Significance of High-Resolution Computed Tomography (HRCT) Chest in Screening Hospital Admissions for Coronavirus Disease (COVID-19) in Preoperative and Non-COVID-19 Clinical Settings

Gurpreet Makkar[1], Sanjay Mehta[2], Ankur Gulati[3]

[1, 2]Department of Radiology, Artemis Hospital, Gurugram, India

[3]Department of Radiology, Artemis Hospital, Sector 51, Gurugram, India
Corresponding author Email-*Ankurgulati59[at]gmail.com*

Abstract: ***Background**: Early diagnosis of Coronavirus disease-19 (COVID-19) can help in triaging and surgical decision making for admitted patients referred for non-COVID-19 symptoms. The study was performed to evaluate the diagnostic accuracy of HRCT chest and its correlation with Reverse transcriptase-polymerase chain reaction (RT-PCR). **Methods**: A hospital-based prospective study was conducted on 548 patients as a part of COVID-19 screening between March to June 2020. HRCT findings were classified based on COVID-19 Reporting and Data System (CORADS) grading and were analysed and corroborated with RT-PCR and clinical parameters. **Results**: 2.91% of cases had HRCT findings as highly suspicious or suspicious for COVID-19 (2% with CORADS-5 and 0.91% with CORADS-4 features, respectively. Amongst these patients, 37.5 % were RT-PCR positive. CORADS-3 features were seen in 4.74% of patients. A false-negative rate of HRCT was found to be 1.9% of patients with CORADS-1 features and RT-PCR positivity. Overall RT-PCR positivity in our study cohort was 3.28%. HRCT and RT-PCR results helped in deferring 7/266 (2.63%) elective surgeries, out of these 0.75% (2/266) were deferred based on HRCT findings alone thereby preventing postoperative morbidity. In a few CORADS 3, 4 and 5 patients, clinical and laboratory correlation helped to distinguish COVID-19 from other diseases. **Conclusions**: HRCT chest came out to be a robust faster screening tool to diagnose COVID-19, although RT-PCR is considered the gold standard. It played a key role in triaging and isolating patients before the availability of RT-PCR results and also helped in reducing morbidity, mortality and cross infection.***

Keywords: COVID-19, CORADS, elective surgeries, HRCT, RT-PCR, triaging

1. Introduction

COVID-19 caused by Severe Acute Respiratory Syndrome-Coronavirus-2 (SARS-CoV-2) started in Wuhan, China in 2019 and has spread globally. It has affected a significant number of asymptomatic patients, the incidence of which ranges from 5-80% [1, 2]. Coexistent infection can impact treatment, prognosis, and surgical decisions. Screening based purely on the typical symptoms may overlook many patients and is inadequate [3, 4].

Identification is essential to prevent cross-infection to patients and healthcare workers, reducing the impact of the epidemic on healthcare facilities. Thus, early diagnosis and isolation in these clinically unsuspected patients become imperative, particularly before surgery or admission. A specific viral nucleic acid assay for rapid and accurate diagnosis was developed using Reverse transcriptase-polymerase chain reaction (RT-PCR) [5, 6]. However, some patients may have initial negative RT-PCR results [7] due to inadequate cellular material or improper extraction of nucleic acid from nasopharyngeal and throat swabs [8, 9] leading to delayed diagnosis and higher infectivity, resulting in the spread of disease. Therefore, the HRCT chest is a rapid tool to detect suspected patients and can be handy for screening, primary diagnosis, and disease severity [10]. However, HRCT may be false-negative in patients with disease confined to the upper respiratory tract, equivocal in cases with Acute respiratory distress syndrome (ARDS) caused due by Congestive heart failure (CHF), chronic kidney disease (CKD), pulmonary hydrostatic effect, and false-positive in other respiratory infections [11].

