Mechanical dispersion

The Forgotten Step-child of strain imaging

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ECHO AUSTRALIA

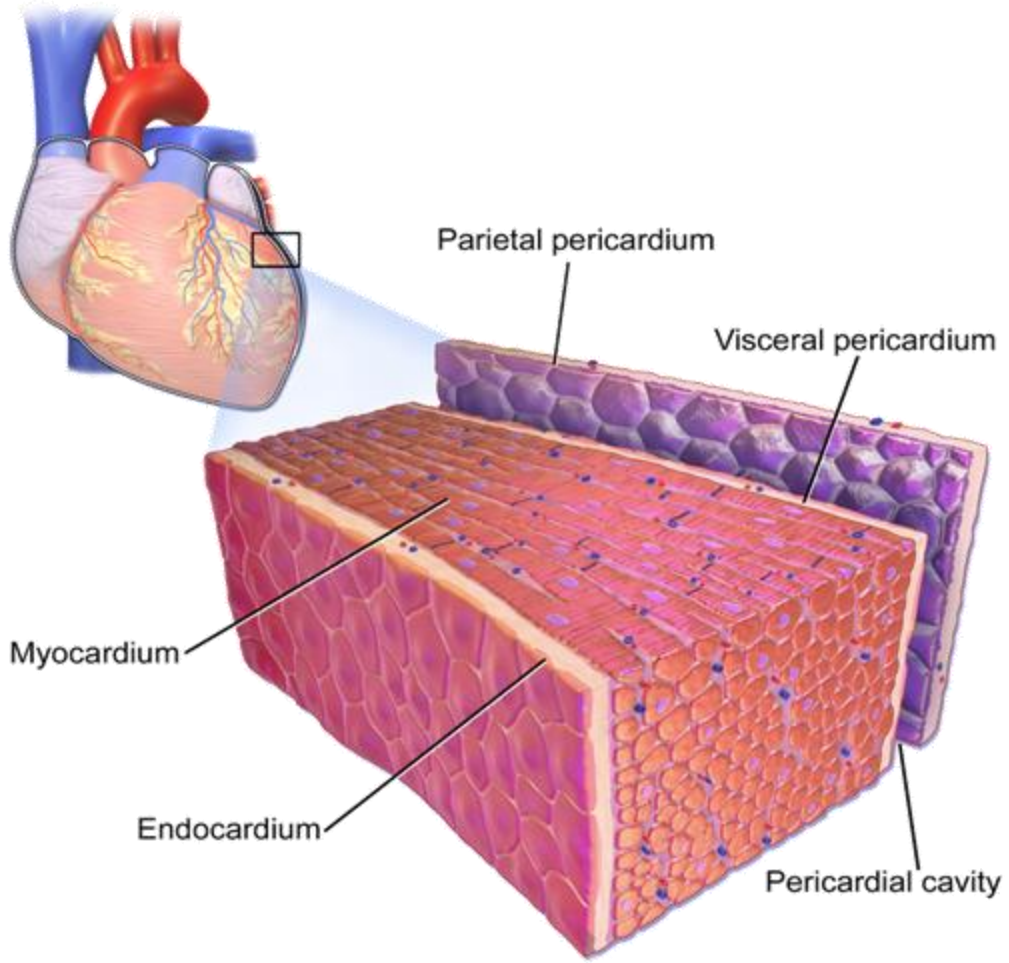
17-19 March 2025

Disclosures

- None to disclose

Setting the scene

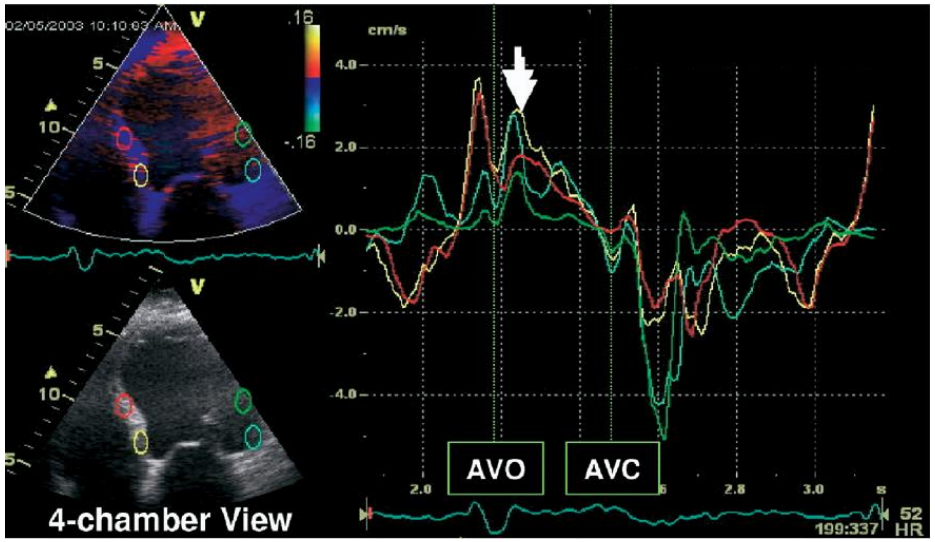
- Understanding myocardial fibre orientation is an important first step in assessing myocardial mechanics.
- Fibre orientation occurs along different planes
- Endocardial layer in a right-handed alignment
- Epicardial layer in a left-handed alignment

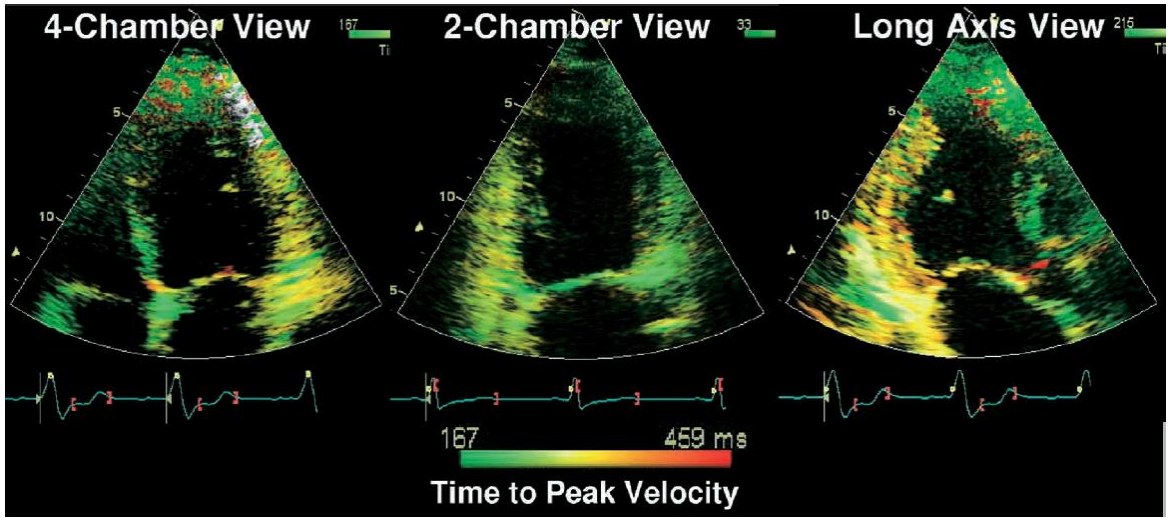


1. Cardioflash College, Oct 2020, *Everything you should know about "myocardial strain"*[video] Youtube, https://www.youtube.com/watch?v=_-ZIGcdU-BE

What do we mean by deformational dyssynchrony?

- Traditional parameters of myocardial dyssynchrony focused on tissue doppler quantification of wall motion velocities
  - Colour TD
  - Yu Index (SD of TTP velocity)
- Initially used for suitability and response to CRT





