Electrosurgery in Structural Interventions

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Disclosures

- Consultant, Medtronic

What is Electrosurgery?

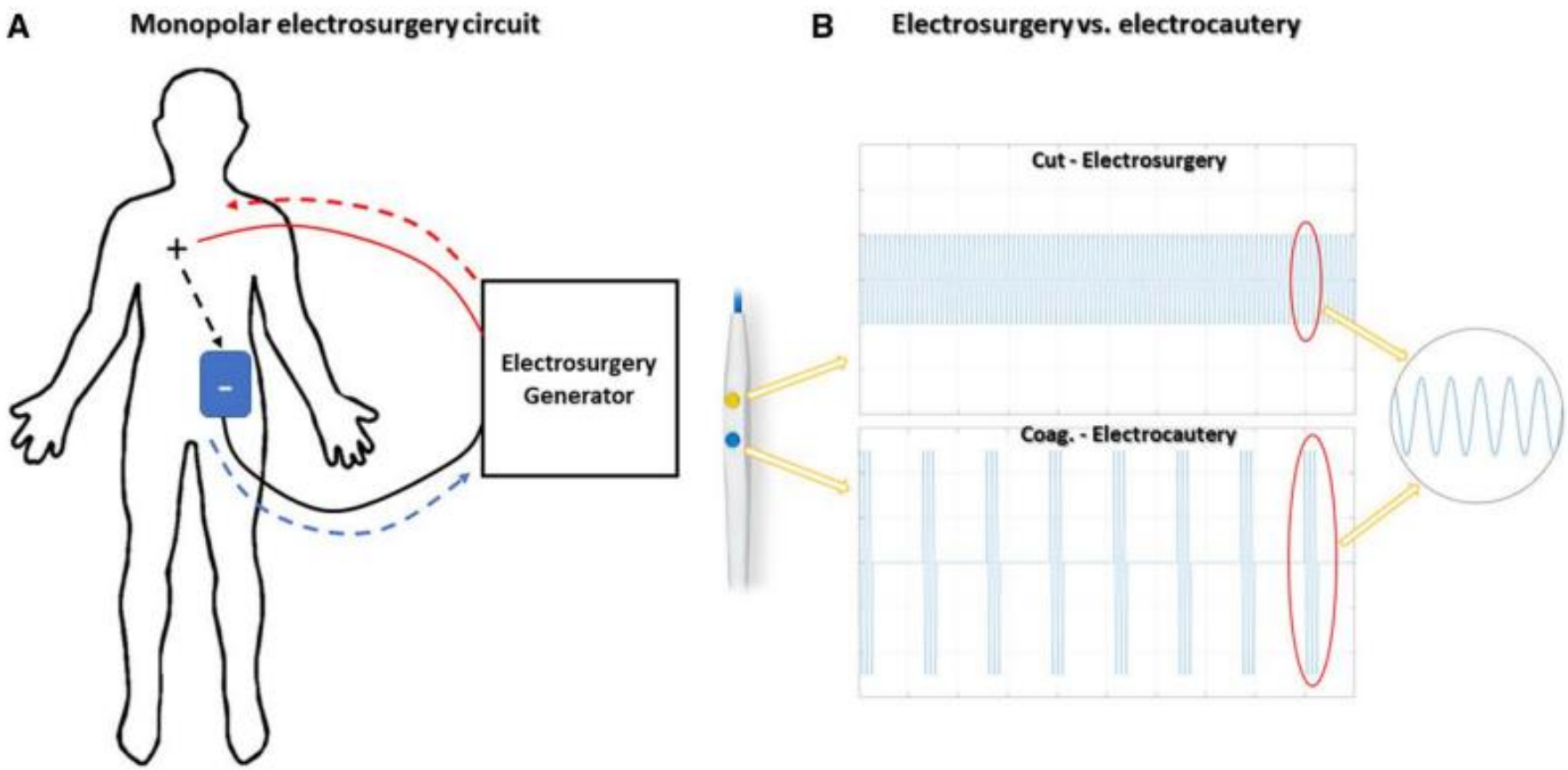
Delivery of high radiofrequency alternating current to cut or traverse tissue

- Current transferred to target tissue, which generates heat and vaporization
- Current delivered by catheters and guidewires

Different from electrocautery, which relies on direct transfer of heat to induce tissue coagulation without vaporization

Khan JM, JACC 2020;75(12):1455-70.
Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

Electrosurgery vs Electrocautery



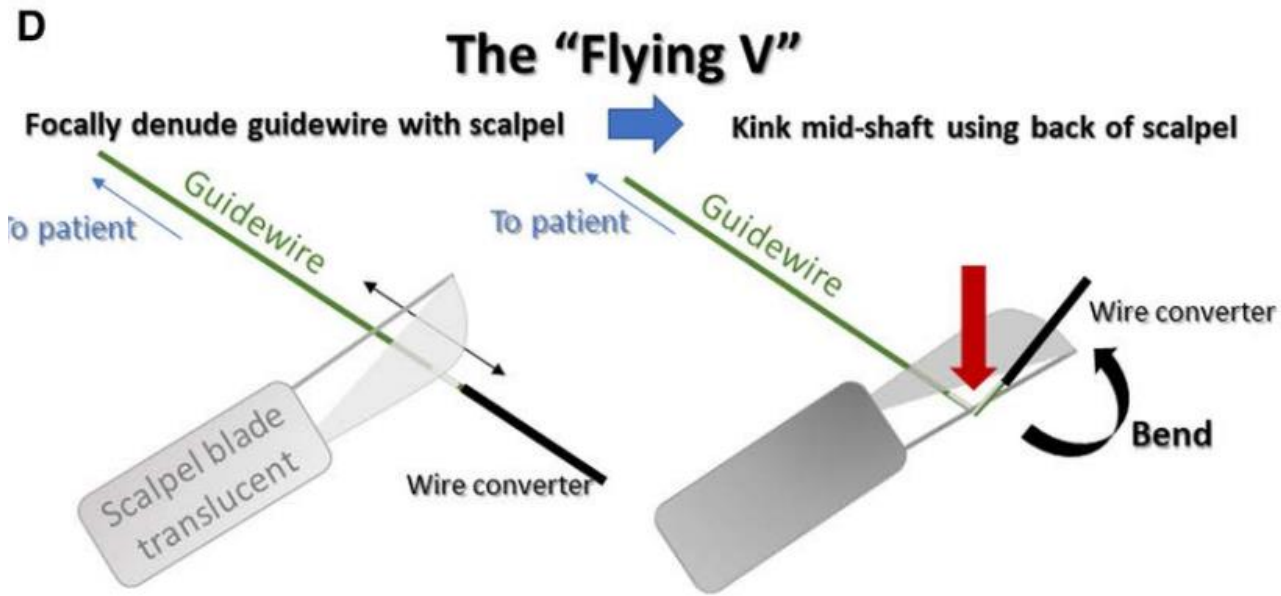
Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

Electrosurgery Principles

- Effective electrosurgery relies on high current density with charge concentration at the site of tissue laceration/traversal
- In the cath lab, needs to be accomplished at a significant distance from the operator and through conductive material (blood)
- Transcatheter electrosurgery circuit includes:
  - Electrosurgery generator
  - Guidewire
  - Insulative catheters
  - Nonionic solution

Electrosurgery Circuit - Guidewire

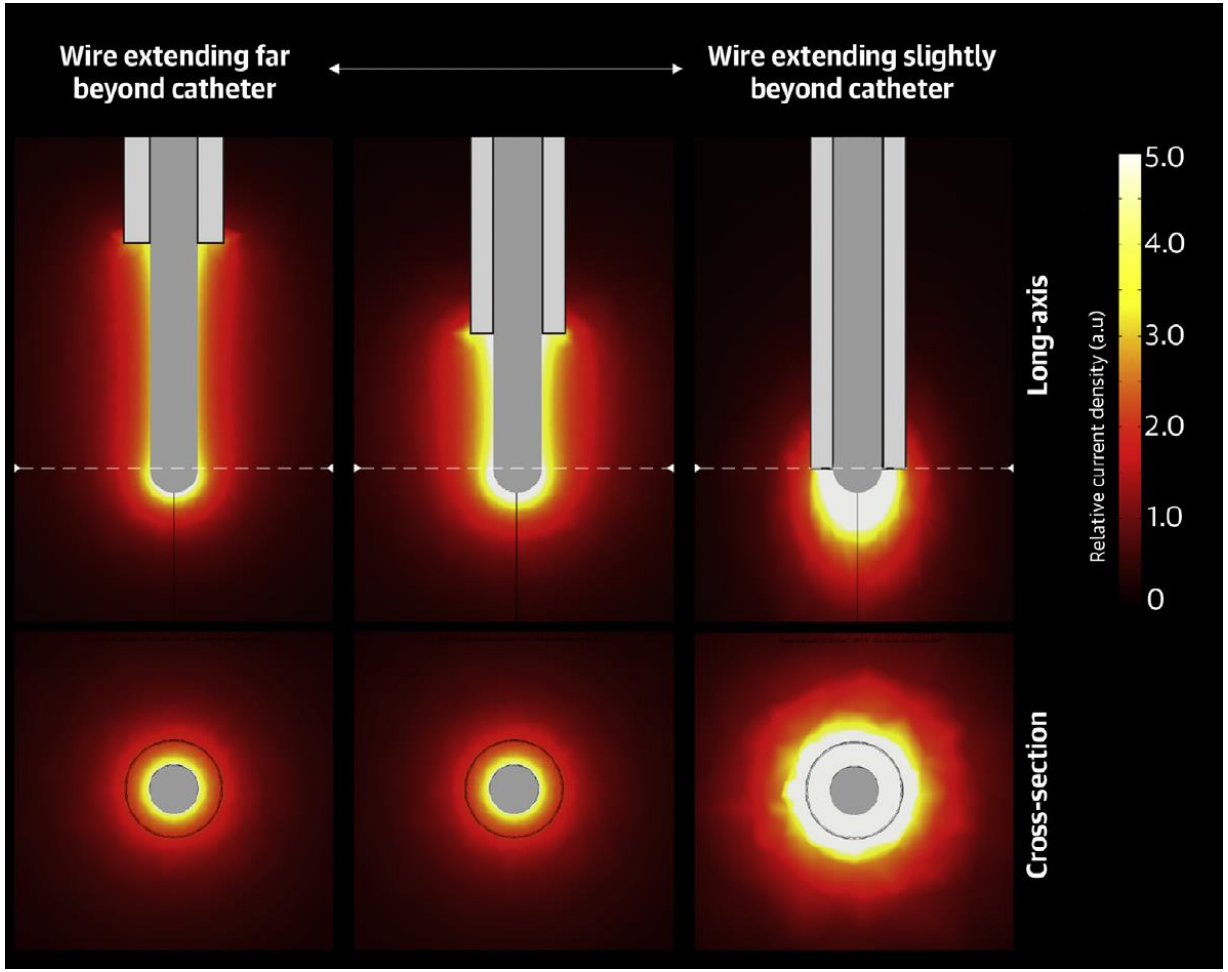
- Tissue laceration is accomplished using a kinked guidewire
  - Inner surface of wire is denuded to focus the charge at the site of laceration (acts as the active electrode)



Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

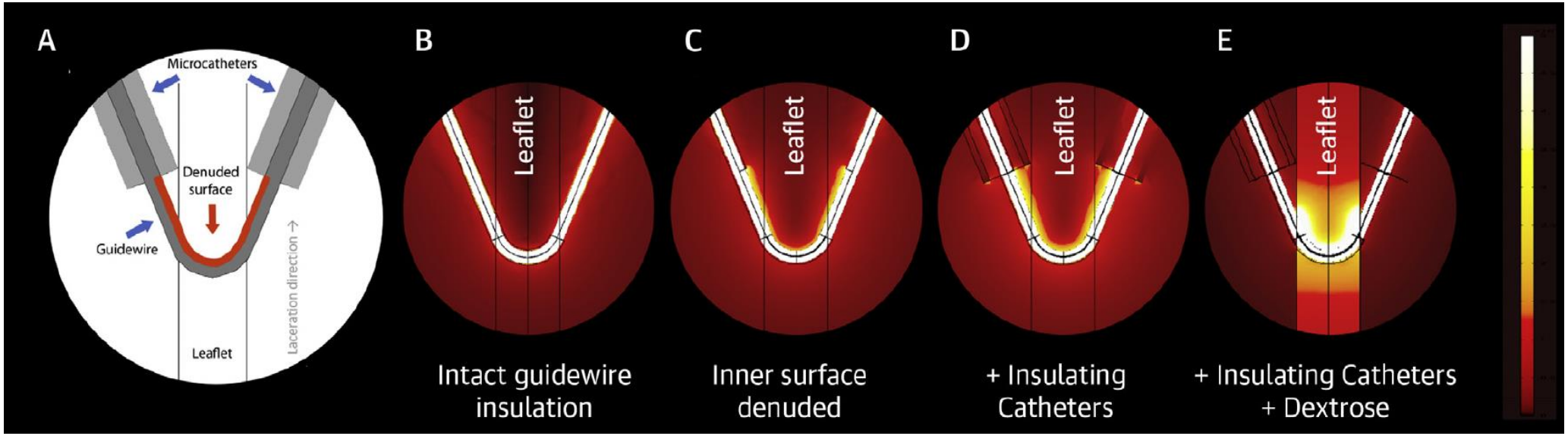
Electrosurgery Circuit - Catheters

Insulating a guidewire with a catheter concentrates the charge at the tip and increases effectiveness



Khan JM, JACC 2020;75(12):1455-70.

