KHRS 2021 The 13th Annual Scientific Session of the Korean Heart Rhythm Society

# Understanding of Pacemaker Timing Cycles

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**Asan Medical Center, RN, CCDS, CEPS**

# Korean Heart Rhythm Society
## COI Disclosure

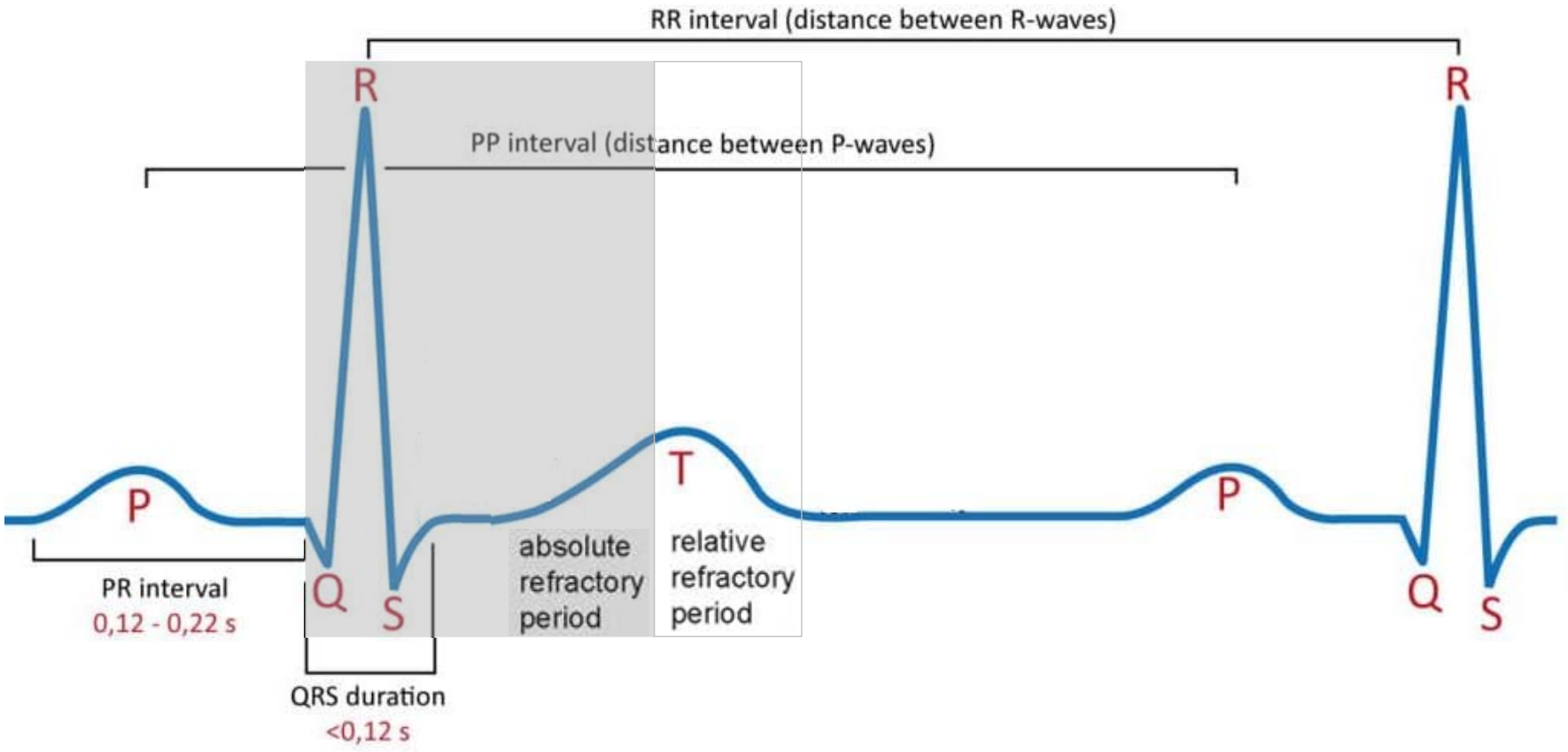
:

None

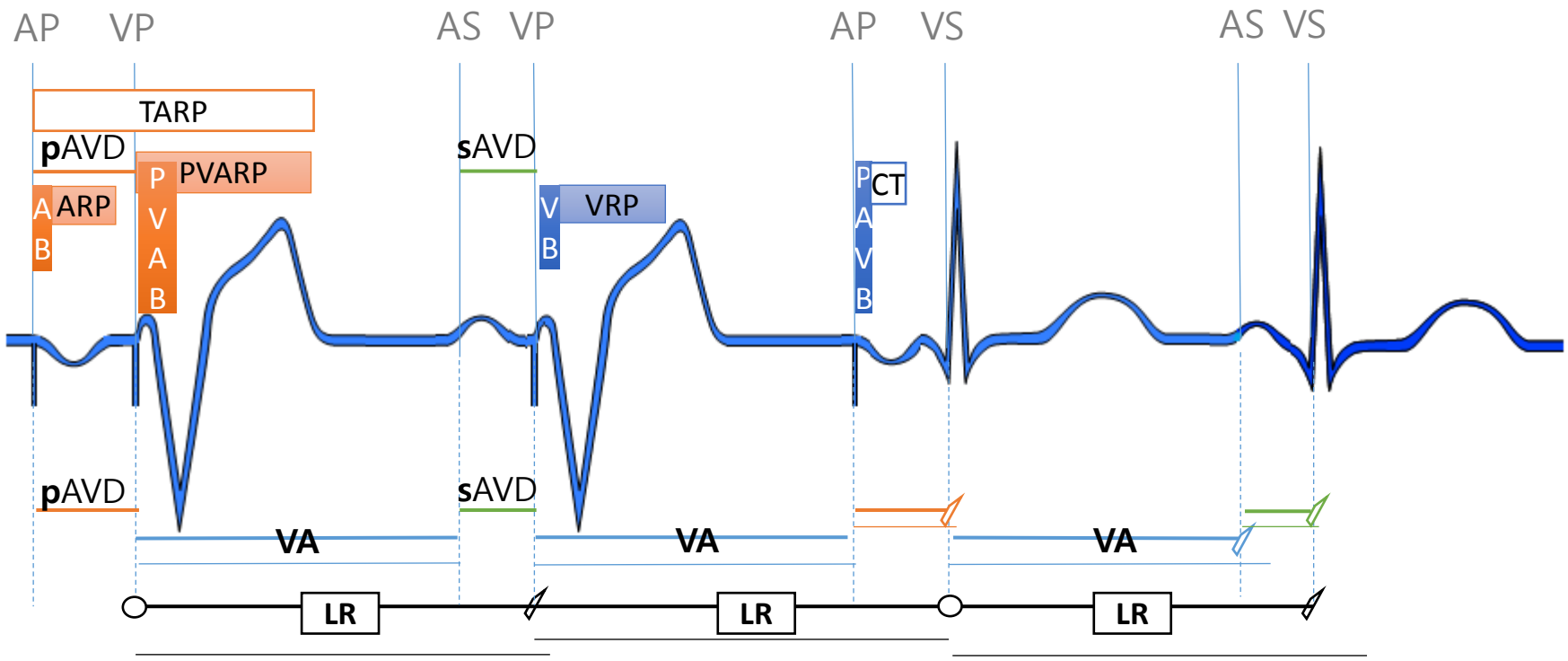
# Contents

- Rate
- Atral Timing Cycles
- Ventricle Timing Cycles

# Normal conduction system



# Pacemaker Timing cycles




AP=atrial pacing ; VP=ventricular pacing ; AS=atrial sensing ; VS=ventricular sensing ; pAVD=paced atrioventricular delay ; sAVD=sensed atrioventricular delay ; AB=atrial blanking ; ARP=atrial refractory period ; PVAB=post ventricular atrial blanking ; PVARP=post ventricular atrial refractory period ; TARP=total atrial refractory period ; VB=ventricular blanking ; VRP=ventricular refractory period ; CT=cross talk window(safety window) ; VA=ventricular atrial interval ; LR=low rate(low rate limit, base rate)

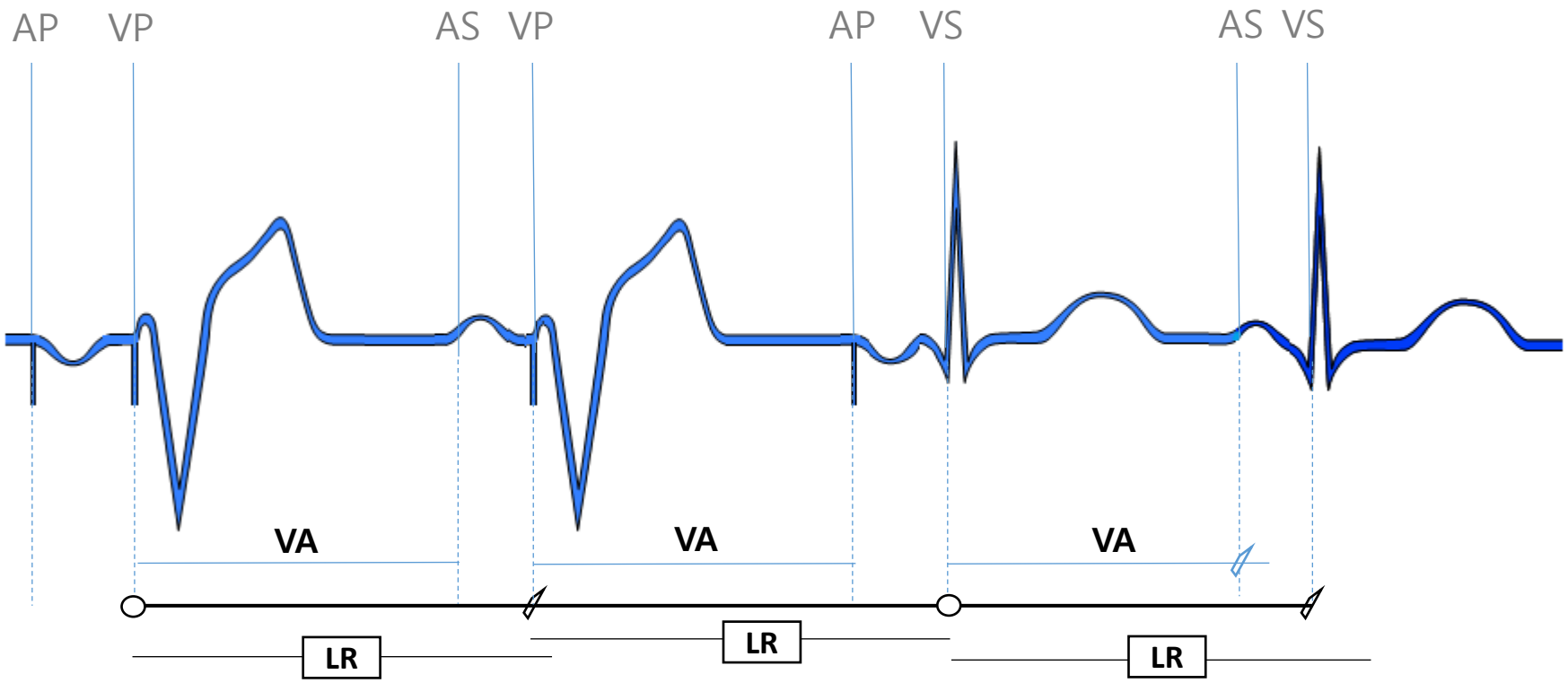
# Rate

- Lower rate
- Upper rate

# Lower rate

= Low rate limit , Base rate

설정 된 **최저 박동수** (bpm)




