CLINICAL CHARACTERISTICS AND TEMPORAL PROFILE OF PATIENTS REFERRED TO A CARDIAC CENTRE FOR STRESS ELECTROCARDIOGRAPHY (ECG) IN SOUTHERN NIGERIA

Abstract

BackgroundThe stress electrocardiographic (ECG), is a dependable method for evaluating cardiovascular health and examining potential heart conditions like myocardial ischemia and arrhythmia. EST is rare in cardiac settings with limited data on diagnosis in the developing worlds. Our main goal was to determine the clinical characteristics of patients referred to our cardiac center.

MethodA retrospective cross-sectional study ofadult patients aged (>18 years old) with low or intermediate pretest symptoms referred for EST to GoodHeart Medical consultant hospital between October 2019 and January 2023. Data included medication, smoking, alcohol, medical history, and symptoms.

ResultsIn a study with 102 subjects (mean age: 49±16 years), 57.8% were aged 41-60, and 72.5% were males. Routine medical fitness and chest pain were common indications for EST.80% of subjects with positive arrhythmia and 50% with positive ischemia had chest pain. None of the patient presenting for routine medical fitness had arrhythmia while 14.3% had ischemia. Arrhythmia correlated significantly with chest pain. Among those with positive ischemia, 71.4% were hypertensive and 64.2% were obese; none smoked or consumed alcohol. For positive arrhythmia cases, 70% were hypertensive and 80% were obese; 40%, 20%, and 10% smoked, consumed alcohol, and were diabetic, respectively.

ConclusionMajority of subjects that underwent the EST has normal result and the few that had positive ischemia 13.7% were referred for angiography and angioplasty while subject with positive arrhythmia 9.8% were recommended for Holter ECG and electrophysiology studies. The occurrence of major cardiovascular events was rare.

Keyword stress electrocardiographic, GoodHeart medical consultant hospital, Cardiac centre, positive

INTRODUCTION

Exercise stress testing has been used for decades as a noninvasive test to diagnose and risk stratify coronary artery disease (CAD).(1)A stress test, sometimes called a treadmill stress test or exercise stress test(EST) is commonly used for the diagnosis and evaluation of cardiac disease.(2)Stress ECG evaluates cardiovascular response to exercise and has been a topic of interest for a long time. Electrocardiographic changes during exercise were first described over a century ago, which emphasized the importance of this dynamic assessment. The Bruce protocol which was introduced about 60 years ago transformed the field by providing a standardized framework for studying this subject. This has led to a widespread use of exercise stress testing with electrocardiographic monitoring (ExECG) in cardiovascular medicine. In recent decades, there have been significant advancements in the understanding and management of cardiovascular disease, which have challenged previous beliefs about its underlying mechanisms and overall treatment.(3) Stress electrocardiographic (ECG) testing is a reliable way to evaluate cardiovascular health and investigate various inducible heart conditions, such as myocardial ischemia and arrhythmia. Previous studies have shown that its diagnostic accuracy for detecting inducible coronary ischemia is only 60%(4). The American College of Cardiology (ACC), American Heart Association (AHA), American College of Sports Medicine (ACSM) and the American Society of Nuclear Cardiology all recommend an EST for diagnosing patients who are at risk of cardiovascular disease (CAD)(5).

Chest pain is a frequent reason for patients to seek primary care, affecting up to 40% of the general population at some point in their lives. In primary care studies, 8-18% of chest pain patients are diagnosed with heart disease and chest pain visits account for 0.7-4% of all primary care consultations. (6,7). Palpitations are the second most common reason for specialist cardiologic evaluation, accounting for 16% of presenting symptoms.(8)While other symptoms like fatigue and dyspnea may also be associated with coronary artery disease, they are not typically included in risk prediction models. However, studies have shown that dyspnea is an independent predictor of cardiac death risk. (9)

An exercise test is therefore still a diagnostic option for patient with pain. To our knowledge,limited studies have been carried outin our environment to address the use of exercise stress testing in medical setting for diagnosis. Our primary aim was to identify clinical characteristics of patient referred to our cardiac center.

