

ORIGINAL PAPER

## Spontaneous resolution of pneumomediastinum in children – clinical experience

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### ABSTRACT

**Introduction:** Pneumomediastinum is defined as the presence of free gas in the mediastinal space and occurs with varying frequency depending on age.

**Aim of the study:** The aim of this study is to report a series of spontaneous pneumomediastina in a paediatric population.

**Material and methods:** The study is a retrospective analysis of five clinical cases of pneumomediastina in adolescent patients hospitalised in the Clinical Department of Paediatric Surgery between 2016 and 2018. Two girls and three boys with a mean age of 16.4 years were admitted to the emergency room due to dyspnoea and visible enlargement of neck circumference, which was due to emphysema of soft tissues of the neck. In three patients, chest pain was the predominant symptom. One patient presented with speech difficulties. On admission the general condition of all patients was good. Cardiovascular and respiratory efficiency was reported in all patients. The main symptom suggesting pneumomediastinum was the presence of soft tissue emphysema of the neck. Chest X-ray was performed in all patients as a preliminary examination, confirming the suspicion of pneumomediastinum. Oesophagography was performed in four patients. However, no abnormalities were detected. All patients underwent chest CT.

**Results:** Despite extensive changes in CT, no progression of symptoms was observed. There was no indication for surgical intervention in any patient. Complete spontaneous regression was observed in all cases between day 4 and day 21 of the follow-up. Patients were discharged home after 6–10 days of hospitalisation. No recurrence in long-term follow-up was observed. Spontaneous resolution of free gas in the mediastinum was observed in all patients.

**Conclusions:** Survival rates of patients with pneumomediastinum of unknown cause that do not require surgical treatment are high and reach about 92.5–100%. In the vast majority of patients, spontaneous resolution is observed. The prognosis is therefore favourable, and the risk of recurrence is low.

### KEY WORDS:

children, pneumomediastinum, spontaneous pneumomediastinum.

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## INTRODUCTION

Pneumomediastinum is defined as the presence of free gas in the mediastinal space. The first reported case was noted by Rene Theophile Laennec (1819), and in 1964 Theler was the first to report this pathology in a child [1, 2]. Pneumomediastinum is a symptom that occurs with varying frequency depending on age. Current statistics indicate that the frequency is one per 40,000 emergency room visits every year [2]. Among the paediatric population two peaks of incidence are observed: early childhood (i.e. 6 months–4 years) and adolescence (i.e. 15–18 years of age) [3, 4]. Most authors indicate the age between 6 and 14 years old as the median age. The prevalence in this age group is 1/8000–1/15,000, while in newborns it reaches 2.5/1000 [2, 3].

Pneumomediastinum can be primary – idiopathic (spontaneous pneumomediastinum; SPM), which accounts for 33–49% of cases [1, 3, 4]. Secondary pneumomediastinum is associated with the co-occurrence of additional underlying diseases. The most common conditions in children include bronchial asthma, various injuries (barotrauma, bronchial, tracheal or oesophageal perforation), iatrogenic complications (e.g. following tonsillectomy), and infections (e.g. RSV) [3, 5]. Less common causes include foreign body aspiration into the airways, severe vomiting, intensive physical effort, seizures, or the use of psychoactive drugs (designer drugs, cannabis) [2, 3, 5].

The most common symptoms of pneumomediastinum include acute chest pain (55–90%), subcutaneous emphysema (66–90%), and dyspnoea (30%), which are the components of the characteristic triad according to Crespo Marcos [1, 3, 6]. Other less common symptoms include neck or throat pain (20–53%), oedema of the neck and face, wheezing, cyanosis, dysphonia, and cough [1, 3]. The Hamman sign, initially reported in 1939, is a crunching, rasping sound in the mediastinum during systole and diastole on auscultation and is relatively rare (11.6%) [3, 7]. Occasionally, pneumomediastinum may be accompanied by pneumothorax. The coincidence rate of these conditions is about 11.6% [3]. It should be borne in mind that cardiac disorders may develop due to heart compression caused by a massive collection of gas in the mediastinum [4].

Due to the variety of causes, clinical symptoms, course, and prognosis, the diagnosis and treatment of pneumomediastinum may pose many challenges. This condition can resolve spontaneously with complete recovery or transform into life-threatening emergency.

## MATERIAL AND METHODS

The study is a retrospective analysis of five clinical cases of pneumomediastinum in adolescent patients hospitalised in the Clinical Department of Paediatric Surgery between 2016 and 2018. Medical history, physical exam-

ination, results of laboratory tests, imaging studies, and endoscopic procedures were analysed. The most probable causes of pneumomediastinum were presented.