2. Materials and Methods

A prospective study was conducted on 548 patients of all age groups who underwent HRCT chest and RT-PCR simultaneously at our hospital as part of COVID-19 screening between March-June 2020. We aimed to assess the diagnostic accuracy and role of HRCT in COVID-19 and its correlation with RT-PCR assay in asymptomatic patients who were screened in a preoperative setting or admitted for other non-COVID-19 indications which included stroke, malignancies, trauma, abdominal symptoms, and medical illnesses. Patients symptomatic of a chest infection and patients who were previously RT-PCR positive were excluded. HRCT scans were performed on a 64-slice scanner at low dose settings which were 120 KV, 100 mAs, pitch 0.9, thickness 1mm, increment 0.5mm. The method used for RNA extraction and RNA amplification was QIAamp Viral RNA Mini Kit and QIAGEN Rotor-Gene Q Real-time PCR cycler respectively. The results were analyzed and corroborated with clinical parameters, RT-PCR, repeat RT-PCR result (in suspicious cases with first

Licensed Under Creative Commons Attribution CC BY

negative RT-PCR), and Absolute Lymphocyte Count (ALC). The patients were isolated and treated based on the following criteria:-

1) Positive RT-PCR.
2) CORADS-4/5 HRCT features.
3) CORADS-3 with hematological parameters like normal or decreased total leucocyte count, decreased ALC<1 or increased C-Reactive Protein (CRP).

Interpretation of HRCT was performed using CORADS, proposed and developed by the Dutch Radiological society [12] reducing inter-observer variation, thus helping in clinical decision making (Table.1).

The radiological features we looked for were ground glass opacities (GGOs), consolidations, nodules, and interlobular septal thickening (ILST). Also, the location in terms of peripheral, sub-pleural, central or mixed distribution and bilaterally or unilaterally were assessed.

3. Results

Out of the 548 patients included in the study; 318 were admitted for surgery [266 (83.6%) elective and 52 (16.3%) emergency] and 230 for the treatment of illnesses including trauma (57), stroke (32), acute abdomen (24), malignancies (85) and miscellaneous medical illnesses (32). HRCT revealed CORADS-5 score in 11 (2%), CORADS-4 in 5 (0.91%), CORADS-3 in 26 (4.74%), CORADS-2 in 33 (6%) whereas CORADS-1 in 473 (86.3%) patients. Thus, almost 2.91% (16/548) cases were suspicious or highly suspicious (CORADS-4/5) and 4.74 % (26/548) were equivocal (CORADS-3) for COVID-19.

Only 45.4% (5/11) CORADS-5 patients and 20% (1/5) CORADS-4 patients were RT-PCR positive constituting 37.5% (6/16) of the CORADS-4/5 category.11.5% (3/26) CORADS-3 and 1.9% (9/473) CORADS-1 patients were RT-PCR positive. The rest of the patients were tested negative on first RT-PCR. Only one CORADS-5 patient was found positive in repeat RT-PCR performed in 11 CORADS-3-5 category patients. HRCT findings were similar in RT-PCR positive and negative patients in the CORADS-5 category. In the preoperative group, 6 (1.88%) had CORADS-4/5 (3 in each) and 11 had CORADS-3 (3.45%) features.3/17 (17.64%) of the CORADS 3-5 patients were RT-PCR positive. Non-COVID-19 HRCT findings were seen in 301 patients (284 CORADS-1, 17 CORADS-2). Out of these, 5/284 (1.76%) CORADS-1 patients were RT-PCR positive.

