ISSN: 2457-0400

Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

www.wjahr.com

Volume: 10, Issue: 2

Page N. 104-112

Year: 2026

Original Article

Coden USA: WJAMA3

ECHOCARDIOGRAPHIC ASSESSMENT OF RIGHT-SIDED HEART IN PATIENTS WITH PULMONARY EMBOLISM

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Article Received: 01 January 2026 **Article Revised:** 22 January 2026 **Article Published:** 1 February 2026

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DOI: https://doi.org/10.5281/zenodo.18440710

How to cite this Article: *[1]Ahmed Saher Rasheed, [2]Mohammed Adnan Hussein (2026). Echocardiographic Assessment Of Right-Sided Heart In Patients With Pulmonary Embolism. World Journal of Advance Healthcare Research, 10(2), 104–112.

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ABSTRACT

Background: Pulmonary embolism (PE) is a life-threatening cardiovascular emergency caused by thrombi from the deep veins of the lower extremities blocking the pulmonary arteries. Early RV function evaluation is crucial for risk classification and therapy since RV dysfunction is connected to unfavorable outcomes. Two-dimensional (2D) echocardiography uses TAPSE, pulmonary artery pressures, the 60:60 sign, and McConnell's sign to quickly assess RV function at bedside. **Aim:** To investigate the role of 2D echocardiography in induced pulmonary embolism patients by measuring TAPSE as a mortality risk predictor, right heart and pulmonary architecture, the 60:60 sign, and RV contractility with a focus on McConnell's sign. **Patients and Methods:** This observational cross-sectional study was conducted in the intensive care unit of Baghdad Teaching Hospital between January and April 2024. Forty adult patients with CT-confirmed provoked pulmonary embolism were enrolled. Comprehensive echocardiographic assessment was performed using a GE Vivid E9 system, including measurements of TAPSE, RV size and function, tricuspid regurgitation (TR), pulmonary trunk diameter, inferior vena cava (IVC) size and collapsibility, and the presence of McConnell's and 60:60 signs. Demographic and clinical data were collected using a structured questionnaire. Statistical analysis was carried out with SPSS version 26, with significance set at $p \leq 0.05$. **Results:** The mean age of patients was 44.4 years, and 80% were female. Impaired TAPSE was observed in 50% of patients. McConnell's sign was present in 30%, and the 60:60 sign in 20%, both significantly associated with RV dysfunction. RV dilatation and IVC non-collapsibility were strongly linked to reduced TAPSE. A significant negative correlation was identified between TAPSE and the severity of tricuspid regurgitation. **Conclusion:** Provoked pulmonary embolism is frequently associated with significant right ventricular dysfunction. TAPSE, together with McConnell's sign and the 60:60 sign, provides valuable prognostic information and should be routinely assessed in PE patients.

KEYWORDS: Pulmonary embolism; Echocardiography; Right ventricular dysfunction; TAPSE.

INTRODUCTION

Pulmonary embolism (PE) is a major cardiovascular emergency characterized by obstruction of the pulmonary arterial tree, most commonly due to thrombi originating from the deep veins of the lower extremities. It remains a leading cause of cardiovascular morbidity and mortality worldwide and represents the third most frequent cardiovascular disorder after myocardial infarction and stroke.[1,2] The clinical spectrum of PE ranges from asymptomatic or mild disease to massive embolism associated with cardiogenic shock and sudden death. Early identification of patients at risk of adverse outcomes is therefore essential to guide management and improve survival. Right ventricular (RV) dysfunction is the principal determinant of prognosis in acute pulmonary embolism. Acute obstruction of the pulmonary vasculature leads to a sudden increase in pulmonary vascular resistance, resulting in RV pressure overload, dilatation, and impaired systolic function. This may compromise left ventricular filling and cardiac output, ultimately causing hemodynamic instability.[3,4] Consequently, rapid and accurate assessment of right-

