Identification of Systolic Time Intervals using Peak Endocardial Acceleration SonR sensor signal

Simon Hoenig

1st Internal Department – Cardiology, General Hospital Linz

Agenda

Introduction

- About Systolic Time Intervals
- Measurement and Informationcontent in STI
- SonR Technology
- Pilotstudy Protocol / Workflow

Methods

- Patient Overview
- SonR STI Measurement
- Echo Measurement

Results

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- Correlation
- STI & SonR in Clinical Setting

Conclusion

- Limitations
- Outlook

Systolic Time Intervals & SonR

Introduction

Systolic Time Intervals & SonR

Most tests of **ventricular performance** deal with **force and/or distance** either alone or as a function of time.

The **STI** are unique because **time is the only variable**. Therefore, there is the need to **show accuracy of STI time measurements** and further to show the **correlation between STI with other parameters** of ventricular function.

Several **clinical studies demonstrated** the value of **STI** measurement in **assessing left ventricular performance**.

In **studies the usefulness** of the systolic time intervals **to improve** both **diagnosis** and **therapy** of **cardiovascular disorders** needs to be shown.

Systolic Time Intervals & SonR

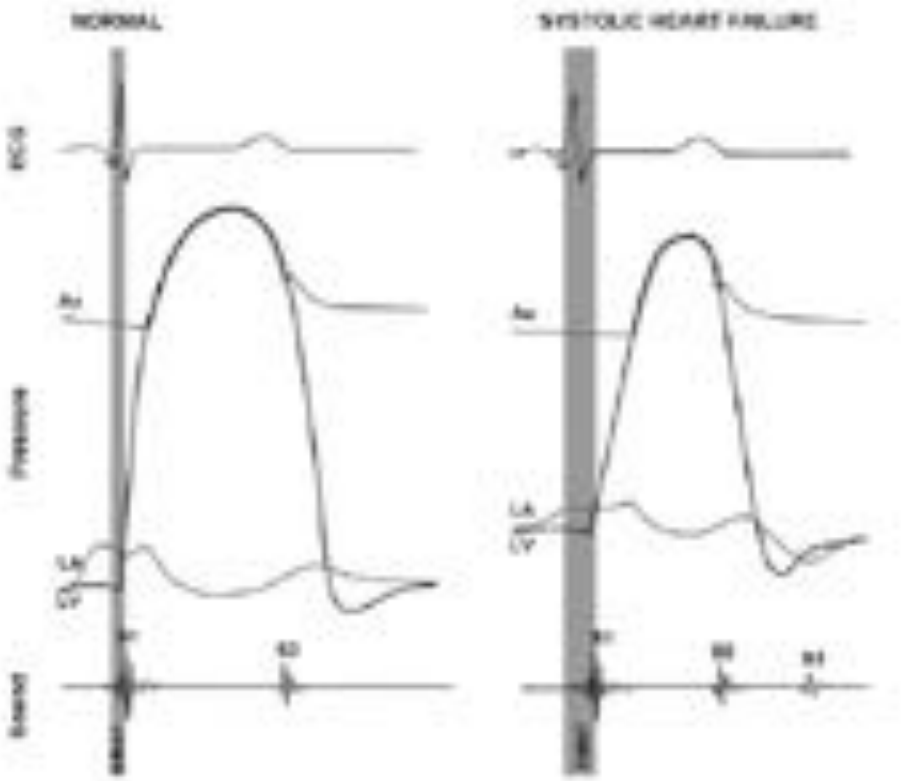
The Systolic time interval EMAT (Q-S1 interval) and the subsequent isovolumic contraction time constitute the **PEP**.

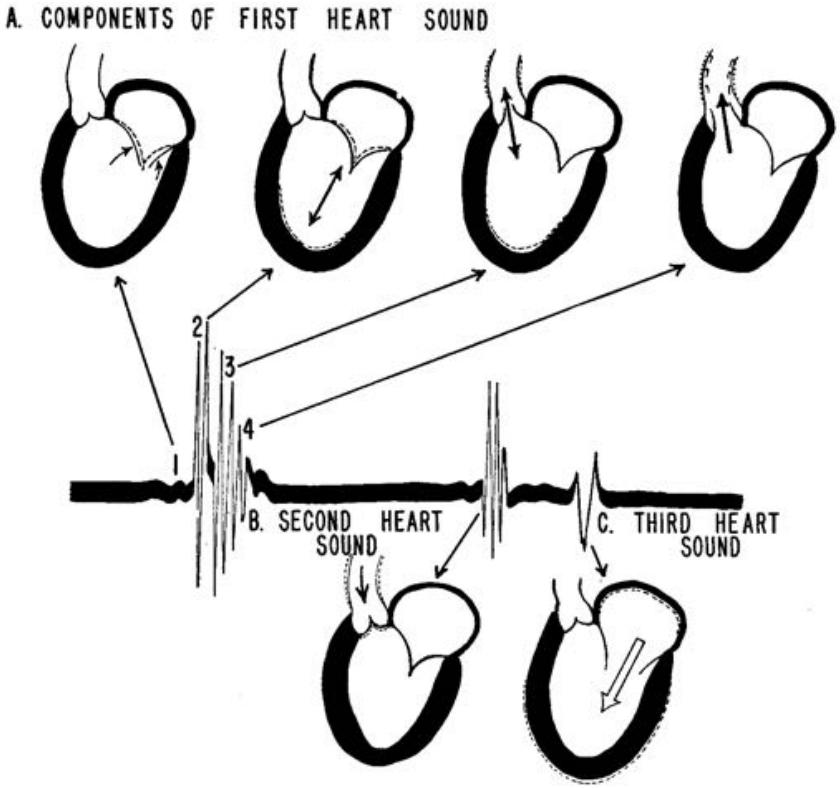
PEP (pre ejection period) measures the amount of time that LV requires to generate sufficient force to first close the mitral valve (EMAT) and then open the aortic valve (isovolumic contraction time).

