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Coexistence of Intramuscular Hematoma in Patients with a Diagnosis of COVID-19

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Abstract

Objective: The current study emphasizes that intramuscular hemorrhage should be considered in cases where low-molecular-weight heparin is applied to prevent and treat hypercoagulability in coronavirus disease-2019 (COVID-19), and these cases should be followed closely because spontaneous bleeding complications may also occur in COVID-19.

Methods: The current study included 24 patients who were hospitalized with a diagnosis of COVID-19 and who had intramuscular bleeding during their follow-up. Data such as gender, age, diabetes, hypertension, cancer history, previous intra-abdominal surgery, coronary artery disease, presence of additional disease such as kidney failure, drugs used before and after hospitalization, and patients' need for intensive care, and the need for intubation and blood replacement were recorded for all patients.

Results: Of the patients, 16 (66.7%) were male, 8 (33.3%) were female, and the mean age was 71.9 (47-87) years. Comorbidities were present in 18 of the patients. It was seen in radiology reports that 54.2% of intramuscular bleeding developed within the psoas muscle in the retroperitoneum. In 21 (87.5%) patients, erythrocyte replacement therapy was performed in line with the clinical findings because of bleeding. The number of patients whose treatment required intensive care was 14 (58.3%) and 6 (25%) patients had to be intubated. Mortality was seen in 9 (37.5%) patients. The presence of comorbidity, international normalized ratio value, high pressure oxygen therapy, the need for intensive care and the need for intubation showed statistically significant differences in the development of mortality.

Conclusion: To reduce mortality and morbidity due to hypercoagulability that may develop after COVID-19 infection, more studies on how, at what doses and when anticoagulation should be given and the preparation of guidelines for this will be beneficial in treatment management. It is thought that cases with intramuscular bleeding should be observed closely, supportive treatment should be applied promptly, and surgical option should be considered.

Keywords: COVID-19, retroperitoneal hematoma, enoxaparin

INTRODUCTION

Coronavirus disease-2019 (COVID-19) turned into a pandemic that affected the entire world in 2019 after the first case was reported in Wuhan, China (1). In addition to clinical findings such as muscle pain, fatigue, cough, and fever, shortness of breath, pneumonia, and even acute respiratory distress syndrome (ARDS), which greatly affects mortality, can be seen among the symptoms of the disease (2). Although almost 2 years have passed since the initiation of the pandemic, different clinical symptoms, and complications can be seen in COVID-19 patients.

Microthrombosis is one of the most severe complications of COVID-19 and affects predominantly respiratory system. Because of these microthrombosis, an increased incidence of pulmonary thromboembolism and cerebrovascular disease was observed (3). Inflammation, endothelial dysfunction, and related thrombosis are also observed in patients with vascular involvement after COVID-19 (2). Especially since pulmonary thromboembolism is a

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complication that increases mortality, many studies recommend the use of heparin, low-molecular-weight heparin (LWMH), and other anticoagulants in the treatment (4).

LWMH is routinely used in our clinical for the prevention and treatment of hypercoagulopathy in COVID-19 patients. Prophylactic dose anticoagulation should be used in hospitalized COVID-19 patients by monitoring bleeding in American Society of Hematology guidelines (5).

Intramuscular hemorrhage was observed in 24 patients who were hospitalized and followed up by us due to COVID-19. The current study emphasizes that intramuscular hemorrhage should be considered in cases where LWMH is applied to prevent and treat hypercoagulability in COVID-19, and these cases should be followed closely because spontaneous bleeding complications may also occur in COVID-19.

METHODS

A total of 24 patients who were hospitalized with the diagnosis of COVID-19 in Bahcelievler State Hospital and University of Health Sciences Turkey, Bakirkoy Dr. Sadi Konuk Training and Research Hospital between March 2020 and May 2021 and who had intramuscular bleeding during their follow-up were included in the current study. Patient information, laboratory results, computed tomography (CT) reports and clinical course were retrospectively reviewed. Data such as gender, age, diabetes, hypertension, cancer history, previous intra-abdominal surgery, coronary artery disease (CAD), presence of additional disease such as kidney failure, drugs used before and after hospitalization, and patients' need for intensive care, and the need for intubation and blood replacement were recorded for all patients.

