



## Treatment of Proximal Femoral Fractures in Patients with COVID-19

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### Abstract

**Background.** In relation with the COVID-19 new coronavirus infection epidemic that began in Russia in the spring of 2020, a completely new group of patients appeared: patients whose coronavirus infection was combined with the proximal femur fractures. In the course of practical work, hospital doctors had to gain experience in treating these complex patients, solve new organizational and medical tasks. **The aim of the study** was to evaluate the results of treatment of patients with the proximal femur fractures in combination with coronavirus infection in a «COVID» hospital at the hospital stage, 30-day and 6-month terms. **Materials and methods.** The retrospective study is based on the collection and generalization of data from 64 patients with the proximal femur fractures in combination with confirmed coronavirus infection who underwent inpatient treatment from 16.03.2020 to 31.05.2021. 38 (59.4%) patients had a femoral neck fracture, 26 (40.6%) had a fracture of the trochanter region. Forty (62.5%) patients underwent surgical treatment (hip replacement was performed in 23 cases, osteosynthesis was performed in 17 cases), 24 (37.5%) patients did not undergo surgery. **Results.** With conservative treatment, the hospital mortality rate was 41.6%, the 30-day mortality rate was 72.7%, and the 6 – month mortality rate was 95.5%. During surgical treatment, the hospital mortality rate was 5.0% (2 patients died). Early postoperative complications were detected in 5 (12.5%) patients. Thirty-one (77.5%) patients walked or stood with a walker on their own at the time of discharge; 7 (17.5%) patients could not be activated. The thirty-day mortality rate in the group of patients who underwent surgical treatment was 8.6%, and the 6-month mortality rate was 32.1%. **Conclusions.** Surgical treatment of patients with the proximal femur fractures in combination with coronavirus infection is much more difficult than the treatment of patients without infectious pathology. However, despite number of unresolved problems, surgical treatment of such patients is possible with good results and should be actively applied.

**Keywords:** proximal femur fracture, coronavirus infection, COVID-19.

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## Лечение пациентов с переломами проксимального отдела бедренной кости в сочетании с коронавирусной инфекцией COVID-19

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### Реферат

**Актуальность.** В связи с начавшейся в России весной 2020 г. эпидемией новой коронавирусной инфекции COVID-19 появилась совершенно новая группа пациентов у которых коронавирусная инфекция сочеталась с переломами проксимального отдела бедренной кости (ППОБК). Врачам стационаров пришлось в процессе практической работы приобретать опыт лечения этих сложных пациентов, решать новые организационные и медицинские задачи. **Цель исследования** — оценить результаты лечения пациентов с переломами проксимального отдела бедренной кости в сочетании с коронавирусной инфекцией в «ковидном» стационаре на госпитальном этапе, 30-дневном и 6-месячном сроках. **Материал и методы.** Ретроспективное исследование основано на сборе и обобщении данных 64 пациентов с ППОБК в сочетании с подтвержденной коронавирусной инфекцией, проходивших стационарное лечение с 16.03.2020 г. по 31.05.2021 г. У 38 (59,4%) пациентов был перелом шейки бедренной кости, у 26 (40,6%) — перелом вертельной области. Сорока (62,5%) пациентам провели оперативное лечение (в 23 случаях выполнено эндопротезирование тазобедренного сустава, в 17 случаях — металлоостеосинтез), 24 (37,5%) пациентам операции проведены не были. **Результаты.** При консервативном лечении госпитальная летальность составила 41,6%, 30-дневная летальность — 72,7%, 6-месячная — 95,5%. При проведении оперативного лечения госпитальная летальность составила 5,0% (умерли 2 пациентов). Тридцатидневная летальность в группе пациентов, прошедших оперативное лечение, составила 8,6%, а 6-месячная — 32,1%. Ранние послеоперационные осложнения выявлены у 5 (12,5%) пациентов. Тридцать один (77,5%) пациент ходили или стояли с ходунками самостоятельно к моменту выписки; 7 (17,5%) пациентов не удалось активизировать. **Заключение.** Хирургическое лечение пациентов с переломами проксимального отдела бедренной кости в сочетании с коронавирусной инфекцией значительно сложнее, чем лечение пациентов без инфекционной патологии. Однако, несмотря на ряд нерешенных проблем, оперативное лечение таких пациентов возможно с хорошими результатами и должно активно применяться.

