Wide QRS 빈맥의 심전도 판독

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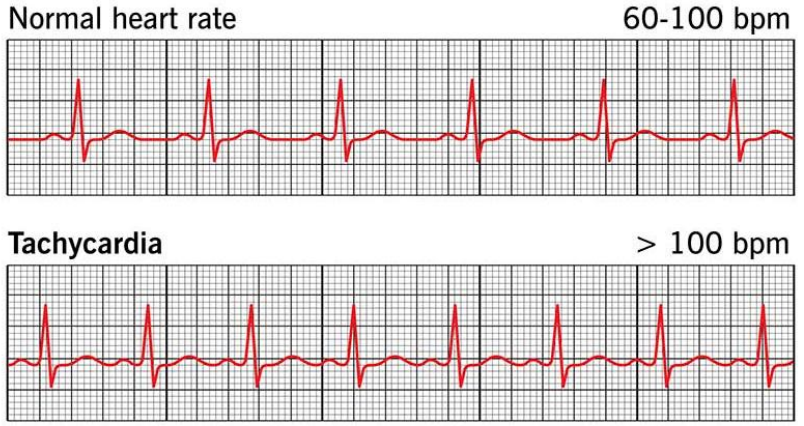
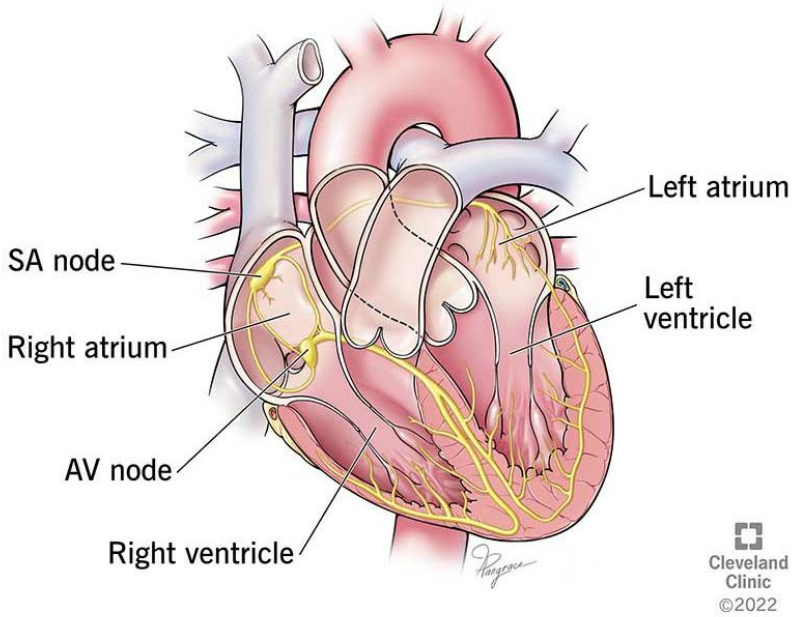
빈맥 (Tachycardia)

- 심박수 분당 100회 이상의 빠른맥
- QRS 폭과 리듬 규칙성을 기반으로 감별진단





빈맥 감별 알고리즘

1) QRS 폭 확인: 좁은 QRS vs 넓은 QRS

2) 리듬 확인: 규칙적(Regular) vs 불규칙적(Irregular)

3) P파 분석: 보이는가? Retrograde P파 확인

4) RP 간격 분석: Short RP vs Long RP

5) 아데노신 반응 확인

빈맥 감별 알고리즘

1) QRS 폭 확인: 좁은 QRS vs 넓은 QRS

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Wide QRS (VT)

3) P파 분석: 보이는가? Retrograde P파 확인

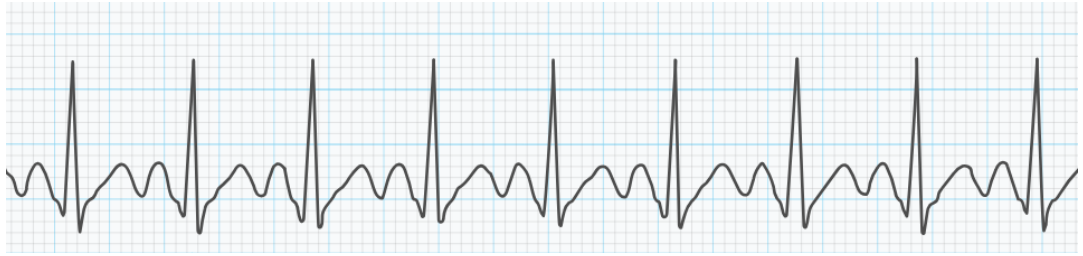
4) RP 간격 분석: Short RP vs Long RP

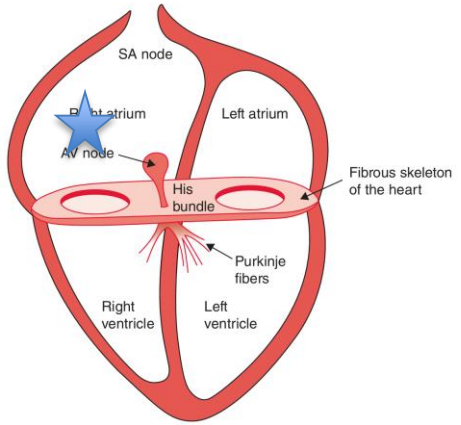
5) 아데노신 반응 확인

Narrow QRS (SVT)

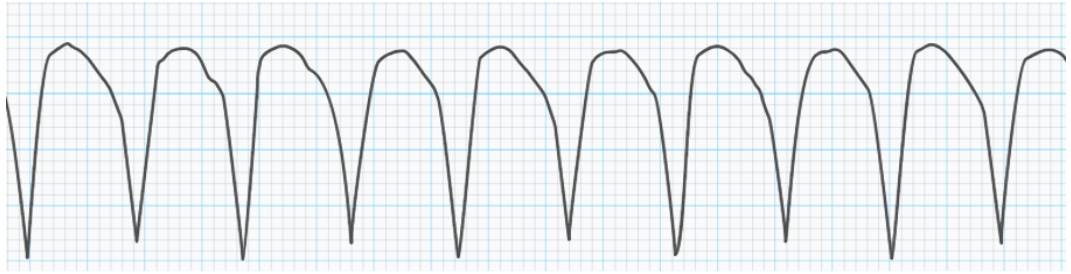
Narrow vs Wide QRS

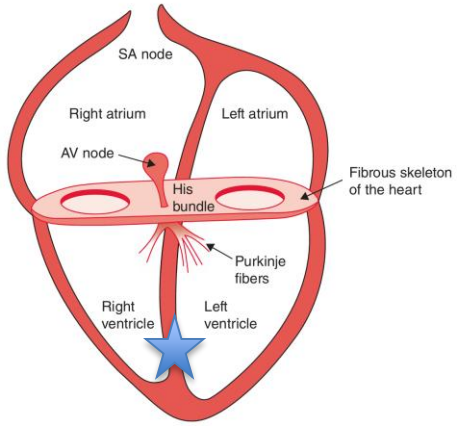
- Narrow QRS (< 120ms, 3칸 이내)





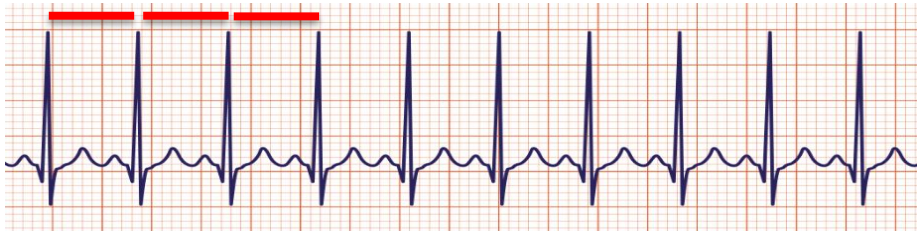
- Wide QRS (> 120ms, 3칸 이상 *VT > 160ms)

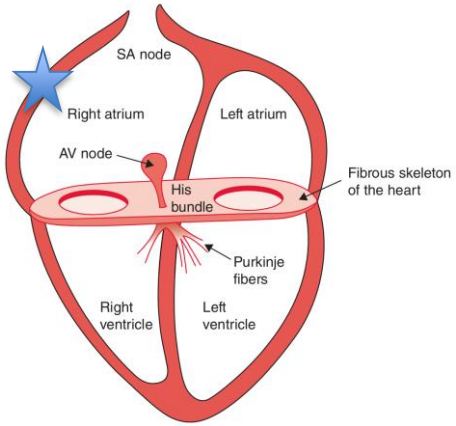




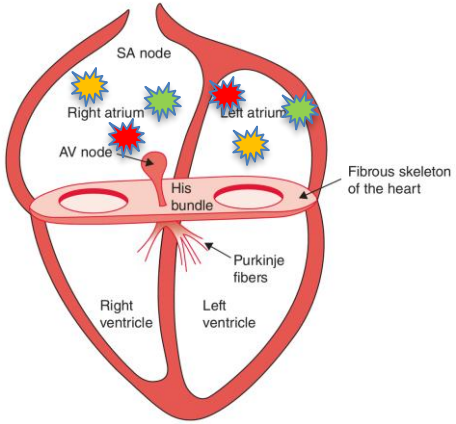
Regular vs Irregular

- Regular QRS

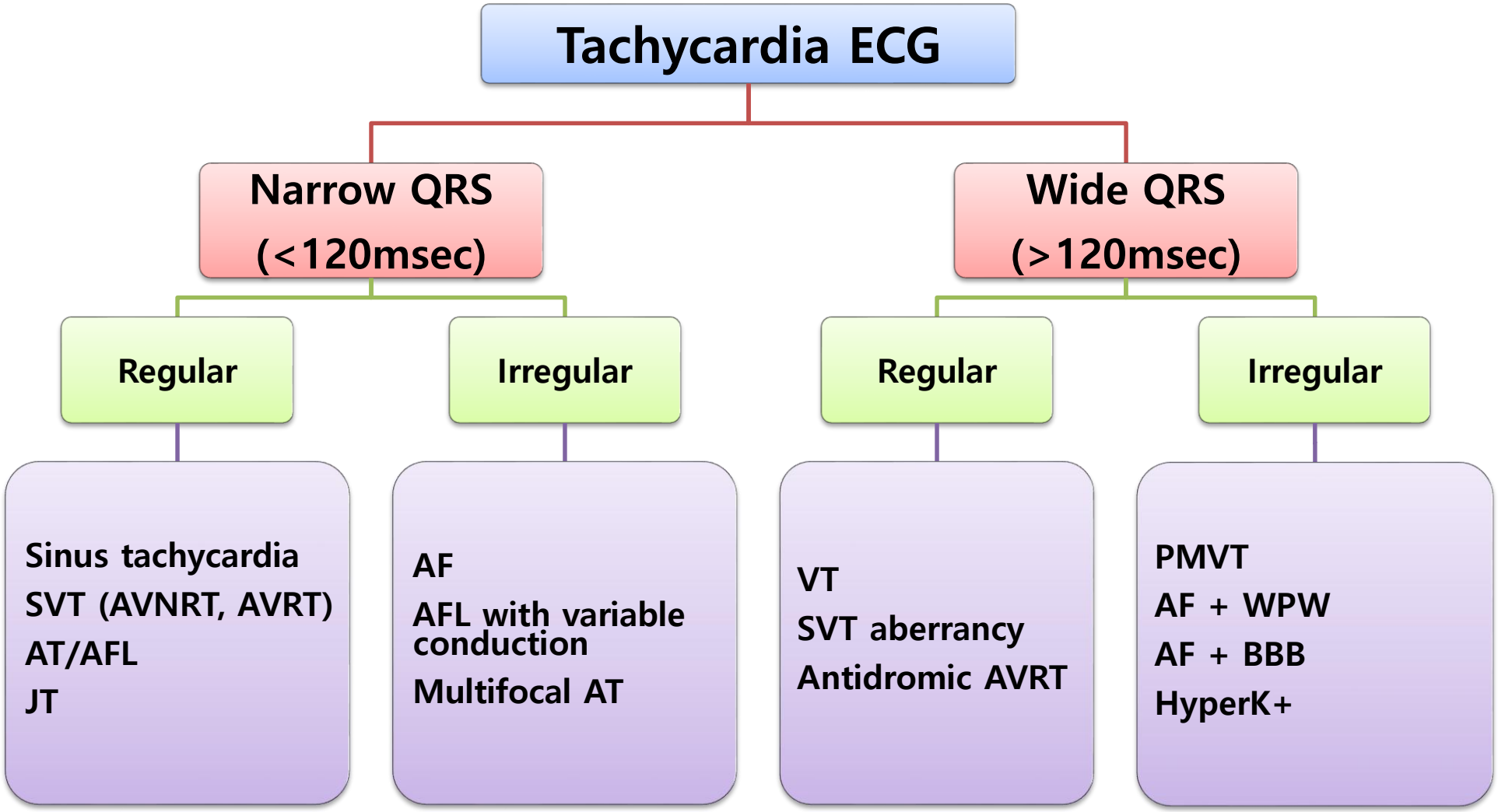




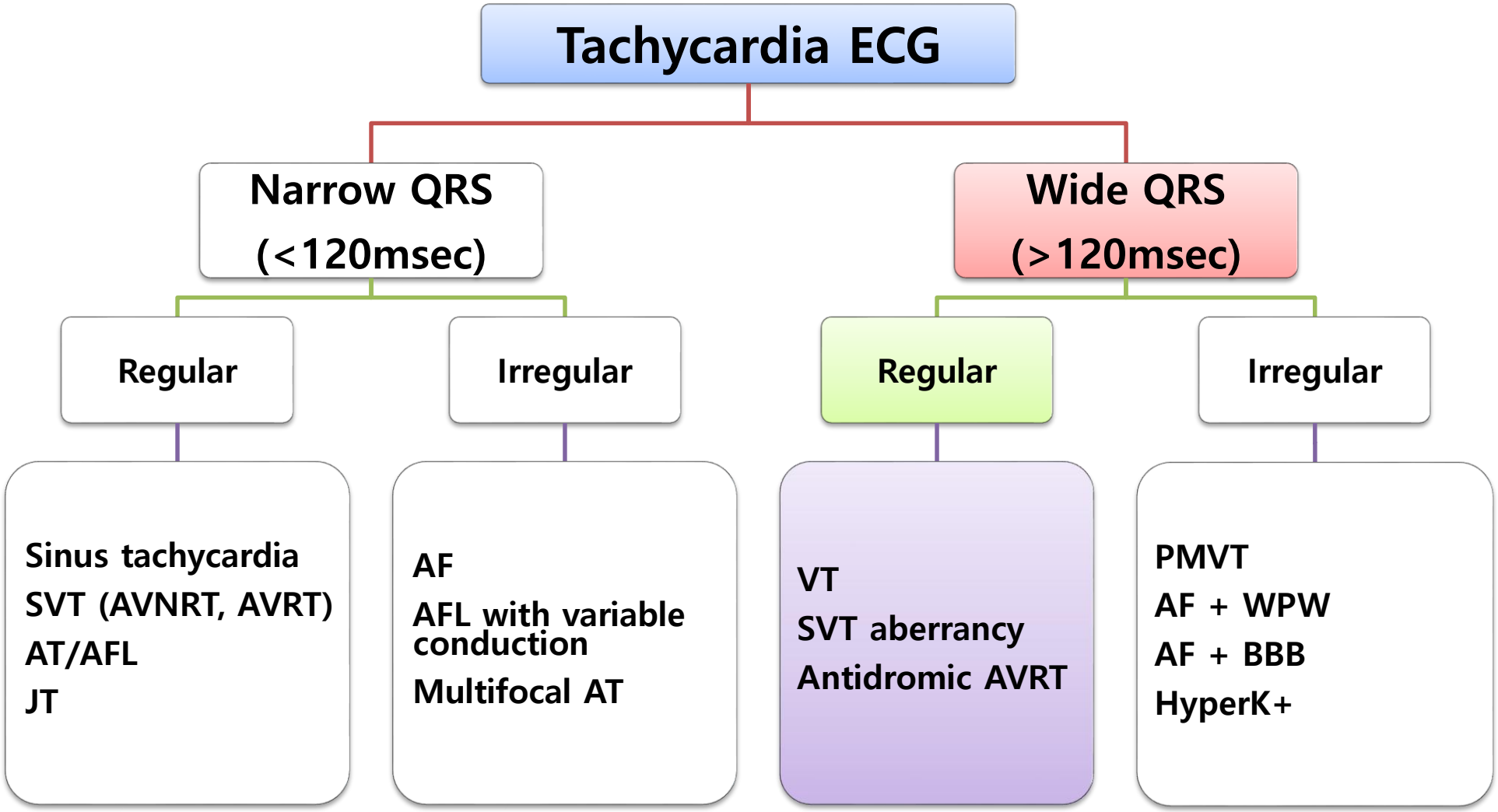
- Irregular QRS



Differential diagnosis

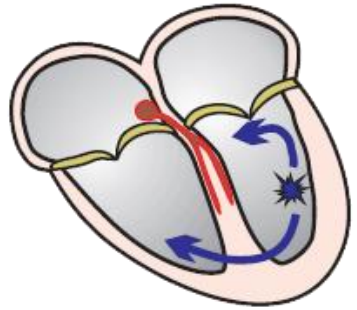


Differential diagnosis

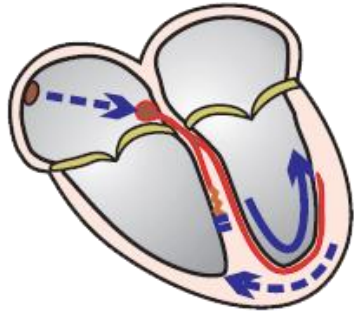


Wide Complex Tachycardia (WCT) Causes

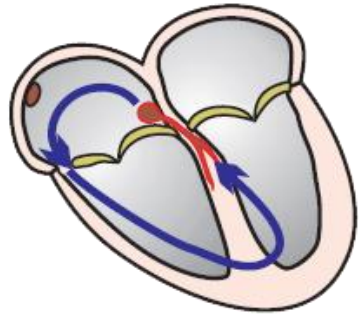
- **심실 빈맥 (Ventricular Tachycardia, VT)**
  - WCT 의 80% 를 차지 **(50세 이상에서는 90%)**
  - His bundle 아래의 비정상적인 ectopic ventricular focus 에서 발생. (Reentry or Focal)



- **상심실성 빈맥 편위전도 (SVT Aberrancy)**
  - 심실이 2개의 bundle branch 중 하나를 통해서만 탈분극.
  - Fixed bundle block 이 있거나, 기능적인 (Functional) 차단이 있을 때 발생한다.



