Evaluation of Pulse Pressure and Proportional Pulse Pressure as Predictors of Severity among Patients Having Heart Failure with Reduced Ejection Fraction

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Abstract

Introduction: Proportional Pulse Pressure (PPP) is a significant risk indicator in heart failure. PPP is a simple, inexpensive and easily measurable clinical index. This non-invasive test provides useful prognostic information for patients with heart failure with reduced ejection fraction (EF) particularly in those with an EF < 30% where lower proportional pulse pressure independently predicts mortality. Methods: A prospective observational study involving 150 patients with reduced ejection fraction was done. Detailed history, clinical examination and parameters like pulse pressure, proportional pulse pressure were evaluated and correlated with ejection fraction. Results: The mean age of the patients was 58.99 ± 11.03 years and the majority of the study participants (57.33 %) were between 45 and 65 years of age. The most common etiology of heart failure (HF) was coronary heart disease in this study (76%). Proportional Pulse pressure showed significant association with ejection fraction. The specificity for detecting heart failure was more for proportional pulse pressure and systolic blood pressure (95 % each). Conclusion: Proportional Pulse Pressure may help to identify HF patients who present with low cardiac output, low ejection fraction, and worse prognosis. Our current observations reinforce the importance of clinically based skills that must not be forgotten when managing HF.

Keywords: Heart failure, prognosis, proportional pulse pressure, pulse pressure

Résumé

Introduction: La pression de pouls proportionnelle (PPP) est un indicateur de risque important dans l’insuffisance cardiaque. Le PPP est un indice clinique simple, peu coûteux et facilement mesurable. Ce test non invasif fournit des informations pronostiques utiles pour les patients souffrant d’insuffisance cardiaque avec une fraction d’éjection réduite (FE), en particulier chez ceux avec une FE <30% où une pression pulsée proportionnelle plus faible prédit indépendamment la mortalité. Méthodes: Une étude observationnelle prospective portant sur 150 patients avec une fraction d’éjection réduite a été réalisée. L’historique détaillé, l’examen clinique et des paramètres tels que la pression de pouls, la pression de pouls proportionnelle ont été évalués et corréls avec la fraction d’éjection. Résultats: L’âge moyen des patients était de 58,99 ± 11,03 ans et la majorité des participants à l’étude (57,33 %) avaient entre 45 et 65 ans. L’étiologie la plus courante de l’insuffisance cardiaque (IC) était la maladie coronarienne dans cette étude (76%). La pression d’impulsion proportionnelle a montré une association significative avec la fraction d’éjection. La spécificité pour détecter l’insuffisance cardiaque était plus pour la pression cardiaque pulsée proportionnelle et la pression artérielle systolique (95% chacune). Conclusion: la pression de pouls proportionnelle peut aider à identifier les patients IC qui présentent un faible débit cardiaque, une faible fraction d’éjection et un pronostic pire. Nos observations actuelles renforcent l’importance des compétences cliniques qui ne doivent pas être oubliées lors de la gestion de l’IC

Mots-clés: Insuffisance cardiaque, pronostic, pression cardiaque proportionnelle

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**INTRODUCTION**

Heart failure (HF) is becoming a major problem in developing countries. Despite the advances in the treatment of HF, the morbidity and mortality remain quite high. The American Heart Association/American College of Cardiology guidelines defines HF as “a complex clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill or eject blood.”[1] Thus, the guidelines state that the condition is mainly a clinical diagnosis, which is based on a careful history and physical examination. Pulsatile components of blood pressure capture elements of cardiac risk beyond that captured by steady components.[2-4] The former, often measured as pulse pressure (PP), is recognized as a potent risk factor for cardiovascular disease, including myocardial infarction, stroke, and cardiovascular mortality.[5] Among clinically relevant physical signs in HF, PP, and proportional PP (PPP) have been found to be independently and significantly associated with low cardiac output in patients with advanced HF.[6] The measurement of PPP is a noninvasive tool to diagnose and prognosticate HF, which has been shown to correlate well with cardiac index in an earlier study.[7] This study was aimed to find the correlation between PPP and ejection fraction (EF) in patients with HF.