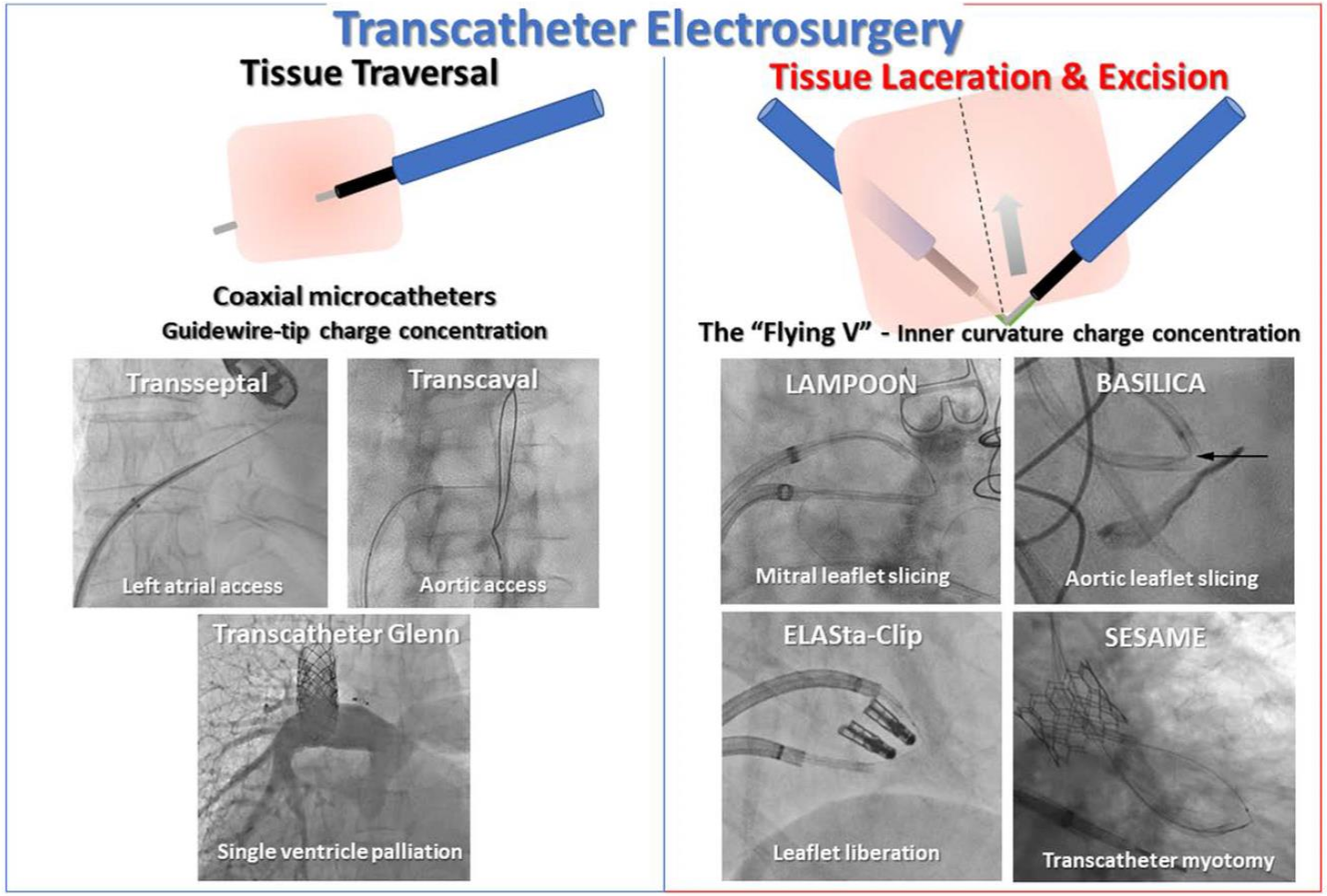
Electrosurgery Circuit – Catheters and Dextrose



- Blood is a highly conductive medium, which results in charge dispersal
- Infusion of nonionic dextrose solution through catheters displaces blood and allows charge to concentrate at the target tissue
- Dextrose also reduces char, coagulation, and possible thromboembolism

Khan JM, JACC 2020;75(12):1455-70.
Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

Electrosurgery Applications



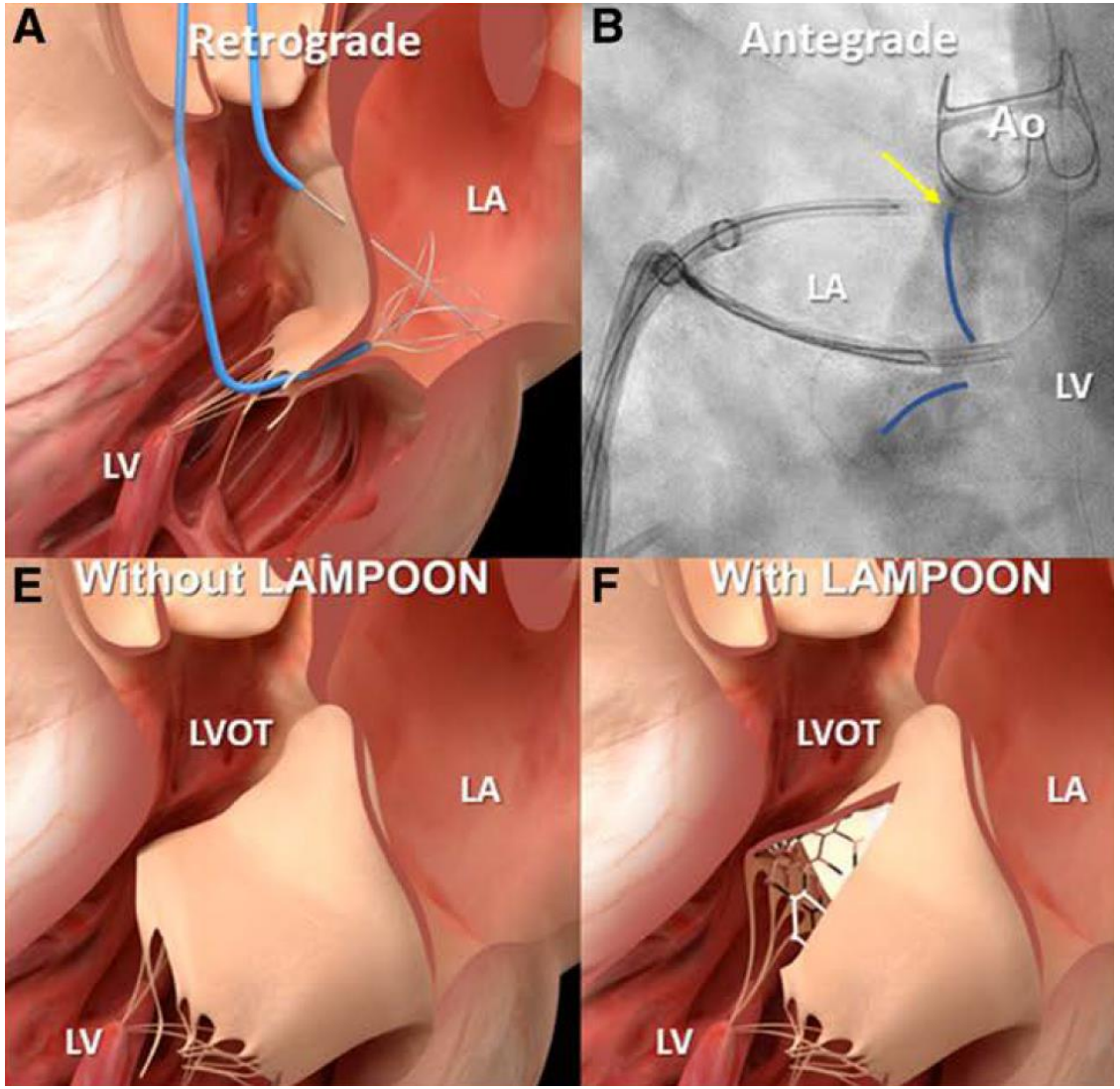
Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

LAMPOON

Laceration of the Anterior Mitral leaflet to Prevent Outflow ObstructioN

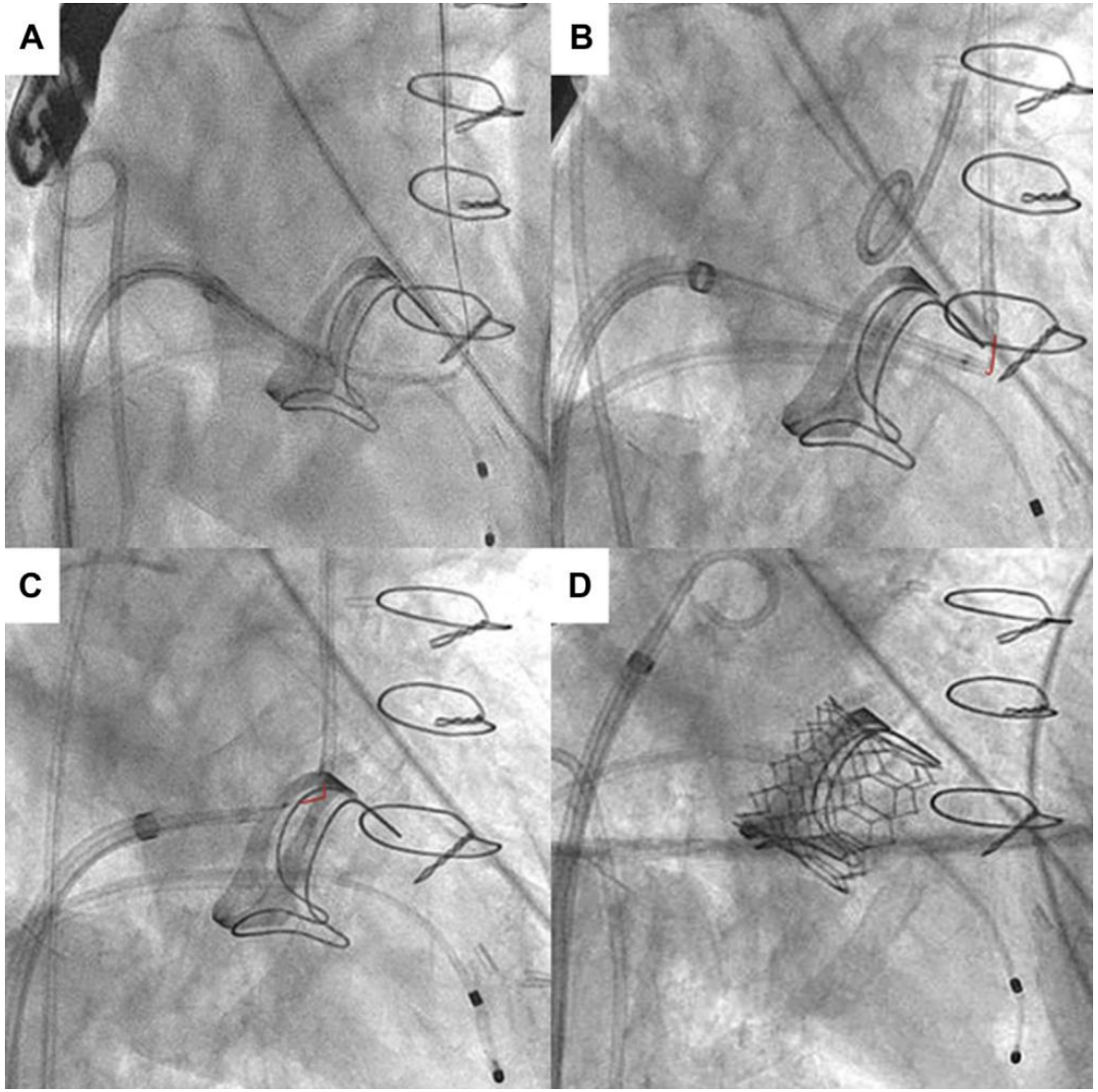
- LVOT obstruction is a potentially life-threatening complication of TMVR related to displacement of the anterior mitral leaflet toward the septum
- Electrosurgical laceration of the anterior mitral leaflet can help mitigate this risk by creating a larger “neo LVOT” after transcatheter valve deployment
- Split leaflet spreads apart and allows blood to travel through the open cells of the transcatheter valve