sided cardiac function plays a pivotal role in risk stratification and therapeutic decision-making in PE patients. Echocardiography, particularly two-dimensional (2D) transthoracic echocardiography, has emerged as an invaluable non-invasive bedside tool for evaluating the hemodynamic consequences of PE. Although computed tomographic pulmonary angiography (CTPA) remains the gold standard for diagnosis, echocardiography provides critical information regarding RV size, function, and pressure overload, especially in unstable patients.[5] Among echocardiographic parameters, tricuspid annular plane systolic excursion (TAPSE) has gained considerable attention as a simple and reproducible measure of RV systolic function. TAPSE reflects the longitudinal shortening of the right ventricle and has been shown to correlate with RV ejection fraction and clinical outcomes. Reduced TAPSE has been independently associated with increased in-hospital mortality and worse prognosis in patients with acute PE.[6,7] In addition to TAPSE, comprehensive echocardiographic evaluation in PE includes assessment of the pulmonary artery, pulmonary trunk, right atrium, right ventricle, and inferior vena cava (IVC). These structures often demonstrate characteristic changes such as RV dilatation, elevated pulmonary artery pressures, tricuspid regurgitation, and reduced IVC collapsibility, all of which reflect increased right-sided pressures and volume overload.[8] Such findings help delineate the severity of embolic burden and guide the urgency and intensity of therapeutic interventions. More recently, the "60:60 sign," which combines a pulmonary artery acceleration time of less than 60 milliseconds with a tricuspid regurgitation gradient below 60 mmHg, has been proposed as a useful echocardiographic marker of acute PE-related hemodynamic compromise. This sign enhances diagnostic accuracy in distinguishing acute from chronic pulmonary hypertension and aids in bedside risk stratification.[9,10] Furthermore, McConnell's sign—defined as akinesia of the mid-free wall of the right ventricle with preserved apical contractility—has been described as a distinctive echocardiographic feature of acute massive PE. Although not highly sensitive, its presence strongly suggests acute RV strain and is associated with poorer outcomes.[11] Given the prognostic importance of right ventricular dysfunction in pulmonary embolism, integrating echocardiographic parameters such as TAPSE, the 60:60 sign, and McConnell's sign may provide valuable insight into disease severity and patient prognosis. This study was therefore designed to evaluate the role of 2D echocardiography in patients with provoked pulmonary embolism, with particular emphasis on right ventricular functional assessment and its prognostic implications.

METHOD

This observational cross-sectional study was conducted in the Intensive Care Unit (ICU) of Baghdad Teaching Hospital over a four-month period, from January 1 to April 31, 2024. The study aimed to evaluate right-sided cardiac function using transthoracic echocardiography in patients with confirmed pulmonary embolism. The study population consisted of 40 adult patients of both sexes who were admitted to the ICU with a diagnosis of provoked pulmonary embolism confirmed by computed tomographic pulmonary angiography (CTPA). All patients were evaluated during the acute phase of the disease. Inclusion criteria comprised patients with radiologically confirmed provoked pulmonary embolism who required ICU admission during the study period. Patients were excluded if they had chronic pulmonary diseases such as chronic obstructive pulmonary disease, congenital heart diseases affecting the right heart, or if they were unable to undergo echocardiographic assessment due to severe clinical instability. A convenient sampling technique was employed owing to the limited study duration and the availability of eligible patients during the study period. Echocardiographic examinations were performed using a GE Vivid E9 ultrasound system (GE Healthcare). Standard transthoracic echocardiographic views were obtained to assess right ventricular structure and function. Parameters evaluated included tricuspid annular plane systolic excursion (TAPSE), measured using M-mode from the apical four-chamber view, with values <17 mm considered indicative of right ventricular dysfunction. Additional assessments included the presence of McConnell's sign, the 60:60 sign (pulmonary acceleration time <60 ms and tricuspid regurgitation gradient <60 mmHg), tricuspid regurgitation severity, right ventricular size, pulmonary trunk diameter, inferior vena cava diameter and collapsibility, visualization of intracardiac or pulmonary thrombus, and interventricular septal configuration for detection of D-shaped septum. Data collection was conducted using a structured questionnaire that recorded demographic variables, relevant medical history (recent surgery, history of deep vein thrombosis, malignancy, family history of thrombophilia), and duration of symptoms, particularly shortness of breath prior to admission. Data were coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics were expressed as frequencies, percentages, means, and standard deviations. Inferential analysis included correlation tests and paired-sample ANOVA, with statistical significance set at $p \leq 0.05$. Ethical approval was obtained from the Ethical Committee of Baghdad College of Medicine. Verbal informed consent was obtained from all participants, and confidentiality of patient data was strictly maintained throughout the study.

