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Imaging of COVID-19 Pneumonia

Review of recent literature (published and in press)

Updated 1 March 2020

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Introduction

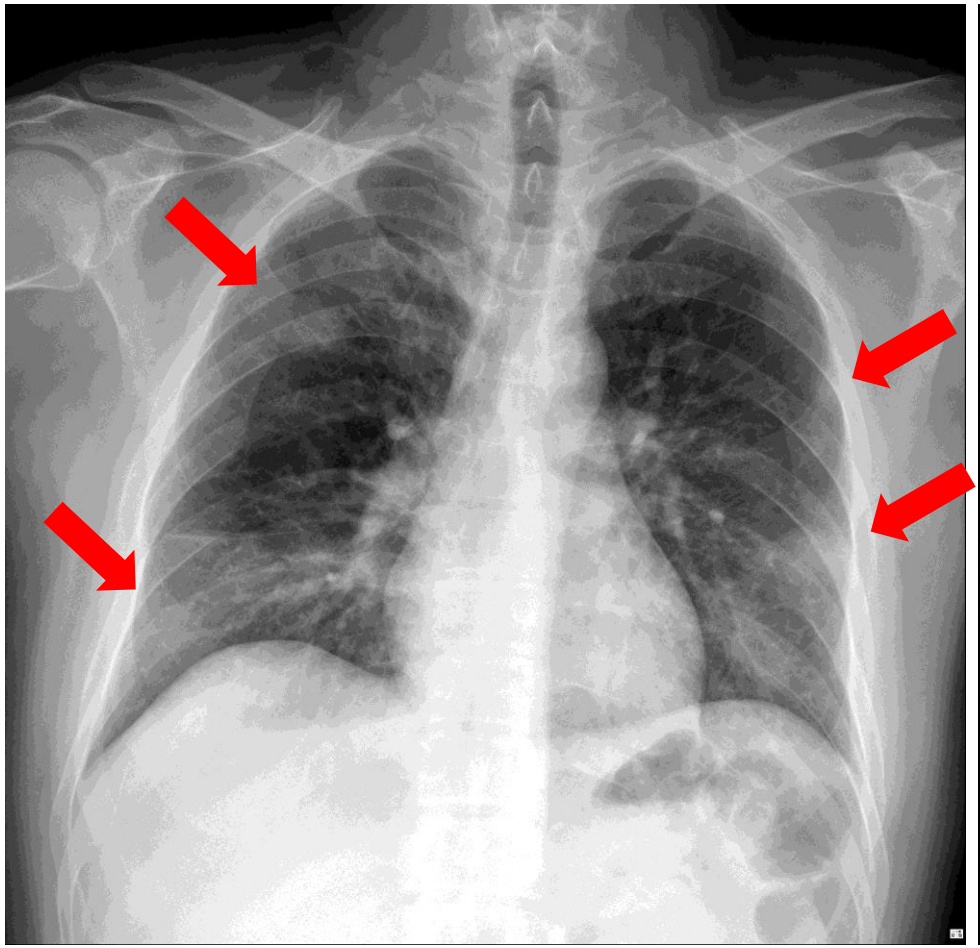
- This deck of slides reviews recent published literature on imaging of COVID-19 pneumonia
- The intention is to share the current findings which may help clinicians better understand the use of imaging in diagnosing and managing COVID-19 pneumonia
- The findings and research continue to evolve and may be superseded at the time of reading