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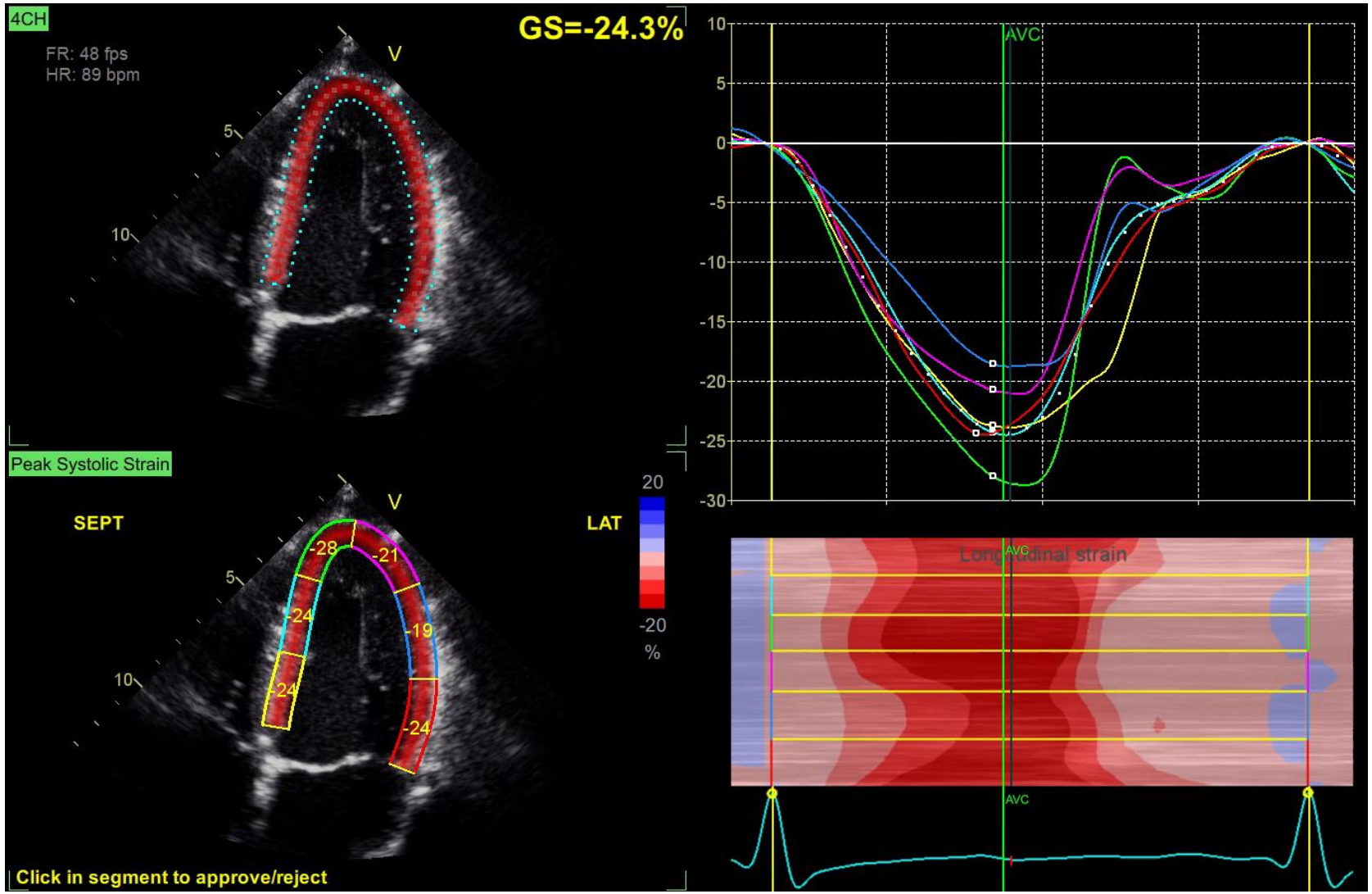
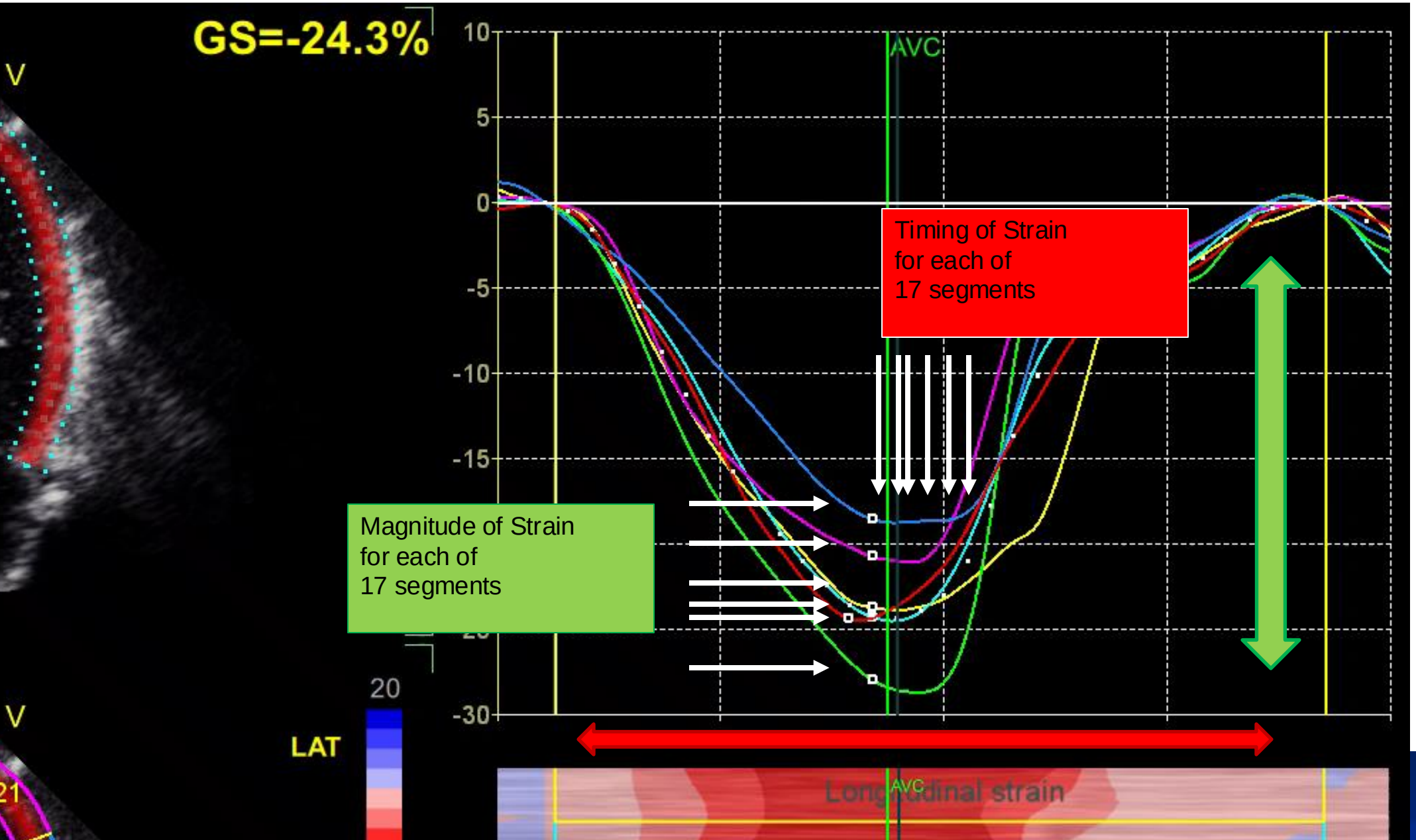
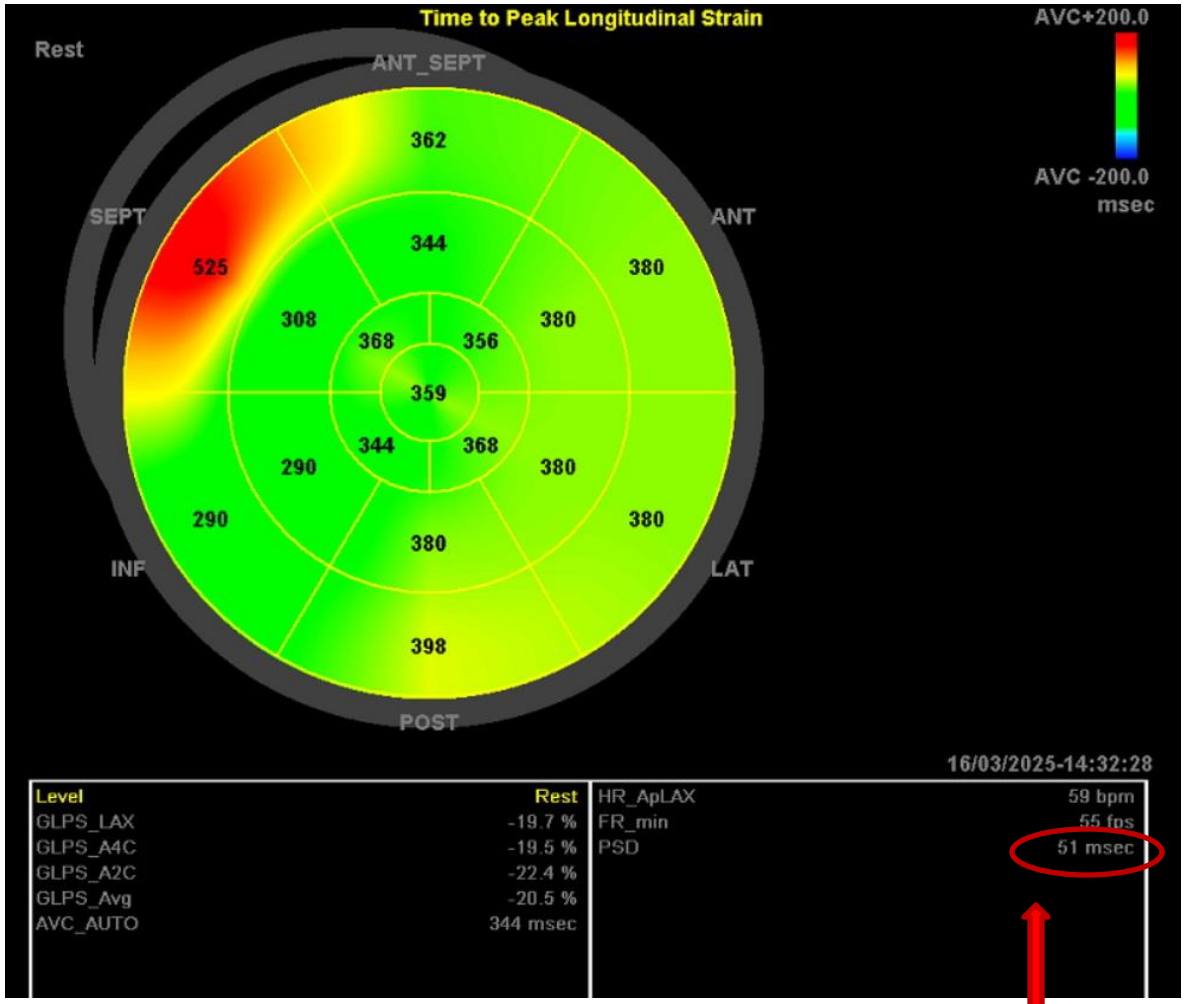


Analysing the strain curves



Analysing the strain curves

- To standardize the quantification of contraction timing differences or “heterogeneity of contraction” across different heart rates
  - Standard deviation of the time-to-peak (TTP) contraction is calculated
  - Referred to as “Mechanical Dispersion”



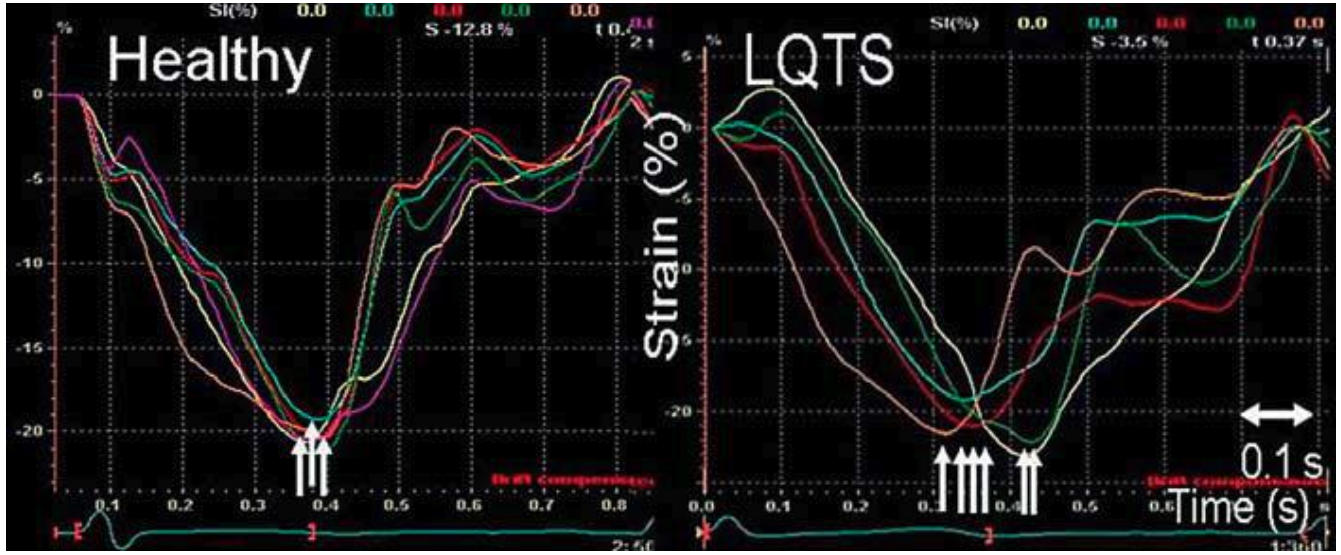
Who did it first?

