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# Initial CT Changes and Patient Comorbidity, Does This Affect Prognosis of COVID-19 Patients?

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## Abstract

*Background:* This study here in tried to study the effect of age and associated comorbidities in accordance to the initial CT findings on the clinical deterioration of patients affected with COVID-19, aiming to help the health providers to triage patients that might require prompt medical care attention.

*Aim of Study:* This study aimed to investigate the effect of age and medical co-morbidities in accordance to the initial CT findings on the clinical deterioration of patients affected with COVID-19.

*Patients and Methods:* The study protocol was approved by the institutional review board of our university hospital, and an informed written consent from the participants was waived. The High-risk group included 88 males and 32 females, their age ranged from 20 to 73 (mean age 60.2±11.6) while the low-risk group included 78 males and 36 females.

*Results:* This retrospective study included 234 confirmed COVID-19 patients including 120 high risk patients and 114 low risk patients. The CT severity was classified as mild and severe according to a visual scoring system of 25 points previously used in other series using a score of 18 as a cut of value. Clinical deterioration was significantly higher among the high-risk group. ICU admission and mortality were recorded in 44.2% and 3.5% of the high-risk group versus 19.2% and 0.9% of the low-risk group. Among patients with initial severe CT changes, clinical deterioration was more significant either in the high-risk group. ICU admission, and mortality occurred in 77.9% and 33.8% on the high risk-group versus 28.6% and 7.1% of the low- risk patients respectively. None of the patients who initially presented with mild CT changes (at either groups) were admitted to ICU or had died.

*Conclusions:* Our results show that clinical deterioration in form of ICU admission, and mortality were significantly higher among high risk patients and among those who presents initially with severe CT changes.

***Key Words:*** *COVID-19 – Chest – Pneumonia – Infection – PCR – Pandemic.*

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## Introduction

**WHO** had declared Corona Virus Disease 2019 (COVID-19) as pandemic with serious burden upon health system in different countries **[1]**.

The clinical scenario remains variable, affected patients may be asymptomatic or may present with mild or severe illness that could be sometimes lethal. Different studies were therefore directed to anticipate the final clinical outcome of this novel disease **[2-4]**. Moreover, timely diagnosis and treatment had well contributed to better prognosis and to less mortality rates **[5]**.

We herein tried to study the effect of age and associated comorbidities in accordance to the initial CT findings on the clinical deterioration of patients affected with COVID-19, aiming to help the health providers to triage patients that might require prompt medical care attention.

## Patients and Methods

Retrospective study from June 18, 2021 to December 2, 2021, including all consecutive patients with a throat swab real-time reverse-transcriptase polymerase-chain-reaction (PCR) laboratory confirmed coronavirus disease 2019 (COVID-19) infection- admitted to our university hospital. Patients were divided in two groups: High-risk group, comprising elderly patients (aged 60 years or more) and/or those with medical co-morbidities regardless their age (including hypertension, diabetes mellitus, chronic cardiac or renal

***Abbreviation:***

COVID-19 : Corona virus disease-19.
ICU : Intensive care unit.
PCR : Polymerase chain reaction.

disease). The low-risk group comprised patients aged less than 60 years old and with no other medical comorbidities. We excluded all patients with no available CT imaging, and those with chronic lung disease that might alter the CT pattern of the lungs and can overlap with COVID changes. We ended with a total of 234 participants, 120 allocated to the high-risk group and 114 to the low-risk group.

The study protocol was approved by the institutional review board of our university hospital, and an informed written consent from the participants was waived.

*Population:* The High-risk group included 88 males and 32 females, their age ranged from 20 to 73 (mean age 60.2 ± 11.6) while the low-risk group included 78 males and 36 females, their age ranged from 20 to 60 (mean age 40.01 ± 10.3) (Table 1).

Table (1): Patient demographic, CT severity and clinical deterioration among the high and low risk groups.

