Published online 2023 June 20 **Original Article**

Effects of the Covid-19 Pandemic on Patients with Fournier's Gangrene

Zeliha Turkyilmaz[1] and Yusuf Emre Aytin[1*]

[1]Department of General Surgery, University of Trakya, Faculty of Medicine, Edirne, Turkey

*** *Corresponding author:*** Yusuf Emre Aytın, Department of General Surgery, University of Trakya, Faculty of Medicine, Edirne, Turkey. Email: aytinyusuf@gmail.com; Tel: +905413391209

Received 2022 August 04; **Revised** 2022 October 05; **Accepted** 2023 May 18.

Abstract

Background: The first case of COVID-19 infection in Turkey was reported on March 11th, 2020, and declared a pandemic by the World Health Organization (WHO) in March 2020, introducing new regulations to national health systems. Some patients with non-COVID-19 presentations may have been adversely affected by this pandemic.

Objectives: The present study aimed to investigate the effect of COVID-19 on patients with Fournier's gangrene during the pandemic and the impact of the COVID-19 pandemic on the clinical management and patient outcomes for Fournier's gangrene.

Methods: This retrospective cross-sectional study was conducted between March 2018 and March 2022 at the General Surgery Department of Trakya University. Patients were stratified into pre-pandemic and pandemic groups based on the date of March 11th, 2020, when the first Covid-19 case was reported in Turkey. Data collection and retrospective analysis were completed for all patients who were operated on for Fournier's gangrene originating from the perianal region. Demographic characteristics, predisposing factors, as well as laboratory and clinical results of the patients treated during the pandemic, were compared with the patients treated before the pandemic.

Results: A total of 43 patients were included in the study (pre-pandemic: 24, pandemic: 19). There was a statistically significant difference between the pre-pandemic and pandemic groups in terms of the median length of hospital stay (7 vs. 16 days, $p<0.001$) and the median number of debridement (4 vs. 2, $p=0.002$).

Conclusion: In the presence of life-threatening surgical pathologies, such as Fournier's gangrene, the number of admissions did not decrease despite the pandemic. Precautions taken to reduce the risk of transmission in pandemic conditions and more aggressive surgical applications can reduce the number of debridement procedures and shorten the length of hospital stay. Subsequently, this is associated with similar treatment outcomes, lower morbidity, and reduced treatment costs.

Keywords: COVID-19, Fournier's gangrene, Gas gangrene, Pandemic, Necrotizing fasciitis

1. Background

The first case of COVID-19 infection in Turkey was reported on March 11th, 2020, and the World Health Organization (WHO) declared it a pandemic in March 2020 (1). The initial lack of information about the mode of transmission, diagnosis, treatment, and follow-up of the disease, especially at the start of the pandemic, led to serious chaos in the healthcare system and the diversion of procedures and hospital services to cope with the pandemic. The increased number of COVID-19 cases in healthcare centers and high mortality among infected individuals caused fear among the population, resulting in decreased numbers or delayed presentations for non-Covid-19 health problems. At a time when the healthcare system worldwide was struggling against COVID-19, non-cancer elective surgeries were largely canceled to reserve hospital resources, decrease the risk of transmission, and have a balanced number of healthcare personnel. Against this background of an unpredictable and adverse situation created by the pandemic in the healthcare system, it remains unclear to what extent COVID-19 affected patients requiring emergency surgery (2, 3).

Fournier gangrene (FG) is a diagnosis requiring emergency surgery in general surgery clinics. It was first described in 1794 by Bauriene and named after the French dermatologist Jean Alfred Fournier (1832-1914), who conducted a considerable number of studies on the subject and suggested that the Fournier gangrene was associated with diabetes (4, 5). Fournier gangrene is frequently observed in the perianal region and external genitalia with a risk of rapid progression within the skin and subcutaneous tissues; it can often spread to the lower limbs, abdomen, and even the thoracic region.

