

Clinical Correlation between Symptoms and Risk Factors with Cardiac Arrhythmias on 24-Hour Holter Monitoring

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ABSTRACT

Introduction

Ambulatory ECG Holter monitoring is necessary for the diagnosis of intermittent arrhythmias. The study aimed to study the clinical profile of symptomatic patients and association between symptoms and risk factors with specific arrhythmia.

Methods

This was a prospective observational study conducted to study the clinical profile of symptomatic patients who presented with unexplained palpitation, dizziness, syncope, or unexplained neurological events and who underwent 24-hour Holter monitoring for suspected cardiac arrhythmias.

Results

Overall, 265 patients were enrolled, of which 127 (47.9%) were male and 138 (52.1%) were female. The mean age of the study population was 55.5 ± 16.7 . The most common indication was palpitation (58.5%), followed by dizziness (20%), unexplained neurological events (10.2%), and syncope (9.1%). The most common finding was Ventricular premature contractions (VPCs) seen in 195 (73.6%), followed by Atrial premature contractions (APCs) in 176 (66.4%), Supraventricular tachycardias (SVTs) in 33 (12.5%), and ventricular arrhythmias in 7 (2.6%). Sinus bradycardia was seen in 6 (2.3%), while sinus pause was seen in 10 (3.8%) patients. SVTs significantly presented with palpitation ($p=0.008$) while sinus pause and sinus bradycardia presented with syncope ($p<0.001$). Sinus pause was exclusively associated with syncope in all 10 patients (100%).

Conclusion

Increasing age, smoking, hypertension, and pre-existing cardiac disease were significantly associated with abnormal Holter reports. Syncope was the only symptom that was associated with a higher prevalence of clinically significant arrhythmias. Only supraventricular tachycardias, sinus bradycardia, and sinus pause were associated with specific symptoms.

Keywords

24-hour Holter monitoring, cardiac arrhythmias, palpitation, syncope

INTRODUCTION

Cardiac arrhythmia is any abnormality in heart rate or rhythm characterized by excessively rapid (tachycardia), excessively slow (bradycardia), or irregular heartbeats.¹ Arrhythmias may be asymptomatic or symptomatic, manifesting as palpitations, dizziness, fatigue, or syncope. Continuous heart rhythm monitoring is essential for diagnosis when arrhythmias are intermittent. Continuous ambulatory ECG monitoring is recommended for assessing symptomatic individuals with unexplained syncope, near syncope, dizziness, recurrent palpitations, or neurological events when arrhythmia is suspected.²

24-hour Holter monitoring is the most commonly employed non-invasive diagnostic test for assessing symptomatic patients suspected of having a cardiac arrhythmia.³ Holter monitoring is important for diagnosing intermittent arrhythmias and assessing the burden of arrhythmias, correlating them with symptoms, and evaluating therapy efficacy.⁴

The incidence of cardiac arrhythmias is anticipated to rise; nevertheless, there is a lack of data regarding the clinical profile of cardiac arrhythmias, particularly in Nepal.⁵ In this regard, there is a necessity for research on the prevalence of various forms of arrhythmia in symptomatic Nepalese patients, along with the associated risk factors and comorbid conditions.

The general objective of the study was to study the clinical profile of symptomatic patients with cardiac arrhythmia on 24-hour Holter monitoring. The specific objectives were to identify common risk factors associated with different types of arrhythmias and to assess the association between specific symptoms and the arrhythmias detected by Holter monitoring. The study also intended to find out common indications of Holter monitoring and to determine the prevalence and types of cardiac arrhythmias detected in symptomatic patients by 24-hour Holter monitoring.

METHODS

It was a quantitative prospective observational study. The study was performed at Manmohan Cardiothoracic Vascular and Transplant Centre (MCVTC), Institute of Medicine, Tribhuvan University. Symptomatic patients undergoing 24-hour Holter monitoring for suspected cardiac arrhythmias were included. The sample size was calculated based on the prevalence of cardiac arrhythmia in symptomatic patients by 24-hour Holter monitoring in a study by Lipski et al⁶ which was 55%. With a 6% margin of error and 95% confidence interval, Cochran's formula yields a sample size of 265 cases.

