



Correlations between Right Heart Catheterization, Echocardiography and Six Minute Walk Test in Assessment Severity of Pulmonary Arterial Hypertension

Thesis

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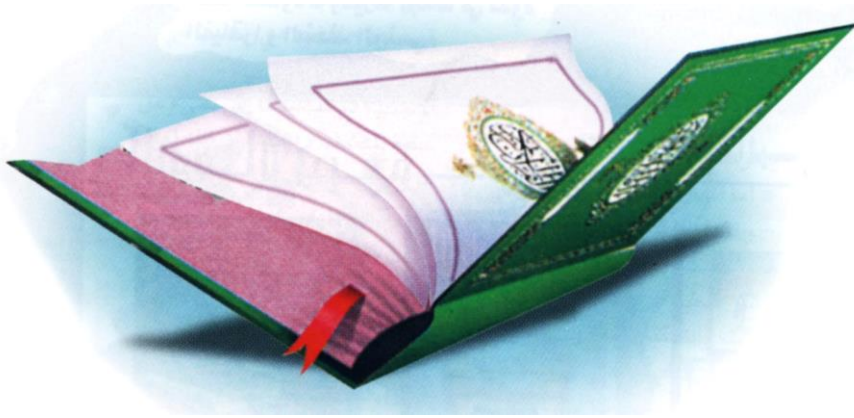
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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَقُلْ اَعْمَلُوا فَسَيَرَى اللَّهُ
عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ



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List of Contents

Title	Page No.
List of Tables	5
List of Figures	7
List of Abbreviations.....	9
Introduction.....	- 1 -
Aim of the Work	5
Review of Literature	
▪ Pulmonary Arterial Hypertension	6
▪ Six Minute Walk Test.....	39
▪ Echocardiography	52
▪ Right Heart Catheterization	56
Patients and Methods	61
Results	67
Discussion.....	100
Summary	109
Conclusion	114
Recommendations	115
References	116
Arabic Summary	

List of Tables

Table No.	Title	Page No.
Table (1):	Demographic and clinical data among 30 PAH patients:.....	68
Table (2):	Immunological profile data among 30 PAH patients:	70
Table (3):	ABG data among 30 PAH patients:	71
Table (4):	PFT data among 30 PAH patients:	71
Table (5):	Radiological data among 30 PAH patients:	72
Table (6):	Echocardiographic data among 30 PAH patients:	73
Table (7):	RHC data among 30 PAH patients:	74
Table (8):	6-MWT test among 30 PAH patients:	75
Table (9):	Comparison between the 3 groups as regards socio-demographic data using Kruskal-Wallis and Chi square tests:.....	76
Table (10):	Comparison between the 3 groups as regards basic clinical data using Kruskal-Wallis and Chi square tests:	78
Table (11):	Comparison between the 3 groups as regards Echocardiographic data using Kruskal-Wallis and Chi square tests:.....	79
Table (12):	Comparison between the 3 groups as regards RHC data using Kruskal-Wallis and test:.....	80
Table (13):	Comparison between the 3 groups as regards 6-MWT test using Kruskal-Wallis test:.....	82

List of Tables cont...

Table No.	Title	Page No.
Table (14):	Comparison between the 3 groups as regards prognostic data using Kruskal-Wallis and Chi square tests:	83
Table (15):	Multiple regression model for the Factors affecting mPAP (Echocardiography) using Forward method:.....	89
Table (16):	Multiple regression model for the Factors affecting mPAP (RHC) using Forward method:.....	91
Table (17):	Multiple regression model for the Factors affecting 6-MWT using Forward method:.....	93
Table (18):	Roc-curve of mPAP methods to predict patients with CHD-PAH:.....	95
Table (19):	Roc-curve of mPAP methods to predict patients with CTD-PAH:	97
Table (20):	Roc-curve of mPAP methods to predict patients with IPAH:.....	98

List of Figures

Fig. No.	Title	Page No.
Fig. (1):	Clinical Classification of Pulmonary Hypertension	8
Fig. (2):	Drugs and toxins indced PAH	11
Fig. (3):	Pathophysiology of pulmonary arterial hypertension	19
Fig. (4):	Diagnostic algorithm for suspected pulmonary hypertension patients	24
Fig. (5):	Pulmonary Hypertension assessment by Echocardiography.....	26
Fig. (6):	Pulmonary hypertension assessment by computed tomography.....	28
Fig. (7):	Borg Dyspnea Scale.....	41
Fig. (8):	Echocardiographic probability of pulmonary hypertension in symptomatic patients with a suspicion of pulmonary hypertension.....	54
Fig. (9):	PA ¼ pulmonary artery	55
Fig. (10):	RHC theater.	58
Fig. (11):	RHC theater in KobryElqoba Military chest hospital.	65
Fig. (12):	WHO FC among 30 PAH patients.....	69
Fig. (13):	Clinical classification of PAH among 30 PAH patients.	69
Fig. (14):	Comparison between the 3 groups as regards age.....	77
Fig. (15):	Comparison between the 3 groups as regards PVR.	81
Fig. (16):	Comparison between the 3 groups as regards 6-MWT.	84

