COMPREHENSIVE CARDIAC ASSESSMENT IN ACUTE ISCHEMIC STROKE PATIENTS: INTEGRATING ELECTROCARDIOGRAM AND 2-DIMENSIONAL TRANSTHORACIC ECHOCARDIOGRAPHY FOR ENHANCED DIAGNOSIS AND RISK STRATIFICATION

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ABSTRACT:

Background: Acute ischemic stroke continues to be one of the top causes of death worldwide, necessitating precise diagnostic techniques for effective treatment. Due to the lack of precise markers, clinical distinction of stroke subtypes is currently difficult. Integrating cutting-edge imaging methods like 2-Dimensional Transthoracic Echocardiography (2D TTE) and Electrocardiogram (ECG) could yield insightful results.

Materials and Methodology: In the prospective observational study, we looked at 2D TTE and ECG changes in 96 patients who had an acute ischemic stroke. Within 72 hours of admission, patients were evaluated, with an emphasis on 2D TTE findings (normal, left ventricular dysfunction, mitral valve abnormalities, and aortic valve abnormalities) and ECG abnormalities.

Results: T wave inversion (30.2%), ST-segment depression (38.5%), and U waves (53.1%), among other ECG anomalies, were among the numerous. 44.8% of the cases with 2D TTE were normal, 34.3% had left ventricular dysfunction, and 14.5% had defective mitral valves. Across age categories, notable ECG and 2D TTE findings were seen, highlighting the value of thorough evaluations.

Conclusion: Combining 2D TTE and the ECG to diagnose acute ischemic stroke can reveal subtle cardiac involvement. These techniques support risk classification and subtype identification, particularly with relation to ASCVD risk factors. For accurate risk assessment and customized treatment options, routine ECG and 2D TTE evaluation is essential.

Keywords: Atherosclerotic Cardiovascular Disease, Electrocardiogram, 2-Dimensional Transthoracic Echocardiography, Cardiac Abnormalities, and Risk Stratification

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INTRODUCTION -

Stroke, a sudden onset of neurological impairments caused by vascular issues, stands as a leading cause of global mortality, claiming millions of lives annually. Its primary

classifications, ischemic and haemorrhagic strokes, necessitate distinct treatments. However, clinical differentiation between these types remains challenging due to the absence of specific markers. Precise evaluation methods are imperative to optimize treatment outcomes *(Mwita et al., 2014).*

The lack of clear clinical differentiators for stroke subtypes poses significant challenges for swift and accurate treatment. Ischemic strokes, resulting from arterial blockages, demand thrombolytic or antiplatelet therapies. In contrast, haemorrhagic strokes require interventions to control bleeding. Presently, the prevailing diagnostic approach involves standard CT scans and clinical assessments. However, this method lacks the finesse required for optimal treatment *(Devarapu & S., 2018).*

Cutting-edge technologies, such as diffusion weighted and perfusion weighted MRI, xenon CT, SPECT, and PET scans, hold promise in revolutionizing stroke diagnosis. These sophisticated imaging techniques offer intricate insights into stroke types and causes, enabling tailored treatment strategies. However, their widespread availability remains a future prospect, leaving a gap in current diagnostic capabilities.

Researchers have delved into the integration of Electrocardiogram (ECG) and 2-Dimensional Transthoracic Echocardiography (2D TTE) to enhance stroke diagnosis *(Elliott & Smith, 2010).* Previous studies have revealed that stroke patients exhibit ECG changes like ST-T alterations, QTc prolongation, and abnormal U waves even without underlying cardiac issues. Additionally, 2D TTE and Doppler evaluations have detected various cardiac abnormalities post-stroke, including left ventricular dysfunction and valvular diseases *(Sandercock et al., 1985).*

The presence of ECG abnormalities in stroke patients, irrespective of existing cardiac conditions, underscores the intricate link between neurological and cardiovascular systems. Detecting these changes offers valuable diagnostic clues, aiding in the differentiation of stroke subtypes. For example, specific ECG alterations often accompany ischemic strokes, aiding in their identification and differentiation from haemorrhagic strokes *(Sheta et al., 2012).*

