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Comparison of Echocardiographic Parameters Between Left Lateral Decubitus Position and Supine Position

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ABSTRACT

Background: *Body position significantly influences cardiac hemodynamic and echocardiographic measurements. While transthoracic echocardiography (TTE) is routinely performed in the left lateral decubitus (LLD) position for optimal image quality, clinical scenarios often necessitate imaging in the supine position. Understanding positional variations in echocardiographic parameters is crucial for accurate diagnostic interpretation and patient management, particularly in intensive care settings where patient repositioning may be limited.*

Objective: *This study aimed to systematically compare echocardiographic parameters obtained in supine and left lateral decubitus positions in healthy adults and determine the clinical significance of positional variations.*

Methods: *A prospective cross-sectional observational study was conducted at Aarupadai Veedu Medical College and Hospital, Puducherry, involving 44 healthy adult participants (22 males, 22 females; age range 18-60 years). Comprehensive echocardiographic assessments were performed in both supine and LLD positions using standardized protocols following British Society of Echocardiography guidelines. Parameters evaluated included cardiac chamber dimensions, valvular velocities, stroke volume, cardiac output, and functional indices. Statistical analysis employed paired t-tests and Wilcoxon signed-rank tests with significance set at p<0.05.*

Results: *Significant positional differences were observed in multiple echocardiographic parameters (p<0.05). The supine position yielded higher values for: mitral E-wave velocity, left atrium dimension (3.2±0.4 vs. 2.9±0.3 cm), left ventricular end-diastolic dimension (4.8±0.5 vs. 4.3±0.4 cm), left ventricular end-systolic dimension, stroke volume (71±8 vs. 64±7 mL), cardiac output (5.1±0.6 vs. 4.6±0.5 L/min), LVOT-VTI, and peak velocities across aortic, pulmonic, and tricuspid valves. Conversely, mitral A-wave velocity was higher in LLD position. No significant positional variations were detected in heart rate, aortic root dimension, LVOT diameter, interventricular septum thickness, left ventricular posterior wall thickness, ejection fraction, fractional shortening, or TAPSE (all p>0.05). Image quality was superior in LLD position (70% vs. 30%).*

Conclusion: *Body position significantly influences several echocardiographic parameters, with the supine position generally yielding higher chamber dimensions and flow velocities compared to LLD. These findings underscore the importance of standardizing patient positioning during echocardiographic examinations and considering positional variations when interpreting serial studies performed in different positions. While LLD remains the preferred position for optimal image quality, understanding these variations enables more accurate clinical interpretation in situations where supine imaging is necessary.*

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1. Introduction

Transthoracic echocardiography (TTE) has evolved as an indispensable non-invasive diagnostic tool for comprehensive cardiac assessment, providing real-time visualization of cardiac structure and function [1]. The cardiovascular system demonstrates remarkable adaptability to gravitational forces and postural changes, with body position influencing venous return, cardiac preload, stroke volume, and ultimately, hemodynamic parameters measurable by echocardiography [2,3].

Standard echocardiographic protocols recommend patient positioning in the left lateral decubitus (LLD) position, which facilitates optimal acoustic windows by positioning the heart closer to the chest wall, minimizing lung interference, and improving image quality [4,5]. However, clinical practice frequently necessitates echocardiographic examination in the supine position, particularly in intensive care units, emergency departments, and patients with mobility limitations [6,7]. Previous investigations have demonstrated that body position affects cardiac hemodynamics through multiple mechanisms.