| | Group | | | | Unadjusted Odds ratio CI (UL-LL) | Chi Square test (*p*-value) |
|---|---|---|---|---|---|---|
| | High risk (n=120) | | Low risk (n=120) | | | |
| | n | % | n | % | | |
| *Age:* | | | | | | |
| Mean ± SD | 60.2± 11.6 | | 40.01± 10.3 | | | Student *t*-test |
| Median | 64.0 | | 39.0 | | – | *t*= 14.03 |
| Min.-max. | 20-73 | | 20-60 | | | *p*=<0.001 * |
| *Sex:* | | | | | | |
| Male | 88 | 73.3 | 78 | 68.4 | 1.269 | $X^2$=0.684 |
| Female | 32 | 26.7 | 36 | 31.6 | (0.7-2.2) | *p*=0.408 |
| *CT findings:* | | | | | | |
| Severe | 68 | 56.7 | 14 | 12.3 | 9.341 | $X^2$= 50.598 |
| Mild | 52 | 43.3 | 100 | 87.7 | (4.8-18.2) | *p*=<0.001 * |
| *ICU admission:* | | | | | | |
| Yes | 53 | 44.2 | 4 | 3.5 | 21.754 | $X^2$=52.450 |
| No | 67 | 55.8 | 110 | 96.5 | (7.5-62.8) | *p*=<0.001 * |
| *Death:* | | | | | | |
| Yes | 23 | 19.2 | 1 | 0.9 | 26.794 | $X^2$=21.246 |
| No | 97 | 80.8 | 113 | 99.1 | (3.6-202.1) | *p*=<0.001 * |

* Significant at ($p \leq 0.05$).

*Image acquisition:* All CT examinations were performed using Siemens Perspective 64-slices scanner (Siemens Healthineers, Erlangen, Germany). The CT protocol was as follow: Non-intravenous contrast axial scans craniocaudal direction, breath hold at full inspiration with tube voltage 130 KV, mAs 102, slice thickness 5mm reconstructed at 1mm, Pitch 1.2 and rotation time 0.6 second. The mediastinal and lung windows were assessed with MPR, MIP, MinIP techniques using the dedicated workstation.

*Image interpretation:* Two radiologists of 17 and 20 years' experience in chest imaging, blinded to the patients age or risk factors, had independently revised the CT images in consensus using dedicated workstation.

To evaluate the severity of lung affection by CT, we referred to visual assessment and scoring system previously described and validated in other published series [6]. Each one of the 5 lung lobes were given a score from 1 to 5 according to percentage of lung affection as follow; score 0: no involvement, score 1: less than 5%, score 2: 5-25%; score 3: 26%-49%; score 4:50%-75% and score 5: more than 75% involvement. Total score was given between 0 to 25.

This study considered that lung scores less than 18 to be as mild CT affection and lung scores of 18 or more as severe. This cut off value was concluded in the study of Francone et al., [7] as predictive value for a worst prognosis.

*Statistical analysis:*

Statistical analyses were performed using IBM SPSS Statistics Software (version 24; IBM, New York, USA).

## Results

The high-risk group showed higher prevalence to present with severe CT changes (56.7% [68 out of 120] of the high-risk group versus 12.3% [14 out of 114] of the low-risk group) (Fig. 1).