RESULTS

Table 1 presents the demographic and clinical characteristics of the 40 patients treated in the Intensive Care Unit of Baghdad Teaching Hospital, diagnosed with pulmonary embolism by CT scan. The gender distribution shows a predominance offemale patients, accounting for 80% of the total (32 out of 40 patients), while male patients represent 20% (8 out of 40 patients). The ages of the patients ranged from 27 to 86 years, with a mean age of approximately 44.40 years and a standard deviation of

13.245 years. The duration of shortness of breath reported ranged from 3 to 7 days, with an average duration of approximately 4.88 days and a standard deviation of 1.436 days.

Table 1: Demographic and Clinical Characteristics of Patients.

Variables		No.	%
Sex	Female	32	80.0
	Male	8	20.0
Age (years)	mean±SD/Range	44.40±13.245 / 27-86 years	
Duration of shortness of breath	mean±SD/Range	4.88±1.436 / 3-7 days	

Table 2 outlines the past medical and surgical history of the patients. A substantial majority of the them, 34 (85%), reported no history of surgical interventions, while 6 (15%) had a surgical history. Regarding deep vein thrombosis (DVT), 34 (85%) of the patients had no previous episodes, and 6 (15%) reported such history. A total of 30 (75%) of the patients had no history of cancer, whereas 10 (25%) had a cancer history. Most patients, 38 (95%), reported no family history of blood clotting disorders, and only 2 (5%) had a positive family history. Hypertension was present in 4 (10%) of the patients, with 36 (90%) reporting no such condition. Diabetes mellitus was reported by 6 (15%), with the remaining 34 (85%) not having diabetes. Ischemic heart disease and atrial fibrillation were each reported by 2 (5%) of the patients, with 38 (95%) having no such conditions. Similarly, a history of COVID- 19 infection was found in 2 (5%) of the patients, with 38 (95%) having no such history. Lastly, pulmonary fibrosis was present in 4 (10%) of the patients, while 36 (90%) did not report this condition.

Table 2: Past Medical and Surgical History of Patients.

Past medical and surgical history		No.	%
Surgery History	No	34	85.0
	Yes	6	15.0
History of DVT	No	34	85.0
	Yes	6	15.0
Cancer	No	30	75.0
	Yes	10	25.0
Family History of BloodClotting Disorders	No	38	95.0
	Yes	2	5.0
Hypertension	No	36	90.0
	Yes	4	10.0
DM	No	34	85.0
	Yes	6	15.0
IHD	No	38	95.0
	Yes	2	5.0
AF	No	38	95.0
	Yes	2	5.0
COVID	No	38	95.0
	Yes	2	5.0
Pulmonary Fibrosis	No	36	90.0
	Yes	4	10.0

Table 3 lists study population echocardiographic parameters. Tricuspid Annular Plane Systolic Excursion (TAPSE) was normal for 18 (45%) patients, borderline for 2 (5%), and impaired for 20 (50%), with a mean of 17.00 and a standard deviation of 3.434 (table 3 and figure 1). Twelve (30%) patients had McConnell's sign, indicating regional RV dysfunction, while 28 (70%) did not.

Eight (20%) individuals had the 60/60 sign, which measures pulmonary hypertension. 32 (80%) did not. Tricuspid regurgitation (TR) jet severity was normal in 2 (5%), trace in 4 (10%), mild in 12 (30%), moderate in 18 (45%), and severe in 4 (10%), with a mean severity score of 1.90 and a standard deviation of 1.008. RV size was normal in 18 (45%) and dilated in 22 (55%), with a mean of 43.32 and an SD of 4.709. The pulmonary trunk was normal in 30 (75%) individuals and dilated in 10 (25%), with a mean size of 23.72 and an SD of 5.129. Twelve (30%) patients had thrombi, while 28 (70%) did not. Concerning the inferior vena cava (IVC), 22 (55%) were normal, 2 (5%) were dilated and collapsable, 10 (25%)

were non-collapsable, 4 (10%) were not, and 2 (5%) were not evaluated owing to operational reasons. D-shaped septums were seen in 18 (45%) individuals and normal in 22 (55%). No individuals died in the trial (40, 100%).

