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Can CT Chest Scores In COVID Predict Clinical Outcome?

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I. BACKGROUND:

A newly found virus called Novel COVID-19 has caused illness and even mortality in those who have contracted it. On March 11, 2020, WHO proclaimed COVID-19 outbreak a worldwide pandemic (1).

It has spread quickly and widely throughout the entire world, having a significant impact on both the sociopolitical climate and the healthcare delivery system. Clinical presentation ranges from asymptomatic carriers to patients needing ICU admission and assisted ventilation and multisystem organ dysfunction .

The confirmatory test used for the disease is the nasopharyngeal swab RT-PCR test. Although the test is useful, some patients have falsely negative values, and results are also not always readily available. Early disease detection and severity assessment are crucial for proper patient isolation and treatment at a time when many patients seek medical attention due to symptoms that may be COVID-19.

Chest computed tomography (CT) may play a key role in patient triage and early COVID-19 infection diagnosis (2,3,4). By determining the extent of lung involvement and calculating the chest severity score (score out of 25 by Pan et al.), imaging results can be used to determine the severity of the disease, which helps clinicians make more informed clinical decisions and ensures effective and timely treatment (5). This study aimsto correlate short term clinical outcome of the COVID-19 infected patients on the basis of day of presentation with the 25– point CT severity score.

II. MATERIALS AND METHOD:

Patients who had positive RT-PCR or HRCT chest suggestive of Covid-19 were enrolled in the study. Due consent of the patients and approval was obtained from Institutional Ethics Committee. Total data of 112 patients was evaluated for the study.

The patients were allocated into two groups on the basis of time of presentation after onset of symptom: Group A: Early presentation (< 7 days) and Group B: Late presentation (≥7 days). A detailed clinical history and chief complains was noted in all patients. General and systemic examination was done. Routine lab tests and blood investigations was done and patients were subjected for HRCT chest and further follow up was done to find out the clinical outcome.

Imaging was done using 128 Slice GE REVOLUTION CT scanner with slice thickness of 0.6 mm and CT severity score assigned by individually assessing the percentage involvement of the three lobes of the right lung andtwo lobes of the leftlung and classified as:

Score-1 (up to 5% lobe was affected)
Score-2 (between 5-25%lobe was affected)
Score-3 (25-50%lobe was affected)
Score-4 (50-75%lobe was affected) and
Score-5 (>75% lobe was affected).

Total score was established on the basis of the proportion area involved out of the total 5 lobes, and it is reported out of 25, with Mild category having a score of<= 7, Moderate has score between 8-17 and Severe has a score of>= 18.

Clinical outcome was noted as follows:

A. ICU Admission - Required ornot required.
B. Oxygen requirement – Room air, mechanical or non mechanical ventilation.
C. Outcome severity
(i)Mild (Criteria – RR<30/min,SpO2> 93%, PaO2/FiO2 >300 mmHg)
(ii)Severe (Criteria– RR>30/min,SpO2< 93%, PaO2/FiO2 <300 mmHg)
(iii) Critical disease (ARDS, Respiratory failure, septicemic shock, MODS)

D. Hospital stay : < 14 days or > 14 days and

E. Mortality

The categorical variables are presented as number and percentage (%). The quantitativevariables are presented as the mean (with SD)and as median. The Kolmogorov-Smirnov test was used to assess the regularityof data. The non parametric tests was utilized for cases where regularity of the data was not established. The following statistical tests were applied for the results:

1. The quantitative variables without normal distribution are analysed with Mann-Whitney Test.
2. Chi-Square test or Fisher's exact test were used for the analysingqualitative variables (if the value is less than 5).
3. Odds ratio with 95% CI was calculated for clinical outcome for group B taking group A as reference.

Statistical Package for Social Sciences (SPSS) was used and p value of less than 0.05 was taken as statistically significant.

III. OBSERVATIONS AND RESULTS:

In our study of 112 cases, patients were grouped on the basis of the day of presentation in hospital after onset of symptoms.

Group A- Day of presentation < 7 days.

Group B- Day of presentation ≥7days.

Group A included 52 cases (46.43%) and Group B included 60 cases (53.57%)

Following parameters in all the patients were noted:

Age , gender, CT score, imaging features (ground glass opacity, consolidation , reticular changes, crazy paving pattern, tractional bronchiectasis ,pleural effusion, lymphadenopathy , patter of involvement of diseased lung- peripheral or central or both and anterior or posterior or both), chief complaints, Laboratory parameters (CRP, D-dimer, lymphocyte and Ferritin level) and clinical outcomes (ICU/Ward admission, oxygen requirement, outcome severity, length of hospital stay and mortality).

Clinical outcome in both groups was noted , analysed and correlated with chest CT Severity Score.

This study showed males having more positivity percentage (61.61 %) as compared to females (38.39%) which was 69 and 43 respectively and the mean age was 48.74±15.2 years (range, 18-83 years) with highest number of cases seen in the age group of 50-59 years.

In group A, 22had mild disease, 25 had moderate disease and 5 cases had severe disease based on CT severity score.

In Group B, 8 had mild disease,32 had moderate disease and 20 cases had severe disease based on CT severity score.

(Representative cases shown in Fig 1,2 and 3)

There were more patients with mild disease severity in group Awhilegroup B has more patients with moderate and severe disease severity.

Median(25th-75th percentile) of total CT score in group B was 16(13-20) while in group A it was 9(6-11.25)) (p value <.0001).

Most of the patients diagnosed with COVID-19 infection presented with complaints of fever, cough and breathlessness of variable duration. In our study all the patients in Group A and Group B presented with complains of fever and cough.

