Role of Dyssynchrony on FMR in Patients with DCM in Association with Geometric Parameters of Mitral Apparatus

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Background

- Functional mitral regurgitation (FMR) occurs commonly in patients with dilated cardiomyopathy (DCM). Its presence increases long-term risk and mortality

- MV tethering secondary to PM displacement and reduction of closing force due to LV dysfunction has been known to be the main mechanism of FMR

Yiu et al Circulation. 2000

Otsuji Y et al J Cardiol. 2008

- Recently, one of the beneficial effects of CRT was shown to be the immediate reduction of FMR due to improved coordinated timing of mechanical activation of papillary muscle insertion sites.

Breithardt et al JACC. 2003
Kanzaki et al JACC 2004

- LV dyssynchrony can potentially contribute to MR

Agricola E et al.J Cardiovasc Med 2008

- LV dyssynchrony is essential to analyze predict FMR severity

Donal E et al. Eur J Echocardiogr. 2008

Objective

- To explore the role of LV dyssynchrony in the mechanism of FMR in DCM in association with the geometry of the mitral apparatus assessed with 3DE

Study population

53 DCM patients (M: F= 29:24 , Age: 62 ± 12 yrs, EF= 28 ± 8 %) with and without significant FMR

- Exclusion Criteria
  - Infiltrative heart disease
  - Organic mitral valve disease
  - Atrial fibrillation
  - Poor window for 3DE
  - Poor cooperation for 3DE

Methods

2D Echocardiography

LV end-diastolic (EDV), end-systolic volume (ESV)
by Simpson's disc method

Ejection fraction (EF) : 100 * (EDV-ESV) / EDV

MR severity: ERO with PISA method

2D Echocardiography

Estimation of LV Dyssynchrony (*EchoPAC, GE. Co.*)

Peak systolic times (PST):

Time from the onset of QRS to peak systole

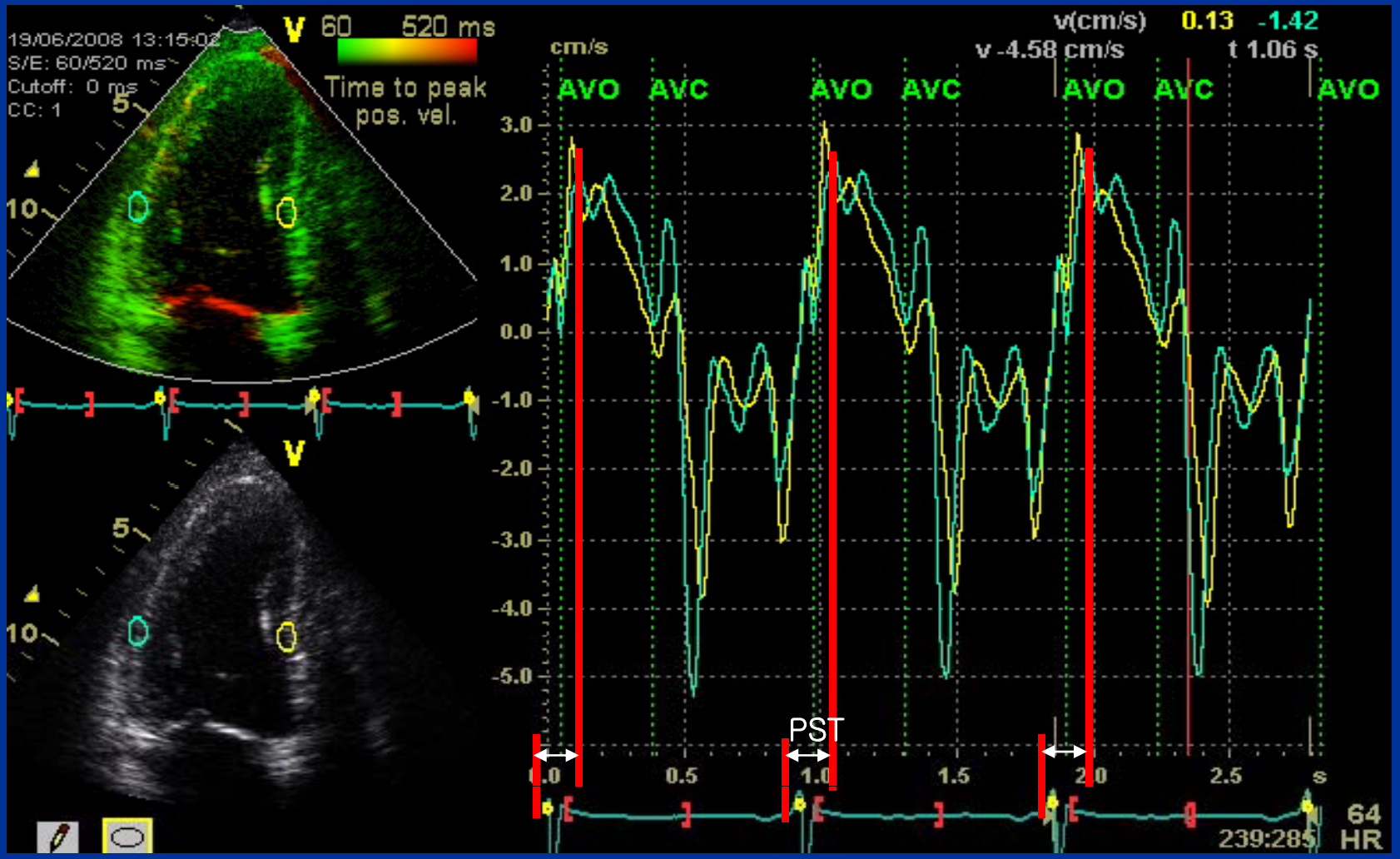
Averaged by 3 PSTs from 3 consecutive heart beats