- **역행성 AVRT (Antidromic AVRT)**
  - **WPW 증후군**: 심실과 심방이 두 개의 경로(AV node와 accessory pathway) 를 통해 연결
  - 역행성 AVRT가 생길때 WCT 를 보이며 이때 탈분극은 accessory pathway를 통해 이루어짐



Probability of Mechanism (Incidence-wise)

- **심실 빈맥(Ventricular Tachycardia, VT) 의 발생 확률이 높아지는 경우**
  - 나이: 35세 이상, 허혈성 심장병, 심근경색, 심부전, 심근병증 진단

    => 심초음파, 심장 MRI 등에서 이상이 보일때
  - 가족력: 가족 중 갑작스러운 심장 사망 이력

- **상심실성 빈맥(Supraventricular Tachycardia, SVT) 의 발생 확률이 높아지는 경우**
  - **Pre-existing BBB**: 기존 심전도 우각 차단(RBBB) 또는 좌각 차단(LBBB)
  - **WPW 증후군**: 기존 심전도에 Delta wave (+)
  - 구조적 심장병이 없는 젊고 건강한 환자

    => 심초음파에서 이상이 없을때

Ventricular Tachycardia

SVT Aberrancy

Antidromic AVRT

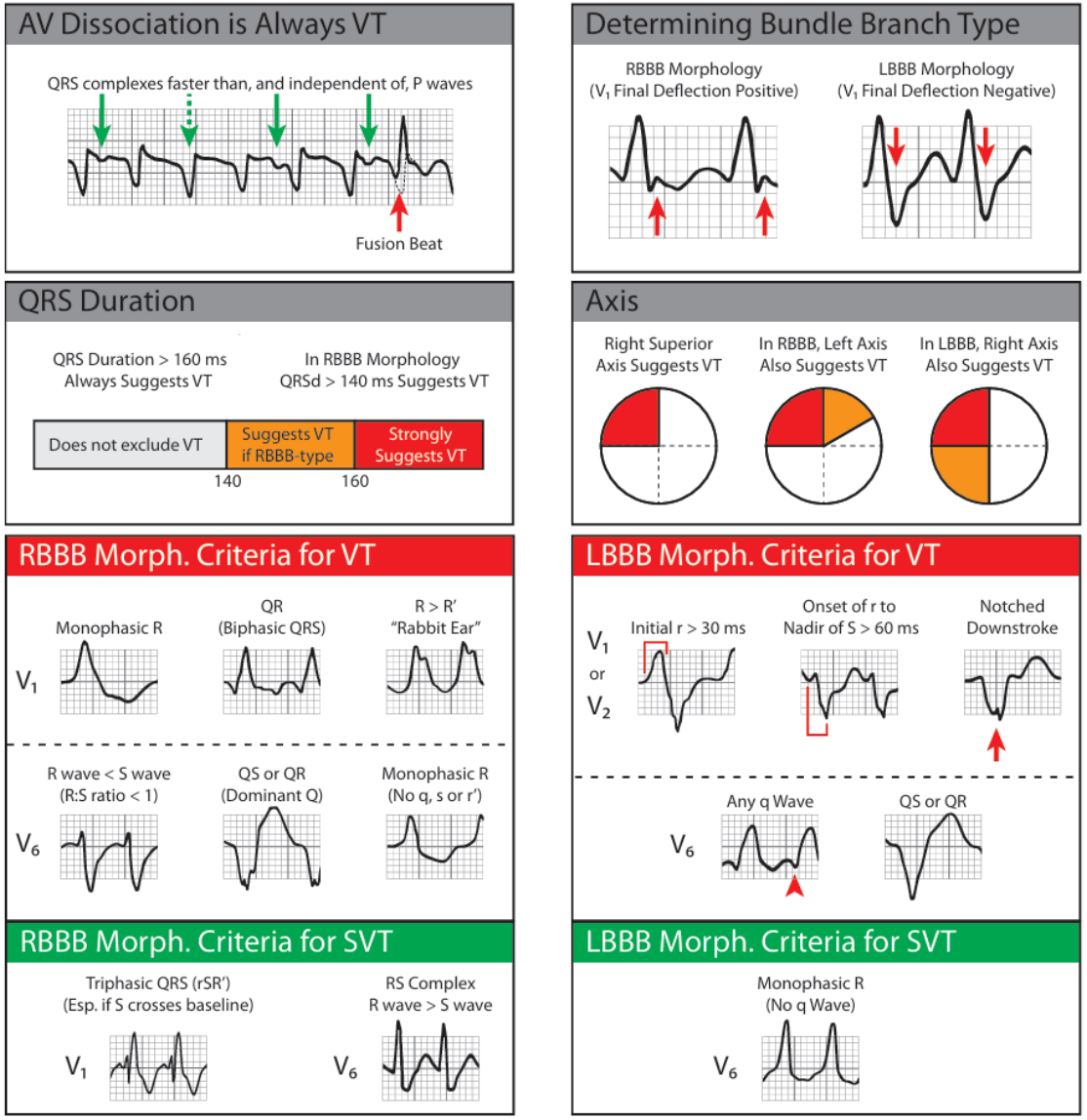
ECG in Ventricular Tachycardia

A. AV relationship

- AV dissociation
- Capture beats
- Fusion beats

B. QRS morphology

- Absence of typical bundle branch block pattern
- Precordial concordance (all positive or all negative)
- Extreme axis deviation ("northwest axis")
- RSr′ in V1 (larger left rabbit ear)



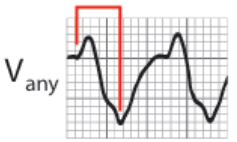
AV = atrioventricular; aVR = augmented vector right; LBBB = left bundle branch block; RBBB = right bundle branch block; SVT = su

Garner J, Miller J, et al. Arrhythm Electrophysiol Rev 2013

	Original Paper	Later Studies
In RBBB and LBBB Morphologies	**Positive Predictive Value**	
AV dissociation → VT	100 %[11]	100 %[9,10,12,13]
Precordial concordance → VT	100 %[8]	89–100 %[7,10]
'Northwest' axis (>270 °) → VT	–	95–96 %[10,22]
In RBBB Morphology Only	**Positive Predictive Value**	
V1: Rsr' (Left peak > right) → VT	100 %[11]	100 %[9,22]
Left axis deviation → VT	94 %[11]	88*–96 %[9,10,22]
QRS width >140 → VT	100 %[11]	89 %[10]
V1: Mono- or biphasic QRS → VT	97 %[11]	82–100 %[7,9,22]
V6: R to S ratio <1 → VT	90 %[11]	90–100 %[10,22]
V1: rSR (S crosses baseline) → SVT	91 %[6]	93 %[11]
In LBBB Morphology Only	**Positive Predictive Value**	
QRS duration > 160 ms → VT	100 %[11]	98–99 %[10,22]
Right axis deviation → VT	100 %[11]	87–96 %[9,10]
Kindwall: V1 or V2: Initial r >30 ms → VT	100 %[14]	–
Kindwall: V1 or V2: Onset of r to nadir of S >60 ms → VT	98 %[14]	–
Kindwall: V1 or V2: Notched downstroke → VT	97 %[14]	–
Kindwall: V6: Any q wave → VT	100 %[11]	98 %[14]
Algorithms Diagnosing Both VT and SVT	**Accuracy**	
Any 1 of 4 Kindwall criteria above → VT	98 %[14]	92 %[22]
The combined Brugada algorithm	98 %[12]	78–79 %[16,17]
aVR algorithm	92 %[13]	72 %[16]
Griffith algorithm	86 %[20]	78–79 %[16,17]
Lead II deflection >50 ms → VT, else SVT	>90 %[19]**	69 %[16]

Brugada Algorithm

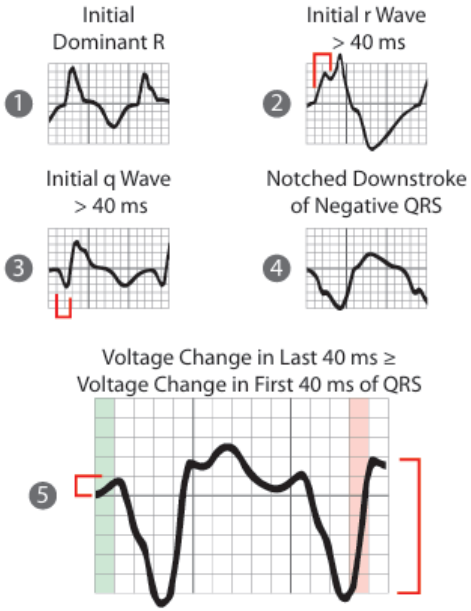
1. No Precordial Lead has Both R and S
2. Onset of R to Nadir of S >100 ms in ANY of V_1-V_6



3. AV Dissociation
4. Morphology Criteria: Both V_1 and V_6 Suggest VT → **VT**

None of the Above → **SVT**

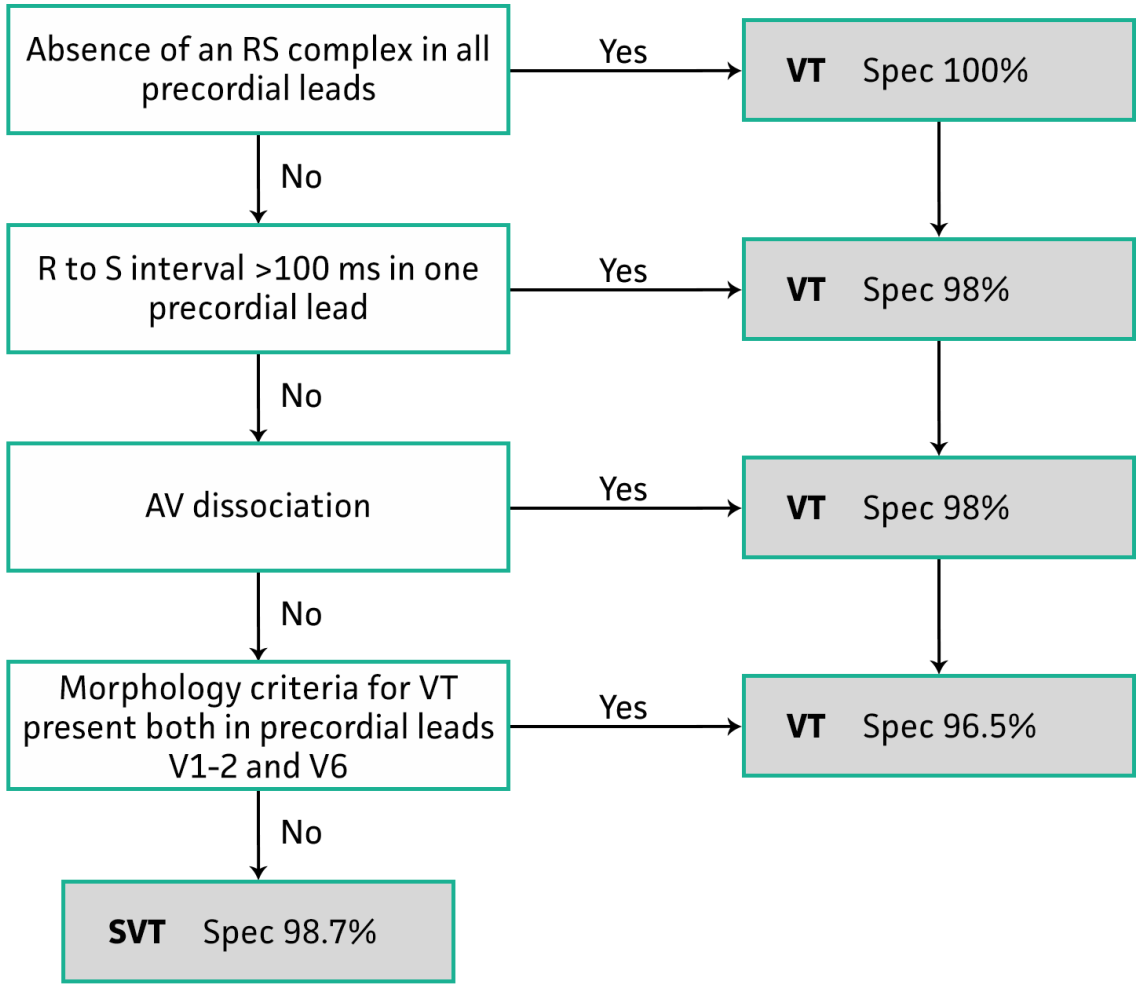
Lead aVR Algorithm



Any of the above in lead aVR ➜ VT
None of the above in lead aVR ➜ SVT

1. **Brugada**
2. Vereckei
3. Basel

VT (Brugada algorithm)



1. **Brugada**
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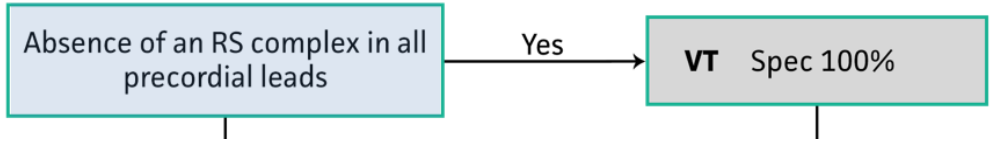
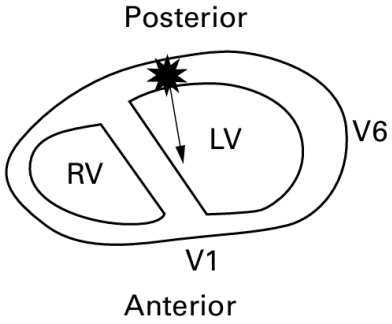
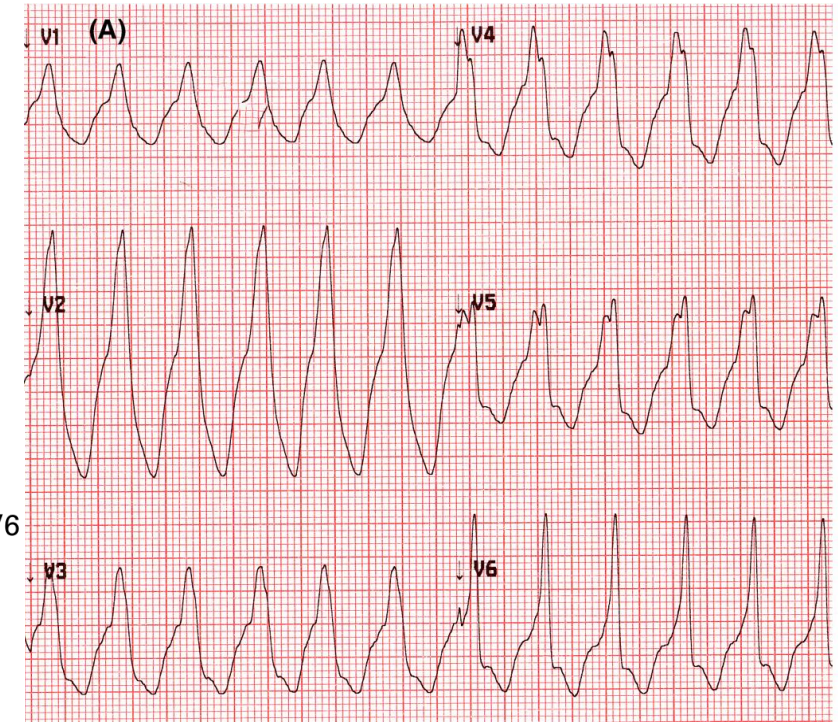
Absence of an RS complex

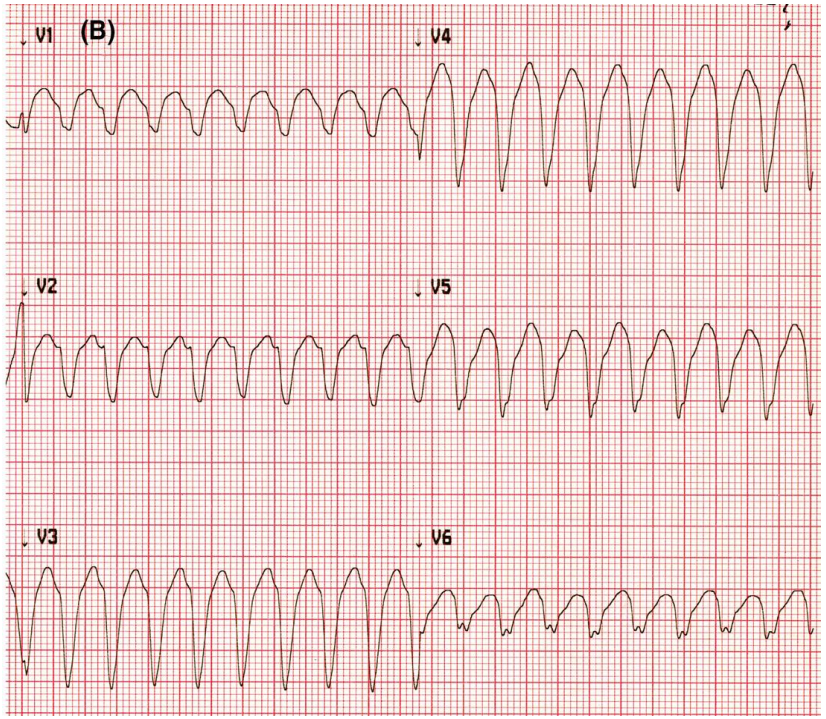
= Concordance



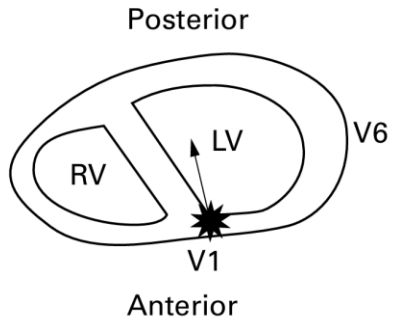




Positive concordance, Only R waves
Basal VT, but also in antidromic AVRT

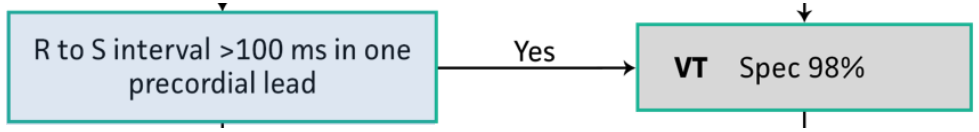


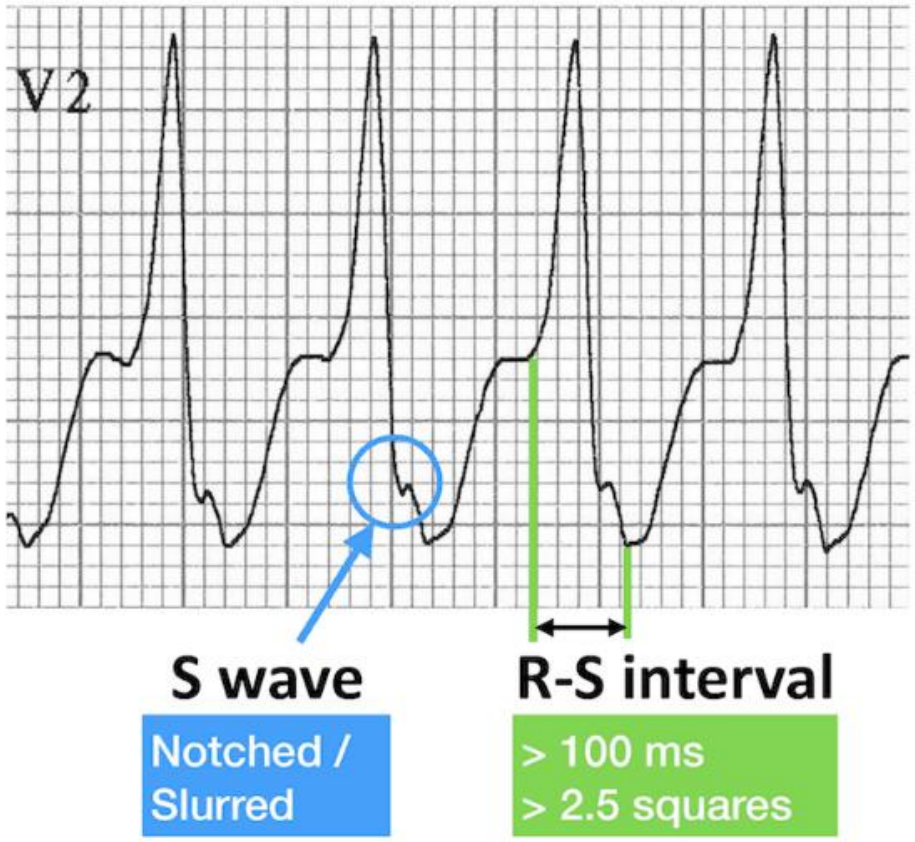
Negative concordance, Only S waves
Almost always apical VT