Patients with any blood disease, a history of previous intra-abdominal surgery and femoral vascular catheterization, and a three-month history of trauma were excluded from the study.

This study was designed in accordance with the principles of the Declaration of Helsinki. Approval received from the Ministry of Health COVID-19 Scientific Research Oversight Committee (2021-05-25T08_36_48).

Statistical Analysis

The SPSS (Statistical Package for the Social Sciences) 24.0 program was used in the analysis of the variables. Evaluating the study data, descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, maximum) as well as the independent samples t-test was used for comparisons of normally distributed groups, while Mann-Whitney U test was used for comparisons of non-normally distributed groups. The Pearson chi-square test was used in the analysis of qualitative data. The multivariate regression analysis was used to determine the effect levels. Significance was evaluated at $p<0.01$ and $p<0.05$ levels.

RESULTS

The data of 24 patients who were hospitalized with the diagnosis of COVID-19 and had intramuscular bleeding during their follow-up were analyzed. The demographic data showed that 16 (66.7%) patients were male and 8 (33.3%) were female. The mean age was 71.96±13 (47-87) years. Comorbidities were present in 18 of the patients. When the diseases were investigated, it was seen that hypertension was the first, followed by diabetes mellitus, CAD, and chronic kidney failure (Table 1). During the examination of the hospitalization files, it was seen that lung involvement was classified in the severe category in 41% of the patients. Radiology reports showed that 54.2% of intramuscular bleeding developed in the psoas muscle in the retroperitoneum. Erythrocyte replacement therapy was performed in 21 (87.5%) patients, in line with the clinical findings because of bleeding. The number of patients whose treatment required intensive care was 14 (58.3%) and 6 (25%) patients had to be intubated. Mortality developed in 9 (37.5%) patients (Table 1). The mean hospital stay of all patients was 13.8 (3-31) days. Radiological examinations showed that intramuscular hemorrhages also occurred on average on the fifth day of hospitalization. The mean hemoglobin (Hgb) value of the patients was measured as 8.6 (g/dL), mean leukocyte count as 13.7 ($\times 10^3$/mL), mean platelet count as 191.25 ($\times 10^3$/mL), mean international normalized ratio (INR) value as 1.31, mean prothrombin time (PT) 1.84 (sec), mean activated partial thromboplastin time (aPTT) as 38.5 (sec), mean fibrinogen concentration as 463.17 (mg/dL), and mean lactate dehydrogenase level (LDH) as 455 (U/L). It was seen that oxygen support was provided to all patients and they received this treatment on an average of 10 liters. The mean intramuscular hemorrhage size was 84 mm and an average of 4 units of erythrocyte replacement was applied to the patients (Table 1).

The patients who had intramuscular bleeding were divided into two groups according to their mortality status and the factor causing mortality was questioned. When the group discharged from the hospital with recovery and the group that had mortality were examined considering the parameters reported above, there was no statistical difference between the two groups in terms of gender distribution, COVID involvement degree, hematoma location, and erythrocyte replacement status ($p>0.05$). However, the presence of comorbidity, the need for intensive care, and the

need for intubation showed statistically significant differences (p=0.028, p=0.019, p=0.001, p<0.05, respectively) (Table 2).