☞ **보통 60 bpm 전.후로 설정하나 상황에 따라 변경 가능함.**

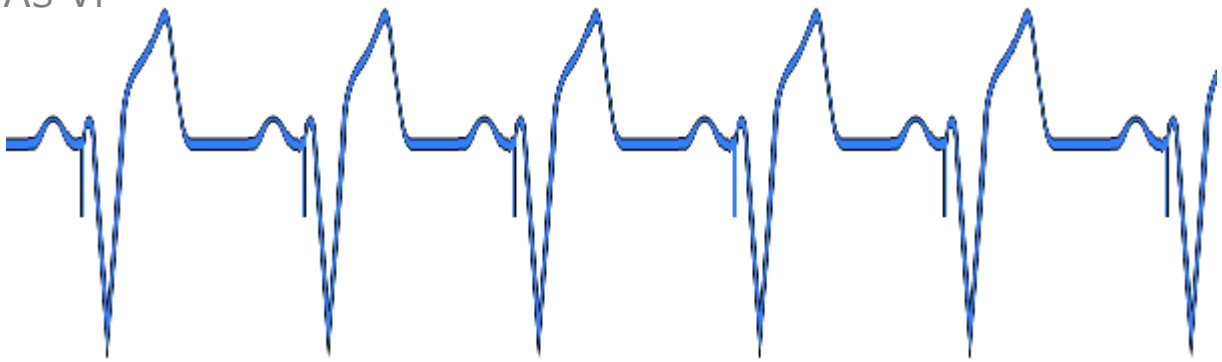
# Upper rate

AS(Atrial signal을 sensing) tracking 하여 V.pacing 되거나,
R-mode(Sensor)로 감지된 움직임에 반응할 수 있는 **최고 박동수**

## Upper Track

= Max tracking rate(MTR)

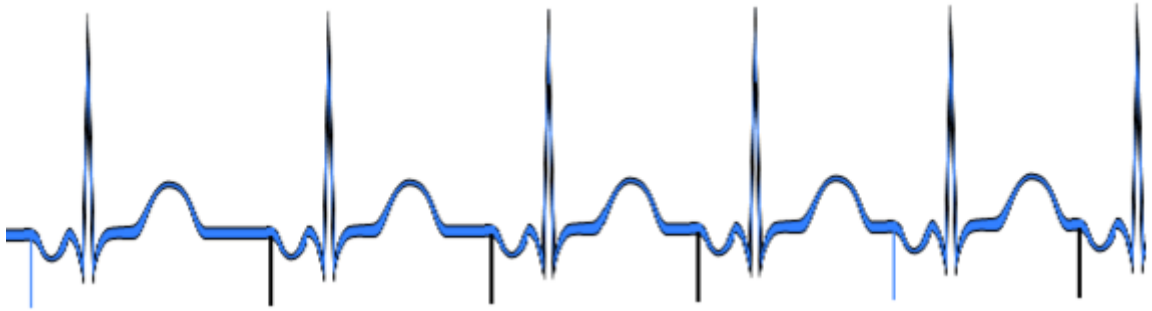
AS VP



## Upper Sensor

= Max sensor rate(MSR)

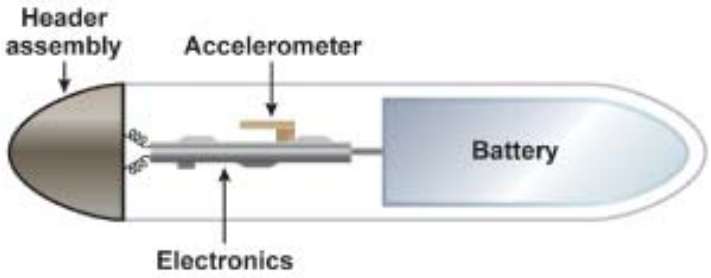
AP VS



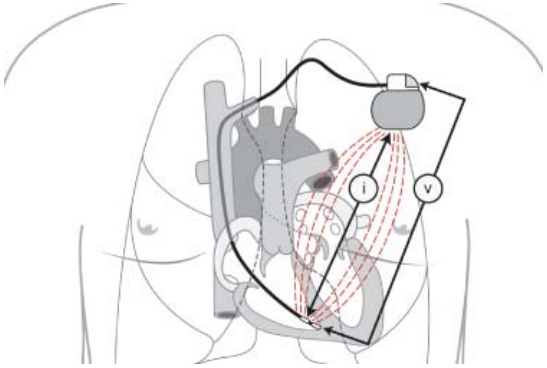
☞ **보통 130 bpm 전.후로 설정하나 상황에 따라 변경 가능함.**

# Sensor

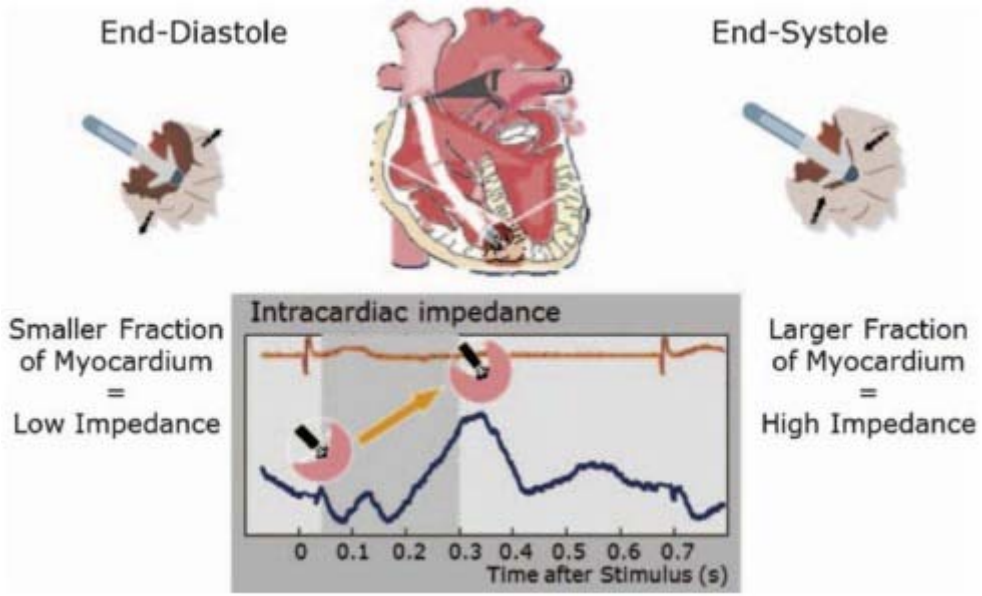
## Accelerometer




## Minute ventilation



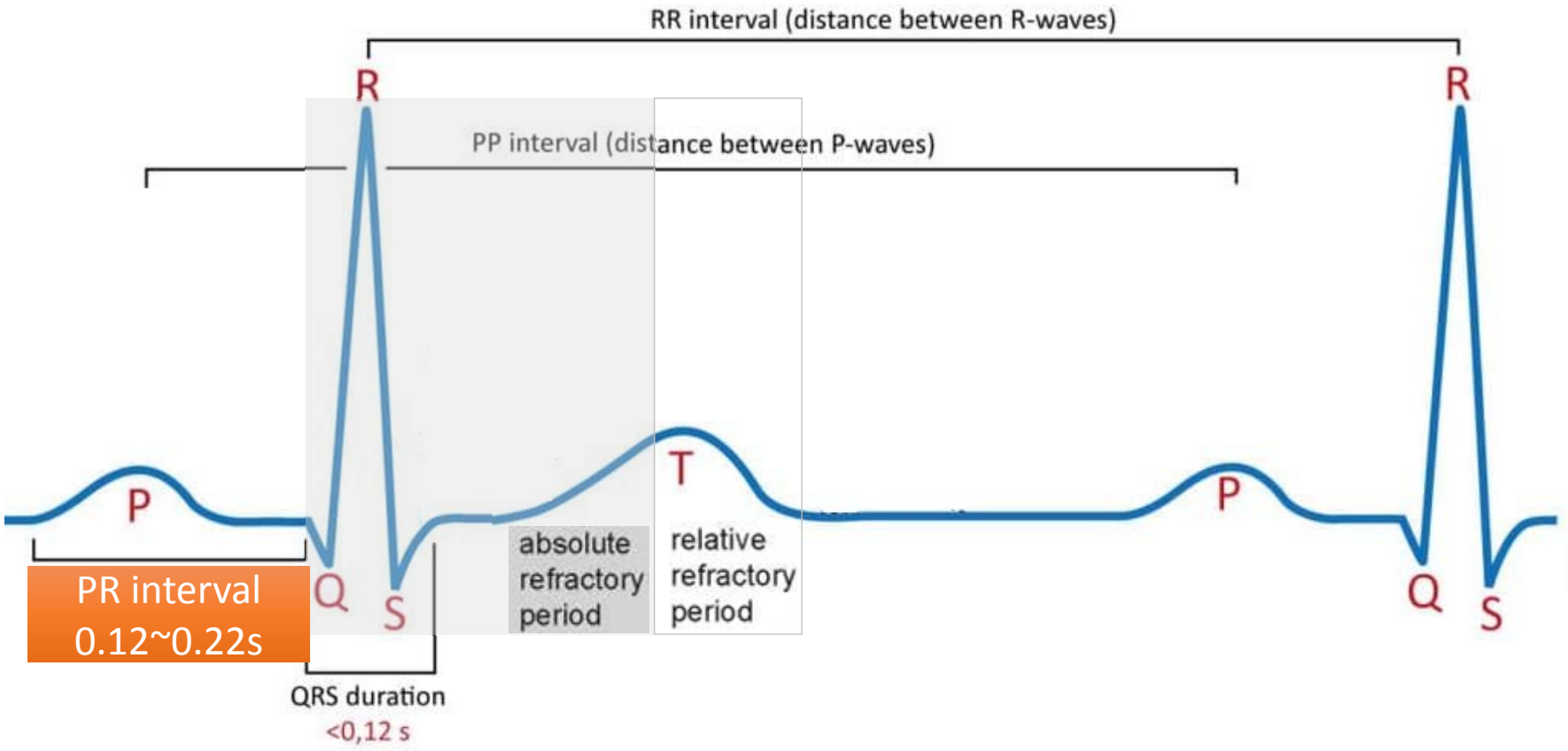
## CLS(Closed Loop Stimulation)



