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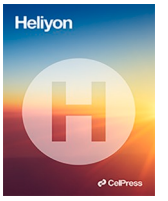

Research article

Approach to primary spontaneous pneumothorax: Experiences of a new pediatric surgery clinic

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ABSTRACT

Background: The prevalence of spontaneous pneumothorax in children during adolescence is low, but not negligible. Treatment involves conservative management and surgery. The aim of this study was to review our patients treated with diagnoses of primary spontaneous pneumothorax and to describe our therapeutic approach, outcomes, and deficiencies.

Methods: Ninety (90) patients diagnosed with primary spontaneous pneumothorax and treated and followed-up in our clinic between June 2020 and December 2023 were included in the study. The research was performed as a retrospective file review. Trauma, secondary pneumothorax, and newborn pneumothorax were excluded.

Results: Seventy six (76) patients were boys and 14 were girls, with a mean age of 16,23 years. Right pneumothorax was present in 44 patients, left pneumothorax in 41, and bilateral pneumothorax in 5. The 90 patients' initial treatment involved tube thoracostomy, and 36 individuals with prolonged and recurrent pneumothorax underwent video-assisted thoracoscopic surgery (VATS).

Conclusion: The success rate of apical wedge resection and mechanical pleurodesis with direct VATS in the treatment of prolonged and recurrent primary spontaneous pneumothorax in children is greater than 90 %. We think that, VATS is a successful, effective and safe treatment for spontaneous pneumothorax due to a significantly lower recurrence rate compared to chest tube insertion.

1. Introduction

Spontaneous pneumothorax is an entity generally more frequently seen in adolescent males, with a 20–60 % probability of recurrence. While no underlying pulmonary disease of trauma is present in primary spontaneous pneumothorax (PSP), secondary spontaneous pneumothorax generally emerges as a complication of another pulmonary event. The incidence of PSP in children is 4:100,000 in boys and 1:100,000 in girls [1]. It is most frequent between the ages of 16 and 24. Although recurrences are more common within the first year, recurrence rates remain high up to the fourth year [1].

Treatment consists of conservative (non-surgical) management such as observation with oxygen support, needle aspiration, and tube thoracostomy, and surgery. Surgical treatment consists of thoracotomy and bullectomy with video-assisted thoracoscopic surgery (VATS) and more invasive procedures such as pleurodesis and resection [1,2].

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There is no consensus regarding the initial treatment of pediatric PSP. The primary management of first attack PSP, particularly in pediatric patients, is controversial. The current therapeutic recommendations are essentially based on data concerning adults [3–7].

The purpose of this study is to evaluate our approach to and outcomes for patients diagnosed with PSP treated over a three-year period in our newly opened, third-level pediatric surgery clinic employing specialists from different schools.

2. Material-method

This study was performed at the Istanbul Başakşehir Çam and Sakura City Hospital Pediatric Surgery Clinic. Approval for the study, performed as a retrospective patient review, was granted by the hospital's ethical committee (Number:2023-321). Ninety patients diagnosed with PSP and treated in our clinic between June 2020 and December 2023 were included. All patient files were screened retrospectively from the hospital information management system and the surgery ledger.

All children aged 1–18 years and hospitalized for treatment with diagnoses of PSP were enrolled. Patients who presented with the same symptoms and findings subsequent to the first admission and treatment, after being discharged with complete clinical and radiological recovery, were considered to have recurrent/recurrent pneumothorax. Patients were followed-up for a mean 6 months-one year after discharge.

Chest pain and respiratory difficulty were investigated as presentation symptoms in all patients. The imaging methods employed at diagnosis and the treatments applied were also determined.

Apical wedge resection including bullae and mechanical pleurodesis were performed in all patients who underwent VATS. Mechanical pleurodesis was performed with the same technique, using cautery sandpaper, in all patients who underwent VATS.

Statistical analyses were performed on SPSS software. Descriptive statistics were expressed as number and percentage values for categorical variables and as mean, standard deviation, and median values for numerical variables. Pairwise independent group comparisons of numerical variables were performed using the independent *t*-test in case of normal distribution or the Mann-Whitney *U* test if normality assumptions were not met. The chi-square test was used in multiple and pairwise comparisons of categorical variables when chi-square conditions were met. p values lower than 0.05 were regarded as significant.

3. Results

Ninety (90) patients diagnosed with PSP, 14 girls (15,5 %) and 76 boys (84,4 %), were treated in our clinic between June 2020 and December 2023. The patients' median age was 16,23 years (range 11–17). Chest pain, particularly during respiration, was present as the presentation symptom in all patients. Shortness of breath was also present in five patients. All patients were diagnosed on the basis of plain chest radiography. All patients' complete blood counts, biochemistry, and blood gas values investigated in the emergency department were normal.

