



THE
DEVIL IS IN
THE **DETAILS**



Pacemaker Behavior's
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Patient Case Description

- This is a patient with SSS + PAF with a DDDR pacemaker . He did not tolerate MVP in the past so we turned it off.
- He recently complains of palpitations of two types :
- Sudden events of rate around 115
- Rate about 80 , general weakness that reminds him of the sense of temporary VVI pacing during clinic visits
- He was able to record both episodes
- We programmed the AHR diagnostics to detect relatively slow tachycardias which were indeed recorded .



Pacemaker setup

Serial Number: NNB834843

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Initial Interrogation Report

Page 3

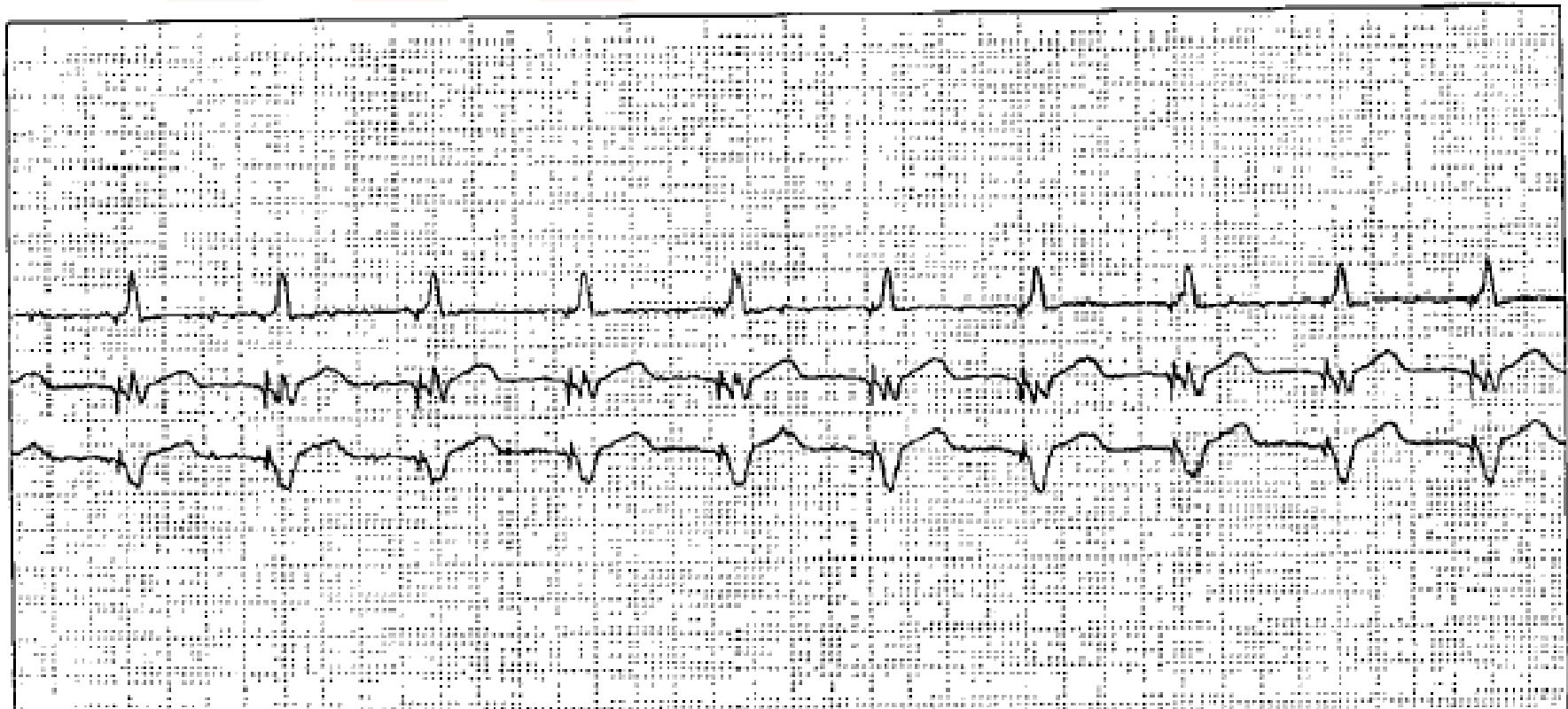
Parameter Summary

Mode	DDDR	Lower Rate	70 ppm	Search AV+	Off
Mode Switch	Off	Upper Tracking Rate	115 ppm	Paced AV	230 ms
		Upper Sensor Rate	100 ppm	Sensed AV	200 ms

