Ethnic Variation in Prevalence of End QRS Notching and Slurring in Apparently Healthy Populations

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Abstract

The presence of end QRS notching or slurring (a characteristic of early repolarization) has been the subject of much recent study with new guidelines being developed for its identification. The aim of the present study was to examine the prevalence of end QRS notching or slurring in apparently healthy populations of different races.

New criteria for the detection of end QRS notching and slurring were implemented in the Glasgow resting ECG analysis program. 4223 ECGs from Caucasian, Black, Chinese and Indian cohorts were analysed and the interpretations examined for the presence of end QRS notching and slurring. Counts were obtained and categorised by age, gender and race. The site of the notching/slurring, e.g. inferior, etc. was also recorded and analysed. Comparisons of proportions were made using a Chi-squared test.

There is a high prevalence of end QRS notching/slurring in normal populations with a significantly higher prevalence in Blacks. The prevalence in Black women, and in particular, in young Black women, was significantly higher than in other races. End QRS notching/slurring was most evident in the inferior leads.

1. Introduction

In the last few years, there has been considerable interest in the clinical significance of notching or slurring at the end of the QRS complex which is a characteristic of early repolarization (ER). It is known that end QRS notching/slurring is associated with idiopathic ventricular fibrillation [1] and it has been postulated that the presence of certain patterns of ER may increase the risk of arrhythmia if there is another proarrhythmic trigger [2]. While the prevalence of classically defined ER has been widely studied, the lack of an agreed definition of end QRS notching and slurring has resulted in different study groups using different criteria when examining the prevalence of this phenomenon.

Studies have been carried out on local populations in different parts of the world [3,4] and these have relied on researchers identifying the pattern by observation. Following discussions and symposia, new guidelines are being developed for its identification by one of the authors (PWM) and others active in this area. The aim of the present study is to use an automated detection method to examine the prevalence of end QRS notching and slurring as previously defined in this lab by Clark et al [5] in apparently healthy populations of different races.

2. Method

In an earlier study carried out to determine the feasibility of automatically measuring end QRS notching or slurring, logic was implemented in the Glasgow resting ECG program (Glasgow program) [6] to detect and measure notches and slurs at the end of QRS complexes [5].

The program was enhanced to report end QRS notching or slurring in the diagnostic statements if the pattern was present in inferior lead pairings (II, aVF or aVF, III), lateral lead pairing (aVL,I) or anterolateral lead pairings (V4,V5 or V5,V6), and if there was no evidence of infarction. The amplitude of the notch or slur, measured at the peak of the notch or start of the slur, required to have a minimum amplitude of 0.1mV (Figure 1).

Four cohorts of ECGs were analysed using the Glasgow program. They were from Caucasian, Nigerian,

Table 1. Numbers of males and females in each cohort. (With, in brackets, mean age and standard deviation for males and females and overall age range for total.)

	Male (Age in years)	Female (Age in Years)	Total (Age range in years)
Caucasian	859(39±12)	637(35±13)	1496 (18 to 82)
Black	782(43±13)	479(43±15)	1261(20 to 87)
Chinese	248(43±15)	255(43±14)	503 (19 to 80)
Indian	670(36±14)	293(36±16)	963 (18 to 83)
Total	2559	1664	4223

Chinese and Indian populations. There were 4223 ECGs analysed of which 1664 were recorded in females. The age range was 18 to 87 years. A detailed breakdown is given in Table 1. The data had been gathered at different times in the last 30 years [7,8,9,10]. For all subjects, the ECGs were recorded at a sampling rate of 500 samples per second. The selection of healthy volunteers for the Caucasian, Nigerian and Chinese cohorts, was made through examination by a physician or screening by medical staff. The subjects in the Indian cohort were selected on the basis of completed medical questionnaires.

End QRS Notch

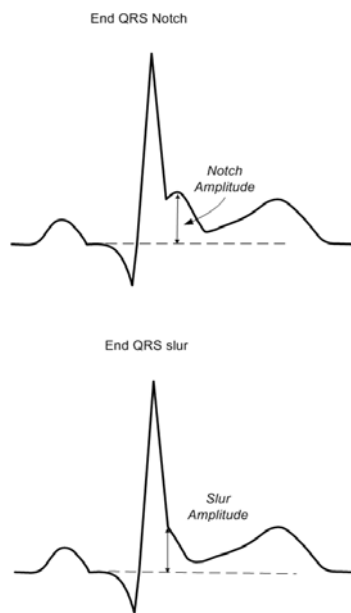Notch Amplitude

End QRS slur

Slur Amplitude

Figure 1. Measurement of amplitude for end QRS notching and slurring.