The uneventful post-surgical outcome was seen in 45/52 emergency patients (40 CORADS-1, 4 CORADS-2, 1 CORADS-3). Complications were seen in 5 patients; 4 neurosurgeries (1 each in CORADS-1, 3, 4, and 5) who were RT-PCR negative, and in one abdominal surgery who were RT-PCR positive. One patient who underwent ventricular shunt catheter placement had CORADS-3 features, suffered arrhythmia, cardiac arrest, and died on the 2nd postoperative day. Although he was RT-PCR negative, he had decreased ALC, increased CRP, and contact history. The rest of the neurosurgeries had prolonged stays. A CORADS-3 RT-PCR positive patient operated for perforation peritonitis developed encephalopathy postoperatively. Thus, postoperative mortality in this group was 1.92% (1/52) and was probably related to COVID-19. Two orthopaedic surgeries of RT-PCR positive, CORADS-1 patients were postponed.266 elective surgeries were performed, out of these 2 were CORADS-5, 2 CORADS-4, 8 CORADS-3, 13 CORADS-2, and 241 CORADS-1 categories. Two surgeries, a renal transplant recipient with CORADS-5 features (Figure.1) and another tympanomastoidectomy with CORADS-4 features, both RT-PCR negative were postponed. A CORADS-5 and a CORADS-3 patient, planned for elective knee surgeries were not operated on as they were found RT-PCR positive. Elective surgeries of three CORADS-1 patients were postponed as they were RT-PCR positive. Thus, 2.63% (7/266) elective surgeries were postponed out of which 0.75% (2/266) were postponed based on HRCT findings, 0.75% (2/266) patients due to both HRCT and RT-PCR and 1.1% (3/266) because of positive RT-PCR. Out of the 230 patients admitted for other medical illnesses; 189 were CORADS-1, 16 CORADS-2, 25 patients belonged to CORADS-3 to 5 categories (15 CORADS-3, 2 CORADS-4 and 8 CORADS-5).10/230 (4.35%) patients were found RT-PCR positive. In 85 oncology patients, one CORADS-5 patient was a case of myelodysplastic syndrome with negative RT-PCR showed false-positive results on HRCT and grew mycoplasma pneumoniae on bronchoalveolar lavage (BAL) cultures (Figure.2).3 RT-PCR negative patients, One CORADS-1 patient died due to meningoencephalitis while 2 CORADS-2 patients developed pneumonia. Mortality was 1.2% (1/85) not related to COVID-19.32 patients presented with neurological symptoms out of which 2 had CORADS-5, 1 CORADS-4, 3 CORADS-3, 2 CORADS-2 and 24 CORADS-1 features. One RT-PCR positive CORADS-5 patient recovered after a prolonged Intensive care unit (ICU) stay. Another post-thrombolysis CORADS-5 patient of acute infarct developed atrial fibrillation and died due to a cardiac arrest, probably COVID-related. Though his initial RT-PCR was negative, repeat RT-PCR after one week of admission was positive. HRCT helped early triaging the patient to COVID-19 ICU.

Mortality due to brainstem haemorrhage was seen in a negative RT-PCR, CORADS-3 patient with multiple, peripheral, bilateral consolidations indistinguishable from COVID-19. Another CORADS-3 patient with unilateral, peripheral GGOs had multiple, intracranial enhancing lesions on MRI, was diagnosed on histopathology as lymphoma. His RT-PCR was negative and he died due to post-biopsy intracranial haemorrhage likely non-COVID-19-related (Figure.3).2 RT-PCR positive patients had negative HRCT results; however, both died of cardiac arrest, likely COVID-related. Another patient with negative RT-PCR and HRCT results died due to neurological complications. Therefore, overall mortality in patients with acute stroke was 18.75% (6/32), 3 were probably COVID-related. Endovascular aneurysmal repair was deferred in a CORADS-1, RT-PCR positive patient. Of the 57 trauma patients; 3 had CORADS-3, 4 CORADS-2, and 50 CORADS-1 features. Peripheral GGOs were seen in CORADS-3 patients, indistinguishable from lung contusions. They were isolated based on HRCT, out of which one was RT-PCR positive. In 24 patients with abdominal symptoms, 4 patients had CORADS-5, 1

