Background: Bicuspid aortic valve (BAV) is a common congenital cardiac disease with a high risk of adverse outcomes. By combining left ventricular (LV) global longitudinal strain (GLS) with LV volume during the cardiac cycle, LV strain-volume loops (SV-loops) can be generated. This may be a valuable biomarker in early detection of LV deterioration. The aim of this study is to describe SV-loop characteristics in BAV patients and investigate its prognostic value.

Methods: BAV patients were compared with healthy controls, matched for age and sex on a group level. Apical 2, 3 and 4 chamber views were used to measure LV GLS and volume to construct SV-loops. The parameters measured from these SV-loops are depicted in Figure 1A. Associations with the composite endpoint of all-cause mortality, heart failure and supraventricular and ventricular arrhythmias were assessed by univariable Cox regression.

Results: 113 BAV patients were included (median age 32 years, 40% female). The median aortic jet velocity was 2.3 m/s [IQR 1.6-3.3] and 21 patients (19%) had moderate aortic regurgitation. A clear rightward shift in average SV-loops was seen between BAV patients and healthy controls (figure 1B). Slope was significantly lower in BAV patients (0.21%/mL, [IQR 0.17-0.28] vs. 0.27%/mL [0.24-0.34], p<0.001), as was ESslope (0.19%/mL [0.12-0.25] vs. 0.29%/mL [0.21-0.43], p<0.001). Moreover, greater uncoupling was seen in BAV patients, both early (0.48 ±1.29 vs. 0.05±1.21, p=0.018) and late diastolic (0.66±1.02 vs -0.07±1.07, p<0.001). During a median follow-up period of 9.9 years [9.3-10.4], 17 patients experienced a primary endpoint. Echocardiographic parameters associated with the primary endpoint were early diastolic uncoupling (HR 1.82, p=0.009), E/e' ratio (HR 1.29, p<0.001), ESslope (HR 0.55, p=0.03) and LV end-systolic volume (HR 1.05, p=0.03).

Conclusion: Significant differences in SV-loop characteristics were observed between BAV patients and healthy controls, suggesting its capability to provide new insights in cardiac hemodynamics and detect LV remodelling at an early stage. Moreover, SV-loops can be promising new prognostic markers.

Figure 1. A. Schematic overview of strain-volume loop characteristics. Sslope: linear slope of the strain-volume relation during systole. ESslope: early linear slope during the first 5% of volume change during systole. EDslope: early linear slope during the first 5% of volume change during diastole. UNCOUP is the mean difference between systolic and diastolic strain for the same volume, and can be divided in early diastolic (UNCOUP ED) during the first 2/3 of diastole and late diastolic (UNCOUP LD) during the last 1/3 of diastole. B. Average strain-volume loop for healthy controls (black) and BAV patients (red). Bold lines represent systole and dashed lines represent diastole.