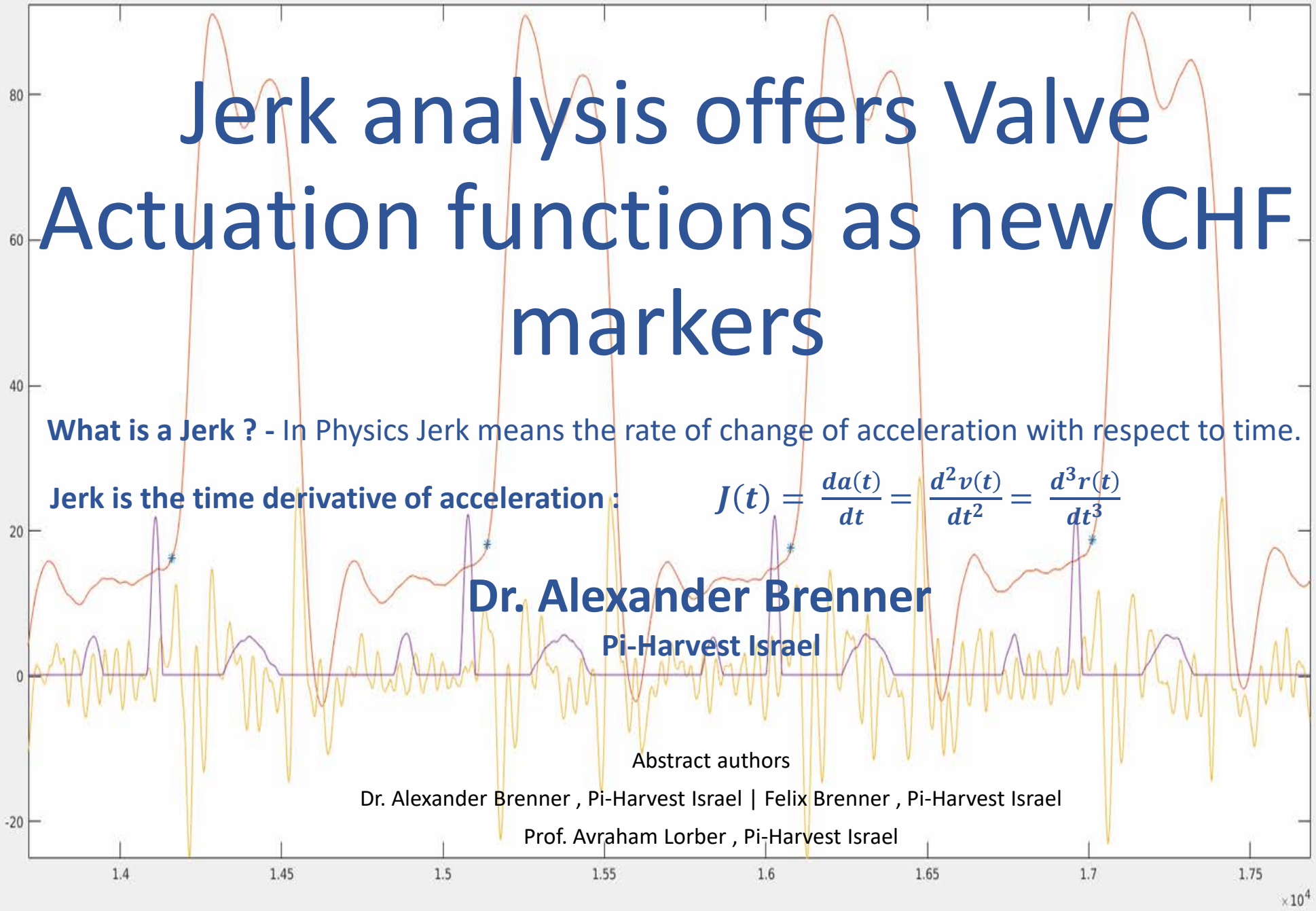
E-POSTER

Jerk analysis offers Valve Actuation functions as new CHF markers



What is a Jerk ? - In Physics Jerk means the rate of change of acceleration with respect to time.

Jerk is the time derivative of acceleration : $J(t) = \frac{da(t)}{dt} = \frac{d^2v(t)}{dt^2} = \frac{d^3r(t)}{dt^3}$

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HARVEST

Jerk analysis & Valve Actuation

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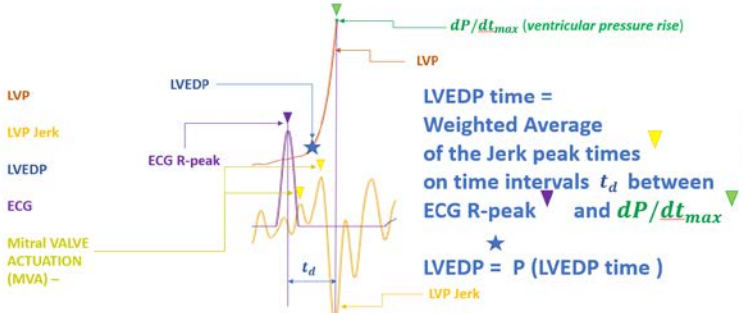
LVP Jerk and LVEDP



LVEDP time = Weighted Average of the Jerk peak times on time intervals t_d between ECG R-peak and dP/dt_{max}

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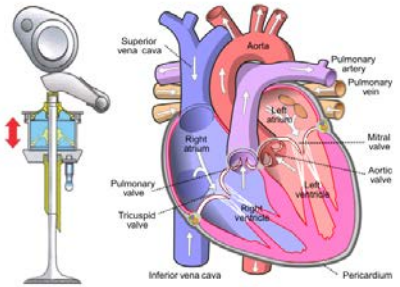
LVEDP = P (LVEDP time)

- If there exists one such LVP jerk peak on this interval, then LVEDP is the pressure at this time moment
- If there exist more than one such peaks, the LVEDP is the LVP at a time point calculated as the weighted average of the two rightmost jerk maxima, where the weights are proportional to the absolute peak ratio of the jerk maxima.

