Signal-averaged electrocardiography in patients with systemic sclerosis

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In this study, the values of high frequency mid-QRS potential (HFQRS) and late potential (LP) to determine myocardial involvement in patients with systemic sclerosis were evaluated. Eightteen patients were examined by 12 lead electrocardiography, M mode and two dimentional echocardiography and signal-averaged electrocardiography (SAECG). Only 9 patients underwent to exercise Thallium 201 (Tl) myocardial perfusion scintigraphy. All patients had sinus rhythm. Three had left anterior fascicular block and one of them had also septal infarction pattern in ECG. SAECG's were recorded in 25-250 Hz, 40-250 Hz, 80-250 Hz (LP) and 150-250 Hz (HFQRS) frequency ranges. Patient group had prolonged filtered QRS and high frequency low amplitude signal duration and lower root mean square voltage (RMS) in 40-250 Hz than normals. According to selected filters, the incidence of LP changed from 17% to 39 % in patients. HFQRS were lower than normals and 56 % of patients had RMS under lower limit of normal. Tl perfusion defects were seen in four patients. All had low HFQRS but two also LP. Left ventricular wall motion abnormality was not found except one patient who showed impairment in SAECG and Tl scintigraphy. SAECG, as a noninvasive method, may be helpful to assess myocardial involvement in patients with systemic sclerosis even if they are asymptomatic. Long term studies are required to reveal the prognostic importance of LP and HFQRS in these cases. [Turk J Med Res 1995; 13(2): 66-70]

Key Words: Systemic sclerosis, Late potential, High frequency mid QRS potential

Patients with systemic sclerosis are known to be at risk for development of myocardial disease which is manifested by cardiac failure, conduction system abnormalities, atrial and ventricular arrhythmias and sudden cardiac death (1). Clinical criteria substantially underestimate the prevalence of cardiac involvement compared more sensitive diagnostic studies (2). Studies of myocardial function (echocardiography, radionuclide angiography, contrast ventriculography) and myocardial perfusion (coronary angiography or thallium scintigraphy) are only performed when clinically indicated. Approximately 50% of patients with systemic sclerosis have normal ECG findings (3). Left anterior fascicular block and septal infarction pattern are seen in 52 percent and 5 percent of these patients, respectively (3). Supraventricular and ventricular tachycardia are common in patients with systemic sclerosis and the predominant arrhythmia is ventricular ectopic activity. Arrythmias are associated with increased mortality and aggravate the risk of death independently of other indexes of severity of organ involvement (4). Twelve lead electrocardiography and nuclear angiography are considered to be useful tools for discovering early cardiac involvement in systemic sclerosis (5). However signal averaged electrocardiography may be helpful to detect myocardial disease because myocardial ischemia and fibrosis can produce areas of delayed myocardial activation (6-10). This study evaluates the high frequency mid-QRS and late potentials in systemic sclerosis.

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MATERIALS AND METHODS

Patients: Eightteen patients, 15 women and 3 men, with systemic sclerosis were enrolled the study. The mean age was 43±12 years. The patients had suffered from systemic sclerosis for a mean of 4.2+2.7 years. They fulfilled preliminary American Rheumatism Association criteria for definite systemic sclerosis (11). None had a history of atherosclerotic coronary artery disease, angina pectoris, myocardial infarction, sustained ventricular tachycardia or cardiac arrest. Seven

patients had Raynaud's fenomenon and have undertaken nifedipine treatment. Only four patients with hypertension were seen. Proteinuria in 3 patients, esophagial involvement in 3 patients were identified. One patient had soft tissue calcification.

Nine patients had exercise SPECT Thallium 201 myocardial perfusion scintigraphy. M mode and two dimentional echocardiography, 12-lead electrocardiography and signal averaged electrocardiography were used in all patients.

Signal averaged electrocardiography: High frequency potentials were recorded by signal averaged ECG (MAC 12, Marquette Electronics, Inc, Milwaukee) with 25-250 Hz, 40-250 Hz, 80-250 Hz (late potentials) and 150-250 Hz (high frequency potentials in mid-QRS) frequency ranges, using X.Y.Z orthogonal leads. The criteria of late potentials are given in Table 1. Late potential is defined as >2 of these parameters (12-15). For analysis of mid-QRS high frequency potentials, root mean square voltage in the entire QRS was printed as vector magnitude waveform.

