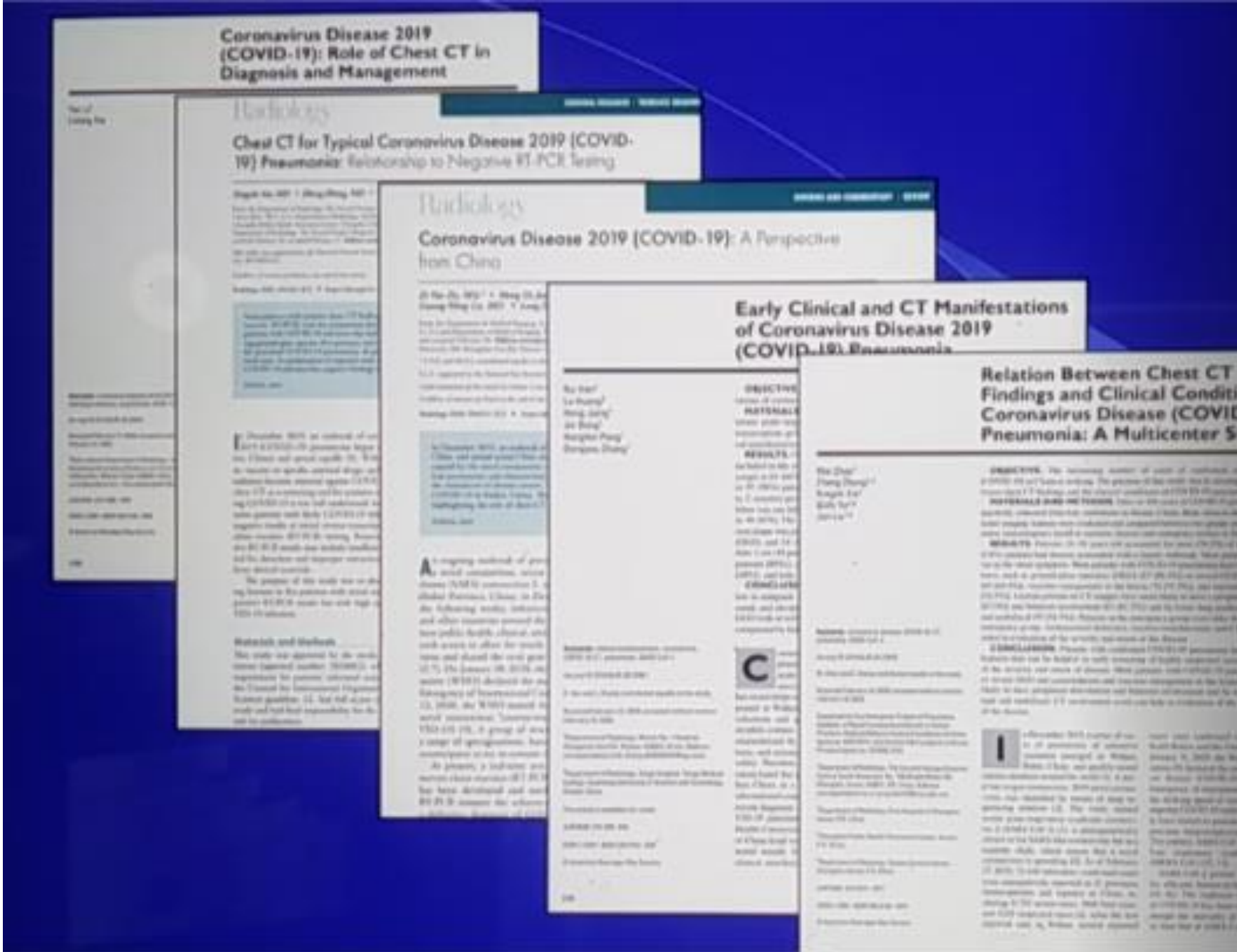


# Radiologische Zeichen von COVID-19

Zur Diagnose der Erkrankung und zur Steuerung von  
Antibiotika- und antifungaler Therapie



Es gibt inzwischen zahlreiche Publikationen und viel Literatur.

Bei der folgenden Aufstellung fließen auch eigene Erfahrungen mit der COVID-Erkrankung von uns ein.

Ein Schwerpunkt liegt auf dem Erkennen von Risiken von und für Superinfektionen (bakteriell und Pilzerkrankungen).

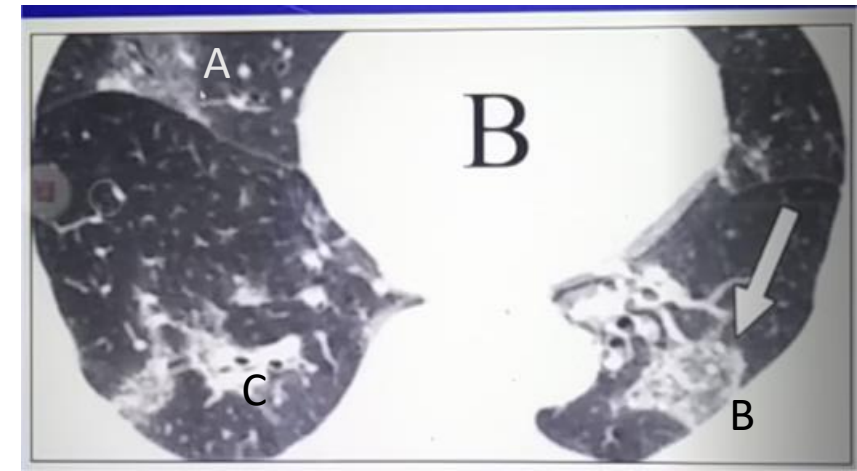
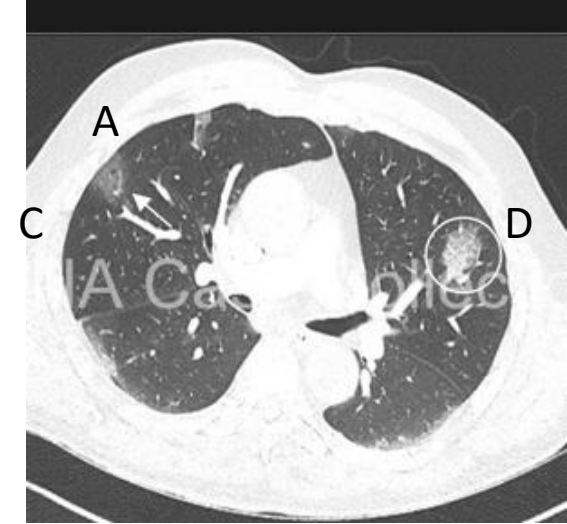
*Insbesondere der Verlauf der Erkrankung bedarf noch der Beobachtung. Oft sind strukturelle Veränderungen schon frühzeitig vorhanden.*

*Wegen des Infektions-Risikos für das Personal wurde auf häufige Verlaufs-CT-Untersuchungen verzichtet. Das kann oder wird sich nach Beginn von Personal-Impfungen sicherlich ändern.*

# Begriffsbestimmungen

## Einfache, unkomplizierte COVID-19-typische Veränderungen:

1. (A) Ground-Glass-Opacity („GGO“) - Milchglastrübung
2. (B) Reversed Halo-Sign - umgekehrtes Halo-Zeichen
3. (C) Vascular Dilatation - Gefäßerweiterungen
4. (D) Crazy Paving - verstärkte Interlobär-Zeichnung mit GGO-Trübung



Definitions of radiological terms like ground glass opacity (GGO), crazy-paving pattern, and pulmonary consolidation were based on the standard glossary for thoracic imaging reported by the Fleischner Society [12].

# Radiology

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**Reviews and Commentary**  
**Special Review**



## Fleischner Society: Glossary of Terms for Thoracic Imaging

David M. Hansell, Alexander A. Bankier, Heber MacMahon, Theresa C. McCloud, Nestor L. Müller, Jacques Remy

▼ [Author Affiliations](#)

**Published Online:** Mar 1 2008 | <https://doi.org/10.1148/radiol.2462070712>

## Ground-Glass-Opacity (GGO) – Milchglastrübung

**Ein Gebiet mit verstärkter Dichte mit verwaschenem Rand, welches aber nicht die bronchialen und vaskulären Ränder verändert.**

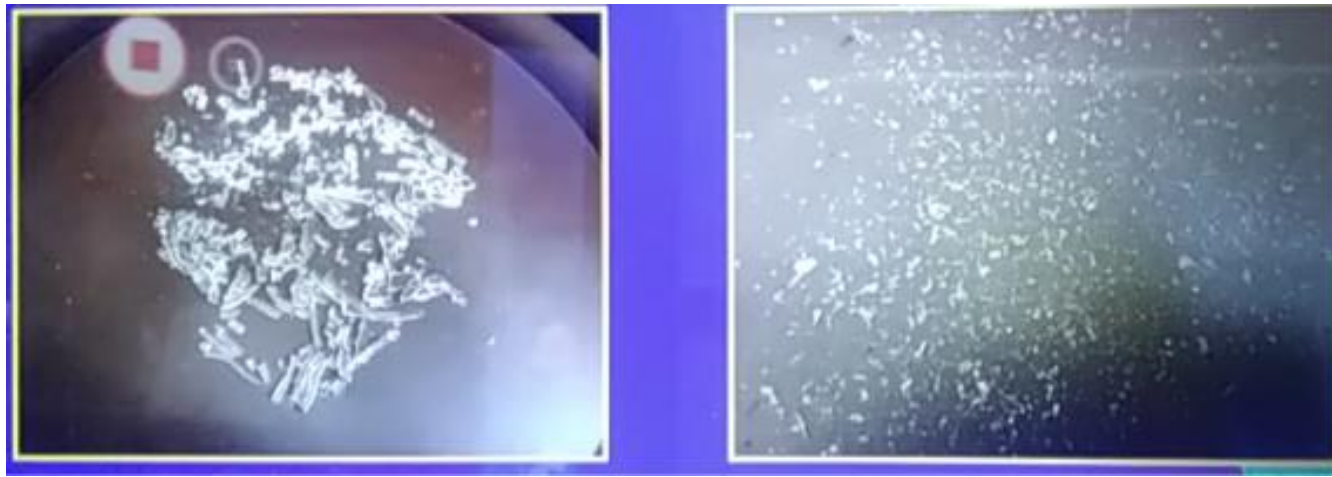
*Das erst-beschriebene, häufigste, wichtigste und einfachste radiologische Zeichen für COVID-19, das für alle Nicht-Radiologen auch in der Notfallbetreuung bekannt sein sollte. Auch bei geringer Erfahrung der Interpretation von CT-Bildern.*

Das Zeichen sollte genügend Hinweis auch für den Nicht-Facharzt sein, den Verdacht auf COVID-19 auszusprechen.

