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YOUNG INVESTIGATOR AWARD SESSION: BASIC SCIENCE

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Intraventricular flow patterns after percutaneous mitral valve repair with MitraClip implantation

D. Filomena[1]; S. Cimino[1]; M. Reali[1]; M. Pagliaro[1]; G. Tonti[2]; G. Pedrizzetti[3]; M. Mancone[1]; G. Sardella[1]; L. Agati[1]
[1]Sapienza University of Rome, Department of Cardiov. & Respiratory Sciences, Nephrology & Geriatrics, Rome, Italy; [2]S.S. Annunziata Hospital, Sulmona, Italy; [3]University of Trieste, Department of Civil and Environmental Engineering, Trieste, Italy

Background: Percutaneous Mitral valve repair using MitraClip implantation has become a valid alternative for patients with severe mitral regurgitation (MR) and high surgical risk. After mitral valve (MV) replacement with mechanical prosthesis, vortex reversal flow and increase in energy dissipation was observed by Echo-PIV analysis. Aim of the present study was to evaluate if the revised valve anatomy with a generated double or multi-orifice configuration after MitraClip implantation may alter intraventricular flow patterns during diastole. Methods: From May 2015 to April 2016, 13 consecutive patients with severe MR undergoing MitraClip implantation were enrolled. All pts underwent contrast echocardiography before and after the procedure (2±1 days) for Echo-PIV analysis and vortex quantification. Acute procedural success (APS) was defined as successful clip implantation with residual MR grade ≤2+. Following parameters were evaluated by 2D/3D echocardiography: the etiology of MR (functional, ischemic and degenerative), MV anatomic characteristics, tricuspid regurgitation (TR) and pulmonary artery systolic pressure (PASP), LV dimension and function. Following parameters were evaluated by Echo-PIV analysis: vortex area, intensity and geometry, energy dissipation, flow force momentum (φ) and flow force dispersion. Results: Study population was divided in two groups according to the success of the procedure (APS in 7 and failure in 6 pts). No difference in MR etiology and severity, leaflets' length and valve area was found. Patients with APS presented with a less pre-interventional PASP (28±6 vs 53±11 mmHg, p=0.005). By comparing vortex data before and after the procedure, in all patients vortex area and intensity were significantly lower after MitraClip implantation (0.39±0.07 vs 0.32±0.11; p=0.006 and -0.53±0.1 vs-0.30±0.34; p=0.009), confirmed in both sub-groups analysis. Contrary to what observed after MV replacement with mechanical prosthesis, vortex reversal flow was not detected. Finally, only in APS subgroup, a significant flow force dispersion reduction (50±3.4 vs 45±5; p=0.01) was found. Conclusion: The results of this study showed significant changes in intraventricular flow patterns following MitraClip implantation with different characteristics as compared to patients undergoing surgical MV replacement. A significant reduction of flow turbulence (flow force dispersion) in APS group was found. Further longitudinal studies are necessary to assess the impact of these intraventricular flow patterns on functional outcome.

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Papillary muscles contribute significantly to shortening of dilated left ventricles

J. Duchenne[1]; A. Turco[2]; P. Claus[1]; K. Vunckx[2]; J. Nuyts[2]; E. Pagourelias[1]; F. Rega[1]; O. Gheysens[2]; J-U Voigt[1]
[1]KU Leuven, Cardiovascular Sciences, Leuven, Belgium; [2]KU Leuven, Imaging & Pathology, Leuven, Belgium