The fifteen healthy subjects consisted as control group.

Table 1. The criteria of late potentials

Frequency (Hz)	QRS dur (ms)	HFLA (ms)	RMS (μv)
25-250	>120	>32	<25
40-250	>114	>39	<20
80-250	>107	>40	<17

QRS dur: Filtered QRS duration
HFLA: High frequency low amplitude (<40 **MV)** signal duration
RMS: Root mean square voltage in the terminal 40 ms of the QRS

Statistical analysis: All data are reported as mean±SD. Student's t test was used to test differences between variables.

RESULTS

In the different frequency ranges for analysis of late potentials, results are given in Table 2. In comparison with control group, patients with systemic sclerosis had prolonged filtered QRS and high frequency low amplitude (<40 uv) signal duration and lower root mean square voltage (<40 ms) in 40-250 and 80-250 Hz frequency ranges but also only lower RMS voltage in 25-250 Hz than normals.

According to generally accepted iate potential criteria, 3 (17%) patients in 25-250 Hz and 3 (17%) patients in 40-250 Hz had late potential. In 80-250 Hz frequency range, late potential was found in 7 (39%) patients (Figure 1).

High frequency mid-QRS potentials (150-250 Hz) were lower than normals in patient group. Ten (56%) patients showed root mean square voltage under the lower limit of normals (Figure 2).

All patients had sinus rhythm. Three had left anterior fascicular block and one of them septal infarction pattern. The last patient's 24 hour Holter recordings showed nonsustained ventricular tachycardia and frequent atrial premature beats. In her echocardiographic evaluation left ventricular wall motion abnormalities and dysfunction were found. Thallium 201 myocardial perfusion scintigraphy revealed fixed perfusion defect. The findings of this patient were accompanied with late potentials in three different frequency ranges and low high frequency mid-QRS potentials.

Except this patient, all had normal echocardiographic examination. Myocardial perfusion scintigraphy could be done in only 9 patients. Perfusion

Table 2. Late potential parameters in patients with systemic sclerosis and normals

SAECG	Control Group (n-15)			Patient Group (n-18)		
Frequency (Hz)	QRSdur (ms)	HFLA (ms)	RMS (MV)	QRSdur (ms)	HFLA (ms)	RMS (μv)
25-250	112±3	16±2	96±41	116±12	21±9	61±27'
40-250	101±5	25±7	58±34	112±14t	40±10*	26±16*
80-250	89±6	30±8	26±16	101±15'	46±16*	10±5'

(') p<0.05 O p<0.001 (*) p<0.01

Table 3. High frequency mid-QRS potentials in patients with systemic sclerosis and normals

SAECG	Control Group n=15		Patient Group n-18	
Frequency (Hz)	QRSdur(ms)	RMSfjiv)	QRSdur(ms)	RMS(MV)
150-250	83±8	6.4±1.4	87±13	5.011.7*