*Die Empfindlichkeit der Diagnostik soll fast „einem PCR-Test“ entsprechen.*

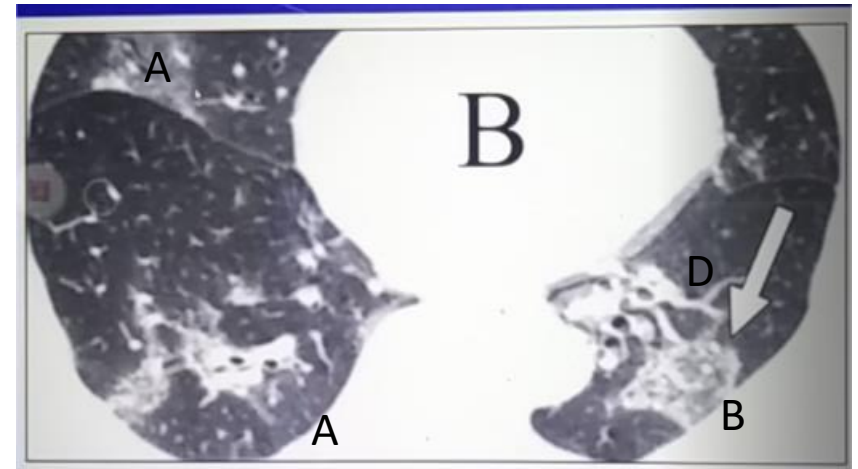
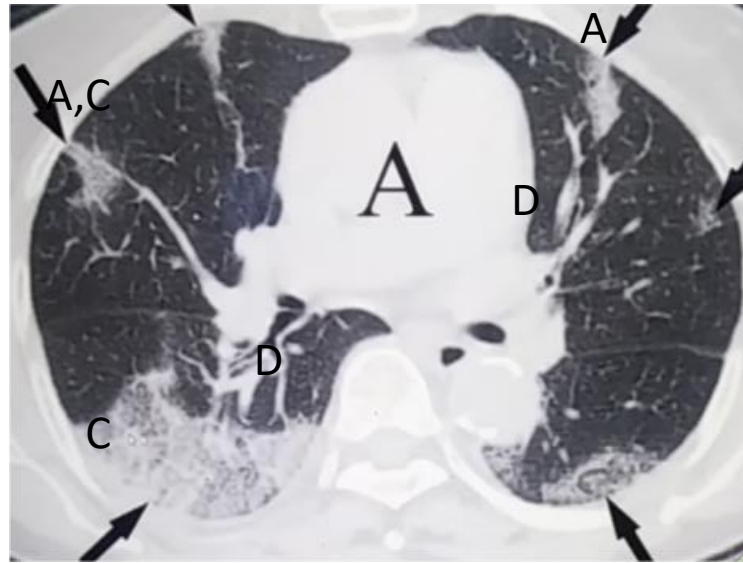
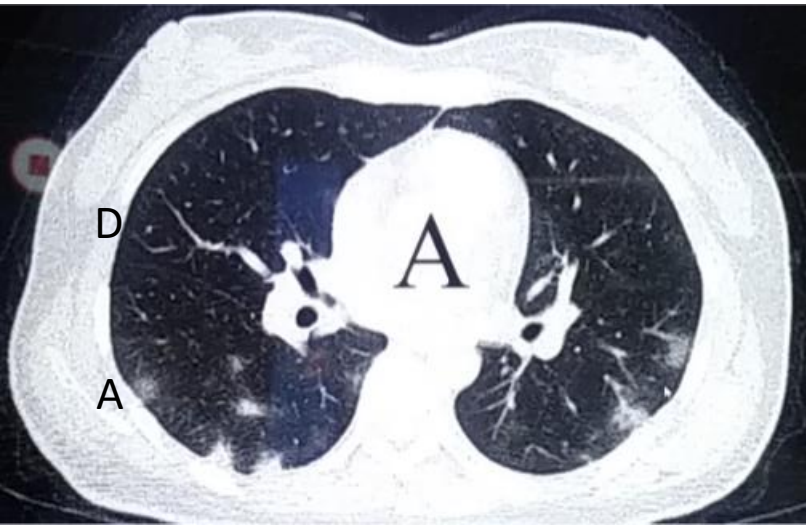
***Es ist ein frühes Zeichen der COVID-19-Pneumonie, und in der Regel beim unkomplizierten Verlauf zu finden. Gutes Ansprechen auf Corticosteroid-Therapie.***

*Eine Antibiotika-Therapie ist nicht erforderlich.*

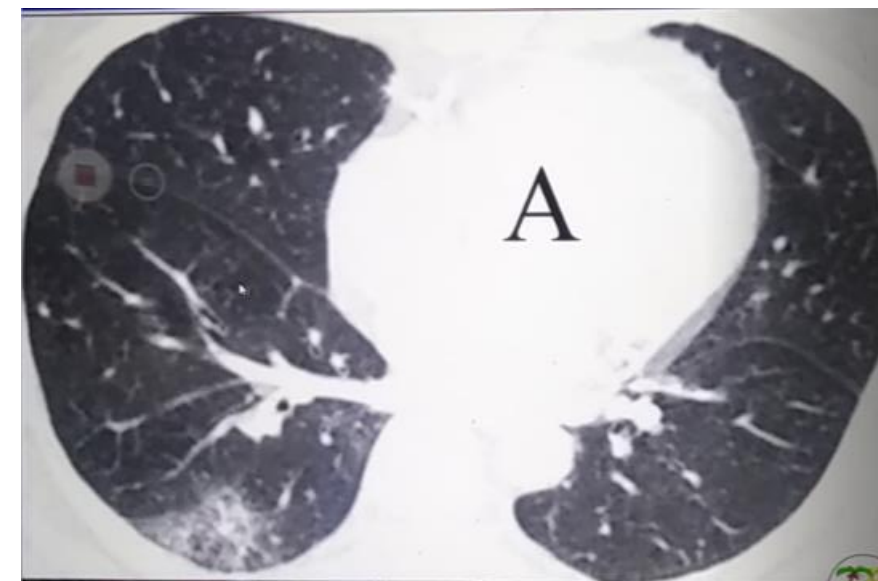
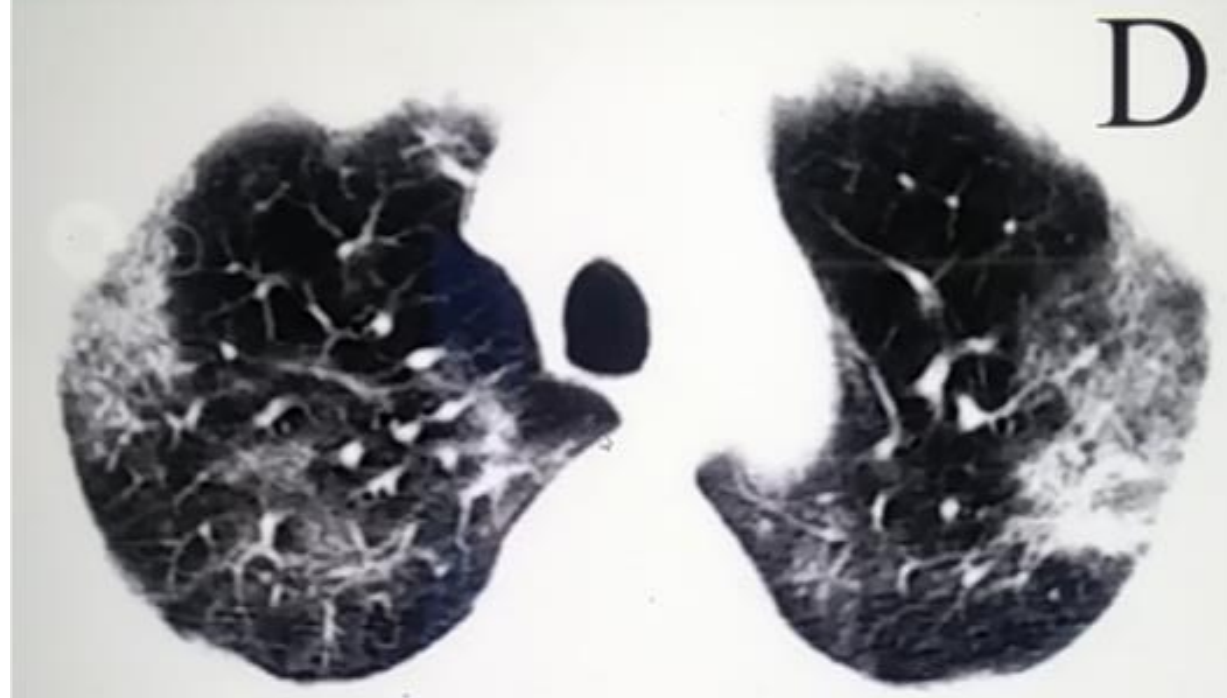
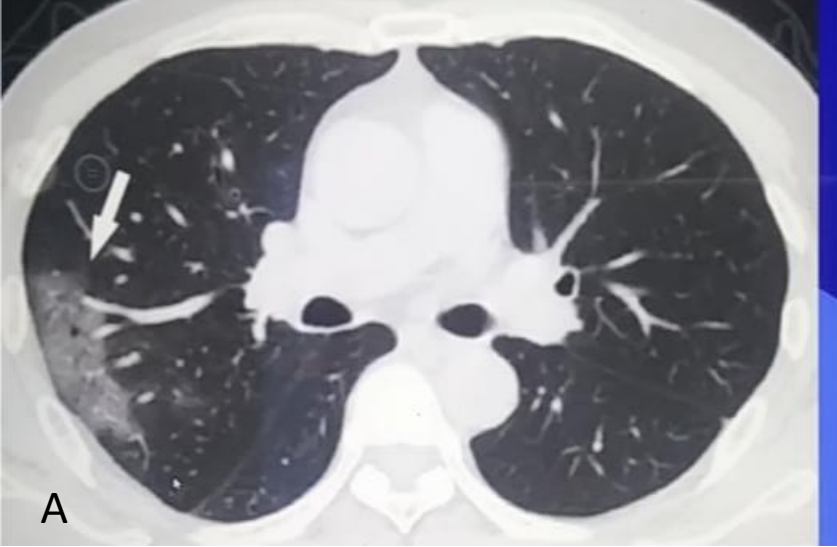


