



Surgical Treatment of Pneumothorax in Patients with COVID-19 – Results and Management

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Abstract

Introduction: The new coronavirus, SARS-CoV-2, provokes infection with different clinical presentation. It involves an asymptomatic condition, mild variants with fever and dry cough to severe pneumonia, adynamia and respiratory failure with lethal outcome. The fibrotic lung tissue after the inflammatory process is a background for development of a secondary pneumothorax. Although it rarely causes lethal outcomes in COVID-19 patients, pneumothorax requires early diagnosis and adequate treatment to prevent any complications and decrease mortality rate.

Aim: The aim of this study was to analyse the results of surgical treatment of hospitalized COVID-19 patients with pneumothorax in terms of demographic data, concomitant diseases, complications, and outcome.

Materials and methods: Longitudinal prospective study was carried out with 26 patients with pneumothorax as a result of SARS-CoV-2 infection. They were treated at the Intensive Care Unit of the Infectious Disease Clinic and at the Second Clinic of Surgery, St George University Hospital in Plovdiv over a 6-month period from September 2020 to February 2021.

Results: Seventeen of the patients were men and nine – women. Twenty-four of all patients underwent thoracocentesis and two of them had a video-assisted thoracoscopy. The mean age of the studied patients with pneumothorax and COVID-19 was 66.77 ± 12.61 years, which shows that it is the patients of advanced age with concomitant diseases that are at a higher risk of serious complications and adverse outcome.

Of the hospitalized 1245 patients with COVID-19, 385 (30.92%) passed away. Of all hospitalized patients with SARS-CoV-2, 26 (2.08%) developed pneumothorax. Sixteen of them (62%) passed away. The possibility of a lethal outcome for intubated patients increased more than twice.

Conclusions: The pneumothorax as a complication of COVID-19 carries high mortality and severely worsens the prognosis for these patients.

Keywords

lung surgery, SARS-CoV-2, thoracocentesis, VATS

INTRODUCTION

Pneumothorax is defined as the presence of air or gas in the pleural cavity with or without lung collapse.¹ This is a life-threatening condition and requires urgent medical intervention. According to etiology, pneumothorax is classified as spontaneous or traumatic (by blunt or penetrating trauma or iatrogenic). Iatrogenic pneumothorax is a complication of a diagnostic or therapeutic intervention, for example, use of central venous catheter, transthoracic aspiration, thoracocentesis, lung biopsy and most often – barotrauma.² Spontaneous pneumothorax is not a result of trauma or an iatrogenic procedure. While it develops without visible lung pathology, the secondary one is most often a complication of a previous lung disease. Although the spontaneous pneumothorax can develop during infection including SARS-CoV-2³, the possibility of its occurrence increases in combination of 1) parenchymal damage with underlying infection and 2) inflammatory response by the ventilation and oxygen pressure^{4,5}. SARS-CoV-2 provokes infection with different clinical presentation. It involves an asymptomatic condition, mild variants with fever and dry cough to severe pneumonia, adynamia, and respiratory failure with lethal outcome. The leading manifestations in COVID-19 from the respiratory system in case of severe respiratory symptoms (bilateral pneumonia with typical image finding) require hospitalization with mechanical ventilation and intubation. An increasing number of cases with pneumothorax, especially in patients on mechanical ventilation⁶ were registered during the pandemic. Parenchymal damage of the lung tissue leads to fibrosis after the inflammatory process and this causes the development of a secondary pneumothorax. Patients with pneumothorax can develop subcutaneous emphysema and SARS-CoV-2 complication – pneumomediastinum.^{7,8} This requires precise and urgent diagnosis and adequate therapy to minimize the extent of worsening the disease.

AIM

The aim of this study was to analyse the results of the surgical treatment of pneumothorax as a complication in COVID-19 hospitalized patients in terms of demographic data, the extent to which it can worsen prognosis of the disease and its outcome.

MATERIALS AND METHODS

Patients

Longitudinal prospective study was carried out with 26 patients with pneumothorax as a result of SARS-CoV-2 infection. They were treated at the Intensive Care Unit of the Infectious Diseases Clinic and at the Second Clinic of Surgery

at St George University Hospital in Plovdiv, Bulgaria, over a 6-month period from September 2020 to February 2021.

