Case Report / Olgu Sunumu

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Prenatally diagnosed fetal thoraco-lumbar spine duplication associated with lipomyelomeningocele: An extremely rare case of split cord malformation

Prenatal dönemde tanı koyulan lipomyelomeningosel ile ilişkili torakolomber omurga duplikasyonu: Nadir bir split kord malformasyon olgusu

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Abstract

Spine duplication is considered rare, a more serious form of split cord malformation. Ultrasonographic evaluation of the spine in the second trimester is central to the antenatal diagnosis of spinal malformations. Here, we report a case of thoraco-lumbar spine duplication associated with lipomyelomeningocele diagnosed by ultrasonography at 19 weeks of gestation. To the best of our knowledge, this is the first case report of spine duplication diagnosed by antenatal ultrasonography.

Keywords: Congenital spine defect, spinal dysraphism, spine duplication, split cord malformations, split notochord syndrome

Öz

Vertebra duplikasyonu, bölünmüş kord malformasyonlarının nadir ve daha ciddi bir şekli olarak kabul edilir. Vertebranın ikinci trimesterde ultrasonografik değerlendirilmesi spinal malformasyonların antenatal tanısında önemli rol oynar. Bu olgu sunumunda, 19. gebelik haftasında ultrasonografi ile tanı koyulan lipomyelomeningosel ile ilişkili torakolomber vertebra duplikasyonu olgusunu sunuyoruz. Bildiğimiz kadarıyla bu olgu, antenatal ultrasonografi ile tanı koyulan ilk vertebra duplikasyonu olgusudur.

Anahtar Kelimeler: Konjenital spinal defect, spinal disrafizm, spinal duplikasyon, split kord malformasyonu, split notokord sendromu

Introduction

Split cord malformations are defined as the formation of two hemicords along with segmental duplication of the spinal cord because of sagittal separation by a bony, fibrous, or cartilaginous spur[1,2]. Each hemicord formed because of this split contains a central canal and a series of ventral and dorsal nerve roots. Spine duplication is considered a more serious form of split cord malformations. In the spine duplication, unlike other split cord malformations, each cord has its own spinal canal in its own set of lumbar vertebrae. Other terms refer to the spine duplication such as "split notochord syndrome", "spinal duplication syndrome" and "fetal vertebral cleft". Spine duplication may be a component of caudal duplication syndrome. However, in caudal duplication syndrome, vertebral anomalies are accompanied by gastrointestinal and genitourinary system anomalies[3-6].

Spine duplication is a very rare malformation and only a few cases diagnosed in childhood or adult patients have been reported. With the widespread use of ultrasonography, spinal malformations can be diagnosed more frequently in the antenatal period. Most spinal malformations diagnosed on prenatal ultrasonography are neural tube defects. However, rarer malformations such as hemivertebrae, diastematomyelia and

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tethered cord, can be diagnosed by prenatal ultrasonography. Here, we present a case of thoraco-lumbar duplication of the spine with lipomyelomeningocele diagnosed in the prenatal period. This case, which included prenatal ultrasonographic findings, fetal radiographic images and fetal autopsy findings, is an extremely rare spinal malformation case. To the best of our knowledge, this is the first case of spine duplication with lipomyelomeningocele diagnosed by prenatal ultrasonography in the literature.

Case Report

A 32-year-old pregnant woman was referred to our tertiary center at the 19th week of gestation with a preliminary diagnosis of lumbar meningomyelocele. The pregnant woman had one healthy child and no known disease in her history. There was no known genetic disease in the first- or second-degree relatives of the pregnant woman and her husband. The marriage between the parents was not consanguineous. She did not have first trimester ultrasonographic fetal anatomical screening and serum screening tests. In fetal ultrasonography, lateral ventricles were measured as 6.1 mm and 5.2 mm and had a normal appearance. When the posterior fossa was evaluated, the cerebellum had a normal shape and the cisterna magna was measured as 3.9 mm. In the fetal dorsal coronal section, a 29x26 mm mass containing cystic and solid components was observed in the thoracolumbar vertebral region and there was no flow in this mass on color Doppler examination. In the evaluation of the spine, duplication and separation of the thoracolumbar spine and rotoscoliosis were observed (Figure 1). In the axial and sagittal sections, it was observed that the cervical and upper thoracic parts of the spine had normal shape, but separated from the eighth thoracic spine and the lower thoracic and lumbar spines were duplicated (Figure 2). Spinal duplication with lipomyelomeningocele was considered in the prenatal ultrasonographic diagnosis. In ultrasonographic examination of other systems, fetal biometric measurements were consistent with gestational age and there was no accompanying fetal malformation. Fetal magnetic resonance imaging (MRI) was not performed due to early gestational age.