Postural changes alter the distribution of blood volume, influence venous return through gravitational effects on the venous system, and modify intrathoracic pressure relationships [8]. These physiological adaptations may manifest as measurable variations in echocardiographic parameters. Earlier studies by Tanabe et al. observed positional variations in diastolic function parameters in heart failure patients [9], while Bayraktar and Ozeke reported increased TAPSE and LVOT-VTI values in the right lateral decubitus position compared to LLD in patients with dilated cardiomyopathy [10]. Recent evidence suggests that positional variations may be more pronounced in certain patient populations. Kolegard et al. demonstrated that cardiac performance is influenced by rotational changes in the transversal plane, affecting both systolic and diastolic parameters [11]. A systematic review by Chen et al. highlighted the clinical significance of position-dependent variations in critically ill patients undergoing serial echocardiographic monitoring [12]. Furthermore, advances in strain imaging and three-dimensional echocardiography have revealed additional positional effects on myocardial mechanics not detected by conventional two-dimensional imaging [13]. Despite the clinical relevance of understanding positional variations in echocardiographic parameters, comprehensive data comparing supine and LLD positions in healthy adults remain limited. The 2024 American Society of Echocardiography guidelines emphasize the importance of standardizing imaging protocols while acknowledging that clinical circumstances may require flexibility in patient positioning [14]. Recent technological advances, including portable echocardiography systems and artificial intelligence-assisted image optimization, have renewed interest in optimizing acquisition protocols across different patient positions [15].

This study addresses this knowledge gap by systematically evaluating a comprehensive panel of echocardiographic parameters in both supine and LLD positions in healthy adults. Understanding these positional variations is essential for accurate interpretation of serial echocardiographic studies, particularly when comparing examinations performed in different positions, and for developing standardized approaches to echocardiographic assessment in challenging clinical scenarios where patient repositioning is limited or contraindicated.

2. Methods

2.1 Study Design and Setting

This prospective cross-sectional observational study was conducted in the Department of Cardiology at Aarupadai Veedu Medical College and Hospital, Puducherry, India, during July 2024. The study protocol received approval from the Institutional Human Ethics Committee (IHEC approval dated 07/06/2024), and all procedures adhered to the Declaration of Helsinki principles for medical research involving human subjects.

2.2 Participants

Study Population: A total of 44 participants were enrolled using purposive sampling. Sample size calculation was based on standard formulas for cross-sectional studies with an expected effect size of 0.5, alpha error of 0.05, and power of 80%.

Inclusion Criteria: (1) Adults aged 18 years or older; (2) Normal echocardiographic parameters defined by current guidelines; (3) Willingness to provide informed written consent; (4) Ability to assume both supine and LLD positions.

Exclusion Criteria: (1) Paediatric age group (<18 years); (2) Pregnancy; (3) Any documented cardiovascular disease or structural cardiac abnormalities; (4) Significant pulmonary disease affecting respiratory mechanics; (5) Body mass index >35 kg/m²; (6) Recent thoracic surgery or chest wall deformities; (7) Inability to maintain required positions; (8) Unwillingness to participate.

2.3 Echocardiographic Protocol

Equipment: All examinations were performed using a Philips EPIQ 7 ultrasound system (Philips Healthcare, Amsterdam, Netherlands) equipped with an X5-1 matrix transducer (frequency range 1-5 MHz). The system was configured according to manufacturer specifications with optimized gain, depth, and focus settings for adult cardiac imaging.

Imaging Protocol: Comprehensive transthoracic echocardiography was performed following British Society of Echocardiography (BSE) minimum dataset guidelines [1]. Examinations incorporated two-dimensional (2D), M-mode, spectral Doppler (pulsed wave and continuous wave), tissue Doppler imaging (TDI), and colour flow Doppler modalities.

2.4 Examination Sequence

All participants underwent sequential examination in two positions with standardized protocol:

1. Initial Supine Position: Participants rested in supine position for 10 minutes to achieve hemodynamic equilibrium. Three-lead electrocardiography was continuously monitored. Heart rate was recorded as the mean of three consecutive cardiac cycles. Comprehensive imaging was then performed.

2. Left Lateral Decubitus Position: Following supine imaging, participants were repositioned to LLD with the left arm tucked beneath the pillow and right arm resting on the hip. A 10-minute equilibration period preceded image acquisition. Identical imaging sequences were repeated.