**Ключевые слова:** перелом проксимального отдела бедренной кости, коронавирусная инфекция, COVID-19.

**Источник финансирования:** государственное бюджетное финансирование.

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## Background

In the spring of 2020, an epidemic of a new coronavirus infection COVID-19 began in Russia. Due to the increasing number of cases and the shortage of beds in infectious diseases hospitals, some multidisciplinary hospitals have been converted into infectious for the treatment of patients with COVID-19. Our hospital was one of the first to be redesigned. From 03.16.2020 to the present, doctors of all specialties of our multidisciplinary hospital have treated more than 20,000 patients with COVID-19. In addition to treating the new COVID-19 infection and its complications directly, specialists had to master approaches to the treatment of patients whose coronavirus infection was combined with various therapeutic, surgical and traumatological pathologies. In particular, the traumatologists of our hospital faced a difficult task of helping patients with proximal femur fractures (PFF) in combination with coronavirus infection.

PFF is one of the most common traumatological pathologies [1, 2, 3]. In Russia, the frequency of PFF according to four cities (Yaroslavl, Pervouralsk, Bryansk and Vladimir) is 174.78 cases per 100 thousand population in men and 275.92 in women, and this indicator is steadily increasing [4]. Patients with PFF are an extremely difficult category to treat due to their advanced age (the average age of patients with PFF according to our data is 79 years), the presence of chronic diseases, age-related mental changes, and a high probability of hypodynamic complications [5, 6].

Treatment of patients with PFF in combination with COVID-19 is an even more difficult task, because this infection in patients with PFF often occurs in severe and moderate forms, which, in addition to significant lung damage, entails decompensation of chronic diseases [7, 8, 9, 10, 11, 12].

The main goal of treatment of this category of patients is the soonest painless activation to prevent hypodynamic complications (pneumonia, venous thrombosis, pressure sores, muscular atrophy, etc.). To achieve this goal, patients with PFF should undergo surgical fixation of the fracture in the near future after admission to the hospital. According to modern protocols, the surgery must be performed within 48 hours from the moment of hospitalization [13, 14, 15, 16, 17]. In the conditions of our hospital's operation in the "covid" mode, we also tried to stay close to this protocol, but we encountered new organizational and medical difficulties that we had to overcome.

The aim of the study was to evaluate the results of treatment of patients with PFF in combination with coronavirus infection in a covid hospital at the hospital stage, 30-day and 6-month terms.

## Materials and methods

### Study design

The retrospective study included 64 patients undergoing inpatient treatment from 03.16.2020 to 05.31.2021.

The criterion for inclusion of patients in the study was the presence of PFF (according to the ICD-10 classification: S72.0, S72.1, S72.2; according to the AO/OTA classification: 31A,B,C) in combination with a confirmed new coronavirus infection COVID-19.

Exclusion criteria: patients with pathological femoral fractures on the background of metastatic lesions, as well as with non-unions of the proximal femur.

Data collection was carried out by analyzing medical records. To obtain 30-day and 6-month treatment results, we conducted a survey of patients or their relatives by phone.

Initially, 20 (31.3%) patients were hospitalized urgently, 44 (68.7%) patients were transferred from "non-COVID" hospitals when a coronavirus infection was detected or suspected in them. Patients were admitted in the period from 0 to 19 days. (on average  $3.2 \pm 3.1$ ) after the injury.

To confirm COVID-19 infection, all patients underwent multispiral computed tomography (MSCT) of the lungs and RT-PCR testing. Lung changes specific to coronavirus pneumonia were detected in 47 (73.4%) patients. There were no changes in the lungs in 17 (26.6%) patients, but they had positive results of RT-PCR testing. A total of 64 patients had a positive RT-PCR test in 42 (65.6%).

