J Surg Med. 2024;8(3):55-58.
https://doi.org/10.28982/josam.7518

JOSAM

Research article
https://jsurgmed.com/

Journal of Surgery and Medicine

e-ISSN: 2602-2079

HRCT severity score as a predictive biomarker in severity assessment of COVID-19 patients

Dipesh Karki [1], Sundar Adhikari [2]

[1] Consultant Physician, Department of Medicine, Fishtail Hospital and Research Center Private Limited, Pokhara, Kaski, Nepal
[2] Head of Department, Department of Pharmacy, Fishtail Hospital and Research Center Private Limited, Pokhara, Kaski, Nepal

ORCID of the author(s)

DK: https://orcid.org/0000-0002-4789-8765
SA: https://orcid.org/0000-0001-8501-0256

Corresponding Author
Sundar Adhikari
Fishtail Hospital and Research Center Private Limited, Pokhara, Kaski, Nepal
E-mail: adhikari.sndr@gmail.com

Ethics Committee Approval
The study was approved by the Institutional Review Committee, Fishtail Hospital and Research Center Pvt. Ltd., Pokhara, Nepal, with reference no. 077/078/160 on 22 January 2021. All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2024 March 15

Abstract

Background/Aim: In 2020, the World Health Organization declared the Coronavirus disease of 2019 (COVID-19) a pandemic due to its widespread nature. The severity of COVID-19 infections leading to patient deaths is influenced by various factors. Therefore, it is crucial to identify and address these contributing causes for effective treatment of COVID-19.

Methods: This study was conducted between 23 January 2021 and 19 June 2021 at a hospital with 100 beds in Western Nepal. Patient demographic data and High-resolution computed tomography severity scores were recorded. Microsoft Excel and Statistical Package for the Social Sciences were used for statistical data analysis. Binomial regression and Chi-square tests were applied, setting the significance level at $P<0.05$ with a confidence interval of 95%.

Results: The study found a significant association between computed tomography (CT) severity, gender, and age with the treatment outcome among COVID-19-infected patients admitted to the hospital. Patients with a CT severity score between 16 and 25 had an eightfold higher mortality rate (OR: -8.802; 95% CI: 3.506–18.491).

Conclusion: The severity and mortality of COVID-19 infections are influenced by factors such as age, gender, and biomarkers indicated by CT severity scores. Identifying additional factors that worsen COVID-19 patient's conditions and increase the risk of mortality is essential.

Keywords: coronavirus, COVID-19, CT severity score, high-resolution computed tomography, Western Nepal

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was initially discovered in Wuhan, China, in December 2019. The World Health Organization officially named the illness coronavirus disease 2019 (COVID-19) on 11 February 2020 [1]. In March 2020, the World Health Organization declared COVID-19 a pandemic due to its rapid global spread from China to other parts of the world [2]. Therefore, it is of paramount importance to identify more accurate prognostic biomarkers for the disease's prognosis. The potential areas where COVID-19 biomarkers can be instrumental include [3];

1) Early symptom severity and disease suspicion
2) Clear evidence and categorization of disease severity
3) Framing criteria for hospital admission
4) Identifying a cohort at high risk
5) Defining ICU admission standards
6) Therapy rationalization
7) A therapeutic response's evaluation
8) Prediction of outcome
9) Defining the criteria for ICU and/or hospital discharge

High-Resolution Computed Tomography (HRCT) examinations are another method to detect viral infections in the body. They can also assess the severity of pulmonary disease and the presence of sequelae, track the disease's course, and eliminate other possible diagnoses [4]. Numerous studies have reported a correlation between inflammatory lab markers, hospital stay, and oxygen requirements with CT severity scores in COVID-19 patients [5]. However, more research is needed to fully understand the value of chest CT in prognosticating COVID-19 outcomes and its correlation with patient prognosis.

Materials and methods

Study population

This study was conducted from 23 January 2021 to 19 June 2021 at a 100-bed hospital in Western Nepal during the peak of Nepal's second wave of COVID-19. The diagnosis of COVID-19 was confirmed by obtaining nasal and pharyngeal swab specimens from patients, which were tested positive using real-time reverse transcriptase-polymerase chain reaction (RT-PCR) for SARS-CoV-2. Prior to conducting the study, consent was obtained from the patients' relatives.

