Uncommon type AVNRT

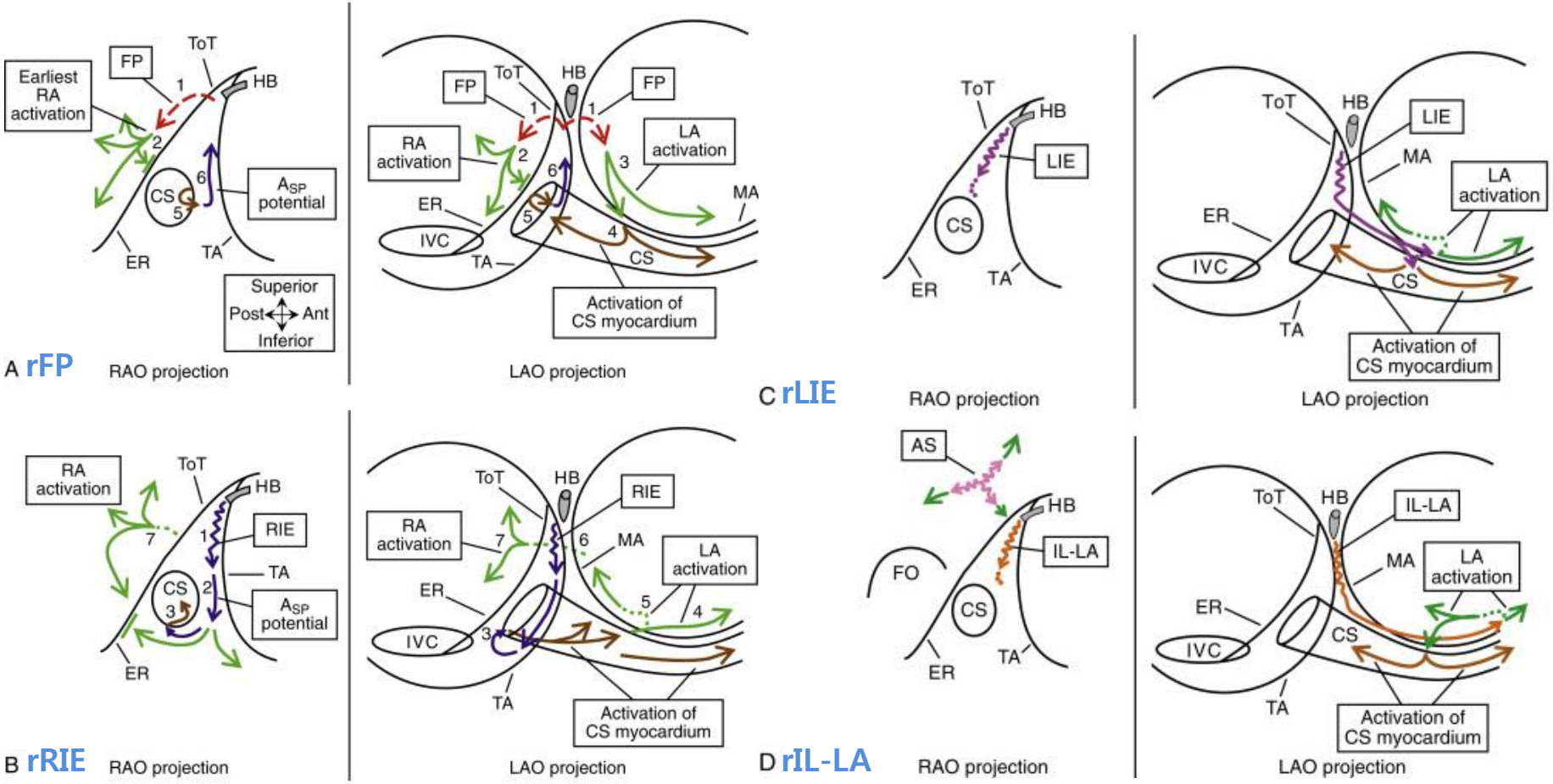
강동경희대학교병원
심장혈관내과
진 은 선

Embarrassing things during AVNRT ablation

- When slow pathway ablation doesn't work
  - Both in typical and atypical AVNRT
  - Then, where to ablate next?

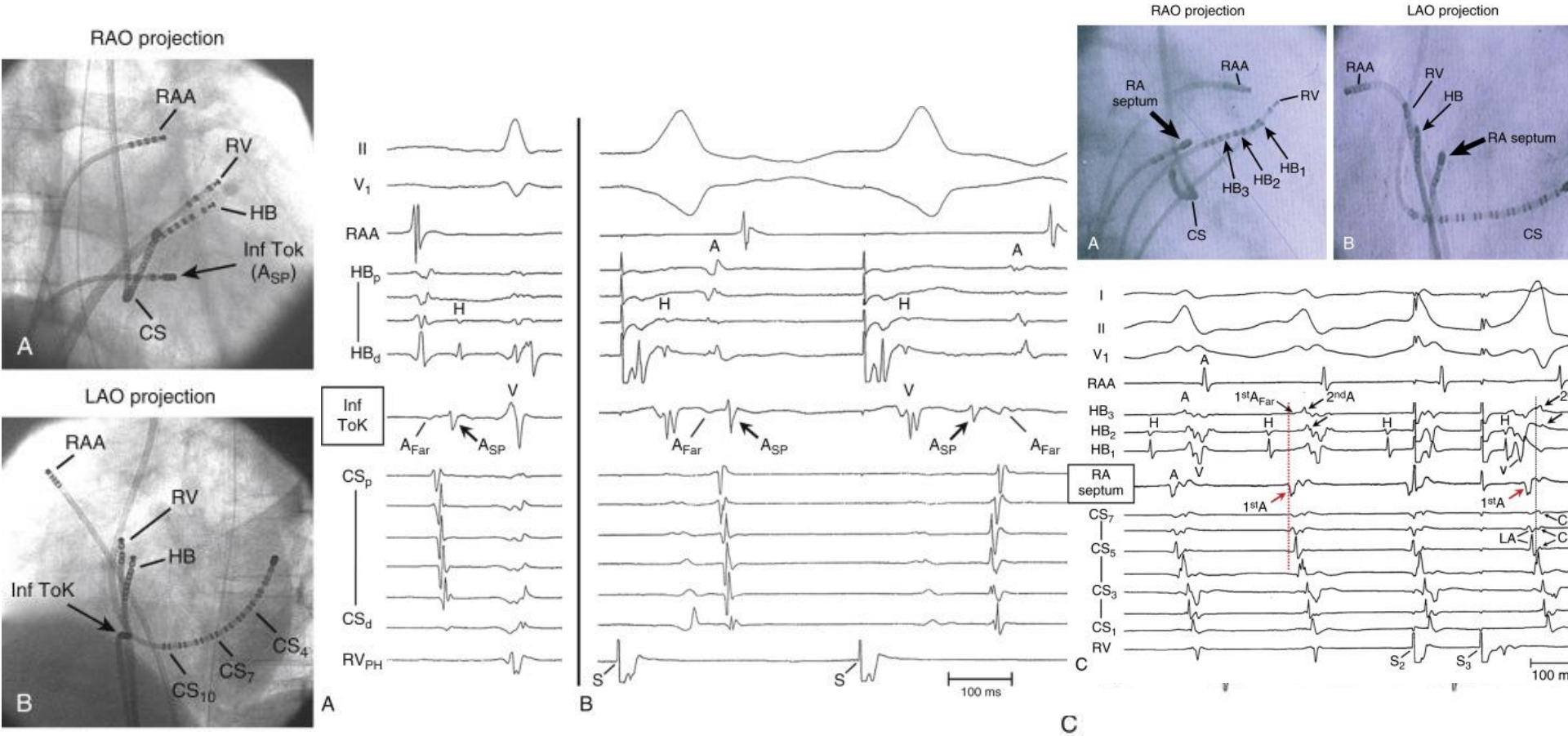
- Earliest retrograde A activation is at CS os (5~7%) or inside CS