### Conservative treatment

Twenty-four (37.5%) patients with PFF were denied surgery and conservative treatment was carried out. Of these, there were 8 men aged 74 to 94 years (average age  $85.6 \pm 6.1$  years) and 16 women aged 82 to 97 years (average age  $86.8 \pm 5.5$  years). The average age of all treated patients was  $86.4 \pm 5.7$  years. 14 (58.3%) patients had a femoral neck fracture, 10 (41.7%) had a fracture of the trochanter area.

Among the patients who underwent conservative treatment, 15 (62.5%) had positive results of RT-PCR testing. Lung lesions according to MSCT data were not present in 8 (33.3%) patients, in 4 (16.7%) patients the volume of lung lesions was 0-25%, in 7 (29.2%) - 26-50%, in 5 (20.8%) - 51-75%, i.e. 50.0% of patients in this group had moderate to severe lung lesions. The decision on conservative treatment was made collectively with the participation of a traumatologist, an anesthesiologist and a therapist.

The reasons for the refusal of surgical treatment were the extremely serious condition of the patient

due to coronavirus infection or due to decompensation of concomitant pathology; the presence of an acute life-threatening condition (acute myocardial infarction, acute cerebral circulation disorder). It should be noted that in 5 (20.8%) patients, massive thrombosis of the lower extremities veins became the reason for refusing surgery. In total, venous thrombosis of the lower extremities was detected in 8 (12.5%) patients during preoperative examination.

The principles of conservative treatment were maximum activation and functional treatment. Derotation bandages and skeletal traction were used rarely and for a short time, solely for the purpose of reducing pain.

With the initial refusal of surgery, the patient was necessarily followed by dynamic observation by a traumatologist, an anesthesiologist, and with the improvement of the somatic condition, the issue of surgical treatment was again discussed.

### *Surgical treatment*

Surgical treatment was performed in 40 (62.5%) patients. Of these, femoral neck fractures were diagnosed in 24 (60.0%): 8 men aged 65 to 96 years (average age  $78.4 \pm 7.0$ ) and 16 women aged 62 to 97 years (average age  $81.4 \pm 6.3$ ). In 16 (40.0%) patients there was a fracture of the trochanter area: 3 men aged 62 to 83 years (mean age  $75.3 \pm 8.9$ ) and 13 women aged 42 to 96 years (mean age  $76.2 \pm 9.8$ ). The average age of all underwent surgery patients was  $78.7 \pm 8.0$  years.

In all patients who underwent surgical treatment, 27 (67.5%) had a positive RT-PCR test. According to MSCT data, lung lesions were not present in 9 (22.5%) patients, in 17 (42.5%) patients the percentage of lung lesions was 0-25%, in 10 (25.0%) - 26-50%, in 4 (10.0%) - 51-75%. i.e., in 35.0% of patients in this group, lung lesions were moderate to severe.

The surgery was performed between 1 and 29 days after injury (on average  $9.3 \pm 4.3$  days) and 1-22 days after admission to the hospital (on average  $6.1 \pm 3.2$  days). Only 8 (20%) patients underwent surgery within 48 hours after admission to the hospital. All surgeries were performed in an emergency surgical operating room located in the "red zone" of the hospital, with the use of personal protective equipment and compliance with sanitary and epidemiological rules.

Hip arthroplasty was used in 23 (95.8%) cases of femoral neck fractures. Bipolar hip arthroplasty was performed in 17 (73.9%) cases, and total hip arthroplasty was performed in 6 (26.1%) cases. In 1 (4.2%) case, a patient with chronic lymphocytic leukemia and severe anemia underwent osteosynthesis with cannulated screws.

In fractures of the trochanter area in 14 (87.5%) cases, osteosynthesis with a proximal femoral nail was used, in 2 (12.5%) cases — with a DHS.

Patients received pre- and postoperative treatment for femoral fracture and coronavirus infection according to federal clinical guidelines [13, 18].

Postoperative rehabilitation was started as early as possible, focusing on the somatic state. The patient was allowed to sit up in bed on the surgery day or the day after it was performed, at the same time physical therapy was started in bed. Further activation (verticalization, walking) was carried out taking into account the presence of respiratory insufficiency, individual patient tolerance of physical load, focusing on oxygen saturation (SpO<sub>2</sub>) in the blood during exercise (at least 92).