Included cases in the study were aged greater than 18 years and presenting with symptoms such

as unexplained palpitations, dizziness, syncope, unexplained chest pain, unexplained shortness of breath, or unexplained neurological events undergoing 24-hour Holter monitoring for suspected cardiac arrhythmia. Excluded cases were patients with acute myocardial infarction and patients who have undergone cardiac intervention such as cardiac ablation, surgery for arrhythmias, implanted pacemakers, or ICDs.

The 24-hour Holter report was considered to be abnormal if any of the following findings were present:

1. Ectopic beats {Atrial Premature Contractions (APCs) or Ventricular Premature Contractions (VPCs)} > 30/h, i.e., Lown class ≥ 2
2. Supraventricular Arrhythmias:
 - Atrial Fibrillation (AF) / Atrial Flutter/ Paroxysmal supraventricular tachycardia (PSVT) > 30 sec
 - Focal atrial tachycardia
 - Multifocal atrial tachycardia (MAT)
3. Ventricular Arrhythmias:
 - Non sustained Ventricular Tachycardia (NSVT)
 - Sustained Monomorphic or polymorphic Ventricular Tachycardia (VT), Ventricular Fibrillation (VF)
4. Sinus Bradycardia (Severe) i.e., heart rate <40/minute
5. Sinus arrest: >3 sec
6. AV Block: 2nd-degree/3rd-degree complete heart block (CHB) AV block

Data was analyzed with IBM SPSS V 26 software. Continuous measurements were presented on mean \pm SD and results on the categorical measurement were presented in numbers (%) for descriptive analysis. The chi-square test / Fisher's Exact test was used for categorical variables for inferential analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age among the patients was 55.4 \pm 16.7 years. Overall, 138 (52.1%) were female and 127 (47.9%) were male. The majority of the patients 122 (46.0%) were from the age group 45 to 65 years. Palpitation was the most commonly reported symptom, with 155 individuals (58.5%) experiencing this issue. Dizziness was noted in 53 patients (20.0%), while unexplained neurological events were reported by 27 patients (10.2%). Additionally, syncope was observed in 24 patients (9.1%). Palpitation was presented more in younger age groups while dizziness was more in elderly patients. Unexplained neurological events included

Table 1. Baseline characteristics

Parameters		Total (n=265)	Age <45 yr (n=66)	Age 45-65 (n=122)	Age >65 yr (n=77)
Age (Mean±SD) years		55.4±16.7	32.59±7.35	55.59±6.03	74.96± 5.99
Sex	Male	127 (47.9%)	31 (11.7%)	56 (21.1%)	40 (15.1%)
	Female	138 (52.1%)	35 (13.2%)	66 (24.9%)	37 (14%)
Indications	Palpitation	155 (58.5%)	42 (63.6%)	75 (61.5%)	38 (49.4%)
	Dizziness	53 (20%)	13 (19.7%)	21 (17.2%)	19 (24.7%)
	Unexplained neurological event	27 (10.2%)	4 (6.1%)	12 (9.8%)	11 (14.3%)
	Syncope	24 (9.1%)	6 (9.1%)	11 (9.0%)	7 (9.1%)
	Miscellaneous	6 (2.3%)	1 (1.5%)	3 (2.5%)	2 (2.6%)
Risk Factors and Comorbidities	Smoking	63 (23.8%)	11 (16.7%)	25 (20.5%)	27 (35.1%)
	Hypertension	53 (20%)	0 (0.0%)	20 (16.4%)	33 (42.9%)
	Cardiac Disease	43 (16.2%)	6 (9.1%)	20 (16.4%)	17 (22.1%)
	Diabetes	27 (10.2%)	2 (3.0%)	17 (13.9%)	8 (10.4%)
	Dyslipidemia	17 (6.4%)	2 (3.0%)	10 (8.2%)	5 (6.5%)
	Psychiatric Illness	17 (6.4%)	13 (19.7%)	3 (2.5%)	1 (1.3%)
	Miscellaneous	28 (10.5%)	8 (12.1%)	8 (6.6%)	12 (15.6%)

ischemic strokes and TIAs, in which intermittent arrhythmias, such as paroxysmal atrial fibrillation or other intermittent arrhythmias, were suspected but couldn't be confirmed. Miscellaneous indications for Holter monitoring were unexplained episodic shortness of breath, unexplained episodic chest pain, and unexplained episodic fatigue. Miscellaneous indications were seen in 6 patients.

