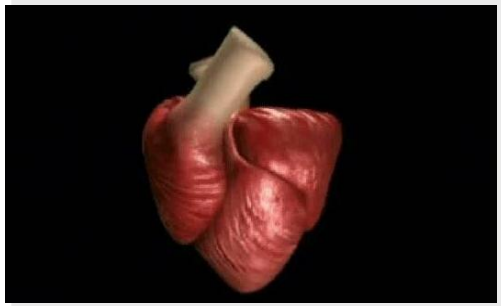
Effect of Pacing Site on Left Ventricular Dyssynchrony and Cardiac Performance

연구비 발표



울산의대 서울아산병원 심장내과

송재관, 김대희, 서정숙, 이은영, 김윤정, 서덕진,
송종민, 김성환, 남기병, 강덕현, 최기준, 김유호

Chronic RV Pacing
Deleterious Effects on Cardiac functions

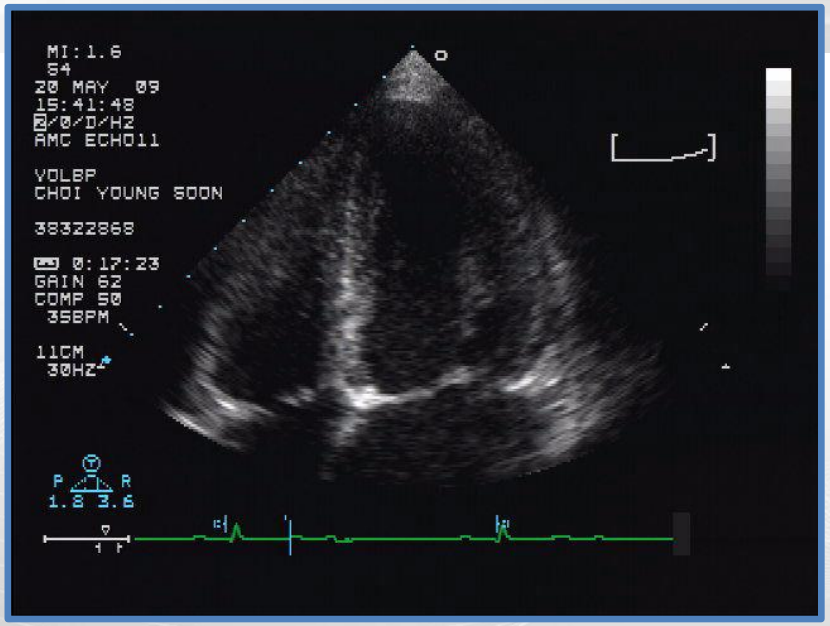
- **Chronic RV pacing: detrimental effects on cardiac functions & outcomes**

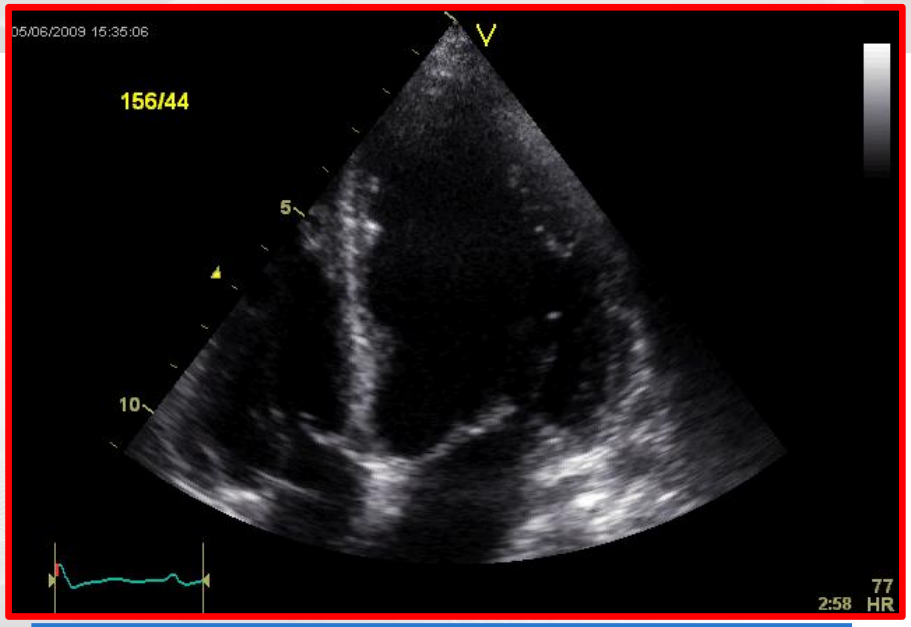
  - Direct electronic stimulation of RV apex induces **abnormal activation sequence** and **asynchronous contraction**

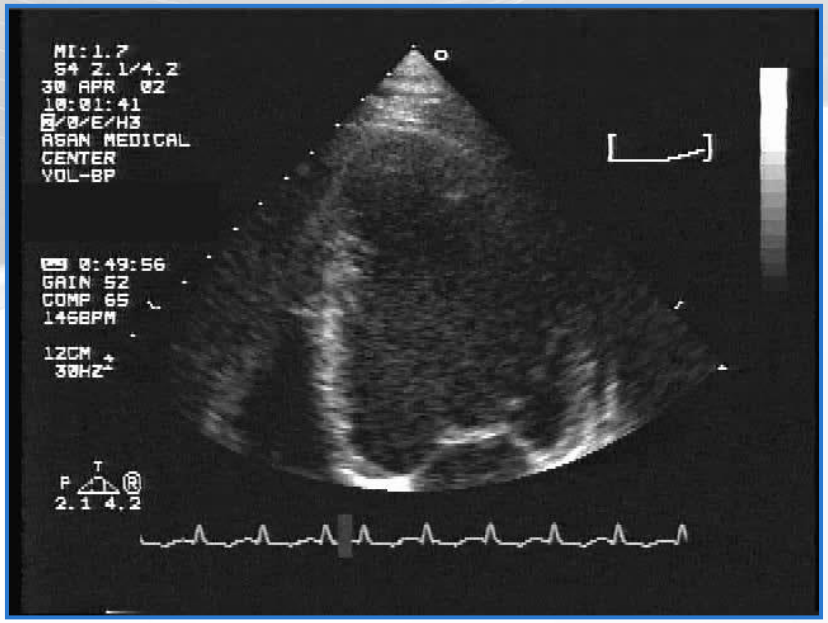
  - Higher incidence of **chronic heart failure**, **atrial fibrillation** and **thromboembolic complication** compared to atrial pacing *Andersen et al. Lancet 1997*