Table 1. Distribution of demographic characteristics and laboratory values

		n	%
Gender n (%)	Male	16	66.7
	Female	8	33.3
Comorbidity n (%)	Absent	6	25.0
	Present	18	75.0
HT		14	77.8
DM		4	22.2
COPD		3	16.7
KAH		4	22.2
CVO		3	16.7
CRF		4	22.2
COVID involvement rate n (%)	Mild	5	20.8
	Medium	9	37.5
	Severe	10	41.7
In-hospital mortality n (%)	No	15	62.5
	Yes	9	37.5
ICU admission n (%)	Absent	10	41.7
	Present	14	58.3
Intubation n (%)	Absent	18	75.0
	Present	6	25.0
Place of hematoma n (%)	Rectus muscle	11	45.8
	Retroperitoneum	13	54.2
Patients with RBC transfusion n (%)	No	3	12.5
	Yes	21	87.5
		Mean ± SD	
Age (year)		71.96±13	
Day when the bleeding occurred (days)		5.04±3.69	
Length of hospital stay (days)		13.83±3.69	
Hemoglobin (g/dL)		8.69±7.17	
INR levels		1.31±0.42	
Prothrombin time, (%)		1.84±2.6	
Activated partial thromboplastin time, (sec)		38.5±18.2	
Platelet (×10³/mL)		191.25±96.58	
Leucocyte (×10³/mL)		13.73±11.03	
Lactate dehydrogenase (U/L)		455±169.12	
Fibrinogen concentration (mg/dL)		463.17±152.75	
Pressurized oxygen liter (L)		10.88±8.05	
Hematoma diameter (mm)		84.54±34.7	
Amount of replacement (unit)		4.33±2.71	

HT: Hypertension, DM: Diabetes mellitus, COPD: Chronic obstructive lung disease, CVO: Cerebrovascular occlusion, CRF: Chronic renal failure, ICU: Intensive care unit, RBC: Red blood cell, COVID: Coronavirus disease, SD: Standard deviation

The data of both groups, such as mean age, day of bleeding, length of hospital stay, Hgb value, platelet count, PT value, aPTT value, LDH value, fibrinogen concentration, hematoma diameter, and amount of erythrocyte replacement did not show any statistically significant difference (p>0.05). However, INR value (p=0.014; p<0.05) and leukocyte values (p=0.008; p<0.05) differed statistically, and these values were higher in the mortality group. Similarly, it was observed that pressure oxygen therapy was given at a higher amount in the mortality group, and this showed a statistically significant difference (p=0.001; p<0.01) (Table 3).

Because of the comparison of the groups, factors associated with mortality were determined. Multivariate analysis was performed on the variables to determine which of these variables made the strongest difference. Intubation requirement and leukocyte value were found to be significant in the model because of multivariate analyses (p<0.01) (Table 4).

DISCUSSION

COVID-19 can cause thrombosis in both small and large vessels due to microthrombi. The incidence of deep vein thrombosis in patients diagnosed with COVID-19 and undergoing autopsy is almost 50% (3). Additionally, complement-mediated microvascular damage and thrombosis were observed in the autopsies of patients who developed ARDS after COVID-19 (6). In their autopsy study conducted in patients who developed ARDS after COVID-19 and influenza, Ackermann et al. (7), reported that the development of capillary microthrombus was nine times higher in the COVID-19 group. In other studies, it was reported that many cases develop hypercoagulopathy after COVID-19 (2). In a study conducted in an intensive care unit, venous thromboembolism was found in many patients who developed ARDS after COVID-19 and used anticoagulants (2,8). As seen in the literature, in patients followed up for COVID-19, respiratory failure is caused by microthrombus (9,10). This hypercoagulable state, which is thought to be triggered by proinflammatory cytokines, can cause microvascular thrombi, multi-organ failure and death (9,11). In a study, 449 patients with a diagnosis of COVID-19 were examined and heparin did not have a significant effect on the 28-day mortality. Again, in the same study, mortality was found to be significantly lower after heparin use in the group with D-dimer levels more than 6 times the normal value (12). Therefore, the patients followed up in this study had been using LWMH since hospitalization.