While the collection of the data was widespread geographically and over a long period of time, all the data was re-analysed in 2014 using the same version of the Glasgow program. The interpretations were examined for the presence of the diagnostic statement indicating the presence of end QRS notching or slurring. The number of occurrences was categorised by age, gender and race. The site of the notching or slurring, i.e. if it was in the inferior, lateral or anterior leads or any combination, was also recorded. Comparisons of proportions were made using a Chi-squared test.

3. Results

The prevalence of the end QRS notching/slurring pattern in the Caucasian, Black, Chinese and Indian data sets was 21%, 26%, 20% and 19% respectively. There was a significant difference between the prevalence in

Blacks and each of the other races: between Blacks and Caucasians ($p = 0.0023$), Blacks and Chinese ($p=0.0096$) and Blacks and Indians ($p=0.0001$). There was no significant difference between the other pairings e.g. Caucasians and Chinese etc.

There was a higher proportion of cases with notching/slurring pattern in males than females in all groups (Table 2).

Table 2. Proportion of cases with end QRS notching/slurring by cohort and gender.

Cohort	Males	Females
Caucasian	24.56%	16.80%
Black	26.47%	25.68%
Chinese	23.79%	15.69%
Indian	21.79%	13.65%

There was a significant difference between the prevalences for females and males in the Caucasian, Chinese and Indian cohorts ($p < 0.05$) but not in the Black cohort. When the prevalence between races was examined by gender, a significant difference between Blacks and each of the other races was found in females. For males, the only significant difference was between Blacks and Indians.

The proportions of cases by gender and age-group for each of the 4 cohorts are shown in figure 2.
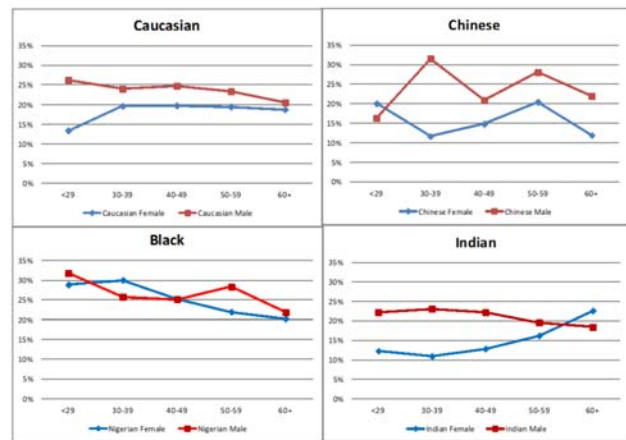

Figure 2. The proportions of cases by gender and age-group for each of the 4 cohorts. (Data for males in red, females in blue).

In the Black, Caucasian and Indian cohorts the proportions become close in value in the oldest age-group.

For females aged less than 40 years, the prevalence of end QRS notching/slurring in the Black population was 28% which was significantly higher ($p < 0.05$) than in the other cohorts where the prevalence for Caucasian,

Chinese and Indian was 15%, 15% and 12% respectively.

For all races and both genders, most occurrences of end QRS notching/slurring were in the inferior leads (Table 3).

Table 3. Percentage of cases with end QRS notching/slurring by site, race and gender.

	Caucasian		Black		Chinese		Indian	
	F	M	F	M	F	M	F	M
Inferior	9	14	12	12	11	14	10	14
lateral	4	5	6	4	1	3	0	1
Antlat	2	3	4	6	2	4	1	3
Mixed	1	3	3	4	1	3	2	3

4. Discussion

We found that there is a high prevalence of end QRS notching/slurring in normal populations. In the four cohorts, the prevalence was approximately 20%. This is in line with the prevalence of "classical" ER pattern (i.e. defined by ST segment elevation) reported by Ilkhanov et al [11] in a study of young adults.