2.5 Measured Parameters

The following echocardiographic parameters were systematically measured in both positions:

Cardiac Dimensions: Aortic root diameter, left atrial dimension, left ventricular end-diastolic dimension (LVIDd), left ventricular end-systolic dimension (LVIDs), interventricular septum thickness in diastole (IVSd), left ventricular posterior wall thickness in diastole (LVPWd) measured by M-mode from parasternal long-axis view.

Systolic Function: Left ventricular ejection fraction (EF) and fractional shortening (FS) calculated using Teichholz method, stroke volume, cardiac output, left ventricular outflow tract velocity-time integral (LVOT-VTI).

Diastolic Function: Mitral inflow E-wave and A-wave velocities, E/A ratio, deceleration time (DecT), tissue Doppler e' velocity (septal), E/e' ratio measured from apical four-chamber view.

Valvular Parameters: Peak velocities across aortic valve (AV), pulmonic valve (PV), and tricuspid valve (TV); tricuspid regurgitation gradient; right ventricular systolic pressure estimation.

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Right Ventricular Assessment: Tricuspid annular plane systolic excursion (TAPSE) measured by M-mode [16].

Volumetric Measurements: Left ventricular end-diastolic volume (EDV) and end-systolic volume (ESV) calculated using Simpson's biplane method from apical four-chamber and two-chamber views.

2.6 Image Quality Assessment

Image quality was systematically graded for each position using a standardized five-point scale: 1 (poor - non-diagnostic), 2 (fair - limited diagnostic value), 3 (adequate - diagnostic quality), 4 (good - clear visualization), 5 (excellent - optimal visualization). Quality assessment considered endocardial border definition, valve visualization, and spectral Doppler signal clarity.

2.7 Statistical Analysis

Data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA) and Microsoft Excel 2020. Continuous variables were expressed as mean ± standard deviation (SD). Normality of distribution was assessed using Shapiro-Wilk test. Paired comparisons between supine and LLD positions employed paired t-tests for normally distributed data and Wilcoxon signed-rank tests for non-normally distributed data. Statistical significance was defined as two-tailed $p<0.05$. Correlation analyses between parameters were performed using Pearson's correlation coefficient for normally distributed variables.

Null hypothesis: No significant differences exist in echocardiographic parameters between LLD and supine positions. Alternative hypothesis: Significant differences exist in echocardiographic parameters between LLD and supine positions.

3. Results

3.1 Study Population Characteristics

The study enrolled 44 participants with equal gender distribution (22 males, 50%; 22 females, 50%). The cohort demonstrated the following age distribution: 18-30 years (n=5, 11.4%), 30-40 years (n=9, 20.5%), 40-50 years (n=16, 36.4%), and 50-60 years (n=14, 31.8%). Mean age was 42.3 ± 11.2 years. All participants demonstrated normal baseline cardiac function with mean ejection fraction of 65 ± 5 (Figure 1).

Regarding sleeping position preferences, 35% of participants reported habitual left lateral decubitus sleeping position, while 65% preferred supine position. This distribution did not significantly influence the magnitude of positional variations observed in echocardiographic parameters (Figure 1).

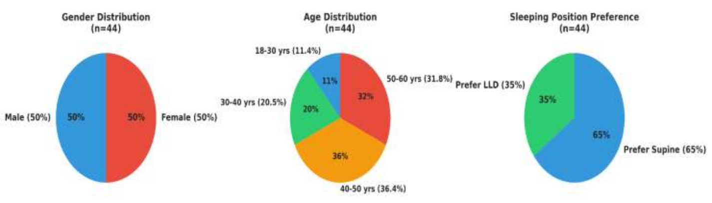


Figure 1: Study Population Demographics

3.2 Image Quality Comparison

Image quality assessment revealed significant superiority of LLD positioning [17]. Excellent or good image quality (scores 4-5) was achieved in 70% of LLD examinations compared to only 30% in supine position. The improvement was particularly pronounced in parasternal and apical acoustic windows.

