Spontaneous pneumomediastinum in COVID-19 patients. Case series

Francina V. Bolaños-Morales,¹ J. Alfredo Santibáñez-Salgado,^{1*} Cristóbal Guadarrama-Pérez,²
Julio de J. Herrera-Zamora,¹ Francisco J. Armas-Zárate¹ and Patricio J. Santillán-Doherty¹

¹Cardiothoracic Surgery Department; ²Emergency Department. Instituto Nacional de Enfermedades Respiratorias, Mexico City, Mexico

Abstract

Spontaneous pneumomediastinum is defined as the presence of free air within the mediastinum without an apparent cause such as chest trauma. It is a benign, self-limiting condition that is conservatively treated. Clinical diagnosis is based on two symptoms: chest pain and dyspnea; and on a particular sign: subcutaneous emphysema. It has been reported in patients with influenza A (H1N1) and severe acute respiratory syndrome; however, it has been rarely observed in COVID-19 patients. In this work, we describe six male patients with COVID-19, aged between 27 and 82 years, who presented with spontaneous pneumomediastinum and subcutaneous emphysema; both conditions were completely resorbed with conservative management.

KEY WORDS: Spontaneous pneumomediastinum. Subcutaneous emphysema. Macklin effect. COVID-19.

Neumomediastino espontáneo en pacientes COVID-19. Serie de casos

Resumen

El neumomediastino espontáneo es la presencia de aire libre en el mediastino sin el antecedente de alguna causa como trauma de tórax. Es una condición benigna autolimitada que se trata en forma conservadora. El diagnóstico clínico se basa en dos síntomas: dolor torácico y disnea; y en un signo en particular: enfisema subcutáneo. Ha sido reportado en pacientes con influenza A (H1N1) y síndrome respiratorio agudo grave; sin embargo, ha sido raramente observado en pacientes con COVID-19. En este trabajo describimos seis pacientes del sexo masculino con COVID-19, con edades entre 27 y 82 años, que presentaron neumomediastino espontáneo y enfisema subcutáneo; ambos se reabsorbieron totalmente con manejo conservador.

PALABRAS CLAVE: Neumomediastino espontáneo. Enfisema subcutáneo. Efecto Macklin. COVID-19.

Introduction

Spontaneous pneumomediastinum (PNM) is presence of free air within the mediastinum not preceded by any cause such as chest trauma or medical or surgical procedure, which causes symptoms such as

retrosternal pain, dyspnea, hoarseness and odynophagia. It is usually a benign and self-limiting condition, which often goes unnoticed by doctors. It has an incidence that ranges from one in 8,005 to one in 42,000 emergency admissions. It may not be identified on physical examination; however, its presence is

Correspondence:

*J. Alfredo Santibáñez-Salgado
E-mail: alf36@hotmail.com

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Figure 1. **A:** Topogram of the computed axial tomography scan performed at admission, showing subcutaneous emphysema on the face, neck, chest and arms (arrows). **B:** Computed axial tomography at admission, showing pneumomediastinum and subcutaneous emphysema (arrowhead), with bilateral lung consolidation and bilateral ground glass areas. **C:** Chest X-ray obtained on the seventh day of hospitalization; no evidence of pneumomediastinum or subcutaneous emphysema is observed.

suspected in patients with subcutaneous emphysema without a history of chest trauma.^{1,2}

In this research, we report six male patients with COVID-19, who presented with spontaneous PNM and subcutaneous emphysema, which was fully reabsorbed with conservative management.

Methods

Patients with a confirmed COVID-19 diagnosis, who presented with PNM and subcutaneous emphysema, were included. The patient or a legally authorized person granted informed consent.

Results

From February 28 to September 30, 2020, 1,300 patients were admitted to the National Institute of Respiratory Diseases, in Mexico City, with a diagnosis of COVID-19, confirmed by pharyngeal or nasal exudate PCR. Six male patients aged between 27 and 82 years presented with spontaneous PNM and subcutaneous emphysema. Four patients had spontaneous PNM and subcutaneous emphysema prior to arrival at the emergency department and two, 24 hours after having been intubated for ventilatory mechanical support. One patient arrived at the Emergency Department with subcutaneous emphysema in the head, neck, chest and both arms, as well as disseminated PNM (Fig. 1); he was intubated upon admission due to the severity of respiratory failure. Five patients had subcutaneous emphysema and mild PNM. In the computed axial tomography images of all patients, ground glass images and areas of consolidation were observed in both lung fields (Figs. 1, 2 and 3).

