

심질환이 없는 환자들에서 Holter Tape를 이용한 Signal Averaged Electrocardiography

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= Abstract =

Signal Averaged Electrocardiography Using Holter Tape in Patients without Heart Disease

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Background : Ventricular tachyarrhythmias are major cause of sudden cardiac death in patients after myocardial infarction and their accurate detection seems to be important in prevention of sudden cardiac death. Clinical findings, treadmill test, holter monitoring and coronary angiography have been used to search for high risk group in sudden cardiac death. Recently electrophysiologic stimulation has been used to this, but it is not practical, because of high cost and invasiveness. Signal averaged electrocardiogram(SAECG) may be helpful in prediction of high risk group in sudden cardiac death. So we try to know the values of SAECG in Korean patients without heart disease.

Results :

- 1) The mean value and standard deviation of Time domain analysis is as follows ; fQRS : 106.8 ± 12.3 ms, RMS : 36.2 ± 21.5 μ V, LAS : 27.2 ± 8.1 ms.
- 2) The mean value and standard deviation of Spectral turbulence analysis is as follows ; LSCR : 58.6 ± 3.9 , ISCM : 95.2 ± 0.8 , ISCD : 71.8 ± 15.7 , SE : 6.9 ± 1.8 .

Conclusion : There was no significant difference between male and female. Time domain analysis shows significant differences among each hour but spectral turbulence analysis did not. Spectral turbulence analysis shows high specificity.

KEY WORDS : Signal-averaged Electrocardiogram · Time domain analysis · Spectral turbulence analysis.

서 론

sudden cardiac death, sudden death detection¹⁻⁵⁾, holter monitoring, electrophysiologic stimulation, Signal averaged electrocardiogram(SAECG) holter recording⁶⁻⁹⁾, signal averaged electrocardiography, high resolution electrocardiography, abnormal myocardial substrate, high frequency, low amplitude signal, ventricular late potentials, spontaneous ventricular tachyarrhythmia, late potentials, time domain analysis, filtering, late potentials, Spectrotemporal analysis(STA)¹⁰⁾, Spectral turbulence analysis, SAECG, QRS complex, terminal region, frequency, frequency error, frequency domain analysis¹¹⁾.

대상 및 방법

1. 대 상

가

27
cording

24 Holter re -
late potential

2. 방 법

frank XYZ leads, Del Mar Avionic CardioCorder® Recorder Model 459, 24 Holter recording, X-lead, anterior axillary line, 5th intercostal space, Y-lead, sternal border, Z-lead, midline, 4th intercostal space, Sampling frequency 1000Hz, Holter recorder, Del Mar's Model 563 StrataScan TM Holter Monitoring System, Time domain analysis, 25, 250Hz, bidirectional 4-pole Butterworth filter, vector magnitude, mean square noise level, 1 μ V, late potential, filtered QRS complex, total duration(fQRS), QRS complex, terminal 40 millisecond, root mean square voltage(RMS40), QRS complex, terminal portion, 40 μ V, low amplitude signal duration(LAS40) parameter, Spectral turbulence analysis, QRS complex, 25 millisecond, (T1) QRS complex가, 125 millisecond, (T2) spectrocardiogram, total high power main QRS region, time domain analysis, late potential, low power terminal QRS region, T1, 2 millisecond, 24 millisecond, signal segmentation, segment, 1 millis-

econd (25 data points) meter (Table 1) . 4
overlapping 24 - ms sig - 가 parameter X, Y Z leads
nal segment 4 - term Blackman - lead
Harris window fast Fourier transform -
ation slice power QRS offset total power spectral density가 2
spectral density spectral mapping slice baseline noise level 5 sta -
correlation coefficient Ventricular wa - ndard deviation , QRS
vefront가 abnormal ventricular substrate onset power spectral density가 maximum power
wave front velocity detect spectral density 0.2%가
4가 spectral turbulence analysis para - time domain analysis

Table 1. Acquired parameters

Time domain analysis	5	signal averaging		4
fQRS : total duration of filtered QRS complex		student t - test		pa -
RMS40 : root mean square voltage in the terminal 40msec of the QRS complex	parameter		가	
LAS40 : low amplitude signal duration below 40 μ V in the terminal portion of QRS complex	18	0	6 , 6	12 , 12
Spectral turbulence analysis	18	18	24	4
LSCR : low slice correlation ratio	signal averaging		parameter	
ISCM : inter-slice correlation mean				
ISCSD : inter-slice correlation standard deviation				time domain an -
SE : spectral entropy	alysis	2가	parameter	

Table 2. Specificity of time domain analysis and spectral turbulence analysis, by dividing the day in 4 time period

