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計畫名稱：利用超音波組織特性以評估慢性左心室功能異常者之心肌存活度：與鉍-201再注射電腦斷層造影之比較

Ultrasonic Tissue Characterization for Assessment of Myocardial Viability in Chronic Left Ventricular Dysfunction: Comparison with Thallium-201 Reinjection SPECT

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一、中英文摘要

超音波組織特性分析 (Ultrasonic tissue characterization, 簡稱UTC), 新近曾被用來評估急性心肌梗塞病人之心肌存活, 但尚未用於慢性冠心病人心肌存活之評估。本研究之目的, 乃比較UTC與鉍-201 SPECT二者對慢性冠心病病人, 於預估冠狀血管再造術後心室功能之復原之價值。研究對象包括48名慢性冠心病者, 經心導管證實其冠狀動脈管腔阻塞 $\geq 70\%$ 且左心室功能異常。研究設計為每位病人於血管再造術前均接受超音波心圖、UTC及 ^{201}Tl (鉍-201) reinjection SPECT等檢查。超音波心圖之追蹤檢查, 於冠狀血管再造術後一至三個月為之。

結果顯示：58 個心肌節段中, UTC (weighted amplitude = 2)偵測左心室壁復原之靈敏度、特定度及準確度各為 82.8%, 而鉍-201 SPECT 分別為 79%、82.8%及 81%。結論：UTC 對於慢性冠心病病人左心室功能復原之評估, 其準確度可媲美鉍-201 SPECT。

Abstract

The usefulness of ultrasonic tissue characterization (UTC) with integrated backscatter (IBS) in patients with chronic left ventricular dysfunction is unknown. The aims of this study were to compare the relative merits of cyclic variation of IBS and ^{201}Tl reinjection SPECT in predicting post-revascularization function recovery in patients

with chronic LV dysfunction.

Forty-eight patients with stable coronary artery disease received UTC and ^{201}Tl SPECT before successful coronary revascularization and were followed up by rest echocardiograms at 1 month after angioplasty or at 3 months after bypass grafting. Among the 58 investigated segments, the sensitivity, specificity and accuracy of UTC using the cutoff value as 2.0 of the weighted amplitude for predicting functional improvement after revascularization were all 82.8%. For ^{201}Tl SPECT, they were 79%, 82.8% and 81%, respectively. UTC, delineating the myocardial physical state and intramural contraction, can be a novel approach in predicting functional improvement of chronic dyssynergy after revascularization.

二、緣由與目的

In patients with chronic coronary artery disease (CAD) and left ventricular (LV) dysfunction, the distinction between ventricular dysfunction arising from irreversible fibrotic and reversible viable myocardium is important for clinical decision making. Ultrasonic tissue characterization (UTC) with integrated backscatter (IBS) has recently been proposed as a method to detecting myocardial viability in patients with acute myocardial infarction (1, 2). Its usefulness in patients with chronic LV dysfunction is unknown. Thallium-201 (^{201}Tl) reinjection single-photon emission computed

tomography (SPECT) has been widely accepted as a highly reliable method for assessing myocardial viability (3-6). However, comparison of ^{201}Tl reinjection SPECT with cyclic variation of IBS for identifying viable myocardium has not been known. Accordingly, the aims of this study were to compare the relative merits of cyclic variation of IBS and ^{201}Tl reinjection SPECT in predicting post-revascularization function recovery in patients with chronic LV dysfunction.

三、方法

The study population consisted of 48 patients with angiographically significant CAD ($\geq 70\%$ diameter stenosis) and LV dysfunction. None of the patients had a recent myocardial infarction (< 6 weeks). Each patient underwent UTC with IBS and dobutamine ^{201}Tl reinjection SPECT, before revascularization. Echocardiography was performed using a Hewlett-Packard SONOS 2500 echocardiograph. After the recording of two-dimensional echocardiographic images, UTC with IBS imaging was performed using a special software package (Acoustic Densitometry in IBS mode, SONOS 2500), as described previously in our laboratory (2). The IBS was quantified by placing a region of interest (ROI) within the myocardium on the frozen image. We used the parasternal short-axis view and 3 ROIs to evaluate the 3 vessel territories simultaneously (2). The weighted amplitude, representing the alteration in amplitude of cyclic variation and nadir ratio simultaneously, can be considered as an index of intramural contractility. For ^{201}Tl reinjection SPECT, each patient underwent a dobutamine stress. One min before termination of dobutamine infusion, 2 mCi of ^{201}Tl was injected intravenously (7, 8). Stress phase ^{201}Tl SPECT was obtained within 10 min after ^{201}Tl injection and again at 4 hr, using a computerized imaging system (General Electric Starcam 3000). Immediately after the 4 hr imaging, 1 mCi of ^{201}Tl was reinjected and a third set of images were obtained 20 min later.