Mitral VALVE ACTUATION (MVA)– new measure of detection and evaluation of heart failure severity



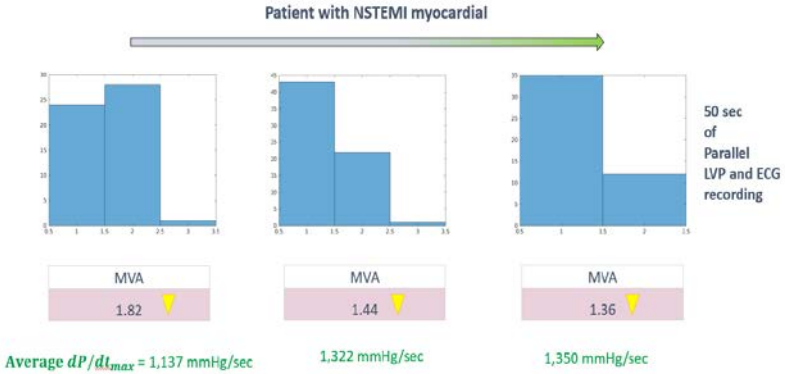
Valve Actuation: Average № of Jerk Maxima points between ECG R-peak and dP/dt_{max}

From the physiological point of view the number of these local maxima points

- characterizes the **non-uniformity** and **quality** of the ventricular preload
- quantifies
  - isovolumetric contraction **smoothness**
  - **irregularities** of a Heart Valve closure.

Tricuspid Valve Actuation (TVA), Aortic Valve Actuation (AVA), Pulmonary Valve Actuation (PVA) are defined similarly

MVA histogram skewed left after stent insertion



Average dP/dt_{max} = 1,137 mmHg/sec

1,322 mmHg/sec

1,350 mmHg/sec

Results

- MVA / TVA as time series are statistically independent from ventricular pressure rise $dP/dt_{max,L/R}$ which are classical quality markers of LV/RV systolic function.
- MVA characterizes the dynamics of Mitral valve closure and $dP/dt_{max,L}$ - Aortic valve opening.
- TVA characterizes the dynamics of Tricuspid valve closure and $dP/dt_{max,R}$ - Pulmonary valve opening.

Left heart	Average	STD	Relative STD	Corr	Correlation with LVE_P
$dP/dt_{max,L}$ (mmHg/msec)	1.22	0.055	0.045	0.059 (with MVA)	-
MVA	2.46	0.64	0.26	0.54 (with AVA)	-0.03 (with LVEDP)
$dP/dt_{min,L}$ (mmHg/msec)	-1.31	0.08	0.06	0.08 (with AVA)	-
AVA	2.26	0.68	0.30	-	0.01 (with LVESP)

Right heart	Average	STD	Relative STD	Corr	Correlation with RVE_P
$dP/dt_{max,R}$ (mmHg/msec)	0.22	0.015	0.068	-0.06 (with TVA)	-
TVA	3.05	0.69	0.23	0.25 (with PVA)	0.09 (with RVEDP)
$dP/dt_{min,R}$ (mmHg/msec)	-0.21	0.013	0.062	0.16 (with PVA)	-
PVA	2.38	0.80	0.34	-	0.06 (with RVESP)

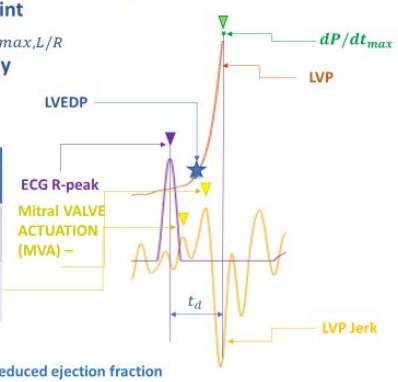
LVEDP : Left Ventricular End Diastolic Pressure
LVESP : Left Ventricular End Systolic Pressure

RVEDP : Right Ventricular End Diastolic Pressure
RVESP : Right Ventricular End Systolic Pressure

Valve Actuation Triangular Indexes (MVATI, TVATI,…)

- Triangular Indexes of the histograms of the time intervals t_d, between ECG R-peak and the L/RVP inflection point corresponding to ventricular pressure rise $dP/dt_{max,L/R}$ across overall measurement time and respectively from ventricular pressure fall $dP/dt_{min,L/R}$ to L/RVESP across overall measurement time.

Left heart characteristics	Average	STD	NSTEMI	NSTEMI with HFpEF	NSTEMI with HFrEF
MVATI	95.92	27.54	104.85	106.06	86.62
AVATI	87.45	45.98	108.92	101.42	221.4



MVATI and AVATI can be the further markers differentiating NSTEMI Myocardial infarction with preserved and reduced ejection fraction

Results

- For NSTEMI patients the average AVA = 2.78 while for leftover group AVA = 1.75 (overall AVA = 2.26 ± 0.68).
- AVA may be considered as an independent marker for NSTEMI myocardial infarction diagnostics,
- In combination with $dP/dt_{max,L}$ and $dP/dt_{min,L}$ NSTEMI patients with preserved and reduced ejection fraction can be differentiated:

Left heart characteristics	Average	STD	NSTEMI	NSTEMI with HFpEF	NSTEMI with HFrEF
$dP/dt_{max,L}$ (mmHg/msec)	1.22	0.055	1.12	1.19	0.72
$dP/dt_{min,L}$ (mmHg/msec)	-1.31	0.08	-1.2	-1.25	-0.84