Tei Index and B-Type Natriuretic Peptide in Assessment of Coronary Artery Stenosis in Patients with Unstable Coronary Disease

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ZHANG ET AL.: ***Tei Index and B-Type Natriuretic Peptide in Assessment of Coronary Artery Stenosis in Patients with Unstable Coronary Disease.*** *In order to assess the value of Doppler echocardiographic Tei index and B-Type natriuretic peptide (BNP) in evaluating the stenosis of coronary artery in patients with unstable angina and their relationship with myocardial ischemia. Ninety-two consecutive patients and 30 controls were included, all participants had underwent coronary angiography, according to the results, patients were divided into One-vessel disease group, Two-vessel disease group, Three-vessel disease group, Gensini Score were recorded. Echocardiography, neurohormonal analysis were performed. The results showed that Tei index and BNP were higher in patients with unstable coronary artery disease, they increased with the number of coronary artery stenosis, and were independent predictors of myocardial ischemia, they were useful in predicting high risk patients for invasive management. (J HK Coll Cardiol 2007;15:62-66)*

B-Type natriuretic peptide, Tei Index, Unstable coronary disease

摘要

探討超聲多普勒指標－Tei指數與血漿腦利鈉肽(BNP)評估冠脈病變程度及心肌缺血的價值。連續入選92例不穩定型心絞痛患者，30例健康者作爲對照組，所有入選者均行冠脈造影檢查，按冠脈造影檢查結果，將不穩定型心絞痛患者分爲單支病變組、雙支病變組及三支病變組，記錄Gensini積分，並進行心臟超聲檢查、血漿BNP濃度測定。結果顯示：Tei指數、BNP在不穩定型心絞痛組顯著增大，且冠脈病變支數越多，Tei指數、BNP越大，兩者是心肌缺血的獨立預測指標，能夠預測高危不穩定性心絞痛患者，在篩選高危患者行進一步有創性的檢查方面有一定價值。

關鍵詞：B型腦利鈉肽　Tei指數　不穩定型心絞痛

Introduction

Unstable coronary disease is the most common cause of chronic heart failure, early diagnosis and accurate assessment is very important to clinical treatment and prognosis. Now, coronary angiography is the 'Gold Standard' for diagnosis, however, it is invasive, expensive, and not available to every patient. To explore simple, noninvasive methods to assess unstable coronary disease is very important.

Doppler echocardiographic Tei index[1] is an indicator reflecting the global function of myocardium; either systolic or diastolic dysfunction can result in a higher Tei index. Myocardial ischemia can influence left ventricular (LV) function, so it is reasonable for Tei index to assess unstable coronary disease.

B-Type natriuretic peptide (BNP) is a cardiac

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hormone secreted mainly from cardiac ventricles. It is related to myocardial function, a lot of studies have demonstrated its value in assessing heart failure patients,[2] and recent studies have found that myocardial ischemia can lead to higher plasma BNP level too.[3]

The aim of this study is to elucidate: 1) The value of Tei index and BNP in diagnosing unstable coronary disease, evaluating the stenosis of coronary artery. 2) Their relationship with myocardial ischemia.

Materials and Methods

Study Population

The study population consisted of a consecutive series of 92 patients (52 men and 40 women, mean age 61.1±10.3 years) with unstable coronary disease admitted to our hospital from 2006 to 2007, The diagnosis of primary unstable angina was made according to Braunwald's definition.[4] Patients with a history of valvular heart disease, acute myocardial infarction, arrhythmia, chronic pulmonary arterial hypertension, chronic obstructive pulmonary disease, anaemia, renal, hepatic or thyroid dysfunction were excluded. 30 age- and gender-matched normal subjects (16 men and 14 women, mean age 60.3±10.1 years) were included as controls. Coronary angiography was performed to all the patients and the controls, the number of stenotic vessels was recorded, patients were divided into One-vessel disease group, Two-vessel disease group, Three-vessel disease group, The degree of coronary artery stenosis was evaluated by Gensini Score System, stenosis=0, record 0; stenosis ≤25%, record 1; stenosis ≤50%, record 2; stenosis ≤75, record 4; stenosis ≤90, record 8; stenosis ≤99%, record 16; stenosis=100%, record 32. For multi-vessel disease group, the score of each vessel were pulsed. In the control group, coronary angiography had ruled out coronary artery diseases (the controls have no coronary artery stenosis or single coronary artery stenosis <50%). The study was approved by regional scientific ethics committee. All participants gave informed written consent.