- LQTS leads to delayed myocardial relaxation, increasing risk of arrhythmias
- Subendocardial and subepicardial layers demonstrate asynchronous contraction contributing to increasing mechanical dispersion
- Enhanced mechanical dispersion may serve as a substrate for TdP and SCD

Transmural Differences in Myocardial Contraction in Long-QT Syndrome

Mechanical Consequences of Ion Channel Dysfunction

Kristina Hermann Haugaa, MD; Jan P. Amlie, MD, PhD; Knut Erik Berge, MD, PhD; Trond P. Leren, MD, PhD; Otto A. Smiseth, MD, PhD; Thor Edvardsen, MD, PhD



Myocardial infarction

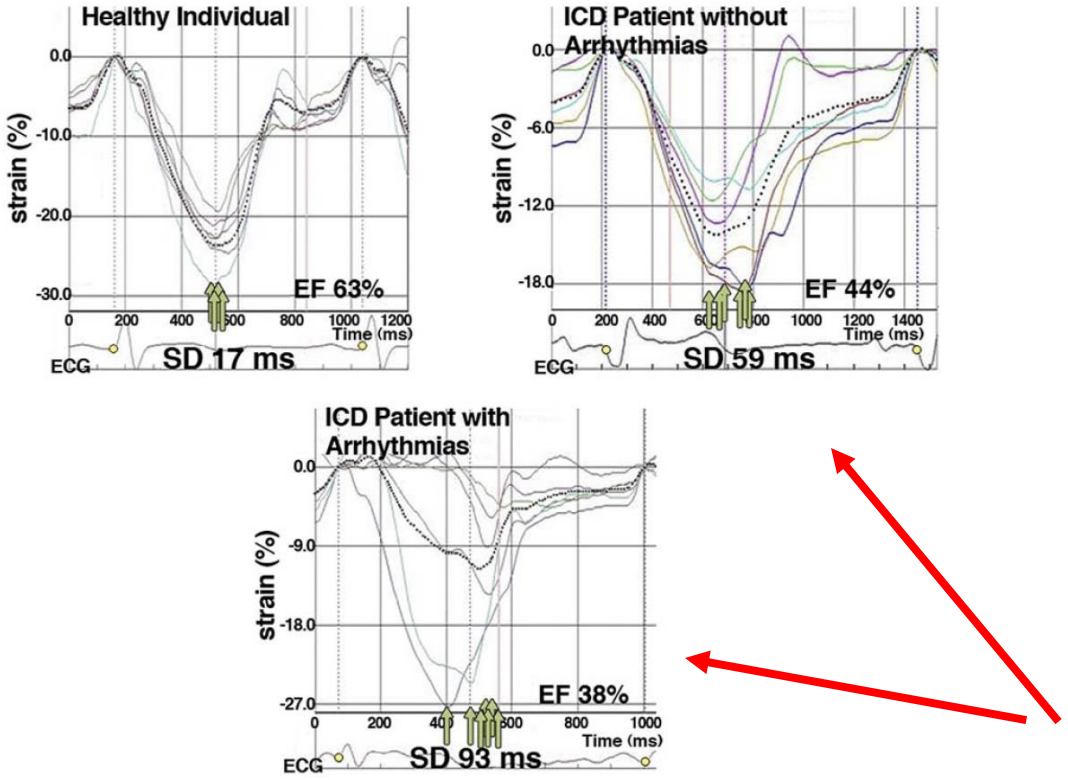


Figure 2. Mechanical Dispersion by Strain Echocardiography in a Healthy Individual and ICD Patients With and Without Arrhythmias During Follow-Up

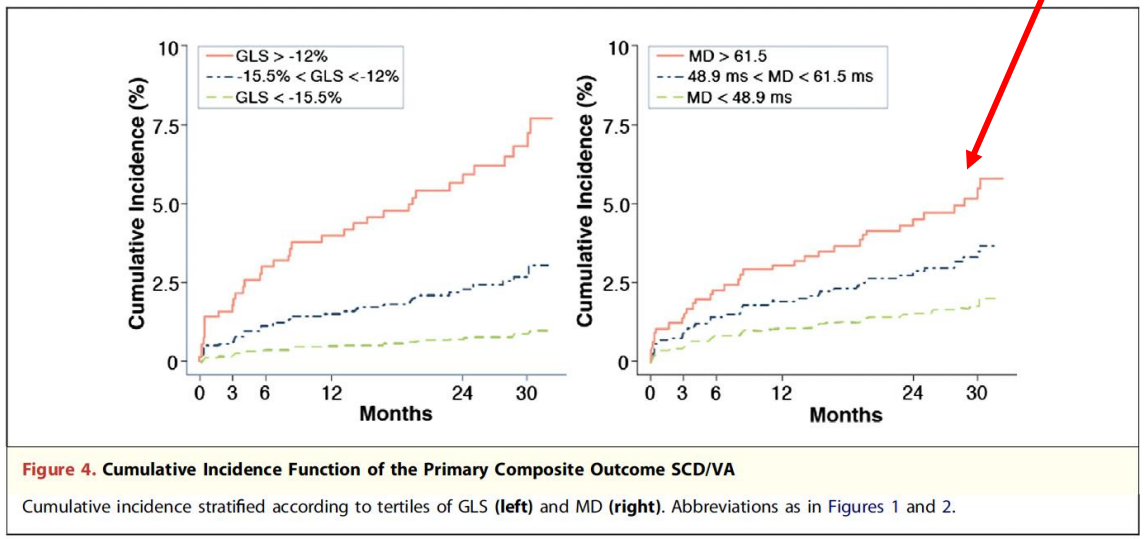


Figure 4. Cumulative Incidence Function of the Primary Composite Outcome SCD/VA

Cumulative incidence stratified according to tertiles of GLS **(left)** and MD **(right)**. Abbreviations as in Figures 1 and 2.

Ersboll M et al. JACC: CVI 2013;6(8);851-60
Haugaa K et al. JACC: CVI 2010;3(3):247-56

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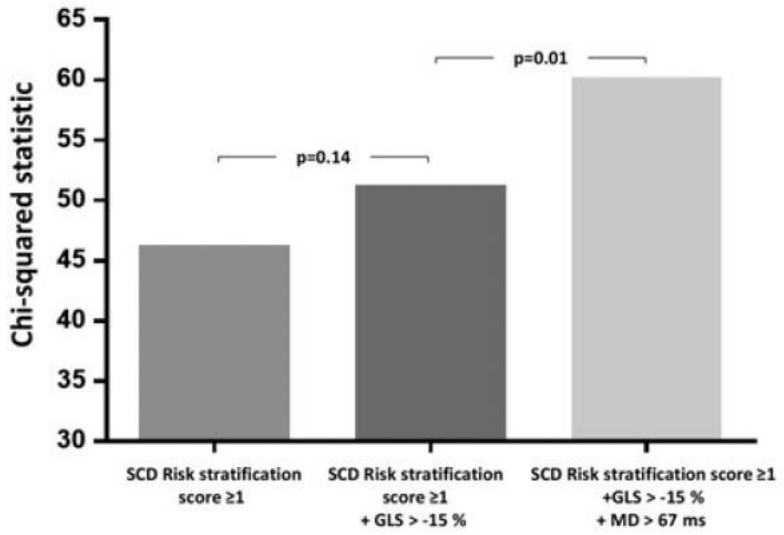
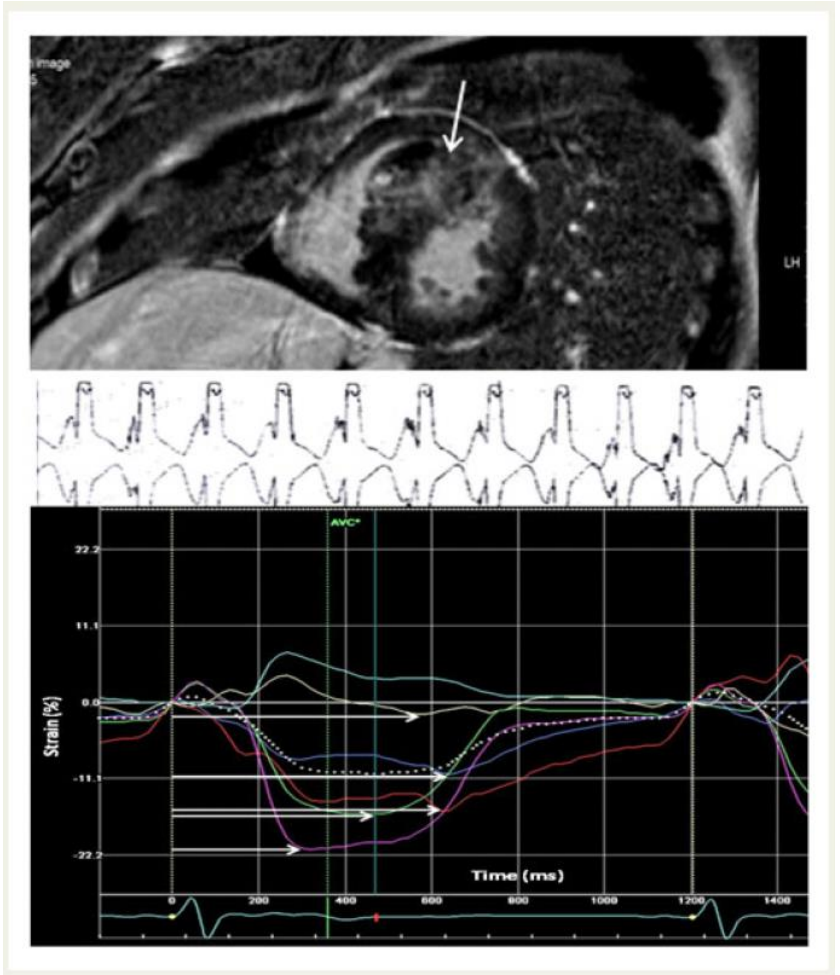
Hypertrophic cardiomyopathy