MATERIALS AND METHOD

We conducted a clinical examination of patients referred for routine exercise stress testing (EST)to GoodHeart Medical consultant hospital between October 2019 and January 2023. It was a retrospective cross-sectional study of adult patients aged (>18 years old) and had low or intermediate pretest symptoms. Patients who were unable to conduct an exercise test or were referred for other reasons were excluded from the study. Data were collected on present medication history, smoking and alcohol habits, past medical history, and presenting symptoms.

The procedure was carried out according to the American Heart Association (AHA) recommendation and guidelines.(10)The Bruce protocol was used in exercise stress testing, the test begins with the treadmill set to a low speed (1.7 miles per hour) and a 10% incline, and every 3 minutes the speed and angle of incline are increased. Other protocols are similar. The test continues for a maximum of 27 minutes (usually attainable only by well-trained individuals) or until the patient quits or develops signs or symptoms of ischemia or an arrhythmia. Average time for a middle-aged adult is 8 to 10 minutes.(11)

RESULTS

The population consist of 102 subjects with an average age of 49±16 years with the majority 71(69.6%) falling in the age group of 41-60 years. This is made up of 74(72.5%) males and 28(27.5%) females. The average duration for EST was 9minutes.

The study participants baseline characteristics indicate that a small percentage of them were smokers or alcohol consumers 2.9% and 7.8% respectively. Hypertension 51(50%) was the most common cardiovascular risk factor, followed by obesity 45(44.1%) and diabetes mellitus 14(13.7%). A majority of the participants had a history of drug medication 76(74.5%). These findings are presented in Table 1.

According to the study, the main reason patients visited the facility was chest pain, accounting for 50(49%) of cases. This was followed by medical fitness at 27(26.5%) and dyspnea at 4(3.9%) was the least cases. In terms of medication, majority of the patients were on hypertensive medication 41(40.2%), followed by diabetic medication 12(11.8%), and the least were on peptic ulcer disease medication 2(1.9%). These findings are illustrated in Figure 2 and Figure 3.

The most common reason for stopping the EST was muscle fatigue accounting for 40(39.2%) of cases. This was followed by reaching the maximum heart rate for age, which accounted for 21(24.5%) of cases. The least common reasons for stopping was tachycardia accounting for 2(1.9%) of cases. 6.9% of the population experienced both muscle fatigue and maximum heart rate. These findings are summarized in Table 2.

Most subjects stopped during the EST at stage 3 53(52.0%) and least stage stopped were stage 5 4(3.9%)(Table 3).ST-T changes were recorded, more than half of the study population had normal study finding.9(8.7%) had ST elevation while 7(6.9%) had T wave inversion and ST depression(Table 4).

The clinical interpretation for EST findings show that 14(13.7%) had stress induced ischemia and 10(9.8%) had stress induced Arrhythmia (Table 5).

It was observed that out of the participants that experienced positive stress induced arrhythmia, 80% had Chest pain. Palpitation, dyspnea and ST depression were reported in 10% of the subjects respectively while, positive stress induced ischemia was observed in 50% of the subjects presenting with chest pain. Pre-mature ventricular complex and routine medical fitness account for 14.5% each, also ST-depression and dyspnea account for 7.1% each. Figure 3

Distribution of positive stress induced ischemia according cardiovascular risk factors showed that. 71.4% were hypertensive, 64.2% were obese, 7.1% were diabetic, and none smokes or consume alcohol. While subjects with stress induced arrhythmia showed that 70% were hypertensive, 40% were diabetic, 80% were obese, 10% smokes and 20% consume alcohol. Figure 4

Table 1: Baseline characteristics of study participants

Variables	Frequency (n=102)
Gender	
Male	74(72.5)
Female	28(27.5)
Age group	
<40	20(19.6)
41-60	71(57.8)
>60	11(10.8)
Average age	49±16
History	
Smokers	
Yes	3(2.9)
No	97(95.1)
Alcohol	
Yes	8(7.8)
No	94(92.2)
Cardiovascular risk factors	
Diabetic mellitus	
Yes	14(13.7)
No	88(86.3)
hypertension	
Yes	51(50.0)
No	51(50.0)
Obesity	
Yes	45(44.1)
No	57(55.9)
Medication history	
Yes	76(74.5)
No	26(25.5)
Average duration of EST time	9.0minutes

