Case Report

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A case of split notochord syndrome: Presenting with respiratory failure in the neonatal period

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Summary **Split notochord syndrome (SNS) is a very rare congenital anomaly. This report describes a male newborn with a neuroenteric cyst in the posterior mediastinum and multiple vertebrae anomalies presenting with respiratory failure and pulmonary hypertension. This report also discusses the embryological development and the etiologic theories of SNS.**

Keywords: Split notochord syndrome, newborn, respiratory failure

1. Introduction

Split notochord syndrome (SNS) is a very rare congenital malformation that is associated with anomalies of the vertebrae, central nervous system, and gastrointestinal tract (*1,2*). In this syndrome, anomalies arise from a connection between the endoderm and dorsal ectoderm (*3,4*). The variety of malformations and clinical symptoms depends on when abnormal splitting of the notochord occurs and the size and location of that split (*5*). The current report describes a newborn with SNS presenting with respiratory symptoms, and this report also discusses SNS and its different presentations.

2. Case Report

A 12-day-old boy, weighing 2,920 g, was referred to the Neonatal Intensive Care Unit (NICU) of Goztepe Medical Park Hospital, Bahcesehir University School of Medicine with respiratory failure.

The baby was born full-term *via* a Caesarean section as the first child of a 24-year-old mother. The mother had no history of radiation exposure, drug ingestion, alcohol use, or smoking during pregnancy, no family history of congenital anomalies, and there was no consanguinity.

At birth, the infant was admitted to the NICU for dyspnea and tachypnea. A few hours later, intubation was performed and an intratracheal surfactant was administered. The infant was administered antibiotics for 10 days because of elevated CRP levels. The initial diagnosis was congenital pneumonia. However, the infant could not be weaned from mechanical ventilation and a computed tomography scan of the chest revealed a cyst in the right lung. The infant was transferred to this facility to determine the etiology of and the treatment for the cyst in the right lung.

Upon physical examination, the infant had severe respiratory failure and decreased breath sounds in the right lung but other findings were normal. An anteroposterior (AP) chest radiograph revealed a large, well-defined mass in the right hemithorax, displacing the mediastinum to the right, and cervico-thoracic vertebral anomalies (Figure 1). Ultrasonography of the right pleura revealed pleural effusion, and magnetic resonance imaging of the chest and abdomen revealed a homogeneous, unilocular hyperintense cystic mass in the right prevertebral region without extension to the spinal canal (Figure 2). Echocardiography findings were consistent with pulmonary hypertension. Blood tests revealed elevated levels of C-reactive protein (71.17 mg/L) and an elevated white blood cell count (28,650 cells per cubic mm). Blood, endotracheal, and urine cultures were negative. The antibiotics vancomycin and

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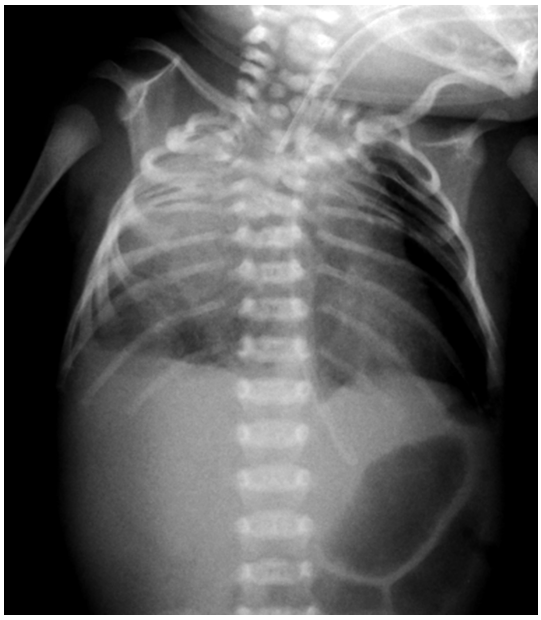

Figure 1. AP chest radiograph showing a large, well-defined mass in the right hemithorax, displacing the mediastinum to the right, and cervico-thoracic vertebral anomalies.

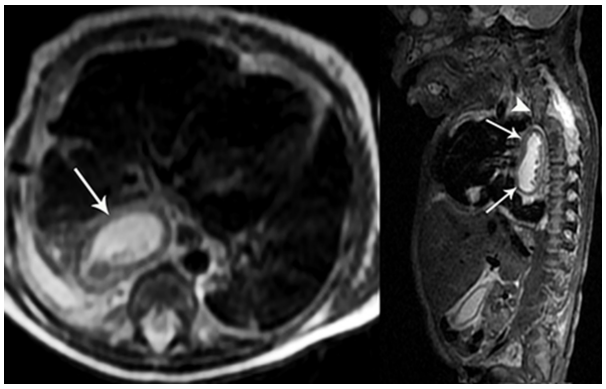

Figure 2. Axial (right) and sagittal (left) T2-weighted magnetic resonance images showing a homogeneous unilocular high signal cystic mass in the right prevertebral region without extension to the spinal canal.

meropenem were initially administered and fluconazole was added. Sildenafil was administered to treat pulmonary hypertension. A chest tube was placed to drain the pleural effusion. The patient was intubated and on mechanical ventilation in the synchronized intermittent mandatory ventilation (SIMV) mode. Since blood gases revealed respiratory acidosis and hypercarbia, the mode of the mechanical ventilator was switched from SIMV to High frequency oscillatory ventilation (HFOV). Ventilation in HFOV mode was continued for 8 days. On the 9th day of hospitalization, mechanical ventilation was changed to SIMV mode, and the infant was sent to Pediatric Surgery for surgery to remove the cyst in his right lung. A right thoracotomy was performed. The mass was in the posterior mediastinum and it was completely removed. Histopathology revealed well-differentiated simple columnar epithelium with glandular organization and smooth muscle (type B neuroenteric cyst, Wilkins and Odom system for histopathological classification of neuroenteric cysts) (Figure 3). After surgery, the infant remained on mechanical ventilation for 18 days. On the 10th day postoperatively, enteral feeding was started and gradually continued. The infant was discharged from the hospital at 53 days of age.