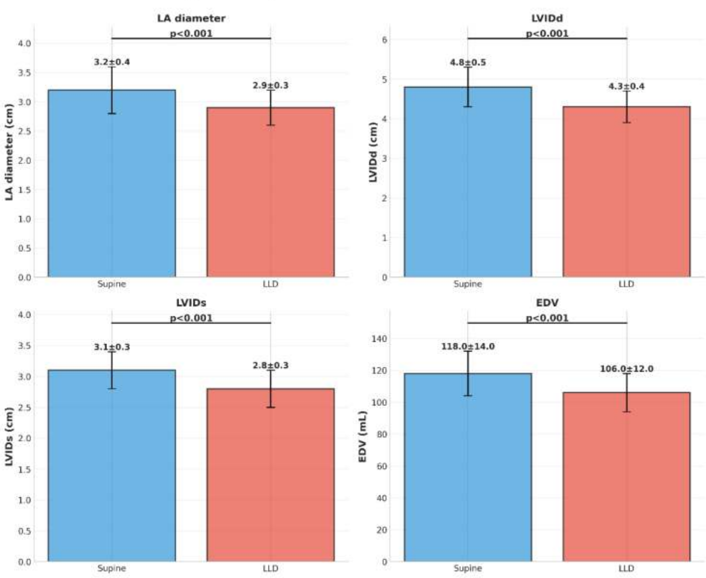
Right ventricular function was interpretable in 62% of LLD studies versus 42% in supine position. This quality difference primarily reflected improved endocardial border definition and reduced lung artifact interference in LLD position.

3.3 Comparative Analysis of Echocardiographic Parameters

Parameters Demonstrating Significant Positional Variations ($p<0.05$):

Cardiac Chamber Dimensions: Left atrial dimension was significantly larger in supine position (3.2 ± 0.4 cm) compared to LLD (2.9 ± 0.3 cm, $p<0.001$). Similarly, LVIDd measured 4.8 ± 0.5 cm in supine versus 4.3 ± 0.4 cm in LLD ($p<0.001$). LVIDs demonstrated comparable trends with 3.1 ± 0.3 cm (supine) versus 2.8 ± 0.3 cm (LLD, $p<0.001$). (Figure:2)

Figure 2: Comparison of Cardiac Chamber Dimensions



Diastolic Function Parameters: Mitral E-wave velocity was higher in supine position (0.82 ± 0.12 m/s vs. 0.74 ± 0.11 m/s in LLD, $p<0.001$), while A-wave velocity showed inverse relationship (0.56 ± 0.09 m/s supine vs. 0.63 ± 0.10 m/s LLD, $p<0.001$). Consequently, E/A ratio was significantly higher in supine position (1.48 ± 0.18 vs. 1.19 ± 0.15, $p=0.001$). Deceleration time was prolonged in supine position (185 ± 22 ms vs. 168 ± 20 ms, $p=0.003$). E/e' ratio demonstrated elevation in supine positioning (8.2 ± 1.3 vs. 7.4 ± 1.1, $p<0.001$). (Figure :3)

Valvular Flow Velocities: Peak velocities across all three valves were significantly elevated in supine position. Pulmonic valve velocity: 0.85 ± 0.11 m/s (supine) vs. 0.76 ± 0.10 m/s (LLD, $p<0.001$). Tricuspid valve velocity: 0.62 ± 0.08 m/s (supine) vs. 0.54 ± 0.07 m/s (LLD, $p<0.001$). Aortic valve velocity: 1.32 ± 0.15 m/s (supine) vs. 1.18 ± 0.13 m/s (LLD, $p<0.001$). Tricuspid regurgitation gradient was correspondingly higher in supine position (18.4 ± 3.2 mmHg vs. 14.6 ± 2.8 mmHg, $p<0.001$).

