Role of CT Chest in Covid-19 - A White Paper from the Society of Chest Imaging and Intervention (SCII)

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Introduction

SARS-CoV-2 has upended the world. In the early days of the pandemic, it was difficult to test and diagnose the disease in many parts of the world including India, a problem that has more or less been solved with widespread RT-PCR testing available in most parts of the country.

While the gold-standard for diagnosis of Covid-19 is RT-PCR testing, many publications starting with those published in January 2020[1][2] have shown that CT scan plays a role in the diagnosis [3][4] management [5][6][7]and follow-up [8][9]of patients with Covid-19.

India, in April 2021, is in the throes of a second pandemic that is proving to be worse than the first one last year[10]. Compared to most Western countries, CT scan has become a de facto modality for patients with suspected or proven Covid-19 [11] . Most of these scans are not indicated and the irrational use of the CT scans is placing an economic, logistical and eventually an overall increased radiation burden on society. This can also have an adverse psychological effect when coupled with the use of other unnecessary tests [12]. Unfortunately,

there are no clear guidelines from any major society or body including the ICMR on the role of CT scan in Covid-19.

The Society of Chest Imaging and Intervention (SCII) believes that it is time there was clarity on the use of CT scan in Covid-19 patients. This white paper uses a combination of data from multiple observational studies, and a deep understanding of the pros and cons of this modality among the members of SCII who have a combined experience of more than 200 years practicing thoracic radiology, to arrive at the recommendations that have been made below.

The indications for CT scan in Covid-19 can be broadly classified into those for
1. Diagnosis
2. Management
3. Follow-Up

1. Diagnosis

The main abuse of CT scan is in the diagnosis of Covid-19. This is primarily because last year when RT-PCR testing was limited and controlled, CT scan became the de facto modality to diagnose Covid-19 in the community at large.

CT scan has been found useful in the diagnosis of Covid-19 in multiple countries, where RT-PCR testing is/was not available or the results are/were not immediately available, especially in symptomatic patients [13] [14] [15]. But where RT-PCR testing is available, CT scan has been used judiciously and only in specific instances

The role of CT scan in the diagnosis of Covid-19 should be restricted to the following scenarios.
1. Moderate to severe symptomatic patients (breathlessness, falling O2 saturations) suspected to have Covid-19 for quick triage. Cough is NOT an indication.
2. Asymptomatic to minimally symptomatic patients, ONLY when
    a. RT-PCR testing not available
    b. RT-PCR testing is available but results are delayed due to backlog or logistical issues by more than 48 hours and the delay will change the way the patient is managed.
3. High clinical suspicion of Covid-19 but a negative RT-PCR report, where the findings of the CT scan will make a difference to management.
4. Other unique or individual situations, e.g. a patient has to undergo emergency surgery and RT-PCR testing or rapid testing is not available or the results will not be available in time and the delay will change management. However, the routine use of CT scan as a pre-admission or pre-surgical test in non-emergency situations is strongly discouraged.

The idea is not to infringe on clinical decision making (e.g. a physician may want a CT scan in an asymptomatic or minimally symptomatic patient who has significant co-morbidities), but to reduce the rate of unnecessary CT scans done as a routine test in people, just because they are suspected to or have Covid-19, or just because patients demand that CT scans

should be done because they have been led to believe via social media that the information from CT scans makes a difference.

CT scan may have up to a 30% false negative rate[4] [16], which means that a negative CT scan does not rule out Covid-19. CT scan also has a false positive rate of between 10-30%[11] [17] depending on the presence of other forms of disease that simulate Covid-19, the quality of the scans and the experience and expertise of the reading radiologists[4] [18]. Hence, a positive CT scan does not automatically mean that a patient has Covid-19.