Postulated Pathways



Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed

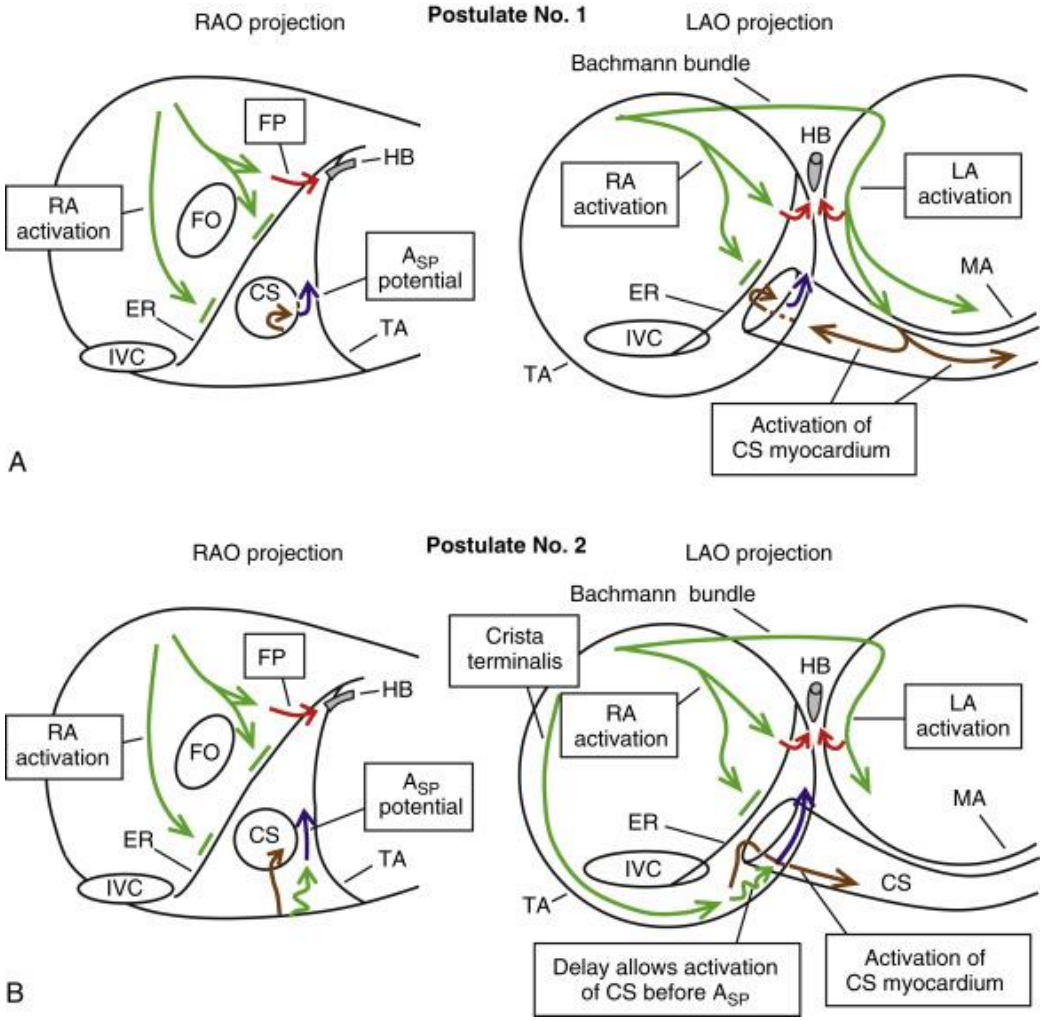
Mapping of RIE



SR rFP rSP AVNRT

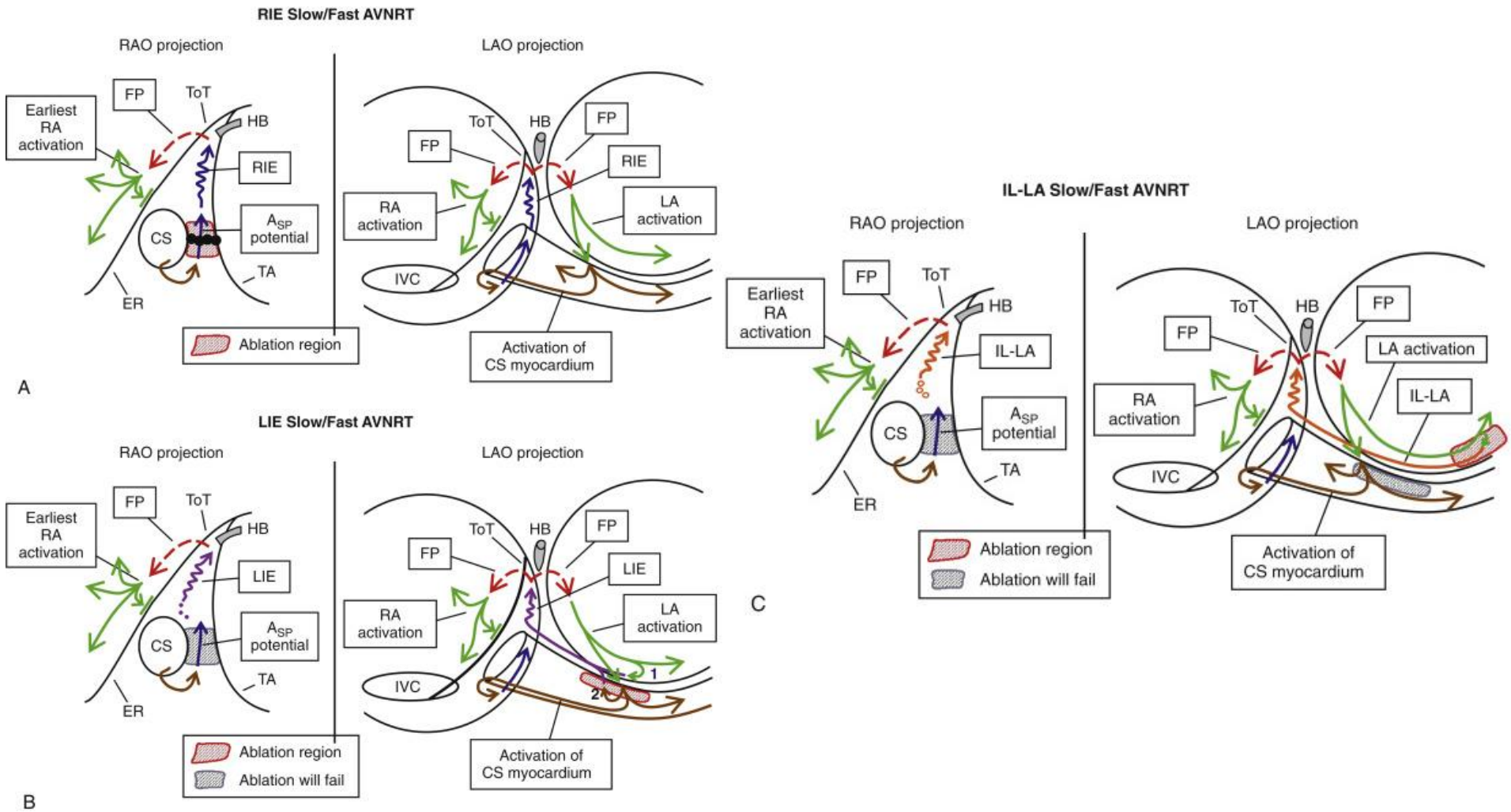
Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed

During Sinus Rhythm



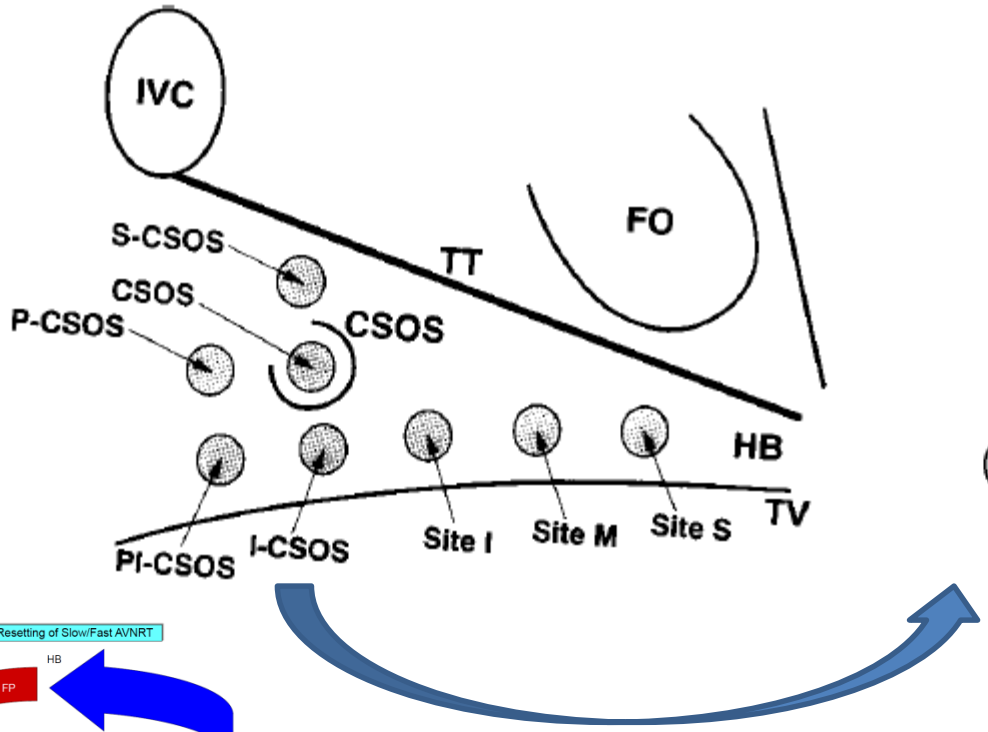
Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed

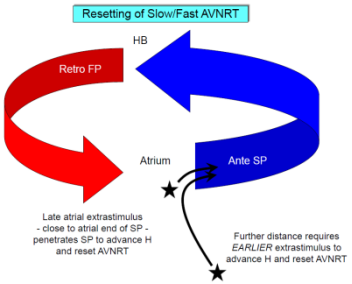
Most Common Form; Typical Slow-Fast AVNRT