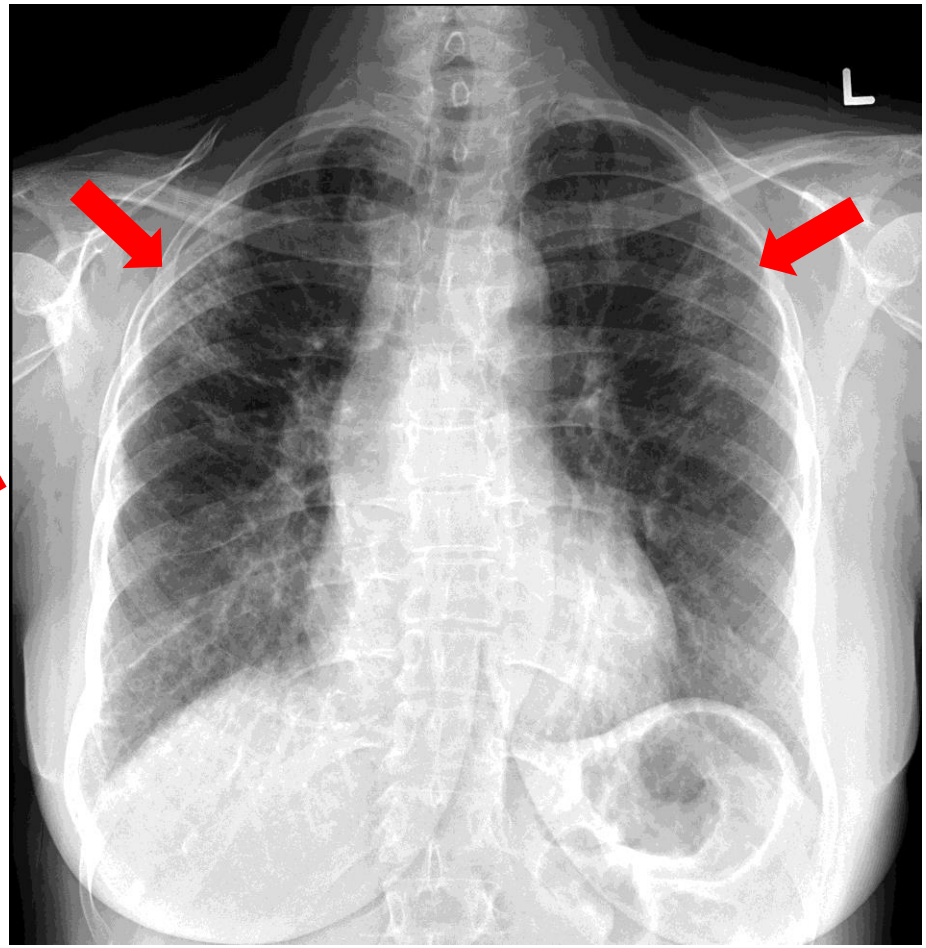
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1 March 2020

Chest Radiograph (CXR)

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Consolidation, multifocal and bilateral





Chest Radiograph (CXR)