Licensed Under Creative Commons Attribution CC BY

CORADS-3, and 19 CORADS-1 features.2 CORADS-5 patients were positive on RT-PCR including a one-year-old with multi-organ dysfunction requiring ICU and ventilation. No mortality was seen in patients presenting with trauma or acute abdominal symptoms. Patients presented with different medical illnesses including CKD, Chronic obstructive pulmonary disease (COPD), Mitral valvular disease, uncontrolled diabetes, showed one patient with CORADS-5 features, 1 CORADS-4, 3 CORADS-3, 3 CORADS-2, and 24 CORADS-1 features. The patient who had CORADS-5 features was negative on RT-PCR presented with joint pains and was diagnosed with Wegener's granulomatosis (Figure.4). Underlying RHD, Mitral Stenosis (MS), Mitral regurgitation (MR) with superimposed areas of consolidation was found in a CORADS-4 patient with positive RT-PCR who died subsequently (Figure.5). Another CORADS-3 patient was diagnosed with Methicillin-sensitive Staphylococcus aureus (MSSA) on microbiology. Severe aortic stenosis (AS) was also found in a CORADS-1 RT-PCR positive patient, deferring his surgery. Overall mortality was seen in 9/548 (1.64%) patients in our study of which 5 appeared COVID-19 related and 4 were non-COVID-19 deaths.9% (1/11) were CORADS-5, 20% (1/5) were CORADS-4, and 11.5% (3/26) were CORADS-3 (of which 2 of these were non-COVID-19-related while one appeared COVID-related).4 deaths (0.84%) were observed in the CORADS-1 category of these 2 being COVID-related. The HRCT findings seen in all 11 CORADS-5 patients were multifocal, bilateral GGOS showing peripheral and sub-pleural distribution. Consolidations were seen in 7, ILST in 6, and nodules in 2 of the 10 patients. Bilateral mild pleural effusions were seen as an additional finding in 3 patients (33% CORADS-5) one of which had concomitant CKD. Of the 5 CORADS-4 category patients revealed GGOs in all 5, consolidation in 2, ILST in 4, and nodules in 2 patients, the distribution of which was peripheral in 2 and mixed (peripheral and central) in 3; unilateral in one and bilateral in 4 patients. Underlying COPD was seen in one patient. Lung nodules were probably COVID-related in one and metastatic in. In 26 CORADS-3 patients, GGOs were seen in 20, consolidation in 7, nodules in 6, and ILST in 8. Bilateral mild pleural effusions were seen in 2 patients and moderate ascites with pleural effusion in 1 patient who had underlying CKD and CHF which were indistinguishable from ARDS pattern. In the 33 CORADS-2 patients, GGOs were seen in 4, consolidation in 15, nodules in 14, and ILST in 3. Centrilobular nodules suggestive of infection were seen in 11 patients. Pleural effusions, bronchiectasis, and tubercular mediastinal lymphadenopathy were observed in one patient each. One patient had oesophageal malignancy with superimposed aspiration pneumonitis. Out of 473 CORADS-1 patients, dependent bilateral GGOS was seen in 8, ILST in 7, and nodules in 45. Emphysema was seen in 6, Nonspecific Interstitial Pneumonia (NSIP) pattern in two, and fibrotic areas in 5 patients. Lymphopenia was observed in COVID-19 patients, thus making ALC a good predictor in assessing disease severity. ALC values in our study cohort ranged from 0.3-4 with average values of 1.02 in adult patients in the CORADS-5 group, 1.23 in CORADS-4, 1.33 in CORADS-3, 1.76 in CORADS-2, and 1.98 in CORADS-1 patients.

4. Conclusion

HRCT has a great role in triaging patients to an isolation facility preventing the spread of infection before the availability of RT-PCR results. Also, in COVID-19 patients negative RT-PCR results, HRCT along with supported clinical and lab correlation helped in reducing morbidity and mortality. The importance of clinical correlation to avoid radiological overlap could not be underscored in few patients. Though we could not establish the role of preoperative HRCT, a protocol based on both RT-PCR and HRCT can be of high significance during potential future viral pandemics.