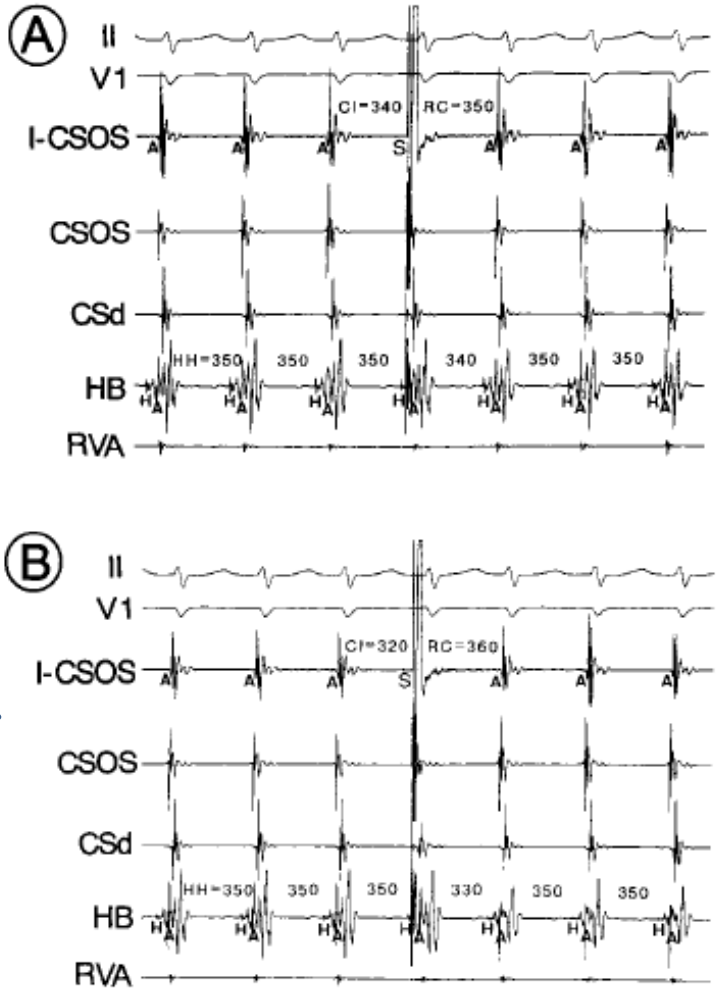


Lockwood D, Jackman WM, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed

Delineation of Circuit



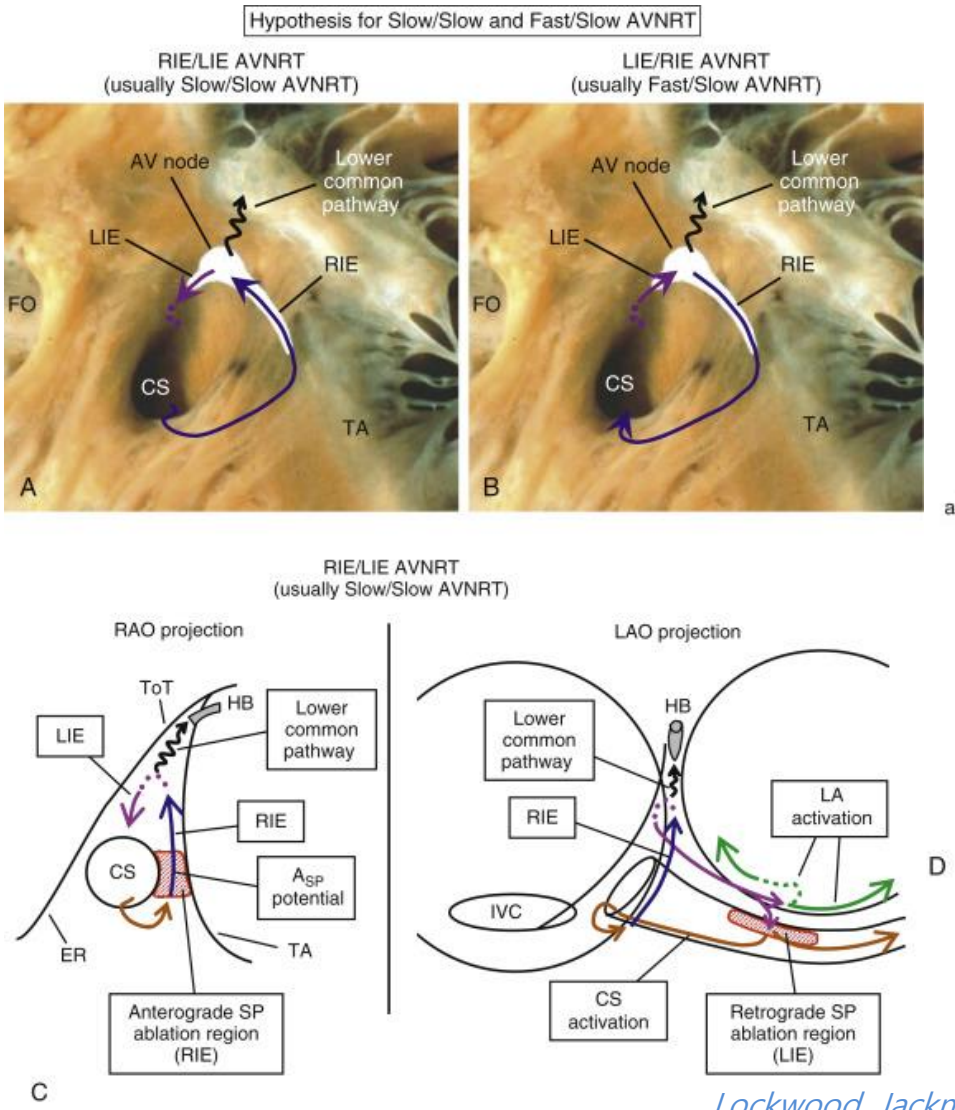


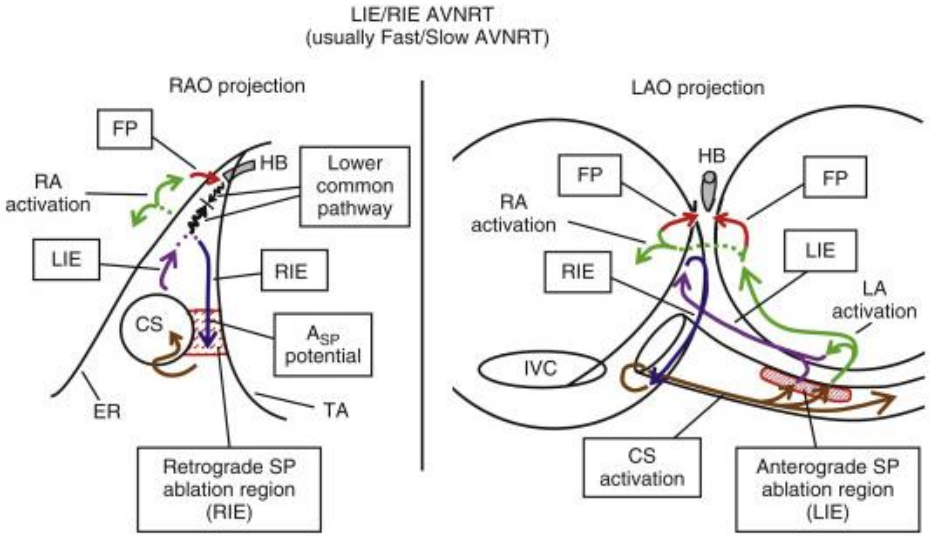


* Reset of next H by delivering late APC

Yamabe, Circulation 1999;100:621-7

Slow-Slow & Fast-Slow AVNRT

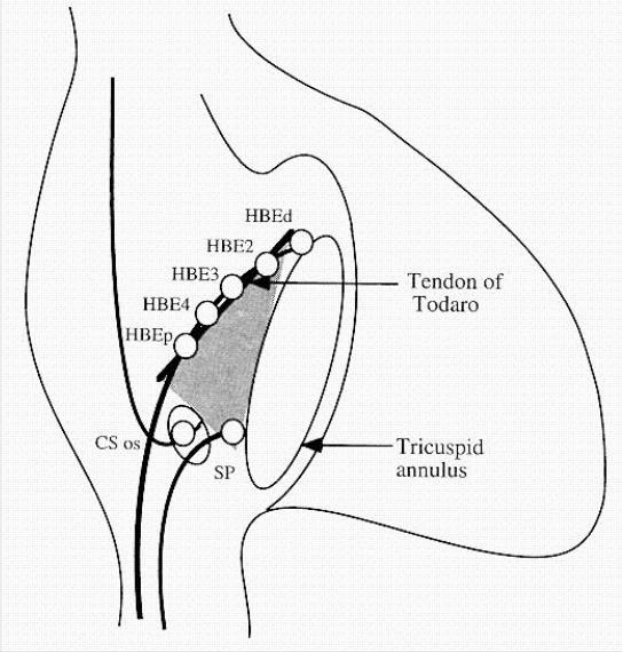


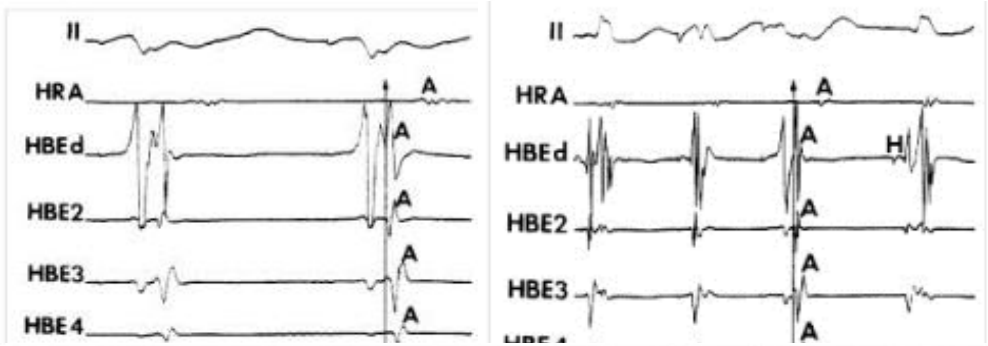


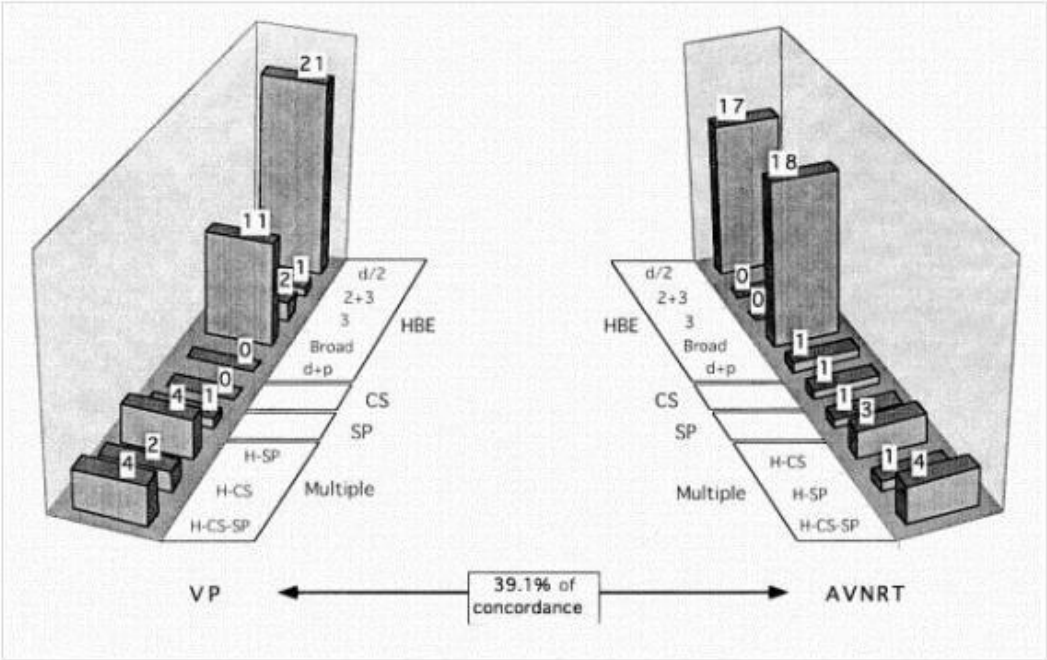
Lockwood, Jackman, Zipes Cardiac Electrophysiology from cell to bedside, 7th ed

Different Stories

Variable Retrograde Activation Pattern; Fast Pathway



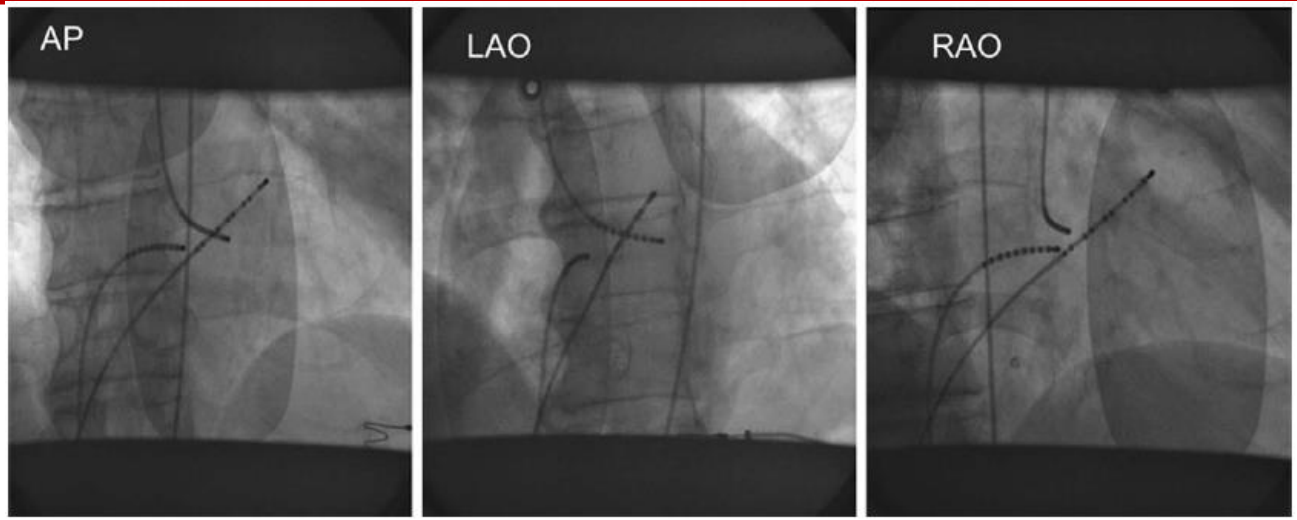


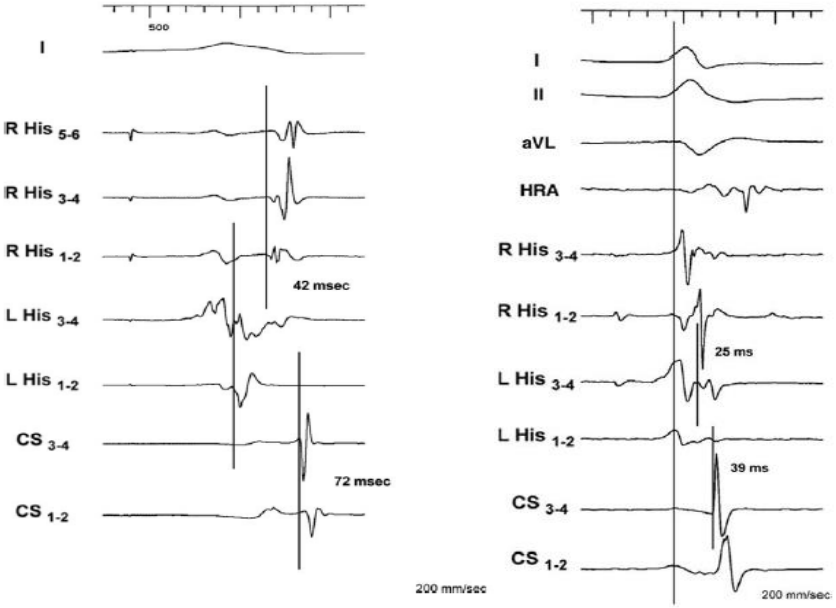


Frederic, Josephson et al. Circulation 1996;93:960-8

Atrial activation during atrioventricular nodal reentrant tachycardia: Studies on retrograde fast pathway conduction

Demosthenes G. Katritsis, MD, PhD,* Kenneth A. Ellenbogen, MD,† Anton E. Becker, MD, PhD‡