Methods

CT scans were used for the image diagnosis of pneumothorax in 10 patients and lung X-ray was done in 16 patients. Fourteen of the patients were intubated at the Intensive Care Unit of the Infectious Disease Clinic. Twelve of them underwent a surgery at the Second Clinic of Surgery, St George University Hospital in Plovdiv. Four of the patients had no concomitant diseases, but the rest 22 of them presented with concomitant diseases – chronic obstructive pulmonary disease (COPD), diabetes, arterial hypertension (AH), and heart failure (HF). Two of the patients underwent a video-assisted thoracoscopy (VATS) with partial lung resection and pleurodesis. Twenty-four of the patients underwent thoracocentesis and three of them – bilateral thoracocentesis from 1 to 3 days.

Statistical analysis

The obtained data were statistically analysed using correlation analysis (Pearson, Spearman coefficient), frequency distribution, linear regression analysis, nonparametric dispersion analysis (Mann-Whitney test), ANOVA test was applied to compare two groups and chi-square test using SPSS v. 23.0. Data are presented as mean values \pm standard deviation ($X \pm SD$) or in percent (%). Statistical significance was considered at $p < 0.05$. The correlation coefficient (r) was used to express how strong a relationship was between two variables.

RESULTS

Demographic characteristics of COVID-19 patients with pneumothorax – age and sex

Over a 6-month period, a total number of 1245 patients were registered with diagnosis of COVID-19 at St George University Hospital in Plovdiv. Of these, 385 (30.92%) passed away (Fig. 1). Twenty-six patients were included in the present study. They developed pneumothorax as a complication of COVID-19 and accounted for 2.08% of the total number of the hospitalized patients with SARS-CoV-2 (Fig. 2).

The mean age of the studied patients was 66.77 ± 12.61 years. The oldest patient was 81 years and the youngest one – 33 years old (Fig. 3). The prevalent part of the patients was in the age group over 70 years. They were 57.69% of all patients with pneumothorax (Fig. 4). This group had the highest mortality rate (68.8%). The distribution by sex showed that men prevailed over women (the ratio of men to women was 1.89:1). The male patients were 17 (65.4%) versus 9 women (34.6%) (Fig. 5).

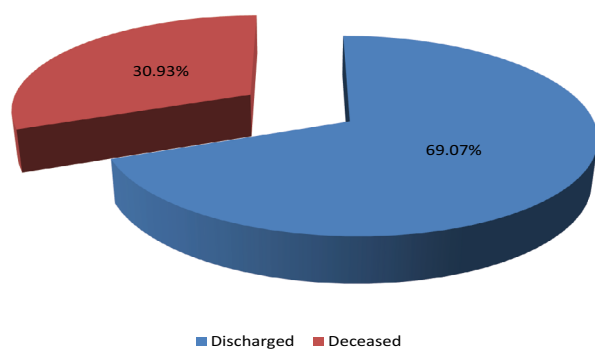


Figure 1. Distribution of discharged and deceased patients with SARS-CoV-2 hospitalized at St George University Hospital, Plovdiv.

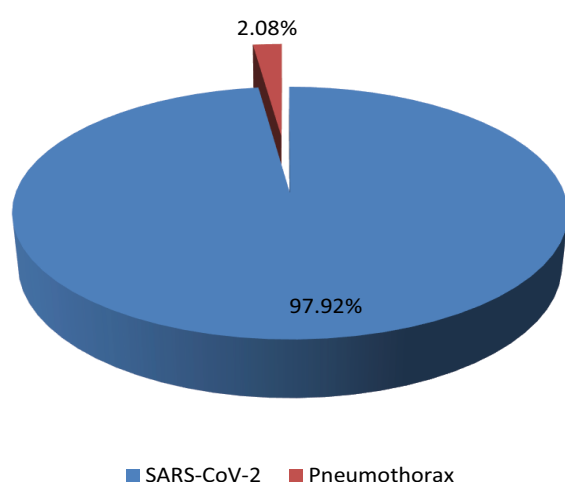


Figure 2. Patients with pneumothorax of all COVID-19 patients.

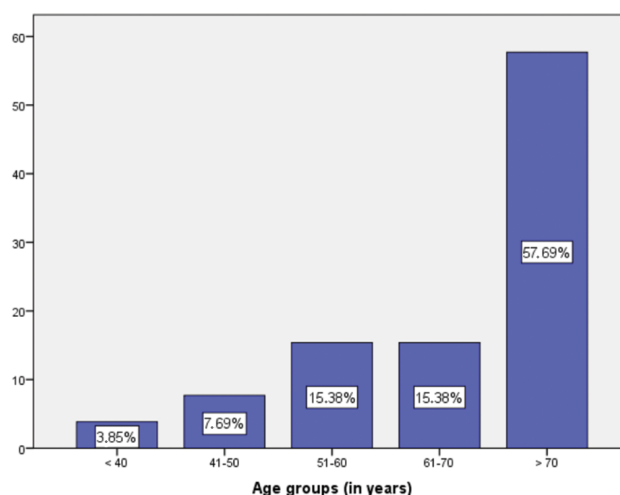


Figure 4. Distribution of the studied patients with pneumothorax in the age group over 70 years.