Echocardiography

Echocardiography was performed by a single investigator in the morning to exclude potential influence of circadian variation. A Hewlett Packard Sonos 5500 ultrasound instrument with a 3.5-MHz transducer was used. Three to five cardiac cycles were stored digitally. LV dimensions were measured as proposed by the American Society of Echocardiography. LV systolic function was estimated using ejection fraction (EF) by Simpson's modified biplane method.[5,6] Transmitral flow was recorded from the apical four-chamber view with a 1-2 mm sample volume placed at the tips of the mitral valve leaflets during diastole. Peak E velocity (cm/s), Peak A velocity (cm/s), E/A ratio, deceleration time (DT) (ms) were obtained.[7]

Tei index was assessed from Doppler recordings of LV inflow and outflow. From mitral inflow, the time interval from cessation to onset of mitral inflow was measured (A-interval). Ejection time (B-interval) was measured from LV outflow velocity curve recorded from an apical long-axis view. Tei index was calculated as (A-B)/B.[8]

Reproducibility

Intraobserver variability was assessed in 10 patients by repeating the measurements on two occasions (1 to 12 days apart) under the same basal conditions. To test the interobserbver variability, the measurements were performed off-line from video recordings by a second observer who was unaware of the results of the first examination. Variability was calculated as the mean percent error, derived as the difference between the two sets of measurements, divided by the mean of the observations.

Measurement of Plasma BNP Level

Venous blood sample for hormone analyses were taken in the morning after 30 min of rest in supine position. Blood was drawn into prechilled EDTA tubes. Plasma was immediately separated by centrifugation in 4 hours, BNP concentration was measured with a fully automated microparticle enzyme immunoassay system.

Statistic Analysis

Continuous variables were summarized as mean±SD, the plasma BNP levels were summarized as

media and interquartile range (IQR). Comparisons between groups for continuous variables were made using student's t-test. The Kruskal-Wallis test was used to compare differences in BNP levels between groups. Correlations between echocardiographic variables, plasma BNP level and Gensini Score were analyzed using linear regression analysis. To define echocardiographic variables, plasma BNP level to predict Gensini Score, multivariate stepwise regression analysis was conducted using variables statistic significant in univariate analysis. A probability value of <0.05 was considered significant. All statistic analysis was performed by SPSS version 13.0.

Results

Echocardiographic Analysis

Table 1 shows the results of echocardiographic analysis. Compared to the control group, Tei index were much higher in One-vessel, Two-vessel and Three-vessel disease groups ($p<0.05$), compared to One-vessel group, patients with Two-vessel or Three-vessel disease had higher Tei index ($p<0.05$), and the differences between Two-vessel and Three-vessel groups were also significant ($p<0.05$). LVEF, reflecting the systolic function of LV, was lower in Two-vessel and Three-vessel groups than in controls ($p<0.05$). However, there was no difference between One-vessel group and controls, and the difference between Two-vessel and Three-vessel group was not significant too ($p>0.05$). Deceleration time (DT) was shorter in Two-vessel and Three-vessel groups than in One-vessel and control group ($p<0.05$). There was no statistic difference in the four group with E/A and LV end diastolic dimensions.

Plasma BNP Level

Plasma BNP levels were on the rise from control group (median 30 pg/ml, IQR 12.4 to 50.6) to One-vessel disease group (median 86.5 pg/ml, IQR 35.1 to 147.9) to Two-vessel disease group (median 283.5 pg/ml, IQR 77.3 to 386.9) to Three-vessel disease group (median 473 pg/ml, IQR 190.8 to 1375.2; $p<0.001$).

Gensini Score

Compared to the control group, Gensini Score were much higher in One-vessel disease group, Two-vessel disease group, Three-vessel disease group ($p< 0.05$), and the differences between One-vessel and Two-vessel disease groups, Two-vessel and Three-vessel disease groups were also significant ($p<0.05$) (Table 1).

Correlation Between Gensini Score and Echocardiographic Variables, Plasma BNP level

There were significant correlation between Gensini Score and LV dimensions, LVEF, DT, E/A, Tei index, plasma BNP level in liner regression analysis ($p<0.01$). However, multiple stepwise regression analysis shows that only Tei index and plasma BNP level were independent predictors of higher Gensini Score ($r=0.50$, $p=0.001$; $r=0.28$, $p=0.01$) (Table 2).