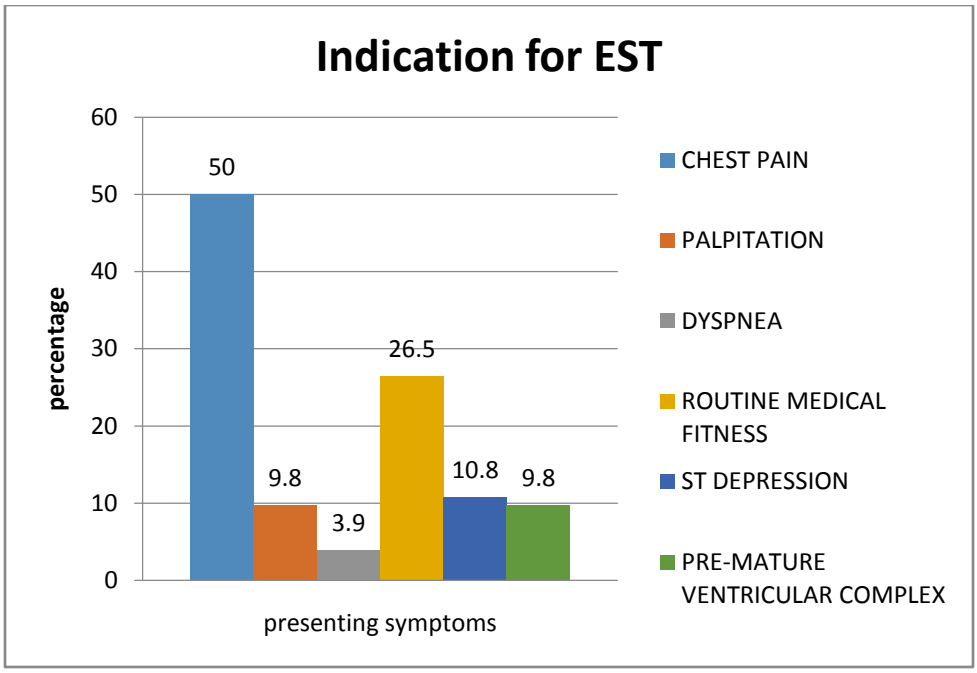

Figure 1: Symptoms at presentation among study participants

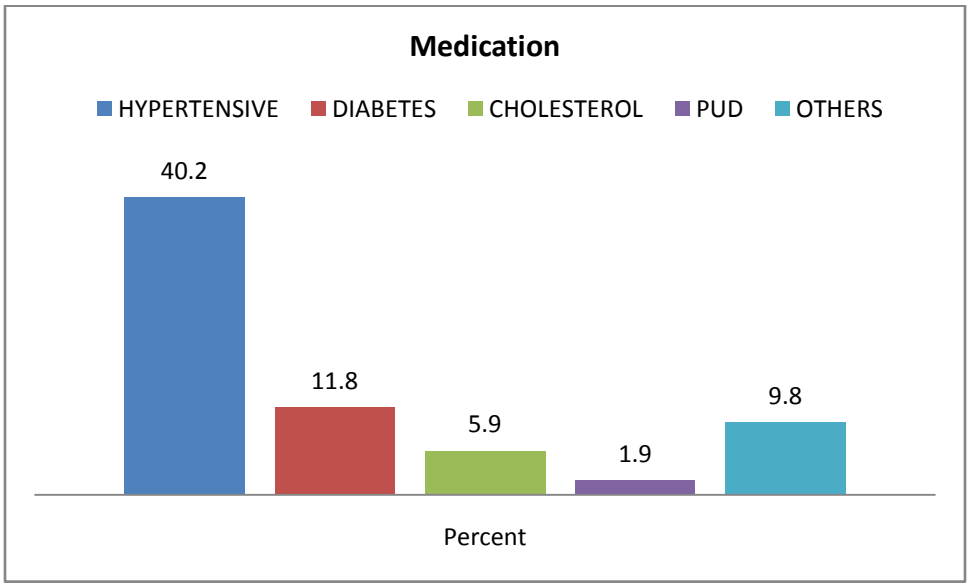

Figure 2: Medication history for patient undergoing exercise stress stressing

Table 2: Patients reason for interrupting the EST

Reason For Stopping	Total	Percent
Muscle fatigue	40	39.2
Maximum HR age	21	24.5
Breathlessness	11	10.8
Chest pain	5	4.9
Tachycardia	2	1.9
Blood pressure spike	3	2.9
Significant ST/ T wave	4	3.9
Muscle fatigue +maximum HR age	7	6.9
Muscle fatigue +chest pain	4	3.9
Muscle fatigue +breathlessness	2	1.9
Breathlessness + maximum HR age	2	1.9
Breathlessness + chest pain	1	1.0