Strain echocardiography is related to fibrosis and ventricular arrhythmias in hypertrophic cardiomyopathy

Trine F. Haland[1,2,3,4], Vibeke M. Almaas[1,2,3], Nina E. Hasselberg[1,2,3,4],

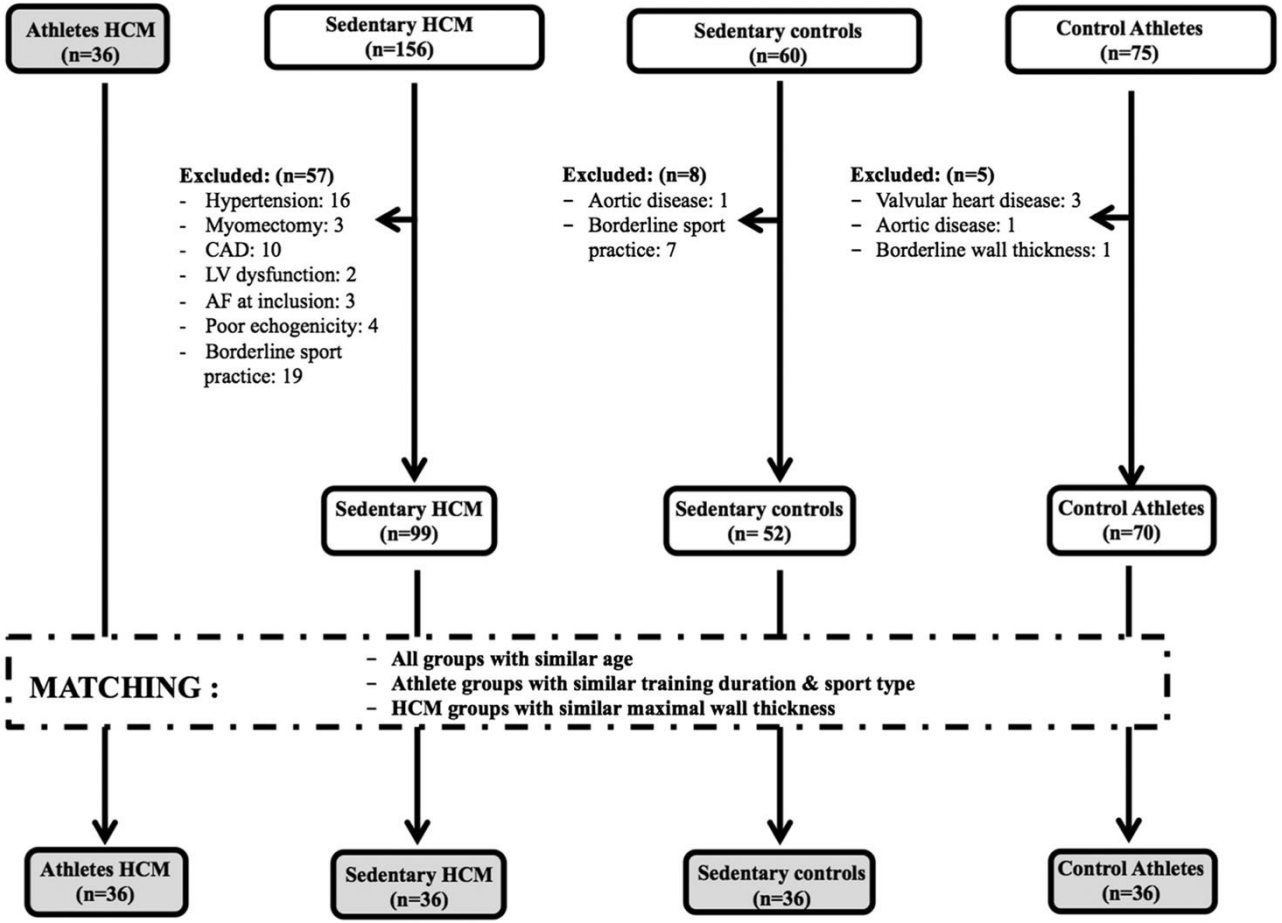


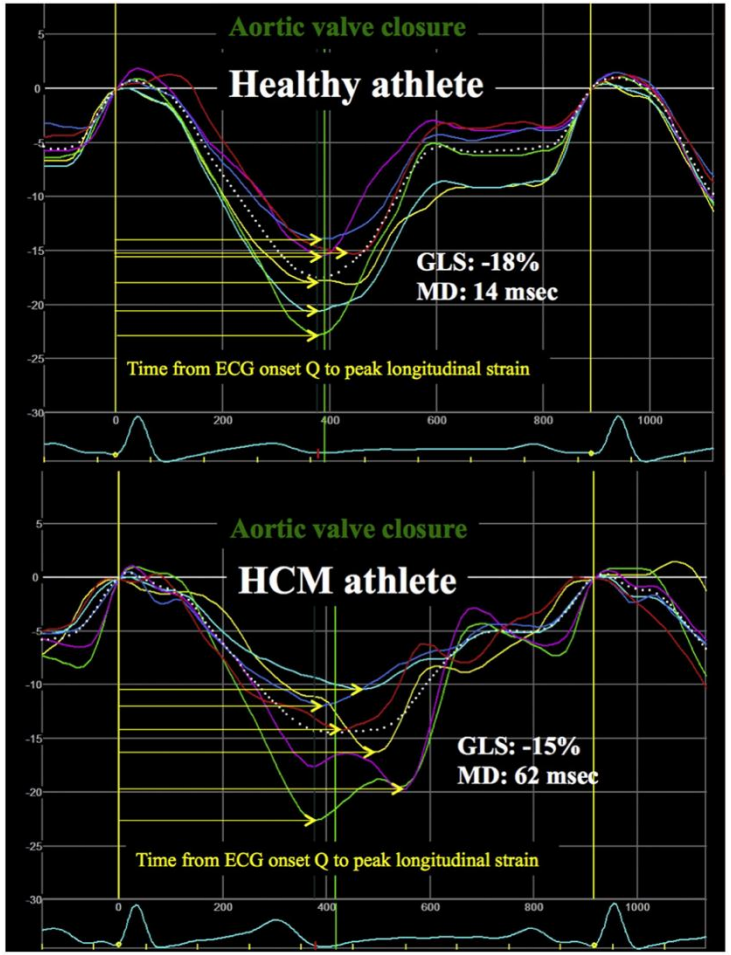


Haland TF et al. EHJ CVI 2016;17;613-621

ECHO AUSTRALIA

Differences in HCM athlete vs Control Athlete

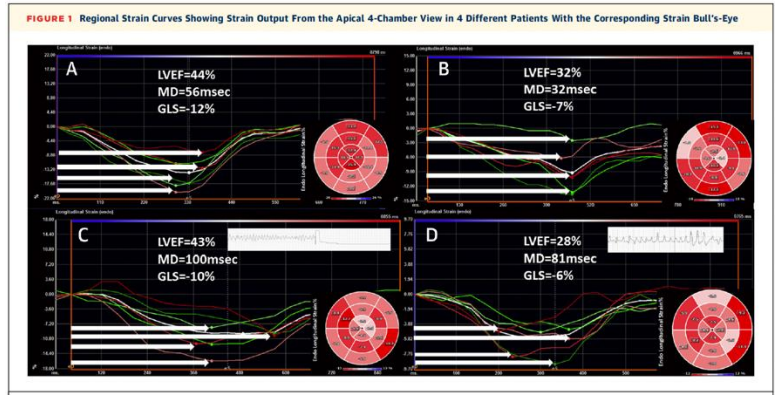


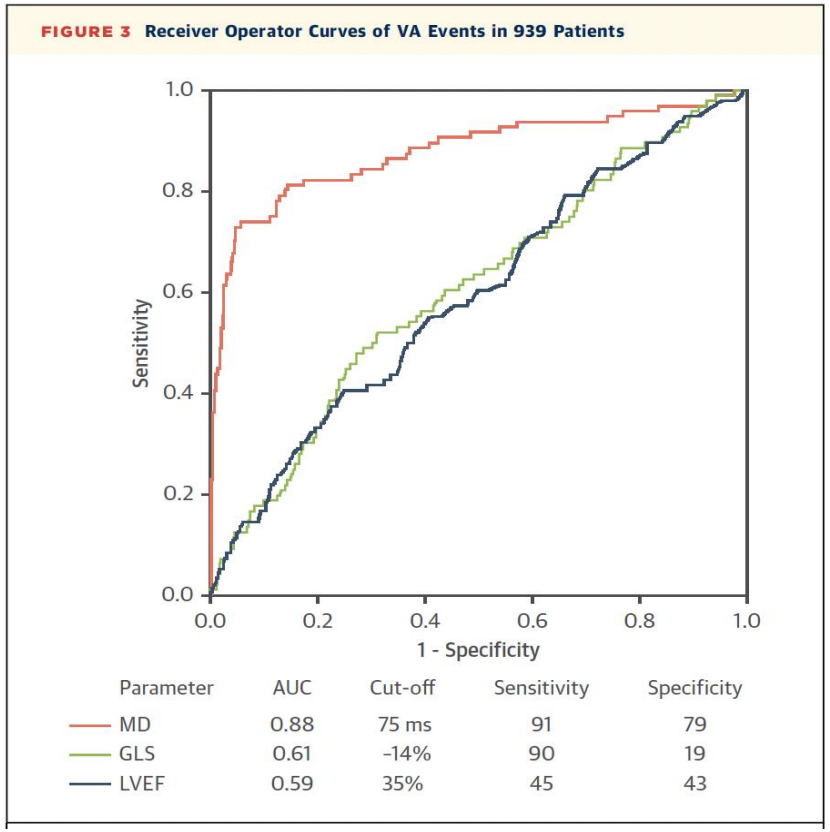


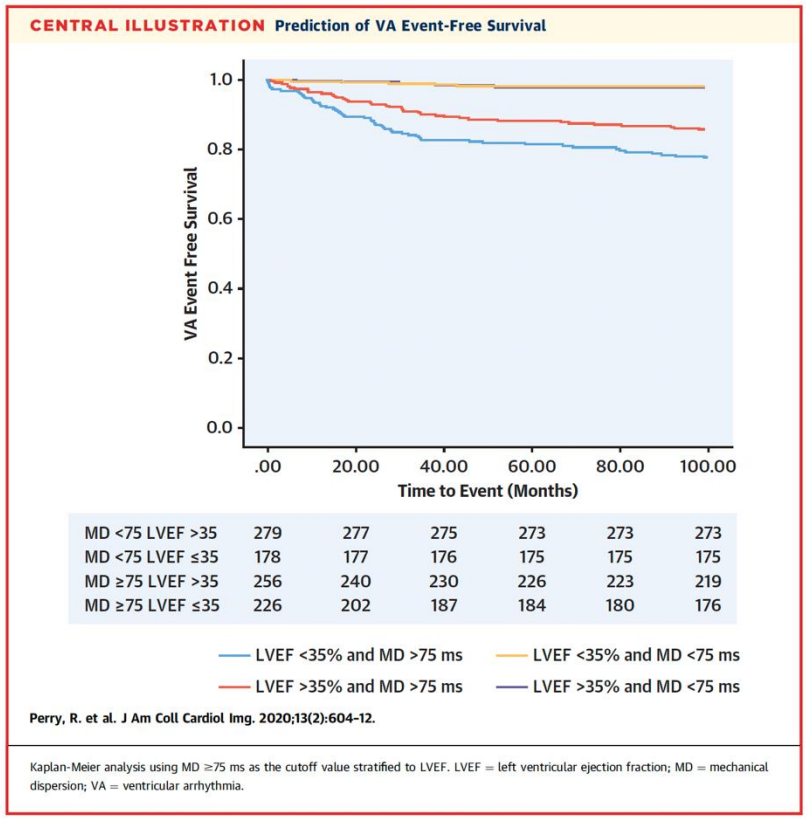
ORIGINAL RESEARCH

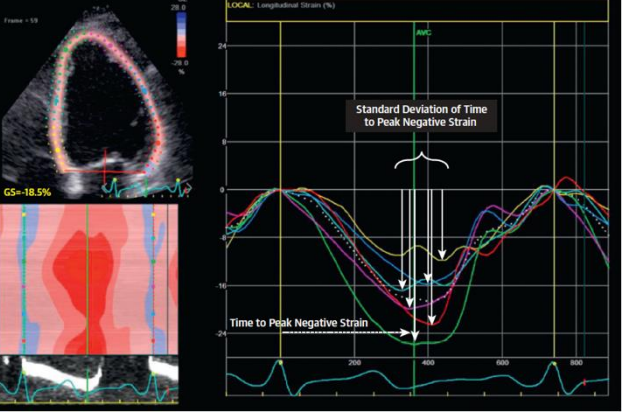
Advanced Echocardiographic Imaging for Prediction of SCD in Moderate and Severe LV Systolic Function

Rebecca Perry, BSc, PhD,[a,b,c] Sanjana Patil, BBMed, BSc (Hons),[a] Christian Marx, BParamedicSc,[a] Matthew Horsfall, RN,[b]









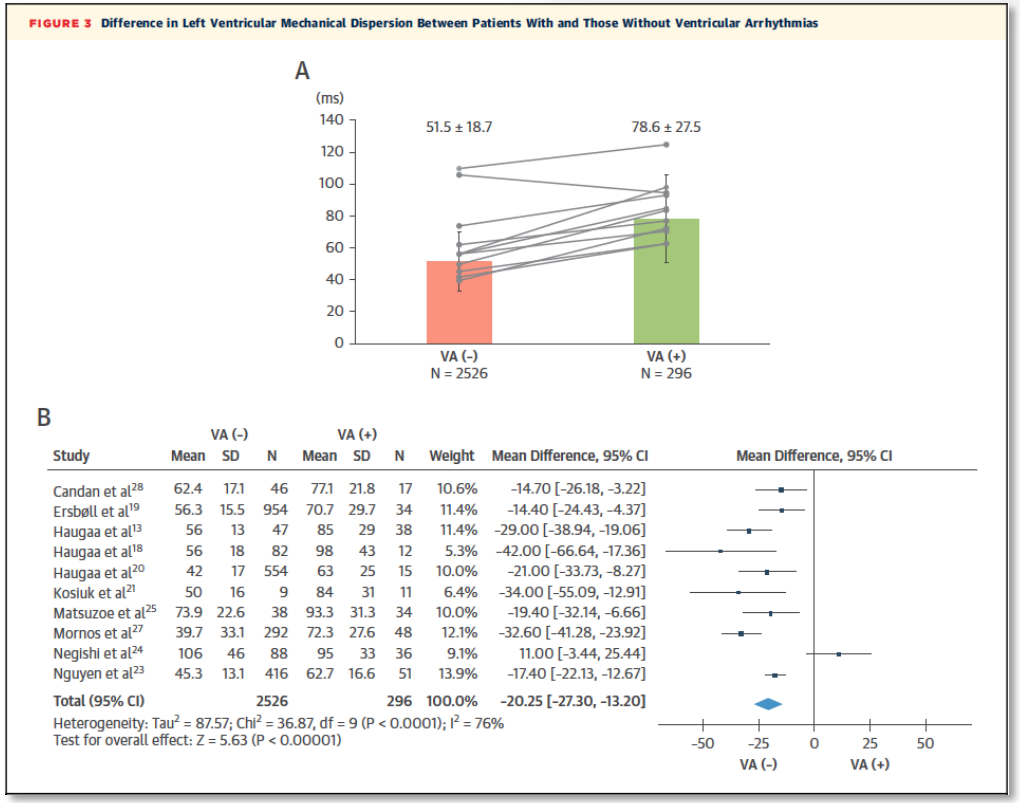
ORIGINAL RESEARCH

Prediction of Ventricular Arrhythmias With Left Ventricular Mechanical Dispersion

A Systematic Review and Meta-Analysis

Hiroshi Kawakami, MD, PhD,[a] Nitesh Nerlekar, MBBS, MPH,[a] Kristina H. Haugaa, MD, PhD,[b] Thor Edvardsen, MD, PhD,[b] Thomas H. Marwick, MBBS, PhD, MPH[a]

FIGURE 3 Difference in Left Ventricular Mechanical Dispersion Between Patients With and Those Without Ventricular Arrhythmias



Study	VA (-) Mean	SD	N	VA (+) Mean	SD	N	Weight	Mean Difference, 95% CI
Candan et al[28]	62.4	17.1	46	77.1	21.8	17	10.6%	-14.70 [-26.18, -3.22]
Ersbøll et al[19]	56.3	15.5	954	70.7	29.7	34	11.4%	-14.40 [-24.43, -4.37]