Reproducibility

Intraobserver variability for measurement of the Tei index was 3.1±1.6%, Interobserver variability was 3.2±2.1%.

Table 1. Echocardiographic variables and Gensini Score

	Controls	One-vessel group	Two-vessel group	Three-vessel group
LVESD (mm)	28.4±4.8	29.6±5.7	29.7±9.5	36.4±10.1†*‡
LVEDD (mm)	48.3±4.9	49.1±5.5	50.2±5.0	51.9±7.9
EF	70.4±7.8	69.4±13.7	63.3±12.5†*	57.6±13.7†*
E/A	0.84±0.26	0.96±0.33	0.96±0.53	1.13±0.67
DT (ms)	181.5±35.4	180.2±39.6	144.1±60.6†*	142.7±42.0†*
TEI	0.37±0.07	0.42±0.09†	0.51±0.14†*	0.61±0.17†*‡
Gensini score	0.07±0.27	7.92±8.27†	22.16±11.42†*	30.32±11.27†*‡

†$p<0.05$ compared to Control group; *$p<0.05$ compared to One-vessel group, ‡$p<0.05$ compared to Two-vessel group

Table 2. Correlation between Gensini Score and Echocardiographic variables, plasma BNP level

	univariate		multivariate standardized	
	r	p	regression coefficient	p
LVESD	0.50	<0.01	0.13	0.19
LVEDD	0.39	<0.01	0.05	0.56
EF	-0.48	<0.01	-0.02	0.84
E/A	0.31	<0.01	0.10	0.23
DT	-0.41	<0.01	-0.09	0.29
TEI	0.69	<0.01	0.50	0.001
BNP	0.63	<0.01	0.28	0.01

Discussion

Tei Index

Tei index, which is defined as the summation of the isovolumic contraction and relaxation times divided by ejection time, can reflect both systolic and diastolic left ventricular performance.[1] It has been demonstrated to be useful in assessing various cardiac disease including dilated cardiomyopathy, hypertrophic cardiomyopathy, cardiac amyloidosis,[9-11] its clinical significance in unstable coronary disease has not been fully investigated. In the present study, we demonstrated that Tei index was higher in unstable coronary disease patients, and the differences between One-vessel and Two-vessel disease groups, Two-vessel and Three-vessel groups were also significant, suggesting that Tei index can assess unstable coronary disease, it is valuable in reflecting the number and stenosis of coronary artery disease, patients with multi-vessel disease have higher Tei index than those with single vessel disease, this is because coronary artery stenosis results in myocardial ischemia, while ischemia influence LV performance, the more number did coronary artery involved in atherosclerosis stenosis, the more serious is myocardial ischemia, LV performance becomes poor and poor, lead to higher Tei index.

Plasma BNP Level

BNP is a cardiac hormone that is secreted mainly from the cardiac ventricles in response to increased pressure and volume,[2] recent studies have found that ischemia itself can promotes the release of BNP, but the responsible mechanisms still remain to be fully elucidated.[3] We found that compared to the control group, BNP was higher in patients with unstable coronary disease, and there was significant difference between One-vessel and Two-vessel disease groups, Two-vessel and Three-vessel groups, suggesting BNP can diagnose unstable coronary disease, the more serious the disease is, the higher is BNP. It is valuable in evaluating the degree of coronary artery stenosis.

In the present study, we use the universial Gensini Score to assess myocardial ischemia. Multiple stepwise regression analysis shows only Tei index, BNP were independent predictors of ischemia, while LV dimensions, LVEF, DT, E/A had no predicting value. We proposed that 1) Ischemia may cause increased ventricular volume and wall stress, leading to elevations in BNP. 2) Ischemia can influence both systolic and diastolic function of left ventricular, not just systolic or diastolic function, so Tei index, as a maker of "global cardiac function", can reflect ischemia accurately. It is superior to traditional echocardiographic indictors, such as LV dimensions, LVEF, DT, E/A. Further research found that, there was significant positive correlation between Tei index and Log BNP (r=0.71, p=0.001).

Conclusions

In summary, The combination of Tei index and BNP may have a specific value in dictating multi-vessel

disease or severe coronary artery disease, LV digital function study using a combination of tei index and BNP prove to be useful in predicting high risk patients for invasive management.

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