### *Statistical analysis*

Statistical processing of the obtained data was carried out using Microsoft Excel software. For descriptive statistics, the data are presented in percentages, minimum and maximum values, absolute averages; to represent the dispersion of values in the samples, the values of the average absolute deviations are indicated. The Mann criterion was used for the intergroup comparison – Whitney. The statistical significance was established at the level of  $p < 0.05$ .

## **Results**

### *Conservative treatment results*

With conservative treatment, 14 (58.3%) of 24 patients were discharged for outpatient treatment after spending 3 to 25 days in hospital (the average bed-day was  $14.1 \pm 4.8$ ). None of them were verticalized at the time of discharge, approximately 50% could sit in bed with outside help. Ten patients died within 2 to 18 days after admission (average bed-day  $9.4 \pm 3.6$ ), 6 of them as a result of an increase in cardiopulmonary insufficiency, 4 as a result of pulmonary embolism (PE). Hospital mortality with conservative treatment was 41.7%. When collecting long-term results from 14 patients discharged from the hospital without surgery, it was possible to contact the relatives of 12 (85.7%) of them. Of these 12 patients, 6 died within 30 days after the injury. Another 5 patients died within 6 months of the injury. Thus, the 30-day mortality rate was 72.7%, and the 6-month mortality rate was 95.5%. Only one patient (4.5%) remained alive at the time of data collection (194 days after the injury), could sit up and turn in bed with outside help.

### *Surgical treatment results*

In total 40 patients received surgical treatment, 31 (77.5%) patients could walk or stand with a walker by the time they were discharged from the hospital. Seven (17.5%) patients could not be verticalized due to the general somatic condition, muscle weakness and encephalopathy, however, the performed surgery provided

easier care for these patients, anti-sore measures and reduction of respiratory failure by safely turning into the prone position. Two (5.0%) patients died: one patient as a result of PE on the 2nd day after surgery, another patient - on the 18th day after surgery as a result of increasing cardiopulmonary insufficiency. 38 patients discharged from the hospital, it was possible to obtain information about 35 (92.1%) who had more than 30 days since the injury, and about 28 (73.7%) patients who had more than 6 months since the injury. One patient died at home within 30 days after injury, another 6 died within 6 months. Thus, the 30-day mortality in the group of patients who underwent surgical treatment was 8.6%, and the 6-month mortality was 32.1%.

Complications in the immediate postoperative period developed in 5 (12.5%) patients. In 2 (5.0%) cases, the development of deep vein thrombosis of the lower extremities was observed, despite standard prevention [13]. One (2.5%) patient had gastrointestinal bleeding.

In one (2.5%) 73-year-old patient, against the background of severe coronavirus infection with 55% lung damage and decompensation of chronic concomitant diseases, the general somatic condition worsened with the development of multiple organ failure (postoperative inpatient treatment was carried out for 67 days). In one (2.5%) 65-year-old patient with a moderate form of coronavirus infection and 28% of lung damage, with concomitant pathology and chronic alcohol intoxication, bacterial pneumonia with an increase in cardiopulmonary and multiple organ failure occurred (died on day 18 after surgery).

The inpatient treatment duration was from 3 to 74 days (the average bed-day was  $15.3 \pm 6.3$ ). After surgical treatment, patients were discharged from the hospital within 2 to 67 days. (on average after  $9.2 \pm 5.7$ ). For patients with no lung damage, the inpatient treatment duration was 2-12 days (on average  $5.5 \pm 2.0$ ), with lung damage up to 25% - 2-28 days. (on average  $8.1 \pm 4.9$ ), with a lesion of 26-50% - 6-18 days. (on average  $9.6 \pm 3.1$ ), with 51-75% - 7-67 days. (on average  $21.3 \pm 22.9$ ). Based on these data, it is possible to make an assumption about the dependence of the inpatient treatment duration on the severity of lung damage. However, due to the small number of patients in the groups, it is too early to talk about the statistical significance of such dependence.

## Discussion

When organizing and providing care to patients with PFF in combination with coronavirus infection in a covid hospital, we noted a number of features that significantly affected both the treatment process and its outcome.