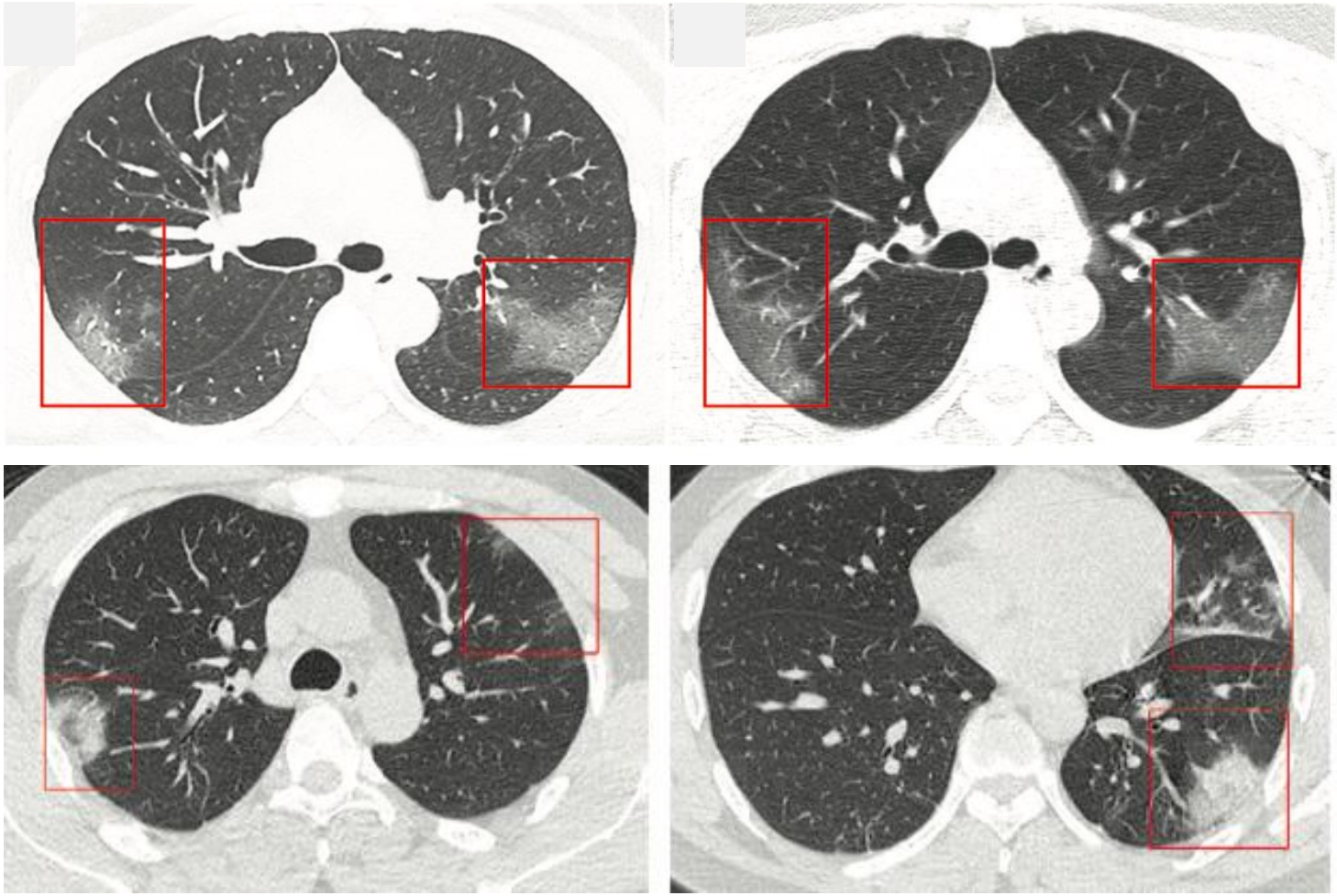
- **Consolidation, typically multifocal and bilateral**
  - may be unilateral
  - pleural effusions are uncommon

- **CXR may be normal**
  - 50% of the 1st 18 cases in Singapore had normal CXR
    (from MOH Circular No. 50/2020)
  - CXR is less sensitive than CT: ground-glass and consolidation visible on CT may be undetectable on CXR

Chest CT – Main Findings

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Ground glass with/ without Consolidation



Lei et al. CT Imaging of the 2019 Novel Coronavirus Pneumonia. https://doi.org/10.1148/radiol.2020200236
Huang P et al. Use of chest CT in combination with negative RT-PCR assay for the 2019 novel coronavirus but high clinical suspicion. https://doi.org/10.1148/radiol.2020200330

Chest CT – Main Findings

- **Ground glass opacities (GGO)** (79 – 86%)
  - may have septal lines/crazy paving
- **Consolidation** (29 - 62%)

- **Bilateral** and **multifocal, peripheral** distribution
- **Lower zone** predominance

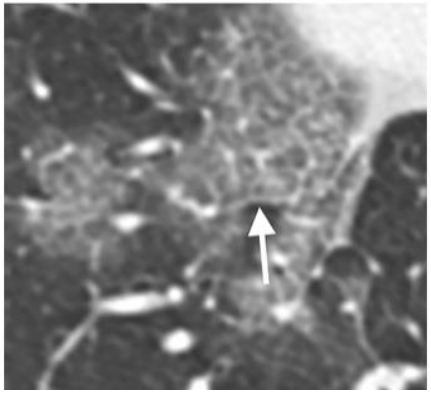
- *Cavitation*
- *Nodules*
- *Pleural effusions*
- *Lymphadenopathy*