Two girls and three boys with a mean age of 16.4 years were admitted to the emergency room due to dyspnoea and visible enlargement of neck circumference, which was due to emphysema of soft tissues of the neck (Table 1). In three patients, chest pain was the predominant symptom. One patient presented with speech difficulties. On admission the general condition of all patients was good. Cardiovascular and respiratory efficiency was reported in all patients. The main symptom suggesting pneumomediastinum was the presence of the soft tissue emphysema of the neck. One patient presented with a positive Hamman sign and arrhythmia. Most patients denied incidents related to excessive effort before admission. Only two patients related the onset of symptoms to sudden movement (running for the bus, PE classes at school). One patient had a history of a right collarbone fracture three weeks before admission. None of the patients was exposed to medical procedures within a month prior to admission. One patient was treated for type 1 diabetes.

None of the patients presented with active infection on admission. Inflammatory parameters in laboratory tests were analysed – WBC: 6.7 K/ul, 15.5 K/ul, 12.2 K/ul, 14.40 K/ul, 8.7 K/ul; CRP: 7.8 mg/l, 1.41 mg/l, 4.2 mg/l, 0.5 mg/l, and 0.3 mg/l.

Chest X-ray was performed in all patients as a preliminary examination confirming the suspicion of pneumomediastinum. Oesophagography was performed in four patients. However, no abnormalities were detected. All patients underwent chest CT (Fig. 1).

CT examination revealed:

- Patient 1: extensive pneumomediastinum surrounding the heart, aorta, superior vena cava and extending upward along the trachea and cervical vessels to the subcutaneous tissue of the right supraclavicular region and neck. Air was present in soft tissues of the throat. Microperforation of the anterior wall of the right main bronchus was suspected.
- Patient 2: extensive pneumomediastinum, subcutaneous emphysema in the neck and along the right side of the thorax. Pneumothorax in the apex of the right lung was visible. Oesophageal microperforation (in the upper part) was suspected.
- Patient 3: pneumomediastinum with massive interfascial emphysema of the neck, mediastinum, spinal canal, and epigastric region. Residual bilateral pneumothorax was visible. Tracheal microperforation at Th5 and Th6 was suspected.
- Patient 4: mediastinal emphysema, surrounding all mediastinal structures (15 mm thick in the upper mediastinum on the right side). Emphysema of the soft tissues at the base of the neck was visible.
- Patient 5: emphysema of the upper mediastinum up to 15 mm thick located along the trachea and heart,

TABLE 1. Symptoms of mediastinal emphysema and the results of additional imaging examinations in patients

