



## BACKGROUND

- COVID-19-related acute respiratory failure leads to silent but severe hypoxemia; underlying mechanism is uncertain
- Intrapulmonary bronchopulmonary anastomoses (IBAs) bypass alveolar capillary beds by utilizing the bronchial circulation to direct blood from pulmonary arteries to pulmonary veins: a unique right-to-left intrapulmonary vascular shunt
- Transcranial bubble ultrasound and 3D histologic image reconstruction in COVID-infected patients shows right-to-left intrapulmonary shunt: possibly due to IBAs

## CASE PRESENTATION

- 17-year-old female with obesity presents with acute shortness of breath and chest pain after one week of upper respiratory symptoms, fever, nausea, and emesis
- Intubated shortly after admission due to increasing hypoxia
- Imaging showed nodularity of the lungs consistent with superimposed pneumonia and/or thromboemboli; echo and EKG negative for significant heart dysfunction
- Tested positive for SARS-CoV2; concern for hyperinflammation
- Treatments: intubation, proning, Remdesivir, steroids, antibiotics, tocilizumab and anakinra
- Progressed to acute respiratory distress syndrome (ARDS) and had 24 hours of pressor-refractory hypotension with tachycardia
- Death 16 days after presentation; autopsy requested

## METHODS

- Standard autopsy sampling + 20 lung tissue blocks for extensive studies, culture
- Cannulation of main pulmonary vessels and injection with tissue ink, PA: blue ink, PV: orange ink, with serial sections
- State-of-the-art imaging of tissue blocks: synchrotron-based phase-contrast imaging, followed by 3D image reconstruction

## RESULTS

- IBAs demonstrated by all modalities: histology via ink injection (Fig. 1), and synchrotron imaging of same tissue block (Fig. 2)
- Extensive acute and focally-organizing thrombi within all sizes of pulmonary arteries, with associated hemorrhagic necrosis (Fig. 3)
- Evolving hyaline membrane disease (Fig. 4)
- Bronchial fibrin plugs/ casts (Fig.5)

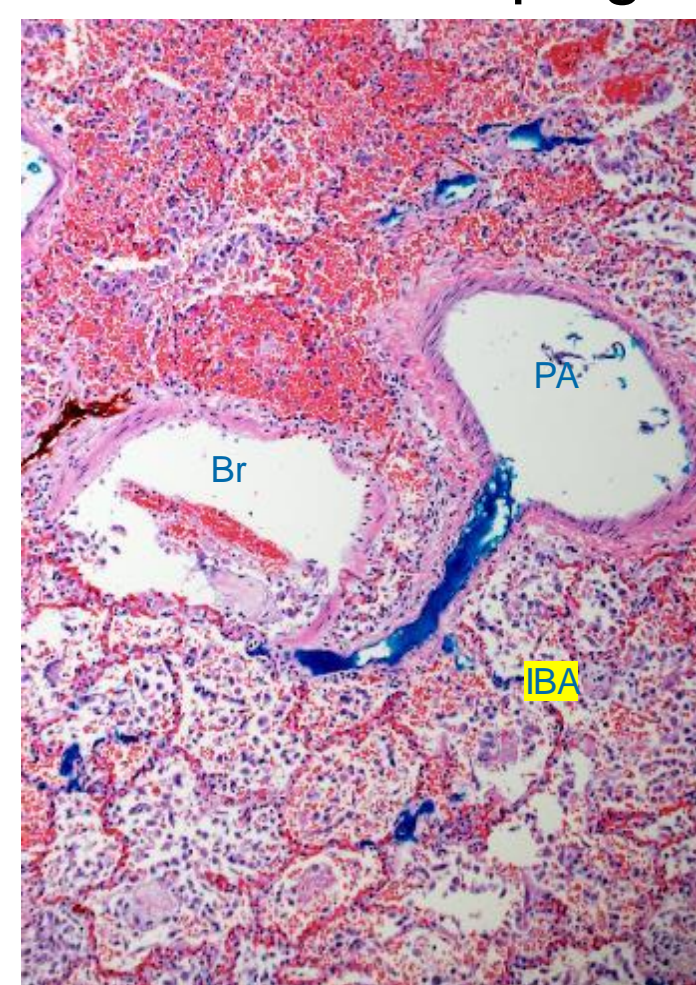


Figure 1, 10x: IBA-pulmonary artery (PA, injected with blue ink) with connection to bronchial microvessels (Br: bronchiole)

