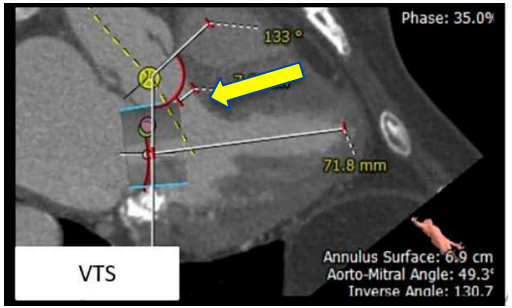
	AUC	Cutoff value	p value	Sensitivity	Specificity
Neo-LVOT Area	0.98	1.7	< 0.001	96.2	92.3
MA-IVS Distance	0.91	17.8	< 0.001	84.6	95.8
LVEDD	0.74	48	< 0.001	88.5	53.3
Relative Wall Thickness	0.70	0.38	0.001	96.2	38.9
LV Mass Index	0.64	105	0.02	65.4	61.1
Aortomitral Angle	0.51	–	0.92	46.2	41.1

Yoon et al, *J Am Coll Cardiol Intv* 2019;12:182-193.

Predictors of LVOT Obstruction after ViMAC

116 patients in the TMVR in MAC Global Registry of which 71 had optimal CT quality for analysis





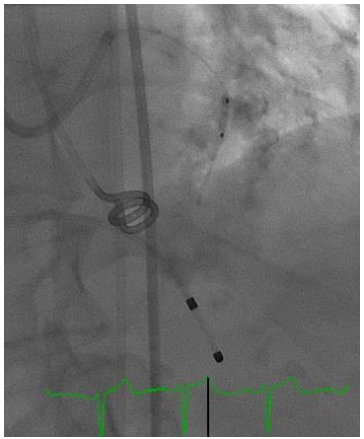
- VTS 5.5mm
- LVOT area 371 mm2
- Indexed Neo-LVOT area 127.5 mm2/m2
- Neo-LVOT area 173.4 mm2
- Expected % LVOT area reduction 63.5%

	AUC	Cutoff Value	Accuracy	Sensitivity	Specificity
LVOT area	0.76	371.5 mm^2	0.54	0.67	0.87
Neo-LVOT area	0.86	173.4 mm^2	0.81	0.8	0.87
Indexed Neo-LVOT area	0.83	127.5 mm^2/m^2	0.73	0.68	1
Expected % LVOT area reduction	0.80	63.5%	0.91	0.62	0.96
VTS	0.86	5.5 mm	0.68	0.72	0.68

El Sabbagh, Guerrero et al, *Circ Cardiovasc Interv* 2021;14:e010854. DOI: 10.1161/CIRCINTERVENTIONS.121.010854

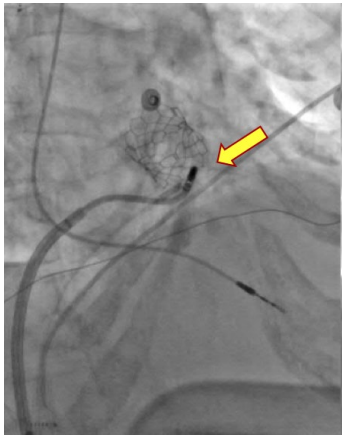
How to Prevent LVOT Obstruction

Septal Reduction Strategies



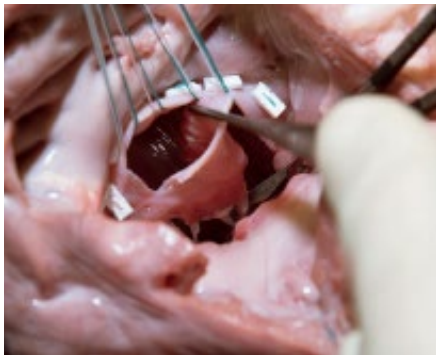
Alcohol
Septal Ablation*

Concept generated in MITRAL trial

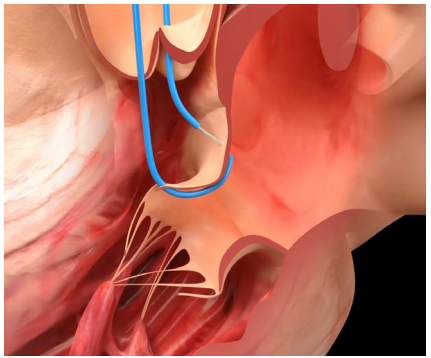


Radiofrequency
Septal Ablation**

Anterior Leaflet Strategies

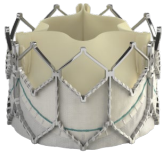


Surgical resection
(MITRAL and SITRAL trials)



Percutaneous laceration
(LAMPOON trial)

*Guerrero et al, *CCI* 2017 Dec 1;90(7):1220-1226.
*Wang, Guerrero et al, *JACC Intv 2019;*12:1268-79.
* *Guerrero et al, JACC Interv 2020.



SAPIEN XT

MITRAL Trial

Mitral Implantation of TRAnscatheter vaLves

91 patients extremely high surgical risk (STS PROM >15% or M&M >50%)

SAPIEN 3

Inclusion Criteria

NYHA II or greater

Valve-in-Valve
n=30

Severe MS (MVA ≤1.5 cm2)

At least Moderate-Severe MR

100% Transseptal

Valve-in-Ring
n=30

Severe MS (MVA ≤1.5 cm2)

At least Moderate-Severe MR

100% Transseptal

Native MV (MAC)
n=31*

Severe MS (MVA ≤1.5 cm2)

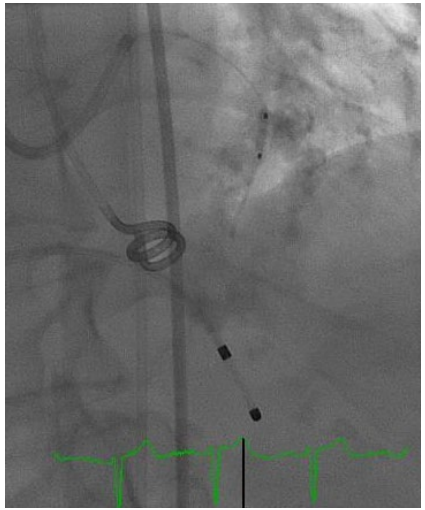
Severe MR + Moderate MS

15 (48.4%) Transseptal
15 (48.4%) Transatrial
1 (3.2%) Transapical

First 2 patients in MAC arm were treated with SAPIEN XT, al subsequent patients were treated with SAPIEN 3 valves

* 1 withdrew consent 3 weeks post TMVR

Role of Alcohol Septal Ablation



16 non-transatrial TMVR procedures
Transseptal=15, Transapical=1

1st TMVR in the trial (TS) was complicated with LVOTO
Treated with bail-out alcohol ablation (Dr. O'Neill)
→ Bail out
Proof of concept