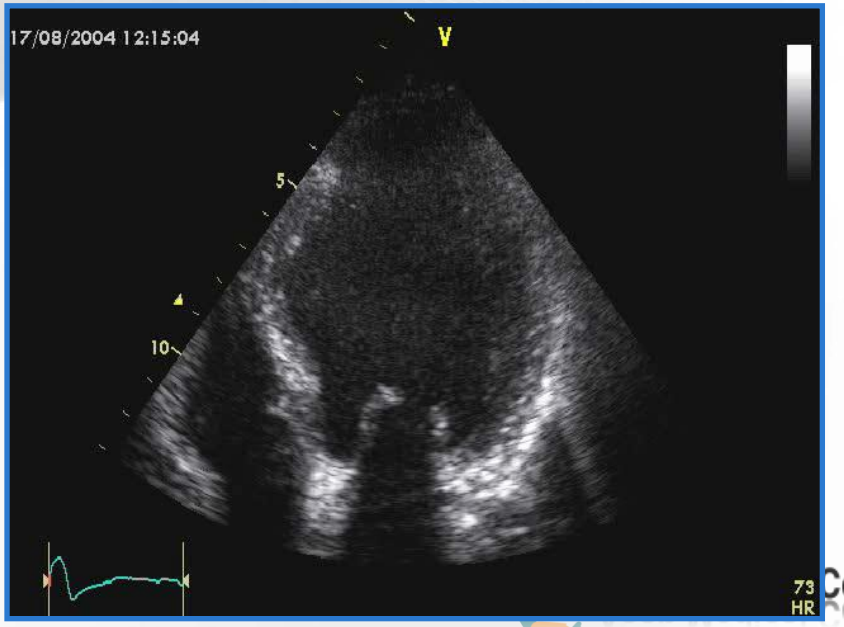
  - Higher risk of **morbidity & mortality**

RV Pacing: Hemodynamic Impact









RV Pacing: Hemodynamic Impact

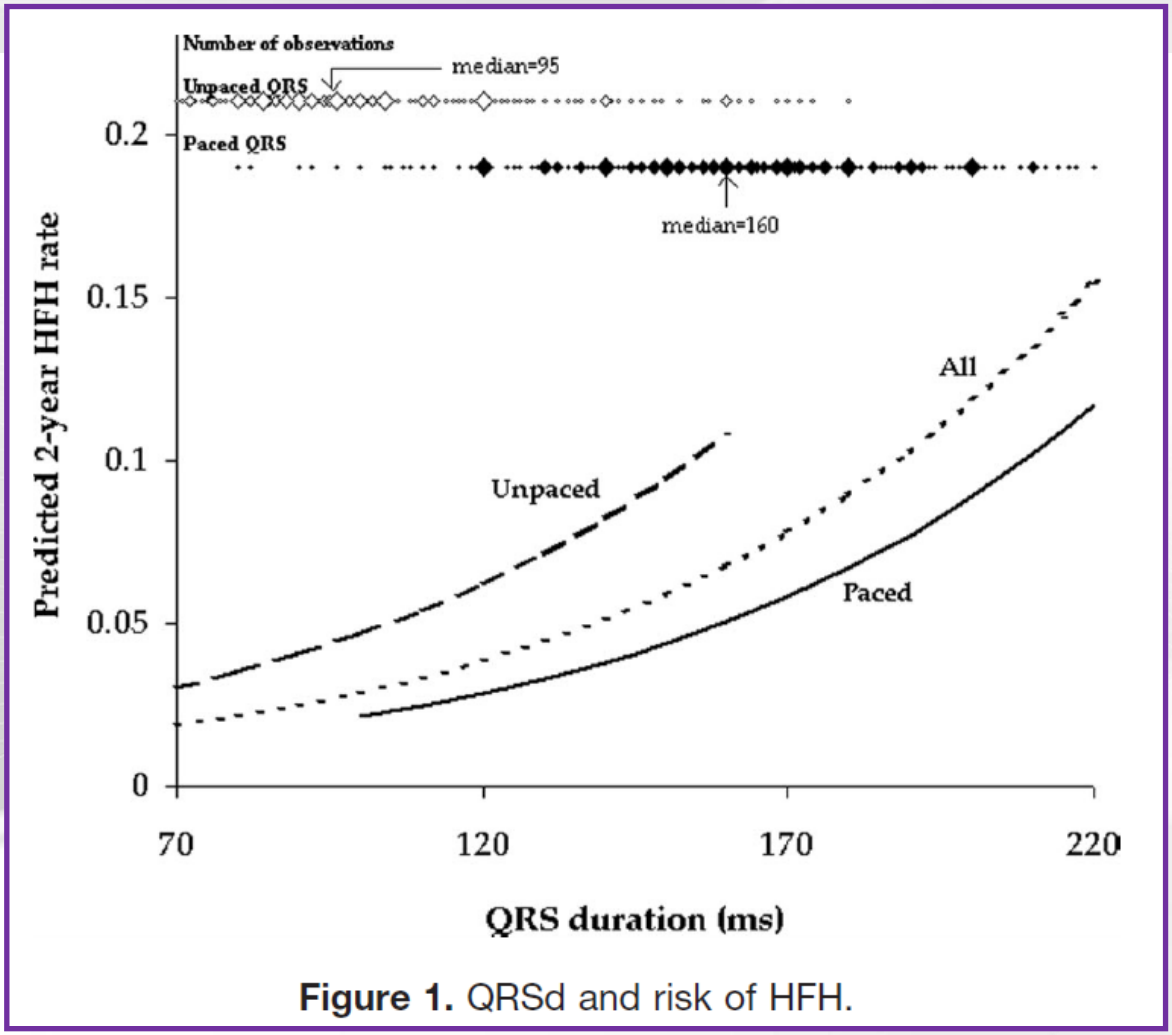


Figure 1. QRSd and risk of HFH.

MOST (Mode Selection Trial)
2010 patient, 6-yr-trial

Circulation 2006;113:2082

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Chronic RV Pacing
Effects of Pacing Site on Cardiac Funcitons

- **Alternative site pacing : pacing site other than apex in RV**

  - **RV apex pacing induced LV mechanical dyssynchrony**

    Liu et al. JASE 2007

  - **Superiority of septal pacing compared to apical pacing in terms of hemodynamic parameters**