„GGO“

- Ähnlichkeit mit geätztem Glas (Milchglas), aber auch zerbrochenem oder zerriebenem Glas (ground...glass)

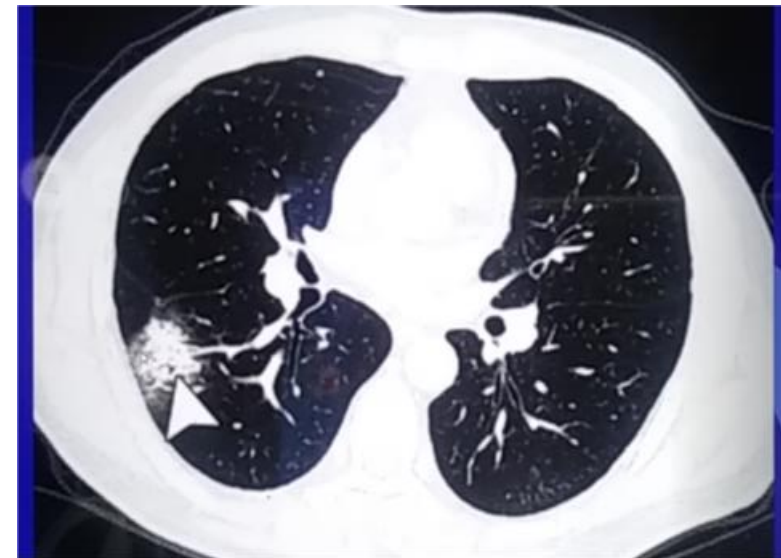


- A: Groud-Glass-Opacity (Milchglastrübung)
- B: Reversed Halo-Sign (umgekehrtes Halo-Zeichen = Rand mit Unschärfe nach Innen)
- C: Crazy Paving („wirres/verrücktes Plaster“....)
- D: Vascular Dilatation



Weitere Beispiele,  
mit zunehmender  
Infiltrations-Komponente

(„tree in bud...“  
... GGO  
... Crazy Paving)

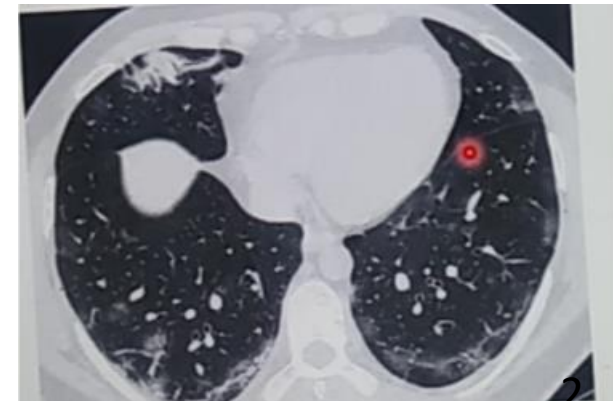


## Begriffsbestimmungen (II)

### Komplizierte, COVID-19-typische Veränderungen:

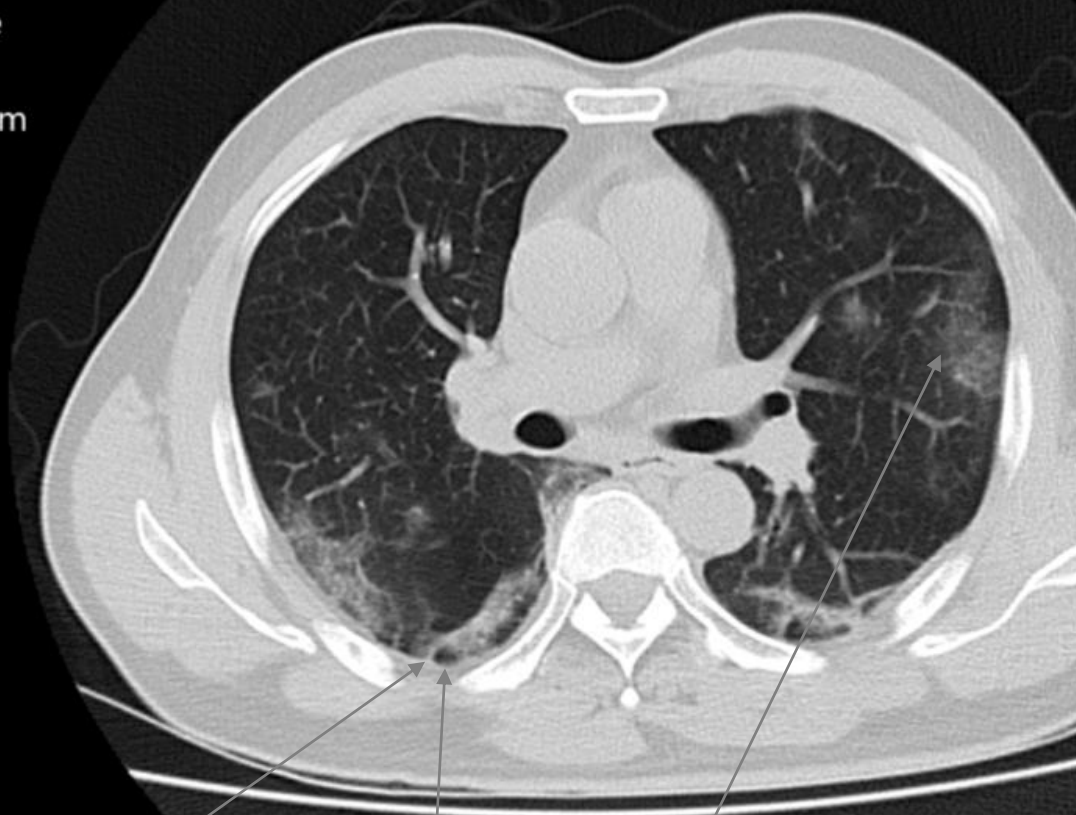
1. „Tree in Bud“ - „Baum in Blüte“ / Kirschbaumblüte : Beginnende Infiltration
2. Strukturveränderungen wie: Subpleurale Linien mit Air-Trapping und weitere SV (abgesonderter Rand...)
3. Kombination von GGO und kleineren Herden der Konsolidierung
4. E: „Advanced Consolidation“ - fortgeschrittene Konsolidierung (flächig, mit Aeroagrammen)

Insbesondere fortgeschrittene Konsolidierungen (3,4) sind verdächtig für Superinfektionen (bakterielle, Pilze) oder tragen das Risiko der Superinfektion in sich.