2D TTE and Doppler evaluations provide comprehensive insights into cardiac structures and functions. Analyzing wall motion abnormalities can unveil vital information about the heart's post-stroke condition. Identifying specific patterns, such as mitral valve prolapse or aortic valvular issues, facilitates a deeper understanding of the underlying stroke pathophysiology, guiding appropriate treatments and interventions *(Allder, 2003).*

Despite advancements, there remains a critical need for extensive studies correlating ECG and echocardiographic findings with specific stroke subtypes. These studies could establish definitive connections between particular ECG changes, cardiac irregularities, and stroke types. Integrating these findings with clinical data creates a holistic diagnostic approach, enhancing the accuracy of stroke subtype identification *(Amarenco et al., 2009).*

The integration of ECG and echocardiographic evaluations with clinical data and advanced imaging techniques signifies the dawn of precision medicine in stroke diagnosis. Tailoring treatments based on individual patient profiles, considering both neurological and cardiac aspects, holds the promise of vastly improved outcomes and reduced mortality rates *(Purushothaman et al., 2014).*

The integration of ECG and echocardiographic evaluations presents a promising avenue for refining stroke diagnosis. When coupled with advanced imaging technologies and clinical data, these methods can significantly enhance the accuracy of stroke subtype identification. As research in this field advances, the medical community edges closer to a future where personalized stroke treatments become standard practice (Dogan et al., 2004). This progress not only saves lives but also alleviates the global burden of stroke-related morbidity and mortality, marking a monumental stride towards a healthier world. Therefore, the objective of this study is to investigate changes in the electrocardiogram and the 2-Dimensional Transthoracic Doppler echocardiogram in people who have recently experienced an ischemic stroke.

MATERIALS AND METHODOLOGY -

The study, which focused on 96 individuals, was conducted at the Krishna Institute of Medical Sciences, admitted to the hospital's Intensive Care Unit and meeting specific criteria. These individuals, diagnosed with acute ischemic stroke through clinical examinations and brain CT scans, were assessed within 72 hours of admission. The study, conducted over 18 months, was observational and non-interventional in nature, concentrating on analyzing ECG and alterations in stroke patients' 2-Dimensional Transthoracic Doppler Echocardiograms.

The study looked at several ECG alteration types, each of which happened in the patient group with a certain frequency. QTc prolongation (50% prevalence, 96 participants required), T wave inversion (32% prevalence, 61 participants needed), ST segment depression (36% prevalence, 69 participants needed), and U waves (31% prevalence, 59 participants needed) were some of these abnormalities. For the study to reach firm findings on the incidence of ECG anomalies in sufferers of acute ischemic stroke, these ratios and the matching sample sizes were required.

The study investigated the frequency of the 2-Dimensional Transthoracic Echocardiogram and Doppler changes in the patient group. These alterations included left ventricular dysfunction (present in 35% of cases, involving 67 patients), mitral valve abnormalities (observed in 16% of patients, totalling 30 individuals), aortic valve issues (found in 6% of cases, affecting 11 patients), and normal cardiac conditions (identified in 44% of patients, totalling 84 individuals). These percentages offered valuable insights into the frequency of these cardiac conditions within the studied patient group.

Inclusion criteria involved conscious and oriented patients admitted within 72 hours of stroke onset, as confirmed by CT scans. Patients willing to participate and providing either written or attender-assisted consent were included. Exclusions encompassed cases related to traumatic neurological deficits, infections, or neoplastic causes of cerebrovascular accidents. Additionally, patients admitted beyond the 72-hour window were excluded due to the rarity of observed ECG changes during this period. Unconscious, non-oriented patients lacking attender-assisted consent were also not part of the study.

A 2-Dimensional Transthoracic Doppler Echocardiogram and an ECG were performed on each subject. Microsoft Excel 2010 was used to arrange the obtained data. Quantitative information was displayed in multiple formats, including mean, median, mean with standard deviation, and standard deviation alone. Qualitative data was represented as percentages or proportions. Statistical analysis was conducted using SPSS software version 21 and OpenEpi

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Software Version 2.3. For quantitative data, significance tests such the student t-test were utilized, whereas the Chi-square test was used for qualitative data.