Table 3: Echocardiographic Parameters of Patients.

Echocardiographic parameters		No.	%
TAPSE	Normal	18	45.0
	Borderline	2	5.0
	Impaired	20	50.0
	mean±SD	17.00± 3.434	
McConnell'sSign	not seen	28	70.0
	present	12	30.0
60/60 Sign	not found	32	80.0
	present	8	20.0
TR Jet	Normal	2	5.0
	Trace	4	10.0
	Mild	12	30.0
	Moderate	18	45.0
	Severe	4	10.0
	mean±SD	1.90±1.008	
RV Size	Normal	18	45.0
	Dilated	22	55.0
	mean±SD	43.32±4.709	
PulmonaryTrunk	Normal	30	75.0
	Dilated	10	25.0
	mean±SD	23.72±5.129	
Thrombus	No	28	70.0
	Yes	12	30.0
IVC	normal	22	55.0
	dilated and collapsable	2	5.0
	dilated non collapsable	10	25.0
	not dilated noncollapsable	4	10.0
	not examined(operation)	2	5.0
D-shapedSeptum	d-shaped Septum	18	45.0
	normal	22	55.0
Outcome	alive	40	100.0
	dead	0	0.0

Figure 1 illustrates the Tricuspid Annular Plane Systolic Excursion (TAPSE) measurements categorized into three groups among the patients diagnosed with pulmonary embolism. The measurements are classified as normal for 18 patients, borderline for 2 patients, and impaired for 20 patients.

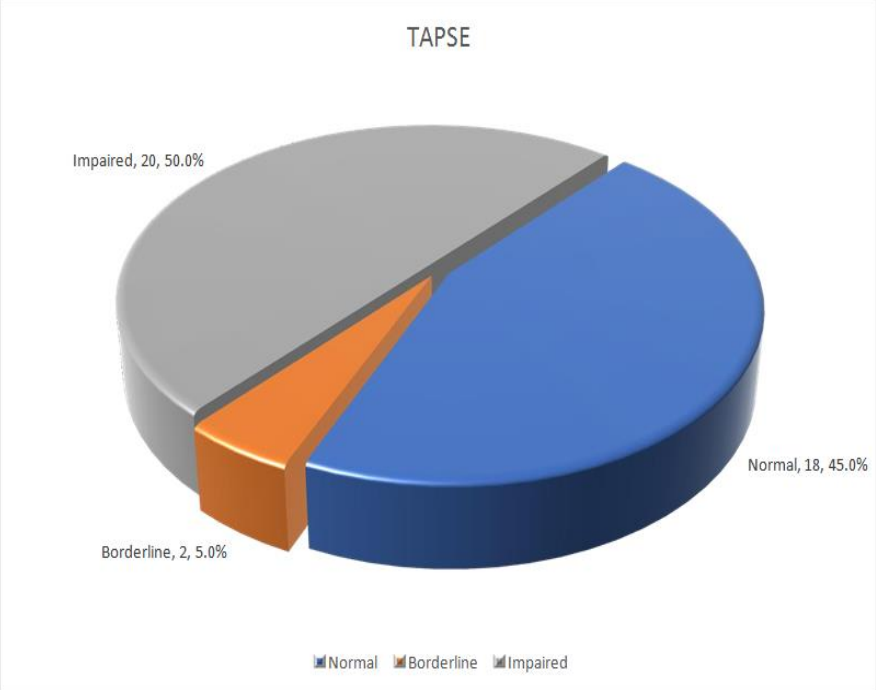

Figure 1: Distribution of TAPSE Among Patients with Pulmonary Embolism.