PST were corrected by the cycle length (CL)

$cPST = PST/\sqrt{R\text{-}R}$

Dyssynchrony Index (DI): standard deviation of cPSTs of eight segments of LV on the apical 2 & 4C planes

Estimation of LV Dyssynchrony



Real-time 3DE

- Full volume image acquisition during 4 heart beats from apical view using a matrix array transducer

  (Live 3D Echo, Sonos 7500, Phillips or Vivid7, GE, Co.)

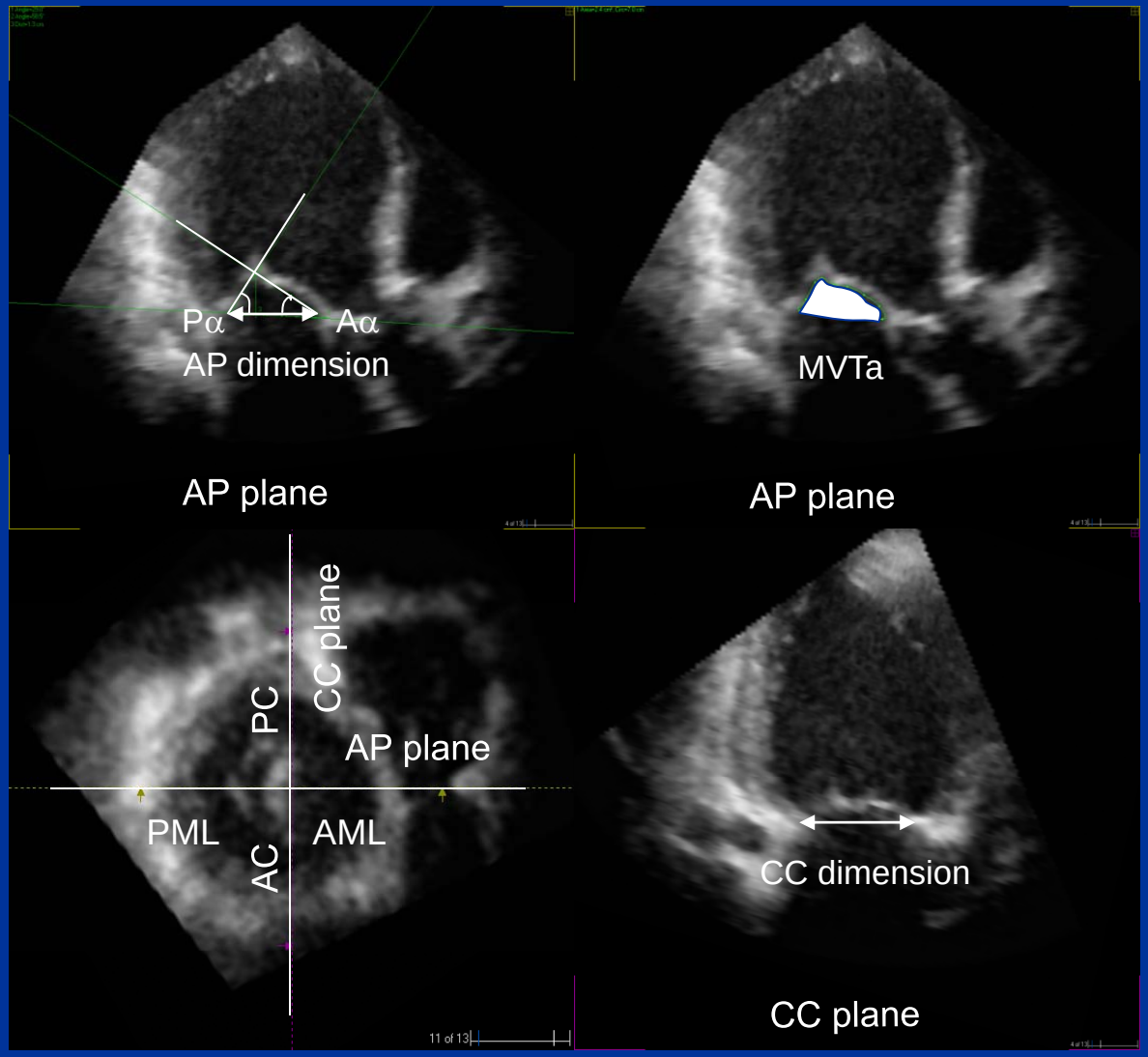
- Off-line MPR (4D Cardio-View, TomTec, Co) guided geometric measurement during mid systole