Selection criteria [6-7]

The following patients met the inclusion criteria: (1) hospitalized patients, (2) confirmed COVID-19 cases through nasopharyngeal swab RT-PCR testing, and (3) patients who underwent their first CT scan while hospitalized and later tested positive on RT-PCR. Exclusion criteria included pregnancy, cancer, hematologic malignancies, chronic liver disease, acute coronary syndrome, surgeries or trauma within the last 30 days, and patients without CT imaging.

Ethical approval

The Institutional Review Committee (IRC) of Fishtail Hospital and Research Center Pvt. Ltd., Pokhara, Nepal, approved the study with reference no. 077/078/160.

Data collection

Age and gender information about the respondents were collected, and age was categorized into three groups: 19 to 39 years old, 40 to 59 years old, and 60 years or older [8].

The CT scanner used to calculate the HRCT severity score for COVID-19 patients was the Somatom Spirit (Siemens in Germany Syngo). The data were divided into two groups: COVID-19 patients with CT severity scores of 1 to 15 were categorized as having mild to moderate symptoms, while those with scores of 16 to 25 were classified as having severe symptoms. Additionally, the study noted two outcome categories for treatment: "improved" and "not improved." The "improved" category referred to patients who were either discharged or expressed desire to be discharged independently. On the other hand, patients whose condition was fatal and who were referred to higher centers for more advanced treatment were categorized as "not improved" [9-10].

Statistical analysis

Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) statistical software (version 20.0, IBM) were utilized for all statistical data analyses. To establish the relationship between the dependent and independent variables, Chi-square and binomial regression tests were applied. Statistical values with a significance level of $P<0.05$ at a 95% confidence interval were considered significant.

Results

Sociodemographic characteristics of respondents

A total of 180 respondents participated in the study. Approximately 20% of the 180 participants were aged 19–39, while 30% were in the 40–59 age range. Most respondents (50%) were above 60, and the smallest proportion was in the 19–39 age group (36%). The data regarding gender distribution indicated that most of the respondents were male (54%), as depicted in Figures 1 and 2.

Figure 1: Percentage distribution of gender.

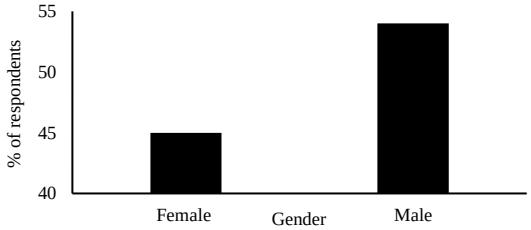
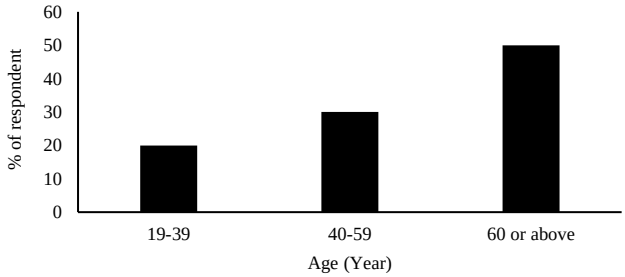


Figure 2: Percentage distribution of patient according to age.



Association of treatment outcome with CT severity score

A notable correlation was observed between the CT severity score and the treatment outcome in COVID-19 patients admitted to the hospital. Patients with a CT severity score of 16-25 were approximately eight times more likely to experience an

adverse outcome (OR: 8.802; 95% CI: 3.506–18.491) than patients with a CT severity score of 1–15, as shown in Table 1.

Table 1: Association of treatment outcome with CT Severity Score.