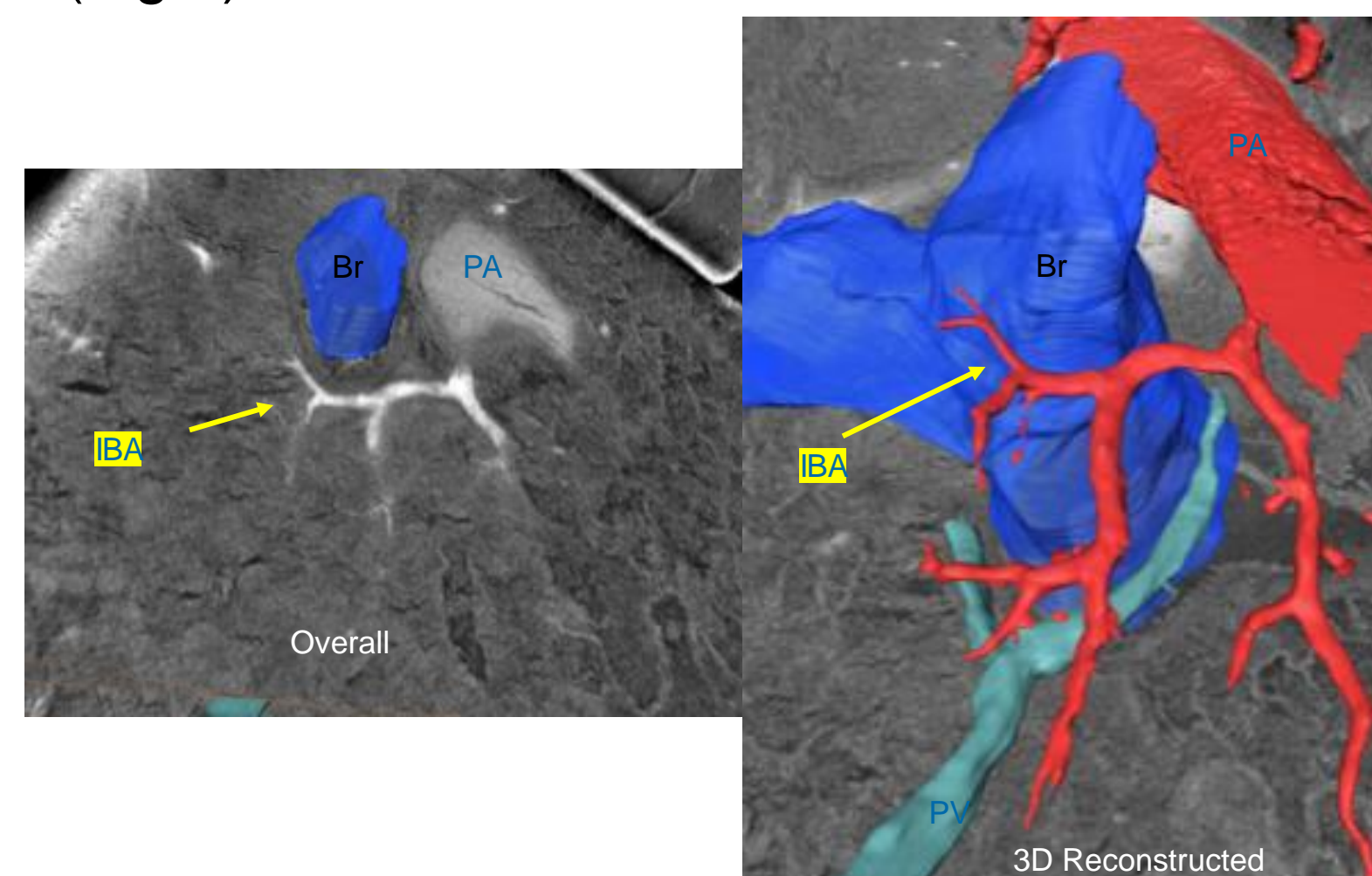


Figure 2: Synchrotron imaging of same block. PA=red, Br=dark blue, pulmonary vein (PV)=light blue. IBA highlighted by yellow arrows.

