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## Editorial

# Black fungus, the darker side of COVID-19

Corona virus-19 disease (COVID-19), caused by SARS-Cov-2, has infected 185 million individuals with 4 million deaths in 220 countries as of July 6th, 2021.<sup>1</sup> What was initially considered to be another worldwide flu epidemic mostly affecting the respiratory system has now emerged as a multi-organ disease due to the SARS-Cov-2 virus.<sup>2</sup> The most common extrapulmonary involved organs include the blood vessels, eyes, central nervous system, heart, gastrointestinal tract, liver, skin, and kidneys.

A growing number of case reports and series describe opportunistic fungal infections in COVID-19 patients. Co-morbidities such as diabetes mellitus, coupled with immune dysfunction and use of steroids, are hypothesized as the main causes.

Pulmonary invasive aspergillosis is the most common fungal superinfection reported in COVID-19 patients, raising concerns about an additional contributing factor to mortality.<sup>3,4</sup>

More recently, many cases of mucormycosis, often termed “black fungus”, have been reported, particularly in Asian countries such as India. An updated and meticulous systematic review of literature assessed data from 30 case reports/series of COVID-19-associated mucormycosis reported till 14 May 2021.<sup>5</sup> Cases were mostly from India, USA, and Egypt, respectively representing 73, 10, and 6% of the 99 patients included. The most prevalent comorbidity was diabetes mellitus (85%). The use of glucocorticoids for the management of COVID-19 was observed in 85% of the cases. Rhino-orbital mucormycosis was most common (42%), followed by rhino-orbito-cerebral mucormycosis (24%). Pulmonary mucormycosis was observed in 10 patients (10%).

Fungal rhinosinusitis is classified as an invasive or a noninvasive disease depending on histopathological proof of tissue invasion by fungal elements. The invasive type can further be divided into acute, chronic, or chronic granulomatous forms.<sup>6</sup>

In this issue of the Journal of Neuroradiology, Ashour MM. et al. report imaging findings of eight patients with confirmed COVID-19 infection that presented with acute invasive fungal rhino-orbital-cerebral sinusitis.<sup>7</sup> All patients were diagnosed with mucormycosis except for one who was proven to have invasive aspergillosis. In most cases, the symptoms occurred at a late stage of the COVID-19 infection. All patients had nasal and paranasal sinus involvement and six of them had orbital infiltration. Intracranial complications of various types were noted on cross-sectional imaging: perineural/meningeal/epidural spread, cavernous sinus involvement, internal carotid thrombosis/vasculitis, cerebral abscesses, and infarctions. All these complications could account for the high long-term morbidity rate of 100% and the mortality rate of 37.5%.

The imaging features described in the Egyptian series were consistent with usual findings of acute invasive fungal rhinosinusitis, with a predominant infiltrative pattern and bone destruction. Typical MR imaging features of acute invasive fungal rhinosinusitis consist in a variable enhancement pattern and a characteristic low signal on T2-weighted images.<sup>8</sup> This can be explained by the fungal elements and the presence of paramagnetic elements such as iron and magnesium as shown in vitro MR evaluation,<sup>9</sup> and/or can be due to the involved mucosa itself in mucormycosis.<sup>10</sup> An early MR imaging finding of nasal mucormycosis is the “black turbinate” sign, featuring a lack of enhancement on postcontrast T1-weighted images, due to devitalization and necrosis of the sinonasal mucosa caused by mycotic vascular invasion.<sup>10</sup> Ashour et al. also review previous case reports and discuss the distinctive imaging features between the acute and chronic forms of invasive fungal sinusitis, based on a series reporting CT and MR findings in eleven patients with chronic invasive or chronic granulomatous invasive fungal sinusitis.<sup>11</sup>

Successful management of acute invasive fungal rhino-orbital-cerebral sinusitis requires early diagnosis and prompt initiation of antifungal therapy and surgical intervention.

Over a year into the pandemic, COVID-19 is still a growing challenge for the health care system. Co-infections and superinfections have been identified as one of the predictors of a fatal outcome in COVID-19 patients. Acute invasive fungal rhino-orbital-cerebral sinusitis, most often mucormycosis, is an emerging problem requiring increased vigilance in COVID-19 patients and regular follow-up even after recovery, especially in patients with diabetes mellitus or who had received high doses of glucocorticoids.

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