

Association between Frontal QRS-T Angle on electrocardiography and early mortality in patients with heart failure

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ABSTRACT

Background:

Local study regarding association between frontal QRS-T Angle on electrocardiography and mortality may help develop guidelines to reduce morbidity and mortality in heart failure.

Objective: To determine the association between Frontal QRS-T Angle on electrocardiography and mortality in patients with heart failure.

Material and Methods:

A Prospective Cohort Study was conducted from January 2021 to December 2022 in different cardiology departments of Punjab province. A total of 672 consecutive patients i.e. 336 with high QRS T Frontal angle (group A with angle > 90°) and 336 with normal QRS T Frontal angle presenting with heart failure to outpatient and emergency department were matriculated for the study. All patients were followed for any adverse event i.e. mortality for three months by telephone on first of every month. Presence of diabetes & hypertension and history of smoking were treated as effect modifier.

Results: 672 patients were included in our sample with mean age of 57.86 ± 5.8 years. 466 patients (69.3%) were male while remaining 206 patients (30.7%) were female. 145 patients (21.6%) died within three months. 110 patients with raised QRS T frontal angle died within three months while only 35 patients with normal QRS T frontal angle died within three months. Diabetes, hypertension, smoking, male gender and age were significant contributor to mortality.

Conclusion:

It is concluded that there is association of raised QRS T frontal angle ($> 90^\circ$) with mortality in patients with heart failure. QRS T frontal angle can be used as cost effective sign of increased risk of mortality in patients with heart failure.

Keywords:

Heart Failure, Mortality, QRS T frontal angle, Diabetes, Smoking

INTRODUCTION

Heart failure (HF) is a major epidemic and is associated with considerable morbidity and mortality.(1-4) Prediction of mortality and morbidity is a major quest for the treating cardiologist to stratify the patient who are more at risk.(1) Different parameters are so far used. One of them is spatial QRS-T angle which has surfaced to be the strongest electrocardiographic predictor of cardiovascular death.(1, 4-7) Its equivalent, the frontal QRS-T angle is easily accessible from the surface ECG and is equivalent to spatial QRS-T angle in term to predict the mortality rate and sudden cardiac death in the general population, also for incidence of cardiovascular disease in women. (1, 5, 6, 8) The frontal QRS-T angle has also been shown to be a predictor of arrhythmic events in patients with reduced left ventricular function.(5, 9, 10) In different studies it is shown that there is an association between increasing QRS-T angle and increased hospitalization for cardiac cases, overall mortality rate and reduced LV function.(4, 6, 9, 11-13)

Objectives of this study is to determine the association between Frontal QRS-T Angle on electrocardiography and mortality in patients with Heart Failure. Rationale of this study is that there came out a strong difference between genders and so it can be proposed that there will be a difference in ethnicity too.(5-7) The available studies are for Caucasians (one ethnic group) only and no study is available addressing the ethnic differences. The current study help establish the association between mortality and QRS T angle. The frontal QRS-T angle, an approximation of the spatial QRS-T angle is an easily obtainable electrocardiographic parameter. If it is validated in our population too, we may use it as a cost-effective indicator of severity of disease as greater angle shows a greater dispute between repolarization and depolarization signifying abnormal and heterogeneous ventricular repolarization. These abnormalities end up with greater risk for the patients to have more ventricular arrhythmias and cardiovascular events. We may expedite our efforts to reduce fatal events thus benefiting the patients.