Haugaa et al[13]	56	13	47	85	29	38	11.4%	-29.00 [-38.94, -19.06]
Haugaa et al[18]	56	18	82	98	43	12	5.3%	-42.00 [-66.64, -17.36]
Haugaa et al[20]	42	17	554	63	25	15	10.0%	-21.00 [-33.73, -8.27]
Kosiuk et al[21]	50	16	9	84	31	11	6.4%	-34.00 [-55.09, -12.91]
Matsuzoe et al[25]	73.9	22.6	38	93.3	31.3	34	10.0%	-19.40 [-32.14, -6.66]
Mornos et al[27]	39.7	33.1	292	72.3	27.6	48	12.1%	-32.60 [-41.28, -23.92]
Negishi et al[24]	106	46	88	95	33	36	9.1%	11.00 [-3.44, 25.44]
Nguyen et al[23]	45.3	13.1	416	62.7	16.6	51	13.9%	-17.40 [-22.13, -12.67]
Total (95% CI)			**2526**			**296**	**100.0%**	**-20.25 [-27.30, -13.20]**

Heterogeneity: $Tau^2 = 87.57$; $Chi^2 = 36.87$, df = 9 (P < 0.0001); $I^2 = 76\%$
Test for overall effect: Z = 5.63 (P < 0.00001)

A

Study	Log [Hazard Ratio]	SE	Weight	Hazard Ratio, 95% CI
Ersbøll et al[19]	0.3221	0.0546	13.3%	1.38 [1.24, 1.54]
Hasselberg et al[26]	0.006	0.0456	13.9%	1.01 [0.92, 1.10]
Haugaa et al[13]	0.2624	0.059	12.9%	1.30 [1.16, 1.46]
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Leong et al[22]	0.131	0.0229	15.2%	1.14 [1.09, 1.19]
Matsuzoe et al[25]	0.0953	0.1001	9.7%	1.10 [0.90, 1.34]
Mornos et al[27]	0.1989	0.0528	13.4%	1.22 [1.10, 1.35]
Negishi et al[24]	-5.2983	4.457	0.0%	0.01 [0.00, 31.10]
Total (95% CI)			**100.0%**	**1.26 [1.14, 1.39]**

Heterogeneity: $Tau^2 = 0.02$; $Chi^2 = 50.12$, df = 8 (P < 0.00001); $I^2 = 84\%$
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Hazard Ratio, 95% CI
0.5
0.7
1
1.5
2