List of Figures *cont...*

Fig. No.	Title	Page No.
Fig. (17):	Comparison between the 3 groups as regards RA area (Echo).....	84
Fig. (18):	Comparison between the 3 groups as regards RAP (RHC).	85
Fig. (19):	Comparison between the 3 groups as regards cardiac index.....	85
Fig. (20):	Comparison between the 3 groups as regards clinical signs of Rt HF.....	86
Fig. (21):	Comparison between the 3 groups as regards syncope.....	86
Fig. (22):	Comparison between the 3 groups as regards WHO FC.	87
Fig. (23):	Comparison between the 3 groups as regards Pericardial effusion.	87
Fig. (24):	Correlation between mPAP (Echo) and age.....	90
Fig. (25):	Correlation between mPAP (Echo) and SPAP (Echo).	90
Fig. (26):	Correlation between mPAP (RHC) and RAP (RHC).	92
Fig. (27):	Correlation between mPAP (RHC) and RVP (RHC).	92
Fig. (28):	Correlation between 6-MWT and age.....	94
Fig. (29):	Correlation between 6-MWT and RA area (Echo).	94
Fig. (30):	ROC curves of CHD-PAH prediction.	96
Fig. (31):	ROC curve of IPAHA prediction.....	99

List of Abbreviations

Abb.	Full term
<i>%</i>	<i>Percentage</i>
ABG	<i>Arterial blood gases</i>
ANA	<i>Antinuclear Antibodies</i>
Anticcp	<i>Anti-cyclic citrullinated peptide</i>
AntidsDNA	<i>Antidouble stranded DNA</i>
Anti-scl-70	<i>Antiscleroderma 70</i>
AUC	<i>Area under Curve</i>
BMI	<i>Body Mass Index</i>
BP	<i>Blood Pressure</i>
CBC	<i>Complete Blood Count</i>
CCBS	<i>Calcium Channel Blockers</i>
CHD	<i>Congenital Heart Disease</i>
CO	<i>Cardiac Output</i>
COPD	<i>Chronic Obstructive Pulmonary Disease</i>
CTD	<i>Connective Tissue Disease</i>
CTD	<i>Connective Tissue Diseases</i>
CTEPH	<i>Chronic Thromboembolic Pulmonary Hypertension</i>
CXR	<i>Chest X ray</i>
DLCO	<i>Diffusing Capacity of the Lung for Carbon Monoxide</i>
ECHO	<i>Echocardiography</i>
ESC	<i>European Respiratory Society</i>
ESR	<i>Erythrocyte Sedimentation Rate</i>
ET-1	<i>Endothelin-1</i>
ETRA	<i>Endothelin A</i>
ETRB	<i>Endothelin B</i>

List of Abbreviations *cont...*

Abb.	Full term
FC	<i>Functional class</i>
FEV1	<i>Forced Expiratory Volume in One Second</i>
FVC	<i>Forced Vital Capacity</i>
HF	<i>Heart failure</i>
HIV	<i>Human Immunodeficiency Virus</i>
HR	<i>Heart Rate</i>
HRCT	<i>High-Resolution Computed Tomography</i>
ILD	<i>Interstitial Lung Disease</i>
INR	<i>International Normalized Ratio</i>
IPAH	<i>Idiopathic Pulmonary Arterial Hypertension</i>
ISHLT	<i>International Society of Heart and Lung Transplantation</i>
IVS	<i>Inter-Ventricular Septum</i>
KFT	<i>Kidney Function Test</i>
LA	<i>Left Atriaum</i>
LFT	<i>Liver Function Test</i>
LV	<i>Left Ventricle</i>
mmHg	<i>Millimeter Mercury</i>
mPAP	<i>Mean pulmonary artery pressure</i>
MRI	<i>Magnetic Resonance Imaging</i>
NFAT	<i>Nuclear Factors of Activated T-Cells</i>
NO	<i>Nitrogen Monoxide</i>
PAH	<i>Pulmonary Arterial Hypertension</i>
PaO2	<i>Oxygen Tension</i>
PAP	<i>Pulmonary Artery Pressure</i>
PASMCS	<i>Pulmonary Artery Smooth Muscle Cells</i>