Table 3:stages of EST attained among study participants

Stages	Frequency	Percent
2	17	16.6
3	53	52.0
4	28	27.5
5	4	3.9

Table 4:prevalence of ST_T changes among subjects

ST/T Evaluation	Frequency	Percent
T wave inversion and ST depression	7	6.9
ST elevation	9	8.7

Table 5 Pattern of Stress induced changes among subjects

Stress induce	frequency	Percent
Ischemia	14	13.7
Arrhythmia	10	9.8

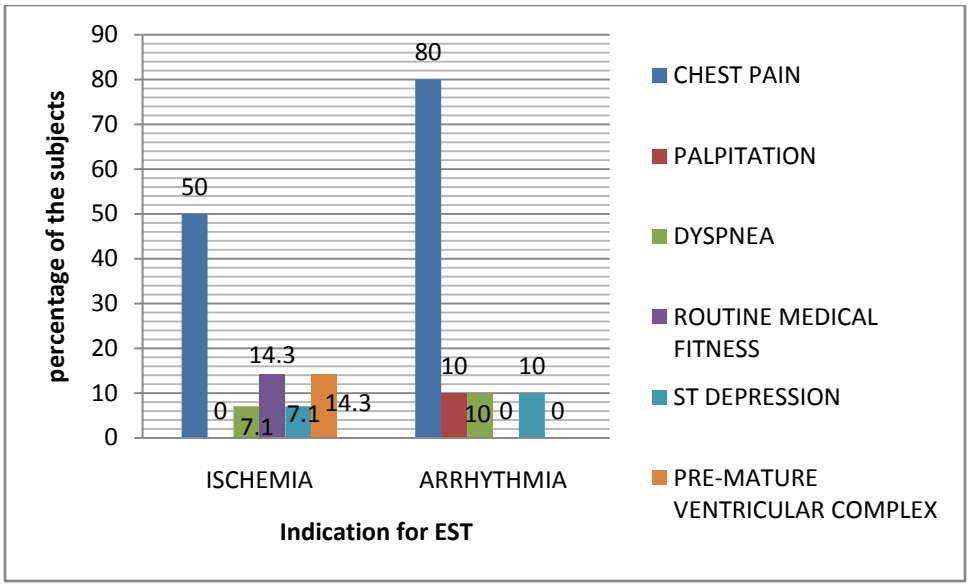

Figure 3: Positive stress test results based on presenting symptoms

Positive stress arrhythmia was significant among subjects presenting with chest painas their initial indication.

