

# Impairment of Myocardial Blood Flow During Hyperemia in Hypertrophic Cardiomyopathy is Caused by Reduced Myocardial Blood Volume

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**Background:** Myocardial blood flow (MBF) per unit time during hyperemia is reduced in patients with hypertrophic cardiomyopathy (HCM). Whether reduced myocardial blood volume (MBV) or impaired blood velocity within the microvasculature predominantly causes this phenomenon remains to be elucidated. We thus evaluated both MBV and MBF at rest and during hyperemia in HCM patients.

**Methods:** Myocardial contrast echocardiography and <sup>15</sup>O-water PET were performed at rest and during hyperemia induced by ATP in HCM patients with asymmetric septal hypertrophy (H, n=22) and in normal volunteers (N, n=15). On harmonic power Doppler images acquired at end-diastole of every 6 beats during Levovist infusion, relative contrast intensity (RelCI, subtraction of contrast intensity in dB between myocardium and the adjacent blood pool) was measured in the interventricular septum (IVS). MBV [%] was derived as  $10^{\text{RelCI}/10} \times 100$ . MBF was measured by PET, and intramyocardial blood velocity was estimated by using calculated  $\beta$  [ $\text{sec}^{-1}$ ] (MBF/MBV).

**Results:** IVS thickness was significantly higher in H than in N ( $19.1 \pm 4.8$  vs  $9.6 \pm 0.9$  mm,  $p < 0.0001$ ). MBF at rest did not differ between H and N ( $72 \pm 15$  vs  $65 \pm 16$  ml/min/100g, NS), whereas hyperemic MBF in H was significantly lower than that in N ( $150 \pm 57$  vs  $344 \pm 107$  ml/min/100g,  $p < 0.0001$ ). MBV in H was significantly lower than that in N both at rest ( $2.0 \pm 0.7$  vs  $3.0 \pm 0.6\%$ ,  $p < 0.0001$ ) and during hyperemia ( $2.1 \pm 1.1$  vs  $3.6 \pm 1.0\%$ ,  $p < 0.001$ ). On the contrary,  $\beta$  in H was significantly higher than that in N at rest ( $0.67 \pm 0.26$  vs  $0.34 \pm 0.17 \text{ sec}^{-1}$ ,  $p < 0.01$ ), and did not differ during hyperemia ( $1.61 \pm 0.91$  vs  $1.45 \pm 0.64 \text{ sec}^{-1}$ , NS).

**Conclusions:** Intramyocardial blood velocity is not reduced in the hypertrophied IVS of HCM patients. MBV is decreased both at rest and during hyperemia. The reduction of MBV causes the impairment of MBF during hyperemia.

# 肥大型心筋症における充血時心筋血流量の増加不全は心筋内血液量の低下に起因する

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肥大型心筋症(HCM)では充血時の分時心筋血流量(MBF)は低下している. この現象が心筋内血液量(MBV)の低下と心筋内血流速度の異常のどちらに起因するのかは明らかでない. そこで非対称性心室中隔肥大を呈する HCM 患者 22 例と健常対照 15 例に対し, 心筋コントラストエコー法(MCE)と水 PET を施行し, 安静時と充血時の MBV, MBF, 心筋内血流速度  $\beta$  を検討した. レボビストの持続静注下に 6 心拍毎の間歇送信による四腔断面ハーモニックパワー Doppler 像を収集し, 心室中隔の補正心筋コントラスト強度(RelCI)を求め, MBV を  $10^{RelCI/10} \times 100$  [%]で算出した. PET で求めた同領域の MBF を MBV で除し  $\beta$  [ $sec^{-1}$ ]を算出した. HCM 群の MBF は安静時には健常群と同等で, 充血時には低値であった. MBV は安静時および充血時で健常群より有意に低値であった. 対照的に  $\beta$  は安静時には健常群より有意に高値であったが, 充血時では同等であった. HCM における充血時 MBF の増加不全は MBV の低下に起因する.

## 質疑応答

1-Q : MBV は他の領域でも計測可能か?

1-A : RelCI は, 心筋のコントラスト強度(CI)を近接する内腔血液の CI で補正することにより, MCE における音場不均一を克服する. 本法により左室のどの領域でも MBV の絶対値を計測できる.

2-Q : 水 PET と MCE による  $\beta$  は, MCE の輝度回復曲線から求めた  $\beta$  と相違があるか?

2-A : 本研究の  $\beta$  値は, やや低い傾向があるものの, 健常例および肥大心でこれまでに報告されている輝度回復曲線から求めた  $\beta$  値から逸脱しないが, やや低めの値である.