There is considerable controversy about LV pumping ability of SHR. Studies on the diastolic function have been rarely performed. We studied LV pumping ability and diastolic function using time constant (T), an accurate index of early LV relaxation, by left-sided catheterization in 3 different age groups (15, 28 and 50 weeks old) of SHR (n=12, 7 and 5) and in sex- and age-matched WKY (n=15, 6 and 7) and their relationship with LV wall thickness (WT) and LV structural changes quantified by microspectrophotometry (MSP).

Under pentobarbital anesthesia (35 mg/kg), a catheter (PE 50) connected to a micro tip manometer was advanced by way of the right carotid artery into the LV for measurement of pressures and dp/dt. T was calculated from the LV pressure and peak negative dp/dt. An electromagnetic flow probe was placed around the abdominal aorta for measurement of aortic blood flow (F) with Narcomatic RT 500. After measurements of basal blood pressures and F, physiologic saline was infused for 1 minute into the femoral vein at the rate of 2 cc/100g of body weight (BW) and peak increment of F (peak F) was recorded. All phasic pressures, dp/dt and phasic F were recorded at a paper speed of 100 mm/sec on a multi-channel polygraph (San-ei). At the completion of the hemodynamic study, the heart was arrested with infusion of 5% potassium citrate, and heart weight (HW) was determined. WT and LV internal diameter (R) were measured on HE stained preparation at the level of the mid-ventricular transverse section of the LV, and the sections were histologically studied. In 14 rats of older than 28 weeks (7 SHR and 7 WKY) in age, quantitative evaluation of myocardial fibers, elastin, collagen, acid mucopolysaccharide (AMPS) and glycoprotein (GP) was done by MSP.

There was a significant increase in HW relative to BW in 28 and 50 weeks old SHR (3.7±0.2 vs 3.5±0.2 mg/g, p<0.02, 3.5±0.2 vs 2.9±0.2, p<0.01, respectively). There was no significant difference in peak positive dp/dt, except in 15 week-old group, in which it was greater in SHR (3759±804 vs 3172±512 mmHg/sec, p<0.05). In Starling curve employing end-diastolic wall stress (LVEDP×R/2WT) as a more accurate index of preload than LVEDP, peak F in acute volume load was not depressed in each age group of SHR. Significant difference in peak negative dp/dt was found only in 15 week-old group, where it was greater in SHR (3191±654 vs 2721±241 mmHg/sec, p<0.02). T was significantly prolonged in older age groups of SHR (16.1±2.3 vs 13.7±2.3 msec, p<0.05, 18.5±2.7 vs 14.9±2.4, p<0.05, respectively), and was positively correlated with WT (r=0.53).

Histologically fibrosis was prominent in LV wall of SHR, which was the most marked in that of 50 week-old SHR. MSP disclosed hypertrophy and scarcity of the cardiac fibers, increase of collagen, decrease of elastin, and increase of GP and AMPS. With principal component analysis, a significant correlation (r=-0.718) was found between T and the scores of the 1st principal components (elastin, GP and cardiac fibers).

We conclude that LV pumping ability of SHR is preserved until 50 weeks of age, whereas LV relaxation tends to be impaired from 15 weeks of age and is definitely impaired in the older groups of SHR, for which we consider hypertrophy of myofibers, fibrosis and quantitative changes in LV structural components are responsible.