LAMPOON



Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

LAMPOON



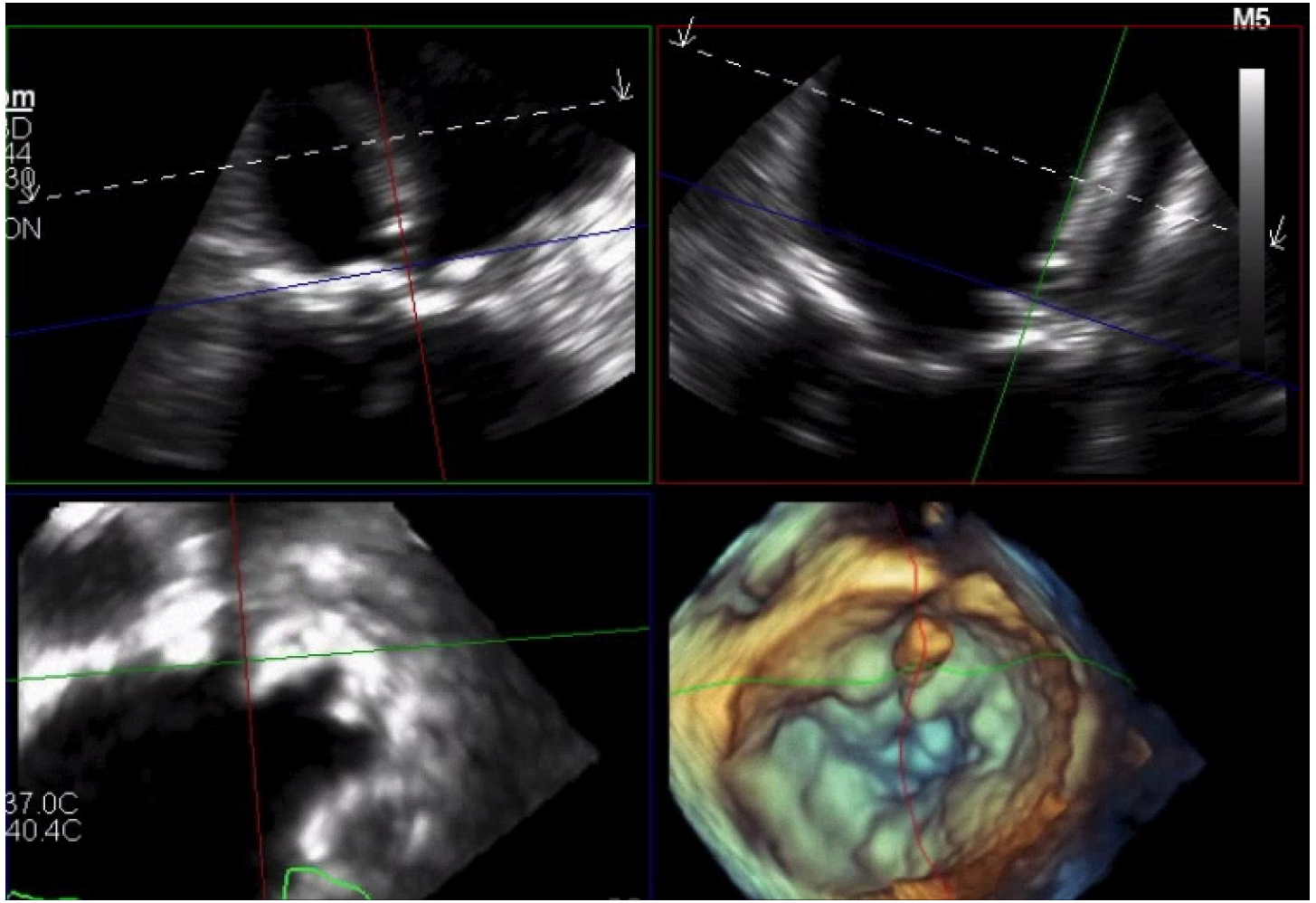
Lisko JC, JACC Cardiovasc Interv 2021; 14(5):541-550.

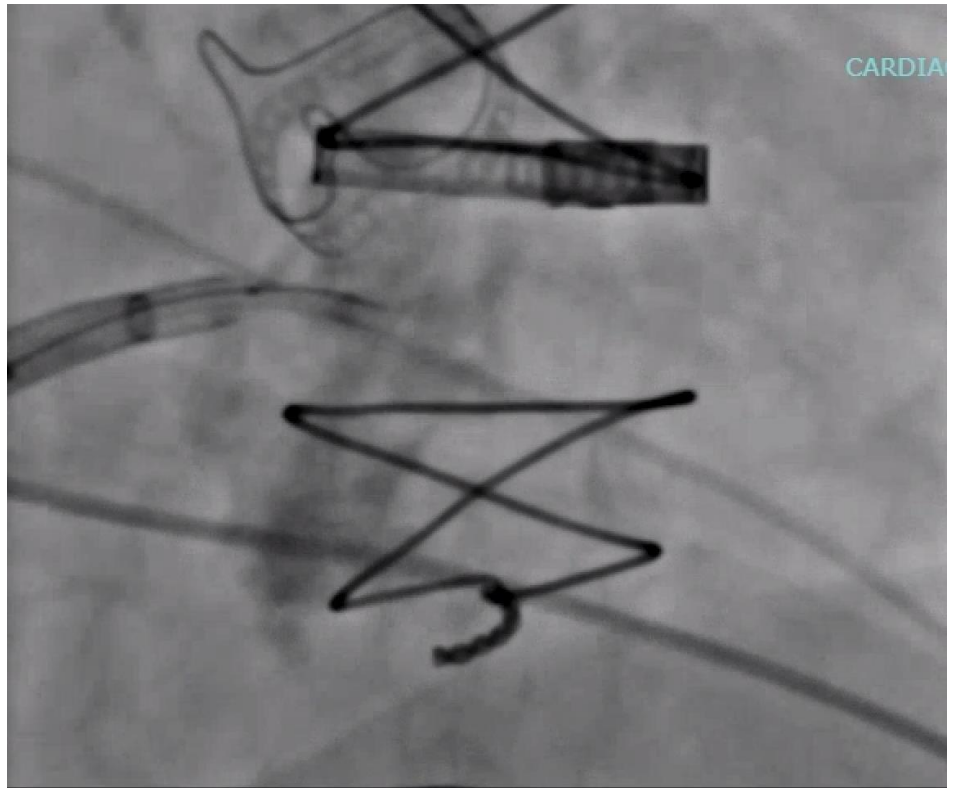
BATMAN

Balloon-Assisted Translocation of the Mitral ANterior Leaflet

- Alternative method to mitigate risk of LVOT obstruction in patients undergoing valve-in-ring (ViR) or valve-in-MAC (ViM) TMVR
- Electrosurgical crossing of the anterior mitral leaflet, followed by deployment of a transcatheter valve within the leaflet tissue

BATMAN





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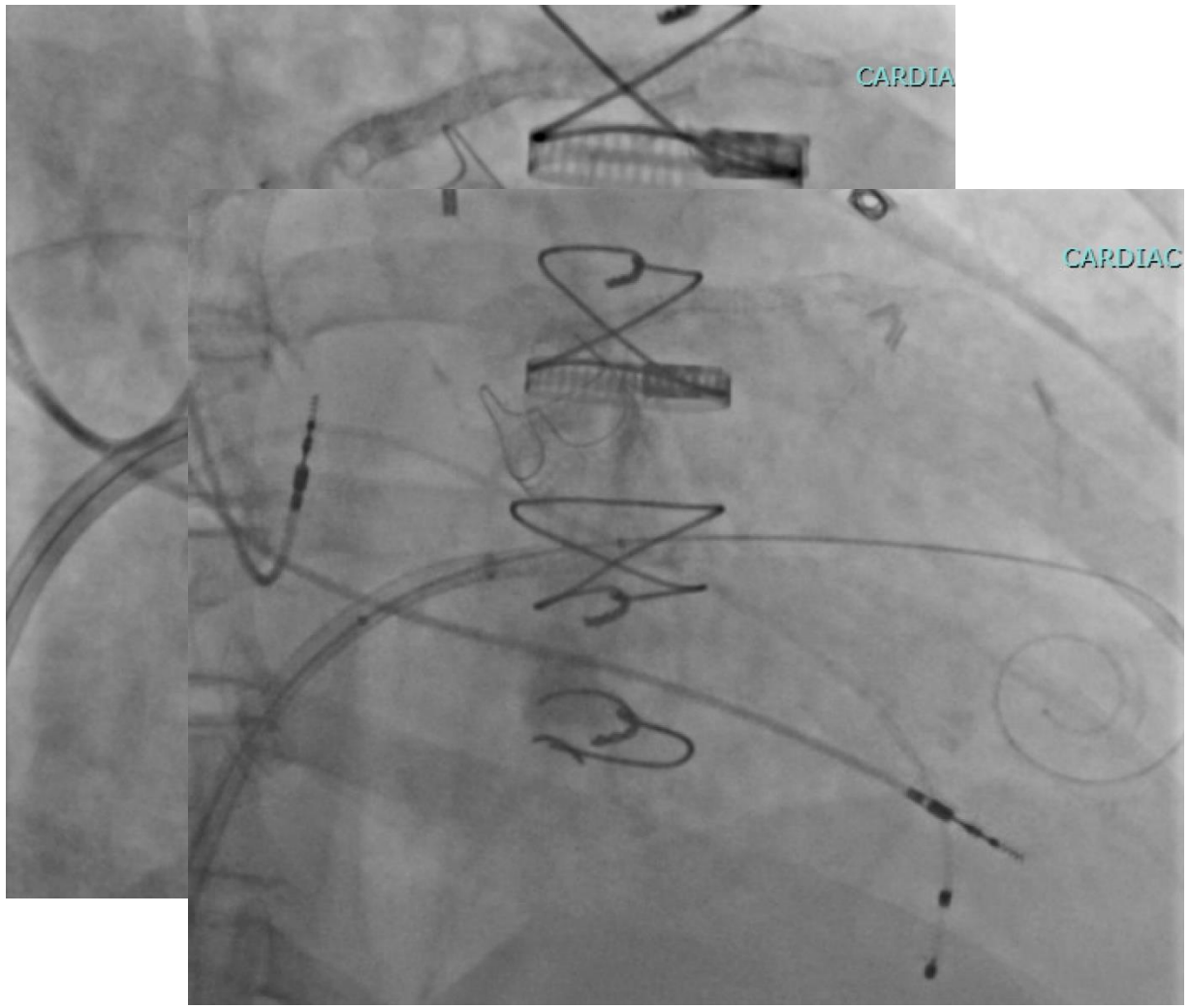
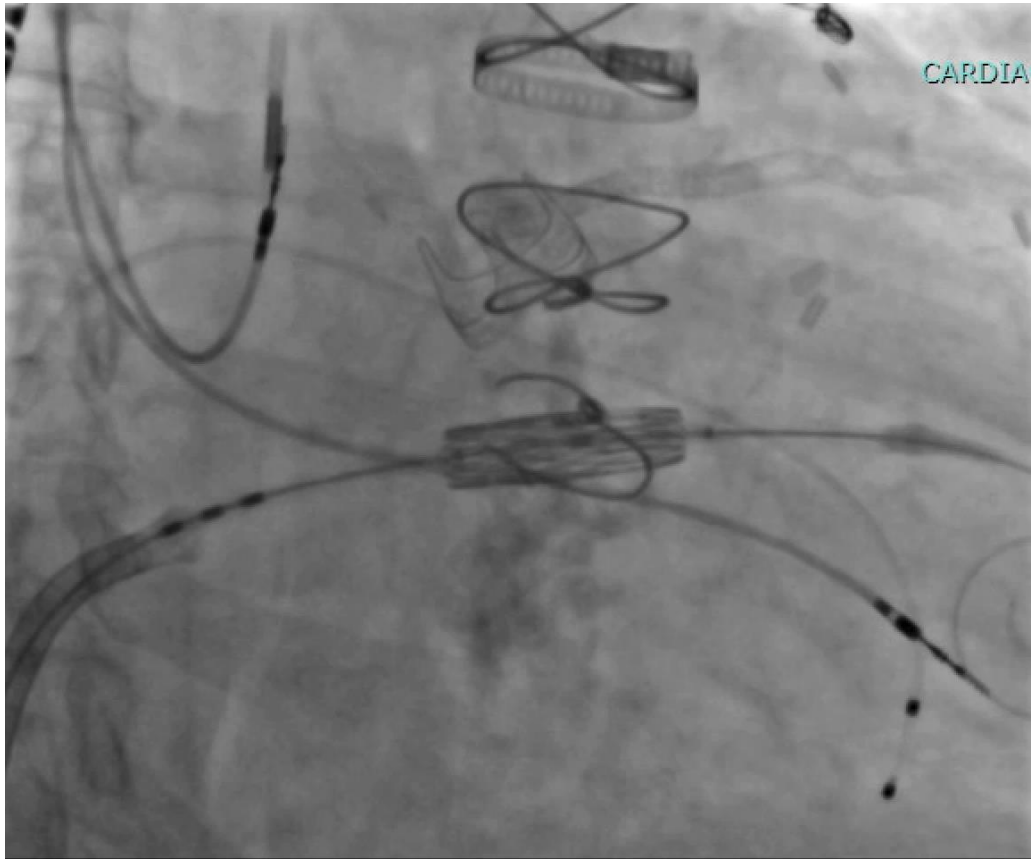


