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Correlation of E/E' on echocardiography and BNP levels in diastolic dysfunction patients visiting Mardan Medical Complex

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Abstract---Introduction: Assessment of diastolic heart function can be challenging due to various factors. Doppler echocardiography is useful but has limitations, pointing to the need for more accurate tests. Tissue Doppler imaging (TDI) is a promising ultrasound technique for diastolic prediction. The E/E' ratio is commonly used to determine LV filling pressures. B-natriuretic peptide (BNP) levels may also indicate diastolic dysfunction. Aims: To compare the BNP levels with E/E' ratios in this investigation to evaluate their effectiveness in predicting LV pressures. Methodology: This study compared BNP levels with E/E' in patients with diastolic dysfunction. Patients with reduced LV function were excluded, and all participants gave informed consent. The study found that BNP levels were a useful diagnostic tool and could be compared with E/E' using ROC curves. Results: The study included 100 patients with diastolic dysfunction and excluded those

with reduced LV function. The patients had a mean age of 60.51, with 60% males and 40% females. The majority of patients were in NYHA class II (56%), followed by NYHA class III (28%) and NYHA class IV (16%). The study also provided mean BNP levels for patients with different E/E' ratios. Conclusion: The study found a significant positive correlation between BNP levels and E/E' ratio in patients with heart failure, and BNP levels can be used to predict LV filling pressures with high detection efficiency.

Keywords--E/E', BNP, correlation, diastolic heart function, Doppler echocardiography, Tissue Doppler imaging (TDI), E/E' ratio, B-natriuretic peptide (BNP), LV pressures, diastolic dysfunction.

Introduction

Impairment of the cardiac functions during diastole is very usual in heart diseases and is characterized by signs and symptoms of heart failure, which is irrespective of the systolic functions. Yet, assessing this disease may be challenging due to the intricate interactions of factors that determine diastolic function.¹ Assessment of the diastolic functions of the left ventricle is effectively done through Doppler studies during echocardiography. Even so, its regular and wide use as a screening test is slender by the expenditures and easy accessibility.²

Doppler studies of heart are crucial for studying the dynamics of the LV's diastolic filling, but it is also limited by knowing that mitral flow is contingent upon a variety of variables, including numerous ones that can have bewildering effects. Variability in beating of heart, the preload, after load, contractile strength, valve regurgitation, and sample volume placement can have an impact on trans mitral filling kinetics irrespective of diastolic function.^{3,4} Assessing the dynamic of venous blood flow through pulmonary system can be used to gauge the filling pressures of left ventricle in settings of impaired systolic function using mitral inflow. Nevertheless, numerous studies provide evidence that trans mitral activities occur in people with intact systolic and diastolic function. Filling pressures and trans mitral parameters have a poor correlation. Doppler echocardiography has limitations, which point to the necessity of further, more accurate tests for diastolic functions. ⁵

A new ultrasound technique such as TDI, monitors localized velocities of myocardium during systole and diastole. By making use of tissue Doppler imaging for mitral annular motion, the impact of relaxing myocardium on trans mitral circulation can be mitigated, and it has been demonstrated that in some patient subgroups, it is an excellent diastolic predictor. ⁶⁻⁸ TDI also makes it possible to measure the degree mitral annular displacement during the cardiac cycle. Preload has a negligible impact on the initially measured velocity at the annulus during diastole(E), which indicates that it correlates well with LV relaxation indices. Since preload affects mitral velocity and is connected with LV relaxation, preload is barely impacted. ^{9, 10}

The E/E' ratio can be applied to determine the filling pressures of LV. As an E/E' ratio >15 particularly shows higher LVEDP, though, an E/E' of <8 is usually rendered as reduced filling pressures. It has been demonstrated that the amalgamation of mitral annulus and mitral inflow velocities yields more accurate estimations of LV filling pressures than other methods. 11

The cardiac neurohormone B-natriuretic peptide (BNP) is yielded as a result of stretching of the myocardial muscles, in response to pressure and volume overload in ventricles. 12 BNP levels are found to be increased in people with apparent LV dysfunction which also correspond with how severe the symptoms are and how well they are expected to go.13-15 BNP concentrations may also be a sign of diastolic dysfunction. 16

In individuals with acute dyspnea, BNP has been demonstrated to be useful in determining or ruling out underlying heart failure. In the present investigations, irrespective of the presence of previous values, a quick assessment was employed to quantify and evaluate, that how effective and efficient are BNP concentrations in forecasting LV pressures by comparing with E/E' ratios values in people sent for echo studies.17 Therefore, the research was conducted to investigate the relationship between E/E' on echocardiography and BNP levels in diastolic dysfunction patients.