Table 4 shows patient Tricuspid Annular Plane Systolic Excursion (TAPSE) classifications by clinical factors. Females had 50.0% normal TAPSE, 6.3% borderline, and 43.8% impaired; men had 25.0% normal and 75.0% impaired, p-value 0.267. The mean TAPSE ages were 46.22 years for normal, 40.00 for borderline, and 43.20 for impaired, with a p-value of 0.706. The mean duration of shortness of breath was 5.83 days for normal, 5.50 days for borderline, and 3.95 days for impaired, strongly linked with TAPSE results (p=0.0001). Regarding surgery history, 41.2% of non-surgery patients had normal TAPSE, 5.9% borderline, and 52.9% impaired; 66.7% of surgery patients had normal and 33.3% impaired (p=0.477). Patients without DVT had 47.1% normal TAPSE, 5.9% borderline, and 47.1% impaired; those with DVT had 33.3% normal and 66.7% impaired (p=0.619). Patients without cancer had 53.3% normal TAPSE, 6.7% borderline, and 40.0% impaired; those with cancer had 20.0% normal and 80.0% impaired (p=0.085). For family history of blood coagulation problems, 42.1% without TAPSE was normal, 5.3% borderline, and 52.6% impaired; all individuals with such a history was normal (p=0.276).

Hypertension, diabetes, ischemic heart disease, atrial fibrillation, COVID-19 history, and pulmonary fibrosis were also assessed. These conditions have different percentages among TAPSE categories, suggesting they may affect results. Hypertension (p=0.884), diabetes (p=0.477), ischemic heart disease (p=0.349), atrial fibrillation (p=0.276), COVID-19 history (p=0.349), and pulmonary fibrosis (p=0.066) had statistical significance.

Table 4: Association of Clinical Variables with TAPSE Categories.

Variables		TAPSE						P value
		Normal		Borderline		Impaired		
		No	%	No	%	No	%	
Sex	Female	16	50.0%	2	6.3%	14	43.8%	0.267
	Male	2	25.0%	0	0.0%	6	75.0%	
Age (years)		46.22±9.626		40.00±		43.20±16.446		0.706
Duration of shortness of breath		5.83±1.249		5.50±2.121		3.95±0.887		**0.0001**
Surgery History	No	14	41.2%	2	5.9%	18	52.9%	0.477
	Yes	4	66.7%	0	0.0%	2	33.3%	
History of DVT	No	16	47.1%	2	5.9%	16	47.1%	0.619
	Yes	2	33.3%	0	0.0%	4	66.7%	
Cancer Hx	No	16	53.3%	2	6.7%	12	40.0%	0.085
	Yes	2	20.0%	0	0.0%	8	80.0%	
Family History of Blood Clotting Disorders	No	16	42.1%	2	5.3%	20	52.6%	0.276
	Yes	2	100.0%	0	0.0%	0	0.0%	

Hypertension	No	16	44.4%	2	5.6%	18	50.0%	0.884
	Yes	2	50.0%	0	0.0%	2	50.0%	
DM	No	14	41.2%	2	5.9%	18	52.9%	0.477
	Yes	4	66.7%	0	0.0%	2	33.3%	
IHD	No	18	47.4%	2	5.3%	18	47.4%	0.349
	Yes	0	0.0%	0	0.0%	2	100.0%	
AF	No	16	42.1%	2	5.3%	20	52.6%	0.276
	Yes	2	100.0%	0	0.0%	0	0.0%	
COVID	No	18	47.4%	2	5.3%	18	47.4%	0.349
	Yes	0	0.0%	0	0.0%	2	100.0%	
Pulmonary Fibrosis	No	14	38.9%	2	5.6%	20	55.6%	0.066
	Yes	4	100.0%	0	0.0%	0	0.0%	

Table 5 shows the distribution of TAPSE readings across echocardiographic and clinical factors in pulmonary embolism patients. 42.9% of non-McConnell's Sign patients showed normal TAPSE, 7.1% were borderline, and 50.0% were impaired, with no significant change (p=0.621). 50.0% of patients with McConnell's sign had normal and 50.0% impaired TAPSE. There was a strong link between the 60/60 Sign and TAPSE results. Those without the sign had normal and impaired TAPSE, whereas those with it had normal, borderline, and impaired TAPSE (p=0.012). TAPSE categories also affected TR Jet severity: normal or trace severity had 100% normal TAPSE, mild severity was evenly normal and impaired, moderate severity had 33.3% normal, 11.1% borderline, and 55.6% impaired, and severe severity had impaired TAPSE (p=0.082).