The number of patients with PFF who were denied surgical treatment has increased dramatically: 37.5% compared to 12.3% in 2018 and 10.7% in 2019. The same trend is noted by K.A. Egol et al [8] and D.G. LeBrun et al

[9], whose surgical activity in the treatment of patients with PFF in combination with coronavirus infection decreased from 95-98% to 76.5% and 77.8%, respectively. This is due to the significantly more severe condition of patients admitted to the hospital during the pandemic, due to the presence of viral pneumonia, decompensation of chronic diseases.

A number of authors adhered to more aggressive tactics in relation to surgical treatment of this category of patients. Thus, Z.B. Cheung and D.A. Forsh and B. Kayani et al treated surgically 100% of patients [10, 12]; E.V. Wright et al - 94.1% [19], A.J. Hall et al - 92.6% [11]. However, none of them managed to avoid a high postoperative hospital mortality - 10.0% [10], as well as a significant 30-day mortality: from 11.8% to 35.5% [11, 12, 19].

Hospital mortality in the group of patients undergoing conservative treatment in our study was 41.6%, which is 2 times more than in 2018 and 2019 - 21.3% and 18.6%, respectively. According to J.M. Munoz Vives et al, the 14-day mortality rate in the conservative treatment of patients with PFF in combination with COVID-19 reached 67% [7].

A number of significant features were noted in the surgical treatment of patients with PFF. We were able to do surgery in only 8 (20%) patients within 2 days after admission to the hospital. According to our data, the average preoperative bed-day increased to  $6.1 \pm 3.2$ , which, of course, goes beyond the 48-hour protocol for providing care to patients with PFF. Similar results are also reported by other authors. According to E.V. Wright et al, only 71% of patients were prepared for surgery in the first 3 days after admission, and sometimes the surgery was postponed until 6 days [19]. J.M. Munoz Vives et al report that the preoperative bed-day reached 13 days [7]. This circumstance is associated with the features of the work in the "covid" hospital, which can be divided into organizational and medical.

The first include factors caused by the conversion of the hospital. In relation with a large number of patients arriving in serious condition, it became necessary to deploy an additional 44 intensive care beds in the the operating rooms. Despite this, our hospital often experienced a shortage of intensive care beds. Planned surgery had to be postponed several times, because there was no place for the patient after the surgery in the intensive care unit due to overcrowding. To perform surgeries of all profiles, it was possible to leave one operating room that works with overload. The deployment of additional intensive care unit also led to an extraordinary increase in the work of anesthesiologists and nurses of the Department of Anesthesiology and Intensive care, which complicated their full-fledged work in the operating room. Many authors report similar organizational problems [7, 8, 9, 19, 20, 21, 22, 23, 24].

Medical factors include the fact that many patients arrive in extremely serious condition. In 40.6% of our

patients with PFF, COVID-19 infection occurred in moderate or severe form. M.A.Lim and R. Pranata, who conducted a meta-analysis of 984 observations, also report a predisposition of patients with PFF to severe coronavirus infection [22].

According to our clinic, every 4th patient needed emergency hospitalization in the intensive care unit, every 13th needed invasive lung ventilation. Accordingly, time was needed (often more than 2 days) to stabilize the patient's condition for the possibility of performing surgical treatment. With the initial refusal of surgery, sometimes long-term dynamic monitoring of the patient was required to make a decision on the possibility of delayed surgery.

The features of the surgery method choice include the priority of less traumatic techniques, in particular, the wider use of bipolar hemiarthroplasty. During the covid period, we performed 73.9% of bipolar hemiarthroplasty and 26.1% of total hip arthroplasty compared to 56.4% and 43.6% for femoral neck fractures in 2018 and 2019. Other authors also tend to perform bipolar hemiarthroplasty in patients with coronavirus infection [8, 19, 25].

