

Q- 및 비Q-파 심근경색증에서 표준화 QT 간격변이

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Normalized Idioventricular QT Interval Variability in Patients with Q- and Non-Q Wave Myocardial Infarction

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ABSTRACT

Background and Objectives : The aim of the study was to evaluate the difference of temporal lability in myocardial repolarization between acute non-Q (NQMI) and Q-wave myocardial infarction (QMI), and to discern whether the locations of myocardial infarction influence such temporal lability. **Subjects and Methods :** Twelve patients with NQMI and 28 with QMI, including 16 anterior (AMI) and 12 inferior MI (IMI) patients were enrolled. Twenty four-hour ambulatory ECG recordings of each patient were analyzed, and the digitized data was partitioned into 30-min sections. The QT intervals were measured using a template matching strategy. We then calculated the low (LF : 0.03 -0.15 Hz) and high frequency (HF : 0.15 -0.4 Hz) power of the QT interval variability using an algorithm capable of removing the influence of the RR-interval on QT interval variability (Normalized Idioventricular QT variability Index : IV-QT). **Results :** For patients with QMI, the low frequency IV QT (LF IV-QT) was higher than that of NQMI (1.941 ± 0.101 and 1.556 ± 0.114 respectively, $p < 0.05$). No difference was seen in the high frequency IV QT (HF IV-QT) of the two groups. For QMI patients, both the LF IV-QT and HF IV-QT were higher in day time (6AM-6PM) than in night time (6PM-6AM). Comparing the differences of these indices by the location of QMI, both the LF IV-QT and HF IV-QT of AMI were higher than those of IMI patients (2.231 ± 0.135 vs 1.355 ± 0.131 and 2.341 ± 0.161 vs 1.346 ± 0.145 respectively, $p < 0.0005$). Both indices of each group also demonstrated a circadian change. **Conclusion :** In cases of QMI, the temporal lability in myocardial repolarization is larger than that seen in NQMI. Moreover, it was worse in AMI than IMI. Finally, such temporal repolarization lability tends to have a circadian pattern in QMI. (Korean Circulation J 2001;31(12):1281-1289)

KEY WORDS : Myocardial infarction ; Electrocardiography, ambulatory.

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서 론

.⁵⁾ QT power spectrum , QT , 가 . Q- 가 Q- . Q- Q- 가 , .⁶⁾⁷⁾ (rep - Q- ,⁸⁾ , Q- 가 ,⁹⁾¹⁰⁾ Q- QT , QT Q- QT RR QT .³⁾ ‘ QT (QT dispersion) ’ 12 QT , QT 가 , QT .⁴⁾ (transmural) , QT ‘ QT , QT creatine kinase - MB(CK - MB) 가 3 (12 ng/mL) 가 , 2 , 30 msec , 25% , 2 Q- 가 Q- 가 Q- . 5% , .

28 (: =17 : 11, 56.6±2.2)
 , Q- 12 (: =8 : 4, 63.7±1.8)

자료획득 및 전처리

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 (Delma Holter Recorder Series 8500, USA),
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 (DT 3001, USA)
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기본틀(template) matching 방법을 이용한 QT 간격의 측정

QT (template) matc-
 hing 가 Beat
 QRS T
 (template) , (algorithm)
 Beat QT
 (stretching) (compr-
 essing)
 QT

- 1) I II
 . Baseline
 0.3 Hz digital filtering
- 2) Beat R peak detecting
 algorithm R
 T i
- 3) beat k QRS T
 QT
 (n), sample number n
 (n)=x(n)(n n₀ n₁) (1)

x(n) signal , n₀ n₁
 가 QT
 n=n₁-n₀
 QT N t가 t digitizing inter-
 val (1 ms) N QT digitizing interval
 beat matching
 , QRS duration
 n=T_k+n n=n₁
 n blanking period(50 ms)
 4) Beat Error function

$$i() = \sum_{j=n}^{n_1-T_k} [(T_k+j) - x(T_i+aj)]^2 \quad (2)$$

time stretching factor , i()
 i beat T T
 5) i()가 가
 search step size 0.0001
 , 0.9 1.1
 6) i beat QT QT_i

$$QT_i = iN t \quad (3)$$

 N t QT duration
 time-stretch model
 T-wave 가 T
 QT , T
 QT
 가 , beat-to-beat variability
 ((2)).