Only 15 out of 52 (i.e, 28.8%) in Group A presented with breathlessness while 47 out of 60 (i.e, 78.3%) in Group B presented with breathlessness (shown in Graph 1)

CRP, D-dimer, lymphocyte and Ferritin level were done in 110, 112, 112 and 101 patients respectively.Lymphocyte was divided as <1000/ul (lymphopenia) and >1000/ul.Proportion of patients with lymphocyte count >1000/µl was significantly more in group A while proportion of patients with lymphocyte count <1000/µl was significantly more in group B. (p value <0.0001).So lymphopenia was seen more in Group B which included more moderate to severe CT severity score cases. As CT Severity score increases lymphocyte count was decreasing (shown in Graph 2)**.** In group A, there were more patients withCRP value <50 mg/L while there were more patients with CRP value 50-100 mg/L and >100 mg/L in group B (p value <0.0001) (shown in Graph 2)**.** Proportion of patients with D dimer <=1 ng/mL was significantly higher in group A and proportion of patients with D dimer >1 and <2 ng/mL, 2-4 ng/mL, >4 ng/mL was significantly higher in group B. (p value <0.0001)(shown in Graph 3)**.** Proportion of patients with Ferritin <600 ng/mL was higher in group A and proportion of patients with Ferritin level 600 -1200 ng/mL, 1201-2400 ng/mL, >2400 ng/mL was significantly higher in group B(p value <0.0001) (shown in Graph 3).

Various imaging features were noted: ground glass opacity, reticulation , crazy paving pattern, consolidation, tractional bronchiectasis, pleural effusion, lymphadenopathy, pattern of involvement of lung like peripheral or central or both, anterior or posterior or both.

GGO was present in all patients of both group A and B. Reticulation and crazy paving pattern was higher in group B. Consolidation, traction bronchiectasis, pleural effusion and lymphadenopathy was comparable between group A and B. Only peripheral and posterior involvement of lung was higher in group A as compared to group B while both peripheral +central and Anterior+ posterior involvement washigher in group B. Thus group B showed more involvement of lung parenchyma. (shown in Graph 4 and Graph 5)

CLINICAL OUTCOME

ICU/ward admission :

In Group A (52) 50 were admitted in ward and only 2 required ICU admission.

In Group B (60) 32 were admitted in ward and 28n required ICU admission.

Proportion of patients with ward admission was higher in group A than group B and it was statistically significant. Proportion of patients with ICU admission was higher in group B. (p value <0.0001). Odds ratio of ICU admission of group B was 21.875(4.873 to98.194) as compared to group A which signifies that patients of group B had higher risk of ICU admission as compared to patients of group A. (shown in Graph 6)

Oxygen requirement:89 patients (79.47%) required oxygen supplementation either in the form of non mechanical ventilation (62 patients) or mechanical ventilation (27 patients) and rest 23 patients were on room air.

Non mechanical ventilation includes oxygen supplementation in the form of nasal canula or face mask.

Mechanical ventilation includes intubation, CPAP and BiPAP.

In Group A (52) 22, 03, 27 required room air, mechanical ventilation and non mechanical ventilation respectively.

In Group B (60) 01,24 and 35 required room air, mechanical ventilation and non mechanical ventilation respectively.

Proportion of patients with O_2 requirement in the form of room air was significantly higher in group A while proportion of patients with O_2 requirement in the form of mechanical ventilation or non mechanical was significantly higher in group B. (p value <0.0001) Odds ratio of O_2 requirement:- mechanical ventilation, non mechanical ventilation of group B was 28.519(3.613 to225.088) and 176(17.023 to1819.695) respectively as compared to group A which signifies that patients of group B had higher chances of O_2 requirement as compared to patients of group A.(shown in Graph 6)

Outcome severity : Outcome severity was divided into mild, severe and critical**.**

In Group A, 37,15 and zero had outcome severity mild, severe and critical respectively.

In Group B, 14,30 and 16 had outcome severity mild, severe and critical respectively.

There were more patients in group A with mild outcome severity and this was statistically significant. There were more patients in group B with severe and critical outcome severity and this was statistically significant when compared to group A(p value <0.0001). Odds ratio of outcome severity:- severe, critical of group B was 5.286(2.208 to12.656) and 85.34(4.8 to 1517.46) respectively as compared to group A which signifies that patients of group B had higher chances of severe, critical outcome as compared to patients of group A.(Shown in Graph 7)

Length of hospital stay: The duration of hospital stay of < 14 days was seen in 83 out of 112 cases and ≥ 14 days was noted in 29 cases.

In Group A , 47 patients had <14 days of hospital stay and only 05 patients had ≥14 days of hospital stay.

In Group B, 36 patients had <14 days of hospital stay and 24 patients had ≥14 days of hospital stay.

Proportion of patients with length of hospital stay <14 days was higher in group A as compared to group B. Proportion of patients with length of hospital stay ≥14 days was higher in group B as compared to group A (p value=0.0003). Odds ratio of length of hospital stay ≥14 days of group B was 5 6.267(2.178 to18.03) as compared to group A which signifies that patients of group B had higher chances of prolonged hospital stay as compared to patients of group A (shown in Graph 7).

Mortality : In our study out of total mortality which was 13/112 (11.61%). 12 mortalities were seen in ICU and 1 mortality was seen isolation ward.

No mortality was seen in mild cases. 4 mortality seen in moderate cases and 9 were seen in severe cases.

Zero mortality was noted in group A while 13 mortality was noted in group B.

Mortality rate was lower in group A as compared to group B (0% vs 21.67% respectively)(p value=0.0002). Odds ratio of mortality of group B was 29.84(1.726 to 515.84) as compared to group A which signifies that patients of group B had

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higher chances of mortality as compared to patients of group A. (Shown in Graph 7).

Association of different variables in the two groups:

ICU/Ward Admission: In group A distribution of ICU/Ward admission was comparable with disease severity {Mild vs moderate vs severe}. (ICU:- 0% vs 8% vs 0% respectively, Ward:- 100% vs 92% vs 100% respectively) (p value=0.585). (Shown in Graph 8)

In group B proportion of patients with ward admission was significantly higher in mild and moderate disease as compared to severe disease. (Ward:- 75%, 78.13% vs 5% respectively) while proportion of patients with ICU admission was higher in severe disease as against the mild and moderate disease. (ICU:- 95% vs 25%, 21.88% respectively)(p value <0.0001) (shown in Graph 10).

