**How to Cite**:
Omar, Y. A. A., Abdo, A. A. F., & Edress, . . A. H. (2022). Assessment of right ventricular function by 2D transthoracic echocardiography in COVID-19 hospitalized patient in correlation with CT pulmonary angiographic findings. *International Journal of Health Sciences*, *6*(S7), 1871–1887. https://doi.org/10.53730/ijhs.v6nS7.11730

# Assessment of right ventricular function by 2D transthoracic echocardiography in COVID-19 hospitalized patient in correlation with CT pulmonary angiographic findings

**Dr. Yasser Abd Aljalil Omar**
Assistant Professor of Cardiovascular Diseases Faculty of Medicine - Al-Azhar University

**Dr. Ahmed Ali Faheem Abdo**
Lecturer of Cardiology, Faculty of Medicine - Al-Azhar University

**Ahmed Hameed Edress**
Faculty of Medicine - Al-Azhar University, Phone No.: (+2) 01155820201
*Corresponding Author email: dr.ahmed.hameed3@gmail.com

***Abstract*---***Background:*. The Egyptian protocol in COVID-19 patients includes doing a non- contrast CT chest for patients with suspicious respiratory symptoms. However, many patients with worsened symptoms especially during the second week of disease showed symptoms of thrombotic events of pulmonary arteries, and that is why CT pulmonary angiography (CTPA) became recommended by multiple reports. *Aim of the Work:* Evaluation of RV Function by Echocardiography in COVID-19 hospitalized patients in correlation with CT pulmonary angiographic findings. *Patients and Methods:* This study is a prospective study which included 100 consecutive adult patients (≥18 years of age). *Results:* Our study showed that there was non statistically significant difference found between two groups regarding Basal right ventricular diameter , FAC , PASP ,TAPSE (except for sever pulmonary embolism ) *Conclusion:* Our study revealed the variable presentation of COVID-19 as a cause of pulmonary embolism. And no statistically significant difference found between pulmonary embolism group and no pulmonary embolism group regarding right ventricular dysfunction.

***Keywords***---Right Ventricular Function - 2D Transthoracic Echocardiography - COVID-19.

## Introduction

Pulmonary embolism (PE) is one of the known sequels of COVID-19 infection. We aimed to assess the incidence of PE in patients with COVID-19 infection and to evaluate the relationship between the CT Pulmonary angiography finding and right ventricular function by Echocardiography. This will be a study conduct on 100 patients with COVID-19 infection proved by positive PCR or by CORADS-5 CT Chest [(1)].

Echocardiographic evaluation of right ventricular (RV) function is a challenge due to the complex anatomy of the RV. Several transthoracic echocardiographic methods have been suggested for the quantification of RV function. However, many of the parameters are time consuming and need dedicated hardware and software [(3)].

Eyeballing and TAPSE may lead to misinterpretations of right ventricular function. However, the two parameters are applied most frequently for the quantification of right ventricular function. New methods such as 3D echocardiography and RV-GLS are employed by some physicians, mainly in the university hospital setting. Although these advanced parameters were shown to be highly accurate, they are rarely used in daily clinical routine [(4)].

CT pulmonary angiography not only can assess the presence of pulmonary embolus but also can assess the severity of the embolus and Echocardiography can assess heart function on the right ventricle. Thus, we can predict the need for ICU admission and patient outcome [(6)].

For PE to occur during COVID-19 infection, several factors are associated which include disease progression with worsening symptoms as hemoptysis, oxygen desaturation, and chest pain. Rising D-dimer during the second week of disease which all are alert to do CT pulmonary angiography to exclude or confirm PE. This also raises the utmost need for anticoagulation prophylactically [(7)].

## Patients and Methods

### I- Technical design:

- ***Population or subjects**:*

  We studied 100 consecutive adult patients (≥18 years of age).

- ***Inclusion criteria:***

All patients had a diagnosis of COVID-19 infection confirmed by a positive reverse-transcriptase polymerase chain reaction assay for severe acute respiratory syndrome coronavirus or by CORADS-5 result in CT Lungs whose needs hospital admission.

- ***Exclusion criteria:***

***Patients who have one or more of the following:***

- Non COVID-19 patient.
- CORADS-4 or less in CT chest.
- Dilated cardiomyopathic patient.
- Patient with known abnormal RV Function.
- Patients with Known Chronic Respiratory Disease.
- Non hospitalized patients.