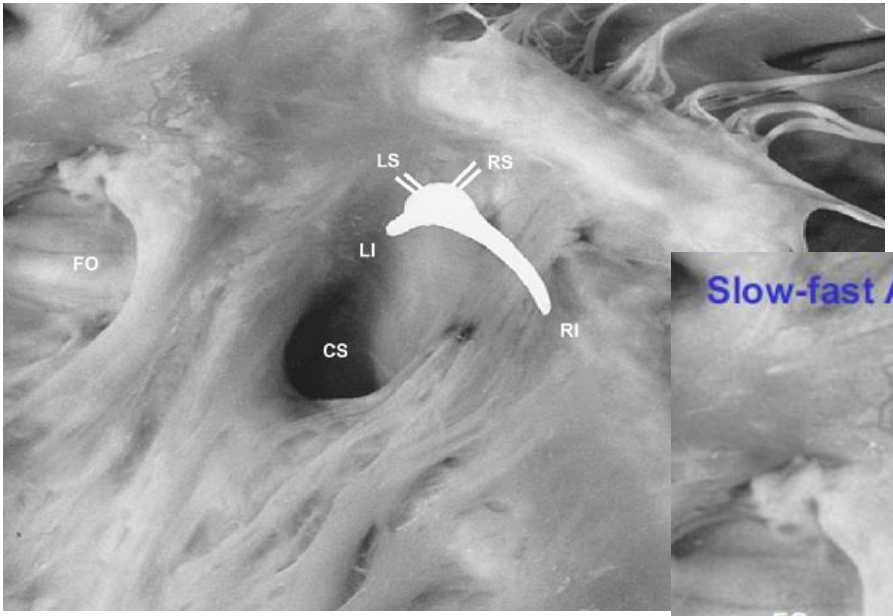


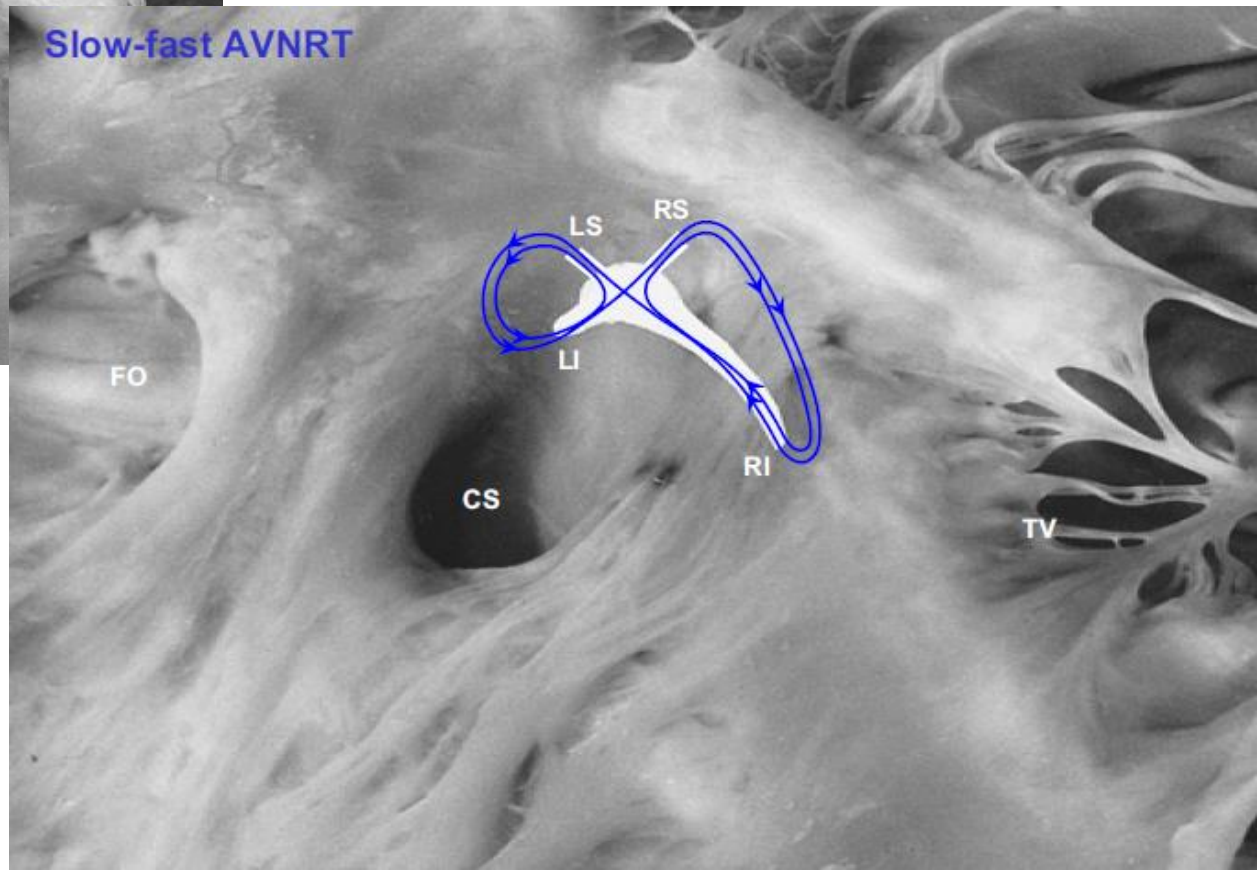


- Earliest Retrograde A
  - During AVNRT (17pts)
    - L; 53%
    - R; 17%
    - Both L&R; 29%
  - During Vp
    - Lt septum 71%
  - Concordance; 57%

Katritsis, Heart Rhythm 2006;3:993-1000

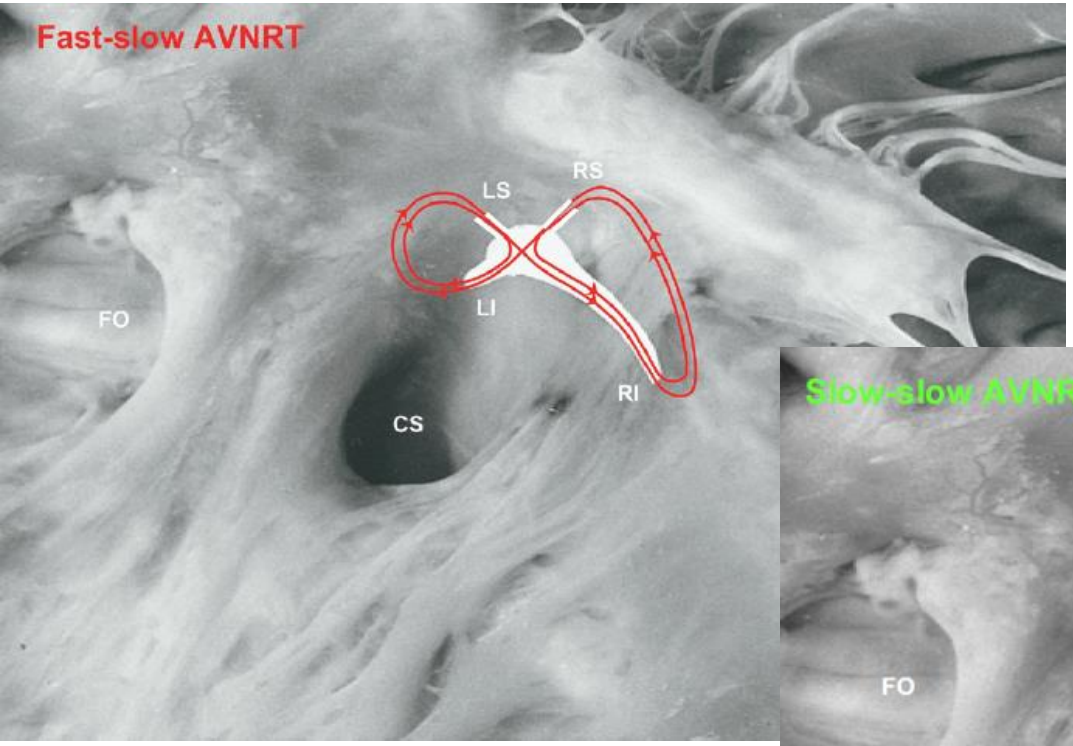
Proposed AVNRT Circuit; Previously by Katritsis

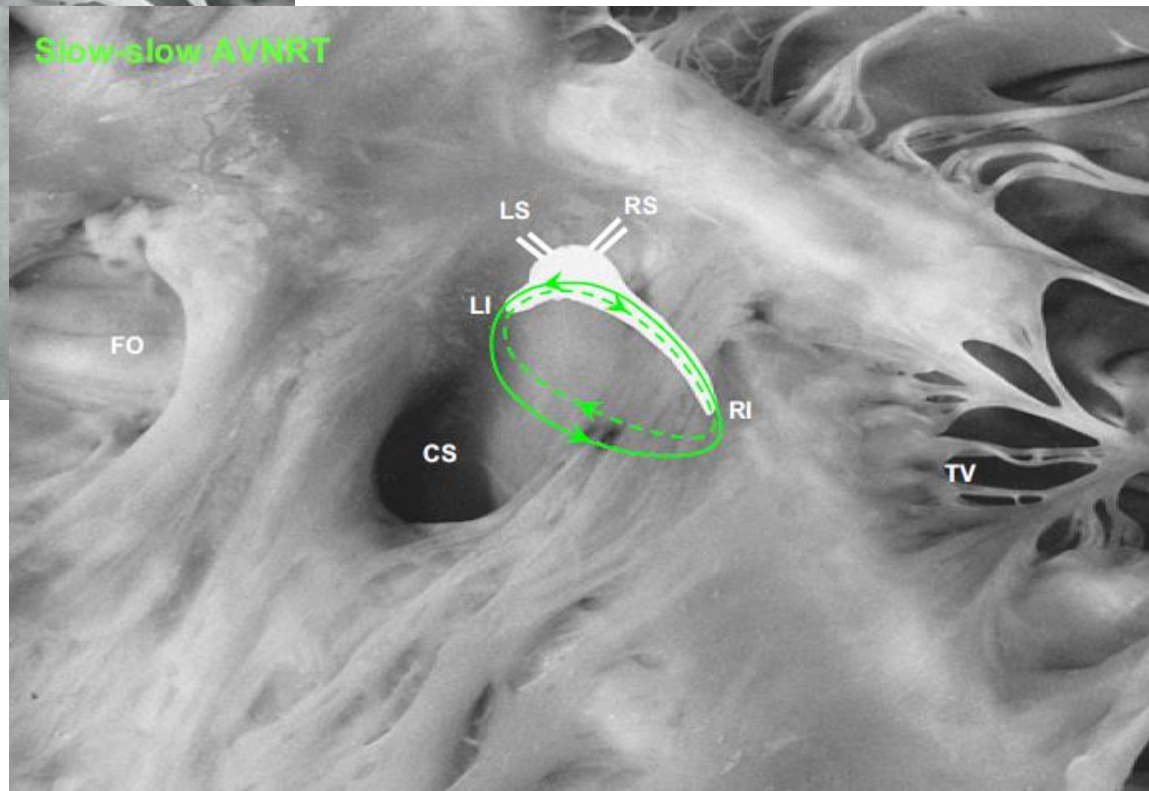




Katritsis, Heart Rhythm 2007;4:1354

Proposed AVNRT Circuit; Previously by Katritsis





Katritsis, Heart Rhythm 2007;4:1354

Fast-Slow & Slow-Fast AVNRT does NOT Use Same Pathway

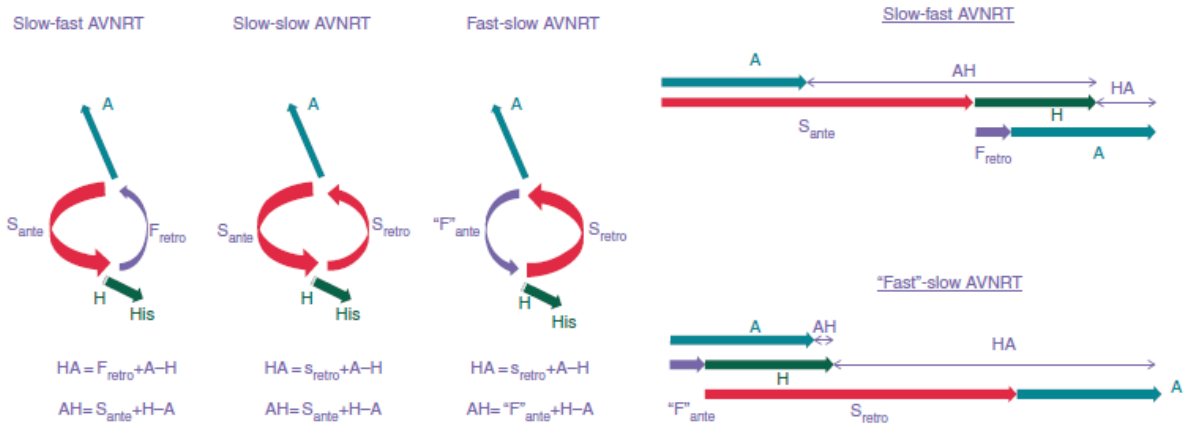
EUROPEAN SOCIETY OF CARDIOLOGY®

Europace (2015) **17**, 1099–1106
doi:10.1093/europace/euu387

CLINICAL RESEARCH
Cardiac electrophysiology

Atypical atrioventricular nodal reentrant tachycardia: prevalence, electrophysiologic characteristics, and tachycardia circuit

Demosthenes G. Katritsis[1]*, Ali Sepahpour[2], Joseph E. Marine[3], George D. Katritsis[4], Tanyanan Tanawuttiwat[3], Hugh Calkins[3], Edward Rowland[2], and Mark E. Josephson[5]