2st TMVR in the trial (TA) was complicated with LVOTO
Treated with bail-out alcohol ablation at Evanston Hospital
LVOT gradient recurred the following day
→ Generated concept of Preemptive ablation weeks prior to TMVR

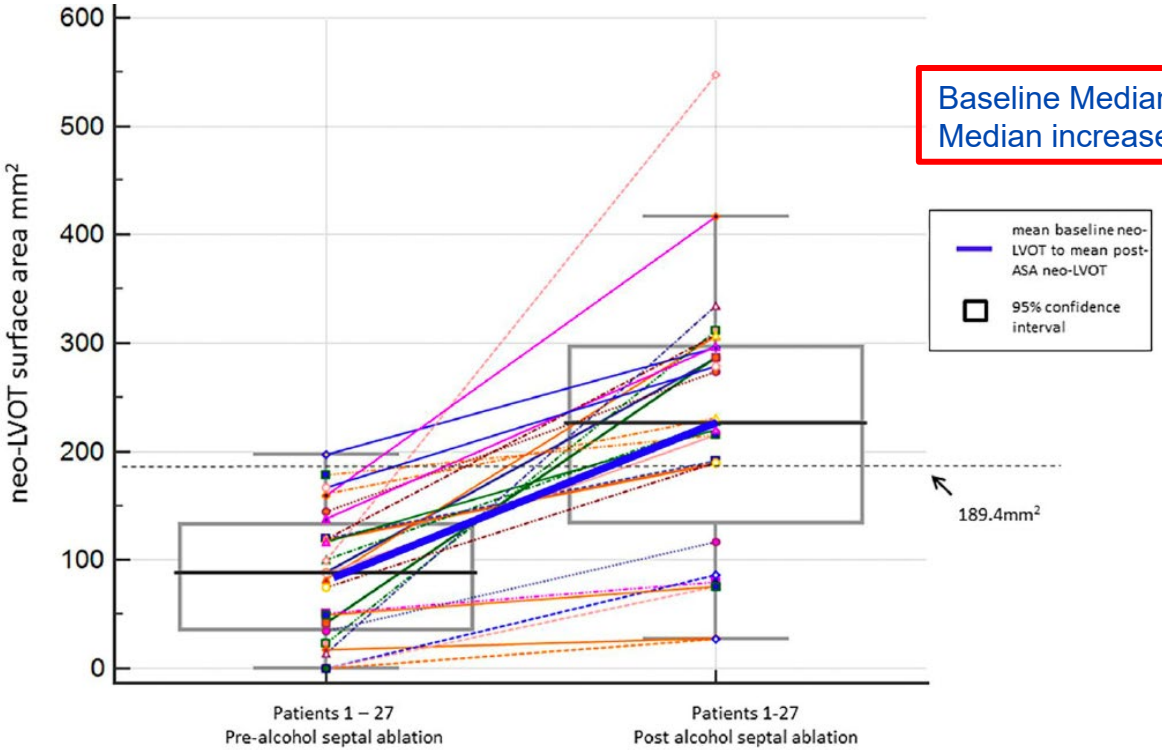
14 additional transseptal TMVR procedures
(7 pretreated with alcohol septal ablation weeks prior to TMVR)
→ 50% underwent Preemptive ablation weeks prior to TMVR

