Comparison of Ventricular Late Potentials in Patients with Ischemic and Non-Ischemic Cardiomyopathies

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Abstract

Objective: Our study aim was to compare the ventricular late potentials in patients with ischemic and non-ischemic cardiomyopathy.

Method: It was a comparative cross sectional study conducted at Cardiac Electrophysiology unit in Armed Forces Institute of Cardiology, Rawalpindi from February 2019 to August 2019. Thirty individuals with ischemic cardiomyopathy as well as thirty with non-ischemic cardiomyopathy were nominated through non-probability purposive sampling. Patients with hypertension, bundle branch block, diabetes mellitus, heart failure, stroke and those on antiarrhythmic therapy were omitted from the study. Mortara ELI 350 Electrocardiograph was used to attain Signal Averaged ECG (SAECG). Data was analyzed using SPSS-23.

Results: Total sixty subjects were recruited. Out of these, 30 were diagnosed cases of Ischemic cardiomyopathy and 30 were diagnosed cases of non-ischemic cardiomyopathy. Among those with ischemic cardiomyopathy 8(26.7%) had VLPs, while 6 (20.0%) non-ischemic patients had VLPs present. This difference was statistically insignificant. VLPs were absent in 22 (73.3%) patients with ischemic cardiomyopathy and 24 (80%) patients with non-ischemic cardiomyopathies.

Conclusion: As proven through literature, ventricular late potentials have a higher negative predictive value in comparison to their positive predictive value. Hence their absence in signal averaged ECG along with other cardiac tests helps us screen high risk population for ventricular arrhythmias.

Keywords: Ventricular late potentials, ischemic cardiomyopathy, non-ischemic cardiomyopathy, Signal Averaged ECG.

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Introduction

Cardiovascular diseases have posed high burden on health care system of Pakistan. In accordance to the Universal health coverage report Pakistan 2019, cardiovascular diseases have shifted from 5th in year 2000 to 2nd in year 2019 as disease ranking in Pakistan.[1] Latest WHO data published in 2020 stated coronary heart disease deaths in Pakistan have reached 16.49% of total deaths.[2] Hence risk stratification is crucial to decrease incidence of sudden cardiac death.

The yearning to find non-invasive cardiac screening markers from arrhythmogenic sudden cardiac death in increasing by the day. Signal Averaged ECG (SAECG) is being used universally as a non-invasive technique to record micro voltage changes in the electrical impulses of heart by uncovering high frequency low voltage activity at end of QRS complex. These electrical activities are labelled as ventricular late potentials. SAECG can help identify at risk individuals for malignant ventricu-

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lar arrhythmias and help prevent sudden cardiac death.[3]

Delayed conduction through the diseased myocardium leads to altered electrical activity that appears as positive potential at end of QRS complex on SAECG. SAECG is specialized non-invasive high resolution ECG machine. Appearance of VLPs on SAECG may indicate underlying anatomical and electrophysiological changes that may contribute to chance of having fatal ventricular arrhythmias in susceptible individuals. VLPs arise as a results of slow activation and conduction from diseased myocardium leading to delayed ventricular depolarization and as a result predisposes to reentry arrhythmias. Their amplitude is often too small to show on normal ECG. When multiple QRS complexes (consecutive 250 QRS complexes) are averaged while filtering random noise, late potentials show up. Such a recording is called signal averaged ECG.[4,5]

Anatomical disturbances like ischemic, dilated or hypertrophic cardiomyopathies and physiological disturbances like abnormalities in distribution and function of cardiac gap junctions contribute to the pathophysiology of VLPs. Ventricular arrhythmias are common in patients with cardiomyopathies. They may range from asymptomatic ventricular premature beats, sustained ventricular tachycardia or ventricular fibrillation ending in sudden cardiac death. Dysfunctional alteration in structure or conductive pathway of myocardium leading to heart failure are categorized as cardiomyopathies. They can be genetic myofibrillar disarray or acquired i.e. secondary to disease. One of the most common acquired cause is ischemic cardiomyopathy where coronary artery disease leads to impaired left ventricular function. Here the scarred myocardium acts as area of slow conduction. This structural change acts as substrate for arrhythmias mainly ventricular tachycardia. Moreover, myofibrillar disarray or gap junction dysfunction results in histological changes rendering a suitable medium for reentry arrhythmias. In non-ischemic cardiomyopathies, causes like viral myocarditis, drug reactions, inflammation, autoimmune reactions, amyloid and sarcoid infiltrations are some of the leading causes that predispose a patient to ventricular arrhythmias.[6]