Seventy-seven (29.1%) patients were elderly (>65 years). Smoking was reported in 63 individuals (23.8%). Fifty-three patients (20%) were hypertensive. Diabetes was present in 27 patients (10.2%), while both dyslipidemia and psychiatric illness were reported by 17 patients each (6.4%). Preexisting Cardiac disease was noted in 43 patients (16.2%), indicating a notable concern among the population studied. Preexisting cardiac diseases

included coronary artery disease, heart failure, cardiomyopathy, and congenital heart disease. Additionally, miscellaneous risk factors, which included COPD, thyroid disease, and Obstructive sleep apnea (OSA) were documented in 28 patients (10.5%).

The mean duration of monitoring was 22.5±1.4 hours. Out of the total patients, 130 individuals (49.1%) had abnormal Holter reports. Only the presence of clinically significant arrhythmias was considered to be abnormal. Ectopic beats < 30/h i.e., Low class-1 were considered to be normal.

Supraventricular arrhythmias were reported in 33 patients (12.5%). Among the Supraventricular arrhythmias, atrial fibrillation (AF) was the most common, noted in 17 patients (6.4%). Additionally, 10 patients (3.8%) experienced paroxysmal

Table 2. Types of arrhythmias among study patients

Characteristics	Number (%)
VPCs	195 (73.6)
Class 1	139 (52.5)
Class ≥ 2	56 (21.1)
APCs	176 (66.4)
Class 1	132 (49.8)
Class ≥ 2	44 (16.6)
Supraventricular arrhythmias	33 (12.5)
AF	17 (6.4)
Atrial Tachycardia	2 (0.8)
PSVT	10 (3.8)
MAT	5 (1.9)
Atrial Flutter	1 (0.4)
Sinus Tachycardia	2 (0.8)
Ventricular arrhythmias	6 (2.3)
VT	1 (0.4)
NSVT	5 (1.9)
Sinus pause	10 (3.8)
Sinus bradycardia	6 (2.3)
Heart Blocks	35 (13.2)
1st Degree AV Block	27 (10.2)
2nd Degree AV Block	7 (2.6)
Mobitz type 1	3 (1.1)
Mobitz type 2	4 (1.5)
CHB	1 (0.4)

supraventricular tachycardia (PSVT), while multifocal atrial tachycardia (MAT) was identified in 5 patients (1.9%). Atrial flutter was the least, found in only 1 patient (0.4%).

Ventricular arrhythmia was seen in 6 (2.3%) cases out of which 5 (1.9 %) were NSVT and 1 (0.4%) was sustained VT.

Heart blocks were reported in 35 patients (13.2%), with first-degree AV block in 27 patients (10.2%), second-degree AV block in 7 patients (2.6%), and complete heart block (CHB) in 1 patient (0.4%).

Smoking, Hypertension, preexisting cardiac disease, and elderly age were significantly associated with abnormal Holter report ($p < 0.05$). Patients with psychiatric illness mostly had normal Holter reports and this was also statistically significant.

Only supraventricular tachycardias, sinus bradycardia, and sinus pause were associated with specific symptoms. Supraventricular tachycardias mostly presented with palpitations. Similarly, patients with Sinus bradycardia and sinus pause usually present with syncope.

In patients with Ventricular Premature Complexes (VPCs), the majority of symptoms presented with palpitations, affecting 116 patients (59.5%), followed by dizziness in 41 patients (21.0%). There was no significant association of VPC with any specific symptom. For APCs also most frequent symptom was palpitation. Supraventricular Arrhythmias had palpitations in 15 patients (45.5%), syncope in 6 patients (18.2%), unexplained neurological events in 8 patients (24.2%), and dizziness in 4 patients (12.1%). The p-value for Supraventricular Arrhythmia was 0.008, indicating a significant association, particularly with palpitations. For Ventricular Arrhythmias (VAs), dizziness was the most common symptom, occurring in 3 patients (50.0%), followed by palpitations in 1 patient (16.7%) and syncope in 2 patients (33.3%), with a p-value of 0.053, indicating a trend toward significance. For Sinus Bradycardia, most common symptom was syncope, affecting 4 patients (66.7%), with other cases related to dizziness and unexplained neurological events (1 patient each, 16.7%), yielding a highly significant p-value of < 0.001 . Sinus Pause was exclusively associated with syncope in all 10 cases (100%), with a p-value of < 0.001 , indicating a strong association. Heart block mostly presented with palpitation but without significant association with any symptoms.