All reports should include a confidence denominator. While the RSNA Consensus Statement [19]is simple, the CO-RADS grading system [20] (Fig. 1) has become widespread in India. A CO-RADS category should be mentioned in the report when the patient is specifically scanned for Covid-19. However, in all other patients who undergo CT scans for other indications, writing down a CO-RADS 1 or 2 category is not needed and makes no sense.

| CO-RADS 1 | CO-RADS 2 | CO-RADS 3 |
| CO-RADS 4 | CO-RADS 4 | CO-RADS 5 |
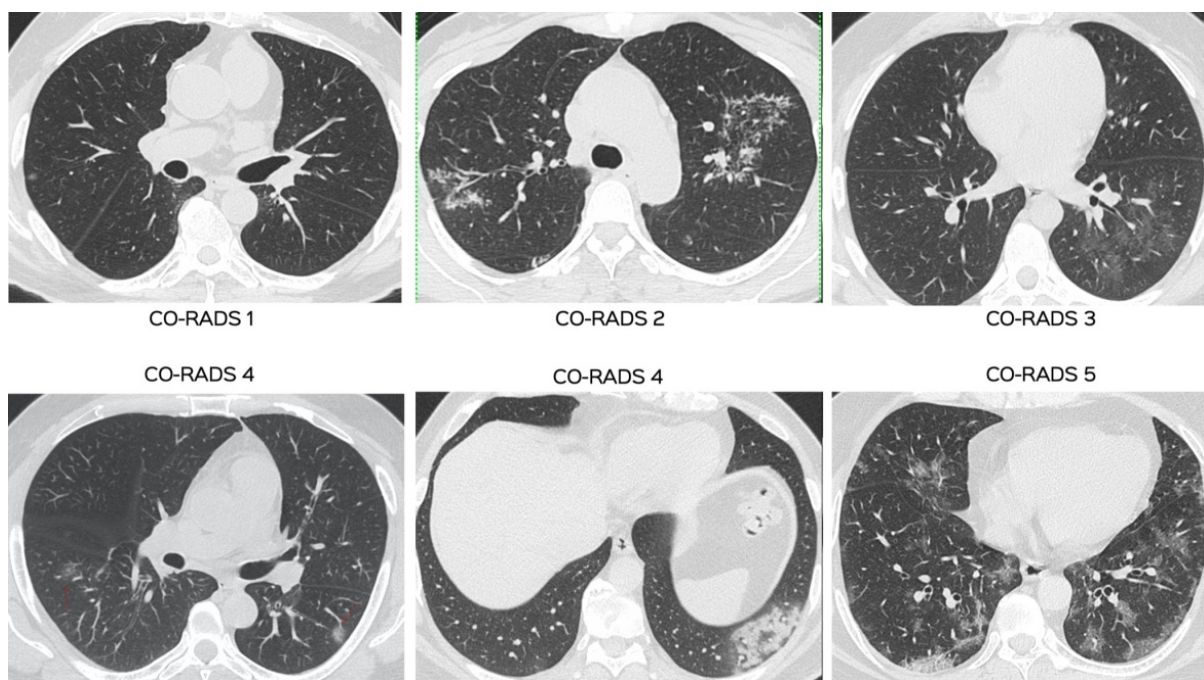
2. Management

CT scan is useful for triaging patients who have breathlessness and falling O2 saturations, but is not indicated as a routine test in patients just to check severity of disease or as part of any routine protocol.