- RAAVD – OFF
- SEARCH AV – OFF
- MS- OFF
- ACM & VCM – ON
- SINUS PREFERENCE –ON

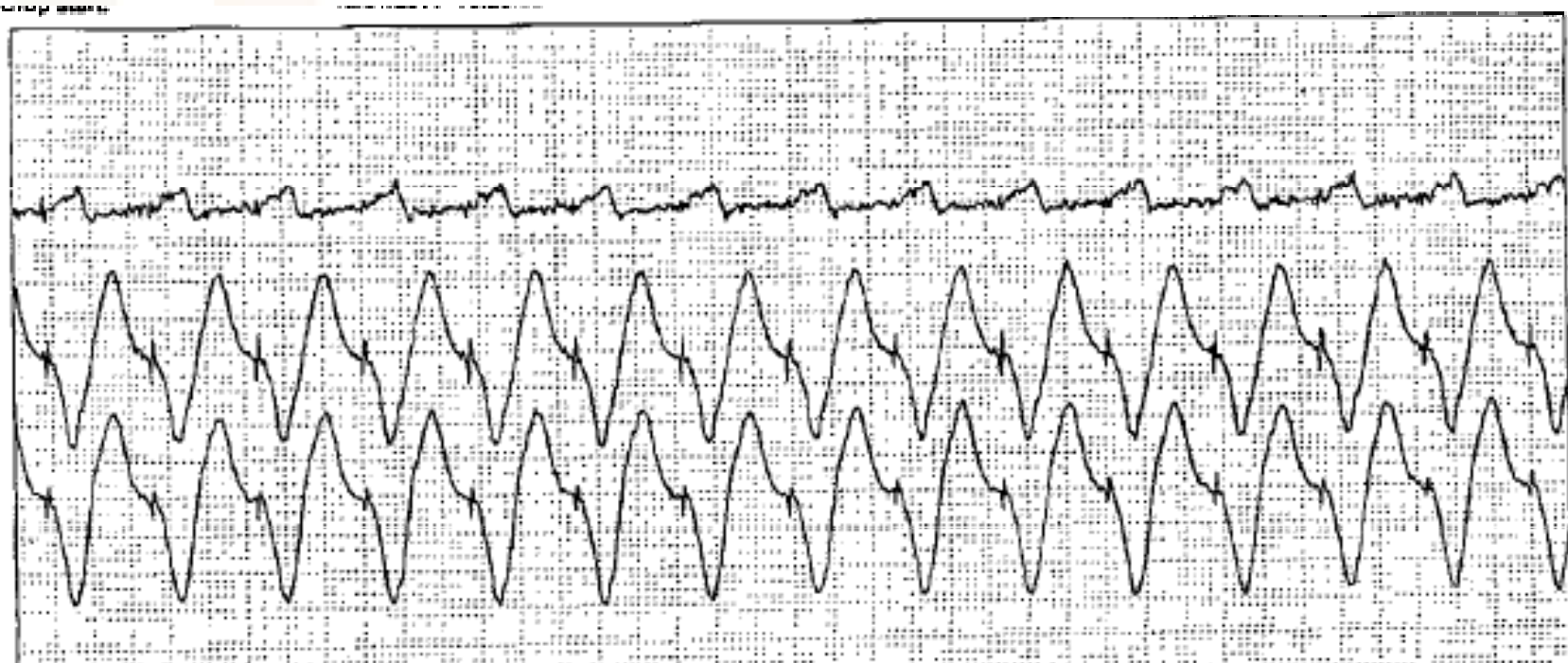


Patient Holter strip – Baseline Rhythm



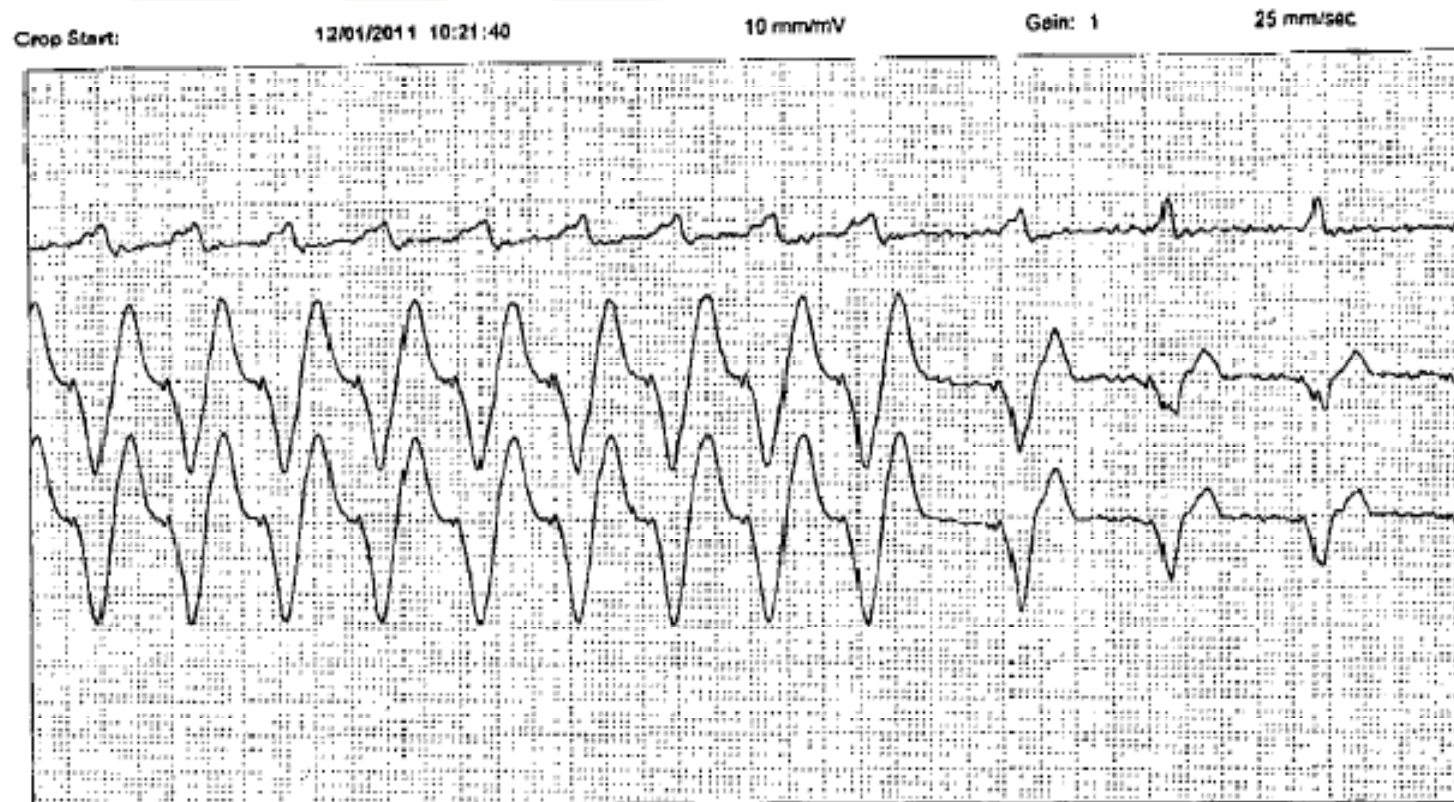


Tachycardia (the faster type) in Holter strip





Sudden termination of the tachycardia





Episodes of AHR From the Pacemaker Memory

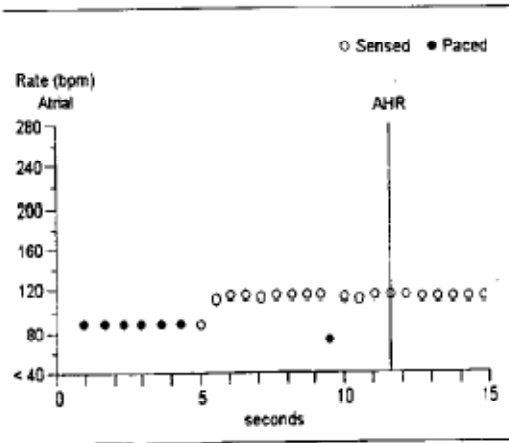
Pacemaker Model: Medtronic Adapta ADR001
 Serial Number: NWB834843

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Atrial High Rate Monitor Detail

Page 1

Onset - Onset Collected - 01/12/11 9:12 AM



Initial Interrogation

Mode: DDDR
 Lower Rate: 70 ppm
 Upper Tracking Rate: 115 ppm
 Upper Sensor Rate: 100 ppm
 Episode Trigger: High Rate