Table 3. Association between indications and Holter report

Indication	Holter Report		p-value
	Abnormal	Normal	
Palpitation	61 (46.9%)	94 (69.6%)	$< 0.001^*$
Dizziness	32 (24.6%)	21 (15.6%)	0.06
Unexplained Neurological Event	15 (11.5%)	12 (8.9%)	0.31
Syncope	19 (14.6%)	5 (3.7%)	0.002*
Miscellaneous	3 (2.3%)	3 (2.2%)	0.64

*Statistically significant

Table 4. Association between Risk factors and Holter report

Indication	Holter Report		p-value
	Abnormal	Normal	
Smoking	No	90(69.2%)	0.01*
	Yes	40(30.8%)	
Hypertension	No	97(74.6%)	0.03*
	Yes	33(25.4%)	
Diabetes	No	117(90.0%)	0.92
	Yes	13(10.0%)	
Dyslipidemia	No	120(92.3%)	0.41
	Yes	10(7.7%)	
Cardiac Disease	No	99(76.2%)	0.001*
	Yes	31(23.8%)	
Age	Elderly (>65)	60 (46.2%)	<0.001*
	Age ≤ 65	70 (53.8%)	
	No (BMI<25)	126 (97%)	0.67
	Yes (BMI ≥25)	4 (3%)	
Miscellaneous	No	113(86.9%)	0.19
	Yes	17(13.1%)	
Psychiatric Illness	No	126(96.9%)	0.021*
	Yes	4(3.1%)	

*Statistically significant

DISCUSSION

Palpitation was the most common indication for Holter monitoring, followed by dizziness and syncope. In a study by Doku et al., the most common indications (symptoms) for Holter monitoring were palpitation (62.9%) and dizziness (34.0%).⁷ Adebayo et al. found that the commonest indication of Holter

monitoring was palpitation (40.3%) followed by syncope (15.7%).⁸ Similar studies done in Nepal by Karki et al. have also shown palpitation (65.4%) to be the most common indication, followed by dizziness (23.1%) and presyncope (7.7%) and syncope (3.8%).⁹ One of the peculiar findings of this study is that unexplained neurological events

Table 5. Association between type of arrhythmia and symptoms

Symptoms	VPCs	APCs	SVTs	VAs	Sinus Bradycardia	Sinus Pause	Heart Block
Palpitation	116 (59.5%)	106 (60.2%)	15 (45.5%)	1 (16.7%)	0 (0.0%)	0 (0.0%)	13 (37.1%)
Dizziness	41 (21.0%)	34 (19.3%)	4 (12.1%)	3 (50.0%)	1 (16.7%)	0 (0.0%)	10 (28.6%)
Unexplained neurological symptoms	21 (10.8%)	15 (8.5%)	8 (24.2%)	0 (0.0%)	1 (16.7%)	0 (0.0%)	5 (14.3%)
Syncope	14 (7.2%)	16 (9.1%)	6 (18.2%)	2 (33.3%)	4 (66.7%)	10 (100.0%)	6 (17.1%)
Miscellaneous	3 (1.5%)	5 (2.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (2.9%)
p-value	0.254	0.629	0.008*	0.053	<0.0001*	<0.0001*	0.082

*Statistically significant

were one of the important indications for Holter monitoring reported in 14.3% of patients, unlike in other studies. This is likely because this study was conducted at a tertiary care hospital that also provides care to a significant number of neurological patients from all around the country.