Oxygen requirement: In group A proportion of patients on room air was higher in mild disease as against the moderate and severe disease. (Room air:- 59.09% vs 36%, 0% respectively). Proportion of patients requiring mechanical ventilation or non mechanical ventilation was higher in severe disease as against the mild and moderate disease. (Mechanical ventilation:- 20% vs 0%, 8% respectively, Non mechanical:- 80% vs 40.91%, 56% respectively). (p value=0.047)(shown in Graph 8).

In group B proportion of patients on room air was higher in mild disease as against the moderate and severe disease. (Room air:- 12.50% vs 0%, 0% respectively). Proportion of patients requiring non mechanical ventilation was higher in moderate disease as against the mild and severe disease. (Non mechanical:- 84.38% vs 62.50%, 15% respectively). Proportion of patients requiring mechanical ventilation was higher in severe disease as compared to mild and moderate disease. (Mechanical ventilation:- 85% vs 25%, 15.63% respectively). (p value <0.0001) (shown in Graph 10).

Outcome severity: In group A proportion of patients with mild outcome severity was higher in mild disease as compared to moderate and severe disease. (Mild:- 86.36% vs 72%, 0% respectively) while proportion of patients with severe outcome severity was higher in severe disease as compared to mild and moderate disease. (Severe:- 100% vs 13.64%, 28% respectively) (p value=0.0008). No cases with critical outcome severity was noted in group A.(shown in Graph 9).

In group B patients with severe outcome severity were higher in mild and moderate disease as compared to severe disease (Severe:- 50%, 56.25% vs 40% respectively). Proportion of patients with mild outcome severity was significantly higher in mild disease as compared to moderate and severe disease. (Mild:- 50% vs 31.25%, 0% respectively). There were higher number of patients with critical outcome severity in severe disease as against the mild and moderate disease (Critical:- 60% vs 0%, 12.50% respectively)(p value=0.0001) (shown in Graph 11)

Length of hospital stay: In group A distribution of length of hospital stay was comparable with disease severity {Mild vs moderate vs severe}. (<14:- 90.91% vs 88% vs 100% respectively, ≥14:- 9.09% vs 12% vs 0% respectively) (p value=1).(shown in Graph 9)

In group B distribution of length of hospital stay was comparable with disease severity in group B { Mild vs moderate vs severe}. (<14:- 87.50% vs 62.50% vs 45% respectively, ≥14:- 12.50% vs 37.50% vs 55% respectively) (p value=0.127).(shown in Graph 11)

Mortality: Zero mortality was noted in group A. (shown in Graph 9)

In group B Mortality rate was higher in severe disease when compared to mild and moderate disease. (45% vs 0%, 12.50% respectively)(p value=0.009)(shown in Graph 11).

Representative cases

FIG 1: MILD CT SEVERITY SCAN

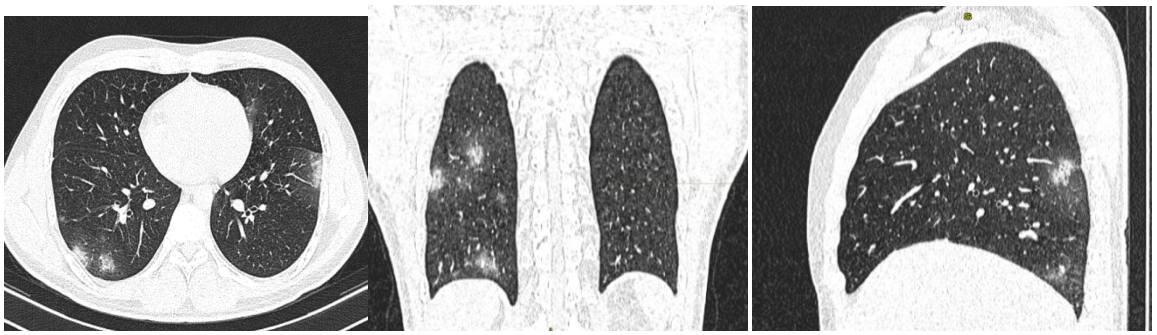

Fig 1.1 Fig 1.2 Fig 1.3

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28 year old male presented with complain of fever and cough since 3 days. RTPCR was positive for COVID-19. CT Severity score was 05 out of 25.

FIG 2: MODERATE CT SEVERITY SCAN

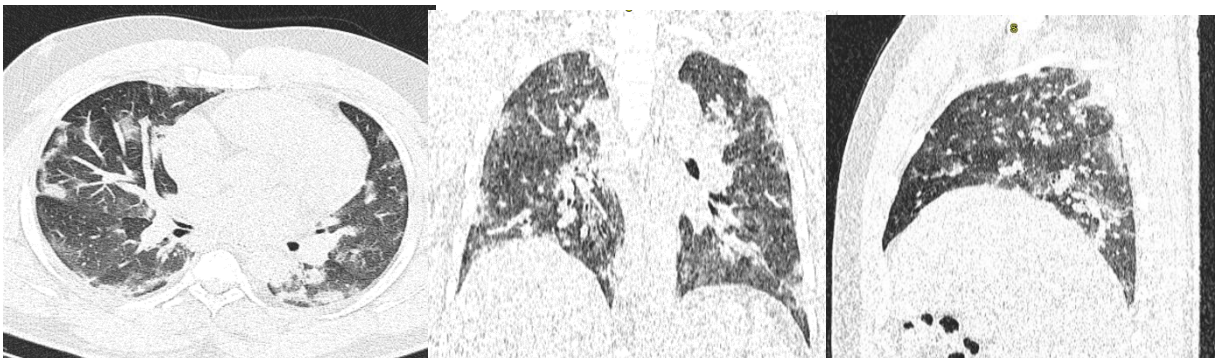

Fig 2.1 **Fig 2.2.** **Fig 2.3**

30 year old male presented with complain of fever and cough since 8 days. RTPCR was positive for COVID-19. CT Severity score was 16 out of 25.