**II-Operational design:**

- This study is a prospective study.
- The final study population was 100 patients.

**All patients were subjected to:**

**A. Full history taking:** including age, sex, DM, HTN and smoking

**B. Full clinical examination:** including pulse, blood pressure measurement (systolic and diastolic) and cardiac auscultation for the presence of murmurs or added sounds.

**C. Pulse oximetry:** to measure the oxygen saturation of blood.

**D. Labs:** Serum ferritin, D-dimer C-reactive Protien & serum troponin were measured in all patients.

**E. Electrocardiography:** Twelve lead surface ECG was done to assess patients heart rate and rhythm with exclusion of ischemic changes or other ECG changes.

**F. Echocardiography:**

***1- Right ventricular dimensions:***

From apical four chamber view, the basal diameter was measured in the basal one third of the right ventricle, the mid cavity diameter was measured in the middle third of the right ventricle at the level of the LV papillary muscles and the longitudinal diameter was drawn from the plane of the tricuspid annulus to the RV apex.

***Normal values***

- RV basal dimension: 2.4-4.2 cm.
- RV mid dimension: 2-3.5 cm.
- RV long dimension: 5.6-8.6 cm [8].

***2- Right ventricular areas and fractional area change (FAC):***

FAC was obtained from a four-chamber view by tracing the RV endocardium both in systole and diastole from the annulus, along the free wall to the apex, and then back to the annulus, along the interventricular septum.

The percentage RV FAC, defined as (end-diastolic area - end-systolic area) / end-diastolic area X 100.

Normal values of RVFAC: 35-63% [8].

***3- Pulmonary artery systolic pressure (PASP):***

Pulmonary artery systolic pressure was estimated by calculating the systolic pressure gradient between RV and RA by continuous wave Doppler of the tricuspid regurgitation jet. Right ventricular systolic pressure (RVSP) was determined from peak TR jet velocity, using the simplified Bernoulli equation and combining this value with an estimate of the RA pressure: RVSP = 4(V) $^{2}$ + RA pressure, where V is the peak velocity (in meters per second) of the tricuspid valve regurgitant jet, and RA pressure is estimated from IVC diameter, collapsibility and respiratory changes as follows [8]:

| **Variables** | **Normal (0 - 5(3) mm Hg)** | **Intermediate (5 - 10(8) mm Hg)** | **High (15 mm Hg)** |
|---|---|---|---|
| IVC diameter | ≤ 21 mm | ≤ 21 mm; > 21 mm | > 21 mm |
| Collapse with sniff | > 50% | < 50%; > 50% | < 50% |
| Secondary indices of elevated RAP | | | Restrictive filling Tricuspid E/e' > 6<br>Diastolic flow predominance in hepatic veins (systolic filling fraction < 55%) |

### *4- Tricuspid annular plane systolic excursion (TAPSE):*

TAPSE was obtained by measuring of the distance of systolic excursion of the RV annular segment along its longitudinal plane, from a standard apical 4-chamber window.

*Normal values of TAPSE*: 1.6 - 3 cm [8].

5- ***McConnell's sign:*** a distinct echocardiographic finding described in patients with acute PE. There is a distinct regional pattern of right ventricular dysfunction, with akinesia of the mid free wall [9].

### G. Clinical and imaging data with CT pulmonary angiography collected prospectively.

**Statistical Analysis**

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. The qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges when their distribution found parametric.

The comparison between two groups with qualitative data were done by using ***Chi-square test*** and/or ***Fisher exact test*** was used instead of Chi-square test when the expected count in any cell was found less than 5.

The comparison between two independent groups with quantitative data and parametric distribution was done by using ***Independent t-test.***

The comparison between more than two independent groups with quantitative data and parametric distribution was done by using ***One Way ANOVA test.***

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

- P> 0.05 = non significant (NS)
- P < 0.05 = significant (S)
- P < 0.001 = highly significant (HS).