CT Severity Scores and Methods

Visual Scoring

The extent of disease can be scored to help decide on the aggressiveness of treatment required. One popular method is a visual scoring system developed first by Pan et al[21] which assigns a score of 0 to 5 to each of the 5 lobes of the lungs based on the extent of lung involvement (no involvement - 0, < 5 % involvement - 1, 6-25% - 2, 26-50% - 3, 51-75% - 4 and >75% - 5) (Fig 2). Hence the severity score (which is truly an "extent of involvement"
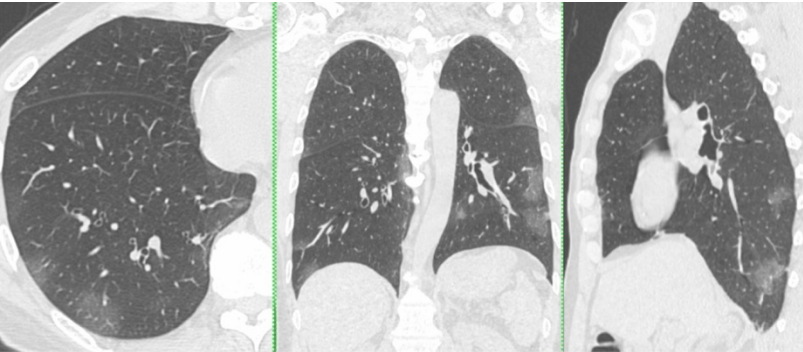
score) is out of 25. Studies have shown that a score > 18 is associated with worse outcomes[6].
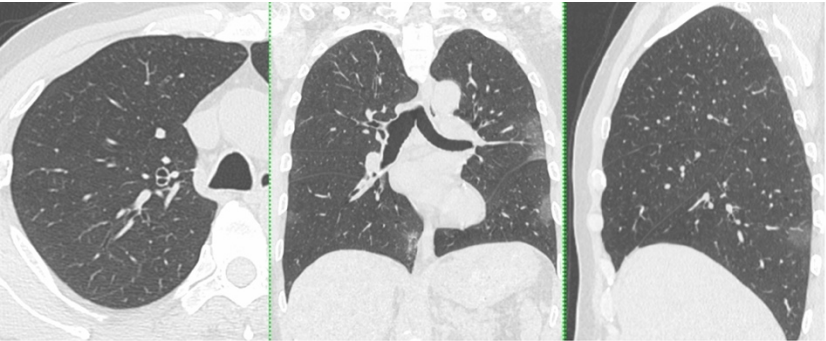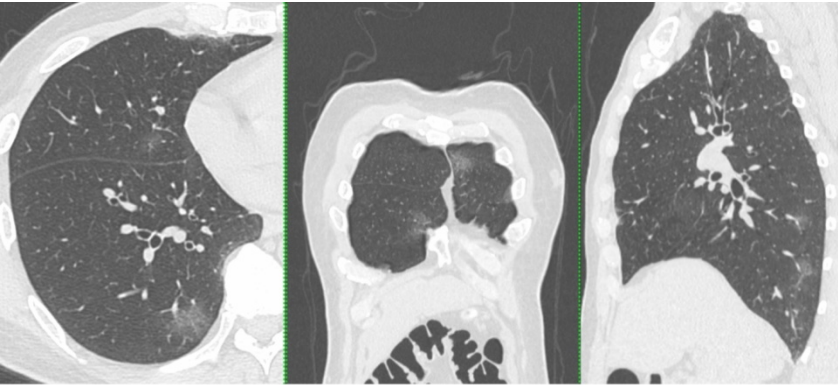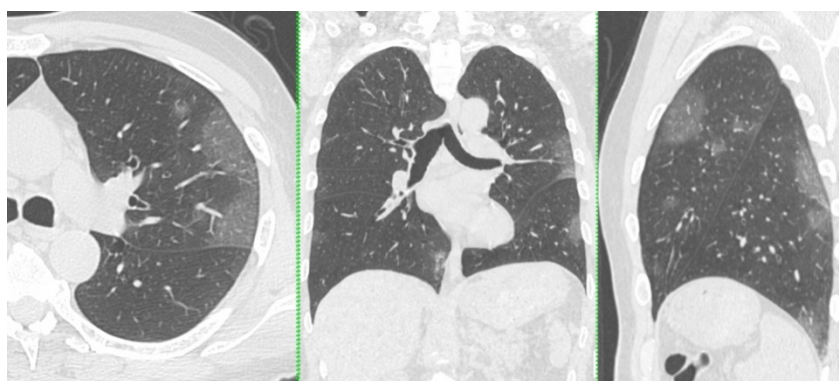