Methodology & Materials

This single-center comparative cross-sectional investigation was carried out at General ward and Echocardiography section of Department of Cardiology MTI, Mardan Medical Complex, Mardan between June 2021 to June 2022. Ethical committee approval was acquired from the concerned hospital.

Patients with reduced LV function were not included in this investigation, only those who had dyspnea or HFpEF were enrolled. All subjects who had signed up had given their informed consent before having their BNP levels checked and were then independently assessed by a Cardiologist for LV filling pressures at Echo Lab while he was kept blind to their BNP levels.

We compared BNP with E/E' in patients with diastolic dysfunction, by using independent sample t-test. BNP levels' sensitivity, specificity, and accuracy were computed, and their diagnostic value was juxtaposed with E/E' >15 and between 8-15 using ROC curves.

Results

Our analysis included 100 patients with a mean age of 60.51 among which Males were 60% while 40% females (Table 1). Patients with E/E' >15 was 20.8% (n=21), whereas, their mean BNP levels were 471.8 ng/ml. Patients with E/E' between 8-15 was 47.5% (n=48), whereas, their mean BNP levels were 140.3 ng/ml, while patients with E/E' < 8 were 30.7% (n=31) and this group of patients had mean BNP level were 102.9 ng/ml (Table 2). All patients were found to have a very high positive connection between their BNP levels and E/E'.

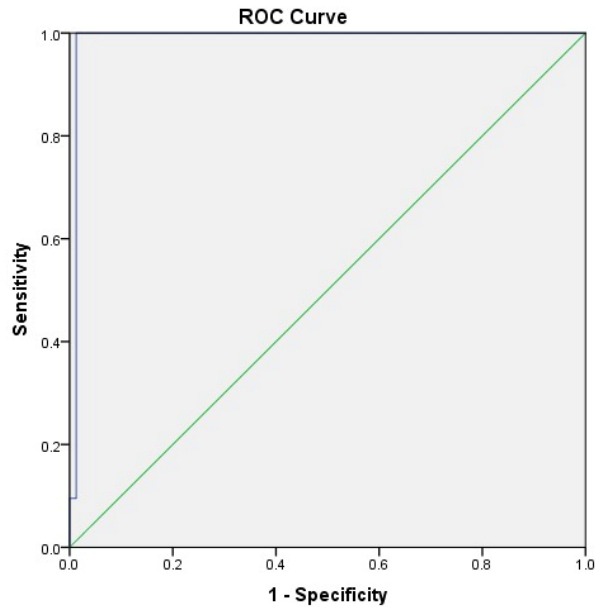
Table 1: Baseline Characteristics

Variables		Mean	Percentages
Age		60.51	-
Gender	Males	1.4	60%
	Females		40%
NYHA Class	NYHA I	2.44	0%
	NYHA II		56%
	NYHA III		28%
	NYHA IV		16%

Table 2: E/E' correlation with mean BNP levels

E/E' Groups	BNP Levels
> 15	471.76
8 - 15	140.40
< 8	102.94

Through the ROC curve, BNP had a 0.98 detection efficiency for E/E' > 15 (95% CI 0.96 to 1, p 0.01) as shown below in (Diagram 1).



Area Under the Curve

Test Result Variable(s): BNP

Area	Std. Error ^a	Asymptotic Sig. ^b	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.989	.011	.000	.966	1.000

Figure 1: ROC graph for BNP to E/E'

A value of 102.3 pg/ml of BNP resulted in higher sensitivity (100%) but low specificity (30%) for detecting E/E' >15. The most desired value of BNP to detect optimal sensitivity (100%) and specificity (91%) is 147.5 pg/ml for sensing E/E' >15 (Table 3).