References

[1] Daniel P. Oran, Eric J Topol et al (2020) Prevalence of asymptomatic SARS-CoV-2 Infection. A narrative review. Annals of Internal Medicine https: //doi. org/10.7326/m20-3012
[2] Jingjing He, Yifei Guo, Richeng Mao, JimingZhang (2020) Proportion of asymptomatic corona virus disease 2019: A symptomatic review and meta-analysis J Med Virol. https: //doi. org/10.1002/jmv.26326
[3] J. C. Yombi, J. De Greef, A.-Marsin, A. Simon, H. Rodriguez-Villabos, A. Penaloza, L. Belklin (2020) Symptom-based screening for COVID-19 in healthcare workers: Importance of fever J. Hosp. Infect. https: //doi. org/10.1016/j. jhin.2020.05.028
[4] Chow E. J., Schwartz N. G., Tobolowsky F. A., Zachs R. L. T., Huntington-Frazier M., ReddyS. C. (2020) Symptom screening at illness onset of health care personnel with SARS-CoV-2 Infection in King County, Washington, JAMA
[5] https: //doi. org/10.1001/jama.2020.6637
[6] Li Y, Yao L, Li J, et al (2020). Stability issues of RT-PCR testing of SARS-CoV-2 for hospitalized patients clinically diagnosed with COVID-19. J Med Virol. https: //doi. org/10.1002/jmv.25786
[7] Ai T, Yang Z, Hou H. et al (2020) Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology 200642. https: //doi. org/10.1148/radiol.2020.200642
[8] Wang W, Xu Y, Gao R, et al (2020) Detection of SARS-CoV-2 in Different Types of Clinical Specimens. JAMA. https: //doi. org/10.1001/jama.2020.3786
[9] Zou L, Ruan F, Huang M, et al (2020) SARS-CoV-2 Viral Load in Upper Respiratory Specimens of Infected Patients. N Engl J Med. https: //doi. org/10.1056/nejmc2001737
[10] Corman VM, Landt O, Kaiser M, et al (2020) Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Eurosurveillance. https: //doi. org/10.2807/1560-7917. es.2020.25.3.2000045
[11] Fang Y, Zhang H, Xie J et al (2020) Sensitivity of chest CT for COVID-19: comparison to RT-PCR. Radiology
[12] https: //doi. org/10.1148/radiol.2020200432
[13] Mathias Prokop, Wouter van Everdingen et al (2020) CO-RADS: A Categorical CT assessment scheme for patients suspected of having COVID-19-definition and

Licensed Under Creative Commons Attribution CC BY

evaluation Radiology. https: //doi. org/10.1148/radiol.2020201473

[14] Inui S, Fujikawa A, Jitsu M et al (2020) Chest CT findings in cases from the cruise ship "diamond princess" with coronavirus disease 2019 (COVID-19). RadiolCardiothorac Imaging https: //doi. org/10.1148/ryct.2020204002

[15] M. R. Chetan, M. T. Tsakok, R. Shaw et al (2020) Chest CT screening for COVID-19 in elective and emergency surgical patients: experience from a UK tertiary centre. Clin Radiol. https: //doi. org/10.1016/j. crad.2020.06.006

[16] X. Zhao, B. Liu, Y. Du, J. Gu, X. Wu et al (2020) The characteristics and clinical value of chest CT images of novel coronavirus pneumonia. Clin Radiol. https: //doi. org/10.1016/j. crad.2020.03.002

[17] Yu F, Yan L, Wang N et al (2020) Quantitative detection and viral load analysis of SARS-CoV-2 in infected patients. Clin Infect Dis. https: //doi. org/10.1093/cid/ciaa34511

[18] Victoria Ducray, Anna SesliaViachomitrou, Maude Bouscambert-Duchamp, Salim Si Mohamed et al (2020) Chest CT for rapid triage of patients in multiple emergency departments during COVID-19 epidemic: experience report from a large French university hospital European Radiology https: //doi. org/10.1007/s00330-020-07154-4

[19] Long C, Xu H, Shen Q et al (2020) Diagnosis of the coronavirus disease (COVID-19): rRT-PCR or CT Eur J Radiol 126: 108961 https: //doi. org/10.1016/j. ejrad.2020.108961

[20] The Royal College of Radiologists [Internet]. The role of CT in screening elective preoperative patients | Rcr. ac. uk. [cited 2020b Sep 4]. https: //www.rcr. ac. uk/college/coronavirus-COVID-19-what-rcr-doing/clinical-information/rolect-chest/role-ct-screening

[21] Nahshon C, Bitterman A, Haddad R, Hazzan D, Lavie O. et al (2020) Hazardous postoperative outcomes of unexpected COVID-19 infected patients: A call for global consideration of sampling all asymptomatic patients before surgical treatment. World J Surg. https: //doi. org/10.1007/s00268-020-05575-2