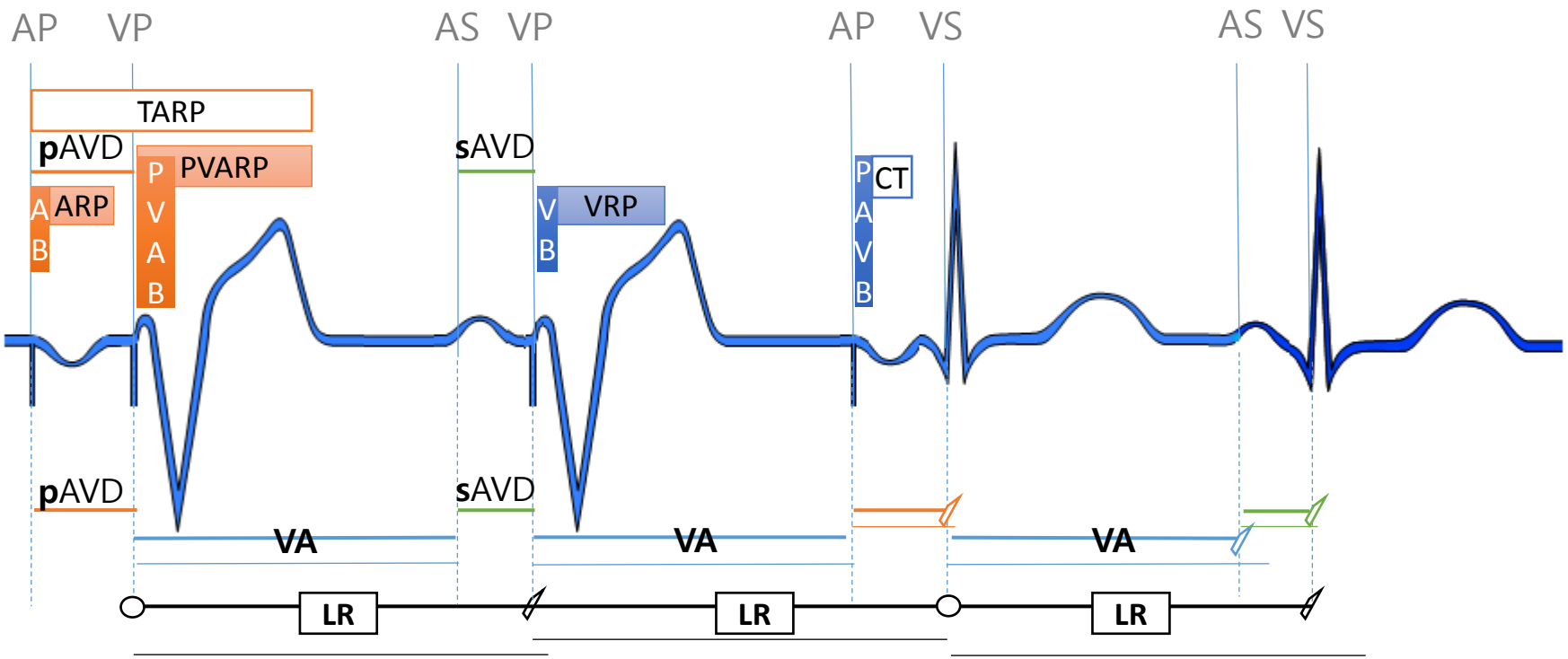
# Atrial Timing Cycles

- Paced AV Delay / Sensed AV Delay
- Atrial blanking(AB) / Atrial refractory period(ARP)
- Post Ventricular Atrial Refractory Period (PVARP)
- Post Ventricular Atrial Blanking (PVAB)
- Total Atrial Refractory Period (TARP)

# Normal conduction system

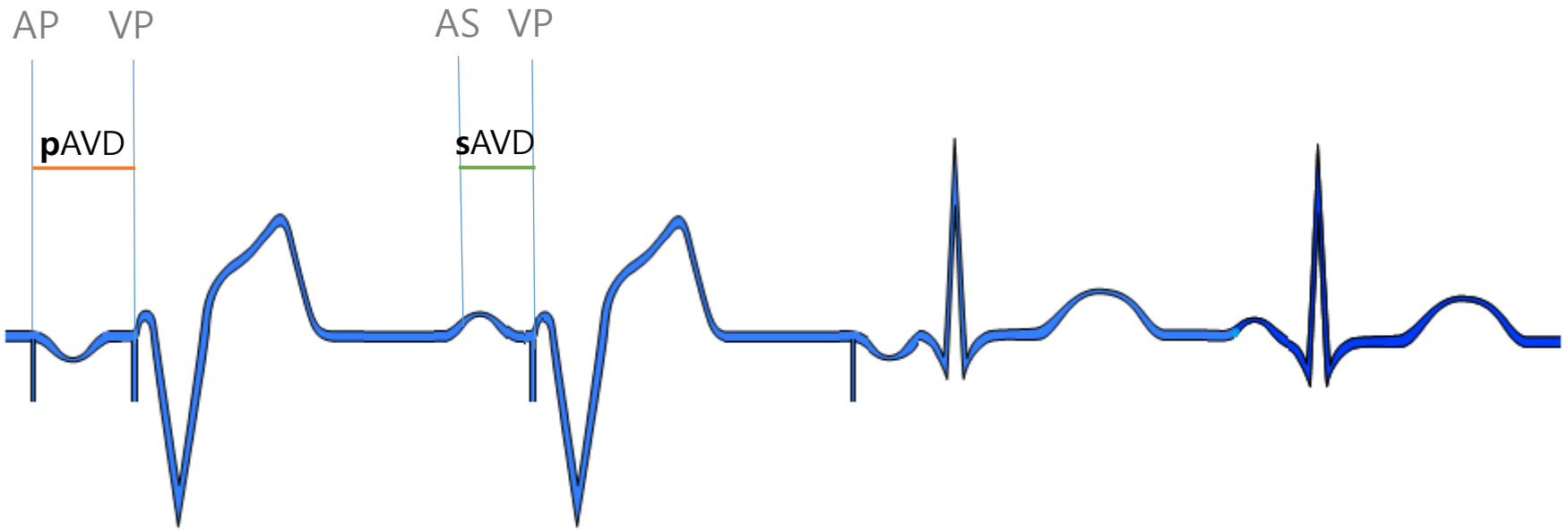


# AV delay


AP
VP
AS
VP
AP
VS
AS
VS
TARP
pAVD
PVARP
ARP
PVAB
sAVD
VRP
VB
PAVB
CT
pAVD
sAVD
VA
VA
VA
LR
LR
LR

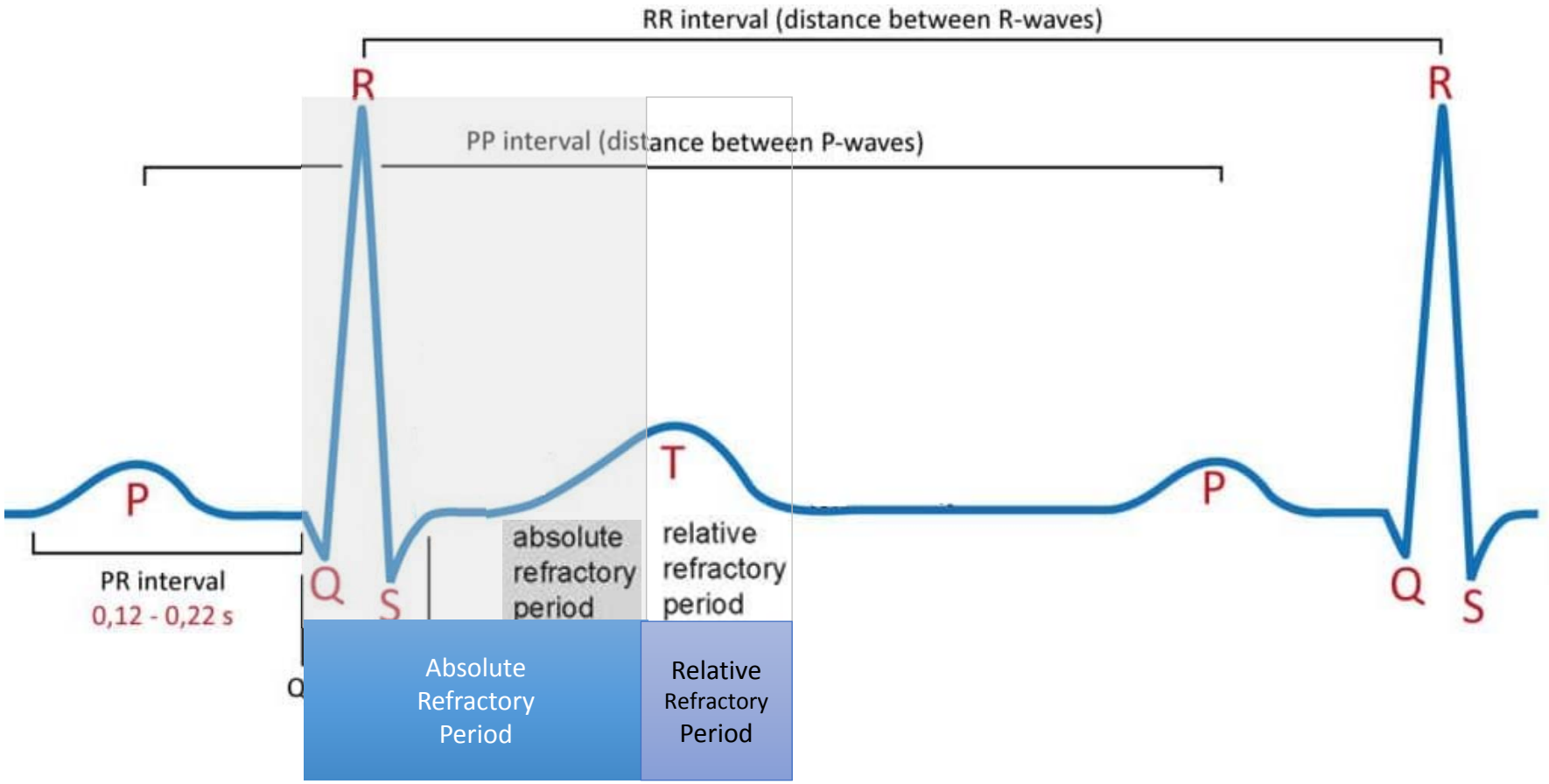
Paced AV delay : AP->VP 까지의 시간 (ms)