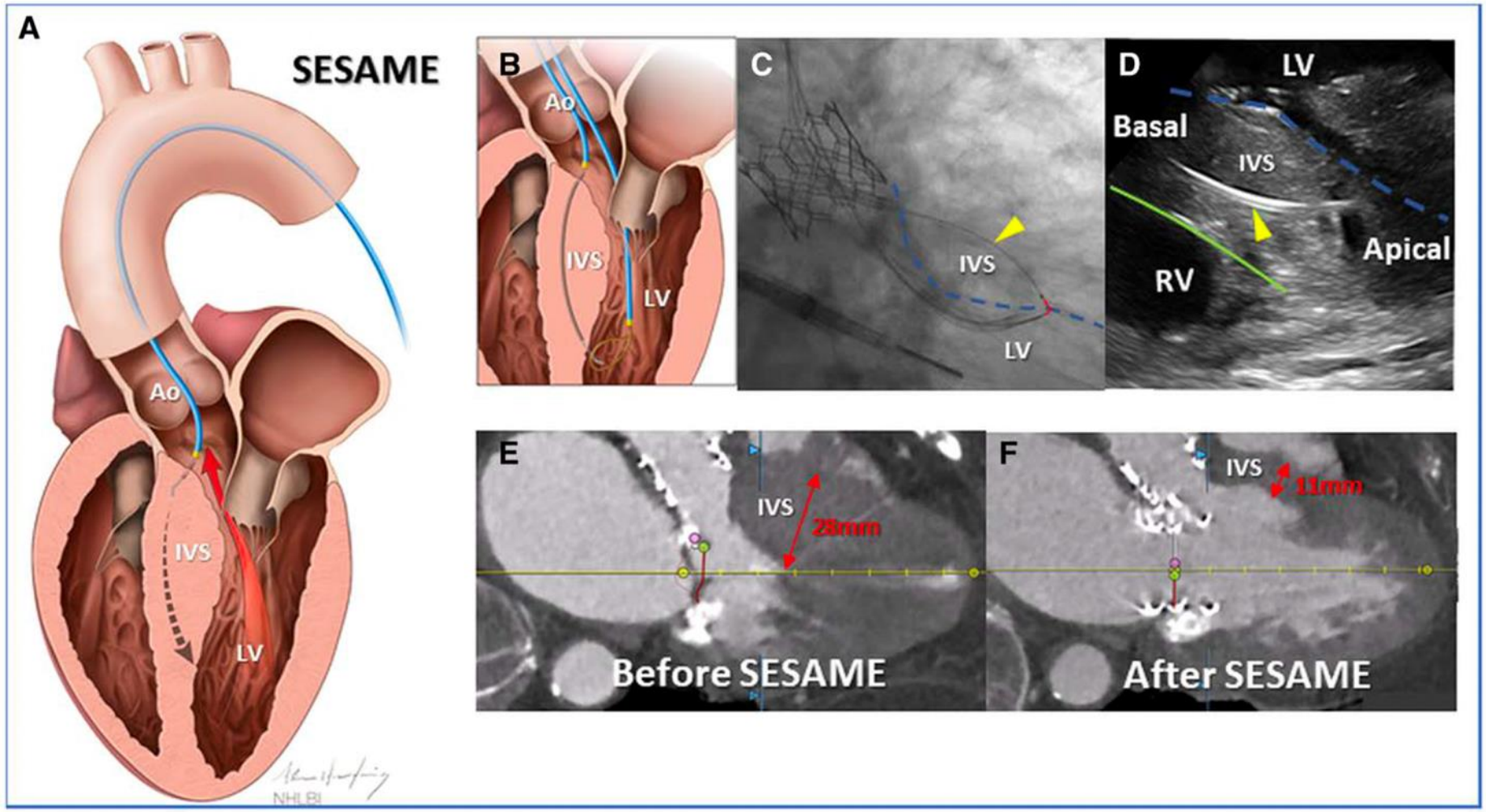


SESAME

SEptal Scoring Along the Midline Endocardium

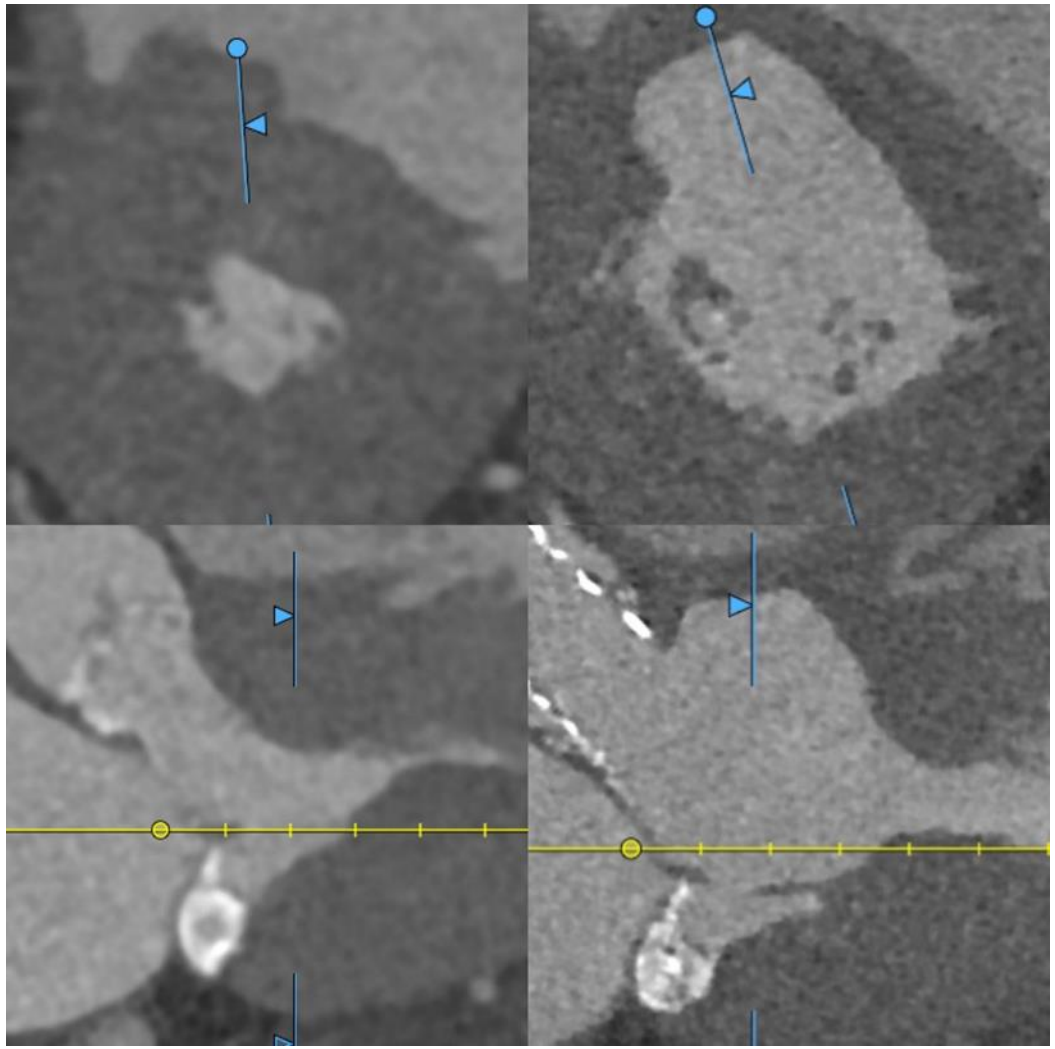
- Percutaneous septal myotomy to address LVOT obstruction
- Alternative or additive to LAMPOON for patients at high risk of LVOT obstruction with TMVR
- Technique could also be applied to patients with HOCM who are not candidates for surgical myectomy

SESAME



Bruce CG, Circ Cardiovasc Interv 2023; 16(3):e012019.

SESAME

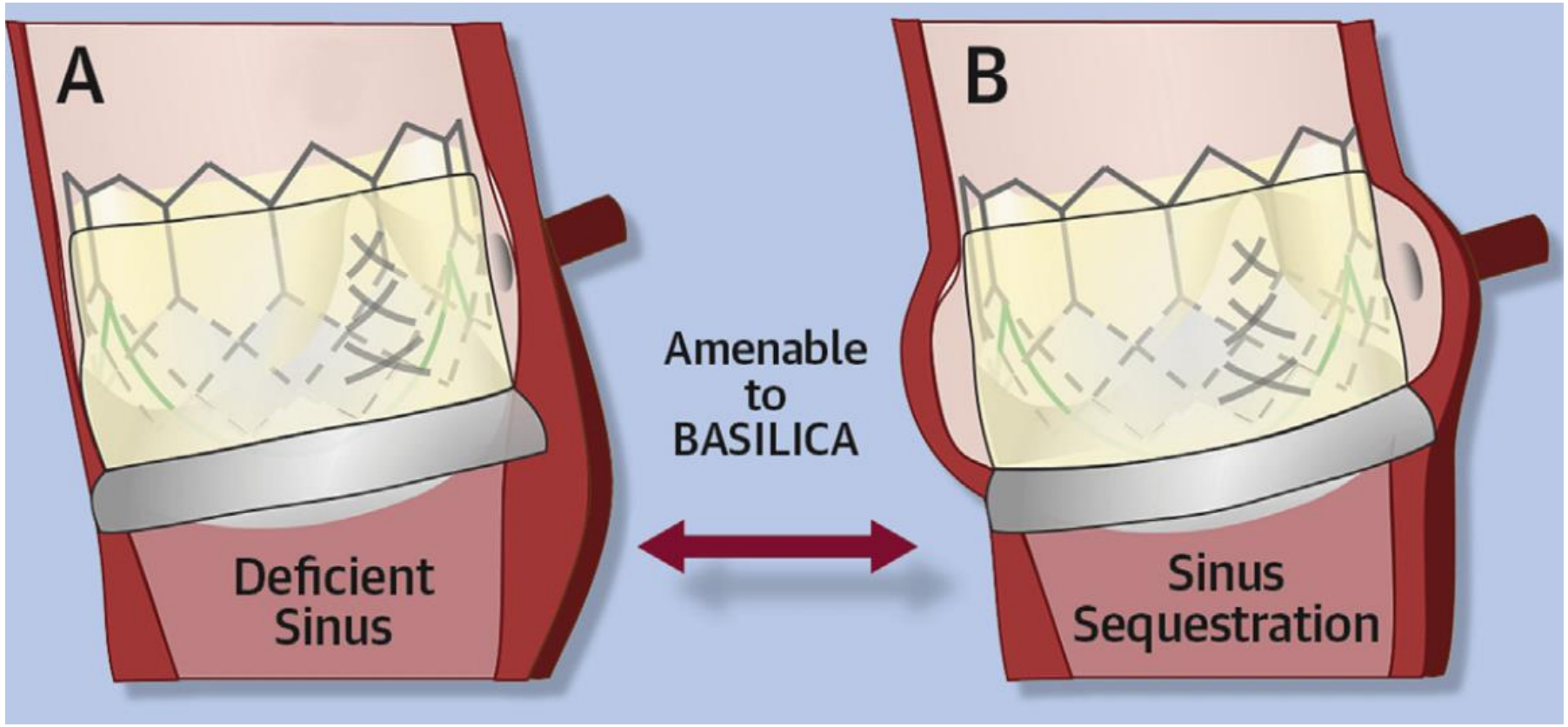


BASILICA

Bioprosthetic or native Aortic Scallop Intentional Laceration to prevent Iatrogenic Coronary Artery obstruction during TAVR

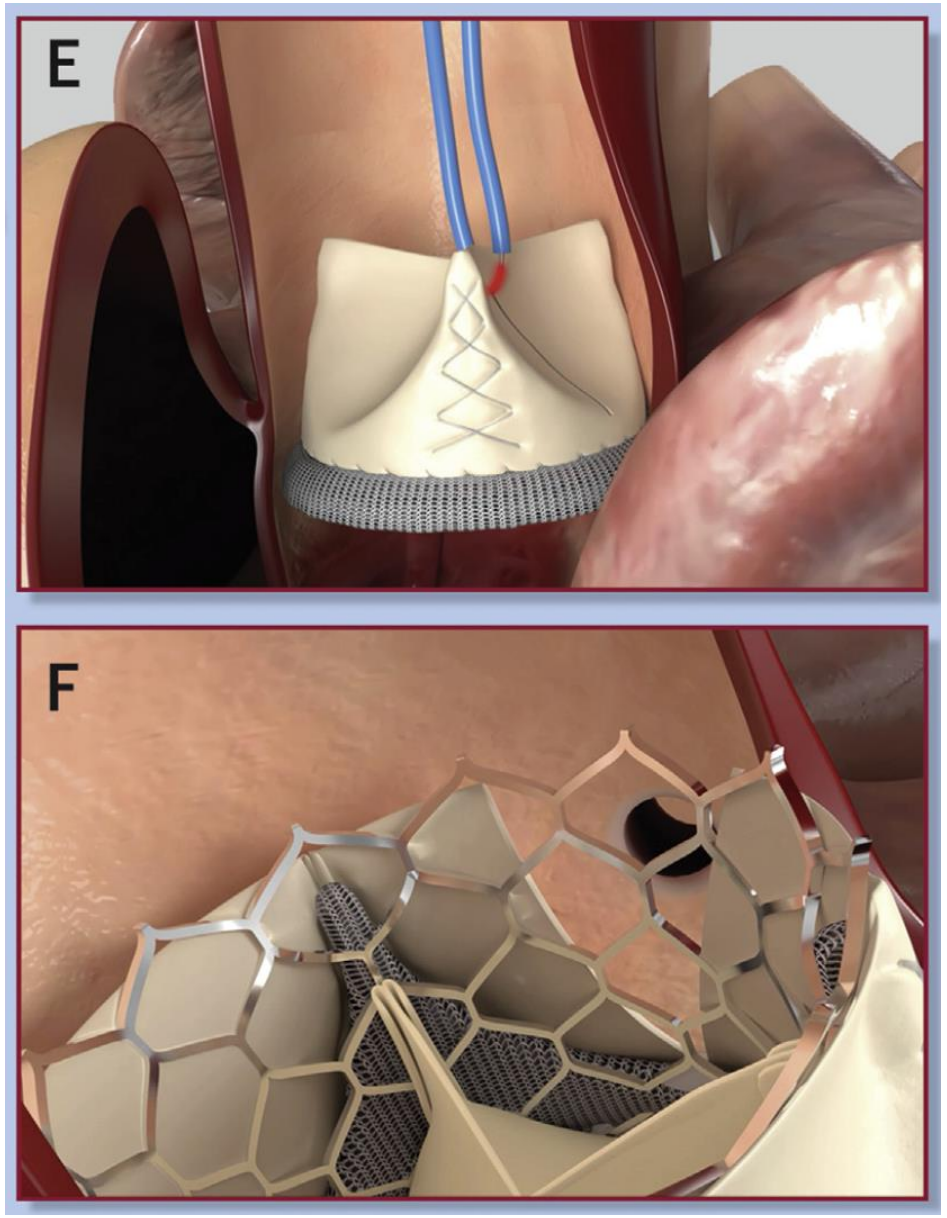
- Coronary artery obstruction is a rare but life-threatening complication of TAVR
- Most common in valve-in-valve TAVR, but occasionally occurs with native valves
- Caused by outward displacement of the surgical or native leaflets that leads to obstruction of the coronary ostia

Mechanism of Coronary Obstruction in TAVR



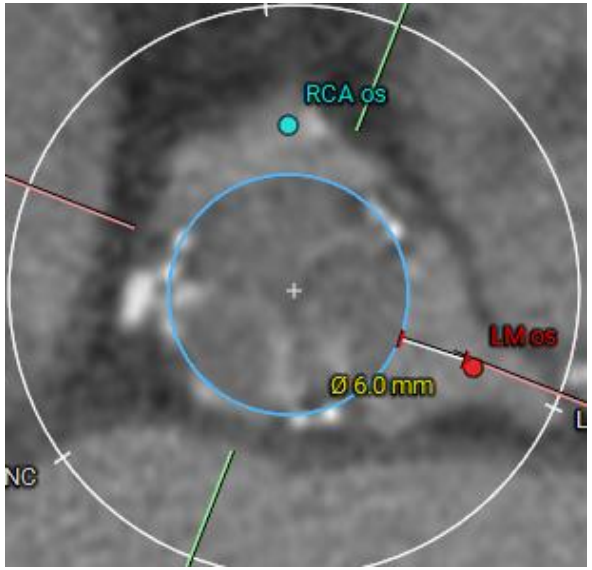
Lederman RJ, JACC Cardiovasc Interv 2019;12(13):1197–216.