100% discharged from the hospital
100% alive at 30 days

Pre-emptive Alcohol Ablation to Prevent LVOT Obstruction

Early Clinical Experience in a Multicenter Observational First-in-Man Study

30 patients STS 7.2%, average 1.6±0.7 ml alcohol, repeat CT 3-4 weeks later

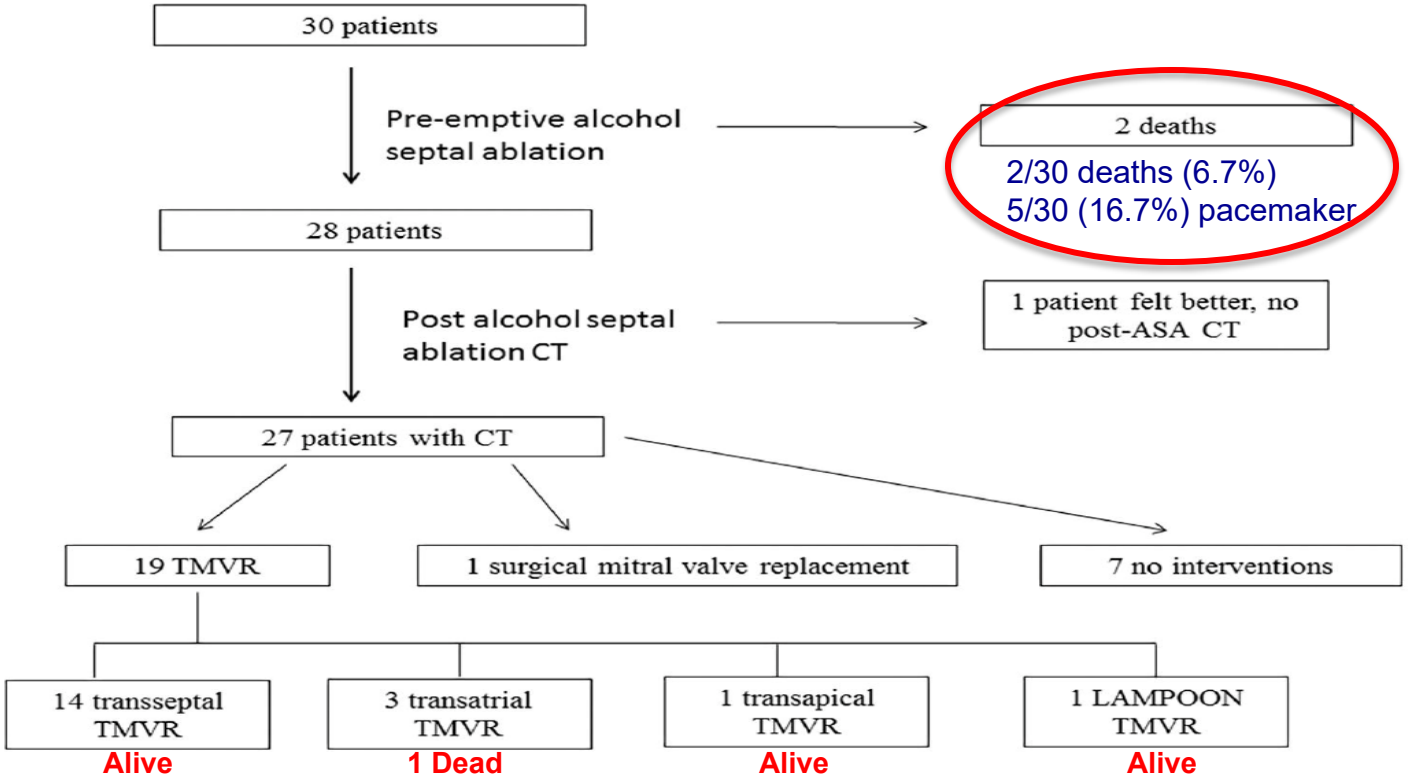


Baseline Median Neo-LVOT= **85.1**mm2
Median increase Neo-LVOT= **111.2** mm2

Wang et al, *JACC Intv 2019;*12:1268-79

Pre-emptive Alcohol Ablation to Prevent LVOT Obstruction

30 day Outcomes

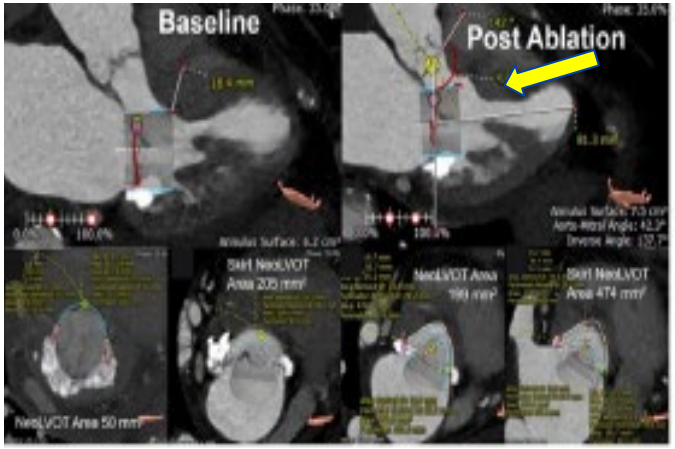


Wang et al, *JACC Intv 2019;*12:1268-79

30 day Mortality= 3/30 (10%)

Pre-emptive Alcohol Ablation to Prevent LVOT Obstruction

22 TMVR patients vs 80 HOCM patients at Mayo Clinic



Septal thickness was less in the TMVR group compared to HCM patients and corresponding lower doses of alcohol were used in this group

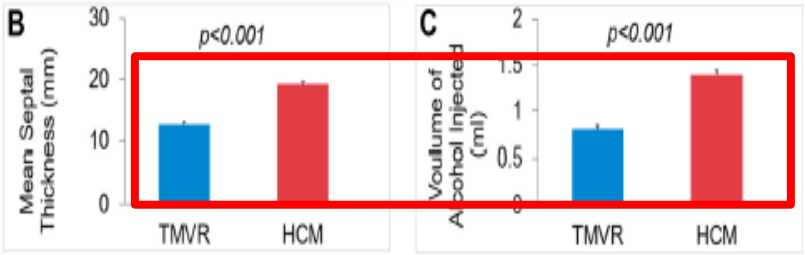


Table 4. Computed tomographic characteristics before and after alcohol septal ablation.

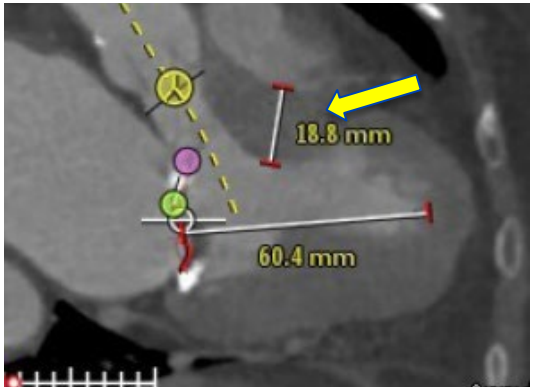
Computed tomography measurements	Before ASA	After ASA	Change	*P* value
Virtual valve frame to septum distance (mm)	2.8 ± 2.9	6.1 ± 3.2	3.2 ± 2.6	<.001
LVOT area (mm^2)	352 ± 79	456 ± 125	98 ± 88	<.001
Neo-LVOT area (mm^2)	135 ± 89	233 ± 111	97 ± 60	<.001
Skirt neo-LVOT area (mm^2)	375 ± 95	357 ± 120	96 ± 100	.005

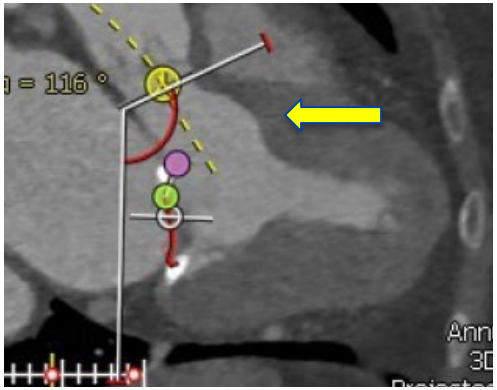
Table 5. Alcohol septal ablation procedural outcomes.

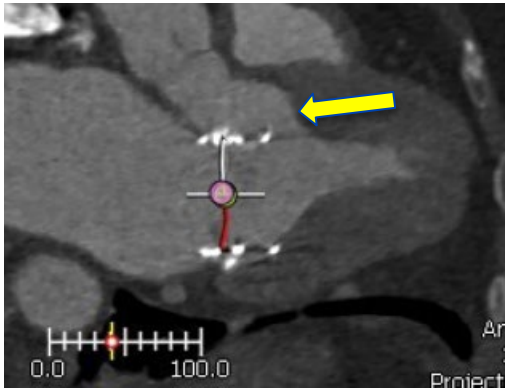
Outcomes at 30 days	HCM group N = 80	TMVR group N = 22	*P* value[a]
Complete heart block	14 (21)	7 (35)	.195
Major bleeding	3 (4)	0	
Sustained VT	0	0	
Stroke	0	0	
In-hospital mortality	0	0	
30-Day mortality	3 (4)[b]	0[c]	

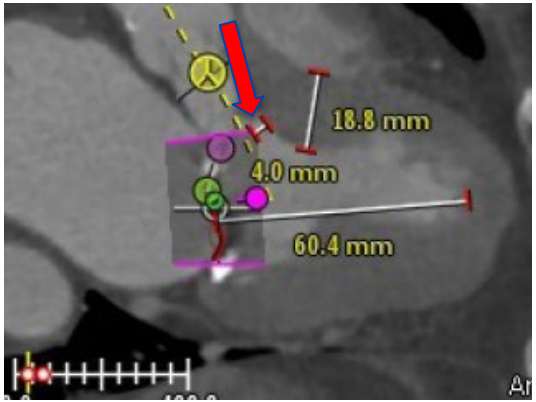
30 day Mortality= zero

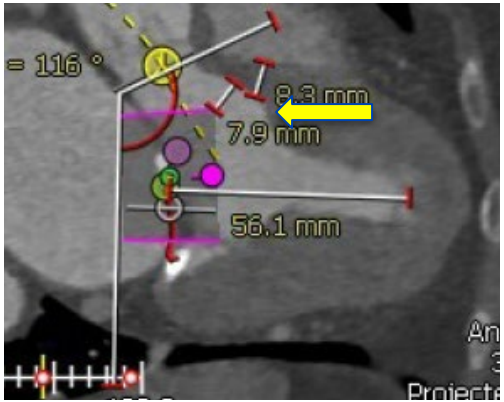
Preventing LVOT Obstruction with Alcohol Ablation

