COVID-19 Induced Thorax Perfusion Deficit

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Severe acute respiratory 2 (SARS-CoV-2) is the most recent pathogenic coronavirus to be identified and the third with a tendency to cause potentially fatal viral pneumonia. Coronaviruses are responsible for illnesses such as the common cold but can also cause more serious respiratory viral infections such as SARS-CoV and MERS which have a death rate of 10% and 37% respectively[1]. Although the mortality rate of COVID-19 is relatively low at 1-3.5%, there is a significant risk to the older populations of the world, especially those aged > 70yrs with comorbidities[2].

Although reverse transcription polymerase chain reaction (RT-PCR) nasal swab testing is considered the gold standard, there have been multiple studies pointing to the effectiveness of CT in diagnosing and defining COVID-19 patients. AI et al. [3] discovered that thorax CT scans had a sensitivity of 97% when using RT-PCR as a reference and Fang et al.[4] made a similar discovery with their study pointing to a sensitivity of 98%. Not only was CT found to have a high sensitivity in CoV-2 detection, but it was also found in some cases that CT was highly suggestable towards COVID-19 pneumonia in patients who returned negative RT-PCR results[3]. This combined with faster result turnaround times, the ability to observe early lung parenchymal changes in asymptomatic patients and the ability to accurately track disease progression makes CT an integral diagnostic tool for COVID-19 detection[1,3,4,5].

The features seen on CT in patients with COVID-19 involvement appear to be very similar to that of SARS and MERS, with ground glass opacities presenting initially followed by more involved consolidation, vascular enlargement, interlobular septal thickening, air bronchogram sign, and air trapping caused by alveolar and interstitial pulmonary injury/edema[1,5]. SARS-CoV-2 directly involves angiotensin-converting enzyme2, which significantly contributes to diffuse alveolar damage and in turn induces direct lung injury[1]. Due to the similar CT features seen in varieties of viral pneumonia, Princess Alexandra Hospital Radiology Department in conjunction with Siemens Healthineers have recently explored the usefulness of Dual Energy CT in helping to differentiate COVID-19 induced pneumonia.

Dual Energy CT refers to the acquisition of two different photon energy levels in order to assess and quantify material interaction. The attenuation coefficient of different materials is what forms the basis of image creation. In single energy level acquisitions, we acquire information about how material interact by using a single polychromatic X-ray beam. We make assumptions about materials based on how they attenuate this beam and thus we can characterise materials by their attenuation value. When utilising Dual Energy we use two polychromatic X-ray beams at different energies and gather information about how materials interact with both beams. By doubling the data we acquire the ability to characterise, highlight and quantify materials that is significantly improved.

The use of Dual Energy CT in thorax imaging can aid the evaluation of thorax abnormalities ranging from vascular irregularities and malignancies, to interstitial lung disease and thorax perfusion deficits[6].

Through injecting an intravenous contrast medium and acquiring Dual Energy datasets, calculations can be done that allow us to highlight the perfusion of contrast material through the lung tissue, aiding in detection of vascular perfusion defects within the lung parenchyma.

Typically this is used to assess for pulmonary emboli and the associated perfusion deficit, however Princess Alexandra have adapted the technique to assess for perfusion defects potentially seen in COVID-19 induced pneumonia. Typically pneumonia has a heterogeneously decreased or increased iodine distribution[6], however initial results have suggested that COVID-19 induced pneumonia is marked by a significant decrease in iodine perfusion

A patient with known COVID-19 infection presented to Princess Alexandra with new Right Bundle Branch Block after experiencing chest tightness post recent long-haul flight from Spain. Patient's D-Dimer test result was 0.54mg/L (Normal Low: 0.02mg/L and Normal High : 049mg/L). A CTPA was requested to rule out a PE. As per departmental protocol a Dual Energy acquisition was performed. Parameters for acquisition can be seen in Table 1.

kV	100/sn140
Ref mAs	105/89
Rot time	0.33s
Pitch	0.6
Collimation	128 x 0.6
Scan time	3.59
CTDI	9.44mGy
DLP	283mGy*cm