FIG 3: SEVERE CT SEVERITY SCAN

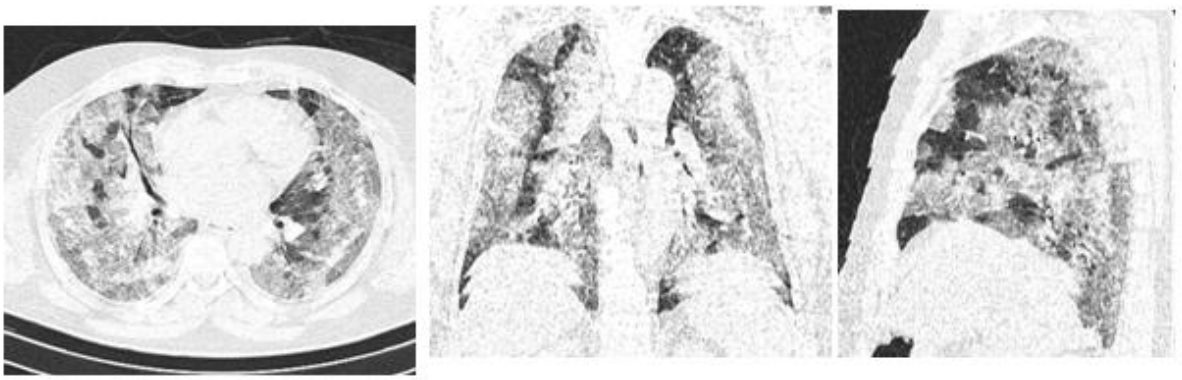

Fig 3.1 Fig3.2 Fig 3.3

61 year old male presented with complain of fever, cough and Shortness of breath since 11 days. RTPCR was positive for COVID-19. CT Severity score was 25 out of 25.

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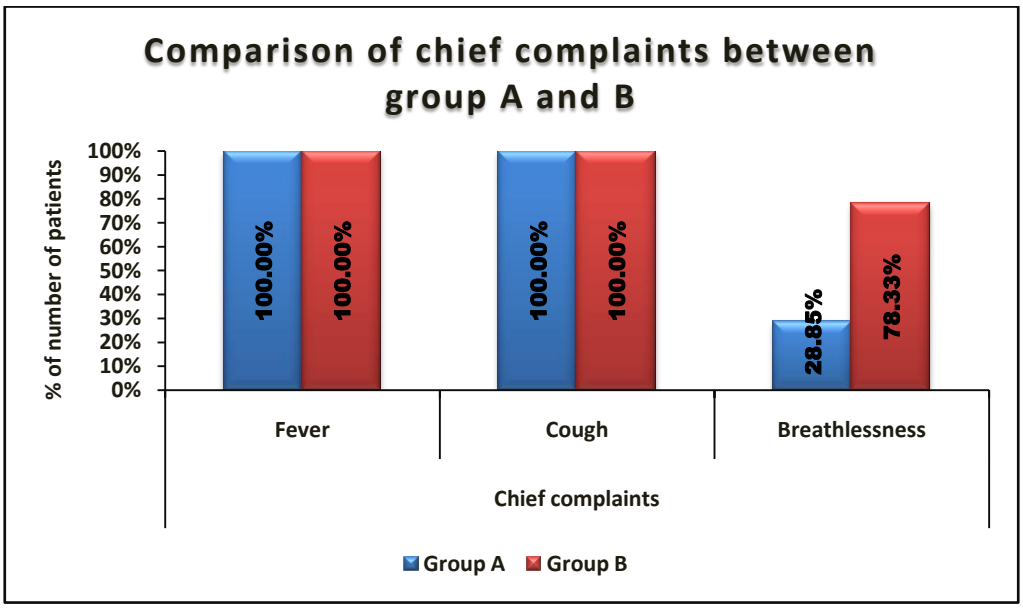
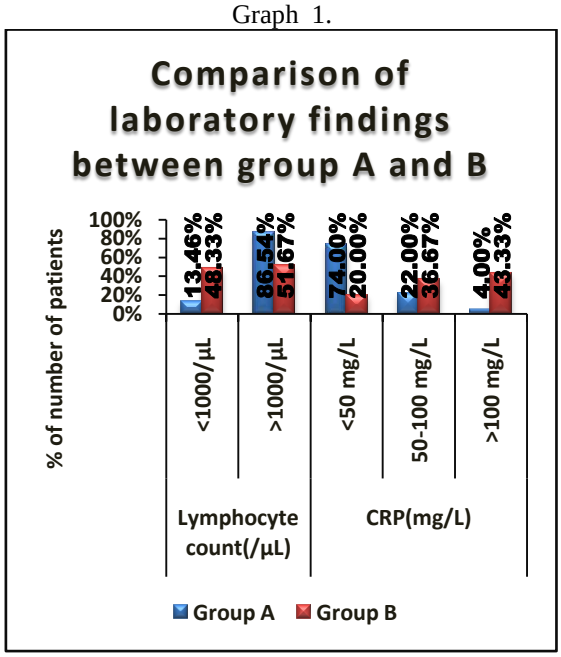


Graph 1.



Graph 2.