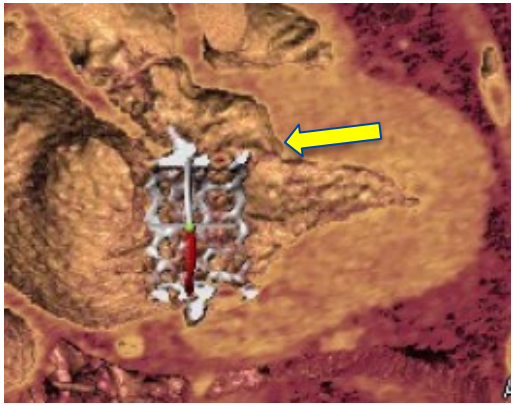






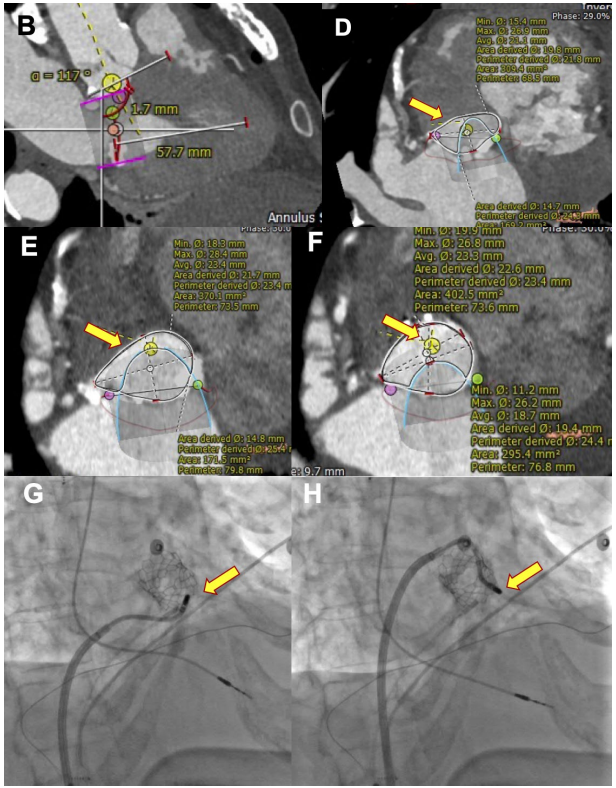


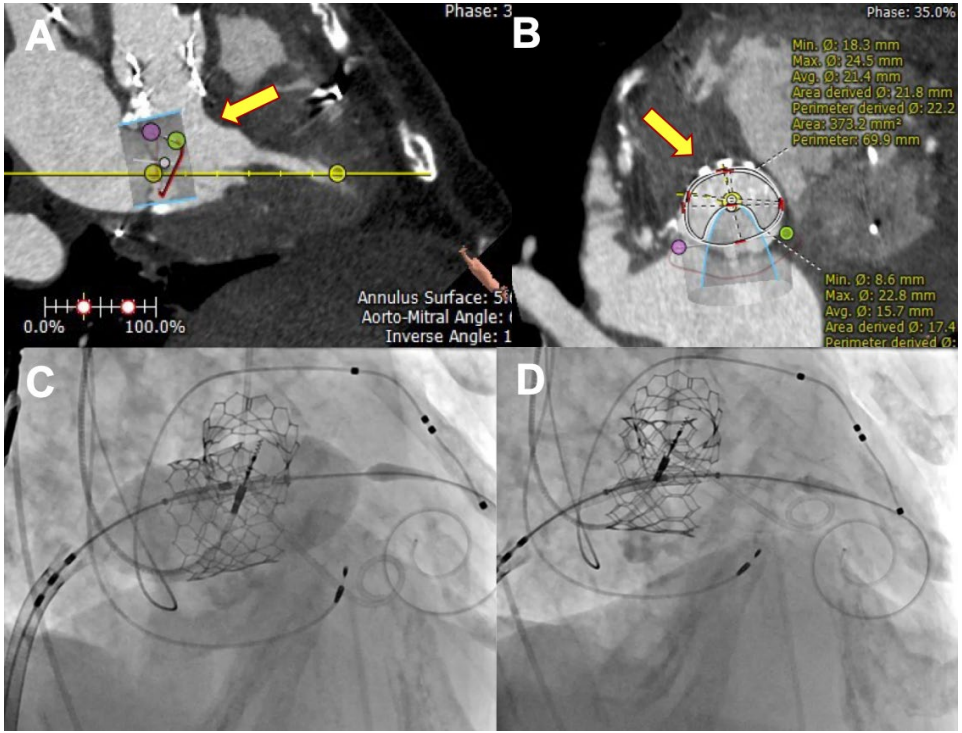




Baseline | Post-alcohol ablation | Post-TMVR

Preemptive Radiofrequency Ablation to Decrease risk of LVOTO after ViMAC "RADIO-TMVR"

