ORIGINAL ARTICLE

Eastern Journal of Medicine

East J Med 29(4): 440-445, 2024
DOI: 10.5505/ejm.2024.28913

Prenatal Diagnosis of Congenital Pulmonary Airway Malformation (CPAM) Types: Case Series

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ABSTRACT

This study retrospectively aims to evaluate nine cases of congenital pulmonary airway malformation (CPAM) diagnosed during the prenatal period. Prenatal diagnosis of CPAMs is critical in the diagnosis of fetal thoracic malformations. Case studies provide a better understanding of the clinical course, treatment options, and outcomes of CPAMs.

Cases with prenatally diagnosed lung lesions screened in the high-risk pregnancy category between October 2021 and February 2024 were analyzed retrospectively. The characteristics, location, and accompanying findings of the lesions were evaluated by perinatology specialists. The diagnosis of CPAM was categorized based on prenatal ultrasound images.

This study show the demographic characteristics and clinical findings of the patients with CPAM. In our study, the mean age was 33 years, and the median week at diagnosis was 21 weeks and 2 days. The median birth weight was 2970 gm. The rate of vaginal delivery was 55.6%, while additional anomalies were detected at a rate of 66.7%. Most lesions were located in the right lung and had a cystic or solid-cystic nature. The distribution according to CPAM type was 22.2% type 1, 33.3% type 2, and 44.4% type 3. According to the results obtained by analyzing nine cases, two cases resulted in termination, regression was observed in two cases, and postnatal surgery was performed in one case. One case was followed up postnatally.

This study examined the clinical course, treatment options, and outcomes of rare cases diagnosed with CPAM. The results highlight the importance of prenatal and postnatal processes of diffeternt types of CPAM.

Keywords: Congenital pulmonary airway malformations (CPAM), thoracic malformation, CPAM types, fetal lung , prenatal diagnosis.

Introduction

Prenatal ultrasound is widely used to diagnose fetal thoracic malformations. In particular, careful assessment of the echogenicity of the lungs is vital for detecting fetal lung masses. The differential diagnoses of echogenic lung masses (solid and/or cystic) include conditions such as congenital pulmonary airway malformation (CPAM), bronchopulmonary sequestration, bronchogenic cysts, thoracic neuroblastoma, tracheal or bronchial atresia, congenital lobar emphysema, and pulmonary arteriovenous malformation (1).

The underlying pathophysiologic mechanisms for CPAM have not yet been fully understood (2). However, it has been suggested that developmental insufficiency in bronchopulmonary structure in the early stages of embryogenesis, increased FGF10 signaling, and problems in the HOXB5 gene may play a role in the formation of lung masses (2). The incidence of CPAM has been reported to be 0.94/10.000 live births (3).

There is limited information in the literature about the outcomes of pregnancies with a diagnosis of prenatal fetal lung mass. This condition is associated with outcomes ranging from intrauterine fetal death to delivery of asymptomatic babies (4,5). The present study focuses on nine cases to better understand the clinical course, treatment options, and outcomes of this rare condition. Our findings are expected to contribute to the studies and clinical practice in this field.

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Received: 02.06.2024, **Accepted:** 13.09.2024

Materials and Methods

Cases with prenatally diagnosed echogenic or complex lung masses that were screened in the high-risk pregnancy department of Etlik Zübeyde Hanım Women's Health Care Training and Research Hospital between October 2021 and February 2024 were retrospectively identified. All cases were thoroughly evaluated by perinatologists using the Voluson E6 device manufactured by GE Healthcare GmbH & Co OG (Austria). Data such as maternal age, gravida, parity, gestational age at prenatal diagnosis, lesion size, and accompanying anomalies were collected from hospital records for the analysis. The size, characteristics (solid, cystic, etc.), location, and accompanying findings on ultrasound were recorded during routine ultrasound evaluation of fetal lung lesions. The locations of the lesions were classified according to the right and left sides of the lungs.

