

Experimental studies of whether echocardiographical strain and strain rate indexes are as reliable as invasive indexes to detect 75% coronary stenosis

**Purpose:** We conducted animal experiments to confirm significant 75% coronary artery stenosis (CAS) causes segmental left ventricular wall dysfunction and significant myocardial ischemia. We also tested how significant 75% CAS behaves hemodynamically. We collected indexes using both echocardiography and invasive devices. All procedures were performed in accordance with the Declaration of Helsinki of the World Medical Association.

**Methods:** Twenty coronary arteries of ten pigs anesthetized with 100% O<sub>2</sub> were divided into two groups: normal coronary artery group (grN) and single 75% stenosis group (gr75). Ultrasonic systems used in this experiment were Vivid S5 Bt13 and EchoPAC PC Bt13. 1.5/4.0 MHz active-matrix array (AMA) probe was used. As non-invasive indexes, peak systolic strain value (PSS) and Z value of strain rate z variable we created (SRZ) were used. Z variable was:  $Z = 4.91 + 1.02 \times (100\text{-ms SR value}) + 1.23 \times (200\text{-ms SR value}) - 0.46 \times (\text{minimum SR value}) + 4.83 \times (\text{mean SR value})$ . As invasive indexes, coronary blood flow (CBF) and fractional flow reserve (FFR) were measured. Blood flow probes (t-402M Transonic System, Inc, USA) to measure coronary blood flow (CBF) and vascular occluders (DOCXS Occluder, BIOMEDICAL PRODUCTS & ACCESSORIES, Inc, USA) were placed on the LAD #6 and/or 7, and on the LCX #11 and/or 13. Fractional flow reserve (FFR) were measured with Primewire Prestige<sup>®</sup> PLUS Pressure Guide Wire. 75% CAS produced by vascular occluders was confirmed by measuring the diameters of coronary arteries using coronary angiography. The grN and gr75 of the four indexes were compared by a paired t-test.

**Results:** The results of ROC analysis of the four indexes were as follows. PSS(%): grN  $-17.78 \pm 3.54$ , gr75  $-14.98 \pm 2.23$ , sensitivity(Sn); 0.71, specificity(Sp); 0.67, accuracy(Ac); 0.75, discriminant probability(Dp); 0.682 (cut-off value  $-16.38 \leq$ ). SRZ: grN  $-1.85 \pm 0.53$ , gr75  $1.87 \pm 0.83$ , Sn; 1.00, Sp; 0.96, Ac; 0.98, Dp; 0.926 (cut-off value  $0.13 \leq$ ). CBF(ml/min.): grN  $54.83 \pm 5.54$ , gr75  $17.41 \pm 6.56$ . Sn; 1.00, Sp; 1.00, Ac; 1.00,

Dp was 0.998 (cut-off value  $\leq 31.4$ ). FFR(%): grN  $0.99 \pm 0.01$ , gr75  $0.81 \pm 0.14$ , Sn; 0.38, Sp; 1.00, Ac; 0.69, Dp; 0.806 (cut-off value  $\leq 0.75$ ). There was significant difference between grN and ge75 of each index (PSS, SRZ and CBF:  $p < 0.0001$ , FFR:  $p < 0.01$ ).

**Conclusion:** The results proved decreased CBF of 75% CAS caused segmental LV wall systolic dysfunction. The non-invasive strain rate value of Z variable is more reliable than the invasive index of FFR and is almost the same as CBF to detect 75% CAS.