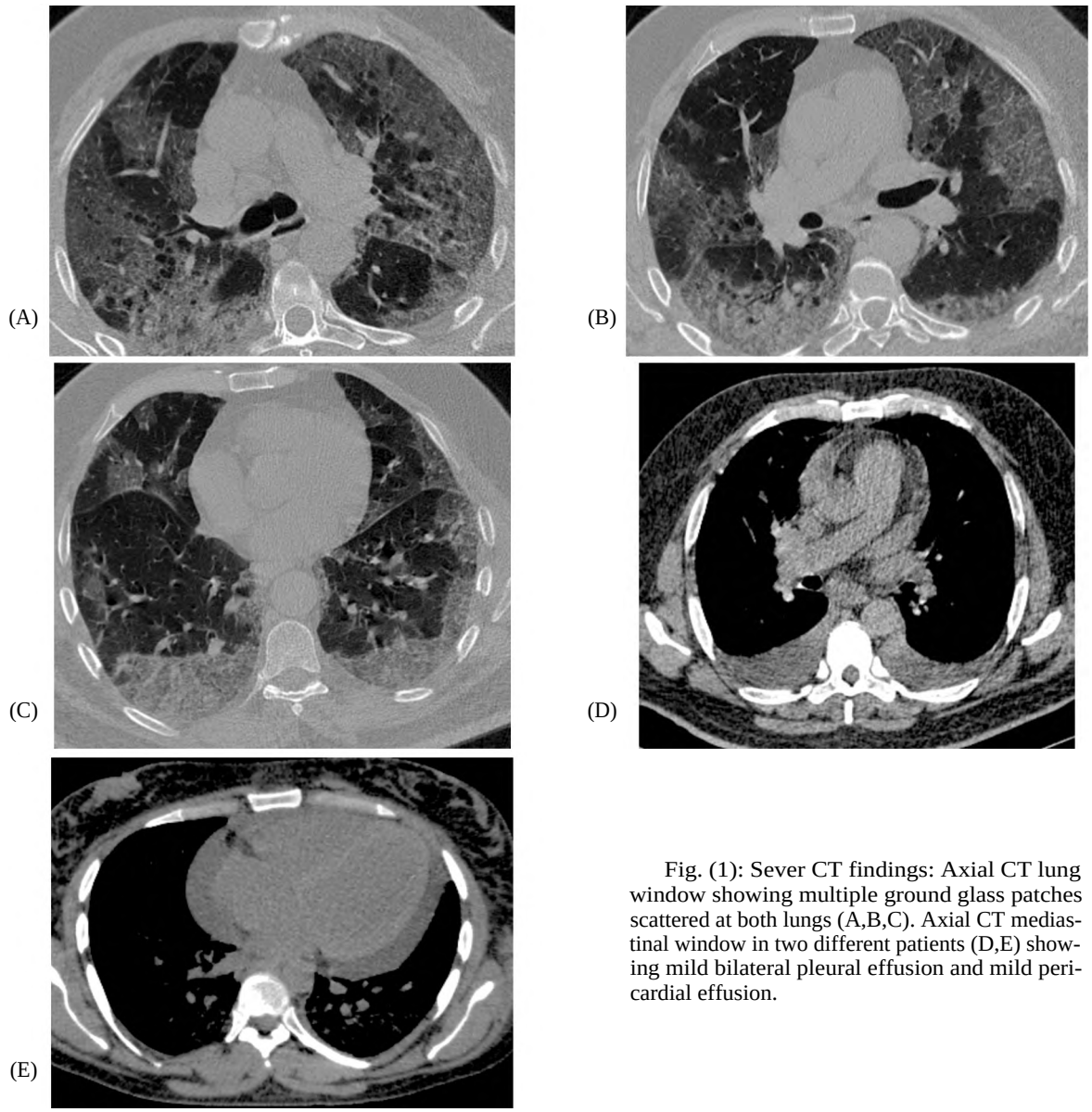


Fig. (1): Sever CT findings: Axial CT lung window showing multiple ground glass patches scattered at both lungs (A,B,C). Axial CT mediastinal window in two different patients (D,E) showing mild bilateral pleural effusion and mild pericardial effusion.

Similarly, the mild form of CT abnormalities (Fig. 2), were significantly more frequent among the low-risk group (87.7% of the low-risk versus 43.3% of the high-risk group; $p$=<0.001). Clinical deterioration (in term of ICU admission and mortality) was significantly more frequent among the high-risk patients as admission to ICU was required in 44.2% [53/120] of the high-risk group versus 3.5% of the low-risk patients, moreover, most of the deceased patients were among the high-risk group (19.2% [23/120] versus 0.9% [1/114] of the low risk group) ($p$<0.001). (Table 1).

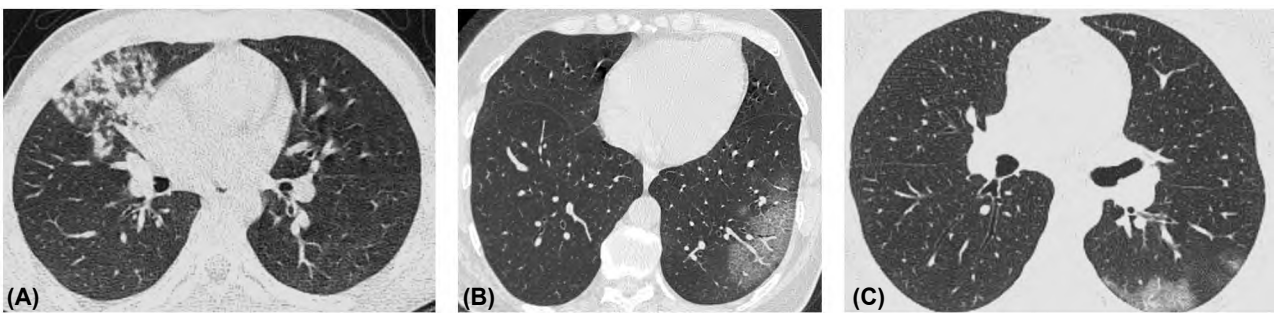


Fig. (2): Mild CT findings: Axial CT lung window in three different patients (A,B,C) Showing single lobar affection in A,B and only few small patches of ground glass attenuation at left lower lobe in C.