Lobe	Percent Involvement	Score
RUL	0	0

RUL – Not involved - 0

Lobe	Percent Involvement	Score
RUL	0	0
RML	0-5%	1

RML – 0-5% - 1

Lobe	Percent Involvement	Score
RUL	0	0
RML	0-5%	1
RLL	5-25%	2

RLL – 5-25% - 2

LUL & lingula – 5-25% - 2

Lobe	Percent Involvement	Score
RUL	0	0
RML	0-5%	1
RLL	5-25%	2
LUL & lingula	5-25%	2

LLL – 26-49% - 3

Final Score – 8/25

Lobe	Percent Involvement	Score
RUL	0	0
RML	0-5%	1
RLL	5-25%	2
LUL & lingula	5-25%	2
LLL	26-49%	3

While we acknowledge that the CTSI is a crude score (e.g. 10% involvement each lobe of the lungs will score 2 per lobe = 10/25 and 20% involvement will also score 10/25), it is in widespread use and physicians and radiologists across the country understand the concept and its relevance and hence its use should continue. It is not a good idea for individual radiologists or institutes to adopt alternate scores, since this will only lead to chaos and confusion.

It is also known that the pattern of disease matters. The presence of consolidation earlier on in the disease is an adverse factor as against just the presence of just ground glass [22], but the clinical relevance of this in patient management has to be decided by the treating physician. There are no robust scoring systems that incorporate the pattern of involvement and those that have been proposed are too complicated and not validated.

Automated Scoring

There are many automated methods (e.g. Predible, etc) that use either texture based techniques or artificial intelligence. Though they may have technical validation, none of them has been validated in practice and we recommend they not be used.

Indications

CT scan is not indicated for routine management of patients[23] [24] [25]. There are no protocols[21] [26] [27]that dictate scanning at day 0, 3, 6, 9 days, etc. and at discharge, a practice apparently followed by many hospitals across the country.

CT scan is indicated when there is a true clinical need to understand the extent and severity of disease when the patient is symptomatic or when symptoms are worsening, and when the findings on the CT scan, as against on radiographs make a difference to management[7] [23]. The type of scan to be done (See Protocol below) will therefore depend on the clinical situation - e.g. if pulmonary thrombosis or embolism is suspected, then a CT pulmonary angiogram will need to be done. CT scan is also indicated when there is high clinical suspicion of co-existing disease such as tuberculosis or interstitial lung disease that may make a difference to the management of the patient[28] [29] [30]

The decision of whether to scan and when to scan is best left to the treating doctor's clinical judgement, but as a rule, CT scan should be used only when needed and not as a routine test to be done as per some "routine protocol" (there is no acceptable routine protocol that incorporates the use of routine CT scan). It would be best for treating physicians to look up national guidelines of their respective physician/intensive care/pulmonology societies and if these don't exist, then international guidelines[24] [25] [31]for the appropriate use of CT scan in specific clinical situations.

3. Follow-up

It is now well known that the expected tsunami of post-Covid fibrosis [32] may not be the norm in most patients. Follow-up data from the first SARS epidemic[33] show that after 6 months[34] [35]most lung lesions regress and after 84 months (7 years)[34] virtually no lung lesion is seen in most patients.

Follow up scans after 6 and 9 months in the current pandemic[8] have also shown a similar temporal course in most patients, unless the patient has been mechanically ventilated or suffered from severe ARDS or superimposed infection[36] .

The routine use of follow-up CT scan is discouraged unless there is a specific clinical indication[37] [38] (e.g. patient not improving or desaturating or PFTs that don't improve or worsen).

There is also increasing evidence that there are significant perfusion changes in the lungs with Covid-19, due to endothelial damage[39] [40]. Many studies have shown reduced blood flow as well as perfusion defects in the absence of pulmonary thrombosis[7] [39] . However the routine use of DECT to assess these perfusion defects is discouraged, unless there is a strong clinical need.