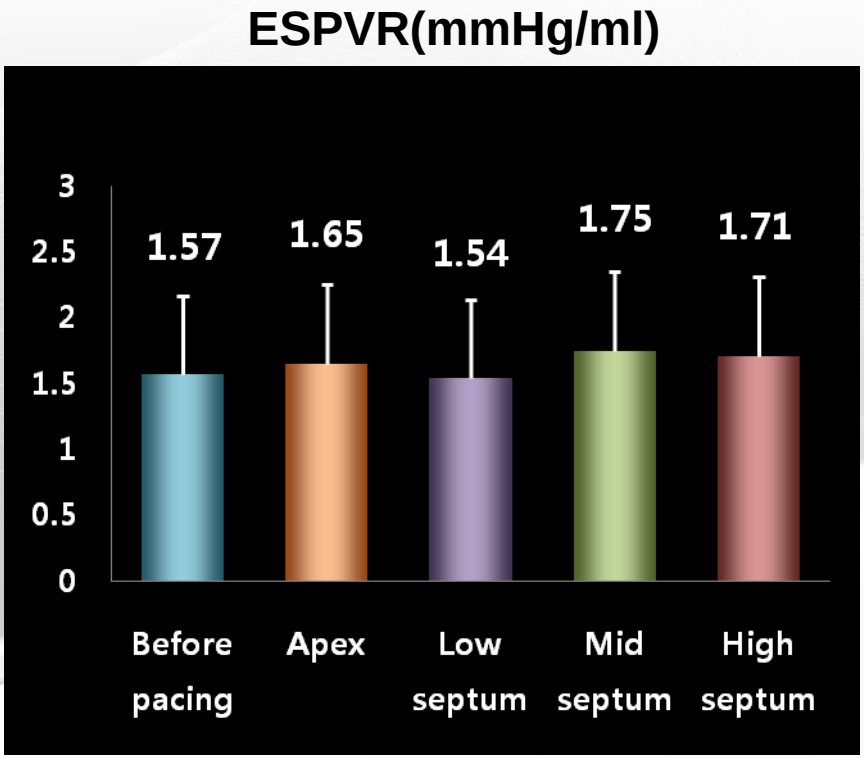
    TAKAGI et al. PACE 1999

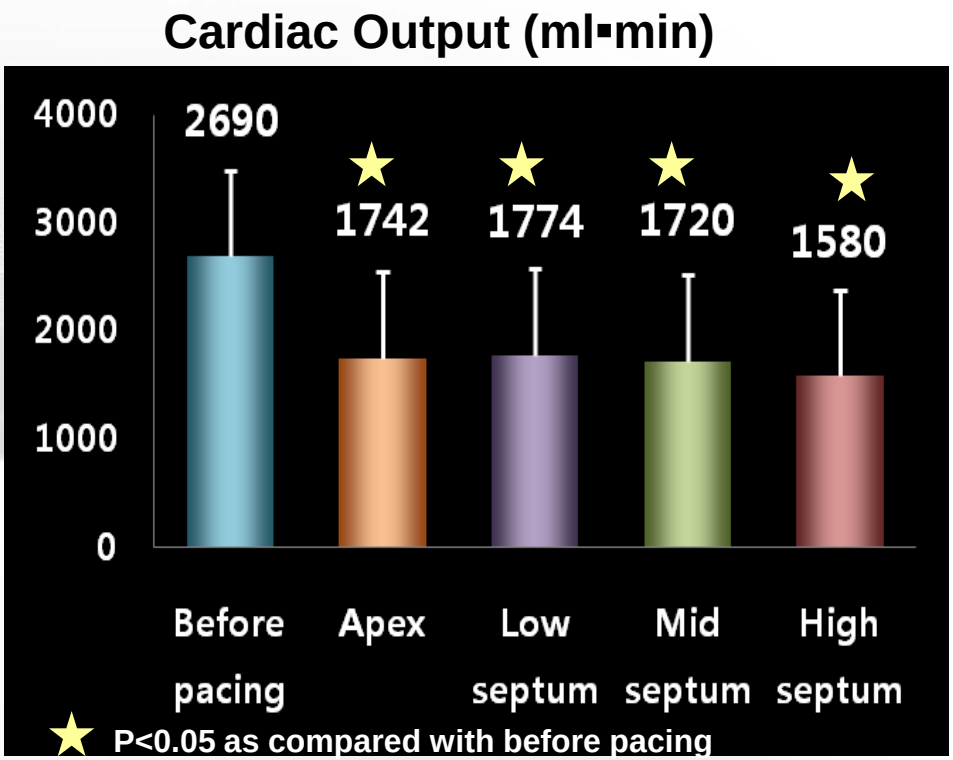
  - **RVOT pacing prevents the long-term deleterious effects of RVA pacing on myocardial perfusion and function**

    TSE el al. JACC 2002

RV Pacing

Effects of Pacing Site on Cardiac Funcitons





Seo et al . KSC annual meeting 2009

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Aim of study

- To evaluate the immediate effects of different pacing site on cardiac performance

- We evaluated the differences between atrial and apical pacing and between septal and apical pacing in terms of dyssynchrony indices and LV systolic function

Methods

Enrollment

- From Jan 2007 to Oct 2009
- Patients who underwent **permanent pacemaker** implantation were prospectively enrolled
- **Group I** : **22** patients with atrial pacing (AAI or AAIR)
- **Group 2** : **20** with RV septal pacing (DDD or DDDR)
- **Group 3**: **28** with RV apex pacing (DDD or DDDR)

Methods: Enrollment

- Conventional echocardiography: before and after implantation
- Tissue Doppler imaging (TDI) and speckle tracking echocardiography (STE) : within 7 days after pacemaker implantation
- Exclusion criteria
  - LV EF<50% before implantation
  - Bundle branch block
  - Atrial fibrillation
  - Presence of coronary heart disease
  - Previous cardiac surgery

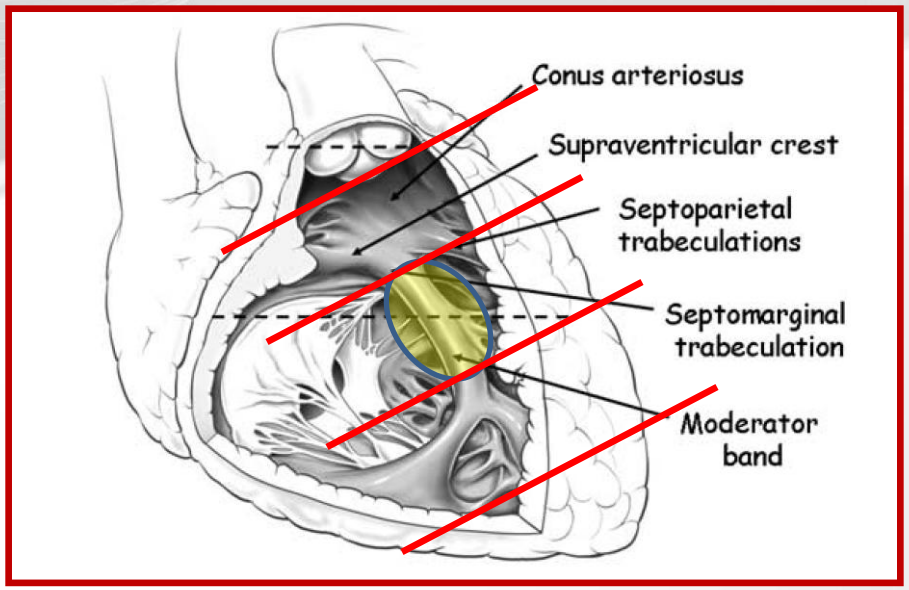
Methods

Lead position

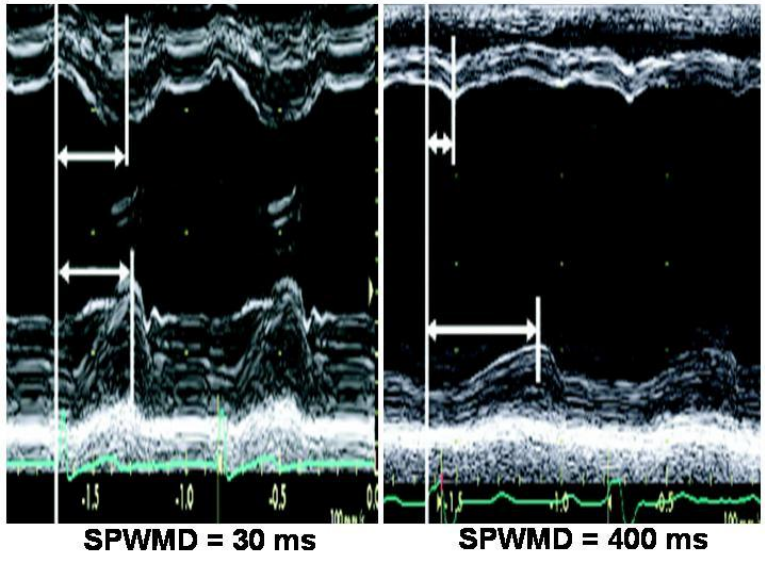
- Atrial pacing lead- right atrial appendage
- Ventricular pacing lead
  - Apex
  - Septum : mid septum (mid 1/3 portion)

