EFFECT OF HYPERTROPHY AND FIBROSIS
ON REGIONAL FUNCTIONAL HETEROGENEITY
IN HYPERTROPHIC CARDIOMYOPATHY

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Hypertrophic Cardiomyopathy

- Heterogeneous hypertrophy of myocardium
- Genetic abnormality in HCMP patients is common
- Global pathology of muscular disarray and hypertrophy

→ HCMP is not a regional disease, but disease involving whole myocardium
Clinical Prognosis in Different Type of HCM

Septal HCMP

Apical HCMP

Kofflard MJM et al. JACC 2003;41:987-93

Eriksson MJ et al. JACC 2002;39:638-45
Functional Difference in Different Type of HCM

Septal HCMP

Apical HCMP

Carasso S et al. JASE 2008;675-81

Chang SA et al. Heart 2010;96:49-55
Myocardial Fibrosis: DHE in HCMP
Significance of DHE in HCM

Myocardial wall scarring and contractility in HCM

Choudhury, JACC 2002

Prevalence of arrhythmias on Holter with respect to DHE in HCM

Adabag, JACC 2008
Aim of Study

- Effect of hypertrophy and fibrosis on regional functional heterogeneity in HCMP
- Effect of regional heterogeneity on global function of LV in HCMP
METHOD
Study Population

Inclusion Criteria

• Confirmative Diagnosis in Cardiac MRI
• Cardiac MRI with delayed enhanced image

Exclusion Criteria

• Arrhythmia including atrial fibrillation
• Significant valvular disease (more than grade 3)
• Poor echoCG window for strain analysis
Cardiac MRI

Siemens 1.5T MRI (AVANTO)

Cine MRI
- 6mm thickness with 2mm gap
- Short axis/Long axis of whole LV

Delayed hyper-enhanced MRI (DHE-MRI)
- Galdolinium contrast agent
- Image acquisition 10 minute after contrast injection
- Segmental analysis (18 segments) of DHE with semi-quantitative manner
Echocardiography

- Vivid 7 machine (GE)

- Blood pressure, BSA measurement: before echoCG

- Routine EchoCG including
  - LVEDD/ESD/EF, mitral inflow, tissue Doppler in mitral septal annulus
  - LA volume

- Image acquisition for speckle tracking
  - Apical 2/3/4 chamber view
  - Frame rate (70~100 fps) and probe frequency of 1.7~2.0 MHz were adjusted during end-expiratory breath-hold
Image Analysis

- Off-line analysis by single researcher
- Echopac PC ver 7.05, GE Medical system
- Manual tracing of endocardial border in end systolic frame → confirm successful tracking score and visually tolerable tracking image
- Regional longitudinal strain was derived (18 segments model)
Longitudinal Strain by 2D Speckle Tracking Image
RESULT
## Characteristics of Patients

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>52.7 ± 12.2</td>
</tr>
<tr>
<td>Male</td>
<td>31 (77.5%)</td>
</tr>
<tr>
<td>Type of HCM</td>
<td></td>
</tr>
<tr>
<td>Septal</td>
<td>15 (37.5%)</td>
</tr>
<tr>
<td>Apical</td>
<td>13 (32.5%)</td>
</tr>
<tr>
<td>Septal + Apical</td>
<td>5 (12.5%)</td>
</tr>
<tr>
<td>Diffuse</td>
<td>4 (10.0%)</td>
</tr>
<tr>
<td>Others</td>
<td>3 (7.5%)</td>
</tr>
</tbody>
</table>
## MRI parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>40</td>
</tr>
<tr>
<td>LV ESV (ml)</td>
<td>41.1 ± 24.1</td>
</tr>
<tr>
<td>LV EDV (ml)</td>
<td>138.3 ± 34.5</td>
</tr>
<tr>
<td>LV EF (%)</td>
<td>71.3 ± 11.0</td>
</tr>
<tr>
<td>LV mass (g)</td>
<td>148.9 ± 62.1</td>
</tr>
<tr>
<td>LV mass index (g/m²)</td>
<td>81.7 ± 30.7</td>
</tr>
<tr>
<td>Presence of DHE in LV</td>
<td>31 (78%)</td>
</tr>
<tr>
<td>DHE (%)</td>
<td>19.41%</td>
</tr>
</tbody>
</table>
DHE in Regional Myocardial Segments