The microorganisms isolated from the tissue cultures include *Escherichia coli, Bacteroides, Staphylococci, Proteus, Streptococci, Pseudomonas,* and *Enterococci,* which are present in the skin flora of the perineal and genital regions (6). Initial symptoms may be confused with benign diseases of the perianal region, leading to delayed presentation. Soft tissue necrosis progresses rapidly to the skin and subcutaneous tissue. If not intervened early, the local infective process can rapidly progress to systemic infection (7). The most common predisposing factor associated with the disease is diabetes mellitus (8). Due to its rapid and insidious progression, mortality has been reported between 16% and 40% by several publications despite current advances in medical care (5, 9, 10).

2. Objectives

In light of the aforementioned issues, the present study aimed to analyze the possible effects of the

pandemic on the diagnosis, treatment, and follow-up for FG by comparing data of the patients who underwent surgery before and during the pandemic. In this context, where early diagnosis and treatment are extremely important, it is paramount to understand the potential adverse implications of the pandemic.

3. Methods

3.1. Study design and participants

This retrospective cross-sectional study was conducted at the General Surgery Department of Trakya University. The date of March 11th, 2020, was selected as the cut-off for stratifying the case and control groups as the date COVID-19 was declared to be a pandemic by WHO. Patients were assigned to two groups; those who underwent surgery for FG during the 24-month period before the pandemic and those who underwent surgery for FG during the 24-month period starting with the onset of the pandemic. A total of 43 patients, 24 from the pre-pandemic period and 19 from the pandemic period were included in the study. Patients were selected from the subjects referred to the Emergency Service of Trakya University Medical Faculty at the specified date range and consulted with the general surgery clinic with a diagnosis of Fournier gangrene. Hospitalized patients after tissue debridement in operating room conditions whose tissue cultures from the perianal region were compatible with Fournier's gangrene were included in the study. Patients who underwent superficial debridement and/or perianal abscess drainage in the emergency service and were followed in the outpatient clinic were excluded from the study. Patients under the age of 18, pregnant, who applied outside the period determined for the study groups, and whose tissue culture results from the perianal region were not compatible with Fournier's gangrene were excluded from the study. Before the commencement of the study, consent was obtained from the Ethics Committee of Trakya University Medical Faculty (TUTF BAEK 2021/347).

3.2. Measured outcomes

Data were extracted from the patient files and electronic patient data system retrospectively. No specimen was obtained routinely for Real-time polymerase chain reaction (real-time PCR) antigen test preoperatively for patients who underwent emergency surgery during the pandemic. Nonetheless, all patients underwent computed tomography (CT) of the thorax after the decision for surgery, and none of the patients had any findings compatible with COVID-19 pneumonia. Demographic characteristics, predisposing factors, hemoglobin (Hb), albumin, and C-reactive protein (CRP) results at the time of diagnosis were compared between the two groups. Glasgow Prognostic Index (GPI), neutrophil-lymphocyte ratio (NLR), platelet-lymphocyte ratio (PLR), and Systemic Inflammatory Response Index (SIRI) were calculated and compared. We also looked at the number of debridements, number of patients undergoing wet dressing and vacuum-assisted closure (VAC), results of tissue cultures, the status of concomitant colorectal malignancy, number of patients requiring diversion, antibiotics used for treatment, number of patients requiring admission to the intensive care unit (ICU) and admission days, duration of hospital stay, and the time between the onset of symptoms and presentation to the hospital between the patient groups during and before the pandemic.

3.3. Statistical analysis

The normal distribution assumption was checked using the Shapiro-Wilk test. Student's T test or Mann-Whitney U test was used depending on normal distribution in comparisons of two independent groups. Relationships between qualitative variables were investigated using the Pearson chi-square test or Fisher's exact test. As descriptive statistics for quantitative variables, mean and standard deviation were used for normally distributed variables, while median and quartiles (or smallest value-largest value) were used for non-normally distributed variables. Frequency and percentage were presented for qualitative variables. The significance level was determined as 0.05 in all statistical analyzes. All statistical analyzes were performed using the statistical package program JAMOVI (version 1.2).