B

Study	Log [Hazard Ratio]	SE	Weight	Hazard Ratio, 95% CI	Covariates in Multivariable Model
Ersbøll et al[19]	0.1398	0.0662	19.9%	1.15 [1.01, 1.31]	Age, QRS, LVEDV, GLS
Haugaa et al[13]	0.2546	0.0691	19.0%	1.29 [1.13, 1.48]	Age, Sex, LVEF, GLS
Haugaa et al[18]	0.1823	0.0779	16.7%	1.20 [1.03, 1.40]	Age, QRS, LVEF, GLS
Haugaa et al[20]	0.5306	0.1777	4.8%	1.70 [1.20, 2.41]	Age, LVEF, GLS
Leong et al[22]	0.1133	0.0281	33.9%	1.12 [1.06, 1.18]	Age, QRS, Cr, Revascularized infarct-related artery Time from MI, LVESVI, LV scare, VT inducible, LVEF, GLS
Mornos et al[27]	0	0.1606	5.7%	1.00 [0.73, 1.37]	Age, LBBB, E/e', LVEF, GLS
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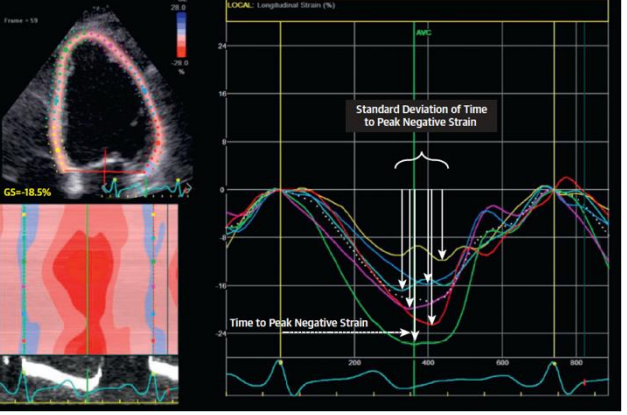
Kawakami et al. JACC CVI 2020;13(2);562-72



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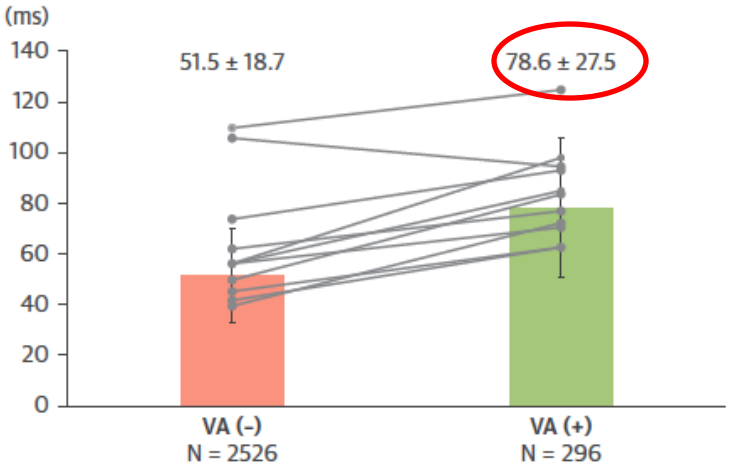

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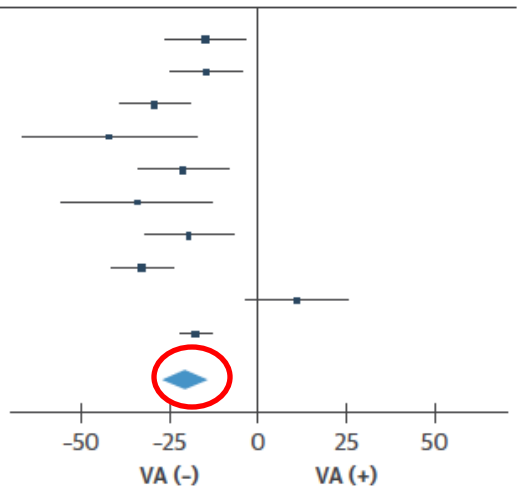
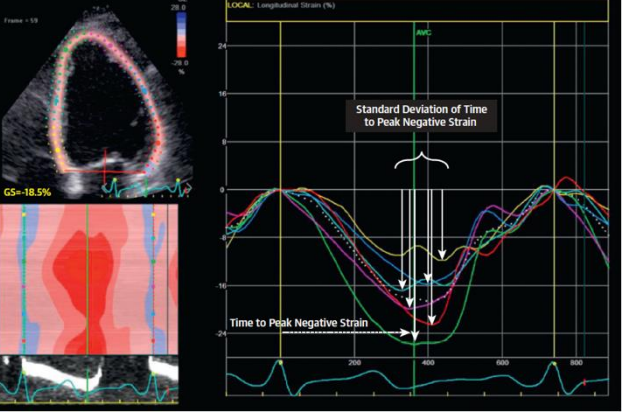


Kawakami et al. JACC CVI 2020;13(2);562-72



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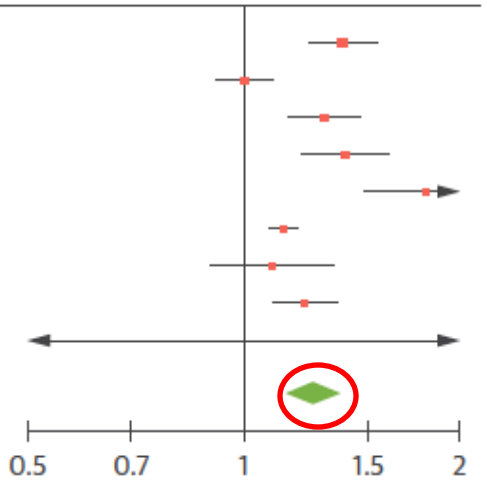

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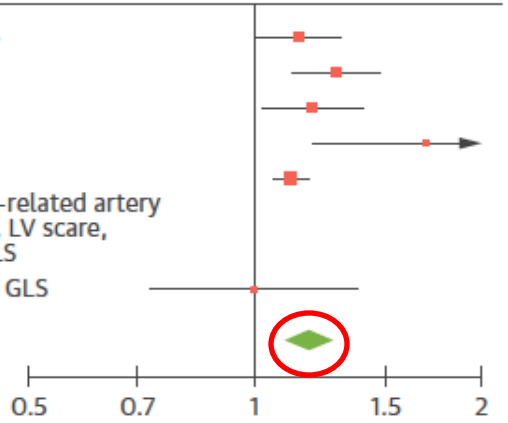

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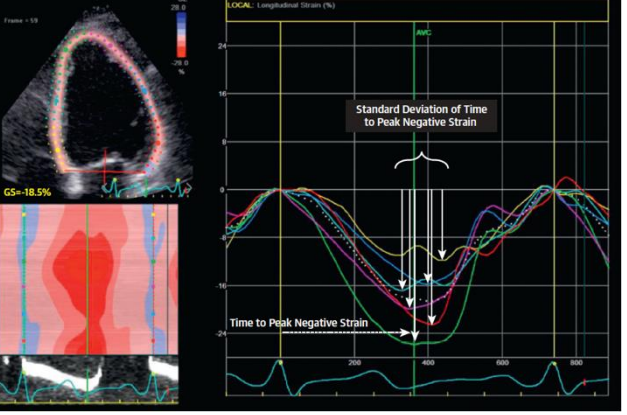
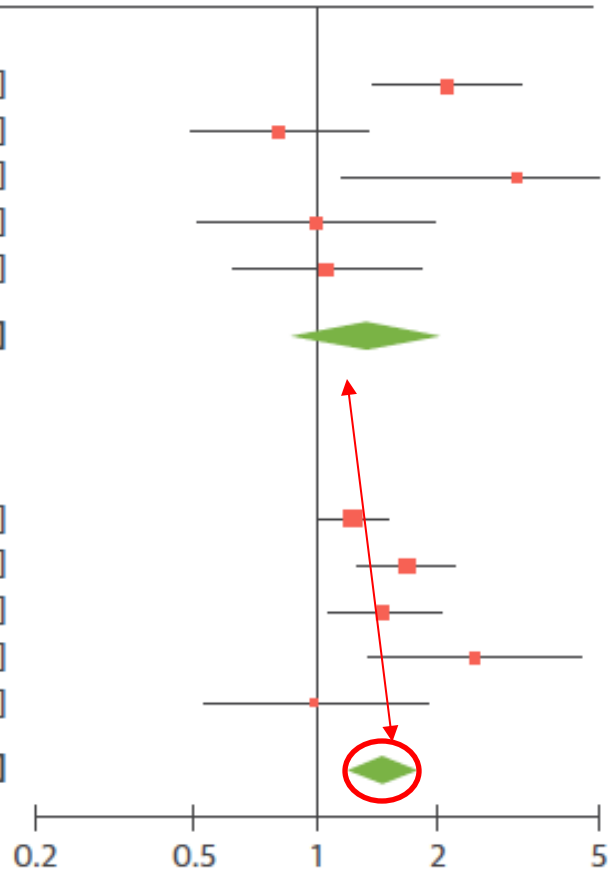


GLS vs LVMD (per 1-SD Increase)

Study	Log [Hazard Ratio]	SE	Weight	Hazard Ratio, 95% CI
GLS				
Ersbøll et al[19]	0.7529	0.214	24.5%	2.12 [1.40, 3.23]
Haugaa et al[13]	-0.2083	0.2549	22.6%	0.81 [0.49, 1.34]
Haugaa et al[18]	1.1555	0.5142	12.6%	3.18 [1.16, 8.70]
Haugaa et al[20]	0	0.3442	18.6%	1.00 [0.51, 1.96]
Mornos et al[27]	0.0647	0.2737	21.7%	1.07 [0.62, 1.82]
Total (95% CI)			**100.0%**	**1.35 [0.84, 2.14]**
Heterogeneity: $Tau^2 = 0.18$; $Chi^2 = 12.72$, df = 4 (P = 0.01); $I^2 = 69\%$				
Test for overall effect: Z = 1.25 (P = 0.21)				
Mechanical Dispersion				
Ersbøll et al[19]	0.2096	0.0993	32.5%	1.23 [1.02, 1.50]
Haugaa et al[13]	0.5185	0.1416	25.7%	1.68 [1.27, 2.22]
Haugaa et al[18]	0.3865	0.1652	22.4%	1.47 [1.06, 2.03]
Haugaa et al[20]	0.9127	0.3057	10.2%	2.49 [1.37, 4.54]
Mornos et al[27]	0	0.3263	9.3%	1.00 [0.53, 1.90]
Total (95% CI)			**100.0%**	**1.46 [1.18, 1.82]**
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 7.99$, df = 4 (P = 0.09); $I^2 = 50\%$				
Test for overall effect: Z = 3.41 (P = 0.0007)				