RESULTS -

In this prospective observational research, 96 individuals diagnosed with acute ischemic stroke participated. Of these, 70.8% were male, and 29.2% were female, resulting in a ratio of 2.42:1 between men and women. Most patients belonged to the 61 to 80 years age group (43.75%), with the 41 to 60 years age group following closely (35.42%). Patient ages ranged from 22 to 62 years.

Concerning associated conditions, hypertension affected 42.71% of patients, making it the most prevalent, followed by type 2 diabetes mellitus (13.54%) and smoking habits (29.17%). Regarding specific ECG findings, 30.2% displayed 'T' wave inversion, and 38.5% exhibited ST-segment depression. 'U' waves were observed in 53.1% of the patients. Sinus tachycardia was found in 37.5% of cases, whereas sinus bradycardia occurred in only 1.04% of patients.

Table 1: ECG results in acute ischemic stroke patients

ECG	Patients out of 96	Percent
'T' wave Inversion	28	29.2
ST-segment Depression	38	39.6
'U' wave	50	52.1
Sinus Tachycardia	37	38.5
'Qtc' prolongation	11	11.5
Sinus Bradycardia	2	2.1

In the analysis of 2-Dimensional Transthoracic Echocardiogram and Doppler results, 44.8% of patients had normal findings. In 34.3% of instances, there was evidence of left ventricular dysfunction, and in 14.5% of patients, there was evidence of mitral valve abnormalities. An defective aortic valve was found in 6.2% of patients. Significantly, left ventricular dysfunction was the most frequently observed abnormality during the echocardiographic assessment.

Table 2: Acute ischemic stroke patients' two-dimensional transthoracic echocardiogram and Doppler results

Findings from a 2-dimensional transthoracic echocardiogram and Doppler	(n=96)	Percent
Normal	45	46.9
Left Ventricular Dysfunction	31	32.3
Mitral Valve Abnormality	12	12.5
Aortic Valve Abnormality	8	8.3

This study involved 96 patients diagnosed with acute ischemic stroke, and a significant majority (53.12%) exhibited abnormal Electrocardiogram (ECG) results. Among these patients, those aged 61 to 80 years displayed noticeable ECG abnormalities, closely followed

by the 41 to 60 years age group. Surprisingly, even individuals in the 21 to 40 years age group showed some irregularities in their ECGs.

Furthermore, among the total 96 patients with acute ischemic stroke, 54.16% had noteworthy 2-Dimensional Transthoracic Echocardiogram and Doppler findings. individuals between the ages of 41 and 60 made the most noteworthy findings, with individuals between the ages of 61 and 80 also showing noteworthy results. Remarkably, even individuals in the 21 to 40 years age group exhibited minimal 2-Dimensional Transthoracic Echocardiogram and Doppler abnormalities.

Among the 14 patients diagnosed with Mitral Valve Abnormalities, the majority (57.1%) had Mitral Valve Stenosis, followed by 28.6% with mitral regurgitation, and 14.3% with mitral valve prolapse. Similarly, among the 6 patients with atrial wall abnormalities, most (66.6%) had atrial wall stenosis, while 16.7% exhibited atrial regurgitation and bicuspid aortic valve. Based on the Mitral Valve Area (MVA), the severity of mitral valve stenosis was categorized as mild, moderate, or severe. Two of the eight cases of mitral stenosis were mild, four were intermediate, and two were severe.

Table 3: Mitral Valve Abnormalities in patients with acute ischemic stroke

Mitral Valve Abnormalities	(n=14)	Percent
Mitral Stenosis	8	57.1
Mitral Regurgitation	4	28.6
Mitral Valve Prolapse	2	14.3
Total	14	100

Six patients showed abnormalities in their atrial walls, with the majority (66.6%) having atrial wall stenosis, followed by 16.7% displaying atrial regurgitation and bicuspid aortic valve. Based on measurements of the mitral valve area (MVA), the severity of mitral valve stenosis was divided into mild, moderate, and severe categories. Mild cases had an area of >1.5 cm^2, moderate cases ranged from 1 to 1.5 cm^2, and severe cases had an area of <1 cm^2. Among the total 8 cases of stenosis, 2 were mild, 4 were moderate, and 2 were severe Mitral Stenosis.