 Detection Rate: 110 ppm
 Detection Duration: 5 sec

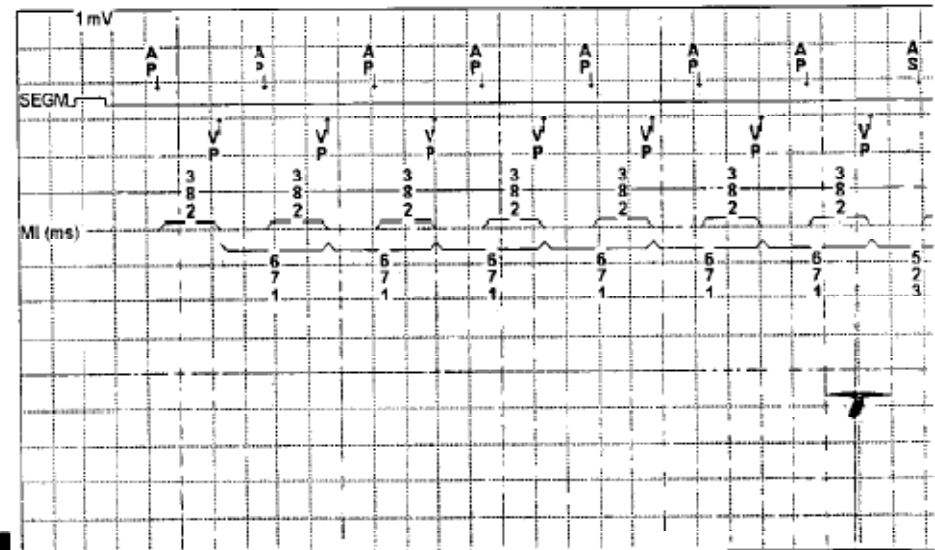
Episode Data

Duration (hh:mm:ss): 00:03:10
 Max Atrial Rate: 114 bpm
 Max Vent. Rate: 115 bpm

Serial Number: NWB834843

Stored Strip

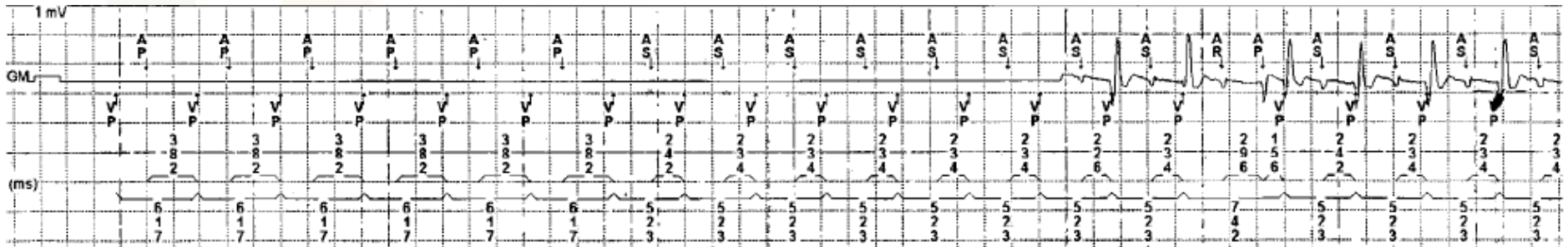
Collected: 01/12/11 9:12 AM



Continued →

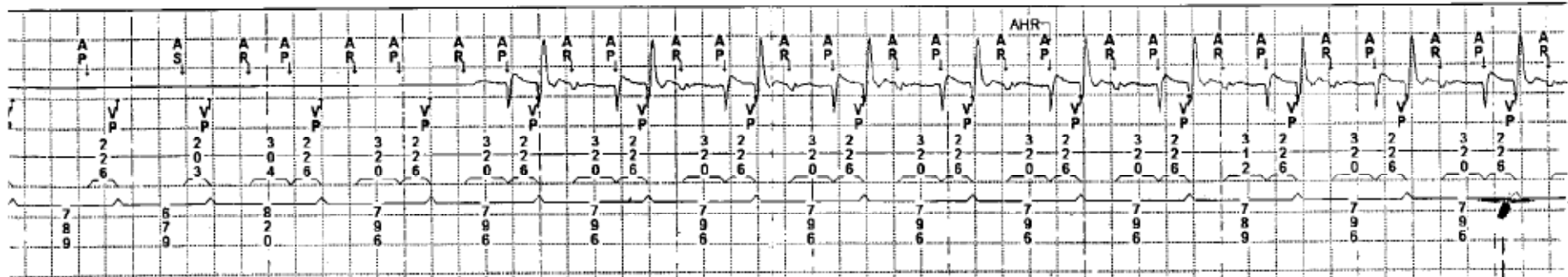


Episodes of AHR From the Pacemaker Memory – the “faster” type





Another AHR Episode From The Pacemaker – the “slower” type





Questions

- What do you think of the strips ?
- Is there any “strange behavior” of the pacemaker ?
- What are the two Different diagnosis for the two strips ?
- Thresholds , sensing and impedances are all within normal ranges



