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REVIEW

Risks of emergency vascular surgery in COVID-19 patients

Raed M. ENNAB [1] *, Waleed M. MOMANI [2], Anas M. JAIUOSSI [3], Alaa A. ALJABALI [4], Murtaza M. TAMBWALA [5]

[1]Department of Clinical Sciences and Vascular Surgery, Faculty of Medicine, Yarmouk University, Irbid, Jordan; [2]Department of Basic Sciences and Microbiology, Faculty of Medicine, Yarmouk University, Irbid, Jordan; [3]Department of Clinical Sciences and General Surgery, Faculty of Medicine, Yarmouk University, Irbid, Jordan; [4]Faculty of Pharmacy, Department of Pharmaceutics and Pharmaceutical Technology, Yarmouk University, Irbid, Jordan; [5]School of Pharmacy and Pharmaceutical Sciences, SAAD Center for Pharmacy and Diabetes, Ulster University, Coleraine, UK

*Corresponding author: Raed M. Ennab, Department of Clinical Sciences and Vascular Surgery, Faculty of Medicine, Yarmouk University, Pr. Hasan St., 21163 Irbid, Jordan. E-mail: raed.ennab@yu.edu.jo

ABSTRACT

COVID-19 is a global and highly contagious pandemic with substantial morbidity and mortality. It has affected the medical care of other diseases with recommendations to postpone elective surgical procedures to decrease infection rates. New surgical triage guidelines have been recommended by the Vascular Surgery Society to manage urgent and emergent conditions. COVID-19 patients especially severe cases have several pathological findings as demonstrated by clinical research. Some of these pathologies including thrombocytopenia, coagulopathy, and cardiac involvement are important to be considered by the vascular surgeon. The aim of this article was to review the literature and discuss these risks in relation to vascular surgery.

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KEY WORDS: COVID-19; SARS-CoV-2; Thrombocytopenia; Vascular surgical procedures; Coronavirus.

COVID-19 is a highly contagious pandemic with substantial morbidity and mortality. It is globally spreading and adversely affecting the health facilities and the medical services, putting limitations on the management of other diseases. The surgical societies including the Vascular Surgery Society have created triage guidelines to differentiate between urgent, emergent, and elective procedures which can be postponed. These guidelines aimed at limiting the cross-infection rate in hospitals with this highly contagious virus and decrease the load on the overloaded health facilities in pandemic areas. In addition, with the expanding knowledge about SARS-CoV-2, it is important to know the added risks of the surgical management of COVID-19 patients who may need urgent or emergent operations.

Literature search

We reviewed the triage guidelines recommended by members of the Society of Vascular Surgery and published at the society website.[1] In addition, we carried out a search in the literature and medical resources related to COVID-19 pandemic. We focused on original research articles that describe the characteristics of admitted COVID-19 patients in areas affected by the pandemic mainly in Wuhan, China. We reviewed the results of these studies focusing mainly on hematologic findings and cardiovascular complications. We reviewed the characteristics of those patients in terms of the presence of preexisting cardiovascular disease, progression to severe disease, the cardiovascular and hematologic complications, and the mortality rates.

The guidelines of the Society for Vascular Surgery (SVS) include triage lists of procedures according to urgency. Conditions and procedures were classified into tier 1 or elective, tier 2 or urgent and tier 3 or emergent procedures.[1] The rule for elective vascular surgical procedure under the COVID-19 pandemic is to postpone them until recovery from the disease. The emergent and urgent procedures which cannot be postponed include symptomatic or ruptured arterial aneurysms, acute aortic dissection complicated by rupture or malperfusion, symptomatic carotid stenosis, acute mesenteric or limb ischemia, prosthetic graft infections, complicated pseudoaneurysm, complicated dialysis access, renal failure with need for dialysis access, vascular injury with hemorrhage and/or ischemia, acute iliofemoral DVT with phlegmasia, and amputations for infection or wet gangrene.[1] The medical staff should take all precautions to prevent cross infection, considering that the incubation period is within 14 days.

