Annals of Diagnostic Pathology 39 (2019) 78–85

Contents lists available at ScienceDirect

Annals of Diagnostic Pathology

journal homepage: www.elsevier.com/locate/anndiagpath

Original Contribution

Cystic and pseudocystic pulmonary malformations in children: Clinico-pathological correlation

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ARTICLE INFO

Keywords:
Surgical pulmonary malformation
Cystic pulmonary malformation
Lung
Congenital
Mexico

ABSTRACT

Pulmonary malformations are rare disorders, with cystic and pseudocystic pulmonary malformations (CPPM) the most frequent, and constitute the first cause of lobectomy in children < 1 year of age. Morphological overlap of congenital cystic pulmonary lesions might correspond to a spectrum of lesions in which bronchial atresia is a common etiopathogenetic mechanism. We aimed to report the frequency of CPPM resected in a tertiary-level hospital and to evaluate the degree of agreement between presurgical and anatomopathological diagnoses. We studied 44 surgical pieces with a diagnosis of CPPM received at the Pathology Service from 2009 to 2014, resected from 39 patients, 51.3 % males, with a median age of 16.8 months. Up to 69.2% of the patients had adenomatoid malformation of pulmonary airway (AMPA), with type 2 the most frequent (55.5%). Pulmonary sequestration was present in 15.4% of patients; in two cases the diagnosis was an incidental finding during surgery for the repair of a diaphragmatic hernia. Congenital lobar hyperinflation (CLH) occurred in 7.6% cases. Bronchogenic cyst (BC) was present in 7.6% cases. Presurgical and anatomopathological diagnoses in all patients coincided in 71.8% of cases. Kappa coefficient was 0.56 for global concordance in patients with AMPA, and 0.72, 0.64, 0.37 and 0.33 for CLH, BC, and types 1 and 2 AMPA, respectively. This relatively low interobserver agreement could reflect the low reproducibility of diagnoses used in the current nomenclature. Thus, the new nomenclature must be promoted in order to allow for better reproducibility and greater clinico-pathological concordance. The anatomopathological analysis must include the intentional search for bronchial atresia.

1. Introduction

Intrapulmonary structures are composed of airway (bronchi, bronchioles, terminal bronchioles) and respiratory (respiratory bronchioles, alveolar ducts, alveolar sacs) segments, which are closely related with arterial, venous and lymphatic vessels. These are complex structures that can be altered during embryonic development, leading to pulmonary malformations. Cystic and pseudocystic pulmonary malformations (CPPM) are rare, localized, and, by far, the most frequent pulmonary malformations. Currently, the majority of CPPM are diagnosed before birth [1-3]. Although CPPM may disappear *in utero* [4] or may be asymptomatic after birth [5,6], they are relevant because they can be responsible for fetal death, severe respiratory distress during the neonatal period, recurrent pulmonary infections, or can even be precursors of malignant lesions [7-9]. CPPM are the leading cause of elective lung lobectomy in children 1 year of age or less, despite the existing controversy in asymptomatic patients regarding the taking of a conservative approach (follow-up) or performing the surgical procedure [3,4,10-14]. Patients submitted to surgery usually have a good evolution and the risk of complications or sequelae is very low [15]. For a proper presurgical diagnosis, it is necessary to perform imaging studies, mainly chest x-rays ultrasound and computed tomography [16,17]. The definitive diagnosis is anatomopathological.

Although the frequency of CPPM is low, it has at present gained

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https://doi.org/10.1016/j.anndiagpath.2019.02.005

Table 1
Concordance between presurgical and anatomopathological diagnoses in a population of 39 children with cystic and pseudocystic pulmonary malformations.

No.	Age at diagnosis (months)	Sex	Affected lobe	Presurgical diagnosis	Anatomopathological diagnosis (only if different from presurgical diagnosis)
1	0.1	Female	PS, LLL	DH	PS + AMPA 2
2	0.2	Female	PS, RLL	PS	PS + AMPA 2
3	0.2	Female	LLL	AMPA 2	*
4	0.2	Female	ML	AMPA 2	AMPA 3
5	0.5	Female	PS, RUL	PT	PS + AMPA 2
6	0.5	Female	RUL	AMPA 1	*
7	0.5	Female	LUL	AMPA 2	*
8	0.5	Female	PS, RLL	AMPA 2	PS + AMPA 2
9	0.5	Male	LUL	AMPA 2	*
10	0.7	Female	RUL, ML	CLH	*
11	1	Male	RLL	AMPA 2	*
12	1	Male	RLL, LLL	CLH	AMPA 2
13	1	Male	RUL	AMPA 1	BC
14	1	Male	RUL	BC	*
15	2	Male	ML	AMPA 1	*
16	2	Male	LLL	AMPA 2	AMPA 3
17	2	Male	ML	CLH	AMPA 2
18	3	Female	PS-right	PS	*
19	3	Female	PS-left	DH	PS
20	5	Female	LUL	AMPA 1	*
21	5	Male	RLL	AMPA 2	*
22	6	Female	RUL, ML, RLL	PS	AMPA 2
23	6	Male	LUL	CLH	*
24	12	Female	LUL	AMPA 2	*
25	12	Female	RLL	AMPA 2	*
26	12	Male	RUL	AMPA 2	AMPA 1
27	12	Male	ML, RLL	AMPA 2	*
28	12	Male	RUL	CLH	*
29	12	Male	RLL	BC	*
30	24	Female	RLL	AMPA 1	AMPA 2
31	24	Male	LLL	AMPA 1	*
32	33	Female	RUL	AMPA 1	AMPA 2
33	48	Male	LUL	AMPA 1	AMPA 2
34	59	Female	RLL	AMPA 1	*
35	84	Male	RLL	Other	AMPA 1
36	96	Female	RUL	AMPA 2	*
37	96	Male	RUL	AMPA 2	AMPA 1
38	108	Male	RUL	BC	AMPA 1
39	168	Male	LLL	CCAP	AMPA 1

* = Anatomopathological diagnosis was equal to presurgical diagnosis, RLL = Right lower lobe, LLL = Left lower lobe, LUL = Left upper lobe, ML = Middle lobe, RUL = Right upper lobe, AMPA = Adenomatoid malformation of pulmonary airway, CLH = Congenital lobar hyperinflation, PS = Pulmonary sequestration, BC = Bronchogenic cyst, DH = Diaphragmatic hernia, CCAP = Complicated community-acquired pneumonia, PT = pulmonary tumor.

interest because, as a result of the extensive use of prenatal ultrasound, they have shown a real increase in their incidence in the last 20 years, rather than a better detection rate [18]. CPPM nomenclature and classification have been controversial for many years [19,20]. Some authors propose not using anatomopathological designations for the clinical diagnosis because these are solely based on imaging studies. Currently, the fundamental problem is to clarify their pathogenesis [1,3,21]. Because bronchial atresia is associated with some CPPM, and due to the overlapping of clinical, imaging, and histopathological manifestations, CPPM have been considered part of a spectrum of disorders that share a common pathogenetic mechanism [20-24]. Although the problems with nomenclature and classification comprise issues of form rather than of content, we agree with Costa [25], who proposed avoiding the term “congenital malformation”, which is a pleonasm, because any malformation, even asymptomatic at birth or during the first months of life, as occurs with many of these children, is congenital [26].