4. Results

The pandemic group included 19 patients aged 40-81, with a mean age of 59.36 years, and the pre-pandemic group included 24 patients aged 34-88, with a mean age of 59.04 years. In both groups, the number of male patients was higher than female ones. Diabetes mellitus was the most frequent co-morbid disease in both groups, with 16 (84.2%) patients in the pandemic group and 21 (87.5%) patients in the pre-pandemic group (Table 1). The hematology and biochemistry results of peripheral venous blood samples taken at the time of diagnosis and the analysis of GPI scores, SIRI scores, NLR, and PLR calculated with the data obtained from these results are displayed in Table 1.

The median time between the onset of symptoms and presentation was higher in the pandemic group than in the pre-pandemic group (Table 2). The number and rate of patients who needed to be admitted to the intensive care unit (ICU) during the treatment process were similar in the pandemic group and the pre-pandemic group (Table 2). The median (min-max) number of debridement for patients who underwent surgery during the pandemic was 2 (1-5), while it was 4 (1-12) for

Table 1. Analysis of demographic characteristics, predisposition factors, and laboratory parameters of patients with Fournier's Gangrene according to case groups

	Pandemic Group (n=19)	Pre-Pandemic Group (n=24)	P-value
Age	59.4±13.3	59.0±14.3	0.939
Gender			
female	5(26.3%)	5(20.8%)	0.728
male	14(73.7%)	19(79.2%)	
Comorbidities			
DM	16(84.2%)	21(87.5%)	1.000
HT	8(42.1%)	9(37.5%)	0.759
SVH	0(0%)	2(8.3%)	0.495
Colorectal malignancy	2(10.5%)	2(8.3%)	1.000
Hb (g/dL)	11.8±1.85	11.3±1.73	0.425
PLT (/µL)	319000±126384	281500±132910	0.472
NEUT (%)	83.6±10.2	81.6±13.7	0.642
MONO (/µL)	969±720	1542±2312	0.315
LYMPH (/µL)	1343±867	1729±2492	0.932
WBC (/mL)	17566±10586	18179±9010	0.541
CRP (mg/L)	84.1±105	25.3±13.1	0.118
ALB (g/dL)	2.68±0.563	2.66±0.447	0.889
GPI			
group 1	3(15.8%)	5(20.8%)	1.000
group 2	16(84.2%)	19(79.2%)	
SIRI	25977±60120	17231±16185	0.434
NLR	23.4±29.8	14.7±12.2	0.933
PLR	446.4±598.8	330.0±324.2	0.633

(Quantitative variables were reported as mean ± standard deviation, while qualitative ones were presented as n (%). In statistical analysis, Fisher's test and chi-square test were used for gender, comorbidities, and colorectal malignancy variables, and Independent T-test was used for other quantitative variables.) (Hb: hemoglobin, PLT: platelet, NEUT(%): neutrophil percentage, MONO: monocyte, LYMPH: lymphocyte, WBC: white blood cell, CRP: C- reactive protein, ALB: albumin, GPI: Glasgow prognostic index, SIRI: systemic inflammatory response index, NLR: neutrophil-lymphocyte ratio, PLR: platelet-lymphocyte ratio)

Table 2. Outcome of patients with Fournier's gangrene during the COVID-19 pandemic period and pre-pandemic period

	Pandemic Group (n=19)	Pre-Pandemic Group (n=24)	p value[c]
Onset of symptoms(day)[a]	4(2-7)	3(2-7)	0.263
Intensive Care Unit Admission(day)[a]	9(47.4%) 4(1-18)	10(41.7%) 7(2-67)	0.200
Number of Debridements[a]	2(1-5)	4(1-12)	0.002
Wet Wound Dressing[b]	17(89.5%)	16(66.7%)	0.145
VAC application[b]	2(10.5%)	8(33.3%)	0.145
Diversion[b]	5(26.3%)	10(41.7%)	0.294
Mortality[b]	4(21.1%)	5(20.8%)	1.000
Hospital Stay(day)[a]	7(2-18)	16(3-67)	<0.001