Table 3: Sensitivity & specificity of BNP level for detecting E/E' >15

BNP	Sensitivity	Specificity
89.0000	1.000	1.000
92.5000	1.000	.975
96.5000	1.000	.924
98.5000	1.000	.899
99.5000	1.000	.886
102.5000	1.000	.785
106.5000	1.000	.709
109.0000	1.000	.684
112.5000	1.000	.570
117.5000	1.000	.519
122.5000	1.000	.468
127.5000	1.000	.418
132.5000	1.000	.367
137.0000	1.000	.291
139.5000	1.000	.278
142.5000	1.000	.177
147.5000	1.000	.089
285.0000	1.000	.013
435.0000	.952	.013
452.5000	.905	.013
457.5000	.857	.013
462.5000	.714	.013
467.5000	.667	.013
475.0000	.476	.013
481.0000	.238	.013
483.5000	.190	.013
487.5000	.143	.013
492.5000	.095	.013
497.5000	.095	.000
501.0000	.000	.000

Discussion

According to this study, BNP levels and E/E' levels are positively correlated. Mitral inflow & pulmonary venous velocities have weak correlations with filling pressures, as influenced by multiple hemodynamic factors. Both E/E' and BNP levels, are positive markers of diastolic dysfunction. Since cardiac ventricles are the primary source of plasma BNP as opposed to the atrium, it is possible that BNP is a more sensitive and focused signal of ventricular problems as opposed to other natriuretic peptides. 9,10 According to research by Lubien and his colleagues. on 294 patients with adequate systolic function, who displayed reduced filling pressure tendencies on echocardiogram had the highest BNP concentrations (408 ± 66 pg/ml). When used to identify diastolic dysfunction, a BNP level of 62 pg/ml had an 85% sensitivity, 83% specificity, and 84% accuracy. In contrast to the EF used to evaluate systolic function, no single parameter exists which is as effectively used to measure cardiac functions during diastole. 11 Diastolic characteristics have been described using an indirect, non-invasive measurement of LV filling dynamics. 2 The four different types of diastolic function described by Appleton and Hatle—normal, prolonged relaxation, pseudo-normal, and restrictive—have come to be regarded as the diagnostic cornerstone for this condition. 14 The Doppler analysis of diastolic dysfunction does, however, have some restrictions. Physiologic alterations in the LV, atrial and ventricular compliance, and filling pressures can all affect the trans mitral velocity pattern. To evaluate diastolic dysfunction and elevated filling pressure of left ventricle, the E/E' ratio has been employed in a number of investigations. 15 Ommen demonstrated that the septal E/E' ratio has the most favorable ROC curve and optimum prediction accuracy for estimating average diastolic pressure of left ventricle (LVDP). 8A higher LVDP (86% specificity and 64% positive predictive value) was indicated by E/E' >15, as well as E/E' prime. A strong association exists between concentrations of BNP and E/E' values which were found in the current investigation. The diagnostic yield of various BNP levels in estimating E/E' values are discussed in relation to the suggestions that E/E' values 15 can be utilized to identify individuals with increased filling pressures. 16BNP level 173 pg/mL continues to be the strongest indication for high filling pressure (sensitivity 88%; specificity 82%).

Same as our investigations, Mak compared the BNP concentrations and Doppler sonographic indices of diastolic dysfunction in 108 individuals. 16BNP levels were greatest (463 ± 80 pg /ml) in those with E/E' >15 patients. The highest levels of BNP, however, are found in patients with E/E' values under 15, which were 463 ± 80 pg/ ml. People whose E/E' was under 8 had an average concentration of BNP as 97–27 pg/ ml, in contrast. When predicting E/E' >15, a BNP level of 173 pg/ ml exhibited an accuracy of 83%, specificity of 82%, and a sensitivity of 88%.

By estimating filling pressures, the levels of BNP correspond with either the existence or lack of diastolic anomalies on cardiac ultrasound, having background of normal heart functions during systole. 20. Particularly people, who don't have symptoms of impaired cardiac functions, a decreased BNP reading may negate the use for echo studies. However, whether or not the patient exhibits symptoms, increased BNP levels may point to an indication of LV dysfunction and call for more cardiac testing. It should be highlighted that the population under study

affects the exceptional sensitivity and specificity of BNP. In this instance, raised BNP values coincident with diastolic disorders are more likely than they would be in a population screened at random across all age categories. Therefore, further research will be required to evaluate whether BNP levels can serve as the gold standard for the diagnosis of diastolic dysfunction.

Conclusion

In patients with dyspnea, in centers without a color doppler equipment, or in situations where an echocardiogram is difficult to interpret, taking BNP levels has a positive predictive value comparable to E/E' in establishing or eliminating heart failure with preserved ejection fraction (HFpEF).

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