

CRT Non Responders **(What is wrong ?)**

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Introduction

- ***CRT is non pharmacological treatment of drug refractory Heart failure ,NYHA class II – IV with prolonged QRS duration and depressed ejection fraction .***
- ***Clinical trials shows that CRT reduce heart failure hospitalization ,improve quality of life , reverse LV remodeling and decrease mortality***

However
30 % of
patients are
non
responder

Responders

☐ Subjective (clinical) :

improved NYHA class

improved 6 minute walk test

>10 %

quality of life

☐ Objective

Acute : Hemodynamic parameters (CO ,
 LV Dp/Dt max)

Chronic : **LV Reverse remodeling**

increase EF 10 %

Decrease LVESV 15 %

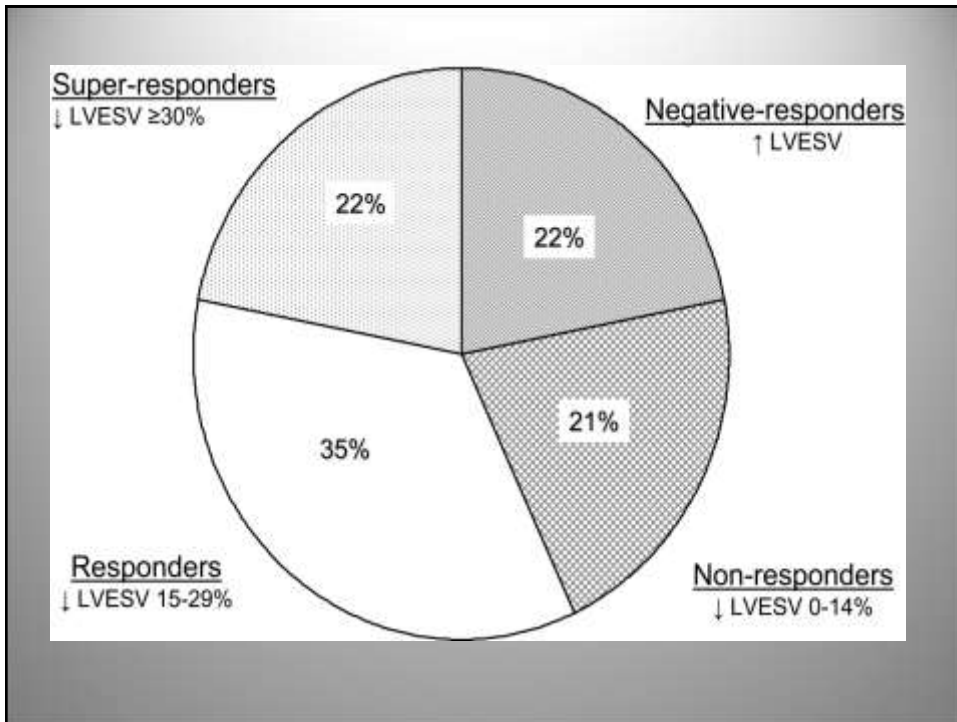
Outcome measures

- ***Reduction in heart failure hospitalization***
- ***Reduction in all cause mortality and morbidity***

Non Responders

Unchanged or worsening of

- ***Clinical***
- ***Echocardiographic parameters***
- ***Unprovoked worsening of heart failure***



Non responders What is wrong ?

- Pre – Implantaion .***
- During implantation .***
- Post implantation .***

□ *Pre Implantation*

Pre implantation

- *Patient selection : (MADIT CRT ,
REVERSE ,COMPANION)*
- *1- female gender respond more*
- *2- Non ischemic cardiomyopathy
respond more .*
- *3-Associated co morbidities (renal ,
hepatic)*
- *4-ECG*
 - *LBBB respond more than RBBB
and IVCD*
 - *Wider QRS >150 msec respond*

□ Echo parameters :

- **marked LV dilatation (LVEDV > 240 ml)**
- **Poor EF less than 20 %**
- **severe MR**
- **Absent dysnchrony by different echo parameters .**
- **Posterolateral scar (better by MRI)**

During Implantation

□ LV lead position

□ Multisite pacing

LV lead positioning

❑ Conventional site :

- Posterolateral vein
- Basal (not apical)