Although the World Health Organization and the American Society of Hematology recommend the use of anticoagulation

Table 2. Evaluation of groups created according to mortality						
		Ex		Discharged		[a]p
		n	%	n	%	
Gender	Male	5	55.6	11	73.3	0.371
	Female	4	44.4	4	26.7	
Comorbidity	Absent	0	0.0	6	40.0	0.028*
	Present	9	100.0	9	60.0	
COVID involvement rate	Mild	3	33.3	2	13.3	0.367
	Medium	2	22.2	7	46.7	
	Severe	4	44.4	6	40.0	
ICU admission	Absent	1	11.1	9	60.0	0.019*
	Present	8	88.9	6	40.0	
Intubation	Absent	3	33.3	15	100.0	0.001**
	Present	6	66.7	0	0.0	
Place of hematoma	Rectus muscle	3	33.3	8	53.3	0.341
	Retroperitoneum	6	66.7	7	46.7	
Patients with RBC transfusion n (%)	No	1	11.1	2	13.3	0.871
	Yes	8	88.9	13	86.7	

[a]Pearson chi-square, *p<0.05, **p<0.01, COVID: Coronavirus disease, RBC: Red blood cell, ICU: Intensive care unit

Table 3. Evaluation of the measurements of the groups created by mortality					
	Ex		Discharged		[b]p
	Mean ± SD	Min-max (median)	Mean ± SD	Min-max (median)	
Age	76.22±13.48	47-87 (81)	69.4±12.46	49-86 (75)	0.107
Day when the bleeding occurred	5.11±3.06	2-11 (5)	5±4.12	1-18 (5)	0.696
Length of hospital stay (days)	11.67±4.3	3-17 (12)	15.13±8.32	3-31 (14)	0.437
Hemoglobin (g/dL)	8.14±1.81	6.4-11.9 (7.4)	9.02±1.66	5.3-12.1 (9.3)	0.083
INR levels	1.49±0.4	1-2.4 (1.39)	1.19±0.41	0.8-2.4 (1.1)	0.014*
Prothrombin time, (%)	1.69±0.4	1-2.4 (1.39)	2.05±3.3	0.8-13.9 (1.1)	0.078
Activated partial thromboplastin time, (sec)	51.28±23.83	22.4-86.8 (42)	40.84±7.18	16.9-45.6 (30.5)	0.219
Platelet ($\times 10^3$ mL)	172.56±109.62	44-372 (155)	202.47±89.98	98-382 (171)	0.325
Leucocyte ($\times 10^3$ mL)	20.78±15.25	10-58 (16)	9.49±3.98	4-18 (8)	0.008**
Lactate dehydrogenase (U/L)	515.56±183.3	189-787 (507)	418.67±154.97	234-893 (391)	0.101
Fibrinogen concentration (mg/dL)	490.67±171.17	120-703 (538)	446.67±144.26	261-740 (402)	0.270
Pressurized oxygen liters	18.89±7.08	6-30 (20)	6.07±3.43	2-15 (4)	0.001**
Hematoma diameter (mm)	85.56±29.89	27-125 (69)	95.93±33.12	40-160 (100)	0.739
Replacement amount (U)	6±3.7	1-12 (6)	3.31±1.11	2-6 (3)	0.058

[b]Mann-Whitney U Test, *p<0.05, **p<0.01, INR: International normalized ratio, SD: Standard deviation

with LWMH in hospitalized COVID-19 patients, there are no guidelines describing dosages and indications (1,9). In a study conducted in China, the use of fractioned heparin was recommended in the treatment because it can be controlled with protamine and is short-lived. However, some researchers reported that this requires frequent injections and may spread the infection (1).

Patients under anticoagulation may encounter a clinical picture ranging from simple hemorrhages to life-threatening retroperitoneal hemorrhages if not followed carefully. Bleeding can also occur spontaneously without anticoagulant drugs. These can often develop due to severe coughing, pregnancy, and trauma. Especially, the superior epigastric artery and its branches passing through the rectus muscles can be injured after sudden and high-intensity contractions in the muscles (13).

