The relationship of cardiovascular risk factors and electrocardiographic findings: Isfahan Healthy Heart Program

Nizal Sarrafzadegan[(1)], Masoumeh Sadeghi[(2)], Forough Khademi[(3)], Mohammad Arash Ramezani[(4)], Mohammad Hashemi[(5)]

Abstract

BACKGROUND: Cardiovascular disease (CVD) is the leading cause of mortality worldwide. Various studies showed relationship between electrocardiographic (ECG) changes at rest and CVD mortality. Present study was performed to find the relation between ECG and CVD risk factors in an Iranian population.

METHODS: This cross-sectional study was performed on 3343 subjects aged ≥ 35 years from three provincial cities of Isfahan, Arak, and Najafabad, Iran. Demographic and lifestyle information, as well as weight, height, blood pressure, hip and waist circumference measurement was recorded. Laboratory tests including total cholesterol (TC), LDL-C, HDL-C, triglycerides (TG) and fasting serum glucose were measured too. Ischemic criteria of ECG included minor and major changes in ST segment, T wave, conductive disorders, blocks and arrhythmias.

RESULTS: Ischemic changes in women were 1.5 times more than men ($P < 0.05$). Mean age of the group with ischemic findings was 5 years more than non-Ischemic group. Comparison of lifestyle variables indicated that physical activity in reverse to nutrient index was significantly more in non-ischemic individuals compared to the ischemic individuals. Smoking showed a significant difference between the two groups, too ($P < 0.05$). Anthropometric variables including body mass index (BMI), hip and waist circumference and diabetic and systolic blood pressure as well as biochemical factors including TC, HDL-C, and LDL-C were significantly higher in Ischemic group ($P < 0.05$).

CONCLUSION: Considering the ischemic change in individuals with unhealthy life style or with CVD risk factors, these should be considered in evaluation of these patients.

Keywords: Ischemic Changes, Electrocardiography, Cardiovascular Risk Factors.

ARYA Atherosclerosis Journal 2012, 7(Suppl): S94-S98

Date of submission: 9 Jan 2012, ***Date of acceptance:*** 26 Feb 2012

Introduction

Cardiovascular diseases (CVD) are an important problem of public health in many developing countries which is estimated to have a greater increase in the next years due to the lifestyle changes and aging in the population.[1] It is also the most prevalent cause of mortality in these countries.[1,2] In a study in Iran in 1999, the prevalence of coronary artery disease (CAD) was reported 19.4 percent and its mortality rate was found to have an increasing trend.[3,4]

Several studies were published about the association of electrocardiogram (ECG) changes, as the simplest way to diagnose CVD and heart rhythm problems, with mortality rate.[5-9] The association of ECG changes with risk factors of CVD has been also reviewed; e.g. the study of Cardoso et al. in Brazil showed that ECG findings were correlated to smoking, serum lipid abnormality, hypertension, diabetes and waist to hip ratio.[1] In another study in Japan, systolic hypertension was associated with ECG changes.[10] Nabipour et al. in Persian Gulf Healthy Heart Study in southern regions of Iran showed that there was an association between ECG changes and risk factors of cardiovascular diseases.[11] The present study aimed to investigate the

1- Professor, Isfahan Cardiovascular Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran.
2- Associate Professor, Cardiac Rehabilitation Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran.
3- Resident, Isfahan Cardiovascular Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran.
4- Specialist in Social Medicine, Isfahan Cardiovascular Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran
5- Associate Professor, Cardiac Rehabilitation Research Center, Isfahan Cardiovascular Research Institute, Isfahan University of Medical Sciences, Isfahan, Iran.
Correspondence To: Masoumeh Sadeghi, Email: sadeghimasoumeh@gmail.com

association of cardiovascular risk factors with ECG changes in an Iranian population.

