ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

Has the Pneumothorax's Course Changed in COVID-19?

COVİD-19'da Pnömotoraksın Seyri Değişti mi?

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ABSTRACT

Aim: *During severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, pneumothorax is a frequent consequence. This study investigated the treatment methods and clinical course of 27 patients with a pneumothorax who were followed up in the intensive care unit for 3 months.*

Material and Method: *The inclusion criteria included patients with Coronavirus disease 2019 (COVID-19) who were admitted to our hospital's intensive care unit and underwent a tube thoracostomy because of the development of a pneumothorax while receiving invasive mechanical ventilation therapy. Over three months, these patients were evaluated based on age, sex, tube thoracostomy duration, and mechanical ventilation parameters.*

Results: *Among the 27 patients, 17 (62.9%) were men and 10 (37.1%) were women. The mean age of the patients was 68 (39–92) years. Chest tubes were removed in 4 of 27 patients within a week.*

Conclusion: *Tube removal takes longer than that in patients with non-COVID-19-related pneumothorax. Care should be taken to ensure full expansion to prevent pneumothorax recurrence after tube thoracostomy.*

Keywords: *SARS-CoV-2; pneumothorax; thoracostomy*

ÖZET

Amaç: *SARS-CoV-2 enfeksiyonu nedeniyle pnömotoraks tipik bir komplikasyon olarak ortaya çıkar. Bu çalışmada, yoğun bakımda üç ay izlenen 27 pnömotorakslı hastanın tedavi yöntemleri ve klinik seyri araştırıldı.*

Materyal ve Metot: *Dâhil edilme kriterleri, hastanemizin yoğun bakım ünitesine kabul edilen ve invaziv mekanik ventilasyon tedavisi alırken pnömotoraks gelişmesi nedeniyle tüp torakostomi uygulanan COVID-19 hastalarını içeriyordu. Üç aylık bir süre boyunca bu hastalar yaşlarına, cinsiyetlerine, tüp torakostomi sürelerine ve mekanik ventilasyon parametrelerine göre değerlendirildi.*

Bulgular: *27 hastanın 17'si (%62,9) erkek, 10'u (%37,1) kadındı. Hastaların ortalama yaşı 68 (39–92) yıldı. Tüp torakostomi uygulanan 27 hastanın sadece dördü bir hafta içinde göğüs tüpünü çıkarabildi.*

Sonuç: *Tüpün çıkarılması, COVID-19 olmayan pnömotoraks hastalarında olduğundan daha uzun sürer. Tüp torakostomi sonrası pnömotoraksın tekrarını önlemek için tam genişlemenin sağlanmasına özen gösterilmelidir*

Anahtar kelimeler: *COVID-19, pnömotoraks, torakostom*

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a viral agent that can cause a variety of clinical manifestations, from cold-like flu to acute respiratory failure syndrome (ARDS). Coronavirus disease 2019 (COVID-19) has a wide range of systemic effects in humans; however, it is mostly responsible for lower respiratory tract diseases. Various clinical manifestations of secondary bacterial infections include cardiac arrhythmia, cardiomyopathy, acute renal injury, and liver dysfunction[1].

Pneumomediastinum, pneumopericardium, pleural effusion, subcutaneous emphysema, and pneumothorax complications are among the thoracic abnormalities associated with COVID-19 in patients monitored in intensive care units[1,2].

Because SARS-CoV-2 infection is frequent in the lung parenchyma and causes damage up to fibrosis, pneumothorax can occur as a typical complication. The interaction of the fibrotic parenchyma and long-term high-pressure breathing can cause pneumothorax.

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This study investigated the treatment methods and clinical course of 27 patients with pneumothorax who were followed up in the intensive care unit for 3 months.