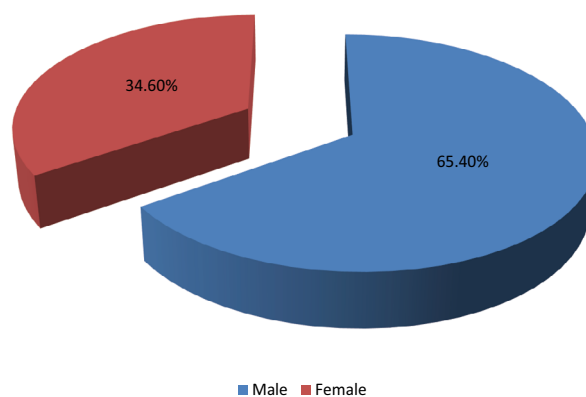


Figure 5. Sex distribution of the patients with pneumothorax.

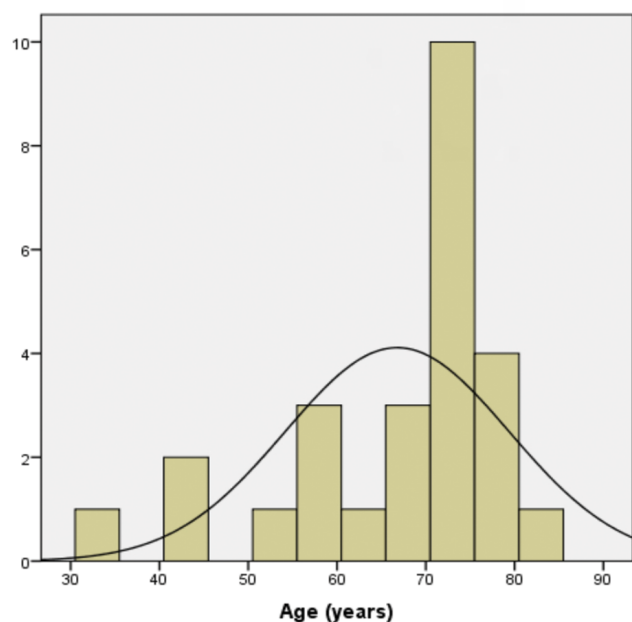


Figure 3. Age distribution of the patients with pneumothorax.

The women in our study were of significantly higher mean age (75.11 ± 4.37 years) while the mean age of men was 62.35 ± 13.38 years ($p=0.001$). It is interesting to note that 100% of these women had concomitant diseases while this percentage of men with such diseases was lower (76.5%). The results showed that the chance a lethal outcome increased 5 times in women ($OR=5.00$; 95% CI (1.73–34.20)). The mortality rate in women was twice as high as that in men (88.9%). Mortality in men was 47.1% ($p=0.03$; $r=0.38$).

Surgical characteristics of pneumothorax in COVID-19 patients and outcome

Twelve of the patients (46.2%) had a right pneumothorax and 11 (42.3%) – a left one. Combined (bilateral) pneumothorax was found in 3 cases (11.5%); at the beginning of the infection, pneumothorax was only one-sided and then it became bilateral in the next 1-4 days. Four of the patients diagnosed initially with mediastinal and subcutaneous emphysema, developed pneumothorax in the next 1-4 days.

Of the cases with left pneumothorax, 41.4% had a lethal outcome. The mortality in the patients with right pneumothorax was 72.2% and the three patients with combined pneumothorax had a lethal outcome (**Fig. 6**). No statistically significant correlation was found between the pneumothorax type and the disease outcome. However, such correlation can be supposed considering the additional factors that influence the development of the disease.

Fourteen patients (53.8%) received intubation and lung ventilation. Eleven of them (78.6%) passed away and only 3 were discharged with improvement (21.4%) (**Fig. 7**). Twelve (46.2%) patients were not intubated. Five of them (41.7%) had a lethal outcome and 7 (58.3%) were discharged with improvement. We found that intubation led to an increased lethal outcome ($p=0.05$; $r=0.35$). The possibility of lethal outcome for intubated patients increased more than twice ($OR=2.29$; 95% $CI (0.84-6.24)$).