  Degree of PM (Ant. & Post.) displacement

  MV geometry

승모판륜 면적 = 3.14 × CC 간격 × AP 간격 / 4

MPR guided MV geometry measurement



Measurements

Pα : tethering angle of PML

Aα : tethering angle of PML

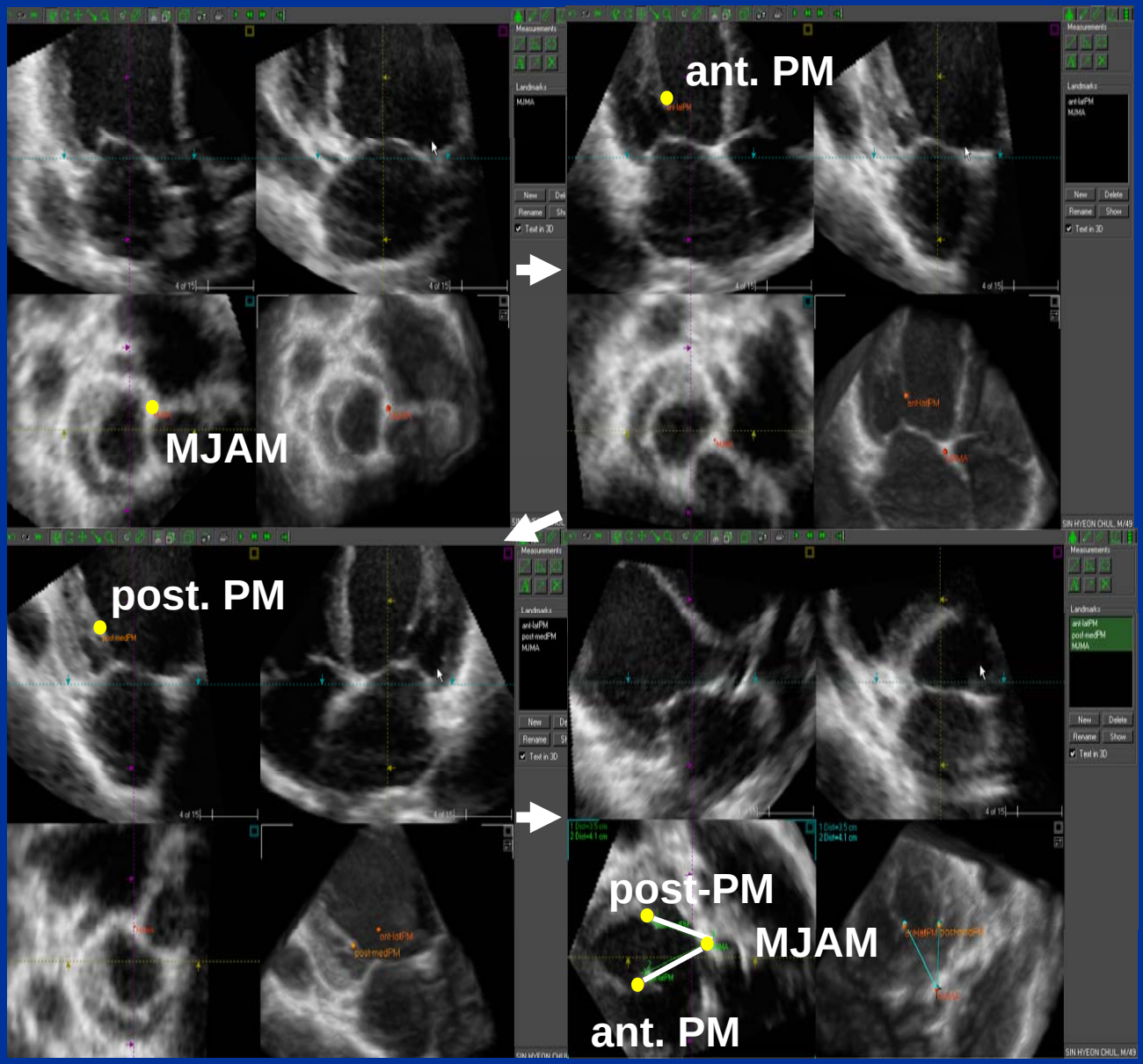
MVTa: MV tenting area

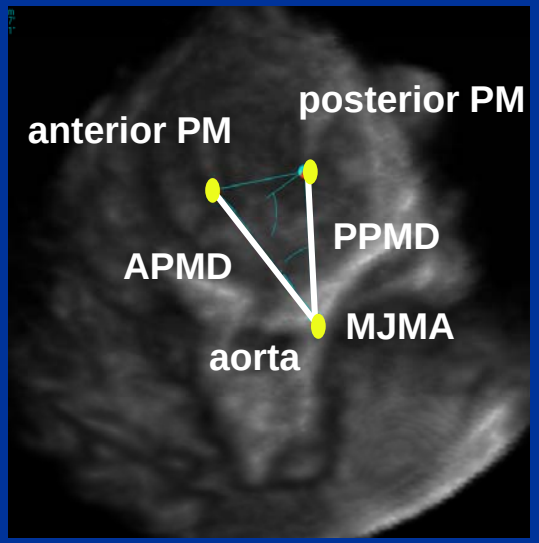
MAA= 3.14 × CC × AP/ 4

LV sphericity:

ratio of LV chamber width to height

MPR guided PM distance measurement





- MJAM: medial junction between aortic & mitral annulus
- APMD: ant PM distance
- PPMD: post PM distance

Baseline Characteristics

	FMR(n=33)	Non-FMR(n=20)	*p*
Age	64±12	58±11	0.06
Sex(M/F)	15/18	14/6	0.08
DM(%)	6(18)	5(25)	0.728
HiBP(%)	7(21)	7(35)	0.270
QRS duration(ms)	117 ± 27	113 ± 27	0.817
LBBB(%)	6(18)	1(5)	0.176