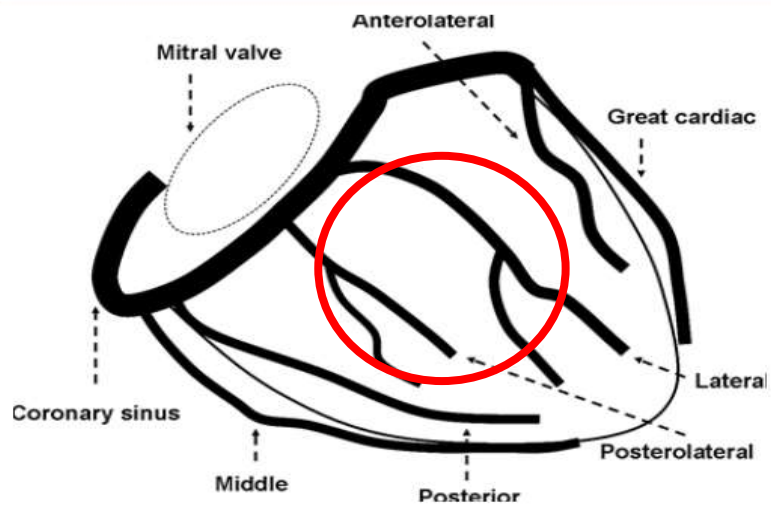
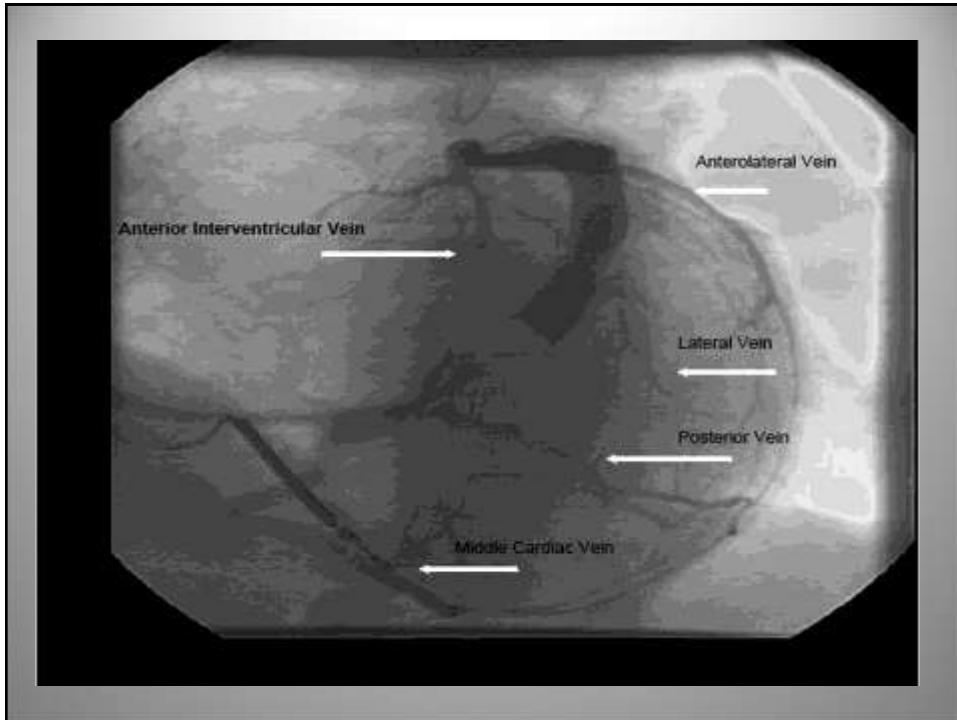


Figure 1 Schematic representation of coronary sinus anatomy.



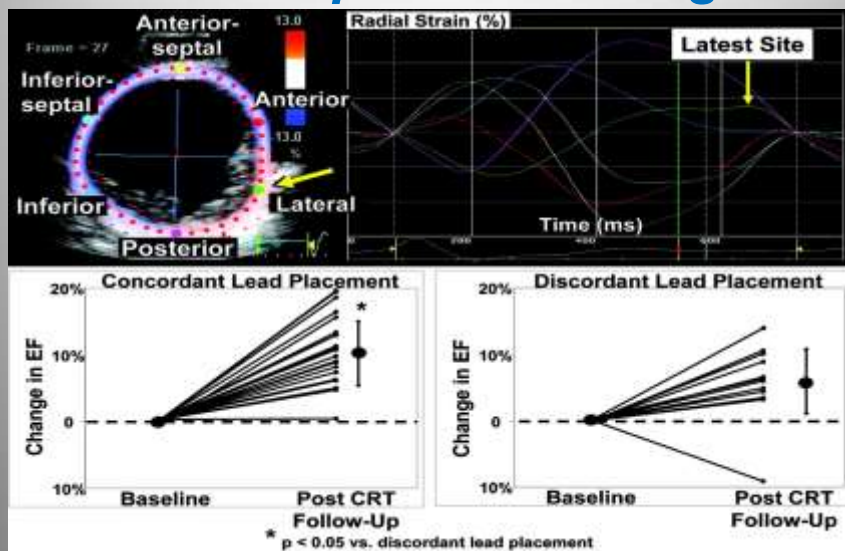
Conventional Vs targeted lead position

- ❑ *Mechanical targeting (latest mechanical Activation)*
- ❑ *Electrical activation (QLV)*