[a] Due to the small size of the sample, the quantitative variables were reported as median (min-max). [b] Qualitative variables were reported as n (%). [c] In statistical analysis, Fischer's exact test was used when the expected count of values in the table was < 5, and the percentage of cells was < 20%. Otherwise, the chi-square test was used.)

patients who underwent surgery before the pandemic (P=0.002). When the groups were compared according to the Vacuum-assisted closure (VAC) procedure and wet dressing application rates for postoperative wound care, the increase in the rate of VAC was noteworthy in the pre-pandemic group (Table 2). Patients who underwent diversion and debridement were higher in the pre-pandemic group (n=10; 41.7%). In the group operated during the COVID-19 pandemic period, the longest hospital stay was 18 days, while the shortest hospital stay was two days, with a median value of 7 days. The median hospital stay for the group which operated in the pre-pandemic period was 16 days (range: 3-67 days) (P<0.001).

The culture results of the tissue samples from the first debridement were evaluated. In both groups, the most commonly isolated bacterial organism was *Escherichia coli* (Table 3). For treatment, three different antibiotic therapies were used, namely ampicillin/sulbactam+ornidazole, imipenem, and meropenem. In the pandemic group, the most common antibiotic therapy agent was ampicillin/ sulbactam +ornidazole which was used in 9 (47.4%) patients. A total of 13 (54.2%) patients in the pre-pandemic group were treated with imipenem, and other types and rates of antibiotic therapy are illustrated in Table 3.

Table 3. Tissue culture results and antibiotic therapy treatments

	Pandemic Group (n=19)	Pre-Pandemic Group (n=24)	a balanced number of healthcare personnel
Bacterial organisms cultured from the wound			
-Escherichia coli	13(68.4%)	19(79.2%)	0.495[a]
-Other Bacterial organisms	6(31.6%)	5(20.8%)	
Antibiotics			
-Ampicilin/Sulbactam+Ornidazole	9(47.4%)	5(20.8%)	
-Imipenem	7(36.8%)	13(54.2%)	0.182[b]
-Meropenem	3(15.8%)	6(25%)	

(In statistical analysis, [a] Fischer's exact test was used when the expected count of values in the table was < 5 and the percentage of cells was < 20%. Otherwise, [b] the chi-square test was used.)

5. Discussion

The COVID-19 pandemic had a global impact leading to adapting healthcare regulations and systems under the pandemic conditions. Operations other than cancer cases and emergency surgical cases were delayed in surgical departments. Non-invasive methods were utilized as much as possible in treatments. In surgery, efforts were made to establish an algorithm compatible during the pandemic for the diagnosis and treatment of emergency surgical cases in order not to miss patients requiring urgent surgery. A recent literature search has shown that general surgery patients were classified according to their emergency status during the pandemic (11, 12). In the classification of pathologies requiring surgery during the COVID-19 era, FG is listed in group 1a, and emergency surgery is recommended within 24 hours following diagnosis (12, 13).

There are reports in the literature indicating a reduction in the number of emergency cases and emergency presentations associated with general surgical pathologies due to the pandemic (14, 15). In a study by Turanlı et al. on patients with acute appendicitis before the pandemic and during the first three months of the pandemic, there was no statistically significant difference between the two periods in the number of emergency cases (16). In a study by McGuinness et al. in New Zealand, there were also no differences in the number of cases requiring emergency surgery in general surgery clinics during and before the COVID-19 pandemic (17). In a similar vein, in our study, the number of patients with FG operated on in the pre-pandemic period was higher; nonetheless, overall, there was no statistically significant difference between the two groups. The COVID-19 pandemic has led to a tendency in the public to avoid hospital visits due to the risk of transmission.

The likelihood of a delayed diagnosis has prompted us to analyze the time between the onset of symptoms and the emergency presentation in our patients. The median time (min-max) was 3 (2-7) days before the pandemic and 4 (2-7) days during the pandemic. There was no statistically significant difference between the two groups. There is no source in the literature comparing the periods before and during the pandemic for FG. Nevertheless, in studies conducted on FG, the median time between the onset of symptoms and the presentation before the pandemic was reported to be seven days by Yılmazlar et al., while the mean time was reported to be 4.31 days by Oymacı et al. (10,18). Our findings suggest that the COVID-19 pandemic did not cause any additional delay in presentation for FG patients.