9157552  
Scax CORONA nat HR 0.5-5mm  
Contrast: Native  
Tilt: 0°  
FOV: 354,687 mm  
Coll: 5 mm  
kV: 125  
AS: 355 mm

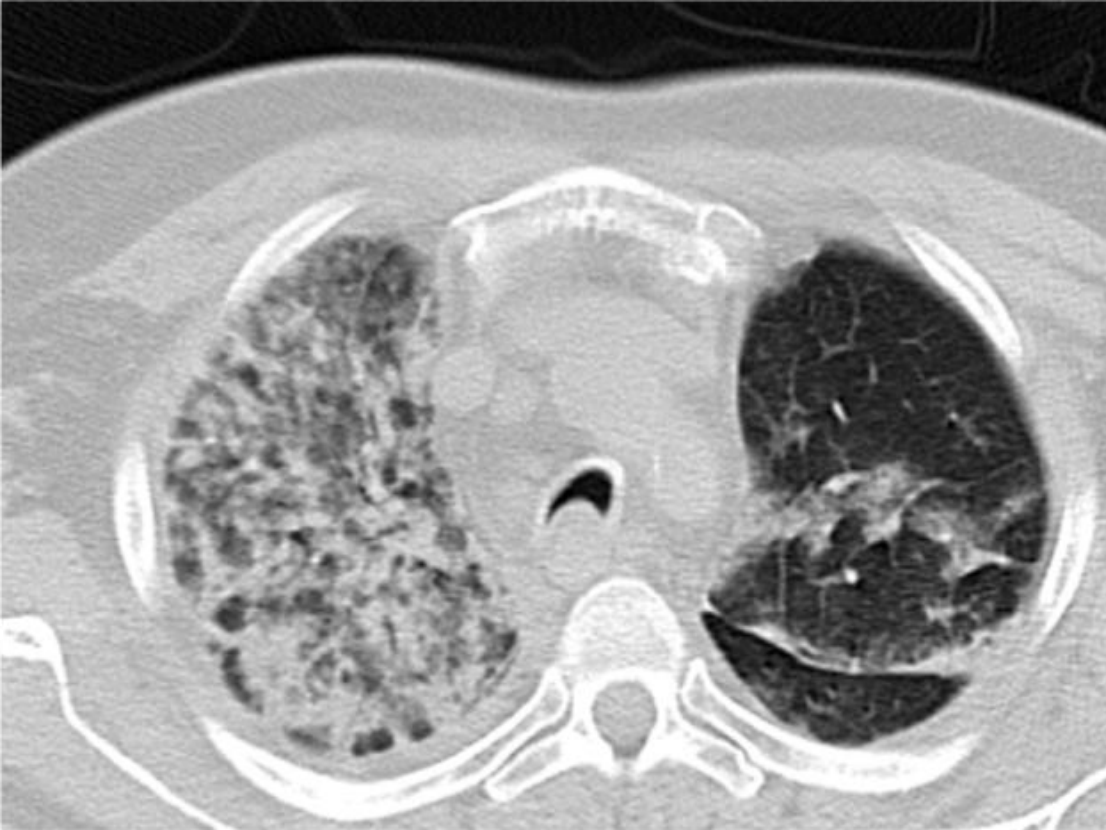


Subpleurale Linien, Air Trapping, dazu GGO

020035623158049

L 2/16  
Bett  
Expiration





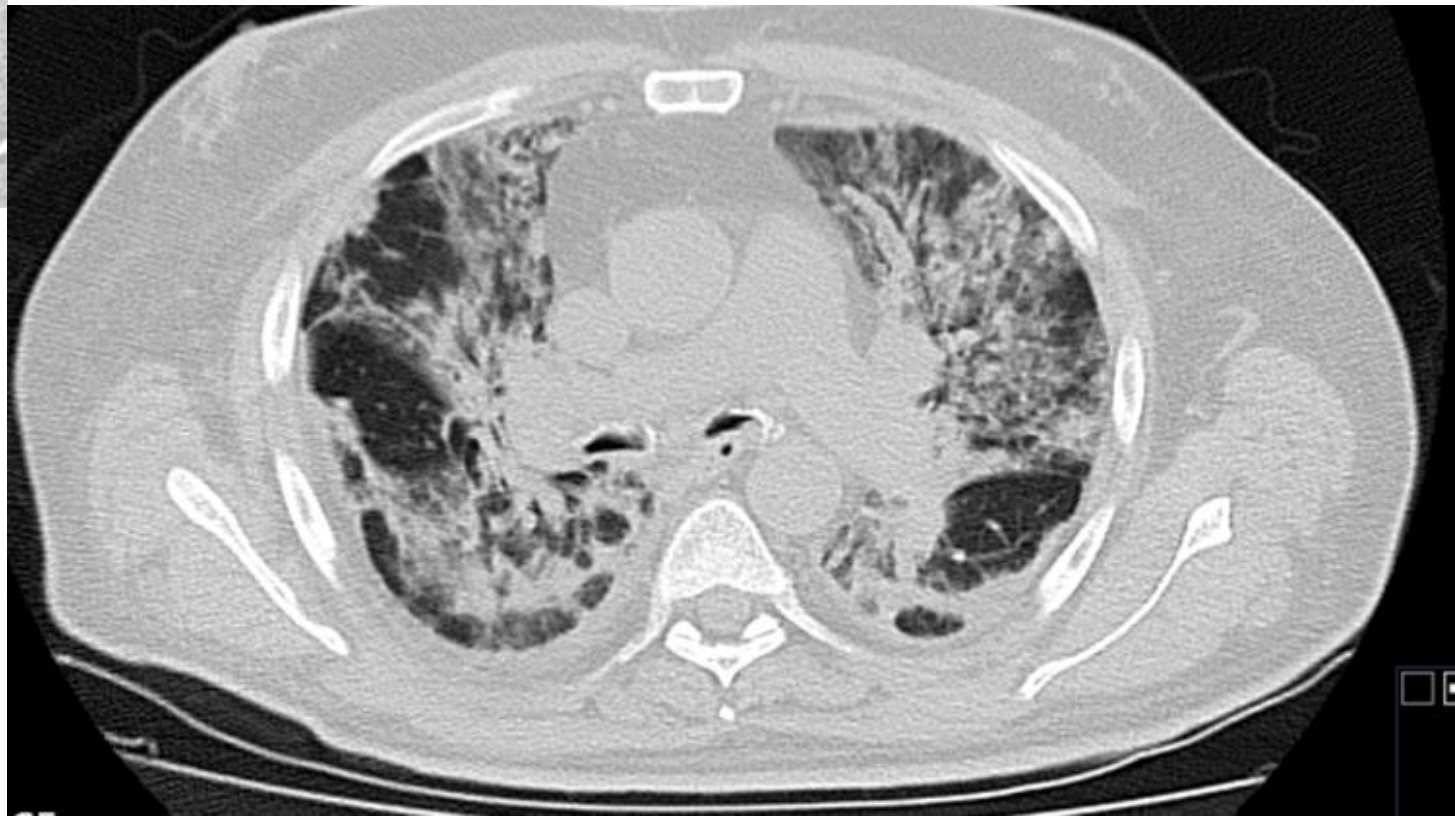
Tree-in-Bud – sehr ausgeprägt.  
Mit bereits lokal infiltrativen Bereichen.  
Primär: Covid-19 typisches Zeichen.

Stark infiltrativ, sehr ausgeprägter Befund.

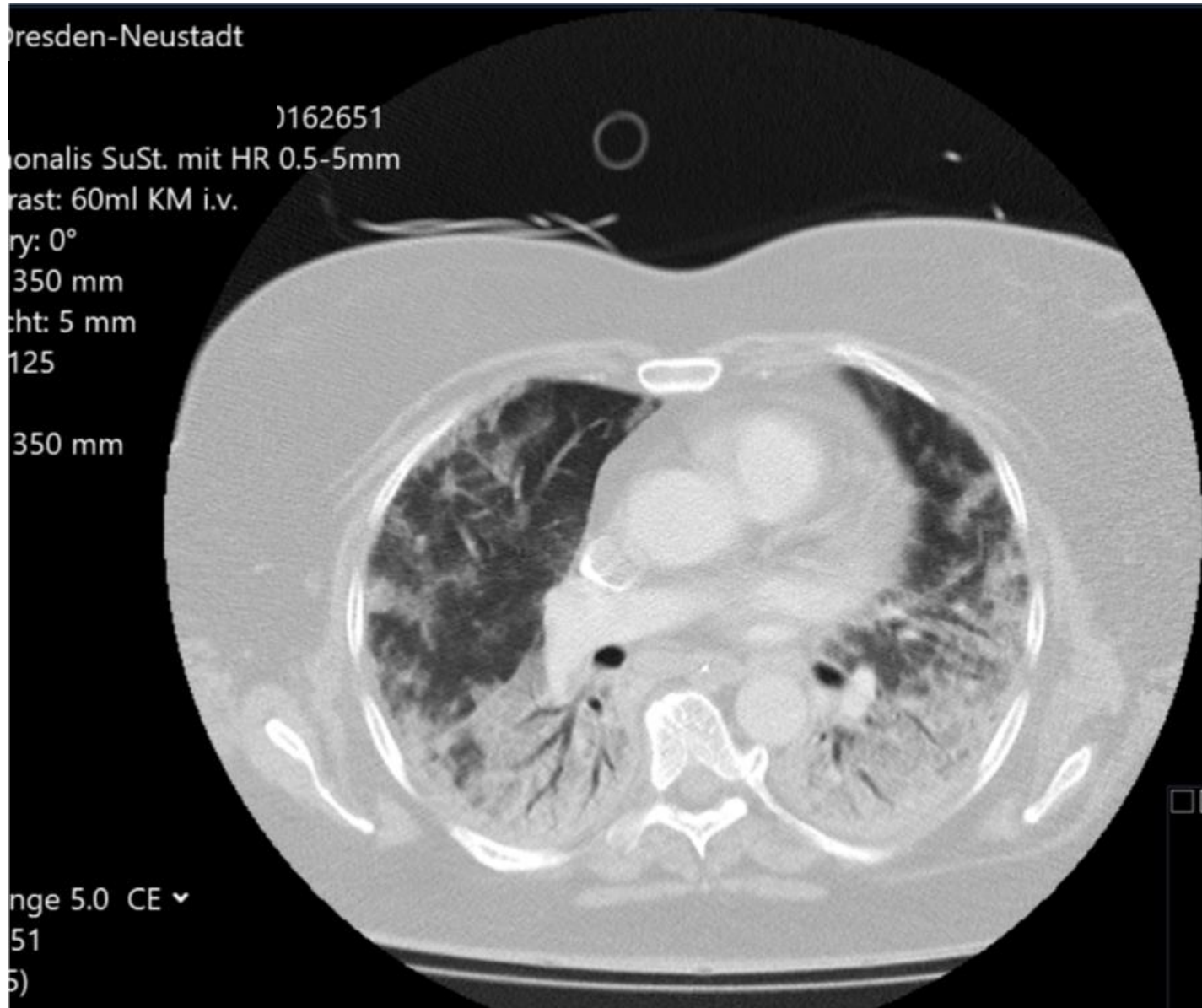
Dazu: Ergüsse und  
beginnende Strukturveränderungen

Pat. Jä.J. 19.12.2020

**Massive strukturelle Veränderungen:**  
Konsolidierungen, Ergüsse, Air-trapping, Treen-in Bud.  
Hier sind Superinfektionen zu erwarten.



## E: Fortgeschrittene Konsolidierung



Hier sind  
Superinfektionen  
zu erwarten.

Trachealsekret,  
BAL: Mikrobiologie.  
Ggf. Blutkulturen.  
Procalcitonin.

Falls Verdacht:  
**Antibiose einleiten.**

## Im Vergleich hierzu die klassischen Kriterien einer pulmonalen Aspergillose im CT:

Diagnostische Kriterien für das Vorliegen einer invasiven pulmonalen Aspergillose in der Thorax-CT.

- Gut definierte noduläre Infiltrate von > 1 cm
- Noduläre Infiltrate mit milchglasartigem Umgebungsinfiltrat über 270° und mehr der Zirkumferenz (Halo-Zeichen, „Heiligenschein“)
- Noduläre Infiltrate mit einer Luftsichel (Luftsichelzeichen)
- Neu aufgetretene Kavernen
- Lungeninfiltrate mit Gefäßabbrüchen in der Angio-CT

Ref.: Invasive Infektionen  
mit *Aspergillus* spp. und  
Pilzen der Ordnung Mucorales:  
Herausforderungen  
und Therapieoptionen

Autoren:  
PD DR. med. Jörg Janne Vehreschild  
Klinik I für Innere Medizin  
Studienzentrum Infektiologie  
Uniklinik Köln