According to the current point of view that all CPPM are part of a spectrum that shares etiopathogenetic and anatomopathological features (*e.g.*, bronchial atresia), it is important to take into account the new nomenclature to have a better understanding of it. In our opinion, the initial clinical classification of “cystic congenital pulmonary disease” is more appropriate than the term “congenital pulmonary airway malformation” proposed by Stocker [27], which only includes one of the four categories; thus, we substituted this term with that of “adenomatoid malformation of pulmonary airway” (AMPA) in order to bear in mind the most frequent forms of CPPM.

The aim of the present work was to analyze the characteristics of CPPM in surgical specimens at a tertiary-level pediatrics hospital and to evaluate the concordance between presurgical and anatomopathological diagnoses of the four most frequent types of CPPM, as well as to emphasize the need for unification of the clinical and anatomopathological nomenclature.

2. Patients and methods

This was a cross-sectional, retrospective study reviewed and approved by our institutional scientific and bioethics committee (approval number R-2016-3603-79). Data from patients with an anatomopathological diagnosis of pulmonary malformation were obtained from records of the 2009–2014 period of the Pathology Service of the Pediatrics Hospital, Centro Médico Nacional Siglo XXI, which is a

Table 2
Characteristics of 39 patients with cystic and pseudocystic pulmonary malformations, and distribution of the 44 surgical specimens analyzed.

Final diagnosis	Patients	Age in months	Males	Females	Resected lobes						
					RUL	ML	RLL	LUL	LLL	PS[a]	Total
AMPA											
Type 1	10 (25.6)	41.5 (0.5–168)	7 (70.0)	3 (30.0)	4	1	2	1	2	0	10 (22.7)
Type 2	15 (38.5)	6 (0.2–96)	7 (46.7)	8 (53.3)	3	3	7	4	2	0	19 (43.2)
Type 3	2 (5.1)	1.1 (0.2–2)	1 (50.0)	1 (50.0)	0	1	0	0	1	0	2 (4.5)
All types	27 (69.2)	12 (0.2–168)	15 (55.6)	12 (44.4)							31 (70.5)
BC	3 (7.7)	1 (1 – 12)	3 (100)	0 (0)	2	0	1	0	0	0	3 (6.8)
CLH	3 (7.7)	6 (0.7–12)	2 (66.7)	1 (33.3)	2	1	0	1	0	0	4 (9.1)
Sequestration	6 (15.4)	0.5 (0.1–3)	0 (0)	6 (100)						6	6 (13.6)[a]
Total	39 (100)	5 (0.1–168)	20 (51.3)	19 (48.7)	11 (26.8)	6 (14.6)	10 (24.4)	6 (14.6)	5 (12.2)	6 (13.6)	44 (100)

The data correspond to frequencies and percentages except for age, which is expressed as median and range. CLH = congenital lobar hyperinflation, RLL = right lower lobe, LLL = left lower lobe, ML = middle lobe, RUL = right upper lobe, LUL = left upper lobe, AMPA = adenomatoid malformation of pulmonary airway, BC = bronchogenic cyst, PS = pulmonary sequestration.

[a] All pulmonary sequestrations were extralobar in nature and, strictly speaking, pulmonary lobes are not resected but the sequestrations themselves; the associated lobes to pulmonary sequestration were RUL (2 cases), RLL (1 case), LLL (1 case) and unspecified (2 cases).

tertiary-level hospital located in Mexico City. All patients with a full anatomopathological report, as well as with written and electronic medical charts, were included in the study. Variables analyzed were age at diagnosis, sex, type of surgical procedure, topography, and clinical diagnosis. The usual protocol for the processing of lung samples was to receive them into 10% formol, perform a macroscopic examination, and select representative areas for histopathological examination. For this study, lesions taken into account were the following 1) AMPA, previously known as cystic adenomatoid malformation [27]; 2) bronchogenic cyst (BC); 3) pulmonary sequestration (PS), and 4) congenital lobar hyperinflation (CLH), previously known as congenital lobar emphysema. One of the authors (AR-V, a Pediatric Pathologist with > 20 years of experience) selected and comprehensively reviewed all of the slides.

2.1. Data analysis

Because the majority of variables did not follow normal distribution (Shapiro-Wilk test), we used a non-parametric approach. Concordance between presurgical and anatomopathological diagnoses for each pulmonary malformation was evaluated through the Kappa concordance coefficient. Excel and R statistical software programs were used for statistical evaluation.

3. Results

In the samples reviewed that corresponded to 6 years, 44 surgical specimens from 39 patients fulfilled the criteria for the study. The population comprised 20 male (51.3%) and 19 female (48.7%) patients, with a median age at diagnosis of 5 months (ranging from 3 days to 14 years); 23 patients (59.0%) were < 1 year of age. The surgical specimens were obtained by an open procedure in 33 (84.9%) patients and by thoracoscopy in six (15.4%). Table 1 shows the major characteristic of the population. The affected side was the right side in 25 (64.1%) patients, the left side in 12 (30.8%), and bilateral in two (5.1%). In 29 (74.4%) patients, the lesions were unilobar, in four (10.3%) these were multilobar, and in six (15.4%), these were extralobar sequestrations. As can be seen in this table, clinical and anatomopathological diagnoses agreed in 71.8% cases (28 of 39 patients).