The echocardiograms, IBS and ^{201}Tl SPECT images were visually analyzed in a double-blind manner, each by 2 investigators. Segmental ^{201}Tl uptakes were color-mapped and scored semiquantitatively. The left ventricle was divided into 10 myocardial segments from short-axis, horizontal long-axis and vertical long-axis slices (9). A myocardial segment was considered viable if there was $\geq 50\%$ ^{201}Tl uptake on the reinjection images, or presence of totally or partially reversible defect (10, 11). Segmental ^{201}Tl uptake was graded on a 5-point scale as follows: 4, normal; 3, mildly reduced; 2, moderately reduced; 1, severely reduced; and 0, absent (12).

Follow-up echocardiography was performed at 1 month after PTCA or at 3 months after CABG (13, 14), to assess the evolution of regional and global LV function. From echocardiograms, the left ventricle was divided into 16 segments and wall motion of each segment was graded as 1 = normal; 2 = hypokinesia; 3 = akinesia. When the wall motion grade decreased by 1 or greater after revascularization, the segments were considered to be improved. Follow-up coronary angiography was obtained in 21 patients. These patients showed no restenosis of vessels.

Student's *t* test was used to determine differences in IBS data between segments with and without viability on ^{201}Tl SPECT. One-way analysis of variance was also performed when appropriate. The specificity and sensitivity for weighted amplitude in predicting post-revascularization recovery of regional wall motion were plotted to determine the optimal cutoff value.

四、結果

Among the 48 patients (38 men; mean age, 58 years) after revascularization (36 with angioplasty and 12 with bypass grafting), 58 segments (26 at the left anterior descending artery territory; 27, right coronary and 5, left circumflex) with baseline dyssynergy (40, akinetic; 18, hypokinetic) were studied.

Table 1 showed the prediction of

functional recovery with ²⁰¹Tl SPECT and UTC. For ²⁰¹Tl SPECT, the addition of mild to moderate fixed defect (²⁰¹Tl activity > 50% of peak count) did not improve the prediction of functional recovery. The weighted amplitude of UTC, with the cut-off value of 2.0 (determined by the receiver operating curve) had a comparable, even better, prediction in functional recovery when compared with ²⁰¹Tl SPECT.

Table 1. Predicting Wall Motion Recovery: Comparison of Thallium-201 SPECT and Ultrasonic Tissue Characterization (UTC)

Criteria for predicting wall motion recovery	Sensitivity	Specificity	accuracy
<i>²⁰¹Tl SPECT</i>			
Complete redistribution only	44.8% (13/29)	100% (29/29)	72.4% (42/58)
Complete + partial redistribution	79.0% (23/29)	82.8% (24/29)	81.0% (47/58)
Complete or partial redistribution + mild to moderate fixed defect	93.1% (27/29)	55.2% (16/29)	74.1% (43/58)
<i>UTC</i>			
Cutoff value with weighted amplitude 2.0	82.8% (24/29)	82.8% (24/29)	82.8% (48/58)

The numbers in the parentheses represent the segment numbers.

五、討論

The backscatter within the volume of ultrasonic interrogation is proportional to that from a single myocyte multiplied by the myocyte number (15). Accordingly, it is supposed that UTC could provide a method in estimating the amount of viable myocytes and predicting functional recovery. In this study, we have disclosed that the weighted amplitude with a cut-off value of 2.0 can reliably predict the functional improvement after revascularization.

For ²⁰¹Tl reinjection SPECT, Bax et al. (16) analyzed the available data and revealed that the average sensitivity and specificity for ²⁰¹Tl reinjection SPECT were 86% and 47%, respectively. In this study, we obtained the sensitivity and specificity for ²⁰¹Tl SPECT using the redistribution criteria were 79% and 82.8%, respectively.

六、結論與成果自評

In conclusion, using the cut-off value as

2.0 of the weighted amplitude, the sensitivity and specificity for predicting functional improvement after revascularization were comparable to those of ²⁰¹Tl reinjection SPECT. UTC, delineating the myocardial physical state and intramural contraction, can be a novel approach in predicting functional improvement of chronic dyssynergy after revascularization.