Participants & Methods:

A Prospective Cohort Study was done in Departments of cardiology in different institutions of Punjab. Using non-probability consecutive/ purposive sampling, a sum of 672 successive patients i.e. 336 having high QRS T Frontal angle (group A with angle $> 90^\circ$) and 336 with normal QRS T Frontal angle presenting with heart failure, after successively meeting the inclusion and exclusion criteria and taking the informed consent, were enrolled for the study. A proforma was filled for each patient by researcher himself, containing all variables of interest i.e. age, sex, date of diagnosis of heart failure and QRS T angle. Duration of heart failure, Presence of diabetes, obesity, hypertension and history of smoking were recorded additionally to control for confounding and effect modification. All patients were followed for any adverse event i.e. mortality for three months by telephone on first of every month. Presence of diabetes & hypertension and history of smoking were treated as effect modifier. Electrocardiographic Frontal QRS-T Angle was defined as the angle between the frontal QRS and T wave electrical axes on electrocardiography. It was labelled increased if it is $> 90^\circ$. (1, 4) Heart Failure was defined as presence of all of these symptom's dyspnea, paroxysmal nocturnal dyspnea, orthopnea, pallor, diaphoresis and tachycardia on history and presence of rales, third heart sound, elevated JVP and fine crept on clinical examination. (3, 14)

Patients with heart failure according to operational definition of both gender with age from 40 to 70 years were included. Availability of QRS T frontal angle on Electrocardiography was also a prerequisite for inclusion. Patients with abnormal pattern on ECG like LGL syndrome, ascertained cases of chronic kidney disease and chronic pulmonary disease finalized by their history and lab investigations, acute or chronic liver disease determined by history and medical record, Individuals with auto-immune diseases determined by history and medical record, patients who refused to consent for study participation and patients with right ventricular hypertrophy diagnosed on ECG were excluded.

Collected data was analyzed using SPSS 19.0. Continuous variables like age, duration of heart failure was illustrated as standard deviations and mean, whereas categorical variables like history of smoking, hypertension, presence of diabetes and deaths were described as frequencies and percentages. Difference in mortality in both groups was compared using chi square or Fischer exact test (if count in any cell is less than 5). Data was stratified for Presence of diabetes &

hypertension and history of smoking and post stratification difference of mortality in both groups was validated using chi square test. A p value < 0.05 was taken as significant.

RESULTS

We enrolled 672 patients in our study having mean age of 57.86 ± 5.870 ranging from 43 to 70 years of age. Among them 466 patients (69.3%) were male while remaining 206 patients (30.7%) were female. Sampled population grouped into two categories based on normal and raised QRS T frontal angle. 336 individuals (50%) were with normal QRS T frontal Angle while remaining half 336 (50%) were in Raised QRS T frontal angle group. 145 patients (21.6%) died within three months while rest of 527 patients (78.4%) survived. 245 patients (36.5%) showed positive results for diabetes whereas 427 patients (63.5%) didn't show diabetes. 228 patients (33.9%) were smoker whereas remaining 444 patients (66.1%) were not actively smoking. The sample population (n=672) was divided into two groups on the basis of their ages. 80 patients (11.9%) were either 50 years of age or below and remaining 592 patients (88.1%) were above 50 years. (Table 1)

We cross tabulated QRS T frontal angle with mortality in three months and applied Pearson Chi Square test the results were significant ($p= 0.00$). 110 patients with raised QRS T frontal angle died within three months while only 35 patients with normal QRS T frontal angle died within three months. (Table 2)

When we cross tabulated age groups with mortality in three months, it resulted in non-significance ($p=0.940$) in term of p value. 17 patients who died within three months were either 50 years of age while remaining 128 were above 50 years. To find out the rate of distribution of mortality in three months in female and male we cross tabulated gender with mortality, the results were significant ($p= 0.020$). 112 male and 33 female patients died within three months. When we cross tabulated diabetes with mortality in three months the results were significant ($p= 0.006$). 67 diabetic patients died within three months while remaining 78 patients were non-diabetic. When we cross tabulated smoking with mortality in three months the results were significant ($p= 0.00$). 107 smokers died within three months while remaining 38 who died within three months were non-smoker. When we cross tabulated hypertension with mortality in three months the results were significant ($p= 0.000$). 104 patients with hypertension died within three months while remaining 41 patients who died within three months were not hypertensive. (Table 3)