Table 4: Aortic Valve Abnormalities in patients with acute ischemic stroke

Aortic Valve Abnormalities	(n=6)	Percent
Aortic stenosis	4	66.6
Aortic regurgitation	1	16.7
Bicuspid Aortic valve	1	16.7
Total	6	100

Out of the 77 instances that tested positive for 2-Dimensional Transthoracic Echocardiogram and Doppler, 35 cases were in the 61–80 age range, followed by 26 cases in the 41–60 age range, 9 cases beyond 80 years old, and 7 cases below 40. Eight of the 18 positive electrocardiogram results instances were in the 41–60 age range, seven were in the 61–80 age

range, three were above 80, and one was under 40. The chi-square test yielded a p-value of 0.79, showing that there was no statistically significant association between these variables.

In terms of gender and results, 52 men and 25 women out of the 77 cases positive for 2-Dimensional Transthoracic Echocardiogram and Doppler. Out of the 18 positive cases with electrocardiogram results, 16 were men and 3 were women. A p-value of 0.07 for the chi-square test indicated that there was no statistically significant relationship between these connections. In terms of risk factors and the presence of abnormalities on the ECG and 2-D Echo and Doppler Study (2D Echo and Doppler), 63 instances showed with hypertension being the most prevalent associated risk factor (34.38%), followed by smoking (22.92%). Similar electrocardiogram results were seen in 19 patients, with smoking (6.25%) and hypertension (8.33%) being the most common risk factors.

Table 5. In the study group with acute ischemic stroke, risk factor profile and the presence of ECG, 2-D Echo and Doppler anomalies

Risk Factors	2-D Echo and Doppler		ECG		Total	
	n	percent	n	percent	n	percent
Hypertension	33	34.38	8	8.33	41	42.71
Diabetes Mellitus	8	8.33	5	5.21	13	13.54
Smoking	**22**	**22.92**	**6**	**6.25**	**28**	**29.17**

DISCUSSION -

This prospective observational study comprised 96 patients with acute ischemic stroke, of which 70.8% were men and 29.2% were women, assuming a ratio of 2.42:1 men to women. The participants, who ranged in age from 21 to 80 and had an average age of 33.86 years, were mostly in the 61 to 80 age group, closely followed by the 41 to 60 age group. According to studies by Venkataraman and Carlo, 41% and 71.8%, respectively, of the participants were above the age of 51. According to Tiago Tribolet de Abreu's study, there were 52.6% of men and a mean age of 73.6+8.7 years. According to Niveditha R's research, the average age was (58.4+13.7) years. *(Niveditha et al., 2017; de Abreu et al., 2005; Venkataraman et al., 1977)*

Risk factors were hypertension (42.7%), diabetes mellitus (13.5%), and smoking (29.2%), with diabetes mellitus exhibiting a substantial prevalence. Comparable investigations showed that various risk variables occurred at varied rates, with hypertension being particularly prevalent. 48% of patients in Carlo's study had hypertension, 12.5% had previously suffered a stroke, and 21% had diabetes mellitus *(Di Carlo et al., 2003).* According to Smith's research, increased rates of hypertension, diabetes mellitus, smoking, and a history of strokes were found in 87% of participants *(Smith et al., 2005).* According to Tiago Tribolet de Abreu's research, 4.1% of people smoked and 65.1% had hypertension, diabetes mellitus, or both *(de Abreu et al., 2005).* According to Niveditha R's study *(Niveditha et al., 2017),* 45% of people had hypertension, 13% had diabetes, and 28% were smokers.