Background: Dilated left ventricles (LV) have a more spherical shape and displaced papillary muscles (PM). We hypothesized that this altered geometry may influence the contribution of PM to LV function. We therefore assessed the regional myocardial work by measuring the myocardial glucose uptake by 18F-fluorodeoxyglucose (FDG) positron emission tomography (PET) in an animal model of normal and dilated LVs.
Methods: Fifteen animals were included in the study. Ten sheep were subjected to 8 weeks of rapid (180 bpm) pacing to induce LV dilatation. Five sheep served as control. Imaging was performed at a heart rate of 110 bpm. Cardiac magnetic resonance imaging (MRI) was performed in all animals to assess end-diastolic (EDV), end-systolic (ESV) volumes and LV ejection fraction (LVEF). LV sphericity index was defined as mid-ventricular septal-to-lateral width divided by LV length. Mitral regurgitation (MR) was graded visually on the MRI cine images as no (0), minimal (0.5), mild (1), moderate (2), moderate to severe (3), severe (4). ECG- and respiratory gating was used to obtain high resolution PET images. Regional metabolism was measured in the PM and compared to the remaining LV myocardium (MYO) (Figure).
Results: Animals subjected to rapid pacing had a higher EDV and ESV compared to controls (105±20 vs. 76±7 ml and 76±16 vs. 41±6 ml, resp., both p<0.01), a lower LVEF (28±5 vs. 46±6 %, p<0.01), a higher MR score (1.6±0.8 vs. 0.2±0.4, p<0.01), and a higher LV sphericity index (0.61±0.03 vs. 0.47±0.02, p<0.01). The ratio of total PM FDG-uptake over total MYO uptake was significantly higher in dilated LVs compared to controls (0.54±0.05 vs. 0.39±0.03, p<0.01). The PM/MYO ratio correlated significantly with LVEF reduction (r=0.79, p<0.01), the MR score (r=0.61, p=0.01), and the LV sphericity index (r=0.86, p<0.01) (Figure). The LV sphericity index remained the strongest determinant of increased PM/MYO ratio after multiple regression analysis (model R^2=0.86, p<0.01).
Conclusions: Our data show that papillary muscles contribute more to LV shortening in dilated compared to normal hearts. We hypothesize that their higher workload is due to geometric abnormalities in dilated LVs which make papillary muscles work more diametral through the LV and less parallel to the LV wall. The increased contribution of papillary muscles to LV work in dilated hearts may further strengthen the argument of their preservation during MV repair/replacement in DCM.
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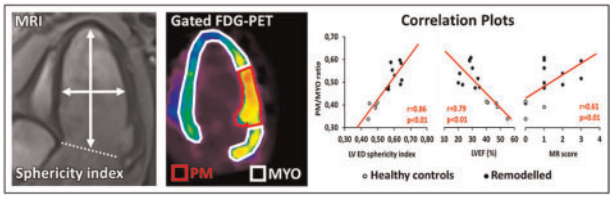

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Relationship between cardiac uptake by 99mTc-DPD scintigraphy and left ventricular longitudinal strain in patients with transthyretin-related cardiac amyloidosis

S. Pradel[1]; S. Brun[1]; G. Robin[1]; G. Victor[2]; D. Ribes[3]; T. Cognet[1]; M. Galinier[1]; D. Carrie[1]; I. Berry[2]; O. Lairez[1]
[1]University Hospital of Toulouse, Department of Cardiology, Toulouse, France; [2]University Hospital of Toulouse, Department of Nuclear Medicine, Toulouse, France; [3]University Hospital of Toulouse, Department of Nephrology, Toulouse, France

Background: Pathophysiology of 99mTc-3,3-diphosphono-1,2-propanodicarboxylic acid (99mTc-DPD) uptake by scintigraphy in transthyretin-related (TTR) amyloidosis remains unclear. Impact of cardiac uptake on cardiac function is unknown.
Purpose: The aim of this study was to explore the relationship between cardiac uptake by 99mTc-DPD scintigraphy and longitudinal myocardial strain assessed by echocardiography.
Methods: Forty patients with TTR cardiac amyloidosis underwent 99mTc-DPD scintigraphy and echocardiography with measure of left ventricular segmental and global longitudinal strain (GLS). Cardiac retention was assessed by visual scoring and the heart/whole body (H/B) ratio was calculated by dividing counts in the heart by counts in late whole body images.
Results: The mean population age was 79±10 years. Most of the patients (88%) were male. Visual score was 2 and 3 for 6 (15%) and 34 (85%) patients, respectively. Mean H/B ratio was 12±7. Mean left ventricular ejection fraction (LVEF) and GLS were 50±10% and -10±3%, respectively. H/B ratio was correlated with GLS (R = 0.490, P=0.001) but not with LVEF (R=-0,097, P=0.558). Segmental myocardial uptake normalized by H/B ratio was correlated with segmental longitudinal strain (n = 480 segments, R = 0.155, P<0.001).
Conclusion: In patients with TTR cardiac amyloidosis, myocardial uptake by 99mTc-DPD scintigraphy is correlated with decrease of myocardial longitudinal strain.
On behalf of: Department of Cardiology, Rangueil University Hospital, Toulouse, France.