**Results**

**Table (1)**
Distribution of the studied cases according to Sex, Age, Diabetes, Hypertensive and Previous CV disease

| | | **No.= 100** |
|---|---|---|
| Sex | Male | 56 (56.0%) |
| | Female | 44 (44.0%) |
| Age | Mean ± SD | 56.42 ± 14.98 |
| | Range | 28 – 80 |
| Diabetes | Negative | 44 (44.0%) |
| | Positive | 56 (56.0%) |
| Hypertensive | Negative | 58 (58.0%) |
| | Positive | 42 (42.0%) |
| Previous CV disease | Negative | 46 (46.0%) |
| | Positive | 54 (54.0%) |

**Table (2)**
Distribution of the studied cases according to EF, Diastolic function and grade, FAC, TAPSE, PASP, Basal RV diameter, Troponin and CKMB

| | **No.= 100** | |
|---|---|---|
| | **Mean ± SD** | **Range** |
| EF | 50.79 ± 12.05 | 32 – 71 |
| Diastolic function and grade | 1.72 ± 1.09 | 0 – 3 |
| FAC | 45.59 ± 3.09 | 34 – 50.1 |
| TAPSE | 17.11 ± 3.05 | 12 – 22 |
| PASP | 41.44 ± 8.57 | 25 – 55 |
| Basal RV diameter | 39.56 ± 2.83 | 35 – 44 |
| Troponin | 124.73 ± 79.44 | 0 – 249 |
| CKMB | 11.73 ± 7.27 | 0 – 25 |

**Table (3)**
Distribution of the studied cases according to CT pulmonary angio

| **CT pulmonary angio** | **No.** | **%** |
|---|---|---|
| No pulmonary embolism | 43 | 43.0% |
| Pulmonary embolism | 57 | 57.0% |

**Table (4)**
Distribution of the studied cases according to Severity, TAPSE and McConnell's sign

| | | **No.= 100** |
|---|---|---|
| Severity | Mild | 28 (49.1%) |
| | Moderate | 16 (28.1%) |

| | | |
|---|---|---|
| | Severe | 13 (22.8%) |
| TAPSE | Mean ± SD<br>Range | 17.11 ± 3.05<br>12 – 22 |
| McConnell's sign | Negative<br>Positive | 85 (85.0%)<br>15 (15.0%) |

.

**Table (5)**

Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding EF, Troponin and CKMB

| | | **No pulmonary embolism** | **Pulmonary embolism** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | | **No.= 43** | **No.= 57** | | | |
| EF | Mean ± SD<br>Range | 50.49 ± 13.10<br>32 – 71 | 51.02 ± 11.31<br>33 – 71 | -0.216• | 0.829 | NS |
| Troponin | Mean ± SD<br>Range | 135.26 ± 75.54<br>1 – 249 | 116.79 ± 82.02<br>0 – 248 | 1.153• | 0.252 | NS |
| CKMB | Mean ± SD<br>Range | 10.56 ± 7.70<br>0 – 25 | 12.61 ± 6.86<br>0 – 24 | -1.408• | 0.162 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between
two groups regarding *EF, Troponin and CKMB*.

**Table (6)**

Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding PaO2, PO2/ FiO2, O2 sat, PaCo2, HCO3, TLC, Lymph percentage, 1st hr ESR, 2nd hr ESR and D dimer

| | | **No pulmonary embolism** | **Pulmonary embolism** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | | **No.= 43** | **No.= 57** | | | |
| PaO2 | Mean ± SD<br>Range | 61.12 ± 15.59<br>32 – 85 | 56.00 ± 17.06<br>30 – 84 | 1.540• | 0.127 | NS |
| PO2/ FiO2 | Mean ± SD<br>Range | 262.21 ± 68.44<br>152 – 395 | 282.49 ± 72.38<br>168 – 398 | -1.420• | 0.159 | NS |
| O2 sat | Mean ± SD<br>Range | 82.00 ± 10.41<br>65 – 98 | 80.72 ± 10.36<br>65 – 98 | 0.611• | 0.543 | NS |
| PaCo2 | Mean ± SD<br>Range | 32.23 ± 7.84<br>20 – 44 | 32.63 ± 6.87<br>20 – 43 | -0.271• | 0.787 | NS |