    -screwed into mid septum under the RV outflow tract

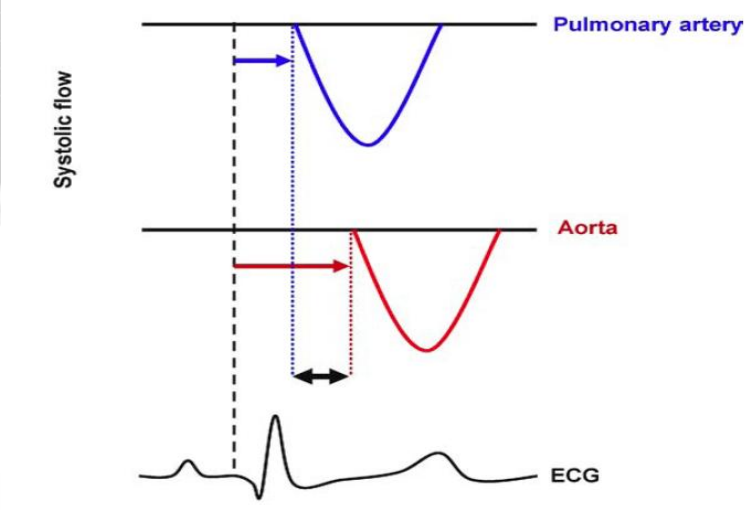
    -septal position of the lead was verified in the left anterior oblique (LAO) view



Method: Interventricular Dyssynchrony, SPWMD



Septal to posterior wall motion delay



Interventricular Dyssynchrony index

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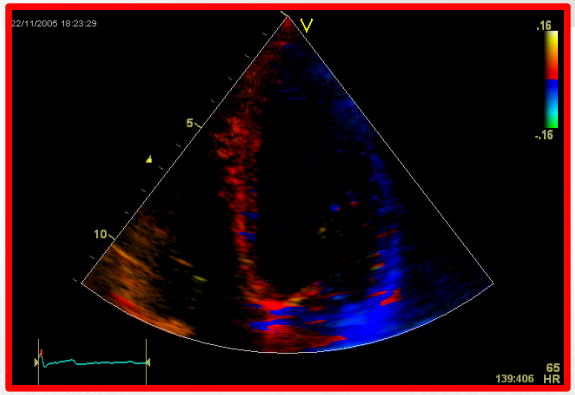
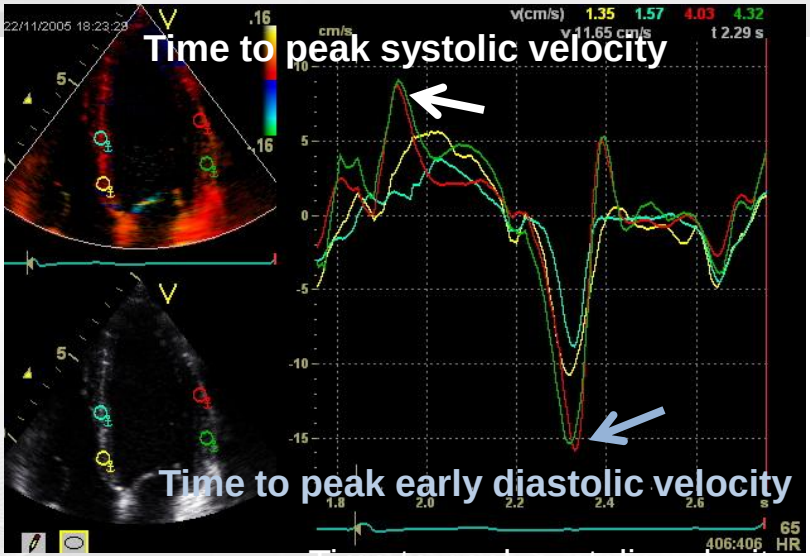
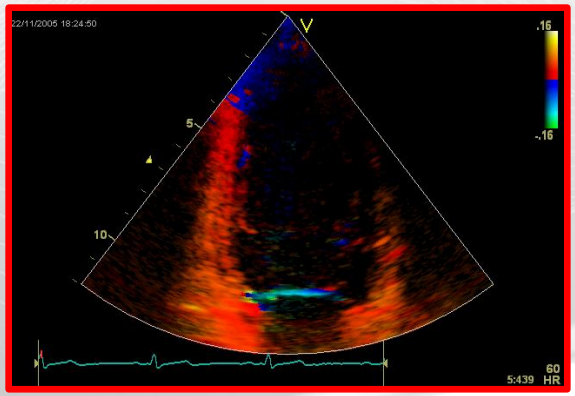
Dyssynchrony indices by TDI