Dr. Kora Huber  
Mikrobiologin  
Consultant Infektiologie

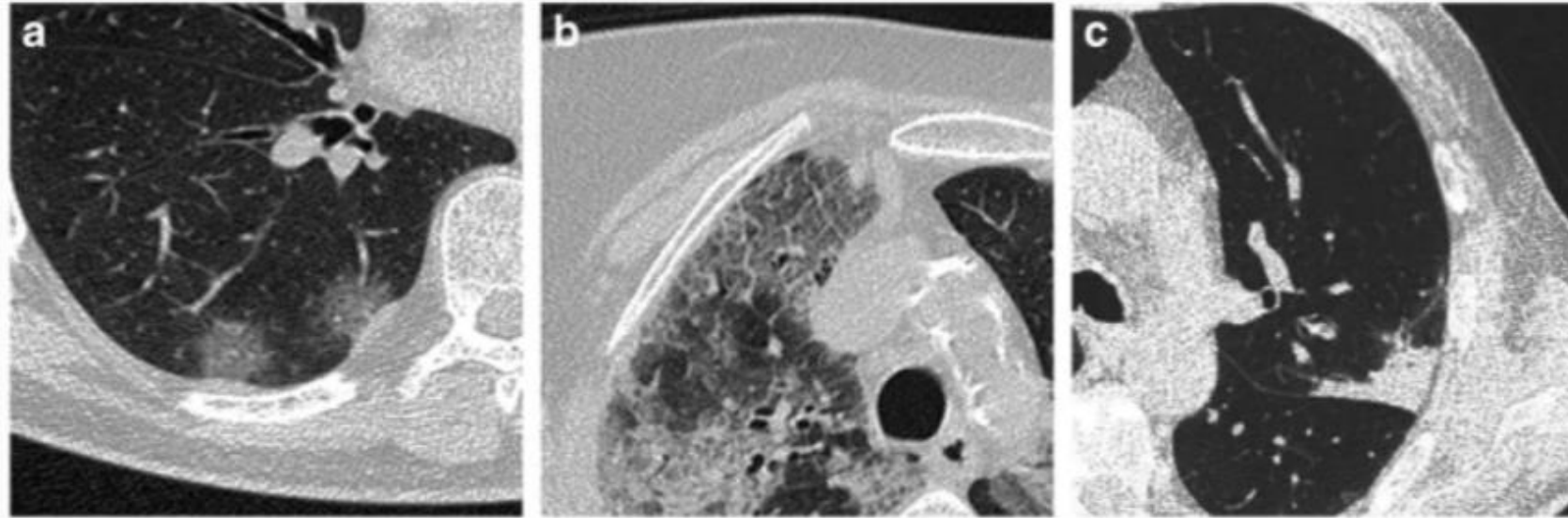
## Wiederholung: Begriffsbestimmungen

1. (A) Ground-Glass-Opacity (GGO) - Milchglastrübung
2. (B) Reversed Halo-Sign - umgekehrtes Halo-Zeichen
3. (C) Vascular Dilatation - Gefäßerweiterungen
4. (D) Crazy Paving Pattern - intralobular septal thickening
5. (-) Combination of GGO and Consolidation - Kombination von GGO und Konsolid.
6. (E) Advanced Consolidation - fortgeschrittene Konsolidierung:  
Risiko für Superinfektion
7. Atypische Erscheinungen:
  - a) „tree in bud“ - blühender Baum (infiltrativ)
  - b) Rand und subpleurale Linien - Strukturveränderungen, Air trapping
  - c) sonstig.: z.B. Erguss

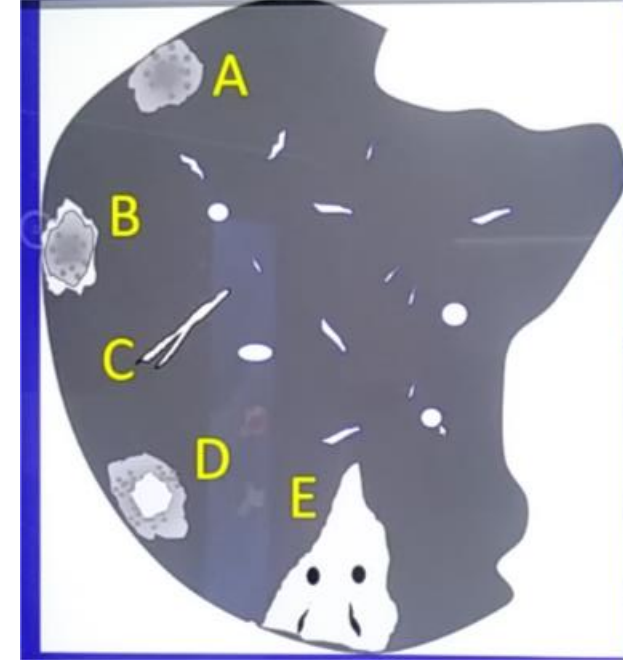
Unterscheidung von einfachen Covid-19 typischen Veränderungen (A-D, ggf. 6a,b), Infiltrativen Veränderungen und strukturellen Veränderungen (E, ff).

Letztere sind der Beginn eines komplikativen Verlaufs. Beginnende Superinfektionen.

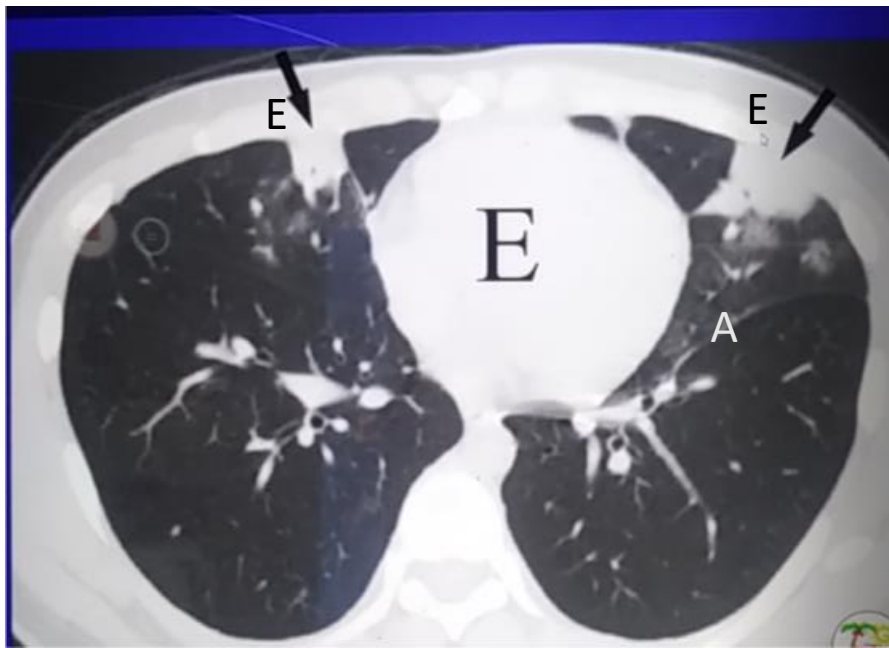
Zur Wiederholungen weitere Beispiele im CT:



Chest CT findings of COVID-19 pneumonia on axial images. GGO (a); crazy-paving pattern (GGO with superimposed inter- and intralobular septal thickening) (b); consolidation (c)



Kombination  
von GGO (A) und  
Konsolidierung (E)





## Simplified visual aid to detect early CT findings in COVID-19 pneumonia for non-radiologists

Fikri M. Abu-Zidan<sup>1</sup> · Taleb M. Almansoori<sup>2</sup>

Received: 14 April 2020 / Accepted: 17 July 2020 / Published online: 24 July 2020  
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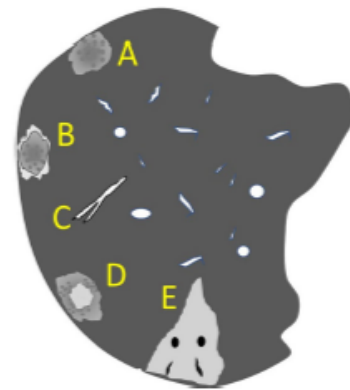
Dear Editor,

Real-time transcription polymerase chain reaction (RT-PCR) assay is the gold standard for diagnosing COVID-19. Nevertheless, it may be negative in the early 3–8 days of the active disease before becoming positive, or it may not be available [1, 2].

Early CT scan findings are very sensitive in detecting COVID-19 disease. Only five out of 167 (3%) patients who had these findings did not have the disease [2]. Accordingly, it is very important for acute-care physicians to be familiar with these findings so that they can independently read the CT scan images of COVID-19 pneumonia patients when radiologists are overwhelmed or not available. This will help isolating highly suspected patients depending on the CT scan findings and not to be mixed with other non-COVID-19 surgical patients before getting the RT-PCR results.

After critically reading the recently published CT scan findings of COVID-19 [1–5], we noticed that the used terminology is difficult for non-radiologist to understand. We tried to simplify the reported radiological findings for the non-radiologists using a simple illustration so that they can be encouraged to read the actual CT scan images independently.

The most common, important, and easy image finding that should be obvious for acute-care physicians with limited experience in reading a chest CT scan is the peripheral ground-glass opacities (GGO). GGO is an area of increased attenuation with hazy margin which does not affect the



**Fig. 1** A simplified illustration demonstrating the early CT findings of COVID-19 pneumonia which include: **a** ground-glass opacity (GGO), **b** reversed halo sign, **c** vascular dilatation, **d** combined GGO and consolidation, and finally **e** advanced consolidation. (Illustrated by Professor Fikri Abu-Zidan)

vascular or bronchial margin (Figs. 1 and 2a). This finding should be sufficient for non-radiologists to suspect COVID-19.

Other useful radiological findings for the acute-care physicians who are experienced in reading CT scans of the chest include the reversed halo sign (B), vascular dilatation (C), combined GGO and consolidation (D), and finally advanced consolidation (E) [1–5] (Figs. 1 and 2b–e). Consolidation is an area of opacification that may surround the GGO (reversed halo sign) or within the GGO, while advanced consolidation is an area of opacification that does not include GGO [1–5].

The percentages of other useful radiological findings in chest CT scans are as follows: the halo sign (64%), vascular dilatation (68–80%), GGO with consolidation (41–64%), and

Eine Übersicht über  
typische Veränderungen bei COVID-19.

<https://cases.rsna.org/coronavirus>

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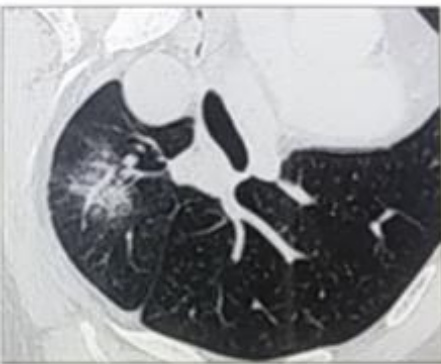
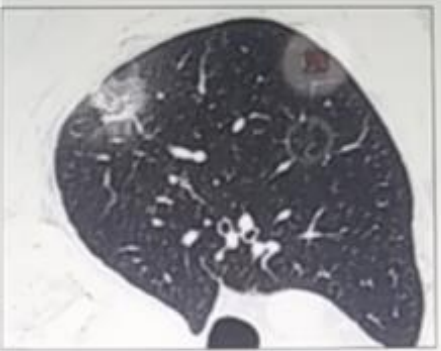
Ref aus: Abu-Zidan, FM, *European Journal of Trauma and Emergency Surgery* (2020) 46:977-8.