3.1. Type of malformation

Table 2 presents the type of malformation, as well as its frequency, lobar distribution, and localization. In 27 (69.2%) patients, the diagnosis was AMPA. Of the 31 lobes with this malformation, the right lung was the most frequently affected (21 lobes). Cyst size ranged from 0.3 to 1.8 cm, with a median of 0.8 cm. AMPA type 2 was the most frequent lesion with 15 (38.5%) cases and 19 resected lobes (Fig. 1). This was followed by AMPA type 1 in 10 (25.6%) patients (Fig. 2). Cyst size ranged from 2 to 5.3 cm, with a median of 2.9 cm. There were two (5.1%) cases of AMPA type 3. In 23 (85.0%) of the 27 patients with an anatomopathological diagnosis of AMPA, presurgical diagnosis was the same, with a Kappa coefficient of 0.56 (95% confidence interval [95% CI], 0.29–0.83). For AMPA types 1 and 2, the Kappa coefficients were 0.37 (95% CI, 0.02–0.73) and 0.33 (95% CI, 0.03–0.63), respectively.

BC was diagnosed in three (7.7%) patients. In two patients, the diagnosis was performed before surgery, and in the third child, the postsurgical diagnosis was AMPA type 1 (Fig. 3). Kappa coefficient was 0.64 (95% CI, 0.15–1.12).

CLH was suspected prior to surgery in five (12.8%) children (Fig. 4) but was only corroborated in three (7.7%) children; in the remaining two children, the final diagnoses were AMPA. Kappa coefficient was 0.72 (95% CI, 0.35–1.10).

PS was extralobar in six (15.4%) patients. Two of these cases were incidental findings during the surgical correction of a diaphragmatic hernia. In four of these, the histopathology corresponded to an AMPA type 2. Lobes involved in the PS were only specified in four cases (two in the right upper lobe, one in the right lower lobe, and one in the left lower lobe). Presurgical diagnosis was suspected in three (50%) patients. Kappa coefficient was 0.38 (95% CI, −0.13-0.89). Table 3 shows the concordance between the presurgical and the anatomopathological diagnoses.

4. Discussion

4.1. Concordance, nomenclature, and etiopathogenesis

The majority of publications on CPPM are review articles or reports of imaging-clinical correlations, with only a few focused on the presurgical and anatomopathological correlation [1,12,22]. Thus, a major relevance of the present work is that it remedies in part the scarcity of publications on anatomo-clinical correlation in CPPM.

Because only patients with a definite anatomopathological diagnosis of CPPM were included in our study, it was not possible to calculate a global Kappa coefficient. However, with respect to specific diagnoses, we found that concordance between presurgical and anatomopathological diagnoses was 71.8%, which is similar to the 56%–78% concordance reported by other authors [1,12].

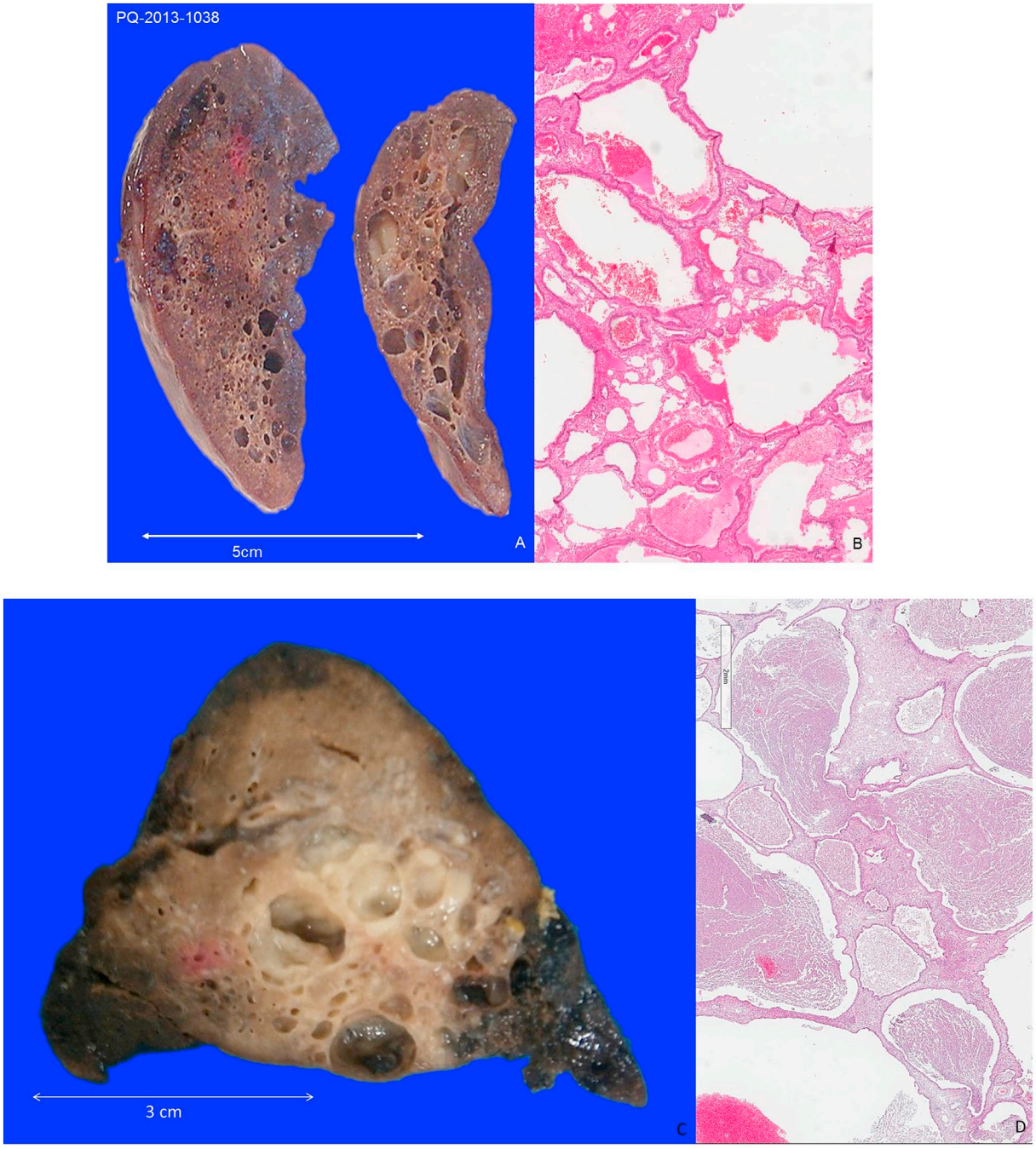

Fig. 1. Middle lobe with an extensive lesion characterized by cysts smaller than 1 cm major axis (A) in an infant aged 4 months; air spaces are enlarged and resemble bronchioles (B); diagnosis corresponded to type 2 adenomatoid malformation of pulmonary airway. Right lower lobe of a 9 days old newborn with a cystic lesion smaller than lesions in Fig. 1B, diagnosed prenatally; microscopic analysis showed characteristics similar to those in Fig. 1B, but filled with purulent material; anatomopathological diagnosis was cystic malformation of pulmonary airway with cyst smaller than 1 cm.