[22] Lei S, Jiang F, Su W, Chen C, Chen J, Mei W, et al. (2020) Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. EClinicalMedicine. https: //doi. org/10.1016/j. eclinm.2020.100331

[23] Young BE, Ong SWX, Kalimuddin S, et al (2020) Epidemiologic Features and Clinical Course of Patients Infected with SARS-CoV-2 in Singapore. JAMA https: //doi. org/10.1001/jama.2020.3204

[24] Fan BE, Chong VCL, Chan SSW et al (2020) Hematologic parameters in patients with COVID-19 infection. Am J Hematol https: //doi. org/10.1002/ajh.25847

[25] Yang X, Yu Y, Xu J, et al (2020) Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med

[26] https: //doi. org/10.1016/s2213-2600 (20) 30079-5

[27] Arentz M, Yim E, Klaff L, et al (2020) Characteristics and Outcomes of 21 Critically Ill Patients with COVID-19 in Washington State. JAMA https: //doi. org/10.1001/jama.2020.4326

[28] Bhatraju PK, Ghassemieh BJ, Nichols M, et al (2020) COVID-19 in Critically Ill Patients in the Seattle Region-Case Series. N Engl J Med https: //doi. org/10.1056/nejmoa2004500

Figure legends

Figure 1: CORADS-5 features with multiple bilateral sub pleural GGOs and consolidations in a prospective renal recipient.

Figure 2: CORADS-5 features with multiple bilateral subpleural GGOs extending centrally with interlobular septal thickening in a patient with Mycoplasma pneumoniae infection

Figure 3: CORADS-3 Unilateral peripheral GGO in right upper lobe in a case of diffuse large B cell lymphoma presenting as acute stroke

Figure 4: CORADS-5 Multiple peripheral sub pleural GGOs and consolidations in both lungs diagnosed as Wegener's granulomatosis

Figure 5 (a): GGOs and consolidations in peripheral and central distribution CORADS-4 features diagnosed covid with underlying Mitral valvular disease.

Figure 5 (b): Cardiomegaly with dilated left atrium, bilateral mild pleural effusions in the same patient