In general, the risks of operating on a COVID-19 patient depend on severity of the disease, degree of systemic involvement and coagulopathy. Many vascular surgery procedures especially urgent and emergent ones are usually high-risk procedures which are done for comorbid patients, and the COVID-19 infection adds additional risks of morbidity and mortality. In the next paragraphs the risks are listed.

Thrombocytopenia

Thrombocytopenia is defined as low platelet count below 150,000/μl. Surgical bleeding due to thrombocytopenia does not generally occur until the platelet count is less than 50,000/μl, and spontaneous bleeding does not occur until the platelet count is less than 10,000 to 20,000/μl.[2] In general, there are many causes for thrombocytopenia in admitted patients including sepsis, disseminated intravascular coagulation (DIC), massive blood transfusion, adult respiratory distress syndrome, pulmonary embolism, and drug induced.[2-4]

Thrombocytopenia is associated with a worse prognosis and increased mortality in ICU patients.[3] Thrombocytopenia was observed in 36.2% of COVID-19 patients on admission and 57.7% of severe cases.[5] However, only 5% of the total cases and 8% of the ICU patients had platelets count below 100,000/μl.[6] A recent metanalysis showed that thrombocytopenia correlates with the severity of the disease and mortality rate.[7] The mechanism may be multifactorial and similar to SARS-CoV. SARS-CoV-2 is 80% similar to SARS-CoV and invades human cells by binding to the angiotensin-converting enzyme 2 (ACE2) receptor.[8] Previous studies on thrombocytopenia in SARS-CoV suggested that the lung endothelial damage may induce platelet aggregation and consumption. In addition, a low grade DIC may be responsible especially that patients showed increase in d-dimer and fibrinogen level.[9] In a study of 183 patients with COVID-19 the mortality rate was 11.5% (21 patients), the non-survivors had elevated D-dimer and fibrin degradation products (FDP), longer prothrombin time, and lower fibrinogen level. Also, 12 patients had platelets count below 100,000/μl of whom 5 patients had the count below 50,000/μl.[10]

Coagulation abnormalities

D-dimer, fibrinogen and prothrombin time have been found to be elevated in large percentage of COVID-19 patients, and this was more pronounced in severe cases. D-dimer elevation was noticed in 59.6% of severe case *vs.* 43.2% for non-severe cases,[5] and levels greater than 1 μg/mL were associated with fatal outcome of COVID-19.[11] Prothrombin time was found to be mildly elevated in most cases.[5, 6, 12] However, it was more than 16s in only 6% of the total cases and 13% among severe cases who did not survive.[11]

Cardiac involvement marked by high troponin T level was associated with high incidence of coagulopathy, and this includes elevated D-dimer level, Prothrombin time (PT), and activated partial thromboplastin time (APTT).[13, 14] Disseminated intravascular coagulation (DIC) criteria were fulfilled in 71.4% of non-survivals *vs.* 0.6 for survivals during hospitalization, with a median time of 4 days (range: 1-12 days) from admission to development of manifestations of DIC.[10] COVID-19 induces a hypercoagulable state supposedly through: 1) the binding of the virus to ACE2 receptors on the surface of endothelial cells causing dysfunction or damage with induction of thrombosis and shutdown of fibrinolysis;[10, 15, 16] 2) the inflammatory mediators storm may in theory be responsible for the increased risk;[17] and 3) the hypoxia can stimulate thrombosis in severe COVID-19 through increasing blood viscosity, and hypoxia-inducible transcription factor-dependent signaling pathway.[4, 18] In addition, the risk of venous thromboembolism is increased by the mechanical ventilation and central venous catheters in severe cases. So, the risk of DVT and PE is increased in COVID-19 patients and this directs us toward prophylaxis and management.