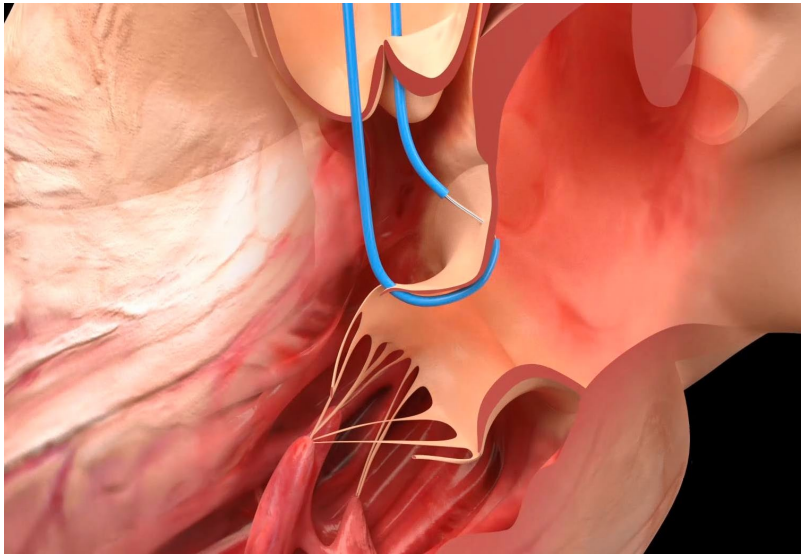


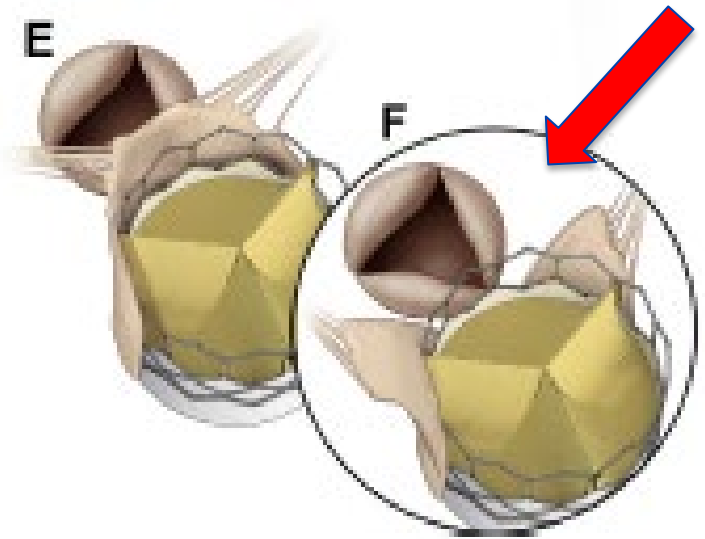


Guerrero, Killu et al, *JACC Cardiovasc Interv* 2020 Mar 19. pii: S1936-8798(20)30522-7. doi: 10.1016/j.jcin.2020.02.016
Killu, Guerrero et al, *In Press* Circ Interventions 2022.

LAMPOON

Laceration of the Anterior Mitral Leaflet to Prevent Outflow ObstructioN



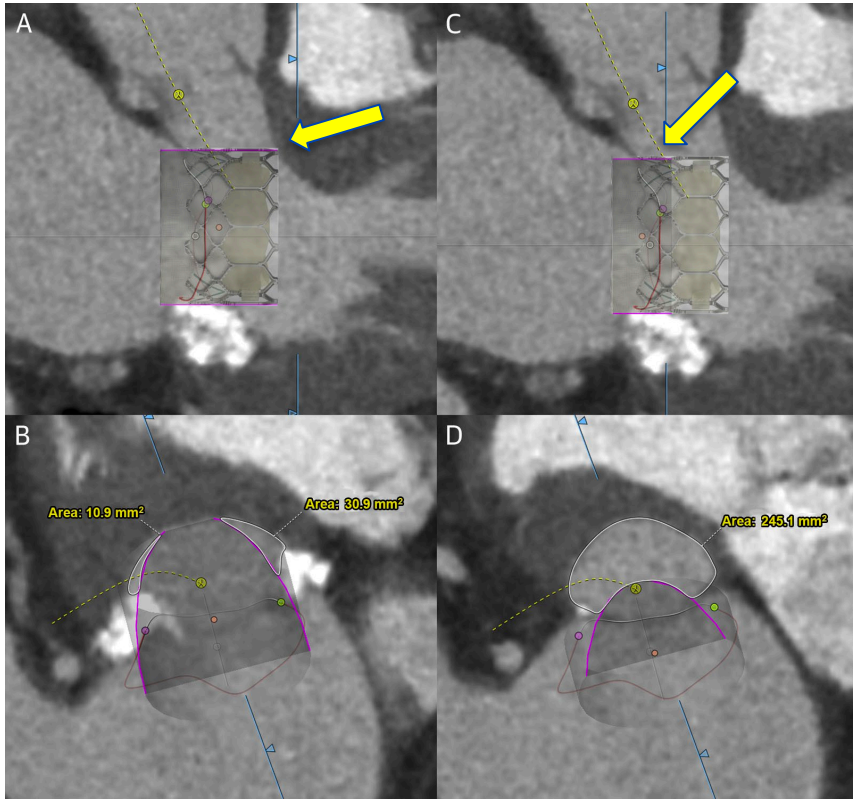


MAC (n=15) and MViR (n=15), STS 10%

30 day mortality 13.3% (2/15) in MAC arm

Khan et al. *JACC* 2019;73:2521-34.

Neo-LVOT and Skirt Neo-LVOT



Khan et al. JACC 2019;73:2521-34.

How to Prevent LVOT Obstruction

Neo-LVOT <200mm2

Skirt Neo-LVOT <200mm2

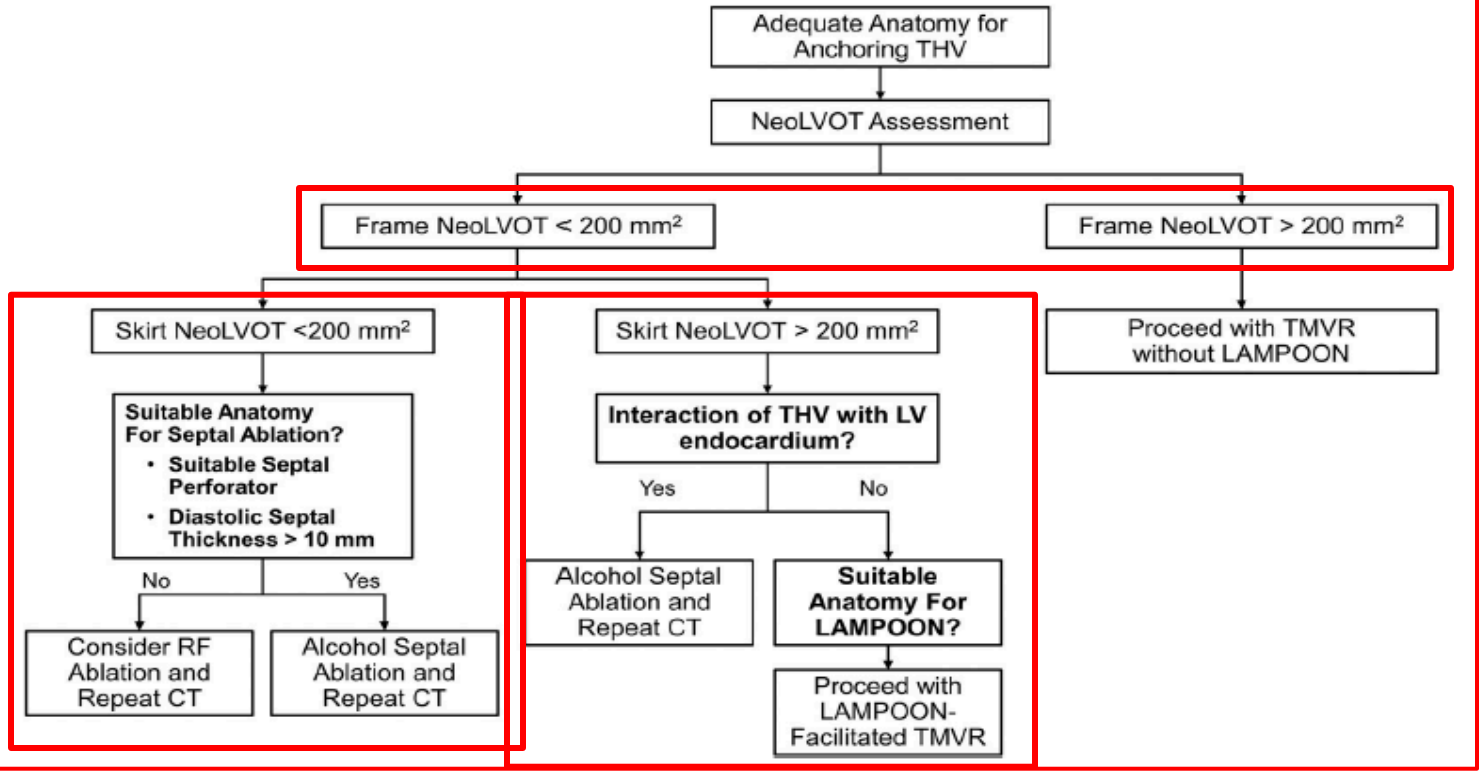
Consider septal reduction strategy
Alcohol or RF Ablation
SESAME?