Concomitant diseases were observed in 22 (84.6%) of the studied patients, 14 of whom (63.6%) had a lethal outcome. Although no significance ($p>0.05$) was observed, we should take into consideration the existing correlation between the concomitant diseases and the unfavourable outcome of the disease. Only 15.4% of the studied patients had no concomitant diseases (**Fig. 8**).

DISCUSSION

The diagnosed pneumothorax in our study is a secondary one. It is a result of the parenchymal damage and the inflammatory process in the lungs. It is considered that mechanical ventilation is one of the most important risk factors for development of pneumothorax in patients with pneumonia with SARS-CoV-2.⁹ The incidence of pneumothorax in patients on mechanical ventilation is high and it increases in acute respiratory failure (14% to 87%). It correlates directly with the severity and the duration of the acute respiratory failure and the barotrauma induced by the mechanical ventilation. This is more characteristic of the cases

with high inspiratory pressure (PIP) (>40 to 50 cm H₂O), high positive end-expiratory pressure (PEEP), high volume and minute ventilation.¹⁰

It is interesting that a patient with SARS-CoV-2 can develop spontaneous pneumothorax, pneumomediastinum and subcutaneous emphysema (some patients present with

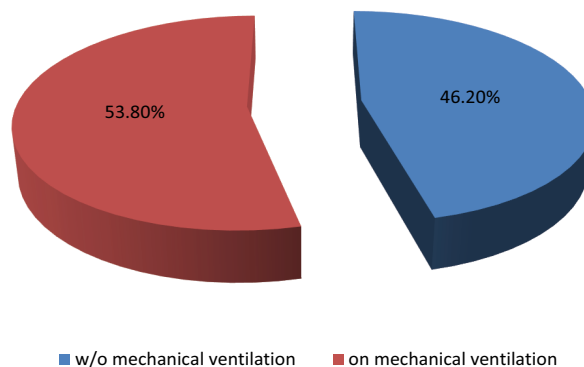


Figure 7. Distribution of patients on mechanical ventilation.

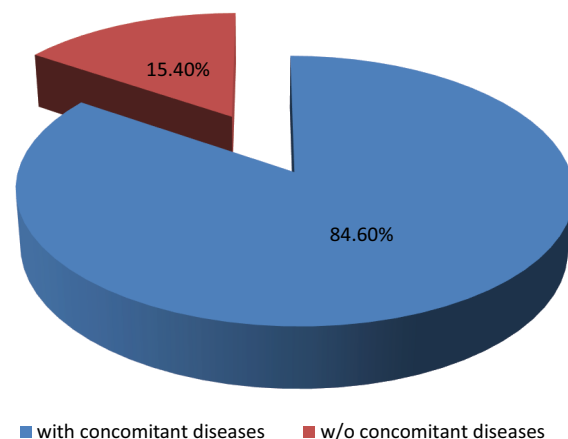


Figure 8. Distribution of patients with concomitant diseases.

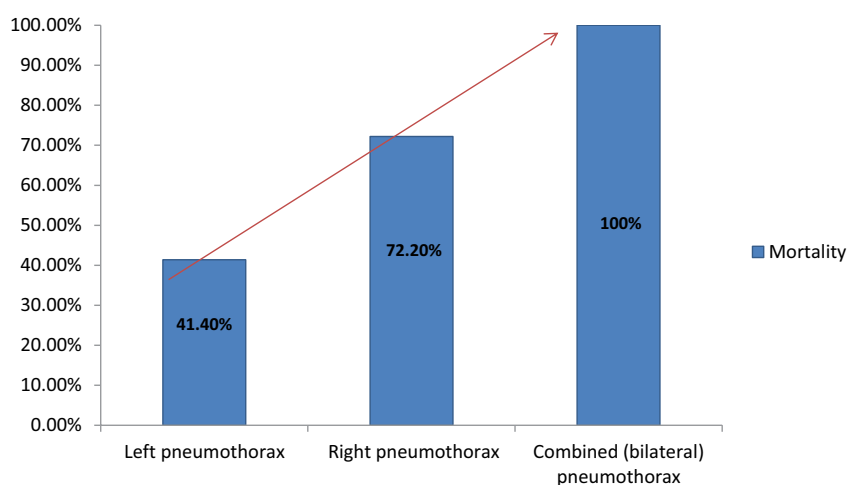


Figure 6. Distribution of mortality by type of pneumothorax.

the last two even later), even though there is no mechanical ventilation¹¹ and there is normal breathing¹². In our study, we observed 4 such patients who at the beginning had subcutaneous mediastinal emphysema and consequently they developed a pneumothorax.