Mechanical targeting

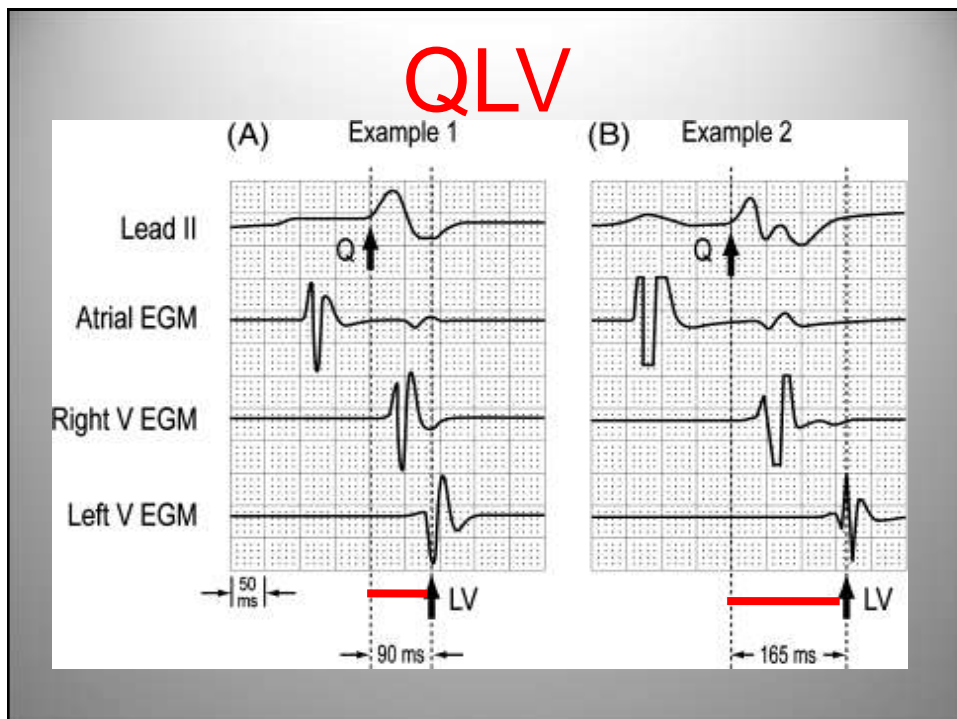
- Targeting The latest area of mechanical activation
 - ❑ **Target Study**
 - Targeted LV lead has more favorable reverse remodeling than conventional positioning
 - ❑ **STARTER Study**
 - Showed reduction in heart failure hospitalization with targeted LV lead

Targeted LV lead radial Speckle tracking



Electrical Targeting

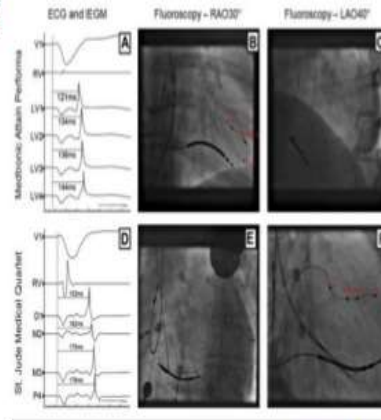
- *Comprehensive mapping of electrical activation in patients with LBBB shows significant heterogeneity in the location of line of functional block .*
- **QLV** : *measures electrical activation between QRS onset on surface ECG to local activation of LV lead*



SMART AV trial

Electroanatomical-guided placement

- QLV interval - time of onset of the QRS complex ("Q") on the ECG and the local depolarization at the LV lead electrode ("LV") on IEGM.
- QLV is related to acute response, reverse remodeling, and long-term outcome.
- Long QLV intervals (>95 ms) were associated with
 - increase in reverse remodeling and quality of life.
 - also result in higher maximal rate of left ventricular pressure rise (dP/dtmax), with a 10-ms increase in QLV leading to a 1.7% to 2.0% increase in dP/dtmax .



A and B) Electrocardiogram (ECG), intracardiac electrogram (IEGM) of atrial rhythm, obtained with the **Stable EP system** (St. Jude Medical Systems, Minneapolis, Wisconsin) (B, C, F) Fluorocopy images of 2 implantations of cardiac resynchronization therapy with quadripolar leads. Image A to C represent a case with an implanted **Stable EP system** (St. Jude Medical) into the coronary sinus to left ventricular ablation (LVA) interval of anterior rhythm of atrial fibrillation (AF) and LVA (LAO and RAO views, respectively). The differences between the QLV intervals of the **Stable EP system** (B to F) are mostly larger (150, 160, 170, and 170 ms). LAD = left anterior oblique, LA = left ventricular, RAO = right anterior oblique, RAO = right ventricular.

J Cardiovasc Electrophysiol 2012;23:1237-45 J Cardiac EP 2014; 25: 624-30
Management of CRT non responders - a practical guide

Multi site Pacing

- ❑ **Multisite stimulation has emerged as way of potentially overcoming non-response.**
- ✓ **This may be achieved by the use of multiple leads placed within the coronary sinus and its tributaries (dual-vein pacing)**
- ✓ **or more recently by the use of multi polar (quadripolar) left ventricular pacing leads which can deliver pacing**

Multiple Leads

- ❑ **The concept of MSP using multiple leads is based on the hypothesis that pacing at multiple points within the ventricles will improve cardiac resynchronization.**
- ❑ **Two different pacing modalities have been proposed using multiple leads:**
 - ✓ **the first using two RV leads and one LV lead,**
 - ✓ **the second using one RV lead and two LV leads inserted in the two separate tributaries of the CS**

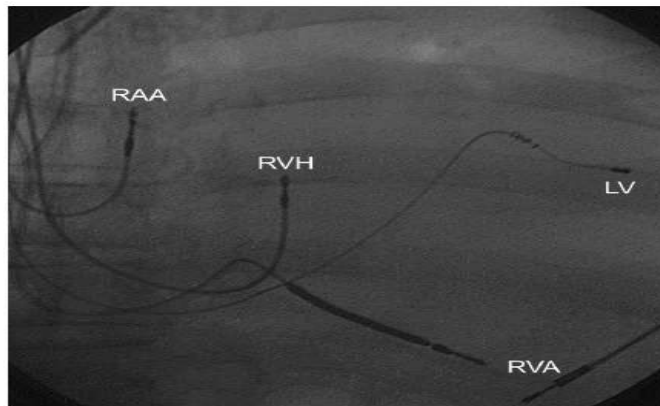


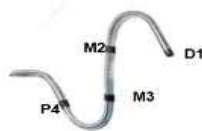
Figure 1 Representative example of a successfully implanted CRT system with four leads. Fluoroscopic image in anterior-posterior view showing a single right atrial appendage lead (RAA); two right ventricular leads (right ventricular septal close to His Bundle [RVH] and right ventricular apex [RVA]) and lateral left ventricular lead (LV).