Feature	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Sex	Male	Female	Female	Male	Male
Age (years)	16	16	16	17	17
Clinical symptoms	Dyspnoea, chest pain, emphysema of the soft tissues of the neck	Dyspnoea, (+) Hamman sign, arrhythmia, emphysema of the soft tissues of the neck	Dyspnoea, emphysema of the soft tissues of the neck, neck	Chest pain, difficulties with speaking, emphysema of the soft tissues of the neck	Chest pain, emphysema of the soft tissues of the neck and chest (preternally)
General condition	Good, cardiovascular and respiratory efficiency	Good, cardiovascular and respiratory efficiency	Good, cardiovascular and respiratory efficiency	Good, cardiovascular and respiratory efficiency	Good, cardiovascular and respiratory efficiency
Physical effort directly before the onset of symptoms	No	No	No	No	Intense sport training
History of trauma	No	No	Injury to the right collar bone 3 weeks before admission	No	No
History of medical interventions	No	No	No	No	No
Infectious symptoms	No WBC 6.7 K/ul CRP 7.8 mg/l	No WBC 15.5 K/ul CRP 1.41 mg/l	No WBC 12.2 K/ul CRP 4.2 mg/l	No WBC 14.4 K/ul CRP 0.5 mg/l	No WBC 8.7 K/ul CRP 0.3 mg/l
CT scan of the chest	Extensive pneumomediastinum surrounding the heart, aorta, superior vena cava, and extending upward along the trachea and cervical vessels to the subcutaneous tissue of the right supra-clavicular region and neck; air collection in the soft tissues of the throat; suspicion of micro-perforation of the anterior wall of the right main bronchus with no connection with pneumomediastinum	Extensive pneumomediastinum, subcutaneous emphysema of the neck and along the right side of the thorax; pneumothorax in the apex of the right lung; suspicion of oesophageal micro-perforation (upper part)	Pneumo-mediastinum with massive interfascial emphysema of the neck, mediastinum, spinal canal and epigastric region; residual bilateral pneumothorax; suspicion of tracheal micro-perforation (at Th5, Th6)	Pneumo-mediastinum surrounding all the mediastinal structures (15 mm thick in the upper mediastinum on the right side). Emphysema of the soft tissues at the base of the neck. Trachea and bronchi without abnormalities	Emphysema of the upper mediastinum paratracheally along the contours of the heart – 15 mm, within the anterior mediastinum – 12 mm, posterior mediastinum – 10 mm, of the neck along the trachea – 15 mm
Additional tests	Chest X-ray(+) Oesophagography(-) Alpha-1 antitrypsin(-)	Chest X-ray(+) Oesophagography(-) Esophagoscopy(-) Bronchoscopy (-) Panel drug tests(-)	Chest X-ray(+)	Chest X-ray(+) Oesophagography(-) Alpha-1 antitrypsin(-) Panel drug tests(-)	Chest X-ray(+) Oesophagography (-)
Follow-up chest X-ray	Yes, complete resolution of changes (day 21)	Yes, complete resolution of changes (day 8)	Yes, regression of changes in the mediastinum to 3–5 mm in diameter (day 4)	Yes, regression of changes in the mediastinum to 7 mm in diameter (day 3)	No, evaluation in Oesophagography – regression of changes in the mediastinum to 4 mm in diameter (day 2)
Treatment	<i>i.v.</i> antibiotic therapy	<i>i.v.</i> antibiotic therapy total parenteral nutrition	<i>i.v.</i> antibiotic therapy	<i>i.v.</i> antibiotic therapy	<i>i.v.</i> antibiotic therapy
Discharge home	Day 8 of hospitalisation	Day 10 of hospitalisation	Day 6 of hospitalisation	Day 8 of hospitalisation	Day 7 of hospitalisation
Recurrence	No	No	No	No	No

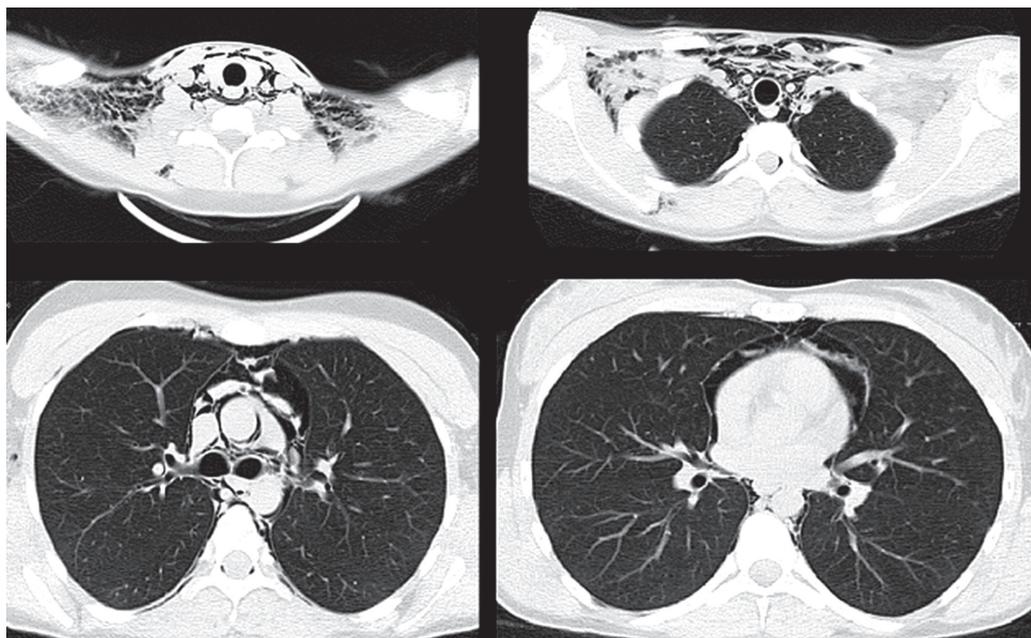


FIGURE 1. CT scans showing subcutaneous emphysema of the neck and pneumomediastinum

up to 12 mm in the anterior mediastinum, and 10 mm thick in the posterior part. Free air around the neck along the trachea was up to 15 mm thick.