Materials and Methods

Ethical approval for this study was obtained from a relevant institute (E1–20–612). Patients with SARS-CoV-2 who were admitted to the intensive care unit and monitored while receiving invasive mechanical ventilation therapy between 1 April 2020 and 30 June 2020 were examined clinically and radiologically retrospectively. Various complications were noted. During these three months, 39 patients from the intensive care unit presented to our hospital for complications such as pneumothorax, pneumomediastinum, pneumopericardium, and subcutaneous emphysema. The patients' mechanical ventilator parameters and the levels of lung parenchymal involvement on radiological imaging were recorded. All patients underwent thorax tomography. The inclusion criteria included patients with SARS-CoV-2 who were admitted to our hospital's intensive care unit and underwent a tube thoracostomy because of the development of pneumothorax while receiving invasive mechanical ventilation therapy. Over three months, these patients were evaluated based on age, sex, tube thoracostomy duration, and mechanical ventilation parameters. Patients were divided into two groups according to tube thoracostomy durations (<1 week and ≥ one week). Descriptive analyses were presented using the means for the fraction of inspired oxygen rate (FiO2) and positive end-expiratory pressure (PEEP) values.

Results

During these three months, 27 of the 39 patients who presented to our hospital from the intensive care unit had pneumothorax, 10 had pleural effusion, and 2 had hemothorax. Polymerase Chain Reaction (PCR) testing established that all patients had SARS-CoV-2 infection.

No patient had a negative test but a positive CT (computed tomography) result.

Among the 27 patients who underwent tube thoracostomy because of pneumothorax (Figure 1) and were monitored while receiving invasive mechanical ventilation therapy, 17 (62.9%) were men and 10 (37.1%) were women. The mean age of the patients was 68 (39–92) years.

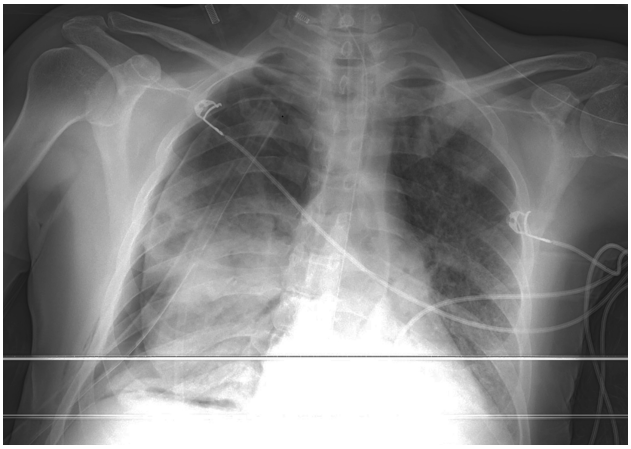

Figure 1. *Patient who underwent tube thoracostomy for pneumothorax*

All patients showed lung involvement and parenchymal infiltrative regions on thorax tomography. At least one lobe of the patients was impacted, and the majority had bilateral parenchymal infiltration.

Of the patients with pneumothorax, 17 (62.9%) had right hemithorax, 8 (29.7%) had left hemithorax, and 2 (7.4%) had bilateral pneumothorax. Of the 27 pneumothorax patients, 25 (92%) had pneumomediastinum, 5 (18.5%) had a mediastinal shift, and 7 (25.9%) had pleural effusion.

Although 4 (14.8%) patients had their chest tube removed within one week, 12 (44.4%) had their tube removed after >1 week. During these three months, the chest tube could not be removed in 11 (40.8%) of the 27 patients, and recurrent pneumothorax developed in 4 (14.8%) within 24 hours of the tube removal. In patients who experienced recurrent pneumothorax, a tube thoracostomy was performed again. The duration after both tube thoracostomies until the tube removal was >1 week in two patients with bilateral tube thoracostomies. The average tube thoracostomy duration of 16 patients with chest tubes removed over three months was 38.4 (2–90) days.

The chest tube could not be removed because, unfortunately, 4 of the 11 patients who had their tube removed died, and the remaining 7 had an expansion defect and severe air leakage. Intermittent negative aspiration was first applied from a chest bottle for unexpanded lungs. Devices with automatic continuous aspiration were used in resistant expansion defects.

In our study, the three-month mortality rate was 14.8%. The cause of death of the patients was determined to be COVID-19.