Quadripolar leads

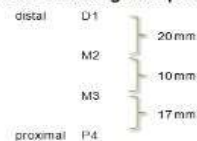
- ❑ **Quadripolar leads offer evident advantages by offering more pacing configurations (up to 17 vs. up to 6) .**
- ❑ **which may alleviate the problem of high thresholds, avoid PNS, or at least offer an adequate safety margin (LV vs. phrenic nerve capture**

Quadripolar Pacing Technology MultiPoint™ Pacing

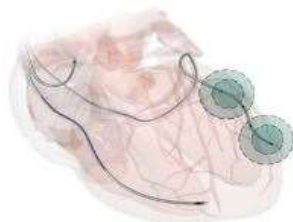
Quartet™ LV Lead 1458Q



Electrode naming and spacing

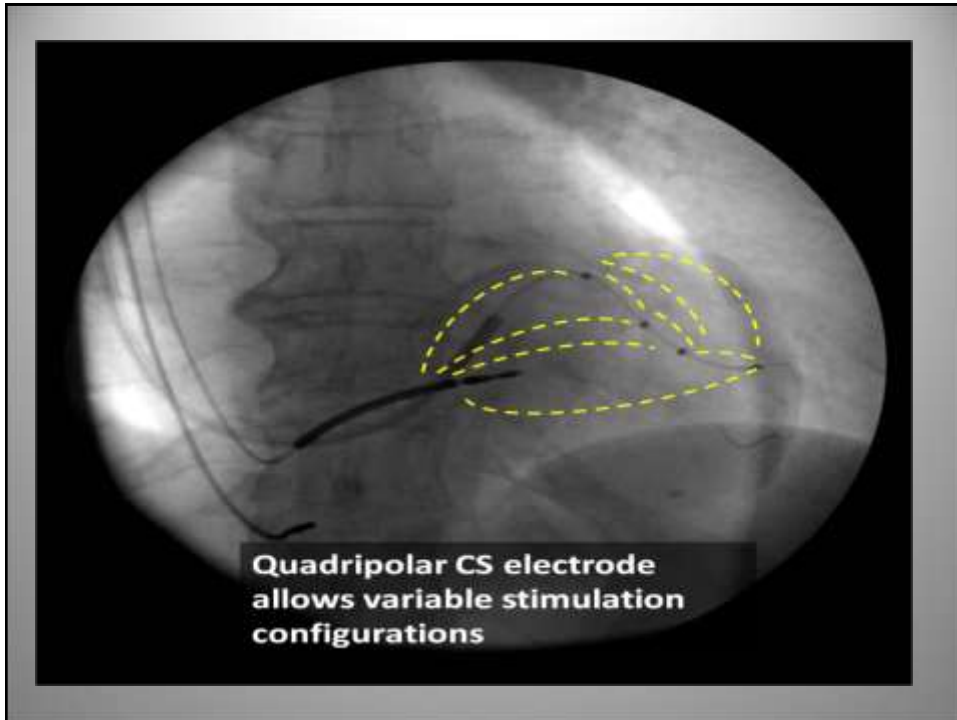


Ability to pace from 2 LV sites with programmable delays



LV1 and LV2
VectSelect™
options

vector	Cathode to Anode
Vector 1	Distal 1 to Mid 2
Vector 2	Distal 1 to Proximal 4
Vector 3	Distal 1 to RV Coil
Vector 4	Mid 2 to Proximal 4
Vector 5	Mid 2 to RV Coil
Vector 6	Mid 3 to Mid 2
Vector 7	Mid 3 to Proximal 4
Vector 8	Mid 3 to RV Coil
Vector 9	Proximal 4 to Mid 2
Vector 10	Proximal 4 to RV Coil



Post Implantation

- I- Non cardiac***
- II- Cardiac (Non Device)***
- III- Cardiac (Device***

I- Non cardiac

- ✓ **Aneamia**
- ✓ **Thyroid disorders**
- ✓ **Sleep Apnea**
- ✓ **Drug toxicity**
- ✓ **Renal problems**
- ✓ **Depression**
- ✓ **Pulmonary disease**

II - Cardiac (non device)

- ✓ ***Residual ischemia***
- ✓ ***RT sided heart failure***
- ✓ ***Volume status***
- ✓ ***Arrhythmia (PVCs , VT , AF)***
- ✓ ***Non Optimized medical therapy***

Arrhythmia and non responders

Atrial fibrillation

- ❑ ***Attacks of AF with rapid ventricular response lead to decrease **BIV Pacing percentage** and Loss of atrial kick .***

❑ Management

- ✓ ***Rhythm control : Amiodarone***
- ✓ ***Rate control : digitalis , BB***
- ✓ ***Triggering Mode .***
- ✓ ***AVN Ablation***

Ventricular tachycardia

- Scar related VT
- BBRVT (bundle branch re entry VT)