In one patient with suspicion of oesophageal microperforation in CT, oesophagoscopy, and bronchoscopy were performed. However, these examinations did not reveal any abnormal findings.

Alpha-1 antitrypsin level test and panel drug tests were performed in two patients. Both tests were negative. Multiple consultations were performed. All patients were consulted with cardiologists, otorhinolaryngologists, and pulmonologists.

All patients were advised to rest, and intravenous antibiotic therapy (prophylaxis of mediastinitis) was applied. One patient suspected of oesophageal microperforation was also treated with short-term parenteral nutrition. Patients were constantly monitored during the follow-up. Despite extensive changes in CT, no progression of symptoms was observed. There was no indication for surgical intervention in any patient. Complete spontaneous regression was observed in all cases between day 4 and day 21 of the follow-up. Patients were discharged home after 6–10 days of hospitalisation. No recurrence was observed in long-term follow-up.

## DISCUSSION

Pneumomediastinum is a condition is potentially life-threatening. Therefore, the necessity of hospital admission should always be considered. The choice of department should depend on the general condition of the patient, the necessity for surgical intervention, and any comorbidities. In the case of patients in good general condition and no gastrointestinal or bronchial perforation, the treatment can be successfully performed in a general

paediatrics department. The aetiological factor should be sought because it may affect further diagnostic and therapeutic procedures. The lack of a specific cause leads to the diagnosis of spontaneous pneumomediastinum. In pre-school children SPM relatively often develops in the course of infection. The possibility of foreign body aspiration into the airways should always be excluded [3, 7]. Even a remote possibility of foreign body aspiration should be an indication for diagnostic bronchoscopy. In adolescence the spectrum of causes of pneumomediastinum is different. In our group the mean age of patients was 16 years. Apart from one boy, all patients denied injury, intense exertion, the possibility of iatrogenic damage, paroxysmal cough, smoking cigarettes, or the consumption of psychoactive substances. Due to the growing abuse of designer drugs and other psychoactive substances among adolescents, the patients were tested for drugs and the results were negative in all cases. Performing these tests is expensive, and even positive results do not contribute to the therapeutic process.

Chest X-ray is the basic diagnostic test that allows the initial diagnosis to be determined [3, 4]. In our group of patients, the diagnosis was based on classical X-ray image after physical examination of patients with dyspnoea. In doubtful cases, a lateral radiograph of the neck may be of value. This examination reveals subcutaneous emphysema and the prevertebral air collections (sensitivity of 95.2%) [4]. This projection should always be performed when CT is not possible. CT is the examination of choice in this group of patients because it allows detailed assessment of the topography of the mediastinal organs in this pathology. Numerous reports confirm the diagnostic efficacy of CT (100% sensitivity and 85% specificity) [8]. Bakhos *et al.* emphasize that CT allows to diagnose pneumomediastinum in 18.36% of patients with no changes in X-ray

[5]. All patients in our group presented with extensive pathological changes in chest CT, which did not correspond to their good clinical condition.

Due to the fact that pneumomediastinum is often considered a potential manifestation of oesophageal perforation, oesophagography or oesophagoscopy is often initially performed. However, this approach is currently widely discussed. Oesophageal perforation in paediatric patients is extremely rare [2, 5, 8, 9]. There are both opponents and supporters of oesophagography in such cases [6]. In our patients these examination results were negative and did not contribute to the diagnosis.

In addition, endoscopic procedures, such as bronchoscopy or oesophagoscopy, are sometimes associated with the necessity of general anaesthesia, which may pose some risk. Such procedures can be replaced by their virtual equivalent – the reconstruction of the image obtained in CT. In our group esophagoscopy and bronchoscopy were performed only in one patient with suspicion of oesophageal microperforation in CT. In this case endoscop-

ic examinations did not reveal the site of perforation. In two patients, bronchoscopy was not performed, despite the suspicion of microperforation of the right bronchus and trachea. It did not affect the course of the disease, which was favourable. Therefore, in our opinion, diagnostic methods should be limited to CT performed after chest and neck X-rays. Time to perform CT should be determined by on the general condition of the patient and progression of clinical symptoms. Even extensive pathological changes in CT combined with good general condition of the patient do not require any follow-up examinations. The use of ultrasound in the diagnosis and monitoring of pneumomediastinum is reported in the literature [10, 11]. However, there are limitations of this method related to the subjective assessment of the image. Comparison of chest CT and ultrasound monitoring performed by one radiologist could be a reliable solution.

