Research Brief

Lung ultrasound evaluation of diabetic patients with acute onset dyspnea and its relationship with established markers of heart failure

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ABSTRACT

Objective: The aim of the study was to assess the interrelation between sonographic pleural B-Line, left ventricular function and Naturetic Peptides in type 2 Diabetics with acute onset class III-IV dyspnea. There is dearth of data in this subset of patients in Asian population.
Methods: Subjects (n = 73) were divided into those with pleural B line (Group A, n = 41) and those without (Group B) and their serum B type Naturetic Peptide (BNP) and Echocardiography evaluated.
Results: The serum BNP was significantly higher and mean Left Ventricular Ejection Fraction (LVEF) lower in Group A compared to Group B (p < 0.001). There was a significant negative correlation between LVEF and BNP and positive correlation between E/E' and BNP. Among patients with LVEF 40% and above (n = 36), patients with B line had significantly higher BNP and E/E' compared to those without. Group A had significantly more patients on insulin therapy and troponin positivity than Group B (p < 0.01). On auscultation though crepitations was found more frequently in group A but it was present in only 50% of the subset.
Conclusion: Pleural B-Lines, LVEF and mitral inflow E/septal E' can be used to rule in heart failure in the above population.

1. Introduction

Bilateral diffuse anterior B-lines along with lung sliding have been demonstrated to predict acute pulmonary edema in the BLUE (Bedside Lung Ultrasound in Emergency) protocol.[1] Though heart failure is a clinical diagnosis, rapid confirmation by reliable bedside tests may be lifesaving. There is dearth of data about the utility of B-line acute in acute onset dyspnea in diabetics, not only in Indian but also in Asian population. Furthermore, there is scarcity of studies about the role of B-line in the above subset with preserved left ventricular ejection fraction (LVEF 50% or more) and mid-range LVEF (LVEF 40–50%).

2. Methods

The study was a retrospective study of records of type 2 diabetes mellitus (T2DM) patients admitted via emergency department (ED) in a tertiary care hospital over a period of 6 months from 8 AM to 8 PM with acute onset New York Heart Association (NYHA) class III–IV dyspnea. The exclusion criteria were- body-mass index >25 kg/m^2, age >75 years and nephropathy (estimated glomerular filtration rate <60 ml/min/m^2).

Echocardiographic evaluation was done with a 5 MHz adult linear echo probe (VIVID 6, GE Healthcare). LVEF was estimated by using modified Simpson's rule from apical 4-chamber view. For diastolic function, transmitral flow velocities (E and A wave) and tissue Doppler septal velocity (E') were obtained from the apical 4 chamber view, as per the standard protocol. It was followed by evaluation of the pleural B-line and lung sliding by 5 MHz convex ultrasound probe from the same machine. Four thoracic ultrasound windows: right mid-axillary, right mid-clavicular, left mid-axillary and left mid-clavicular were included in the study as per established protocol.[1] Three or more pleural B-lines (vertical comet-tail like artefacts) (Fig. 1) in any window on both the right and left thorax were required for labelling the subject as positive for B-lines.

Serum B-type natriuretic peptide (BNP) and troponin I were measured by fluorescence immunoassay with commercial kit (Alere Triage Cardio 3 Panel, Alere Inc San Diego CA, USA).

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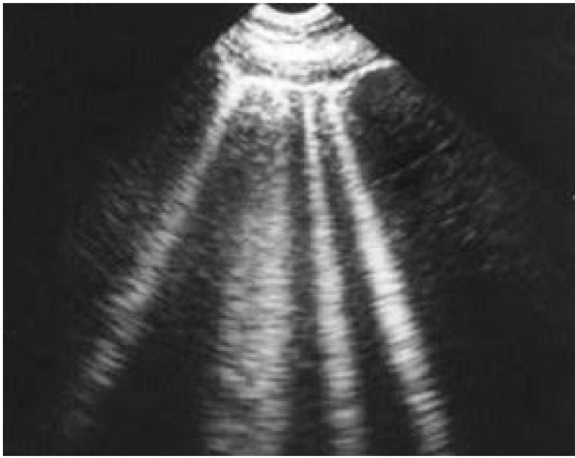E-mail address: sunandansikdar@gmail.com (S. Sikdar).

Fig. 1. Ultrasonic B line. Note the vertical comet-tail like artifacts arising from the pleural line extending to the far field without a decrease in intensity while effacing the horizontal A lines. They represent extravascular lung water.

Subjects were divided into group A (patients who had B-lines with lung sliding) and group B (those without B-lines).

Statistical analysis was performed using Pearson's chi-square test and Mann-Whitney U test/Kruskal Wallis test to evaluate whether mean BNP, E/E' and LVEF of group A differed significantly from that in the other group.