BASILICA

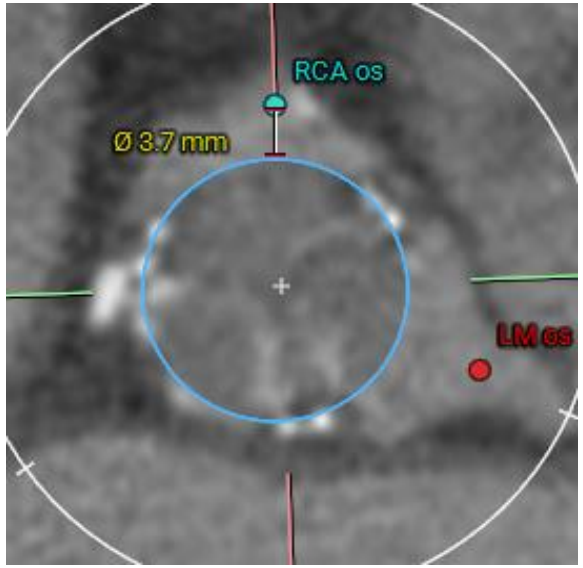


Lederman RJ, JACC Cardiovasc Interv 2019;12(13):1197–216.

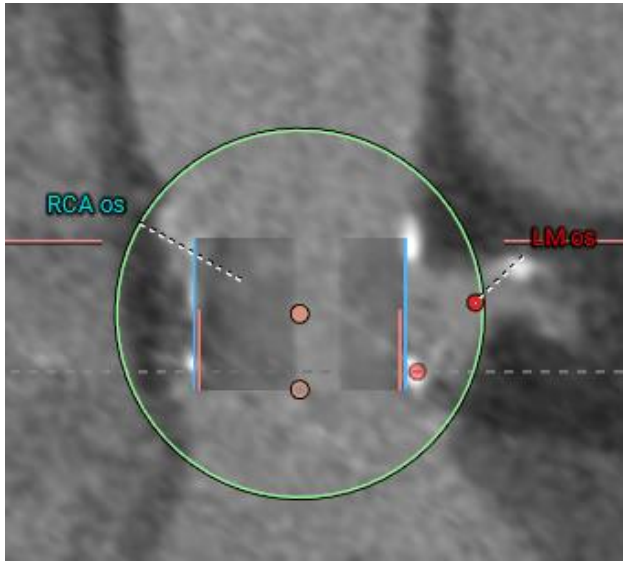
BASILICA CASE – Sinus Sequestration



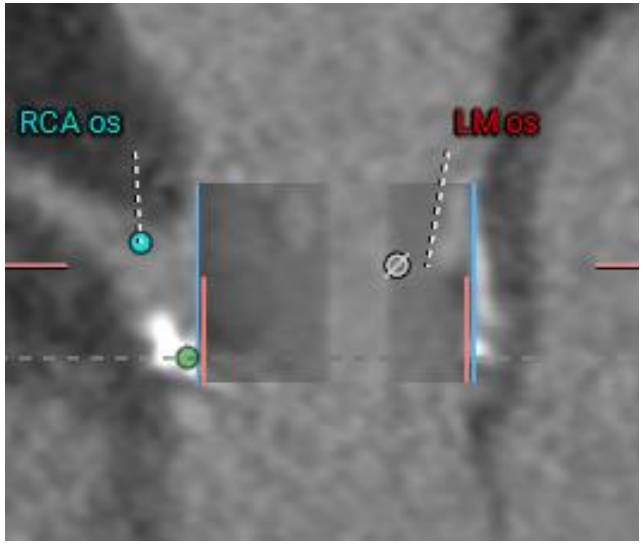
Left VTC



Right VTC



Left VTSTJ

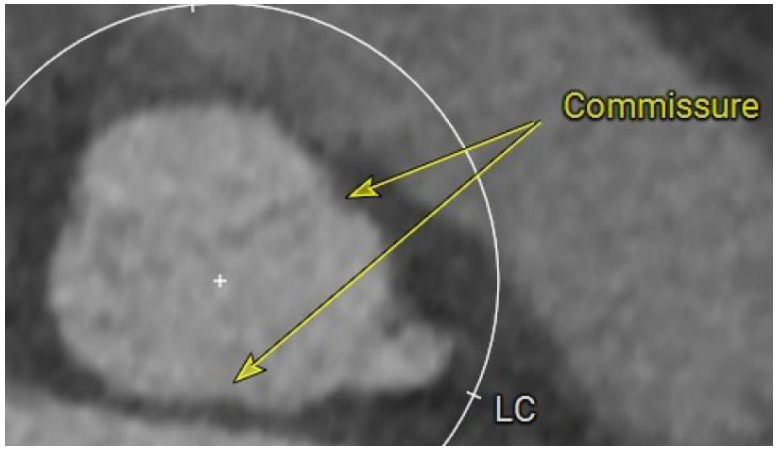


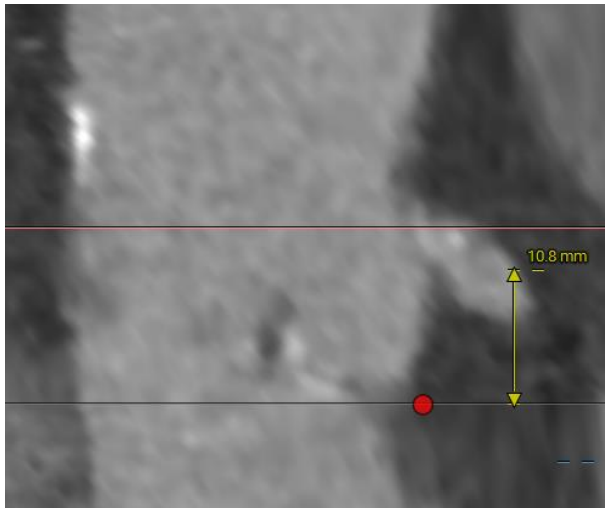
Right VTSTJ

BASILICA Case - Deficient Sinus

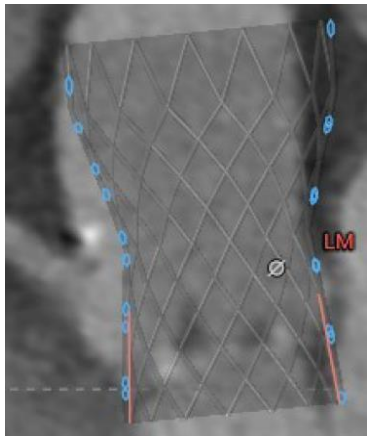
High risk for left coronary obstruction

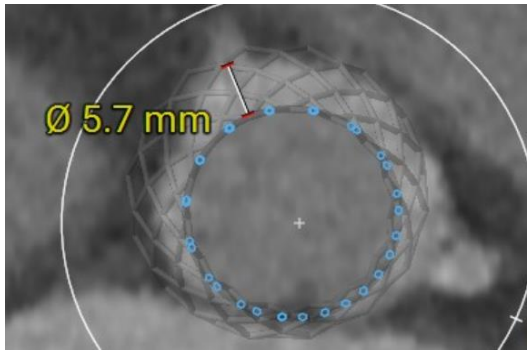
Low risk for right coronary obstruction



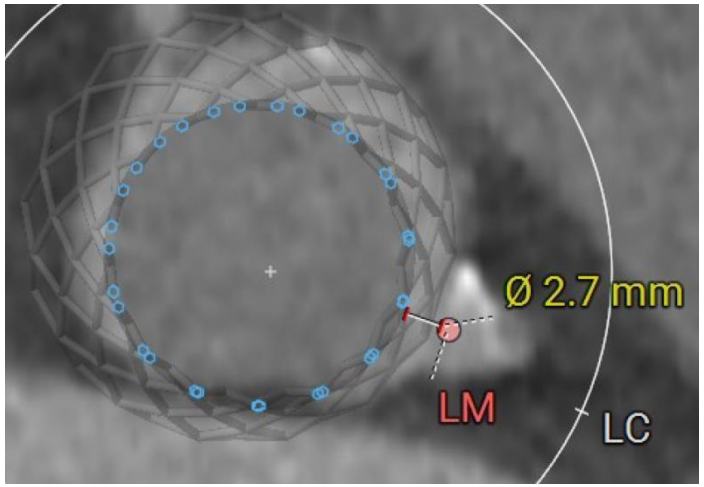


Commissures extend to level of mid LM