From the features of the postoperative period, it can be noted that rehabilitation was significantly hampered by the fact that all employees of the department of physiotherapy and physical therapy after the hospital was redesigned due to the extremely large number of incoming patients were transferred to clinical infectious diseases departments as attending physicians and nurses and were not able to fully rehabilitate patients. Rehabilitation measures were carried out by traumatologists, as well as employees of clinical departments who did not have special training. Rehabilitation was hampered by the severe somatic condition of the patients, the presence of respiratory insufficiency, which sharply limited their physical activity after surgery, as well as pronounced manifestations of encephalopathy associated with the presence of intoxication and respiratory failure.

The difficulties of postoperative rehabilitation during the pandemic are also reported by E.V. Wright et al [19]. According to their data, up to 47% of patients cannot be rehabilitated sufficiently after surgery.

A number of foreign authors indicate a significant increase in the inpatient treatment duration. B. Kayani et al report an increase in the inpatient treatment duration in nine hospitals in England by an average of 2 times (average bed-day — 13.8) [12]. According to E.V. Wright et al, in three hospitals in London, the inpatient treatment duration increased by 1.7 times (the average bed-day is 17.1) [19]. According to our data, the average postoperative bed-day did not significantly increase compared to the "non-typical" 2019 — the average values were  $9.2 \pm 5.7$  and  $7.6 \pm 3.0$ , respectively;  $p = 0.055$ ). The absence of a significant increase in the inpatient treatment duration compared to the data of

other authors is because we sought to discharge the patient from the hospital as early as possible that due to the lack of full-fledged rehabilitation in the hospital, overcrowding of departments with patients with infectious lung disease. We used this tactic in order to prevent the addition of nosocomial bacterial pneumonia, the speedy return of an elderly patient to familiar living conditions for the normalization of his mental state.

The number of postoperative complications in the "covid" period (12.5%) and postoperative mortality (5.0%) in our patients increased significantly compared to the "pre-covid" period: 2.8-3.7% of general and local complications and 1.5-2.0% of mortality in 2018 and 2019. This is natural and is due to lower compensatory capabilities in patients due to the presence of a coronavirus infection aggravating the condition.

According to K.A. Egol et al, hospital mortality in patients with PFF in combination with COVID-19 was 35.3%, without COVID-19 — 0.9%, complications in patients with COVID-19 developed in 70.8%, without infection — in 2.8%, 30-day mortality in patients with COVID-19 was 53%, without it — 5.6% [8]. According to D.G. LeBrun et al, the 14-day mortality rate in patients with PFF in combination with coronavirus infection was 30.3%, without COVID-19 — 2.7% [9]. According to J.M. Munoz Vives et al, the 14-day mortality was 30.4% and 2.7%, respectively [7].

Those who adhered to the most aggressive tactics of early surgical treatment of the number of patients with COVID-19 also talk about an increase in mortality by 3-4 times. According to B. Kayani et al, the 30-day postoperative mortality in patients with PFF was 30.5%, without coronavirus infection — 10.3%, the complication rate was 89.0% and 35.0%, respectively [12]. According to E.V. Wright et al, the 30-day postoperative mortality in patients with COVID-19 was 11.8%, without infection — 6% [19], according to A.J. Hall et al — 35.5% and 8.3% respectively [11]. Z.B. Cheung and D.A. Forsh reports 10% postoperative hospital mortality in patients and a 20% postoperative complication rate [10].

It is worth noting that in the surgical treatment of patients with PFF in combination with COVID-19, the 30-day mortality, according to our data, was 8.6%, which is not much different from the data of the authors who analyzed the results of surgical treatment of patients with PFF without coronavirus infection. According to the Swedish registry, the 30-day mortality rate was 7.5% [26], according to the Danish registry — 10.8% [27], according to the Norwegian registry — 7.2% [28]. Based on this, we can say that we have obtained good results of surgical treatment of patients with PFF in combination with COVID-19.

Separately, attention should be paid to thrombotic postoperative complications — according to our data — 5.0%, in normal times — no more than 1%. Also, deep

vein thrombosis of the lower extremities was detected in 8 (12.5%) of our patients at the stage of preoperative examination, which is significantly higher than in 2018 and 2019, when venous thrombosis was detected in no more than 3% of patients during screening examination of patients with PFF. Similar results were obtained by K.A. Egol et al – venous thrombosis of the lower extremities was diagnosed in 11.8% of patients [8], according to Z.B. Cheung and D.A. Forsh - in 10% [10]. This is due to the phenomena of coagulopathy in patients with COVID-19 due to an inflammatory reaction caused by a viral disease. Many authors pay attention to this circumstance [29, 30, 31, 32, 33, 34, 35].