ACE inhibitor (%)	32(96)	17(90)	0.273
Beta blocker (%)	16(48)	11(55)	0.523

FMR; functional mitral regurgitation, ERO; Effective regurgitant orifice,

LBBB; left bundle branch block, LVEDVI; left ventricle end diastolic volume index

Functional & Geometric Parameters

	FMR(n=33)	Non-FMR(n=20)	*P*
ERO(cm^2)	0.17±0.10		-
cLVEDVI(cm^3/m)	110.4 ± 42.2	119.7 ± 107.9	0.638
LV EF(%)	28 ± 8	29 ± 7	0.616
cDI	1.43 ± 0.47	1.12 ± 0.37	0.018
cMVTa(cm^2/m)	1.23 ± 0.40	0.89 ± 0.19	<0.005
cMAA(cm^2/m)	4.58 ± 0.98	4.55 ± 1.30	0.20
cPPMD(cm/m)	2.38 ± 0.22	2.27 ± 0.18	< 0.05
cAPMD(cm/m)	2.65 ± 0.21	2.59 ± 0.19	< 0.05
cAPPMD(cm/m)	1.64 ± 0.24	1.62 ± 0.43	0.87
LV sphericity index	1.52 ± 0.22	1.35 ± 0.13	< 0.005
Pα (°)	65 ± 10	56 ± 8	<0.01
Aα (°)	35 ± 8	26 ± 5	<0.01