Parents were informed about the fetal, neonatal and childhood prognosis of spine duplication with lipomyelomeningocele and the option of termination of pregnancy and prenatal genetic diagnostic tests were offered to the parents. The pregnancy was terminated after obtaining the informed consent of the parents. A female fetus, weighing 320 g, was delivered with vaginal misoprostol treatment. Postnatal fetal examination revealed a protruding cystic mass on the thoracolumbar vertebra of the fetus and duplication and separation of the thoracolumbar spine and rotoscoliosis was observed on fetal radiography (Figure 3). External genitourinary system examination of the fetus was normal. In fetal autopsy, when the spine was evaluated after abdominal dissection, two separate spinal process lines were palpated under the thoracolumbar junction. No malformations were detected in the thoracic, abdominal and pelvic organs in the fetal autopsy. No duplication was detected in the gastrointestinal tract or genitourinary system. During retroperitoneal dissection of the fetus, spine duplication was confirmed and lipomyelomeningocele was observed between the duplicated vertebrae. The cystic mass located in the midline between the doubled vertebrae and surrounded by adipose tissue was evaluated as lipomyelomeningoceles because it originated from the spinal cord and contained neural tissue. The karyotype and microarray results of the genetic diagnostic tests were reported as normal.

Discussion

Spine duplication is considered a more serious form of split cord malformations. Split cord malformation is the general term used to describe malformations involving two spinal cords, including traditionally used definitions such as diplomyelia and diastematomyelia. In 1992, Pang et al. [1,2] described the embryogenesis of the currently accepted split cord malformations and proposed a classification. This "unified theory of embryogenesis" suggested that all split cord malformations resulted from a fundamental ontogenetic error that occurred at the time of closure of the primordial neuroenteric duct. According to this theory, an "accessory neuroenteric canal" is formed through the midline embryonic disc, which provides contact between the ectoderm and the endoderm. The accessory neuroenteric canal, which is covered with mesenchyme to form the endomesenchymal pathway, causes regional separation of the notochord and the overlying neural plate. The final state of the resulting split neural tube and the constituent components of the endomesenchymal pathway ultimately determine the configuration and orientation of the hemicords, the median septum, and the coexistence of various vascular, lipomatous, neural, and fibrous anomalies. According to the classification proposed by Pang et al.[1,2] split cord malformations are classified as type 1 if the hemicords are in separate dural sacs separated by a rigid osseo-cartilaginous spur, and type 2 if they are in a single dural sac separated by a fibrous midline septum. However, this classification excludes the spine duplication, in which the bone elements are completely and separately copied. Some authors consider spine duplication a type 1 split cord malformation, while others suggest that it is unclassified[7].

Spine duplication is an extremely rare malformation and has been published as a limited number of case reports in the literature. Moreover, all of these cases were diagnosed during the postnatal period. To the best of our knowledge, the case we report is the first case diagnosed in the prenatal period, and it demonstrates that the spine duplication can be diagnosed by prenatal ultrasonography. Some of the reported cases were neurologically asymptomatic patients diagnosed between the ages of 1 and 44 years[7-11]. Among the reported cases, the one that was most similar to our case is a neurologically

asymptomatic female who did not require surgical treatment and was followed up for 6 years[8]. Here, the patient had a mass protruding from her back, and the authors did not report any symptoms other than cosmetic problems. However, in this study, unlike this case, there was a large lipomyelomeningocele sac that may cause possible neurological symptoms in the early stages of life and may require surgical treatment. In another reported case of spine duplication accompanied by lipomyelomengocele, the patient was diagnosed at the age of 14 and was neurologically asymptomatic[7]. In that case report, due to concerns about the clinical consequences of the tethered cord, the authors planned fusion for scoliosis and a surgical operation to release the tethered cord and instrumentation; but the operation was refused by the patient. Since it has been observed that the risk of neurological deficits increases with age in patients with split cord malformations, the necessity of

