Original Article

Exposing Subclinical Cardiac Dysfunction in Shift Workers Using Speckle Tracking Echocardiography

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ABSTRACT

Objective: To assess subclinical myocardial disorders in shift workers using Speckle tracking echocardiography, compare shift workers and day employees' left ventricular global longitudinal strain and right ventricular free wall longitudinal strain and investigate the relationship between myocardial stress and sleep quality.

Study Design: Cross-sectional study

Place and Duration of Study: This study was conducted at the Department of Physiology, Faculty of Medicine, University of Kufa from 1st October 2024 to 28th February 2025.

Methods: A total of 120 healthy adults were recruited for this cross-sectional study, 60 of whom were shift workers (including those who work nights) and 60 of whom were day workers, matched for age and sex. Every subject received a thorough echocardiographic evaluation, which included Speckle tracking echocardiography to assess the right ventricular free wall longitudinal strain and left ventricular global longitudinal strain. Standard echocardiographic measurements and surveys on work schedules and sleep quality were safeguarded by further tests.

Results: The left ventricular global longitudinal strain was significantly lower for shift workers (-18.4±2.3%) than for day workers (-20.3±1.5%, $p < 0.001$). One Likewise, shift workers had a decline in right ventricular free wall longitudinal strain (-22.1±2.7%) compared to day workers (-24.5±2.4%, $p <0.001$).The ejection fraction and chamber diameters, two common echocardiographic metrics, did not differ significantly between study groups. In shift workers, poor sleep was most closely associated with lower strain levels.

Conclusion: Even in the absence of overt cardiac illness, shift workers are linked to subclinical myocardial impairment that can be identified by Speckle Tracking Echocardiography. These results highlight the importance of early cardiac monitoring for shift workers in order to impose preventive measures.

Key Words: Shift work, Speckle tracking echocardiography, Subclinical cardiac dysfunction, Circadian rhythm, Myocardial strain

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INTRODUCTION

`A growing portion of today's workforce relies on shift labor to maintain continuous operations across a wide range of industries. Shift occupations, especially those involving night shifts, provide significant health risks even yet they are essential for economic productivity. Irregularworking hours have been linked to a number of harmful health effects, most notably cardiovascular diseases (CVD), by upsetting the body's natural circadian rhythm.[1]Circadian rhythms alter cardiovascular characteristics as well as a number of physiological processes. As shift workers demonstrate, a misalignment between endogenious circadian cycles and external environmental cues can lead to autonomic imbalance, metabolic disruptions, and inflammatory reactions, all of which increase the risk of cardiovascular disease.[2] Shift workers have been associated in epidemiological research with increased rates of stroke, coronary artery disease, and hypertension.[3]Conventional cardiovascular imaging diagnostics are unable to detect myocardial alterations before symptoms appear. A sensitive imaging technique that can identify distributed myocardial deformation and provide information on subclinical cardiac dysfunction is Speckle tracking echocardiography (STE).[4]

Speckle tracking echocardiography derived metrics, such as global longitudinal strain, can serve as early indicators of myocardial damage in asymptomatic individuals and have prognostic value in a variety of

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cardiac scenarios.[5]Few studies have examined the effectiveness of Speckle tracking echocardiographyin identifying early cardiac alterations in shift workers. Early measures to reduce long-term cardiovascular outcomes could be made easier with an understanding of subclinical myocardial changes in those individuals. This study examines efforts to evaluate myocardial characteristics in shift workers using Speckle Tracking Echocardiography, comparing results with those of day workers in order to identify potential subclinical heart disorders.

METHODS

This cross-sectional study was conducted on 120 healthy adults. Participants were split into two groups: 60 shift workers (who had worked night shifts and other rotating shifts for at least a year) and 60 day workers (who worked regular daylight hours). Excessive blood pressure, diabetes mellitus, established cardiovascular disease, and several chronic conditions were excluded.In order to use the Pittsburgh Sleep Quality Index (PSQI), participants filled out questionnaires on their demographics, work schedules routines, lifestyle choices, and sleep quality.

Transthoracic echocardiography was performed on each person using a standard protocol. Ejection fraction (EF), wall thickness, and chamber dimensions were all covered by standard measurements. Using specialized software, Speckle tracking echocardiographyis performed to evaluate left ventricular global longitudinal strain (LVGLS) andright ventricular free wall longitudinal strain (RVFWLS) using strain measurements averaged over three cardiac cycles.

Statistical Package for Social Sciences version 25 has been used to analyze the data.Unbiased t-tests were used to compare continuous variables, which were represented as indicate ± fashionable deviation. Chi-rectangular assessments have been used to compare categorical variables. Relationships between strain levels and assessments of sleep quality were evaluated using Pearson correlation analysis. A p-value below zero was considered P<0.05 statistically significant.