Table 4. Multivariate analysis of groups by mortality				
	Multivariate p value	Odd's ratio	95% CI for EXP (B)	
			Lower	Upper
Comorbidity	0.346	0.125	-0.164	0.442
ICU admission	0.199	0.181	-0.103	0.459
Intubation	**0.005**	**0.684**	**0.266**	**1.262**
INR	0.794	0.031	-0.254	0.327
Leucocyte	**0.009**	**0.558**	**0.007**	**0.043**
Pressurized oxygen liters	0.550	-0.168	-0.046	0.025
ICU: Intensive care unit, INR: International normalized ratio, CI: Confidence interval				

Retroperitoneal bleeding is seen, especially around the psoas muscle, and the hematoma can grow up to 10 times that of the psoas muscle (14,15). The incidence may also increase after heparin administration. Intramuscular hematoma can be seen after LWMH application, particularly in elderly patients, even if there is no underlying disease (2). However, it has been stated in many studies that COVID-19 is also a factor that develops spontaneous muscle hematoma (2). In the literature, studies have stated that hematochezia, subarachnoid, and intracerebral hemorrhage, petechiae and purpura are seen after COVID-19 (2). In one study, a large intracerebral hemorrhage was detected by CT in a 79-year-old patient who was followed up for COVID-19 and did not have hypertension and did not receive anticoagulant therapy (16). Terzi et al. (17), on the other hand, reported a case of intramural hematoma seen after COVID-19 and emphasized that it can cause vascular damage with inflammation, microangiopathy, and thrombosis in the vascular system in COVID-19 patients in the same study. Rogani et al. (2), similarly, stated that not only hypercoagulability is observed in COVID-19, but also bleeding may develop. In this study, bleeding was detected in 11 patients (45.8%) in the rectus muscle and in 13 patients (54.2%) in the retroperitoneal region. No underlying cause for bleeding was found in these patients. However, bleeding in the mortality group was in the rectus muscle in 3 patients (33.3%) and in the retroperitoneal area in 6 patients (66.7%). In this study, there was no statistically significant relationship between the site of hematoma and mortality (p=0.347).

In another case, hematoma in the neck and upper chest was reported after prophylactic LWMH use (18). In another study, 4 patients who were treated with LWMH in post-COVID-19 treatment and who developed hematomas in different regions were treated with vascular coil embolization that caused bleeding. In the study, it was evaluated that trauma may have bled 2 patients, while no cause was found in the other two patients (19). In a case study by Javid et al. (3), we presented a patient who was followed up with the diagnosis of COVID-19 and developed spontaneous retroperitoneal hematoma and had no known disease other than hypertension and diabetes before. Since D-dimer was higher than normal, 5000 units of intravenous heparin was given to the patient every 6 h. After 2 days, the patient started to have right flank pain and a large bleeding area was observed around the psoas muscle in the contrast-enhanced CT. After heparin was discontinued, the patient's hematoma regressed. As a result, they recommended careful monitoring of Hgb levels in patients who received heparin at the therapeutic dose (3). In this study, 18 patients (75%) had an additional disease. The mean Hgb level was found to be 8.69. While gender, age, degree of COVID involvement, the location of hematoma, Hgb, aPTT and platelet level, and amount of blood transfusion were not statistically significant in terms of mortality, the presence of additional disease and high leukocyte level were found to be factors affecting mortality (p=0.028, p=0.008). Contrary to the current study, in the study by Lippi et al. (20), low leukocyte levels were found to be significant in terms of mortality. They also stated that low platelet count was also associated with mortality (20). In the study by Canoglu and Saylan (1) similar to the current study, the platelet level was not found to be significant in terms of mortality. However, in the study by Canoglu and Saylan (1), INR, and aPTT levels were significant in terms of mortality. Although INR, aPTT and platelet levels are not significant in the current study, low platelet levels will lead to continued bleeding (p=0.014, p=0.219, p=0.325). It is considered that this will increase mortality later on.