Kawakami et al. JACC CVI 2020;13(2);562-72

Determinants and prognostic implications of left ventricular mechanical dispersion in aortic stenosis

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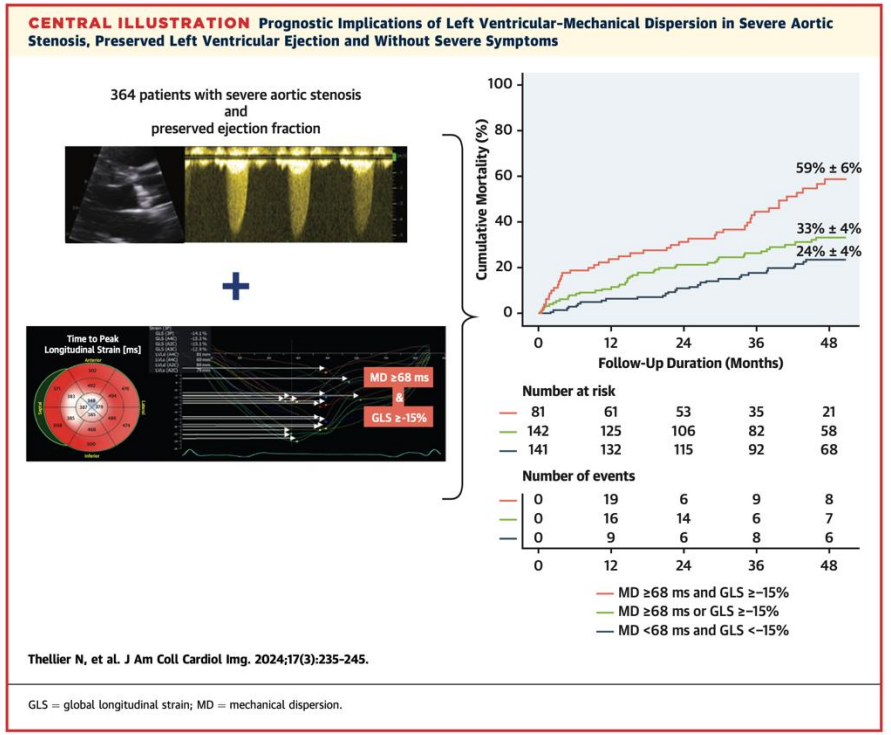
ORIGINAL RESEARCH

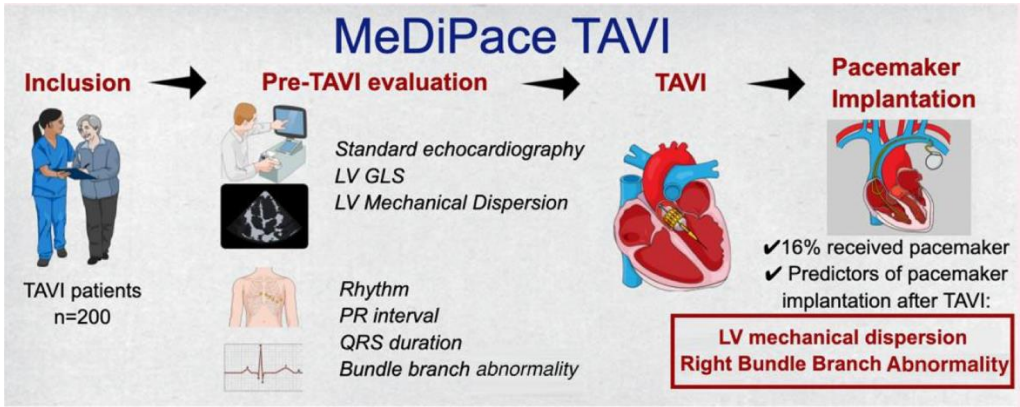
Additive Prognostic Value of Left Ventricular Dispersion and Deformation in Patients With Severe Aortic Stenosis

Nicolas Thellier, MD,[a] Alexandre Altes, MD,[a] Michael Rietz, MD,[a] Aymeric Menet, MD, PhD,[a] Jeremy Layec, MD,[a] François Outteryck, MD,[a] Ludovic Appert, MD,[a] Christophe Tribouilloy, MD, PhD,[b,c] Sylvestre Maréchaux, MD, PhD[a]



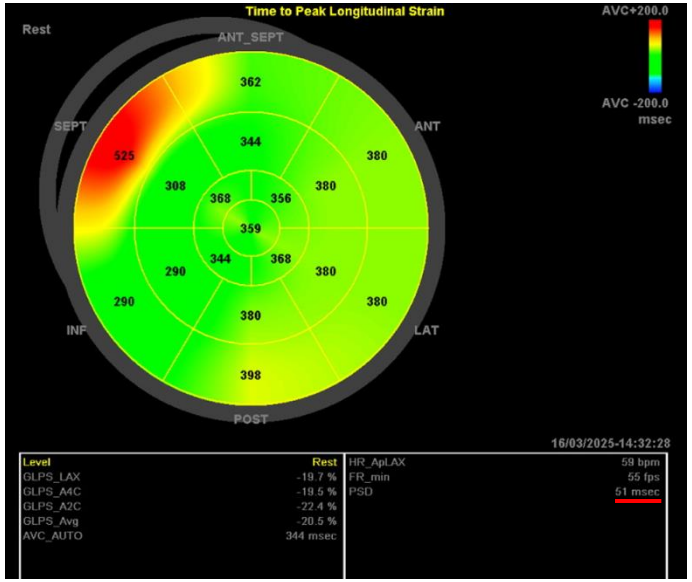
Left ventricular mechanical dispersion as a predictor of the need for pacemaker implantation after transcatheter aortic valve implantation: MeDiPace TAVI study

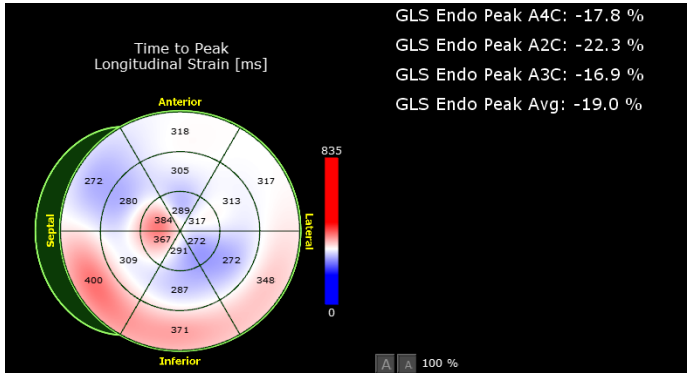
Esra Kaya [1,2,3], Kristoffer Andresen[1,3,4], Øyvind H. Lie[1,3], Lars Aaberge[1], Kristina H. Haugaa[1,3,4], Thor Edvardsen [1,3,4], and Helge Skulstad [1,2,3,4]*



How can you measure it?

- GE - Automated
- TomTec - Manual
- Philips – Manual
- Siemens - ?Manual





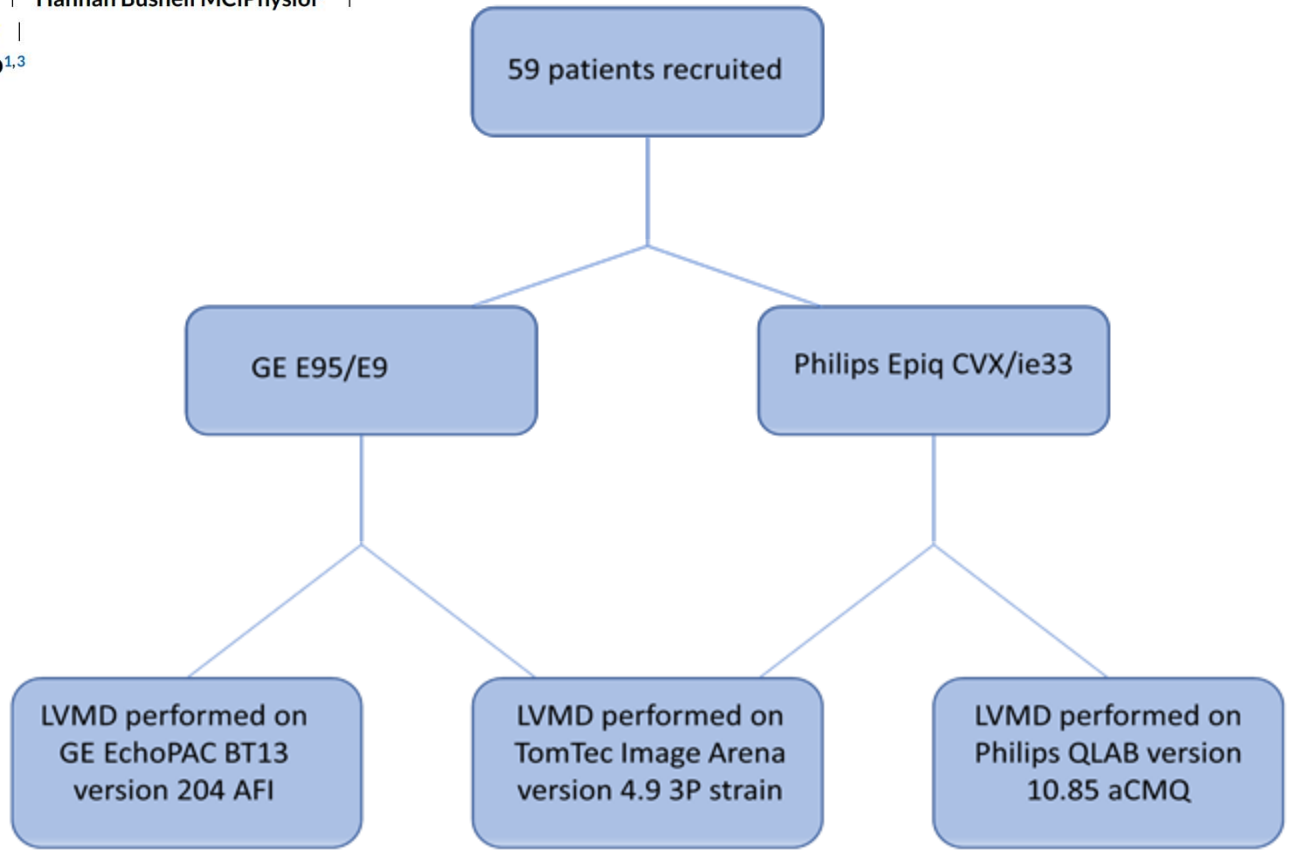
Are there intervendor differences?

