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## ST segment elevation in COVID-19-related pulmonary embolism



In their retrospective study of pulmonary embolism (PE) in COVID-19 infection Kho et al. made the following points:

- (i). COVID-19 patients with acute clinical deterioration should be investigated for PE [1]. I would go further to assert that the association of unexplained hypotension and hypoxemia should also raise the index of suspicion for PE, thereby triggering a work-up that includes, not only electrocardiography (ECG) (for stigmata of either acute myocardial infarction or PE), but, also, point-of-care transthoracic echocardiography (TTE) (to look for stigmata of PE).
- (ii). Kho et al. also asserted that ECG and TTE, respectively, were of limited diagnostic help in a COVID-19-infected patient with suspected PE [1]. My contention is that, in the era antedating the COVID-19 pandemic it was recognised that some PE patients were characterised by ST segment elevation [2]. Furthermore, it is well recognised that, when a hypotensive patient is evaluated by TTE, absence of documentation of right ventricular dilatation almost completely rules out PE [3].
- (iii). Kho et al. also make the important point the COVID-19 promotes a procoagulant state which predisposes to the development of venous thromboembolism and, hence, PE [1]. I would go further to say that COVID-19 is also a predisposition to the coexistence of PE and AMI, thereby mandating clinical vigilance for the coexistence of the two disorders.

The following examples bring some of the above issues into sharper focus:-

A 62 year old man gave a 7 days history of dizziness, fatigue, nausea and vomiting followed by a syncopal episode. An ECG recorded during his ambulance journey to hospital showed ST segment elevation followed by an episode of ventricular fibrillation. He was successfully resuscitated but remained hypotensive, and was subsequently taken to the catheterisation facility. Coronary angiography did not reveal any coronary stenosis. Point-of care TTE demonstrated a dilated right ventricle with severely reduced function. Subsequently he had pulmonary angiography which showed bilateral PE [4]. Computed tomography (CT) of the chest showed bilateral peripheral ground glass opacities typical of COVID-19 infection, and also some wedge shaped opacities in the right lung. He was also found to be SARS-CoV-2 positive [4].

A 61 year old man presented with cough and dyspnoea. Due to concurrent hypoxemia, COVID-19 infection was suspected. Chest X-ray showed bilateral pulmonary infiltrates. His ECG showed ST segment elevation in the inferior leads, and ST depression in leads I, AVL, V2-V4. TTE showed right ventricular (RV) dilatation, RV lateral wall akinesia, and pulmonary artery systolic pressure (PASP) >60 mm Hg. Due to

persistent hypoxemia and subsequent development of hypotension PE was suspected, and the TTE was repeated. TTE now showed worsening of right ventricular function and an increase in PASP. Thrombolytic treatment was empirically administered for suspected PE. The latter diagnosis was subsequently validated by computed tomography pulmonary angiography (CTPA). Coronary angiography did not show any significant coronary stenosis. CT also showed diffuse bilateral ground glass opacities consistent with COVID-19 infection. The patient also tested positive for SARS-Cov-2 on reverse transcriptase polymerase chain reaction evaluation [5].

In the presence of the association of ST segment elevation and COVID-19 infection it is also possible that thrombotic occlusion of a coronary artery can coexist with pulmonary embolism [6]. This is likely to occur because COVID-19 infection is a risk factor for both acute myocardial infarction (AMI) [7] and pulmonary embolism [8]. The coexistence of AMI and PE was reported in an 82 year old woman with COVID-19 pneumonia. She had tested positive for SARS-Cov-2 after complaining of fever and mild dyspnea. When the dyspnea got worse she was admitted to hospital, where she was found to be hypoxemic. An ECG showed inferoposterior ST segment elevation. CT showed ground-glass opacities and consolidation. Furthermore, an embolus was identified in the right pulmonary artery. Coronary angiography showed thrombotic occlusion of the proximal left circumflex artery. Optical coherence tomography delineated evidence of a superimposed thrombus on a lipid-rich plaque without overt evidence of plaque rupture [6].

In the presence of COVID-19, ST segment elevation can also occur as a manifestation of Takotsubo cardiomyopathy (TTC) [9]. ST segment elevation can also occur as a result of COVID-19 myocarditis, in the total absence of either AMI, PE, or TTC [10].

### Comment

When ST segment elevation occurs in a patient with COVID-19 infection clinicians must be vigilant for the possibility that the underlying cause may either be AMI, PE, or the association of AMI and PE. Persistent hypotension [4], and persistent hypoxemia should also raise the index of suspicion for PE [5]. Point-of-care TTE should be routine practice in a patient with ST segment elevation, especially in the presence of either hypotension and/or persistent hypoxemia because those stigmata are also the hallmarks of life-threatening PE. TTE can be rewarding when it generates images that support the diagnosis of PE, thereby facilitating timely thrombolysis even in the absence of confirmatory CTPA [5]. The important cardiac implication is that, in the context of COVID-19 infection the differential diagnosis ST segment elevation encompasses, not only PE, but also coexistence of PE and AMI, coexistence of COVID-19 and TTC, and COVID-19-related myocarditis.

### Declaration of Competing Interest

None

## Acknowledgment

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## References

- [1] Kho J, Van den Abbeele A, Mandal K, Amit KJ, Canstantinos M Pulmonary embolism in COVID-19 Clinical characteristics and cardiac implications Am J Emerg Med (Article in Press).
- [2] Villablanca P, Vlismas PP, Aleksandrovich T, Omondi A, Gupta T, Briceno DF, et al. Case report and systematic review of pulmonary embolism mimicking ST-elevation myocardial infarction. *Vascular*. 2019;27:90–7.
- [3] Konstantinides SV, Meyer G, Becattini C, Bueno H, Geersing G-J, Harjola V-P. 2019 ESC guidelines for the diagnosis and management of acute pulmonary embolism developed in collaboration with the European Respiratory Society. *Eur Heart J*. 2020; 41:543–60.
- [4] Sang CJ, Heindl B, Von Mering G, Rajapreyar I. Massive pulmonary embolism in a COVID-19 patient : a case report. *Eur Heart J Case Rep*. 2020;4:1–5.
- [5] Ioan A-M, Durante-Lopez A, Martinez-Milla J, Perez-Calvo C, Santos A. Pulmonary embolism in COVID-19. When nothing is what it seems. *Rev Esp Cardiol*. 2020;73: 665–7.
- [6] Ueki Y, Otsuka T, Windecker S, Taber L. ST-elevation myocardial infarction and pulmonary embolism in a patient with COVID-19 acute respiratory distress syndrome. *Eur Heart J*. 2020. <https://doi.org/10.1093/eurheartj/ehaa399>.
- [7] Long B, Brady WJ, Koyfman A, Gottlieb M. Cardiovascular complications in COVID-19. *Am J Emerg Med*. 2020;38:1504–6.
- [8] Klok FA, Kruip MJHA, Van der Meer NJM, Arbous MS, DAMPJ Gommers, Kant KM, et al. Incidence of thromboembolic complications in critically ill ICU patients with COVID 19. *Thrombosis Res*. 2020;191:145–7.
- [9] Bottiroli M, De Caria D, Belli O, Calini A, Andreoni P, Siragusa A, et al. Takotsubo syndrome as a complication in a critically ill COVID-19 patient. *ESC Heart Failure*. 2020. <https://doi.org/10.1002/ehf2.12912>.
- [10] Fried JA, Bhatt R, Horn E, Rabbani L, Brodie D, Jain SS, et al. The variety of cardiovascular presentations of COVID-19. *Circulation*. 2020;141:1930–6.

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