Right pneumothorax was present in 44 patients, left pneumothorax in 41, and bilateral pneumothorax in 5. All 90 patients underwent insertion of a chest tube through the fifth intercostal space as the primary treatment option. VATS was performed on patients who underwent tube thoracostomy with air leaks exceeding five days and with recurring pneumothoraxes resulting in more than one hospitalization. Thirty-six (36) patients underwent VATS, 12 (13,3 %) due to recurring pneumothorax and 24 (26,6 %) due to prolonged pneumothorax (Table 1). Bilateral VATS was performed on three patients. All patients exposed to VATS also underwent mechanical pleurodesis together with apical wedge resection. A chest tube was re-inserted in 2 patient (5,5 %) who underwent VATS due to recurring pneumothorax, and no further recurrence was observed over follow-ups exceeding one year in duration following intubation in that cases. In terms of general outcomes, the tube thoracostomy success rate was 60 %, while a success rate of 94,4 % was

Table 1
Characteristics of patients.

	Patients (%)
Total (%)	90
Female (%)	14 (15,5)
Male (%)	76 (84,4)
Age (%)	10-17 (median age:16)
Right Px (%)	44 (48,8)
Left Px (%)	41 (45,5)
Bilaterally Px (%)	5 (5,5)
Chest pain (%)	90 (100)
Smoke (%)	50 (55,5)
CXR (%)	90 (100)
CT (%)	36 (40)
TT (%)	90 (100)
VATS (%)	36 (40)
>5 day px (%)	24 (26,6)
Recurrens after TT (%)	12 (13,3)
Recurrens after VATS (%)	2 (5,5)

Pneumothorax, Px; CXR, chest x-ray; Video-assisted thoracic surgery, VATS; Tube thoracostomy, TT.

achieved in patients undergoing VATS.

Bullae were present at chest computed tomography (CT) in 23 of the patients who underwent VATS. Although there were no blisters on CT in the other 13 patients, all but one had single or multiple blisters in the apical region as a surgical finding. No bullae/blebs were observed in one patient who underwent VATS. The success rate of chest CT in showing the presence of bullae/blebs in this study was calculated at 66,6 %.

4. Discussion

PSP refers to the accumulation of air in the pleural cavity in patients with no underlying lung disease. This entity is frequently thought to occur due to spontaneous rupture of subpleural bullae and blebs in the apical segment. PSP is a relatively rare entity in the pediatric population, being seen in 3.4:100,000 children. The incidence peaks in adolescence, and it is most commonly seen in tall, thin boys. The male:female ratio is 4:1. Reported risk factors for PSP include male gender, tall stature, smoking, a family history of pneumothorax, connective tissue disorders such as Marfan syndrome, and asthma. Secondary spontaneous pneumothorax has been linked to an underlying disease such as cystic fibrosis and infection [6–12].

In the present retrospective patient evaluation, girls represented 15,5 % of our patients and boys 84,4 %. The majority of patients were thin, tall males who smoked. The M:F ratio in this study was more pronounced compared to the previous literature. Marfan syndrome was present in only one patient.

PSP is almost always diagnosed by means of plain chest radiograpy. Chest CT is not required in the majority of uncomplicated PSP cases identified on CXR. Various studies have shown that point of care ultrasonography (POCUS) possesses high sensitivity and specificity for pneumothorax. However, the routine application of POCUS in pediatric PSP is uncertain and it has not entered into use [10]. CT is the gold standard imaging technique for assessing blebs and bullae in patients presenting with pneumothorax. Some authors have proposed the detection of bullae at CT as an indication for surgical intervention. However, there is still an ongoing debate in the literature concerning pediatric PSP regarding the use of CT scanning to detect bleb disease and predict recurrence. One disadvantage of the use of CT scanning involves the lifelong increased risk of cancer, including leukemia and brain tumors in particular, as a result of cumulative exposure to radiation. Laituri et al. espoused the view that CT provides no advantage in the management of pediatric PSP due to high costs and the radiation risk, in addition to low efficacy [4,13,14].

In the present study, pneumothorax was diagnosed at initial presentation using plain chest radiograpy. Follow-up involved daily chest x-rays. We used chest CT to identify the presence of blebs and bullae in prolonged and recurrent pneumothoraxes, and for planning VATS. Bullae in the apical region were present at chest CT in only 23 of the 36 patients who underwent VATS. No bullae were observed in the other patients at chest CT, but these were present in all but one patients at VATS, and apical wedge resection with mechanical pleurodesis was performed. CT yielded an accurate result in only 66,6 % of the cases.