In short, follow-up scans are left to the discretion of the treating doctor, are not indicated for routine follow-up but only when the patient is not improving as expected or is deteriorating.

Scan Protocol

For diagnosis and staging
One single volume end-inspiratory scan reconstructed at 1 or 1.25 mm at 0.5 to 1.25 mm contiguous or overlapping intervals, reconstructed in high resolution (e.g. B70 Siemens), but not in ultra-high resolution.

In case thrombosis or thromboembolism is suspected, then a CT pulmonary angiogram (CTPA) study may be performed using a standard CTPA protocol. Most of these patients are likely to have moderate to severe clinical disease and hence most CTPAs are likely to be done only in hospitals.

For Follow-up
CT scan with an ILD protocol with supine volume inspiratory and expiratory images. Prone inspiratory images if there is disease that needs further characterization.

If needed for the evaluation of perfusion defects, then a CTPA with dual energy may be performed.

Points to be Covered in the Report

1. Pattern of disease
   A narrative description on the pattern (ground glass, consolidation, reticular opacities and band-like opacities)
2. Extent of disease (CT Severity Score out of 25)
3. Superimposed complication
   This would imply any lesion that is out of context, e.g. superimposed consolidation or cavitation that suggests superadded infection
4. Additional lung findings
   Old infection, bronchiectasis, cysts and other lesions that either pre-existing or not related to Covid-19 including pre-existing interstitial abnormalities
5. Mediastinum (lymph nodes, pericardial thickening), hila (lymph nodes), pleura (pleural thickening, effusion), chest wall (rib, spine lesions, osteoporosis)
6. Additional findings
   Coronary calcium, abdominal - e.g. fatty liver, renal calculi
7. MPA diameter (this is not an absolute necessity)
8. CO-RADS grade (4,5). If Covid-19 is not seen, then to say that there is no CT scan finding suggestive of Covid-19 or that the findings are equivocal.

Summary

CT Scan Indications

1. **Diagnosis**
   a. Moderate to severe symptomatic patients (breathlessness, falling O2 saturations) suspected to have Covid-19 for quick triage. Cough is NOT an indication.
   b. Asymptomatic to minimally symptomatic patients, only when
      i. RT-PCR testing not available
      ii. RT-PCR testing is available but results are delayed due to backlog or logistical issues by more than 48 hours and the delay will change the way the patient is managed.
   c. High clinical suspicion of Covid-19 but a negative RT-PCR report, where the findings of the CT scan will make a difference to management.
   d. Other unique or individual situations, e.g. a patient has to undergo emergency surgery and RT-PCR testing or rapid testing is not available or the results will not be available in time and the delay will change management. However, the routine use of CT scan as a pre-admission or pre-surgical test in non-emergency situations is strongly discouraged.

2. **Management**
   a. The patient is symptomatic or symptoms are worsening, and the findings on the CT scan, as against on radiographs, make a difference to management
   b. High clinical suspicion of co-existing disease such as tuberculosis or interstitial lung disease that would make a difference to the management of the patient
   c. Any other clinical scenario where the findings on the CT scan are likely to make a tangible difference to management

3. **Follow-Up**
   a. Specific clinical situation (patient not improving, worsening, symptomatically or on PFTs)
   b. Any other clinical scenario where the findings on the CT scan are likely to make a tangible difference to management

CT scan - Non-Indications
1. **Diagnosis**
   a. Routine evaluation of the lungs in asymptomatic, minimally symptomatic patients. Cough is not an indication
   b. Routine pre-admission or pre-surgical evaluation when RT-PCR testing is available
   c. Patient/relatives wanting/demanding a CT scan to check status of lungs
2. **Management**
   a. Routine evaluation as part of a routine protocol
   b. Patient/relatives wanting regular check CT scans
3. **Follow-up**
   a. Routine follow-up to check the status of the lungs
   b. Patient/relatives wanting to check the status of the lungs

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