} **Uncommon**

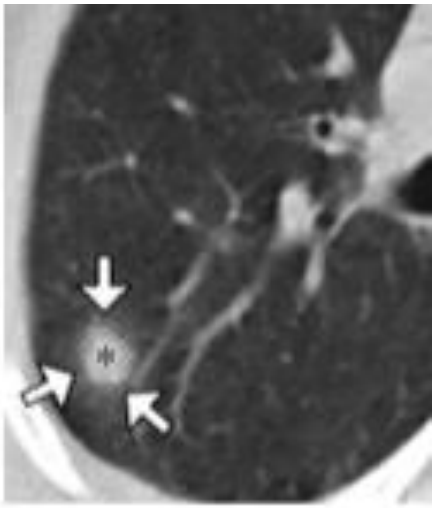
Chest CT – Spectrum of Findings

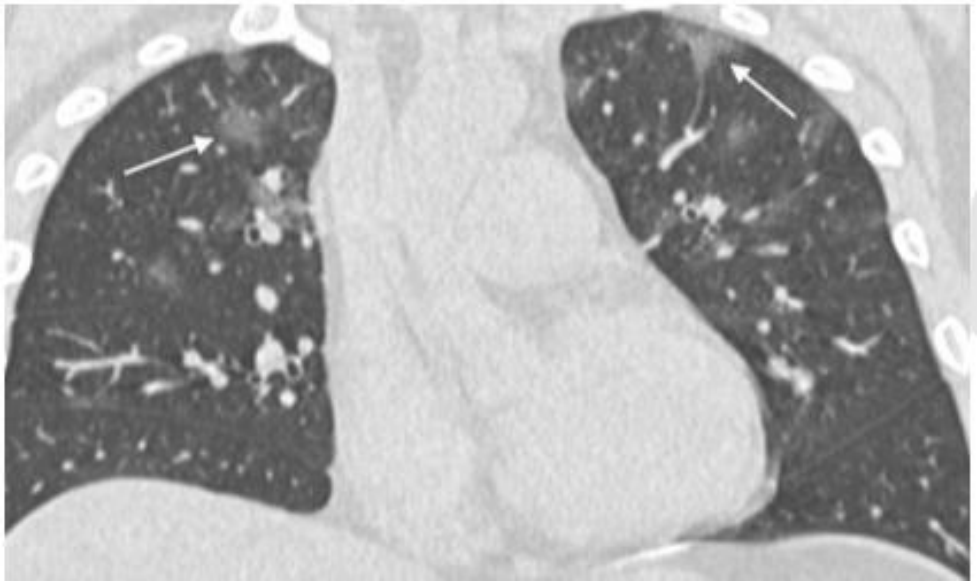
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Crazy-paving