Regarding Electrocardiogram (ECG) findings, 30.2% of the patients displayed 'T' wave inversion, 38.5% had ST-segment depression, 12.5% exhibited 'QTc' prolongation, and

53.1% showed 'U' waves. Sinus tachycardia was found in 37.5% of cases, while sinus bradycardia occurred in only 1.04% of patients. These results aligned with prior studies, which also reported a range of ECG abnormalities in stroke patients. Ramani A et al(1990) identified common ECG abnormalities, including prolonged 'QTc', ST-segment depression, and abnormal 'T' waves *(Ramani et al., 1990).* Goldstein et al's study reported 32% with prolonged 'QTc', 15% with 'T' wave inversion, 13% with ST-segment depression, 28% with 'U' waves, 2% with tachycardia, and 8% with bradycardia *(Ramani et al., 1990*). In the research by *Tomar et al.,* participants had a prolonged QTc in 63.23%, a T wave inversion in 69.1%, an ST-segment depression in 969.1%, and U waves in 48.5% of cases. Using a 2-Dimensional Transthoracic Echocardiogram and a Doppler Study, the study further assessed the patients. 44.8% of the outcomes were normal, 34.3% indicated left ventricular dysfunction, 14.5% had mitral valve abnormalities, and 6.2% had aortic valve abnormalities, according to the findings. Among those with mitral valve abnormalities, 57.1% had mitral wall stenosis. Similarly, among patients with atrial wall abnormalities, 66.6% had atrial wall stenosis.

Comparing diagnostic effectiveness, the study suggested that 2-Dimensional Transthoracic Echocardiogram and Doppler Study performed better in diagnosing acute ischemic stroke compared to Electrocardiogram. Harris J et al's research revealed positive findings in 38% of echocardiograms *(A P S et al., 2014).* A significant amount of the subjects in research by *Niveditha R et al.,* had left ventricular dysfunction. In addition, a large percentage of individuals in another study done by *Uma N et al.,* had both mitral valve abnormalities and aortic valve abnormalities. In a different study, left ventricular dysfunction, abnormalities of the mitral valve, and abnormalities of the aortic valve were detected in the majority of individuals *(Tomar et al., 2017).*

This study underscores the superior diagnostic accuracy of 2-Dimensional Transthoracic Echocardiogram and Doppler Study in comparison to Electrocardiogram for diagnosing acute ischemic stroke. Niveditha R et al's findings indicated that 35% of stroke survivors had normal Electrocardiogram results, whereas 22.72% succumbed to a stroke. 43.59% of stroke survivors had abnormal 2-Dimensional Transthoracic Echocardiogram and Doppler Study results, compared to 56.41% who had normal results. Contrarily, only 9.09% of patients who died from a stroke had normal results from their 2-Dimensional Transthoracic Echocardiogram and Doppler Study, whereas 90.91 percent of them did. The statistical significance of this difference was 0.001 *(Niveditha et al., 2017).*

According to Tomar et al.'s study, aberrant electrocardiogram and 2-Dimensional Transthoracic Echocardiogram and Doppler Study findings were found in 71% of cases and 54% of cases, respectively *(A P S et al., 2014).* 56.41% of stroke survivors had normal findings from their 2-Dimensional Transthoracic Echocardiogram and Doppler Study, whereas 43.59% had problems. In contrast, only 9.09% of patients who died from a stroke had normal results from their 2-Dimensional Transthoracic Echocardiogram and Doppler Study, whereas 90.91 percent had adverse findings. According to Ramani et al. (1990), this difference was statistically significant (p<0.001).

Thus, this study highlights the varied cardiac abnormalities observed in acute ischemic stroke patients, underscoring the significance of both ECG and 2-Dimensional Transthoracic Echocardiogram and Doppler Study in diagnosing and comprehending these conditions.

CONCLUSION –

In the general population, atherosclerotic cardiovascular disease (ASCVD) is a substantial source of morbidity and death. Non-invasive bedside investigations like Electrocardiogram and 2D Echocardiogram provide essential insights into the cardiac implications of the atherosclerotic disease process. In our study, we noted common Electrocardiogram abnormalities such as ST-segment depression and 'T' wave abnormalities, along with prevalent Echocardiogram findings like Left Ventricular Dysfunction (LVD). These observations provide important indicators of ASCVD risk factors like Hypertension and Diabetes Mellitus, allowing for effective risk stratification methods. Additionally, electrocardiograms and echocardiograms are helpful tools for figuring out risk variables that apply to both acute ischemic stroke (AIS) and coronary artery disease (CAD). To improve the precision of risk assessment techniques, we advise regular electrocardiogram and 2D echocardiogram evaluations for all AIS patients.

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