



Relationship between pulmonary artery systolic pressure estimated by Doppler echocardiography and values obtained by right heart catheterization.

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Abstract

Introduction: Right heart catheterization is the gold standard for the diagnosis of pulmonary hypertension; however, Doppler echocardiography is a less invasive instrument that can aid in the initial treatment and detection of patients with this disease.

Methodology: A retrospective study was conducted on patients who underwent right heart catheterization at our institution and who underwent Doppler echocardiography, with an interval of less than 48 hours between the two studies.

Results: A total of 206 patients underwent right heart catheterization (RHC), 98 of whom were women (47%), with a mean age of 50 years. The mean pulmonary artery systolic pressure (PASP) estimated by RHC was 55 mmHg versus 47 mmHg estimated by transthoracic echocardiogram. Type 1 pulmonary hypertension (PH) was the predominant group (47%), mostly attributable to congenital heart disease with a shunt; the most frequent comorbidity in the study population was heart failure (52%). The PASP correlation coefficient was 0.83 ($p < 0.03$), suggesting a high degree of correlation for the entire sample evaluated; however, the agreement was 0.35 (CI: 0.13–0.21), and the intraclass correlation coefficient was 0.09, indicating low agreement between the two methods.

Conclusion: The degree of agreement for PSAPm measurement in patients with pulmonary hypertension between right heart catheterization and transthoracic echocardiography is poor for establishing a diagnosis and for patient follow-up.

Keywords:

Pulmonary hypertension, cardiac catheterization, echocardiogram.

Abbreviations

CD: Right coronary angiography.
EDT: Transthoracic Doppler echocardiography.
PSAP: pulmonary artery systolic pressure.

Supplementary information

No supplementary materials are declared.

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Authors' contributions

Richard López Mendoza, Methodology, Data Curation, Formal Analysis, Fundraising, Project Management, Validation, Visualization, Writing – Review and Editing.
Eduardo Barrio Núñez, Methodology, Data Curation, Formal Analysis, Fundraising, Project Management, Validation, Visualization, Writing – Review and Editing.
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Kris-topher Santo: Conceptualization, research, writing – original draft, resources, software, supervision.

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Availability of data and materials

The datasets used and analyzed during this study are available to the corresponding author upon reasonable request.

Introduction

Pulmonary hypertension is a hemodynamic and pathophysiological condition characterized by an increase in mean pulmonary arterial pressure greater than or equal to 25 mmHg at rest, measured by right heart catheterization, which is the gold standard for diagnosis; its practice confers some degree of morbidity and mortality and, in addition, requires its performance in specialized centers [1].

Transthoracic Doppler echocardiography (TDE) is a fundamental tool in the initial approach and screening of patients with pulmonary hypertension, as it offers indirect estimation of some hemodynamic variables; its advantages lie in its wide availability, noninvasive nature, low cost and possibility of expanding information regarding global cardiac anatomy and function [2, 3].

Pulmonary hypertension, both from Group 1 and other etiologies, has a poor prognosis. Transcranial Doppler (TCD) allows for indirect estimation of pulmonary artery systolic pressure (PASP) by adding the tricuspid regurgitation gradient to the right atrial pressure when there is no right ventricular outflow tract obstruction; however, right heart catheterization (RHC) remains the gold standard for PASP estimation. The need for an appropriate diagnostic approach is imperative to comprehensively optimize the therapeutic approach in these patients [4].

The objective of this study was to analyze whether there is a correlation and agreement between the PSAP values obtained via EDT and the CD parameters of our center.

Materials and methods

Studio design

This study is observational. The source is retrospective.

Scenery

The study was conducted in the cardiology department of Alcívar Hospital in Guayaquil, Guayas Province, Ecuador. The research period ran from June 1, 2020, to June 30, 2024.

Participants

Records of adult patients who underwent cardiac catheterization (CC) and had concomitant transcranial Doppler (TCD) were included, with less than 48 hours between studies. The exclusion criteria were patients with illegible records; patients for whom it was not possible to measure any of the study variables; and patients with clinical deterioration or intercurrent pathological conditions requiring hospitalization between the echocardiogram and catheterization, which could affect the outcome.