CT halo sign





Ground glass opacities with rounded morphology

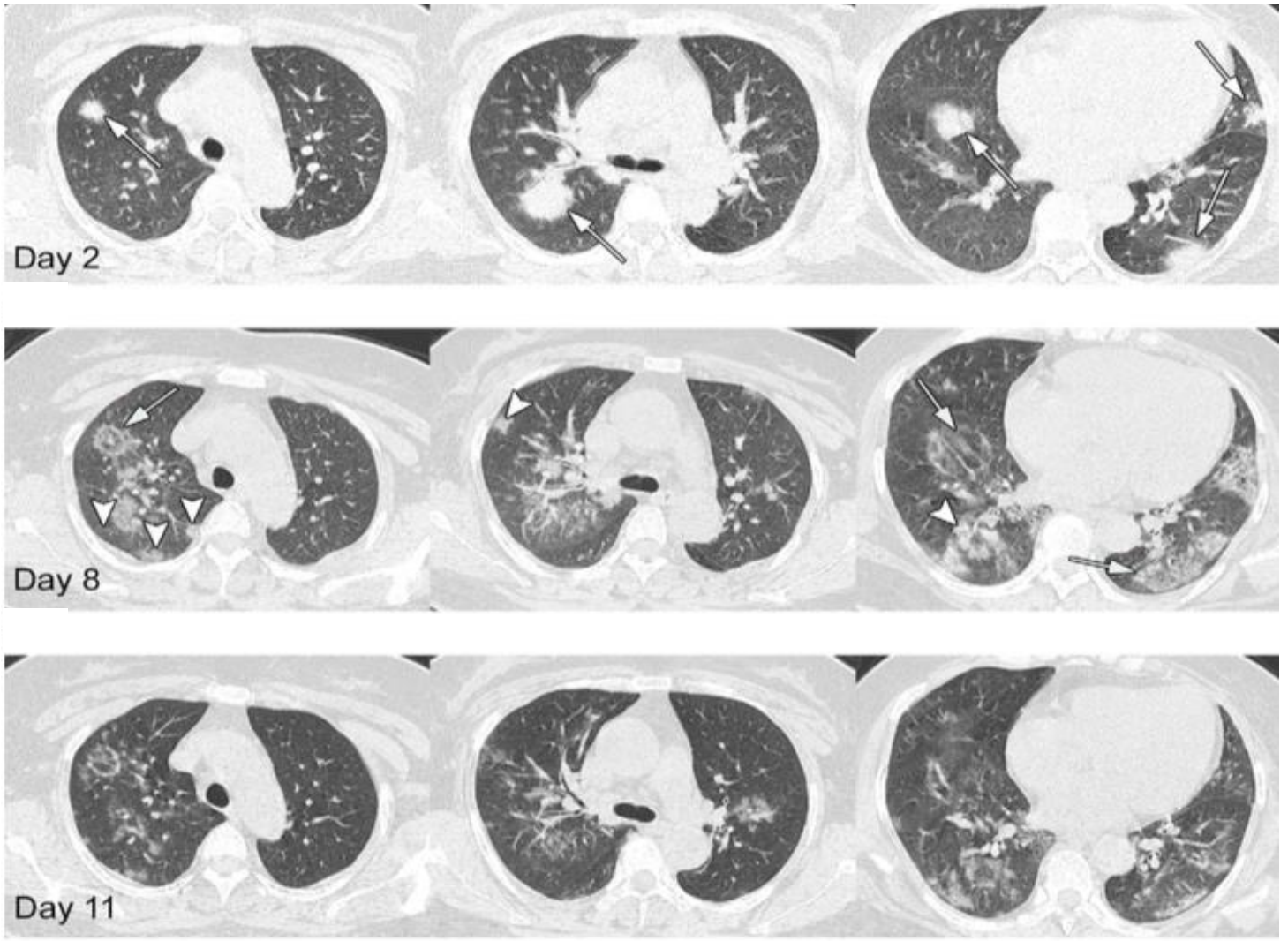
Chung et al. CT imaging features of 2019 novel coronavirus https://doi.org/10.1148/radiol.2020200230
Li X et al. COVID-19 Infection Presenting with CT Halo Sign https://doi.org/10.1148/ryct.2020200026

Chest CT – Spectrum of Findings

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Nodules

Reversed halo sign



Wu et al. Longitudinal CT Findings in COVID-19 Pneumonia: Case Presenting Organizing Pneumonia Pattern https://doi.org/10.1148/ryct.2020200031

Chest CT – Spectrum of Findings

- **Superimposed infections may occur**
  - esp. severely ill patients (*bacteria and fungi e.g. K pneumoniae, A flavus, C albicans)*
- **May progress to ARDS**
  - extensive consolidation and ground-glass opacity