No. of segments

Total Number = 720

Regional DHE (%) By segments
## Echocardiographic parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=40</td>
<td></td>
</tr>
<tr>
<td>Presence of LVOT obstruction</td>
<td>9 (23%)</td>
</tr>
<tr>
<td>E (m/s)</td>
<td>0.67 ± 0.17</td>
</tr>
<tr>
<td>A (m/s)</td>
<td>0.63 ± 0.21</td>
</tr>
<tr>
<td>DT (msec)</td>
<td>244.1 ± 84.5</td>
</tr>
<tr>
<td>E’ (cm/sec)</td>
<td>6.0 ± 2.2</td>
</tr>
<tr>
<td>A’ (cm/sec)</td>
<td>9.8 ± 10.1</td>
</tr>
<tr>
<td>E/E’</td>
<td>12.0 ± 3.5</td>
</tr>
<tr>
<td>LA volume index (ml/m²)</td>
<td>40.5 ± 18.5</td>
</tr>
</tbody>
</table>
Regional wall DHE and Regional Strain

Longitudinal strain
(absolute value, %)

*P<0.001, †P<0.01, ‡P<0.05
Regional wall thickness and Regional Strain

Regional wall thickness (mm)

R = 0.48, p < 0.001

Regional longitudinal strain (%)
DHE, Hypertrophy, and Strain
Global longitudinal strain, LV mass, and DHE

<table>
<thead>
<tr>
<th>Parameters</th>
<th>r</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total DHE amount (%)*</td>
<td>0.50</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LV mass index (g/m²)*</td>
<td>0.49</td>
<td>0.001</td>
</tr>
</tbody>
</table>

* nonparametric Spearman correlation
# Global longitudinal strain and LV function

<table>
<thead>
<tr>
<th>Parameters</th>
<th>r</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>E (m/s)</td>
<td>-0.36</td>
<td>0.02</td>
</tr>
<tr>
<td>A (m/s)</td>
<td>0.41</td>
<td>0.01</td>
</tr>
<tr>
<td>DT (msec)</td>
<td>0.05</td>
<td>0.77</td>
</tr>
<tr>
<td>E’ (cm/sec)*</td>
<td>-0.53</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>A’ (cm/sec) *</td>
<td>-0.13</td>
<td>0.44</td>
</tr>
<tr>
<td>E/E’*</td>
<td>0.33</td>
<td>0.04</td>
</tr>
<tr>
<td>LA volume index (ml/m²)</td>
<td>0.35</td>
<td>0.03</td>
</tr>
<tr>
<td>LV EF (%MRI)</td>
<td>0.01</td>
<td>0.98</td>
</tr>
</tbody>
</table>

*nonparametric Spearman correlation
Global longitudinal strain, LV mass, and DHE

**DHE %**
- Septal: 20 ± 5
- Apical: 5 ± 2
- Diffuse: 40 ± 10
- Sep+Ap: 30 ± 8
- Other: 15 ± 3

**LV mass index**
- Septal: 120 ± 10
- Apical: 90 ± 5
- Diffuse: 150 ± 20
- Sep+Ap: 130 ± 15
- Other: 110 ± 12

**Global Strain**
- Septal: -0.5 ± 0.2
- Apical: -1.0 ± 0.3
- Diffuse: -1.5 ± 0.4
- Sep+Ap: -2.0 ± 0.5
- Other: -2.5 ± 0.6

* P < 0.05
SUMMARY

• Presence and degree of DHE represents more severe functional impairment of regional myocardium
• Amount of DHE is related with increased wall thickness of regional myocardium
• Global longitudinal strain is correlated with total amount of DHE, LV mass index, and diastolic functional parameters.
CONCLUSION

• HCMP is a global myocardial disease, however morphologic heterogeneity of HCMP is associated with regional heterogeneity of myocardial function.

• Different severity of fibrosis and hypertrophy in regional walls is associated with functional impairment. It might explain the different myocardial mechanics and clinical prognosis in different type of HCMP.
Thank You for Your Attention