Also important was RV size, with 66.7% normal TAPSE in normal RV size and 33.3% impaired; dilated RV size revealed 27.3% normal, 9.1% borderline, and 63.6% impaired (p=0.032). Dilated pulmonary trunk conditions had 40.0% normal and 60.0% impaired TAPSE distribution (p=0.604). Normal trunk circumstances had 46.7% normal and impaired. A tendency toward TAPSE impairment was seen with 42.9% normal and 57.1% impaired in those without thrombi and 50.0% normal, 16.7% borderline, and 33.3% impaired in those with thrombi, reaching significance (p=0.057). Dilated and non-collapsable inferior Vena Cava (IVC) status was associated with TAPSE impairment in 100% of patients (p=0.001). TAPSE scores were similarly affected by D-shaped septum condition, with 33.3% normal, 11.1% borderline, and 55.6% impaired compared to 54.5% normal and 45.5% impaired in normal septum patients (p=0.162).

Table 5: Association of Echocardiographic and Clinical Variables with TAPSECategories

Variables		**TAPSE**						**P value**
		Normal		**Borderline**		**Impaired**		
		No	%	No	%	No	%	
McConnell's Sign	not seen	12	42.9%	2	7.1%	14	50.0%	0.621
	present	6	50.0%	0	0.0%	6	50.0%	
60/60 Sign	not found	16	50.0%	0	0.0%	16	50.0%	**0.012**
	present	2	25.0%	2	25.0%	4	50.0%	
TR Jet	Normal	2	100.0%	0	0.0%	0	0.0%	0.082
	Trace	4	100.0%	0	0.0%	0	0.0%	
	Mild	6	50.0%	0	0.0%	6	50.0%	
	Moderate	6	33.3%	2	11.1%	10	55.6%	
	Severe	0	0.0%	0	0.0%	4	100.0%	
RV Size	Normal	12	66.7%	0	0.0%	6	33.3%	**0.032**
	Dilated	6	27.3%	2	9.1%	14	63.6%	
Pulmonary Trunk	Normal	14	46.7%	2	6.7%	14	46.7%	0.604
	Dilated	4	40.0%	0	0.0%	6	60.0%	
Thrombus	No	12	42.9%	0	0.0%	16	57.1%	0.057
	Yes	6	50.0%	2	16.7%	4	33.3%	
IVC	dilated and collapsable	0	0.0%	0	0.0%	2	100.0%	**0.001**
	dilated non collapsable	4	40.0%	0	0.0%	6	60.0%	
	normal	14	63.6%	0	0.0%	8	36.4%	
	not dilated non collapsable	0	0.0%	2	50.0%	2	50.0%	
	not examined(operation)	0	0.0%	0	0.0%	2	100.0%	
D-shaped Septum	d-shaped Septum	6	33.3%	2	11.1%	10	55.6%	0.162
	normal	12	54.5%	0	0.0%	10	45.5%	

TAPSE showed a moderate, statistically significant negative correlation with TR jet severity ($r = -0.38$, $p = 0.016$), indicating that better right ventricular systolic function is associated with less severe tricuspid regurgitation. This relationship likely reflects reduced right heart strain and improved overall RV performance in patients with higher TAPSE values. The correlation between TAPSE and pulmonary trunk size was weakly positive ($r = 0.21$) and not statistically significant, suggesting no consistent direct association. Similarly, TAPSE and RV size demonstrated a weak negative, non-significant correlation ($r = -0.24$), indicating only a trend toward lower TAPSE with RV enlargement. Overall, these findings highlight the complex interplay between RV structure and function, where RV size alone does not reliably predict systolic performance. As in fig 2.

