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IMAGING MASS CYTOMETRY
PUBLICATION REVIEW
WITH COMMENTARY

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Clinical pathology of a critical patient with novel coronavirus pneumonia (COVID-19)

REVIEW OF PUBLICATION

Clinical pathology of a critical patient with novel coronavirus pneumonia (COVID-19)

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COVID-19 has been compared to other coronavirus infections, particularly severe acute respiratory syndrome (SARS). In a recent publication[1], the authors hypothesize that the pulmonary pathology of COVID-19 might be comparable to the primary indications of SARS, including localized hemorrhage and necrosis, pulmonary alveolitis and bronchitis, and desquamation of alveolar epithelial cells. In addition, COVID-19 tends to be accompanied by inflammatory injury of epithelial cells, potentially contributing to the development of acute respiratory failure and severe acute respiratory distress syndrome.

A look into the lungs

Researchers from The Second Affiliated Hospital of Southern University of Science and Technology, Shenzhen, performed a series of pathology and immunohistochemistry (IHC) experiments to characterize a lung biopsy taken from a patient with critical COVID-19. Experiments included haemotoxylin and eosin (H&E) staining, Masson staining to detect pulmonary interstitial fibrosis and periodic acid Schiff (PAS) and silver methenamine staining to identify bacterial and fungal infections, of which there were none.

Lung tissue histology showed prominent areas of hemorrhagic necrosis along with severe congestive and hemorrhagic changes. Immune cell evaluation supported the team's hypothesis, indicating interstitial infiltration of inflammatory cells including lymphocytes, plasma cells and mononuclear cells. Immunologic cells expressing markers such as CD3, CD4, CD5, CD8, CD20, CD38 and CD79a were identified across several serial sections and staining rounds (Figure 1). Results suggested general spatial context of the cells present focally in lung interstitium and near blood vessels.

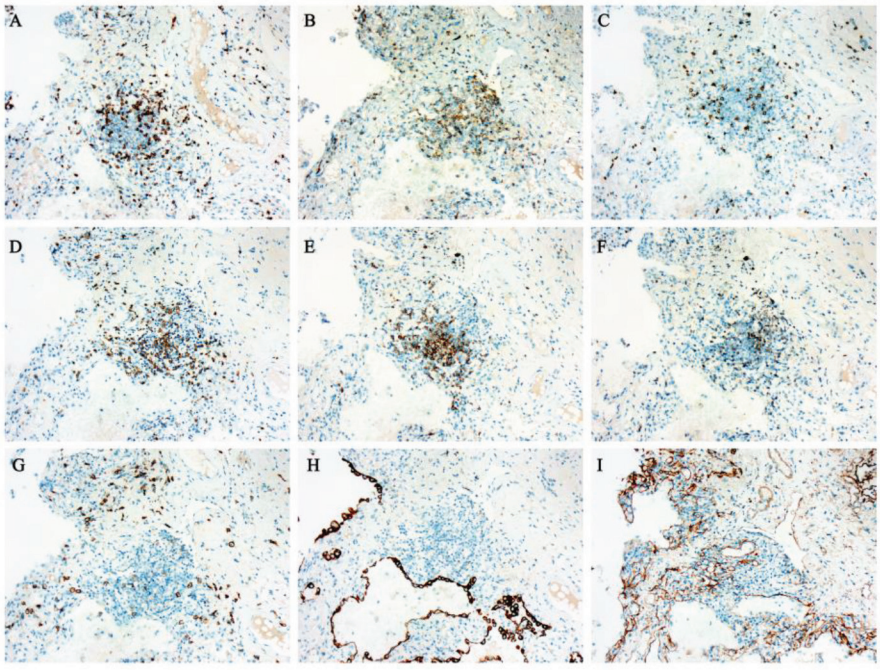

Figure 1. Immunohistochemical staining of lung sections obtained from a COVID-19 infected patient. Positive expression of CD3 (A), CD4 (B), CD8 (C), CD20 (D), CD79a (E), CD5 (F), CD38 (G), CK7 (H) and collagen IV (I) assessed by DAB (3,3′-diaminobenzidine) staining. (Luo et al., 2020)

Leveraging Hyperion Imaging System for functional use of Imaging Mass Cytometry in lung tissue analysis

The Hyperion™ Imaging System for Imaging Mass Cytometry™ (IMC™) can be used to characterize lung tissues from patients with critical COVID-19 or other diseases. The system is an imaging solution that expands on high-parameter CyTOF® technology to simultaneously image up to 37 markers for use with a variety of tissue types. Benefitting from metal-tagged antibodies, the Hyperion Imaging System overcomes challenges related to autofluorescence inherent in many tissues. Lung tissue is one that frequently shows autofluorescence, which as shown in Figure 2 is absent when IMC is used to provide a quantitative image of the tissue in spatial context.