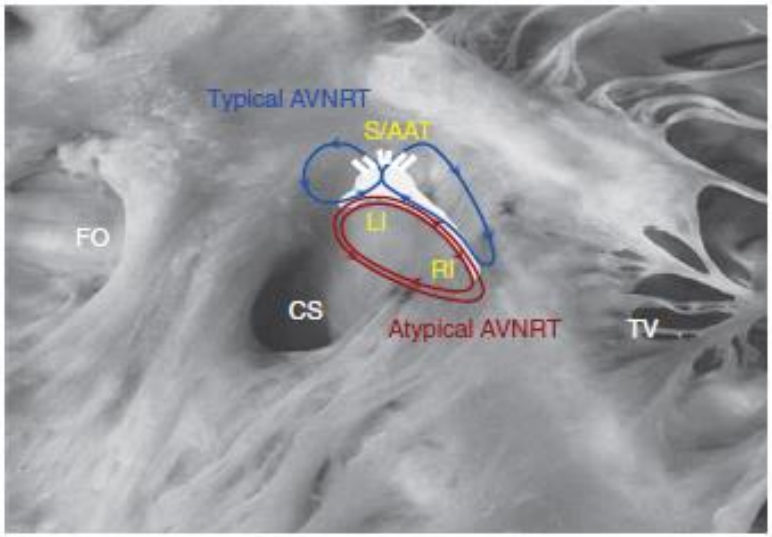


Fast-Slow & Slow-Fast AVNRT does NOT Use Same Pathway

Table I Tachycardia types and conduction intervals

AVNRT type	*n*	Age	Sex (F/M)	CL (ms)	AH (His) activation	HA (His) activation	HA (pCS) activation	Earliest retrograde atrial activation
Fast–slow	44	50.7 ± 19.3	23/21	379.1 ± 68.5	99.7 ± 40.5	251.7 ± 76.4	251.5 ± 77.2	pCS (59%)
Slow–slow	9	45.6 ± 20.0	7/2	476.4 ± 137.9	286.0 ± 83.2	163.3 ± 60.5	171.0 ± 60.9	His (67%)
Intermediate	6	52.5 ± 13.7	4/2	395.8 ± 105.5	197.0 ± 31.1	176.0 ± 72.9	173.8 ± 66.7	His/pCS (50%)
Slow–fast	34	39.0 ± 7.5	22/12	331.1 ± 46.8	270.4 ± 44.3	45.8 ± 7.7	51.4 ± 7.5	His (85%)

Fast–slow type: AH < 200 ms and AH < HA; slow–slow type: AH > 200 ms and AH > HA; intermediate: all other patterns.
CL, tachycardia cycle length; AH tachy, atrial to His interval during tachycardia; HA tachy, His to right atrium interval during tachycardia.



Katritsis DG, Euroopace 2015;17:1099

EUROPEAN SOCIETY OF CARDIOLOGY®

Europace (2013) **15**, 1231–1240
doi:10.1093/europace/eut100

REVIEW

Classification of electrophysiological types of atrioventricular nodal re-entrant tachycardia: a reappraisal

Demosthenes G. Katritsis[1]* and Mark E. Josephson[2]

[1]Athens Euroclinic, 9 Athanassiadou Street, Athens 11521, Greece; and [2]Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

Table 1 Classification of AVNRT types

	HA	VA (His)	AH/HA
Typical AVNRT	≤70 ms	≤60 ms	>1
Atypical AVNRT	>70 ms	>60 ms	Variable

Fast-Slow AH/HA<1
Slow-Slow AH/HA >1, AH >200 ms

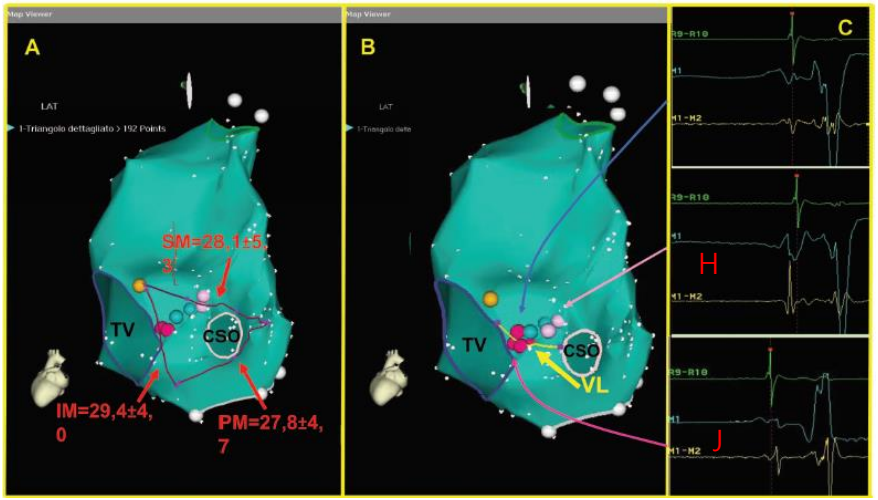
Target for AVNRT ablation

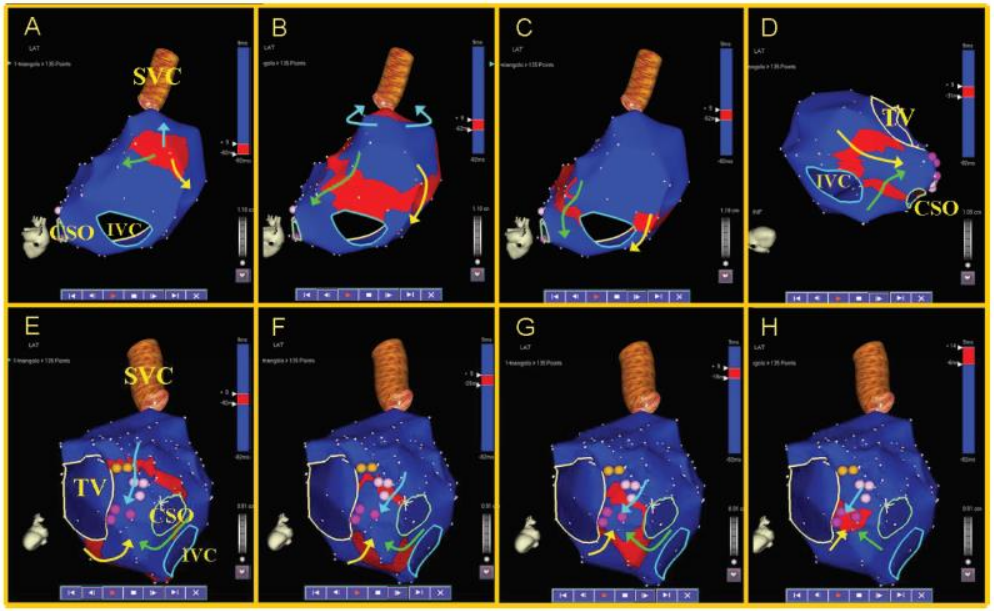
- Jackman/Haissaguerre potential

Editorial

The "Slow Pathway" Potential: Fact or Fiction?

Joseph J. Gard, MD; Samuel J. Asirvatham, MD, FACC



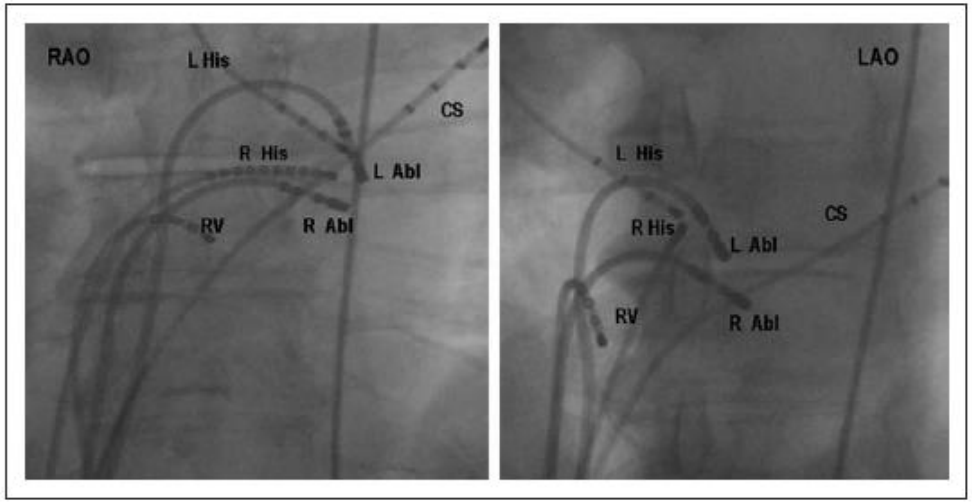


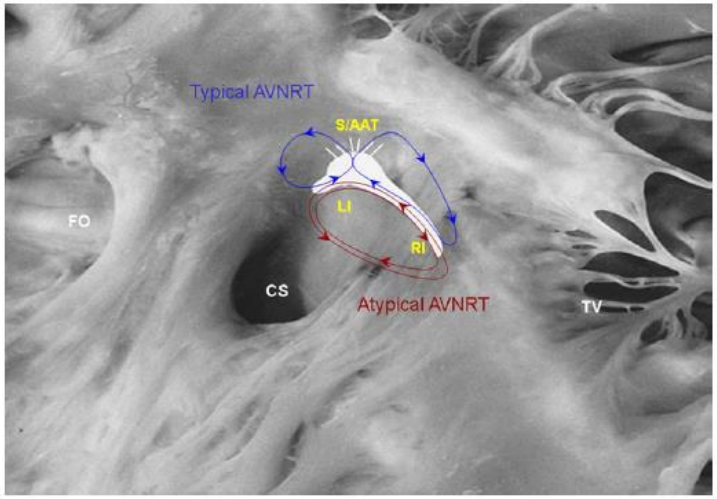
Pandozi, Circ Arrhythm Electrophysiol 2011;4:225-34

Ablation of Atypical AVNRT

ORIGINAL RESEARCH ARTICLE

Catheter Ablation of Atypical Atrioventricular Nodal Reentrant Tachycardia

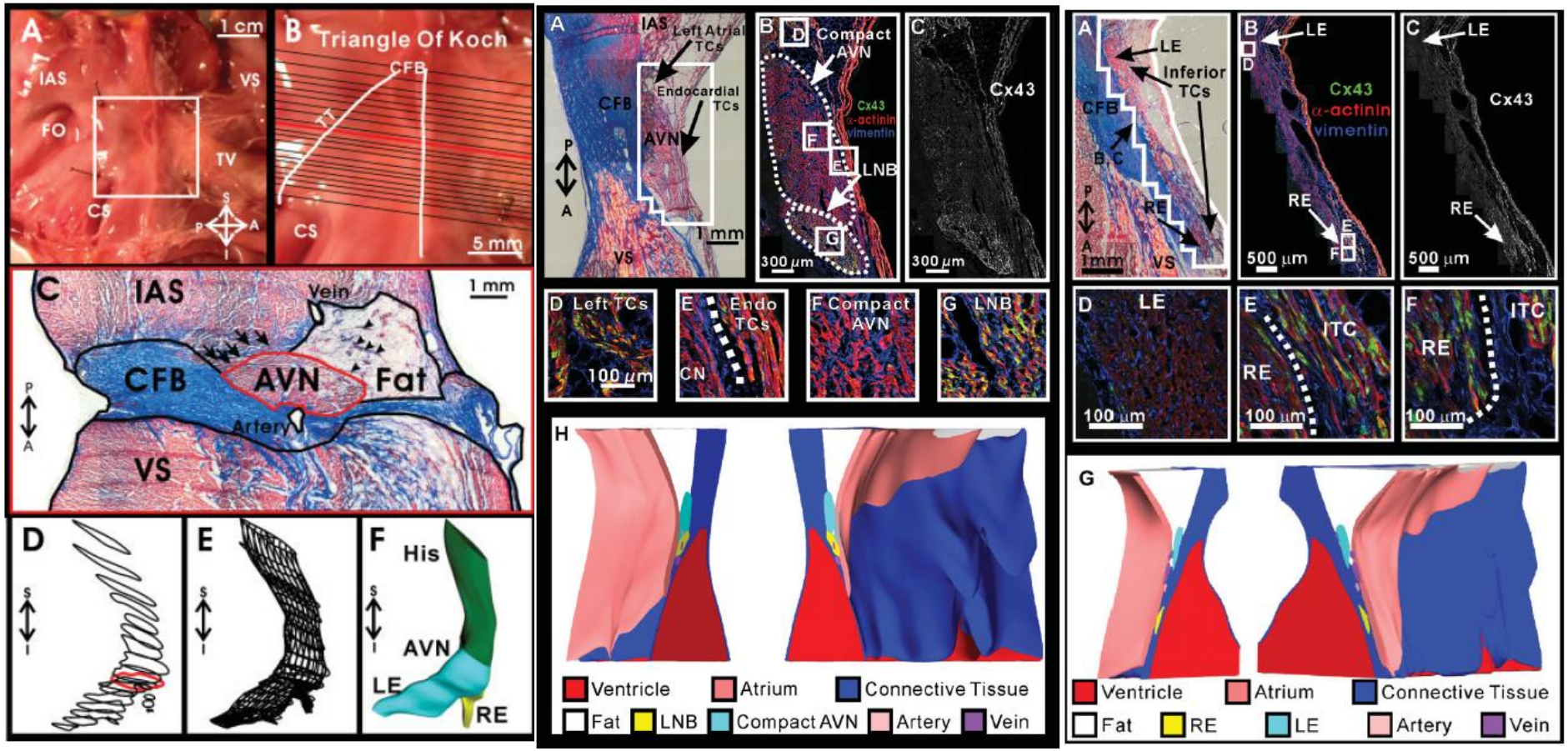




113 pts, 75.2% fast-slow, 8.9% had both typical and atypical AVNRT
- All but 3 pts, conventional right-sided ablation was successful

