Congenital high airway obstruction syndrome

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Abstract

Congenital high airway obstruction syndrome (CHAOS) is a very rare fetal malformation caused by obstruction of fetal airway because of laryngeal or tracheal atresia, subglottic stenosis, laryngeal cyst or laryngeal web. The prenatal diagnosis is inferred from secondary changes such as enlarged, hyperechogenic lungs, ascites and/or hydrops, flattened or everted diaphragms, dilated distal airways and mediastinal compression. There are only few cases of long-term survival described in literature.

We present the case of fetus with such secondary changes diagnosed during routine ultrasound evaluation in 20 weeks' gestation. There were no other abnormalities and the kariotype was normal. In 26 weeks' gestation fetal hydrops appeared and subsequent polyhydramnios occurred in 28 weeks' gestation. The patient was planned for EXIT procedure during labor in experienced in CHAOS cases center. In 29 weeks' gestation the premature rupture of membranes and regular uterine contractions occured and we've performed cesarean section. A multidisciplinary team of neonatologists, laryngologists and pediatric surgeons made their efforts to save the newborn, but there was complete laryngeal atresia and tracheal agenesia and immediate tracheostomy was impossible.

The most important about CHAOS are early diagnosis, detailed fetal assessment and an adequate postnatal intervention for establishing fetal airways.

CASE REPORT

A 32-year-old woman, gravida 3, para 1, was referred to the hospital at 20 weeks' gestation for evaluation of massive fetal ascites and enlarged, hyperechogenic lungs.

By that time the course of pregnancy was complicated with bleeding and abdominal pains between 7–14 weeks of gestation. The ultrasound evaluation at 20 weeks of gestation showed massive ascites (AC corresponded with 26 weeks' gestation), bilaterally enlarged, hyperechogenic lungs, flattened diaphragms, dilated distal airways and mediastinal compression (Figures 1 and 2). No other fetal malformations were found. Biometry (besides AC diameter) within normal range. The heart was small and compressed but echocardiography was normal. Oligohydramnios was present at that time.

At 21 weeks' gestation the patient was consulted with prof. Adzick from Children's Hospital of Philadelphia in the USA, who confirmed the diagnosis of CHAOS and proposed further evaluation and treatment in this hospital.

At 26 weeks' gestation amniocentesis was performed, confirming normal male kariotype and

CASE REPORT

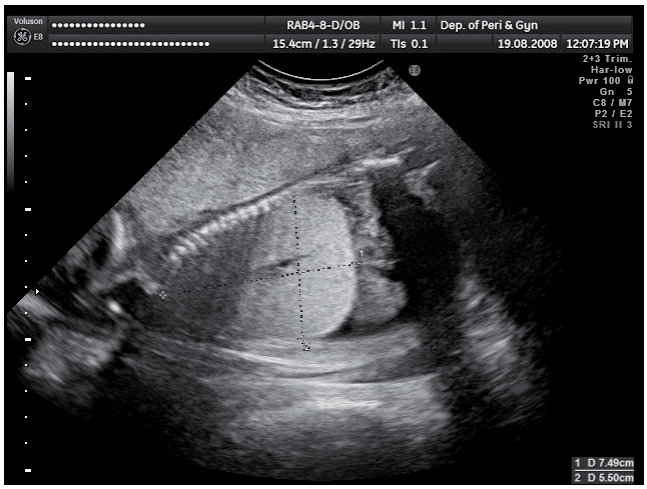

Figure 1 Ultrasound image of fetal thorax and abdomen in sagittal plane in 23 weeks' gestation shows enlarged, hyperechogenic lungs, everted diaphragms and massive ascites.