All patients had malaise, chest pain, odynophagia, and coughing spells; five, severe dyspnea and low

Figure 2. **A:** Computed axial tomography scan performed at admission; pneumomediastinum and subcutaneous emphysema are observed (arrows). **B:** Computed axial tomography scan performed at admission; areas of bilateral lung consolidation and areas of bilateral ground glass are observed. Pneumomediastinum (arrows).

oxygen saturation despite non-invasive supplemental oxygen. One patient with very mild respiratory symptoms was discharged one week after admission, in good conditions. In all subjects, spontaneous PNM and subcutaneous emphysema were conservatively managed, with total reabsorption of both between days 7 and 12 of hospital stay (Figs. 1 and 3). Three patients were discharged in good health conditions and three died of COVID-19 complications. Demographic characteristics, management, and outcome are summarized in tables 1 and 2.

Discussion

Spontaneous pneumomediastinum is the result of a pressure variation between the alveolus and the pulmonary interstitium that leads to alveolar rupture.^{1,2} Two mechanisms can generate this pressure gradient: the first one is an increase in intra-alveolar pressure (intentional Valsalva maneuver), described as a precipitating factor; the second is a pressure decrease in the perialveolar interstitial space, which is observed during intense respiratory effort or a rapid decrease in atmospheric pressure, which have been described as predisposing factors.^{3,4} Once alveolar rupture occurs,

Figure 3. **A:** Computed axial tomography at admission; pneumomediastinum and cervical region subcutaneous emphysema are observed (arrows). **B:** Computed axial tomography at admission; areas of bilateral lung consolidation and areas of bilateral ground glass, indicative of pneumomediastinum (arrows), as well as anterior chest region subcutaneous emphysema (arrowhead), are observed. **C:** Chest X-ray carried out on hospitalization day 11; there is no evidence of pneumomediastinum or subcutaneous emphysema.

Table 1. Demographic data and clinical evolution

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Age (years)	37	47	27	55	38	82
Gender	Male	Male	Male	Male	Male	Male
Comorbidity	Obesity	Obesity	No	IHD	No	Obesity
Time with COVID-19 symptoms prior to hospital admission	20 days	10 days	11 days	11 days	7 days	21 days
Ventilatory support	IMV	IMV	IMV	IMV	No	IMV
PEEP (cm H ₂ O)	6	8	6	8	No	6
Spontaneous pneumomediastinum	Yes (prior to IMV)	Yes (prior to IMV)	Yes (prior to IMV)	Yes (24 h after IMV)	Yes	Yes (24 h after IMV)
Subcutaneous emphysema	Yes (prior to IMV)	Yes (prior to IMV)	Yes (prior to IMV)	Yes (24 h after IMV)	Yes	Yes (24 h after IMV)
Pneumothorax	No	No	No	No	No	No
Spontaneous PNM treatment	Conservative	Conservative	Conservative	Conservative	Conservative	Conservative
Spontaneous PNM resolution	IH day 7	IH day 10	IH day 11	IH day 10	IH day 7	IH day 12
Outcome	Discharge at IH day 27	Deceased on IH day 14	Discharge at IH day 25	Deceased on IH day 22	Discharge at IH day 7	Deceased on IH day 27

PEEP = positive end-expiration pressure, IMV = invasive mechanical ventilation, IH = in-hospital, IHD = ischemic heart disease, PNM = pneumomediastinum.

the air is centripetally expelled through the pulmonary interstitium along the bronchoalveolar sheaths towards the pulmonary hilum and the mediastinum, and can continue towards the cervical subcutaneous planes and the pleura. This pathophysiological mechanism is known as the Macklin effect.¹⁻⁴ Presence of at least one precipitating factor such as a coughing spell, emesis and vigorous exercise was observed in 21 to 88.9 % of patients, and at least one predisposing factor such as smoking, asthma, respiratory infection and interstitial lung disease was present in 22 % of patients with spontaneous PNM.^{3,4}