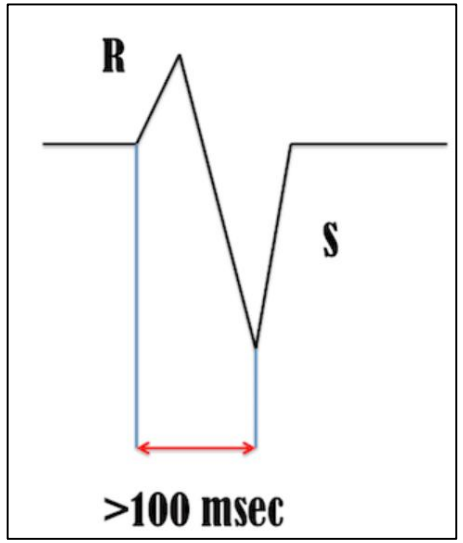
1. **Brugada**
2. Vereckei
3. Basel

R to S interval





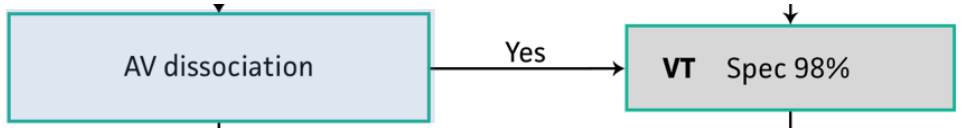
Josephson sign

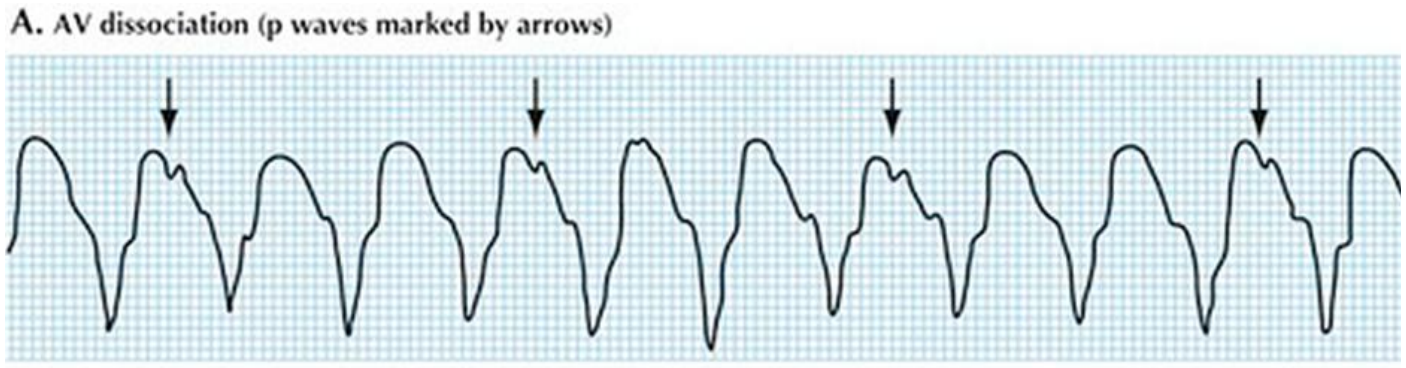


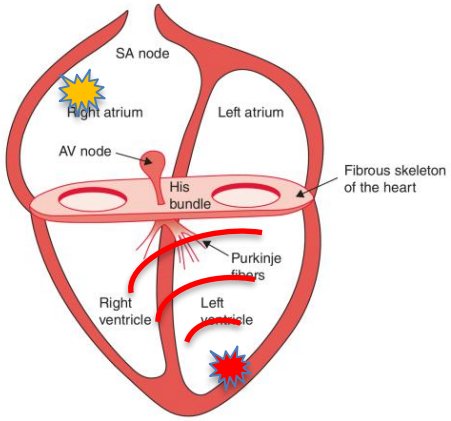
Onset of R to nadir (lowest point) of S

1. **Brugada**
2. Vereckei
3. Basel

AV dissociation







1. **Brugada**
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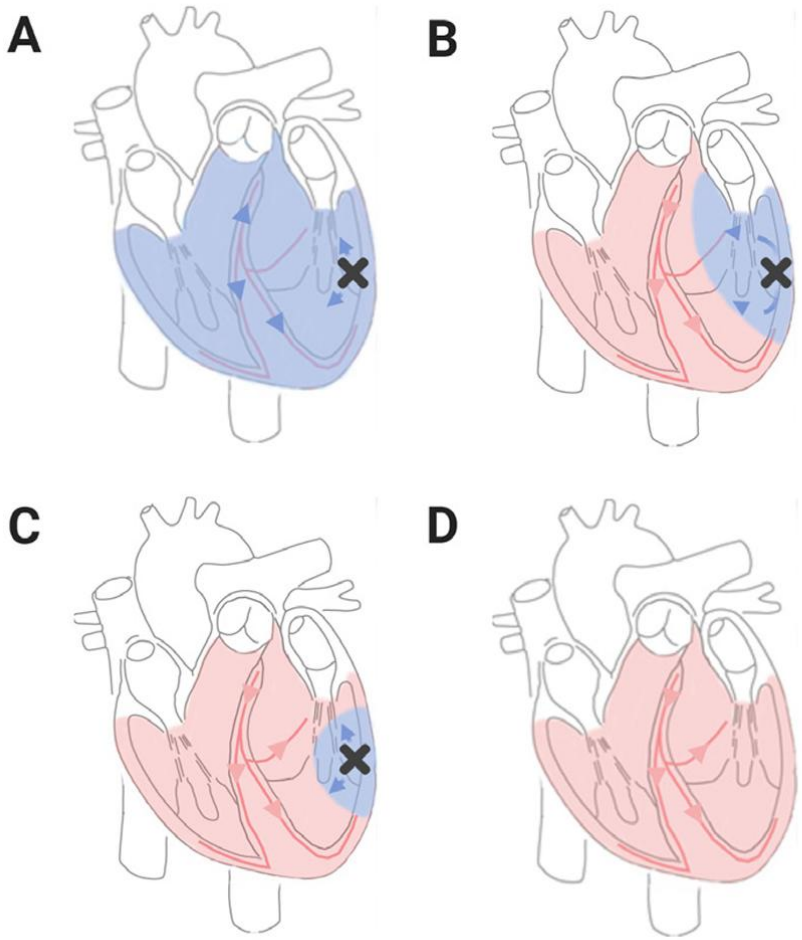
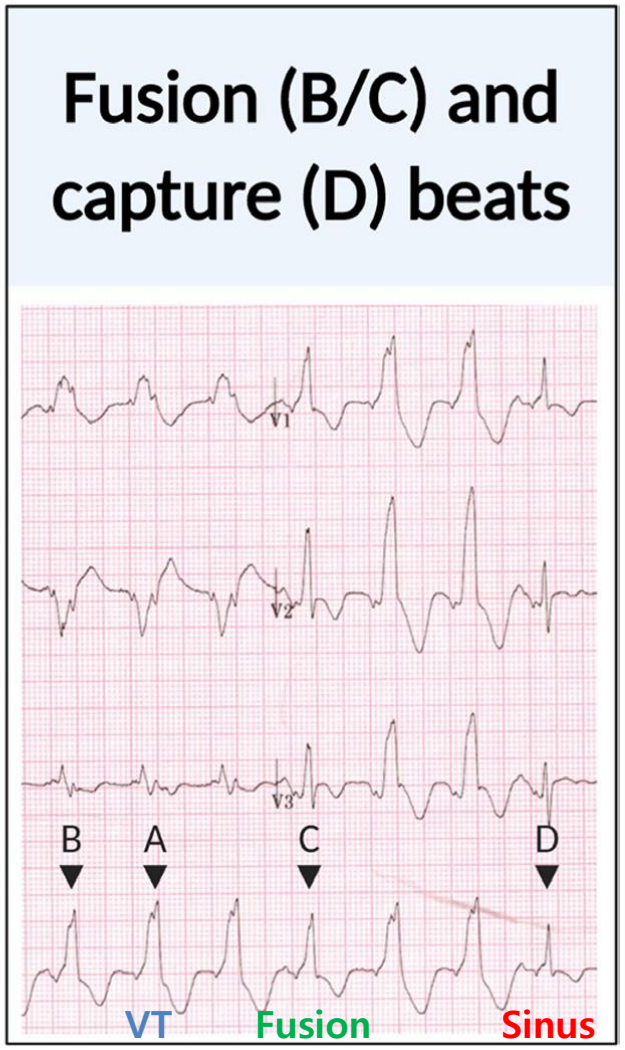
3. Basel

Fusion and Capture beats



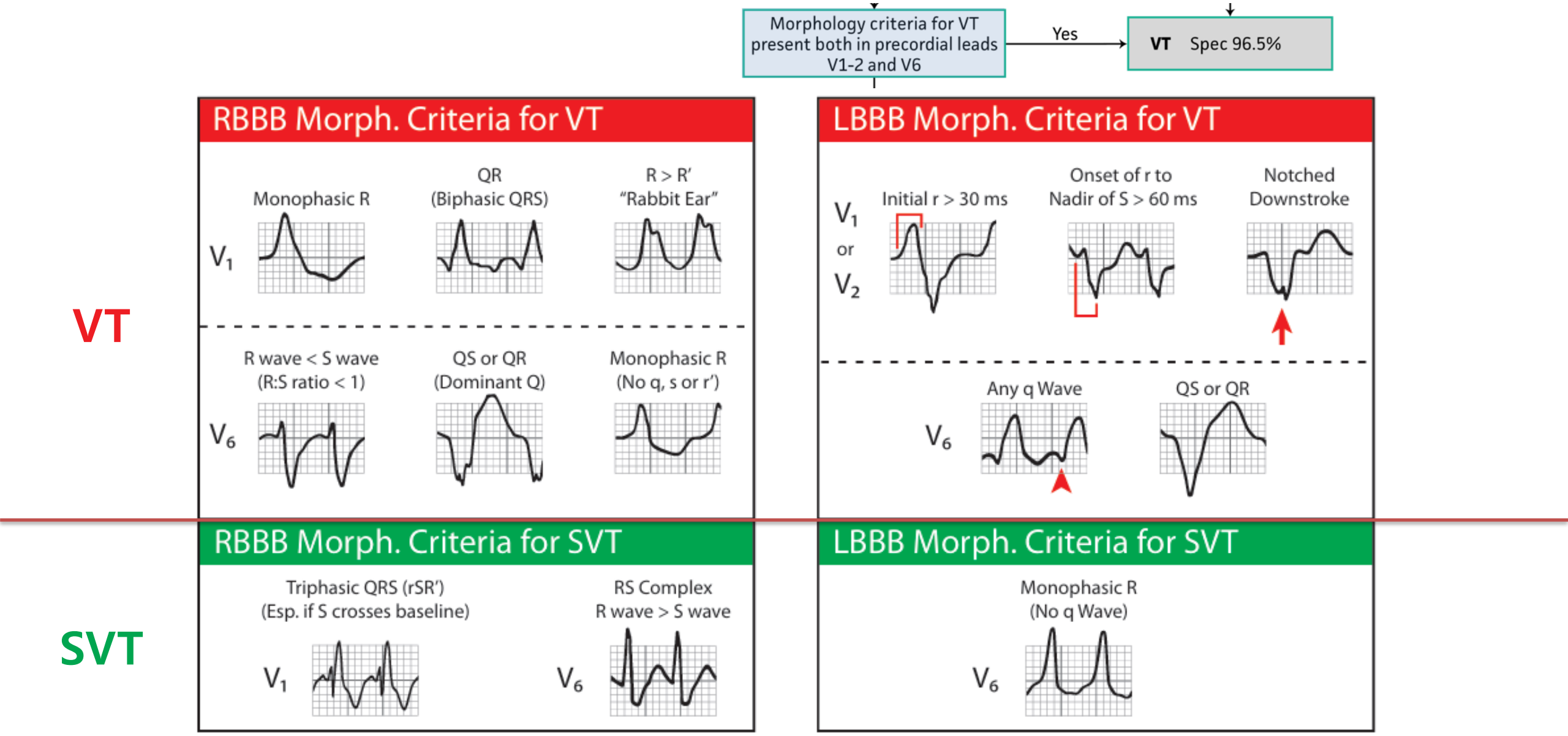


- Activation from **VT: blue**
- Activation from **Sinus: red**

Ding WY, Mahida S. Wide complex tachycardia: differentiating VT from SVT. Heart 2021;107:1995–2003.

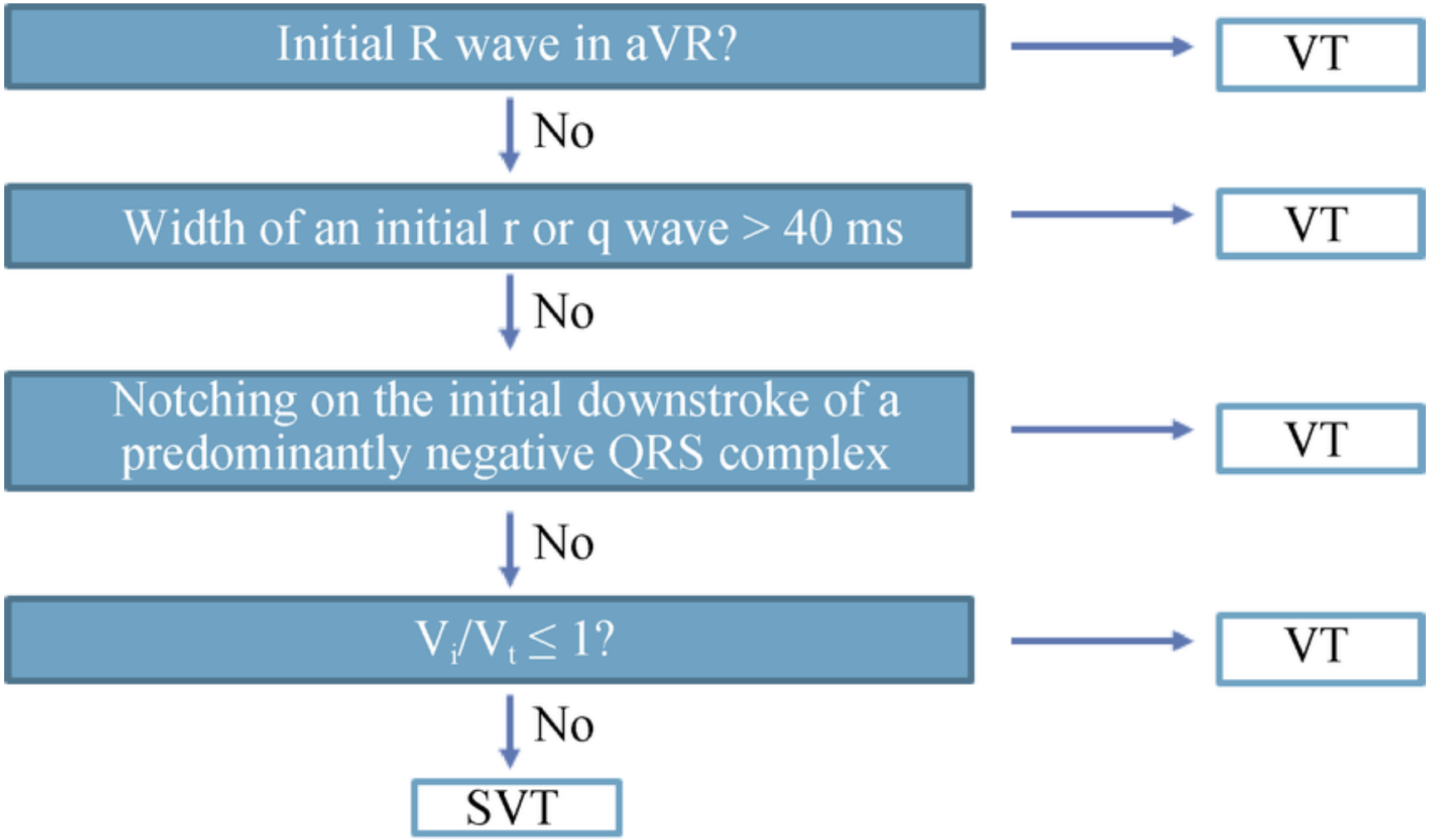
1. **Brugada**
2. Vereckei
3. Basel

Morphology criteria



1. Brugada
2. **Vereckei**
3. Basel

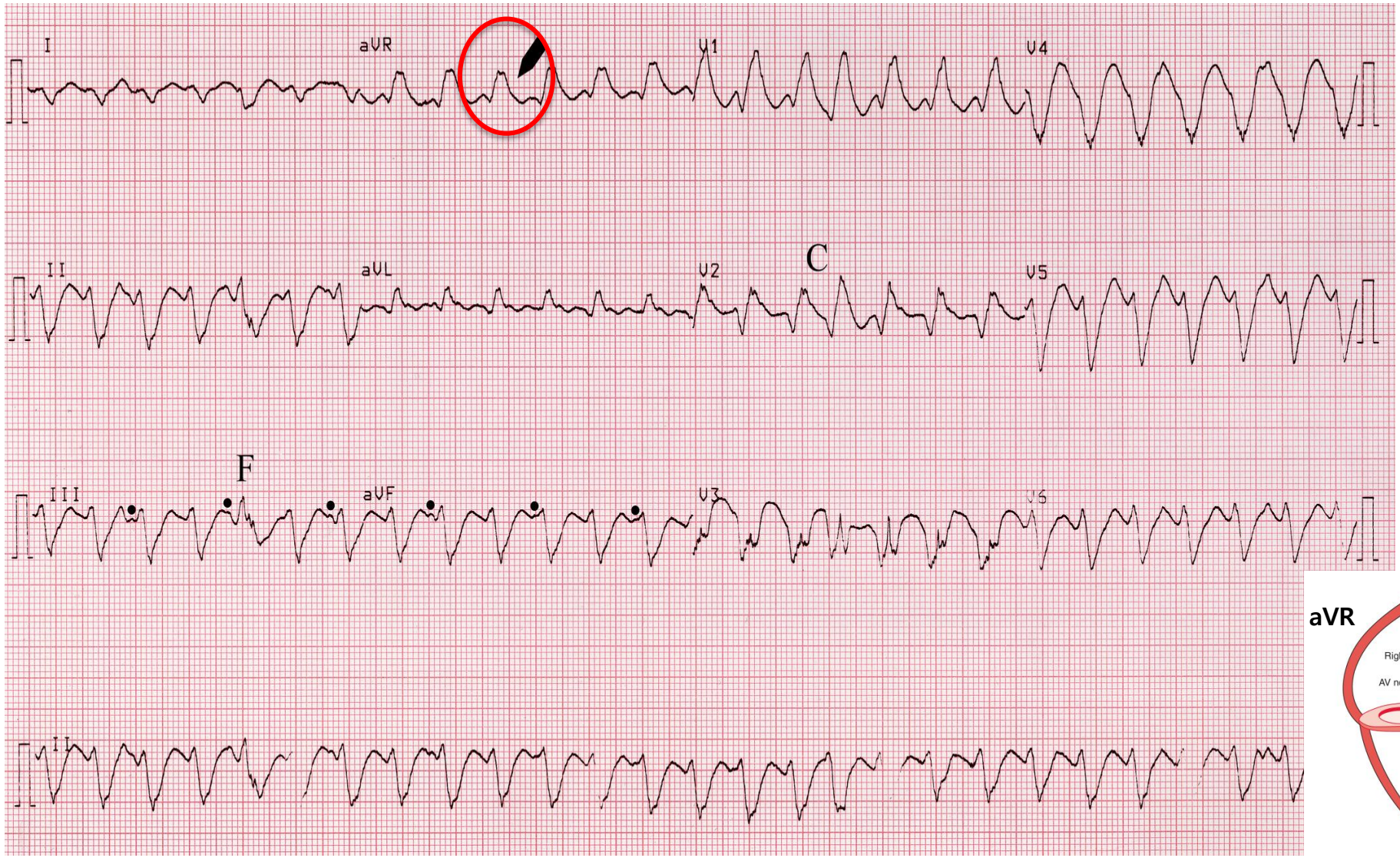
Vereckei algorithm (aVR)