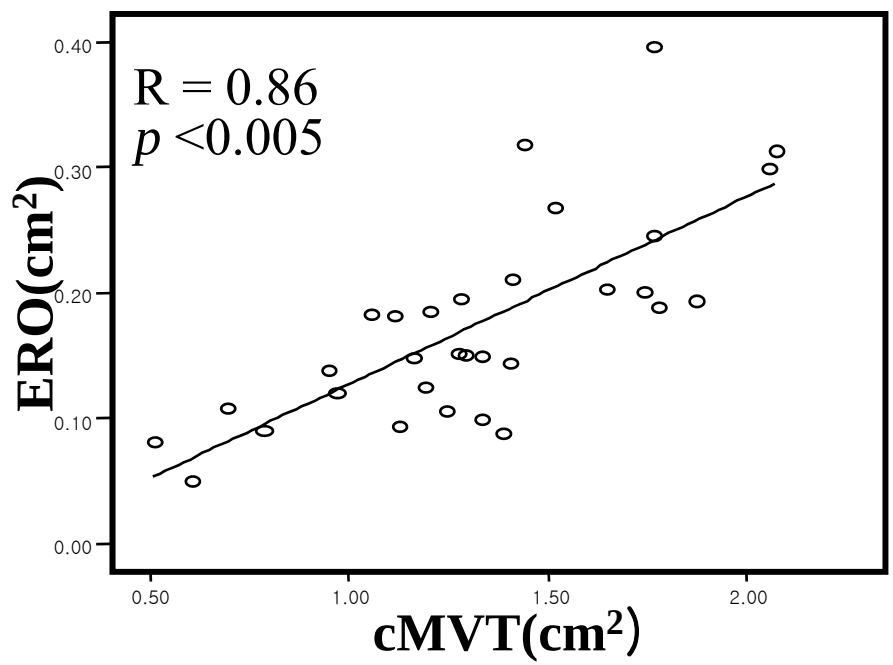
c; corrected by height, ERO; effective regurgitatn orifice, LVEDVI; LV end diastolic volume index, MVTa; MV tent area, DI; dyssynchrony index, MAA; mitral anular area, PPMD; posterior papillary muscle distance, APMD; anterior papillary muscle distance, APPMD; anterior-posterir papillary muscle distance, Pα; tethering angle of PML, Aα; tethering angle of PML

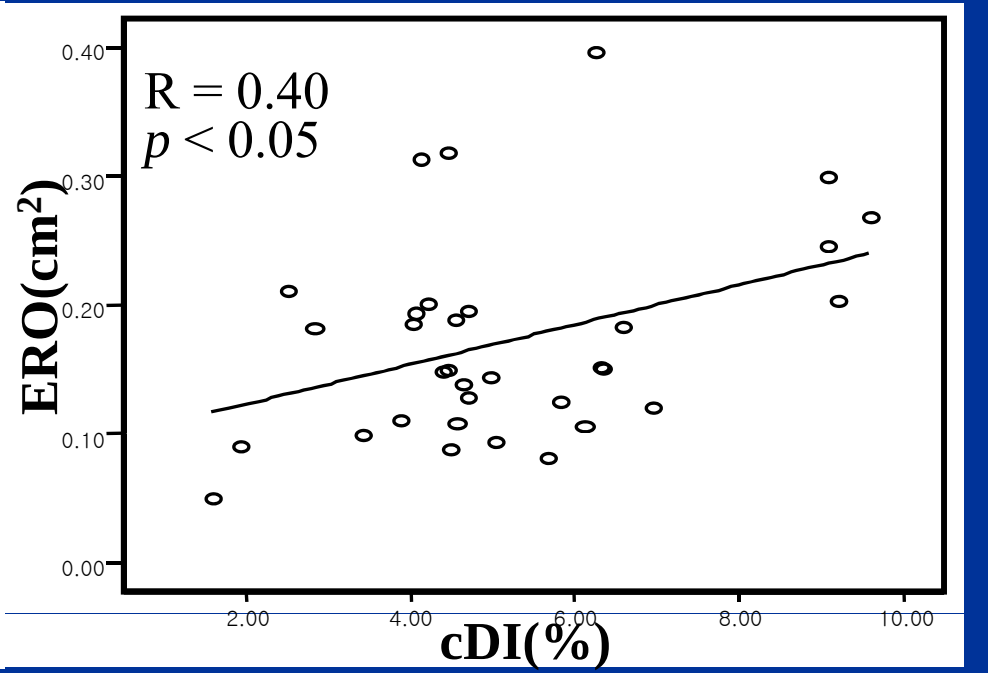
Univariate realtionships of parameters with ERO in patients with FMR