The alveolus is prone to rupture in patients with severe viral pneumonia because the virus damages the

alveolar membrane given that it infects type I and II pneumocytes. Most patients with viral pneumonia have at least the precipitating factor of cough, which can cause alveolar rupture and PNM development.⁴⁻⁶

The described patients had dry cough, chest pain, myalgia, and malaise; four had fever, subcutaneous crackles with no history of chest trauma or manipulation of the airway or esophagus. Two patients developed PNM and subcutaneous emphysema 24 hours after having been intubated for invasive mechanical ventilatory support. We hypothesized that PNM was not related to invasive mechanical ventilation. Alveolar rupture has been reported not to be related to the use of positive end-expiratory pressure

Table 2. Patient signs, symptoms and arterial blood gas upon arrival at emergency department

Parameter	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Coughing	Severe spells	Severe spells	Mild spells	Mild spells	Mild spells	Severe spells
Chest pain	Yes	Yes	Yes	Yes	Yes	Yes
Odynophagia	Yes	Yes	Yes	Yes	Yes	Yes
Malaise	Yes	Yes	Yes	Yes	Yes	Yes
Temperature	36.5 °C	39.6 °C	37 °C	38 °C	37.1 °C	38 °C
Dyspnea	Yes	Yes	Yes	Yes	No	Yes
Heart rate	110x'	120x'	106x'	104x'	90x'	100x'
Respiratory rate	34x'	30x'	40x'	30x'	20x'	40x'
O ₂ saturation	43 % with nasal prongs at 15 L/min	65 % with nasal prongs at 15 L/min	86 % with nasal prongs at 10 L/min	56 % with nasal prongs at 15 L/min	96 % while breathing ambient air	80 % with nasal prongs at 15 L/min
pH	7.19	7.42	7.45	7.15	7.46	7.17
pO ₂ , mm Hg	46	24	58.2	65.3	93.6	82.9
pCO ₂ , mm Hg	68.7	24	30.6	69.1	30	25.8
HCO ₂ , mmol/L	25	16.2	21.3	18.8	27.3	9.1

in patients with SARS, but to invasive mechanical ventilatory support with plateau pressures higher than 35 cm H₂O.⁵⁻⁸ In our patients, invasive mechanical ventilatory support did not worsen PNM or subcutaneous emphysema.

Subcutaneous emphysema and a history of severe coughing spells suggested the spontaneous PNM diagnosis, which was confirmed by chest X-ray and computed tomography. Chest X-ray is the gold standard for diagnosing spontaneous PNM; however, half the cases can go unnoticed without lateral chest X-ray,^{1,2} which cannot be practiced in patients with invasive mechanical ventilatory support. Chest computed axial tomography is the most reliable imaging study to confirm spontaneous PNM; however, follow-up is carried out with serial chest X-rays due to the possibility of pneumothorax, which can cause cardiopulmonary compromise and whose treatment will require the placement of a drainage system or surgical treatment if air leak continues.⁹

Spontaneous PNM and subcutaneous emphysema clinical evolution in our patients was good, with gradual reabsorption of air through tissues, despite COVID-19 severity. Spontaneous PNM is usually a self-limiting, benign condition, which is why conservative management is sufficient.⁹

Conclusions

Patients with COVID-19 have coughing spells, which can cause spontaneous PNM and subcutaneous emphysema. PNM is suspected in patients with cervical or thoracic subcutaneous emphysema without a history of chest trauma. Clinical follow-up, as well as radiological evaluation, are sufficient to detect improvement or cardiorespiratory complications. PNM patients can be conservatively managed, and invasive mechanical ventilation positive pressure does not exacerbate PNM or subcutaneous emphysema.

Conflict of interests

The authors declare that they have no conflicts of interest.

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Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this research.

Confidentiality of data. The authors declare that they followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors obtained informed consent from the patients or subjects referred to in the article.

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