Role of HRCT Pulmonary Artery Diameter Measurement in Assessment of Severity and Prognosis of COVID-19 Patients

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Abstract

Background: In times of pandemic where health care workers cannot depend on auscultation and percussion methods to assess the clinical status of patients, radiological methods and lab parameters are being the mainstream deciding parameters for treatment. Corads score and CT severity score are popular methods of determining the status and treatment of a corona virus patient. Our study aims on correlating pulmonary artery diameter with severity of the corona virus patient. **Subjects and Methods:** The present cross-sectional study was conducted at VIMS, Bellary during from August 1st 2020 to December 26th 2020. The study included all patients of all age groups who tested RT- PCR positive and CT done within 72 hours of admission. Clinical data regarding the patients like presenting complaints, co-morbidities, duration of hospital stay, mode of treatment and outcome was collected. CT severity scoring was done based on involvement of bronchopulmonary segments. Later the outcome of patients, CT severity score and Pulmonary artery diameter were correlated and analyzed. **Result:** In our study, out of 41, 12 (29 %) cases showed MPAD above 31.09 mm (i.e moderate – severe MPAD). Among the 12 cases with enlarged MPAD, 9 cases had death as outcome, i.e 56 %. 3/13 (23%) are cases with death as outcome among mildly enlarged MPAD. **Conclusion:** MPAD can be used as an independent parameter to risk stratify COVID-19 patients, predict severity and mortality of COVID-19 patients. Thus it should be measured on a regular basis in COVID-19 patients and can be used to guide the management accordingly for better prognosis of COVID-19 patients.

Keywords: Pulmonary Artery Diameter, COVID-19 patients, CT severity score, Mortality.

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Introduction

In this 21st century, corona virus has taken a toll on people's lives, mental, physical, social, economic status. But still we need to evolve diagnostically and medically to fight this challenge as its going to be a part of our lives. HRCT lunghas been an invaluable tool to guide the status of the coronavirus patients throughout. In times of pandemic where health care workers cannot depend on auscultation and percussion methods to assess the clinical status of patients, radiological methods and lab parameters are being the mainstream deciding parameters for treatment. Corads score and CT severity score are popular methods of determining the status and treatment of a corona virus patient. It is given based on the involvement of bronchopulmonary segments which correlates with the severity of patients. Also there are few unexplored parameters which can be used to determine the status of corona virus patient. One such parameter is pulmonary artery diameter, it increases as the severity of the disease increases. Our study aims on correlating pulmonary artery diameter with severity of the corona virus patient. Thus pulmonary artery diameter can be used as a red flag bearer for more aggressive treatment as a prognostic marker. In the very few autopsies performed on covid patients, they have found interstitial pneumonia with diffuse alveolar damage, pulmonary arteriole thrombosis and right ventricle dilation, suggesting that RV afterload due to endothelial injurywith lung vessel micro thrombosis might be a pathological cause in critical covid 19 patients.[1–4] Thus in our study we hypothesized that pulmonary artery diameter increases with severity in covid 19 patients which can be used for risk stratification and also as an independent risk factor to predict mortality.

Subjects and Methods

Type of study: Cross Sectional Retrospective study.

Sample size: n = Z^2 pq/d^2 Z=standard normal variate = 1.96, p= Prevalence of Covid-19 reported in an Indian study is 21.5%, d= Absolute error=15%. Sample needed to conduct this study is 29 cases. 41 cases will be selected.

Place of Study: Vijayanagara institute of medical Sciences, Trauma care, Bellary.

Study period: From August 1st 2020 to December 26th 2020.

Study participants: Participants of all age groups who tested RT- PCR positive.

Inclusion criteria:

- Participants of all age groups who tested RT- PCR positive and CT done within 72 hours of admission.

Exclusion criteria:

- Participants with previous history of cardiovascular and chronic lung disease

Clinical data regarding the patients like presenting complaints, co morbidities (diabetes melitus, hypertension, chronic lung disease, cardiovascular disease etc.), duration of hospital stay and mode of treatment, and outcome of patient (discharge/ death) was collected.

All chest CT images were collected and analysed. Ct severity scoring was done based on involvement of bronchopulmonary segments. Mild (if score was btw 1 -8); Moderate (if score was 9 – 15); Severe (if score was 16 – 25). Main pulmonary artery diameter was measured just before the bifurcation of pulmonary artery diameter. (In female's diameter > 27 mm was considered enlarged; males > 28 mm was considered enlarged.) For assessing mortality 31mm was considered as cut off and 29mm (mean value was taken) was considered as the cut off value to correlate with mild moderate and severe CT severity scoring.

Later the outcome of patients, CT severity score and Pulmonary artery diameter were correlated and analyzed.

Statistical Analysis

Categorical data was represented in the form of frequency and percentage. Association between variables was assessed with Chi Square Test. To test the agreement, Kappa was applied. Validity of the test is assessed with sensitivity, specificity, PPV, NPA and Diagnostic accuracy. ROC was plotted to know the area covered. A P value of <0.05 was considered statistically significant. Data was analyzed with IBM SPSS Version 22 for windows.