Pneumothoraces occurring in patients with SARS-CoV-2 have been reported since last year. The incidence of pneumothorax in these patients differs by less than 1% to 6%.^{6,13,14} In a study of 202 patients in Wuhan, it was confirmed that 12 of them (5.9%) developed pneumothorax during the mechanical ventilation.¹⁴ Chen N et al. also reported a low incidence of pneumothorax (1%) in the first patients in Wuhan.¹³ However, more than 50% of the patients had chronic concomitant diseases. Pneumothorax was also a rare complication in our study. Of the 1245 patients treated in our hospital, only 26 (2.08%) developed pneumothorax. However, we observed concomitant diseases (diabetes, COPD, AH, HF) in even higher percentages than in our patients (84.6%). Our study contributes to the previous reports demonstrating that the average occurrence of pneumothorax in COVID-19 registered patients is about 2% and that it is comparable with the lower incidence of this complication during the course of infection. Yang et al. published data on pneumothorax as SARS-CoV-2 complication which led to a lethal outcome during the period between 6 January and 25 February 2020.¹⁵ The comparative analysis of 92 deceased patients with COVID-19 in Wuhan showed that pneumothorax was a rare cause for the lethal outcome (only in 1.1%). The acute respiratory failure was the main cause for the lethal outcome in the deceased patients (79.3%) followed by a septic shock (7.6%), heart attack (6.5%), and multiorgan failure (2.2%). Our findings showed that the pneumothorax as a cause for a lethal outcome (1.28%) was comparable to that reported by Yang et al.¹⁵

In our study, 16 out of all 28 patients with pneumothorax passed away (62%). Mortality in patients on mechanical ventilation was also high (78.6%). This can be explained by the advanced age, the immunosenescence and the variety of concomitant diseases in these patients. Women had twice as high mortality as men had. These results can be accounted for by the fact that women had higher average age and all of them had concomitant diseases. Akdogan et al. showed similar results about mortality in patients with pneumothorax with SARS-CoV-2 pneumonia (60%).¹⁶

However, although rare as a cause for mortality in patients with COVID-19, pneumothorax requires early diagnosis and treatment for prevention of complications and decrease in mortality.

Age can also be a risk factor for pneumothorax development in patients with COVID-19. It has also a significant importance for the occurrence of other complications, especially in people over 60 years old.¹⁵ The mean age of the patients in our study is similar and women showed significantly higher average age compared to men although men with pneumothorax prevailed over women.

Pneumothorax in patients with SARS-CoV-2 pneumonia needs thorough examination and control since it can

lead to other complications. According to another survey, 80% (4/5) of the intubated patients with SARS-CoV-2 pneumonia had a bilateral pneumothorax. Three of them (75%) developed a secondary bacterial pneumonia, two – pneumomediastinum and massive subcutaneous emphysema and one – pneumoperitoneum.¹⁶

CONCLUSIONS

This is the first study in Bulgaria on the occurrence of pneumothorax in COVID-19 patients. It shows that development of pneumothorax in the course of SARS-CoV-2 infection is a serious complication carrying high mortality. In patients on mechanical ventilation, the mortality rate is twice as high as in the group with normal breathing.

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REFERENCES

1. Roberts DJ, Leigh-Smith S, Faris PD, et al. Clinical presentation of patients with tension pneumothorax: a systematic review. *Annals of Surgery* 2015; 261(6):1068–78.
2. Miller MP, Sagy M. Pressure characteristics of mechanical ventilation and incidence of pneumothorax before and after the implementation of protective lung strategies in the management of pediatric patients with severe AIRDS. *Chest* 2008; 134(5):969–73.
3. Alhakeem A, Khan MM, Al Soub H, et al. Case report: COVID-19 associated bilateral spontaneous pneumothorax – a literature review. *Am J Trop Med Hyg* 2020; 103(3):1162–5.
4. Abushahin A, Degliomini J, Aronow WS, et al. A case of spontaneous pneumothorax 21 days after diagnosis of coronavirus disease 2019 (COVID-19) pneumonia. *Am J Case Rep* 2020; 21:e925787-1–4.
5. Mallick T, Dinesh A, Engahl R, et al. COVID-19 complicated by spontaneous pneumothorax. *Cureus* 2020; 12(7):e9104.
6. Zantah M, Castillo ED, Townsend R, et al. Pneumothorax in COVID-19 disease-incidence and clinical characteristics. *Respiratory Research* 2020; 21(1):1–9.
7. Al-Azzawi M, Douedi S, Alshami A, et al. Spontaneous subcutaneous emphysema and pneumomediastinum in COVID-19 patients: an indicator of poor prognosis. *Am J Case Rep* 2020; 21:e025557.
8. Quincho-Lopez A, Quincho-Lopez DL, Hurtado-Medina FD. Case report: pneumothorax and pneumomediastinum as common complications of COVID-19 pneumonia – literature review. *Am J Trop Med Hyg* 2020; 103(3):1170–6.
9. Aiolfi A, Biraghi T, Montisci A, et al. Management of persistent pneumothorax with thoracoscopy and blebs resection in COVID-19 patients. *Ann Thorac Surg* 2020; 110(5):e413–5.
10. Woodside KJ, Van Sonnenberg E, Chon KS, et al. Pneumothorax in