Materials and Methods

The present study was a part of Isfahan Healthy Heart Program (IHHP) which its details have been published by Sarrafzadegan et al.[12] IHHP was a community-based study conducted in 2001-2007. This comprehensive study was carried out in three cities of Isfahan, Najafabad as the intervention cities and Arak as the control city. These three cities were selected due to an identical and equivalent population structure and their availability with minimum migration movement. The inclusion criteria were minimum age of 19 years and Iranian citizenship, no well known disease or mental retardation and living in the mentioned cities at least for 6 months. Sampling method multistage random cluster and the study samples were 9000 people at the final phase in which 3343 people over 35 years underwent ECG.

Following ECG test in those aged over 35 years, demographic characteristics of the study subjects including age, sex, education (0-5, 6-12 and over 12 years) and occupation (governmental, self-employed, housekeeper, jobless and retired) were collected in a 45-minute interview. Furthermore, participants were asked about their lifestyle such as nutrition, diet, physical activity and smoking. Nutritional status was determined based on a qualitative food frequency questionnaire and Global dietary Index (GDI) was calculated. Nutritional information about frequency of consumption of 7 food groups including beneficial and harmful oils, fruit and vegetables, processed foods, confectionaries, red meat and fat dairy products, white meat, soy protein and grains were scored based on the atherogenic role of each food group using Likert scale (maximum atherogenic = 2 and minimum atherogenic = 0). Higher GDI indicated higher atherogenic risk.[13] Physical activity was calculated as total daily activity including transport, leisure time and working time physical activity as METs/day unit (metabolic equivalent).[14]

The participants were asked to refer to measurement center while they were 12-hour fasting. In addition to blood sampling, blood pressure, weight, height, waist circumference (WC), and hip circumference (HC) were measured by standard methods.[15] Total cholesterol level (TC) and triglyceride (TG) were assessed enzymatically by Autoanalyzer Hitachi 902. HDL-C was measured by dextran sulfate-Mg2+ precipitation[16] and LDL-C by Friedewald formula.[17] If TG was > 400 mg/dL, LDL-C was measured directly. Fasting blood sugar (FBS) was measured by glucose oxidase enzyme method. Diabetes was determined by blood sugar greater than 126 mg/dL or consumption of anti-diabetic drugs.[18] In terms of cigarette smoking, the study subjects were divided into non-smoker, active smoker, ex-smoker and passive smoker groups.

In all study subjects over 35 years, 12-lead ECG was performed by a trained technician based on MONICA Protocol (Multinational Monitoring of trends and determinants in Cardiovascular diseases).[19] Thereafter, abnormal data were investigated based on Minnesota coding.[20] Required abnormalities included any major or minor changes in MONICA protocol such as ST segment changes or T wave, major and minor changes of T wave, pathologic QS pattern, right bundle branch block (RBBB) and left bundle branch block (LBBB), atrial tachyarrhythmia including atrial fibrillation and atrial flutter, tachyarrhythmia attack, ventricular tachyarrhythmia, block and sinoatrial node arrest (SA-node), sinus bradycardia and atrioventricular node (AV-node) and second and third-degree heart block.

The data were analyzed by SPSS software version 15 using t-student and chi-square (χ^2) test.

Risk factors were defined as follows: Diabetes, fasting blood sugar ≥ 126 mg/dL or consumption of anti-diabetic drugs; hypercholesterolemia, total cholesterol ≥ 200 mg/dL or consumption of cholesterol lowering drugs; hypertriglyceridemia, triglyceride ≥ 200 mg/dL or consumption of triglyceride lowering drugs; poor physical activity, physical activity lower than 30 minutes or at least twice a week; hypertension: systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg or consumption of antihypertensive; abdominal adiposity, waist to hip ratio in women greater than 0.8 and in men greater than 0.9; body mass index (BMI) higher than 25 was defined as overweight and greater than 30 as obesity.

Results

A total of 3343 subjects over 35 years who underwent a complete ECG were investigated. Out of these participants, 1787 were females (53.5%) and 1556 were males (46.5%). 39% of these people had ischemic changes. Ischemic changes in females were 1.5 times more than men ($P < 0.05$).

Mean age of people with ischemic changes was approximately five years more than the group without ischemic changes. Increased educational level was significantly associated with lower ischemic changes (Table 1).