Variables

The variables used were age, sex, PSAPm estimated by echocardiogram and catheterization, left ventricular ejection fraction and comorbidities.

Data sources/measurements

The data source was indirect; an electronic form was completed using information from the institutional medical records. Pulmonary artery pressure (PASP) was estimated via transcranial Doppler (TCD) via the tricuspid regurgitation velocity and estimated atrial pressure on the basis of the vena cava status, whereas PASP via right heart catheterization (RHC) was measured directly, and peripheral vascular resistance (PVR) was estimated via an indirect formula. The data collection technique consisted of reviewing electronic medical records on the basis of the available database of right heart catheterizations. Echocardiographic studies recorded in the institution's noninvasive studies archive and in the medical records were reviewed, considering the echocardiogram closest to the catheterization for each patient.

Biases

Observation and selection bias were avoided by applying participant selection criteria. To prevent potential interviewer, information, and memory biases, the principal investigator maintained data collection under a guideline and with records approved according to the research protocol. Two researchers independently analyzed each record in duplicate, and variables were entered into the database after their consistency was verified.

Study size

The sample was probabilistic. In 2023, Guayaquil registered 2,303 adult deaths due to cardiovascular causes. With an annual intake of 2.22% of these cases, Hospital Alcívar accounts for 51 cases per year. With a hospitalization rate of 86.6%, the population comprises 44 cases per year (220 over 5 years). With a confidence level of 99.99%, a confidence interval of 5%, and an expected frequency of 87%, the calculated sample size was 167 cases. Epi Info™ version 7.2 (CDC, Atlanta, March 9, 2025) was used.

Quantitative variables

The variables were considered continuous, as their entire original distribution was used. No mathematical transformations (such as logarithms or square roots) were applied. Outliers were identified via a Tukey diagram, and extreme values were addressed via primary source

verification. Missing data were handled by exclusion. No dichotomization or categorization groups were defined for the continuous variables.

Statistical analysis

Qualitative variables were analyzed using frequencies and percentages. An analysis of the eFast diagnostic tests is presented, comparing them with the final diagnosis. The statistical package used was IBM Corp. (released from 2018). IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.

Results

Participants

A total of 206 patients who met the inclusion criteria were analyzed, allowing us to reach 100% of the sample.

Characteristics of the study group

There were 98 women (47%) and 108 men (53%), with a mean age of 50 ± 9 years. The left ventricular ejection fraction was $51.43\% \pm 11.54\%$. The mean pulmonary arterial pressure measured via catheterization was 8 ± 2.89 mmHg greater than that measured via echocardiography.

([Table 1](#)).

Board 1. Description general of patients.

Variable	N=206
mPSAP -Echocardiogram (mmHg)	47 \pm 5.67
PSAPm - Catheterization (mmHg)	55 \pm 8.56
FEVI (%)	51.43 \pm 11.54

PSAPm (mean pulmonary arterial pressure), LVEF (left ventricular ejection fraction).

Hemodynamic characteristics

Among the clinical and hemodynamic characteristics, type 1 pulmonary hypertension was predominant in 47% of the patients, which was attributable mostly to congenital heart disease with shunts, collagen vascular disease and idiopathic pulmonary hypertension, followed by group 2 in 25% of the patients, group 3 in 15%, group 4 in 9.2% and group 5 in 3.8%. Among the comorbidities of the entire population, the most common comorbidities were heart failure (42%), NYHA functional class II, arterial hypertension (30%), hypothyroidism (11%), coronary artery disease (10%) and chronic obstructive pulmonary disease (7%). Thirty-five percent of all patients presented with severe pulmonary hypertension ([Table 2](#)).

Table 2. Clinical and hemodynamic characteristics of patients with HTP.