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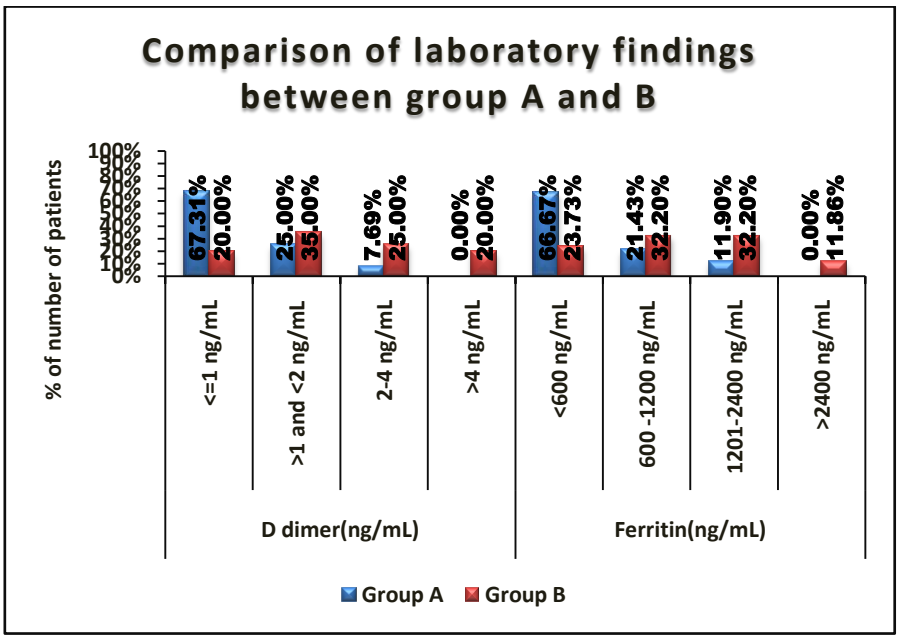
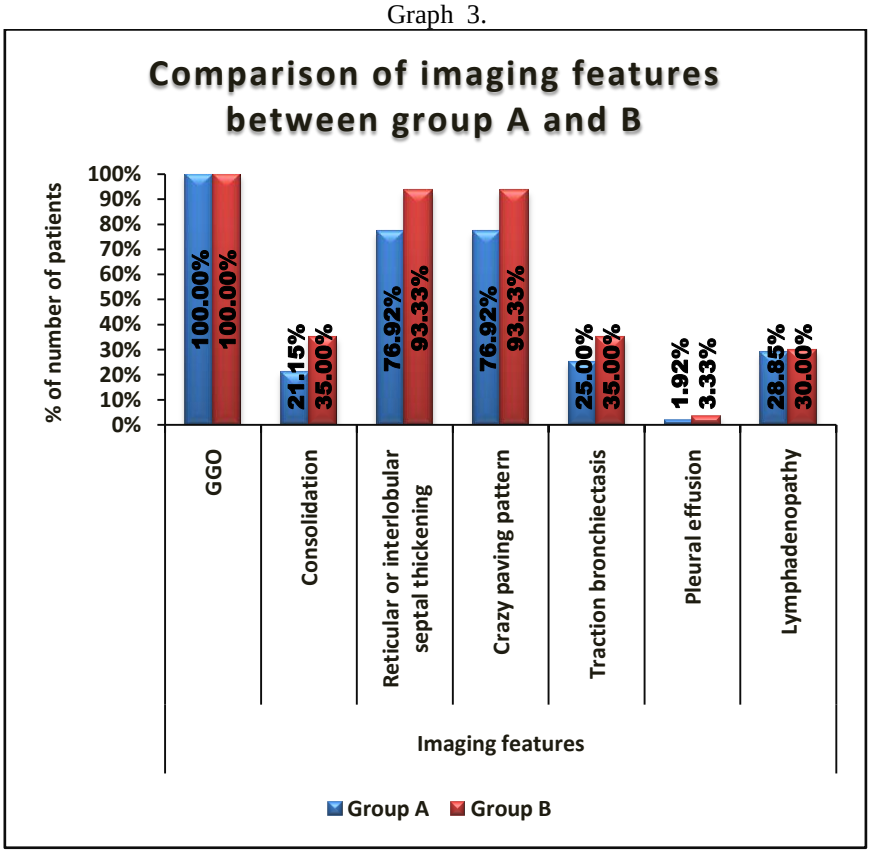


Graph 3.



Graph 4.

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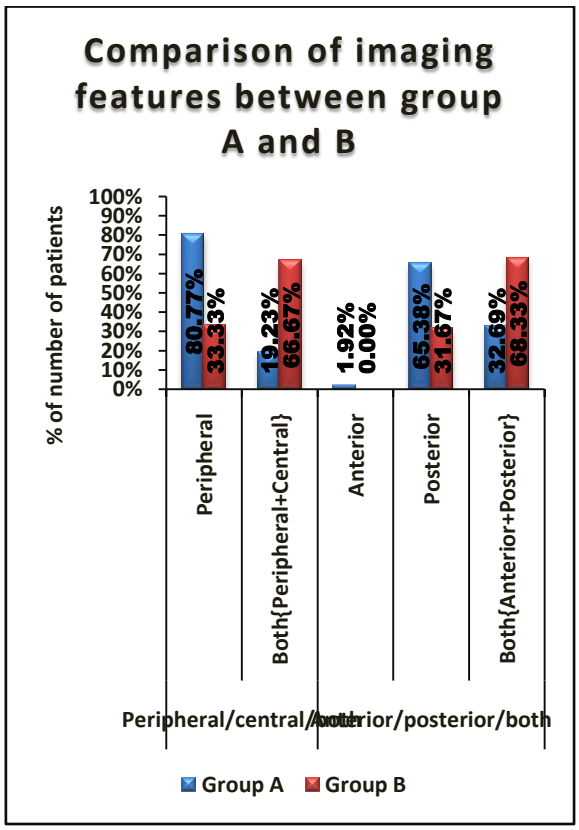
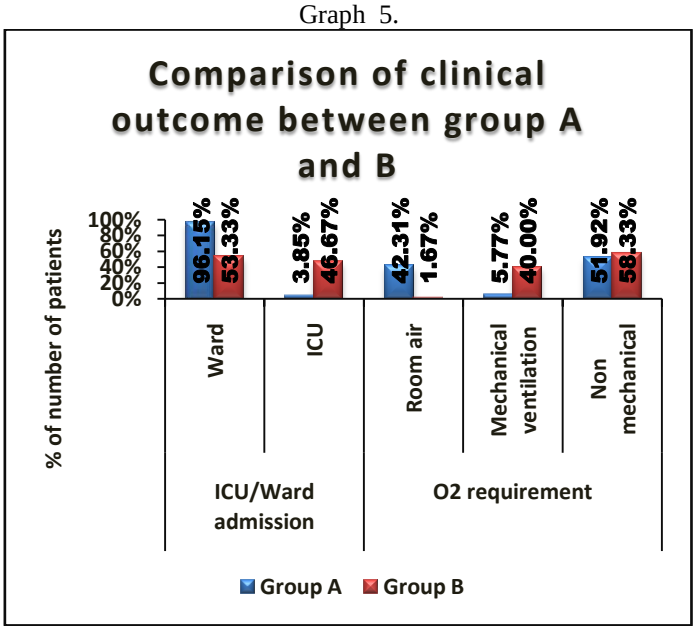