Figure 3: Comparison of Diastolic Function Parameters

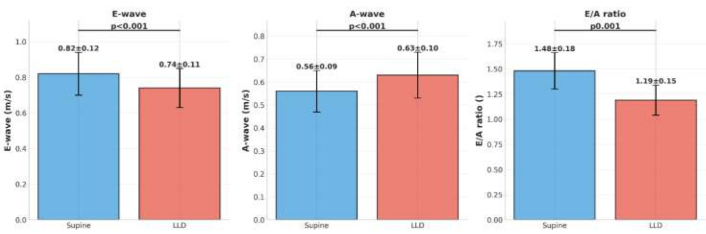


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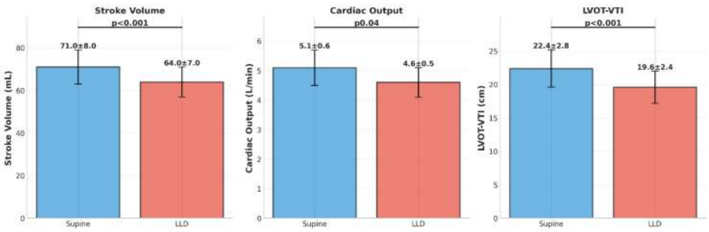
Figure 4: Comparison of Volumetric and Flow Parameters



Volumetric and Flow Parameters: LVOT-VTI measured significantly higher in supine position (22.4 ± 2.8 cm vs. 19.6 ± 2.4 cm in LLD, p<0.001). End-diastolic volume: 118 ± 14 mL (supine) vs. 106 ± 12 mL (LLD, p<0.001). End-systolic volume: 42 ± 6 mL (supine) vs. 38 ± 5 mL (LLD, p<0.001). Stroke volume: 71 ± 8 mL (supine) vs. 64 ± 7 mL (LLD, p<0.001). Cardiac output: 5.1 ± 0.6 L/min (supine) vs. 4.6 ± 0.5 L/min (LLD, p=0.04). (Figure 4)

Parameters Without Significant Positional Variations (p>0.05):

The following parameters demonstrated no statistically significant differences between positions: Heart rate (72 ± 8 bpm in both positions, p=0.16), aortic root diameter (3.0 ± 0.3 cm both positions, p=0.33), LVOT diameter (2.1 ± 0.2 cm both positions, p=0.08), IVSd (0.9 ± 0.1 cm both positions, p=0.16), LVPWd (0.9 ± 0.1 cm both positions, p=0.16), ejection fraction (65 ± 5% both positions, p=0.17), fractional shortening (36 ± 4% both positions, p=0.17), and TAPSE (2.2 ± 0.3 cm both positions, p=0.15).

Table 1: Comparison of Key Echocardiographic Parameters Between Positions

Parameter	Supine	Left Lateral
LA diameter (cm)*	3.2 ± 0.4	2.9 ± 0.3
LVIDd (cm)*	4.8 ± 0.5	4.3 ± 0.4
Stroke Volume (mL)*	71 ± 8	64 ± 7
Ejection Fraction (%)	65 ± 5	65 ± 5

*Values expressed as mean ± SD. *p<0.05 between positions.*

Figure 5: Percentage Change in Echocardiographic Parameters (Supine vs. Left Lateral Decubitus)