In **patients** with **myocardial infarction** and **heart failure** with impaired myocardial function, **both EMAT and isovolumic contraction time are prolonged**.

Systolic Time Intervals & SonR

EMAT measurement is performed with **ECHO** (as the Gold Standard) and needs to be **compared with** the obtained values by **SonR**





Systolic Time Intervals & SonR

As mentioned before Systolic time intervals are very **interesting** for **determining** the **left ventricular performance** and therefore could be used for **predicting** the **HF status** and probably the **response to CRT** therapy.

The **QS2 (electromechanical systole)** can be obtained using the *permanently* measured **SonR signal** and could be used as a **predictor** variable for patient outcome **in CRT**.

Systolic Time Intervals & SonR

SonR1, LV dP/dt and Heart sound

- S1 amplitude correlates to LV dP/dt max
  Sakamoto T; Circ. Res. 1965; 16:45-57
- SonR 1 amplitude correlates to heart sound amplitude
  - Tassin A. PACE; 2009, Vol. 32, Sup. 1, S101-104
- SonR 1 amplitude correlates to LV dP/dt max
  Bordachar P; J Cardiovasc Electrophysiol. 2008; Feb 12

VV opt

- SonR varies like LV dP/dt max with VV delay changes
- Delnoy PP. Europace (2008) 10, 801–808

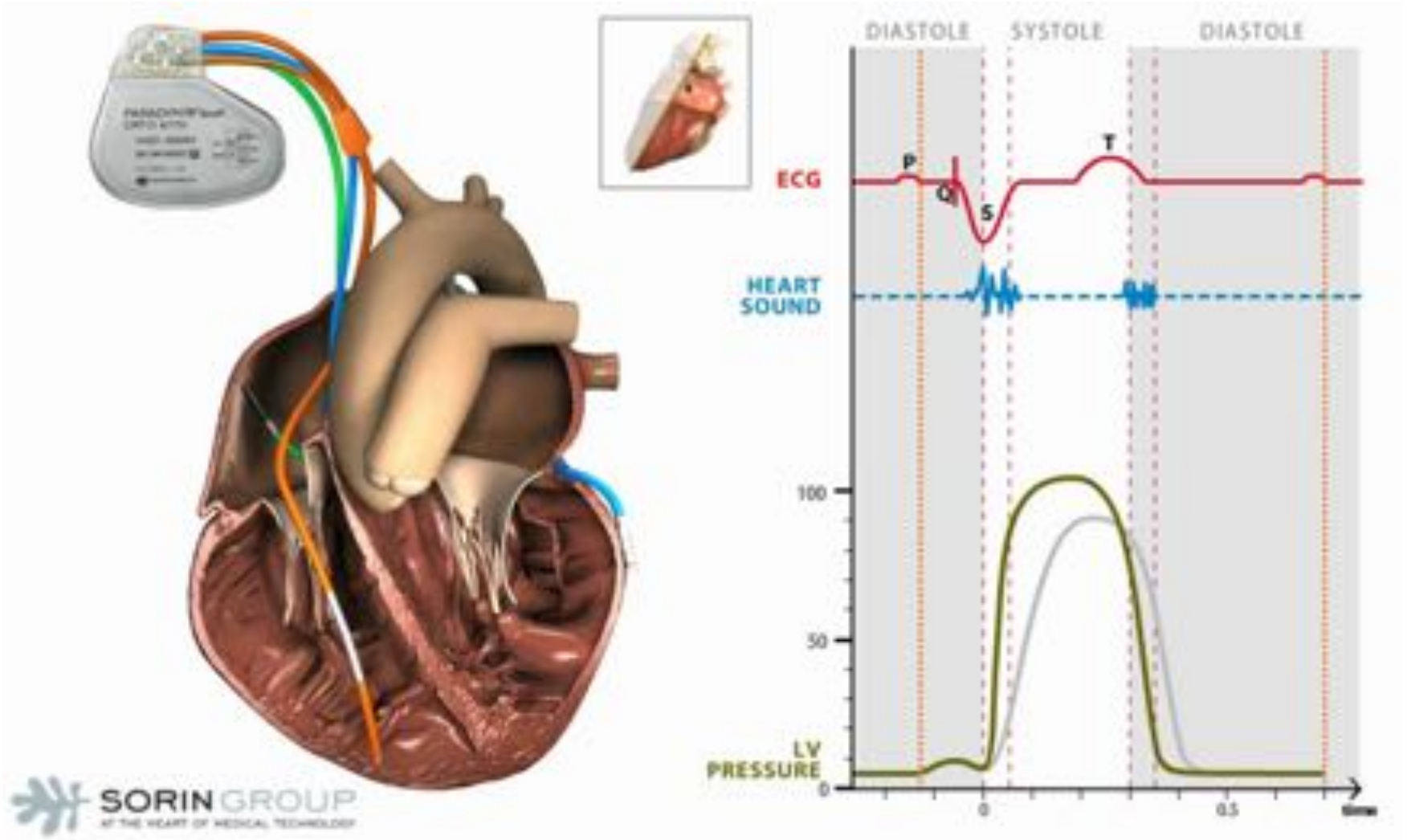
AV delay

- SonR AV delay optimal value corresponds to echo opt value
- Ritter P; Heart Rhythm 2004; 1(1S):377

