Mechanistic insights of papillary muscle dyssynchrony mediated function mitral regurgitation and modulation by cardiac resynchronization

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Topic(s): Valvular Heart Disease – Pathophysiology and Mechanisms

Citation:

Abstract:

Background: Mechanistic features of functional mitral regurgitation (FMR) include papillary muscle displacement due to left ventricular remodeling. Intraventricular conduction delay might further augment this condition by introducing inter-papillary muscle dyssynchrony.

Objectives: To define this mechanism as a major contributing factor in FMR and prove the reversibility of FMR by inter-papillary muscle resynchronization.

Methods: We enrolled 269 chronic HFrEF patients with conduction delay and comprehensively assessed dyssynchrony by complementary echocardiographic techniques. Opposing wall delay, calculated by speckle tracking, was determined as the time difference between peak longitudinal strain of the mid-anterior and inferior wall from a 2-chamber view. Furthermore, opposing wall delay was assessed as the time difference between peak strain values from tissue Doppler velocity-coded data of the mid-inferior septal and mid-lateral wall segments.

Results: Patients with severe FMR had markedly increased inter-papillary longitudinal dyssynchrony (160ms[IQR120-200]) compared to those with moderate (70ms[IQR40-110]), no, or mild FMR (60ms[IQR30-100]; P<0.001). Increased inter-papillary muscle dyssynchrony was correlated with effective regurgitant orifice area (P<0.001; Figure A), regurgitant volume (P<0.001, Figure B) and vena contracta width (P<0.001, Figure C). Restoration of longitudinal papillary muscle synchronicity by cardiac resynchronization therapy (CRT) was correlated with FMR regression, as reflected by the reduction in regurgitant volume (P<0.001) and vena contracta width (P<0.001). Conversely, the improvement of FMR was associated with improved inter-papillary radial (P=0.006) and longitudinal (P<0.001) dyssynchrony. The improvement of dyssynchrony-mediated FMR signified a better prognosis compared to no improvement in FMR during the 8-year follow-up period even after comprehensive adjustment by a bootstrap-selected confounder model (adj. HR of 0.41; 95% CI 0.18-0.91; P=0.028; Figure D). The results remained virtually unchanged after adjustment for left bundle branch block.

Conclusion: Intraventricular dyssynchrony introduces unequal contraction by papillary muscle bearing walls, which has an adverse effect on FMR. CRT can effectively restore inter-papillary balance and thus create a less tented leaflet configuration, resulting in a clinically meaningful reduction of FMR. The restoration of papillary muscle synchronicity in dyssynchrony-mediated FMR translates into a significantly better prognosis.
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