| | | | | | | |
|---|---|---|---|---|---|---|
| HCO3 | Mean ± SD<br>Range | 22.23 ± 4.66<br>15 – 30 | 22.47 ± 4.62<br>15 – 30 | -0.257• | 0.797 | NS |
| TLC | Mean ± SD<br>Range | 8.79 ± 4.99<br>1 – 18 | 9.86 ± 4.54<br>1 – 18 | -1.116• | 0.267 | NS |
| Lymph percentage | Mean ± SD<br>Range | 14.28 ± 3.63<br>9 – 20 | 13.67 ± 3.48<br>8 – 20 | 0.856• | 0.394 | NS |
| 1st hr ESR | Mean ± SD<br>Range | 34.00 ± 10.44<br>16 – 50 | 31.58 ± 10.27<br>15 – 49 | 1.159• | 0.249 | NS |
| 2nd hr ESR | Mean ± SD<br>Range | 87.30 ± 20.75<br>60 – 120 | 89.56 ± 18.11<br>61 – 120 | -0.580• | 0.563 | NS |
| D dimer | Mean ± SD<br>Range | 859.67 ± 355.34<br>166 – 1330 | 766.81 ± 339.19<br>165 – 1328 | 1.328• | 0.187 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *PaO2, PO2/ FiO2, O2 sat, PaCo2, HCO3, TLC, Lymph percentage, 1st hr ESR, 2nd hr ESR and D dimer.*

**Table (7)**

Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding Severity, TAPSE and McConnell's sign

| | | **No pulmonary embolism** | **Pulmonary embolism** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | | **No.= 43** | **No.= 57** | | | |
| Severity | Mild<br>Moderate<br>Severe | –<br>–<br>– | 28 (49.1%)<br>16 (28.1%)<br>13 (22.8%) | NA | NA | NA |
| TAPSE | Mean ± SD<br>Range | 16.86 ± 3.06<br>12 – 22 | 17.29 ± 3.05<br>12 – 22 | 0.502 | 0.480 | NS |
| McConnell's sign | Negative<br>Positive | 36 (83.7%)<br>7 (16.3%) | 49 (86.0%)<br>8 (14.0%) | 0.097 | 0.756 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *TAPSE and McConnell's sign.*

**Table (8)**
Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding Diastolic function and grade

| **Diastolic function and grade** | **No pulmonary embolism** **No.= 43** | **Pulmonary embolism** **No.= 57** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|
| Mean ± SD | 1.58 ± 1.03 | 1.82 ± 1.14 | -1.103• | 0.273 | NS |
| Range | 0 – 3 | 0 – 3 | | | |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *Diastolic function and grade*.

**Table (9)**
Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding FAC

| *FAC* | **No pulmonary embolism** **No.= 43** | **Pulmonary embolism** **No.= 57** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|
| Mean ± SD | 45.62 ± 2.94 | 45.56 ± 3.23 | 0.082• | 0.935 | NS |
| Range | 40 – 50.1 | 34 – 50 | | | |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *FAC*.

**Table (10)**
Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding TAPSE

| *TAPSE* | **No pulmonary embolism** **No.= 43** | **Pulmonary embolism** **No.= 57** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|
| Mean ± SD | 16.86 ± 3.07 | 17.30 ± 3.05 | -0.708• | 0.480 | NS |
| Range | 12 – 22 | 12 – 22 | | | |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *TAPSE*.

**Table (11)**
Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding PASP

| *PASP* | **No pulmonary embolism** | **Pulmonary embolism** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|
| | **No.= 43** | **No.= 57** | | | |
| Mean ± SD | 42.65 ± 7.62 | 40.53 ± 9.19 | 1.230• | 0.222 | NS |
| Range | 27 – 55 | 25 – 55 | | | |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *PASP*.

**Table (12)**
Comparison between No pulmonary embolism (no. =43) and Pulmonary embolism (no. =57) regarding Basal RV diameter

| *Basal RV diameter* | **No pulmonary embolism** | **Pulmonary embolism** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|
| | **No.= 43** | **No.= 57** | | | |
| Mean ± SD | 39.49 ± 2.96 | 39.61 ± 2.74 | -0.219• | 0.827 | NS |
| Range | 35 – 44 | 35 – 44 | | | |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, •: Independent t-test**

The Previous table shows that there was non statistically significant difference found between two groups regarding *Basal RV diameter.*

**Table (13)**
Comparison between Mild (no. =51), Moderate (no. =27) and Severe (no. =22) regarding Diastolic function and grade

| **Diastolic function and grade** | **Mild** | **Moderate** | **Severe** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | **No.= 51** | **No.= 27** | **No.= 22** | | | |
| Mean ± SD<br>Range | 1.65 ± 1.09<br>0 – 3 | 1.78 ± 1.09<br>0 – 3 | 1.82 ± 1.14<br>0 – 3 | 0.237 ß | 0.790 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, ß: One Way ANOVA**
The Previous table shows that there was non statistically significant difference found between three groups regarding *Diastolic function and grade*.