Abnormal Holter reports were observed in 130 patients (49.1%). This finding is similar to the diagnostic yield of Holter monitoring in symptomatic patients reported in several studies which range between 33 % to 55%^{6,10,11}. VPC and APC were the most common reports observed in Holter reporting. In a study in Nepal by Paudel et al, among the 335 patients undergoing 24-hour Holter monitoring for unexplained palpitation, VPCs were the most common abnormalities seen in 57 % of patients followed by APCs and SVTs.¹² Similar findings were observed in studies by Adebola et al¹³ and Pandey et al¹⁴ VPCs and APCs are usually seen as benign, particularly when they are infrequent (i.e., class 1). However, frequent VPCs and APCs may be a precursor of more severe potentially life-threatening arrhythmias. A higher VPC burden is an independent risk factor for cardiovascular death.¹⁵

Statistically significant abnormal Holter report was seen in elderly age group. Adebola et al also showed increasing age was associated with increased prevalence of abnormal Holter report while sex had no association with Holter report.¹³ The elderly population has a higher risk of arrhythmias due to age-related changes in cardiac function and overall health status.¹⁶ Structural alterations, including fibrosis and remodelling of cardiac tissue, interfere with electrical signals, whereas degeneration of the sinus node and conduction pathways lead to slower or irregular impulses.¹⁶ Advancing age also increases the incidence of comorbidities such as hypertension, coronary artery disease, and diabetes, all of which augment the risk of arrhythmia.

Smoking, hypertension, and preexisting cardiac disease were also found to have a statistically significant association with abnormal Holter reports. Several studies have shown that smoking increased the incidence of supraventricular tachycardia (SVT) including AF, ventricular tachycardia (VT), and early after depolarisations similar to the findings of this study.¹⁷⁻¹⁹ Smoking elevates the risk of cardiac arrhythmias due to a confluence of structural, electrical, and neurological remodeling of the heart. Fibrosis induced by nicotine and the activation of nicotinic acetylcholine receptors are regarded as the common substrates for arrhythmogenesis.²⁰ Systemic hypertension and preexisting cardiac disease such as coronary artery disease, heart failure, valvular heart disease, and cardiomyopathy, markedly elevate the risk of arrhythmias by causing structural and electrical alterations in the

heart. Hypertensive heart disease leads to structural changes and left ventricular hypertrophy, resulting in subsequent electrophysiological changes in both ventricular and atrial myocardial tissue.²¹ Preexisting cardiac conditions, such as myocardial infarction and heart failure, lead to scarring, fibrosis, and remodelling of the heart, disrupting electrical pathways and promoting arrhythmogenic regions.²²

Among all the symptoms, syncope was the only symptom that was associated with a higher prevalence of clinically significant arrhythmias in Holter monitoring whereas palpitation had more normal reports. However, Adebola et al reported a significant association of both palpitation and presyncope/ syncope with abnormal Holter reports.¹³ In a study by Karki et al, none of the symptoms were significantly associated with abnormal Holter reports.⁹

With regards to the association of type of arrhythmia and its clinical presentation, only supraventricular arrhythmias, sinus bradycardia, and sinus pause were statistically significant. Supraventricular tachycardias mostly presented with palpitations. Similarly, patients with Sinus bradycardia and sinus pause usually present with syncope. Sinus pause was exclusively associated with syncope in all 10 patients (100 %). Ectopic beats (VPCs and APCs) were the most common abnormality in the patient presenting with any of the symptoms, such as palpitations, dizziness, syncope, or unexplained neurological symptoms. So, regardless of the symptoms of the patient, ectopic beats (VPCs/APCs) were the most prevalent arrhythmia. So, none of the symptoms were associated with a specific type of arrhythmia. Similar to this study Zides et al. found that no particular symptom or combination of symptoms was more predictive of a specific arrhythmia.²³

CONCLUSION

The most common indication for 24 hours Holter monitoring was palpitation. Most common abnormality detected in 24 hours Holter monitoring was VPCs. SVTs usually presented with palpitations, whereas sinus bradycardia and sinus pause usually presented with syncope. Increasing age, smoking, hypertension, and preexisting cardiac disease were significantly associated with abnormal Holter reports. Among all the symptoms, syncope was the only symptom that was associated with a higher prevalence of clinically significant arrhythmias in Holter monitoring. None of the symptoms were associated with a specific type of arrhythmia.

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CONFLICT OF INTEREST

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AUTHOR CONTRIBUTIONS

Research Concept: HS, SBC, RMG; Research design: HS, SBC, RMG; Literature review: HS, SBC; Data Collection: SBC, SB; Data Analysis: HS, SBC, BB, SB; Statistical analysis: HS, SBC, BB, SB; Manuscript preparation: HS, SBC, RMG.

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