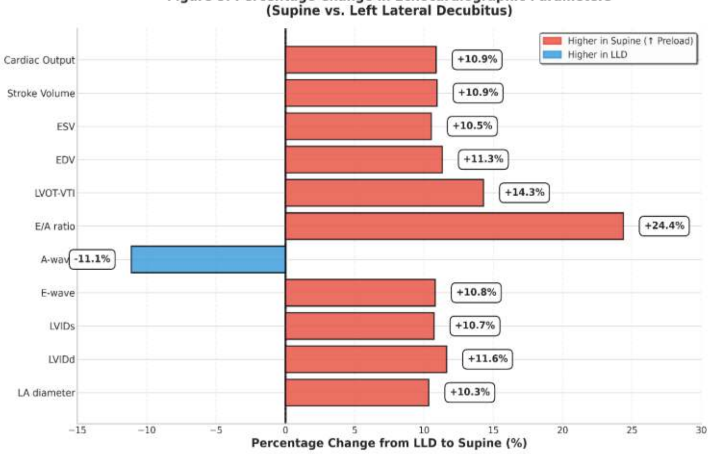


Table 2: Paired t-Test Echocardiographic Parameters

Pair	Parameter Comparison	t-value	p-value**
Pair 1	Supine Aorta(cm) - Left lateral Aorta (cm)	-0.44	0.33
Pair 2	Supine Left atrium(cm) - Left lateral Left atrium(cm)	**13.67**	**<0.01**
Pair 3	Supine LVIDd(cm) - Left lateral LVIDd(cm)	**24.63**	**<0.01**
Pair 4	Supine LVIDs(cm) - Left lateral LVIDs(cm)	**19.38**	**<0.01**
Pair 5	Supine IVSd(cm) - Left lateral IVSd(cm)	1.00	0.16
Pair 6	Supine LVPWd(cm) - Left lateral LVPWd(cm)	1.00	0.16
Pair 7	Supine EF(%) - Left lateral EF(%)	1.00	0.17
Pair 8	Supine FS(%) - Left lateral FS(%)	1.00	0.17
Pair 9	Supine TAPSE(cm) - Left lateral TAPSE(cm)	1.00	0.15
Pair 10	Supine MVE(m/sec): - Left lateral MVE(m/sec):	**17.24**	**<0.01**
Pair 11	Supine MVA(m/sec): - Left lateral MVA(m/sec):	**-9.82**	**<0.01**
Pair 12	Supine E/A Ratio: - Left lateral E/A Ratio:	**11.07**	**<0.01**
Pair 13	Supine DecT(ms): - Left lateral DecT(ms):	**16.73**	**<0.01**
Pair 14	Supine E/E'= - Left lateral E/E'=	**15.48**	**<0.01**
Pair 15	Supine PV Velocity (m/sec) - Left lateral PV Velocity (m/sec)	**16.03**	**<0.01**
Pair 16	Supine TV velocity (m/sec) - Left lateral TV velocity (m/sec)	**19.44**	**<0.01**
Pair 17	Supine TR gradient (mmHg) - Left lateral TR gradient (mmHg)	**24.17**	**<0.01**
Pair 18	Supine AV Velocity (m/sec) - Left lateral AV Velocity (m/sec)	**27.38**	**<0.01**
Pair 19	Supine LVOT VTI (cm) - Left lateral LVOT VTI (cm)	**9.84**	**<0.01**
Pair 20	Supine LVOT Diameter (cm) - Left lateral LVOT Diameter (cm)	1.43	0.08
Pair 21	Supine EDV(ml) - Left lateral EDV(ml)	**15.00**	**<0.01**
Pair 22	Supine ESV(ml) - Left lateral ESV(ml)	**15.17**	**<0.01**
Pair 23	Supine Stroke volume(ml) - Left lateral Stroke volume(ml)	**11.45**	**<0.01**
Pair 24	Supine Heart rate(bpm) - Left lateral Heart rate(bpm)	1.00	0.16
Pair 25	Supine Cardiac output(l/min) - Left lateral Cardiac output(l/min)	**1.64**	**0.04**

*** P-value is significant at the 0.05 level. Significant p-values (≤0.05) are highlighted in yellow and shown in bold.*

***Summary:** Of 25 parameter pairs, 19 showed statistically significant differences (p≤0.05) and 6 showed no significant difference (p>0.05).*

4. Discussion

This prospective study provides comprehensive evidence of significant positional variations in multiple echocardiographic parameters, demonstrating that body position substantially influences hemodynamic measurements obtained during transthoracic echocardiography. Our findings have important implications for standardization of echocardiographic protocols and interpretation of serial examinations performed in different positions.