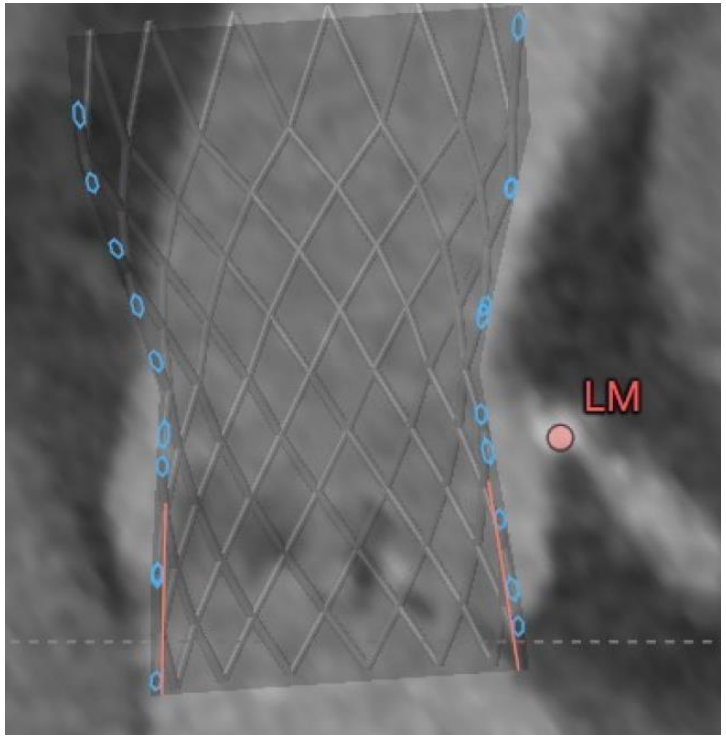




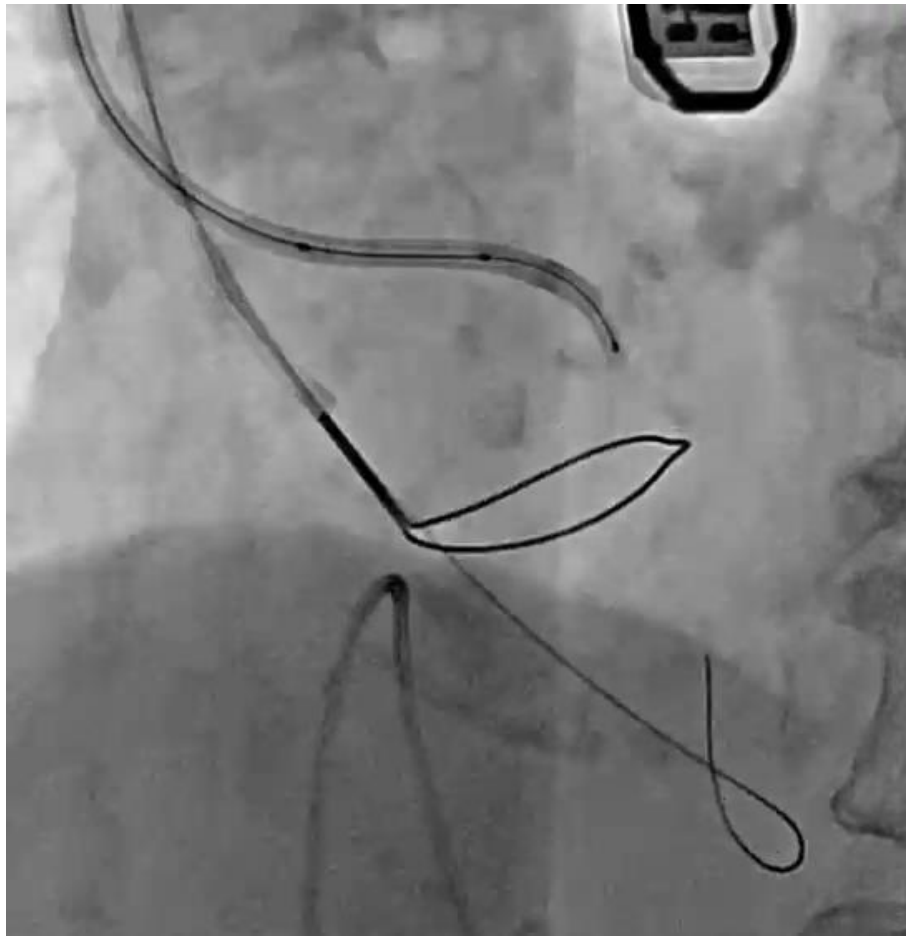
Right VTC



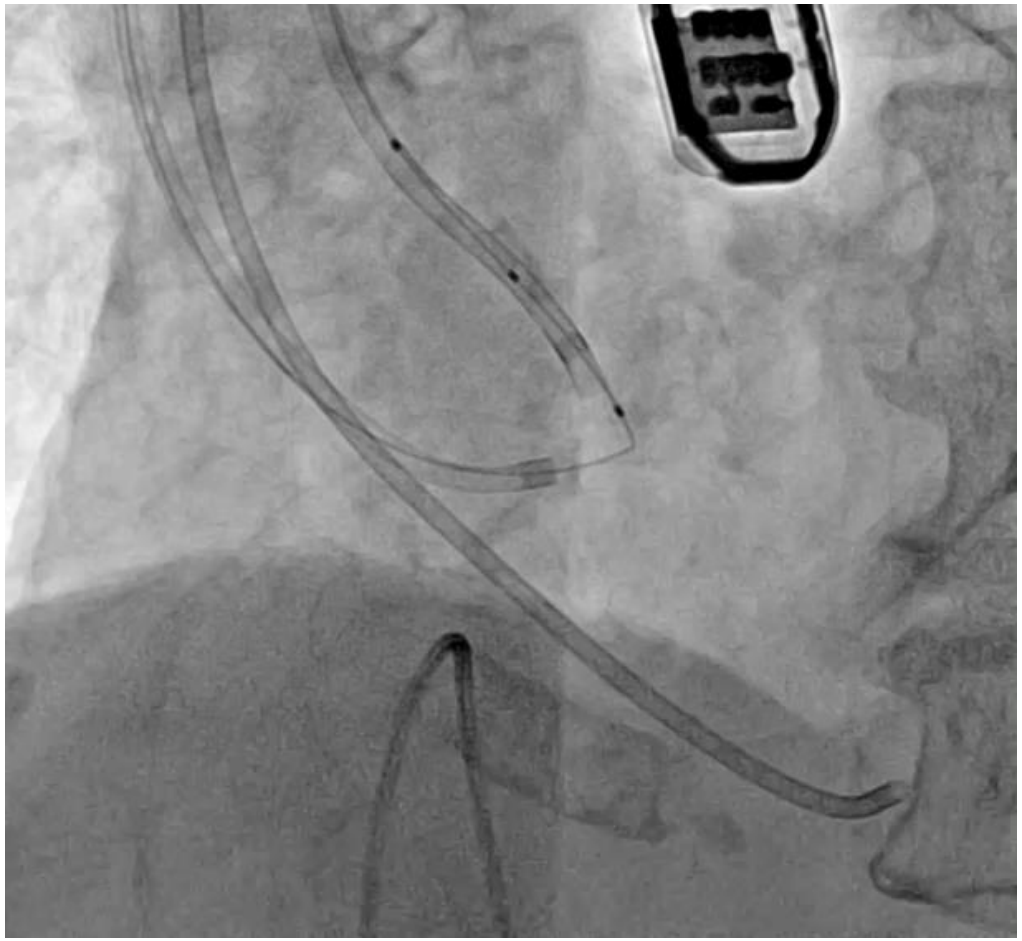
Left VTC



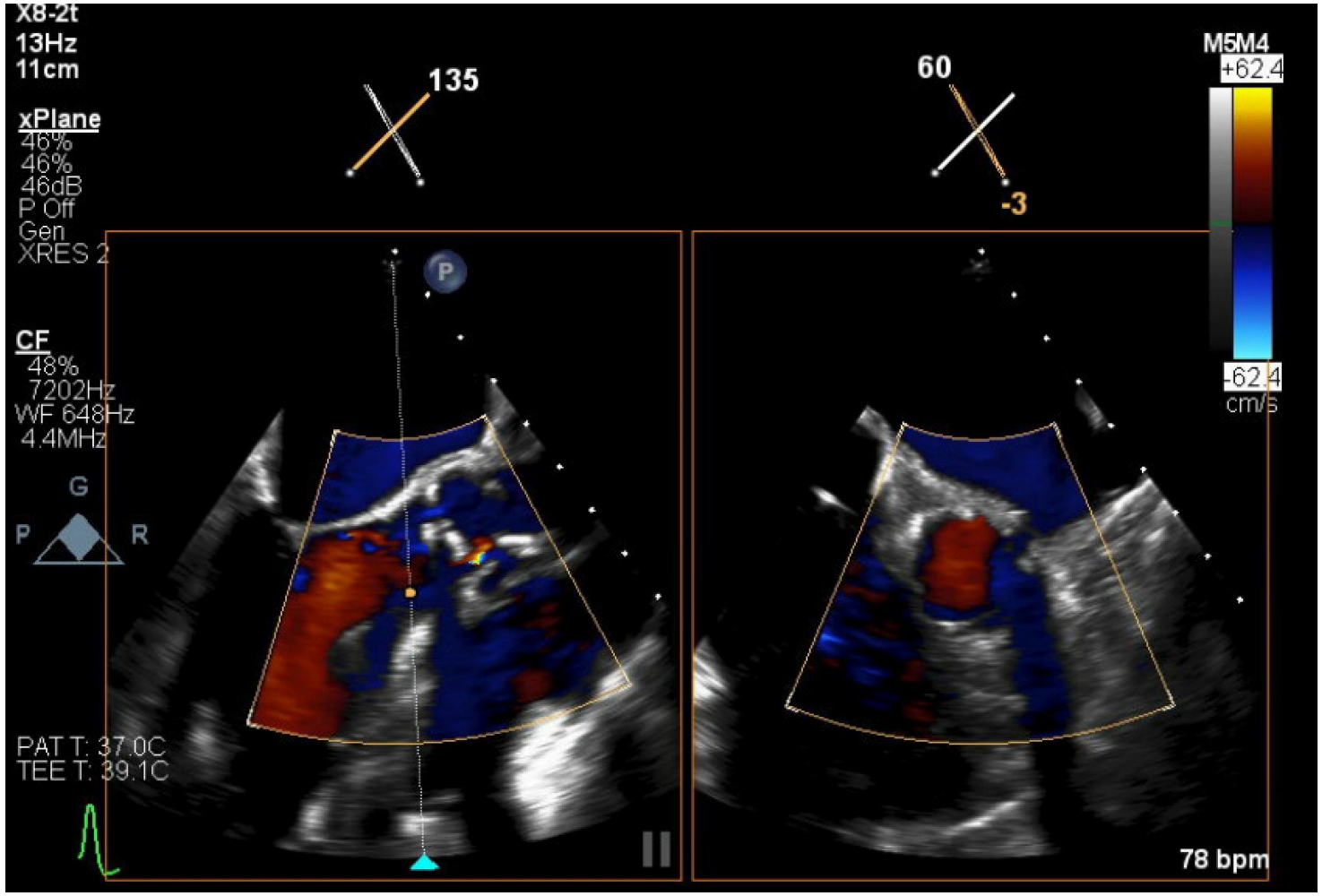
BASILICA

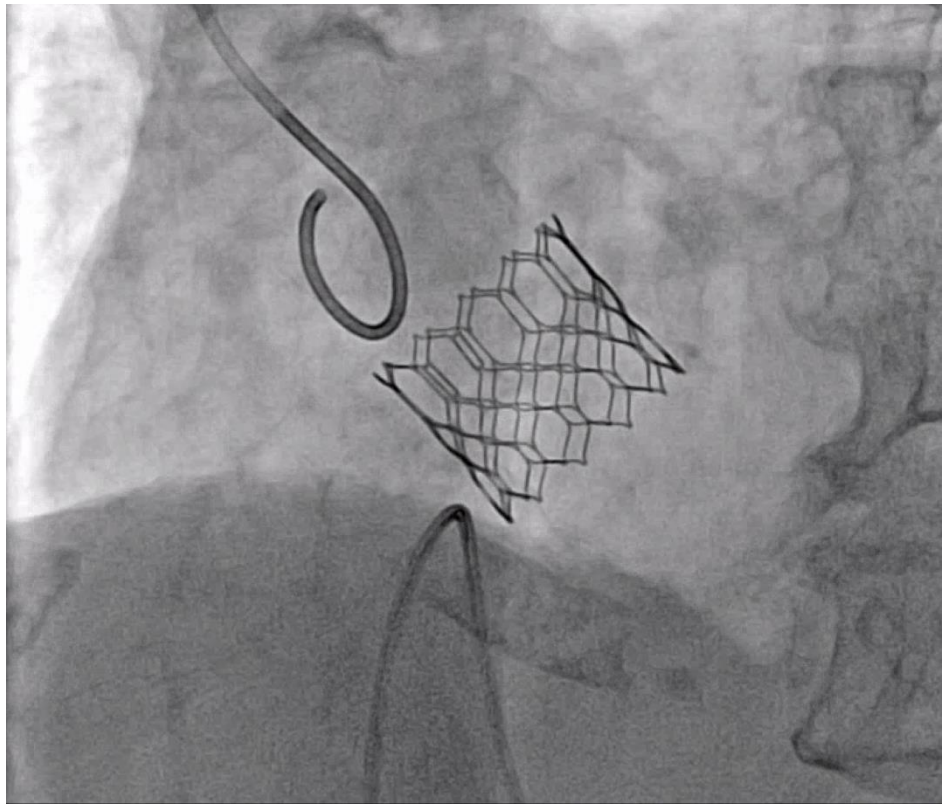


BASILICA



BASILICA


X8-2t
13Hz
11cm
xPlane
46%
46%
46dB
P Off
Gen
XRES 2
CF
48%
7202Hz
WF 648Hz
4.4MHz
G
P
R
135
60
-3
M5M4
+62.4
-62.4
cm/s
PAT T: 37.0C
TEE T: 39.1C
78 bpm

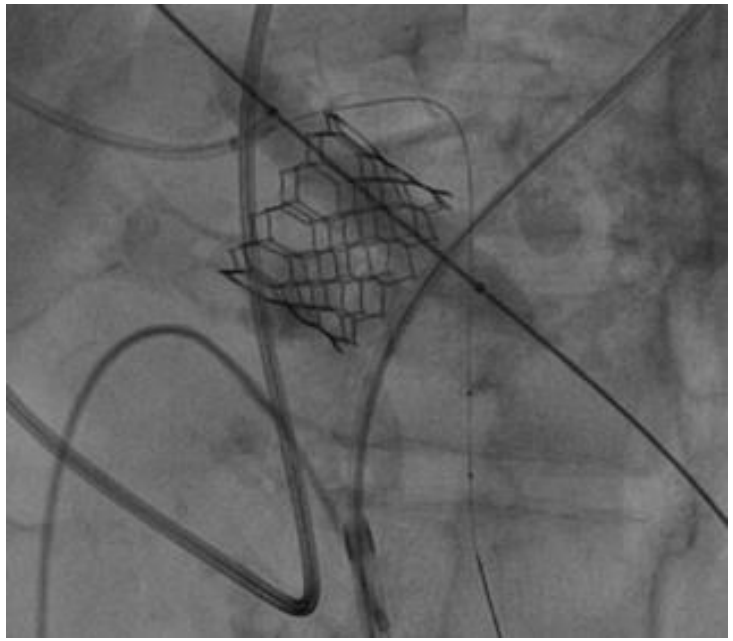


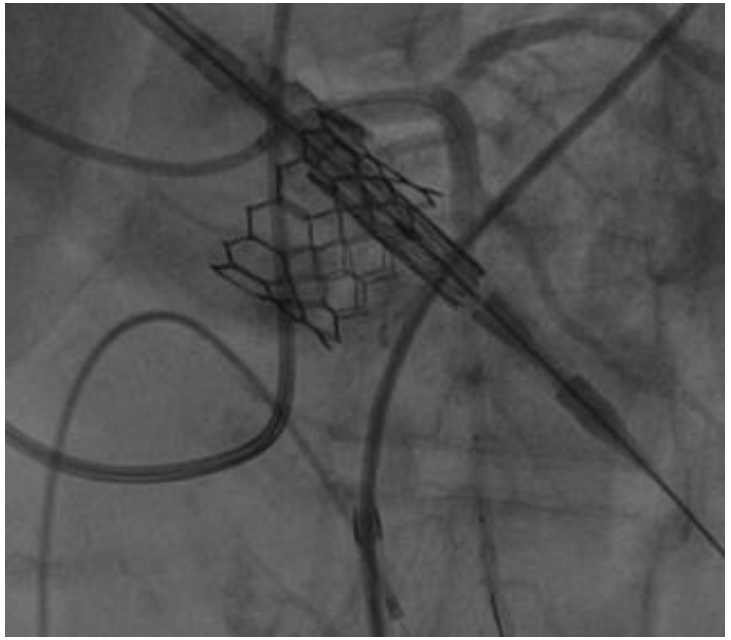
UNICORN

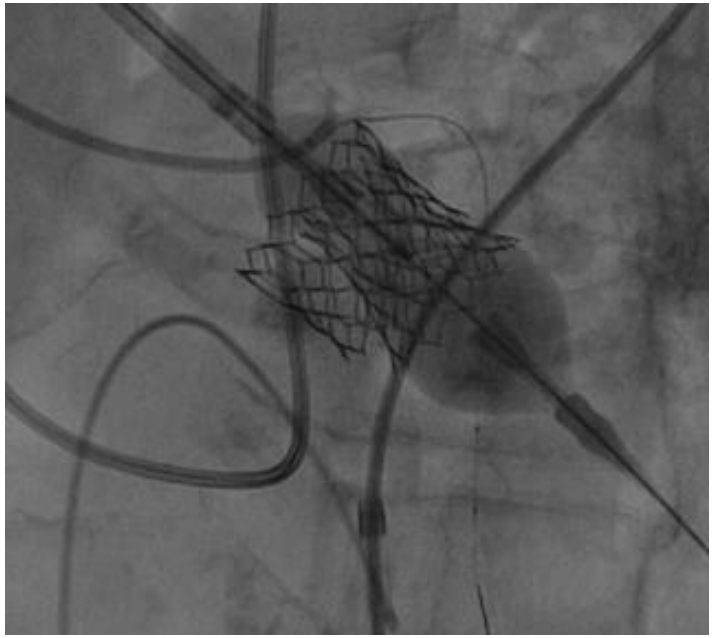
UNdermining Iatrogenic Coronary Obstruction with Radiofrequency Needle