Outcome

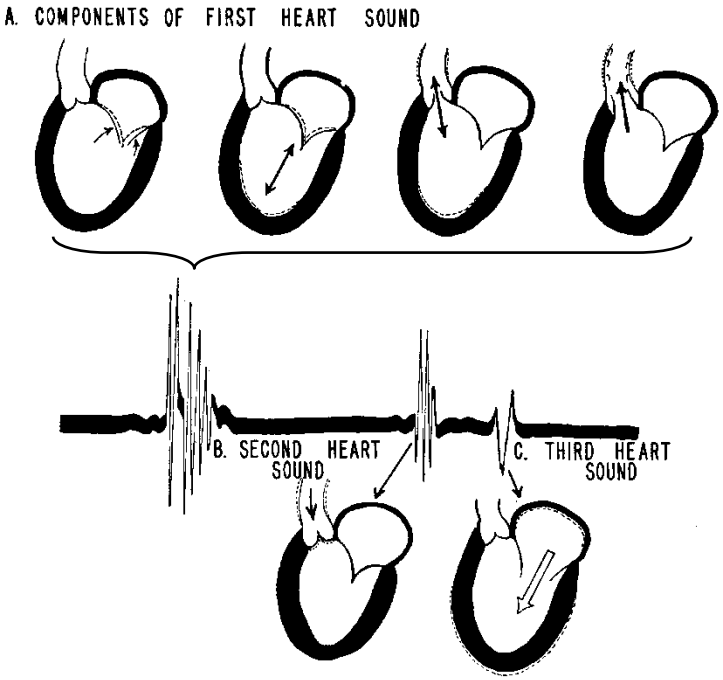
- Promising indication that SonR Opt weekly results in significant NYHA reduction and good QOL, HF hospitalisation results
- CLEAR – Padeletti HRS 2010

Systolic Time Intervals & SonR

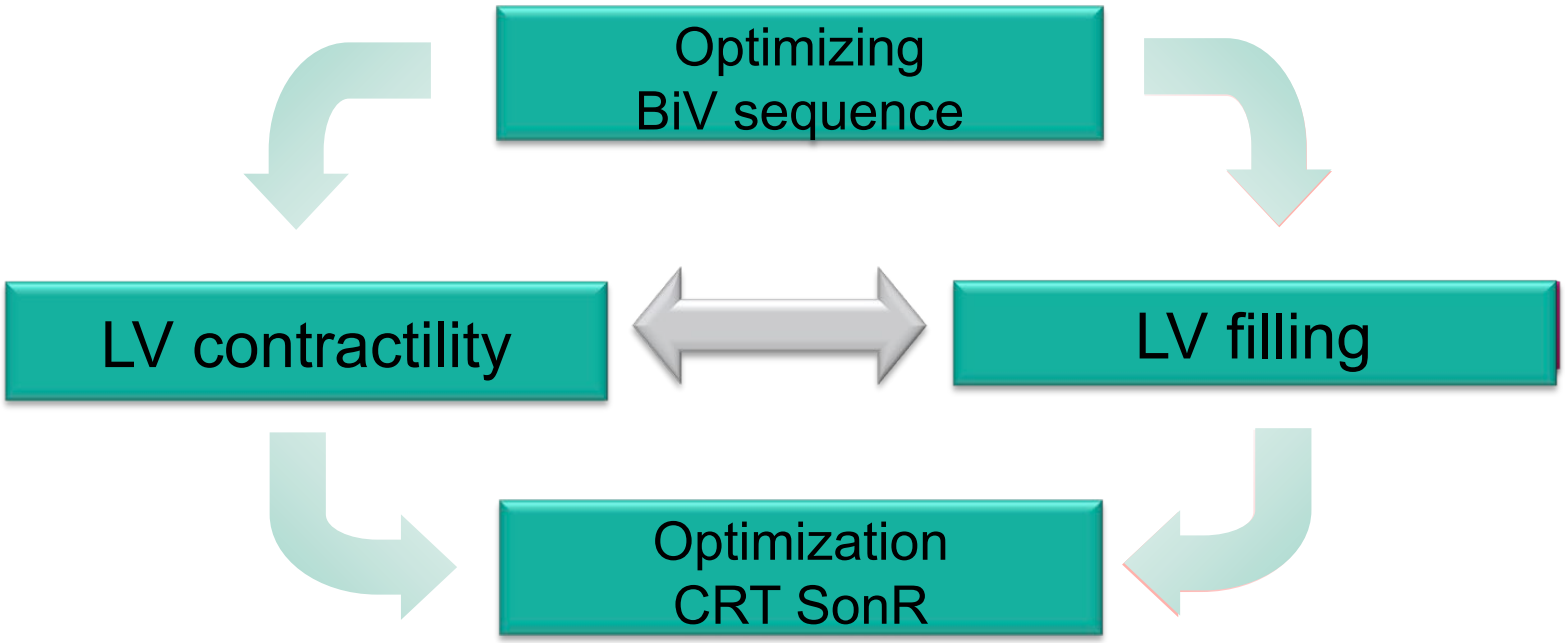


Systolic Time Intervals & SonR

- Vibrations are generated predominantly in the left ventricle, at different times of the systole; main steps are :
- Initial ventricular contraction directs blood towards mitral valve, causing closure and traction on the papillary muscles.
- Blood is suddenly decelerated when mitral valve is completely closed
- Opening of the aortic valve
- Blood outflow turbulence at the beginning of aortic ejection