Table 1. *Results and patient characteristics*

Features		Number of patients/Rate
Sex	Men	17
	Women	10
Hemithorax	Right	17
	Left	8
	Bilateral	2
Concomitant Pathology	Pneumomediastinum	25
	Mediastinal shift	5
	Pleural effusion	7
Chest tube duration	< 1 week	4
	≥ 1 week	12
	Not terminated within 3 months	11
Chest tube duration <1 week	The FIO_2 value required to provide 80% or more oxygen saturation	≤75%
	the required PEEP value	≤8 cm H_2O
Recurrent pneumothorax	4	
3-month mortality	14.8%	

Based on the radiological examination results of the patients and the mechanical ventilation parameters, we compared the duration of chest tube removal in patients who were monitored while receiving invasive mechanical ventilation therapy in the intensive care unit. For patients whose chest tube was removed in <1 week, the highest FiO2 rate necessary to achieve a saturation of ≥80% was ≤75, whereas it was higher in the other group. The PEEP was ≤8 cmH_2O in patients whose tube was removed within one week, whereas it was higher in the other group.

Although both groups had bilateral parenchymal infiltrative involvement, the entire group with tube thoracostomy had bilateral diffuse homogenous infiltration for over a week. The patient characteristics and outcomes are summarized in Table 1.

Discussion

With the progression of the COVID-19 pandemic, clinicians' understanding of uncommon symptoms, radiographic findings, ARDS, clinical stages, and associated complications has improved. Recent studies have focused on disease-related pneumothorax, pleural effusion, and pneumomediastinum. In patients monitored in the intensive care unit, pneumomediastinum, pneumopericardium, pleural effusion, subcutaneous emphysema, and pneumothorax have been identified as complications associated with COVID-19[3–5].

Pneumothorax and pneumomediastinum can appear even without barotrauma associated with mechanical ventilation in patients with SARS-CoV-2 pneumonia[2,6,7]. Pneumothorax is a known complication of intubated patients receiving mechanical ventilation[8,9]. COVID-19-related pneumothorax can be detected during hospitalization,[3] in the delayed period after the SARS-CoV-2 treatment,[4] and at the time of hospitalization[5].

Spontaneous pneumothorax is often detected in younger patients compared with secondary pneumothorax. Sahn et al. reported that primary and secondary spontaneous pneumothoraxes were more common in males than females[10]. They also indicated that the mean age of patients with secondary spontaneous pneumothorax was higher than that of those with primary spontaneous pneumothorax[10]. As in non-COVID-19 secondary pneumothorax cases, the proportion of male patients was higher than that of female patients in cases of pneumothorax due to COVID-19[11,12].

In this study, pneumothorax was 1.7 times more common in male patients than female patients, which is consistent with the literature. Although it is similar to the male-to-female ratio found in non-COVID-19 spontaneous pneumothorax, a statistical comparison requires more patients.

The mean age of patients with pneumothorax who underwent tube thoracostomy as a result of COVID-19 was 68 (39–92) years. COVID-19 increases the demand for intensive care in patients who are older and have more comorbidities. This circumstance is known to apply to all secondary spontaneous pneumothorax patients[7].

In total, 248 hospitalized patients with a diagnosis of COVID-19 were evaluated by Wang et al.[12], and 49 of these patients were diagnosed with ARDS. According to the study, 21 patients with ARDS were started on mechanical ventilation, and 9 received invasive mechanical ventilation therapy. According to Wang et al., pneumothorax was observed in 2.01% of patients overall, 10% in patients with ARDS, 24% in patients receiving mechanical ventilation support, and 56% in patients receiving invasive mechanical ventilation therapy[12]. In several other studies, the rate of COVID-19-related pneumothorax was reported to be 0.66%–0.97% in all patients[13,14].

Pneumothorax is the most common manifestation of alveolar macroscopic damage due to mechanical

ventilation in a hospital[15]. Pneumothorax is a common complication in mechanically ventilated patients, with rates ranging from 4% to 15%[16,17]. Gammon et al. reported a 14% pneumothorax incidence rate in 139 patients receiving mechanical ventilation therapy compared with a 60% pneumothorax incidence in 29 patients with ARDS[18]. Another study reported a 30%–87% incidence rate of pneumothorax, depending on the severity and duration of ARDS as well as the mode of ventilator management[19]. COVID-19 has been associated with barotrauma in up to 40% and pneumothorax in up to 25% of patients receiving invasive mechanical ventilation therapy in the intensive care unit[20].

In pneumothorax, persistent air leakage is defined as air leakage that lasts for >7 days after tube thoracostomy. Only 4 of the 27 patients who underwent a tube thoracostomy were able to have the chest tube removed within one week. Prolonged tube thoracostomy duration was observed in 23 (85.1%) patients.