A recent lung organ dissection has reported microthrom-

bosis formation and occlusion in pulmonary small vessels of a critical patient with COVID-19.[19] The International Medical Prevention Registry on Venous Thromboembolism (IMPROVE) have added an elevated D-dimer in the inclusion criteria for VTE high risk patients creating the modified IMPROVE VTE Score.[4, 20] Elevated D-dimer is a prominent feature in COVID-19 patients, which increases the risk score and makes them eligible for thromboprophylaxis. It was found that prophylactic regimen of LMWH is associated with improved survival among COVID-19 patients who had sepsis induced DIC or elevated D-dimer.[21]

Acute myocarditis

In a study that involved 187 COVID-19 patients elevated troponin T levels was noted in 27.8% of patients due to myocardial injury, and this subgroup of patients had higher rate of malignant arrhythmias, mechanical ventilation and mortality.[14] Another study showed elevation of troponin I in 8-12% of hospitalized COVID-19 patients, and this was associated with poor prognosis.[22] Proposed mechanisms of myocardial injury include the binding of the virus to the endothelial ACE 2 receptors, the hypoxia due to lung involvement, and the inflammatory cytokine storm especially that elevated Troponin levels had linear correlation with C reactive protein (CRP) level.[14, 23] A case report for a patient with COVID-19 cardiac complication who had a myocardium biopsy showed virus localization within myocardial macrophages with low grade inflammation, this indicates a direct invasion of the virus of the myocardial tissue.[24]

The distribution of ACE2 receptors in tissues may explain the targeting of the virus to these tissues including type 1 and II lung alveolar epithelium, cardiomyocytes, vascular endothelial cells, pericytes, and enterocytes in the small bowel.[25] Patients with preexisting cardiovascular disease are more prone to develop cardiac injury in COVID-19.[14, 23, 26, 27] Elderly patients more than 60 years old with previous cardiovascular comorbidities like coronary artery disease, hypertension, diabetes, and/or arrhythmias are highly susceptible to have severe COVID-19 and high mortality rates.[12, 23, 26, 27] In one study, large percentages of patients with severe COVID-19 had cardiovascular disease including 25% had ischemic heart disease, 44% had arrythmias, and 58% had hypertension.[12]

The cardiovascular complications related to COVID-19 have been termed acute COVID-19 cardiovascular syndrome (ACovCS).[28] Manifestations of this syndrome may include arrythmias, acute heart failure, and cardiogenic shock with the absence of coronary artery disease [12, 28, 29]. These complications may occur at any time during hospitalization even after improvements in the respiratory status.[26, 27]

Conclusions

Substantial percentages of COVID-19 patients especially severe cases develop thrombocytopenia, Coagulopathy, and acute myocarditis. These complications may increase the risk in vascular procedures.

References

1. COVID-19 Resources for Members. Guidelines & Tools, Vascular Surgery Triage by Tier Class. Society for Vascular Surgery; 2020 [Internet]. Available from: https://vascular.org/news-advocacy/covid-19-resources#Guidelines&Tools [cited 2021, May 28].

2. Zarychanski R, Houston DS. Assessing thrombocytopenia in the intensive care unit: the past, present, and future. Hematology (Am Soc Hematol Educ Program) 2017;2017:660–6.

3. Khurana D, Deoke SA. Thrombocytopenia in Critically Ill Patients: Clinical and Laboratorial Behavior and Its Correlation with Short-term Outcome during Hospitalization. Indian J Crit Care Med 2017;21:861–4.

4. Terpos E, Ntanasis-Stathopoulos I, Elalamy I, Kastritis E, Sergentanis TN, Politou M, *et al.* Hematological findings and complications of COVID-19. Am J Hematol 2020;95:834–47.

5. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, *et al.*; China Medical Treatment Expert Group for Covid-19. Clinical Characteristics of Coronavirus Disease 2019 in China. N Engl J Med 2020;382:1708–20.

6. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al.* Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497–506.

7. Lippi G, Plebani M, Henry BM. Thrombocytopenia is associated with severe coronavirus disease 2019 (COVID-19) infections: A meta-analysis. Clin Chim Acta 2020;506:145–8.

8. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, *et al.*; China Novel Coronavirus Investigating and Research Team. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020;382:727–33.

9. Yang M, Ng MH, Li CK. Thrombocytopenia in patients with severe acute respiratory syndrome (review) [review]. Hematology 2005;10:101–5.

10. Tang N, Li D, Wang X, Sun Z. Abnormal coagulation parameters are associated with poor prognosis in patients with novel coronavirus pneumonia. J Thromb Haemost 2020;18:844–7.

11. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, *et al.* Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet 2020;395:1054–62.

12. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, *et al.* Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. JAMA 2020;323:1061–9.

13. Guo T, Fan Y, Chen M, Wu X, Zhang L, He T, *et al.* Cardiovascular Implications of Fatal Outcomes of Patients With Coronavirus Disease 2019 (COVID-19). JAMA Cardiol 2020;5:811–8.

14. Guo J, Huang Z, Lin L, Lv J. Coronavirus Disease 2019 (COVID-19) and Cardiovascular Disease: A Viewpoint on the Potential Influence of Angiotensin-Converting Enzyme Inhibitors/Angiotensin Receptor Blockers on Onset and Severity of Severe Acute Respiratory Syndrome Coronavirus 2 Infection. J Am Heart Assoc 2020;9:e016219.

15. Schmitt FC, Manolov V, Morgenstern J, Fleming T, Heitmeier S, Uhle F, *et al.* Acute fibrinolysis shutdown occurs early in septic shock and is

associated with increased morbidity and mortality: results of an observational pilot study. Ann Intensive Care 2019;9:19.

16. Zhang YH, Zhang YH, Dong XF, Hao QQ, Zhou XM, Yu QT, *et al.* ACE2 and Ang-(1-7) protect endothelial cell function and prevent early atherosclerosis by inhibiting inflammatory response. Inflamm Res 2015;64:253–60.

17. Evans CE. Hypoxia and HIF activation as a possible link between sepsis and thrombosis. Thromb J 2019;17:16.

18. Luo W, Yu H, Gou J, Li X, Sun Y, Li J, *et al.* Clinical Pathology of Critical Patient with Novel Coronavirus Pneumonia (COVID-19). Transplantation 2020. [Epub ahead of print]

19. Spyropoulos AC, Lipardi C, Xu J, Peluso C, Spiro TE, De Sanctis Y, *et al.* Modified IMPROVE VTE Risk Score and Elevated D-Dimer Identify a High Venous Thromboembolism Risk in Acutely Ill Medical Population for Extended Thromboprophylaxis. TH Open 2020;4:e59–65.

20. Tang N, Bai H, Chen X, Gong J, Li D, Sun Z. Anticoagulant treatment is associated with decreased mortality in severe coronavirus disease 2019 patients with coagulopathy. J Thromb Haemost 2020;18:1094–9.

21. Lippi G, Lavie CJ, Sanchis-Gomar F. Cardiac troponin I in patients with coronavirus disease 2019 (COVID-19): evidence from a meta-analysis. Prog Cardiovasc Dis 2020;63:390–1.

22. Zheng YY, Ma YT, Zhang JY, Xie X. COVID-19 and the cardiovascular system. Nat Rev Cardiol 2020;17:259–60.

23. Tavazzi G, Pellegrini C, Maurelli M, Belliato M, Sciutti F, Bottazzi A, *et al.* Myocardial localization of coronavirus in COVID-19 cardiogenic shock. Eur J Heart Fail 2020;22:911–5.

24. Hamming I, Timens W, Bulthuis ML, Lely AT, Navis G, van Goor H. Tissue distribution of ACE2 protein, the functional receptor for SARS coronavirus. A first step in understanding SARS pathogenesis. J Pathol 2004;203:631–7.

25. Bhatraju PK, Ghassemieh BJ, Nichols M, Kim R, Jerome KR, Nalla AK, *et al.* Covid-19 in Critically Ill Patients in the Seattle Region - Case Series. N Engl J Med 2020;382:2012–22.

26. Fried JA, Ramasubbu K, Bhatt R, Topkara VK, Clerkin KJ, Horn E, *et al.* The Variety of Cardiovascular Presentations of COVID-19. Circulation 2020;141:1930–6.

27. Hendren NS, Drazner MH, Bozkurt B, Cooper LT Jr. Description and Proposed Management of the Acute COVID-19 Cardiovascular Syndrome. Circulation 2020;141:1903–14.

28. Inciardi RM, Lupi L, Zaccone G, Italia L, Raffo M, Tomasoni D, *et al.* Cardiac Involvement in a Patient With Coronavirus Disease 2019 (COVID-19). JAMA Cardiol 2020;5:819–24.

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