

ORIGINAL ARTICLE

COMPARISON OF VENTRICULAR LATE POTENTIALS IN PATIENTS WITH CARDIOMYOPATHY AND HEALTHY CONTROLS

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Background: Ventricular late potentials (VLPs) are low amplitude high frequency signals present in the terminal part of QRS complex detected by signal averaged ECG. They have emerged as robust tools for arrhythmia risk stratification in patients with cardiac diseases. Early detection of ventricular late potentials in patients with cardiomyopathy can help in risk stratification of ventricular arrhythmias leading to sudden cardiac death. The purpose of this study was to compare VLPs in patients with cardiomyopathy and healthy controls. **Methods:** The study was conducted in Department of Cardiac Electrophysiology, Armed Forces Institute of Cardiology, Rawalpindi. Sixty patients with cardiomyopathy (any type) along with 60 healthy controls were selected through non-probability purposive sampling. Patients meeting inclusion criteria were selected for Signal-Averaged ECG (SAECG). **Results:** Ventricular late potentials were seen in 14 (23.3%) out of 60 patients with cardiomyopathy, while only 5 (8.3%) out of 60 healthy controls demonstrated ventricular late potentials. There was significant variation in frequency of patients with ventricular late potentials as compared to healthy controls ($p=0.02$). The mean value of fQRS was 107.53 ± 37.70 in cases while 80.32 ± 24.19 in controls and the difference was statistically significant ($p<0.001$) while insignificant for RMS and LAS ($p=0.52$ and 0.87 respectively). **Conclusion:** The frequency of patients with cardiomyopathy having ventricular late potentials is significantly higher compared to healthy controls.

Keywords: Ventricular late potentials, Cardiomyopathy

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INTRODUCTION

Ventricular Late Potentials (VLPs) are low amplitude high frequency signals present in the terminal part of QRS complex that may extend up to a variable length in ST segment. They are considered as noninvasive markers of myocardial tissue damage.¹ Ventricular late potentials are perceived by a noninvasive, high resolution signal detecting technique known as signal averaged ECG.² Presence of ventricular late potentials on signal averaged electrocardiogram is considered as an evidence of underlying anatomical and electrophysiological changes which can give rise to life threatening ventricular arrhythmia.³

Cardiomyopathy is a structural and pathological condition associated with muscle or electrical dysfunction of the heart often leading to heart failure.⁴ The four major types of cardiomyopathy are dilated cardiomyopathy, hypertrophic cardiomyopathy, restrictive cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy.⁵

Scarred myocardium due to cardiomyopathy acts as an area of slow conduction. This part of myocardium is detected by signal averaged electrocardiogram as ventricular late potentials.⁶ These structural changes set a substrate for arrhythmias of different mechanisms⁷ mostly ventricular tachycardia⁸. Early detection of ventricular late potentials in patients with cardiomyopathy can help in risk stratification of ventricular arrhythmias which are the leading cause of

sudden cardiac death in these patients. The purpose of this study was to compare ventricular late potentials in patients with cardiomyopathy and healthy controls.

MATERIAL AND METHODS

This cross-sectional comparative study was carried out at the Department of Cardiac Electrophysiology, Armed Forces Institute of Cardiology (AFIC) in association with Army Medical College (AMC), Rawalpindi. An official approval was obtained prior to commencement of the study from Institutional Review Board of AFIC and Ethical review committee of AMC, Rawalpindi.

WHO sample size calculator was used to calculate sample size considering hypothesis test for two population means (two-sided test). By keeping the values of alpha as 5%, power as 80%, population standard deviation as 22 and mean difference as 8, sample size was calculated as 119. However, we used sample size of 120 in current study.

Sixty patients with cardiomyopathy along with 60 healthy controls were enrolled through non-probability purposive sampling. Cases diagnosed as cardiomyopathy by the cardiologist at Outpatient Department of AFIC were nominated for the study. Controls were healthy individuals without cardiomyopathy. Written informed consent was taken from all the patients included in the study. History and general physical examination of all the cases and controls were carried out and the individuals having known cardiac diseases or diabetes mellitus were

omitted. The selected participants were subjected to standard ECG and echocardiography to rule out bundle branch block, heart failure, hypertension and any other structural heart disease. Patients with ongoing antiarrhythmic therapy were also excluded.

Selected participants were requested to visit Electrophysiology Department of AFIC. Signal Averaged ECG of every participant was recorded by using commercially available Mortara ELI 350 ECG Machine by Mortara Instruments available at AFIC. The ELI 350 Electrocardiograph features a large, 17-inch color display, enabling a complete preview of ECG waveform. It records 12 or 15-lead resting electrocardiograph. It is a portable battery operated signal acquisition device allowing for Signal averaged ECG testing at bedside. It checks each incoming QRS complex for uniformity, aligns it with the template, add each new point to the average and increments the total number of beats. Thus, a 'signal averaged recording' is built over time.

Data was analyzed using IBM SPSS-23. Mean and standard deviation were calculated for numerical variables like age and signal averaged ECG parameters whereas frequency and percentage was calculated for categorical variables like gender and status of ventricular late potentials (present/absent). Independent samples t test was used to compare mean values of signal averaged ECG parameters between cases and controls. Chi-square test was used to compare the frequency of individuals with ventricular late potentials between cases and controls. Alpha value was kept at 0.05 at confidence level of 95%.

RESULTS

There were 89 (74.16%) male and 31 (25.83%) female participants (N=120) with the mean age of 45.01±15.75 years. Among cases, there were 43 (71.66%) male and 17 (28.33%) female patients with mean age of 51.25±14.45 years whereas among controls there were 46 (76.66%) male and 14 (23.33%) female participants with mean age of 38.77±14.56 years.