Idioventricular QT interval variability index의 계산
 (Fig. 1)
 RR QT (real time se-
 ries) , RR QT
 1,000 Hz
 RR QT
 (normalization) (Fig. 1A, B).

QT, RR, Squared cross coherence(SCC)

QT

, Normalized high and low frequency idioventricular QT interval variability index(HF IV - QT, LF IV - QT)

(Frequency domain analysis)

RR, QT

Cross spectral analysis

$K_{QT,RR}^2(f) = S_{QT,RR}(f)^2 / S_{QT}(f) S_{RR}(f)$ (4)

$K_{QT,RR}^2(f)$ Squared cross coherence(SCC)

(Fig. 1E), $S_{QT,RR}(f)$ cross spectrum $S_{QT,RR}(f)$

, $S_{QT}(f)$ $S_{RR}(f)$ QT RR

normalize power spectrum (Fig. 1C, D).

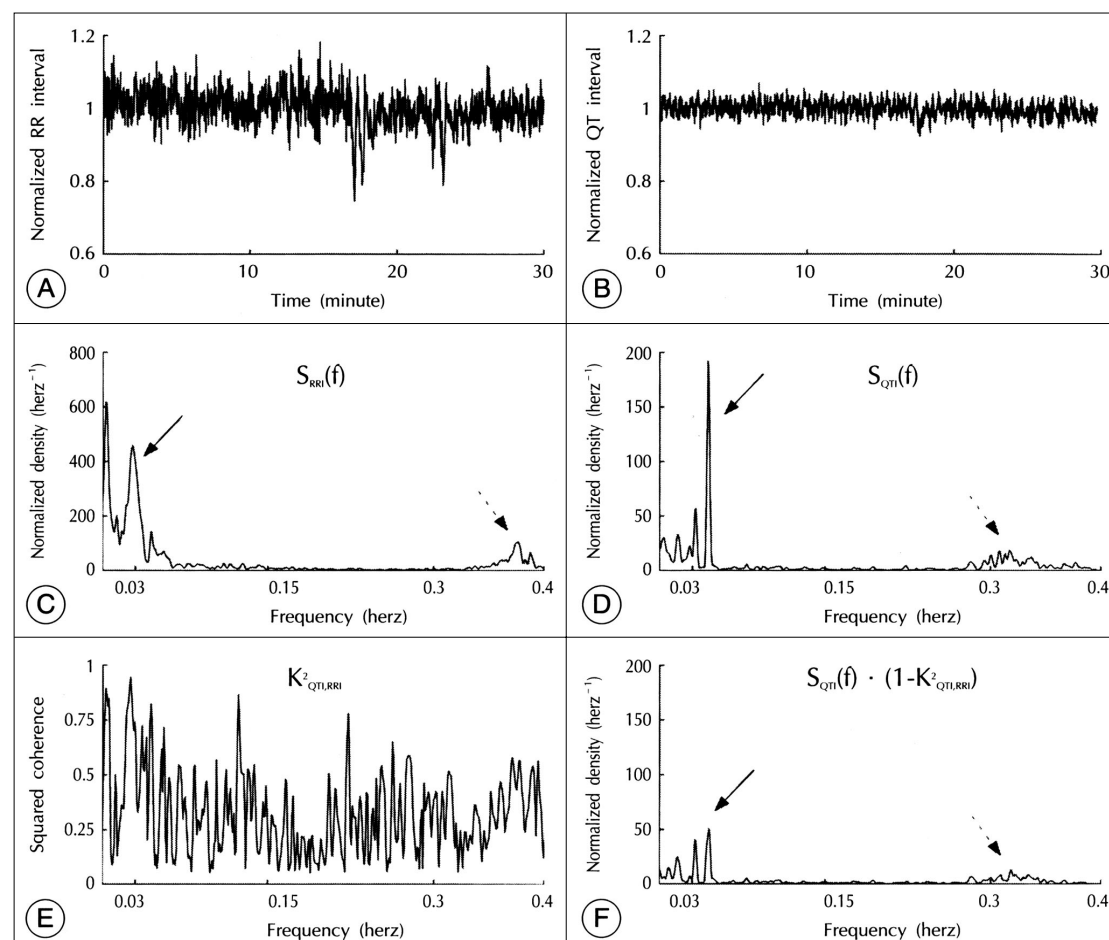


Fig. 1. The procedure to calculate normalized idioventricular QT interval variability of a patient with non-Q myocardial infarction. A : normalized RRI time series, B : normalized QTI time series, C : normalized RRI power spectral density function, $S_{RRI}(f)$. D : normalized QT power spectral density function, $S_{QTI}(f)$. There were peaks at low-frequency range (solid arrow) and high frequency range (dotted arrow) in the spectral density functions of both RRIs and QTIs. E : squared cross coherence function between the normalized QTI and RRI, $K_{QTI,RR}^2(f)$. F : normalized idioventricular QTI power spectral function, $S_{IVQT}(f)$. Note $S_{IVQT}(f) = S_{QTI}(f) (1 - K_{QTI,RR}^2(f))$. At the range near the low-frequency peak, the coherence is large, and consequently, the fluctuation of QTIs at the frequency range is largely dependent on the fluctuation of RRIs. Therefore, the amplitude