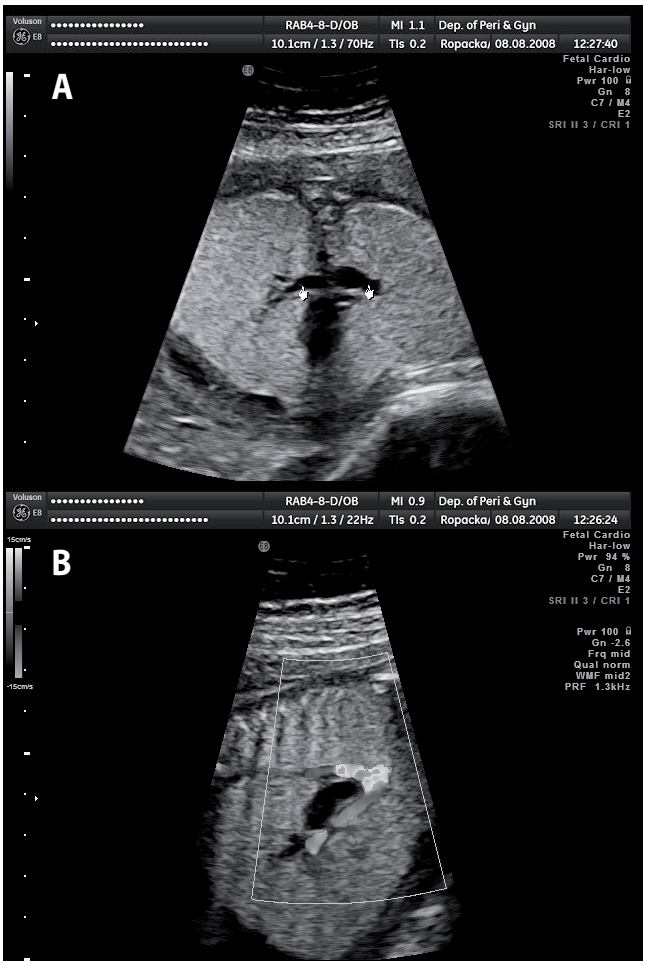

Figure 2 (A) ultrasound image of fetal thorax in transverse section in 23 weeks' gestation shows hyperechogenic, enlarged lungs with dilated distal airways (arrows) and mediastinal compression. (B) doppler ultrasound image of fetal thorax in sagittal section in 23 weeks' gestation shows aortic arch surrounding dilated distal airways (arrows).

FISH testing for chromosomal region 22q11.2 microdeletion was negative. The MRI examination was planned. At 26 weeks' gestiation fetal hydrops appeared including massive edema on fetal head and thorax with placentomegaly of 55 mm. The subsequent ultrasound scans revealed the apperance of polyhydramnios at 28 weeks' gestation and enlargement of fetal hydrops. Echocardiography didn't reveal heart insufficiency. Our patient was admitted to the hospital with suspicion of "mirror syndrome" because of massive legs edema. Laboratory tests and blood pressure examinations excluded those diagnosis.

At 29 weeks' gestation premature rupture of membranes and regular uterine contractions appeared. Despite beta-mimetics and antibiotics therapy the contractions tended to intensify. Few hours later we've performed cesarean section. A multidisciplinary team of neonatologists, laryngologists and pediatric surgeons was present at the operating room. On the account of massive fetal hydrops neonatologist desisted from the intra-partum manipulation and the umbilical cord was clamped. Immediate laryngoscopy showed complete laryngeal atresia. The pediatric laryngologysts made an effort to perform tracheostomy, but the trachea was not developed. On the ground of lethal malformations the neonatologyst decided to provide only palliative procedures. The patient was a boy, weighted 2,193 g, Apgar scores of 1 in 1st, 3rd, 5th and 10th minute (Figure 3). Umbilical cord blood pH values of 7.14 and 7.11. The newborn died after 2 hours. The autopsy revealed complete laryngeal atresia, tracheal agenesis and hyperplastic lungs.

DISCUSSION

The acronym congenital high airway obstruction syndrome (CHAOS) was introduced by Hedrick *et al.* (1994) in 1994 to describe specific ultrasonographic findings of upper airway obstruction. The diagnosis is inferred from secondary changes such as enlarged, hyperechogenic lungs, ascites and/or hydrops, flattened or everted diaphragms, dilated distal airways and mediastinal compression.

Fetal lungs normally secrete a fluid that evacuates through the larynx. In the case of complete obstruction the fluid accumulates within the lungs causing distal airways dilation and hyperplasia of lungs (Lim *et al.*2003). Upper airway obstruction stimulates lung growth, their structural development and maturity. Histologically fetal lungs with CHAOS may be normal and show proliferation of lung parenchyma and expansion of terminal bronchioles and alveoli. Nowadays this procedure of an *in utero* tracheal occlusion is used for diaphragmatic hernia treatment (Lippsett *et al.* 1998).

Enlareged lungs stretch the diaphragm causing diaphragmatic dysfunction and need for prolonged postnatal ventilatory support. The esophageal compression impairs amniotic fluid swallowing which results in

polyhydramnios. Lung expansion causes cardiac and caval compression manifested by ascites or even fetal hydrops and placentomegaly, as it occurred in our case. Previous experience had suggested that development of non-immune hydrops is usually a harbinger of imminent intrauterine fetal demise. On the other hand, there were few cases in literature that survived in spite of long lasting hydrops in the course of CHAOS (Crombleholme *et al.* 2000). Lim *et al.* (2003) presented the case of a fetus with CHAOS and persistent progressive hydrops that was well tolerated from 19 to 31 weeks of gestation. Literature describes few cases of spontaneous resolution of ascites or fetal hydrops in CHAOS. In all those cases postnatal laryngoscopy visualised small pharyngotracheal fistula in artretic larynx, or a patent pharyngoglottic duct which allowed egress of the fetal lung fluid and released elevated intratchoracic pressure during pregnancy (Lim *et al.* 2003; Kanamori *et al.* 2004).