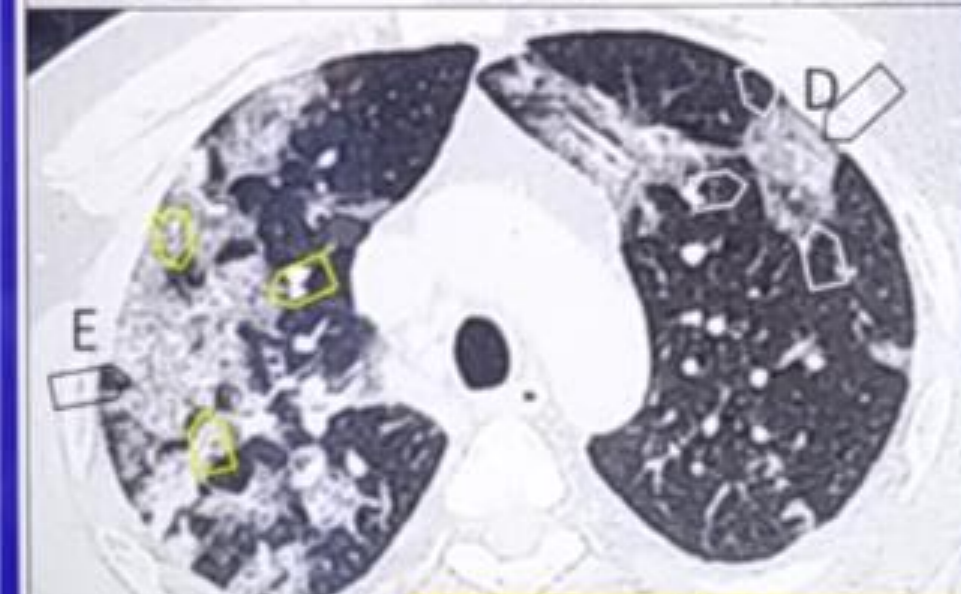
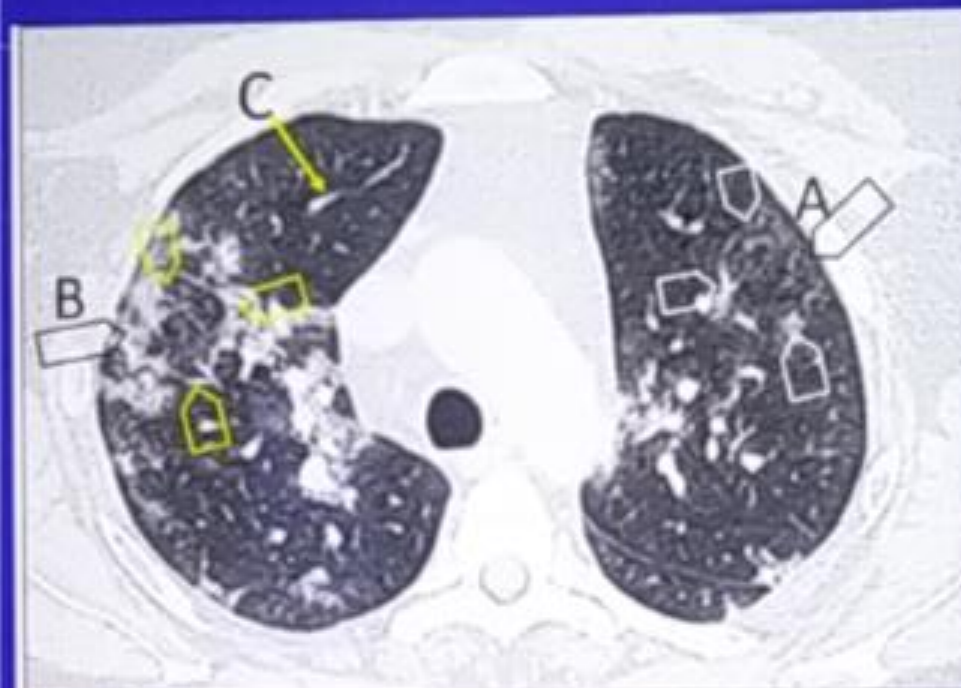
## Ungefähre Häufigkeiten bei COVID-19

- |   |         |
|---|---------|
| 1. Ground-Glass-Opacity (GGO) – Milchglatrübung             | 60-84%  |
| 1. Reversed Halo-Sign (umgekehrtes Halo-Zeichen)            | 64 %    |
| 2. Vascular Dilatation (Gefäßerweiterungen)                 | 68-80%  |
| 3. Combination of GGO and Consolidation                     | 41-64 % |
| 4. Advanced Consolidation (Fortgeschrittene Konsolidierung) | 6 – 41% |

Atypische Zeichen: im fortgeschrittenen Verlauf häufig.



Han et al. AJR Am J Roentgenol. 2020



Located peripherally in the sub-pleural regions of the lungs and are present in 96% of patients

A. ground-glass opacity (GGO)	60-84 %
B. Reversed halo sign	64%
C. Vascular dilatation	68-80%
D. Combined GGO and consolidation	41- 64%
E. Advanced consolidation.	6-41%

Abu-Zidan and AlMansoori EJTES. 20

Ref.: Mit freundlicher Genehmigung von Abu-Zidan (VAE, 11/2020, Ai Ain).

## Der bei uns verwendete Covid-19 CT-Score (nach „Francone“)

**Je 5 Punkte für 5 Regionen der Lunge (= die 5 Lungenlappen) ergibt Werte von 0 bis maximal 25 Punkte**

Bitte beachten:

Der Score selbst beschreibt aber nicht die qualitativen Veränderungen.

Diese müssen deskriptiv hinzugefügt werden.

Er beschreibt auch nicht typische und atypische Veränderungen (z.B. als Risiken für Superinfektionen)

*Per each of the 5 lobes considering the extent of anatomic involvement, as follows:*

*0, no involvement*

*1, < 5% involvement*

*2, 5–25% involvement*

*3, 26–50% involvement*

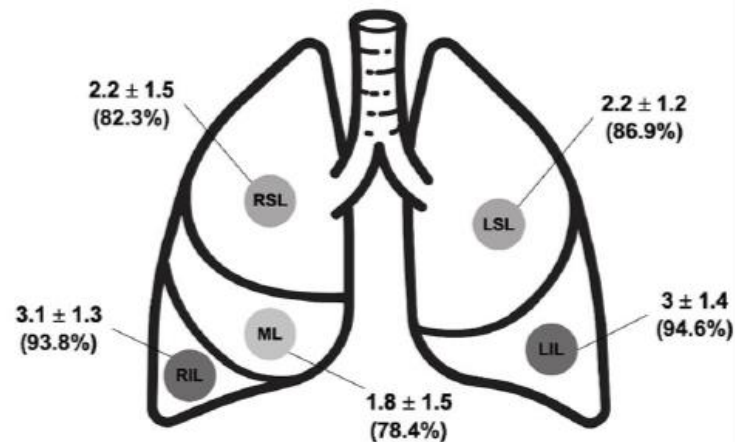
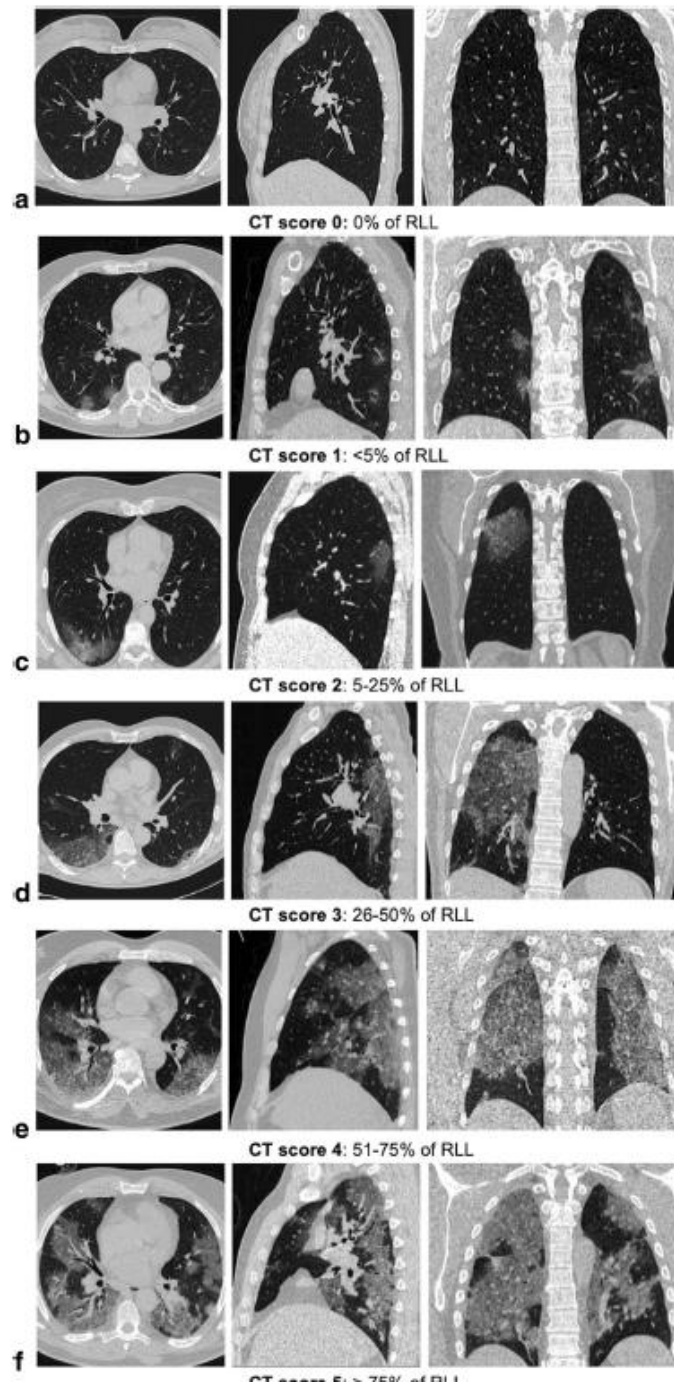
*4, 51–75% involvement*

*5, > 75% involvement*

The resulting global CT score was the sum of each individual lobar score and (0 to 25).