We also compared the neutrophil count/lymphocyte count (NLR), platelet count/lymphocyte count (PLR), and systemic inflammation response index (SIRI) results calculated from the whole blood count parameters in the peripheral blood samples from patients at the time of diagnosis between the two groups. Some studies have reported that NLR and PLR can be used as prognostic factors for mortality in patients with FG (19,20). An NLR value above 8 and a PLR above 140 were proposed to be negative prognostic factors for mortality (19). In the current study, there were no significant differences between the pandemic group and the pre-pandemic group in NLR, PLR, and SIRI values. However, NLR and PLR values of patients associated with mortality found in both periods were higher than the cut-off values proposed by Yim et al.

Studies evaluating the effects of the COVID-19 pandemic on general surgery clinics reported that hospital stays were shorter compared to before the pandemic. Along the same lines, a study by Cantay et al. indicated a shortened hospital stay during the pandemic due to early diagnosis and treatment along with the discharge of patients at the first suitable opportunity with recommendations for medical treatment in order to minimize the risk of COVID-19 infection (15). Our results further support earlier studies; we described a shorter median (min-max) hospital stay of 7 (12-18) days for the pandemic group and 16 (3-67) days for the pre-pandemic group. There was a statistically significant difference between the two groups.

The median number of debridement was 2 in the pandemic group and 4 in the pre-pandemic group. There was also a statistically significant difference between the number of debridement procedures. In

a study conducted in 2017, it was stated that rapid surgical source control is the most important principle of treatment in FG. In the same study, it was reported that source control was achieved after two to three operative debridement procedures (21). In our study, the presence of similar mortality rates and similar success rates of treatments in both groups demonstrated that treatment was not compromised despite the decrease in the number of debridement. The decrease in the number of debridement, as well as the rate of diversion and VAC application, is a factor in decreased length of stay of our patients with COVID-19. In our study, there was no statistically significant difference between the groups in terms of VAC application and follow-up with wet dressing. Nonetheless, VAC was applied to 33.3% of patients in the pre-pandemic group, while this rate decreased to 10.5% in the pandemic group. This may suggest a shift in clinician preference for wet dressing. In a case series of 25 patients with FG reported by Yucel et al., hospital stays and debridement procedures in patients who underwent VAC were statistically significantly higher than the patients who were followed with wet dressing (22).

Diversion is recommended in patients with FG who may suffer from sphincter dysfunction and/or ineffective wound care due to fecal contamination as a result of aggressive debridement in the perianal region (23). Ozturk et al. reported that diversion increases morbidity, hospital stay, and treatment costs in patients with FG (24). The rate of diversion was 41% in their patients with FG. In a cases series published by the same authors in 2014, the rate of diversion was reported to decrease with clinical experience, leading to a rate of 25.8% (18,24). In our population, diversion was considered in 5 (26.3%) patients in pandemic group and 10 (41.7%) patients in the pre-pandemic group. Increased morbidity risk and adverse effects on hospital stay due to diversion were less in the pandemic group. Although it was not statistically significant, the higher rate of diversion in the pre-pandemic group may have contributed to the significant difference in the length of hospital stay between the groups. The treatment success remaining unchanged despite decreased diversion rates in the patients during the pandemic has demonstrated that rates of diversion can be decreased with close follow-up and appropriate treatment in patients with FG.

In the study by Lauerman et al., it was reported that if rapid source control is provided in the treatment of patients with FG, broad-spectrum and long-term antibiotics will not be required. In this study, it was reported that the spread of the infection could be prevented with short courses of antibiotics if rapid source control was provided and there was no delay in primary wound closure (21). In a similar vein, in our study, the rates of antibiotic use, such as imipenem and meropenem, which were broad-spectrum and required long treatment courses, decreased in the pandemic group; nonetheless, with appropriate source control, similar treatment success was achieved in the pre-pandemic period.

