

## Morphological features of mitral annular calcification leading to systolic anterior motion of the mitral valve

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**Funding Acknowledgement:** Type of funding sources: None.

**Background:** Systolic anterior motion (SAM) of the mitral valve (MV) can develop after mitral valve repair with placement of an annuloplasty ring. It is occasionally seen in patients with mitral annular calcification (MAC) but mechanisms have not been carefully delineated. Using 2-dimensional echocardiography we explored morphologic parameters which may contribute to SAM in patients with MAC.

**Hypothesis:** We hypothesized that in cases of MAC where SAM is present there would be anterior displacement of the valve by the posterior annular calcification.

**Methods:** From our echocardiographic database we identified 20 patients with severe MAC who also had SAM with definite septal contact. Each subject was paired with 2 controls free of MAC and 1 control with severe MAC but no SAM. All controls were matched for age, sex, BSA, and septal wall thickness ( $\pm 1.5$  mm). 2-D echocardiographic measurements were taken from the parasternal long-axis (PLAX), apical 3-chamber and apical 4-chamber views.

**Results:** MAC+SAM vs MAC no-SAM. Three notable differences were observed: MAC+SAM patients, as compared with MAC no-SAM, had a smaller left ventricular outflow tract (LVOT), longer anterior mitral leaflet, and greater displacement of the MV coaptation point towards the interventricular septum (Figure 1). Median values for these 3 factors were deter-

mined using the no-MAC controls; each MAC subject was then scored for number of factors exceeding those values. MAC+SAM patients had a mean score of 2.7 vs 1.1 for MAC no-SAM patients. By combining anterior mitral leaflet length and coaptation point-septal distance as a ratio we could effectively separate MAC+SAM vs MAC no-SAM when  $>0.9$  with one exception (Figure 2). We also observed a smaller anteroposterior annular dimension in the MAC+SAM group.

MAC no-SAM vs no-MAC. Comparing these groups there were no differences in LVOT diameter or coaptation-septal distance; effective anterior mitral leaflet length was smaller in MAC no-SAM subjects vs no-MAC controls while anteroposterior dimension of the annulus was larger.

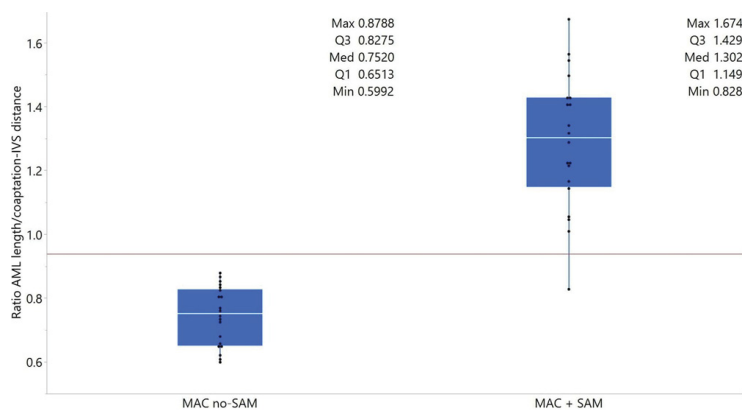
**Conclusions:** SAM develops in a subset of patients with severe calcification of the mitral annulus. These patients have a smaller anteroposterior annular dimension, possibly due to severe MAC. Other notable differences characterize MAC patients with SAM from those without. The LVOT is smaller, the effective anterior mitral leaflet length is longer, and the point of leaflet coaptation is displaced towards the septum. Using the ratio of anterior mitral leaflet length/coaptation point-septal distance in this study sample effectively separated those MAC patients with SAM from those without.

	SAM+MAC (n=20)	MAC no-SAM (n=20)	No-MAC (n=40)	P value
LVOT diameter (mm; PLAX)	18.8 $\pm$ 1.8	21.5 $\pm$ 2.2	21.2 $\pm$ 1.7	<0.0001
AML length (mm; PLAX)*	22.4 $\pm$ 3.2	17.7 $\pm$ 2.2	19.9 $\pm$ 3.0	<0.0001
Coaptation point-septal distance (mm; PLAX)	17.8 $\pm$ 3.7	24.1 $\pm$ 4.0	23.8 $\pm$ 4.0	<0.0001
Anteroposterior annular diameter (mm; 3 chamber view)	24.6 $\pm$ 5.0	29.0 $\pm$ 4.9	25.9 $\pm$ 4.1	0.008
Ratio AML length/coaptation point-septal distance	1.3 $\pm$ 0.2	0.74 $\pm$ 0.1	0.85 $\pm$ 0.1	<0.0001

AML= anterior mitral leaflet; LVOT=left ventricular outflow tract; MAC=mitral annular calcification; PLAX=parasternal long-axis view; SAM=systolic anterior motion

\*measured from the coaptation point to the effective hinge point if the annulus was calcified

Figure 1



Creating a ratio of AML length/(distance from valve coaptation point to interventricular septum) provided good discrimination of those MAC patients who had systolic anterior motion of the valve with dynamic outflow tract obstruction. All but one of the MAC + SAM patients had a ratio  $>0.9$

Figure 2