3. Results

In the current study, there was no significant difference in the distribution of gender, age, glycemic control, hypertension and hypothyroidism between group A and group B (Table 1). The BNP level was significantly higher in group A compared to group B (p < 0.001). The mean LVEF in group A (33.48 ± 7.52%) was significantly lower than that in group B (50.77 ± 10.72%) (Fig. 2). Group A had significantly higher E/E' (15.21 ± 2.10 vs 8.19 ± 2.24, p < 0.001). There was a significant negative correlation between BNP and LVEF (coefficient of determination, $R^2 = 0.2$, p < 0.01) and stronger positive correlation between BNP and E'/E ($R^2 = 0.6$,

p < 0.001) (Fig. 2). Group A had significantly more patients on insulin therapy and troponin positivity than group B (p < 0.01). On auscultation, crepitations were found more frequently in group A. Nearly half of those in group A had crepitations on auscultation.

The subgroup of patients (n = 36) with LVEF equal to or more than 40% were divided into two groups, based on the presence (group A', n = 8) or absence (group B', n = 28) of B-lines (Table 2). The mean BNP in group A' (3052.50 ± 1052.77 pg/ml) was significantly more (p < 0.001) than that in group B', (1141.28 ± 1080.51 pg/ml). Similar was the case with E/E' (14.2 ± 1.5 vs 7.9 ± 2.2, p < 0.001). Thus, even in predominantly diastolic dysfunction, the B-line was a clinically useful metric.

4. Discussion

It has been shown that in acute dyspnea patients are clinically misdiagnosed in nearly 15% cases.[2] The results of the study indicate that in acute dyspnea in diabetic subjects, pleural B-line significantly predicts elevated serum BNP, an established marker of heart failure.[3] BNP is less useful in flash pulmonary edema and borderline values.[4–6] Thus, heart failure may be confirmed by using lung ultrasound as point of care.

Presence of crepitations on chest auscultation has been reported from as low as 34%[3] to as high as 75%[2] attesting to its unreliability in diagnosing heart failure. Half of the patients with B-lines had auscultatory crepitations; this implies B line may be more useful in acute onset dyspnea in diabetics.

In one study, bilateral B-lines had a low sensitivity (33%) but high specificity (91%).[7] Our study differs from this, which may be because pretest probability of getting an acute heart failure was higher in our study as the patients were diabetic.

A peculiar finding of this study was that group A had significantly more insulin requiring diabetics and troponin positive patients than group B. This may be related to the fact that subjects with advanced diabetes and atherosclerosis burden were more prone to have heart failure.

In our study, E/E' correlated directly with plasma BNP level as they both relate to ventricular filling pressures. However, E/E' did not show correlation with LVEF probably because reduced LVEF

Table 1
Comparison of Group A and Group B.

Parameter	Group A (n = 42)	Group B (n = 31)	P value
Age (years)	69.81+/−10.17	66.48+/−10.78	NS
Glycosylated hemoglobin (%)	8.75+/−1.39	8.21+/−1.19	NS
Male gender	31(73%)	19 (61%)	NS
Hypertension	24 (57 %)	15 (48%)	NS
Hypothyroidism	6(14%)	2(6%)	NS
Insulin therapy	30(71%)	16(51 %)	<**0.001**
Chest crepitations	21(50%)	6(19%)	<**0.001**
Left ventricular ejection fraction (%)	33.48+/− 7.52	50.77+/− 10.72	<**0.001**
Early diastolic mitral inflow to mitral annular velocity ratio (E/E')	15.21+/− 2.1	8.19+/− 2.24	<**0.001**
Serum brain natriuretic peptide level (pg/ml)	3118.52+/− 1776.52	1135.35+/− 1033.98	<**0.001**
Serum troponin I (ng/ml)	2.91+/− 4.10	0.59+/− 1.92	<**0.001**

Categorial variables are presented as number with percentages in parentheses, whereas continuous variables are presented as mean ± standard deviation.

Table 2
Comparison of subjects with and without B-lines among those with left ventricular ejection fraction 40% or greater.