Concordance between presurgical and anatomopathological diagnoses was good, (0.64) for BC, and even better for CLH (0.72). In a previous work, interobserver concordance for the anatomopathological diagnosis of CPPM was 0.15, lower than that in the present work [28]. The poor interobserver concordance for anatomopathological diagnoses, which is lower than for clinico-pathological diagnoses, can only be explained by the lack of precise and easily reproducible morphological criteria, mainly with respect to the AMPA, inasmuch as imaging and anatomopathological studies employ the same terms for different lesions, or different terms for the same lesions [25,28]. For this reason, it has been proposed that the best way to establish a clinical diagnosis of AMPA is to use only descriptions based on imaging studies, without using anatomopathological nomenclature [19,20]. Based on this proposal, we agree with Langston [20] regarding the use of a nomenclature that allows for better diagnostic concordance, not only in clinico-pathological, but also among anatomopathological diagnoses.

Obstetric ultrasonography has documented that in fetal life, there are changing aspects among different CPPM, with an overlapping of clinical, imaging, and even anatomopathological data among lesions, which somehow explains the low global interobserver concordance.

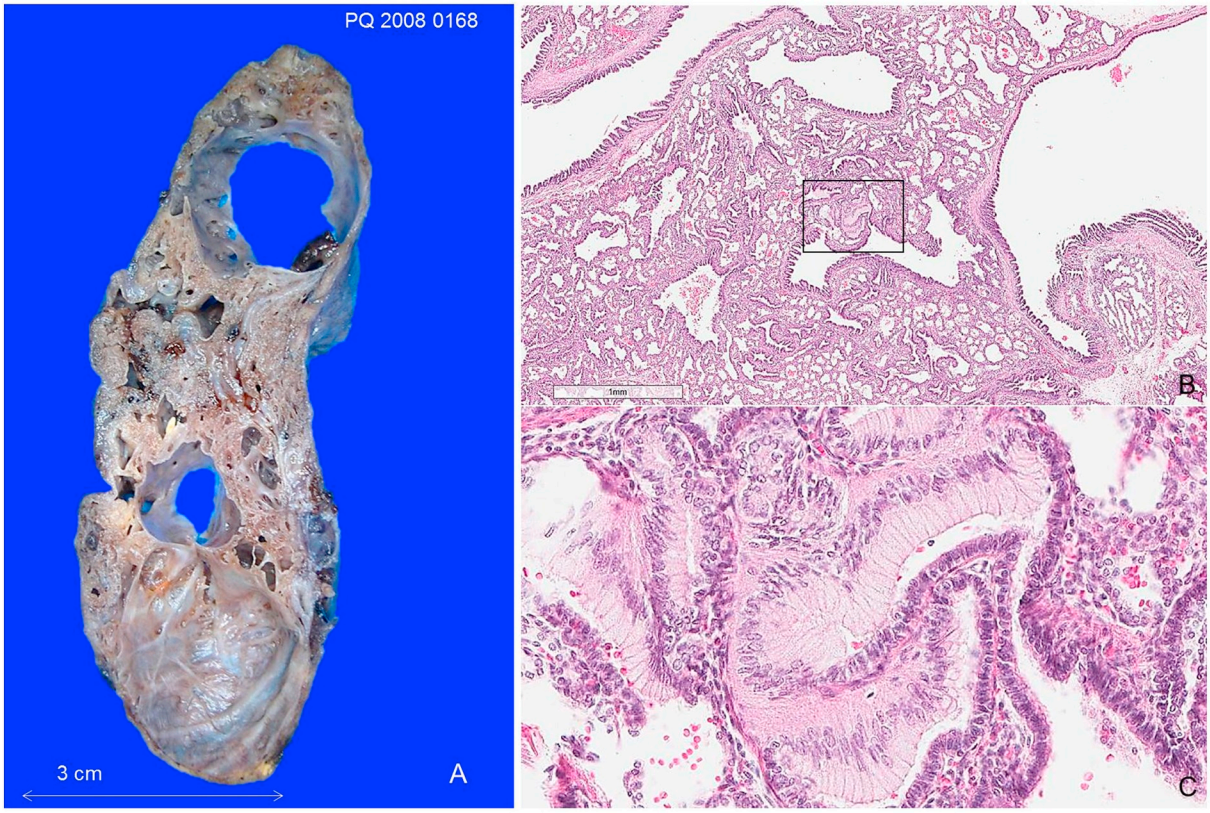

Fig. 2. Middle lobe of an infant aged 2 months with cyst smaller than 2 cm (A). Initial diagnosis was type 2 adenomatoid malformation of pulmonary airway, but the saw-shape epithelium covering the largest cavities (B) and the presence of mucous-producing cells in some cysts suggested a type 1 adenomatoid malformation of pulmonary airway.

This discrepancy diminishes in the case of better characterized lesions, as occurred in our cases of BC and CLH.