- patients with ARDS: pathophysiology, detection and treatment. *J Intensive Care Med* 2003; 18(1):9–20.
11. Wang W, Gao R, Zheng Y, et al. COVID-19 with spontaneous pneumothorax, pneumomediastinum and subcutaneous emphysema. *J Travel Med* 2020; 27(5):taaa062.
 12. Zhou C, Gao C, Xie Y, et al. COVID-19 with spontaneous pneumomediastinum. *Lancet Infect Dis* 2020; 20:510.
 13. Chen N, Zhou M, Dong X, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; 395:507–13
 14. Yao W, Wang T, Jiang B, et al. Emergency tracheal intubation in 202 patients with COVID-19 in Wuhan, China: lessons learnt and international expert recommendations. *Br J Anaesth* 2020; 125(1):e28–37.
 15. Yang F, Shi S, Zhu J, et al. Analysis in mechanically ventilated patients with COVID-19 infection. *Case Rep Crit Care* 2021; doi.org/10.1155/2021/665753
 16. Akdogan RE, Mohammed T, Syeda A, et al. Pneumothorax in mechanically ventilated patients with COVID-19 infection. *Case Rep Crit Care* 2021; 2021. doi.org/10.1155/2021/6657533

Хирургическое лечение пневмоторакса у пациентов с COVID-19 – результаты и лечение

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Резюме

Введение: Новый коронавирус SARS-CoV-2 вызывает инфекцию с различными клиническими проявлениями. Он варьируется от бессимптомных состояний, лёгких вариантов с лихорадкой и сухим кашлем до тяжёлой пневмонии, летаргии и дыхательной недостаточности с летальным исходом. Фиброзная ткань лёгкого после воспалительного процесса является основой развития вторичного пневмоторакса. Хотя пневмоторакс редко приводит к летальному исходу у пациентов с COVID-19, он требует ранней диагностики и адекватного лечения для предотвращения любых осложнений и снижения смертности.

Цель: Цель исследования – проанализировать результаты хирургического лечения госпитализированных пациентов с COVID-19, страдающих пневмотораксом, с точки зрения демографических данных, сопутствующих заболеваний, осложнений и исходов.

Материалы и методы: Проведено долгосрочное проспективное исследование среди 26 пациентов с пневмотораксом в результате инфекции SARS-CoV-2. Они лечились в отделении интенсивной терапии клиники инфекционных заболеваний при второй хирургической клинике университетской больницы «Св. Георги», Пловдив, сроком на шесть месяцев с сентября 2020 года по февраль 2021 года.

Результаты: Семнадцать пациентов были мужчинами и девять женщинами. Двадцать четыре пациента прошли торакоцентез, двое из них – видеоторакоцентез. Средний возраст обследованных пациентов с пневмотораксом и COVID-19 составил 66.77±12.61 года, что свидетельствует о том, что именно пожилые пациенты с сопутствующими заболеваниями имеют наибольший риск серьёзных осложнений и нежелательных явлений.

Из 1245 пациентов, госпитализированных с COVID-19, 385 (30.92%) умерли. Из всех госпитализированных пациентов с SARS-CoV-2 у 26 (2.08%) развился пневмоторакс. Шестнадцать из них (62%) умерли. Вероятность смерти интубированных пациентов увеличилась более чем вдвое.

Заключение: Пневмоторакс как осложнение COVID-19 вызывает высокую смертность и сильно ухудшает прогноз пациентов.

Ключевые слова

хирургия лёгких, SARS-CoV-2, торакоцентез, VATS