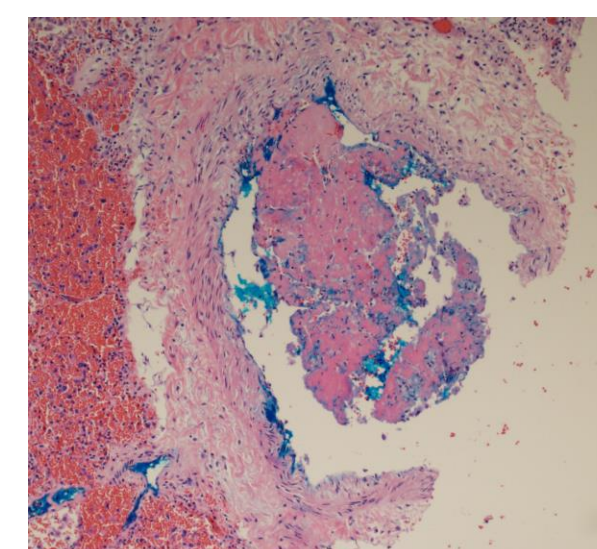


Figure 3, 10x: Hemorrhage and PA thrombus

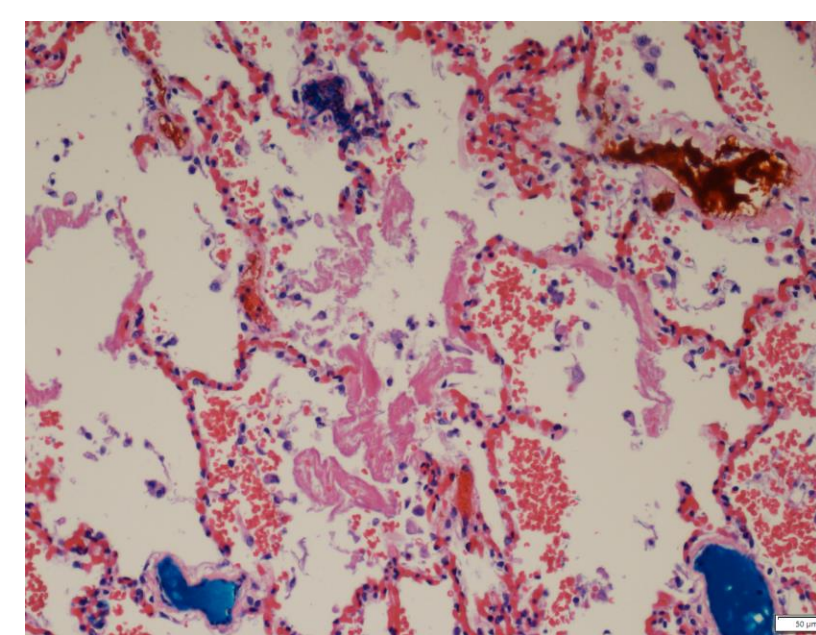


Figure 4, 20x: hyaline membranes of ARDS

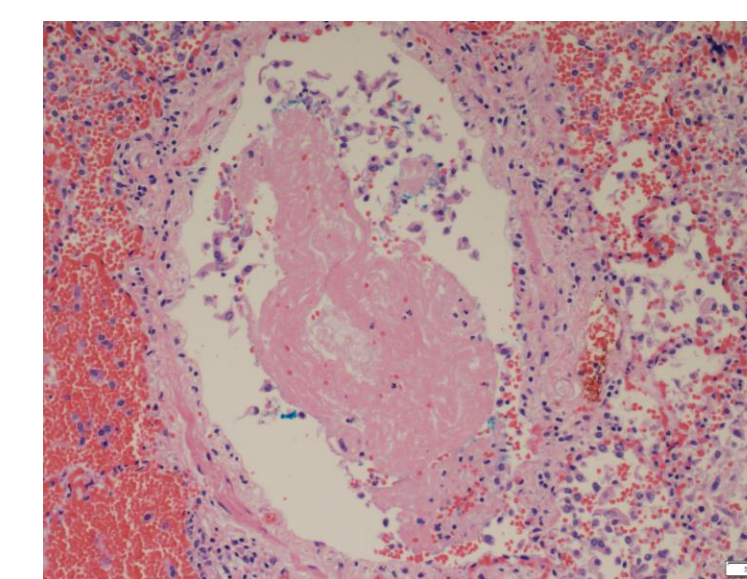


Figure 5, 20x: Bronchial fibrin plug/cast

## CONCLUSION

- IBAs are present in COVID-related respiratory failure
  - Ink injection studies show open anastomotic connections between pulmonary artery and bronchial vasculature
  - Synchrotron based 3D image reconstruction confirms this relationship
- Other histopathologic findings in line with prior COVID literature: striking ARDS and extensive vascular insult (numerous pulmonary artery fibrin thrombi, focal vasculitis)
- Novel finding: Bronchial fibrin plugs and casts

## SPECULATION

Precapillary right-to-left shunt via IBAs plays a key role in COVID-related silent hypoxemia and respiratory failure

## REFERENCES

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