Moerman et al. [21] reported 36 years ago the coexistence of bronchial atresia, AMPA (mainly the type 2), and PS (both intra and extralobar). Thus, it is currently considered that such lesions form part of a spectrum with a common etiopathogenetic mechanism of bronchial atresia. Furthermore, there are case reports of the coexistence of AMPA and the polyalveolar lobe, which is a variety of CLH, without bronchial atresia. Therefore, the term "bronchial atresia sequence" has been proposed to refer to these four groups of pulmonary malformations (AMPA, PS, BC, and CLH). The final malformation pattern will depend on the following: 1) the gestational time at which the obstruction occurred; 2) the site of the bronchial tree in which the obstruction occurred, and 3) the degree of the bronchial obstruction [20]. The findings by Riedlinger et al. [24], obtained by means of dissection microscopy, support the hypothesis of a common etiopathogenesis, and that anatomopathological differences may be determined by genetic problems conditioning molecular deficiencies in proteins and signaling factors, or other factors related to the pregnancy and its duration. These authors found lobar, segmental, or subsegmental bronchial atresia in 100% of extralobar PS, in 82% of intralobar PS, in 70% of AMPA, and in 50% of the cases of CLH. In the study, AMPA was present in 91% of PS cases, both in the intra- or extralobar types and in 50% of patients with combined CLH and bronchial atresia. We did not identify bronchial atresia in our cases, surely because it was not intentionally searched for, but by definition the six cases of extralobar PS have it, and three (50%) of these had the histopathology of AMPA type 2. These aspects are similar to those established by previous reports [20,29-32]. In addition, it was surprising that, in our series, we did not identify any intrapulmonary PS. The association of extralobar PS and diaphragmatic hernia has been reported, as occurred in two of our patients, which implies that the defect is developed during the early stages of embryogenesis [33].

4.2. Frequency

In our hospital, the incidence of CPPM in all biopsies received during a 6-year period was < 1% [28], but it was 20% in pulmonary biopsies and increased up to 74% in children aged < 1 year, supporting the opinion of other authors that these lesions are the most frequent cause of lung surgery in young children, emphasizing their relevance [1,2,5,6,10,13,14].

Table 4 compares some of the features of our series with those from another 19 authors [10,12,13,16,20,22,24,34-44]. The number of cases included in these studies ranged from 12 to 87 and the time period of the collection ranged from 4 to 34 years. In these series, the annual frequency of CPPM ranged from 0.7 to 11.2 cases/year. At our hospital, there was an average of 6.5 cases/year and our study constituted the third largest series, which is expected because our hospital is a referral unit.

CPPM are nearly always detected at pediatric age, and in our patients, the median age at diagnosis was 5 months, a figure that agrees with other reports (ranging from 2 to 31 months) [20,34,35,37,39,42,44]. In the series reviewed, the male:female ratio was 1.4:1, very close to our finding of 1.08:1. However, when this ratio was broken down by age group, there was a predominance of males in the 0–12 months-of-age group, reaching a 3:1 ratio with respect to females.

In the present study, distribution of lesions was similar to that reported by other series, with the right lung the most frequently affected

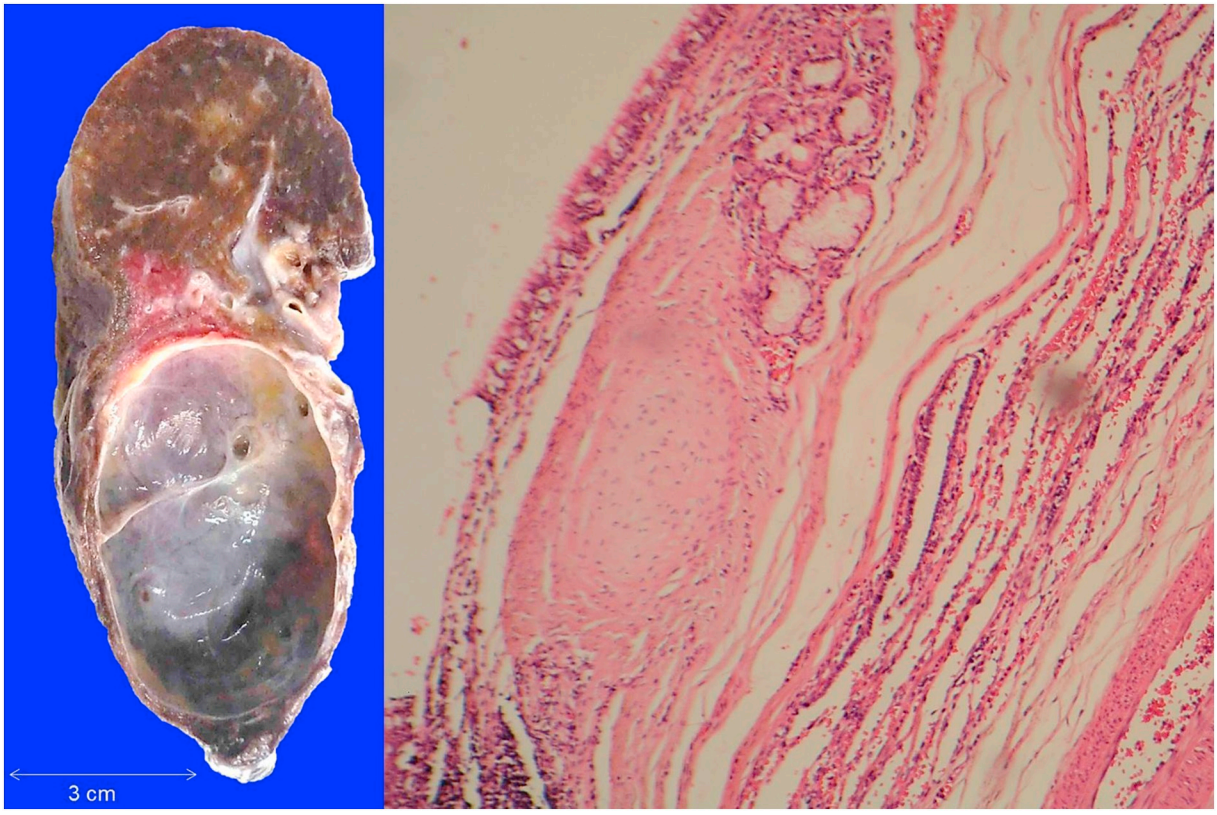

Fig. 3. Lung from a 9 year old boy with history of asthma and single cystic lesion in right upper lobe. Cyst wall is covered by respiratory-type epithelium and there are small muscle and cartilage into the wall. Initial anatomopathological diagnosis was type 1 adenomatoid malformation of pulmonary airway, but the final diagnosis corresponded to an intrapulmonary bronchogenic cyst.