Sensed AV delay : AS->VP 까지의 시간 (ms)

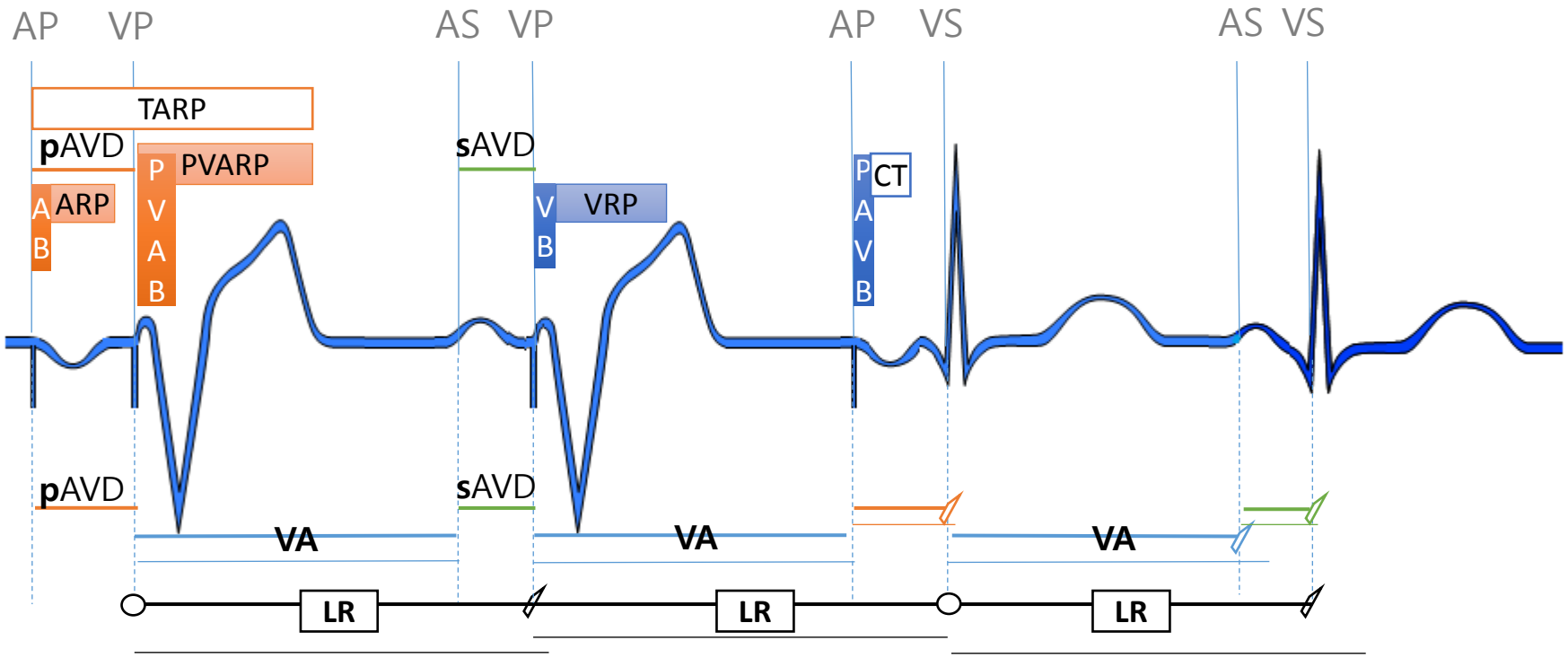



☞ **Norminal**
**Paced AV delay : 170~180ms**
**Sensed AV delay : 150~160ms**
**(Rate adaptive)**

# Normal conduction system



# Refractory periods of a dual chamber pacemaker



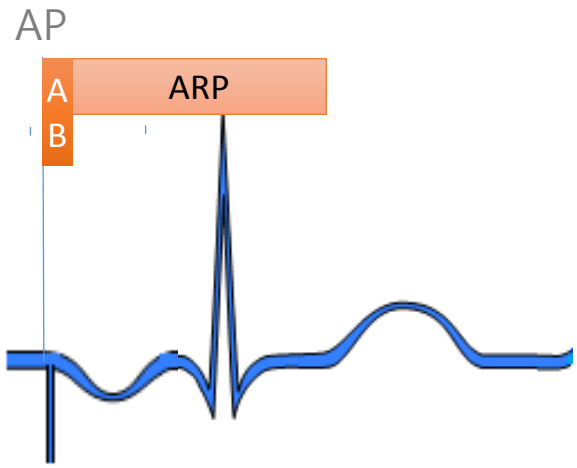
| Blanking Period | Refractory Period |
| --- | --- |
|  |  |
| |  |

# Atrial Blanking / Atrial Refractory Period

## AB(Atrial blanking)

(post AS, AP)

Atrial event에 의해 Pacing이 "self-inhibit" 되는 것 예방




## ARP (Atrial refractory period)

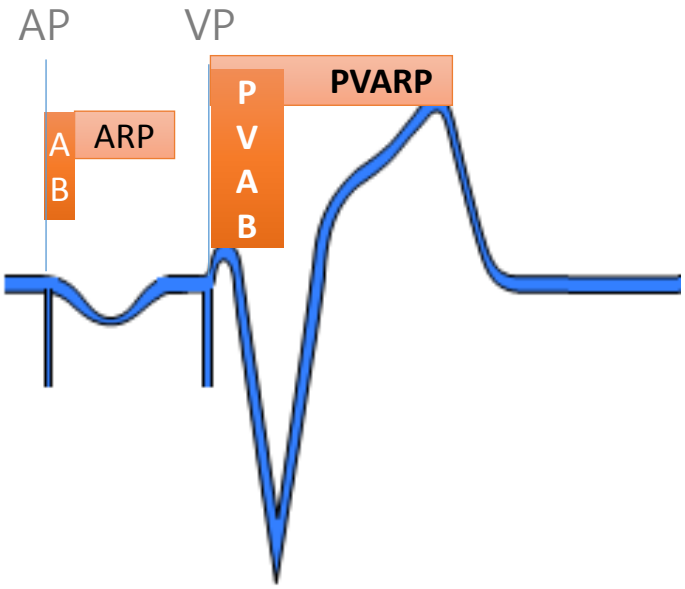
AAI 에서 Atrial event나 QRS를 sensing 하여
부적절하게 A interval 이 다시 시작 되는 것 방지

# PVARP / PVAB

## PVARP (Post ventricular atrial refractory period)

Ventricular event 후의 Atrial 불응기 (R로 표시-AR-)

Far-field R-wave oversensing 또는 역행전도(retrograde conduction)에 의한 부적절한 반응을 차단



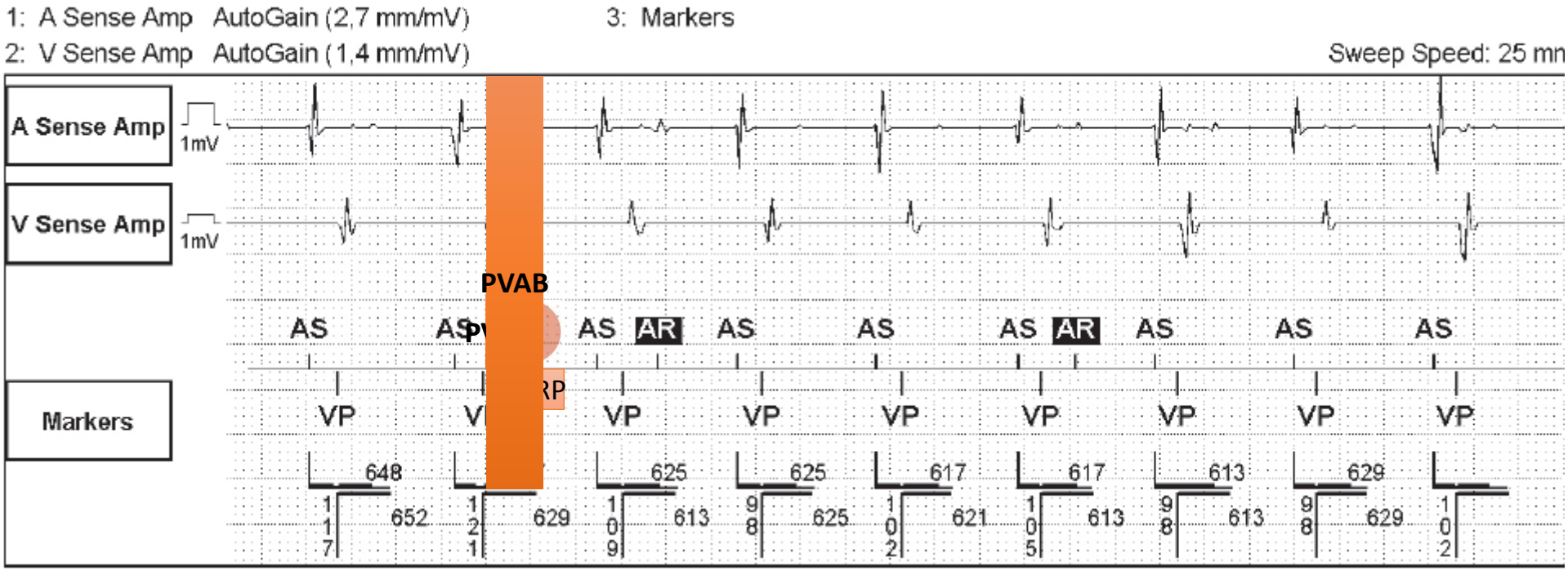

## PVAB (Post ventricular atrial blanking)

Ventricular event 후의 Atrial 장님기 (B로 표시–Ab-)