List of Abbreviations *cont...*

Abb.	Full term
PAWP	<i>Pulmonary Artery Wedge Pressure</i>
PCWP	<i>Pulmonary Capillary Wedge Pressure</i>
PDE-5	<i>Phosphodiesterase type-5</i>
PGI2	<i>Prostaglandin I2</i>
PH	<i>Pulmonary Hypertension</i>
PVOD	<i>Pulmonary Veno-Occlusive Disease</i>
PVR	<i>Pulmonary vascular resistance</i>
RA	<i>Right Atrium</i>
RAP	<i>Right Atrial Pressure</i>
RHC	<i>Right-Sided Heart Catheterization</i>
ROC	<i>Receiver operating Characteristic</i>
RT	<i>Right</i>
RV	<i>Right Ventricle</i>
RVP	<i>Right ventricular Pressure</i>
SaO2	<i>Oxygen Saturation</i>
SD	<i>Standard deviation</i>
SE	<i>Standard Error</i>
SPAP	<i>Systolic Pulmonary Artery Pressure</i>
SSRIs	<i>Selective serotonin reuptake inhibitors</i>
TLC	<i>Total Lung Capacity</i>
TR	<i>Tricuspid Regurgitation</i>
V\Q scan	<i>Ventilation Perfusion Scan</i>
VIP	<i>Vasoactive Intestinal Peptide</i>
WHO	<i>World Health Organization</i>

INTRODUCTION

Pulmonary arterial hypertension (PAH) is a disease of the pulmonary vasculature leading to an increase in pulmonary vascular pressure (mean arterial pulmonary pressure ≥ 25 mm Hg) causing exertional dyspnea and progressive right heart failure (*Galie et al., 2015*).

There is a marked increase in the pulmonary vascular resistance resulting in right ventricular remodeling and eventual failure, which, in the majority of cases, results in the patient death (*Tuder et al., 2013*).

Given the evolving definition of PH, the incidence and prevalence of the disease is difficult to define (*Strange et al., 2012*).

Regardless of etiology, PH is characterized by limited exercise capacity and a progressive increase in breathlessness. Until recently, treatment options for PH remained limited and patient prognosis poor. One early registry of PH patients reported a median survival time of 2.8 years post diagnosis without treatment (*D'Alonzo et al., 1991*).

The World Health Organization functional class (WHO-FC), despite its interobserver variability, remains one of the most powerful predictors of survival, not only at diagnosis, but also during follow-up. A worsening FC is one of the most alarming indicators of disease progression, which should

trigger further diagnostic studies to identify the causes of clinical deterioration (*Nickel et al., 2012*).

The 6-minute walking test (6MWT), a submaximal exercise test, remains the most widely used exercise test in PH centers. The test is easy to perform, inexpensive and familiar to patients and centers. As with all PH assessments, 6MWT results must always be interpreted in the clinical context (*Savarese et al., 2012*).

The prognostic value of this parameter lies not in the change of 6MWD in response to treatment, but most of all in its absolute value, particularly if it is lower than 250 m (*Benza et al., 2010*). There was significantly lower mortality in patients with 6MWD higher than 440 m (*Farber et al., 2015*).

Echocardiography is commonly used for diagnostic and treatment monitoring purposes in patients with PAH due to its wide availability, non-invasive nature, and reproducibility (*Eysmann et al., 1989*).

A comprehensive echocardiographic assessment includes a description of chamber sizes, particularly of the Right Atrium and Right Ventricle area, the magnitude of tricuspid regurgitation, the Left Ventricle eccentricity index and RV contractility, which can be, determined by several variables, including RV longitudinal systolic strain/strain rate and RV fractional area change, Tei index and tricuspid annular plane systolic excursion (TAPSE) (*Fine et al., 2015*).

European Society of Cardiology Guideline suggests grading the probability of PH based on TRV at rest and on the presence of additional pre-specified echocardiographic variables suggestive of PH. The probability of PH may then be judged as high, intermediate or low (*Rudski et al., 2010*).

RHC is a technically demanding procedure that requires meticulous attention to detail to obtain clinically useful information. To obtain high-quality results and to be of low risk to patients, the procedure should be limited to expert centers (*Kovacs et al., 2014*).

RHC is required to confirm the diagnosis of PAH and chronic thromboembolic pulmonary hypertension, to assess the severity of haemodynamic impairment and to undertake vasoreactivity testing of the pulmonary circulation in selected patients. When performed at expert centers, these procedures have low morbidity (1.1%) and mortality (0.055%) rates (*Hoeper et al., 2006*).

Current diagnostic criteria for pulmonary artery hypertension based on right heart catheter. Mean pulmonary arterial pressure $>25\text{mmHg}$ at rest a pulmonary capillary wedge pressure $< 15\text{mmHg}$ and by pulmonary vascular resistance >3 Wood Units (*Frost et al., 2013*).

Haemodynamics assessed by RHC provide important prognostic information, both at the time of diagnosis and during

follow-up. RA pressure, cardiac index (CI) and mixed venous oxygen saturation (SvO₂) are the most robust indicators of RV function and prognosis, whereas mPAP provides little prognostic information (except for Calcium Channel Blockers responders) (*Nickel et al., 2012*).