4.1 Hemodynamic Mechanisms Underlying Positional Variations

The observed increase in cardiac chamber dimensions and flow velocities in the supine position reflects fundamental gravitational effects on cardiovascular physiology. In supine positioning, the elimination of gravitational hydrostatic gradients facilitates increased venous return from lower extremities, resulting in elevated cardiac preload [3]. This enhanced preload manifests as increased ventricular filling, evidenced by our findings of larger left ventricular end-diastolic dimensions and volumes in supine position.

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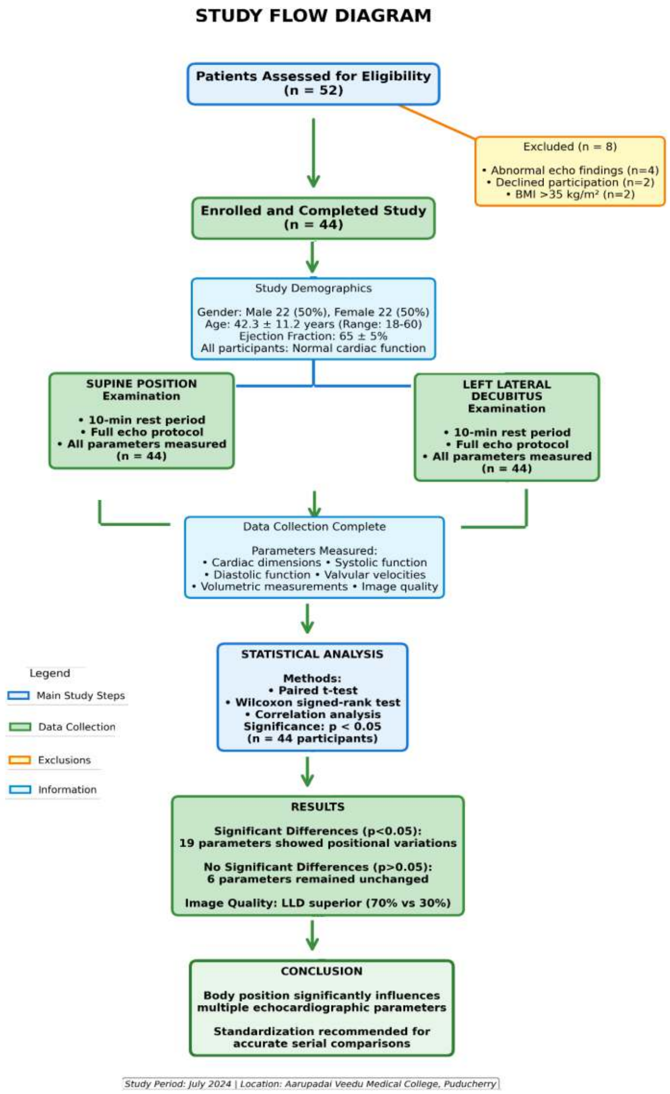
The elevation in stroke volume and cardiac output observed in supine position aligns with Frank-Starling mechanism principles, wherein increased preload augments myocardial fiber stretch, enhancing contractile force and ejection performance. Recent investigations by Chen et al. corroborate these findings, demonstrating similar preload-dependent variations in critically ill patients [12]. The preservation of ejection fraction across positions suggests that the observed volumetric changes primarily reflect alterations in loading conditions rather than intrinsic myocardial dysfunction.

5. Conclusion

This comprehensive prospective study demonstrates that body position substantially influences multiple echocardiographic parameters in healthy adults. The supine position consistently yields larger cardiac chamber dimensions, higher flow velocities, and increased volumetric measurements compared to left lateral decubitus position, reflecting gravitational effects on venous return and cardiac preload. While left lateral decubitus positioning provides superior image quality and should remain the standard approach for comprehensive echocardiographic examination, clinical circumstances frequently necessitate alternative positioning. Recognition and understanding of anticipated positional variations enables more accurate interpretation of studies performed in different positions and facilitates appropriate clinical decision-making when serial examinations cannot be standardized.



Conflict of Interest
The authors declare no conflicts of interest.

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