Results

41 subjects were taken for study for whom CT severity scoring and Main pulmonary artery diameter was measured. The most common co-morbidities among all the cases were diabetes and hypertension. Mean MPAD of mortality cases was 31.09 mm. In our study in all 12/41 (29 %) cases showed MPAD above 31.09 mm (i.e moderate – severe MPAD). Among the 12 cases with enlarged MPAD, 9 cases had death as outcome, i.e 56 %. 3/13 (23%) are cases with death as outcome among mildly enlarged MPAD.

Table 1: Showing the correlation between MPAD and outcome of covid patients.

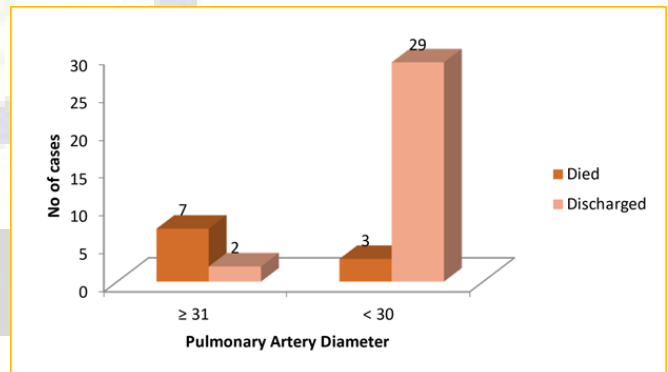| Pulmonary Artery Diameter	Outcome		Total
	Died	**Discharged**	
≥ 31	7	2	9
< 30	3	29	32
Total	10	31	41
Kappa agreement P<0.001, Highly Sig			

Figure 1: Bar diagram representation showing the outcome of COVID-19 patients with pulmonary artery diameter above and below 31 mm.

Maximum proportion of people with mortality as outcome have pulmonary artery diameter more than 31 mm. Also, those with a lesser pulmonary artery diameter were discharged signifying the strong correlation between pulmonaery diameter and outcome of COVID-19 patients.

When MPAD was compared with CT severity score we noticed that mild cases had a MPAD of < 29 mm whereas 62 % of moderate to severe cases had MPAD more than 29 mm.

The main finding of our study is pulmonary artery diameter increases with severity and also is an independent predictor of death in covid 19 patients.
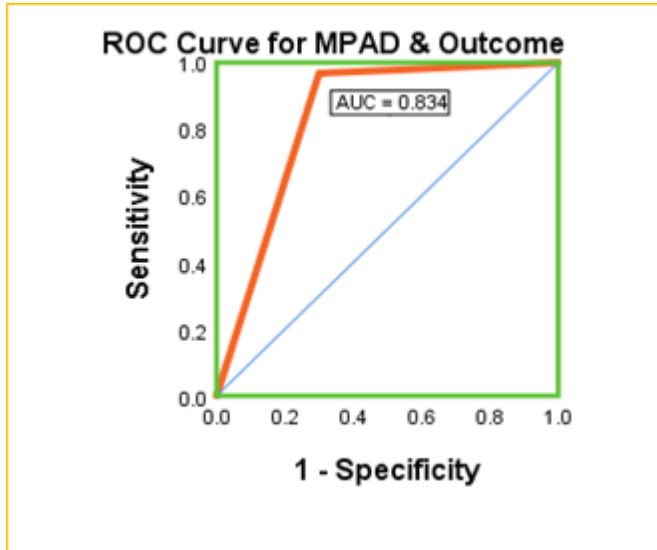
Figure 2: ROC curve for MPAD & Outcome.

Table 2: Diagnostic parameters of the correlation between MPAD & outcome.

Sensitivity	70%
Specificity	93%
Positive Predictive validity	78%
Negative Predictive validity	91%
Diagnostic Accuracy	90%

Table 3: Comparision Between MPAD and Ct Severity Score

CT – Severity Score	Pulmonary Artery Diameter		Total
	<29 mm	≥ 29 mm	
Mild	13	0	13
Moderate to Severe	10	18	28
Total	23	18	41
Chi Square test P<0.001, Highly Sig			

Table 4: Grading of CT severity score and its corresponding MPAD values.

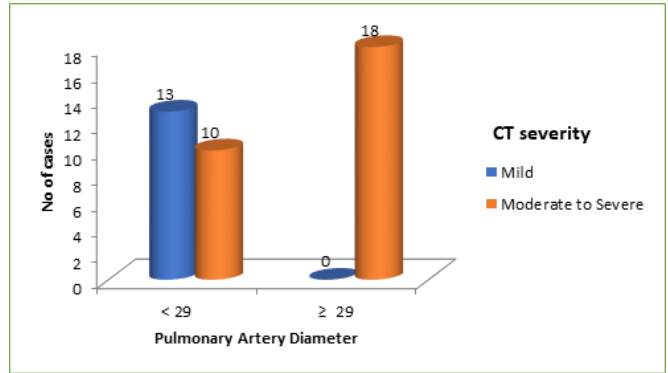| CT severity score.	Mean pulmonary artery diameter
Mild (13)	24 mm
Moderate to severe (28)	29 mm
Death (10)	31.0 mm

Figure 3: Pictorial representation of MPAD when compared with CT severity score.