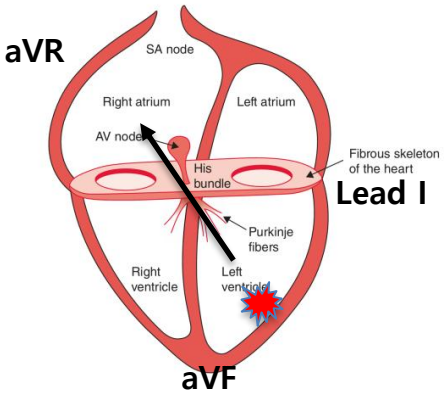


1. Brugada
2. **Vereckei**
3. Basel

Initial R wave in aVR? → VT

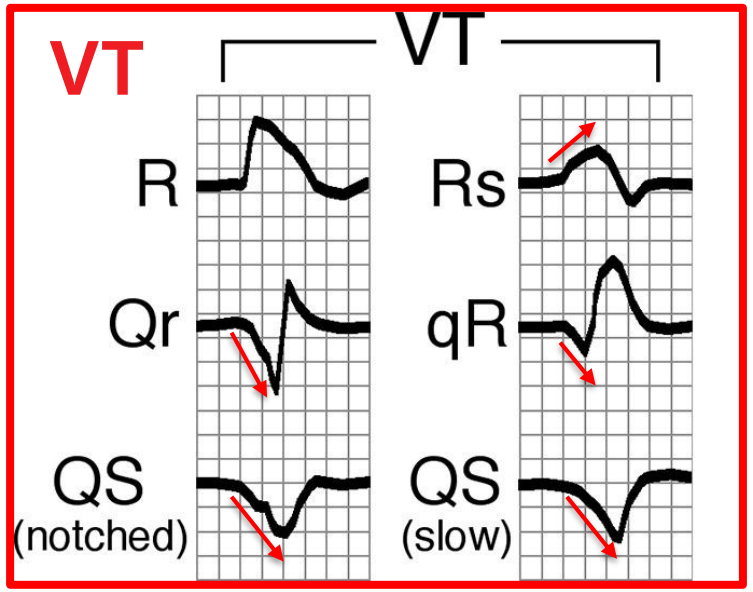
↓ No

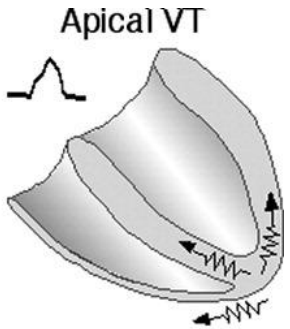


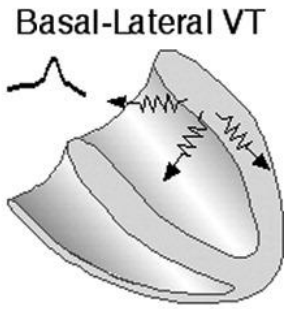


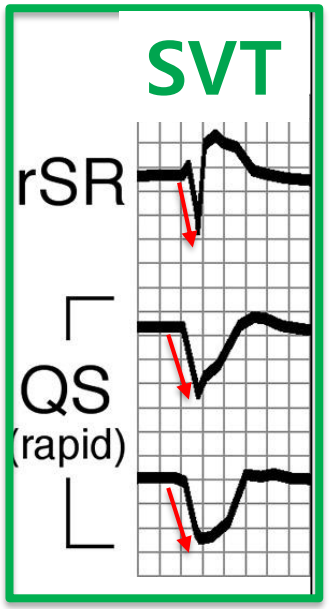
1. Brugada
2. **Vereckei**
3. Basel

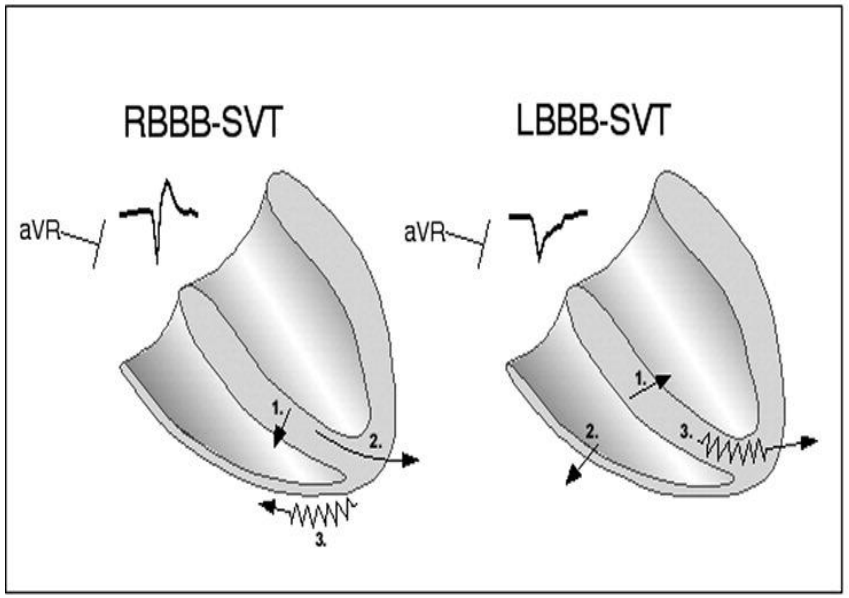
ECG patterns in lead aVR

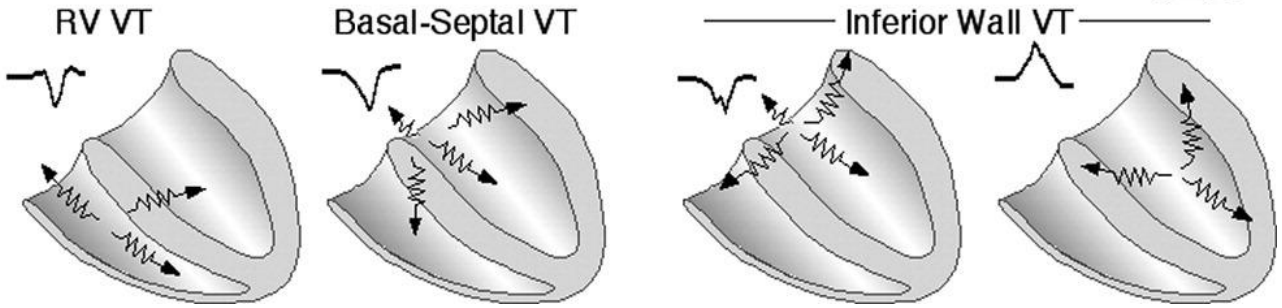


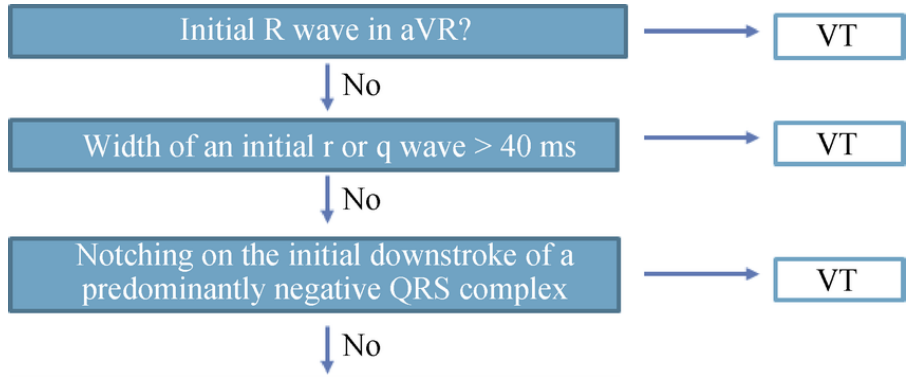






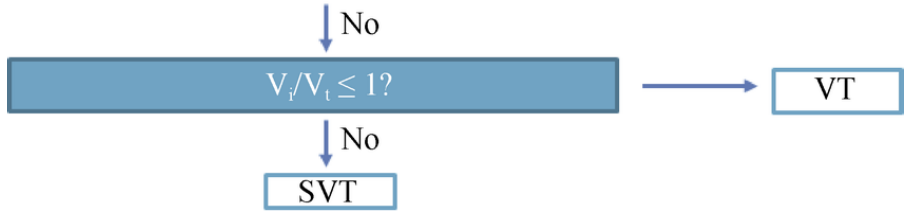


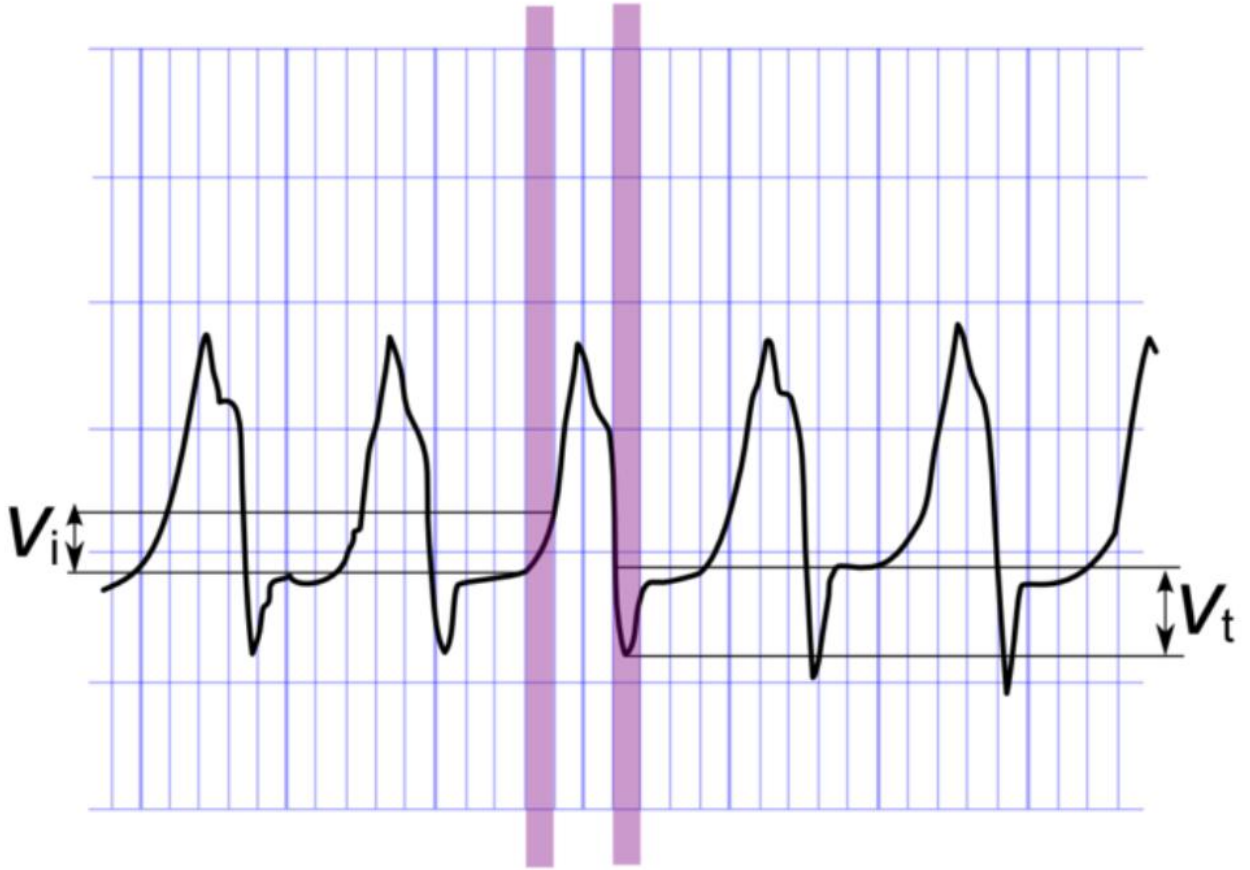




1. Brugada
2. **Vereckei**
3. Basel

Vi/Vt < 1





v_i=0.3

v_t=0.65

$v_i < v_t \rightarrow$ VT

Comparison of Brugada and Vereckei algorithm

Publication	Sensitivity (%)	Specificity (%)
Brugada, original publication	98.7	96.5
Jastrzebski M et al.	89	59.2
Isenhour JL et al.	79 – 91	43 – 70
Kaiser E et al.	90.1	35.7
Lau EW et al.	92	44

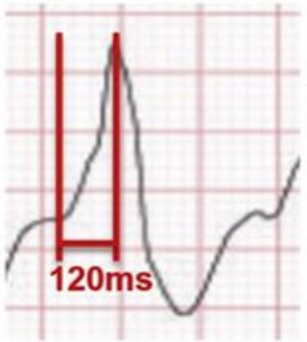
Publication	Sensitivity (%)	Specificity (%)
Vereckei, original publication	96.5	75
Jastrzebski M et al.	87.1	48
Baxi RP et al.	70.3 – 83.8	25.0 – 63.9
Szelényi Z et al.	92.4	64.7
Kaiser E et al.	89.2	28.6

1. Brugada
2. Vereckei
3. **Basel**

Basel Algorithm

Structural Heart Disease + **Lead-II** Time to First Peak > 40ms + **Lead-aVR** Time to First Peak > 40ms

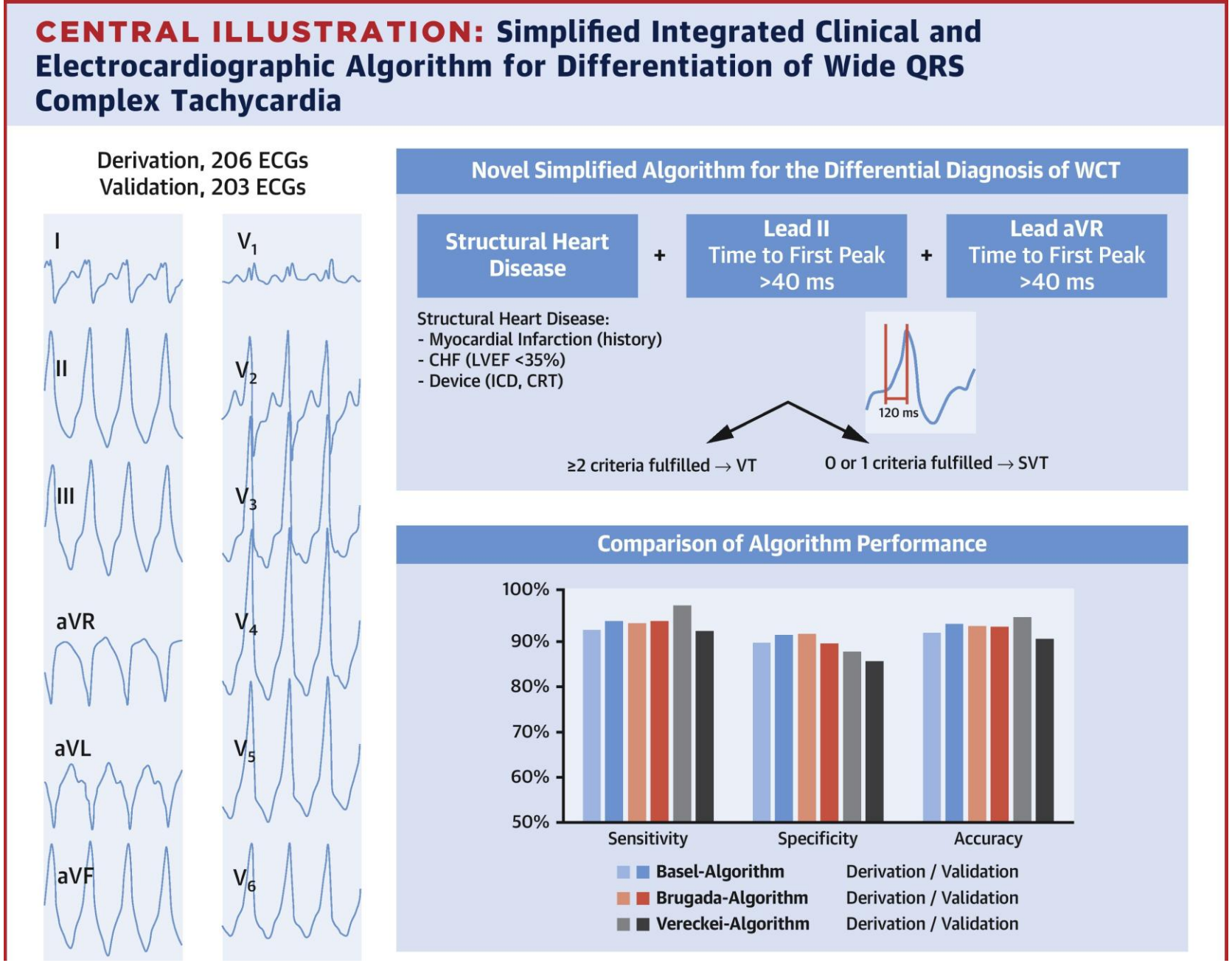
Structural Heart Disease:
- Myocardial Infarction (history)
- CHF (LVEF <35%)
- Device (ICD, CRT)