Usually CHAOS is an isolated malformation, but may be a presentation of Fraser syndrome or Di George syndrome (chromosome 22q11.2 microdeletion) and detailed ultrasound examination, kariotype evaluation and FISH testing for 22q11.2 microdeletion must be performed, to exclude the presence of associated anomalies (Fraser & van de Kamp 1975). Kanamori *et al.* (2004) described one case of laryngeal atresia with chromosome 5 p deletion (Cri du Chat syndrome). Vanhaesebrouck *et al.* (2006) reported a unique family with autosomal dominant inheritance of CHAOS and variable expression in the affected family members. It is also necessary to perform fetal echocardiography to exclude heart malformations. Despite cardiac compression CHAOS is not connected with congenital heart malformations (Lim *et al.* 2003).

The detailed diagnostic management should include also fetal MRI imaging to evaluate the cause and level of an airway obstruction (Kuwashima *et al.* 2007). Our patient was planned for MRI, but the premature rupture of membranes and preterm labour occurred at that time. Congenital fetal malformations of lungs and airways are very rare, nevertheless one must take into consideration other causes of upper airway obstruction like cervical teratoma, neuroblastoma, congenital goitre or any tumor arising from oropharynx, oral cavity, larynx and neck (Walker *et al.* 2005). The differential diagnosis include bilateral CCAM, though it's very rare and in contrast to CHAOS, color Doppler imaging show fluid flow in the trachea (Kuwashima *et al.* 2007).

In the case of massive maternal edema it is very important to observe the mother towards "mirror syndrome" (edema, proteinuria, low hematocrite, elevated blood urine level) associated with fetal hydrops and placentomegaly (Carbillon *et al.*1997). These symptoms may accompany hypertension or eclamptic state and may be indication for earlier delivery (Heyborne & Chism 2000).

Understanding CHAOS pathophysiology initiated trials of an in utero treatment. Fetoscopic tracheoscopy with performing of venting tracheostomy or creation of a pharyngotracheal fistula were described (Adzick & Harrison 1994), however there are reports which prove that chronic drainage of fetal lung fluid results in pulmonary hypoplasia in sheep (Lanman *et al.* 1971). There are only few cases treated in utero and there are no uniform algorytms for CHAOS treatment. In the past fetus with CHAOS has been at high risk of anoxia or death after conventional cesarean section or vaginal delivery due to time required to secure the airway (Bouchard *et al.* 2002). The EXIT (Ex Utero Intrapartum Treatment) procedure gives much time (even 8–66 minutes) to establish newborn airways while the uteroplacental circulation is preserved. Literature gives examples of successful application of the EXIT procedure in management of giant fetal neck masses, CCAM or unilateral pulmonary agenesis (Bouchard *et al.* 2002).

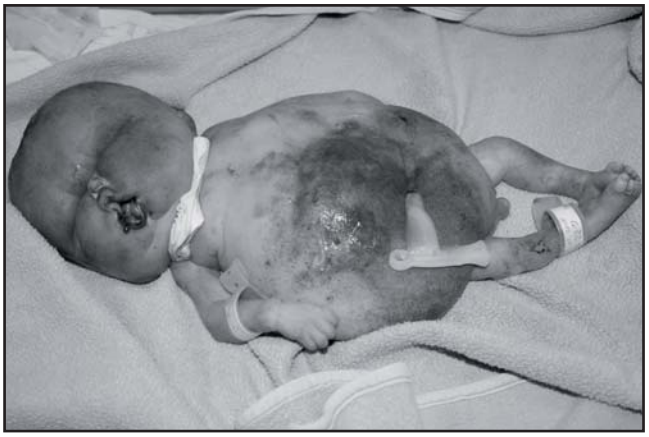

Figure 3 Post partum image of newborn with CHAOS. Massive ascites and edema of the face are seen.

Complete airway occlusion is a lethal malformation if not diagnosed prenatally and without appropriate intrapartum airway establishing procedure. Even if baby survives the EXIT, there are still a lot of problems to face. The consequences include capillary leak syndrome, respiratory distress syndrome, tracheobronchomalacia, diaphragmatic dysfunction. The newborn might be mechanical ventilation dependent for months and many complications including death can occur during that time. A laryngotracheal reconstruction is performed when the child is older. Most of the patients with complete larynx atresia are not able to speak even after reconstruction operations. Literature describes only a few cases of long-term survival with CHAOS (Lim *et al.* 2003; Crombleholme *et al.* 2000).

Conclusions: the most important about CHAOS are early diagnosis, detailed fetal assessment and an adequate postnatal intervention for establishing fetal airways. The cooperation of experienced with CHAOS multidisciplinary team (obstetrician, neonatologist, laryngologist, pediatric surgeon and anesthesiologist) is crucial in these cases.

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