Table 2 illustrates the smoking status in the two groups which shows a significant association between

Table 1. Frequency of demographic characteristics in subjects with and without ischemic changes

	Without ischemic changes	With ischemic changes	P
Male	1070	486	< 0.0001
Female	974	813	
Age (year)*	49.7 ± 11.8	54 ± 13.2	< 0.0001
Education			
0-5 years	1398	1006	< 0.0001
6-12 years	483	237	
≥ 12 years	160	52	
Occupation			
Governmental	178	78	< 0.0001
Self-Employed	658	258	
Housekeeper	918	780	
Jobless and retired	201	138	

* Mean ± SD

Table 2. Frequency of smoking in subjects with and without ischemic changes

Smoking Status / ECG changes	Non-Smokers	Current Smoker	Stopped Smoking	Passive Smoker
Without ischemic changes	1244	179	76	544
With ischemic changes	852	85	47	314

P < 0.0001

Table 3. Comparing the mean indices of weight and blood pressure in participants with and without ischemic changes

	Without ischemic changes	With ischemic changes	Statistical test
BMI (Kg/m2)	26.3 ± 0.19	26.6 ± 0.21	P = 0.323
Waist circumference (cm)	95.2 ± 0.48	95.4 ± 0.53	P = 0.69
Systolic blood pressure (mmHg)	125.2 ± 0.76	128.8 ± 0.83	P = 0.001
Diastolic blood pressure (mmHg)	78.3 ± 0.49	80.7 ± 0.53	P = 0.001
Nutritional index (GDI)	0.74 ± 0.013	0.75 ± 0.014	P = 0.504
Physical activity (METs)	618.8 ± 24.7	602.8 ± 27.2	P = 0.664

Data are presented as mean ± SD

Table 4. Mean of biochemical indices in people with and without ischemic changes

ECG changes / Biochemical indices	Without ischemic changes	With ischemic changes	Statistical test
Total cholesterol (mg/dL)	207.8 ± 1.7	211.9 ± 2	P = 0.123
Triglyceride (mg/dL)	167 ± 4.8	172.5 ± 5.4	P = 0.443
HDL-C (mg/dL)	44.1 ± 0.5	44 ± 0.5	P = 0.84
LDL-C (mg/dL)	119.4 ± 1.2	122.6 ± 1.4	P = 0.086
FBS (mg/dL)	98.1 ± 1.3	27.2 ± 1.5	P = 0.65

smoking and ischemic changes in ECG. Physical activity in those without ischemic changes was greater than those with them. Nutritional index of those without ischemic changes was lower than those with ischemic changes. However, the differences in physical activity and GDI were not statistically significant.

Table 3 indicates the difference between the two groups in terms of lifestyle variables. There was only a statistically significant difference between the two groups in systolic and diastolic blood pressure showing higher values in the group with ischemic changes. Biochemical indices are illustrated in table 4. There were no differences between the two groups in terms of serum lipids and glucose.

Discussion

The results of the present study showed that a large percentage of people who apparently were healthy had ischemic changes in their ECG. These ischemic changes were higher in women than in men and reduced with increased educational level. Ischemic changes were associated with lifestyle i.e. physical activity, nutrition and smoking; however, obesity, cholesterol level, HDL-C and LDL-C showed no difference between the two groups. There was only a significant difference in mean blood pressure that it was higher in the group with ischemic changes.

Study of the ECG changes in the population has a long history. The first study was done in the U.S. in 1960s. The reason for these studies was lack of patient's involvement in diagnosis of cardiac ischemia. Due to these studies, researchers found the occurrence of new epidemics of coronary artery diseases.[7-9]

In the present study, the presence of ischemic disorders in ECG was 39 percent which is a relatively high rate compared to previous studies that was approximately 5 percent[7]. The major reason of this difference might be in time of study and age of the study subjects. Previous studies have been done almost 30-40 years ago and in population over [16,8] while in the present study, it was done on people over 35. Most recent study was conducted on athletes in 2007; the prevalence of ECG changes was approximately reported as 12 percent.[21] The frequency of ischemic changes in terms of sex in the present study was in accordance with other studies.[9]