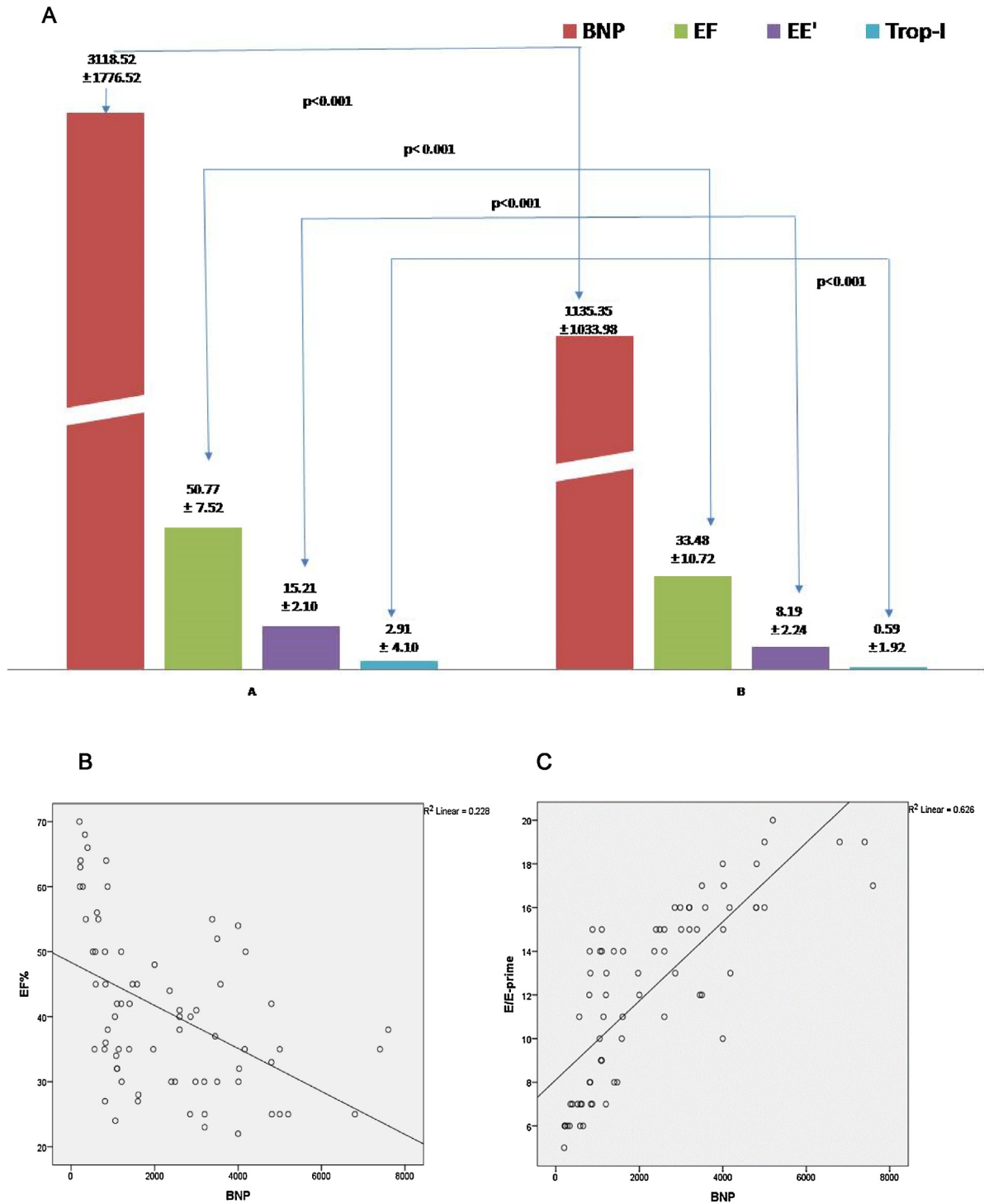| Parameter	Group A' (B-line present, n = 8)	Group B' (No B-lines, n = 28)	P-value
Brain natriuretic peptide (pg/ml)	3052.50 +/− 1052.77	1141.28+/− 1080.51	< **0.001**
Early diastolic mitral inflow to mitral annular velocity ratio (E/E')	14.2+/− 1.5	7.9 +/− 2.2	< **0.001**

Fig. 2. A) Comparison of major parameters of Group A and B: BNP, LVEF, E/E' and Troponin I . B) Correlation of LV EF and BNP. C) Correlation of E/E' and BNP (BNP in pg/ml, Troponin I in ng/ml). Histograms related to BNP are truncated as they are not in scale.

per se may not imply raised left ventricular end-diastolic pressure.[8]

While our subjects were acutely decompensated in-patients, recently it was reported that in moderate to severe systolic heart failure outpatients, B-lines (especially if ≥15) suggest decompensation) and correlated with E/E' and N-terminal pro-BNP.[9] Our findings were consistent with these observations. A small study from south India (n = 42) had looked into correlation of number of B-lines (comet score), echocardiography, BNP and

chest X-ray findings in decompensated heart failure in an all-comer population and had reported similar findings.[10] However, we have found the comet score to have rapid temporal variation related to fluid status and hence have avoided using this number as a clinical tool.

The sub-study involving the patients with mid-range LVEF (LVEF 40–50%) and preserved LVEF (50% or more), in whom there is greater diagnostic dilemma, revealed that evaluation of B-line added incremental value.

5. Conclusion

Ultrasound guided assessment of pleural B-Lines, LVEF and mitral inflow E/septal E' ("triple tool") can be used to confirm heart failure in T2DM patients with acute onset dyspnea. Ultrasound assessment must be used in acutely dyspneic diabetic patients even if auscultation fails to reveal crepitations.

Conflict of interest

None.

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