≥2 criteria fulfilled -> VT

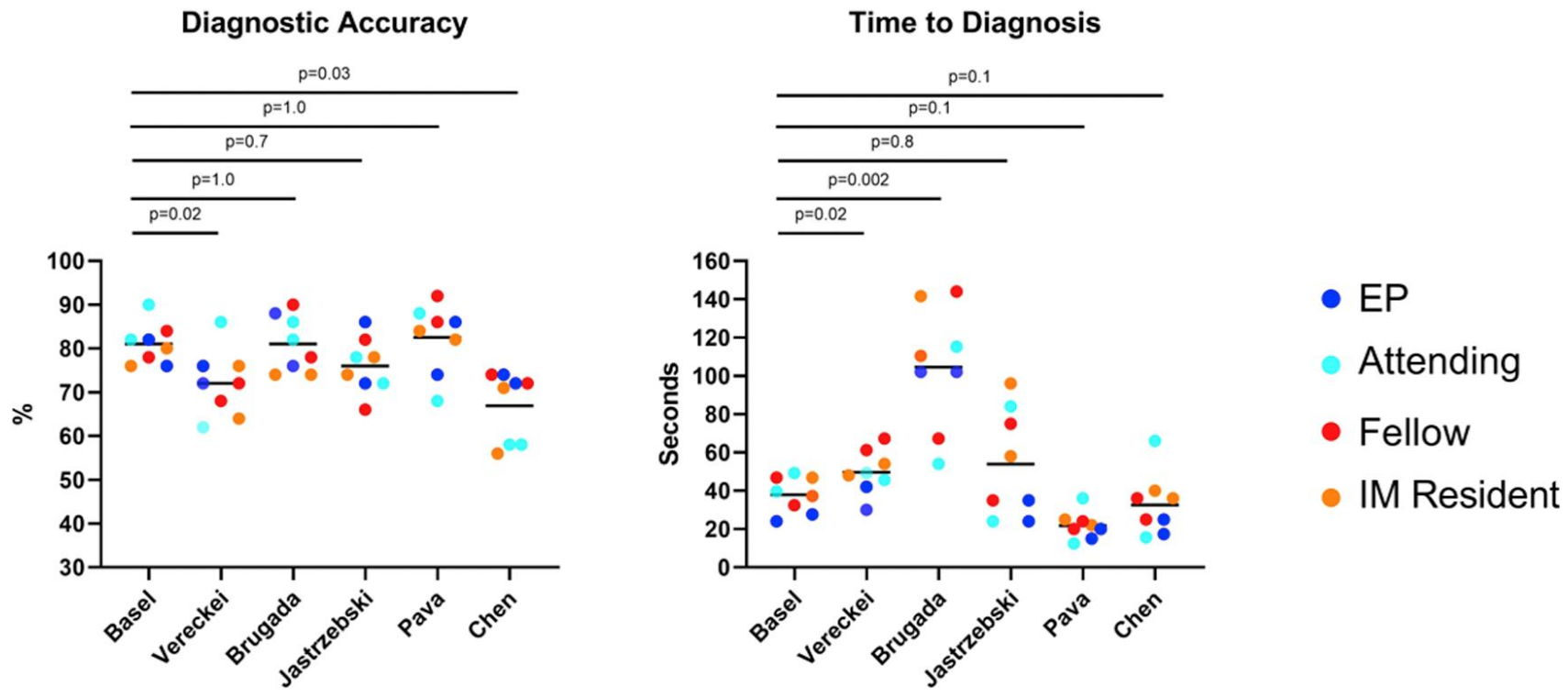
0 or 1 criteria fulfilled -> SVT

1. Brugada
2. Vereckei
3. **Basel**



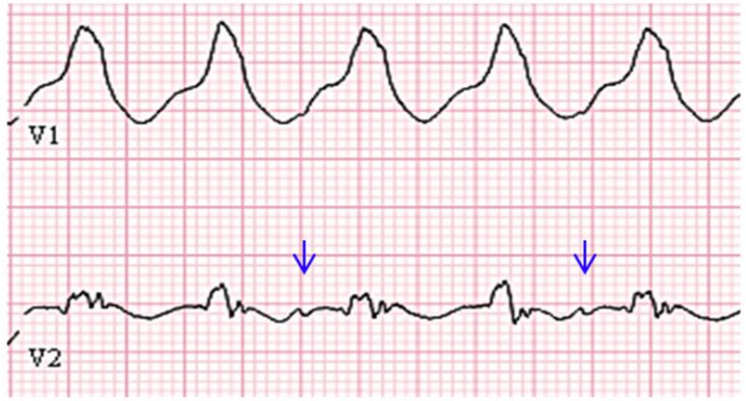
Moccetti, F, Yadava, M, Latifi, Y. et al. Simplified Integrated Clinical and Electrocardiographic Algorithm for Differentiation of Wide QRS Complex Tachycardia: The Basel Algorithm. *J Am Coll Cardiol EP. 2022*

Performances in special situations



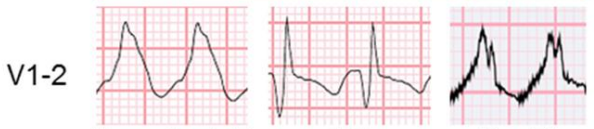
Arrhythmia	Correct Basel Algorithm	Correct Brugada Algorithm	Correct Vereckei Algorithm
Fascicular, n=3	0/3	0/3	1/3
Antidromic AVRT, n=1	0/1	1/1	0/1
Mahaim, n=2	0/2	0/2	0/2

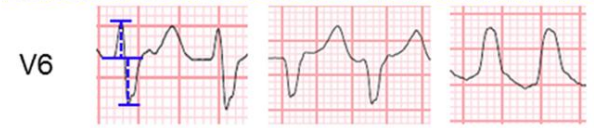
AV Dissociation



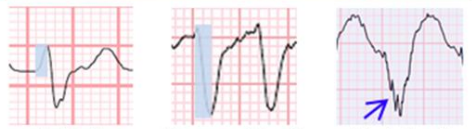
Morphological Criteria

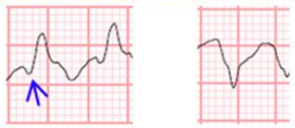
RBBB Morphology



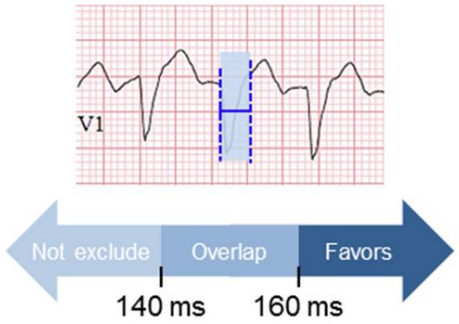


LBBB Morphology



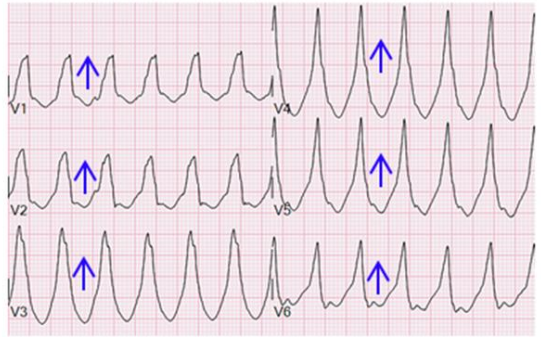


QRS Duration

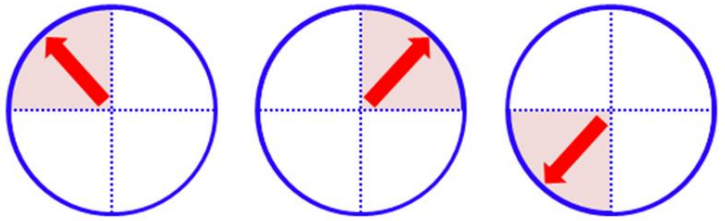


Chest Lead Concordance

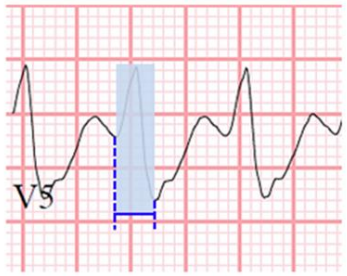
V1-6: positive or negative concordance



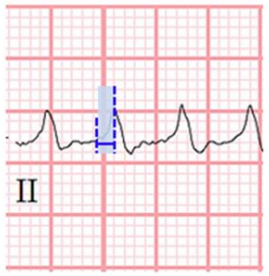
QRS Axis



Ventricular Activation Velocity



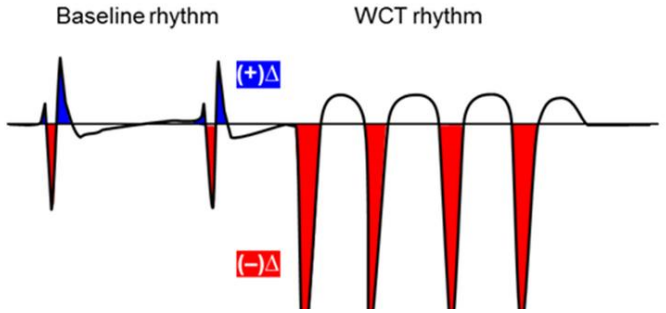
RS interval ≥ 100 ms



RWPT ≥ 50 ms

$V_i \leq V_t$

Baseline ECG Comparison



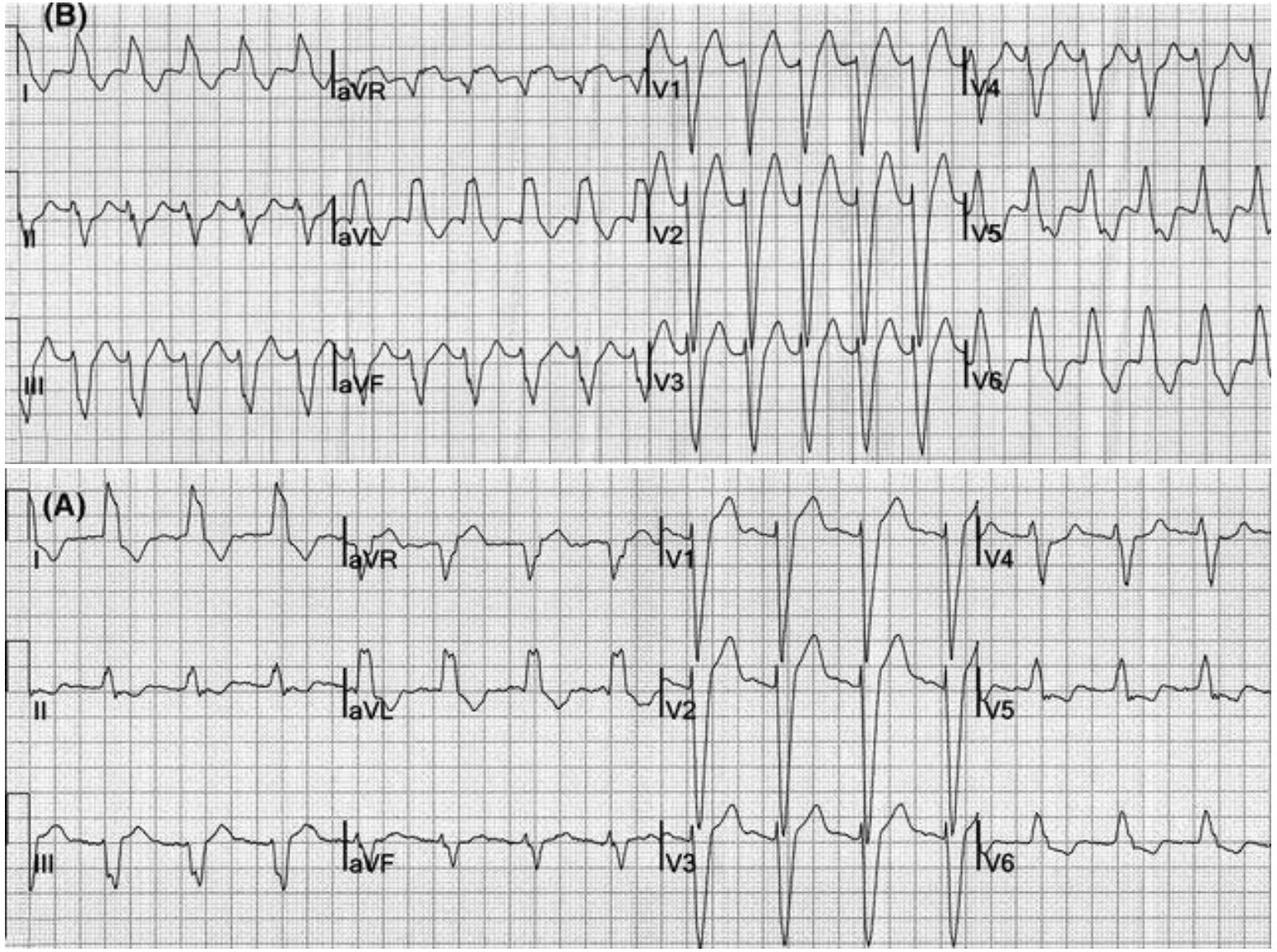
Kashou AH, Noseworthy PA, DeSimone CV, et al. *J Am Heart Assoc 2020*

Ventricular Tachycardia

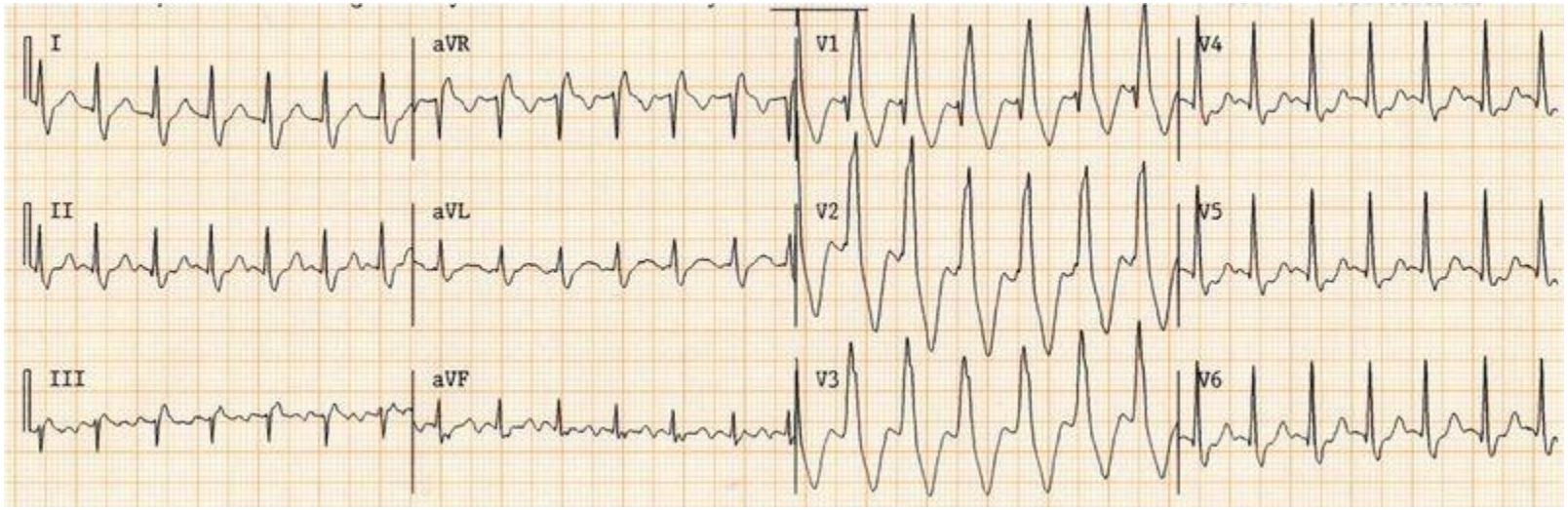
SVT Aberrancy

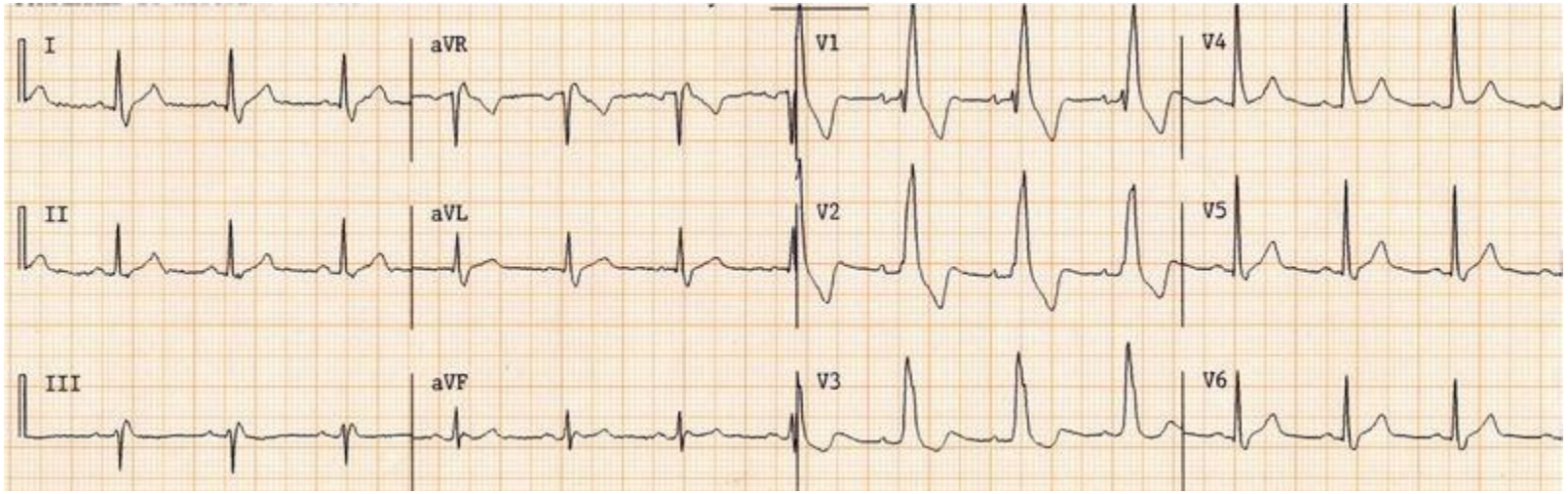
Antidromic AVRT

SVT aberrancy (fixed LBBB)