Ventricular event로 인한 Far-field R-wave oversensing 예방

☞ **Norminal**
**PVARP : 250~275ms**
**(rate adaptive)**
**PVAB : 100~150ms**

# Case 1




PVAB을 늘려 Far R oversensing 차단

- PVAB : Ventricular event로 인한 Far-field R-wave oversensing 예방

## 슬라이드 19

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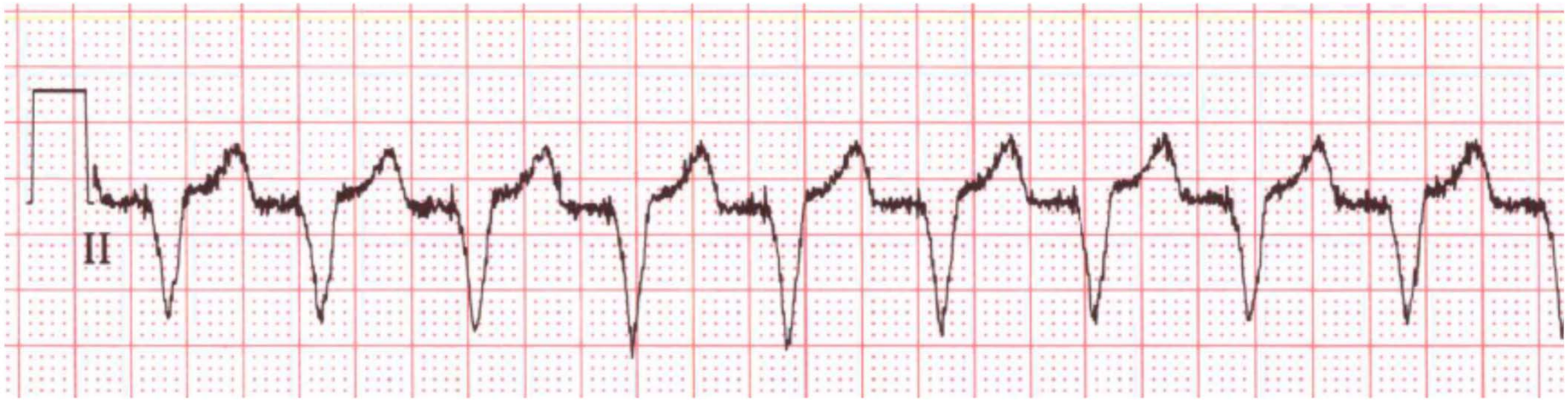
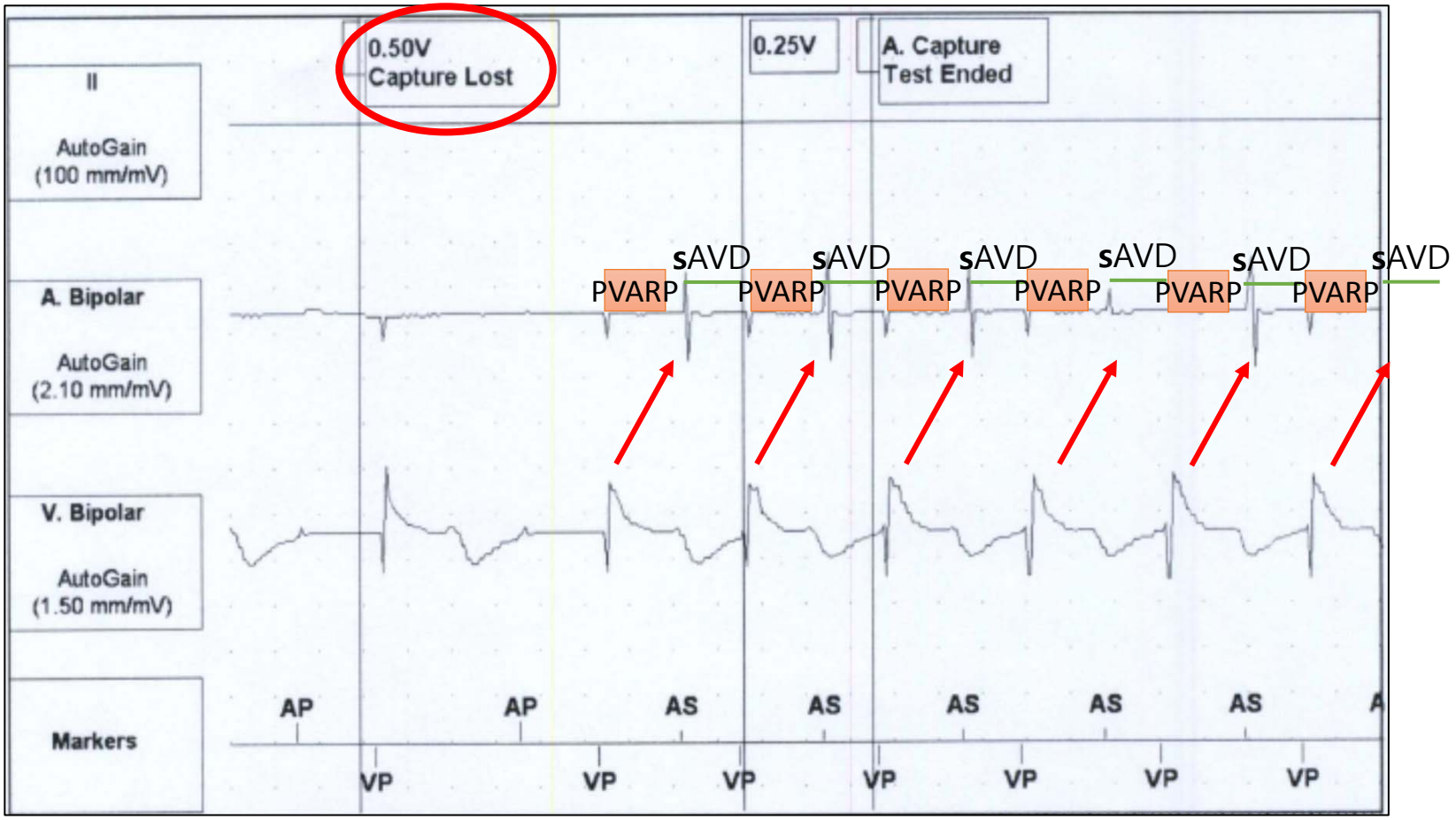
**g2** greenhannah@amc.seoul.kr, 2021-04-24