Mean systolic and diastolic blood pressure were higher in the group with ischemic changes. Probably, this finding was resulted from the effect of increased blood pressure on increased cardiac activity and maybe increased left ventricular muscle mass and related changes in ECG.[22,23] No significant association was found in overweight and obesity with ischemic changes; however, the effect of overweight on left ventricular mass has already been approved.[24]

Ischemic changes in ECG showed no association with total cholesterol and LDL-C; while an identical study in Poland showed a significant relationship in this regard.[25] Another difference of the Poland study with the present study was in serum HDL-C, in which HDL-C in those with ischemic changes was significantly lower in Poland.[25]

Previous studies showed the association between ECG changes and high risk behaviors such as smoking, physical inactivity and inappropriate nutrition.[26] Another study, carried out in Iran, also showed that smoking, obesity and physical inactivity can increase the risk of ischemic changes in the community to 1.5 times.[3]

The most important result of the present study was the relationship between blood pressure, as a risk factor and smoking as a high risk behavior with ECG changes. these associations were also seen in many other studies; however, it should be noted that in the one hand the study subjects in the present study are relatively large and representative of population and on the other hand, these people were in an age group that the likelihood of ECG changes was higher.

The limitations of this study should be taken into account. Most importantly, it was conducted based on single electrocardiogram. Several ECGs or 24-hour Holter Monitoring may have shown different findings. However, ECG is a very acceptable method in diagnosis of ischemic disorders. The ECG interpretation in the present study was done through Minnesota coding method that is used in epidemiologic studies and possesses a very high sensitivity, but also causes false positive results.[19]

Finally, it can be concluded that ischemic changes in ECG of apparently healthy individuals were associated with their lifestyle and its risk factors and perhaps these changes can be altered by modification of lifestyle. Furthermore, when interpreting the ECG of people, their lifestyle and its risk factors should also be taken into account.

Acknowledgements

Hereby, we would like to thank the staff of Isfahan Cardiovascular Research Center, particularly Surveillance and Analysis Departments who assisted us in conducting this project.

The Persian version of this article has been previously published in Iranian Journal of Medical Education: 2010 No: 5; 593-601.

Conflict of Interests

Authors have no conflict of interests.

