

Assessment of Contractile Reserve of Infarcted Myocardium Using Contrast Echocardiography: a Novel Index of Myocardial Blood Volume Fraction Compensating for Ultrasound Attenuation

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Background: Inhomogeneous acoustic field caused by the attenuation of incident ultrasound is one of major limitations of quantitative myocardial contrast echocardiography (MCE). We have previously proposed a novel index 'relative signal intensity (ReISi)' to estimate myocardial blood volume (MBV) fraction by compensating for ultrasound attenuation, which is calculated as the relative signal intensity of myocardium to that of the intracavity blood area adjacent to the myocardium. The purpose of this study was to elucidate whether ReISi measured in multiple segments reflects contractile reserve of infarcted myocardium.

Methods: Using Phillips Sonos 5500, harmonic power Doppler images were acquired at end systole of every 6 beats during continuous infusion of Levovist (2-3 ml/min) in 12 normal subjects (apical 4-chamber views), and 25 patients with prior myocardial infarction (apical views). In the normals, interventricular septum was divided into 3 segments (control segments). In the patients, 35 segments showing severe asynergy were defined as infarct segments (15 apical, 10 mid and 10 basal segments). In each segment, ReISi was calculated by subtracting the signal intensity (in decibels) of the intracavity blood area adjacent to the segment from that of myocardium. ReISi represents the ratio (myocardium/adjacent blood) of microbubble concentration, which means MBV fraction because the bubble concentration in blood pool is constant and blood volume fraction of blood is 100%. Contractile reserve (CR) of the infarct segments was determined by dobutamine echocardiography.

Results: In the normals, although the myocardial signal intensity of basal segment was lower than those of the other segments, ReISi was not different among apical, mid and basal segments (-14.7 ± 1.5 ; -15.0 ± 1.2 ; -15.7 ± 1.1 dB, $p=0.25$, ANOVA). ReISi in the infarct segments was significantly lower than that in the control segments (-18.3 ± 2.8 vs -15.1 ± 1.3 dB, $p<0.0001$). ReISi in the 17 segments with CR was significantly higher than that in the 18 segments without CR (-16.8 ± 2.1 vs -19.8 ± 2.7 dB, $p<0.01$).

Conclusion: ReISi, representing MBV fraction, reflects contractile reserve of infarcted myocardium. This novel index is useful for multi-segment analysis of myocardial viability by compensating for ultrasound attenuation in MCE.

コントラストエコー法を用いた慢性期梗塞心筋の収縮予備能評価 ：心筋内血液量推定のための新しい指標

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背景：我々は、超音波造影剤濃度と画像輝度(AU2)との直線関係の観察に基づき、心筋コントラストエコー法における音場不均一性を補正する心筋輝度の指標‘relative signal intensity (ReISI)’を考案した。

目的：ReISIが慢性期梗塞心筋の収縮予備能を反映するか否かを検討する。

方法：健常者11例、陈旧性梗塞患者25例において、レボピスト持続静注下に1:6心拍収縮末期の心尖部断面ハーモニックパワープラ画像を収集し、各セグメントで心筋とそれに隣接する左室腔との輝度(dB)の差ReISIを求めた。ReISIは気泡密度比を表し、心筋内血液量分画を表すと考えられる。梗塞心筋の収縮予備能(CR)は、低用量ドブタミン負荷心エコー法での壁運動改善の有無により判定した。

結果：健常者の心筋輝度そのものはセグメント間で異なっていたが、ReISIには差がなかった。梗塞心筋のReISIは健常心筋に比し低く(-18.3 ± 2.8 vs -15.1 ± 1.6 dB, $p < 0.0001$)、また梗塞巣のうちCR(-)と判定された18区域のReISIはCR(+)と判定された17区域より低かった(-19.8 ± 2.6 vs -16.8 ± 2.0 dB, $p < 0.001$)。

結論：ReISIを用いることにより、音圧の異なる多セグメントで慢性期梗塞心筋の収縮予備能を推定可能である。

質疑応答

質問 1 AU2とはどういう単位か。

応答 受信信号パワーに比例する単位で、dB(X)の間には $AU2 = 10X/10$ が成り立つ。音圧の等しい条件下では、AU2の比、dBの差が気泡密度を表す。

質問 2 新しい方法の利点は何か。

応答 心筋輝度そのものは音場不均一の影響を受けるが、ReISIはそれを克服できる。