A4C



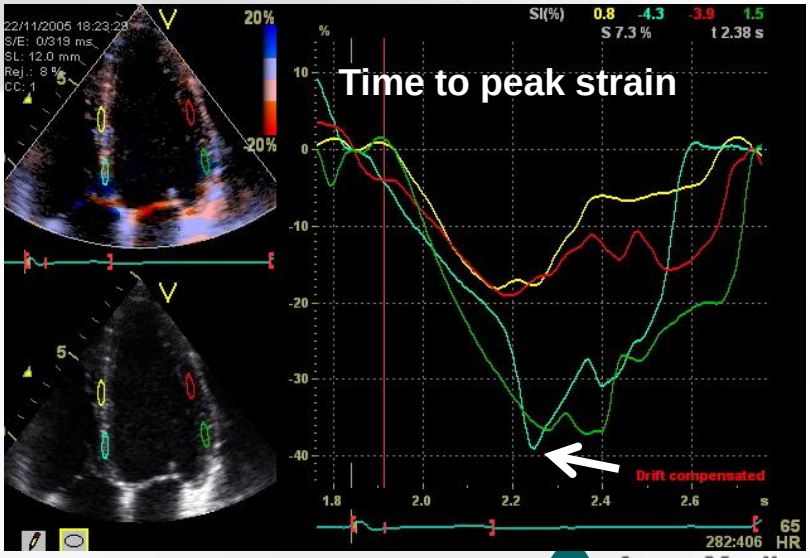


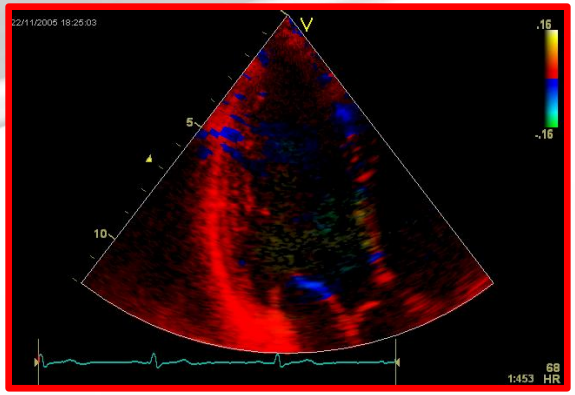
A2C

T_s -SD 12

T_e -SD 12

T_{st}-SD 12





A3C

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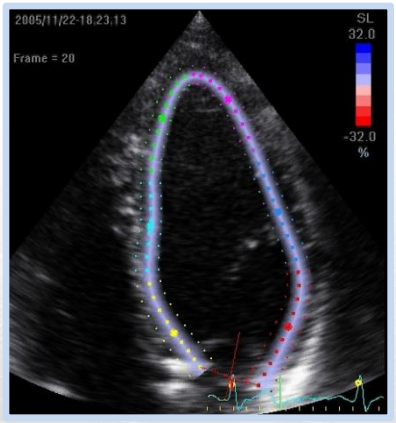
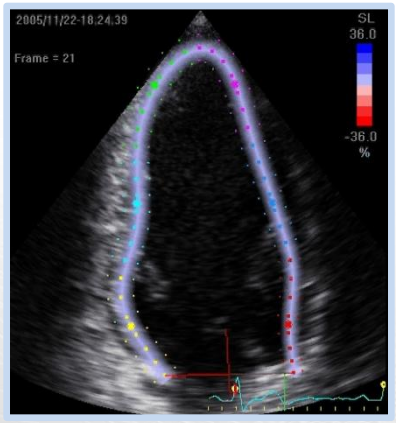
Dyssynchrony indices by STI:
longitudinal strain



4ch



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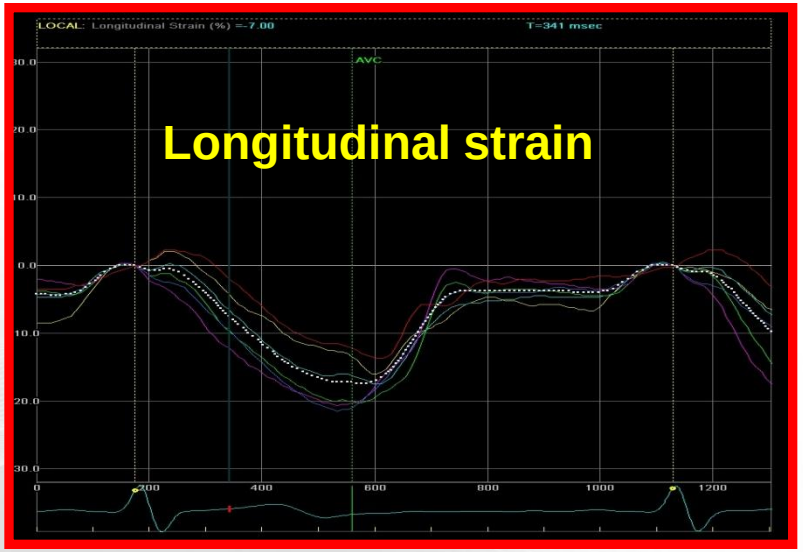
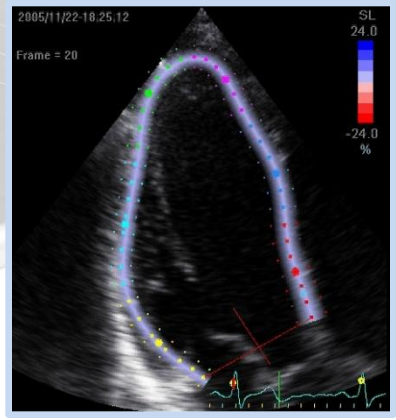
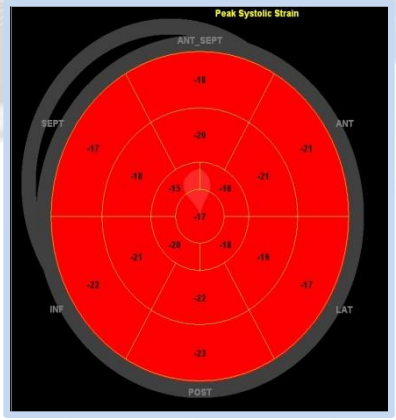




ALAX



GLS

T_{st}-SD 18

Tst-SD6 by STI (apex only)

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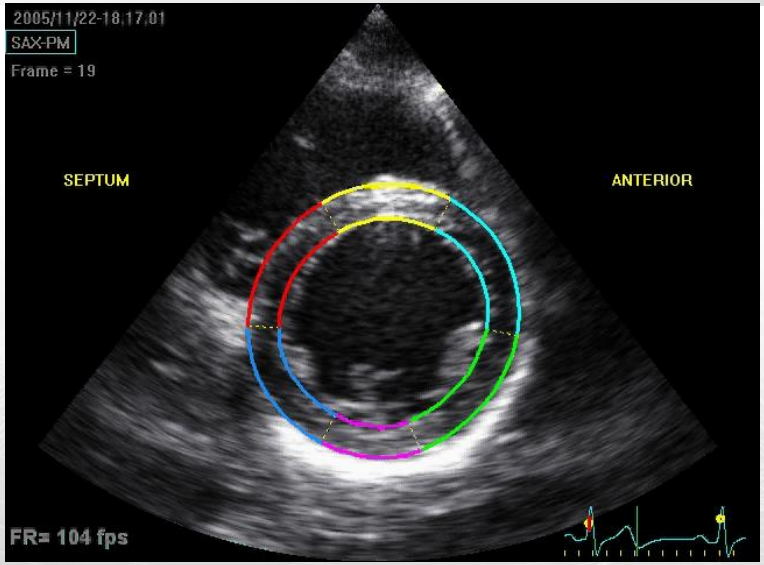
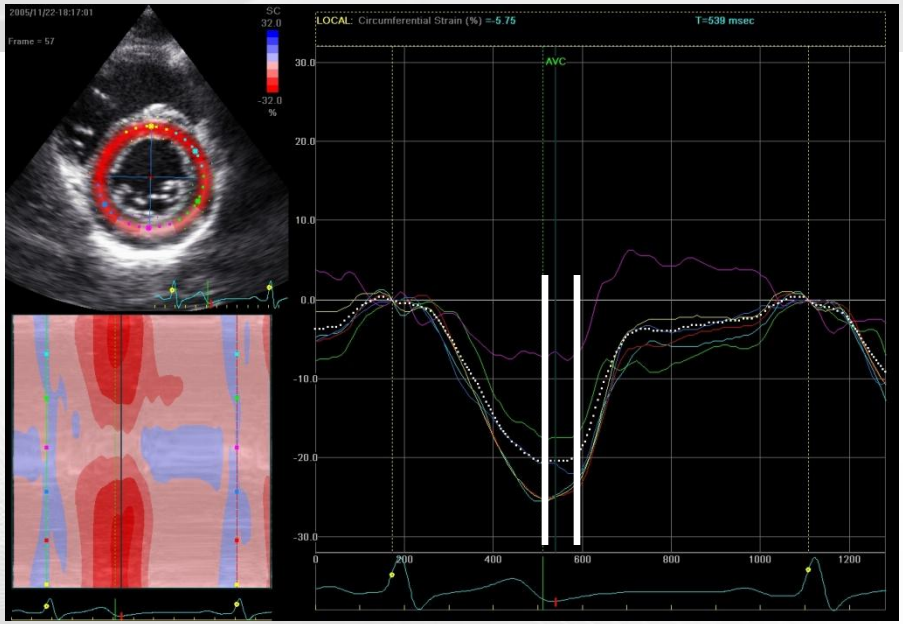
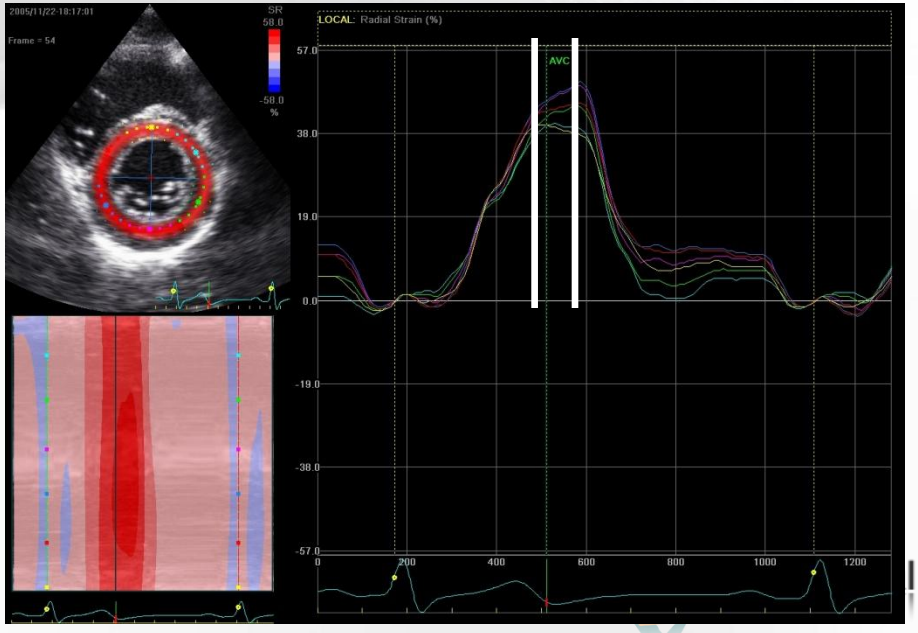
Dyssynchrony indices by STE