RESULTS

Participant Characteristics: Age and sex were matched among the groups. Compared to day workers, shift workers reported significantly lower levels of sleep satisfaction with 8±2.2 with high Pittsburgh Sleep Quality Index5.3±1.9 (<p0.001) [Table 1].

Table No. 1: Demographic and clinical characteristics

Variable	Shift worker (n=60)	Day worker (n=60)	p-value
Age (years)	38.8±5.5	39±5.9	0.6
Male	59%	59%	0.8
BMI (kg/m2)	26±2.6	25.7±3	0.5
PSQI score	8±2.2	5.3±1.9	<0.001
Smoking	28.2%	24.9%	0.7

Table No.2: Echocardiographic and Speckle tracking echocardiography(STE) parameters

Parameter	Shift worker (n=60)	Day worker (n=60)	p-value
LVEF (%)	61±3.7	62±3	0.3
LVGLS (%)	-18.4±2.3	-20.3±1.5	<0.001
RVFWLS (%)	-22.1±2.7	-24.5±2.4	<0.001

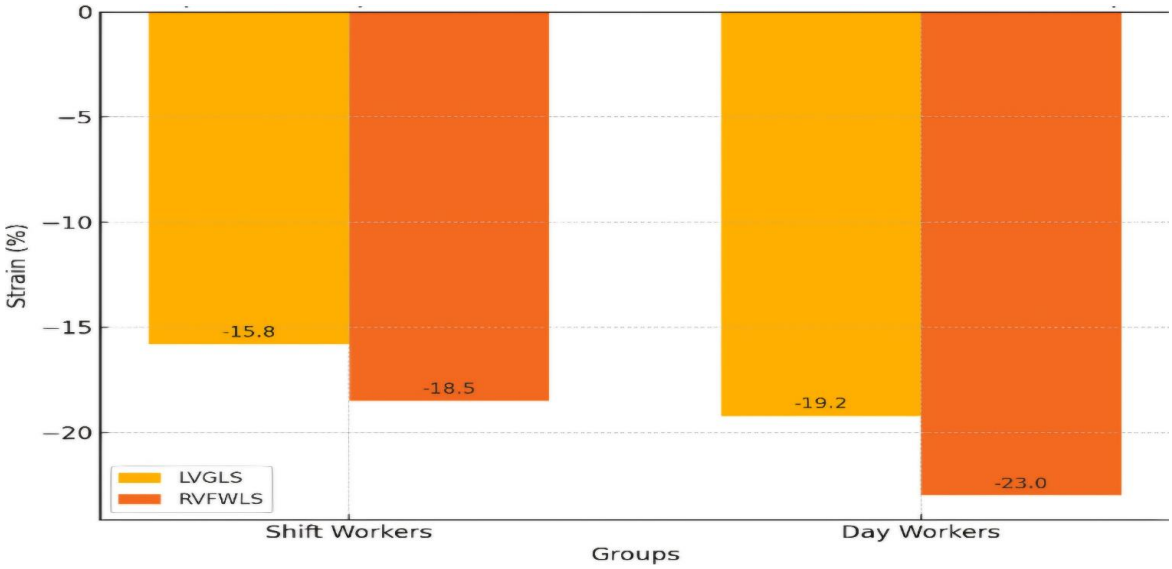

Figure No. 1: Comparison of left ventricular global longitudinal strain (LVGLS) and right ventricular free wall longitudinal strain (RVFWLS) between groups