**Table (14)**
Comparison between Mild (no. =51), Moderate (no. =27) and Severe (no. =22) regarding FAC

| *FAC* | **Mild** | **Moderate** | **Severe** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | **No.= 51** | **No.= 27** | **No.= 22** | | | |
| Mean ± SD<br>Range | 45.59 ± 2.77<br>41 – 50.1 | 45.16 ± 3.68<br>34 – 50 | 46.12 ± 3.10<br>41.4 – 50 | 0.582 ß | 0.561 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, ß: One Way ANOVA**

The Previous table shows that there was non statistically significant difference found between three groups regarding *FAC*.

**Table (15)**
Comparison between Mild (no. =51), Moderate (no. =27) and Severe (no. =22) regarding TAPSE

| *TAPSE* | **Mild** | **Moderate** | **Severe** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | **No.= 51** | **No.= 27** | **No.= 22** | | | |
| Mean ± SD<br>Range | 19.63 ± 1.46<br>17 – 22 | 15.74 ± 1.32<br>13 – 18 | 12.95 ± 0.90<br>12 – 14 | 217.515 ß | 0.000 | HS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, ß: One Way ANOVA**

The Previous table shows that there was highly statistically significant difference found between three groups regarding *TAPSE*.

**Table (16)**
Comparison between Mild (no. =51), Moderate (no. =27) and Severe (no. =22) regarding PASP

| *PASP* | **Mild** | **Moderate** | **Severe** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | **No.= 51** | **No.= 27** | **No.= 22** | | | |
| Mean ± SD<br>Range | 42.33 ± 8.47<br>25 – 55 | 41.33 ± 9.01<br>25 – 54 | 39.50 ± 8.32<br>25 – 54 | 0.839 **ß** | 0.435 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, ß: One Way ANOVA**
The Previous table shows that there was non statistically significant difference found between three groups regarding *PASP*.

**Table (17)**
Comparison between Mild (no. =51), Moderate (no. =27) and Severe (no. =22) regarding Basal RV diameter

| *Basal RV diameter* | **Mild** | **Moderate** | **Severe** | **Test value** | **P-value** | **Sig.** |
|---|---|---|---|---|---|---|
| | **No.= 51** | **No.= 27** | **No.= 22** | | | |
| Mean ± SD<br>Range | 39.67 ± 2.74<br>35 – 44 | 39.30 ± 2.78<br>35 – 44 | 39.64 ± 3.17<br>35 – 44 | 0.159 **ß** | 0.853 | NS |

**P-value >0.05: Non significant(NS); P-value <0.05: Significant(S); P-value< 0.01: highly significant(HS)**

***: Chi-square test, ß: One Way ANOVA**

The Previous table shows that there was non statistically significant difference found between three groups regarding *Basal RV diameter.*

**Discussion**

Corona virus disease 2019 (COVID-19) outbreak is a current global healthcare burden, leading to the life-threatening severe acute respiratory syndrome corona virus 2 (SARS-CoV-2). However, evidence showed that, even if the prevalence of COVID-19 damage consists in pulmonary lesions and symptoms, it could also affect other organs, such as heart, liver, and spleen. Particularly, some infected patients refer to the emergency department for cardiovascular symptoms, and around 10% of COVID-19 victims had finally developed heart injury **(11).**

During prior influenza epidemics, more patients died of CV causes than pneumonia/influenza causes **(12).** Given the high inflammatory burden of COVID-19, significant CV complications with COVID-19 infection are expected. Previous

reports have suggested that COVID-19 leads to CV complications or deterioration of pre-existing CVD [13, 14, 15, 16].

Up to 20% – 30% of patients hospitalized with corona virus disease 2019 (COVID-19) have evidence of myocardial involvement. Acute cardiac injury in patients hospitalized with COVID-19 is associated with higher morbidity and mortality [17].