□ Management

- ✓ *Medical therapy : Amiodarone*
- ✓ Upgrade to CRT-D
- ✓ Ablation (Right bundle ablation with BBRVT
And ablation for scar related VT)

***High PVC burden >10,000
/24h***

Impair BLV pacing

- ✓ *Check first atrial undersensing*
- ✓ *Medical therapy : amiodarone*
- ✓ *Ablation*

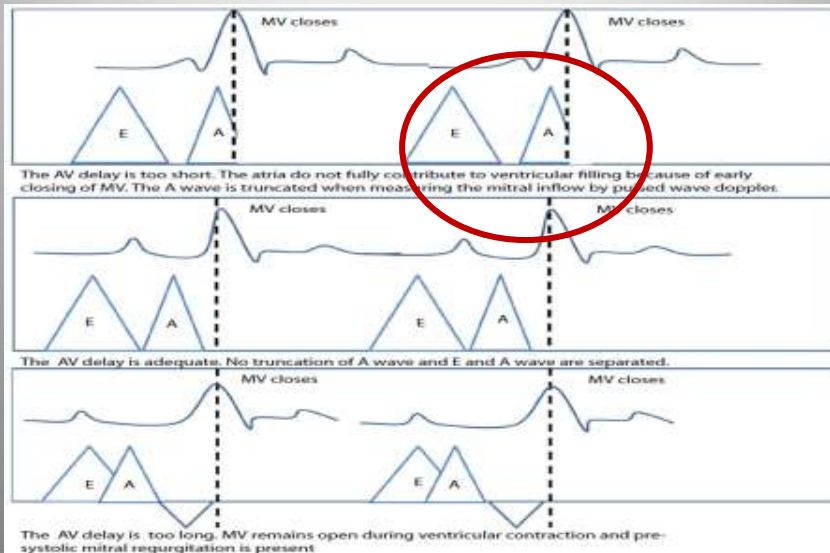
III- Cardiac (Device related)

- AV interval Optimization**
- V-V optimization**
- BIV pacing less than 99 %**
- ✓ **Fusion and pseudo fusion**
- ✓ **Atrial undersensing (high PVC burden)**
- ✓ **Arrhythmia**
- ✓ **Lead malcapture**
- ✓ **Anodal stimulation**

AV interval optimization

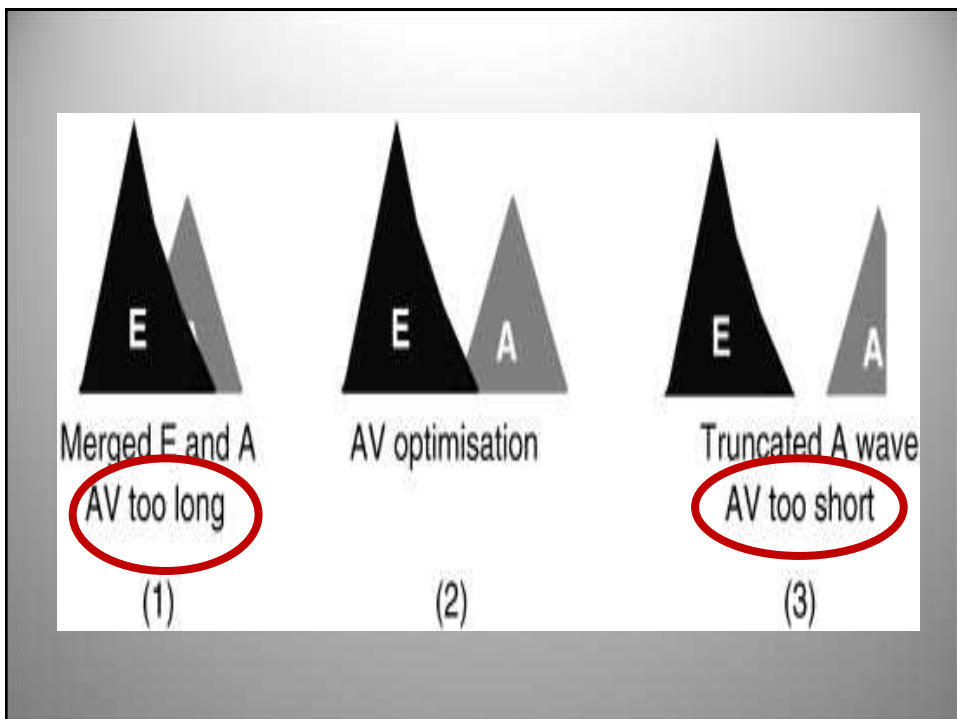
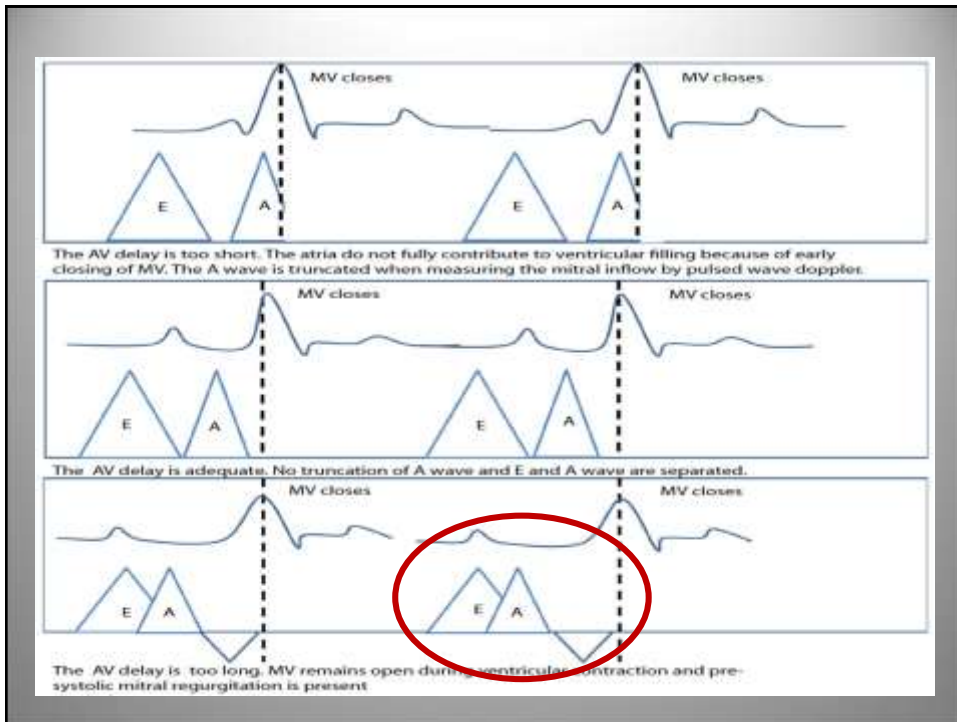
- **Default AV Interval (110-120 msec)**
- **To allow BIV pacing before intrinsic AV conduction occur**
- **BUT this could lead to ???**

