



University of Michigan
Health System

Comparison of Velocity Vector Imaging and a Prototype Radiofrequency-based Speckle Tracking Echocardiography System to Tissue Doppler-based Strain Imaging

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ABSTRACT

Background: Conventional strain imaging has relied on tissue Doppler (TDI) for determination of strain. Velocity vector imaging (VVI) is a newer non-Doppler method for measuring strain, but data comparing it to TDI are lacking. In this study, we compared VVI to TDI for measurement of longitudinal strain (ϵ). In addition, we also compared a prototype radiofrequency-based speckle tracking system (RF) to TDI and VVI for measurement of ϵ . This prototype operates at a high frame rate of 100 frames/sec and uses the signal phase information from the RF-signal to improve tracking quality.

Methods: 20 subjects (age 55 ± 16 , 40% female) underwent echocardiography using color TDI and VVI (Siemens Sequoia), and RF-based speckle tracking using the prototype system (Pixel Velocity, Inc). Longitudinal ϵ was measured offline in 18 segments derived from 3 standard apical views using each modality ($n=360$ segments). Pearson's correlation testing was used to compare the different modalities for measurement of ϵ . **Results:** Longitudinal ϵ could be measured in 64% of segments using TDI, 98% using VVI, and 89% using the RF prototype. VVI- ϵ did not have a significant correlation with TDI- ϵ ($r = 0.024$; $p = 0.713$). RF- ϵ had a modest but significant correlation with TDI- ϵ ($r = 0.172$; $p = 0.012$). There was also a mild correlation between RF- ϵ and VVI- ϵ ($r = 0.138$; $p = 0.014$).

Conclusions: Longitudinal strain measured by VVI did not significantly correlate with TDI-derived strain, whereas strain measured from the RF-based prototype had a modest correlation with TDI-derived strain. These data suggest that further development and validation of these techniques are needed before they are ready for widespread clinical application. RF-based speckle tracking for measurement of strain appears feasible, however, and may be a step in the right direction.

DISCLOSURE INFORMATION

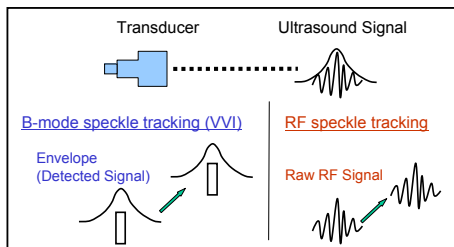
The following relationships exist related to this presentation:

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INTRODUCTION

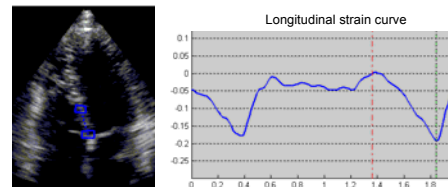
- Conventional strain imaging relies on tissue Doppler (TDI) for determination of strain (ϵ).
- Velocity vector imaging (VVI) is a newer non-Doppler method for measuring ϵ .
- We have also developed a prototype radiofrequency (RF)-based speckle tracking echocardiography system for measurement of ϵ .
 - Operates at high frame rate (100 frames/sec).
 - Real time display of B-mode and tracking correlation magnitudes allows the sonographer to optimize the image for tracking.
- The objective of this study was to compare VVI and the prototype RF-based system to conventional TDI-based strain imaging.



METHODS

- 20 subjects (age 55 ± 16 , 40% female) underwent echocardiography with color TDI and VVI using a commercial system (Siemens Acuson Sequoia C512) and also underwent RF-based speckle tracking using the prototype system (Pixel Velocity, Inc.) in the same setting.
- End-systolic longitudinal ϵ was measured offline in 18 segments derived from 3 standard apical views (ap4, ap2, and ap3 chamber views; $n = 360$ segments) using each modality.
- The time interval from the QRS until the end of aortic flow by spectral Doppler was used to define end-systole.
- Pearson's correlation testing was used to compare the different modalities for measurement of ϵ .

Example of using the RF-prototype to measure strain.



RESULTS

Table 1. Percent of segments in which ϵ could be measured.

| | TDI - ϵ | VVI - ϵ | RF - ϵ |
|---------------|------------------|------------------|-----------------|
| % of segments | 64% | 98% | 89% |

Figure 1. Relationship between VVI - ϵ and TDI - ϵ .

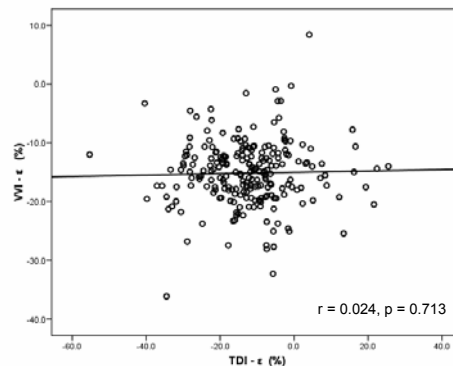
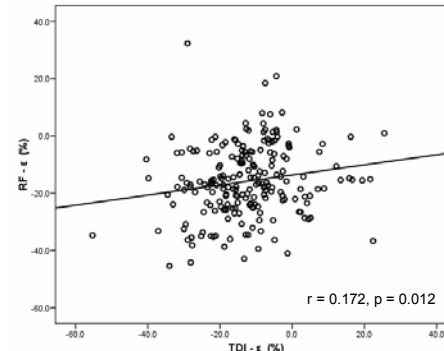


Figure 2. Relationship between RF - ϵ and TDI - ϵ .



Relationship between RF - ϵ and VVI - ϵ :

- There was a mild correlation between RF - ϵ and VVI - ϵ ($r = 0.138$; $p = 0.014$).

CONCLUSIONS

- Longitudinal strain measured by VVI did not significantly correlate with TDI-derived strain.
- Strain measured using the RF-based prototype had a modest but significant correlation with TDI-derived strain.
- These data suggest that further development and validation of these techniques are needed before they are ready for widespread clinical application.
- RF-based speckle tracking for measurement of strain appears feasible, however, and may be a step in the right direction. We are currently performing ongoing work aimed at further developing this technology.