The initial CT changes had also significantly affected the clinical outcome of both groups.

Among 68 out of 120 high-risk patients who presented with severe CT changes, ICU admission and mortality occurred in 77.9% (53/68) and 33.8% (23/68) respectively whereas none of those with mild CT changes was admitted to ICU or had died ($p$<0.001) (Table 2). Similarly, among the 14 out of 114 low risk patients who presented with severe CT changes, ICU admission, further ventilation and mortality were seen in 28.6% (4/14), 28.6% (4/14) and 7.1% (1/14) respectively and none of the other 100 patients showed this deterioration (Table 3).

Table (2): Association between severe CT finding with ICU admission and death among high-risk group (n=120).

| | CT Severity among 120 high risk patients | | | | | |
|---|---|---|---|---|---|---|
| | Severe CT changes (n=68) | | Mild CT changes (n=52) | | Unadjusted Odds ratio CI (UL-LL) | Chi Square test ($p$-value) |
| | n | % | n | % | | |
| *ICU admission:* | | | | | | |
| Yes | 53 | 77.9 | 0 | 0.0 | 4.467 | $X^2$=72.590 |
| No | 15 | 22.1 | 52 | 100.0 | (2.9-6.9) | $p$=<0.001 * |
| *Death:* | | | | | | |
| Yes | 23 | 33.8 | 0 | 0.0 | 2.156 | $X^2$=21.759 |
| No | 45 | 66.2 | 52 | 100.0 | (1.7-2.6) | $p$=<0.001 * |

* Significant at ($p$!90.05).

Table (3): Association between severe CT finding with ICU admission, and death among low- risk group (n= 114).

| | CT Severity among 114 low risk patients | | | | | |
|---|---|---|---|---|---|---|
| | Severe CT changes (n=14) | | Mild CT changes (n=100) | | Unadjusted Odds ratio CI (UL-LL) | Fisher exact test ($p$-value) |
| | n | % | n | % | | |
| *ICU admission:* | | | | | | |
| Yes | 4 | 28.6 | 0 | 0.0 | 11.00 | $p$=<0.001 * |
| No | 10 | 71.4 | 100 | 100.0 | (6.1-19.9) | |
| *Death:* | | | | | | |
| Yes | 1 | 7.1 | 0 | 0.0 | 8.692 | $p$=0.007* |
| No | 13 | 92.9 | 100 | 100.0 | (5.2-14.5) | |

* Significant at ($p$!90.05).

## Discussion

Prognosis of COVID 19 is highly variable and unpredictable. Inspite the current available numerous publications, still the available knowledge is scarce, making the clinical decisions based on institutional experience rather than on solid result of large studies.

In the current study, we divided the participants with PCR positive COVID-19 affection into low risk and high-risk groups according to their age and presence of associated comorbidities.

We aimed to study the clinical progression of both groups and in accordance to their initial CT findings (either mild or severe) Different CT scoring systems are described in the current literature to assess the CT severity.

We used the system previously approved by other published series scoring each lung lobe with a score out of 5 points and total of 25 points for both lungs [1,7]. Francone et al., [7] concluded that CT score at a cut of value of 18 (out of 25 points) was correlated with higher rate of mortality. Others referred to a scoring system of 24 points, by assigning a score of 1 to 4 for each of three zones per lung (above the carina, between carina and inferior pulmonary vein and below the pulmonary vein) and assigned a cut of value of 10 or more to predict mortality with 84% sensitivity and 66% specificity [8]. Yuan et al., [9] multiplied the score of lung affection by type of CT abnormalities (either normal, ground glass or consolidation) and suggested a scoring system of 72 points. They identified a cut of value of 24.5 to predict mortality with sensitivity and specificity of 85.6% and 84.5%.

We observed a higher rate of severe CT changes at presentation among the high-risk group. This was coherent with the conclusions of many other reports, confirming higher vulnerability of this fragile group of patients to get a more severe form of the disease **[5,9-11]**.

In a series of 83 patients, elderly patients and those with chronic diseases showed significantly more severe clinical presentations, higher CT scores and more frequent atypical CT findings including pleural effusion, pericardial effusion and enlarged lymph nodes **[12]**.

A larger meta-analysis of 919 patients showed a higher prevalence of consolidations among elderly people **[2]**. Song et al., **[13]** compared CT features among different age groups and showed higher predilection of consolidations among patients older than 50 years compared to the younger group (45% versus 23% respectively). Similarly, Francone et al., **[7]** showed significantly higher CT score among patients aged 75 years or more as compared to those less than 50 years old. Nevertheless, no difference was shown between patients more than 75 years and those aged 50 to 75 years.