Conti et al. (21) reported two psoa hematomas that developed pneumonia due to COVID-19 and were supported by a continuous positive airway pressure (CPAP) mask. LWMH was used in two patients and LWMH was administered at the therapeutic dose in one patient because of underlying DVT. Embolization under angiography was used as a treatment method in both patients. It was emphasized that the use of CPAP and cough symptoms may increase intra-abdominal bleeding (21). In this study, an average of 10.88 liters of pressurized oxygen was administered to all patients, and a statistically significant difference was found between the groups in terms of mortality (p=0.001). Additionally, hospitalization in the intensive care unit and intubation of the patients were found to be statistically significantly correlated (p=0.019, p=0.001).

Intramuscular bleeding may present with hypotension, low Hgb, and abdominal pain. CT is useful for diagnosing (9). In this study, hematoma was determined by CT taken after hospitalization due to COVID-19 and CT images taken after low hemogram in the follow-ups. Hematoma localization and hematoma diameter were followed. The first recommendation in treatment is the

discontinuation of the anticoagulant drug, fluid replacement and support of the patient's blood values. In the case of active bleeding, endovascular and surgical methods can be applied (2,9). In the patient group in this study, supportive treatment was applied to the patients who had laboratory and clinical follow-ups. Mean Hgb levels were 8.69. hematoma diameter was measured to 84.54 mm on average. Blood transfusion was performed in 21 patients (87.5%). An average of 4.33 units of erythrocyte suspension was applied. Hgb level, mean hematoma diameter, and blood transfusion were not among the factors affecting mortality. Multivariate analysis was performed for comorbid disease, hospitalization in the intensive care unit, intubation, INR level, leukocyte level and pressurized oxygen liter, which are among the factors affecting mortality. In patients who developed intramuscular bleeding after COVID-19, the factors that most affected mortality was found to be high leukocyte levels and intubation ($p=0.009$, $p=0.005$).

CONCLUSION

The COVID-19 pandemic has caused serious mortality and morbidity in our country and has become a major health problem. Hypercoagulable events such as proinflammatory processes and subsequent D-dimer increase are quite common in COVID-19. Hemorrhagic problems that may develop after hypercoagulability are not fully known. However, intramuscular bleeding is observed after the use of high-dose heparin for treating COVID-19. Therefore, to reduce mortality and morbidity, more studies on how, at what doses and when anticoagulation should be given, and the preparation of guidelines will be beneficial in the management of treatment. In conclusion, it is evaluated that cases with intramuscular bleeding should be kept under close observation, supportive treatment should be applied promptly, and a surgical option should be considered.

Ethics

Ethics Committee Approval: This study was designed in accordance with the principles of the Declaration of Helsinki. Approval received from the Ministry of Health COVID-19 Scientific Research Oversight Committee (2021-05-25T08_36_48).

Informed Consent:

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Authorship Contributions

Surgical and Medical Practices: M.A., E.G., Concept: M.A., E.G., Design: M.A., E.G., Data Collection or Processing: M.A., E.G., Analysis or Interpretation: M.A., E.G., Literature Search: M.A., Writing: M.A., E.G.