Table 1

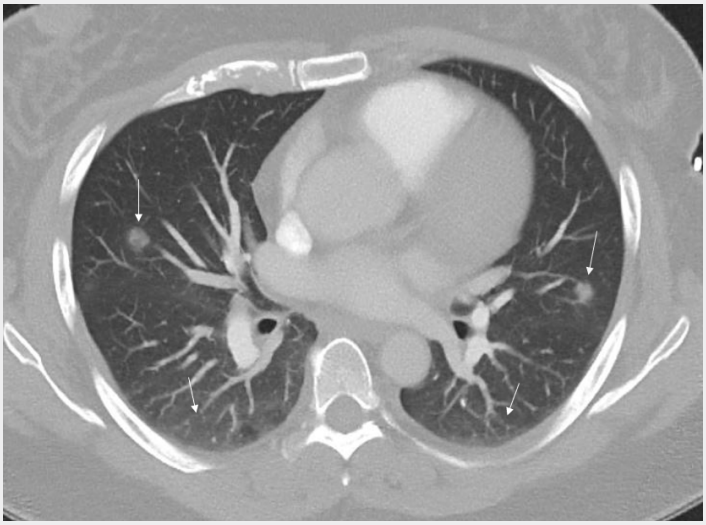

Figure 2a - Ground Glass Patches from COVID pneumonia

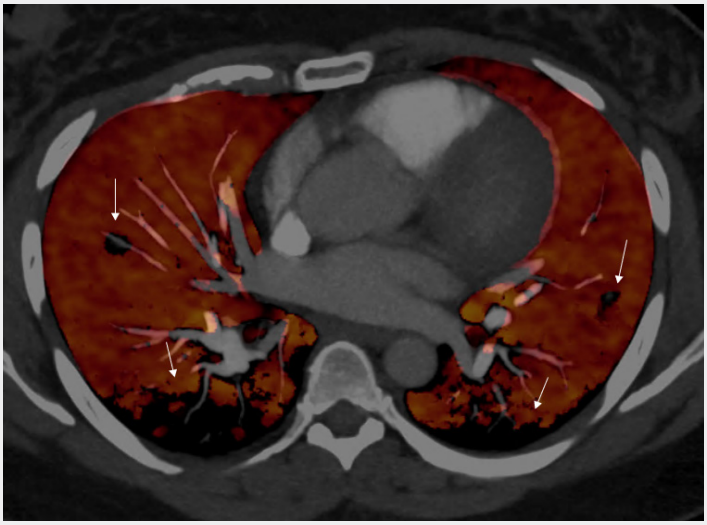

Figure 2b - Total loss of all perfusion in areas of COVID

**Images are sourced from Princess Alexandra Hospital Radiology Department*

Figure 2a shows areas of ground glass opacities from COVID-19 induced pneumonia and **Figure 2b** shows a significant lack of iodine perfusion to these same areas. Although viral pneumonia can typically be defined by the presence of ground glass opacities and consolidation on CT, the complete loss of perfusion to the affected areas appears to be something that may be attributed to COVID-19.

With the potential for undeniable strain on the worlds healthcare system, COVID-19 is the topic at the forefront of all healthcare professionals' minds at this present time. With the proven benefits of CT in detection and diagnosis, Dual Energy acquisitions can only help to provide even more diagnostic information to physicians. Siemens Healthineers is also working on an AI based algorithm to aid in the detection of COVID-19 lung parenchymal changes. Although still in development, early studies have highlighted the significant benefits of such software[7].

"Dual Energy CT can assess for early lung parenchymal changes"

In addition to the benefits seen in using Dual Energy for symptomatic patients , we also see potential for use in early diagnosis and detection. Asymptomatic patients who return a negative RT-PCR test but are still under a high suspicion of COVID-19 infection could have a dual energy CT to assess for early lung parenchymal changes were deemed clinically relevant[8]. It has been suggested that COVID-19 lesions may be present in the lungs before symptoms present[1] thus Dual Energy CT could significantly help to assess COVID-19 induced changes at the early stages.

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