Licensed Under Creative Commons Attribution CC BY

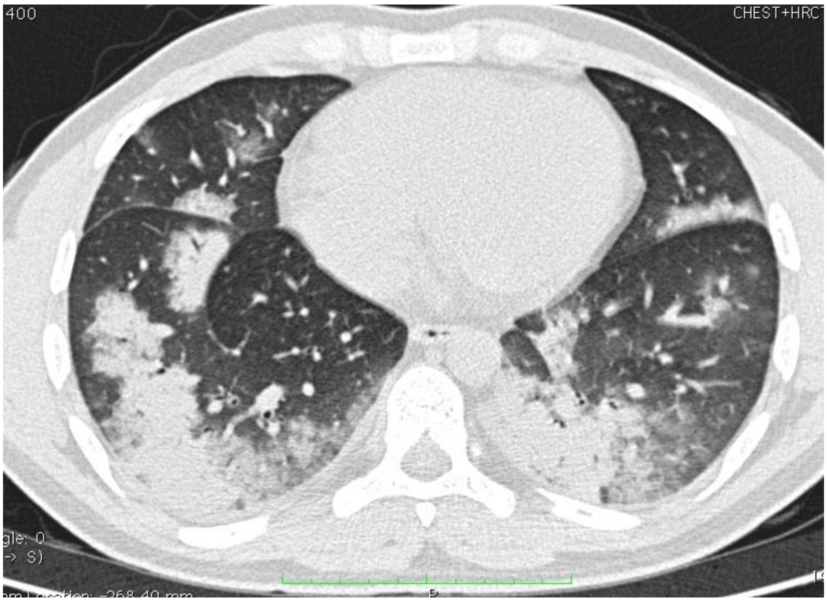

Figure 1

Figure 2

Figure 3

Licensed Under Creative Commons Attribution CC BY

ISSN: 2319-7064
SJIF (2022): 7.942

Figure 4

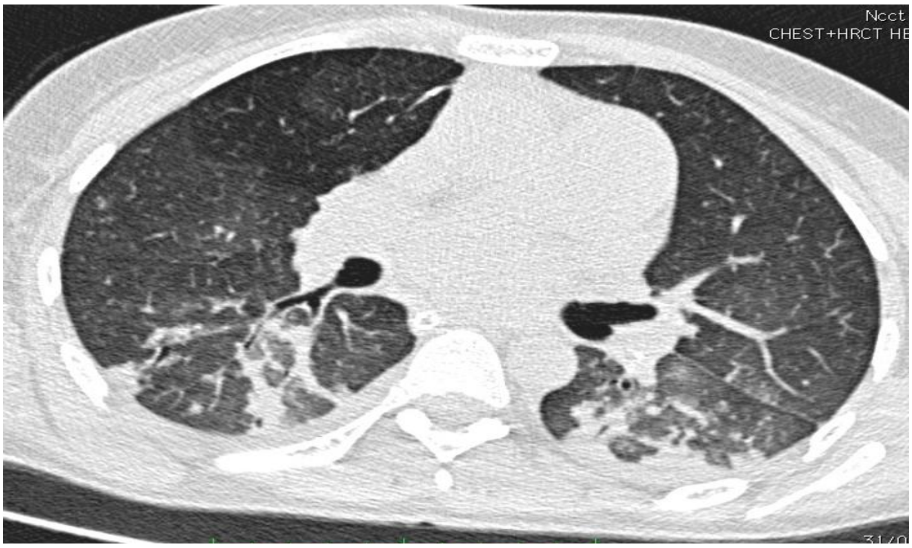

Figure 5 (A)

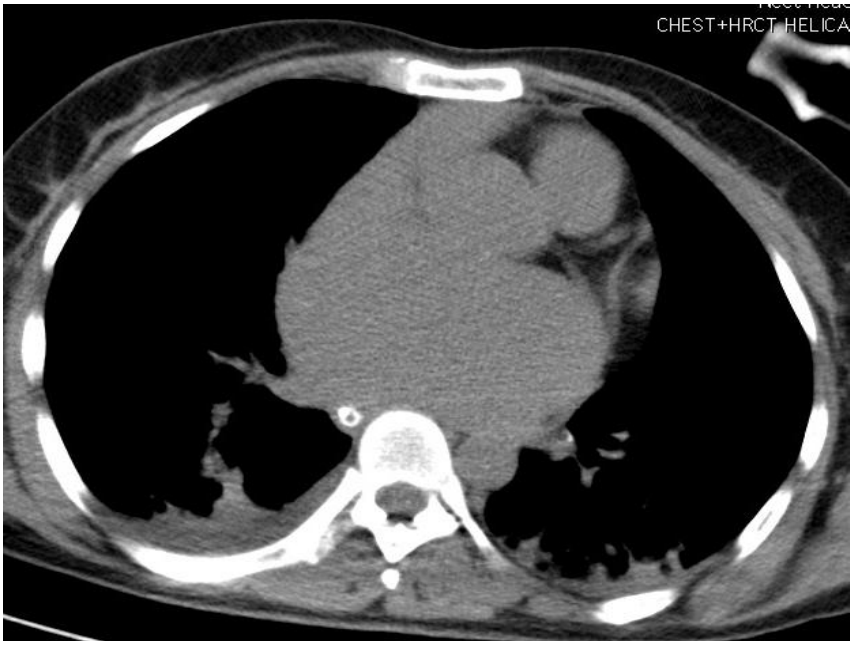

Figure 5 (B)

Licensed Under Creative Commons Attribution CC BY
Paper ID: SR22718005733 DOI: 10.21275/SR22718005733

Author Profile

Gurpreet Makkar, Consultant, Department of Radiology, Artemis Hospital, Gurugram, India

Sanjay Mehta, Director, Department of Radiology, Artemis Hospital, Gurugram, India

Ankur Gulati, DNB Resident, Department of Radiology, Artemis Hospital, Gurugram, India

Table 1: COVID-19 Reporting and Data System (Corads) [12]