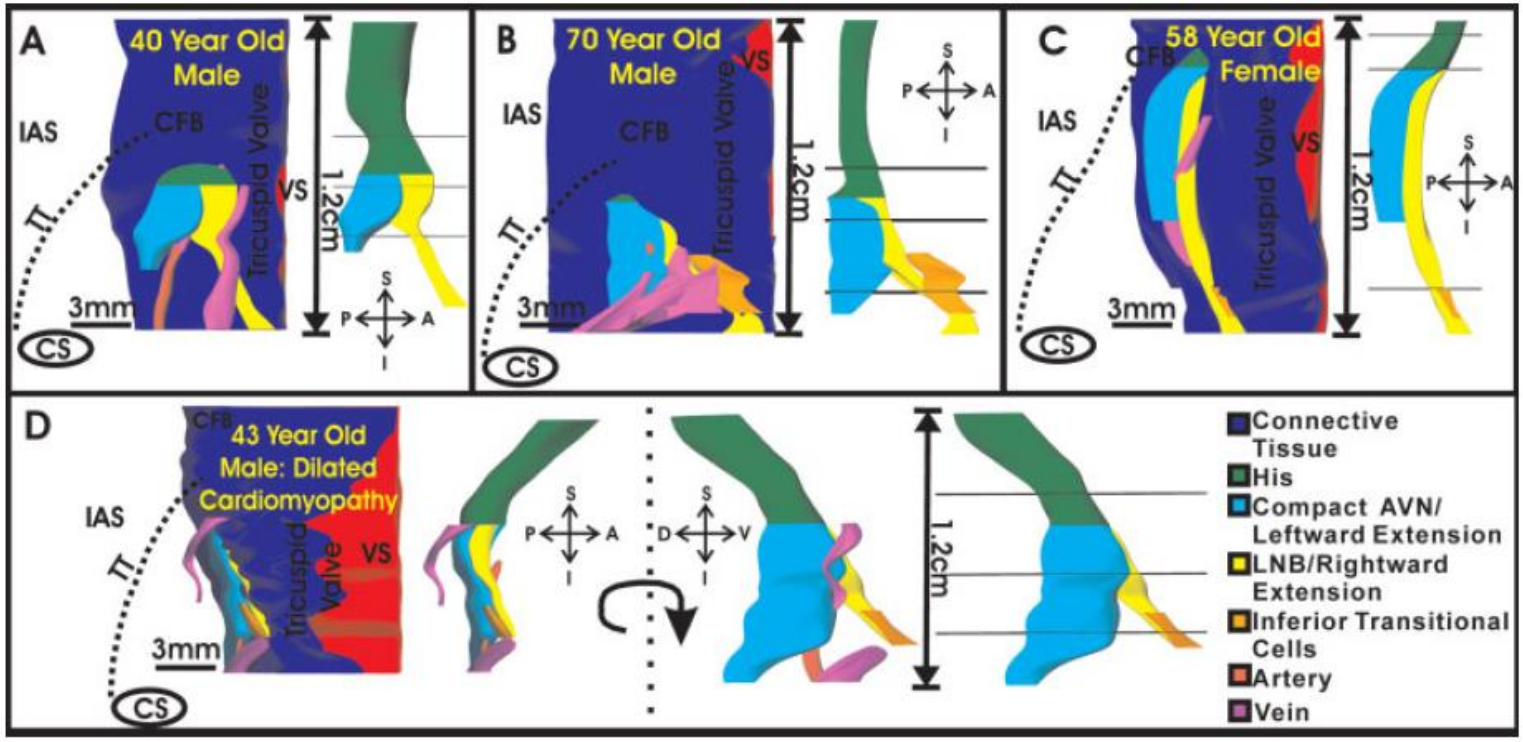
Katritsis, Josephson, Circulation 2016;134:1655-63

Lt Inferior Nodal Extension is Anatomical Substrate of SP



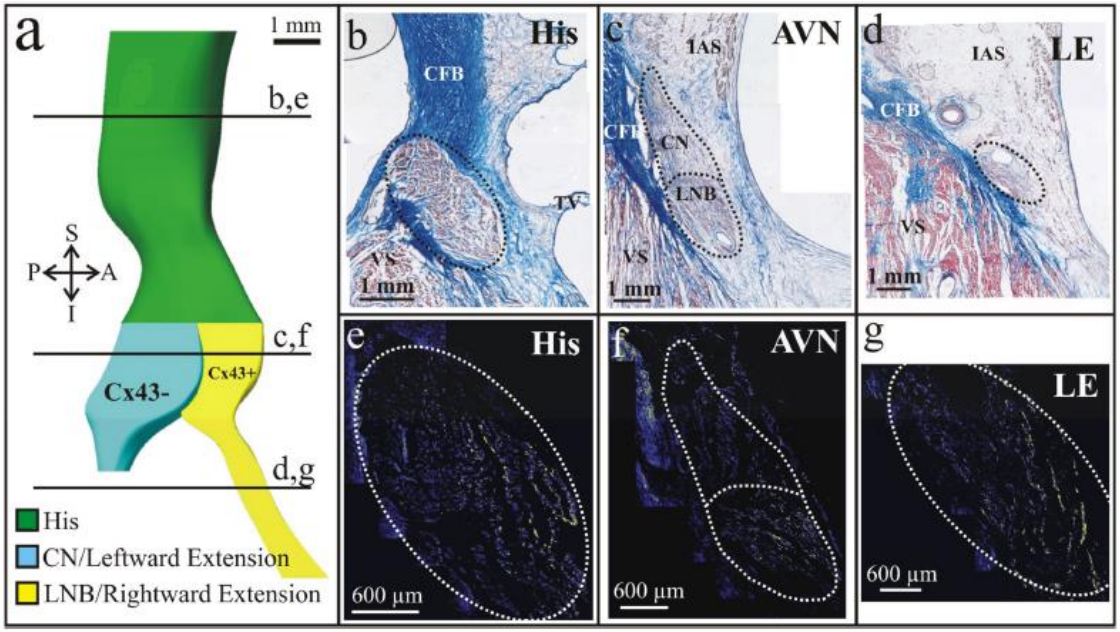
Hucker WH, Anat Rec 2008;291:204-15

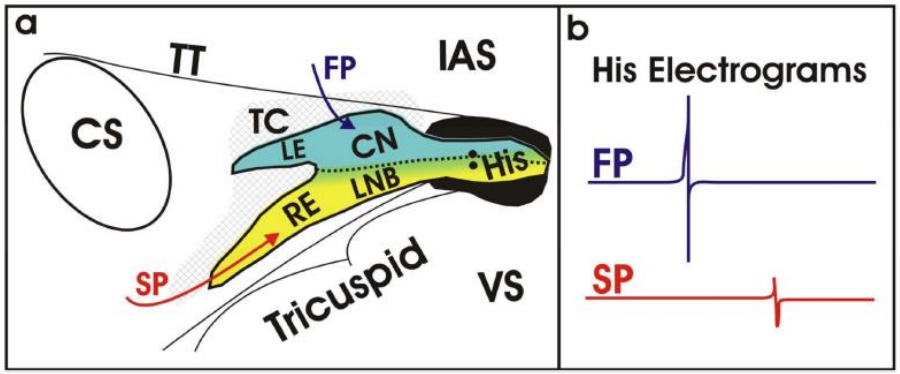
Lt Inferior Nodal Extension is Anatomical Substrate of SP

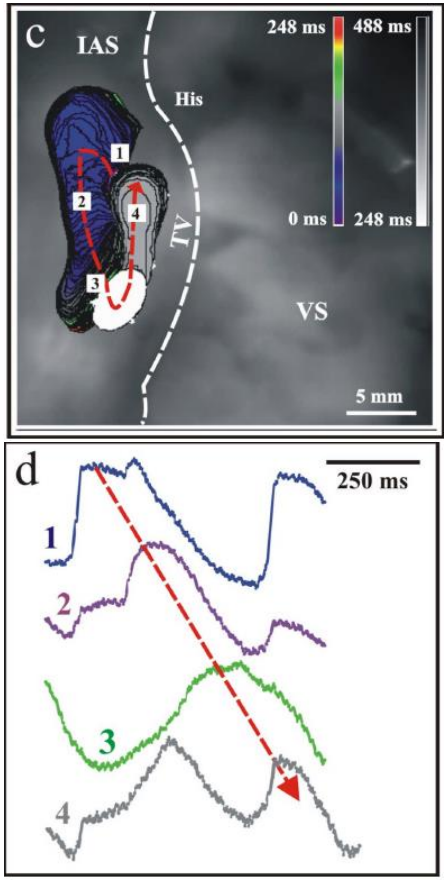


Hucker WH, Anat Rec 2008;291:204-15

Lt Inferior Nodal Extension is Anatomical Substrate of SP?