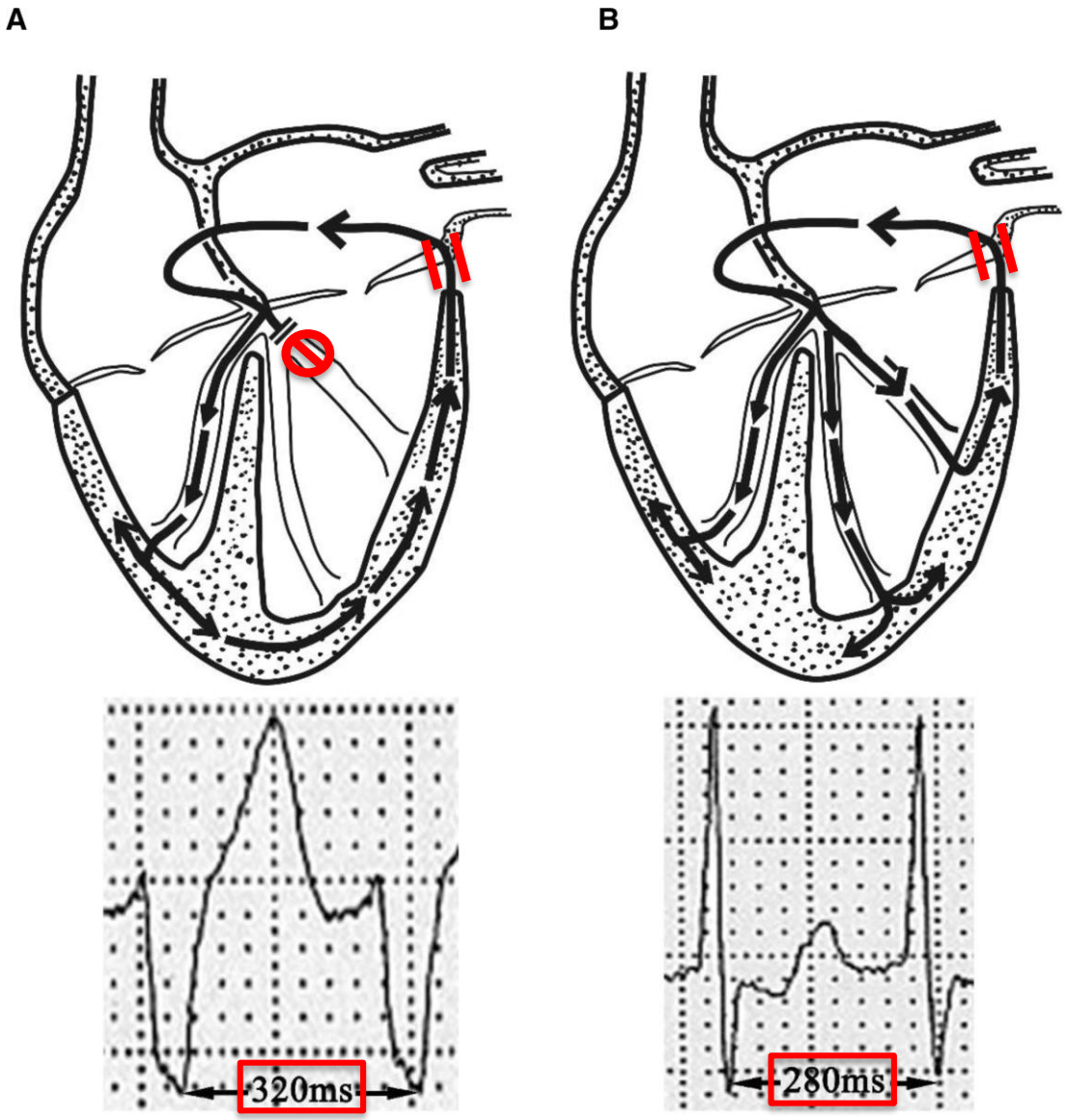


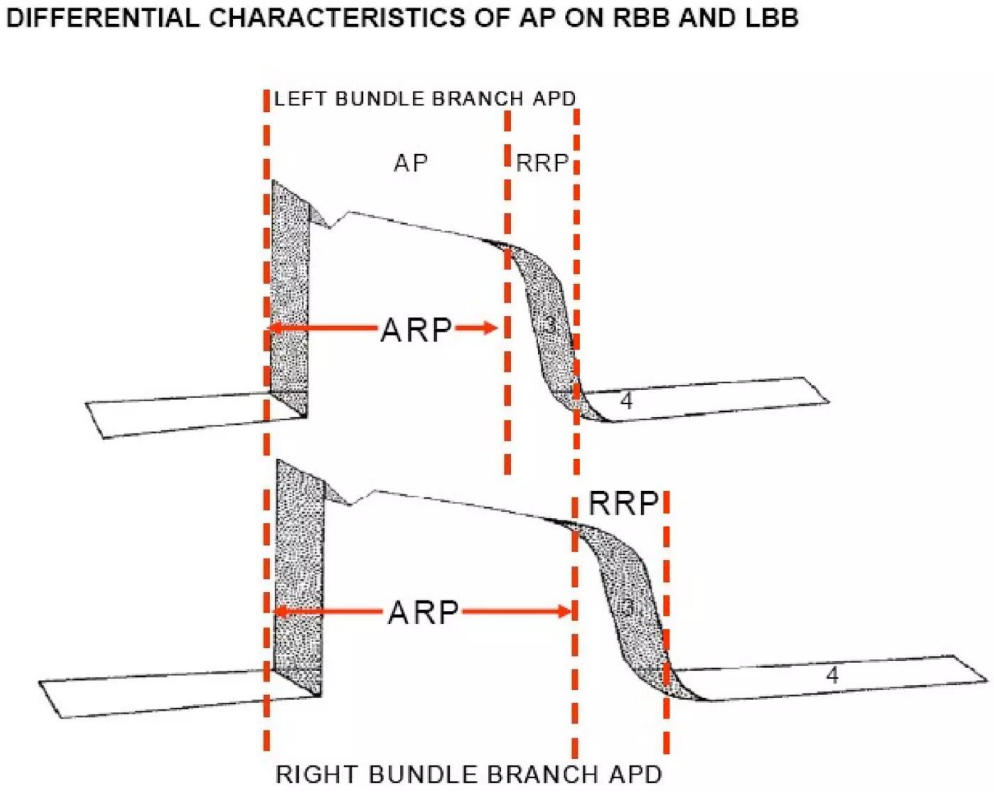
SVT aberrancy (fixed RBBB)





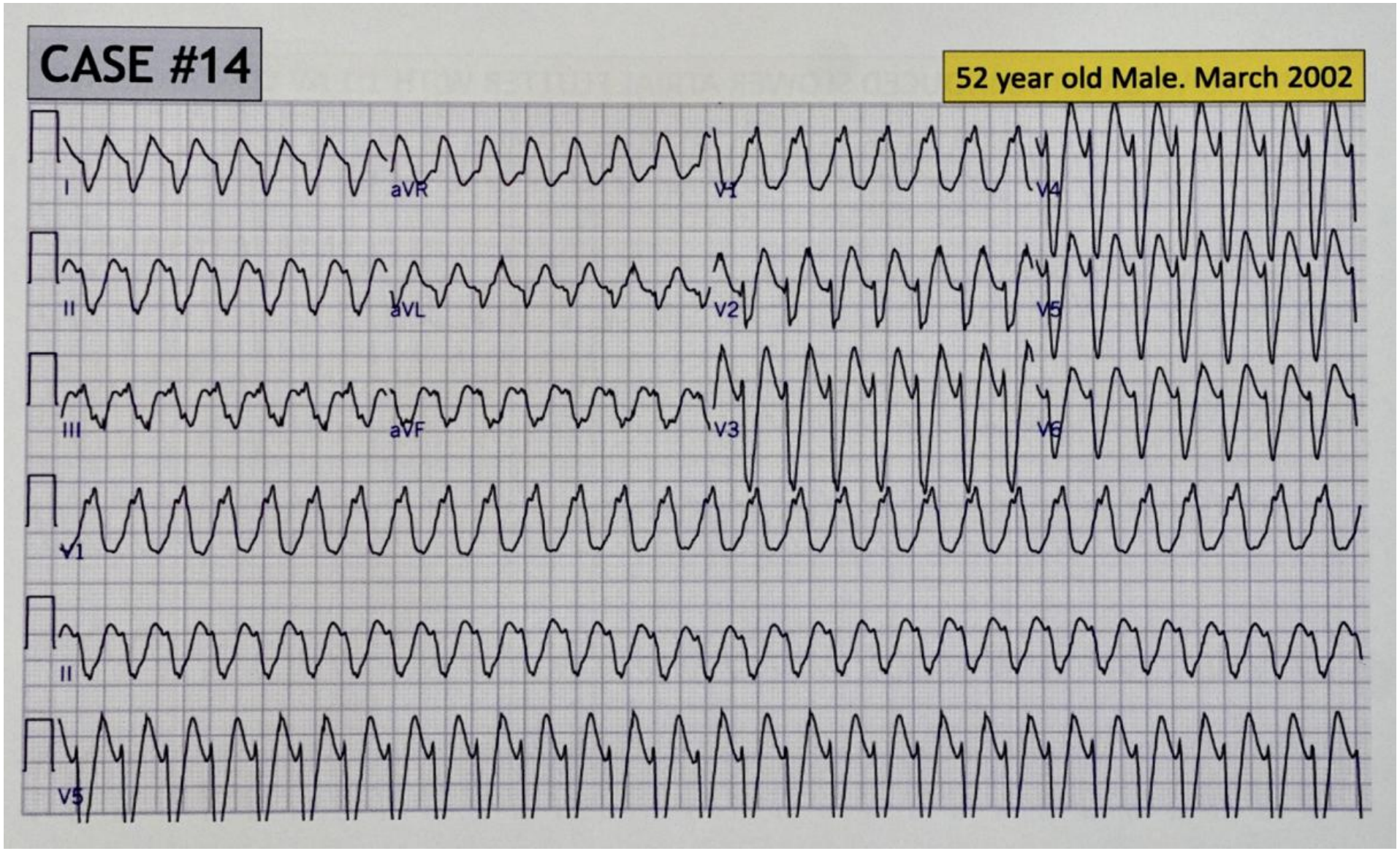
SVT aberrancy (functional block)



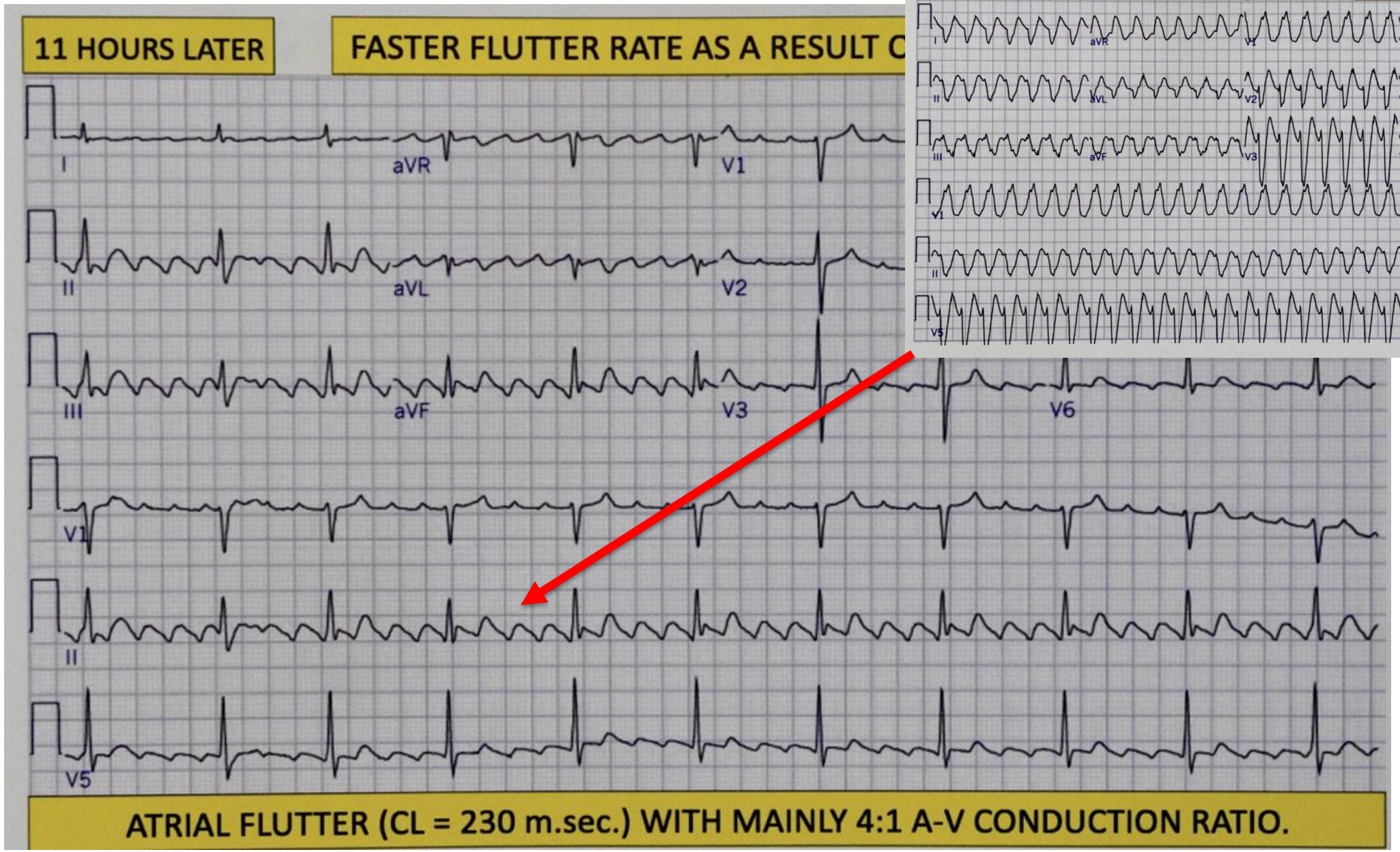


coumel's law

Case

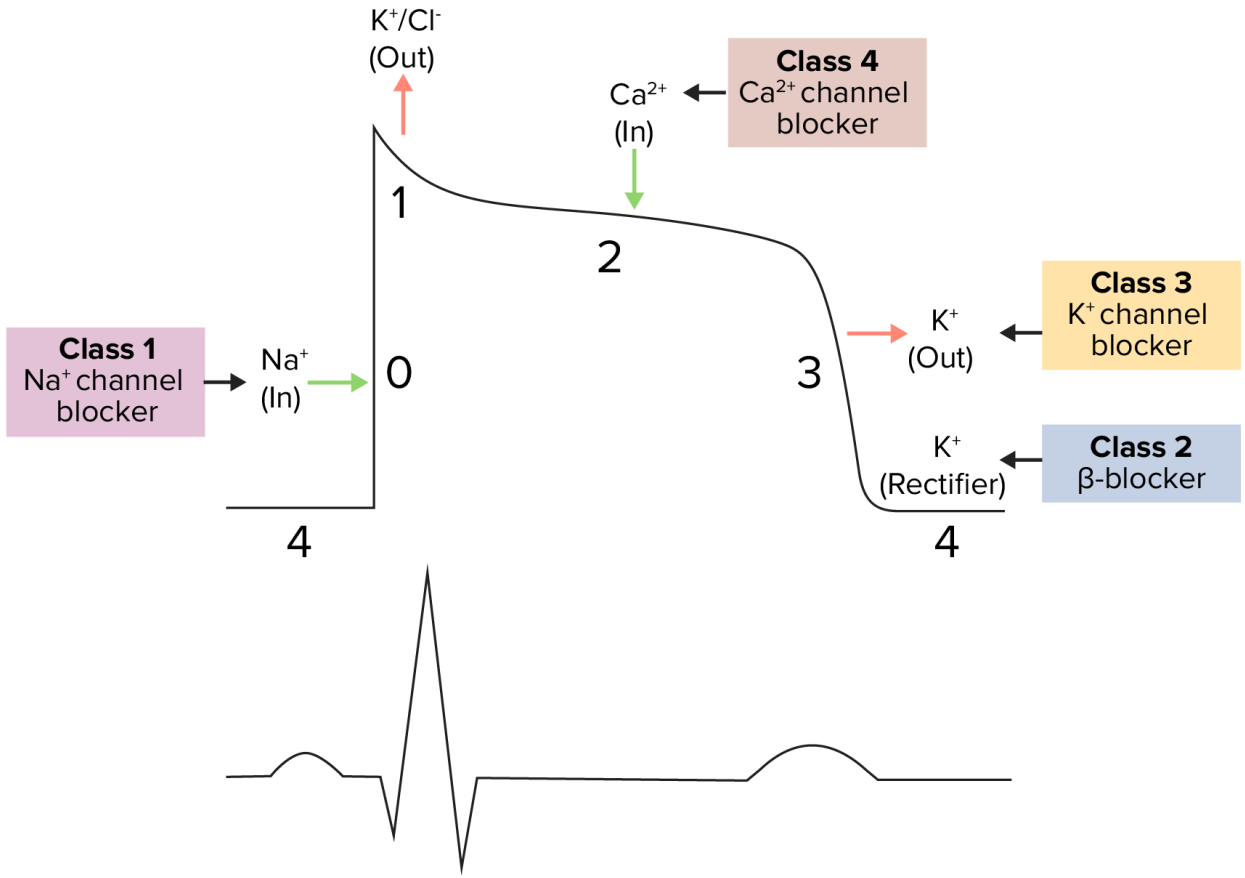


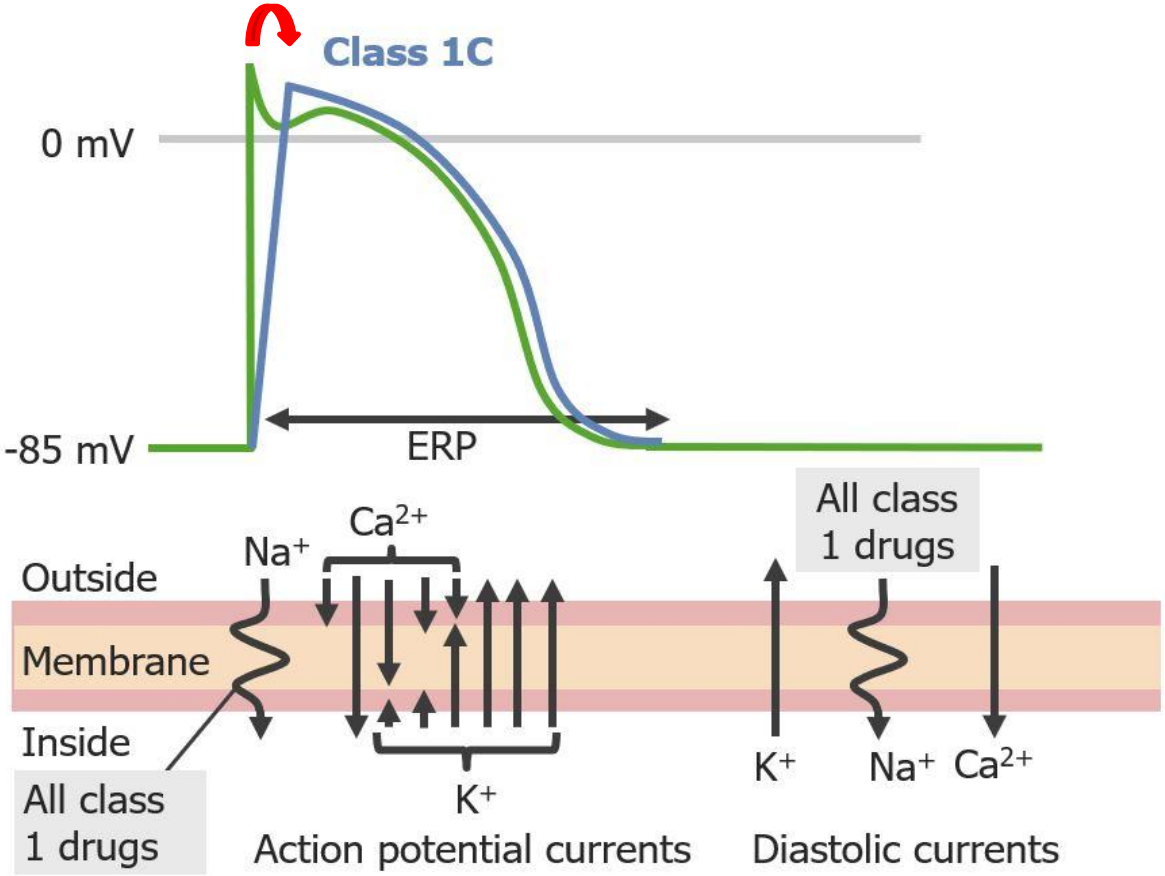
Peter CT. *Hearts Behaving Badly: A Collection of Uncommon Cardiac Arrhythmias*