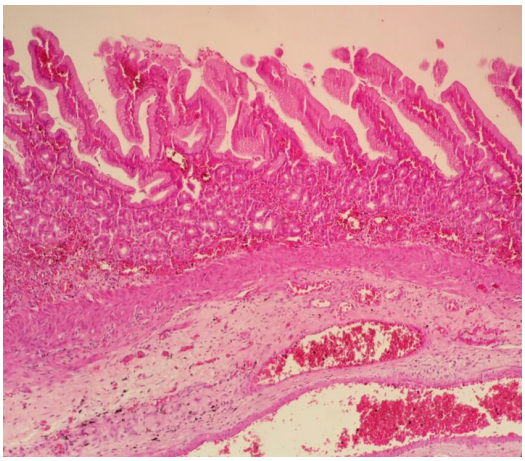

Figure 3. Resected specimen. Well-differentiated simple columnar epithelium with glandular organization and smooth muscle (type B neuroenteric cyst, Wilkins and Odom system for histopathological classification of neuroenteric cysts).

3. Discussion

SNS was first described by Rembe in 1887 (*6*). The congenital anomalies in SNS include anomalies of the vertebrae (anterior and posterior spina bifida and butterfly vertebrae), the central nervous system (diastematomyelia, diplomyelia, and myelomeningocele), and the gastrointestinal tract (fistulas, dermal sinus tract, diverticula, and enteric cysts) (*7,8*). The syndrome manifests as a cleft in the dorsal midline of the body through which intestinal segments are exteriorized, myelomeningocele, and occasionally as a teratoma. Hydrocephalus and diastematomyelia/diplomyelia are also associated with the syndrome (*9*). Congenital anomalies associated with SNS can be detected antenatally (*4*). The current case involved a newborn with an esophageal duplication cyst in the posterior mediastinum.

During the embryological development of the human embryo, the human embryo consists of ectoderm, mesoderm, and endoderm layers in the third week of gestation. The notochordal process appears as a tube in the mesodermal layer by day 20. The ventral wall of the notochordal process then begins to fuse with the endoderm and thus forms the notochordal plate. In a short amount of time, an open neuroenteric canal is formed between the yolk sac cavity and the amniotic cavity. The final remnants of this canal are located at the tip of the os coccygis. The notochordal process then forms the notochord. The paraxial mesoderm forms somitomeres and somites, and somites differentiate into

sclerotomes. These give rise to the vertebral bodies, vertebral arches, and part of the back of the skull. In the fourth week of the development, the neural plate transforms into the neural tube. Vertebral anomalies result because of inadequate closure of the neural tube (*10*). SNS is a failure of the notochord to split from the foregut, resulting in a fistula or cyst. Attachment of a cyst to the notochord prevents the fusion of vertebral bodies. This results in vertebral column anomalies such as scoliosis, hemivertebrae, and spina bifida. As the embryo grows, these cysts move caudally and the intrathoracic viscera descend, and vertebral anomalies are often found in the lower cervical spine. The current patient had anomalous fusion of the upper cervical vertebrae. The clinical findings of a duplication cyst depend on the origin, size, and nature of the cyst. The most common form is midgut duplication (*11,12*).

Bremer and Sanders have described 2 theories regarding the etiology of SNS. Bremer suggested that a dorsal intestinal fistula may result from the complete retention or only partial obliteration of the primitive neurenteric canal. A widely accepted view is that presented by Sanders, who suggested that a split or localized duplication of the notochord may cause this anomaly and that the primitive gut or endoderm herniates through the opening and adheres to the dorsal ectoderm (*2*).

Although most reported cases of SNS involve the cervical and thoracic region, signs of the syndrome can be found at any level of the spine. Schurink *et al*. described a 5-year-old boy with a mass between the shoulder blades, and they noted that the tumor affected the sixth and seventh thoracic vertebrae *(13*). Although the mass was successfully removed, the thoracic vertebrae had partially collapsed. The current case involved a neuroenteric cyst in the posterior mediastinum and multiple cervical and thoracic vertebral anomalies. A significant symptom in the current case is severe respiratory failure. Plain chest x-rays revealed vertebral and rib anomalies. During follow-up, the infant was unsuccessfully extubated several times, so lung tomography was performed, followed by MR imaging of the chest and abdomen.

A neuroenteric cyst does not present with any pathognomonic signs, so the infant's chest x-rays showed no specific features of a cyst. Magnetic resonance imaging of the chest and abdomen revealed a cyst in the mediastinum that communicated with the esophagus. After excision of the cyst, histologic examination of specimens revealed gastric mucosa, gastric submucosa, and pancreatic tissue. Pathology proved that the cyst was a neuroenteric cyst.

In conclusion, SNS is very rarely seen, so the management of SNS must be tailored to the different anomalies present in each case. In the present case, excision of a cyst resulted in improvement of respiratory symptoms. Early diagnosis and treatment of SNS improves the prognosis for patients.

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