Skirt Neo-LVOT >200mm2

LAMPOON-Facilitated TS ViMAC

How to Prevent LVOT Obstruction

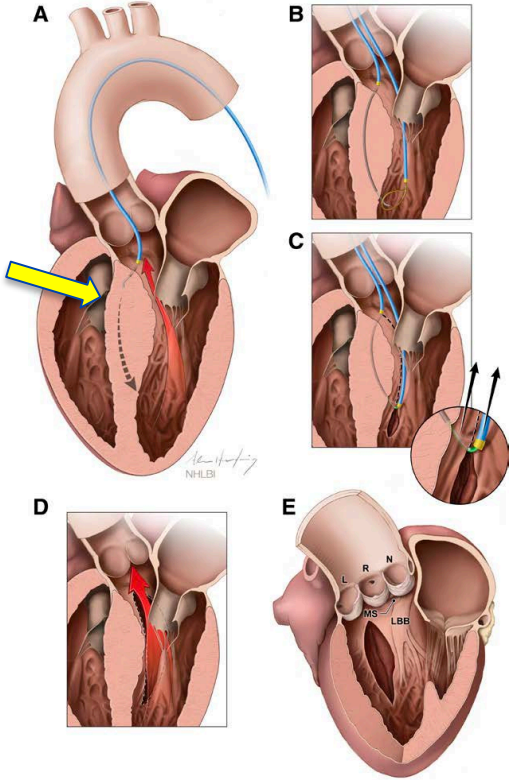
FIGURE 7 Algorithm for Management of LVOT Obstruction Risk Before TMVR

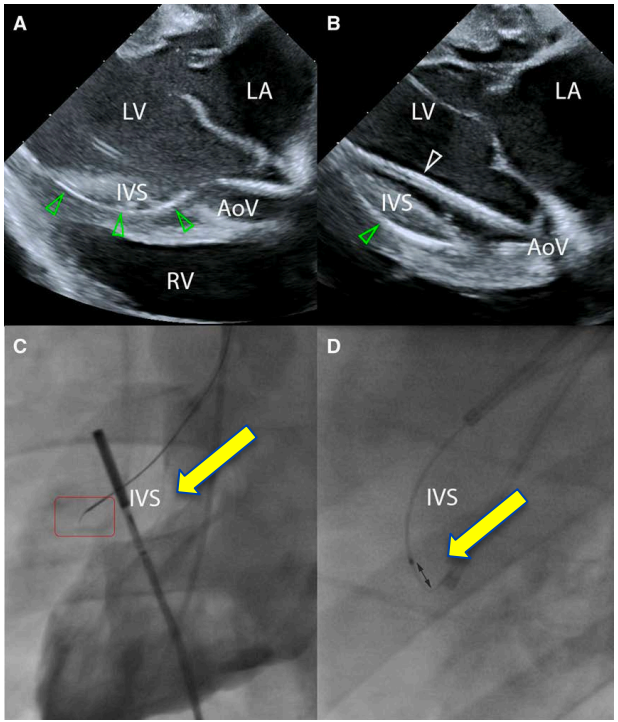


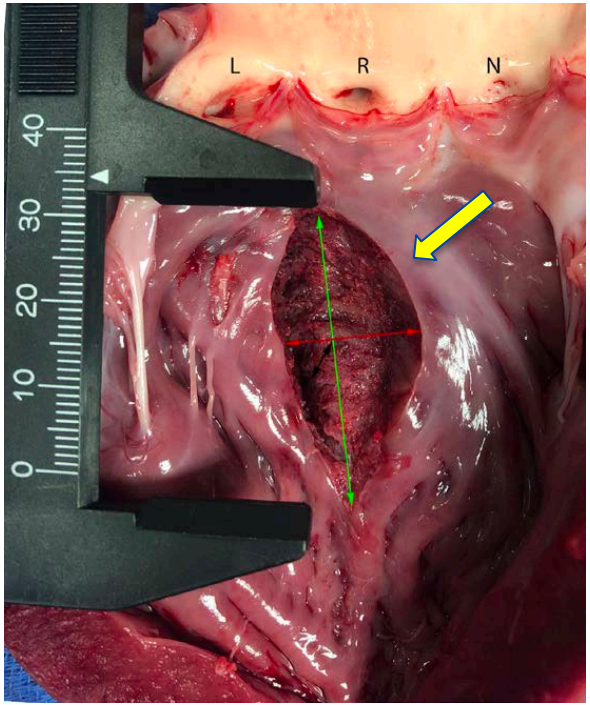
Eleid, Guerrero, et al. *JACC* Interv 2023;16:885-895.