ORIGINAL ARTICLE

Echocardiography WILEY

Impact of inter-vendor variability on evaluation of left ventricular mechanical dispersion

Vinesh Appadurai MBBS[1,2] | Gregory M. Scalia MBBS[1,2] | Katherine Lau MBBS[1,2] | Robert Chamberlain BSc[1,3] | Natalie Edwards PhD[1,3] | Hannah Bushell MClPhysiol[1] | William Scalia MBBS[1,2] | Stephen Tomlinson MBBS[1,3] | Christian Hamilton-Craig PhD[1,2,3] | Jonathan Chan PhD[1,3]



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Software Variability in Measurement of LV Mechanical Dispersion in Patients With LV Hypertrophy

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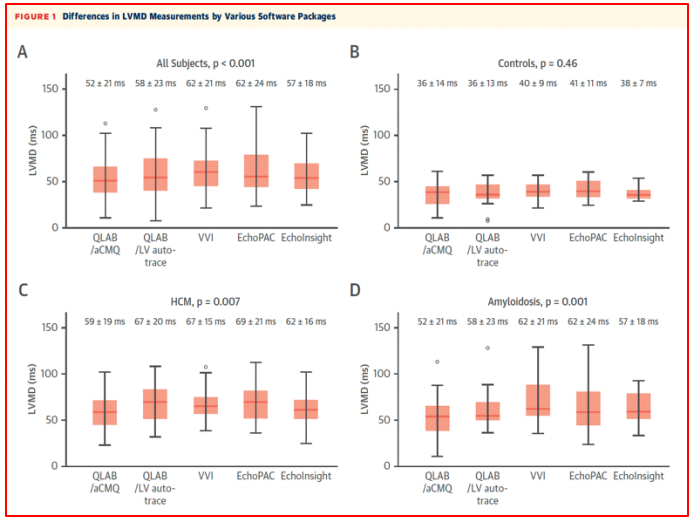
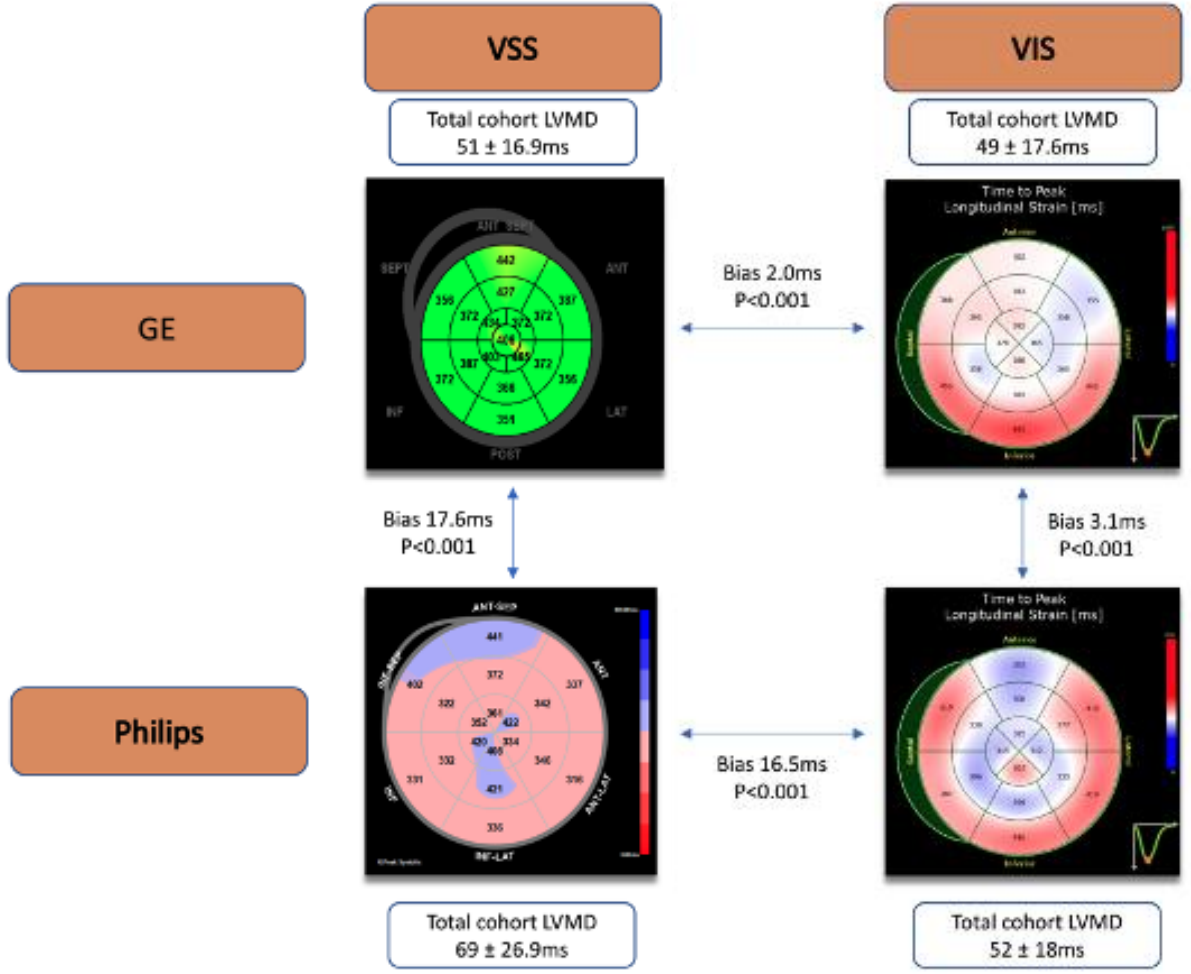




Are there normal reference ranges for it?

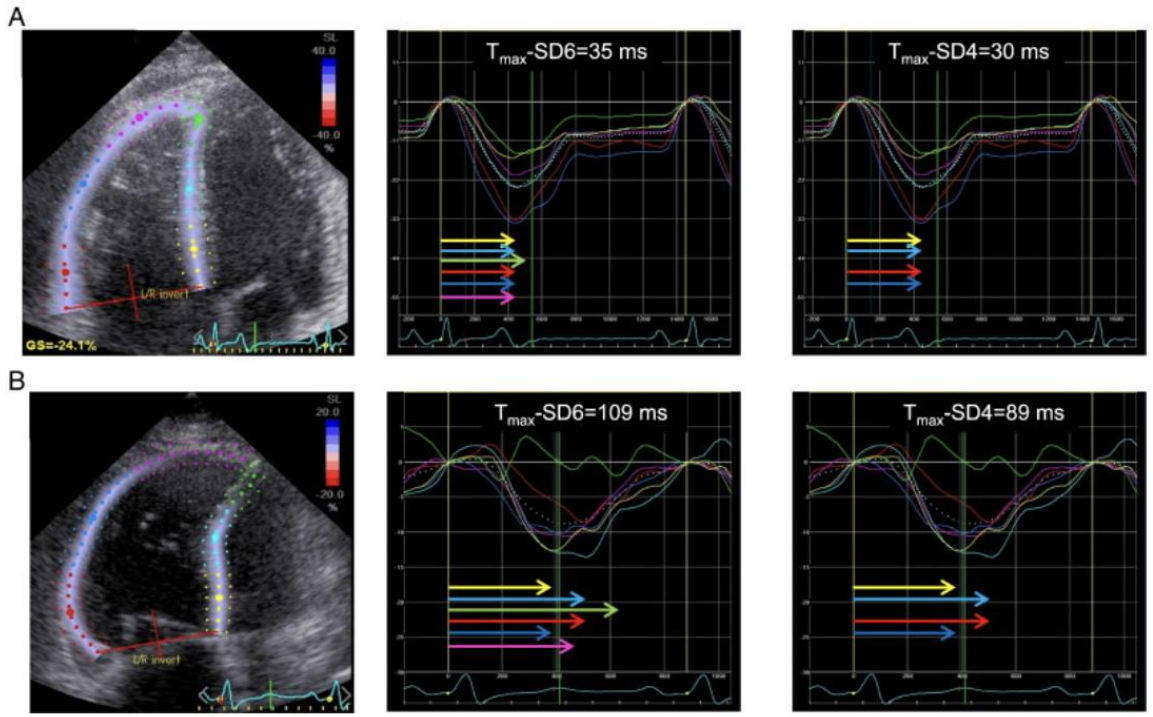
- Different across age groups
  - Young adults ~30-40ms
  - Middle age ~35-50ms
  - Elderly ~40-60ms
- Different across Athletes
- Different across vendors

Table 1.
Reference Values for Mechanical Dispersion Across Age Decades

	Overall (N = 303)	Age Groups (yrs)					p Value
		18–30 (n = 63)	31–40 (n = 71)	41–50 (n = 67)	51–60 (n = 51)	>60 (n = 51)	
MD, ms	34 ± 10	29 ± 8	30 ± 9	34 ± 10	37 ± 10	41 ±10	<0.001
ULN	56	49	50	55	64	64	<0.001

RVMD/LAMD

- RVMD in pulmonary hypertension
- RVMD in ARVC
- RVMD in severe TR
- LAMD in AF



Murata M et al. Int J Card 2017;228(1);912-18

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Where would you apply it?

- Patients with preserved LVEF and arrhythmia risk
  - Genetic CMs/Channelopathies
  - HCM
- Sequential testing on the same vendor if under surveillance
- Pre-TAVI when in sinus and no significant BBB

Thank you

Any questions?

ECHO AUSTRALIA

17-19 March 2025