When present, related features such as fibrosis, subpleural lines, reversed “halo sign,” pleural effusion, and lymphadenopathy were also described.

**Fig. 1** Different CT score of RLL involvement in COVID-19 pneumonia on axial, sagittal, and coronal images. 0% of RLL lobe involvement (a); < 5% of RLL involvement (b); 20% of RLL involvement (c); 40% of RLL lobe involvement (d); 70% of RLL involvement (e); >75% of RLL involvement (f)



**a**

**Fig. 3** Lobar CT scores (a) and CT score comparisons between lobes in right and left lungs (b) in SARS-CoV-2+ patients. Data are expressed as mean value ± SD (% of occurrences of involvement for each lobe) (a).

European Radiology (2020) 30:6808–6817  
<https://doi.org/10.1007/s00330-020-07033-y>

CHEST



## Chest CT score in COVID-19 patients: correlation with disease severity and short-term prognosis

Marco Francone<sup>1</sup> · Franco Iafrate<sup>1</sup> · Giorgio Maria Masci<sup>1</sup> · Simona Coco<sup>1</sup> · Francesco Cilia<sup>1</sup> · Lucia Manganaro<sup>1</sup> · Valeria Panebianco<sup>1</sup> · Chiara Andreoli<sup>2</sup> · Maria Chiara Colaiacomo<sup>2</sup> · Maria Antonella Zingaropoli<sup>3</sup> · Maria Rosa Ciardi<sup>3</sup> · Claudio Maria Mastroianni<sup>3</sup> · Francesco Pugliese<sup>4</sup> · Francesco Alessandri<sup>4</sup> · Ombretta Turriziani<sup>5</sup> · Paolo Ricci<sup>1,2</sup> · Carlo Catalano<sup>1</sup>

Received: 7 April 2020 / Revised: 5 June 2020 / Accepted: 12 June 2020 / Published online: 4 July 2020  
 © European Society of Radiology 2020

## **Anhang:**

Es folgen weitere Beispiele aus Literatur und Vorträgen

Nur zur persönlichen Verwendung

## Einige Gedanken und Spotlights der Darstellung von Dr. S. Dhake, VAE /11-2020:


### Role of CXR

- Easily available
- Portable
- Can often be repeated
- Often used as a first line investigation
- Not a routine tool for screening or diagnosis

### Fleischner Society consensus

- Imaging is not indicated in patients with suspected COVID-19 and mild clinical features unless they are at risk for disease progression
- Imaging is indicated in a patient with COVID-19 and worsening respiratory status
- In a resource-constrained environment, imaging is indicated for medical triage of patients with suspected COVID-19 who present with moderate-severe clinical features and a high pretest probability of disease

### CXR IN COVID




### “Imaging Findings of COVID Infection”

Ref.: Dr. Suvarna Dhake, Burjeel Royal Hospital, VAE.

Many opacities in the periphery.  
Consolidation, mostly in the lower lobes

### CT findings- Ground glass opacities

- most common finding
- multifocal, bilateral and peripheral
- in the early phase of the disease, may present as a unifocal, most commonly located in the inferior lobe of the right lung



Ersatz von Luftraum durch Flüssigkeit

## CT findings: air space consolidation

royal hospital  
A unit of VPS Healthcare



## CT findings- Crazy paving

royal hospital  
A unit of VPS Healthcare

- thickened interlobular and intralobular lines in combination with a ground glass pattern



## CT findings-Subpleural bands and Architectural distortion

burjeel  
royal hospital  
A unit of VPS Healthcare



## CT findings- Ground glass opacities

royal hospital  
A unit of VPS Healthcare

- most common finding
- multifocal, bilateral and peripheral
- in the early phase of the disease, may present as a unifocal, most commonly located in the inferior lobe of the right lung



## RSNA consensus for diagnosis on CT

### • atypical Appearance

- absence of typical or indeterminate features and the presence of
  - isolated lobar or segmental consolidation without GGO
  - discrete small nodules (e.g. centrilobular, tree-in-bud)
  - lung cavitation
  - smoother interlobular septal thickening with pleural effusion

- **negative for pneumonia:** no CT features to suggest pneumonia, in particular, absent GGO and consolidation

## RSNA consensus for diagnosis on CT

### • typical appearance

- peripheral, bilateral, GGO +/- consolidation or "crazy paving" pattern
- multifocal GGO of rounded morphology +/- consolidation crazy paving" pattern
- reverse halo sign or other findings of organizing pneumonia

### • indeterminate appearance

- absence of typical CT findings and the presence of
  - Multifocal GGO /consolidation lacking a specific distribution, non-peripheral
  - few very small GGO with a non-rounded and non-peripheral distribution

## Atypische Erscheinungsformen (COVID-19)

- isolierte lobäre oder segmentale Consolidation ohne GGO
- diskrete kleine Knoten (zentrilobulär, tree-in-bud)
- Lung cavitation
- Smoother interlobular septal thickening with pleural effusion

## Negativ für Pneumonie:

- keine GGO, keine Consolidation.

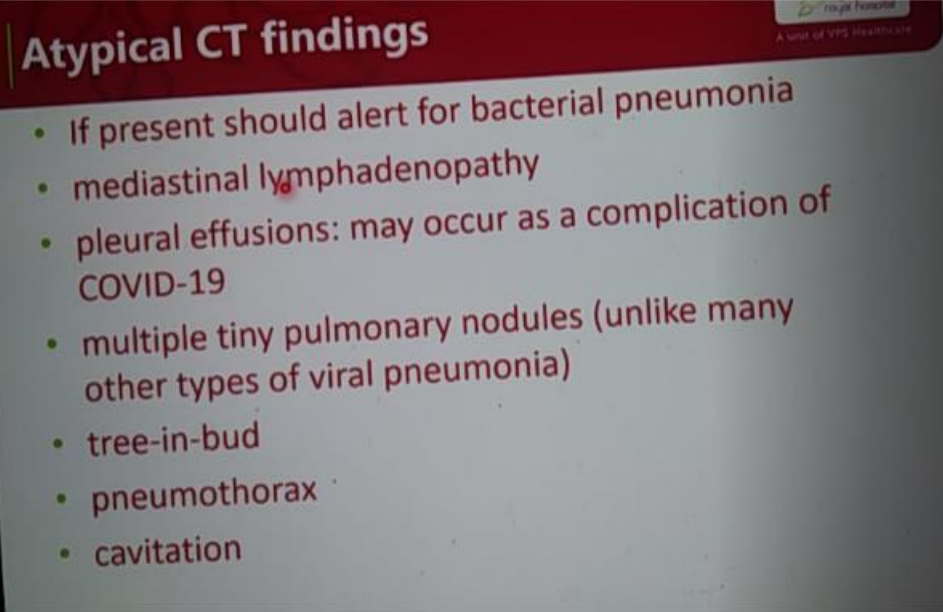


Atypische CT-Erscheinungen:

Achtung: kann bakterielle Pneumonie sein !

z.B.

- mit mediastinaler Lymphadenopathie
- mit Pleura-Erguss: Kann aber Komplikation von COVID sein
- multiple kleine Knoten (nicht ganz so wie bei anderen viralen Pneumonien)
- Tree-in-bud
- Pneumothorax
- Cavitation



# CO-RADS

**Table 1: Overview of CO-RADS Categories and the Corresponding Level of Suspicion for Pulmonary Involvement in COVID-19**


CO-RADS Category	Level of Suspicion for Pulmonary Involvement of COVID-19	Summary
0	Not interpretable	Scan technically insufficient for assigning a score
1	Very low	Normal or noninfectious
2	Low	Typical for other infection but not COVID-19
3	Equivocal/unsure	Features compatible with COVID-19 but also other diseases
4	High	Suspicious for COVID-19
5	Very high	Typical for COVID-19
6	Proven	RT-PCR positive for SARS-CoV-2

Note.—CO-RADS = COVID-19 Reporting and Data System, COVID-19 = coronavirus disease 2019, RT-PCR = reverse transcription-polymerase chain reaction, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

## RSNA International COVID-19 Open Radiology Database

- Radiology organizations around the world have responded to RSNA's call to build a COVID-19 imaging data resource.
- RICORD will provide imaging data with annotations and supporting clinical information for use in education and research.

<https://cases.rsna.org/coronavirus>

Wählen Sie zum Anzeigen der Favoriten  dann  und in den Ordner der Favoritenleiste ziehen. Oder aus einem anderen Browser importieren. [Favoriten importieren](#)

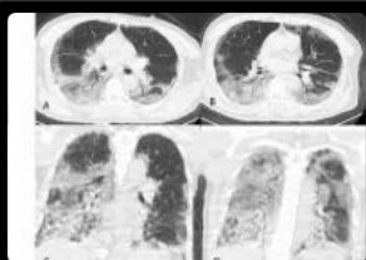
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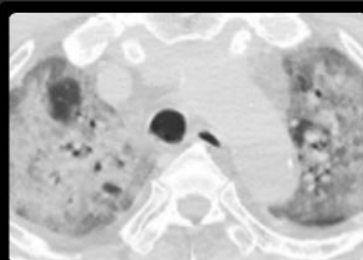
## RSNA Coronavirus cases

RSNA is currently processing peer-reviewed cases of 2019 Novel Coronavirus (COVID-19) to provide the global radiology community with a free diagnostic resource to help control this outbreak and get more patients the care they need. Bookmark this page to access additional cases as they are added. To learn more about the details of each case, simply click on an image below. [Submit cases here](#).

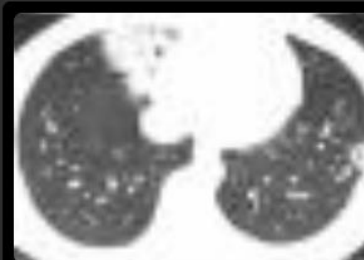
Review the [Radiology Department Preparedness for COVID-19: Radiology Scientific Expert Panel](#) article to learn more about radiology preparedness and sustaining radiology department operations during a surge.