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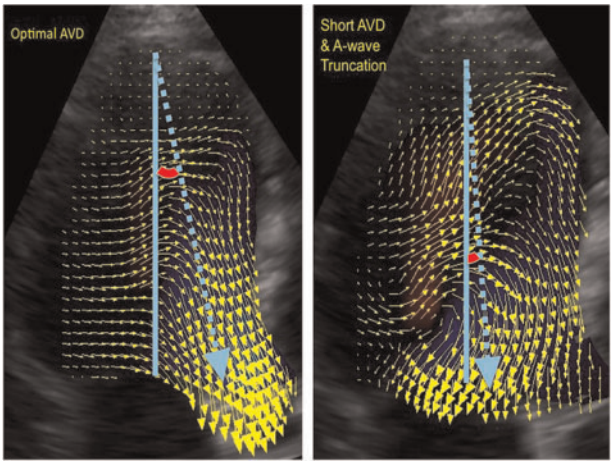
Premature ventricular contraction in resynchronized patients with short atrio-ventricular delay: hemodynamic impact beyond A-wave truncation

D. Rodriguez Munoz; JL. Moya Mur; B. Berlot; C. Fernandez-Golfin; J. Moreno; E. Casas Rojo; A. Garcia Martin; JJ. Jimenez Nacher; R. Matia Frances; E. Franco Diez; A. Hernandez-Madrid; JL. Zamorano
University Hospital Ramon y Cajal, Department of Cardiology, Madrid, Spain

Introduction: Optimization of atrio-ventricular delay (AVD) is one of the interventions that has been suggested to improve response to resynchronization therapy in heart failure patients. Excessively short AVD leads to A-wave truncation and, consequently, compromises left ventricular (LV) end-diastolic volume.

Previous studies of intracardiac flow have suggested that atrial contraction impacts LV flow dynamics beyond its filling by generating a vortex that redirects flow towards the LV outflow tract, minimizing energy dissipation and facilitating initial ejection.
In this study we assess the consequences of A-wave truncation on LV flow mechanics through LV flow mapping.
Methods: Patients under cardiac resynchronization therapy (CRT) and in sinus rhythm underwent echocardiographic AVD optimization with transmitral flow assessment. Using intracardiac flow mapping, we measured Kinetic Energy Dissipation (KED) with automated software comparing flow direction and velocity in each pixel with its neighbouring points and integrates it into an image displaying energy loss in bright colours compared to dark areas with minimal energy dissipation.
We also measured the angle between the longitudinal axis of the LV and the vector of early ejection flow (axis-flow angle, or AFA).
Results: 25 patients (67% male, aged 72 ±11.7, LVEF 39.2±10.8) were included in the study. KED and AFA were measured in all patients in optimal AVD (Opt) and short AVD (Opt – 60 ms). Student's t test showed a significant difference in KED between short (48,76 ± 8,33 J/m*s) and optimal AVD (24,32 ± 8,61 J/m*s, $p<0,0001$) in early ejection. The Flow – LV-Axis Angle was significantly narrower in short AVD vs. optimal AVD (20,2 ± 1,9° vs. 10,1 ± 1,3°, $p<0.01$), which implied that flow collided with the mitral valve and mitro-aortic junction before being ejected, with consequent energy dissipation, in short but not in optimal AVD. See Figure 1.
Conclusions: Premature ventricular contraction due to short atrio-ventricular delay impacts LV flow dynamics causing higher kinetic energy dissipation due to impaired flow redirection to the LV outflow tract, which adds to the compromise of LV filling due to A wave truncation in explaining poor response to CRT in patients with suboptimal AVD programming.



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