Cardiac and Vascular Complications of COVID-19: A Review

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Pathogenesis of COVID-19 Cardiovascular Disease and Effects

Six proposed mechanisms:

1. Angiotensin converting enzyme (ACE-2) receptor-dependent myocardial infection causing direct cardiac damage. (1)
2. Hypoxia-induced injury due to oxidative stress, acidosis, and mitochondrial damage. (1)
3. Inflammation resulting in vessel hyperpermeability and angiospasm, causing damage to the heart's microvasculature. (1)
4. Systemic inflammatory reaction and cytosine storm mediating damage (1)
5. Vessel occlusion due to coagulopathy, thrombosis, embolus, plaque instability, or plaque rupture from system inflammatory response. (1)
6. Stress-induced cardiomyopathy and cardiac injury due to increases in catecholamines from a stress response in a patient. (1)

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Vascular Complications

VTE

~31% of patients with COVID-19 in the ICU had thrombotic complications despite thromboprophylaxis.

These patients exhibited prolonged PT (prothrombin time) and aPTT (activated partial thromboplastin time) time (3).

Concomitant venous and arterial thrombotic events

Several studies showed the presence of venous and arterial thrombosis in a high percentage of COVID-19 patients, with suggestive lab values including elevated D- dimer and elevated c-reactive protein (4,5)

Stroke

It is very important to screen high risk COVID-19 patients that present with comorbidities especially **hypertension** for the potential of stroke. (6)

Studies have shown that important markers in high risk patients that may indicate stroke include:
Elevated D-dimer, cardiac troponin T, prothrombin time, and c-reactive protein (7).

Coagulopathy

Some COVID-19 patients present with a term known as COVID-19 associated coagulopathy (CAC), similar to DIC (disseminated intravascular coagulation).

CAC differs from DIC in that it has:
elevated fibrinogen levels, elevated c-reactive protein, activated complement, and presence of antiphospholipid antibodies (2,4,7-9)

Cardiac Complications

Myocarditis

Similar to COVID-19, myocarditis is often preceded by flu-like and gastrointestinal symptoms (10)
46% of patients infected with COVID-19 with no known underlying cardiac disease had abnormal echocardiography findings (11))

Arrhythmias

16.7% of COVID-19 patients were seen with arrhythmias with 44.4% prevalence in those who were admitted to the ICU (18, 19)

Arrhythmias could be due to myocarditis, myocardial ischemia, infection-induced hypoxia, fever, metabolic disarray, hormonal dysregulation, medication (ex. azithromycin and hydroxychloroquine COVID-19 treatments), or inflammation. (20, 21, 22, 23)

Cardiac Biomarkers

Elevated troponin levels in COVID-19 patients were associated with elevated levels of CRP and NT-proBNP, linking myocardial injury to severity of inflammation,, and were also associated with a more severe disease course and worse prognosis (12-15)

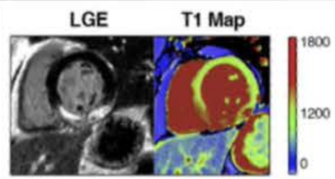
Acute Coronary Syndrome

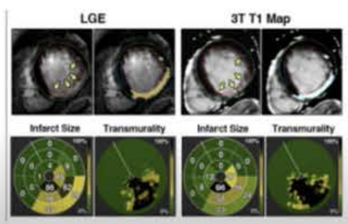
Increased thrombotic event risk can cause increased ACS risk in COVID-19 positive patients. (24)

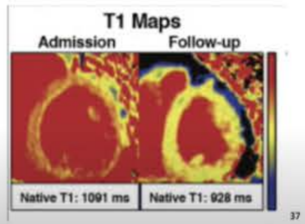
Myocardial injury with ST-segment elevation has been observed in positive patients in addition to reduced left ventricular ejection fraction and Brugada pattern have also been observed (25, 26-29)

Heart Failure

Heart failure related to ventricular dysfunction, myocarditis, acute coronary syndrome, arrythmia, pulmonary hypertension, ARDS, and cardiomyopathy occurs in up to 23% of COVID-19 patients (16,17).







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The COVID-19 Patient

- Patients with later confirmed COVID-19 may initially present to the doctor because of cardiovascular symptoms such as heart palpitations and chest tightness (30,31)
- Patients may also present with elevated cardiac biomarkers, myopericarditis, angina, chest pressure, ST-elevation, and systolic dysfunction without any signs or symptoms of infection such as fever, cough, dyspnea, or respiratory involvement (32-34)
- Atrial fibrillation, ventricular dysfunction, and myocarditis are sequelae seen in COVID-19 patients despite no evidence of prior CVD, CAD, HF, cancer, hypertension, or smoking

Does the risk of cardiovascular disease persist after COVID-19 infection?

- 10-year follow-up study showed an increased risk of cardiovascular disease and cardiac complications in pneumonia patients
- COVID-19 is primarily a respiratory illness and is likely to cause similar, long-term outcomes (35)
- COVID-19-recovered patients, 2-3 months after diagnosis, showed cardiac MRI abnormalities in 78% and myocardial inflammation in 60% (36)

Conclusion

Acute cardiac injury is a common cardiovascular complication of Covid19 and little is currently known about the long term implications of the complications and manifestations. Vascular complications show a hypercoagulable state which indicates potential for thromboembolism. By monitoring for both cardiac and vascular complications after hospitalization and administering anti-platelet and anti-coagulation therapies we have seen prevention of complications such as VTE. Developing a CV screening protocol for Covid-19 patients and recovered patients is crucial in monitoring and further research.

Literature Cited