VLPs assessment in signal-averaged ECG offers a rational and low-cost solution to an otherwise fatal undetected ventricular arrhythmia. Our study was designed to appraise Ventricular late potentials in patients with two different types of cardiomyopathy i.e. ischemic and non-ischemic cardiomyopathy. Outcomes of the study will not only help isolate patients endangered of developing ventricular arrhythmias but also impart understanding about the conceivable pathophysiologic mechanism for the deranged electrical activity within their myocardium. Furthermore, they can be subjected to additional investigations for enhancement of arrhythmia risk and for starting appropriate therapeutic measures in order to avoid sudden cardiac death.

Material and Method

It was a comparative cross sectional study conducted at Cardiac Electrophysiology unit in Armed Forces Institute of Cardiology, Rawalpindi from February 2019 to August 2019. Age and gender matched thirty patients with non-ischemic cardiomyopathy and thirty with ischemic cardiomyopathy patients were recruited. The probability purposive sampling was applied to recruit patients. Diagnosed cases of ischemic and non-ischemic cardiomyopathy were included in the study after taking written consent. Brief history, general physical examination, standard 12 lead ECG and echocardiogram were implied, excluding those having cerebrovascular accidents, bundle branch blocks, heart failure, systemic arterial hypertension, diabetes mellitus and anti-arrhythmic drugs. The chosen individuals were requested to come to electrophysiological department of AFIC. Signal averaged ECG (SAECG) using Mortara ELI 350 machine was obtained for each patient. IBM SPSS version 23 was employed to analyze the data. Mean and standard deviation were estimated and independent t-test was applied to compare mean values of signal averaged ECG parameters between non-ischemic and ischemic cases. Chi-square test was employed to compare frequency of ventricular late potentials in non-ischemic and ischemic patients. Confidence interval of 95% with a p-value of 0.05 was considered significant.

Results

Out of 60 selected individuals, 30 (50%) had diagnosed non-ischemic and 30 (50%) had ischemic cardiomyopathy. Among the ischemic, 7 (23%) were females and 23 (76.7%) were males. Their mean age was 51.27 ± 12.65 years. Among the non-ischemic, 10(33.3%) were females and 20 (66.7%) were males. Their mean age was 51.23 ± 16.28 years. Comparison of frequency of presence or absence of ventricular late potentials among both groups is shown in Table 1. Out of 30 individuals with ischemic cardiomyopathy 8 (26.7%) had VLPs, while 6 (20.0%) non-ischemic patients had VLPs. This difference was statistically insignificant. Whereas, VLPs

were absent in 22 (73.3%) patients with ischemic cardiomyopathy and 24 (80%) patients with non-ischemic cardiomyopathies, as shown in Table 1. Table 2 shows comparison of various specification of Signal Averaged

Table 1: *Frequency comparison of individuals with and without ventricular late potentials between ischemic and non-ischemic cardiomyopathies*

		VLPs		p-value
		Present	Absent	
Group	Ischemic cardiomyopathy	8 (26.7%)	22 (73.3%)	0.54
	Non-ischemic cardiomyopathy	6 (20.0%)	24 (80%)	

Table 2: *Comparison of SAECG variables between ischemic and non-ischemic cardiomyopathies*

		Mean ± SD		p-value
		Ischemic cardiomyopathy	Non-ischemic cardiomyopathy	
SAECG variable	fQRS	105.07±37.34	110.00±38.52	0.62
	RMS	21.73±12.32	30.43±16.89	0.02*
	LAS	37.00±20.83	31.64±13.20	0.24

**p-value significant (<0.05)*

ECG between patients with ischemic and non-ischemic cardiomyopathies. The difference was significant only for mean values of RMS (p=0.02).