of low-frequency peak in idioventricular power density decreased significantly (F, solid arrow). In contrast, at the range of the high-frequency peak, the coherence is low, and the fluctuation of QTIs are less influenced by the fluctuation of the power of RRIs (F, dotted arrow). RRI : RR interval, QTI : QT interval. See text.

HF IV - QT LF IV - QT , QT
normalized power spectral density
(1 - SCC) . ,

$$S_{IVQT}(f) = S_{QT}(f) \cdot (1 - K^2_{QT,RR}(f)) \quad (5)$$

$S_{IVQT}(f)$ QT normalized idioventricular power spectrum , $S_{QT}(f)$ QT normalized power spectrum .
(5) RR QT
, $K^2_{QT,RR}(f) = 1$, QT
RR , $S_{IVQT}(f)$
0 . SCC가 1 RR
QT (idioventricular power spectrum) . (5) LF IV - QT
0.03 0.15 Hz , HF IV - QT 0.15
0.4 Hz .
Fig. 1 Q - normali -
zed idioventricular QT interval variability function
($S_{IVQT}(f)$) . Fig. 1A
Fig. 1B (normalized) RR QT
RR QT
1 , RR
QT .
Fig. 1C Fig. 1D RR
QT normalized power spectral function
RR ($S_{RR}(f)$) QT ($S_{QT}(f)$)
(Fig. 1C Fig. 1D
Y scale RR QT 4
) . RR QT norm -
alized power spectral function (Peak)
) () (Peak)
. Fig. 1E RR QT sq -
uared coherence function($K^2_{QT,RR}(f)$) , Fig.
1F RR QT normali -
zed ' idioventricular ' variability function($S_{IVQT}(f) =$
 $S_{QT}(f) \cdot (1 - K^2_{QT,RR}(f))$) . Fig. 1E sq -
uared coherence가
QT 가 RR
, Fig. 1F

idioventricular QT interval variability(IV - QT)
() .
RR () .
LV IV - QT HF IV -
QT . Q - Q -
LF IV - QT HF IV - QT
, , (6 6
) (6 6)
. Q -
(16) (12)
.
통계 방법
' ± ' .
QT Wilcoxon rank test
,
unpaired t - test .
p<0.05 .