The main limitations of the study include possible selection bias due to the nature of a retrospective cross-sectional study and the limited generalizability of the results to the general population due to the relatively low sample size.

6. Conclusion

This study contributes to the understanding of emergency surgical provisions for FG during the pandemic. The time elapsed between symptom onset and hospital admission and the number of hospital admissions were similar in the study, suggesting that the COVID-19 pandemic did not cause a delay in diagnosis in patients with FG. Due to the increased risk of infection in health centers during the pandemic period, the number of debridement procedures decreased, and hospital stays shortened as a result of more aggressive surgical treatments in FG patients. The decrease in the number of debridement procedures and the shortened hospitalization length of stay in FG patients do not affect the treatment outcome; moreover, these issues are associated with lower morbidity and treatment costs. Therefore, we suggest it can be beneficial to incorporate the treatment approaches established during the pandemic period into general practice. More broadly, extensive studies comparing surgical capacity and outcomes for the pandemic and pre-pandemic periods are required to corroborate our findings and provide a further accurate assessment which would have important implications for future practice.

Acknowledgments

None.

Footnotes

Conflicts of Interest: The authors declare no conflict of interest.
Authors' contributions: All authors contributed equally to the research design, conduction of the experiment, analysis of the results, and preparation of the manuscript.
Funding/Support: This study did not receive any funding/support.
Ethical Statements: This study was approved by the Ethic Committee of Trakya University, Faculty of Medicine. (Ethics code: TUTF BAEK 2021/347)