C) p<0.05

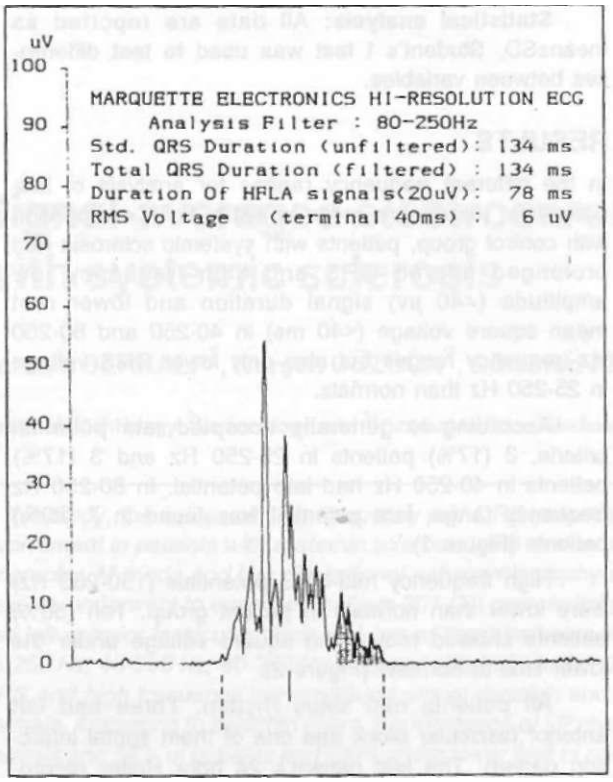


Figure 1. Late potential in a patient with systemic sclerosis

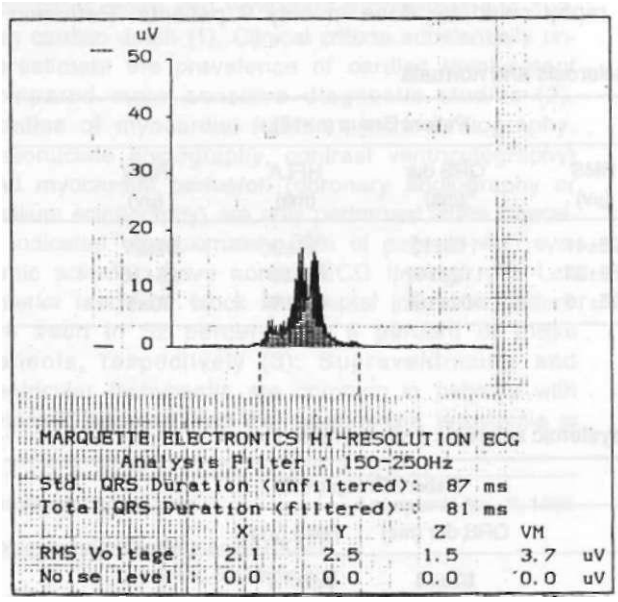
defects were found in 4 (44%) patients (3 fixed, 1 reversible). Two of them had late potential. Late potential was present only one of 5 patients with normal myocardial perfusion scintigraphy. High frequency mid-QRS potentials were low in all patients with perfusion defects and only one without perfusion defects.

Atrial premature beats were identified in two patients, they had normal signal averaged ECG potentials.

DISCUSSION

The majority of patients with progressive systemic sclerosis have clinically detectable myocardial involvement. Myocardial dysfunction is secondary to ischemic injury resulting from an abnormality of the intramyocardial circulation and injury that eventually results in fibrosis. Since overt myocardial dysfunction is associated with poor prognosis, it is hoped that earlier detection of myocardial abnormalities will permit the evaluation of therapies to treat or prevent this ominous complication (2). Intermittent ischemia has long been suspected from histopathologic studies revealing myocardial contraction band necrosis (16). Clinical physiologic studies have supported this notion, including demonstrations of high prevalence of both fixed and reversible Thallium perfusion abnormalities in patients with progressive systemic sclerosis (2). Raynaud-like reactivity of the coronary microvasculature may be responsible from ischemia (17). Pathologic series have noted patchy and small myocardial fibrosis (18). For this reason, Thallium imaging is not a reliable technique for determining the extent of myocardial fibrosis when it is present (2).

The approximately 50 percent of patients with systemic sclerosis can be expected to have normal electrocardiographic finding. This result virtually assures normal left ventricular function at rest and usually during exercise. However a normal ECG does not exclude significant cardiac involvement, since thallium perfusion abnormalities, occasionally including large



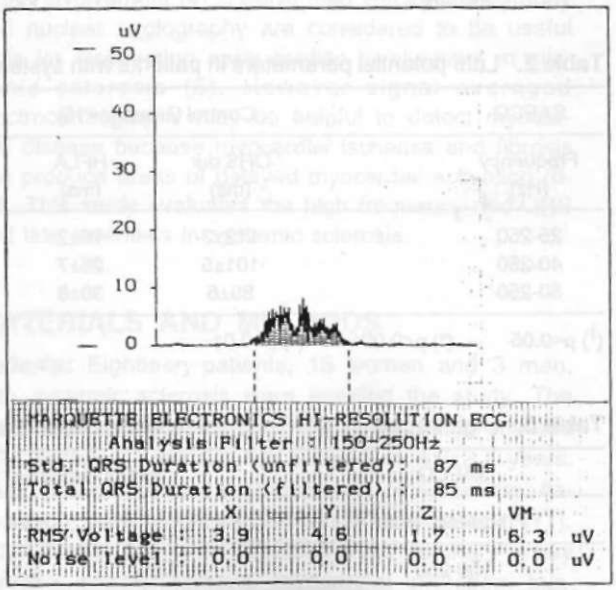


Figure 2. High frequency mid-QRS potential. A: Normal B: A patient with systemic sclerosis

perfusion defects, are commonly found in patients with normal ECG. These abnormalities appear to represent myocardial involvement which is not yet functionally significant, but may be a precursor of more advanced myocardial disease (3).