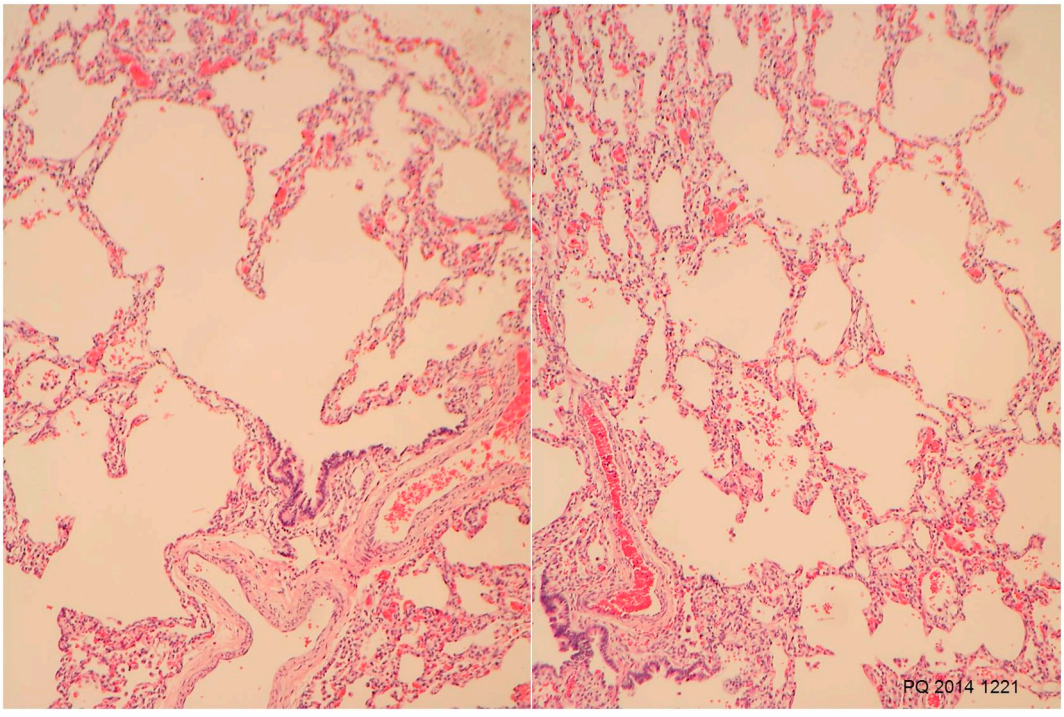

Fig. 4. Microscopic images of the lung from a 20-days old female newborn that showed respiratory distress from birth. Right upper and middle lobes were resected. Figures show notable dilatation of alveolar ducts and sacs, without evidence of interstitial emphysema. Anatomopathological diagnosis was congenital lobar hyperinflation.

Table 3
Concordance between presurgical and anatomopathological diagnoses of cystic and pseudocystic pulmonary malformations in 39 patients.

Type of malformation	Kappa (95% CI)
AMPA	
Type 1	0.21 (−0.13 a 0.56)
Type 2	0.33 (0.03 a 0.63)
Type 3	0 (−0.74 a 0.74)
All types	0.56 (0.29 a 0.83)
BC	0.64 (0.15 a 1.12)
CLH	0.72 (0.35 a 1.10)
Sequestration	0.38 (−0.13 a 0. 89)

CLH = congenital lobar hyperinflation, AMPA = adenomatoid malformation of the pulmonary airway, BC = bronchogenic cyst.

side [34,35,44], with 26.8% in the upper lobe and 24.4% in the lower lobe. This distribution was also encountered for the anatomopathological types, for which the AMPA constituted 69.2% of cases, although some series reported BC as the most frequent lesion [10,44]. AMPA is considered a hamartomous lesion that, according to its size, may contain small or large cysts. In our study, the most frequent AMPA was the type 2 with 38.5% of cases, differing from that reported by Stocker [27], who referred that the most frequent type was type 1, in up to 70% of cases. The frequency and location of PS, CLH, and BC were similar to those reported by other series [12,37].

4.3. Surgical procedure

In our cases, early surgery was performed in patients with extralobar PS, which is explained because these two patients had a diaphragmatic hernia. Cases resolved late were those with type 1 AMPA. Although in some reports thoracoscopic surgery was preferred [36,40], in our patients the most frequent procedure was thoracotomy; selection of the procedure depends on the skillfulness of the surgeon and the availability of equipment. When lesions are asymptomatic, surgical resection is controversial [38,40,41,43,45]. In review articles, it is recommended to follow up these patients and, after 3.6 months, to resect the lesion because of the risk of repetitive infections and, occasionally, malignization [2,3,5,6,10-17].

Limitations of our study include the lack of some details such as how many patients had a prenatal diagnosis and/or infectious processes, age at presentation, and follow-up of patients. Despite these limitations, a major strength of our study, aside from being the only series reported to date, to our knowledge, in Mexico, lies in the evaluation of the concordance of clinico-pathological diagnoses, which unveiled the need for homogenization of the nomenclature of these lesions in order to achieve a better understanding of their origin. Thus, we consider that this revision may be the starting point for promoting the use of a more reproducible nomenclature and to motivate further multi-institutional, long-term investigations.

Proposals drawn from the present work are the following.

1. When a clinician considers the diagnosis of CPPM, he or she must catalog it as “cystic congenital pulmonary lesion” or “cystic pulmonary malformation”, and not use the term “congenital malformation”, inasmuch as malformations are always congenital and the use of both terms is a pleonasm.
2. For the nomenclature of clinical diagnoses, either prenatal or postnatal, we recommend using the classification proposed by Bush [19] and Langston [20]. To adopt descriptive nomenclatures by clinicians and pathologists will allow for better interobserver understanding.
3. Surgical specimens must be sent fresh to the Pathology Service in order to carry out a meticulous macroscopic analysis, even using a dissecting microscope, with the intentional search for bronchial atresia. This search can be difficult or even impossible if the pieces are already fixed.
4. Surgeons must always mention the type of blood vessel irrigating the lesion, either pulmonary or systemic, in order to identify intrapulmonary sequestration.

Table 4
Comparative analysis of 20 series of cystic and pseudocystic pulmonary malformations including this study.