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REFERENCES

1. Canoglu K, Saylan B. Therapeutic dosing of low-molecular-weight heparin may decrease mortality in patients with severe COVID-19 infection. Ann Saudi Med 2020;40:462-8.
2. Rogani S, Calsolaro V, Franchi R, Calabrese AM, Okoye C, Monzani F. Spontaneous muscle hematoma in older patients with COVID-19: two case reports and literature review. BMC Geriatr 2020;20:539.
3. Javid A, Kazemi R, Dehghani M, Bahrami Samani H. Catastrophic retroperitoneal hemorrhage in COVID-19 patients under anticoagulant prophylaxis. Urol Case Rep 2021;36:101568.
4. Kollias A, Kyriakoulis KG, Dimakakos E, Poulakou G, Stergiou GS, Syrigos K. Thromboembolic risk and anticoagulant therapy in COVID-19 patients: emerging evidence and call for action. Br J Haematol 2020;189:846-7.
5. Cuker A, Tseng EK, Nieuwlaat R, Angchaisuksiri P, Blair C, Dane K, et al. American Society of Hematology 2021 guidelines on the use of anticoagulation for thromboprophylaxis in patients with COVID-19. Blood Adv 2021;5:872-88.
6. Magro C, Mulvey JJ, Berlin D, Nuovo G, Salvatore S, Harp J, et al. Complement associated microvascular injury and thrombosis in the pathogenesis of severe COVID-19 infection: A report of five cases. Transl Res 2020;220:1-13.
7. Ackermann M, Verleden SE, Kuehnel M, Haverich A, Welte T, Laenger F, et al. Pulmonary vascular endothelialitis, thrombosis, and angiogenesis in Covid-19. N Engl J Med 2020;383:120-8.
8. Llitjos JF, Leclerc M, Chochois C, Monsallier JM, Ramakers M, Auvray M, et al. High incidence of venous thromboembolic events in anticoagulated severe COVID-19 patients. J Thromb Haemost 2020;18:1743-6.
9. Patel I, Akoluk A, Douedi S, Upadhyaya V, Mazahir U, Costanzo E, et al. Life-threatening psoas hematoma due to retroperitoneal hemorrhage in a COVID-19 patient on enoxaparin treated with arterial embolization: a case report. J Clin Med Res 2020;12:458-61.
10. Klok FA, Kruip MJHA, van der Meer NJM, Arbous MS, Gommers DAMPJ, Kant KM, et al. Incidence of thrombotic complications in critically ill ICU patients with COVID-19. Thromb Res 2020;191:145-7.
11. Thachil J, Tang N, Gando S, Falanga A, Cattaneo M, Levi M, et al. ISTH interim guidance on recognition and management of coagulopathy in COVID-19. J Thromb Haemost 2020;18:1023-6.
12. 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.
13. Nematihonar B, Qaderi S, Shah J, Bagherpour JZ. Spontaneous giant rectus sheath hematoma in patients with COVID-19: two case reports and literature review. Int J Emerg Med 2021;14:40.
14. Artzner T, Clere-Jehl R, Schenck M, Greget M, Merdji H, De Marini P, et al. Spontaneous ilio-psoas hematomas complicating intensive care unit hospitalizations. PLoS One 2019;14:e0211680.
15. Surani S, Estement B, Manchandan S, Sudhakaran S, Varon J. Spontaneous extraperitoneal lumbar artery hemorrhage. J Emerg Med 2011;40:111-4.

16. Sharifi-Razavi A, Karimi N, Rouhani N. COVID-19 and intracerebral haemorrhage: causative or coincidental? New Microbes New Infect 2020;35:100669.

17. Terzi F, Cefarelli M, Fattori R, Di Eusanio M. Intramural hematoma as unexpected complication of COVID-19 infection. Aorta (Stamford) 2020;8:74-5.

18. Mattioli M, Benfaremo D, Fustini E, Gennarini S. Atypical spontaneous hematomas in a patient with severe coronavirus disease 2019 (COVID-19). Semin Thromb Hemost 2020;46:856-8.

19. Bargellini I, Cervelli R, Lunardi A, Scandiffio R, Daviddi F, Giorgi L, et al. Spontaneous bleedings in COVID-19 patients: an emerging complication. Cardiovasc Intervent Radiol 2020;43:1095-6.

20. 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.

21. Conti CB, Henchi S, Coppeta GP, Testa S, Grassia R. Bleeding in COVID-19 severe pneumonia: the other side of abnormal coagulation pattern? Eur J Intern Med 2020;77:147-9.