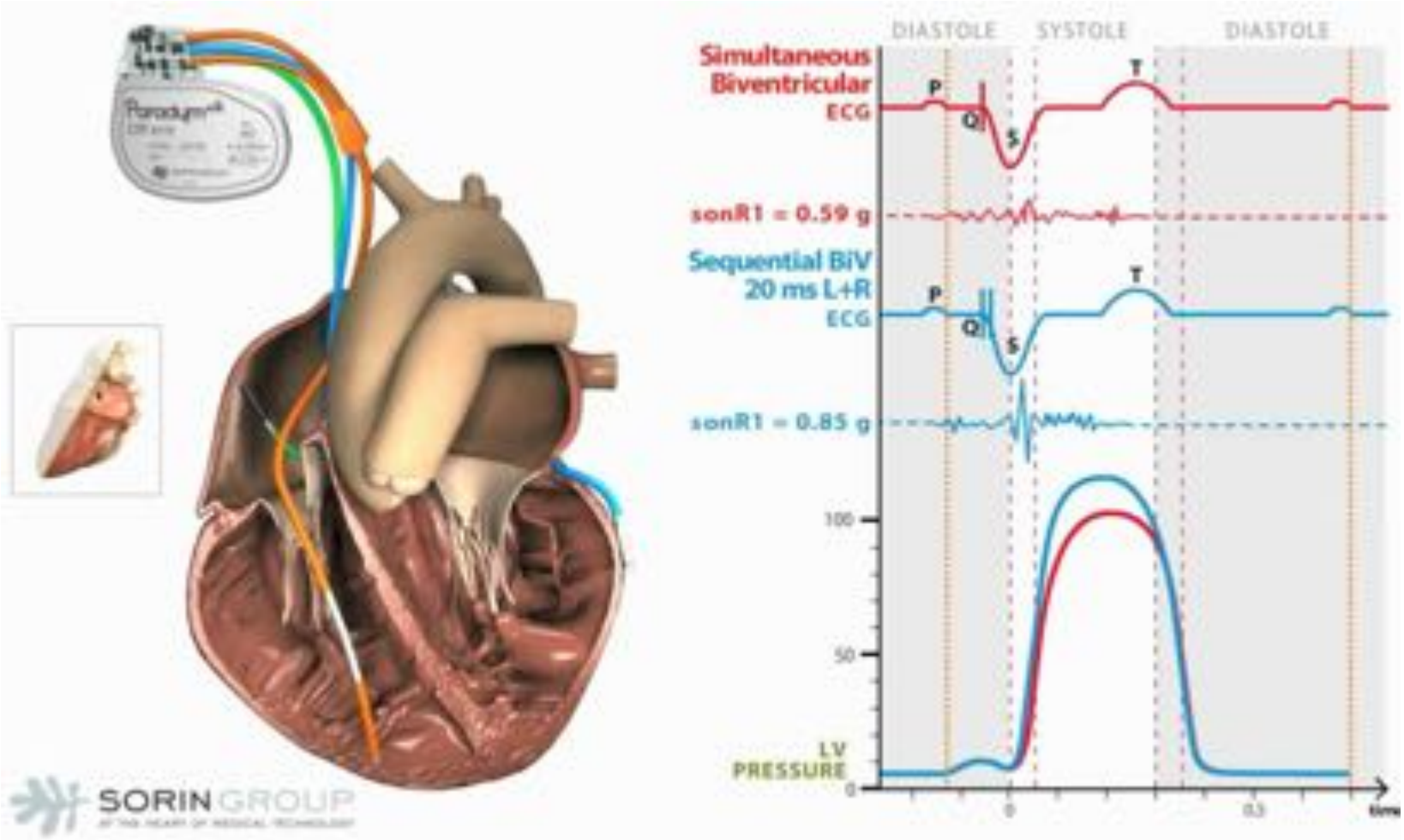


Systolic Time Intervals & SonR

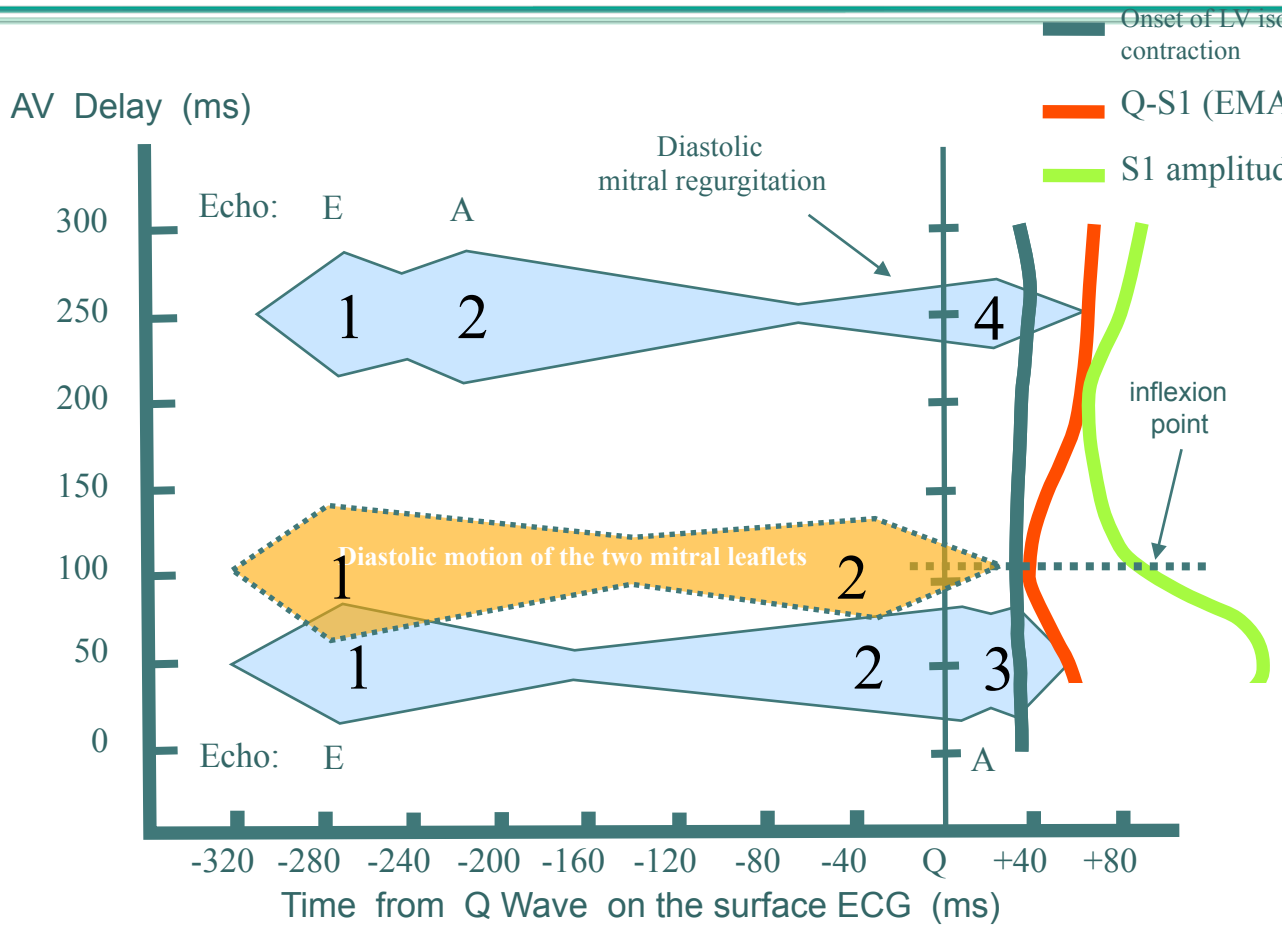


SonR CRT optimization is designed to determine optimal VV & AV parameters associated with best LV contractility and best LV filling.

Systolic Time Intervals & SonR



Systolic Time Intervals & SonR



1. Passive filling of the ventricles
2. Active filling of the ventricles
3. Mitral regurgitation
