**Inter-Observer and Inter-Vendor Variability in Strain Measurements in Patients with Single Right Ventricular Anatomy**

**Alex J. Thompson, MD (Fellow)**, Patrick W. O’Leary, MD, Benjamin W. Eidem, MD, Megan M. O'Byrne, MA, Angela Miller, RDCS, Sara Martineau, RDCS, Chelsea Reece, RDCS, Amanda Breuer, RDCS, M. Yasir Qureshi, MBBS

**Background:** Myocardial strain offers new insights into ventricular performance. However, there is little data on inter-observer and inter-vendor variability in patients with single, right ventricular (sRV) physiology.

**Methods:** Echocardiograms from 85 patients (122 separate studies) with sRV (post Glenn and/or Fontan) were prospectively evaluated after IRB approval and patient consent was obtained. Longitudinal strain was assessed in apical 4 chamber (4LS) and inflow/outflow (IO) views. Circumferential and radial strain were assessed in the short axis plane at the mid-ventricular level. Results were analyzed using both Velocity Vector Imaging (VVI, Siemens, Munich) and Automated Functional Imaging (AFI, General Electric, Boston) software. Paired “inter-observer” analyses were performed in a subset (n=74) of the patients, whose studies were read by two sonographers, for each type of strain measurement.

**Results:** Adequate 4LS curves were obtained by both observers in 95% sRV patients (70/74) using VVI software, but Inflow/Outflow (IO), circumferential and radial strain curves were suboptimal more frequently. Inter-observer and inter-vendor variability, including mean difference and correlations, are shown in Table 1. Both vendor software packages showed fair inter-observer correlation and a small mean difference for apical 4-chamber longitudinal strain with ICC of 0.56 for VVI and 0.61 for AFI. Similar interclass correlation coefficients (ICC) were observed with circumferential strain values (VVI = 0.55, AFI = 0.61). AFI ICC values for IO assessments were superior (0.61 and 0.53) relative to VVI (0.12 and 0.43). There was a reasonable inter-vendor correlation for sRV global circumferential strain values (0.76). However, correlation between vendor packages was ≤ 0.6 for all other assessments.

**Conclusions:** Inter-observer correlation in sRV longitudinal and circumferential strain values was modest, but the clinical difference between programs was small. Inter-vendor variability persists with poor correlation, with the exception of global circumferential strain. Therefore, serial evaluations of myocardial strain in the sRV should be made using the same analysis software.

**Table 1.** Average inter-sonographer and inter-vendor variability for VVI and AFI

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Inter-Sonographer** | **n (74)** |  | **Mean Difference** |  | **Limits of Agreement** | **ICC** |  |
| VVI Apical 4-Chamber Longitudinal | 70 |  | 0.2 ± 3.0 |  | (-6.0, 5.7) | 0.56 |  |
| VVI IO Anterior Longitudinal | 62 |  | 0.2 ± 6.0 |  | (-11.5, 11.9) | 0.12 |  |
| VVI IO Inferior Longitudinal | 62 |  | 0.9 ± 4.7 |  | (-8.3, 10.2) | 0.43 |  |
| VVI Average Circumferential | 68 |  | 0.03 ± 3.6 |  | (-7.1, 7.0) | 0.55 |  |
| VVI Average Radial | 66 |  | 2.6 ± 17.7 |  | (-37.3, 32.2) | 0.22 |  |
| AFI Apical 4-Chamber Longitudinal | 63 |  | 0.02 ± 2.5 |  | (-4.9, 5.0) | 0.65 |  |
| AFI IO Anterior Longitudinal | 54 |  | 0.9 ± 4.6 |  | (-9.9, 8.1) | 0.61 |  |
| AFI IO Interior Longitudinal | 54 |  | 0.6 ± 4.4 |  | (-9.2, 8.1) | 0.53 |  |
| AFI Average Circumferential | 40 |  | 0.5 ± 3.5 |  | (-6.3, 7.3) | 0.61 |  |
| AFI Average Radial | 50 |  | 1.0 ± 14.1 |  | (-26.6, 28.5) | 0.26 |  |
| **Inter-Vendor** | **n (122)** | **VVI Mean** | **Mean Difference** | **AFI Mean** | **Limits of Agreement** | **Spearman Correlation** | **95% CI** |
| Apical 4-Chamber Longitudinal | 122 | -14.6 ± 3.5 | 2.1 ± 3.2 | -16.6 ± 3.3 | (-4.3, 8.4) | 0.56 | (0.4, 0.7) |
| IO Anterior | 101 | -12.5 ± 4.1 | 1.1 ± 5.8 | -11.4 ± 5.7 | (-12.5, 10.3) | 0.38 | (0.2, 0.5) |
| IO Inferior | 100 | -17.7 ± 4.7 | 0.5 ± 4.7 | -18.1 ± 4.6 | (-8.7, 9.7) | 0.52 | (0.4, 0.7) |
| Global Circumferential | 76 | -15.4 ± 4.6 | 1.1 ± 3.5 | -14.2 ± 4.8 | (-8.0, 5.7) | 0.76 | (0.6, 0.8) |
| Global Radial | 87 | 30.4 ± 13.4 | 5.7 ± 16.5 | 24.7 ± 11.3 | (-26.6, 38.0) | 0.18 | (0, 0.4) |

VVI: Velocity Vector Imaging; AFI: Automated Functional Imaging; n: number of individual echocardiograms; ICC: interclass correlation coefficient; IO: inflow/outflow