Graph 5.



Graph 6.

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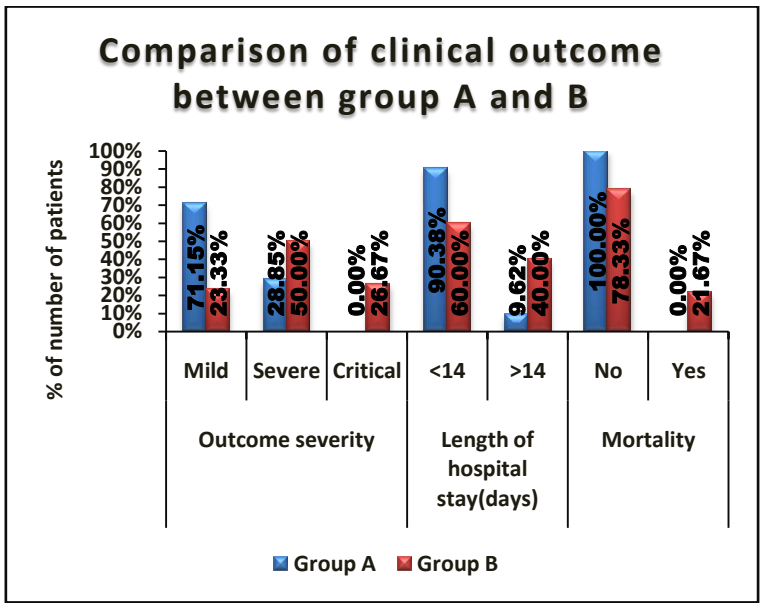
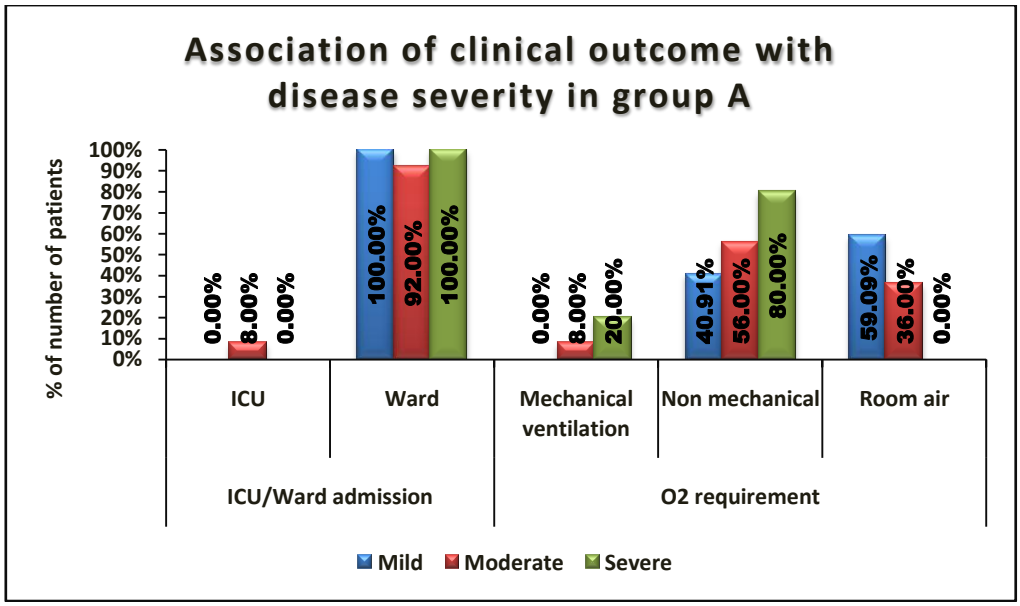


Graph 7.



Graph 8.