SESAME

SEeptal Scoring Along de Midline Endocarium



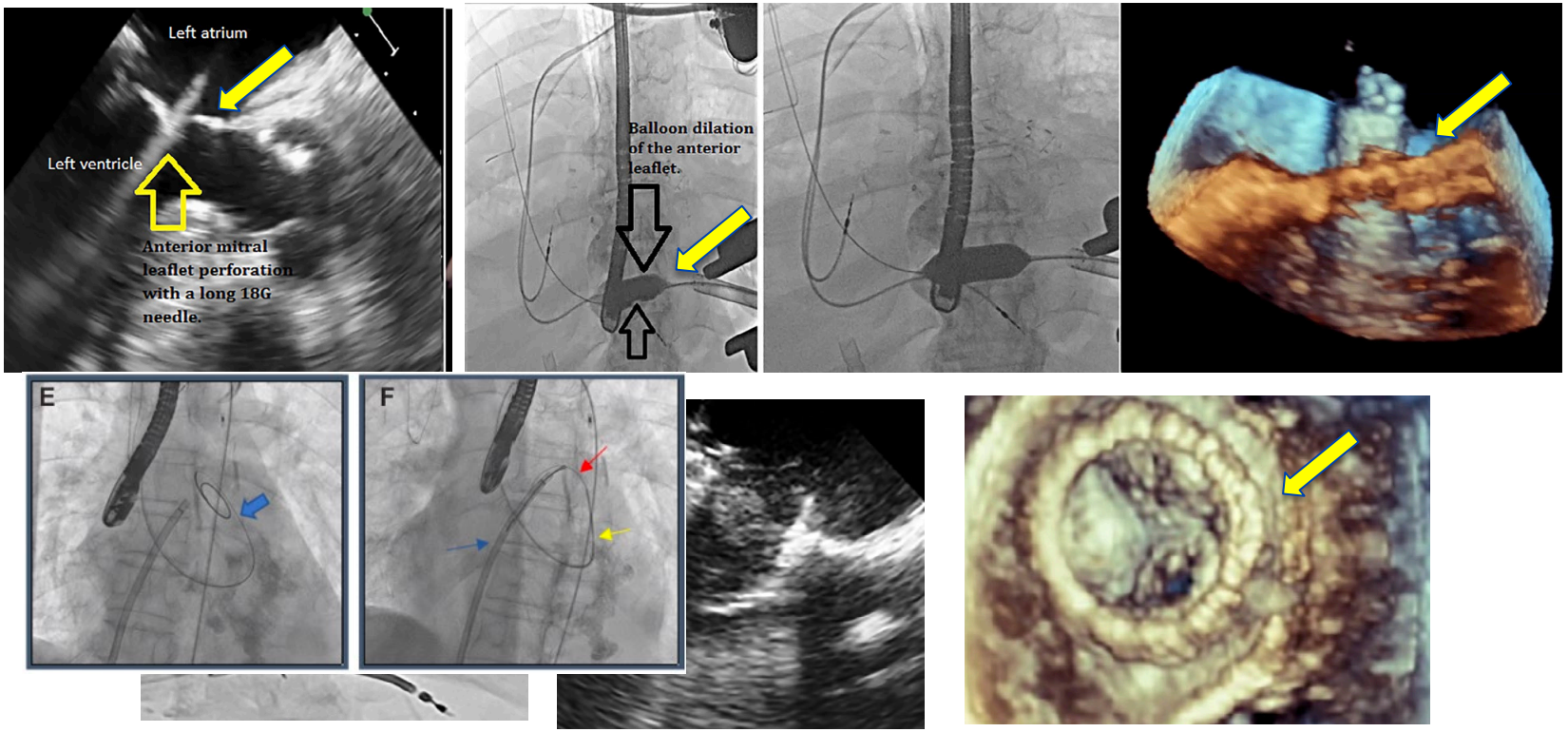




Khan et al, *Circ Cardiovasc Interv* 2022;15:e011686. DOI:10.1161/CIRCINTERVENTIONS.121.011686

BATMAN

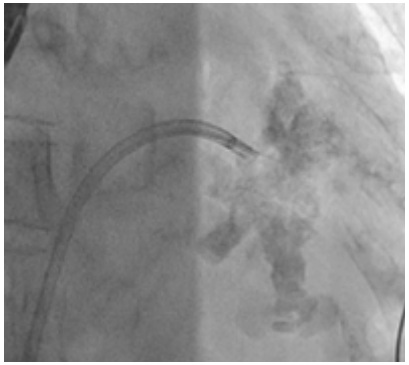
Balloon Assisted Translocation of the Mitral ANterior Leaflet

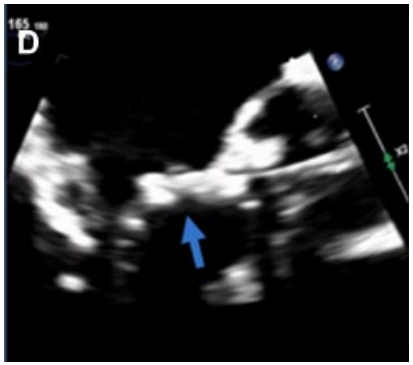


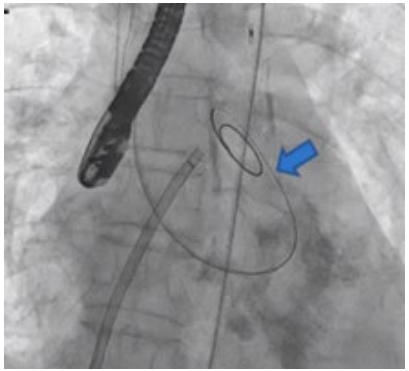
BATMAN & ROBIN

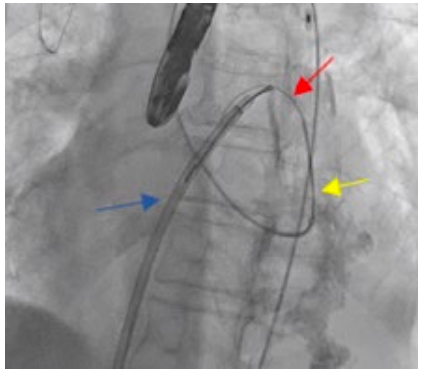
Balloon **A**ssisted **T**ranslocation of the **M**itral **AN**terior Leaflet

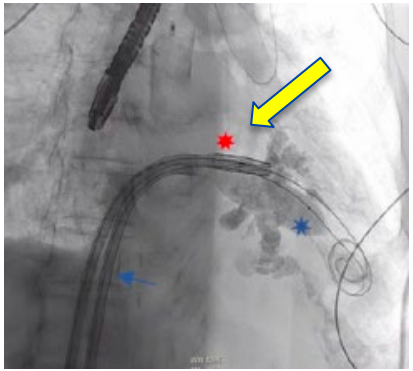
Retr**O**grade Radiofrequency **B**alloon-Assisted opt**I**mization of **N**eo-LVOT