Conventional IHC experiments like those performed in the Shenzhen study are limited by the number of markers that can be visualized in a single scan. The ability to perform multiplex experiments with a complete set of immune and structural markers on one section becomes increasingly important when handling precious samples, such as those taken from patients. This high-dimensional, single-stain, single-scan approach has recently been validated to IHC[2,3] and enables deeper profiling and spatial data generation.

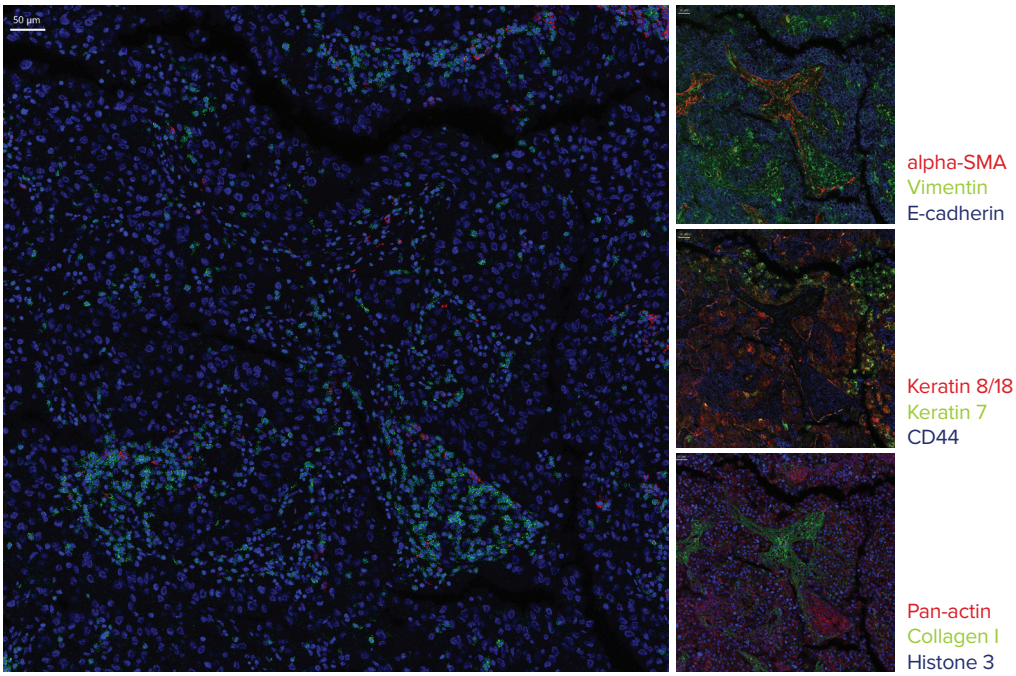

Figure 2. Lung tissue using Imaging Mass Cytometry on the Hyperion Imaging System.
Single section, one region of interest with 9 different markers, as shown. (Fluidigm)

Using the Hyperion Imaging System, immune cells clustered in the lung interstitium in proximity to blood vessels could also be quantitatively measured and the spatial distance compared in patients with mild vs. critical COVID-19. While IHC studies can provide meaningful data, the lungs of patients with COVID-19 can be more deeply profiled using the high-plex ability of the Hyperion Imaging System, enabling quantitative insights into lung tissue architecture, immune populations present in the lung infiltrate and their functional states.

References

1. Luo, W., Yu, H., Gou, J. et al. “Clinical pathology of critical patient with novel coronavirus pneumonia (COVID-19).” *Preprints* (2020).
2. Jackson, H.W., Fischer, J.R., Zanotelli, V.R.T. et al. “The single-cell pathology landscape of breast cancer.” *Nature* 578 (2020): 615–20.
3. Carvajal-Hausdorf, D.E., Patsenker, J., Stanton, K.P. et al. “Multiplexed (18-plex) measurement of signaling targets and cytotoxic T cells in trastuzumab-treated patients using Imaging Mass Cytometry.” *Clinical Cancer Research* 25 (2019): 3,054–62.

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