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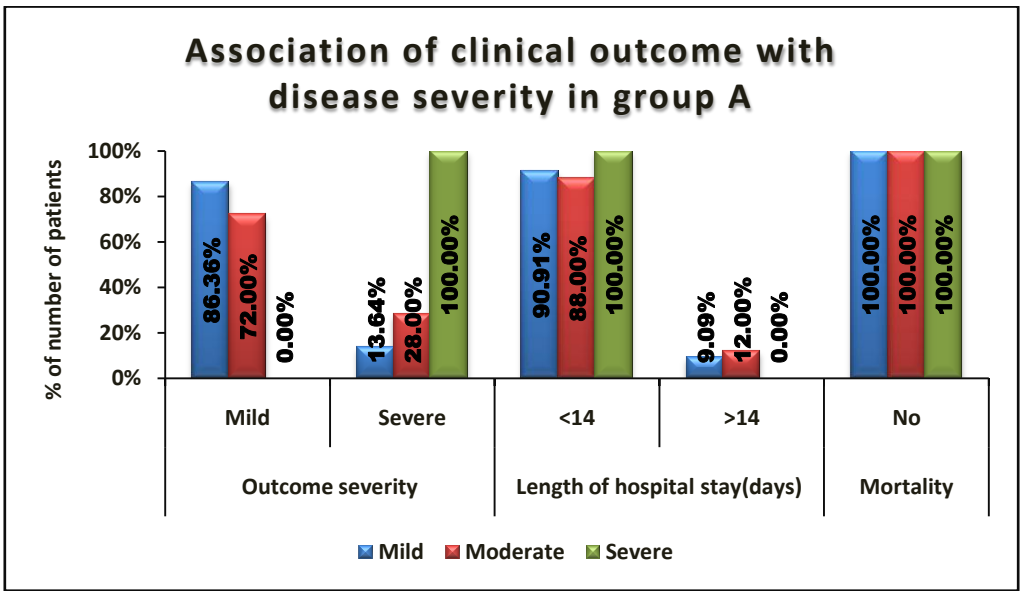
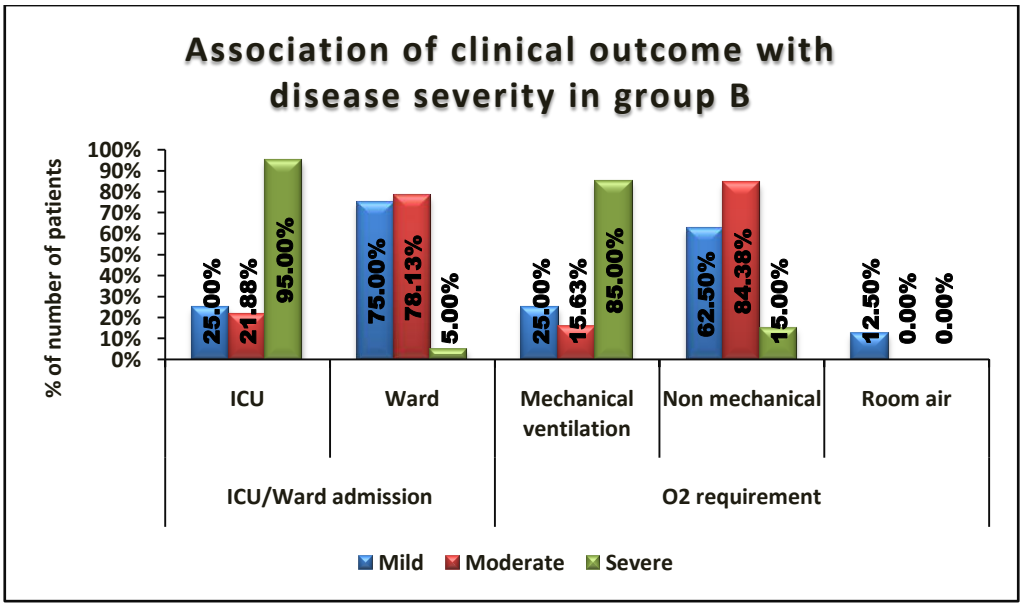


Graph 9.



Graph 10.

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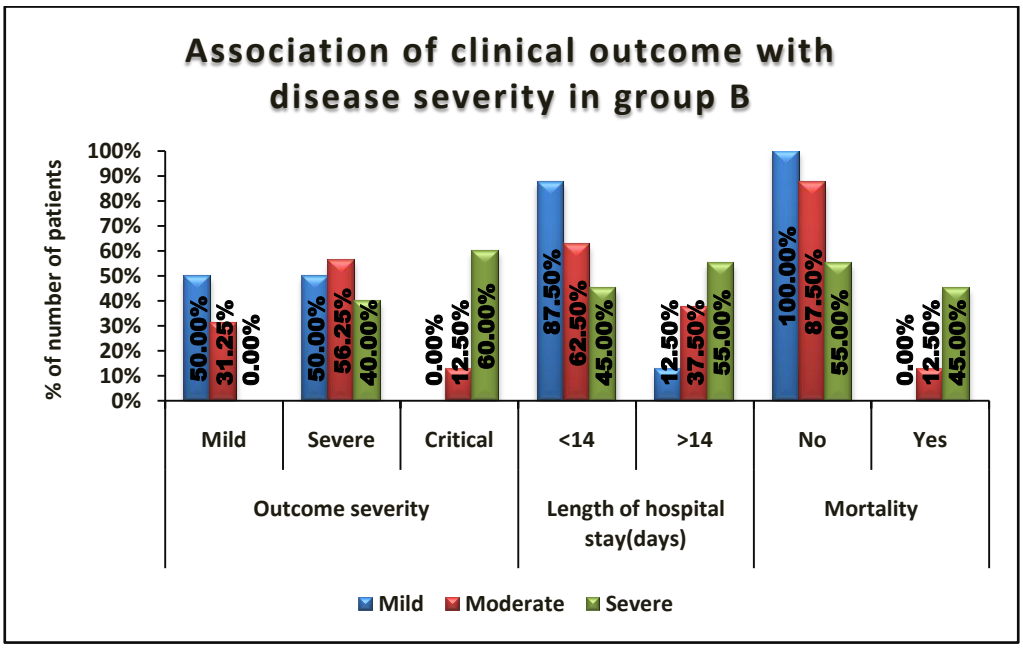

Graph 11.

IV. DISCUSSION:

The present study comprised of a total of 112 cases of COVID-19 infection on whom HRCT was performed for CT severity scoring

Association of the clinical outcomes with the chest CT severity scores in Group A (presentation < 7 days)and Group B (presentation ≥ 7 days) was done

ICU/ward admission:

In groupA, more patients were admitted in ward while in group B more patietns required ICU admission. This was statistically signisficant. In group A distribution of ICU/Ward admission was comparable with disease severity {Mild vs moderate vs severe} (shown in Graph 8). In group B, more patients were aditted in ward having mild and moderate disease as compared to severe disease where ICU admission was significantly higher (shown in Graph 10).**Gaba et al ., in 2020** observed that ICU admission was required in 22.4%. Among patients mild CT scan findings 8%, with moderate 7.6% and with severe CT scans 4.2% required ICU admission.