References

1. Cardoso E, Martins IS, Fornari L, Monachini MC, Mansur AP, Caramelli B. Electrocardiographic abnormalities and cardiovascular risk factors for ischemic heart disease in an adult population from Sao Paulo, Brazil. Rev Assoc Med Bras 2002; 48(3): 231-6.
2. Stampfer MJ, Hu FB, Manson JE, Rimm EB, Willett WC. Primary prevention of coronary heart disease in women through diet and lifestyle. N Engl J Med 2000; 343(1): 16-22.
3. Sarraf-Zadegan N, Boshtam M, Malekafzali H, Bashardoost N, Sayed-Tabatabaei FA, Rafiei M, et al. Secular trends in cardiovascular mortality in Iran, with special reference to Isfahan. Acta Cardiol 1999; 54(6): 327-33.
4. Sarraf-Zadegan N, Sayed-Tabatabaei FA, Bashardoost N, Maleki A, Totonchi M, Habibi HR, et al. The prevalence of coronary artery disease in an urban population in Isfahan, Iran. Acta Cardiol 1999; 54(5): 257-63.
5. Rautaharju PM, Kooperberg C, Larson JC, LaCroix A. Electrocardiographic predictors of incident congestive heart failure and all-cause mortality in postmenopausal women: the Women's Health Initiative. Circulation 2006; 113(4): 481-9.
6. Keys A, Taylor HL, Blackburn H, Brozek J, Anderson JT, Simonsone. Coronary heart disease among Minnesota business and professional men followed fifteen years. Circulation 1963; 28: 381-95.
7. Blackburn H, Keys A, Simonson E, Rautahaju P, Punsar S. The electrocardiogram in population studies. A classification system. Circulation 1960; 21: 1160-75.
8. Hiss RG, Lamb LE. Electrocardiographic findings in 122,043 individuals. Circulation 1962; 25: 947-61.
9. Ostrander LD, Brandt RL, Kjelsberg MO, Epstein FH. Electrocardiographic findings among the adult population of a total natural community, Tecumseh, Michigan. Circulation 1965; 31: 888-98.
10. Nakayasu K, Nakaya Y, Oki Y, Nomura M, Ito S. Long-term follow-up in Japanese public office workers of the influence of blood pressure on ECG changes. Circ J 2004; 68(6): 563-7.
11. Nabipour I, Amiri M, Imami SR, Jahfari SM, Nosrati A, Iranpour D, et al. Unhealthy lifestyles and ischaemic electrocardiographic abnormalities: the Persian Gulf Healthy Heart Study. East Mediterr Health J 2008; 14(4): 858-68.
12. Sarraf Zadegan N, Baghaei A, Sadri CH, Kelishadi R, Malekafzali H, Boshtam M, et al. Isfahan healthy heart program: Evaluation of comprehensive, community-based interventions for non-communicable disease prevention. Prevention and control 2006; 2(2): 73-84.
13. Mohammadifard N, Kelishadi R, Safavi M, Sarrafzadegan N, Sajadi F, Sadri GH, et al. Effect of a community-based intervention on nutritional behaviour in a developing country setting: the Isfahan Healthy Heart Programme. Public Health Nutr 2009; 12(9): 1422-30.
14. Saidi M, Rabeie K, Kelishadi R, Sadeghi M, Roohafza HR. Relation between leisure time physical activity and TV watching with atherosclerotic risk factors. 2003; 71: 31-7.
15. WOrld Health Organization. Obesity: preventing and managing the global epidemic; report of a WHO consultation. Technical Report Series. Geneva: WHO; 2000. p. 894.
16. Warnick GR, Benderson J, Albers JJ. Dextran sulfate-Mg^{2+} precipitation procedure for quantitation of high-density-lipoprotein cholesterol. Clin Chem 1982; 28(6): 1379-88.
17. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972; 18(6): 499-502.
18. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications; report of a WHO consultation. Geneva: World Health Organization; 1999.
19. World Health Organization, Cardiovascular Diseases Unit. Monica manual. Revised ed. Geneva: World Health Organization; 1990.
20. Rose GA, Blackburn H. Cardiovascular survey methods. Geneva: World Health Organization; 1968.
21. Pelliccia A, Culasso F, Di Paolo FM, Accettura D, Cantore R, Castagna W, et al. Prevalence of abnormal electrocardiograms in a large, unselected population undergoing pre-participation cardiovascular screening. Eur Heart J 2007; 28(16): 2006-10.
22. Ang D, Lang C. The prognostic value of the ECG in hypertension: where are we now? J Hum Hypertens 2008; 22(7): 460-7.
23. Araoye MA, Omotoso AB, Opadijo GO. The orthogonal and 12 lead ECG in adult negroes with systemic hypertension: comparison with agematched control. West Afr J Med 1998; 17(3): 157-64.
24. Gray RJ, Sethna DH. Medical management of the patient undergoing cardiac surgery. In: Libby P, Bonow RO, Zipes DP, Mann DL, Editors. Braunwald's heart disease: a textbook of cardiovascular medicine. Philadelphia: W.B. Saunders; 2008. p. 1993-2012.
25. Dobrzycki S, Kozuch M, Kaminski K, Korecki J, Ostasz A, Podgrudna E, et al. High cholesterol in patients with ECG signs of no-reflow after myocardial infarction. Rocz Akad Med Bialymst 2003; 48: 118-22.
26. Schmermund A, Lehmann N, Bielak LF, Yu P, Sheedy PF, Cassidy-Bushrow AE, et al. Comparison of subclinical coronary atherosclerosis and risk factors in unselected populations in Germany and US-America. Atherosclerosis 2007; 195(1): e207-e216.