	R	*p*
cDI	0.400	0.015
cMVTa	0.868	0.000
cMVAa	0.255	0.125
cPPMD	0.742	0.005
cAPMD	0.801	0.005
LV sphericity index	0.452	0.016
Pα	0.073	0.698
Aα	0.454	0.010
LV EF	-0.283	0.111
cLVEDVI	0.555	<0.001

c; corrected by height, ERO; effective regurgitatn orifice, LVEDVI; LV end diastolic volume index, MVTa; MV tent area, DI; dyssynchrony index, MAA; mitral anular area, PPMD; posterior papillary muscle distance, APMD; anterior papillary muscle distance, Pα; tethering angle of PML, Aα; tethering angle of PML, LV sphericity; ratio of LV chamber width to height

Relationship between ERO and cMTA, cDI





Multivariate analysis of parameters with ERO in patients with FMR

Variables	B	Std. Error	*p*
cMVTa	0.115	0.025	<0.001
cAPMD	0.087	0.036	0.022

종속변수: ERO

Variables	B	Std. Error	*p*
cAPMD	1.435	0.207	<0.001

종속변수: cMVTa

LV dyssynchrony in a patient with & without FMR

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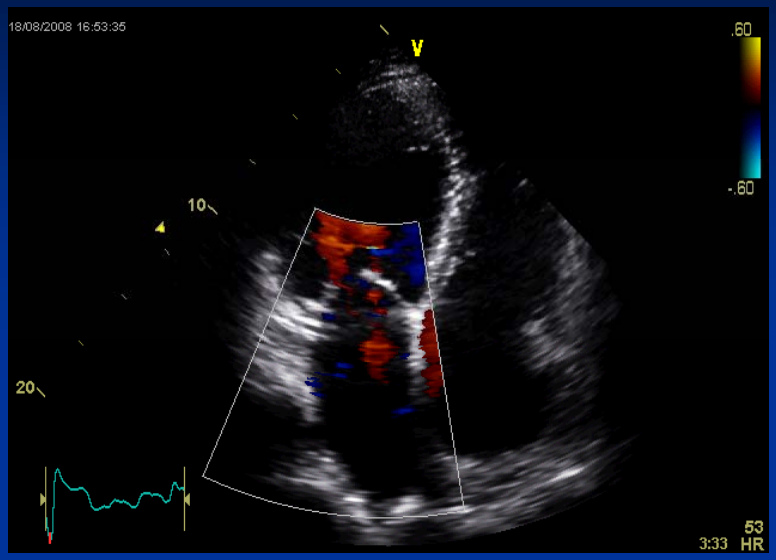