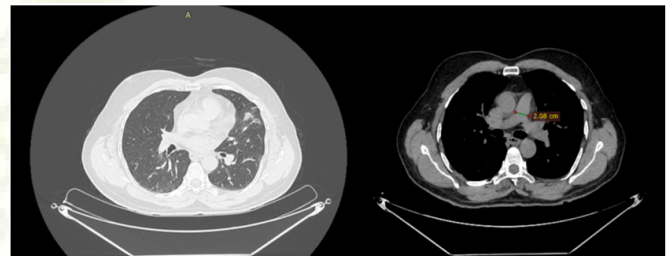## Clinical presentation

Figure 4: A COVID-19 case with mild CT severity scoring (5 /25) with MPAD 20.8 mm as shown above.
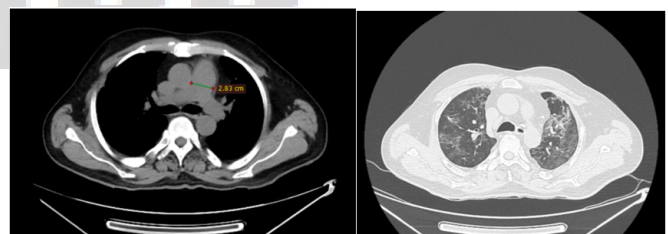

Figure 5: A COVID-19 case with moderate CT severity (16/25) scoring with MPAD 28.3 mm as shown above.

Discussion

In our study subjects mortality was seen in patients with moderate CSS and severe CSS patients Thus the wide varied difference between the mean MPAD between patients with mild CSS moderate CSS and Severe CSS shows that MPAD can be used as a predictor for prognosis of corona virus patients. Increased MPAD also correlated with increased
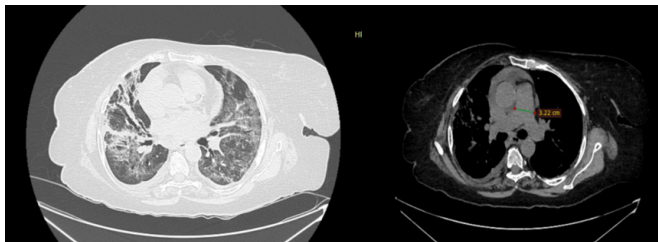
Figure 6: A COVID-19 case with Severe CT severity scoring (23/25) and mortality as outcome with MPAD 32.2 mm as shown above

duration of hospital stay. As observed from the trends of measurement of pulmonary artery diameter in mortality cases 70% of cases showed moderate – severe enlargement of MPAD. Thus enlarged pulmonary artery diameter can be considered as a sensitive predictor for mortality. Also, it was noticed that as MPAD increased even the hospital stay of patients also increased. In total, we can comprehensively interpret that enlarged pulmonary artery diameter can be used as an alarming indicator for increased care and aggressive treatment from the beginning to reduce mortality. Similar findings were also reported by another study conducted in Italy.[5]

Also as compared with the CT severity score it is quite evident that MPAD increases with severity and can be used as an independent predictor for severity as well.

We excluded the patients with cardiovascular history in our study as we wanted to reduce the possibility of the enlargement of pulmonary artery diameter in a chronic setting, even though we can't completely rule out the possibility.

Despite ruling out cardiovascular history, one of the drawbacks of our study is a smaller sample size. When we compared our study to a similar study conducted in Italy also had results in agreement with our results.[5] Another limitation of our study is measuring CT MPAD as is done manually it can't match the actual vessel size thus being approximate measurement but still considered as a reliable tool as the error is negligible.

Angiotensin Converting enzyme 2 on epithelial cells was recognized as a functional receptor for COVID-19, low levels of angiotensin and decreased downregulation of angiotensin II may contribute to determine acute pulmonary hypertension by increasing pulmonary vasoconstriction.[6] Also, pulmonary small vessel thrombosis can be the main cause of pulmonary hypertension in COVID-19 pneumonia.

Early detection of pulmonary hypertension at admission could also guide treatment of COVID-19 patients, triggering modifications of anticoagulation therapies from prophylactic to therapeutic dosage.[7–9]

Another study performed with 40 subjects to study the relation of MPAD in COVID-19 patients; they also compared the present HRCTS with previous HRCT of the patients and obtained comparable and similar results of present study.[9]

The measurement of MPAD on HRCT is an easy and less time taking. It can have a potential impact on deciding the patient treatment and risk stratification as well. Also, no special software installation is needed. So it can be used as an independent risk factor for mortality and as a prognostic factor for aggressive treatment.

Conclusion

In conclusion, MPAD can be used as an independent parameter to risk stratifies COVID-19 patients; predict severity and mortality of COVID-19 patients. According to our study, 29mm can be used as cut off to stratify risk as mild, moderate –severe casesPatients with MPAD more than 31 mmare more susceptiblefor mortality. Thus it should be measured on a regular basis in COVID-19 patients and can be used to guide the management accordingly for better prognosis of COVID-19 patients.

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