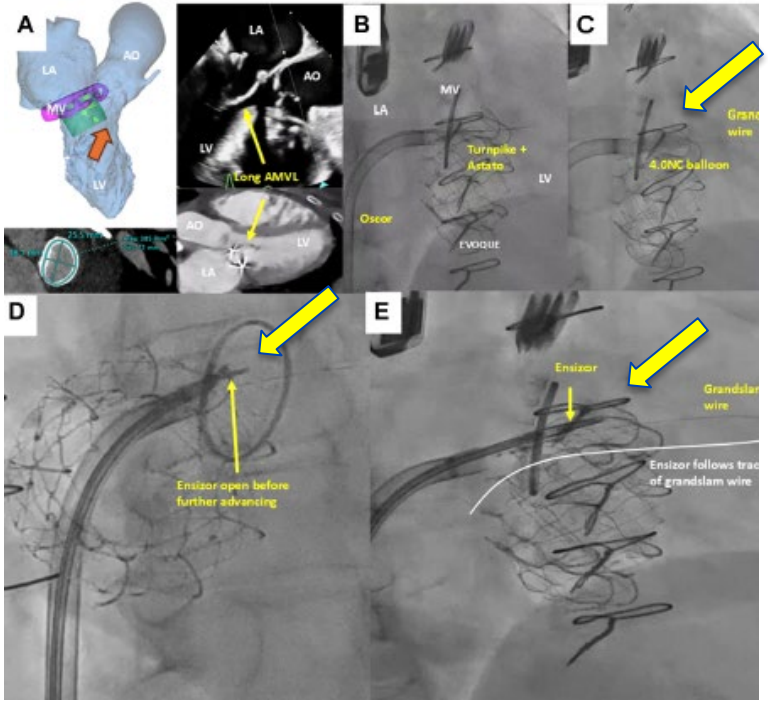


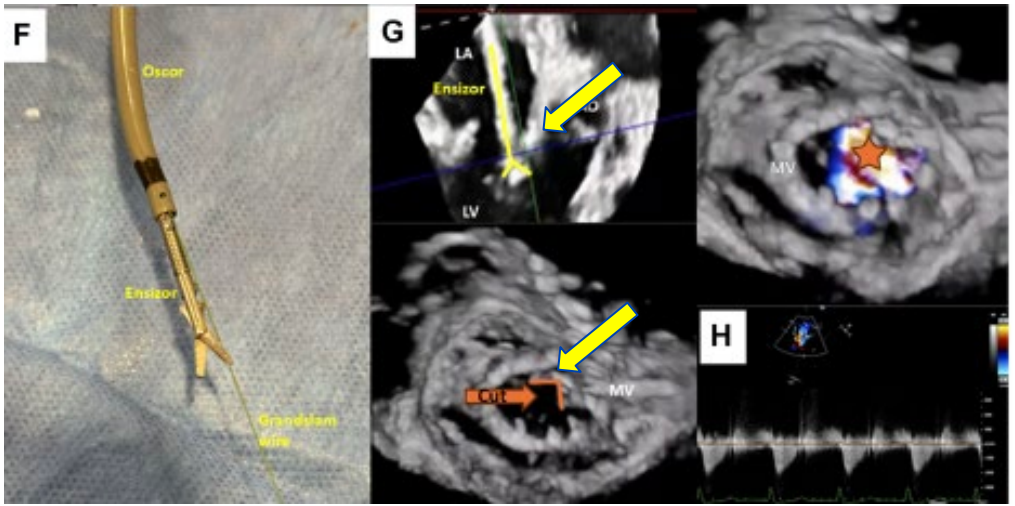


Alnasser et al, *JACC Interv* 2025 Apr 14;18(7):948-949.

WOLVERINE

Wire Landmark-Guided Orientation Controlled Leaflet-Resection to PreVEnt Left-VentRIcular Outflow Tract ObstructioN using Endoscopic-Scissors





Lai et al, *JACC Interv* 2025 July 17:S1936-8798(25)01658-9.doi:10.1016/j.jcin.2025.06.014.

Coming next…

El CHAPULIN Colorado ?

Leaflet Cutting Devices

Pi-Cardia

Pi-Cardia completes first-in-human mitral valve splitting with ShortCut

AUGUST 22, 2022 BY SEAN WHOOLEY

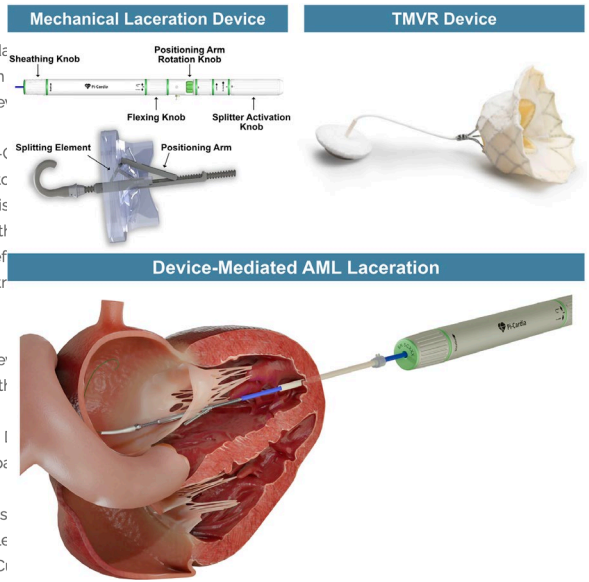
Pi-Cardia announced toda
successful first-in-human
valve with its ShortCut de

Rehovot, Israel-based Pi-(
to split the leaflets prior to
treatment in patients at ris
obstruction after transcath
replacement (TAVR) or lef
(LVOT) obstruction after tr
replacement (TMVR).

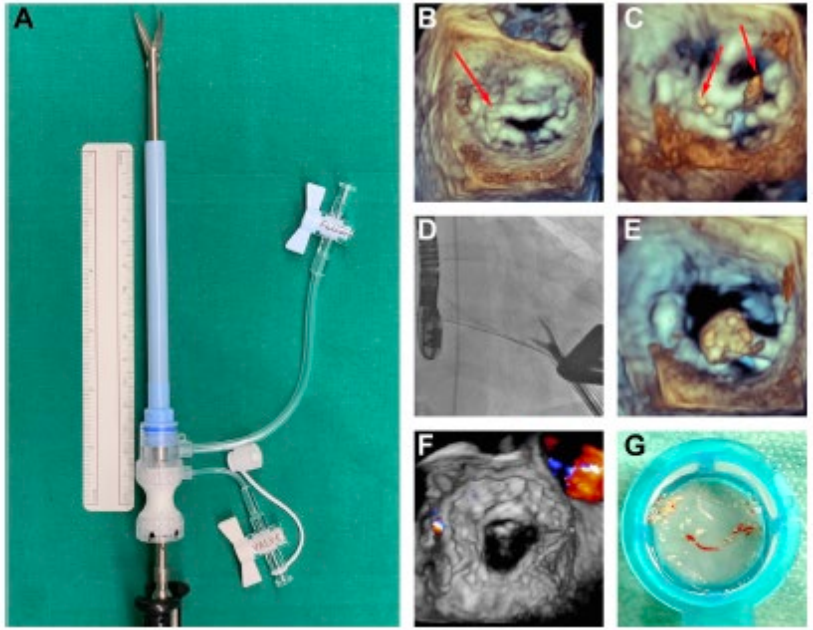
The company said in a ne
device designed to split th

Prof. Lenard Conradi and I
the ShortCut Mitral compa

"We were able to success
splitting the anterior leafle
Conradi. "With the ShortC
mitral valve disease who otherwise have no other option."



MitraCut



Ludwig et al, *JACC Case Reports 2023 May 11*;16:101873.
Mach et al, *JACC Intv* 2022;15(20):2107-2108.

Summary

- LVOT obstruction is the Achilles' Heel of TMVR
- TMVR-induced LVOT Obstruction can be predicted with Cardiac CT Neo-LVOT area, Neo-LVOT Area Index, VTS, Skirt Neo-LVOT Area.
- Percutaneous septal and leaflet strategies to decrease the risk of LVOTO include: Alcohol or RF septal ablation, LAMPOON, SESAME, BATMAN, BATMAN & ROBIN, WOLVERINE.
- New transcatheter devices are being developed to cut anterior MV leaflet prior to TMVR to decrease the risk of TMVR-induced LVOTO

MAYO CLINIC
guerrero.mayra@mayo.edu
mayraguerrero@me.com

Thank You

guerrero.mayra@mayo.edu

mayraguerrero@me.com