**Short AV interval
lead to premature valve closure
Truncation of A wave**

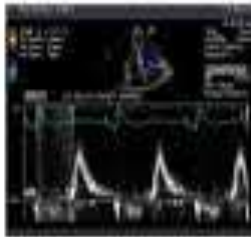


Lengthen AV interval ?

- Loss of CRT BIV pacing due to intrinsic AV conduction and possible fusion .**
- Diastolic MR**



Effect of AV Delay on LV Diastolic Filling Pattern



Short AV Delay
50 ms

- A-wave truncated
- Less time for filling
- Atrial contraction against a closed Mitral valve



Long AV Delay
280 ms

- Fused A and E wave
- Less time for filling
- Pre-systolic Mitral regurgitation



Optimized AV Delay
200 ms

- Max diastolic filling time
- Mitral closure occurs at end of A wave

Iterative method

- ❑ ***Must be done using ECG guided to verify that Optimum AV interval not Lead to ***intrinsic AV conduction or Fusion*** .***
- ❑ ***Give drug lead to AVN delay***

V- V Optimization


□ Default

Simultaneous LV –RV pacing

- **LV Latency** : **time between LV lead discharge and actual LV capture .**
- **SO** ,, **pre excite LV by LV Latency time to allow simultaneous LV –RV capture**

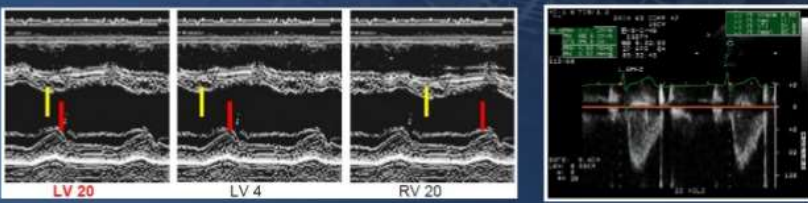
Echo V- V Optimization

- **Echo base LVOT VTI measurements**
- **M mode and doppler method**


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 Taipei Tzu Chi Hospital,
 Buddhist Tzu Chi Medical Foundation

Echo-guided V-V optimization

- Adjusts sequence & timing of LV & RV pacing, to make the LV as efficient as possible, and to produce an optimal stroke volume
- Either M-mode or VTI can be used for V-V optimization.

