# Left Ventricular Twist and Systolic Twist-Per-Volume Slope in Patients with Mitral Regurgitation

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**PURPOSE –** Primary mitral regurgitation (MR) is a common valvular disorder that foments left ventricular (LV) dysfunction. LV twist is a quantitative imaging biomarker for LV dysfunction and is known to decrease in subjects with MR (1-3). LV systolic twist-per-volume slope has been proposed as a better measure of LV dysfunction because it accounts for changes in both rotational mechanics and ejection, but it has not been evaluated in patients with primary MR using tagged MRI. We ***hypothesized*** that LV twist and systolic twist-per-volume slope decrease with increasing severity of MR.

**METHODS –** Normal subjects (n=54), moderate MR patients (n=29), and severe MR patients (n=54) were studied. MRI was performed on a 1.5T scanner and grid tagged LV images were collect at the base and apex. Images were analyzed with FAST(4), a recently validated novel method for the semi-automatic rapid quantification of LV twist in the Fourier domain. The FAST algorithm was used to measure LV twist and systolic twist-per-volume slope parameters with ~3 minutes of user interaction. Peak LV twist, CL-shear-angle, and systolic twist-per-volume slope, was reported as mean±SD. CL-shear angle was calculated as the apical and basal difference of the product of rotation and epicardial radius normalized by the distance between the apical and basal slices. Systolic twist-per-volume was calculated as peak twist divided by the difference between end-systolic and end-diastolic blood volumes. ANOVA were used to test differences in peak twist, CL-shear angle, and systolic twist-per-volume slope between normal, moderate MR, and severe MR groups with adjustments for the covariates of age, weight, height, and gender.

**RESULTS –** Compared to normal subjects (11.5°±3.2°) peak LV twist was decreased in both moderate (9.0°±3.0) and severe MR (8.8°±2.6°) (p=0.001). Figure 1 illustrates the changes in mean LV twist between the groups, error bars are the standard error of the mean. In moderate MR patients this decrease was primarily due to a significant decrease in apical twist, while in patients with severe MR there was a significant reduction in both basal and apical rotations. Figure 2 is a scatter plot of the systolic twist-per-volume slope for the three different groups; the 'X' represents the mean systolic twist-per-volume slope and the error bars represent the standard deviation. Peak systolic twist-per-volume slope was significantly different for all pairwise comparisons (p<0.0001) and was decreased in moderate MR (-0.12±0.04°/mL) and further decreased in severe MR (-0.07±0.03°/mL) compared to normal subjects (-0.14±0.05°/mL). Twist-per-volume slope was the only measure of rotational mechanics that distinguished all three groups. Furthermore, no differences were detected in CL-shear angle between normal, moderate MR, and severe MR groups: 5.0±1.4°, 4.7±1.6°, 5.0±1.3° respectively, p=0.7. Figure 3 illustrates the changes in mean CL-shear angle between the groups, error bars are the standard error of the mean.

**DISCUSSION –** Peak LV twist decreased significantly in moderate and severe MR, but only peak systolic twist-per-volume slope decreased with increasing severity of MR. The pseudo-normalization of CL-shear angle in moderate and severe MR was unexpected, but can be explained by the significant increase in the apical and basal epicardial radii in conjunction with the significant decrease in apical rotation in MR patients compared with normal subjects (data not shown).

**CONCLUSION –** Peak systolic twist-per-volume slope significantly decreased with increasing severity of MR and may possibly serve as sensitive imaging biomarkers for LV dysfunction in patients with primary MR.

**REFERENCES –** 1. Ennis. Circ Cardiovasc Imaging 2009; 2:85-92. 2. Tibayan. J Heart Valve Dis 2002; 11:39-4. 3. Borg. Heart 2008; 94:597-603. 4. Reyhan. J Magn Reson Imaging 2012; 35:587-593. Funding: AHA 11PRE6080005, NIH R00-HL087614, UCLA

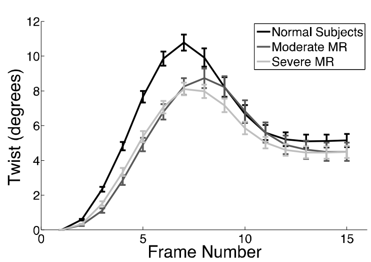

**Figure 1. LV Twist**

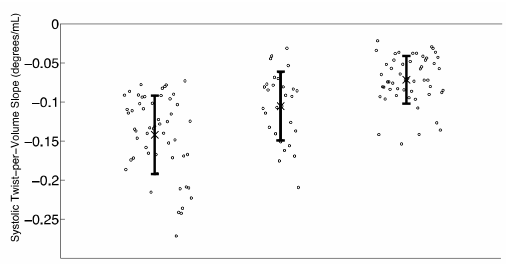

**Figure 2. Systolic Twist-per-volume slope**

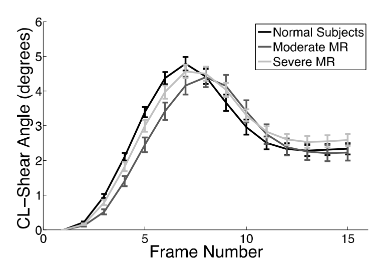

**Figure 3. CL-Shear Angle**