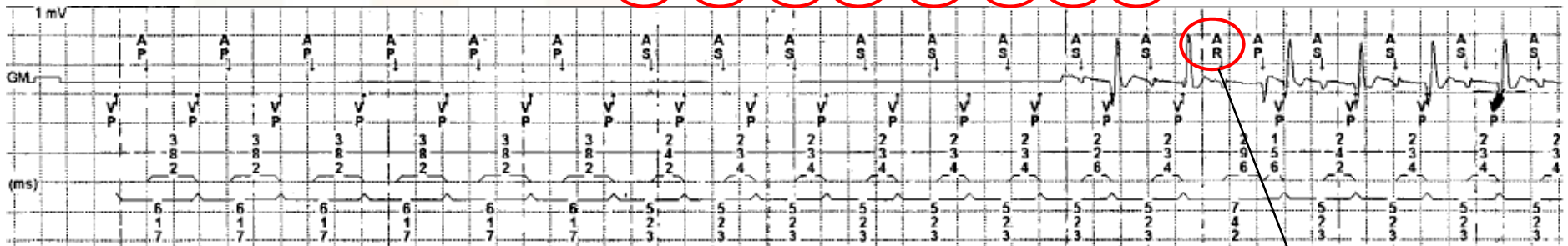
Think and





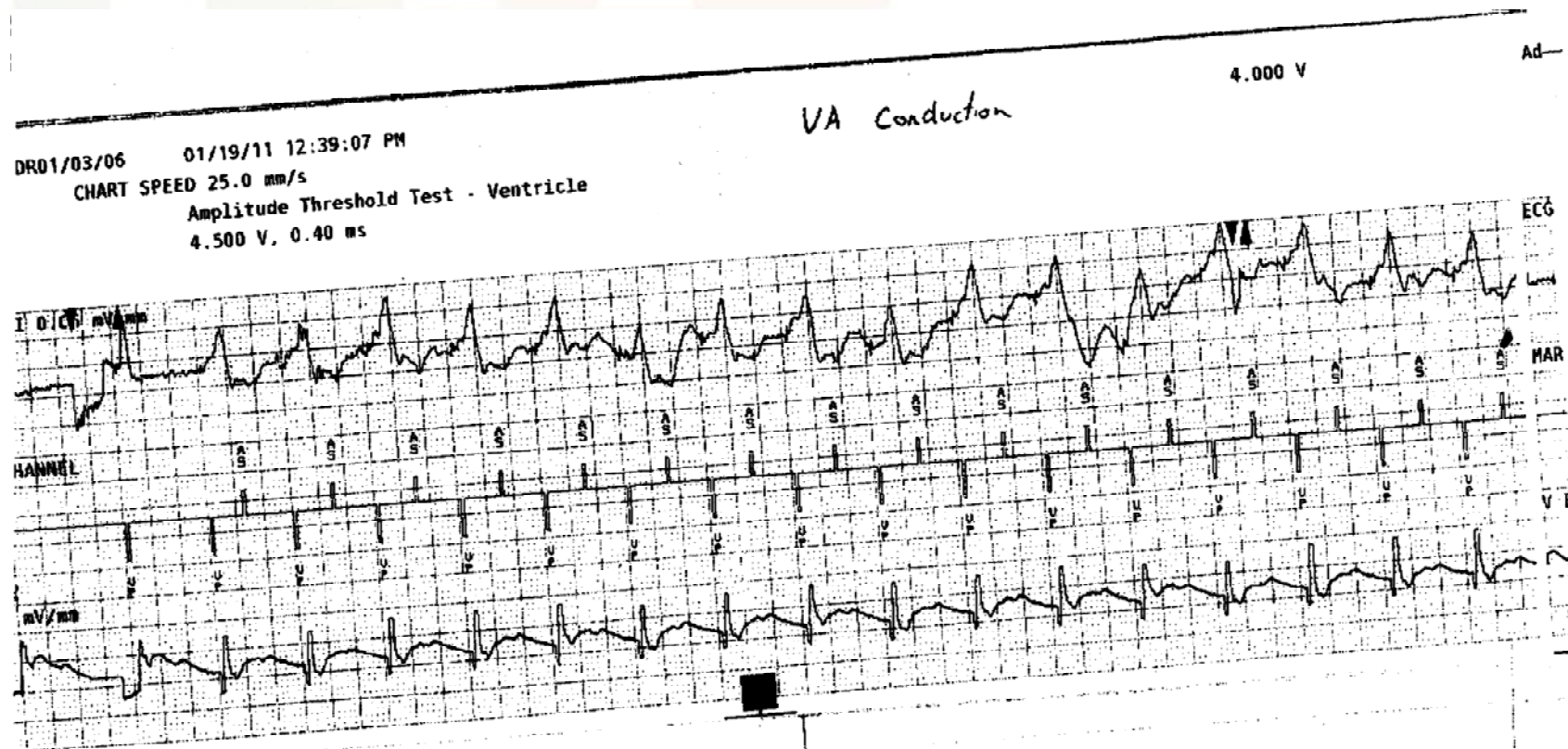
Answer to The first rhythm – is it PMT?