Peter CT. *Hearts Behaving Badly: A Collection of Uncommon Cardiac Arrhythmias*

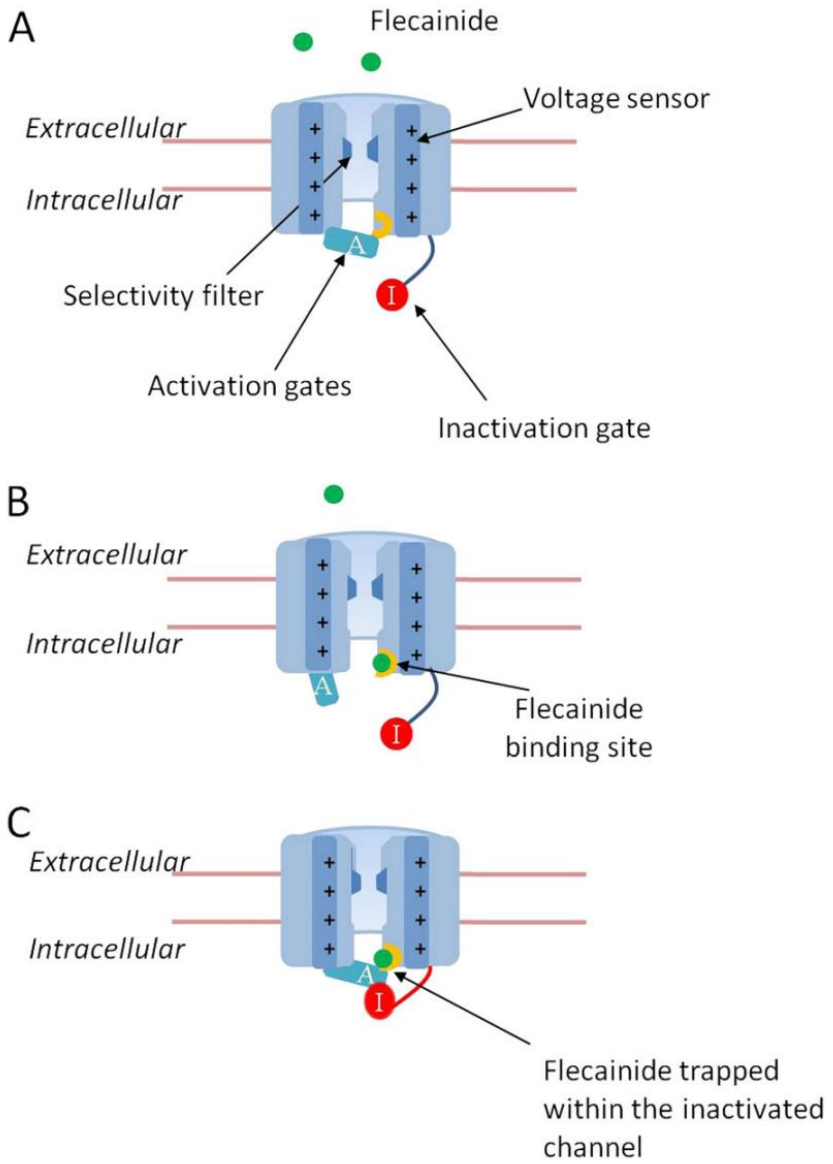
Class 1c drug

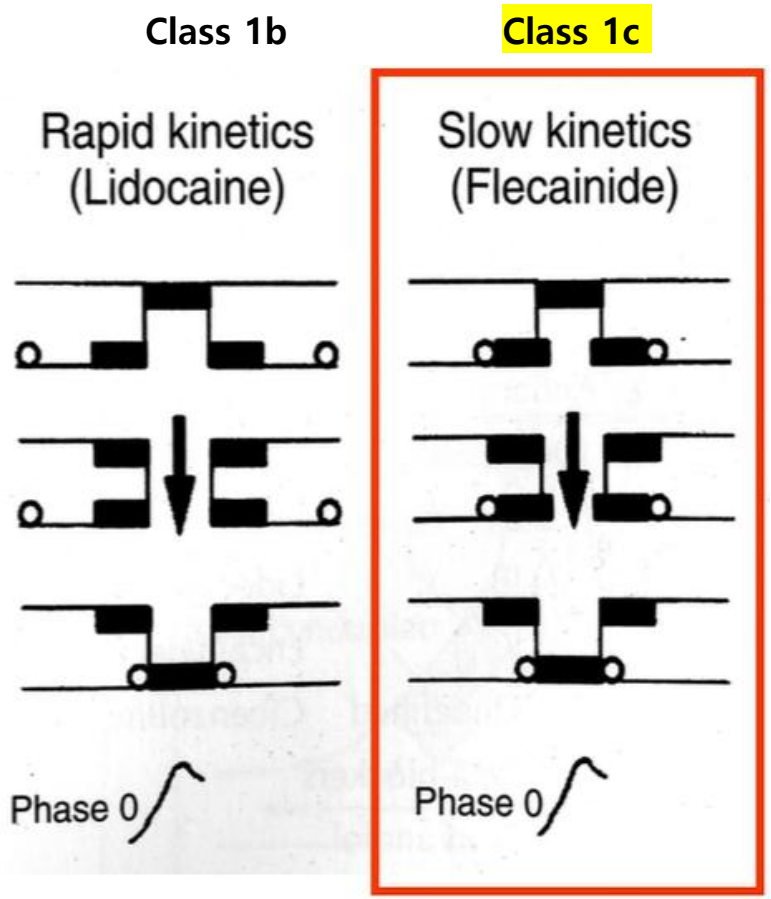




https://www.lecturio.com/concepts/class-1-antiarrhythmic-drugs/

Use dependency

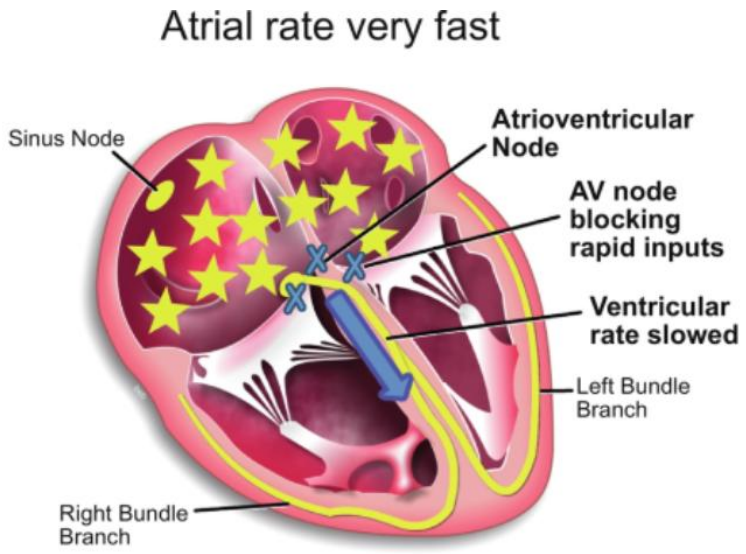


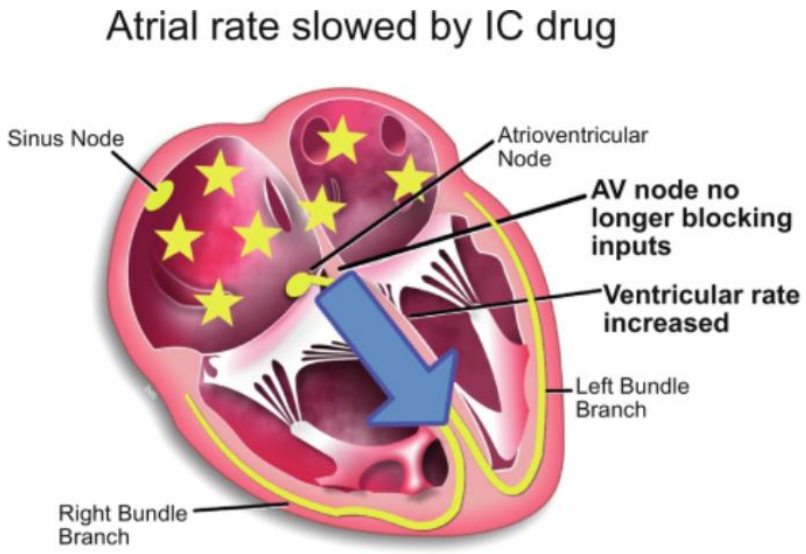


단위시간당 myocardium 이 자극되는 빈도가 높아지는 Tachy 때 => Na+ channel 에 붙어있는 Flecainide 가 많아 짐에 따라 효과가 증대되어 WQCT 가 발생함.

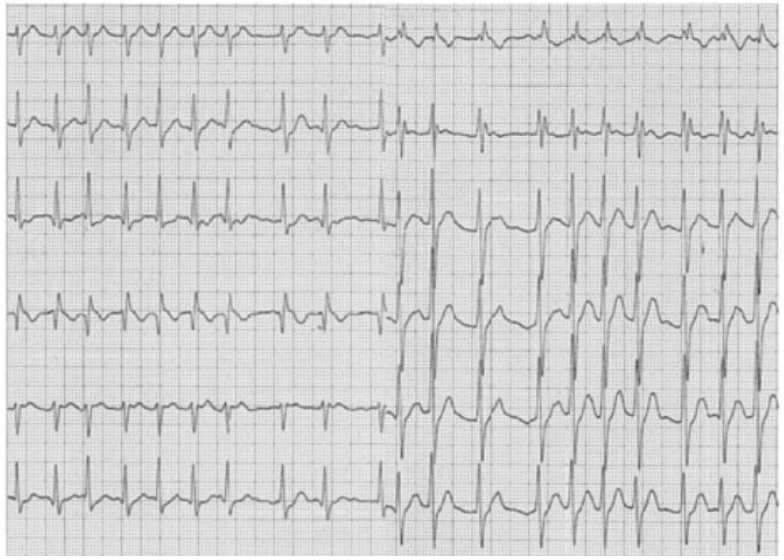
British Journal of Pharmacology (2018) 175 1260–1278

1c Flutter

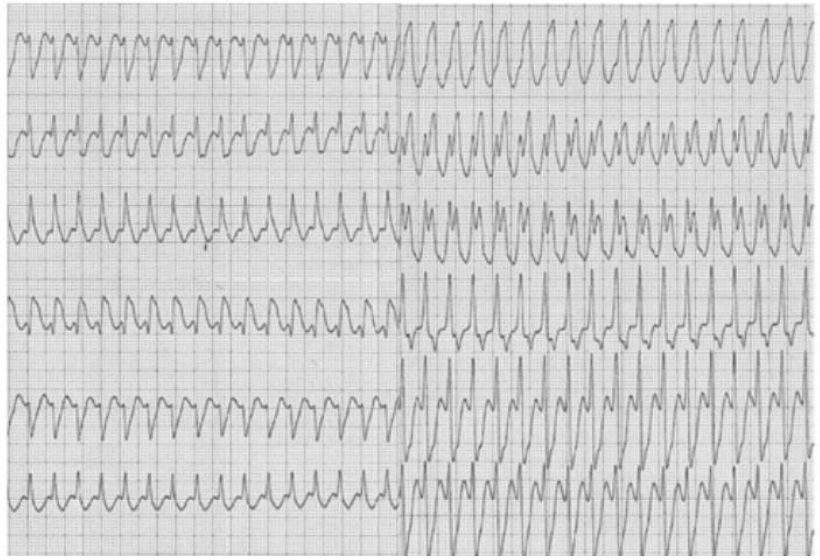




AV node has decremental properties that allow it to block conduction to ventricle (2:1. 3:1) when atrial rates are very high



Atrial rate slows, which now permits AV node to conduct 1:1 to the ventricle with increase in ventricular rate



AF환자, 1c drug 단독 투여

➔ Atrial slowing effect 로 Organized AFL 발생

➔ AV node 가 slow flutter 는 1:1 conduction

➔ Use dependency에 의해 flecainide 효과 증강, WQCT 발생

➔ AV node healthy 한 AF 환자는 반드시 BB/CCB 함께 사용!

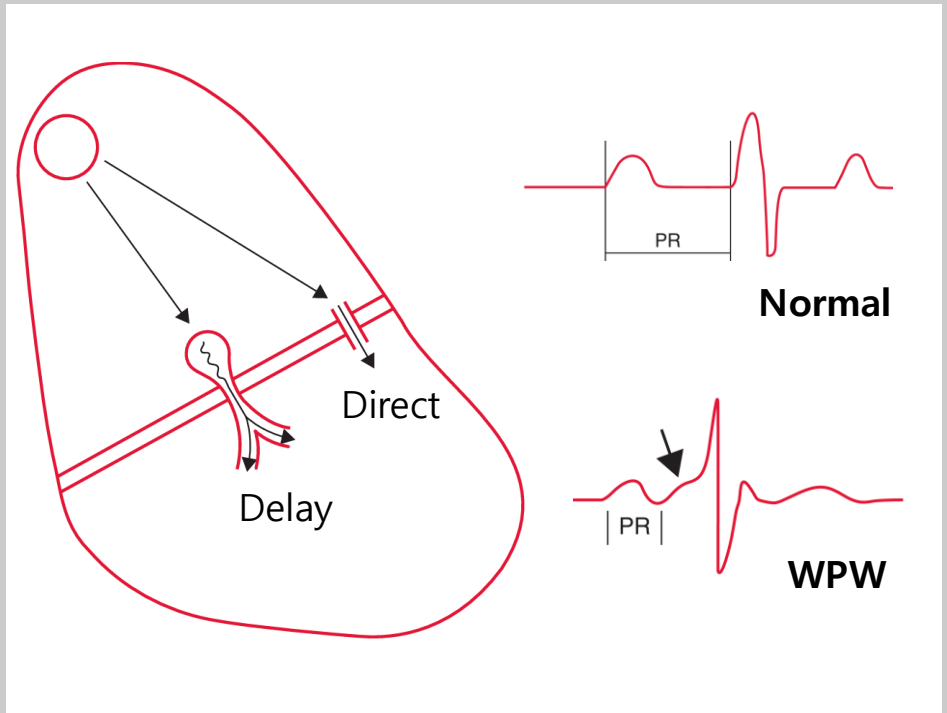
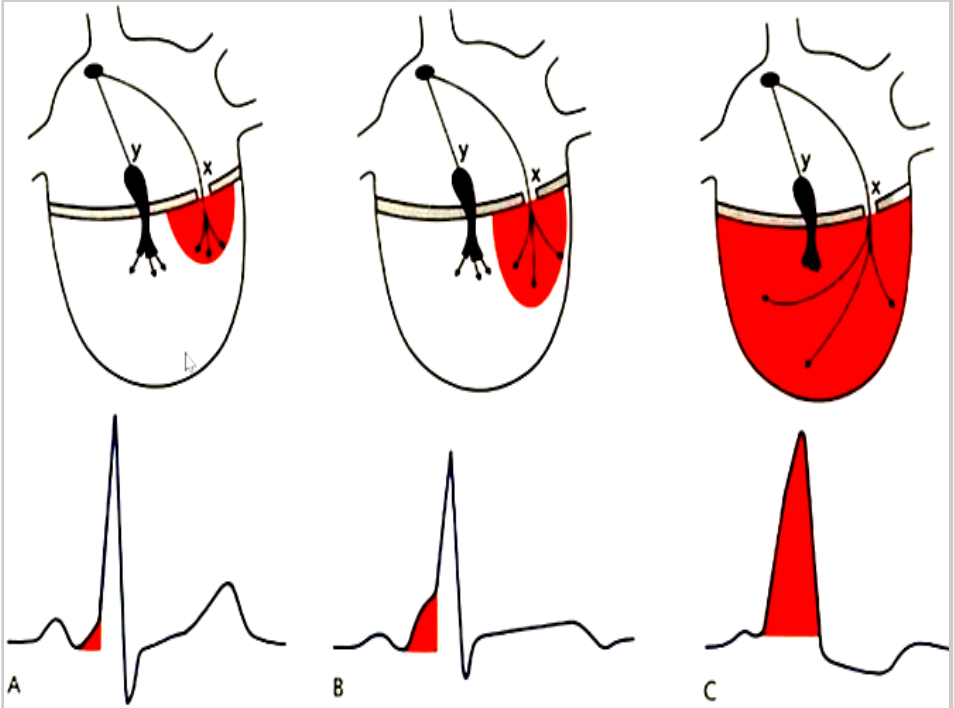
https://thoracickey.com/antiarrhythmic-drugs-6/