According to **Hilal et al., 2021,** patients withmoderate CT severity score (i.e. 8-10 score) had high chances of ICU admission &requirement for intubation (53.8% vs. 23.5%) as well as higher mortality (35.9% vs. 11.8%; p = 0.017), as compared to those with mild CT severity score. (0-7 score). This study was concordant with the studies mentioned above.

Oxygen requirement :

Proportion of patients with O_2 requirement in the form of room air was higher(statically significant) in group A while proportion of patients with O_2 requirement in the form of mechanical ventilation or non mechanical ventilation was higher(statically significant)in group B(shown in Graph 6).In group A proportion of patients on room air was more in mild disease. Proportion of patients requiring mechanical or non mechanical ventilation was more in severe disease as compared to mild and moderate disease(shown in Graph 8). In group B proportion of patients on room air was significantly higher in mild disease. Proportion of patients requiring non mechanical ventilation was higher in moderate disease as compared to mild and severe disease. Proportion of patients requiring mechanical ventilation was higher in severe disease. (shown in Graph 10).

Study done by **Gaba et al., 2020** observed that 89.1% of patients having mild scan category, 49.8% of patients having moderate CT findings and 3.3% with severe scan findings, did not require any oxygen support. In our present study patients with higher and severe CT severity scores had more requirement of critical care and oxygen support.

Outcome severity :

In group A, there were more patients with mild outcome severity which was statistically significant as well. On the other hand there were more patients of severe and critical outcome in

group B as against the group A and this was again statistically significant(Shown in Graph 7).

In group A, there were more patients of mild outcome severity amongst the patients with mild disease as against the moderate and severe disease while proportion of patients with severe outcome severity was higher in severe disease as against the mild and moderate disease. No case with critical outcome severity was noted in group A.(shown in Graph 9).

However in group B. there were more patients with severe outcome severity amongst the patients with mild and moderate disease as compared to severe disease and this was statistically significant. There was higher proportion of patients with critical outcome severity in severe disease as against the mild and moderate disease (shown in Graph 11).**Gaba et al., ,Xie et al and Hilal et al** likewiseobserved that outcome severity was more severe in cases with higher CT score and it was relatedto higher mortality.

In our study group B which included more of moderate to severe cases shows more severe and critical outcome compared to group A.

Length of hospital stay:

In group A, there were more patients who had a hospital stay of <14 days and this was statistically significant when compared to group B. In group B, there were more patients who had hospital stay of more than 14 days and when compared to group A it was statistically significant(shown in Graph 7).

In group A distribution of hospital stay was comparable with disease severity {Mild vs moderate vs severe}(Shown in graph 9). In group B distribution of hospital stay was comparable with disease severity in group B { Mild vs moderate vs severe}.(shown in graph 11)

Gaba et al., in 2020 observed patient's duration of hospital stay. He observed that <5 days admission was required maximum (30.6%) in patients with mild scans. Duration of 6-10 days was maximum seen in moderate cases and duration of 11–15 days of hospital stay maximum was seen in moderate group followed by severe.

Hilal et al., 2021 observed thatpatients having mild CT score (44.1%) had shorter length of stay in hospital of <10 days, however patients with severe CT severity score had >10 days hospital stay in 66.7% of the patients.

Our present study findings were similar to these studies done by **Hilal et al., in 2021**, which showed patients with increased CT severity scores had a longer hospital stay.

Mortality :

No mortality was seen in mild cases. Four deaths were seen in moderate cases and 9 were seen in severe cases.

Zero mortality was noted in group A while 13 deaths was noted in group B.

Mortality was lower in group A as compared to group B and this was statically significant. (Shown in Graph 7).

Zero mortality was noted in group A. (shown in Graph 9). In group B, mortality rate was higher in severe disease as compared to mild and moderate disease (45% vs 0%, 12.50% respectively)(p value=0.009)(shown in Graph 11) and this was statistically significant.

Gaba et al., in 2020 observed mortality in different category of CT scans, and observed that best results were seen in patients with negative and milder CT findings as against those with severe score had high mortality.

Severe CT score was seen as predictor of mortality, according to **Xie et al., 2020.** According to **Hilal et al., 2021,** relatively higher mortality (35.9%) rates has been observed in patients with high CT scores.

Higher the CT core higher the mortality rate. This finding was seen in our study also.

V. SUMMARY AND CONCLUSION

The CT severity scores in the early (< 7 days) and late (≥7 days) group when correlated with the clinical outcome which included need for ICU/Ward admission, oxygen requirement , outcome severity , length of hospital stay and mortality, it showed that above parameters were more seen in severe CT severity score. Thus, initial CT Scans can predict clinical severity and outcome of the patient and can be a vitaltool in prognosticating Covid-19 patients. However for best results we should always correlate the patient clinical condition and laboratory parameters with HRCT scans.

CT severity score has a positive correlation with increased serum CRP, D-Dimer, ferritin level and lymphopenia.Thestandard 25 point CT severity score shows good correlation with COVID 19 clinical presentation, laboratory parameters and short term clinical outcome. This study suggests that CT severity score can aid in predicting and deciding management of COIVD 19 infected patients.

In this study we concluded that day of presentation, when categorized as Group A: early (<7days) and Group B: late (≥7days) showed that when the patient had late presentation,the CT

severity score was in moderate to severe category and shows poor clinical outcome in the form of increased ICU admission, increased oxygen requirement , severe or critical clinical outcome, long stay in hospital and more mortality while those who presented early had mild to moderate CT severity score with better clinical outcome.

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