Radial & circumferential strain







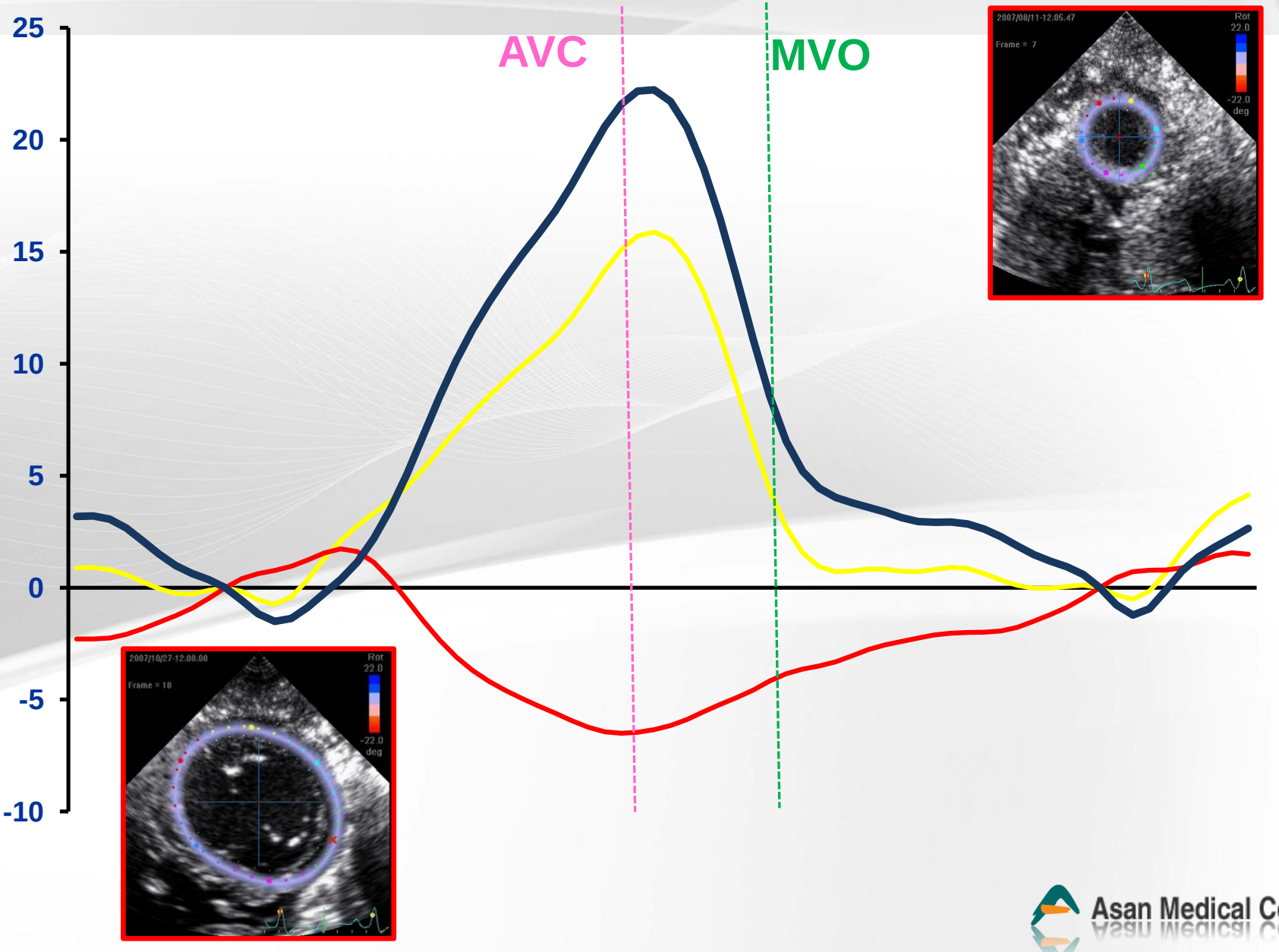
Radial strain

Maximal time difference

Circumferential strain

Maximal time difference

LV twisting & untwisting



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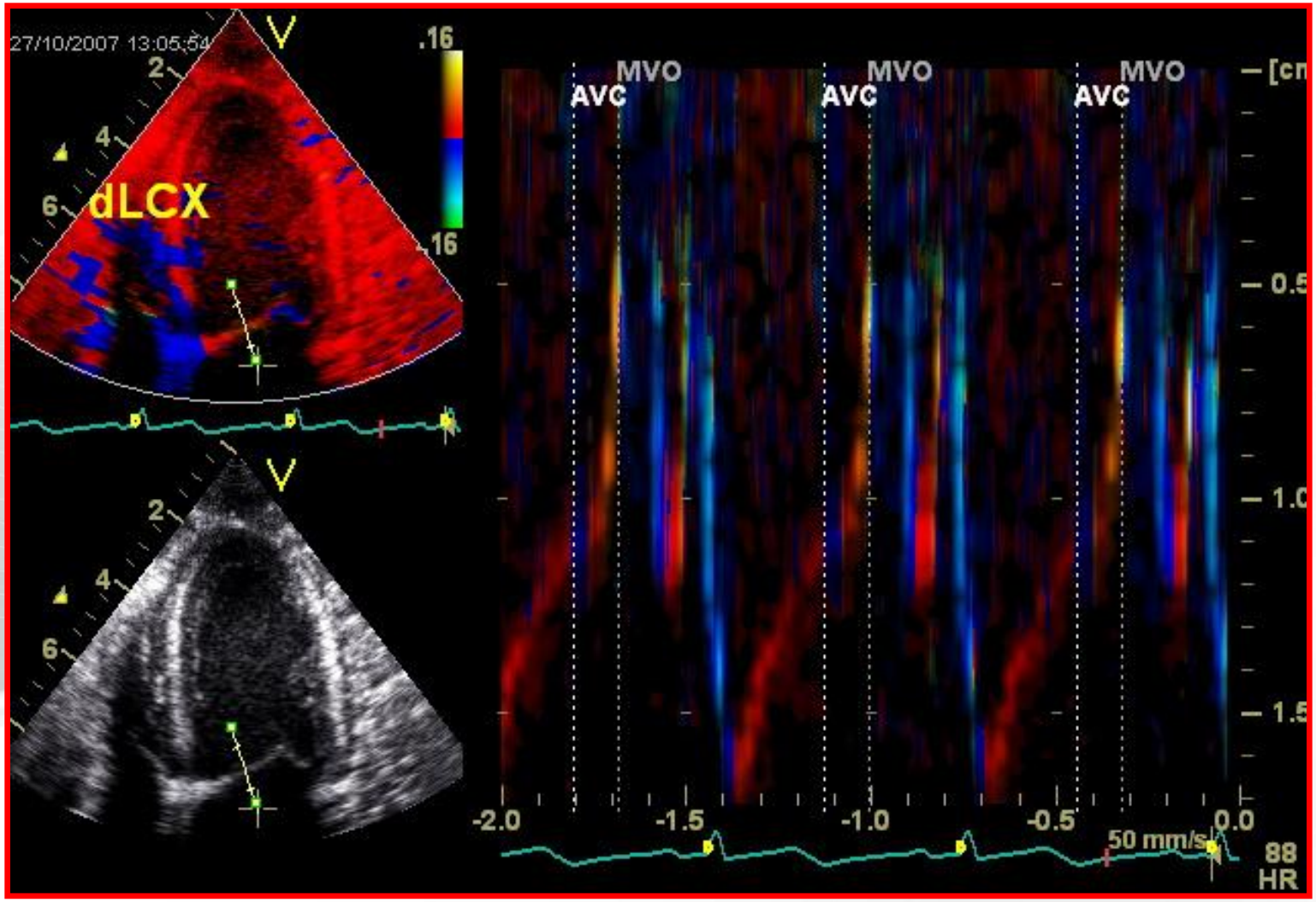
Determination of event timings



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Result

Result

	Group I (atrial pacing)	Group II (Septal pacing)	Group III (apical pacing)
Age (years)	63±17	63±11	64±12
Male(%)	41	50	47
Pre QRS duration(ms)	99±15	105±24	102±21
Post QRS duration(ms)	100±21	156±26*	153±23*
Heart rate (BPM)	64.5±13.1	68.5±9.7	67.4±9.1
Pre ESV (ml)	36.1±5.8	46.0±12.3	45.2±23.1
Pre EDV (ml)	94.3±13.1	99.2±21.3	102.3±19.1
Post ESV (ml)	38.1±6.4	44.0±17.6	46.8±25.3
Post EDV (ml)	95.5±15.1	97.8±27.9	101.3±33.7
Pre EF (%)	63±4	61±5	62±6
Post EF (%)	60±3	55±6*	56±6*

*p<0.05 for difference from Group I.

Result

	Group I (atrial pacing)	Group II (Septal pacing)	Group III (apical pacing)
Mitral inflow			
E (cm/s)	69±20.6	59±15	62±18
