The Prognostic Value of TAPSE/SPAP Ratio for Adverse Outcomes in Acute Heart Failure

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Abstract

The ratio of tricuspid annular plane systolic excursion to systolic pulmonary artery pressure (TAPSE/SPAP) help us in determination the right ventricular function. This ratio has prognostic role in chronic heart failure, but its value in acute decompensation still uncertain. Our study evaluated the association between this ratio and short term in hospital adverse outcomes in patients with acute decompensated heart failure (ADHF).

We performed a retrospective observational analysis including 78 ADHF patients. Clinical, laboratory, and echocardiographic variables were obtained on admission. The primary composite outcome included in hospital death, intravenous inotrope use, or admission to the cardiac intensive care unit.

We applied ROC analysis and logistic regression models to assess the prognostic performance of TAPSE/SPAP.

The composite outcome occurred in 44.9% of the study population. Patients who developed adverse events present with lower systolic blood pressure, ejection fraction, and TAPSE/SPAP ratio. The TAPSE/SPAP ratio demonstrated modest discrimination (AUC 0.613). In multivariable analysis, ejection fraction remained the only independent predictor of the composite outcome.

Lower TAPSE/SPAP values were associated with unfavorable in hospital outcomes; however, its independent prognostic value was limited when adjusted for other variables.

Keywords: *Acute Heart Failure, TAPSE, SPAP, TAPSE/SPAP.*

1. INTRODUCTION

Acute decompensated heart failure (ADHF) represents a major cause of hospital admission worldwide and is associated with morbidity, mortality, and healthcare

burden. Despite advances in diagnostic and therapeutic strategies, early risk stratification continues to be challenging, particularly in the acute status, where clinical deterioration may occur within hours. Left ventricular ejection fraction (EF) assesses cardiac function and guiding management. However, growing evidence indicates that right ventricular (RV) function and pulmonary hemodynamics also play an critical role in determining prognosis in heart failure patients (1). Right ventricular–pulmonary arterial coupling describes the capacity of the right ventricular to adapt to variations in afterload. This can be quantified noninvasively using the ratio of (TAPSE) to (SPAP) (2). TAPSE reflects longitudinal RV systolic motion, while SPAP represents RV afterload. Their ratio has emerged as a simple, physiologically meaningful index that integrates RV contractility with the pulmonary vascular load (3). In chronic heart failure populations, impaired RV–arterial coupling assessed by lower TAPSE/SPAP values has been linked with higher mortality, worsening functional status, and increased hospitalization rates (4). The prognostic significance of the TAPSE/SPAP ratio in the setting of acute heart failure remains unclear. Patients with acute decompensation have variations in volume status, and dynamic changes in pulmonary pressures, all of which may affect the RV. Additionally, acute hemodynamic compromise may reveal RV dysfunction earlier than structural LV changes that is meaning the need for markers that can be obtained quickly and easily during early evaluation (5).

This marker simple, bedside available, and strong physiological rationale of TAPSE/SPAP, understanding its prognostic role in acute heart failure may aid clinicians in identifying high-risk patients who may require intensive monitoring, early intervention, or advanced supportive therapies (6). However, data in this area remain limited.

2. METHODOLOGY AND RESULTS

All We carried out a retrospective observational study enrolling 78 patients with acute decompensated heart failure to AL-Mouwasat Hospital in Damascus. Clinical, laboratory, and echocardiographic information were obtained at hospital admission. Variables including: age, sex, and smoking, as well as comorbidities such as chronic heart failure, hypertension, diabetes mellitus, ischemic heart disease, chronic kidney disease, stroke, and cancer, as well as systolic blood pressure (SBP), heart rate, oxygen saturation, pulmonary crackles, and peripheral edema were documented. Laboratory measurements included hemoglobin, serum creatinine, and sodium levels. (TAPSE) was obtained using M-mode echocardiography in the apical four-chamber view. (SPAP) was calculated from the maximal tricuspid regurgitation velocity using the modified Bernoulli equation and adding estimated right atrial pressure. The TAPSE/SPAP ratio as an echocardiographic surrogate for right ventricular–arterial coupling. The composite in-hospital outcome included one or more of the following events: in-hospital mortality, intravenous inotrope use, or admission to the cardiac intensive care unit. Statistical analyses were performed using standard methods. ROC curve analysis was applied to determine the discriminatory performance of the TAPSE/SPAP value, with AUC interpretation based on established methodology. Univariate and multivariable logistic regression models were conducted to evaluate predictors of the composite outcome. A total of 78 patients hospitalized with acute decompensated heart failure were included in the analysis. The mean age was 64.3 ± 11.7 years, and 62.8% (n = 49) were male. With 75.6% (n = 59) classified as NYHA IV on admission. Smoking was reported in 56.8% of patients, hypertension (HTN) in

47.7%, diabetes mellitus (DM) in 40.9%, ischemic heart disease (IHD) in 59.8%, and chronic kidney disease (CKD) in 17.4% of the cohort.