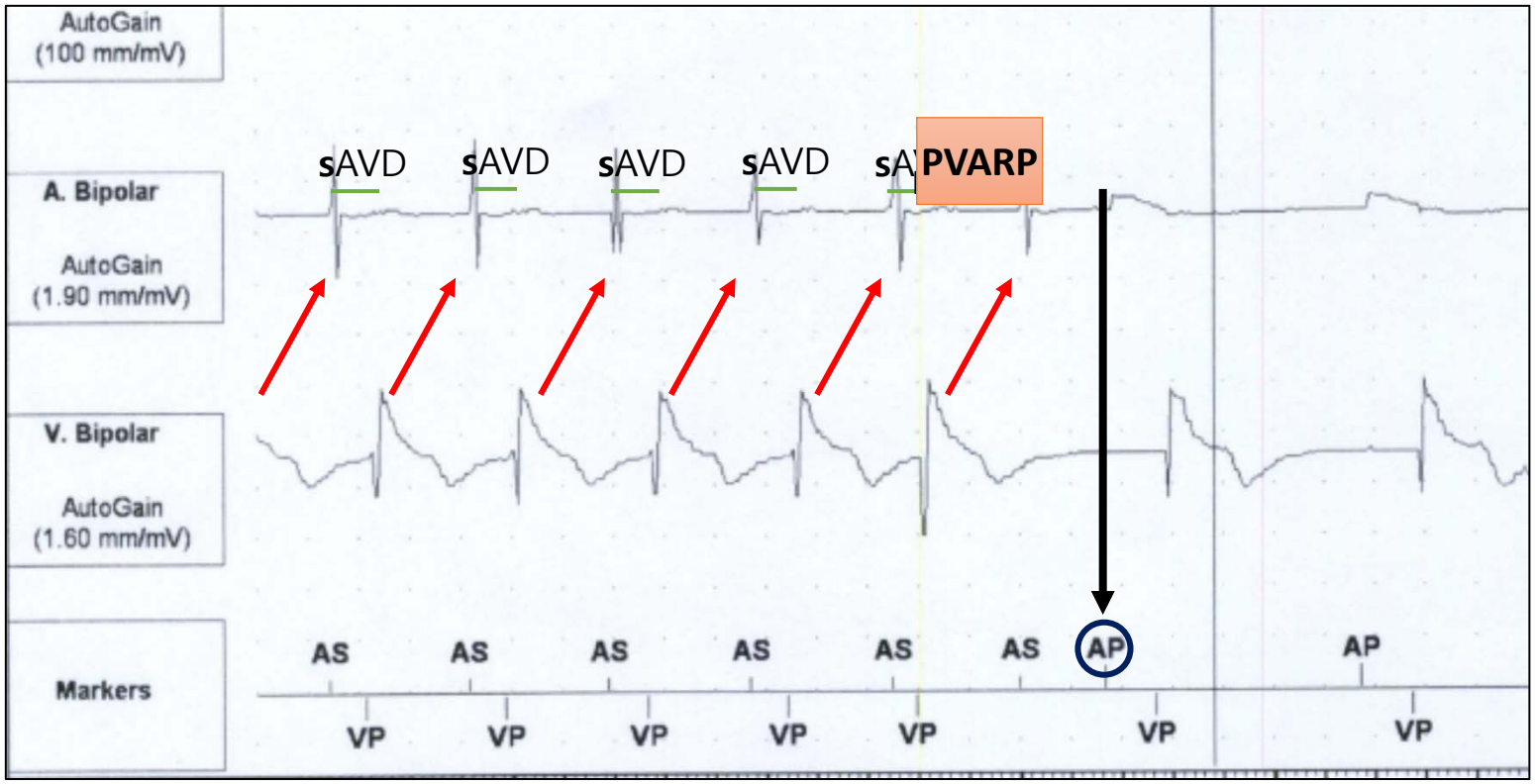
# Case 2



# PMT (Pacemaker mediated tachycardia)
# (Endless-loop tachycardia)

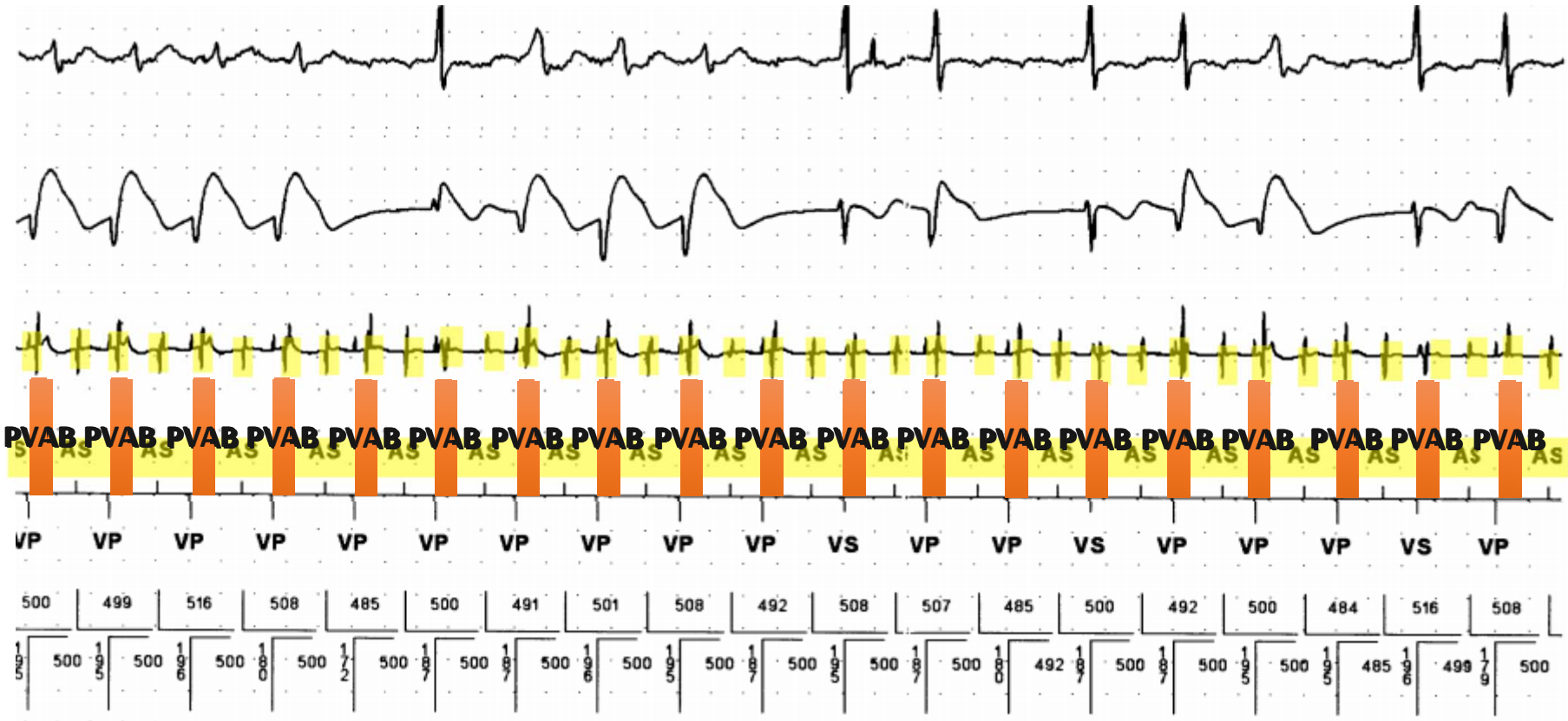


- PVARP : Far-field R-wave oversensing 또는 역행전도(retrograde conduction)에 의한 부적절한 반응을 차단

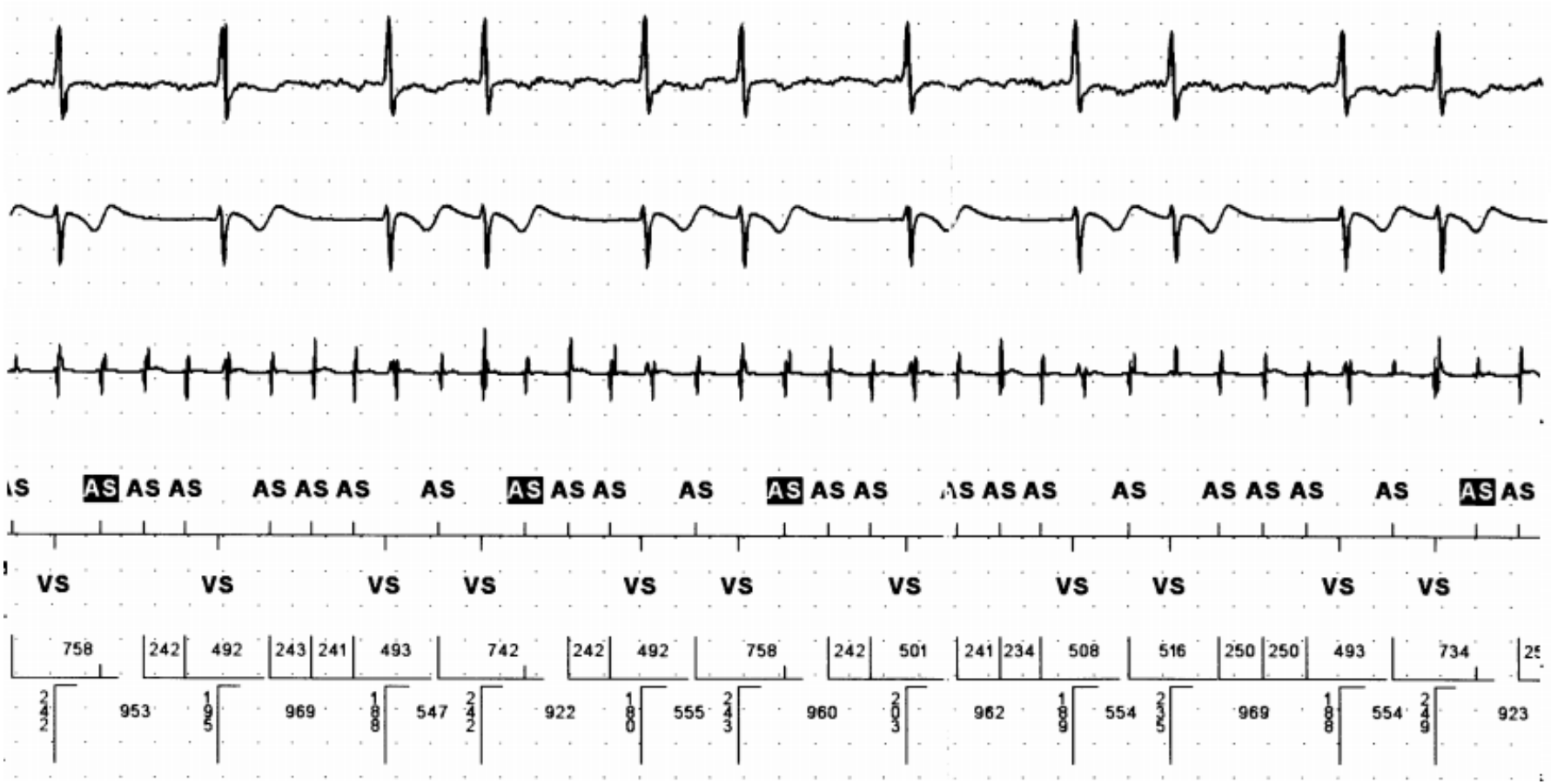



PMT option : PVARP extension + A.pacing

# Case 3



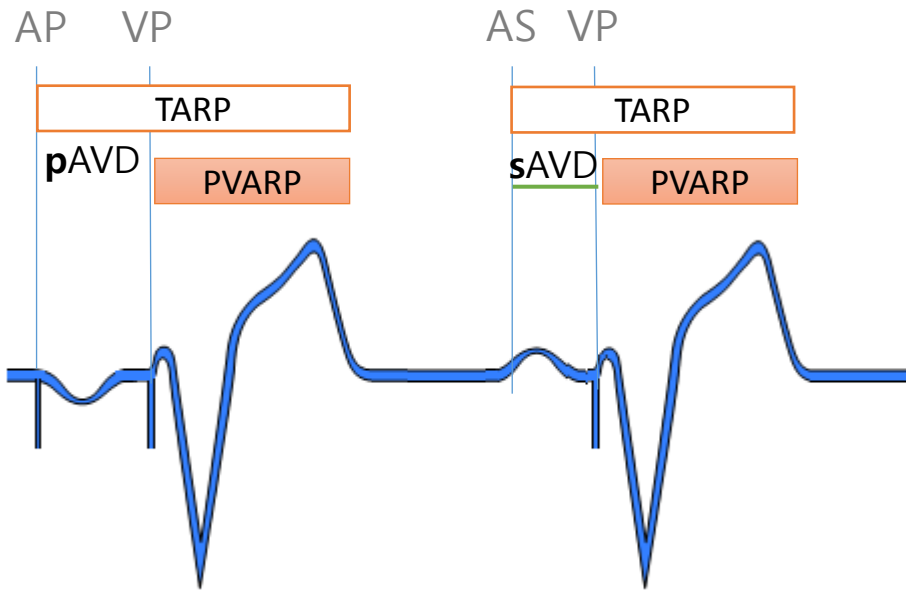

- PVAB : Ventricular event로 인한 Far-field R-wave oversensing 예방


AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS AS
VS VS VS VS VS VS VS VS VS VS VS
758 242 492 243 241 493 742 242 492 758 242 501 241 234 508 516 250 250 493 734
953 969 547 922 555 960 962 554 969 554 923

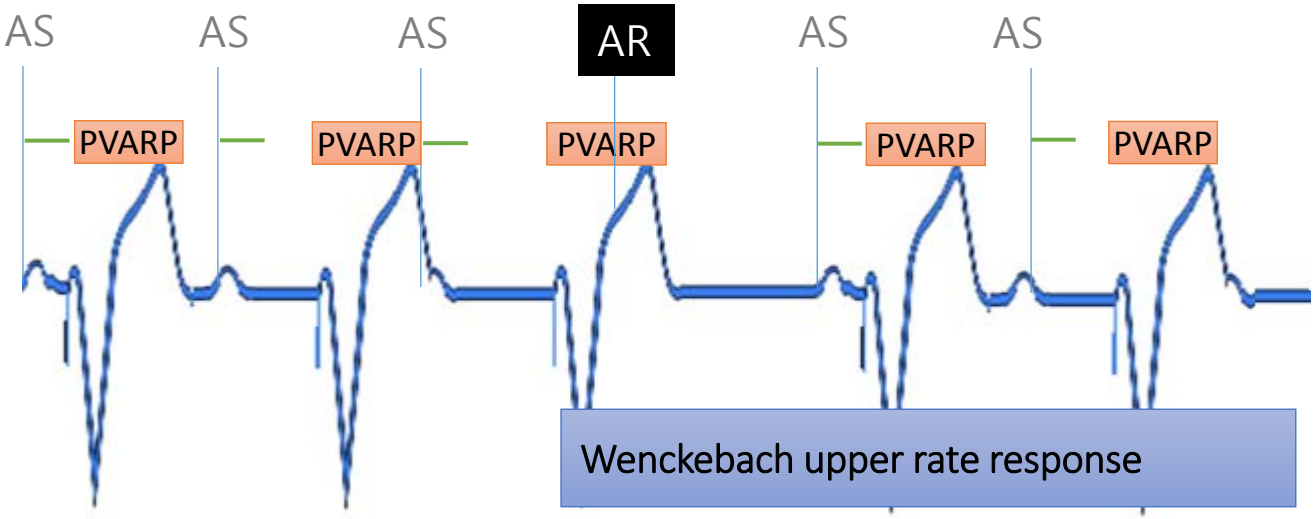
# TARP (total atrial refractory period)