- Intraleaflet deployment of a balloon-expandable valve during valve-in-valve TAVR
- Simultaneously lacerates and traps the prosthetic valve leaflet
- Pros (compared to BASILICA): fewer steps, possibly less time with severe AI
- Cons: less predictable leaflet laceration, risk for leaflet avulsion, can only be used if one coronary artery is at risk

UNICORN

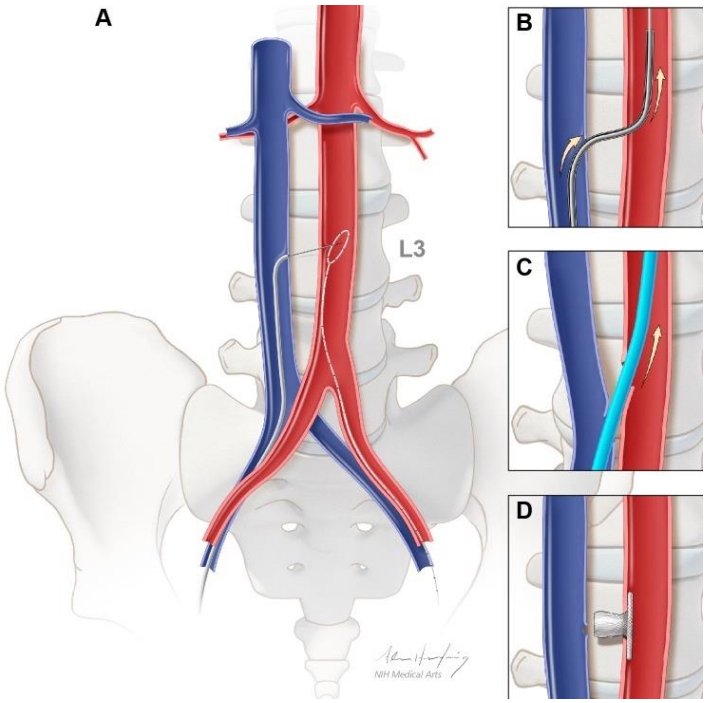


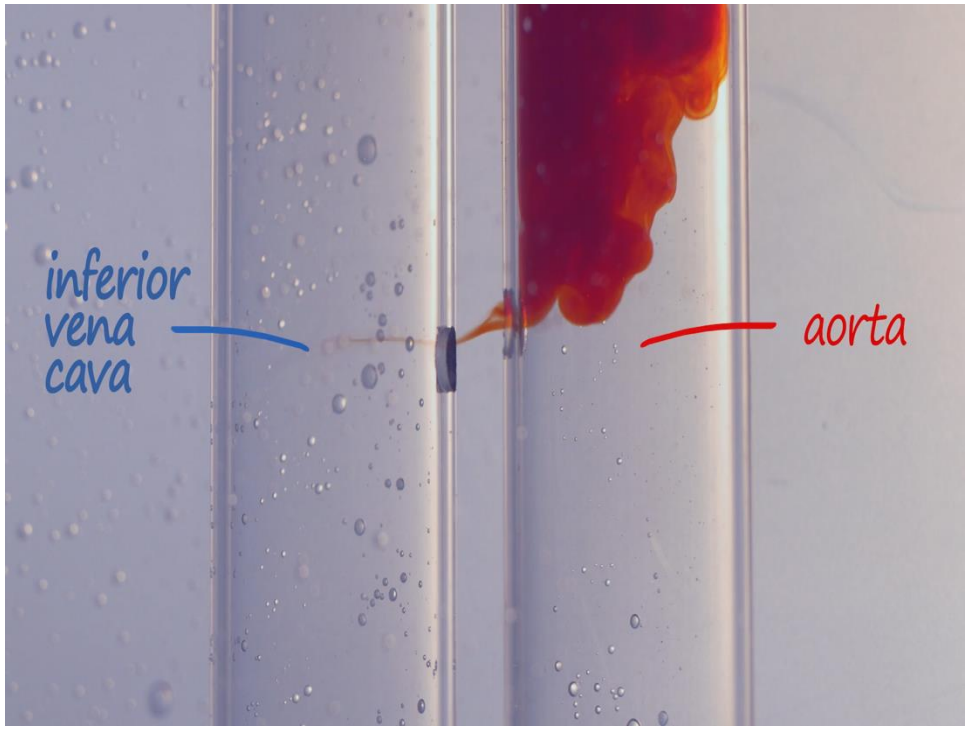




Chan et al, Circ Cardiovasc Interv 2022; 15(11): 928-931.

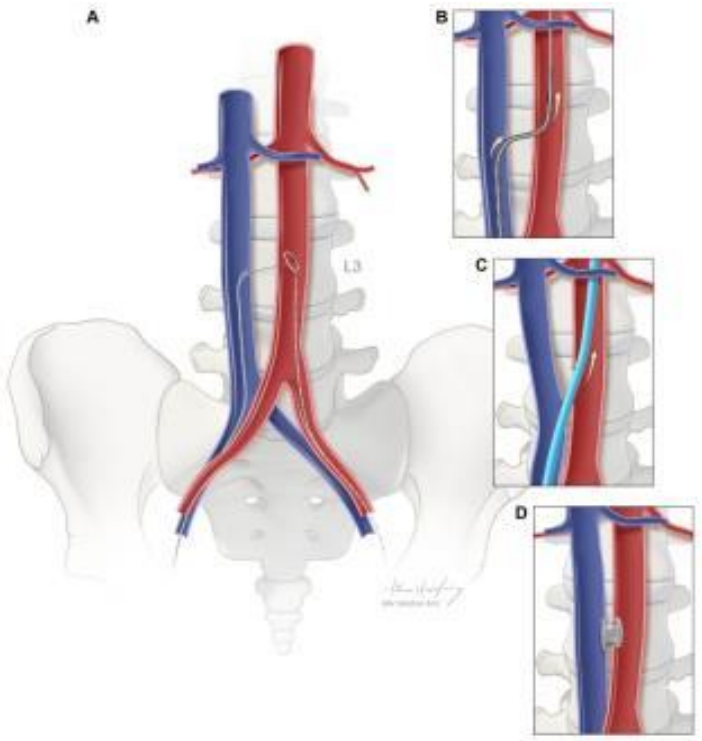
Transcaval Access





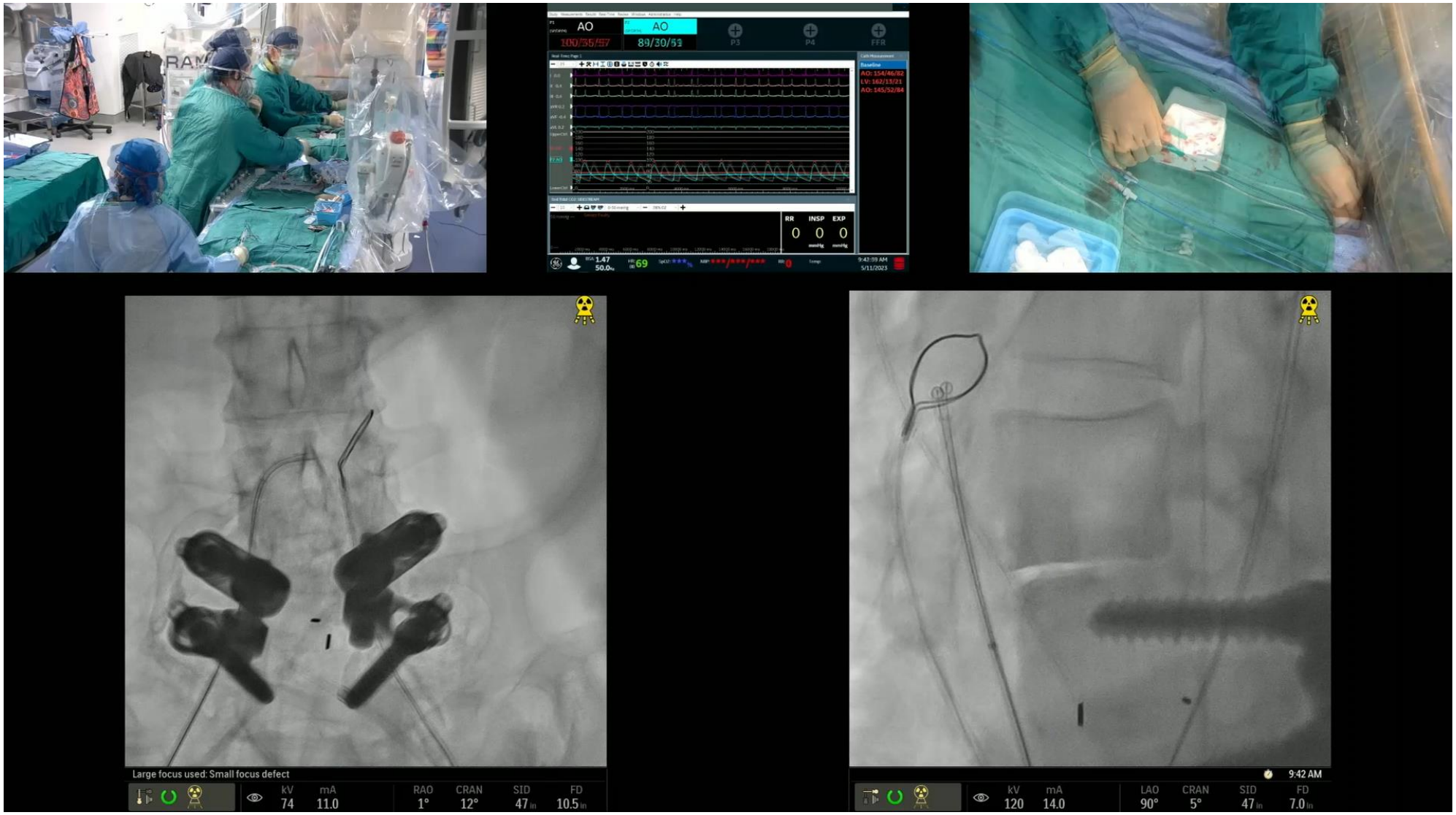
Halabi et al. JACC 2013; 61(16):1745-9
Greenbaum et al. JACC 2014; 63(25): 2795-804
Greenbaum et al. JACC 2017; 69(5):511-21

Transcaval Access

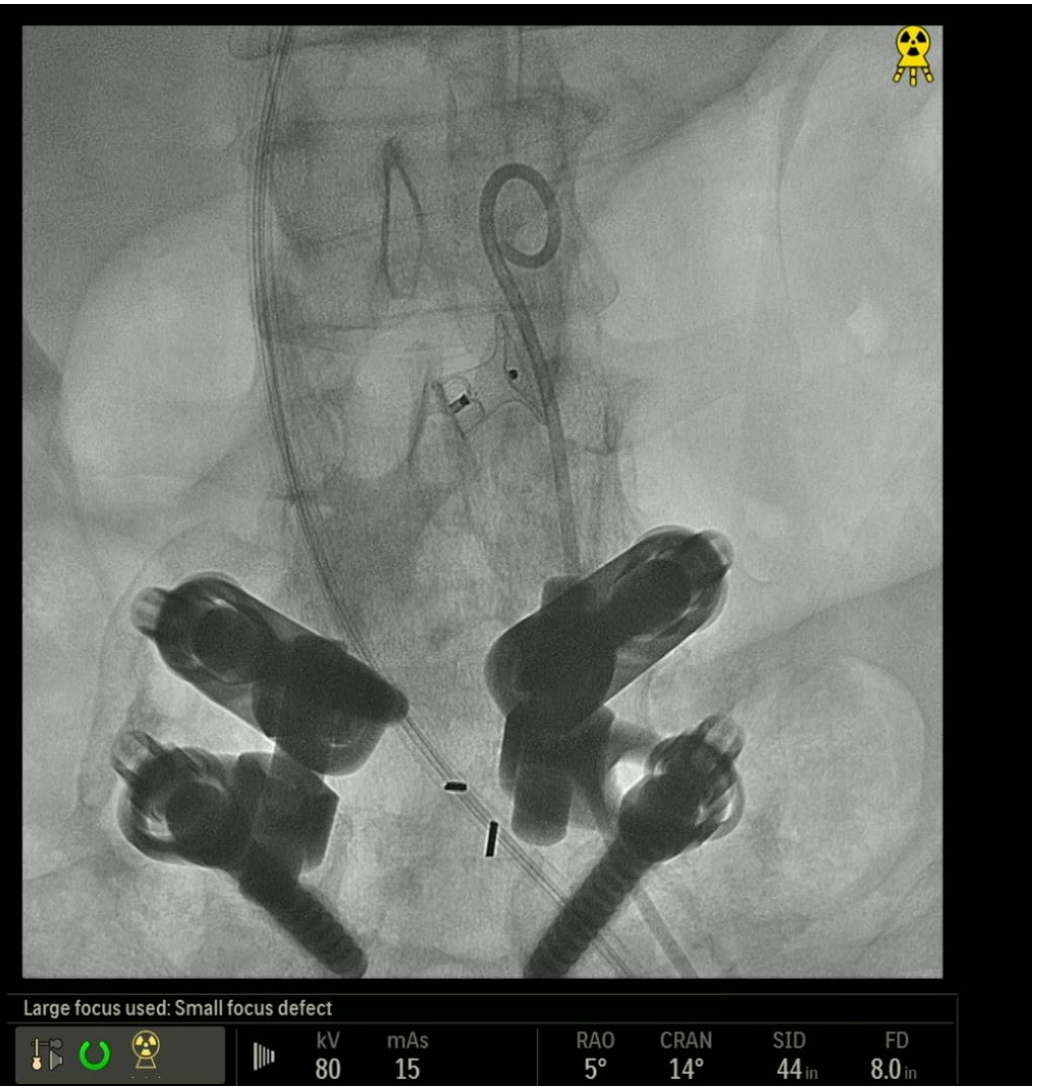


First-line non-femoral access	Well over 1000 cases performed worldwide
Completely percutaneous	Other alternatives require operative space and recovery (percutaneous trans-axillary excepted)
Femoral-like ergonomics	Do you want YOUR doctor leaning over your head or shoulder when performing YOUR TAVR?
Less operator radiation (much!)	Operators are much farther away from beam and scatter during femoral-trans-caval than subclavian, carotid, transapical
Lower stroke risk	Should be no different than femoral access (PAD-associated risk aside)