결 과

임상특성

Q - (28) Q -

Table 1. Clinical characteristics

	NQMI (n=12)	QMI (n=28)	p
Sex (Male)	8 (67%)	17 (60%)	NS
Age (years)	63.7 ± 1.8	56.6 ± 2.2	<0.05
LVEF	60.5 ± 16.7	59.9 ± 2.0	NS
Peak CK-MB	148.1 ± 43.8	445.8 ± 174.9	NS
Smoking	23 (83%)	8 (67%)	NS
Thrombolytic Tx	5 (42%)	15 (54%)	NS
Medications			
Beta blockers	9 (75%)	19 (64%)	NS
ACE inhibitors	3 (25%)	12 (43%)	NS
Aspirin	11 (92%)	27 (96%)	NS
Nitrates	11 (95%)	21 (75%)	NS
PTCA	1 (8%)	10 (36%)	<0.01
Diabetes mellitus	5 (42%)	6 (21%)	NS

QMI : Q-wave myocardial infarction, NQMI : non-Q-wave myocardial infarction, LVEF : left ventricular ejection fraction, PTCA : percutaneous transluminal coronary angioplasty, NS : not significant, CK-MB : creatine kinase-MB, ACE : angio-tensin converting enzyme, Tx : therapy

Table 2. Normalized idioventricular high- (HF IV-QT) and low-frequency variability indices (LF IV-QT) of NQMI and QMI patients

	HF IV-QT		LF IV-QT	
	NQMI (n=12)	QMI (n=28)	NQMI (n=12)	QMI (n=28)
24 hr mean	1.854 ± 0.151	2.013 ± 0.119	1.556 ± 0.114*	1.941 ± 0.101*
6AM - 6PM	2.104 ± 0.208	2.310 ± 0.172	1.760 ± 0.158 [†]	2.384 ± 0.169 [†]
6PM - 6AM	1.632 ± 0.214	1.780 ± 0.164	1.374 ± 0.163	1.595 ± 0.119

NQMI : non-Q-wave myocardial infarction, QMI : Q-wave myocardial infarction, HF IV-QT : high frequency normalized idioventricular QT variability index, LF IV-QT : low frequency normalized idioventricular QT variability index, * : p<0.05, [†] : p<0.005, [: p<0.05

Table 3. Normalized idioventricular high- (HF IV-QT) and low-frequency variability indices (LF IV-QT) of AMI and IMI patients

	HF IV-QT		LF IV-QT	
	AMI (n=16)	IMI (n=12)	AMI (n=16)	IMI (n=12)
24 hr mean	2.341 ± 0.161 [†]	1.346 ± 0.145 [†]	2.231 ± 0.135 [‡]	1.355 ± 0.131 [‡]
6AM - 6PM	2.557 ± 0.219 [¶]	1.799 ± 0.265 [¶]	2.662 ± 0.218*, [¶]	1.810 ± 0.247*, [¶]
6PM - 6AM	2.171 ± 0.230 [§]	1.002 ± 0.149 ^{§, ¶}	1.890 ± 0.165 [¶]	1.009 ± 0.123 [¶]

AMI : anterior myocardial infarction, IMI : inferior myocardial infarction, HF IV-QT : high frequency normalized idioventricular QT variability index, LF IV-QT : low frequency normalized idioventricular QT variability index, * : p<0.05, [†] [‡] [§] : p<0.0005, [¶] : p<0.05

(12) ,
Q - 63.7 ± 1.8 Q -
56.6 ± 2.2 (p<
0.05). Stent Q -
10 (36%) Q -
1 (8%) Q -
(p<0.01). ,
, CK - MB ,
(Table 1).
QT 간격의 파워 스펙트랄 분석
LF IV - QT 24 Q -
1.941 ± 0.101 Unit, Q -
1.556 ± 0.114 Unit Q -
가 (p<0.05),
, (6 6)
Q - 2.384 ± 0.169 Unit
Q - 1.760 ± 0.158 Unit
(p<0.005). (6 6)
가 .
, Q - (6 6)
2.384 ± 0.169 Unit