	0 - 6AM		6 - 12AM		12 - 18PM		18 - 24PM		P
	mean	sp(%)*	mean	sp(%)*	mean	sp(%)*	mean	sp(%)*	
Time domain analysis*									
FQRS	106.7 \pm 11.7	-	111.8 \pm 21.8	-	99.1 \pm 7.1	-	104.3 \pm 15.2	-	<0.05
RMS40	35.3 \pm 21.7	96.0	55.2 \pm 22.0	87.5	49.2 \pm 22.3	83.3	44.0 \pm 23.2	92.0	<0.05
LAS40	28.2 \pm 9.5	-	22.0 \pm 8.1	-	23.1 \pm 9.1	-	24.4 \pm 8.6	-	<0.05
Spectral turbulence analysis**									
Total high power main QRS region									
LSCR	58.1 \pm 4.7	-	56.4 \pm 2.6	-	58.6 \pm 2.9	-	59.4 \pm 4.3	-	NS**
ISCM	95.2 \pm 0.9	100.0	95.6 \pm 0.5	100.0	95.2 \pm 1.0	100.0	95.2 \pm 0.8	100.0	NS
ISCSD	73.9 \pm 18.3	-	69.3 \pm 13.8	-	71.2 \pm 21.9	-	72.4 \pm 21.5	-	NS
SE	7.4 \pm 1.5	-	7.5 \pm 1.0	-	75.1 \pm 1.1	-	7.9 \pm 1.9	-	NS
Terminal low power QRS region									
LSCR	53.5 \pm 14.5	-	52.4 \pm 6.5	-	51.9 \pm 12.8	-	53.1 \pm 13.0	-	NS
ISCM	92.8 \pm 4.4	100.0	93.0 \pm 1.3	100.0	92.4 \pm 3.6	83.3	92.0 \pm 4.6	92.0	NS
ISCSD	69.3 \pm 26.4	-	70.1 \pm 17.3	-	75.4 \pm 34.9	-	81.2 \pm 51.3	-	NS
SE	10.2 \pm 9.5	-	7.3 \pm 9.5	-	13.2 \pm 11.4	-	10.6 \pm 7.7	-	NS

* Specificity

**Not significant

+ Abnormal when at least 2 parameters were out of normal range : fQRS>120msec, RMS40<25 μ V, LAS40>40msec at 25Hz filter

++ Abnormal when at least 3 parameters were out of normal range : LSCR > 73.5, ISCM < 92.3, ISCSD > 104.8, SE > 14.4

spectral turbulence analysis, 40Hz high pass filter
Kelen 37가 103.4 ± 10.8 millisecond, 30.0 ± 9.1 μV, 30.8 ± 7.6 millisecond, noise 0.4 ± 0.2 μV
parameter (Table 2). Spectral turbulence analysis parameter
total high power main QRS region
LSCR 58.6 ± 3.9, ISCM 95.2 ± 0.8, ISCS
가 71.8 ± 15.7 SE가 6.9 ± 1.8, ter -
minal low power QRS region LSCR 57.8 ±
13.3, ISCM 91.8 ± 5.7, ISCS가 70.1 ± 27.5
SE가 9.7 ± 8.5 parameter
terminal low power QRS region LSCR
monitoring 24 holter (p<0.05), param -
4 5 eter (Table 3).
signal averaging(total beats averaged=349
± 119) parameter ti - parameter
me domain analysis 25Hz high pass filter time domain analysis
fQRS duration 106.8 ± 12.3 millisecond, fQRS, RMS40 LAS40 paraeter
RMS40 36.2 ± 21.5 μV, LAS40 27.2 ± 8.1 fQRS
millisecond noise 0.5 ± 0.2 μV 6 12 가 .

Table 3. Results of signal averaged electrocardiography and gender difference in 27 subjects without cardiac disease

	Total (n=27)*	Male (n=11)	Female (n=16)	p
Time domain analysis				
25Hz high pass filter				
FQRS	106.8 ± 12.3	108.3 ± 13.1	105.6 ± 12.0	NS**
RMS40	36.2 ± 21.5	30.2 ± 18.1	40.2 ± 23.3	NS
LAS40	27.2 ± 8.1	28.6 ± 8.9	26.3 ± 7.7	NS
Noise	0.5 ± 0.2	0.5 ± 0.0	0.5 ± 0.2	NS
40Hz high pass filter				
FQRS	103.4 ± 10.8	100.9 ± 11.0	104.8 ± 10.7	NS
RMS40	30.0 ± 9.0	32.7 ± 13.7	28.6 ± 5.4	NS
LAS40	30.8 ± 7.6	28.3 ± 6.6	32.1 ± 7.9	NS
Noise	0.4 ± 0.2	0.6 ± 0.3	0.4 ± 0.1	NS
Spectral turbulence analysis				
Total high power main QRS region				
LSCR	58.6 ± 3.9	58.0 ± 4.0	59.1 ± 3.8	NS
ISCM	95.2 ± 0.8	95.1 ± 0.8	95.3 ± 0.8	NS
ISCS	71.8 ± 15.7	75.3 ± 14.6	69.3 ± 16.3	NS
SE	6.9 ± 1.8	7.2 ± 0.7	6.7 ± 2.3	NS
Terminal low power QRS region				
LSCR	57.8 ± 13.3	50.3 ± 13.8	62.9 ± 10.5	NS
ISCM	91.8 ± 5.7	92.2 ± 5.4	91.5 ± 6.0	NS
ISCS	70.1 ± 27.5	73.0 ± 22.4	68.1 ± 31.0	NS
SE	9.7 ± 8.5	7.6 ± 2.7	11.1 ± 10.8	NS