Antenatal ultrasound diagnosis of the lesions was categorized based on sonographic appearance, similar to the pathological criteria for CPAM proposed by Stocker et al (6). Echogenic lung masses containing large cysts (>3 cm) were defined as type 1, masses containing multiple small cysts (<2 cm) were classified as type 2, and homogeneous echogenic lesions with a cyst size of <1 cm were categorized as type 3 (6). In order to obtain the necessary data in the postnatal period, hospital records were used for the cases diagnosed and treated in our hospital; on the other hand, the cases diagnosed by our clinic and treated in other centers were invited to our hospital to obtain the necessary information. Our study was approved by the non-interventional clinical research ethics committee of our hospital with the number 03/12.

Statistics Analysis: Descriptive statistics for the continuous and categorical variables was used. Continuous variables were presented as Median (Minimum-Maximum), and categorical variables were presented as numbers and percentages, n (%). The data were analyzed using IBM SPSS Statistics for Windows, Version 23.0.

Results

Table 1 presents the demographic characteristics and clinical findings of the patients with CPAM. The mean age was 33 years (22–38). The median gravida was 2 (1–4), and the median parity was 1 (0–2). The median week at diagnosis was 21 weeks and 2 days (19/0–40/3), and the median week at delivery was 39 weeks and 1 day (21/2–40/3). The median birth weight was 2970 gm (378–3550).

With respect to the mode of delivery, 55.6% had a vaginal delivery and 44.4% had cesarean section. Additional anomalies were present at a rate of 66.7%. Furthermore, 66.7% and 33.3% of the lesions were located in the right and left lungs, respectively.

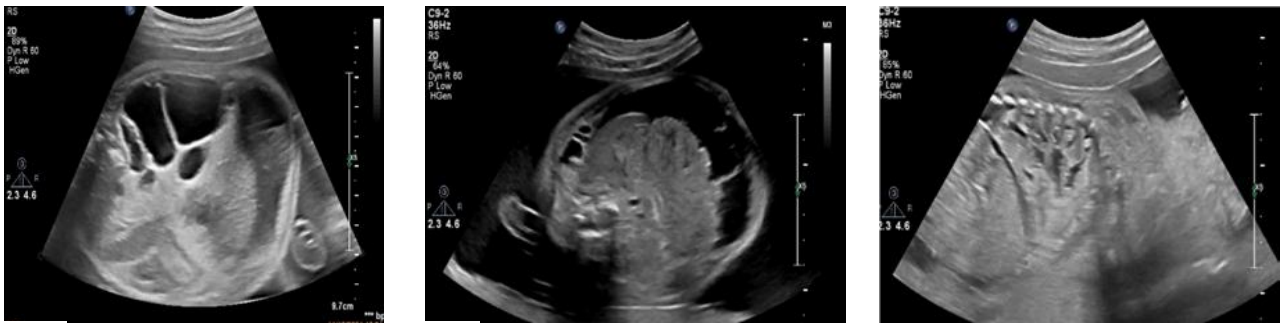
According to the appearance of the lesions, 44.4% were cystic, and 55.6% were solid-cystic. Based on cyst size, 33.3% were smaller than 2 cm, 44.4% were smaller than 1 cm, and 22.2% were larger than 3 cm. Regarding CPAM type, 22.2% were defined as type 1, 33.3% as type 2, and 44.4% as type 3.

Neonatal outcomes were obtained by analyzing a total of nine cases, as presented in Tables 1 and 2. Two cases (22.2%) resulted in termination. The number of cases that showed regression in the prenatal and postnatal period was two (22.2%). Postnatal surgery was performed in one case (11.1%). The number of cases under postnatal follow-up was one (11.1%). Some ultrasound images from our case series are shown in figure 1.