Table 4. Coronary angographic findings of NQMI and QMI patients

	NQMI (n=12)	QMI (n=28)
CAG performed	6	16
Culprit artery		
LAD	4	6
RCA	1	6
LCx	1	3
LMCA	0	1
No. of vessel with obstruction (>50%)		
0	1	3
1	2	2
2	2	8
3	1	2
LMCA	0	1

NQMI : non-Q-wave myocardial infarction, QMI : Q-wave myocardial infarction, LAD : left anterior descending coronary artery, RCA : right coronary artery, LCx : left circumflex, LMCA : left main coronary artery

(6 6) 1.595 ± 0.119 Unit
(p<0.05). Q -
(Table 2).
HF IV - QT 24 가
가 . , Q -

(6 6) Q -
 2.310 ± 0.172 Unit (6 6)
 1.780 ± 0.164 Unit (p< , Q -
0.05). Q -
(Table 2). QT
Q - Bonnemeier ²⁾
, LF IV - QT 24
 2.231 ± 0.135 Unit, QT 가 , QT
 1.355 ± 0.131 Unit (p<0. ,
005). 가
(6 6) (, QT 가
6 6) LF IV - QT가 $2.662 \pm$ 가
 0.218 Unit 1.890 ± 0.165 Unit QT QT
 1.810 ± 0.247 Unit 1.009 ± 0.123 Unit , RR
(p<0.05, p<0.005). (, Frequency - domain QT
6 6) (6 6) 가 . Sosnowski
(p<0.05)(Table 3). ¹³⁾ (Heat rate
HF IV - variability) , RT
QT 2.341 ± 0.145 Unit 1.346 ± 0.145 (RT interval complexity)
(p<0.005). 가
(6 6) QT RT
 2.171 ± 0.230 Unit
 1.002 ± 0.149 Unit QT
(p<0.005). (6 6) ³⁾¹⁴⁾ 가 ,
가 . HF IV - QT가 (가 QT
6 6) ¹⁵⁾¹⁶⁾ , (dia -
(p<0.05)(Table 3). stolic interval) (action po -
관동맥촬영 소견 tential duration)
Q - Q - (phenomenon of electrical restitution)
16 (56%) 6 (50%)
, , 50%
가 (Table 4). ¹⁷⁾
고 찰 ¹⁸⁾ RR QT
⁵⁾ 가 ,
Q - Q - ¹⁹⁾
Power spectrum QT 가 ,
, (0.15 0.4 Hz) RR QT
, (0.03 0.15 ²⁰⁾ Sarma ²¹⁾
Hz) Q - QT 가 Q - , RR 가 QT

0.05 0.25 Hz 가 RR 가 ,¹⁹⁾ Q- Q- 가 QT QT 가 가 , 가 가 . QT Q- Q- ,⁶⁻⁹⁾ normalized QT idioventricular QT interval variability index(HF IV -¹⁹⁾ QT LF IV - QT) , Q- Q- , QT , Q- QT 가 가 QT Q- , Q- 가 가 가 .⁶⁾ Q- 요 약 , QT 가 가 QT 가 배경 및 목적 : Q- Q- , 가 , QT 가 , 방 법 : 12 Q- 28 Q- (16 (stretching) (template) QT 12) 24 30 (compressing)¹¹⁾ QT (template matching strat -¹¹⁾ QT QT . RR QT normalized idioventricular QT variability index(IV - QT) (LF : 0.03 0.15 Hz) (HF : 0.15 0.4) QT , QT 가 가 QT 가 IV - QT(LF IV - QT) Q- Q- .

Q- 가 (1.
 941 ± 0.101 1.556 ± 0.114 , $p < 0.05$).
 IV - QT(HF IV - QT) 가 .
 Q- LF IV - QT HF IV -
 QT 가 .
 Q-
 , LF IV - QT HF IV - QT
 가
 (LF IV - QT : 2.231 ± 0.135 $1.355 \pm$
 0.131 , HF IV - QT : 2.341 ± 0.161 1.346 ± 0.145 ,
 $p < 0.0005$).
 결 론 :
 Q- Q-
 가 Q-
 , 가 Q-
 .
 중심 단어 : ; .

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