Patient admitted to ICU with diffuse GG and consolidation

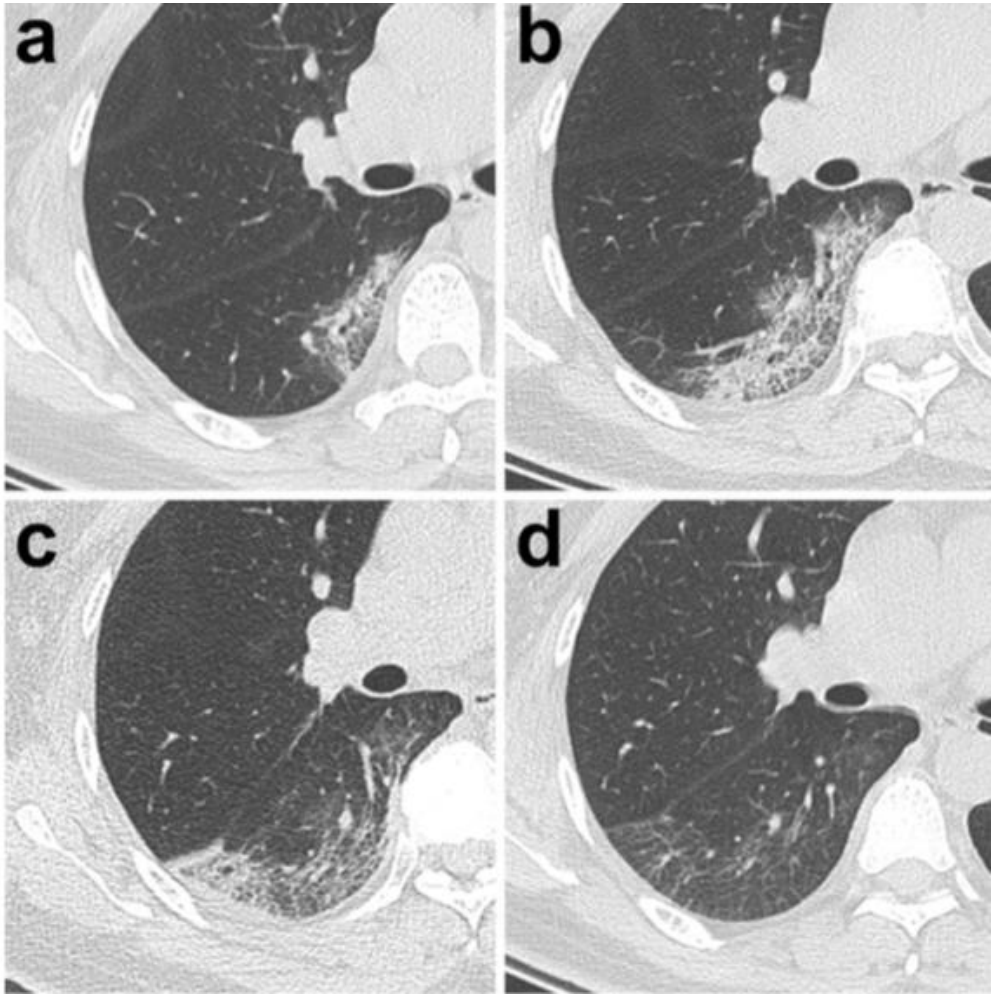
Chung et al. CT imaging features of 2019 novel coronavirus https://doi.org/10.1148/radiol.2020200230

Chest CT – Time course of lung changes

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In patients **recovered** from COVID-19 pneumonia**:**

- Subpleural **GGO** enlarging with **crazy-paving pattern and consolidation**
- Peak around **9-13 days**
- Gradual improvement leaving **GGO** and **parenchymal bands**



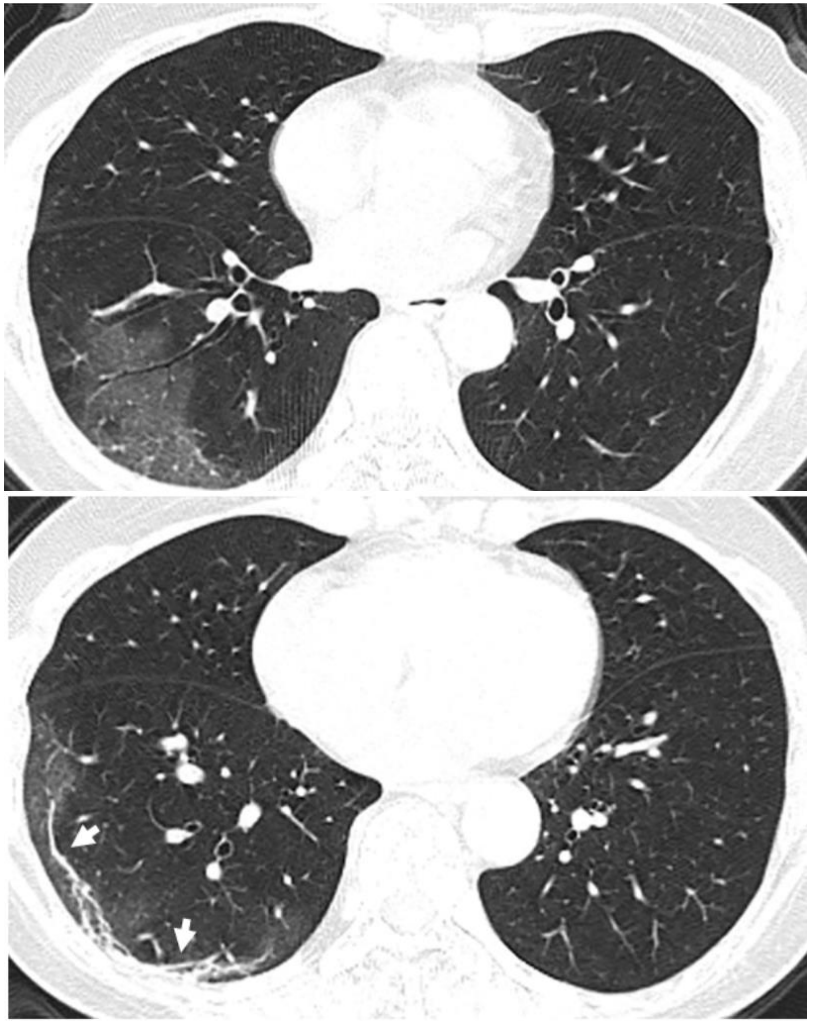
Pan et al. Time Course of Lung Changes On Chest CT During Recovery From 2019 Novel Coronavirus (COVID-19) Pneumonia. https://doi.org/10.1148/radiol.2020200370