Discussion

CPAM is a rare congenital anomaly and constitutes approximately 25% of congenital lung malformations (7,8). It was first described by Chi and Tang in 1949 (9). CPAM, previously called congenital cystic adenomatoid malformation (CCAM), was first classified into three types by Stocker et al. in 1977 (10). Later, it was renamed as CPAM by Stocker et al. and expanded to five types (6). Although most fetuses with a prenatal diagnosis of CPAM have a good perinatal outcome, serial ultrasonographic examinations and careful management are essential in these pregnancies (11).

Type 1 is the most common type of CPAM, accounting for approximately 60%–70% of cases, and has the most favorable prognosis (6). In our study, type 1 CPAM was diagnosed prenatally in two patients (22.2%). One of these cases was diagnosed at 22 weeks and 3 days in the prenatal period, and the lesion regressed in the prenatal period. In the other case, it was found that the lesion was accompanied by hydrops, polyhydramnios, and mediastinal shift, but this case did not remain in our pregnancy follow-up. Large CPAM lesions may cause fetal hydrops and fetal death by causing cardiac compression (12). In fetuses affected by hydrops, fetal surgical resection of the lung mass can cause the hydrops to regress and provide sufficient lung tissue growth to allow for survival (13,14). However,



A B C

Fig. 1. Some ultrasound findings in our case series**.** Type 3 CPAM (a), hydrops image (b), type 2 CPAM (c)

Table 1: Demographic Characteristics and Clinical Findings of CPAM Patients

		Median (min-max)
Maternal age (years)		33 (22-38)
Gravidity		2 (1-4)
Parity		1 (0-2)
Gestational age of diagnosis(week/day)		21/2 (19/0-40/3)
Birth week (week/day)		39/1 (21/2-40/3)
Birth weight (gram)		2970 (378-3550)
Type of birth n(%)	VD	5 (55.6)
	CS	4 (44.4)
Additional anomalies n(%)		6 (66.7)
Lesion localization n(%)	Right	6 (66.7)
	Left	3 (33.3)
Lesion appearance n(%)	Cystic	4 (44.4)
	Solid-Cystic	5 (55.6)
Cyst size n(%)	< 2cm	3(33.3)
	> 3cm	2 (22.2)
	< 1cm	4 (44.4)
Type of CPAM n(%)	Type 1	2 (22.2)
	Type 2	3(33.3)
	Type 3	4 (44.4)
Neonatal outcome n(%)	Termination	2 (22.2)
	Prenatal regression	2 (22.2)
	Postnatal regression	2 (22.2)
	Postnatal surgery	1 (11.1)
	Postnatal follow-up	1(11.1)

VD; Vaginal Delivery, CS;Cesarean section, CPAM; congenital pulmonary airway malformations

since the case was no longer in the pregnancy follow-up of our hospital, no definite information could be obtained about the prenatal and postnatal follow-up results.

Type 2 CPAM originates from terminal bronchioles with smaller lesion sizes (<2 cm) (15,16). It constitutes 15%–30% of the cases, and accompanying anomalies, especially intrathoracic and abdominal anomalies, as well as skeletal malformations, are more common (15,16). In our study, three patients were prenatally diagnosed with type 2 CPAM and had accompanying anomalies. In one case, the lung lesion regressed in the prenatal period, and in the other two cases, the pregnancies were terminated after counseling with the parents due to accompanying major

Table 2*:* Clinical features associated with Congenital Pulmonary Airway Malformations (CPAM)

Case	Age (years)	Gestational age of diagnosis Week/day	Lesion size	Type of CPAM	Additional anomalies	Birth Week Week/day	Type of birth	Birth weight gr	Neonatal outcome
1	33	21/2	<2cm	Type2	Agenesis of CC	21/2	VD	489	Termination
2	22	24/1	<1cm	Type3	-	39/1	CS	2900	Asymptomatic Follow-up with CT
3	30	22/3	>3cm	Type1	-	39/3	VD	3120	Prenatal regression
4	26	19/0	<1cm	Type3	-	40/2	VD	3550	Postnatalregression
5	30	20/6	<1cm	Type3	-	38/5	CS	3040	RDS Postnatal surgery
6	35	28/4	>3cm	Type1	Hydrops, polihidroamnios Left mediastinal shift	-	-	-	Unfollowed
7	35	25/6	<1cm	Type3	Minimal acid	37/4	CS	2776	Postnatalregression
8	37	20/1	<2cm	Type2	Mesocardia, scoliosis, CHAOS	20/2	VD	378	Termination
9	38	20/0	<2cm	Type2	Hyperechoic bowel	40/3	VD	3390	Prenatal regression

