Borderline Left Ventricles: morphological differences in papillary muscles compared to normal.

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Introduction:
Papillary muscles (PM’s) are usually organized as two equal-sized muscles holding superolateral (SL) and inferomedial (IM) positions. However, as described in autopsy studies, their morphology may vary. In this study, we describe differences in PM morphology in borderline and normal-sized left ventricles (LV’s) using MRI.

Methods:
This retrospective study comprised thirty-one consecutive children with borderline LV (heterogenous group with severe aortic stenosis, coarctation with borderline LV and aortic atresia with VSD) and thirty consecutive subjects with a normal-sized LV. PM morphology, location, angle created between them and their length ratio related to LV length was assessed using steady-state-free-precession short-axis (SAx) cine and 3D-whole-heart sequences.

Results:
The median age was 4.3 years (range: 4 months-20 years; 36 male). The combination of SAx and 3D-whole-heart imaging demonstrated PM anatomy in all cases. All patients with normal-sized LV had two PM’s whereas eight (24%) borderline LV cases had a single IM muscle, and one had a single SL muscle. Splitting of PM into groups was found with equal frequency in normal and borderline LV’s when considering the SL muscle (40 vs. 24%; p=0.21) but more frequently in the normal LV when considering the IM muscle (64 vs. 36%; p=0.03). Although PM splitting is common in the normal LV, the PM pedicle was narrow or fused in all normal cases. However, 16% of borderline LV’s showed at least one PM, which was split and had a broad insertion. SL muscles were shorter in the borderline group (SL/LV ratio 0.31±0.17 vs 0.46±0.09; p<0.001) but IM muscles were of similar lengths between groups (IM/LV ratio 0.39±0.15 vs. 0.43±0.09; p=0.2). The mean angle between PM insertion points was also similar between groups (118±42º vs. 114±17º; p=0.63).

Eight children underwent successful biventricular repair in this series of borderline LV. There were no significant differentiating features for PM morphology in this subgroup.

Conclusions:
In normal-sized LV, PM’s are dual with narrow/fused pedicles. In comparison, the AL muscle is shortened or often even absent in the borderline LV. Additionally, the PM pedicle in borderline LV’s can be split with a broad-based insertion. A combination of 3D whole-heart and short-axis cine is helpful to delineate papillary morphology.