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Estimating the Pulmonary Artery Pressure: Transthoracic Echocardiography vs. Right Heart Catheterization

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ABSTRACT

Pulmonary hypertension is defined as a mean pulmonary artery pressure (MPAP) ≥ 20 mmHg at rest, measured by right heart catheterization (RHC). The accuracy of measuring PH without invasive procedures remains a challenging task. The current study was aiming to evaluate the correlation between transthoracic echocardiography (TTE) and RHC in estimating pulmonary artery pressure (PAP) and to assess whether TTE can be a reliable tool for diagnosing and following up with patients with PH. This is a cross-sectional study of 29 patients seen at Benghazi Medical Centre diagnosed with PH in order to compare invasively measured PAP to estimated PAP by TTE. The mean age of the patients was 45.6±16.2 years, with female predominance (86.21%). RHC confirmed PH in 26 patients (89.8%), while 3 patients (10.2%) had normal PAP. The mean PAP estimated by TTE was 68.2±26.9 mmHg, significantly higher than that measured by RHC (46.31±26.2 mmHg, $p < 0.05$). Primary PAH was the leading cause of PH, followed by cardiac etiologies. TTE showed a sensitivity close to 100%, a specificity of 50%, and an overall accuracy of 90.6% in estimating PAP compared to RHC. The Pearson correlation coefficient between PAP measured by RHC and TTE was 0.692 ($p < 0.0001$). These findings suggest that TTE might be a valuable non-invasive tool for diagnosing and monitoring PH, though caution is warranted due to the variability observed in specific measurements compared to RHC.

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1. Introduction

Pulmonary hypertension is defined as mean pulmonary artery pressure (PAP) ≥ 20 mmHg at rest, measured by right heart catheterization (RHC) [1,2]. The accuracy of measuring pulmonary hypertension without the use of invasive procedures is a challenging task in clinical practice [2,3]. It has been established that the RHC is the gold standard method to accurately measure PAP [4,5]. However, its routine use is limited due to multiple factors and that include being an invasive procedure, inherent complications, incurring cost, accessibility to trained cardiologists, and cardiac catheterization laboratory equipped medical center [6, 7].

Transthoracic echocardiography (TTE) is a non-invasive, affordable, and widely available test [8]. Therefore, it's commonly considered as a reasonable initial tool for the initial assessment of patients with pulmonary arterial hypertension (PAH) [9,10,11]. PAH is caused by a heterogeneous group of disorders, and is well known to be associated with higher morbidity and mortality, regardless of the underlying cause [12,13,14]. Using the TTE in the assessment of pulmonary artery systolic pressure can be done by measuring maximum tricuspid regurgitation velocity (TRV) and applying modified Bernoulli equation to convert these values into pressure values; PASP = (Vmax2 × 4) + right atrial pressure (RAP) [15,16,17]. Many clinical studies have calculated the different parameters of TTE and found that there is close correlation in the accuracy of measurements especially peak and mean pulmonary artery pressure as compared to cardiac catheterization [18,19]. While other studies suggest using TTE not only as an initial screening tool but also for the monitoring of the disease progression [20,21,22]. The aim of this study was to evaluate the correlation between TTE and RHC in the estimation of pulmonary artery pressure and whether the use of TTE can be a reliable and accurate tool for the diagnosis and follow-up of patients with PAH.

2. Methodology

A cross sectional study of 29 patients from the rheumatology, pulmonology and cardiology clinics at Benghazi medical center, Benghazi – Libya. All patients were diagnosed with pulmonary hypertension according to the ESC/ERS 2015-2018, and confirmed by RHC in order to compare invasively measured PAP to the estimated PAP by TTE. Pulmonary artery systolic pressure was measured by both TTE first then confirmed by RHC. RHC was performed by using the Swan-Ganz catheter, multi-lumen, balloon tipped, 110 cm long, done under complete aseptic precautions. The route of entry was via the right subclavian vein and plain chest X-ray was done post catheterization to detect any complications.

3. Results and discussion

A total number of 29 patients were included in this study. The mean age was 45.6±16.2 years, ranging from 19 to 79 years old as shown in (figure 1) which was in contrasts with findings from other studies, such as those reporting mean ages of 36.4±15 years, 37 years and 53±14 years [18,19, 20, 21]. The majority of our patients were female 86.21% and 13.79% males, inconsistent with other findings reported from Egypt [20, 22].

All patients in our study exhibited elevated PAP assessed by TTE, the mean PAP by was 68.3±26.9 mmHg ranging from 23 to 125 mmHg. This is much higher than results from an Iraqi study [23], in which a mean PAP of 36±4.9 mmHg was reported, but our results were similar to Seyyedi et al. [24].

The whole sample was assessed for tricuspid valve regurgitation (TR) using TTE, and 75.9% of them had TR where as 24.1% had no valve regurgitation, comparable to meta-analyses reporting TR rates ranging from 33.9% to 56% [25], and contrasting with higher rates seen in other studies [26]. These variations likely stem from differences in PAH etiology, classification, and severity.