CHAOS; Congenital High Airway Obstruction Syndrome, CC; Corpus Callosum, CPAM; Congenital Pulmonary Airway Malformations RDS: Respiratuar Distress Syndrome,CT: Computed Tomography

malformations (congenital high airway obstruction syndrome, scoliosis, and agenesis of the corpus callosum). Termination of pregnancy following detailed counseling is a preferable option for managing severe cases (17). The development of fetal hydrops and the presence of larger cysts have been demonstrated to be among the indicators of poor prognosis (18).

CPAM cases of type 3 are rare and account for 5%–10% of all cases (6). These lesions are large lung lesions originating from distal bronchioles and alveoli (6). The cystic structures are usually <0.2 cm in size, and the lesions usually have a solid appearance since the cyst sizes are very small (6). In our study, type 3 CPAM was diagnosed prenatally in 44.4% of the cases, and regression was observed in 2 cases during postnatal follow-up. Surgical intervention was performed due to respiratory distress in the postnatal period in only one case, but the operation report of this case was not available. The other type 3 CPAM case continues to be followed up because it has had an asymptomatic course in the postnatal period. Stocker (2002) added type 0 and type 4 CPAM to the CPAM classification. Type 0 CPAM originates in the trachea and bronchi and occurs in 1%–3% of all cases. It is the rarest type of CPAM; it is difficult to differentiate it from a bronchogenic cyst and it has a mortal course (6). On the other hand, type 4 CPAM originates from the most distal acinar region of the lungs. Similar to type 1 CPAM, it contains many large cysts (19). Furthermore, type 4 CPAM has been associated with malignancy (20). In our case series, prediagnoses of type 0 and type 4 CPAM were not made in the prenatal period.

Most CPAMs (80%–85%) are diagnosed in the first 2 years of life (21). This condition frequently causes recurrent resistant infections and may rarely lead to malignant cases (22-24). Treatment of CPAMs depends on the clinical course and extent of the disease (25). Surgical excision may be required in cases of symptoms, recurrent lung infections and respiratory distress (26). However, lesions that are small in size and not symptomatic can be followed up. Signs of spontaneous regression may be observed in cases diagnosed on prenatal ultrasound (27). In our study, two cases were identified with spontaneous regression in the prenatal period. In addition, a patient who was prenatally diagnosed as type 3 was followed up because of an asymptomatic course after delivery. Our findings confirm the information in the literature.

The weaknesses of this study include the limited sample size, retrospective nature of the study, and lack of pediatric surgery service, which poses a problem for accessing data from postnatal follow-up. The strength of this study is that it reviews in detail the clinical course, treatment options, and outcomes of prenatally diagnosed cases of a rare congenital anomaly. Furthermore, cases that were thoroughly evaluated by perinatologists were used for a comprehensive assessment of the study.

In conclusion, this study examined the clinical course, treatment options, and outcomes of cases with CPAM diagnosed prenatally. Our findings emphasize the importance of prenatal and postnatal processes in diagnosing and treating different types of CPAM. The results of our study have indicated that lung lesions may improve during prenatal and postnatal follow-up, and surgical intervention may be necessary in symptomatic cases, whereas follow-up may be sufficient in asymptomatic cases. The study results also suggest that prenatal diagnosis and careful follow-up play a vital role in the effective management of CPAM. However, the limited sample size and retrospective nature of the study should be considered. These results may constitute an important contribution to the studies and clinical practice pertaining to congenital lung malformations.

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