This article presents our first experience of treating patients with PFF in combination with COVID-19 coronavirus infection. Currently, there are many problems that need to be studied and solved. In particular, it is very important to define clear criteria for choosing the optimal surgery time. On the one hand, it is necessary to stabilize the fracture as soon as possible. On the other hand, it cannot be excluded that the outcome of surgical treatment is influenced by the stage of development of the infectious process and the activity of the inflammatory reaction. For example, against the background of a progressively developing severe infectious process, even minimally invasive surgery entails an increase in the systemic inflammatory response, which can be critical in terms of the development of complications. If it was impossible to perform the surgery in the near future due to the severity of the patient's condition, we followed the tactics of dynamic observation and delayed surgery. At the same time, we came to the conclusion that it is necessary to identify factors characterizing the severity of the inflammatory response and the stage of development of the infectious process in COVID-19 in order to choose the safest time for performing surgery in patients with coronavirus infection. D.G. LeBrun et al paid attention to this fact in their article [9], but it is not sufficiently covered in the literature we have studied.

Another unexplored issue is the correction of drug therapy aimed at reducing the systemic inflammatory response in patients with COVID-19 coronavirus infection at the stage of preparation for surgery and in the immediate postoperative period.

Also, taking into account the number of thromboembolic complications in patients with PFF against the background of proven coagulopathy in COVID-19, the scheme of thrombosis prevention in this category of patients needs to be revised. This direction is also not covered in the literature and requires research.

However, despite many unresolved problems, it can already be unequivocally stated that conservative treatment of patients with PFF in combination with the new coronavirus infection COVID-19 is not the

optimal choice, which is confirmed by extremely high mortality rates, as well as the obvious fact that without surgery, even when recovering from coronavirus infection, the patient remains immobile and unable to elementary self-care. This point of view is shared by the authors of all the works considered in the preparation of this article.

Surgical treatment of patients with PFF in combination with the new coronavirus infection COVID-19 is associated with a number of serious organizational and medical problems. However, surgical fixation of the fracture is even more important for patients with COVID-19 infection than for ordinary patients with PFF. This statement is indirectly confirmed by the fact that the 30-day mortality rate in patients with coronavirus infection when refusing surgery, according to our data, was 8.5 times higher than with surgical treatment. In patients without coronavirus infection, according to a meta-analysis performed by P. Joosse et al., the 30-day mortality differed by only 3.95 times [36]. This is understandable, since surgical fixation of fragments and early activation of a patient with COVID-19 are extremely important for preventing the aggravation of an existing viral lung lesion and, as a consequence, respiratory failure, which entails decompensation of chronic diseases of an elderly person.

### *Study limitations*

The disadvantages of our study include the inability to compare the results of conservative and surgical treatment of patients with PFF in combination with COVID-19 coronavirus infection due to the lack of full-fledged comparability of patient groups. The reason for this is the retrospective nature of the study. At the same time, it is natural that patients in the conservative treatment group were older, more severe in terms of comorbidity and the course of coronavirus infection. It is the main reason why we were unable to provide them with surgical treatment. Theoretically, this lack of research can be eliminated. To do this, it is necessary to identify criteria for comparability of patient groups and conduct a prospective study in which patients from statistically comparable groups will receive different treatment. Of course, certain ethical issues will have to be taken into account. We do not exclude that in future work we will consider the possibility of conducting such a study. Additional analysis of the patients with PFF treatment results before and after the onset of the pandemic is also required. In the future, we plan to compare more parameters using a full-fledged statistical analysis.

### **Conclusions**

Despite a number of unresolved problems, our experience presented in this article suggests that surgical treatment of patients with PFF in combination with

COVID-19 coronavirus infection is already possible with good results and should be actively applied.

### Informed consent

The patients gave written informed consent to participate in the study.

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*Conflict of interest:*

The authors declare that there is no conflict of interest.