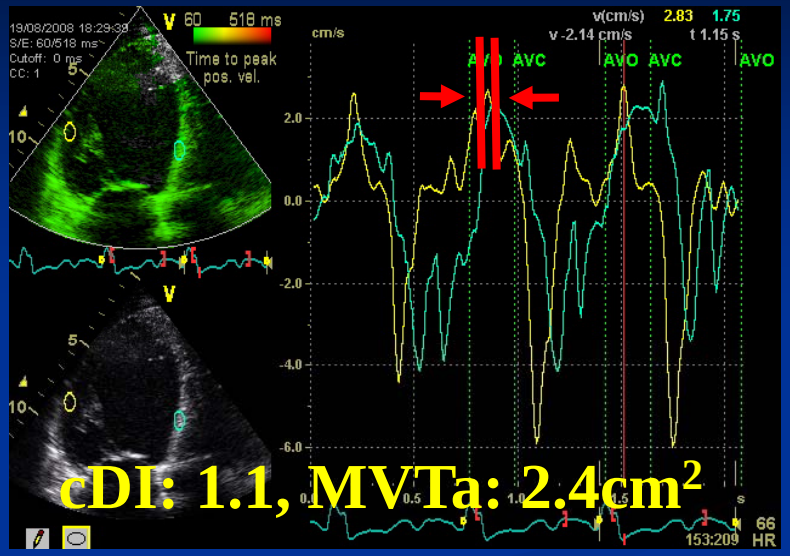

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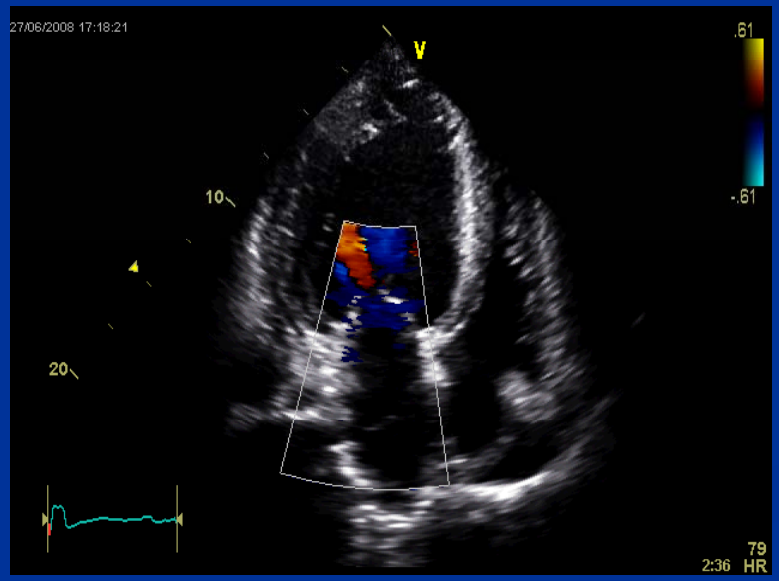

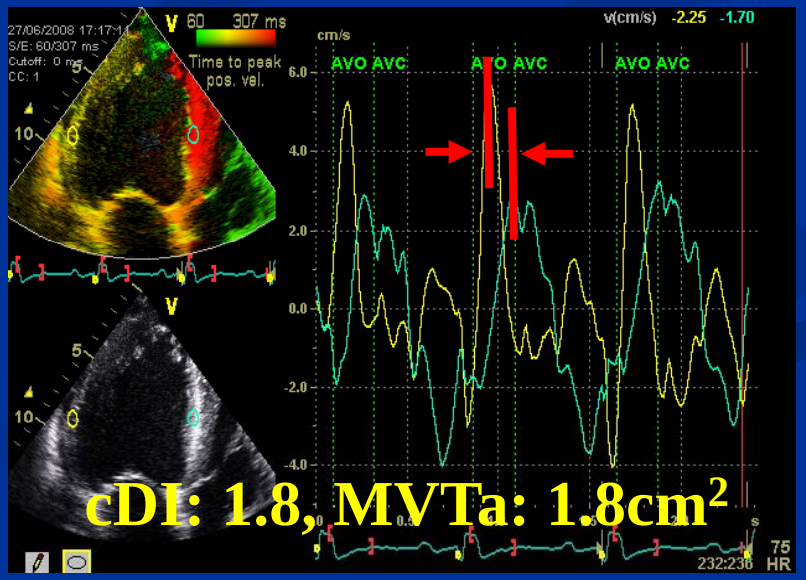

Study Limitations

- Limitation of PISA method
  - PISA geometry is not always hemispherical particularly in FMR
  - FMR is dynamic condition that depends on preload, afterload
- DI was assessed from 8 segments relatively small no of segments, comparing with other studies (12 segments) and segments that papillary muscles attached was not included
- Individual variability in 3D echocardiography analysis
  - Because ECG was not transfer, we determined analysis point according to mitral valve movement

Conclusions

- The degree of anterior PM displacement and the consequent increase of MV tenting area seem to have a major role in developing FMR severity in DCM

- LV dyssynchrony is also an independent determinant of FMR but seems to play an additional role in the mechanism of FMR.