**MATERIALS AND METHODS**

The study was carried out as a prospective observational study at the ESIC Medical College Hospital, a tertiary care hospital in Chennai, India, after obtaining clearance from the institutional ethics committee. All patients who were admitted with a diagnosis of HF were eligible for enrolment in the study after meeting the inclusion and exclusion criteria. Patients aged > than 18 years who presented with symptoms and signs of HF were eligible to participate in the study. Patients with valvular heart disease, pericardial disease, and cor pulmonale were excluded from the study. Written informed consent was obtained from the patients before the beginning of the study. A detailed history was obtained, followed by a thorough clinical examination, and the findings were recorded.

PP was calculated as equal to the difference between the systolic and diastolic blood pressures (expressed in mm Hg). PPP was calculated by dividing the PP by systolic blood pressure and expressed in percentage.[8] The echocardiographic examination was done in the resting state with an ACUSON Sequoia ™ ultrasound machine with 3.5-MHz phased array transducer. 2D, M mode, and color Doppler studies were done, and EF was calculated.

For quantitative data, descriptive statistics are presented by N, mean, and standard deviation. For qualitative data, frequency count, N, and percentage were put in a tabular manner. Appropriate statistical tests were applied to find the association between parameters, including correlation analysis, was also carried out. \( P < 0.5 \) was considered statistically significant. All the statistical analysis has been performed using statistical software, SPSS for Windows (IBM Corp., IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY).

**RESULTS**

A total of 150 patients with HF were enrolled for the study. The age-sex distribution of the patients is shown in Figure 1. The mean age of the patients was 58.99 ± 11.03 years and the majority of the study participants (57.33%) were between 45 and 65 years of age. There was a male preponderance (60%). The baseline characteristics of the study participants are shown in Table 1. The most common etiology of HF was coronary heart disease in this study (76%).

Among patients with EF < 30%, the mean PP and PPP were 24.68 ± 5.03 mm Hg and 24.86 ± 2.74%, respectively, whereas among the patients with EF 31%–40% the corresponding values were 35.38 ± 7.16 mm Hg and 29.53 ± 3.52%, respectively. The difference between means of PP was 10.71 mm Hg (95% confidence interval [CI] 8.70–12.71, \( P < 0.0001 \)) and the difference between means of PPP was 4.67% (95% CI 3.65–5.69, \( P < 0.0001 \)). Regression analysis [Figure 2] showed a linear correlation between PPP and EF (\( r = 0.667, P < 0.001 \)).

**DISCUSSION**

HF remains a common diagnosis for patients presenting with breathlessness on exertion. Because of poor quality of life, patients with HF require repeated admissions. HF is often diagnosed by detailed clinical history, careful clinical examination, and echocardiographic findings. In the current scenario in India, most of the patients belonging to the lower socioeconomic status may not be able to afford to get an...
echocardiographic assessment done periodically. In such patients, inexpensive clinical measurements such as PP and PPP, which correlate to the measured EF may help in clinical decision making.

In this study, most of the patients were above 55 years, which was similar to the findings of Petrie et al. [8] The male-female ratio was approximately 3:2 in this study, which was different from previous studies which did not find any sex-related differences. [Figure 1] In this study, nearly 80% of patients presented with NYHA class 3 and 4. In our study, 76% of patients had associated coronary artery disease, which was similar to the findings of Lee et al., which found that in developed countries, coronary artery disease has become the predominant cause and was responsible for 60%–75% of patients with HF. [9] In this study, systolic and diastolic blood pressures were lower among patients with a lower EF, and this difference was statistically significant (P < 0.0001).

This study found a statistically significant relationship between the PPP and EF [Figure 2]. In an earlier study, the relation between PPP and CI was studied and found to have a statistically significant relationship. [10] In another study, PP was demonstrated to be an effective predictor of the cardiac index in patients with advanced cardiac dysfunction. [10] In this study, there was a statistically significant difference in the PP and the PPP among patients who had an EF <30% and among patients who had an EF between 31 and 40%.

In the study by Petrie et al., low PP was a predictive factor for adverse cardiovascular events in patients with advanced HF. [11] PPP was found to be useful as a noninvasive predictor of long-term prognosis among patients with HF. [12] Similarly, among patients with preserved EF the PP correlated positively with the LV stroke volume index in a study conducted by Tokitsu et al. [13]

**Conclusion**

In this study, we evaluated the utility of clinical data (PP and PPP), which are noninvasive and easily measured even at primary health-care settings for assessing patients with HF. The findings of the study warrant more evaluation of these parameters so that in future, this information will help physicians in decision-making and prognosis assessment in HF patients.

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**Conflicts of interest**

There are no conflicts of interest.

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