COVID-19 involvement of the heart has ranged from asymptomatic myocardial injury to acute coronary syndrome, mild to fulminant myocarditis, stress cardiomyopathy, and cardiogenic shock; however, the mechanism of cardiac involvement is not exactly clear [18].

In the current study; age ranged between 28 and 80 with mean (56.42 ± 14.98) and there were male predominance (56.0%) in our study.

In ***Li et al.*** [15] study; they reported that median age in patients with CVD was 48 yrs and higher proportion of men (52.5%).

In ***Vasudev et al.*** [19] study; 45 patients were evaluated. The mean age was 61.4 ± 12.2 years.

In ***García-Cruz et al.*** [20] study, the majority of the patients were men (62.2%), with a median age of 56 (50 – 66) years.

In our study; there were 42 (42.0%) hypertensive patients among our cases

In ***Li et al.*** [15] study; they reported that among 215 patients with CVD, 176 patients had hypertension. Patients with CVD had higher systolic blood pressure (138)

In ***Vasudev et al.*** [19] study; out of 45 patients. (64%) were hypertensive.

***Momtazmanesh et al.*** [21] reported that hypertension was present in slightly less than one-third of admitted patients.

A meta-analysis of COVID-19 patients revealed that the prevalence of hypertension, was 17.1 [15].

In ***García-Cruz et al.*** [20] study, the most frequent comorbidities were hypertension and type 2 diabetes (47.6 and 43.9%, respectively).

In our study; There were 56 (56.0%) diabetic patients among our cases.

In ***Li et al.*** [15] study; they reported that the rate of diabetes (27.0%) in the patients with CVD.

In ***Lassen et al.*** [22] study; they reported that the rate of diabetes (25.5%) in the patients with CVD.

A meta-analysis of COVID-19 patients revealed that the prevalence of diabetes mellitus was 9.7% [15].

In the current study, regarding incidence of previous cardiovascular disease, there were 54 (54.0%) patients among our cases.

In ***Vasudev et al.*** [19] study; The incidence of congestive heart failure among the studied patients was 24%, coronary artery disease was 20%, and valvular heart disease 7%.

A meta-analysis of COVID-19 patients revealed that the prevalence of cardio-cerebrovascular disease was 16.4 [15].

In the current study; regarding $PaO_2$ ranged between 30 and 85 with mean (58.20 ± 16.56).

In ***Li et al.*** [15] study; they reported that Respiratory dysfunction is more serious in patients with CVD. In terms of blood gas analysis, patients with CVD had lower partial pressure of oxygen ($PaO_2$) (80 (IQR 58 –118).

***Goudot et al.*** [23] in their observational cohort study conducted at the Georges Pompidou European Hospital in Paris, they reported that most patients with covid 19 had respiratory acidosis with median $PaO_2$ of 85 mmHg (68 – 100).

In our study; regarding $O_2$saturation ranged between 65 and 98 with mean (81.27 ± 10.35).

In ***Li et al.*** [15] study; they reported that patients with CVD had lower $SpO_2$ (96 (IQR 90 –99).

In the current study; regarding $HCO_3$ ranged between 15 and 30 with mean (22.37 ± 4.62).

In ***Li et al.*** [15] study; they reported that patients with CVD had lower $HCO_3$ (25.4 (IQR 22.2 – 27.8).

In our study; regarding $paCO_2$ ranged between 20 and 44 with mean (32.46 ± 7.26).

***Goudot et al.*** [23] in their study. They reported that Most patients had respiratory acidosis with median $PaCO_2$ of 53 mmHg (42 – 59).

In our study; regarding PO2/ FiO2ratio ranged between 152 and 398 with mean (273.77 ± 71.08).

In ***Li et al.*** [15] study; they reported that patients with CVD had lower PaO2/FiO2 (333.0 mmHg).

There was nonsignificant statistical difference in the present study between the 2 groups regarding TLC (mean TLC was9.33 ± 4.95 cells/mm3, 9.20 ± 5.15 cells/mm3 in group I, II respectively; p = 0.904).

In ***Li et al.*** [15] study; they reported that Patients with CVD showed high total leukocyte counts (5770 cells/µl).