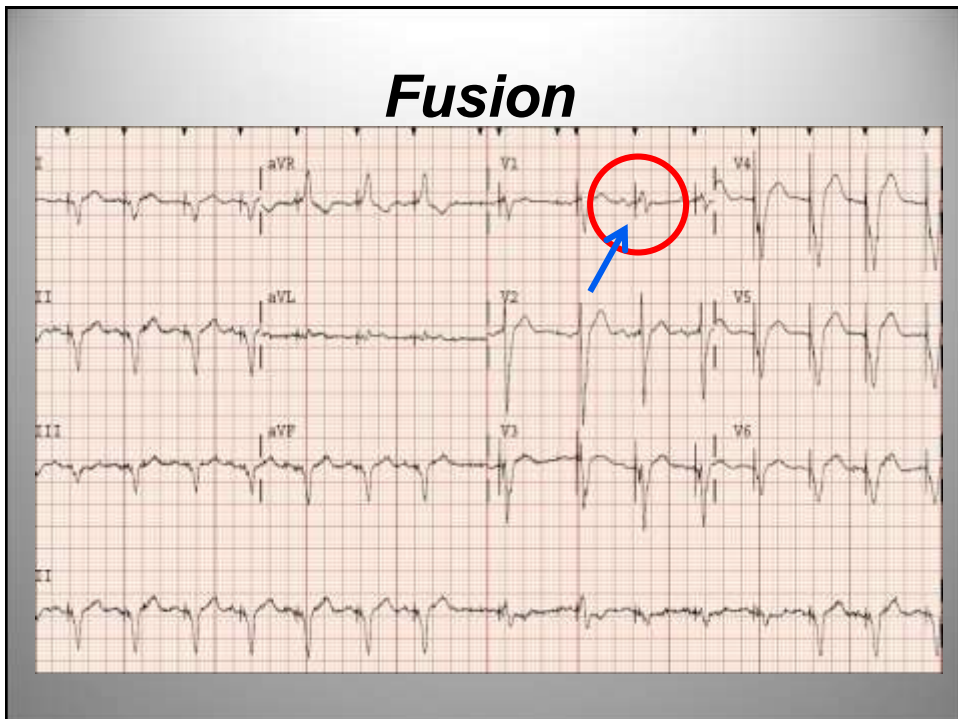
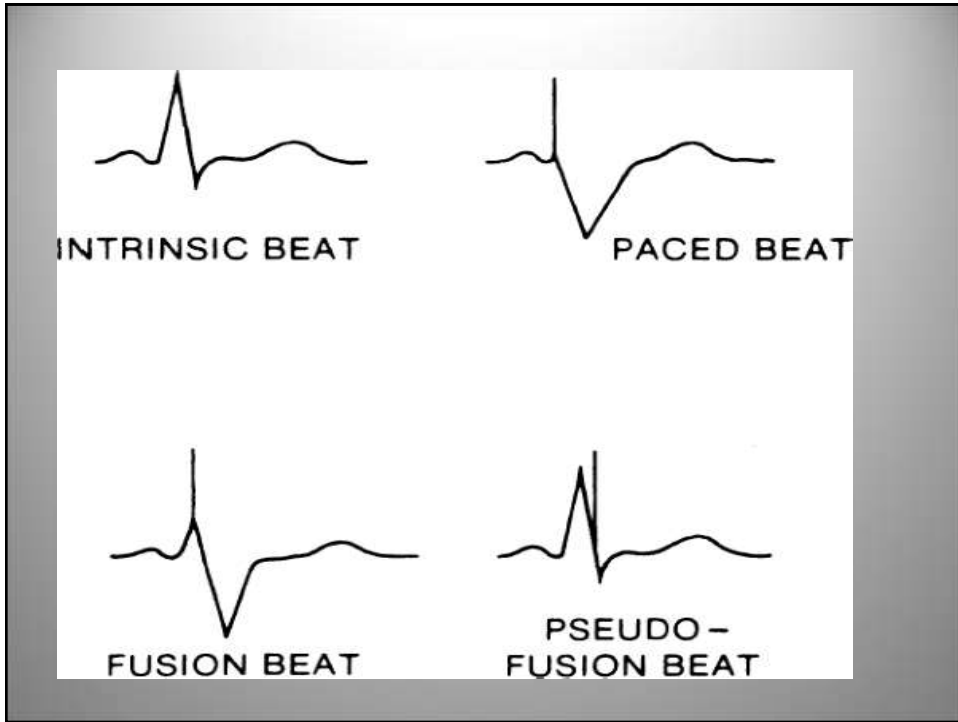


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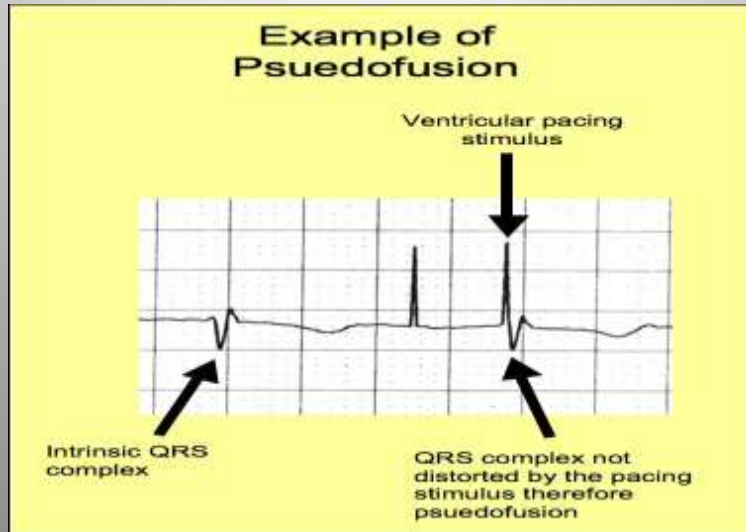
Fusion and Pseudofusion