4. Diastolic mitral regurgitation

Q-S1=time from the V spike and the onset of the ventricular contraction

Has to be the shortest to have the best electro-mechanical delay

Optimal AV delay has been reported to correspond to the shortest Q-S1 interval[1]

Optimal AV delay has been reported to correspond to the inflexion point of the S1 amplitude curve[1]

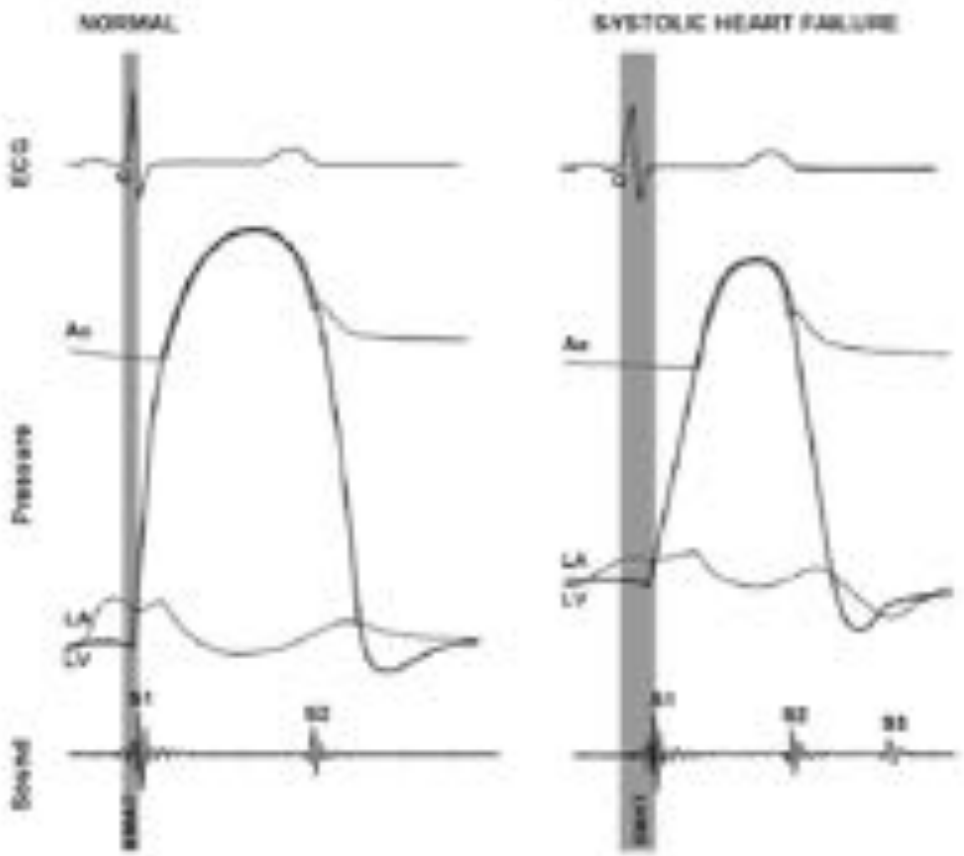
Wexler LF; Circulation 1982;66(1):235-43