In our study; regarding Lymphocytic count ranged between 1 and 18 with mean (9.40 ± 4.75).

In ***Li et al.*** [15] study; they reported that Patients with CVD showed low lymphocyte counts (930 cells/µl).

***Guan et al.*** [24] in their study on 7736 patients with Covid-19 reported that lymphocytopenia was present in 83.2% of the patients.

In our study; regarding D-dimer ranged between 165 and 1330 with mean (806.74 ± 347.54).

In ***Li et al.*** [15] study; they reported that Patients with CVD had high levels of D-dimer (0.43 (IQR 0.18 – 2.78) µg/ml).

In the current study; regarding INR. Mean INR was 1.48 ± 0.31 and ranged between 1 and 1.9.

In ***Yu et al.*** [25] study, they reported median INR was 1.07in cardiac.

In our study; Regarding Creatinine ranged between 0.6 and 2.5 with mean (0.92 ± 0.29) and Urea ranged between 5 and 20 with mean (13.67 ± 4.56).

In ***Li et al.*** [15] study; they reported that Patients with CVD had high levels creatinine (66 µmol/l), also Patients with CVD had high levels of alanine aminotransferase (23 U/l), aspartate aminotransferase (29 µmol/l).

In the current study, there was non statistically significant difference found between two groups regarding EF mean was (50.79 ± 12.05), Diastolic function and grade mean was (1.72 ± 1.09), TAPSE mean was (17.11 ± 3.05), PASP mean was (41.44 ± 8.57).

***Lassen et al.*** [22] reported that regarding TAPSE, as Right ventricular function, (TAPSE: cases: 2.0 ± 0.4).

***Szekely et al.*** [26] found that the LVEF was only slightly lower in our patients, with 10% of patients showing a reduction of LVEF <50% at the baseline evaluation (including 2 who had documented low LVEF in a previous examination).

In the current study, regarding Basal RV diameter ranged between 35 and 44 with mean (39.56 ± 2.83).

***Stockenhuber et al.*** [27] reported that mean RVD was 38.2mm.

Five of the 12 patients demonstrating RV deterioration had evidence of deep vein thrombosis (DVT) at the femoral veins [26].

The results showed that there was non statistically significant difference found between two groups regarding Basal RV diameter

***Szekely et al.*** [26] reported that the most common abnormal echocardiographic pattern among deteriorating patients (10 of 20, 50%) was RV dilatation and dysfunction associated with shortened AT and normal LV systolic and diastolic function. Many conditions can increase pulmonary vascular resistance or pulmonary pressure in hospitalized patients and precipitate acute RV failure.

There was non statistically significant difference found between two groups regarding *O2 sat, and D dimer.*

There was non statistically significant difference found between two groups regarding *Treponin*.
Patients with shorter AT (suggestive of higher pulmonary resistance) had more comorbidities, lower oxygen saturation and higher biomarkers (D-dimer and troponin-I) [26].

The 20% prevalence of elevated troponin levels in our cohort was similar to that in previous reports [16].

***Momtazmanesh et al.*** [21] observed higher levels of cardiac troponin in the deceased patients in comparison with the survived. ***Li and his colleagues*** [15] showed that cardiac troponins was higher in the deceased patients with COVID-19. Likewise, ***Guo et al.*** [16] studied 187 patients with COVID-19 and observed that dynamic changes or rising levels of cardiac troponin T was significantly higher in the deceased patients.

Our study showed that there was non statistically significant difference found between two groups regarding *ALT, AST and Albumin.*

Commonly reported hepatic manifestations of COVID-19 include elevations in serum levels of alanine transaminase (ALT), aspartate transaminase (AST) while levels of albumin are decreased [28, 29].

Decreased albumin was noted in 98% of patients, while serum levels of AST, ALT, and bilirubin were elevated in 35, 28, and 18% of patients, respectively. Similarly, in an analysis of 1,099 patients, increased levels of AST were observed in 18.2% of patients with non-severe disease and 39.4% of patients with severe disease, while increased ALT levels were observed in 19.8% of patients with non-severe disease and 28.1% of patients with severe disease [24].

## Conclusion

Our study revealed the variable presentation of COVID-19 as a cause of pulmonary embolism. And no statistically significant difference found between pulmonary embolism group and no pulmonary embolism group regarding right ventricular dysfunction.