Variables	Treatment Outcome			Chi-square value	*P*-value	OR	95% CI
	DOPR/ Discharged n(f)	Expired n(f)	Total				
CT Severity Score							
1-15	92 (91.1%)	9(8.9%)	101			Ref.	
16-25	43 (54.4%)	36(45.6%)	79	31.771	<0.001*	8.052	3.506-18.491

CI: Confidence Interval, DOPR: Discharge on Patient Request, OR: Odds Ratio, Ref: Reference

Discussion

The screening of effective biomarkers, patient classification, clinical management, and prevention of serious complications are essential in combating the progression of COVID-19, reducing severe and fatal outcomes, and improving treatment strategies [11]. Prominent biomarkers such as D-dimer, Serum ferritin, C-reactive protein (CRP), Interleukin-6, Lactate dehydrogenase (LDH), and HRCT have been identified for this purpose. Additionally, our study found that age, gender, and biomarkers significantly increased the risk of death in patients with COVID-19 [12].

Based on sociodemographic information, males are at a higher risk of COVID-19 than females [13]. They are also more susceptible to experiencing severe acute respiratory distress syndrome (ARDS) or fatal outcomes following SARS-CoV-2 infection. The exact reasons for this gender disparity are not yet fully understood; however, it may be attributed to factors such as smoking habits and higher plasma levels of androgen hormones in men than women. These androgens are believed to play a role in the transcription of Transmembrane serine protease 2 (TMPRSS2), a gene encoding a protease necessary for SARS-CoV-2 cell entry after its spike protein binds to the cell membrane's Angiotensin-converting enzyme 2 (ACE2) [14].

Another study has proposed that the X chromosome and sex hormones, which have been linked to both innate and adaptive immunity, might contribute to the higher susceptibility of males to COVID-19 infection [15].

There was a notable correlation between age groups and COVID-19 patients, with a higher vulnerability observed in the age group above 60. Previous studies have consistently reported that older individuals experience greater COVID-19 morbidity and mortality rates [16]. The aging process is often associated with an increased risk of mortality, which could be attributed to a weakened immune system. As individuals age, their immune competence tends to decline. In our investigation of the relationship between CT severity score and treatment outcomes for COVID-19 patients admitted to the hospital, we found that patients with a CT severity score of 16 to 25 were nearly eight times more likely to pass away than those with a score of 1 to 15. The extent of chest computed tomography involvement is a visible parameter indicating the degree of inflammation [17-19].

Limitations

As this was a single-center study, it is recommended that future research be conducted with a larger sample size across multiple centers. Performing similar studies on a broader scale will provide more robust and generalizable findings. Since this was a single-centered study, similar research should be conducted in the future with a large sample size in several centers.

Conclusion

In conclusion, a positive and significant association was found between oxygen consumption, length of hospital stays, and inflammatory lab markers. Although the prognostic value of chest CT in COVID-19 disease shows promise, further investigation is warranted to establish its correlation with patient outcomes. This study revealed that patients with higher CT severity scores exhibit greater disease severity, leading to an increased mortality risk. Hence, CT severity scores can serve as useful biomarkers for assessing the severity of COVID-19 in patients. Furthermore, additional research is necessary to identify other relevant characteristics and biomarkers that accurately gauge the severity of COVID-19 in patients.

Acknowledgments

The authors would like to acknowledge the Department of Pharmacy, Department of Medicine, Department of Laboratory, Fishtail Hospital and Research Center Pvt. Ltd., Pokhara, Nepal.