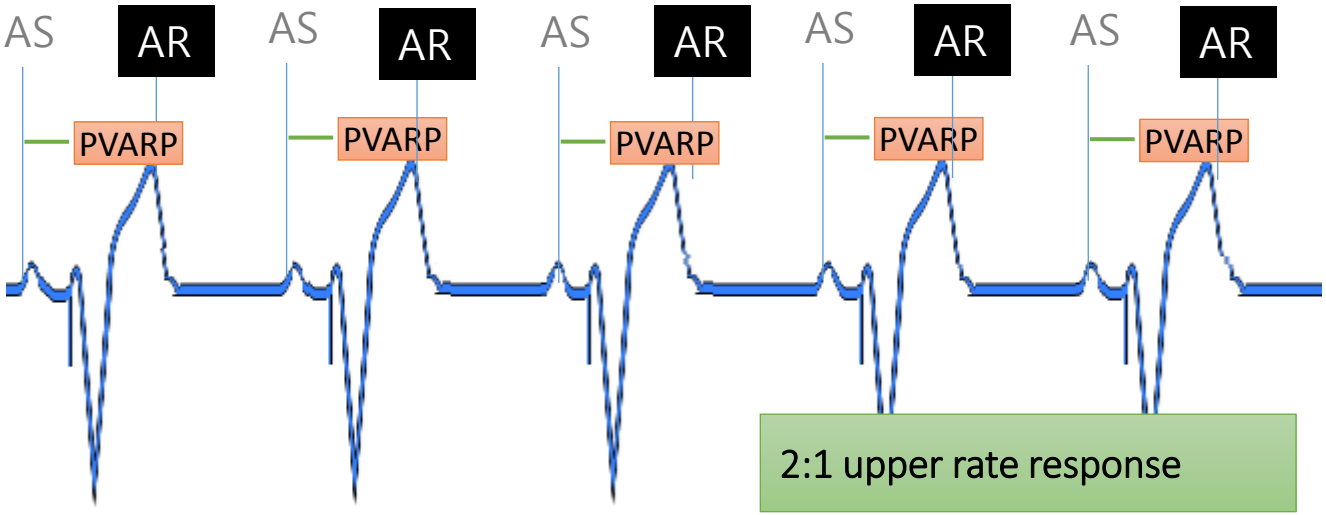
AVD + PVARP

2:1 Block 구간



sAVD




sAVD + PVARP = TARP = 2:1 AV Block

# Ventricular Timing Cycles

- Ventricular Blanking (VB)
- Ventricular Refractory Period (VRP)
- Cross Talk Window = safety window

## VB (Ventricular Blanking)

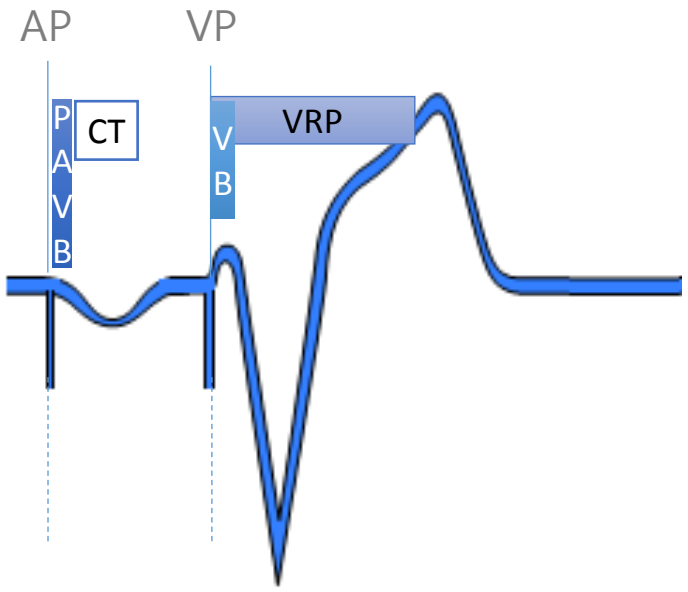
### Ventricular 장님기 (post AP, VS, VP)

Atrial pacing output에 의해 Ventricular sensing 되는 것 예방
QRS double count 예방

## VRP (Ventricular refractory period)

### Ventricular 불응기 (post VP, VS)

T-wave를 oversensing 예방




## Cross Talk Window

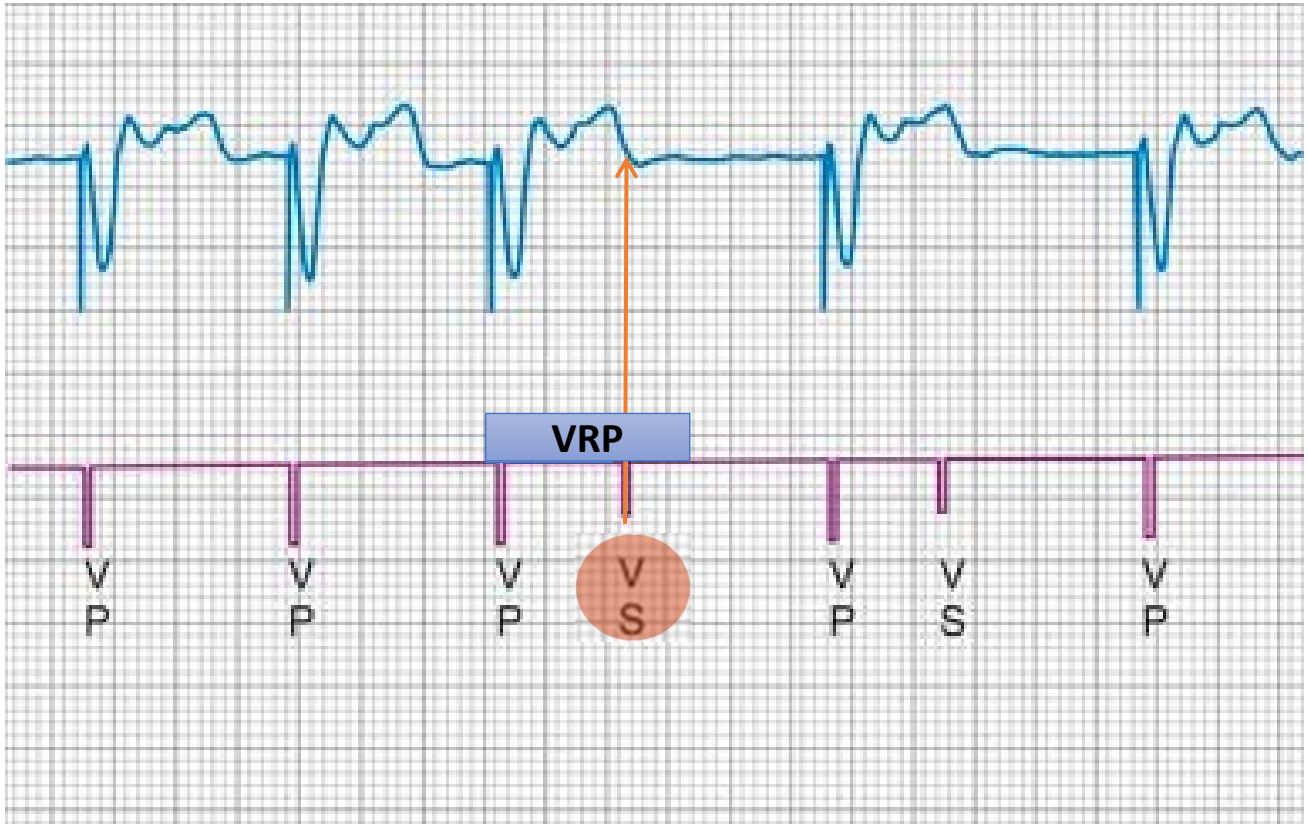
= safety window

Atrial event 후 oversensing 으로 인한 Ventricular pacing의 inhibition 예방 위한 구간

이 구간안에 Ventricle sensing 되면 V safety pacing 나감.
(AVD 100~110ms)

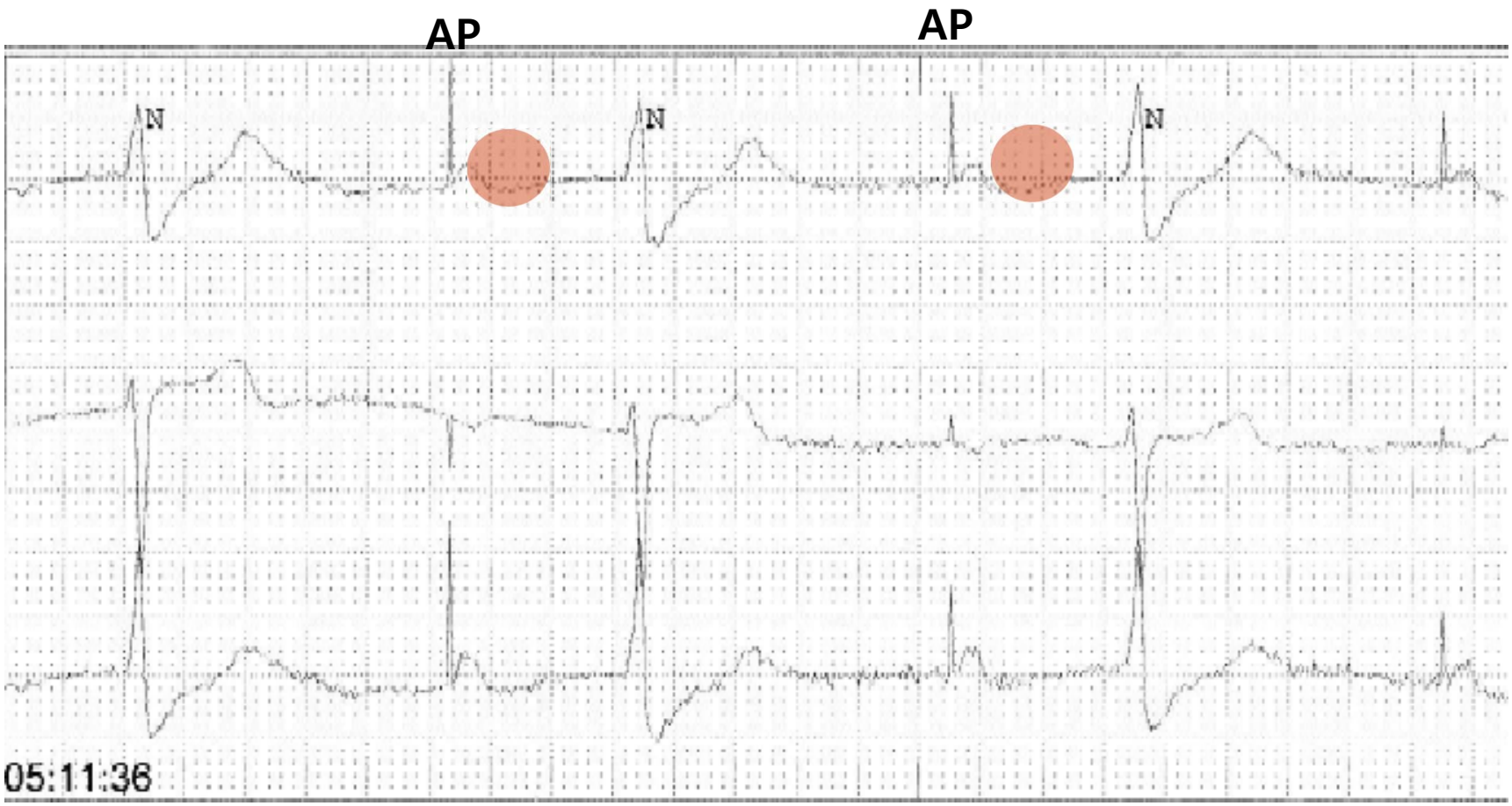
☞ **Norminal**
**VRP : 200~250ms**
**VB : 12~65ms**