In an early report of the pandemic, the comorbidities didn't show any statistical significance as regards ICU admission (seen among 38% of patients admitted to ICU versus 29 % of group treated outside the ICU). This could be attributed to the small number of the studied sample (41 patients) and the limited number of those with comorbidities (32%) **[11]**. Inversely, in our larger cohort, we showed higher rate of ICU admission among the high-risk patients compared to the low-risk group (44.2% versus 3.5%). Moreover, the addition of severe CT changes had even worsened the prognosis of both groups, as ICU was need in 77.9% and 28.6% of the high and low risk groups with severe CT changes respectively. None of our patients with mild CT changes in both groups showed a clinical deterioration.

Reported mortality rates varies across the literature between 11 and 15% **[5,11]** and reached 37% in a study of 27 patients **[9]**. Consistent with many reports, we showed a more frequent mortality among the high-risk group compared to the low-risk group (19.2% versus 0.9%) and higher mortality among the high-risk patients presenting with severe CT changes versus those with mild CT changes (33.8% versus 7.1% respectively). Yuan et al., **[9]** showed significant higher mortality rates among patients with comorbidities as compared to those lacking these diseases (80% vs 29%). Moreover, severe CT findings had been linked to higher mortality rate in many series **[7,8]**.

Several limitations in our study exists. First, we missed the inclusion of many patients who presented during the study period, as all patients with CT suspected but not laboratory confirmed COVID 19 were not included. Second, we lacked the data concerning the body mass index of our enrolled patients. Adding obesity as a risk factor might have shifted patients with bad prognosis from the low risk to the high-risk groups. Obesity was considered as a risk factor among HIN1 patients **[14]** and an association between higher adipose tissue area CT and worst outcome had been observed among COVID19 patients **[15]**.

*Conclusion:*

To sum up, we conclude that elderly patient and or those with comorbidities have higher prediction for a worsened clinical scenario especially when severe CT changes co-exists. This group of patients is might therefore get benefit from an early medical attention.

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# التغيرات الأولية فى الأشعة المقطعية والأمراض المصاحبة للمريض، هل هذا يؤثر فيتشخيص مرضى كوفيد ؟

الهدف من هذا البحث : هو دراسة تأثير السن والأمراض المزمنة المصاحبة لمرضى كوفيد ١٩ على شدة المرض والتدهور السريرى للمرضى وفقاً لنتائج تصوير الصدر بالأشعة المقطعية وقد تم تصنيف الحالات على حسب شدة المرض اعتماداً على نسبة تأثر الرئة وفقاً لدراسات سابقة.

وقد قمنا بتقسيم الحالات إلى مجموعتين على حسب السن ووجود أمراض مزمنة من عدمه.

شملت هذه الدراسة بأثر رجعى ٢٣٤ مريضاً مؤكدا كوفيد-١٩ عن طريق إيجابية التحاليل بما فى ذلك ١٢٠ مريضاً عالى الخطورة و ١١٤ مريضاً منخفض الخطورة.

تم عمل أشعة مقطعية متعددة المقاطع بدون صبغة لجميع الحالات حتى نتمكن من حساب نسبة تأثر الرئة.

وبعد مراجعة نتائج الأشعة المقطعية ومقارنتها بالحالة الأكلينيكية للمرضى وعمل التحليل الإحصائى للنتائج تبين الآتى :

كان التدهور السريرى أعلى بشكل ملحوظ بين المجموعة التى تشمل الحالات التى تعانى من أمراض مزمنة حيث تم تسجيل الدخول فى العناية والوفيات فى ٤٤.٢٪ و ٣.٥٪ فى المجموعة الأكثر عرضة أو ذوى الأمراض المزمنة مقابل ١٩.٢٪ و ٠.٩٪ من المجموعة الأقل عرضة للأصابة الشديدة.

لم يتم قبول أى من المرضى الذين تعرضوا فى البداية لتغيرات طفيفة فى اظهرتها الأشعة المقطعية (فى أى من المجموعتين) إلى وحدة العناية المركزة أو ماتوا.

الاستنتاجات : تظهر نتائجنا أن التدهور السريرى فى شكل القبول فى وحدة العناية المر كزة، والوفيات كانت أعلى بشكل ملحوظ بين المرضى المعرضين لخطر كبير وبين أولئك الذين ظهروا فى البداية بتغيرات الأشعة المقطعية الشديدة.