References

1. Søreide K, Hallet J, Matthews JB, Schnitzbauer AA, Line PD, Lai PB, et al. Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. *Br J Surg*. 2020;**107**(10):1250–61. doi: 10.1002/bjs.11670. [PubMed: 32350857]
2. Ti LK, Ang LS, Foong TW, Ng BS. What we do when a COVID-19 patient needs an operation: operating room preparation and guidance. *Can J Anaesth.* 2020;**67**(6):756–8. doi: 10.1007/s12630-020-01617-4. [PubMed: 32144591].
3. Kuitunen I, Ponkilainen VT, Launonen AP, Reito A, Hevonkorpi TP, Paloneva J, et al. The effect of national lockdown due to COVID-19 on emergency department visits. *Scand J Trauma Resusc Emerg Med*. 2020;**28**(1):114. doi: 10.1186/s13049-020-00810-0. [PubMed: 33276799].
4. Norton KS, Johnson LW, Perry T, Perry KH, Sehon JK, Zibari GB. Management of Fournier's gangrene: an eleven year retrospective analysis of early recognition, diagnosis, and treatment. *Am Surg*. 2002;**68**(8):709–13. [PubMed: 12206606].
5. Şahiner IT, Kendirci M, Dolapçı M. Evaluation of patients with a diagnosis of necrotizing fasciitis within the last year. *Dicle Med J.* 2017;**44**:271–6. doi: 10.5798/dicletip.339011.
6. Sökmen S. Fournier's gangrene. *ANKEM J*. 2012;**26**:331–6.
7. Kaya E, Yılmaz S, Ebiloğlu T, Kangal KO, Bedir S, Zor M. A multistep approach in fournier's gangrene management: serial surgical debridement, protective colostomy, vacuum assisted closure therapy and hyperbaric oxygen treatment. *New J Urol*. 2018;**13**(1):56–9.
8. Sehmi S, Osaghae S. Type II diabetes mellitus: new presentation manifesting as fournier's gangrene. *JRSM Short Rep.* 2011;**2**(6):51–6. doi: 10.1258/shorts.2011.011055.
9. Osbun N, Hampson LA, Holt SK, Gore JL, Wessells H, Voelzke BB. Low-volume vs high-volume centers and management of fournier's gangrene in washington state. *J Am Coll Surg*. 2017;**224**(3):270-5. doi: 10.1016/j.jamcollsurg.2016.11.012. [PubMed: 27965132].
10. Oymacı E, Coşkun A, Yakan S, Erkan N, Uçar AD, Yıldırım M. Evaluation of factors affecting mortality in Fournier's Gangrene: retrospective clinical study of sixteen cases. *Ulus Cerrahi Derg.* 2014;**30**(2):85–9. doi: 10.5152/UCD.2014.2512. [PubMed: 25931901].
11. COVID-19: Guidance for triage of non-emergent surgical procedures. 2020. Available from: https://www.facs.org/covid-19/clinical-guidance/triage
12. Clinical guide to surgical prioritisation during the coronavirus pandemic. 2020. https://www.england.nhs.uk/coronavirus/wpcontent/uploads/sites/52/2020/03/C0221-specialty-guide-surgical-prioritisation-v1.pdf
13. Çelik SU, Çetinkaya ÖA, Tüzüner A. Surgery and COVID-19. Yalçın Ş, Özet A, editörler. Cancer and COVID-19 Pandemic. Ankara: Turkey Clinics; 2020.
14. Guidance for surgeons working during the COVID-19 pandemic. Royal Collage of Surgeons. 2020. Available from: https://www.rcseng.ac.uk/coronavirus/joint-guidance-for-surgeons/
15. Cantay H, Anuk T, Dogan G, Eren MS, Gonullu D. Effects of Covid-19 pandemic on general surgery emergency protocol. *Kocaeli Med J.* 2021;**10**(1):56–60. doi: 10.5505/ktd.2021.58224.
16. Turanli S, Kiziltan G. Did the COVID-19 pandemic cause a delay in the diagnosis of acute appendicitis? *World J Surg*. 2021;**45**(1):18–22. doi: 10.1007/s00268-020-05825-3. [PubMed: 33089347].
17. McGuinness MJ, Harmston C. The effect of national public health interventions for COVID-19 on emergency general surgery in Northland, New Zealand. *ANZ J Surg*. 2021;91(3):329–34. doi: 10.1111/ans.16562. [PubMed: 33475217].
18. Yılmazlar T, Işık Ö, Öztürk E, Özer A, Gülcü B, Ercan İ. Fournier's gangrene: review of 120 patients and predictors of mortality. *Ulus Travma Acil Cerrahi Derg*. 2014;**20**(5):333–7. doi: 10.5505/tjtes.2014.06870. [PubMed: 25541844].
19. Yim SU, Kim SW, Ahn JH, Cho YH, Chung H, Hwang EC, et al. Neutrophil to lymphocyte and platelet to lymphocyte ratios are more effective than the fournier's gangrene severity ındex for predicting poor prognosis in fournier's gangrene. *Surg Infect (Larchmt).* 2016;**17**(2):217–23. doi: 10.1089/sur.2015.126. [PubMed: 26835748].
20. Zuhour M, Dadacı M, Baycar Z, İnce B, Soylu A. Fournier's gangrene as a possible surgical complication of COVID-19: two case reports and literature review. *Turk J Plast Surg*. 2022;**30**(1):17–20.
21. Lauerman MH, Kolesnik O, Sethuraman K, Rabinowitz R, Joshi M, Clark E, et al. Less is more? Antibiotic duration and outcomes in Fournier's gangrene. *J Trauma Acute Care Surg*. 2017;**83**(3):443-8. doi: 10.1097/TA.0000000000001562. [PubMed: 28538648].
22. Yücel M, Özpek A, Başak F, Kılıç A, Ünal E, Yüksekdağ S, et al. Fournier's gangrene: A retrospective analysis of 25 patients. *Ulus Travma Acil Cerrahi Derg*. 2017;**23**(5):400–4. doi: 10.5505/tjtes.2017.01678. [PubMed: 29052826].
23. Bronder CS, Cowey A, Hill J. Delayed stoma formation in Fournier's gangrene. *Colorectal Dis*. 2004;**6**(6):518–20. doi: 10.1111/j.1463-1318.2004.00663.x. [PubMed: 15521946].
24. Ozturk E, Sonmez Y, Yilmazlar T. What are the indications for a stoma in Fournier's gangrene? *Colorectal Dis.* 2011;**13**(9):1044–7. doi: 10.1111/j.1463-1318.2010.02353.x. [PubMed: 20579084].