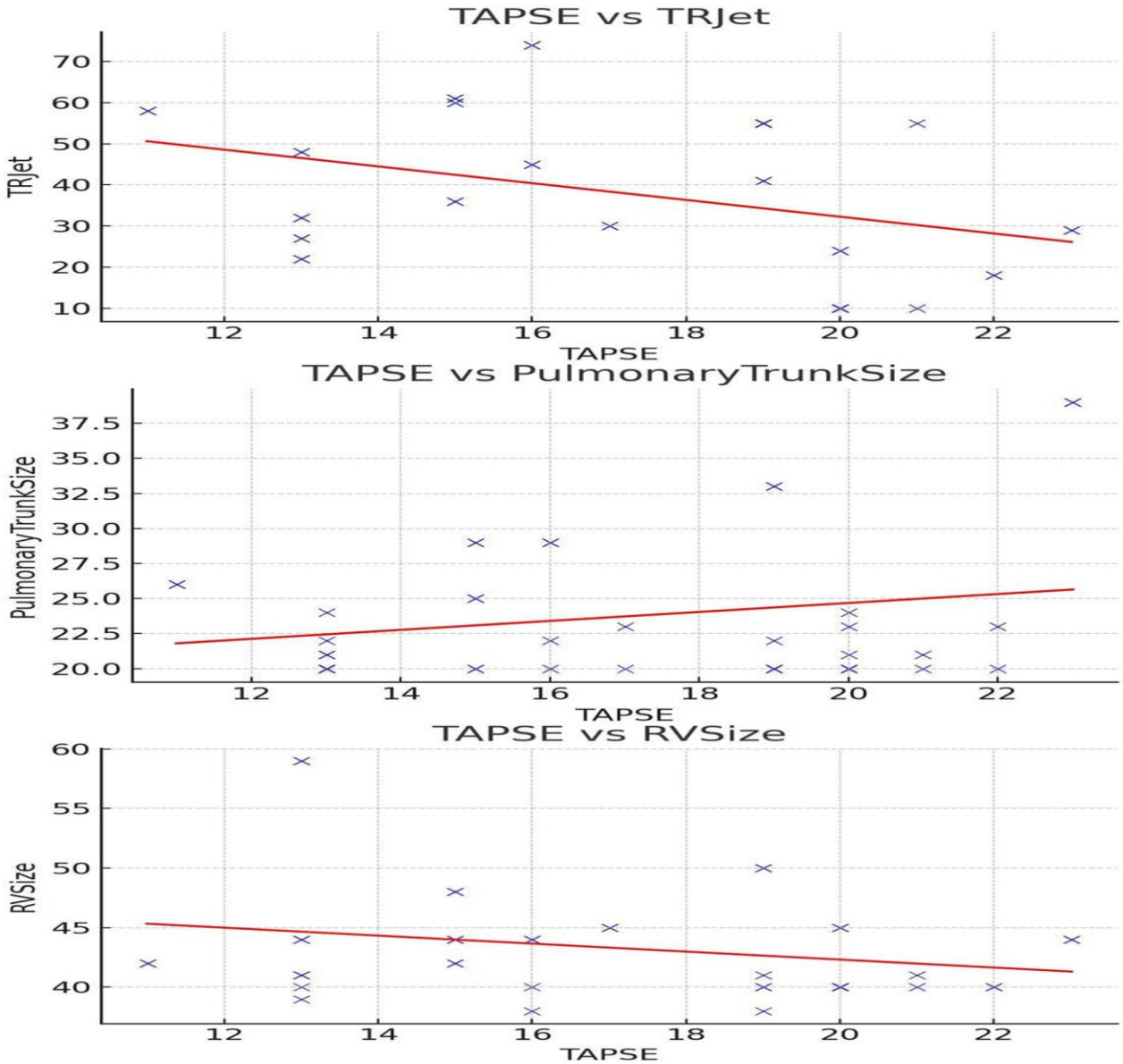

Fig 2: Correlation of TAPSE with tricuspid regurgitation jet velocity, pulmonary trunk size, and right ventricular size in patients with pulmonary embolism.