Survival rates of patients with pneumomediastinum of unknown cause that do not require surgical treatment are high and reach about 92.5–100%. In the vast majority

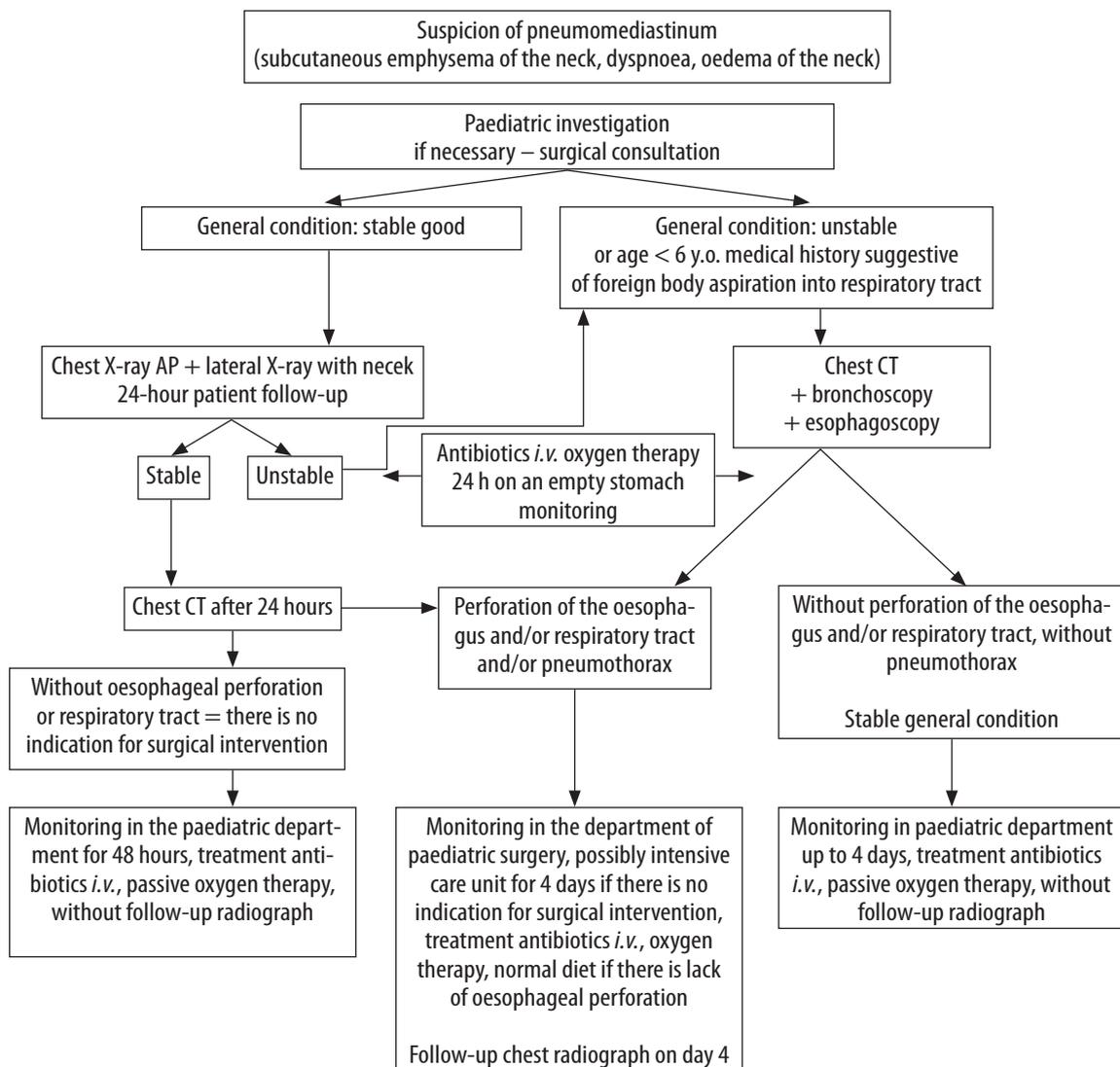


FIGURE 2. Proposal of diagnostic and therapeutic procedures in pneumomediastinum

of patients, spontaneous resolution is observed. The prognosis is therefore favourable, and the risk of recurrence is low [3, 5].

Based on the available literature and our own experience with juvenile patients affected with spontaneous pneumomediastinum, the following scheme of diagnostic and therapeutic procedures can be proposed (Fig. 2).

## DISCLOSURE

The authors declare no conflict of interest.

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