Fusion : ventricle being activated by spontaneous activation and paced impulse

Pseudofusion : superimposition of inefficient pacemaker spike on spontaneous QRS

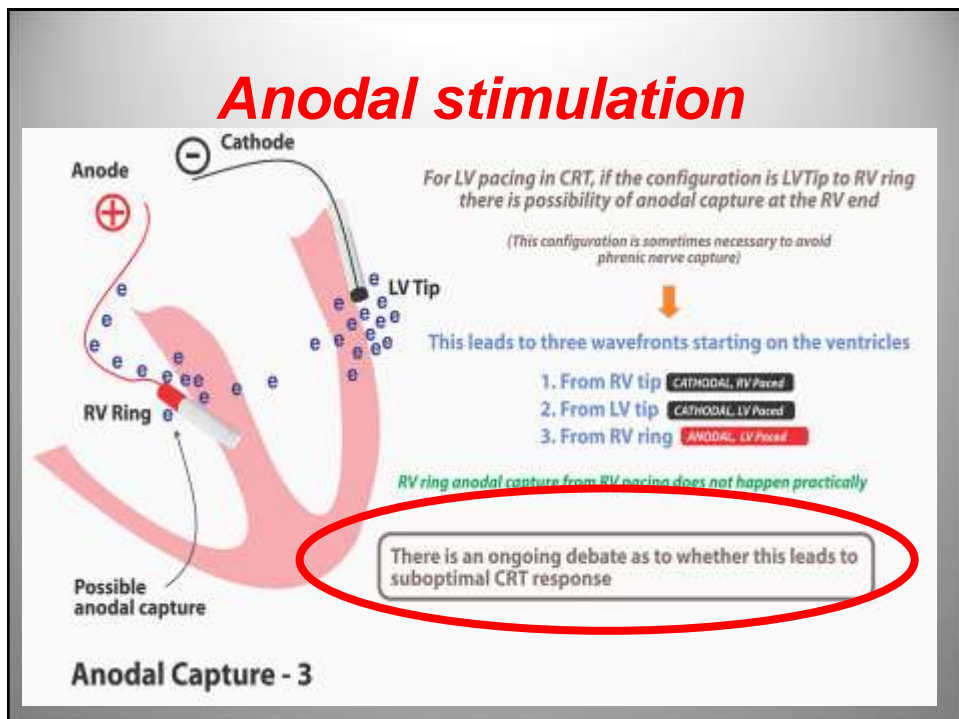
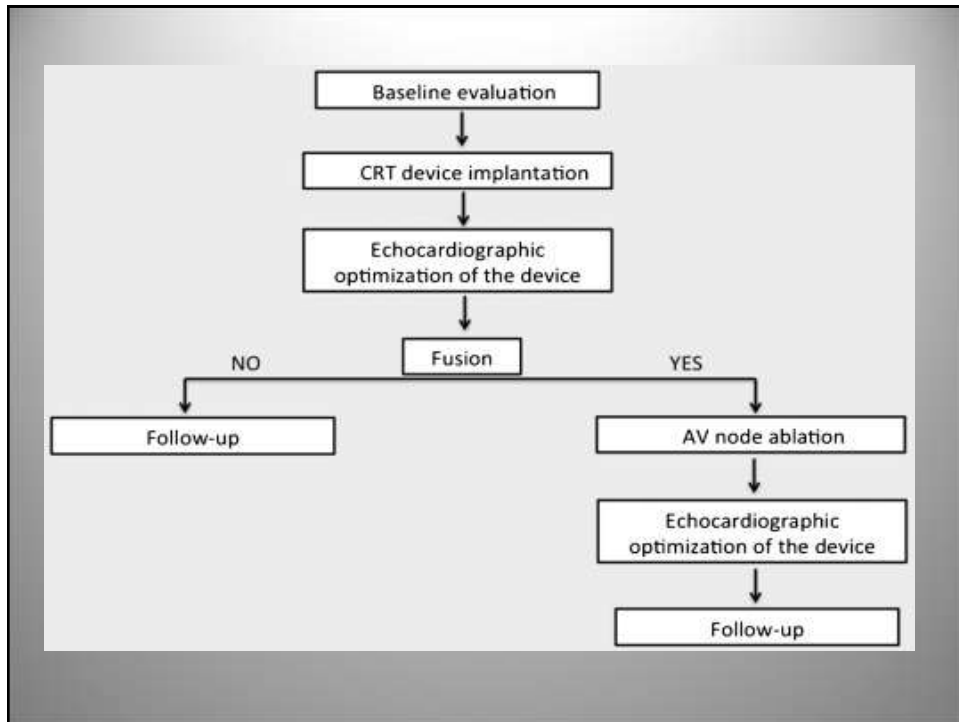


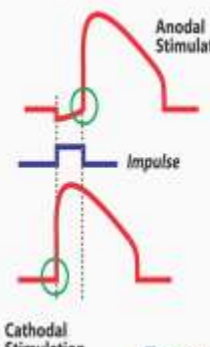
Pseudofusion



❑ Fusion and pseudofusion :

- ***Give false impression of Biv Pacing more than 99 % during programming***
- ***So holter study is recommended and meticulous examination of QRS morphology is warranted***





Anodal Stimulation

Anodal capture is associated with short refractory periods

Theoretically, anodal stimulation can initiate a capture in the relative refractory period of the myocardium of the preceding beat (i.e. a paced R on T)

which may lead to a VT/VF

This can occur only,

During fast heart rates in a background of ischemia / electrolyte disturbance while pacing from equal size high output bipolar electrodes

Cathodal Stimulation

To prevent anodal capture, the anode must be large as possible (to reduce electron density)

or use unipolar pacing

In practice, most of the "ring" electrodes are floating in blood (especially when implanted septally) and hence anodal capture is a theoretical concern.

Anodal Capture - 2

BUT, there is an ongoing concern for CRT as certain configurations of LV pacing can cause anodal capture

Role of holter study

- ***Detect fusion and pseudofusion***
- ***Detect burden of PVCs***
- ***Detect arrhythmia burden***

Conclusion

- Problem of Non Responders***
- ✓ ***Could be preventable***
- ✓ ***Could be manageable***
- ***So choose well , and operate well , and Optimize well***

Thank you