1 2 3 4 5 6 7 8





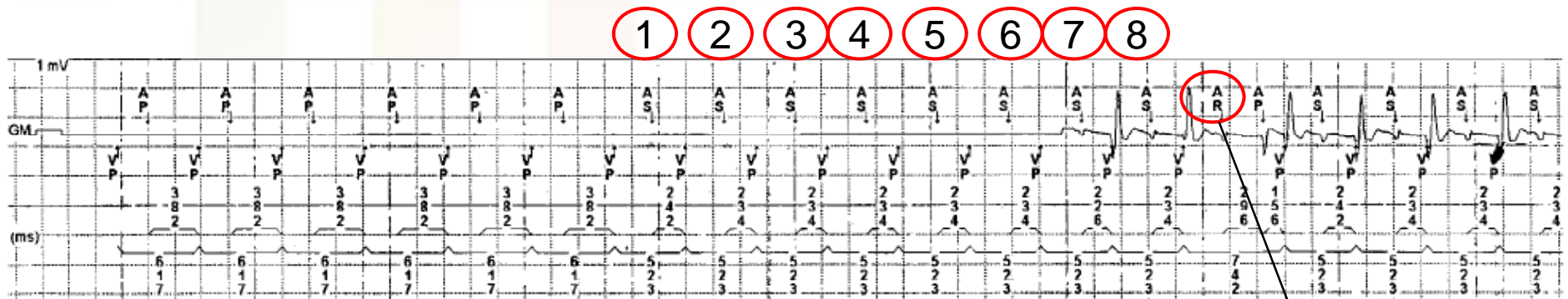
VA conduction test performed in clinic by pacing V



VA during testing is indeed very similar to VA in tachycardia:
PMT most likely explanation



**OK so it is PMT what happened after 8 beats ?
PMT termination algorithm attempted to terminate the tachycardia**



8.10.4 Details about PMT Intervention

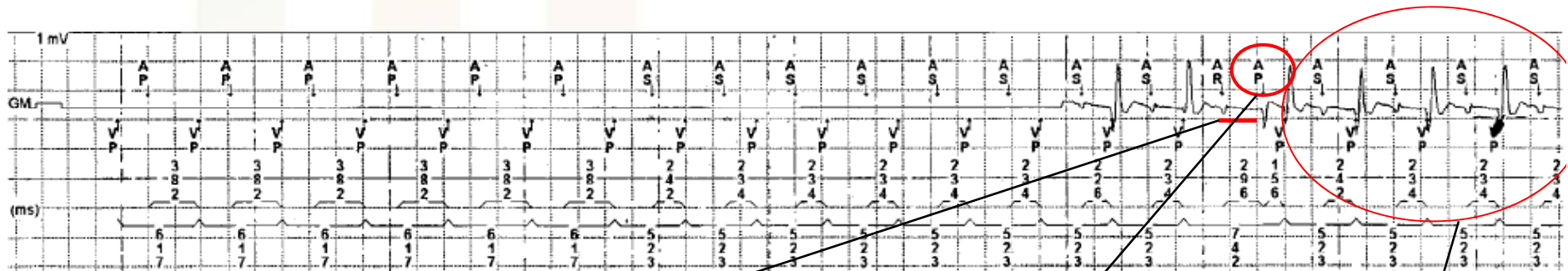
PMT Intervention is applicable when the device is operating in the DDDR or DDD mode. The device detects a PMT after sensing 8 VA intervals with the following characteristics:

- The interval duration is less than 400 ms.
- Each interval starts with a ventricular paced event.
- Each interval ends with a nonrefractory atrial sensed event.

PVARP
EXTENSION
TO 400MS



Why didn't it terminate the tachycardia ?



NCAP
Interval of
300ms

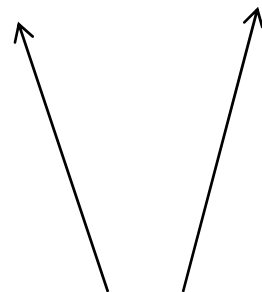
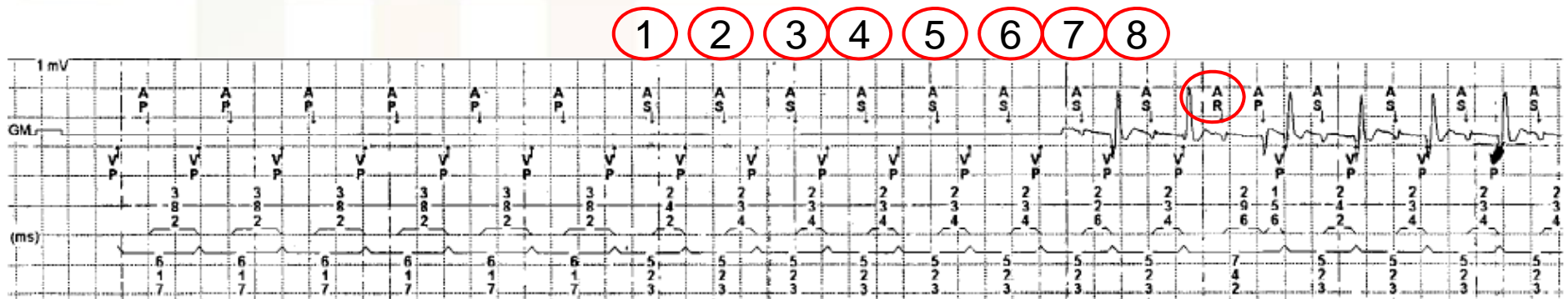
Atrial pacing without capture due
To atrial refractoriness resulting in
Triggerring of PMT again

Ongoing PMT

When NCAP is programmed to On, a refractory sensed atrial event falling in the PVARP starts a 300 ms NCAP period, during which no atrial pacing may occur:



Now that we believe that this is PMT why did it start?