Systolic Time Intervals & SonR

Methods

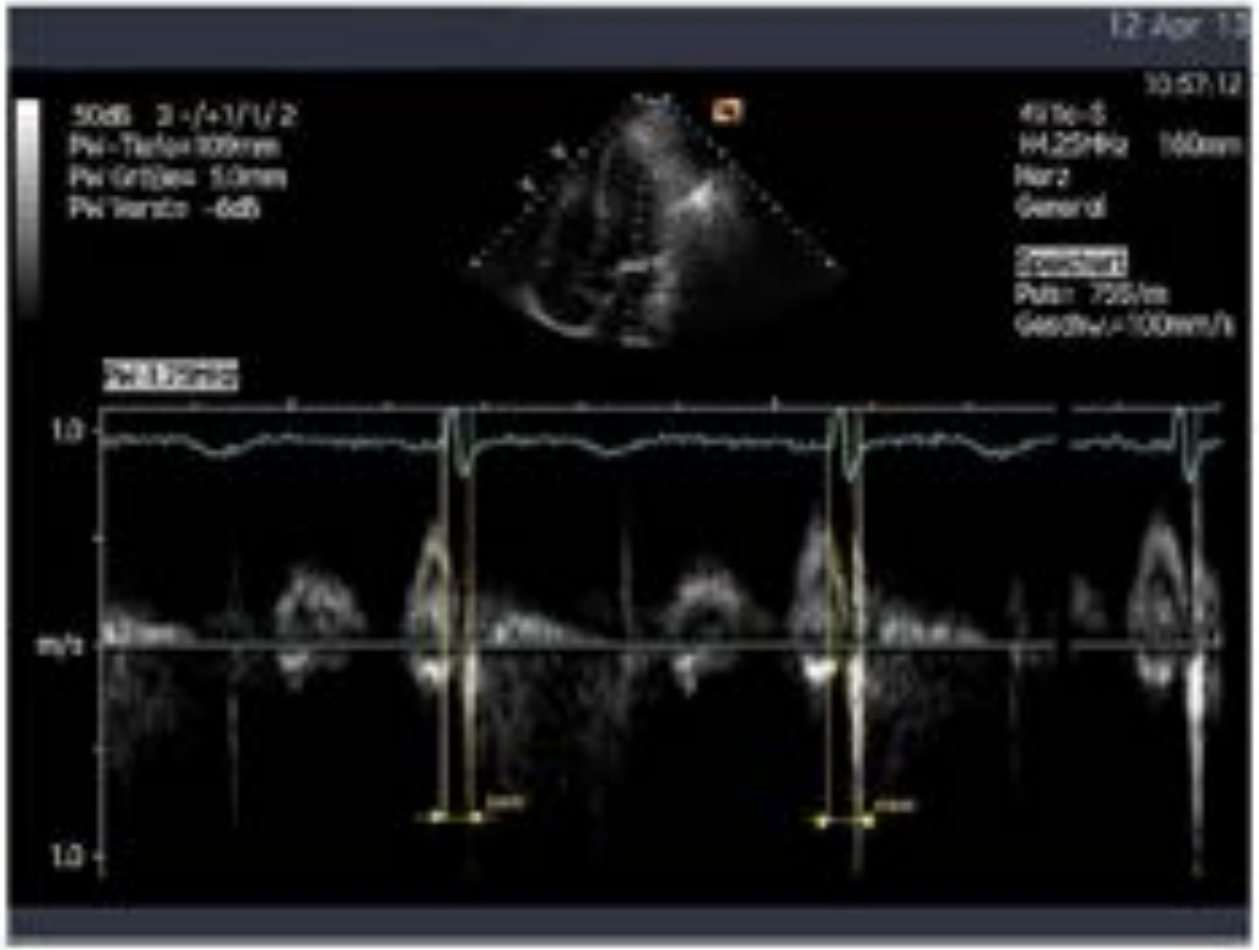
Systolic Time Intervals & SonR

Measurement was performed with Echo (gold standard) and by deriving the SonR as well as the according ECG signal