Baseline clinical and echocardiographic characteristics:

The mean systolic blood pressure (SBP) was 108.7 ± 35.0 mmHg, and the mean left ventricular ejection fraction (EF) was 33.3 ± 11.5%.

Right-sided echocardiographic parameters showed a mean TAPSE of 1.46 ± 0.46 cm and a mean systolic pulmonary artery pressure (SPAP) of 47.9 ± 13.5 mmHg, and a mean TAPSE/SPAP ratio of 0.0336 ± 0.0169.

Laboratory values at admission:

A mean hemoglobin level of 11.2 ± 2.3 g/dL, a mean serum creatinine of 1.82 ± 1.02 mg/dL, and a mean sodium level of 133.2 ± 5.5 mmol/L.

In hospital composite outcome:

The predefined composite outcome: in hospital mortality, intravenous inotrope use, or cardiac intensive care unit (CICU) admission, occurred in 35 patients (44.9%).

Compared with the no event group, patients who developed the composite outcome had:

Lower systolic blood pressure:

Event: 96.4 ± 39.7 mmHg
No-event: 118.6 ± 27.2 mmHg
$p = 0.0067$

Lower ejection fraction:

Event: 27.1 ± 11.3%
No-event: 38.3 ± 9.1%
$p < 0.001$

Lower TAPSE/SPAP ratio:

Event: 0.0295 ± 0.0123
No-event: 0.0369 ± 0.0194
$p = 0.044$

There were no significant differences between groups in TAPSE alone (1.37 vs 1.53 cm, $p = 0.13$), SPAP (48.7 vs 47.2 mmHg, $p = 0.63$), or age (64.9 vs 63.7 years, $p = 0.68$).

ROC analysis:

The TAPSE/SPAP ratio demonstrated modest discriminative ability for predicting the composite outcome, with:

AUC = 0.613
Optimal cutoff value = 0.034
Sensitivity = 80%
Specificity = 46.5%

Logistic regression:

In univariate logistic regression, both EF and SBP were significantly associated with the composite outcome:

EF: OR 0.90, 95% CI 0.86–0.95, p < 0.001
SBP: OR 0.98, 95% CI 0.96–0.99, p = 0.008
TAPSE/SPAP ratio showed a trend toward significance (p = 0.064).
Age was not a significant predictor (p = 0.67).
In the multivariable model including EF, SBP, TAPSE/SPAP, and age:
EF remained the only independent predictor of the composite outcome
Adjusted OR 0.91, 95% CI 0.86–0.96, p = 0.0016
TAPSE/SPAP ratio lost statistical significance (p = 0.13).
SBP (p = 0.67) and age (p = 0.30) were not independent predictors.

Table 1. Baseline Characteristics

Variable	Value
Age (years)	64.3 ± 11.7
Male sex	49 (62.8%)
Smoking	(56.8%)
Hypertension	(47.7%)
Diabetes mellitus	(40.9%)
Ischemic heart disease	(59.8%)
Chronic kidney disease	(17.4%)
NYHA class II / III / IV	7 / 12 / 59
SBP (mmHg)	108.7 ± 35.0
Hemoglobin (g/dL)	11.2 ± 2.3
Creatinine (mg/dL)	1.82 ± 1.02
Sodium (mmol/L)	133.2 ± 5.5
Ejection fraction (%)	33.3 ± 11.5
TAPSE (cm)	1.46 ± 0.46
SPAP (mmHg)	47.9 ± 13.5
TAPSE/SPAP ratio	0.0336 ± 0.0169

Table 2. Event vs No-Event Groups

Variable	No-event (n=43)	Event (n=35)	p-value
Age (years)	63.7 ± 11.8	64.9 ± 11.7	0.68
SBP (mmHg)	118.6 ± 27.2	96.4 ± 39.7	0.0067
Ejection fraction (%)	38.3 ± 9.1	27.1 ± 11.3	<0.001
TAPSE (cm)	1.53 ± 0.40	1.37 ± 0.52	0.13
SPAP (mmHg)	47.2 ± 14.0	48.7 ± 13.0	0.63
TAPSE/SPAP	0.0369 ± 0.0194	0.0295 ± 0.0123	0.044