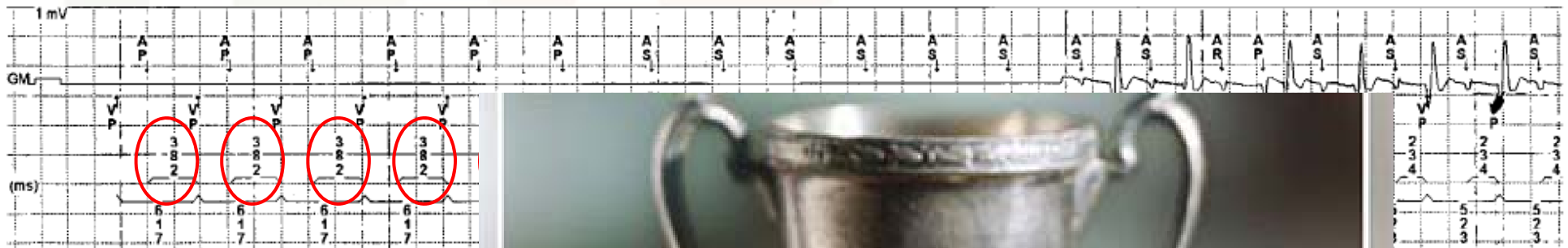
What is unusual here ?

Why is it pacing at 100 bpm with AV delay = 380 ?

Why does this rhythm trigger PMT?



Why are the AV Delays prior to tach lengthening?





ACM Overview

- Runs only in MVP, DDD, or DDDR modes
- No anticipated lead restrictions
- Scheduling the search
 - “Day at 1:00 AM” is nominal
 - “Day at Rest” value allows pacing system to determine best time of day to run the test successfully

	Atrium	Ventricle
Capture Test Frequency	Day at ...	Day at Rest
Capture Test Time	1:00:00 AM	
Acute Phase Days Remaining	Off	Off
Acute Phase Completed	12/28/04	12/28/04
Sensing During Search		Adaptive

Programmable “Test Frequency/Test Time” may allow physicians to titrate therapy during medication changes and periods of potential threshold instability.

“Acute Phase OFF” allows daily measurements to begin immediately, and output to be adapted, following successful measurements in patients with chronic leads.



ACM vs. VCM

Overview

It's not at all like VCM

- ACM does NOT look for “Evoked Response”
 - Evoked response P-wave is small, prone to under-sensing
- ACM runs in patients with either:
 - Periods of sinus rhythm (AS's), or
 - Periods of AV conduction (AP-VS's)
- ACM does not have an in-office test



ACM Details

ACM Observes the Timing of Sensed P- and R-Waves to Evaluate Capture

- Using the intrinsic sensing and pacing characteristics of the device, determine capture using one of the following two algorithmic methods:
 - Atrial Chamber Reset (ACR)
 - AV Conduction (AVC)
- Method is selected automatically by the device at the time of test execution, after performing the following checks:
 - Device operation check
 - Feature interaction check
 - Rhythm stability check



ACM Details

Method Selection – “Stability Check” Asks/Answers the Question: Are Conditions Favorable Within the Patient’s Rhythm to Conduct Atrial Threshold Measurements?

- Atrial Chamber Reset (ACR) method runs during stable sinus rhythm
 - If 8 consecutive AS events are sensed and rate < 87 bpm \Rightarrow ACR method is chosen
- AV Conduction (AVC) method runs when stable intrinsic 1:1 AV conduction is observed with atrial pacing
 - If all VS events are observed and the max AP-VS interval is < 296 ms \Rightarrow AVC method is chosen
- If rhythm conditions above are favorable for both \Rightarrow ACR



AVC Details

- If AP-VS interval > 296 ms, device conducts one test cycle (2 of 3 test paces must conduct and capture) using PAV = 383 ms
 - If VS conducts at the max interval, and the VS event occurs during the capture expected “window,” device runs threshold test using this offset
 - If no VS, test aborts; stability check will occur 30 minutes later
- First test sequence measures using the permanently programmed outputs to ensure that VS events are conducted, and occurring during the “windows” expected for captured test pace
- AVC method can only be chosen to run every 8 hours

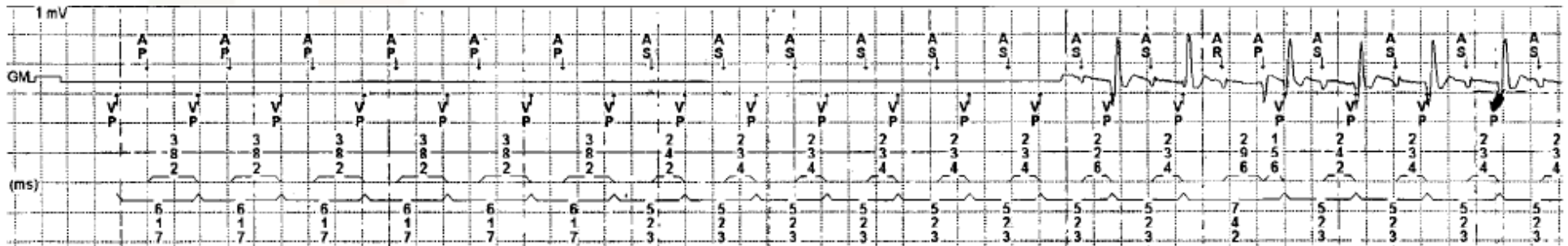
MGP4

What is the rate of pacing during ACM ? Does it correspond with the rate that we observed ?