Author and reference	Initial year of revision/ Years revised	Number of cases	Age at diagnosis, median (range)	Sex, male/ female	Clinical presentation,† RDS/ RoAI/A/O	Type of lesion, AMPA/BC/*, **PS/CLH/BA/Others
Takeda et al. [44]	1962/34	26	5.6y (3d–14y)	17/9	7/14/–/–	4/13/6/**3, *4/–/–
Bailey et al. [10]	1970/18	45	– (1d–13y)	23/22	21/12/10/–	9/13/6/6/1/5
Schwartz et al. [41] ‡	1970/25	70	5.0y (1d–17y)	–	20/6/4/–	5/–/20/*10, **9/–/35
Wesley et al. [17]	1974/11	22	– (1d–18y)	14/8	10/10/2/3	7/3/*5, **5/3/0
Coran et al. [45]	1974/19	44	– (1d–18y)	25/19	33/–/6/–	17/6/*9, **6/7/–/–
Evrard et al. [36]	1979/17	48	8.8y (1d–62y)	30/18	–	14/13/*9, **7/5/–/–
Soosay et al. [43] ‡	1980/9	12	– (8d–17y)	7/5	5/7/0/0	6/2/*2/0/0/1
Nuchtern et al. [40]	1983/10	22	– (1d–11y)	12/10	–	7/2/*5, **1/6/1
Al-Bassam et al. [35]	1985/10	57	24m (1d–5y)	39/18	46/19/3/38	7/8/5/37/–/–
Naito et al. [39]	1985/17	28	13m (3d–4.6y)	12/16	–/–/13/–	26/–/*1/–/–/–
Langston [20]	1990/12	59	2m (1d–15y)	–	–	9/6/*6, **11/10/10/9
Shanmugan et al. [42]	1993/10	31	30.01m (3d–12y)	17/14	9/22/–/9	13/3/*2, **4/9/–/3
Ferreira et al. [37] ‡	1997/19	35	31m (30d–10y)	21/14	–/–/9/–	14/–/*4, **4/13/–/1
Griffin et al. [22]	1999/7	24	3y (2.1–9.5y)	16/8	–	12/–/*6, 1**/–/1/–
Colon et al. [12]	2000/9	87	19.6m (1d–13y)	–	18/12/51/6	35/16/11/10/–/–
Karunasumetta et al. [13]	2001/10	25	7m (1d–30y)	16/9	7/15/2/–	12/1/*3, **4/4/–/1
Kunisaki et al. [38]	2001/12	62	–	36/26	–	
Riedlinger et al. [24]	2001/4	45	11m (1d–9y)	26/19	–	44/–/**11/2/35/–
Mehta et al. [34]	2006/7	15	3.6m (36.5d–24y)	8/7	11/4/–/–	15/–/–/–/–
This series	2009/6	39	21.9m (1d–14y)	20/19	–	27/3/**6/3/–/–
Total		796		339/241	196/121/100/64	279/109/160°/24/56

A = asymptomatic, AMPA = adenomatoid malformation of pulmonary airway, BA = bronchial atresia, BC = bronchogenic cyst, CLH = congenital lobar hyperinflation, d = days, F = female, M = male, m = months, O = others, PS = pulmonary sequestration, RDS = respiratory distress syndrome, RoAI = recurrent or acute infection, y = years.*Intralobar. **Extralobar. ‡Reference [41] includes other malformations, and references [37] and [41] include adult patients, but only children were taken into account. °This series does not specify the type of sequestration.