The prevalence of notching/slurring in older age groups was also around the 20% mark. Figure 3 shows
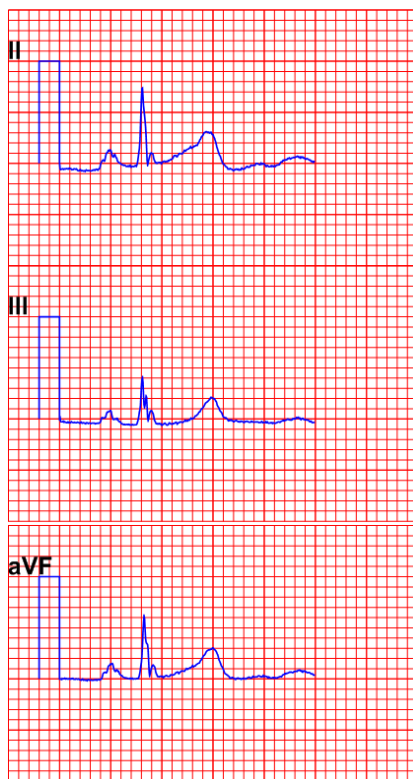

Figure 3. End QRS notching in the ECG of a 66-year old Nigerian man.

evidence of notching in the inferior leads in an ECG recorded on a 66-year old Nigerian man.

The high prevalence found in the 60+ years age-group is in contrast to the prevalence of classical ER found in the older age-groups in the Ilkhanov study (6%) and also to that measured in the Tikkanen study of a Finnish middle-aged population (5.3%) [4]. In the Ilkhanov study[11], the subjects were followed over time and it was found that the prevalence of classical ER decreased as the individuals got older. This highlights the different behaviour of the newly defined ER (1,13) and classically defined ER. In the Tikkanen study [4], paper copies of the ECGs were used and the difference in prevalence may be partly due to automated versus manual measurements.

Another explanation of the differences in prevalences may be that the automatic detection of slurring is too sensitive. Although a minimum angle of deflection of the onset of the slur from the vertical has been set in the criteria, there are still cases where a slur detected using the automatic procedure might be considered insignificant if a paper copy were being examined visually for a decision (Figure 4).
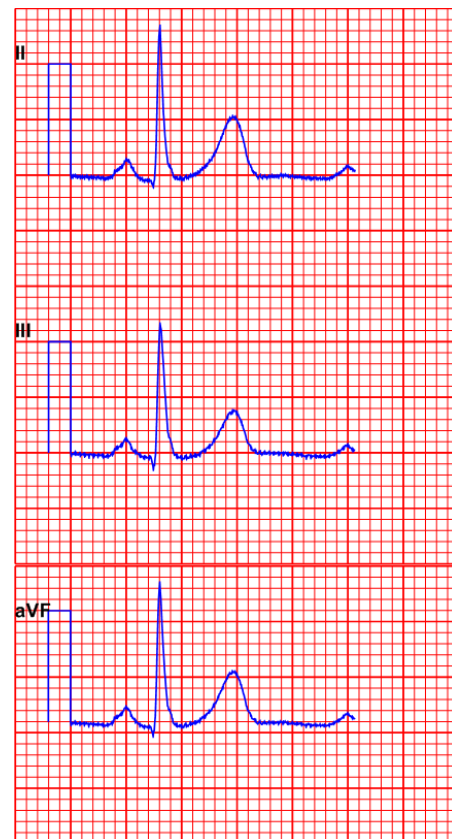

Figure 4. Example of automatically detected slurring in leads II, III and aVF from an ECG of a 36 year old Chinese male.

While the presence of notching/slurring in ECGs was high across all age-groups in these cohorts, further study is needed of cases that are followed over a number of years to see if this phenomenon is an indicator of risk.

Rosso analysed the prognostic effect of notching, of slurring and of STsegment elevation and found that only notching had a prognostic impact for idiopathic VF [12]. This finding was for visually identified notching and slurring. It would be interesting to see if these results were replicated for the automatically detected pattern.

End QRS notching/slurring has been associated with sudden cardiac death but the figures of 19% to 26% for the prevalence of the pattern which have been found in this study are far removed from the reported incidence of 0.1% for sudden cardiac arrest in the United States [14]. This would suggest that end QRS notching/slurring per se is non-specific and that further refinement of the new early repolarization definition, e.g. to include criteria on ST slope as suggested by Tikkanen, may be required to improve specificity. This requires further investigation.

Acknowledgements

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