Michael Glikson Prof., 06/02/2011



device conducts one test cycle (2 of 3 test paces must conduct and capture) using PAV = 383 ms



- First test sequence measures using the permanently programmed outputs to ensure that VS events are conducted, and occurring during the “windows” expected for captured test pace

You did not mention that the beat that triggers the tach is probably the one with first noncapture due to test

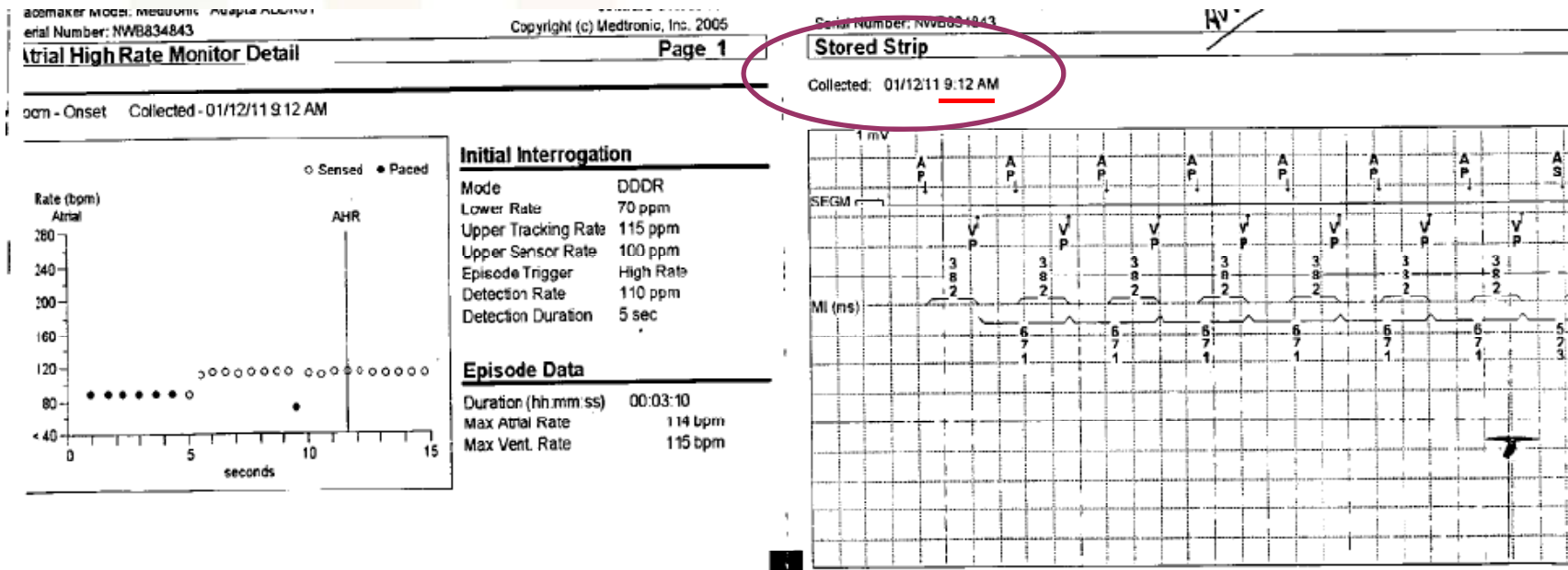
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Scheduling the search

“Day at 1:00 AM” is nominal

“Day at Rest” value allows pacing system to determine best time of day to run the test successfully



AVC method can only be chosen to run every 8 hours....

Look at the time of the episode ...