[Cases](#)[Media](#)

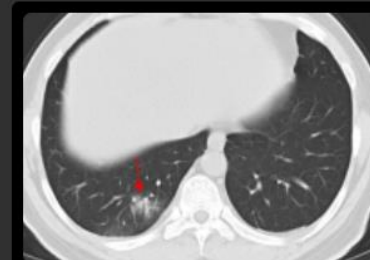
Spontaneous



Severe Coronavirus disease 2019



COVID-19 pneumonia : CT halo



COVID-19 pneumonia

**Figure 3:** CT images of cases where, during the review process, radiologists mistakenly diagnosed coronavirus disease 2019 (COVID-19) pneumonia or non-COVID-19 pneumonia. **(a, b)** Example cases where the majority of radiologists mistakenly diagnosed COVID-19 pneumonia when the actual diagnosis was non-COVID-19 pneumonia. Imaging features are consistent with COVID-19 pneumonia. **(c–h)** Example cases where the majority of radiologists mistakenly diagnosed non-COVID-19 pneumonia when the actual diagnosis was COVID-19. **(c)** Lesions (arrow) are small and can be misdiagnosed as pulmonary hypostatic effect. **(d)** Small ground-glass opacity (arrow), with no obvious interstitial abnormality. **(e)** The absorbent-stage lesions appear as a subpleural line (arrow) and can be difficult to distinguish from other organizing pneumonia. **(f)** Typical reverse halo sign, which can be difficult to distinguish from other diseases with a reverse halo sign. **(g)** The advanced-stage lesions appear as “white lung,” which can be difficult to distinguish from acute respiratory distress syndrome caused by other diseases. **(h)** Obvious consolidation combined with pneumothorax and hypostatic pneumonia, which can be difficult to distinguish from other diseases.

Ref.: **Performance of Radiologists in Differentiating COVID-19 from Non-COVID-19 Viral Pneumonia at Chest CT**

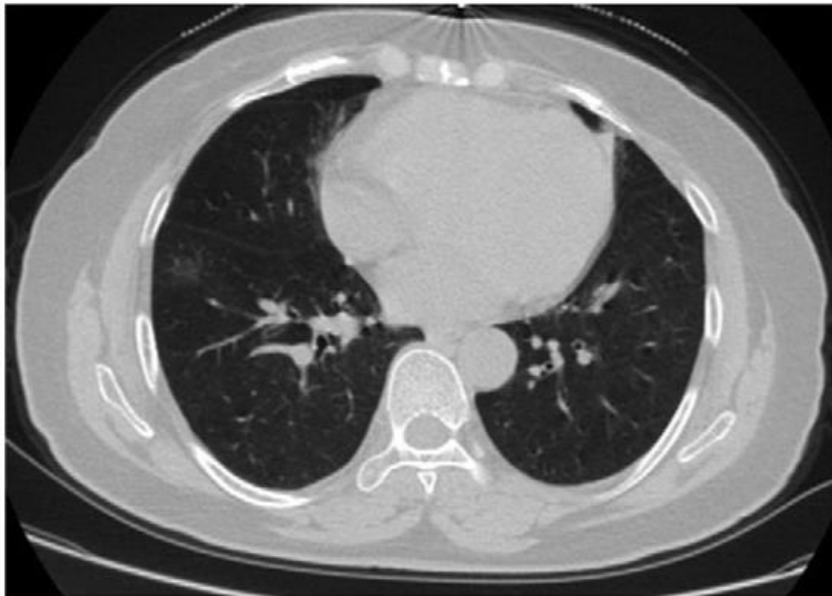
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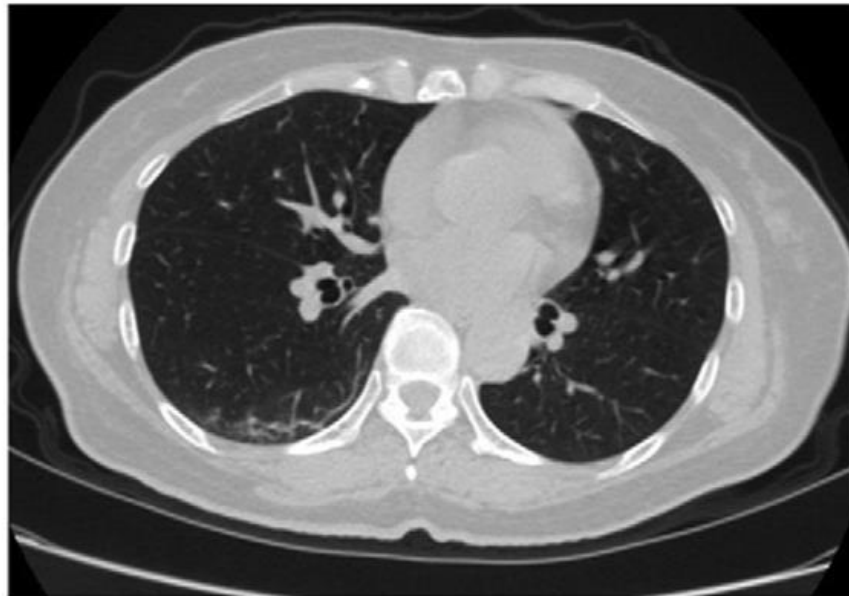
Supported by the Brown COVID-19 Research Seed Award (GR300196 to H.X.B.).

\* H.X.B. and B.H. contributed equally to this work.

Conflicts of interest are listed at the end of this article.



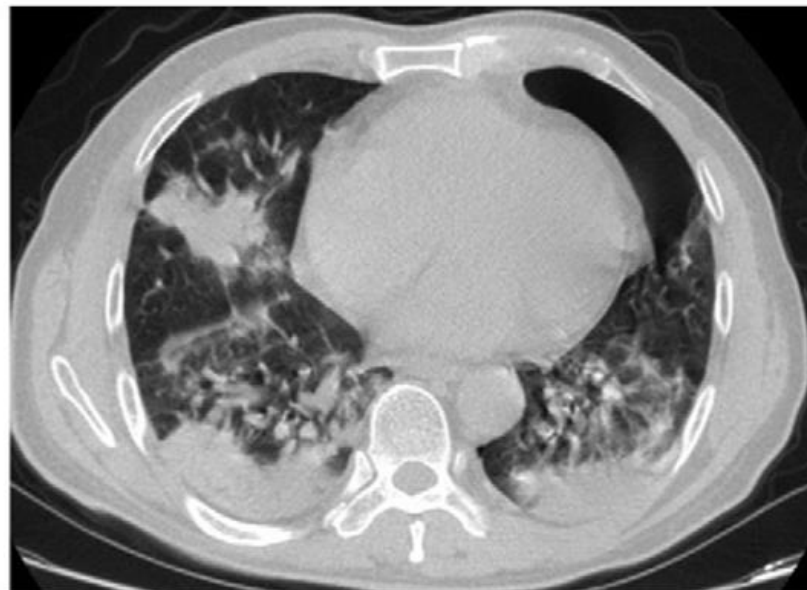
d.



e.



f.



## Performance of Radiologists in Differentiating COVID-19 from Non-COVID-19 Viral Pneumonia at Chest CT

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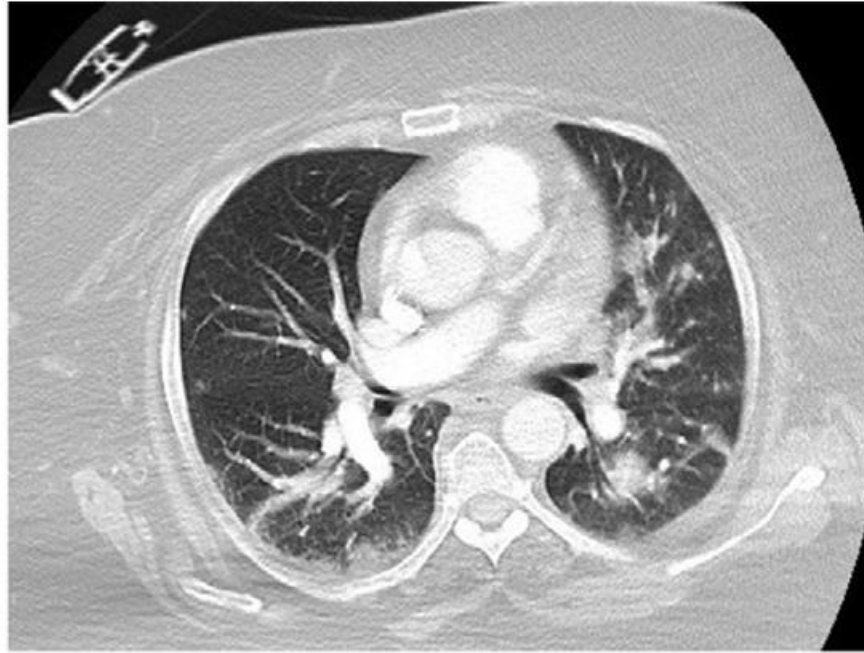
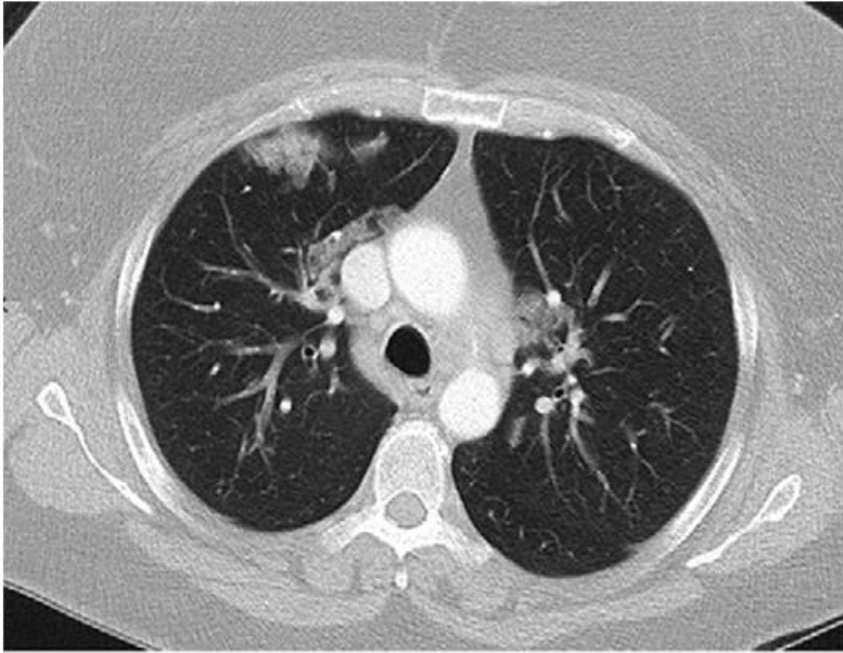
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