It has been shown that myocardial fibrosis produces areas of delayed myocardial activation in coronary artery disease. Low amplitude, high frequency electrocardiograms can be recorded from such areas. Signal averaged ECG detects this low amplitude high frequency electrical activities known as late potential and high frequency mid-QRS potential. Late potentials identify the risk group of malign ventricular arrhythmias and sudden death. High frequency mid-QRS potentials are related with myocardial ischemia and the extent of pathologic process. It is suggested that high frequency ECG is helpful in noninvasive diagnosis of ischemia, arrhythmia potential and prognosis (7-10,19,20).

In systemic sclerosis, pathologic changes of myocardium are similar in coronary heart disease. So, high frequency ECG may show same changes. In this way, we found significant results. Fifteen (83%) patients with systemic sclerosis had normal ECG recording but the frequency of late potential has changed from 17% to 39% according to selected filters as high frequency mid QRS potentials were low in 56% of patients. In astudy which revealed the frequency of late potentials in systemic sclerosis, abnormal signal-averaged ECG parameters (25 Hz) were found in up to 26% of patients and in up to 22% of control subjects (6). They did not examine signal averaged ECG parameters in other filters and the association of late potentials with abnormal left ventricular wall motion was suggested. In our study none subjects had late potential in control group. The presence of late potentials and decreased high frequency mid-QRS potentials were not correlated with left ventricular wall motion abnormality except one patient. However myocardial perfusion defects were seen frequently although we were not able to use thallium 201 perfusion scintigraphy in all patients.

In our sense late potentials and especially high frequency mid-QRS potentials can identify the small and patchy myocardial involvement in systemic sclerosis even in asymptomatic patients and longitudinal studies will be required to reveal the prognostic importance of these findings.

Sistemik sklerozlu hastalarda sinyal ortalamalı elektrokardiyografi

Bu çalışmada, sistemik skleroz tanısı almış hastalarda miyokard tutulumunu değerlendirmede yüksek frekanslı mid-QRS potansiyelleri (YFQRS) ve geç potansiyellerin (GP) yeri araştırılmıştır. Onsekiz hasta 12 derivasyonlu EKG, M mode ve iki boyutlu ekokardiografi ve sinyal ortalamalı EKG (SOEKG) ile incelenmiş, ancak 9 hastaya Thallium 201 (Tl) miyokart perfüzyon sintigrafisi yapılmıştır. Hastaların tümü sinüs ritminde idi. 12 derivasyonlu EKG'de, üç hastada sol ön fasikül bloğu ve bunlardan birinde ayrıca septal infarktüs örneği bulunmaktaydı. SOEKG, GP için 25-250 Hz, 40-250 Hz, 80-250 Hz ve YFQRS için 150-250 Hz frekans aralığında kaydedildi. Hastalar normallerle karşılaştırıldığında 40-250 Hz ve 80-250 Hz aralığında, filtre edilmiş QRS ve düşük amplitüdlü sinyal süresinde uzama, kare kök voltaj değerinde (RMS) azalma gösterdiler. 25-250 Hz frekans aralığında ise yalnızca RMS'de anlamlı düşme saptandı. Seçilen filtrelere göre hastaların %17 ile %39'unda GP bulundu. Hastalarda YFORS kontrol grubuna göre düşüktü ve olguların %56'sında RMS normalin altındaydı. Dört hastada Tl perfüzyon defekti görüldü. Bunların hepsinde YFORS azalmıştı ve ikisinde GP de mevcuttu. Anormal SOEKG ve Tl sintigrafisi olan bir hasta dışında, bütün olgularda ekokardiyografik inceleme normaldi. Noninvasiv bir method olan SOEKG, asemptomatik bile olsalar sistemik sklerozlu hastalarda miyokard tutulumunun saptanmasında yararlı olabilir. GP ve YFQRS'in bu hastalardaki Prognostik öneminin ortaya konulabilmesi için ileri çalışmalar gereklidir.

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