We initially thought that chest CT should be reserved for relapse cases or prolonged pneumothorax in order to avoid the cumulative effect of radiation in children, who are still developing. However, we observed a significant inconsistency between the CT reports and surgical findings in these cases. We therefore think that performing CT for diagnostic purposes or to show the presence of blebs/bullae does not provide an additional advantage. We recommend direct VATS in cases of prolonged and recurrent pneumothorax.

There is no consensus on the initial treatment of pediatric PSP. The primary management of first attack PSP, particularly in pediatric cases, is still controversial. The existing therapeutic recommendations basically rely on data for adults. Practical guidelines for PSP in adults have been published by the American College of Chest Physicians (ACCP) and the British Thoracic Society (BTS) and are also applied to the pediatric population. The ACCP and BTS guidelines both recommend emergency department observation for clinically stable patients with small pneumothoraxes and tube thoracostomies, and hospitalization for unstable or large pneumothoraxes. Both also recommend surgical consultation for recurrent pneumothorax or for air leaks persisting beyond 3–5 days [6,7].

There is currently no management guideline for PSP in the pediatric population. Conservative treatment is generally the first option in first attacks. However, recurrence rates for PSP on the ipsilateral side as high as 48–57 % have been reported in children and adolescents receiving conservative treatment [3]. Initial management generally consists of needle aspiration, and prompt evacuation of PSP with the insertion of a percutaneous drainage catheter or tube thoracostomy, and supplementary oxygen. Hemodynamic impairment at initial presentation is rare [8].

Since there is also no agreement on the subject of the ideal timing for surgical intervention for pediatric PSP, many surgeons decide to operate in case of persistent air leak, generally defined as a period of 3–10 days. The majority of pediatric surgeons prefer chest tube decompression, an adult-based recommendation, as the first management strategy for progressive PSP [11]. Surgical intervention is usually limited to recurrence or failure to resolves with thoracostomy alone, and generally involves wedge resection of the blisters (blebectomy) and subsequent pleurectomy or pleurodesis (mechanical or chemical) [12]. Pleurodesis is frequently recommended in patients who have undergone VATS in order to reduce ipsilateral recurrence rates. Pleurodesis is performed to create adhesion between the visceral and parietal membranes. There are various approaches available for pleurodesis, including partial pleurectomy, chemical pleurodesis, mechanical pleurodesis with pleural abrasion, and extensive coverage of the staple line with absorbable material [10].

We performed apical wedge resection and mechanical pleurodesis, including the bullae, in all patients in whom we performed VATS. Mechanical pleurodesis with pleural abrasion was performed on all our 36 patients who underwent VATS. We applied mechanical pleurodesis via cautery sandpaper.

Despite the lower recurrence rate associated with surgery, a recent study showed that only 4 % of pediatric surgeons use VATS as the initial treatment [12]. In a study conducted by Olesen WH and colleagues comparing conventional tube thoracostomy and VATS, it was reported that primary VATS treatment was an effective treatment method in preventing ipsilateral recurrence in patients with >2 cm bullae on CT [15].

Tube thoracostomy was applied as the first therapeutic option in all our patients presenting with PSP. VATS was performed in 36 patients (40 %) with recurrence or prolonged air leaks despite tube thoracostomy. Recurrence of pneumothorax was subsequently observed in only two (5,5 %) of these 36 patients. Repeat tube thoracostomy was performed on that patients, and no further recurrence was observed at one-year follow-up. The tube thoracostomy success rate was thus 60 %, and the VATS success rate was 94,4 %. We evaluated the success rate according to whether there was a recurrence in our post-procedure follow-ups.

In conclusion, VATS is a successful, effective and safe treatment for spontaneous pneumothorax due to a significantly lower recurrence rate compared to chest tube insertion. Our high surgical success rate is most encouraging. However, we also think that larger patient numbers are needed for us to recommend direct surgical treatment in PSP in children.

5. Limitations

The retrospective nature of the study means that we were unable to clearly determine our criteria.

Although different approaches being adopted in our pediatric surgery clinic in which numerous specialists trained in a large number of other centers work together raises doubts on the subject of standardization, the purpose of our study is to establish a common language.

Larger patient numbers are now needed to establish a guideline in the treatment of pediatric PSP, and this study will be updated in the future.

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Ethics approval

Approval was obtained from the ethics committee of Istanbul Başakşehir Çam and Sakura City Hospital. The procedures used in this study adhere to the tenets of the Declaration of Helsinki (project number:2023-321).

Use of AI and AI-assisted technologies statement

We dont use of generative AI and AI-assisted technologies in the writing process.

Data availability statement

All data is recorded in our hospital database. The data of all our patients were available in the "HBYS" patient information system of Başakşehir Çam and Sakura City Hospital.

CRediT authorship contribution statement

Fatma Sarac: Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mehmet Yazici:** Supervision, Investigation, Formal analysis, Data curation, Conceptualization. **Mehmet Özgür Kuzdan:** Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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