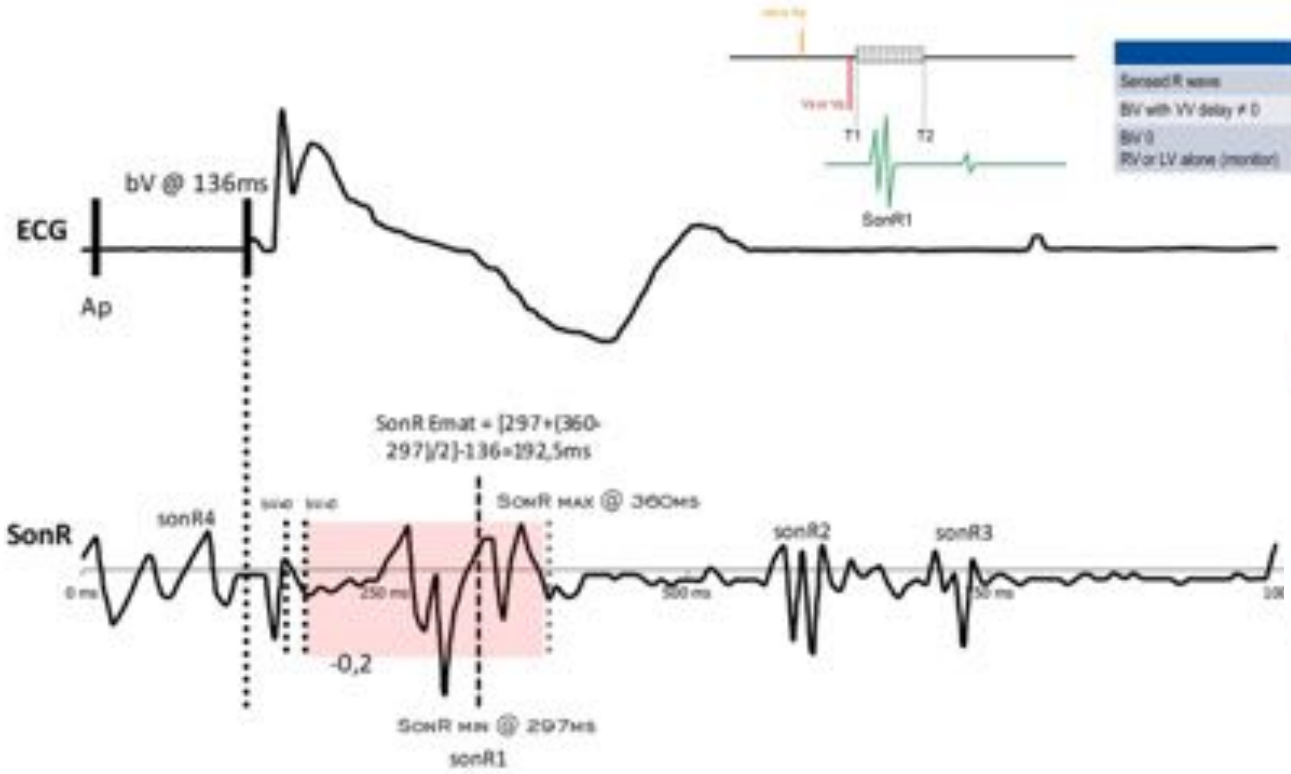
Systolic Time Intervals & SonR

Echo measurement of STI

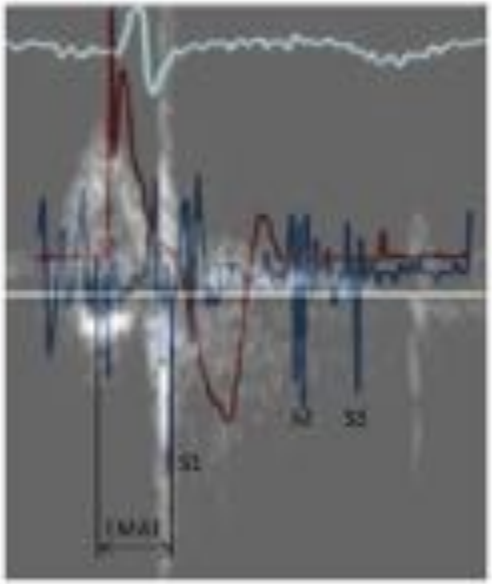


Systolic Time Intervals & SonR

SonR measurement of STI



	T1	T2
Sensed R wave	0 ms	250 ms
BiV with VV delay ≠ 0	32 ms	250 ms
BiV 0 RV or LV alone (monitor)	48 ms	250 ms



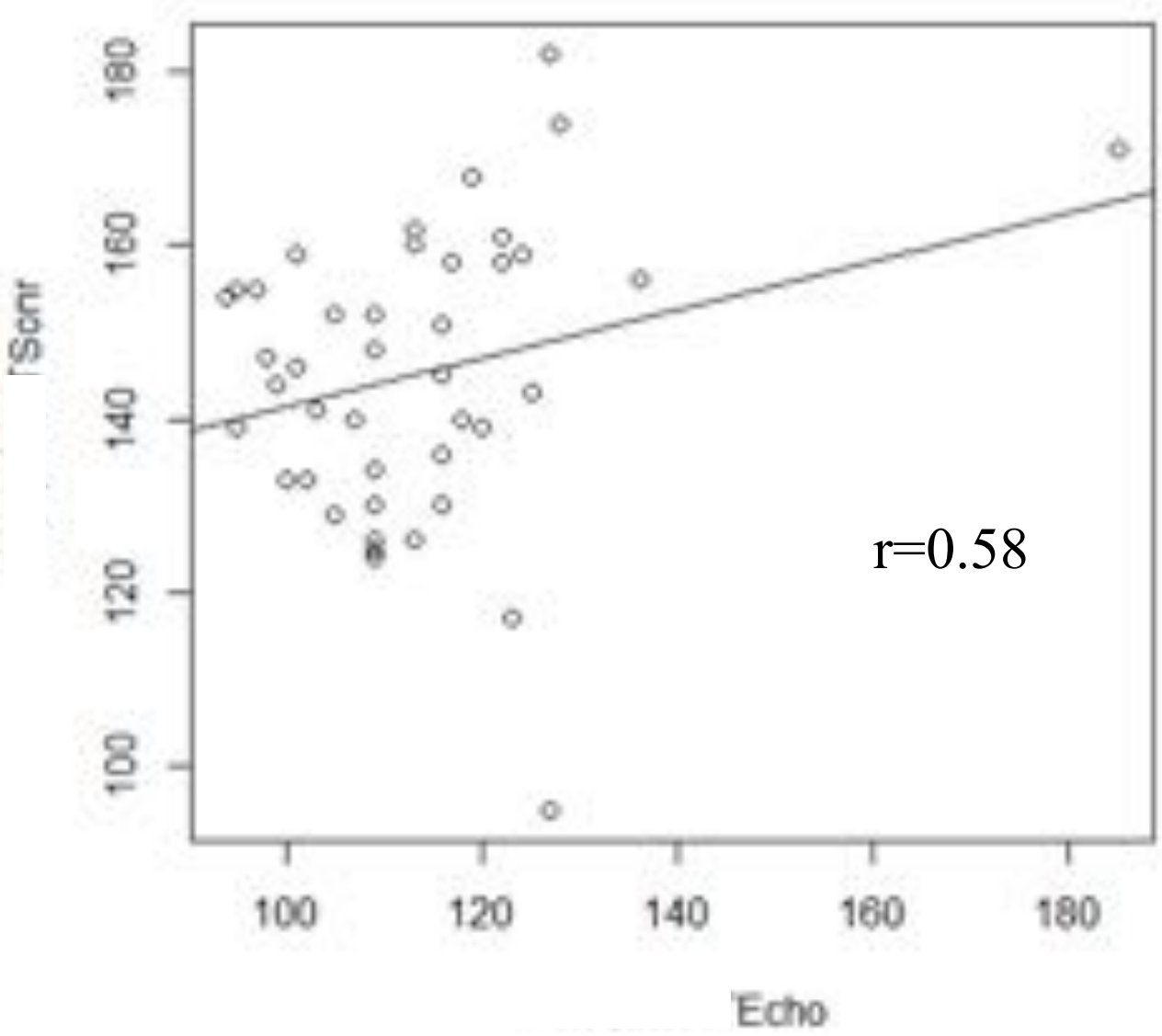
Systolic Time Intervals & SonR

Results

Systolic Time Intervals & SonR

The signals from **seven patients** were derived and compared **computing the correlation coefficient with ECHO measurements.**