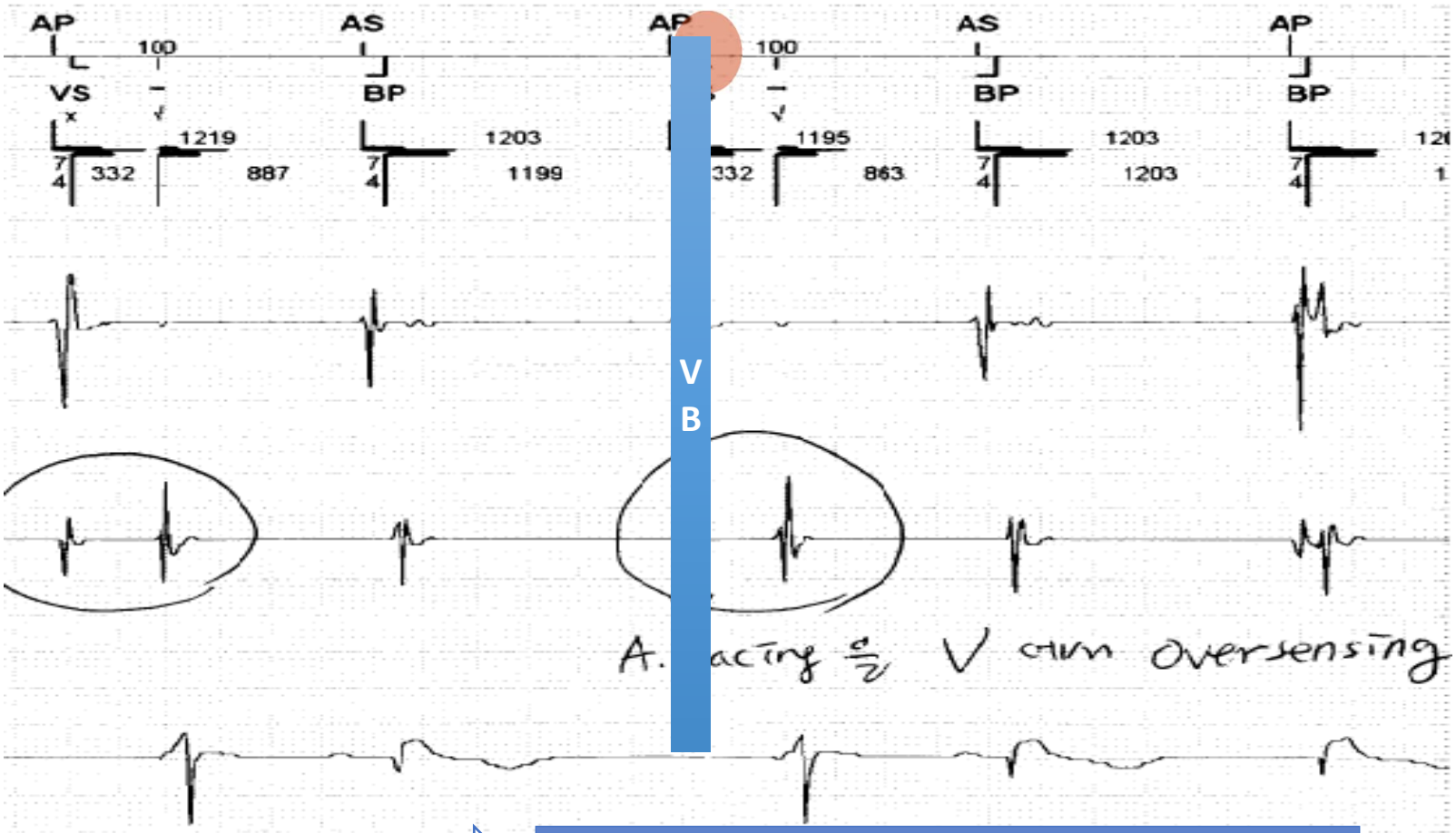
- VRP : T-wave를 oversensing 예방




VRP를 늘려 T-wave oversensing 차단

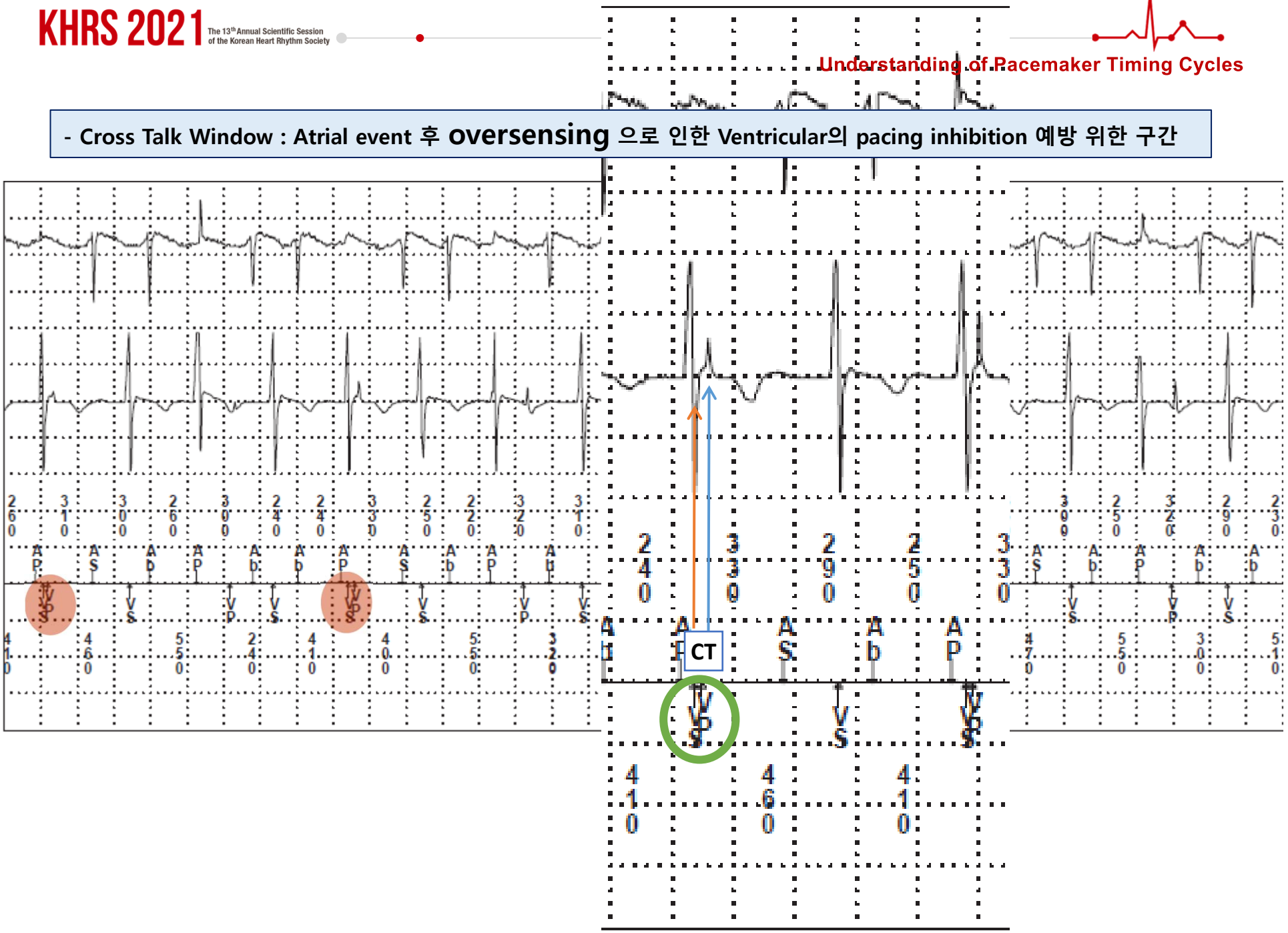
- VB : Atrial pacing output에 의해 Ventricular sensing 되는 것 예방






VB를 늘려 AP oversensing 차단

- Cross Talk Window : Atrial event 후 **oversensing** 으로 인한 Ventricular의 pacing inhibition 예방 위한 구간



# Summary

| | Meaning | Norminal value (ms) | Role |
|---|---|---|---|
| **pAVD** | Atrial Pacing 부터 VP 까지 interval | **170~180, rate adaptive** | |
| **sAVD** | Atrial Sensing 부터 VP 까지 interval | **150, rate adaptive** | |
| **ARP** | AV delay 기간 안의 Atrial 불응기 | | Atrial event 를 sensing 하여 부적절하게 AV interval 이 다시 시작 되는 것 방지 |
| **PVARP** | Ventricular event 후의 Atrial 불응기 R로 표시 (AR, VR) | **250~275, rate adaptive** | Far-field R-wave 또는 역행전도(retrograde conduction)에 의한 부적절한 반응을 차단 |
| **PVAB** | Ventricular event 후의 Atrial 장님기 B로 표시 (Ab) | **100~150** | Ventricular event로 인한 Far-field R-wave sensing 예방 |
| **TARP** | AVD + PVARP | | 2:1 Block 구간 |
| **AB** | Atrial 장님기 (post AS, AP) | | Atrial event에 의해 Pacing이 "self-inhibit" 되는 것 예방 |
| **VB** | Ventricular 장님기 (post AP, VS, VP) | **12~65** | Atrial pacing 과 V. event에 의해 Ventricular sensing 되는 것 예방 |
| **VRP** | Ventricular 불응기 (post VP, VS) | **200~250** | T-wave를 oversensing 예방 |
| **CT** | Atrial event 후 oversensing 으로 인한 Ventricular pacing inhibition 예방 위한 구간 | | 이 구간안에 Ventricle sensing 되면 V safety pacing 나감. (AVD 100~110ms) |


감사합니다.