DISCUSSION

Pulmonary embolism (PE) remains a major public health problem, particularly among critically ill patients admitted to intensive care units, where delayed diagnosis and suboptimal risk stratification may lead to serious complications and increased mortality. This study addresses an important gap in local Iraqi data by providing a comprehensive evaluation of demographic characteristics, clinical risk factors, and echocardiographic findings in patients with provoked PE, with special emphasis on right ventricular (RV) function assessed by Tricuspid Annular Plane Systolic Excursion (TAPSE). In the present cohort, TAPSE demonstrated marked variability, reflecting heterogeneous RV responses to acute pulmonary embolic load. Nearly half of the patients exhibited impaired TAPSE (<16 mm), indicating significant RV systolic dysfunction and higher risk of adverse outcomes. This finding reinforces the established prognostic value of TAPSE in acute PE, as reported by Eid et al. and Lyhne et al., who identified

reduced TAPSE as a reliable predictor of short-term mortality and RV failure.[12,13] Borderline TAPSE values were observed in a smaller subset, suggesting early or evolving RV dysfunction, while patients with normal TAPSE likely retained sufficient RV reserve to tolerate increased afterload. Demographically, the study population showed a female predominance (80%), consistent with observations by Thachil et al., who reported sex-related differences in PE presentation and biomarker profiles.[14] The wide age range, with a mean age in the mid-forties, aligns with previous epidemiological studies indicating that PE affects both younger and older adults, although severity and diagnostic yield increase with age.[15,16] Symptom duration, particularly shortness of breath, was significantly shorter in patients with impaired TAPSE, suggesting that more severe hemodynamic compromise leads to earlier clinical deterioration and ICU admission, a pattern also described by Lobo et al.[17] Traditional risk factors such as prior surgery, deep vein thrombosis, and inherited thrombophilia were relatively uncommon in this cohort, highlighting the multifactorial nature of PE. Malignancy was present in 25% of patients and showed a trend toward association with impaired TAPSE, consistent with evidence that cancer-related PE is often more severe and associated with worse RV function.[18] Other comorbidities, including hypertension, diabetes mellitus, ischemic heart disease, atrial fibrillation, and prior COVID-19 infection, were infrequent and did not demonstrate significant associations with TAPSE, reflecting population-specific variability.[19,20] Echocardiographically, RV dilation was present in more than half of the patients and was significantly associated with TAPSE impairment, confirming that structural RV changes parallel functional deterioration.[21,22] The 60/60 sign showed a significant correlation with TAPSE categories, supporting its role as a marker of acute RV strain in PE, as described by Çizgici et al. and Zuin et al.[23,24] In contrast, McConnell's sign, although present in 30% of patients, did not correlate significantly with TAPSE, underscoring its limited sensitivity and supporting previous reports that it should be interpreted in conjunction with other echocardiographic parameters.[25] Tricuspid regurgitation (TR) severity demonstrated a meaningful relationship with TAPSE, with a significant negative correlation, indicating that worsening RV systolic function is associated with more severe TR. This finding is clinically relevant and consistent with studies emphasizing TR severity as an important prognostic marker in PE and other RV pressure overload states.[26,27] Inferior vena cava dilation with absent collapsibility was strongly associated with impaired TAPSE, reflecting elevated right atrial pressures and advanced RV dysfunction, as previously reported.[28] Importantly, all patients in this study survived, reflecting timely diagnosis, effective ICU management, and adherence to contemporary PE treatment guidelines.[29] Overall, these findings support the integration of TAPSE with complementary echocardiographic markers for comprehensive risk stratification in acute PE. Such an approach is particularly valuable in resource-limited settings, where bedside echocardiography can guide early clinical decision-making and improve patient outcomes.

CONCLUSION

Pulmonary embolism patients demonstrated significant right ventricular dysfunction, evidenced by impaired TAPSE, with McConnell's sign and the 60/60 sign present in a subset, reflecting acute RV strain and pulmonary hypertension. Moderate to severe tricuspid regurgitation was common, alongside structural abnormalities such as right ventricular and pulmonary trunk dilatation, indicating increased pulmonary vascular resistance. Frequent thrombus detection and inferior vena cava abnormalities highlighted substantial hemodynamic burden on the right heart. A significant inverse relationship between TAPSE and tricuspid regurgitation severity confirmed that better RV systolic function is associated with less severe TR, while other correlations were weak, reflecting complex RV–pulmonary interactions.

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