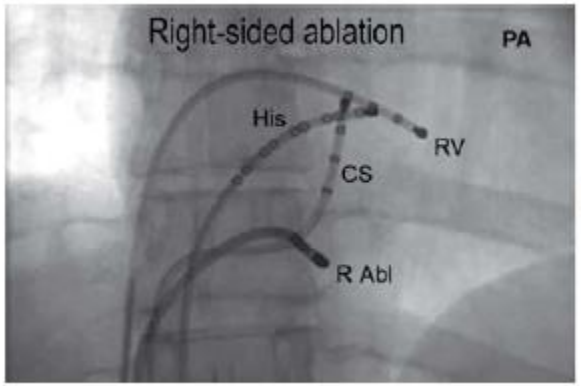




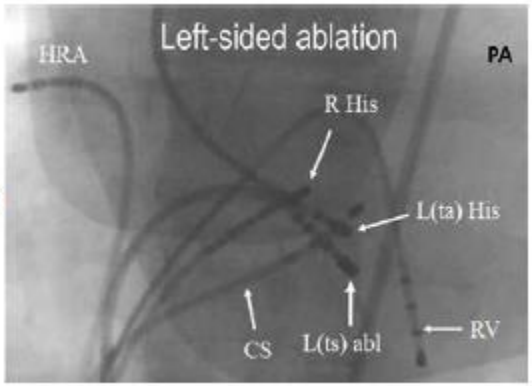


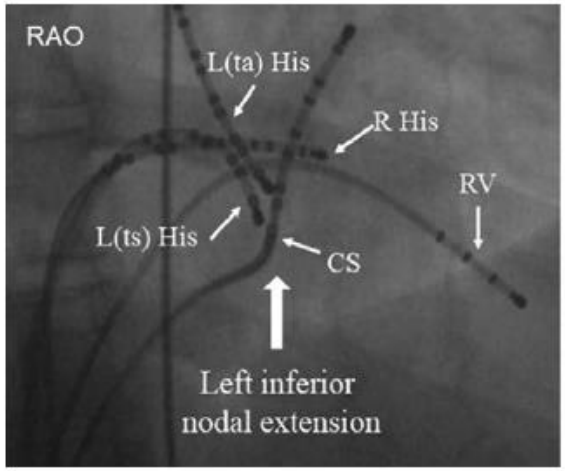
Kurian T, PACE 2010;33(6):754-62

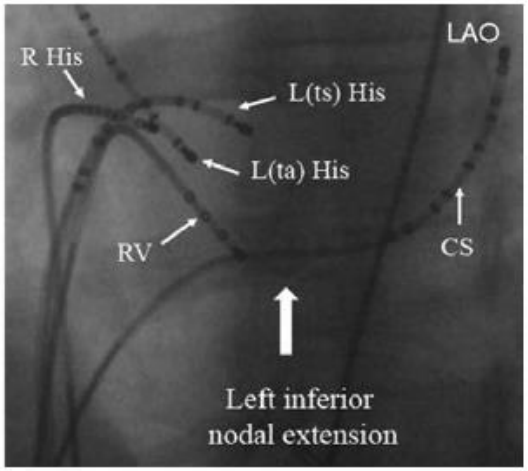
Left Septal Slow Pathway Ablation for Atrioventricular Nodal Reentrant Tachycardia



Inability to obtain non-inducibility of AVNRT







Katritsis, Circ Arrhythm Electrophysiol 2018;11:e005907

Better Results in Lt Septal SP Ablation

Table. Electrophysiology and Ablation Characteristics of Patients Subjected to Left Septal Slow Pathway Ablation

	R+L Group (n=15)	L Group (n=11)	*P* Value
Atypical AVNRT, %	4 (26.7%)	0 (0%)	0.113
Female sex, %	9 (60%)	8 (73%)	0.683
Age, years	53±12.7	43±10.7	0.045
Tachycardia cycle length, ms	370.7±59.7	359.0±37.1	0.573
AH, ms	317.0 (213.5–349.5)	288.0 (254.0–340.0)	0.649
HA, ms	63.0 (42.5–106.0)	48.0 (32.0–59.0)	0.106
Fluoroscopy time, min	30.5 (21.0–44.0)	20.0 (17.0–25.0)	0.061
RF delivery time, min	11.3 (5.0–19.1)	10.0 (7.0–12.0)	0.897
Postablation dual AV nodal conduction, %	2 (13.3%)	0 (0%)	0.492
Tachycardia recurrence, %	1 (6.7%)	0 (0%)	1.000

Katritsis, Circ Arrhythm Electrophysiol 2018;11:e005907

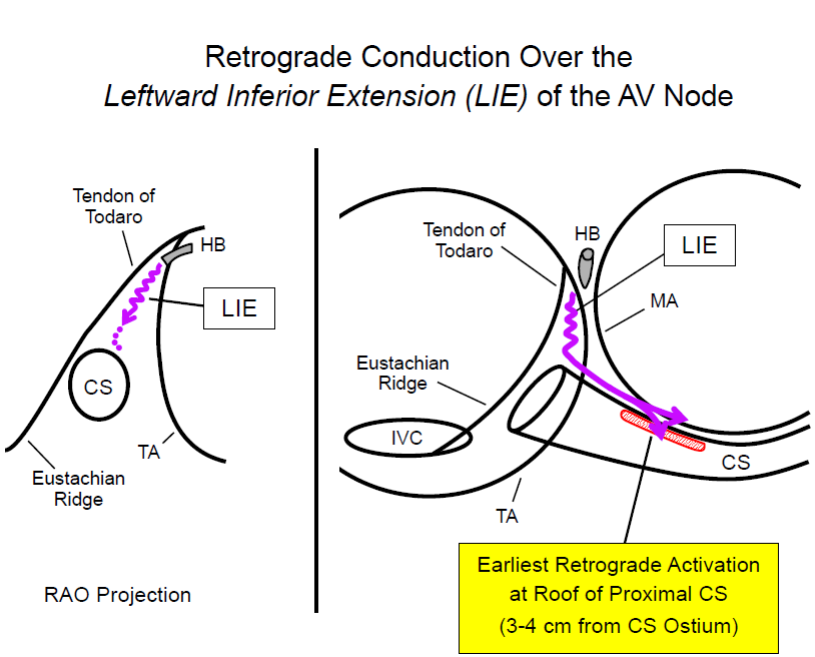
When Rt sided ablation fails

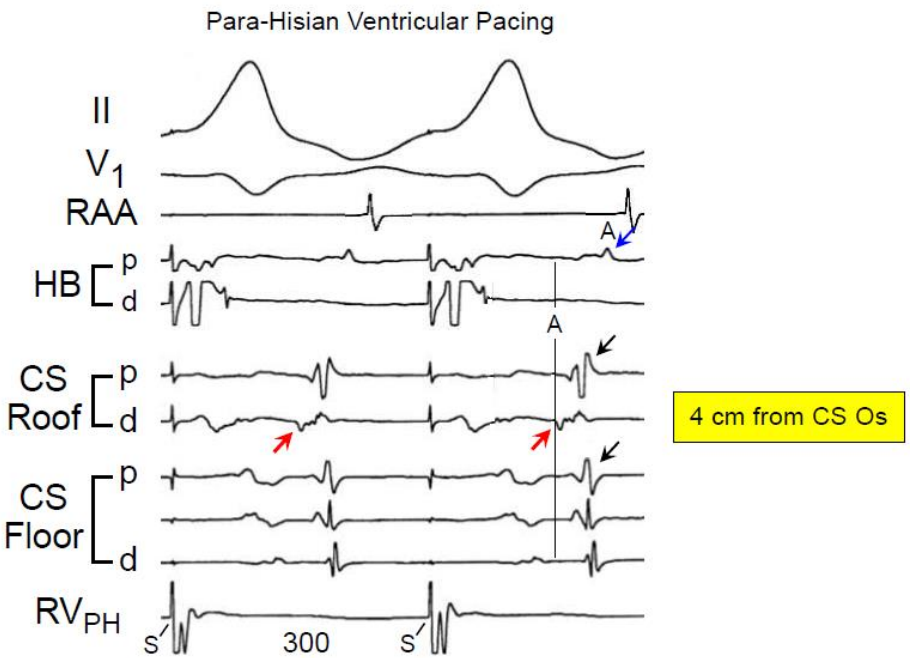
- Targeting earliest retrograde activation?
  - NOT in typical AVNRT
  - Could be attempted in atypical AVNRT; targeting Lt inferior nodal extension

- Lt inferior extension vs LA septal ablation
  - LIE ablation from CS os; risk of AVN damage
  - Junctional rhythm

When LA approach is needed

- Anterograde Limb: Slow/Fast or Slow/Slow
- Retrograde Limb: Slow/Slow or Fast/Slow
  - **Targeting earliest retrograde A**



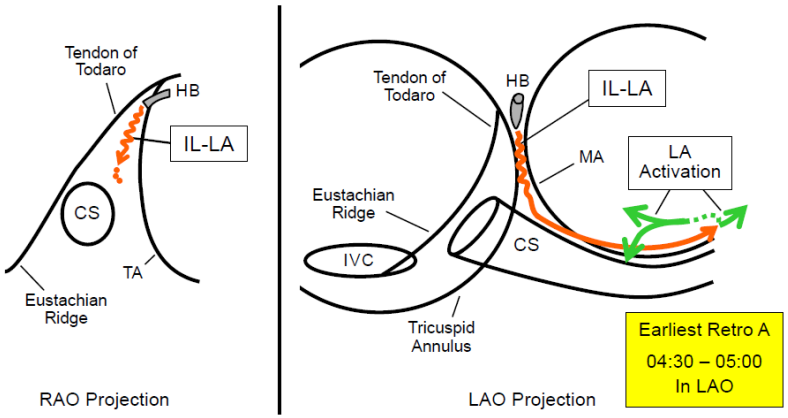


Jackman WM, HRS 2017

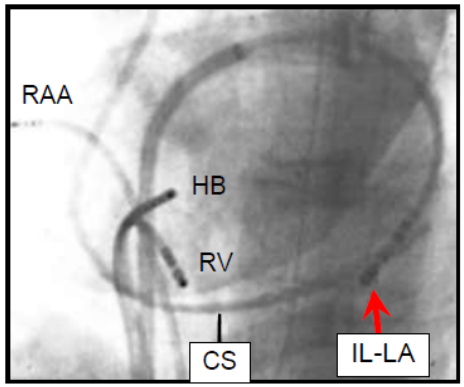
When LA approach is needed

- Retrograde Limb: Slow/Slow or Fast/Slow

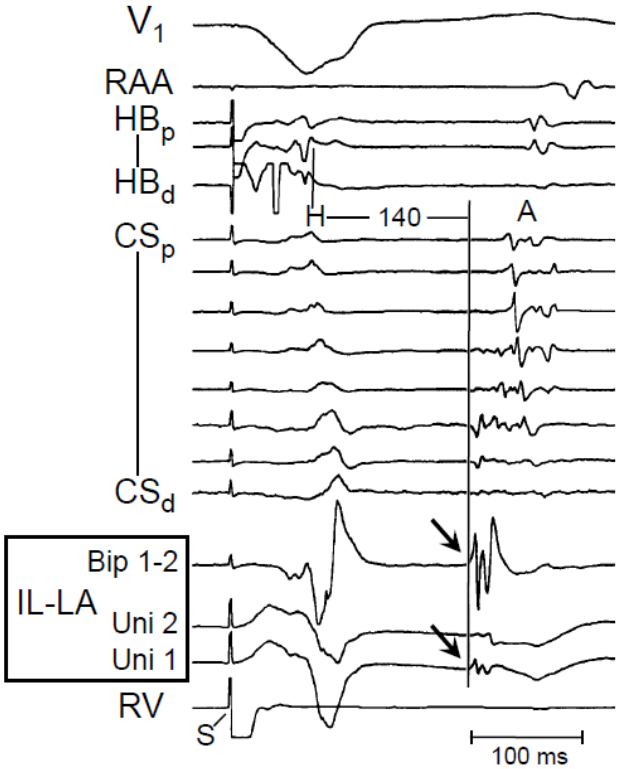
Retrograde Conduction Over the
"Inferolateral Left Atrial" Slow Pathway



LAO Projection



Ablation of "Inferolateral Left Atrial" Slow Pathway



Jackman WM, HRS 2017

When LA approach is needed

Slow/Fast AVNRT

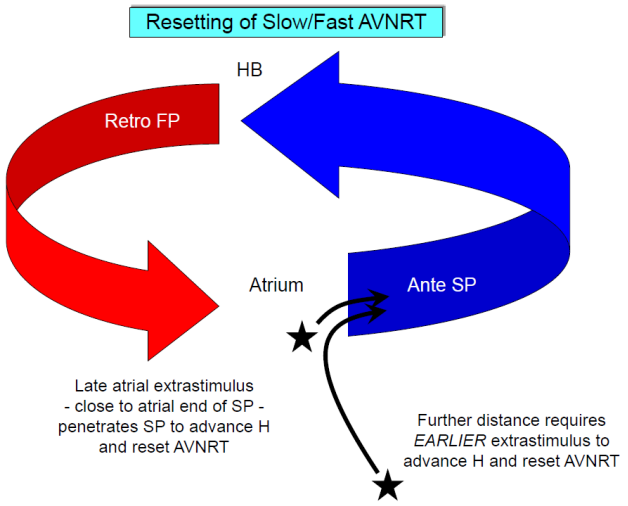
3 Forms

- All use Fast Pathway for Retrograde Limb
- 3 Different Slow Pathways for Antegrade Limb
  1. Rightward Inferior Extension of AV Node (most common)
  2. Leftward Inferior Extension of AV Node (uncommon)
  3. Inferolateral Left Atrial Slow Pathway (rare)

Sometimes Ablate the LIE or IL-LA by Delivering RF Progressively Higher in Triangle of Koch