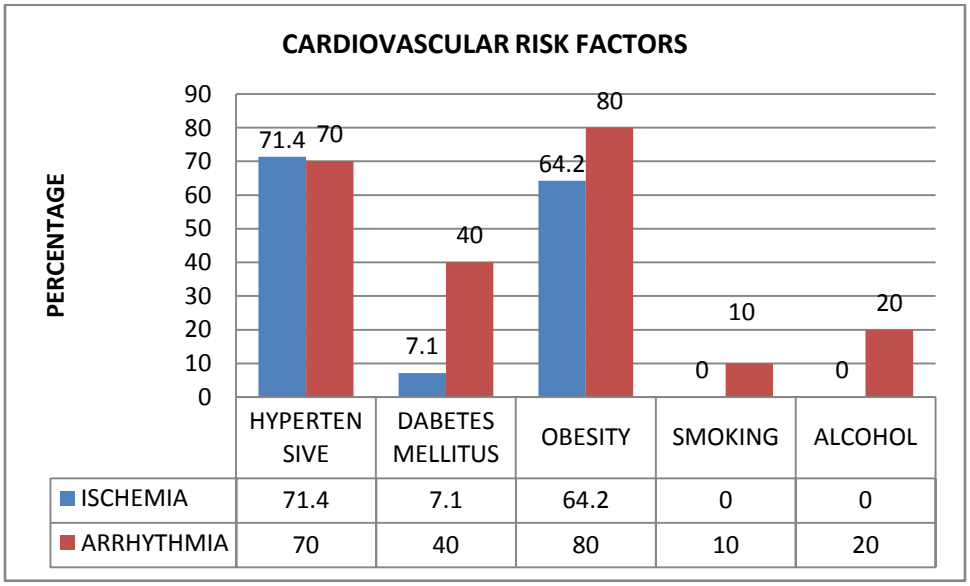

Figure4:Positive stress testresult based on cardiovascular risk factor

Positive stress arrhythmia was significant among diabetic and obese subjects

DISCUSSION

This study is a retrospective cross-sectional study that involved 102 healthy subjects referred from primary care facilities to a cardiac center for routine exercise stress testing for various reasons such as chest pain, routine medical fitness, dyspnea, ST-depression and pre-mature ventricular complexbetween October 2019 and January 2023. The average age of the referred patients was 49±16, with a higher proportion of males in the study population. Most of the subjects were aged between 41 and 60 years, and the rates of smoking and alcohol intake were low. In terms of medication, the highest numbers of patients were on hypertensive medication, followed by diabetic medication, and the least were on peptic ulcer disease medication.Most subjects stopped during the EST at stage 3 53(52.0%) and least stage stopped were stage 5 4(3.9%).Each test was tailored to the individual's symptoms, with emergency measures like injection amiodarone available if needed. Stress testing is not typically recommended for those with known coronary disease.(12) Most subjects undergoing exercise stress testing had chest pain as the primary reason for referral, although not all cases of chest pain are necessarily cardiac-related. The second most common reason for referral was to assess subjects' fitness to work(routine medical fitness) as part of their company's requirements.Patients may not always accurately describe the characteristics of their symptoms, making it difficult to identify especially in cases of normal rate palpitations.The proportion of subjects that undergoes the EST, many did not have any issue and the few that had the positive test where referred out for further evaluation. Patient with positive inducible ischemia 14(13.7%) were referred to a facility outside our location where angiography and angioplasty were to be performed while subject with positive inducible arrhythmia 10(9.8%) were recommended for Holter ECG and electrophysiology studies. Although, ischemic heart disease is receiving attention, there is no clear indication that the use of stress ECG to evaluate ischemia is becoming more common.However,by following the established guidelines and protocols for EST, the occurrence of major cardiovascular events was rare and the procedures were safe.Further studies are needed to investigate the pattern of coronary diagnosis of these positive subjects referred out for further diagnosis.

Chest pain was the most common reason for referral accounting for 50% of the presenting symptoms. Chest pain is the chief complaint in about 1 to 2 percent of out-patient visits(13) While it can be caused by a wide range of different illnesses, cardiac disease is the most concerning.(6) The frequency of chest pain as the main complaint ranged from 0.7% to 7%, with ischemic heart disease being diagnosed in 9% to 22% of cases. Approximately 15% of cases had chest pain of unknown cause.(14)

In our study, 9.8% of the population experienced palpitations, which is similar to the 11.7% reported in a UK cardiology clinic.(15)Palpitations pose a challenge for primary care services, as patients may be referred due to concerns about missing potential heart issues. Many patients seen in secondary care for palpitations do not have cardiac arrhythmias, but rather benign palpitations.(16)

Dyspnea account for 3.9% of the study population. It can be explained that patients experiencing dyspnea, regardless of whether they have a history of coronary artery disease or

not, face higher mortality rates due to cardiac causes and overall mortality. In comparison to asymptomatic patients, those with dyspnea have a fourfold increased risk of death from cardiac causes and more than double the risk compared to patients with typical angina. These results suggest that dyspnea may be an indicator of underlying cardiovascular disease.(9)

Stress electrocardiograph was interrupted mostly due muscle fatigue accounting for 40(39.2%) of our study population this was followed by maximum heart rate age attained 21%, breathlessness 10.8%, chest pain 4.9%. The study also recorded co-morbidities of muscle fatigue and maximum heart rate as more prevalent reason followed by muscle fatigue and chest pain with the least occurring as breathlessness and chest pain as a reason for interruption during the EST.Arrhythmia was rarely a reason for stopping the stress ECG test, as ST elevation and ischemia were minimal. Many patients stopped the test due to non-cardiac complaints like muscle fatigue and breathlessness rather than worsening angina.