Variable	Total number: 206	%
Type of Pulmonary Hypertension		

1	97	47
2	51	25
3	31	15
4	19	9.2
5	8	3.8
Comorbidities		
Heart Failure	87	42
High Blood Pressure	62	30
Hypothyroidism	23	11
Coronary Artery Disease	21	10
Chronic Obstructive Pulmonary Disease	13	7
Degree of Pulmonary Hypertension according to Right Catheterization		
Mild	87	42
Moderate	47	23
Severe	72	35

HTP: Pulmonary hypertension.

Diagnostic tests

Echocardiography showed 89% sensitivity for detecting significant pulmonary hypertension and 46% specificity, with positive and negative predictive values of 70% and 76%, respectively. The Pearson correlation coefficient (r) for the PASP between catheterization and echocardiography in the total population was 0.83 ($p < 0.03$, 95% CI 0.567–0.789). In contrast, the kappa coefficient was 0.35 (95% CI 0.130–0.215, $p = 0.009$).

Discussion

The present study analyzes the correlation between CD and EDT, where a statistically significant correlation was observed, as in other previously reported studies [5 - 9], where echocardiography shows a positive correlation with CD in the estimation of PSAPm; therefore, it is appropriate for screening, but to confirm the diagnosis, it is necessary to monitor and follow PH by means of high-specificity echocardiography.

Another study [100], which confirms the results of the present study, described a Pearson correlation of 0.69 ($P < 0.001$) between pulmonary artery systolic pressure (measured by echocardiography) and mean pulmonary artery pressure (measured by an invasive method). Echocardiography showed 89% sensitivity for detecting significant pulmonary hypertension and 46% specificity, with positive and negative predictive values of 70% and 76%, respectively.

However, the agreement between the PSAPm was poor, as corroborated in other studies [11 - 14], where there was also no agreement; therefore, when guiding the clinical decision to determine the diagnosis and follow-up of patients with pulmonary hypertension, echocardiography does not replace catheterization.

In this study, the Pearson correlation coefficient ($r=0.83$) suggested a moderately strong linear association between both methods studied for the diagnosis of pulmonary hypertension, but the low ICC value (0.09) and the kappa value

(0.35) confirmed that there was no good agreement; moreover, there was no similarity between the measurements estimated by catheterization and those estimated via echocardiography. Therefore, the two methods studied do not measure the same thing accurately, thus confirming that echocardiography does not replace catheterization in the diagnosis and monitoring of this pathology, which reinforces the need to perform catheterization for an accurate diagnostic evaluation.

Limitations

This is one of the few studies conducted in our region, with certain inherent limitations: a considerable number of patients were not obtained, the total calculated sample size was not collected, and the selected patient population does not represent the general population. Its retrospective nature also makes it more susceptible to bias, primarily in the selection of information obtained from medical records. This bias is reflected in some of the discrepancies already mentioned in the results regarding echocardiographic variables due to the use of multiple echocardiographic instruments. Interobserver variability in measurements to determine pulmonary pressures is also a factor inherent to the person performing the measurements, which may have resulted in overestimation of the indices in question. Therefore, greater methodological rigor is essential in future studies to extrapolate these data.

The assessment of pulmonary systolic pressure requires accurate determination of the tricuspid regurgitation jet and alignment of no more than 20° between this jet and the continuous-wave Doppler. This is because alignments exceeding this angle decrease the accuracy of the pressure calculation, which could have contributed to the low agreement observed.

Conclusions

Compared with right heart catheterization, the measurement of mean pulmonary artery systolic pressure (mPASP) in patients with pulmonary hypertension has high sensitivity and good correlation; therefore, mPASP is suitable for screening. However, for diagnostic confirmation, monitoring and follow-up of pulmonary hypertension (PH) via cardiac catheterization are necessary because of the low degree of agreement between the two methods. This could be attributed to the severity of the disease in some patients. Consequently, echocardiography does not replace catheterization when guiding clinical decisions for the diagnosis and follow-up of these patients.

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Statements

Ethics committee approval and consent to participate

The study was approved by the bioethics committee of the Faculty of Medical Sciences, University of Guayaquil.

Publication consent

This information was not needed, as the present study did not publish images, radiographs, or specific patient studies.

Conflicts of interest

The research has no financial interests or conflicts of interest.

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