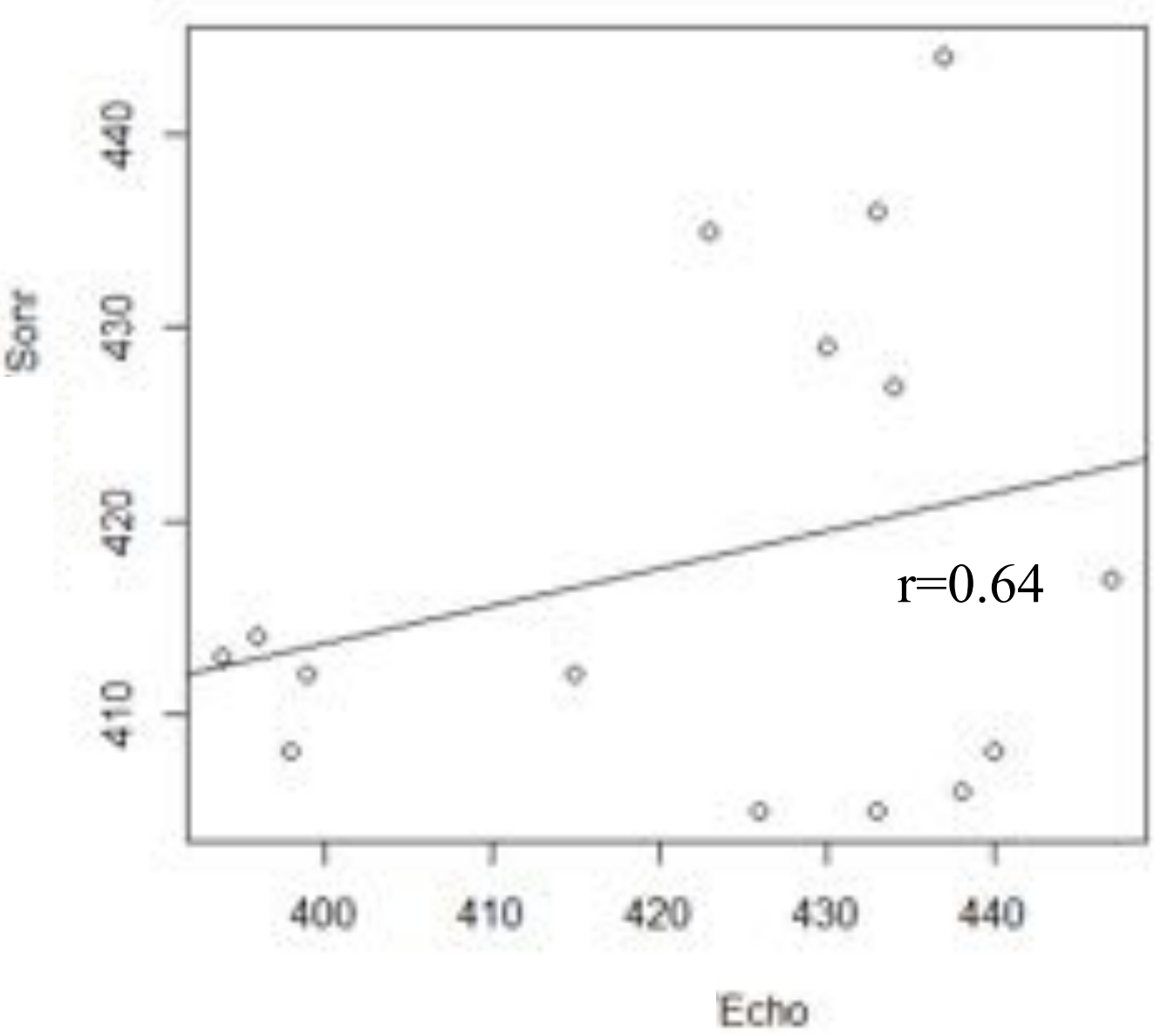
Systolic Time Intervals & SonR



r=0.58

QS1

Systolic Time Intervals & SonR



QS2

Systolic Time Intervals & SonR

Without data cleansing the correlation found was r=0.26 and r=0.28 respectively

After removing outliers and obviously measurement failures we obtained a good correlation with r=0.58 for EMAT and r=0.64 for QS1.

Systolic Time Intervals & SonR

Conclusion & Outlook

Systolic Time Intervals & SonR

In this pilot study we were able to show that STI can be permanently measured using SonR signal.

SonR measured EMAT values are **in** the **range of** the **ECHO measured EMAT** but are higher. Due to our understanding this results from uncertainy where the SonR peak should be taken (dev = +/- 20ms, which is in range of deviation)

A **good (fair) correlation** between the two measurement methods exist

One variable can be predicted the other using a linear function (linear regression model)

Systolic Time Intervals & SonR

STI SonR measurement hypothesis **might be TRUE** but needs to be **confirmed with more patients** in order to **assure statistical results**

Thank you for your attention !