Ideal Target: Atrial End of LIE or IL-LA Slow Pathways

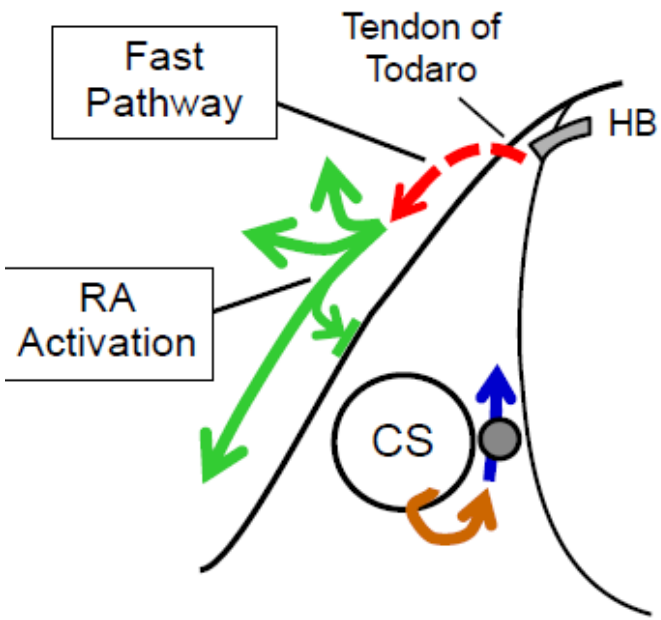
- Techniques for Differentiating Antegrade Pathway
  - Ablation Site of Antegrade Slow Pathway
  - Resetting Response (Single Atrial Extrastimulus)



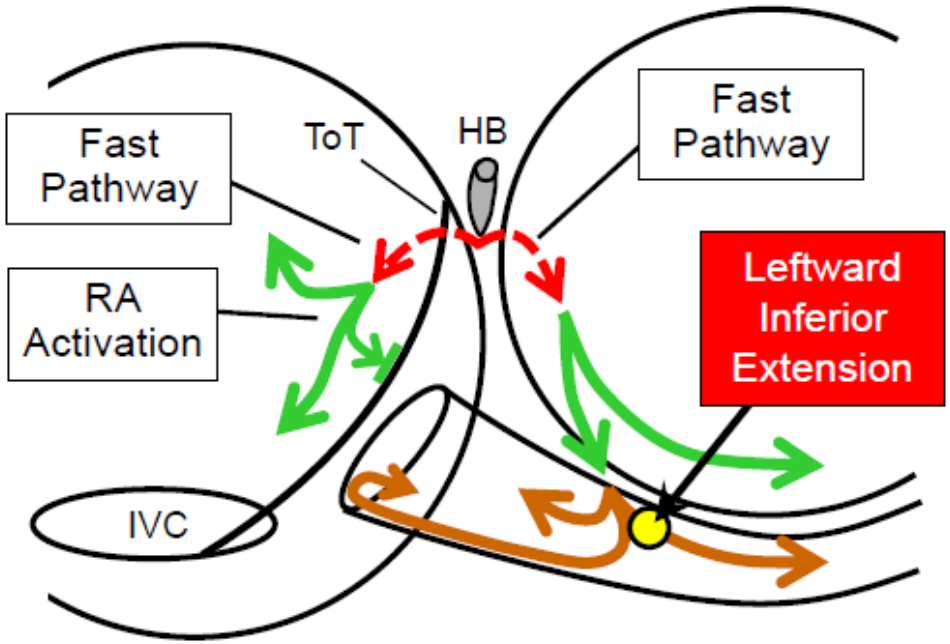
Jackman WM, HRS 2017

Use of Resetting to Identify Antegrade Limb (Slow Pathway) of Reentrant Circuit

RAO Projection



LAO Projection



Late Extrastimulus at

- Inferior Triangle of Koch
- Roof of Proximal CS

Site Where *Latest Extrastimulus* Advances Next H - Closest to Antegrade Slow Pathway

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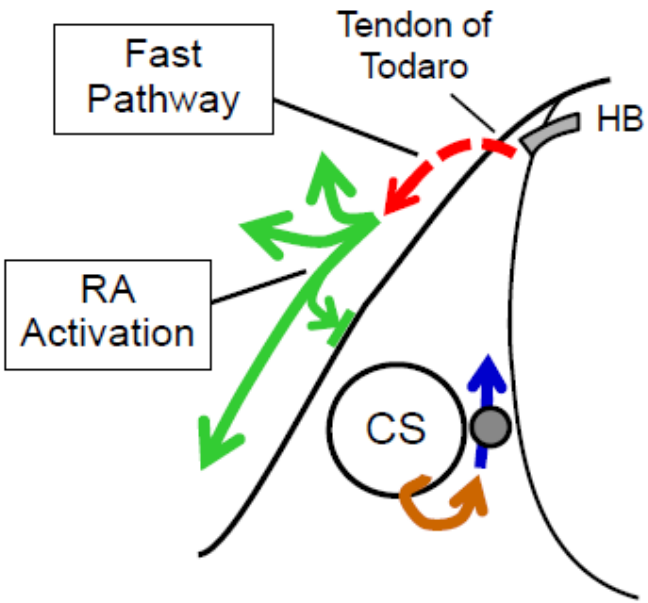
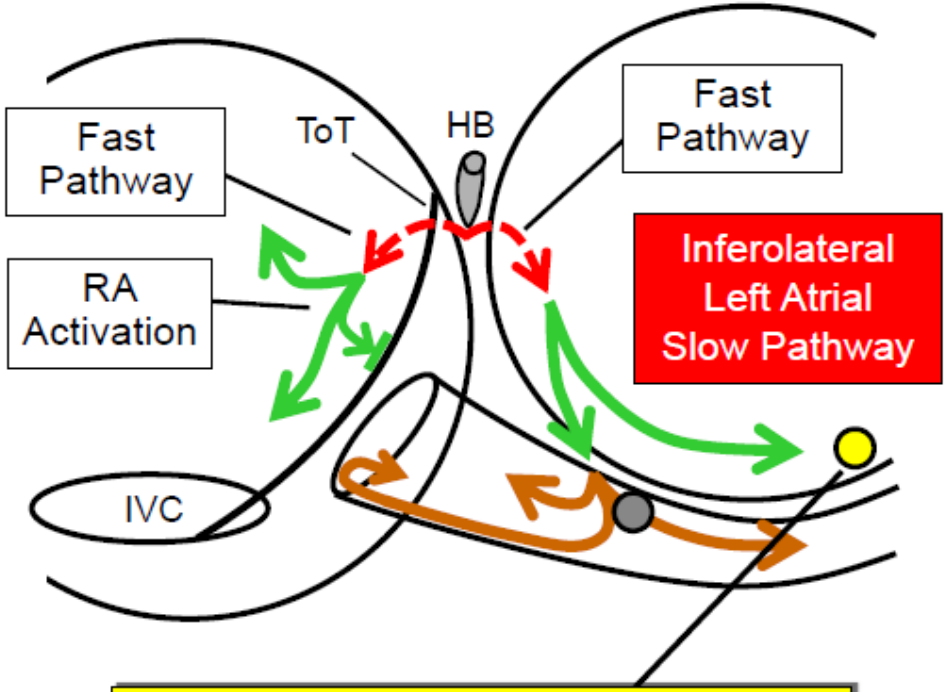
Use of Resetting to Identify Antegrade Limb (Slow Pathway) of Reentrant Circuit

RAO Projection



LAO Projection



Late Extrastimulus at

- Inferior Triangle of Koch
- Roof of Proximal CS

Late Extrastimulus at Inferolateral LA, Close to Mitral Annulus (4:30-5:00)

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Case

- Prior failed AVNRT ablation x 2
  - Vigorous accelerate junctional rhythm in usual SP region
- Resetting Response
  - ToK: failed to advance H
    - RIE is not a limb of reentry

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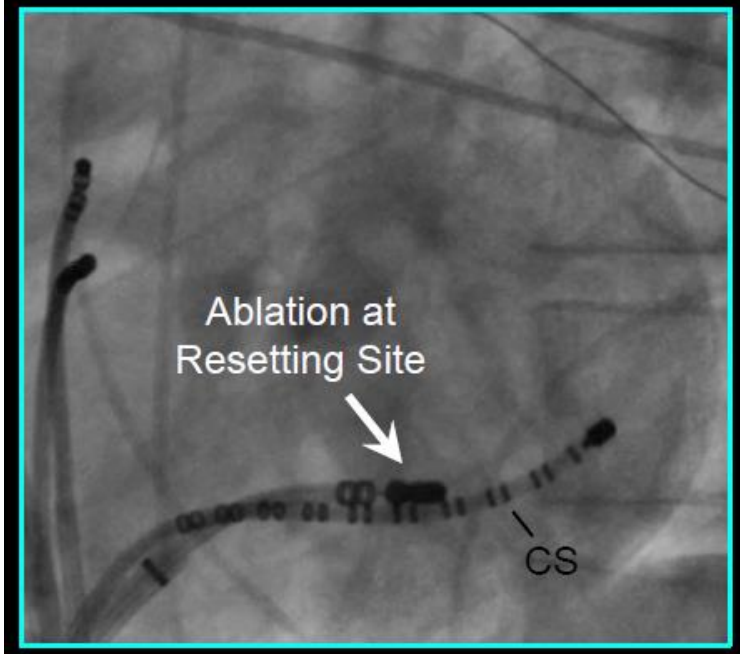
When Rt sided ablation fails

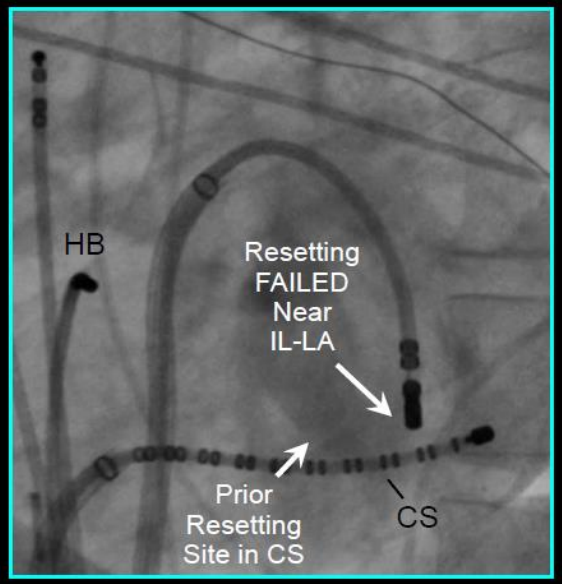
Ablation at
Roof of CS



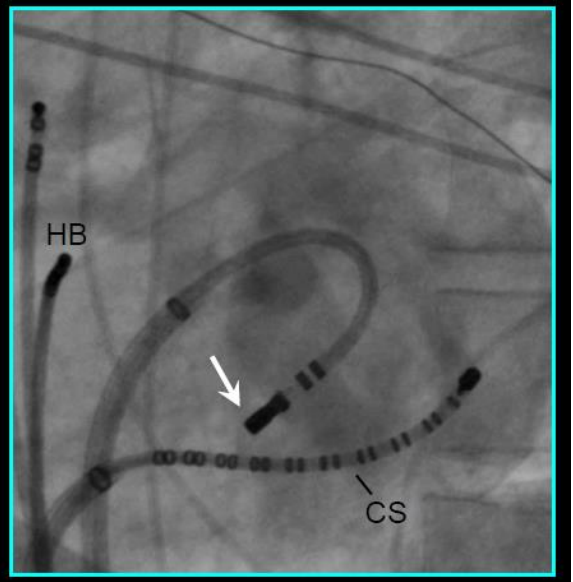
Failed to
Terminate AVNRT

Resetting Sites in LA

Near Inferolateral MA
(IL-LA)



Near Inferior MA
(LIE)



LAO Projection

Ablation in LA
Required for 25% of LIE

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Take Home Message

- Simplified Dx criteria for typical/atypical AVNRT
- AVNRT circuit
  - Variable retrograde fast pathway conduction
  - RIE, LIE, IL-LA
- Stepwise approach in ablation
  - Rt sided posterior septal ablation
  - LIE vs LA septal ablation, IL-LA SP ablation
    - Earliest retrograde A for retrograde pathway
    - Reset response for anterograde pathway