Chest CT – Time course of lung changes

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- Subpleural **GGO**

- Gradual improvement leaving **GGO** and **parenchymal bands**



Kong et al. Chest Imaging Appearance of COVID-19 Infection - Case Series
https://doi.org/10.1148/ryct.2020200028

Normal Chest CT

- Chest CT may be **normal**, particularly in **early stages**

  Wide range reported in studies from **4% - 50**%
  - Different study designs
  - Probable selection bias

- Thus, normal Chest CT **does not rule out** COVID- 19 infection.

Pan et al. Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia. https://doi.org/10.1148/radiol.2020200370

Xie et al. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. https://doi.org/10.1148/radiol.2020200343

Chung et al. CT imaging features of 2019 novel coronavirus https://doi.org/10.1148/radiol.2020200230

Bernheim et al. Chest CT Findings in Coronavirus Disease-19 (COVID-19): Relationship to Duration of Infection https://doi.org/10.1148/radiol.2020200463

Diagnosis of COVD-19 Infection

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RT-PCR

Pros:

- **real-time reverse transcriptase polymerase chain reaction (RT-PCR)** for COVID-19 remains **the reference standard**

Cons:

- **False negative rates** may be affected by:
  - *immature development of nucleic acid detection technology*
  - *variation in detection rate from different manufacturers*
  - *sampling errors*
  - *low virus load*
- **Limited number of RT-PCR kits** (in some centres / countries)
- **Longer wait for results** (compared to Chest CT)

Chest CT

Pros:

- **Easy to perform and fast, without iv contrast**
- **Typical CT features established:**
  - *ground-glass opacities +/- consolidation, usually bilateral, multifocal, and peripheral*
- **Detect early phase lung infection with negative RT-PCR results (3-22%)**
  - ***Sensitivity of CT 98% and RT-PCR 71%*** *for COVID-19 infection (p<.001)*
- **Assess severity /monitor progression of infection**

Cons:

- Chest CT may be normal, in early stage **(4-50%)**
- Ionising radiation

SUMMARY

- Chest CT plays a role in **early detection** and **disease evaluation** to guide clinical management.

- **Low dose chest CT** without iv contrast may be performed.
  (Since the CT findings are mainly parenchymal changes)

- In the **correct clinical setting** or in **endemic areas, bilateral ground-glass opacities or consolidation** on chest CT suggest diagnosis of COVID-19 infection, *even with **negative** RT-PCR test.*

- However, **normal chest CT does not exclude the diagnosis of COVID-19 infection.**

Further Work

- CT findings suggest **Organizing Pneumonia** pattern of lung injury.
- Analysis of CT findings and severity (from normal to severe pneumonia and ARDS) to identify **potential imaging predictors** of outcome.
- Evaluation of **pattern of chronic radiologic findings**, and **detailed histopathology** to better understand the disease process and spectrum of radiologic features.

References

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