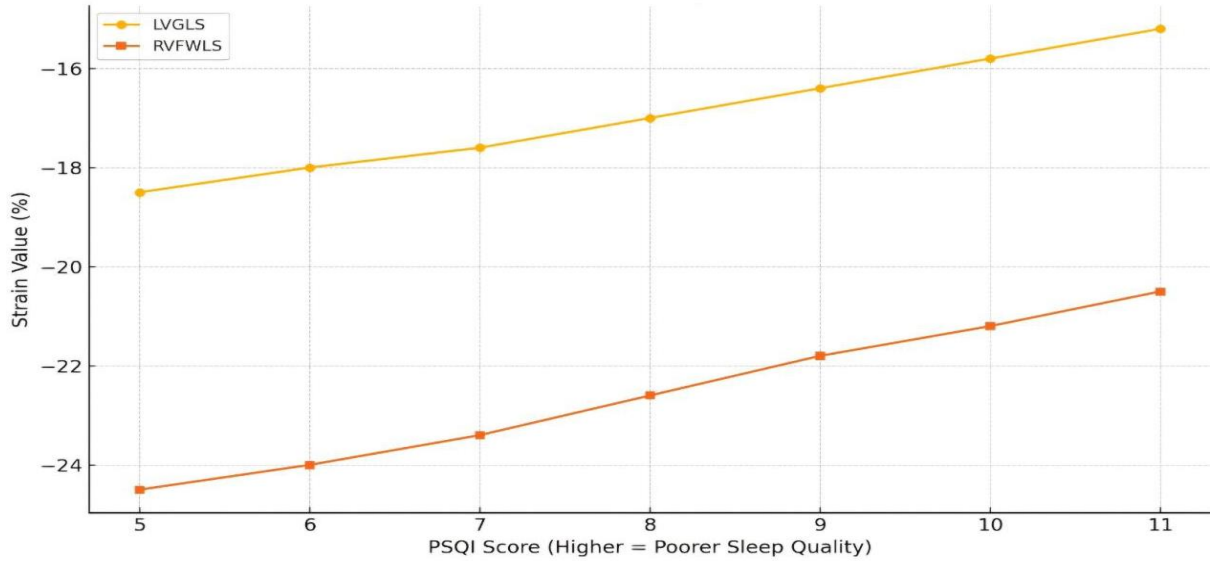

Figure No. 2: Correlation between Pittsburgh Sleep Quality Index(PSQI) and myocardial strain in shift workers

Echocardiographic findings: Standard echocardiogram parameters showed no significant change in chamber size and ejection fraction values but Speckle tracking echocardiography discovered significant differences (Table 2). Figure 1 Clearly indicating lower strain values in shift workers.

Correlation with Sleep Quality: Higher Pittsburgh Sleep Quality Indexscores, which indicate poorer sleep quality, have been significantly linked to lower left ventricular global longitudinal strain(r = 0.40, p 0.002) and right ventricular free wall longitudinal strain(r = 0.4, p 0.004) in shift workers, indicating that sleep disturbances may also worsen myocardial strain abnormalities even when there is no overt scientific illness (Fig. 2)

DISCUSSION

By showing that shift workers exhibit lower global longitudinal strain values detectable by Speckle tracking echocardiography (STE), even in the absence of overt cardiovascular disease, this observation offers new insight into the subclinical effects of shift work on myocardial function. These results are consistent with growing evidence that cardiovascular risk is influenced by disrupted circadian rhythms.[6]Despite the conserved ejection fraction, the observed decreases in left ventricular global longitudinal strain and right ventricular free wall longitudinal strainamong shift workers support early myocardial deformation and contractile dysfunction. This highlights how Speckle tracking echocardiographyis more sensitive than traditional echocardiographic measures at identifying myocardial disorders early on.[7]

This phenomena may also be caused by a number of processes, such as endothelial disorders linked to circadian disturbance, systemic inflammation, and chronic autonomic imbalance.[8,9]An indication of shift employment, circadian misalignment, can cause prolonged cardiac stress by impairing sympathetic-parasympathetic stability, increasing nocturnal blood pressure, and reducing night-time dipping.[10] The biological plausibility of our findings is enhanced by the evidence from animal studies that circadian gene disruption causes cardiac remodeling, fibrosis, and decreased contractility.[11]

Additionally, poor sleep is strongly associated with strain impairment and is much worse in the shift workgroup. Lack of sleep is linked to oxidative stress and prolonged inflammatory indicators (such as IL-6 and C-reactive protein), all of which have a detrimental influence on cardiac mechanics.[12,13] The complex character of cardiovascular stress in shift workers is affected by these facts.Our analysis emphasizes the subclinical spectrum of heart disorders, supporting early detection methods, whereas previous research has mostly focused on medical endpoints like hypertension or coronary events. Additionally, the application of Speckle tracking echocardiography(STE) in occupational health examinations may provide valuable predictive data and direct prompt actions.[14,15]To the best of our knowledge, this is among the first studies to confirm right ventricular (RV) and left ventricular (LV) strain in healthy shift workers, adding original data to the field. Even in the absence of structural abnormalities, the significant variation in strain readings highlights the hidden cardiovascular load on this population.

CONCLUSION

Early indicators of subclinical cardiac impairment as identified by Speckle tracking echocardiography(STE) are linked to shift workers, which mostly involve circadian disturbance and poor sleep quality. These findings undoubtedly enable preventative

cardiovascular methods by assisting with the integration of myocardial strain analysis into routine health opinions for shift workers.

Limitations: This examination has a number of challenges. First, causal inference is not possible because to its cross-sectional design. Second, the sample size restricts generalizability even though it is sufficient for first comparisons. Lastly, using single imaging modality (speckle Tracking Echocardiography) can miss useful information that could be gleaned via biomarkers or cardiac magnetic resonance imaging.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Asaad Hasan Noaman, Ali Ismail Qasim
Drafting or Revising Critically:	Asaad Hasan Noaman, Shaymaa AH Jasim
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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