Ventricular Tachycardia

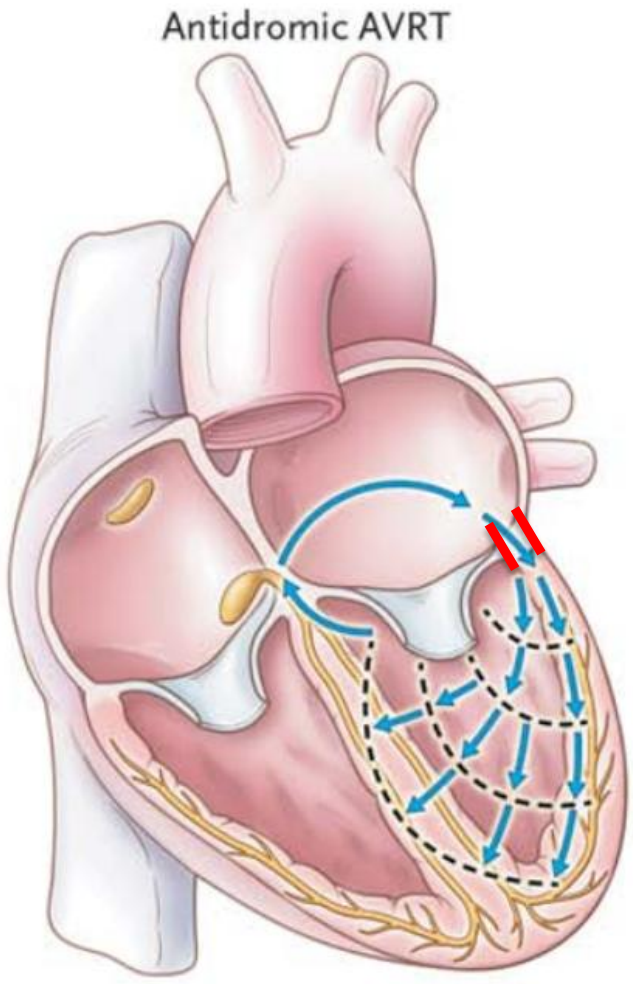
SVT Aberrancy

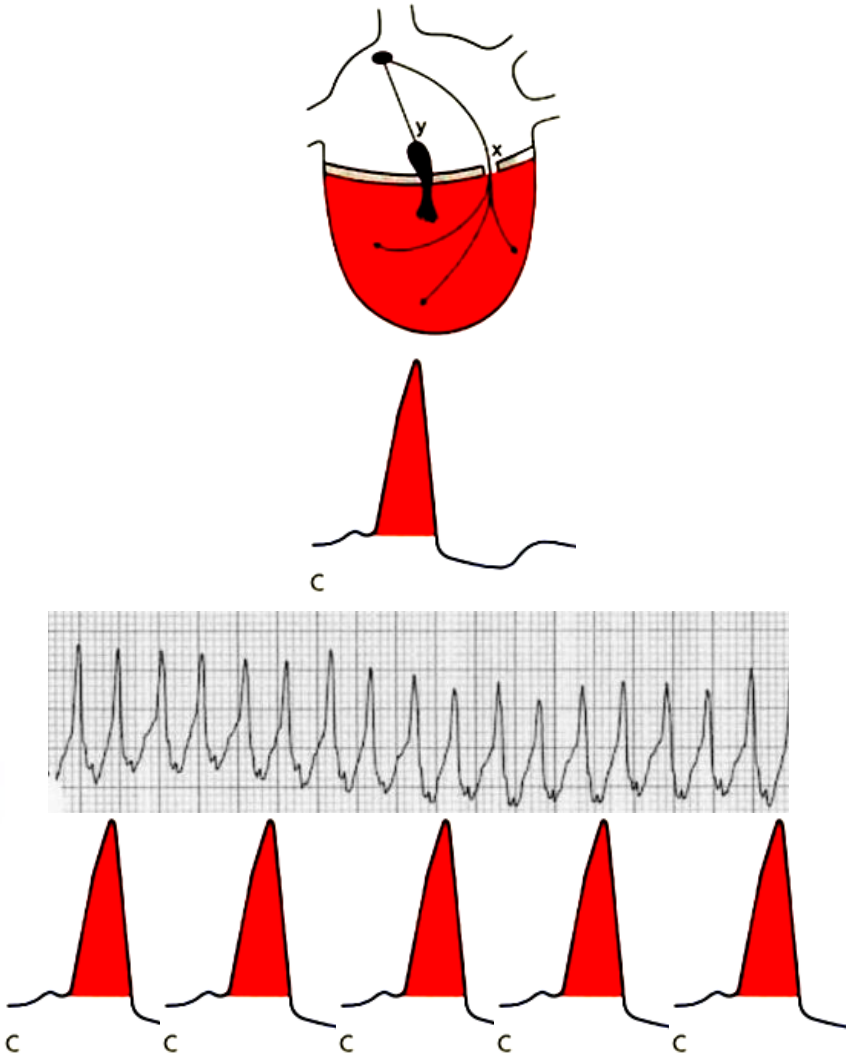
Antidromic AVRT

Pre-excitation (WPW)

AV Node와 AP의 전도특성 차이	심방 기원의 전도 경로와 특징
	

Antidromic AVRT





VT vs SVT aberrancy

- SVT with Aberrancy의 원인

1) Pre-existing BBB

Sinus 때 우각차단(RBBB) 또는 좌각차단(LBBB)

2) Rate-dependent (=Functional) BBB

빠른 심박수에서 특정 분지 ERP 로 인한 차단

3) Accessory pathway conduction

Antidromic AVRT

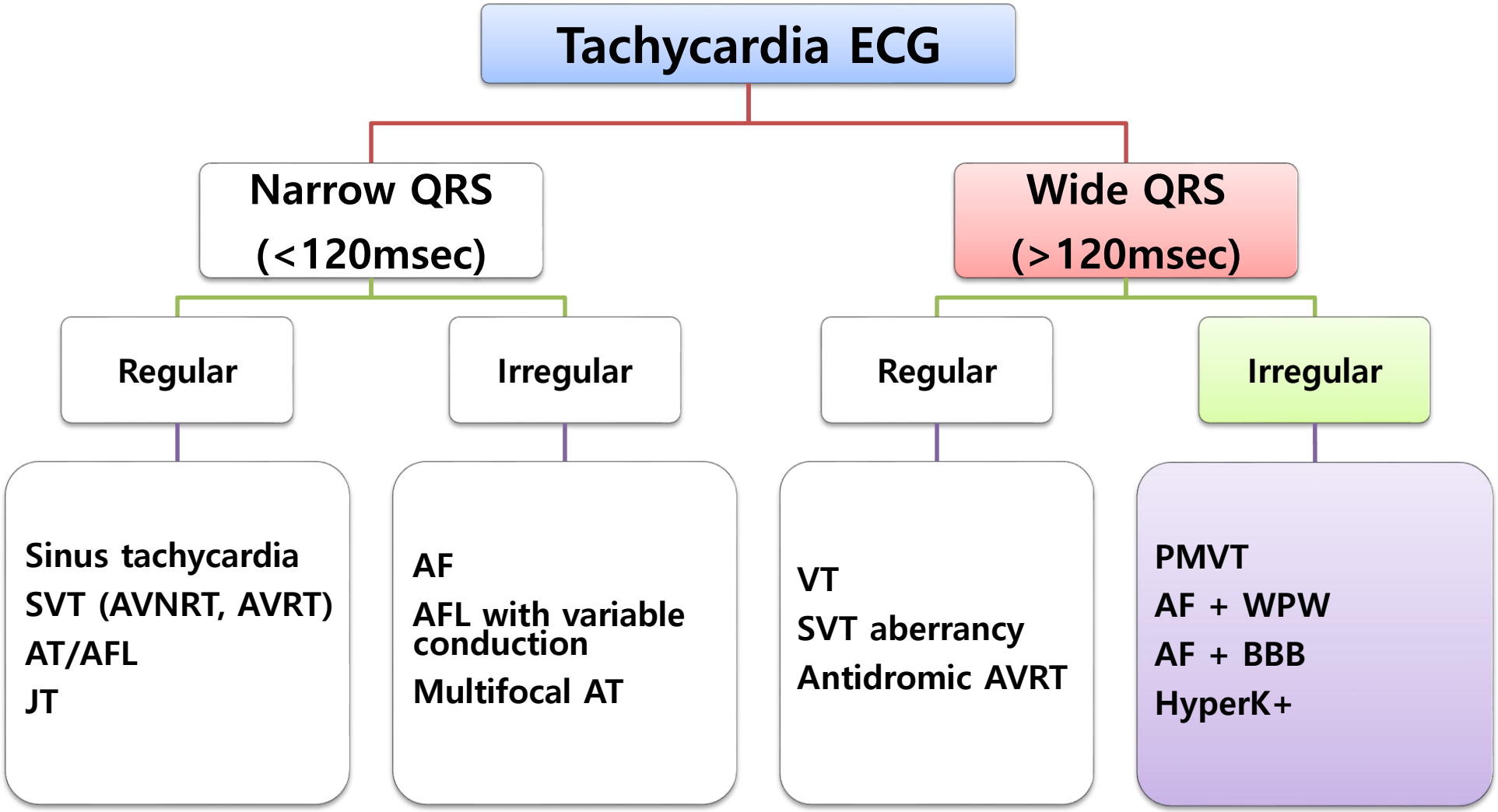
4)약물/전해질 이상

Class IC, III 항부정맥제, Hyperkalemia

	SVT with Aberrancy	VT
QRS 폭	120-160ms	>160ms
QRS 모양	기저 BBB와 일치	불일치 (BBB 패턴과 다름)
QRS axis	정상축	NW axis 가능
AV dissociation	거의 없음	흔함
Fusion/Capture	없음	흔함
RS Interval	<100ms	≥100ms
Concordance	거의 없음	가능
aVR에서 Initial R	없음	있으면 VT 가능성 증가

애매하면 VT 에 준해서 처치하자

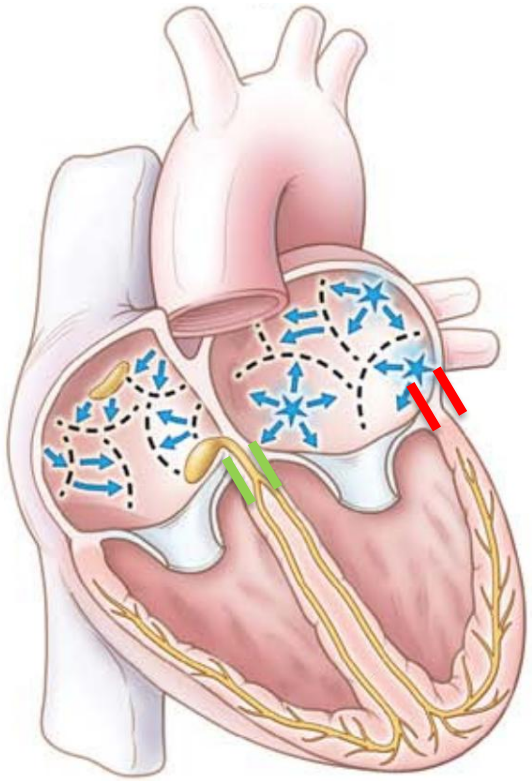
Differential diagnosis



AF WPW

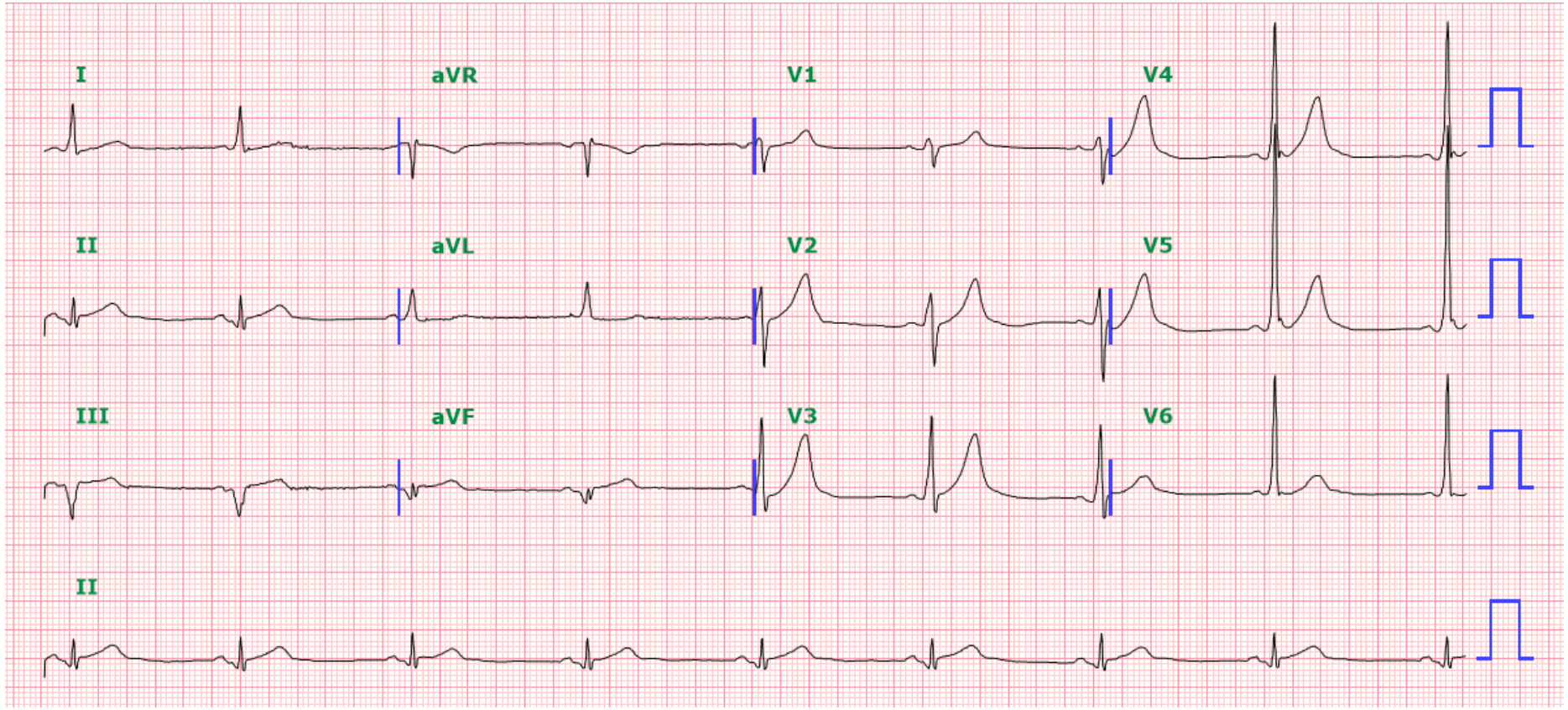
AF WPW 치료

- AV nodal blocking agent 는 금기
  - Adenosine, CCB, BB, Digoxin, Amiodarone
- **Procainamide**
  - Class Ia AAD, targets the accessory pathway
  - No AV nodal blocking effect
- Immediate DCCV

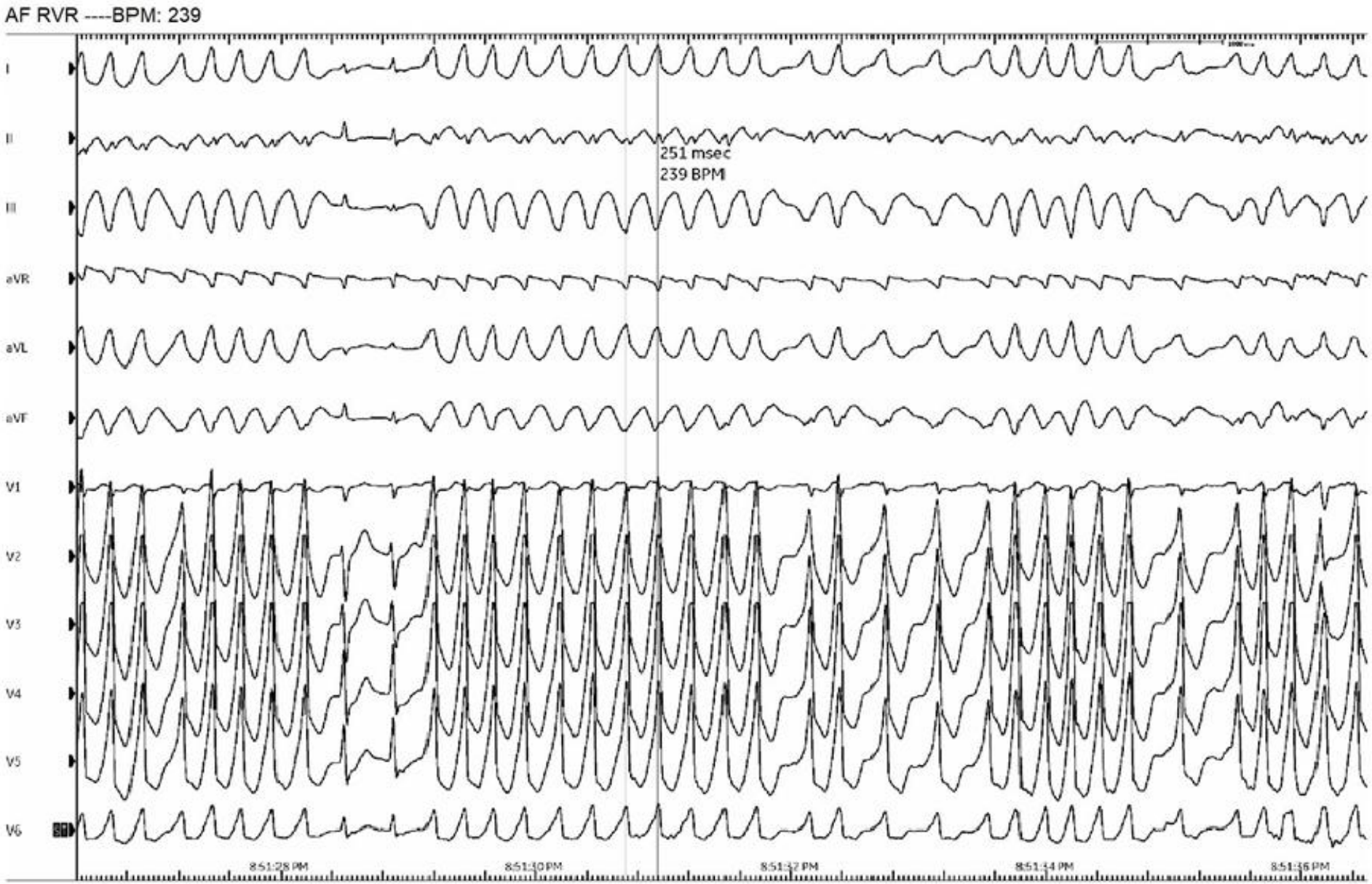


Case

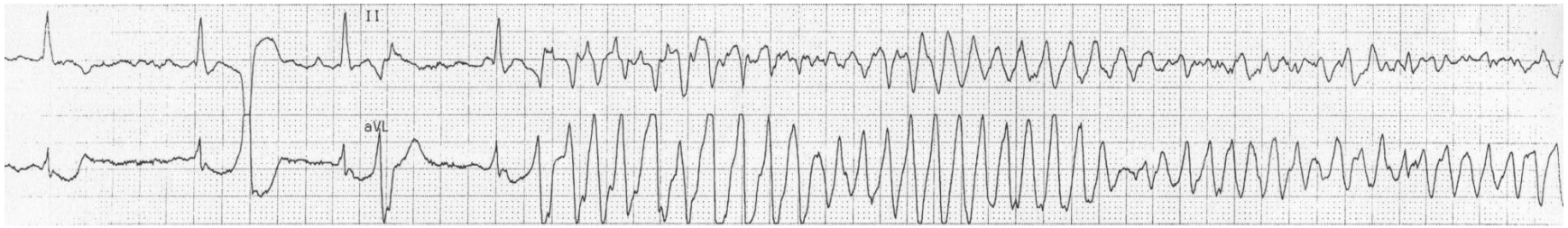
- 54/M
- VF arrest 로 타원 응급실 내원, ROSC 후 신경학적 후유증 없음
- EPS [prn] ICD 위해 전원



EPS


AF RVR ----BPM: 239
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
251 msec
239 BPM
8:51:28 PM
8:51:30 PM
8:51:32 PM
8:51:34 PM
8:51:36 PM

Torsade de pointes (TdP)



1) 전해질 보충

- K+ 목표: 4.5~5.0 mmol/L 유지
- $MgSO_4$ 2g IV 투여 (정상 수치여도 권장)

2) 서맥 교정 (QT 단축 유도)

- 임시박동기 (HR 90~100 bpm 유지)
- Isoproterenol IV 고려 (임시박동기 어려운 경우)

3) 약제 점검

- 정신과약 (Quetiapine, Haloperidol, Fluoxetine)
- 항생제 (Azithromycin, Cipro/Levofloxacin, Azole 계열)

4) 항부정맥제 사용 금지

- **아미오다론 금지**

경청해 주셔서 감사합니다.

References

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- https://www.ecgbook.com/
- Peter CT. *Hearts Behaving Badly: A Collection of Uncommon Cardiac Arrhythmias*