References

[1] Bondioni MP, Gatta D, Lougaris V, Palai N, Signorelli M, Michelini S, et al. Congenital cystic lung disease: prenatal ultrasound and postnatal multidetector computer tomography evaluation. Correlation with surgical and pathological data. Radiol Med 2014;119(11):842–51.
[2] King SJ, Pilling DW, Walkinshaw S. Fetal echogenic lung lesions: prenatal ultrasound diagnosis and outcome. Pediatr Radiol 1995;25(3):208–10.
[3] Puligandla PS, Laberge JM. Congenital lung lesions. Clin Perinatol 2012;39(2):331–47.
[4] MacGillivray TE, Harrison MR, Goldstein RB, Adzick NS. Disappearing fetal lung lesions. J Pediatr Surg 1993;28(10):1321–4. (Discussion, 4-5).
[5] Laberge JM, Bratu I, Flageole H. The management of asymptomatic congenital lung malformations. Paediatr Respir Rev 2004;5(Suppl A):S305–12.
[6] Laberge JM, Puligandla P, Flageole H. Asymptomatic congenital lung malformations. Semin Pediatr Surg 2005;14(1):16–33.
[7] MacSweeney F, Papagiannopoulos K, Goldstraw P, Sheppard MN, Corrin B, Nicholson AG. An assessment of the expanded classification of congenital cystic adenomatoid malformations and their relationship to malignant transformation. Am J Surg Pathol 2003;27(8):1139–46.
[8] Ramos SG, Barbosa GH, Tavora FR, Jeudy J, Torres LA, Tone LG, et al. Bronchioloalveolar carcinoma arising in a congenital pulmonary airway malformation in a child: case report with an update of this association. J Pediatr Surg 2007;42(5):E1–4.
[9] Ueda K, Gruppo R, Unger F, Martin L, Bove K. Rhabdomyosarcoma of lung arising in congenital cystic adenomatoid malformation. Cancer 1977;40(1):383–8.
[10] Bailey PV, Tracy Jr. T, Connors RH, deMello D, Lewis JE, Weber TR. Congenital bronchopulmonary malformations. Diagnostic and therapeutic considerations. J Thorac Cardiovasc Surg 1990;99(4):597–602. (Discussion, 3).
[11] Ceran S, Altuntas B, Sunam GS, Bulut I. Congenital lobar emphysema: is surgery routinely necessary? Afr J Paediatr Surg 2010;7(1):36–7.
[12] Colon N, Schlegel C, Pietsch J, Chung DH, Jackson GP. Congenital lung anomalies: can we postpone resection? J Pediatr Surg 2012;47(1):87–92.
[13] Karunasumetta C, Kuptarnond C, Prathanee S, Intanoo W, Wongbuddha C. Surgical outcomes for congenital lung malformations: 10 years experience at a single center. J Med Assoc Thai 2014;97(1):52–9.
[14] Stanton M, Njere I, Ade-Ajayi N, Patel S, Davenport M. Systematic review and meta-analysis of the postnatal management of congenital cystic lung lesions. J Pediatr Surg 2009;44(5):1027–33.
[15] Kotecha S, Barbato A, Bush A, Claus F, Davenport M, Delacourt C, et al. Antenatal and postnatal management of congenital cystic adenomatoid malformation. Paediatr Respir Rev 2012;13(3):162–70. (Quiz, 70-71).
[16] Keidar S, Ben-Sira L, Weinberg M, Jaffa AJ, Silbiger A, Vinograd I. The postnatal management of congenital cystic adenomatoid malformation. Isr Med Assoc J 2001;3(4):258–61.
[17] Wesley JR, Heidelberger KP, DiPietro MA, Cho KJ, Coran AG. Diagnosis and management of congenital cystic disease of the lung in children. J Pediatr Surg 1986;21(3):202–7.
[18] Stocker LJ, Wellesley DG, Stanton MP, Parasuraman R, Howe DT. The increasing incidence of foetal echogenic congenital lung malformations: an observational study. Prenat Diagn 2015;35(2):148–53.
[19] Bush A. Congenital lung disease: a plea for clear thinking and clear nomenclature. Pediatr Pulmonol 2001;32(4):328–37.
[20] Langston C. New concepts in the pathology of congenital lung malformations. Semin Pediatr Surg 2003;12(1):17–37.
[21] Moerman P, Fryns JP, Vandenberghe K, Devlieger H, Lauweryns JM. Pathogenesis of congenital cystic adenomatoid malformation of the lung. Histopathology 1992;21(4):315–21.
[22] Griffin N, Devaraj A, Goldstraw P, Bush A, Nicholson AG, Padley S. Ct and histopathological correlation of congenital cystic pulmonary lesions: a common pathogenesis? Clin Radiol 2008;63(9):995–1005.
[23] Imai Y, Mark EJ. Cystic adenomatoid change is common to various forms of cystic lung diseases of children: a clinicopathologic analysis of 10 cases with emphasis on tracing the bronchial tree. Arch Pathol Lab Med 2002;126(8):934–40.
[24] Riedlinger WF, Vargas SO, Jennings RW, Estroff JA, Barnewolt CE, Lillehei CW, et al. Bronchial atresia is common to extralobar sequestration, intralobar sequestration, congenital cystic adenomatoid malformation, and lobar emphysema. Pediatr Dev Pathol 2006;9(5):361–73.
[25] Costa Ada Jr. S. Surgical treatment of lung malformations in pediatric patients. J Bras Pneumol 2010;36(4):521–2.
[26] Bush A. Rare lung diseases: congenital malformations. Indian J Pediatr 2015;82(9):833–40.
[27] Stocker JT. Congenital pulmonary airway malformation - a new name for and an expanded classification of congenital cystic adenomatoid malformation of the lung. Histopathology 2002;41(Suppl. 2):424–30.
[28] Eligio-Ángeles M, Rodríguez-Velasco A. Malformaciones pulmonares focales: conceptos actuales e inconsistencia diagnóstica a propósito de 34 casos de biopsia. Patol Rev Latinoam 2014;52:196–209.
[29] Becmeur F, Horta-Geraud P, Donato L, Sauvage P. Pulmonary sequestrations: prenatal ultrasound diagnosis, treatment, and outcome. J Pediatr Surg 1998;33(3):492–6.
[30] Cass DL, Crombleholme TM, Howell LJ, Stafford PW, Ruchelli ED, Adzick NS. Cystic lung lesions with systemic arterial blood supply: a hybrid of congenital cystic adenomatoid malformation and bronchopulmonary sequestration. J Pediatr Surg 1997;32(7):986–90.
[31] Halkic N, Cuenoud PF, Corthesy ME, Ksontini R, Boumghar M. Pulmonary sequestration: a review of 26 cases. Eur J Cardiothorac Surg 1998;14(2):127–33.
[32] Roggin KK, Breuer CK, Carr SR, Hansen K, Kurkchubasche AG, Wesselhoeft Jr. CW, et al. The unpredictable character of congenital cystic lung lesions. J Pediatr Surg 2000;35(5):801–5.
[33] Achiron R, Hegesh J, Yagel S. Fetal lung lesions: a spectrum of disease. New classification based on pathogenesis, two-dimensional and color Doppler ultrasound. Ultrasound Obstet Gynecol 2004;24(2):107–14.
[34] Mehta AA, Viswanathan N, Vasudevan AK, Paulose R, Abraham M. Congenital cystic adenomatoid malformation: a tertiary care hospital experience. J Clin Diagn Res 2016;10(11):SC01–4.
[35] Al-Bassam A, Al-Rabeeah A, Al-Nassar S, Al-Mobaireek K, Al-Rawaf A, Banjer H, et al. Congenital cystic disease of the lung in infants and children (experience with 57 cases). Eur J Pediatr Surg 1999;9(6):364–8.
[36] Evrard V, Ceulemans J, Coosemans W, De Baere T, De Leyn P, Deneffe G, et al. Congenital parenchymatous malformations of the lung. World J Surg 1999;23(11):1123–32.
[37] Ferreira HP, Fischer GB, Felicetti JC, Camargo J de J, Andrade CF. Surgical treatment of congenital lung malformations in pediatric patients. J Bras Pneumol 2010;36(2):175–80.
[38] Kunisaki SM, Powelson IA, Haydar B, Bowshier BC, Jarboe MD, Mychaliska GB, et al. Thoracoscopic vs open lobectomy in infants and young children with congenital lung malformations. J Am Coll Surg 2014;218(2):261–70.
[39] Naito Y, Beres A, Lapidus-Krol E, Ratjen F, Langer JC. Does earlier lobectomy result in better long-term pulmonary function in children with congenital lung anomalies? A prospective study. J Pediatr Surg 2012;47(5):852–6.
[40] Nuchtern JG, Harberg FJ. Congenital lung cysts. Semin Pediatr Surg 1994;3(4):233–43.
[41] Schwartz MZ, Ramachandran P. Congenital malformations of the lung and mediastinum- a quarter century of experience from a single institution. J Pediatr Surg 1997;32(1):44–7.
[42] Shanmugam G, MacArthur K, Pollock JC. Congenital lung malformations- antenatal and postnatal evaluation and management. Eur J Cardiothorac Surg 2005;27(1):45–52.
[43] Soosay GN, Baudouin SV, Hanson PJ, Fontana G, Jagjivan A, Goldstraw P, et al. Symptomatic cysts in otherwise normal lungs of children and adults. Histopathology 1992;20(6):517–22.
[44] Takeda S, Miyoshi S, Inoue M, Omori K, Okumura M, Yoon HE, et al. Clinical spectrum of congenital cystic disease of the lung in children. Eur J Cardiothorac Surg 1999;15(1):11–7.
[45] Coran AG, Drongowski R. Congenital cystic disease of the tracheobronchial tree in infants and children. Experience with 44 consecutive cases. Arch Surg 1994;129(5):521–7.