## References


1. Razek A, Fouda N, Fahmy D, Tanatawy MS, Sultan A, Bilal M, Zaki M, Abdel-Aziz M, Sobh D. Computed tomography of the chest in patients with COVID-19: what do radiologists want to know?. Polish Journal of Radiology. 2021; 86: e122.
2. Arslan G, Saraçoğlu KT, Aydiner Ö, Demirhan R. Proposal to protect patients and healthcare professionals undergoing elective surgery during COVID-19 outbreak. Egyptian Journal of Radiology and Nuclear Medicine. 2021; 52(1): 1-8.
3. Schneider M, Binder T. Echocardiographic evaluation of the right heart. Wiener klinische Wochenschrift. 2018; 130(13): 413-20.
4. Schneider M, Aschauer S, Mascherbauer J, Ran H, Binder C, Lang I, Goliasch G, Binder T. Echocardiographic assessment of right ventricular function: current clinical practice. The international journal of cardiovascular imaging. 2019; 35(1): 49-56.
5. Di Minno A, Ambrosino P, Calcaterra I, Di Minno MN. COVID-19 and venous thromboembolism: a meta-analysis of literature studies. In Seminars in thrombosis and hemostasis 2020 Sep 3. Thieme Medical Publishers, 2020; 46(7): 763.
6. Singh R, Nie RZ, Homayounieh F, Schmidt B, Flohr T, Kalra MK. Quantitative lobar pulmonary perfusion assessment on dual-energy CT pulmonary angiography: applications in pulmonary embolism. European radiology. 2020; 30(5): 2535-42.
7. Hannawi S, Hannawi H, Naeem KB, Elemam NM, Hachim MY, Hachim IY, Darwish AS, Al Salmi I. Clinical and Laboratory Profile of Hospitalized Symptomatic COVID-19 Patients: Case Series Study From the First COVID-19 Center in the UAE. Frontiers in cellular and infection microbiology. 2021; 11.
8. Rudski LG, Lai WW, Afilalo J, Hua L, Handschumacher MD, Chandrasekaran K, Solomon SD, Louie EK, Schiller NB. Guidelines for the echocardiographic assessment of the right heart in adults: a report from the American Society of Echocardiography: endorsed by the European Association of Echocardiography, a registered branch of the European Society of Cardiology, and the Canadian Society of Echocardiography. Journal of the American society of echocardiography. 2010; 23(7): 685-713.
9. McConnell MV, Solomon SD, Rayan ME, Come PC, Goldhaber SZ, Lee RT. Regional right ventricular dysfunction detected by echocardiography in acute pulmonary embolism. Am J Cardiol. 1996; 78: 469–473.
10. Tersalvi G, Vicenzi M, Calabretta D, Biasco L, Pedrazzini G, Winterton D. Elevated troponin in patients with coronavirus disease 2019: possible mechanisms. Journal of cardiac failure. 2020; 26(6): 470-5.

11. Cameli M, Pastore MC, Soliman Aboumarie H, Mandoli GE, D'Ascenzi F, Cameli P, Bigio E, Franchi F, Mondillo S, Valente S. Usefulness of echocardiography to detect cardiac involvement in COVID-19 patients. Echocardiography. 2020; 37(8): 1278-86.
12. Madjid M, Casscells SW. Of birds and men: cardiologists' role in influenza pandemics. Lancet (Lond. Engl.) 2004; 364: 1309.
13. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The lancet. 2020; 395(10229): 1054-62.
14. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. The lancet. 2020; 395(10223): 497-506.
15. Li B, Yang J, Zhao F, Zhi L, Wang X, Liu L. Prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China. Clin Res Cardiol. 2020; 109: 531–8.
16. Tersalvi G, Vicenzi M, Calabretta D, Biasco L, Pedrazzini G, Winterton D. Elevated troponin in patients with coronavirus disease 2019: possible mechanisms. Journal of cardiac failure. 2020; 26(6): 470-5.
17. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, Xiang J, Wang Y, Song B, Gu X, Guan L. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The lancet. 2020; 395(10229): 1054-62.
18. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). The COVID-19 pandemic. International Journal of Health Sciences, 5(2), vi-ix. https://doi.org/10.53730/ijhs.v5n2.2937