This study has several limitations. First, the myocardial anisotropy will complicate the assessment of IBS in those segments whose fiber orientation is not perpendicular to the interrogated ultrasonic beam. Second, only 21 of the 48 patients received follow-up coronary angiography. Some patients developing coronary restenosis can not be completely excluded.

七、參考文獻

[1] Takiuchi S, Ito H, Iwakura K, et al. Ultrasonic tissue characterization predicts myocardial viability in early stage of reperfused acute myocardial infarction. *Circulation* 1998;97:356-62.

[2] Lin LC, Wu CC, Ho YL, et al. Ultrasonic tissue characterization in predicting residual ischemia and myocardial viability for patients with acute myocardial infarction. *Ultrasound Med Biol* 1998;24:1107-20.

[3] Bonow RO, Dilsizian V, Cuocolo A, Bacharach SL. Identification of viable myocardium in patients with chronic coronary artery disease and left ventricular dysfunction: comparison of thallium scintigraphy with reinjection and PET imaging with 18-F-fluorodeoxyglucose. *Circulation* 1991;83:26-37.

[4] Tamaki N, Ohtani H, Yonekura Y, et al. Significance of fill-in after thallium-201 reinjection following delayed imaging: comparison with regional wall motion and angiographic findings. *J Nucl Med* 1990; 31:1617-22.

[5] Ohtani H, Tamaki N, Yonekura Y, et al. Value of thallium-201 reinjection after delayed SPECT imaging for predicting reversible ischemia after coronary artery bypass grafting. *Am J Cardiol* 1990; 66:394-9.

[6] Dilsizian V, Freedman NMT, Bacharach SL,

- et al. Regional thallium uptake in irreversible defects: magnitude of change in thallium activity after reinjection distinguishes viable from nonviable myocardium. *Circulation* 1992; 85:627-34.
- [7] Huang PJ, Yen RF, Chieng PU, et al. Do B-blockers affect the diagnostic sensitivity of dobutamine stress thallium-201 single photon emission computed tomographic imaging? *J Nucl Cardiol* 1998;5:34-9.
 - [8] Huang PJ, Ho YL, Wu CC, et al. Simultaneous dobutamine stress echocardiography and thallium-201 perfusion imaging for the detection of coronary artery disease. *Cardiology* 1997;88:556-62.
 - [9] Iskandrian AS, Heo J, Askenase A, et al. Thallium imaging with single photon emission computed tomography. *Am Heart J* 1987;114:852-65.
 - [10] Johnson LL. Thallium-201 to assess myocardial viability. In Iskandrian AS and van der Wall EE (eds): *Myocardial Viability*. Dordrecht, The Netherlands, Kluwer, 1994, pp19-37.
 - [11] Arnese M, Cornel JH, Salustri A, et al. Prediction of improvement of regional left ventricular function after surgical revascularization: a comparison of low-dose dobutamine echocardiography with ²⁰¹Tl single-photon emission computed tomography. *Circulation* 1995; 91:2748-52.
 - [12] Panza JA, Dilsizian V, Laurienzo JM, et al. Relation between thallium uptake and contractile response to dobutamine: implications regarding myocardial viability in patients with chronic coronary artery disease and left ventricular dysfunction. *Circulation* 1995; 91:990-8.
 - [13] Iskandrian AS, Verani MS. Myocardial Viability. In Iskandrian AS, Verani MS (eds). *Nuclear Cardiac Imaging: Principles and Applications*. 2nd ed. Philadelphia, Davis, 1996,305-26.
 - [14] Sciagra R, Bisi G, Santoro GM, et al. Comparison of baseline-nitrate technetium-99m sestamibi with rest-redistribution thallium-201 tomography in detecting viable hibernating myocardium and predicting postrevascularization recovery. *J Am Coll Cardiol* 1997;30:384-91.
 - [15] Rose JH, Kaufmann MR, Wickline SA, et al. A proposed microscopic elastic wave theory for ultrasonic backscatter from myocardial tissue. *J Acoust Soc Am* 1995; 97:656-68.
 - [16] Bax JJ, Wijns W, Cornel JH, et al. Accuracy of currently available techniques for prediction of functional recovery after revascularization in patients with left ventricular dysfunction due to chronic coronary artery disease: comparison of pooled data. *J Am Coll Cardiol* 1997; 30:1451-60.