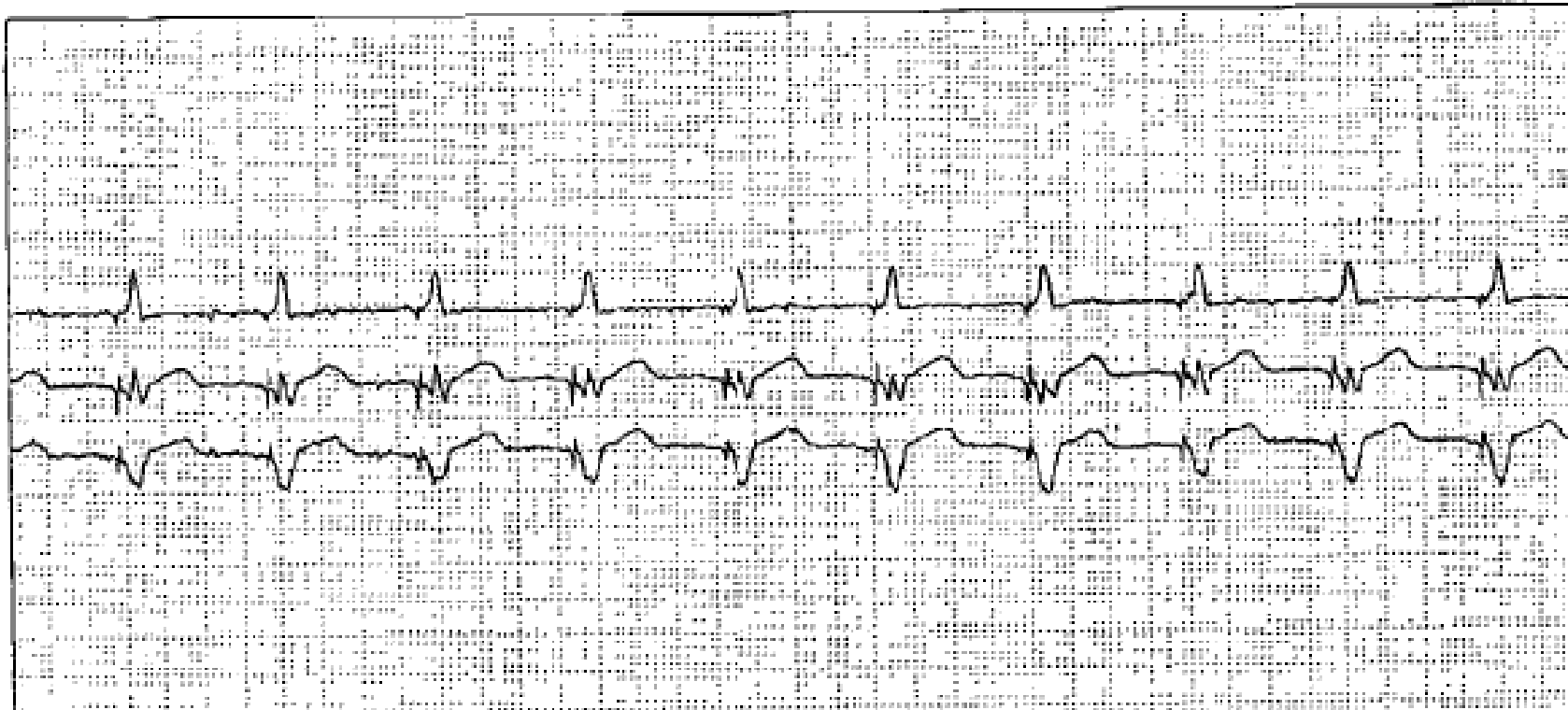


Conclusion

- Atrial capture management resulted in pacing with long AV delay and eventual loss of capture in the atrium
- As soon as capture is lost in A, the following VP is followed by retrograde conduction to A that triggers PMT



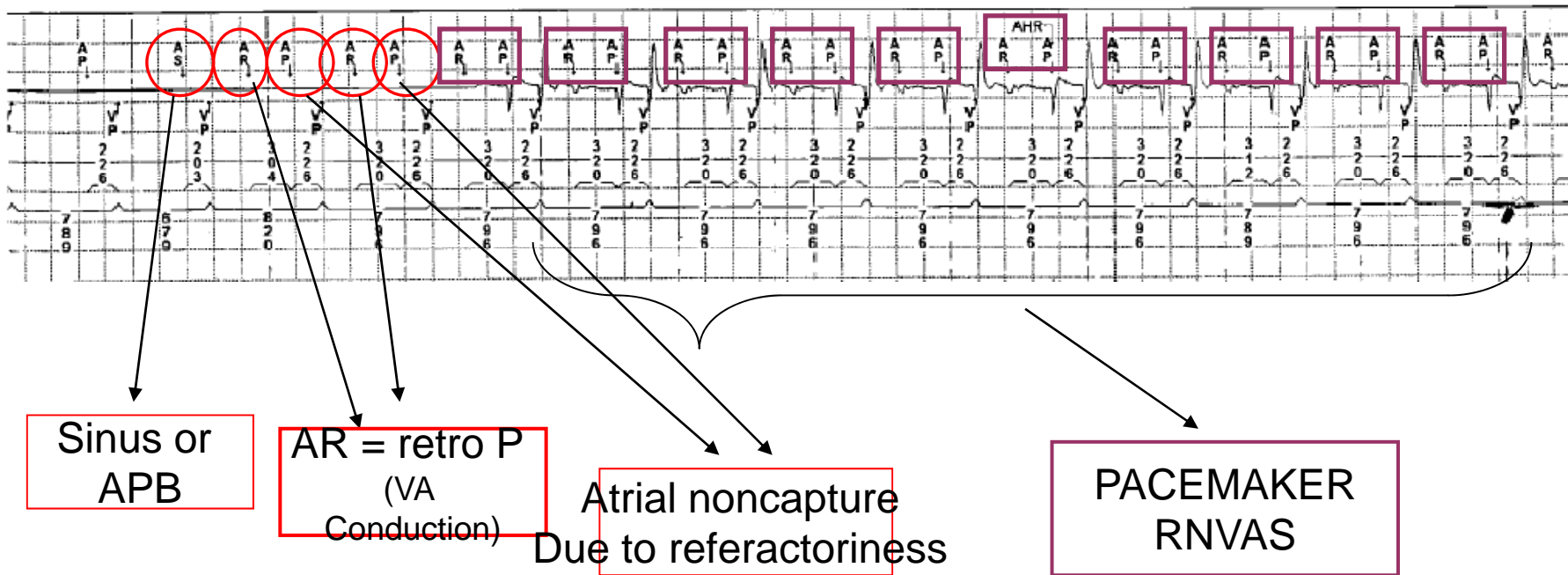
What about the other rhythm that is around 80 bpm and is very symptomatic ?



Lets see what the pacemaker point of view... next slide



Pacemaker repetitive non-reentrant ventriculoatrial synchronous (RNVAS) rhythm





By the way – what is RNVAS ?

- RNVAS = repetitive nonreentrant ventriculoatrial synchronous rhythm
- RNVAS results from a situation of retrograde P sensed in PVARP (AR) that is followed shortly thereafter by pacing in A that does not capture the atrium because it has just been captured by the AR
- This atrial noncapture sets the stage for another retrograde P in PVARP , another noncapture of AP and so on again and again
- The patient feels like pacemaker syndrome as all Ps are retrograde
- This phenomenon occurs more frequently in patients with SSS paced with relatively long AV delay



Summary of phenomena observed

- This case demonstrates :
 - Intermittent pacing with long AV delay + Loss of atrial capture due to atrial capture management
 - Loss of atrial capture during ACM immediately results in triggering of PMT when retrograde P falls out of PVARP
 - PMT termination is successful but PMT recurs almost immediately or is replaced by RNVAS
 - Loss of atrial capture results in RNVAS rhythm when retrograde P falls within PVARP (AR) and the immediately following P can not capture the refractory atrium



Solution

- We programmed ACM to OFF .
- Since then the patient has no complains.
- Additional Recommendation :
- fixed PVARP that is ~50ms longer than retrograde conduction time or change minimum PVARP under Auto PVARP to ~50 ms longer than retrograde conduction time.
- Sinus preference – OFF (hoping to pace the atrium most of the time and avoiding APB's)



Pacemaker behaviors lays in the

DETAIL