The mean values of various parameters of signal averaged ECG (SAECG) were compared between cases and controls (Table-1). The difference of mean values of SAECG was statistically significant for fQRS ($p<0.001$) but insignificant for RMS and LAS ($p=0.52$ and 0.87 respectively). The mean noise level during recording of ventricular late potentials was 0.21±0.09 μV for cases whereas for controls it was 0.19±0.05 μV and the difference was statistically insignificant ($p=0.61$). Frequency of individuals with and without ventricular late potentials was also compared between cases and controls as shown in Table-2.

Ventricular late potentials were present in 14 (23.3%) cases and 5 (8.3%) controls and the difference was statistically significant ($p=0.02$). Difference in

frequency of individuals with ventricular late potentials as well as without ventricular late potentials between cases and controls (14 versus 5 and 46 versus 55) was significant ($p=0.02$).

Table-1: Comparison of mean values of signal averaged ECG (SAECG) between cases and controls

| SAECG variable | Cases | Controls | p |
|----------------|--------------|-------------|---------|
| fQRS | 107.53±37.70 | 80.32±24.19 | <0.001* |
| RMS | 26.08±15.30 | 31.33±23.24 | 0.52 |
| LAS | 34.32±17.50 | 32.02±11.36 | 0.87 |

*significant

Table-2: Frequency of individuals with and without ventricular late potentials (VLP)

| Group | Present | Absent | p |
|----------|------------|------------|-------|
| Cases | 14 (23.3%) | 46 (76.7%) | 0.02* |
| Controls | 5 (8.3%) | 55 (91.7%) | |

*significant

DISCUSSION

Frequency of patients with cardiomyopathy having ventricular late potentials was high as compared to healthy controls. Cases with ventricular late potentials were 14 (23.3 %) out of 60, while only 5 (8.3%) out of 60 healthy controls showed ventricular late potentials. This difference was significant ($p=0.02$). This could facilitate in identification of patients with cardiomyopathies that are at risk of fatal arrhythmias. There is substantial evidence regarding slowing of cardiac impulse due to structural inhomogeneity which is the basis of prolonged filtered QRS complex duration in patients of cardiomyopathy.⁹ This structural inhomogeneity leads to the genesis of ventricular arrhythmias hence establishing a link between ventricular late potentials and arrhythmias.¹⁰

A study was conducted by Ohnishi *et al*¹¹ in Japan evaluating the value of signal averaged ECG in patients with cardiomyopathy. The mean value of fQRS complex in cardiomyopathic patients they studied was 111.4±28.9 ms which was nearly the same as our study. This similarity may be attributed to the fact that mean age of their study group (51.25±14.4 years) was approximately the same as ours. In another study by Marques *et al*¹², ventricular late potentials were checked in a population of 487 healthy individuals in France. The mean value of fQRS in their study group was 97±12 ms, mean value of LAS was 32±10 ms and RMS was 39±27 μV . In our study, mean value of fQRS was 80.32±24.19 ms, RMS was 31.33±23.24 μV while mean value of LAS was nearly same as ours, i.e., 32.02±11.36 ms. The difference in the mean values between two studies may be because in our study both male and female participants were included whereas they enrolled only male subjects. The number of total subjects also varied between the two studies, as there were 487 total subjects in Marques *et al*¹² study while only 60 patients were enrolled in our study.

The frequency of individuals having ventricular late potentials was found to be significantly different among cases and controls of our study. Our results were almost synchronous with a study conducted by Adachi *et al*¹³. Out of 58 cardiomyopathy patients they studied, 12 (20.6%) had ventricular late potentials which was almost similar to the results of our study where 14 patients (23.4%) out of 60 were found to have ventricular late potentials. In contrast to our study, Khan *et al*¹⁴ demonstrated the frequency of ventricular late potentials in healthy population. Out of 37 individuals only 1 (2.7%) had ventricular late potentials whereas in our study 5 (8.3%) individuals out of 60 had ventricular late potentials. This contrast in the frequency may be due to strict healthy criteria used by Khan and his colleagues. Firstly, they used ECG, ETT and angiography to label healthy individuals whereas we used only routine tests and echocardiography. Secondly the mean age of participants in Khan *et al*¹⁴ study was 26±5 years while mean age of healthy controls in our study was 38±14 years. This difference in mean ages may have played its part in this disparity of results.¹⁴

A study was conducted by Poll *et al*¹⁵ on 41 cardiomyopathic patients evaluating ventricular late potentials. Out of twelve of their patients presenting with ventricular arrhythmias 83% had ventricular late potentials. Mancini *et al*¹⁶ recruited 114 patients with cardiomyopathy and did follow-up for 5 years. Out of their 20 patients with abnormal signal averaged ECG, 4 patients developed ventricular tachycardia, 5 had sudden cardiac death and 2 died of progressive heart failure. We were unable to follow the cases with ventricular late potentials for arrhythmic events due to time restriction, but with abundant confidence from literature, can relate the presence of ventricular late potentials with vulnerability to fatal arrhythmias.

Cardiomyopathy mostly occurs in old age patients. Preferably, age matched controls must have been taken in the study but due to time constraints it was difficult to find age matched controls.

CONCLUSION

Frequency of patients with cardiomyopathy having VLPs was significantly higher compared to controls. The presence of VLPs in patients with cardiomyopathy recognizes the vulnerability of these patients to ventricular arrhythmias and sudden cardiac death. VLPs assessment can be used as a non-invasive tool for stratification of high risk patients.

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