Table 3. Logistic Regression Analysis

Variable	Univariate OR (95% CI)	p-value	Adjusted OR (95% CI) / p-value
Age	1.01 (0.97–1.05)	0.67	1.03 (0.97–1.09) / 0.30
SBP	0.98 (0.96–0.99)	0.008	1.00 (0.98–1.02) / 0.67
Ejection fraction	0.90 (0.86–0.95)	<0.001	0.91 (0.86–0.96) / 0.0016
TAPSE/SPAP	~0 (scale effect)	0.064	~0 (scale effect) / 0.13

Table 4. ROC Analysis for TAPSE/SPAP

Parameter	Value
AUC	0.613
Optimal cutoff	0.034
Sensitivity	80%
Specificity	46.5%

3. DISCUSSION

In our study, we looked into the prognostic value of the TAPSE/SPAP ratio as a marker of right ventricular–pulmonary arterial coupling in patients with acute decompensated heart failure. Our results show that patients who experienced the composite in-hospital outcome had lower TAPSE/SPAP ratios at admission, suggesting that impaired RV–arterial coupling is associated with early clinical deterioration in acute heart failure (7). However, the predictive value of the TAPSE/SPAP ratio did not remain significant in the multivariable model, where (EF) was the only variable that independently predicted of adverse outcomes.

Lower TAPSE/SPAP values were linked to poorer outcomes, in line with earlier studies showing that RV dysfunction plays an important role in circulatory instability, reduced organ perfusion, and mortality in heart failure (8). TAPSE/SPAP has been recognized as a physiologic measure that reflects RV contractility relative to pulmonary vascular load and has shown prognostic value in chronic heart failure and pulmonary hypertension (9). Our findings show a similar pattern in the acute setting; however, its ability to distinguish high-risk patients was modest in our cohort (AUC 0.613), which aligns with observations from smaller studies in acute decompensated heart failure (10).

There are several possible reasons why the TAPSE/SPAP ratio did not remain significant after statistical adjustment. In patients with acute heart failure, severe impairment of left-ventricular systolic function usually has the strongest impact on short-term outcomes, and this can overshadow markers related to right-sided function when many variables are analyzed together (11). Another point is that the acute phase of decompensation is unstable by nature, with rapid shifts in preload, afterload, and pulmonary pressures. These fluctuations make a single RV measurement taken at admission less reliable and more difficult to interpret (12). The relatively small sample size in our study may also have limited our ability to detect additional prognostic value beyond the stronger predictors such as EF.

The initial association we observed between lower systolic blood pressure (SBP) and the composite outcome agrees with previous reports showing that hypotension is often a sign of hemodynamic compromise in acute heart failure (12). However, SBP lost significance after adjustment, which is likely due to its close link with severe LV dysfunction and the resulting systemic hypo perfusion.

Comorbidities such as smoking, hypertension, and diabetes were not included in the multivariable model due to the limited sample size and event rate, in order to avoid model overfitting. These factors may still influence outcomes and should be considered in larger prospective studies.

Despite there are some limitations, the TAPSE/SPAP ratio remains a useful clinical tool because it is, rapid, simple, bedside available. Although its prognostic value was modest in our study, it may still add useful value when considered together with other RV and LV assessment. Future studies with larger populations and serial echocardiographic measurements may help determine whether changes overtime in TAPSE/SPAP more accurately reflect the patient's changing hemodynamics status and better predict clinical deterioration during hospitalization (13).

4. CONCLUSION

Lower TAPSE/SPAP ratios were linked to worse in-hospital outcomes, but left ventricular ejection fraction remained the most powerful independent marker. TAPSE/SPAP may offer supplementary information, yet further research is required to define its prognostic value in acute heart failure.

5. DECLARATIONS

Ethics approval and consent to participate

"Ethical approval was waived because this retrospective study used fully anonymized clinical data. Individual patient consent was not required."

Consent for publication

"Not applicable."

Availability of data and materials

"The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request."

Competing interests

"The authors declare that they have no competing interests."

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Authors' contributions

Ali Ahmad Alhasan: conceived and designed the study, collected the data, and performed the initial draft of the manuscript.

Prof. Mohammad Ali AL Mubarak supervised the study, provided critical intellectual input, and revised the manuscript for important academic content.

Jumah Ahmad Swid : performed the statistical analysis and assisted in data interpretation.

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