CORADS	Level of suspicion	HRCT features
1	Very low suspicion	Normal or noninfectious
2	Low suspicion	Typical for other infection (non covid)
3	Equivocal	Features compatible with COVID-19 and also other diseases
4	High suspicion	COVID-19 features with loss of contact with visceral pleura /peribronchovascular /unilateral disease / superimposed on other disease
5	Very high suspicion	Typical for COVID-19 with bilateral multifocal sub pleural GGOs and /or consolidation
6	Proven	Already proven RT-PCR positive for SARS –Cov-2

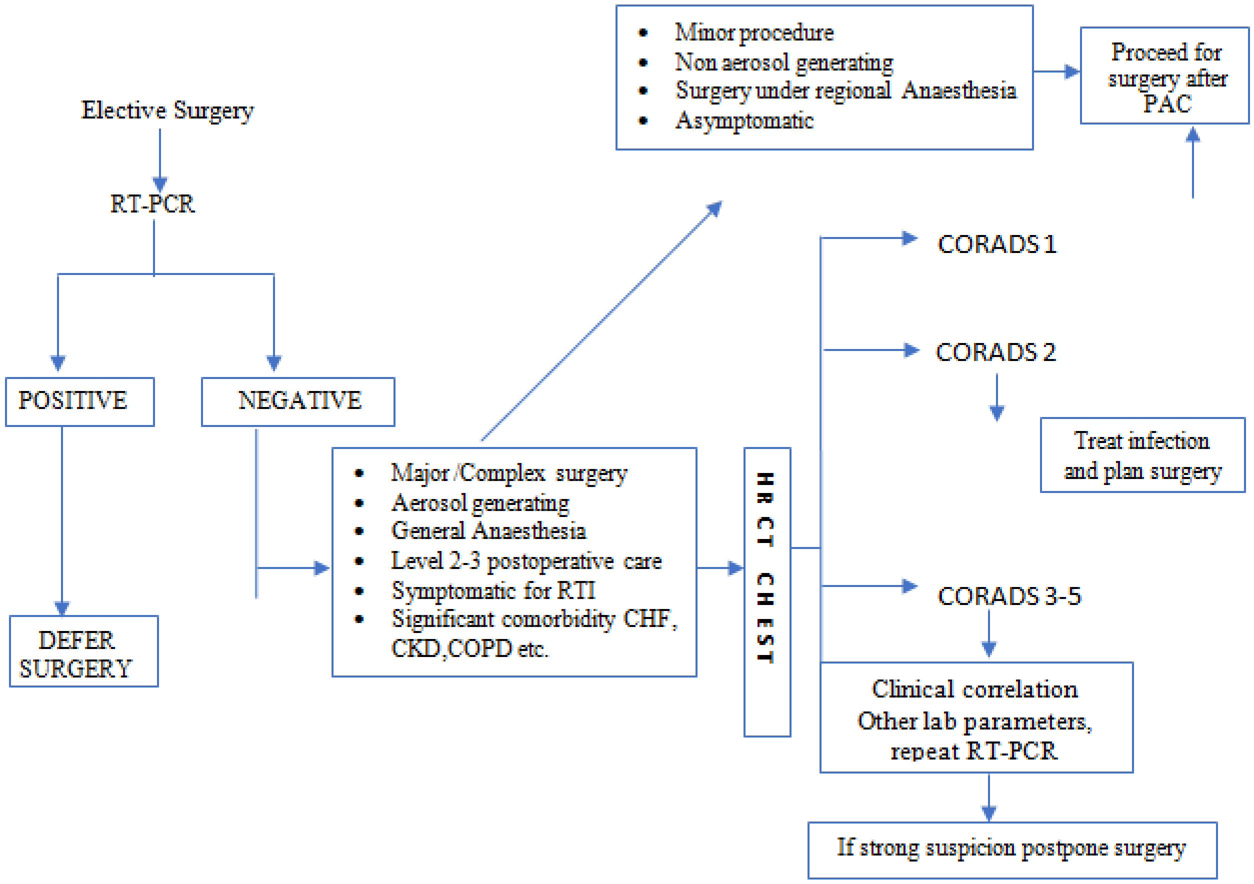

Table 2: Suggested Pre-Surgical Protocol for COVID-19 Screening

Licensed Under Creative Commons Attribution CC BY