References

1. Yang R, Li X, Liu H, Zhen Y, Zhang X, Xiong Q, et al. Chest CT severity score: an imaging tool for assessing severe COVID-19. Radiology: Cardiothoracic Imaging. 2020;2(2):e200047. doi: 10.1148/ryct.2020200047
2. Abdel-Tawab M, Basha MA, Mohamed IA, Ibrahim HM. A simple chest CT score for assessing the severity of pulmonary involvement in COVID-19. Egypt J Radiol Nucl Med. 2021;52(1):1-0. doi: 10.1186/s43055-021-00525-x
3. Biomarkers Definitions Working Group, Atkinson Jr AJ, Colburn WA, DeGruttola VG, DeMets DL, Downing GJ, et al. Biomarkers and surrogate endpoints: preferred definitions and conceptual framework. Clin Pharm Therap. 2001;69(3):89-95. doi: 10.1067/mcp.2001.113989
4. Rahman MH, Amir N, Rahman MA, Islam AT, Islam MS, Huda MD, et al. Role of HRCT scan of chest in the evaluation of COVID-19 Pneumonia. TAJ: J Teach Assoc. 2021;34(1):109-14. doi: 10.3329/TAJ.V34I1.54914
5. Saeed GA, Gaba W, Shah A, Al Helali AA, Raidullah E, Al Ali AB, et al. Correlation between chest CT severity scores and the clinical parameters of adult patients with COVID-19 pneumonia. Radiol Res Pract. 2021;2021. doi: 10.1155/2021/6697677
6. Kim JH, Ta CN, Liu C, Sung C, Butler AM, Stewart LA, et al. Towards clinical data-driven eligibility criteria optimization for interventional COVID-19 clinical trials. J Am Med Inform Assoc. 2021;28(1):14-22. doi: 10.1093/jamia/ocaa276
7. Yasin R, Gomaa AA, Ghazy T, Hassanein SA, latif Ibrahem RA, Khalifa MH. Predicting lung fibrosis in post-COVID-19 patients after discharge with follow-up chest CT findings. Egypt J Radiol Nucl Med. 2021;52(1):1-3. doi: 10.1186/s43055-021-00495-0
8. Ye C, Zhang S, Zhang X, Cai H, Gu J, Lian J, et al. Impact of comorbidities on patients with COVID-19: A large retrospective study in Zhejiang, China. J Med Virol. 2020;92(11):2821-9. doi: 10.1002/jmv.26183]
9. Li K, Wu J, Wu F, Guo D, Chen L, Fang Z, et al. The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. Invest Radiol. 2020;55(6):327-31. doi:.10.1097/rli.0000000000000672
10. Karki D, Saksham KC, Gurung R, Adhikari S. Association of HRCT severity score, pre-existing comorbidities, and ABO blood group with treatment outcomes of COVID-19 patients admitted in a hospital of Western Nepal. Asian J Med Sci. 2022;13(4):1-6. doi: 10.3126/ajms.v13i4.42468
11. Karki D, Gurung R, Nepali P, Kaphle HP, Subedi B, Adhikari S. Raised D-dimer among Admitted COVID-19 Patients in a Tertiary Care Centre: A Descriptive Cross-sectional study. JNMA: J Nepal Med Assoc. 2022;60(251):596. doi: 10.31729/jnma.7579
12. Ponti G, Maccaferri M, Cristel R, Tomasi A, Ozben T. Biomarkers associated with Covid-19 disease progression. Crit Rev Clin Lab Sci. 2020;57(6):389-99. doi: 10.1080/10408363.2020.1770685
13. Yazar H, Kayacan Y, Özdin M. Investigation of C-reactive Protein and D-dimer Findings in Patients with COVID-19. Bezmialem Science. 2021;9(Supplement 1):4-8.
14. Wambier CG, Goren A. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection is likely to be androgen mediated. J Am Acad Dermatol. 2020;83(1):308-9. doi: 10.1016/j.jaad.2020.04.032
15. Jaillon S, Berthenet K, Garlanda C. Sexual dimorphism in innate immunity. Clin Rev Allergy Immunol. 2019;56(3):308-21. doi: 10.1007/s12016-017-8648-x
16. Davies NG, Klepac P, Liu Y, Prem K, Jit M, Eggo RM. Age-dependent effects in the transmission and control of COVID-19 epidemics. Nat Med. 2020;26(8):1205-11. doi: 10.1038/s41591-020-0962-9

17. Yilmaz A, Sabirli R, Seyit M, Ozen M, Oskay A, Cakmak V, et al. Association between laboratory parameters and CT severity in patients infected with Covid-19: A retrospective, observational study. Am J Emerg Med. 2021;42:110-4. doi: 10.1016/j.ajem.2021.01.040
18. Zhang L, Yan X, Fan Q, Liu H, Liu X, Liu Z, et al. D-dimer levels on admission to predict in-hospital mortality in patients with COVID-19. J Tromb Haemost. 2020;18(6):1324-9. doi: 10.1111/jth.14859
19. Cummings MJ, Baldwin MR, Abrams D, Jacobson SD, Meyer BJ, Balough EM, et al. Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study. Lancet. 2020;395(10239):1763-70. doi: 10.1016/S0140-6736(20)31189-2