8.7% of the total population experienced ST changes.These changes, whether they occur during exercise or recovery, have been shown to have negative prognostic significance. Resting ST-segment depression has also been identifiedhistorically as a marker for adverse cardiac events.(17)Exercise stress testing is useful for diagnosing and predicting outcomes in patients with ischemic heart disease who have normal resting ECGs. However, its value in patients with abnormal resting ECGs has been uncertain, and some researchers have been hesitant to subject these patients with abnormal resting ECG to stress testing due to potential hazards and questionable diagnostic value.(18)

The interpretation of EST finding of our study showed Ischemia 14(13.7%), Arrhythmia 10(9.8%). The ECG interpretation is considered positive if the ST criteria are met regardless of heart rate, and there are no factors that would prevent a proper interpretation. On the other hand, if no significant ST changes are observed, the interpretation is negative.(1)

In the study, it was observed that out of participants that experienced stress induced arrhythmia, 80% had Chest pain. Palpitation, dyspnea and ST depression were reported in 10% of the subjects respectively, while arrhythmia was absent in those presenting for routine medical fitness and pre-mature ventricular complex. A significant difference was observed between the presences of arrhythmia among subjects with chest pain based on the presenting symptoms. However, Stress induced ischemia was observed in50% of the subjects presenting with chest pain.Pre-mature ventricular complexand routine medical fitness account for 14.5% respectively,ST-depression and dyspnea account for 7.1% respectively. There was no induced ischemic finding among subjects presenting with palpitation. Notably, no significant difference was observed in the occurrence of stress-induced ischemia based on the presenting symptoms.

Distribution of positive stress induced ischemia according cardiovascular risk factors showed that. 71.4% were hypertensive, 64.2% were obese,7.1% were diabetic, and none smokes or consume alcohol with no significant difference observed. While subjects with positive stress induced arrhythmia showed that 70% were hypertensive, 40% were diabetic, 80% were obese, 10% smokes and 20% consume alcohol. There was a significant difference in the prevalence of diabetes and obesity among the subjects with stress induced-arrhythmia.

CONCLUSION

More than half of the study population had normal study with minimal ST-T changes. Most subjects during the EST stopped at stage 3 and muscle fatigue was observed to be the most common reason for stopping the test. EST induced ischemia and arrhythmia are not statistically significant. Chest pain which was the most common indication for EST was statistically significant for arrhythmia but not significant for ischemia. Patient with inducible ischemia were referred to a facility outside our location where angiography and angioplasty were to be performed while subject with inducible arrhythmia, Holter ECG and electrophysiology studies were recommended.

By following the established guidelines and protocols for EST, the occurrence of major cardiovascular events was rare and the procedures were safe. Centers should be established in developing countries to confirm and provide further advanced cardiovascular care to those with positive EST.

LIMITATION OF THE STUDY

The limited number of subjects used in this study would not allow for generalization of our findings.

It would be necessary to carry out angiography and electrophysiology studies to ascertain the exact culprit coronary vessels and pattern of arrhythmia in the few patients that has positive EST.

Ethical approval and Consent

Ethical approval was obtained from the Ethics and research committee of UPTH. We obtained informed consent obtained from all participants prior to procedure. Data obtained was analyzed using the Microsoft excel version 2019 and Stata version 15.0 softwares. The chi-squared test was used to determine the difference between two categories. P value of <0.05 was considered as significant.

Conflicts of interest

Authors declared they have no conflicts of interest

Authors' contributions:C.E.N performed the clinical examination of the patients, and C.E.N and J.A was a major contributor in writing the manuscript. J.A collected, analyzed and interpreted the patients' data. All authors read and approved the final manuscript.

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