Surgical treatment is preferred in patients with non-COVID-19 pneumothorax with persistent air leakage[13]. Previous studies have recommended thoracoscopic surgery for COVID-19-associated persistent air leakage patients[13,21]. Surgical treatment is impossible in our patients because of their general state in the follow-up. Depending on whether bullae are identified on a thorax tomography scan, some studies recommend evaluating patients with primary or secondary pneumothorax and persistent air leakage for emergency surgery[22]. In patients with persistent air leakage, chemical pleurodesis with an intrapleural sclerosing agent has a low success rate. Some studies have reported performing chemical pleurodesis through tube thoracostomy in patients with COVID-19-associated pneumothorax[13]. Because our patients had substantial expansion defects, we could not predict the effect in patients with ARDS, and some patients were candidates for lung transplantation. We did not opt for chemical pleurodesis in our study. A suction apparatus was used to create an intermittent vacuum in these patients. However, the patient's overall status was monitored, and surgical intervention was planned.

Although 75% and 61% of primary and secondary spontaneous pneumothorax air leakages, respectively, resolve one week after the tube thoracostomy, approximately 100% and 79% of the cases are settled after 15 days[10]. In our study, 14.8% of patients who had pneumothorax due to COVID-19 and mechanical ventilation had lung expansion within one week of tube thoracostomy, and 44.4% achieved lung expansion after one week and the chest tube was removed. In 40.8% of patients, the tube could not be removed within three months.

Barotrauma due to mechanical ventilation has been reported to be more common in patients with COVID-19[23]. In the early stages of ARDS due to COVID-19, low tidal volume (6–8 ml/kg), increased respiratory rate (35/min), PEEP >5 cmH_2O, and PaO2 55–80 (SaO2 88%–95%) are all classic lung-protective mechanical ventilation parameters. These parameters were used to maintain appropriate, suitable FiO2 levels. Because patients with COVID-19 did not respond to a high PEEP, the pathophysiology of ARDS was considered different, and some studies supported this hypothesis[24,25]. This explains the increased incidence of barotrauma in patients receiving mechanical ventilation therapy. In our study, patients ventilated at a high PEEP (>8 cmH_2O) had longer tube thoracostomy durations and massive air leakages. This condition might have resulted from the significant barotrauma that the patients experienced due to mechanical ventilation.

Parenchymal expansion defects, diffuse consolidation, and infiltration areas were prominent on the chest radiographs of the patients with prolonged tube thoracostomy. There was massive air leakage from the tube thoracostomies. The clinical parameters were poorer in patients with bilateral tube thoracostomy, and the tube thoracostomy duration was more prolonged.

An increased risk of death has been associated with advanced age (>65 years), male sex, hypertension, cardiovascular diseases, diabetes, chronic obstructive pulmonary disease, and cancer. The survival rate of patients with pneumothorax receiving invasive mechanical ventilation therapy has been estimated to be approximately 50%0,[11] In our study, the three-month mortality rate was 14.8%. The fact that parenchymal infiltration areas are bilateral and widespread, as well as the need for high FiO_2 (≥75%) and high PEEP (≥8 cmH_2O) to achieve a saturation of ≥80%, all contribute to the poor prognosis of the patients and the longer duration of tube thoracostomies.

There are some limitations of this study. First, the data retrospectively reflect the data of a limited time in a single center. The study includes only adult patients. Although pneumothorax might occur during SARS-CoV-2 infection, patients may have parenchymal lung illness, which can cause pneumothorax. Furthermore, patients need long-term follow-up data.

Conclusions

In patients with pneumothorax who underwent tube thoracostomy and were monitored in the intensive care unit for COVID-19, conditions such as bilateral, diffuse, and late-healing lung parenchyma involvement, as well as mechanical ventilation support, prolong the duration of tube thoracostomy. Physicians show interest in exploring the impact of disease-induced widespread fibrosis on the onset and progression of pneumothorax.

Tube thoracostomy treats patients with parenchymal involvement and pneumothorax due to COVID-19. In these patients, however, tube removal takes longer than in patients with non-COVID-19 pneumothorax. Care should be taken to ensure complete expansion to prevent pneumothorax recurrence after tube thoracostomy.

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