All patients underwent RHC to assess their PAP, of all patients 26 (89.9%) had a high PAP ≥ 20 mmHg, on the other hand 3 (10.2%)

patients had a normal PAP (figure3). The mean of PAP by RHC was 46.3±26.2 mmHg ranging from 10 to 110 mmHg. The mean of PAP by TTE was 68.2±26.9mmHg which was higher than RHC estimated PAP at 46.31±26.2 mmHg ($p < 0.05$). The correlation coefficient for PAP by RHC and TTE was 0.692 (p 0.0001) with statistically significant result (figure 2). Sensitivity of TTE as a test to assess PAP was nearly 100%, the specificity was 50% and the accuracy of TTE was 90.6%. Our results is surpassing results reported by Seyyedi SR (sensitivity 89.2%, specificity 42.8%) [24, 27, 28].

Furthermore, different causes and types of pulmonary artery hypertension were studies (tables 1 and 2). The primary type emerged as the leading cause of pulmonary hypertension in our cohort, followed by cardiac-related causes. This finding aligns with the Pan African Pulmonary Hypertension Cohort (PAPUCO) study, which classified the etiologist of pulmonary hypertension according to Simmoneau and colleagues [29, 30, 31]. In their multinational study, primary type accounted for 15.8% of cases, with the majority attributed to left heart disease (68.9%), lung disease (12.0%), chronic thromboembolic PH (1.9%), and unclear/multifactorial causes (15.8%).

Table 1: Distribution of patients with PAH according to causes.

	No	**%**
Old TB + COPD	2	7.69
CTD	9	34.6
Pulmonary fibrosis	1	3.84
Idiopathic	10	38.5
CHD	1	3.84
VHD	2	7.69
Recurrent PE	1	3.84
Total	26	100.0

TB=tuberculosis, COPD=chronic obstructive airway disease, CTD=connective tissue disease, CHD= congenital heart disease, VHD= valvular heart disease, PE= pulmonary embolism.

Table 2: Types of pulmonary arterial hypertension.

Type of PAH (group)	**No**	**%**
1	19	73.1
2	3	11.5
3	3	11.5
4	1	3.9
5	0	0

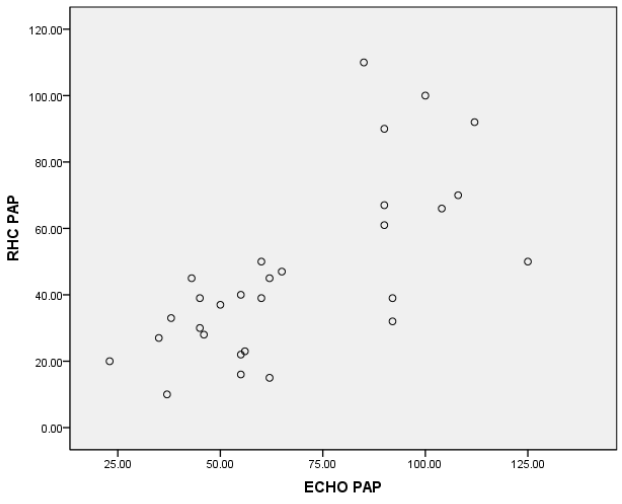

Figure 1: Age distribution of studied patients**.**

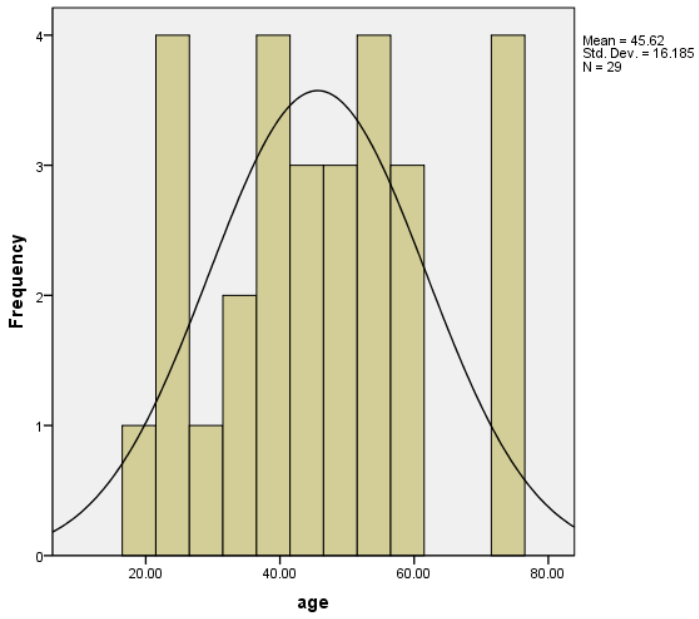

Figure 2: Linear correlation between transthoracic echocardiography PAP and right heart catheterization PAP.

4. Conclusions

The use of TTE in the assessment of PAH has a correlation with RHC. TTE might have a great benefit as a screening test for PH, although it is less specific than RHC.

Conflict of Interest

The authors did not reveal any potential conflicts of interest

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