Table I: Baseline characteristics of sample population (n=672)			
Age groups	50 years & below	80	11.9
	Above 50 years	592	88.1
Gender	Male	466	69.3
	Female	206	30.7
Diabetes	Yes	245	36.5
	No	427	63.5
Smoking	Yes	228	33.9
	No	444	66.1
Hypertension	Yes	252	37.5
	No	420	62.5
Early Mortality	Yes	145	21.6
	No	527	78.4

Table 2: Cross tabulation between QRS T Frontal Angle and Early Mortality				
		Early Mortality		Total
		No	Yes	
QRS T Frontal Angle	Normal QRS T Frontal Angle	301	35	336
	Raised QRS T Frontal Angle	226	110	336
Total		527	145	672
Using Pearson Chi-Square, p value < 0.001 (Significant)				

Table 3: Cross tabulation between baseline characteristics & Early mortality				
		Early Mortality		P value
		Yes	No	Using Chi square
Age groups	50 years & below	17	63	0.09
	Above 50 years	128	464	
Gender	Male	112	354	0.02
	Female	33	173	
Diabetes	Yes	67	178	0.01
Smoking	Yes	107	121	0.01
Hypertension	Yes	104	148	0.01

DISCUSSION

The frontal QRS-T angle, an approximation of the spatial QRS-T angle is an easily obtainable electrocardiographic parameter.(3, 14, 15) If it is validated in our population too, we may use it as a cost-effective indicator of severity of disease as greater angle represents a greater dispute between repolarization and depolarization signifying abnormal and heterogeneous ventricular repolarization. These deformities put the patients at risk of developing more cardiovascular events and ventricular arrhythmias.(4, 5) We may expedite our efforts to reduce fatal events thus benefiting the patients.

110 patients with raised QRS T frontal angle ($> 90^\circ$) had died within three months while only 35 patients with normal QRS T frontal angle died within next three months. Results were significantly different ($p < 0.001$) when we applied chi square test. This implies that QRS T frontal angle can be used as an indicator of increased risk of mortality. This can be used to triage the patients and may be stratified for early and prompt treatment. 672 patients were included in our sampled population with mean age of 57.86 ± 5.87 ranged from 43 to 70 years of age. Age distribution of included patient shows that in our population, the group of younger ones with a mean age of 57 years have greater chances of heart failure. This value is different in developed countries where the age is above 60 years. Our mean age which is 43-70 years is alarming us to have a major preventive program which would help us to reduce the mortality rate in young ones having risk of coronary artery disease. In one study overall survival during the follow-up period came out 83%. (6, 7)

The study included more male patients which may be because of estrogenic protection of female which reduces occurrence of myocardial infarction in them. The male patients were comprised of almost $3/4^{\text{th}}$ of the whole population. Mortality came out significantly high as 145 patients (21.6%) out of 672 patients died within three months while rest 527 patients (78.4%) survived. 245 patients (36.5%) were diabetes, which showed greater frequency of heart failure in them. Similarly, there was a greater ratio of smokers. This is also a sign of collapse of different smoking preventive programs as 228 patients (33.9%) were smokers. When we cross tabulated age groups with mortality, 17 patients who died within three months were 50 years of age while rest 128 patients were above 50 years. When we cross tabulated diabetes with mortality in three months the results were significant ($p = 0.006$). 67 diabetic patients died within three months while remaining 78 patients were non-diabetic.

Our result also revealed that male patients are at greater risk of death as compared to their counterpart. When we cross tabulated hypertension with mortality in three months, the results were significantly different ($p= 0.000$). 104 patients who died within three months were hypertensive while remaining 41 patients who died within three months were not hypertensive.

Similarly smoking increased the risk of mortality in these patients with QRS T frontal angle ($> 90^0$).

Conclusion:

It is concluded that there is association of raised QRS T frontal angle ($> 90^0$) with mortality in patients with heart failure. QRS T frontal angle can be used as cost effective sign of increased risk of mortality in patients with heart failure. Further research in this regard may be helpful.

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