A (cm/s)	69±21	73±23	72±17
DT (ms)	223±48	216±52	197±53
Mitral annulus TDI			
Sm (cm/s)	8.3±1.7	7.1±1.3	7.3±1.4
Em (cm/s)	5.7±2.0	5.8±2.8	6.3±7.0
IVRT (ms)	79±22	100±31*	95±36*

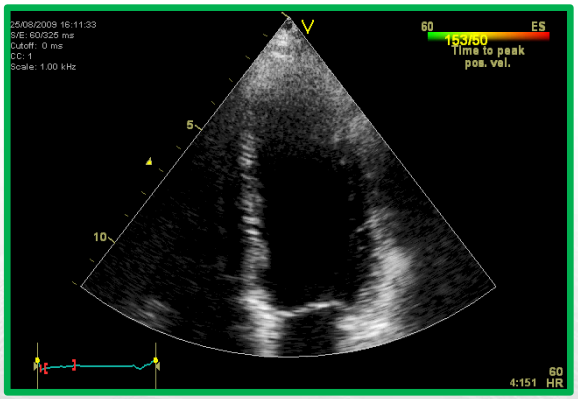
*p<0.05 for difference from Group I.

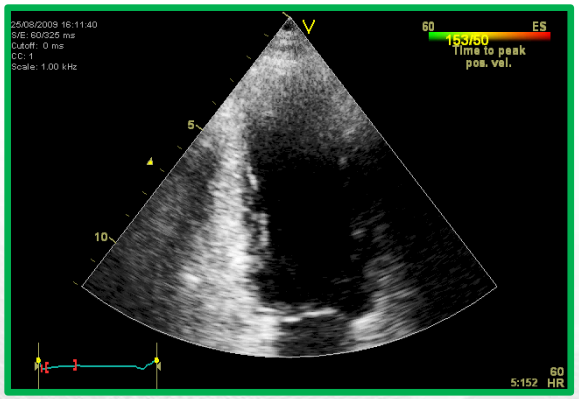
Result

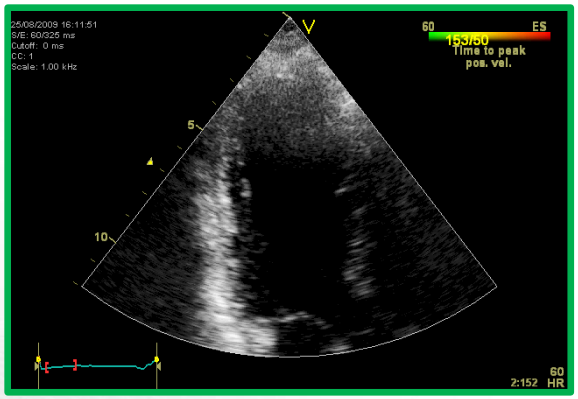
	Group I (atrial pacing)	Group II (Septal pacing)	Group III (apical pacing)
Inter-ventricular dyssynchrony index	15.7±14.5	24.5±16.8	26.6±19.8
SPWMD	78.4±22.8	90.3±41.5	72.8±30.1
Ts-SD12 by TDI (ms)	39±21	36±11.2	42.4±18
Te-SD12 by TDI (ms)	25±7	36±24	34±29
Tst-SD12 by TDI (ms)	62±17	73±21	72±24
Tst-SD18 by STI	52±15	69±21*	73±16*
Tst-SD6 by STI (apex only)	38±17	69±21*	68±31*
LV global longitudinal strain by STI	-25±6	-21±5	-20±4
Radial dyssynchrony index	74±53	103±50	88±52
Circumferential dyssynchrony index	121±44	126±44	129±44
Basal rotation	-6.8±2.6	-5.7±3.4	-6.3±3.4
Apical rotation	14.1±5.3	9.9±5.5*	10.8±5.5*
LV twist	21.0±6.8	16.1±6.0*	16.3±5.7*

*p<0.05 for difference from Group I.