SAECG parameters:- fQRS: filtered QRS, LAS: Low amplitude signals, RMS: Root mean square.[7]

Discussion

Being a multifactorial disease, causes of cardiomyopathy range from genetic abnormalities to those secondary to myocardial ischemia and other cardiovascular diseases. They can be broadly classified into ischemic and non-ischemic cardiomyopathies. In our study we divided the patients into two categories based on the same classification and assessed them for ventricular late potentials' presence or absence. Presence of VLPs were slightly lower in ischemic patients in comparison to non-ischemic but the difference was statistically insignificant (p= 0.54). As shown in the table, VLPs were absent in 73.3 % (n=22) of ischemic and 80% (n= 24) of the non-ischemic among our study population. As shown through literature, VLPs have a greater importance due to their negative predictive value.i.e. if VLPs are absent in patients, indicating decreased likelihood of future arrhythmic episode. Santangeli P states in his article that although VLPs have a weakness regarding their low positive predictive values particularly when they are used as a single diagnostic tool, but their negative predictive value is very high making them an affordable and practical tool for screening of future arrhythmic events.[5,8] An international research mentioned 94.1% sensitivity, 72.3% specificity, 13.6% positive predictive value and 73.2% negative predictive value of ventricular late potentials with sudden cardiac death in 385 patients.[9] Bobkowski W conducted a follow-up research on children with mitral valve prolapse and looked for ventricular late potentials. He found out that sensitivity of VLPs was low i.e. 52% (ppv of 50%) but specificity was high i.e. 90% (npv of 91%) for development of ventricular tachycardia in children with mitral valve prolapse. He concluded that SAECG alone is a specific but not sensitive tool for prediction of development of ventricular tachycardia in these diseased children.[10] Middlekauff et al evaluated VLPs in 62 patients, 31 with ischemic and 31 with non-ischemic cardiomyopathy. He assessed efficiency of multiple non-invasive tools to screen out patients who were at high risk of developing ventricular arrhythmias. He settled that existence of ventricular late potentials may distinguish between occurrence and absence of ventricular tachycardia irrespective of the cardiomyopathy type.[4,9] Mancini et al recruited 114 patients having cardiomyo-pathy and observed them up for 5 years. He concluded that among 20 patients having abnormal SAECG, 4 developed ventricular tachycardia, 5 ended up with sudden cardiac death and 2 died of progressive heart failure.[4,11] Amino et al assessed the value of signal averaged ECG in Japanese patients suffering from cardiomyopathy. He calculated the mean value for fQRS complex as 111.4± 28.9 ms nearly similar to our study (107.53±37.7 ms). This could be ascribed to the fact that their patients' mean age was closer to ours i.e. 51.25 ±14.4 years and 55±6.7 years, sequentially.[12] In another study by Marques and his colleagues, checked ventricular late potentials in 487 healthy French males. Their mean fQRS value came out to be 97±12 ms, mean LAS value was 32±10 ms and mean RMS value was 39±27 µV. Contrary to that, our mean fQRS value was 80.32±24.19 ms, mean RMS value was 31.33±23.24 µv and mean LAS value was 32.02±11.36 ms. This difference could be attributed to the fact that our study comprised of both genders while our total number of patients were also considerably less as compared to Marques study.[13]

Our study in contemporization with other studies as mentioned above shines emphasis on the practical employment of signal averaged ECG and ventricular

late potentials as a low cost empirical non-invasive screening tool for arrhythmia risk assessment.

Conclusion

Ventricular late potentials assessment through a portable bed side ECG machine presents cardiologists with an affordable, practical and easy to manage screening tool for identification of possible electrophysiological substrate that may lead to life threatening arrhythmias. Negative predictive values of VLPs render them their strength whereas when positive, they act as an adjunct for risk stratification of arrhythmias in potential at risk patients.

Conflict of interest *None*

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Authors Contribution

HA: Conceptualization of Project
HA, SN: Data Collection
AA, HA: Literature Search
MI, HA: Statistical Analysis
MA: Drafting, Revision
HA, AA, SN: Writing of Manuscript