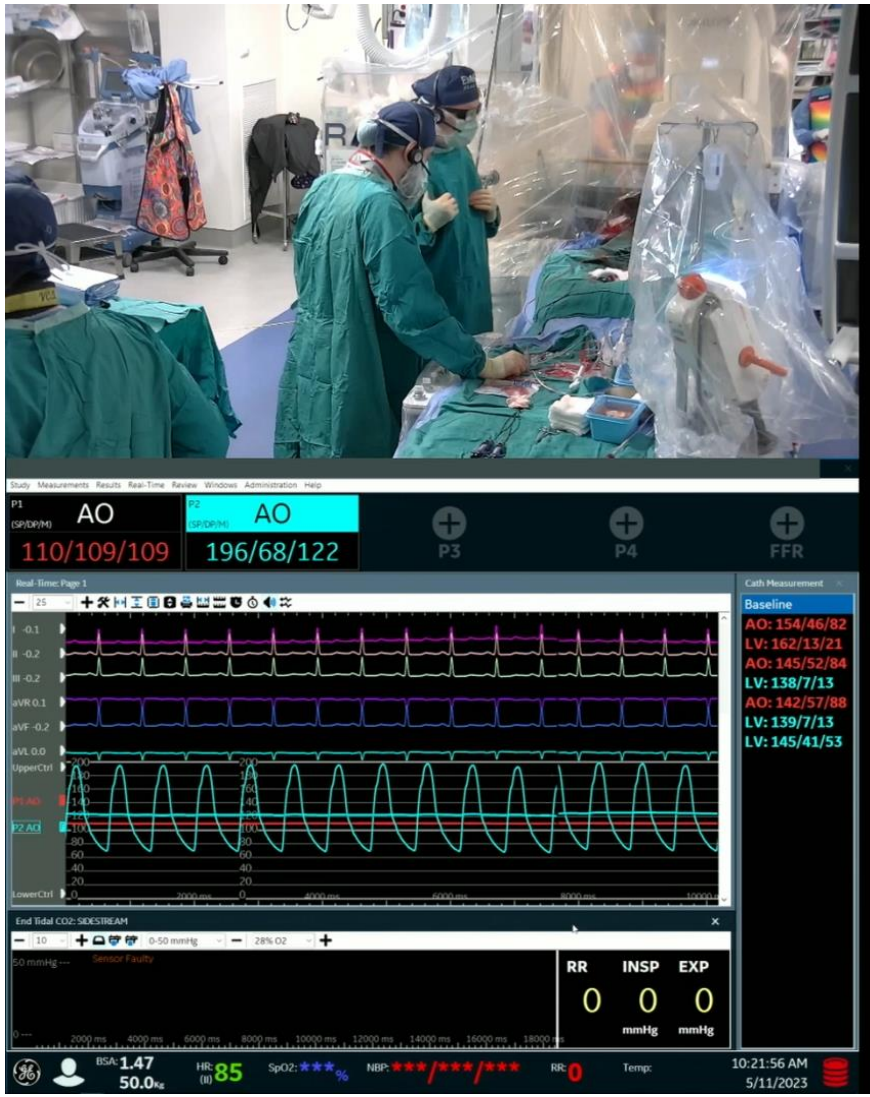
Transcaval Crossing

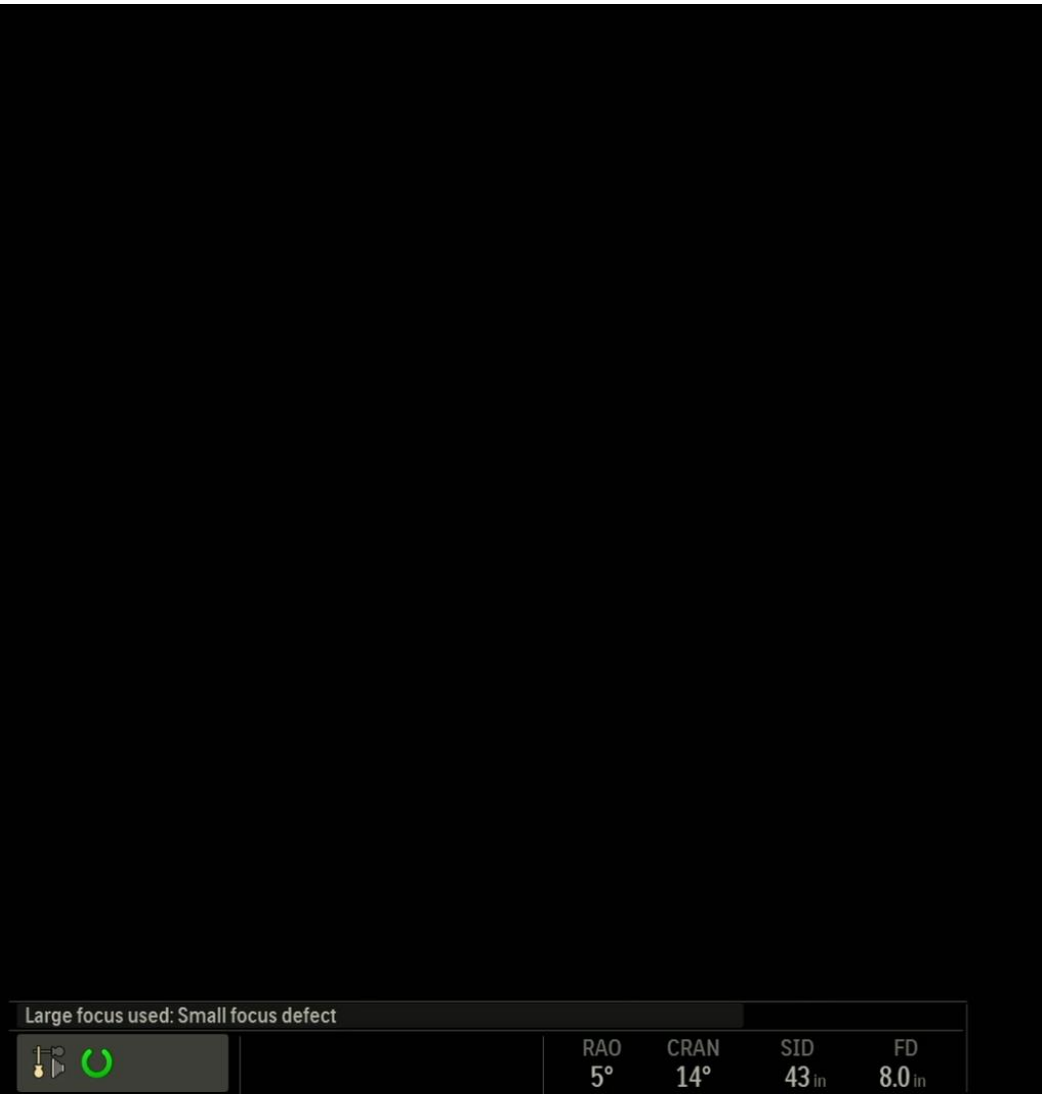


Transcaval Closure



Transcaval Closure



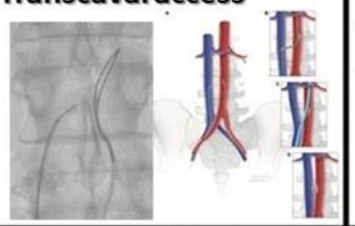
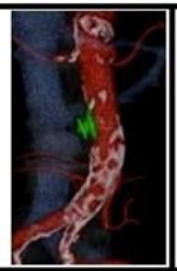
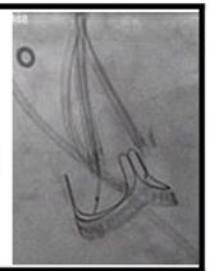
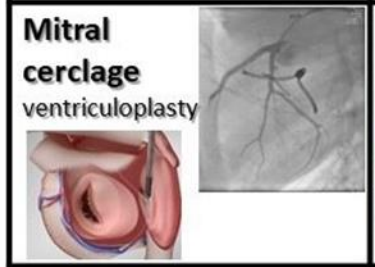
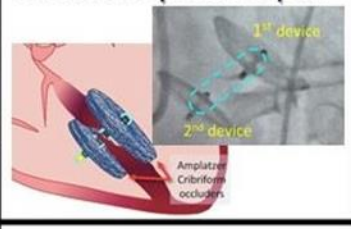
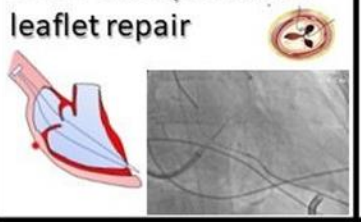
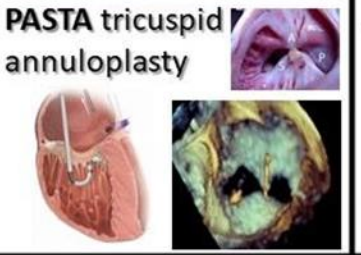
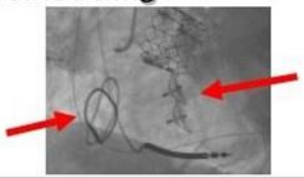
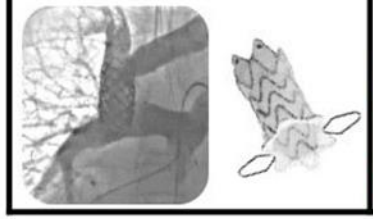
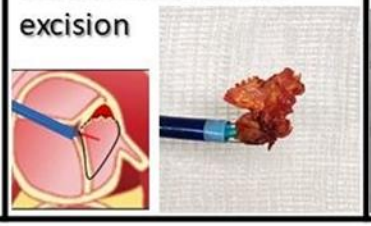
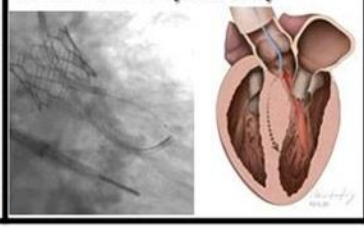
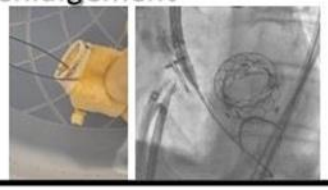
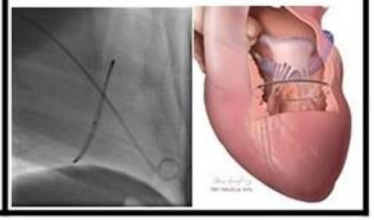


Electrosurgery Procedures To Date

NIH National Heart, Lung, and Blood Institute

Transcatheter electrosurgery in patients

TGS

Transcaval access 	**Transmural TCD** transcaval closure device 	**LAMPOON** mitral modification 	**ELASTIC & ElastaCLIP** mitral leaflet rescue 	**BASILICA** aortic leaflet laceration for TAVR 
Mitral cerclage ventriculoplasty 	**BASSINET** piVSD repair 	**TASTI** tricuspid suture leaflet repair 	**PASTA** tricuspid annuloplasty 	**Ante-PASTA** RV remodeling 
Perc. Glenn Shunt 	**CATHEDRAL** leaflet excision 	**SESAME** myotomy 	**ALFRESCO** annular enlargement 	**MIRTH** ventriculoplasty 

Greenbaum. *JACC* 2014; Rogers. *JACC Intv* 2019; Babaliaros. *JACC Intv* 2017; Lisko. *JACC Intv* 2020; *Khan. JACC Intv* 2018; Rogers. *JACC* 2022; Kamioka. *Circ Intv* 2019; Greenbaum. *CCI* 2021; Ratnayaka. *JACC Intv* 2016; Babaliaros. *JACC Intv* 2022; Greenbaum. *Circ Intv* 2022; Bruce. *JACC BTS* 2022

Conclusions

- Transcatheter electrosurgery utilizes radiofrequency current to cut or traverse tissue to facilitate percutaneous intervention in patients with complex anatomies
- Thus far has primarily utilized off-the-shelf devices, but purpose-built devices are in development
- This technology has allowed us to substantially broaden our armamentarium of transcatheter therapies to treat patients who previously would not have been candidates for intervention