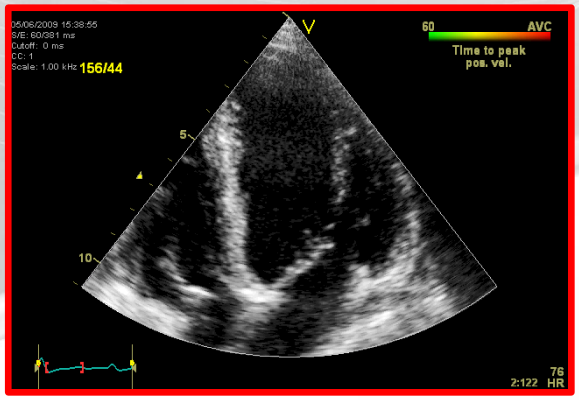
Result

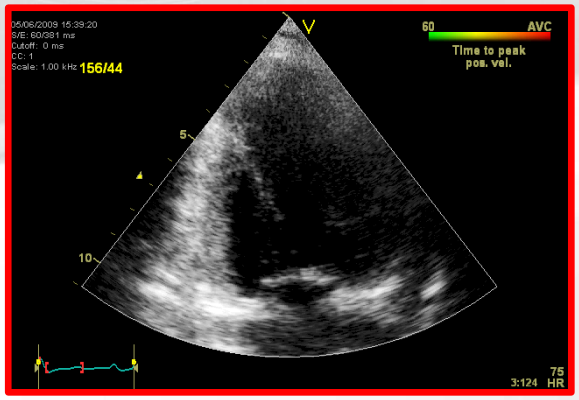


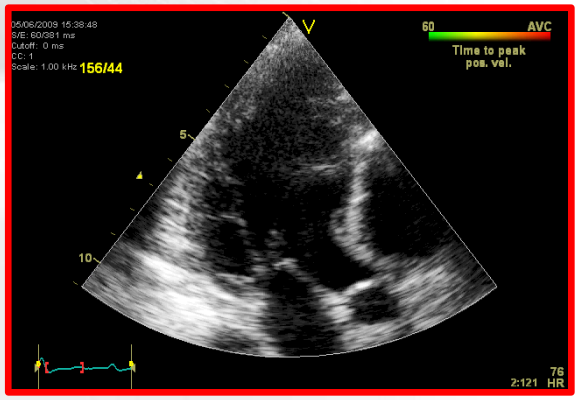




Atrial pacing







Ventricular pacing

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Summary

- **Ejection fraction** and **apical peak rotation degree** were significantly higher in atrial pacing group compared to RV pacing group (septum and apex)

- There was no difference in dyssynchrony indices derived from 12 segments between atrial and ventricular pacing

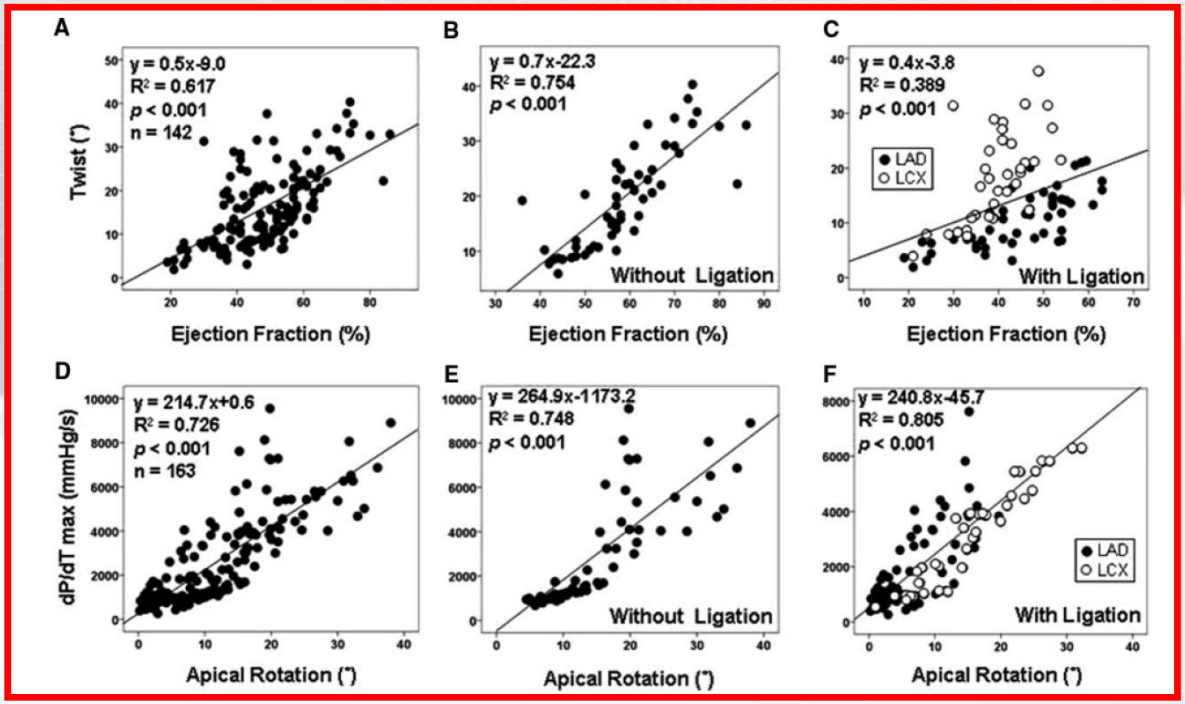
- However, ventricular pacing increased regional heterogeneity of LV apex regardless of pacing site, and led to significant differences in dyssynchrony indices derived from 18 segments

- Any dyssynchrony indices were not different between mid septal and apical pacing group

Summary

Ventricular pacing → **↑ Apical heterogeneity** → **↓Apical rotation** → **↓Global LV Systolic function**

- Importance of apical rotation as an index of global LV systolic function



Kim et al. Circ Cardiovasc Imaging. 2009

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Summary

- High septal pacing vs. mid septal pacing ??

Differences in left ventricular dyssynchrony between high septal pacing and apical pacing in patients with normal left ventricular systolic function

Results: The high septal pacing group had significantly shorter TD-TDI (20.0 ± 24.3 ms vs. 59.7 ± 43.0 ms, $p < 0.0001$), TD-RS (13.5 ± 19.9 ms vs. 45.8 ± 24.6 ms, $p < 0.0001$), and TD-LS (42.7 ± 22.0 ms vs. 66.6 ± 26.8 ms, $p = 0.001$) values compared to the apical pacing group. There was no significant difference in TD-CS between the two groups.
Conclusion: Left ventricular dyssynchrony was smaller in patients with high septal pacing. The results show that 2D-STE is useful for detection of differences in left ventricular mechanical dyssynchrony in patients with permanent pacemaker implantation, in addition to TDI.

Yoshikawa et al. Journal of Cardiology 2010