* Beats averaged = 349 ± 119

** Not significant

Spectral turbulence analysis			mitee of the European Society of Cardiology, American Heart Association, and American College of Cardiology				
lysis	time domain analysis		40Hz high pass bidirectional filtering				
	90.6%, 87.5%, 83.3%	92.5%	fQRS가 114	LAS40			
6	6		38msec	RMS40 20 μ V	late potential		
	가 87.5%, 83.3%		25Hz				
Spectral turbulence analysis			High Pass Filter				
power main QRS region		가	95.9 \pm 1.4, Gomes	fQRS(ms) Denes	99.0		
nal low power region		100%, 100%, 83.3%	\pm 9.9, Kelen	97 \pm 2			
92%		가	106.8 \pm 12.3				
27	time domain analysis		4	RMS40(μ V)	Denes 67.1 \pm 5.2,		
2				Gomes 117 \pm 103, Pierce	73.6 \pm 45.9, Kelen		
spectral turbulence		2	56 \pm 8		36.2 \pm		
		time domain	21.5	가	LAS 40(ms)		
analysis		spectral turbulence analysis	Denes 23.3 \pm 1.1, Gomes	20 \pm 6, Pierce			
			23.6 \pm 8.7, Kelen	26 \pm 2			
			27.2 \pm 8.1		12,13)		
고 안			40Hz High Pass Filter				
			fQRS(ms)				
1978	Berbari	late potential	Denes 93.7 \pm 1.4, Hammill	109 \pm 8, Mittleman			
			95.2 \pm 10.3, Timmermans	97 \pm 2, Shin			
			107.3 \pm 7.0				
			103.4 \pm 10.8		RMS40(μ V)		
			Denes 41.6 \pm 3.5, Hammill	44 \pm 20, Mittleman			
			60.1 \pm 53, Timmermans	43.5 \pm			
			20.6, Shin	42.5 \pm 14.8			
			30.0 \pm 9.1				
. 1991 The joint task force com-							

Table 5. SAECG parameters in subjects without cardiac disease by spectral turbulence analysis

Author	N	LSCR	ISCM	ISCSD	SE	Recording
	27	58.6 ± 3.9	95.2 ± 0.8	71.8 ± 15.7	6.9 ± 1.8	Holter, Frank
Kelen	99	67 ± 6	94 ± 1	85 ± 20	11 ± 3	Real, Frank

Analysis was done in total high power main QRS region with fast Fourier transformation

LAS40(ms) Denes 29.5 ± 1.1, Hammill 31 ± 8, Mittleman 28.2 ± 8.4, Timmermans 30.4 ± 8.4, Shin 28.2 ± 7.0, 30.8 ± 7.6 (Table 4). Spectral Turbulence Analysis LSCR 58.6 ± 3.9, ISCM 95.2 ± 0.8, ISCSD 71.8 ± 15.7, SE 6.9 ± 1.8 Kelen LSCR 67 ± 6, ISCM 94 ± 1, ISCSD 85 ± 20, SE 11 ± 3 (Table 5).

eter 25Hz High Pass Filter fQRS(ms)가 106.8 ± 12.3, RMS40(μV) 36.2 ± 21.5, LAS40(ms) 27.2 ± 8.1, 40Hz High Pass Filter fQRS(ms)가 103.4 ± 10.8, RMS40(μV) 30.0 ± 9.1, LAS40(ms) 30.8 ± 7.6. Spectral Turbulence Analysis LSCR 58.6 ± 3.9, ISCM 95.2 ± 0.8, ISCSD 71.8 ± 15.7, SE 6.9 ± 1.8. , time domain analysis central turbulence analysis

요 약

연구배경 :

(sudden cardiac death)

Averaged ECG late potential . Signal

signal

방 법 :

27 24 Holter re-cording late potential time domain analysis spectral turbulence analysis mean value standard deviation .

결 과 :

Time Domain Analysis SAECG parameter fQRS LAS40 가 , RMS40 가 .

결 론 :

Time domain analysis SAECG param -

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