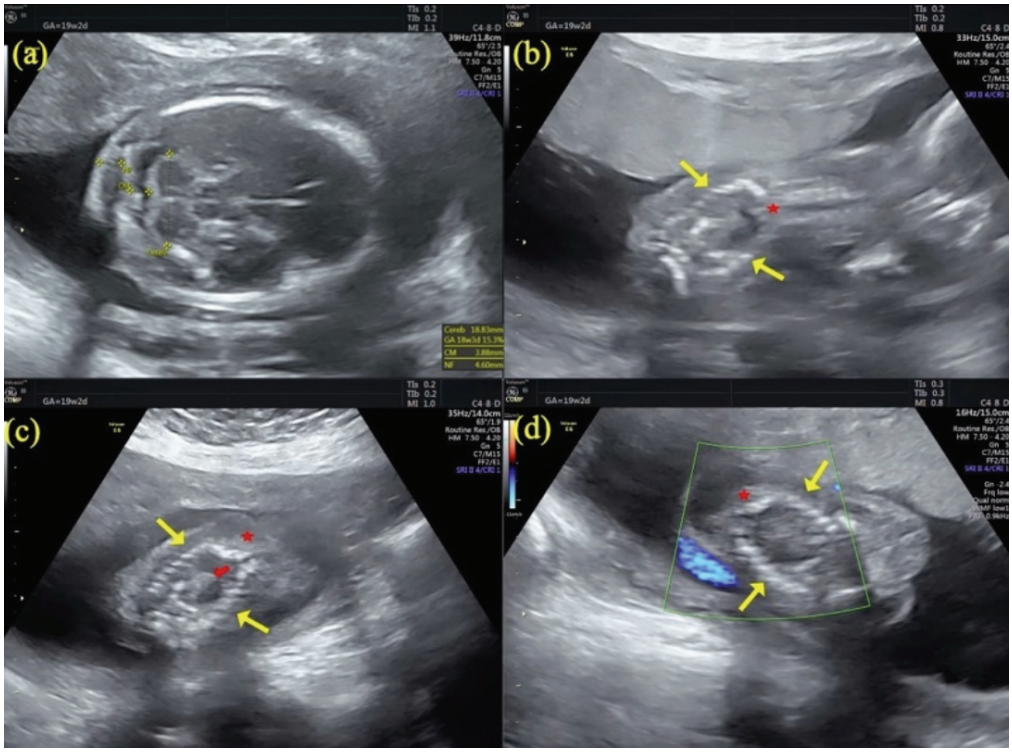

Figure 1. Ultrasonographic images of fetal spine duplication with lipomyelomeningocele. In the axial transcerebellar section, the cerebellum is in normal shape and the posterior fossa is open (a). Ultrasonographic images of the duplication and separation of the thoracolumbar spine distal to the T8 vertebra (Red star) in the evaluation of the spine in the dorsal coronal section (Yellow arrows mark right and left vertebrae) (b, c). The hyperechoic appearance (Red arrow) between the duplicated vertebrae was diagnosed as the lipomatous part of the lipomyelomeningocele at fetal autopsy (c). In color Doppler examination, no flow is observed in the mass between the vertebrae (d)

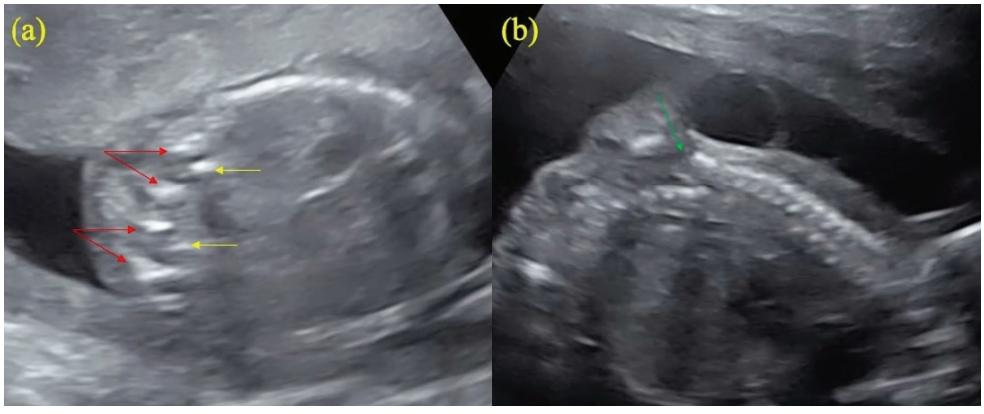

Figure 2. Ultrasonographic images of fetal spine duplication with lipomyelomeningocele in axial and sagittal section. Ultrasonographic image of spine duplication in axial section distal to T8 vertebra (Yellow arrows mark the vertebral bodies and red arrows mark the vertebral laminae) (a). Ultrasonographic image of spine duplication with lipomyelomeningocele in sagittal section (Green arrow marks the meningomyelocele sac at the level of the T8 spinal bifurcation) (b)

prophylactic surgical treatment has been suggested even if the patients are asymptomatic[12,13]. However, it is still controversial whether neurologically asymptomatic cases require surgery. In a case report of a 44-year-old neurologically intact patient with spine duplication, the authors suggested that asymptomatic patients without associated abnormalities should be followed up before planning surgical intervention[9]. Furthermore, none of the previously reported cases of asymptomatic isolated spine duplication were treated surgically and none had neurological symptoms.

Spine duplication may be a component of the caudal duplication syndrome, which includes gastrointestinal, genitourinary, and distal neural tube malformations[3-7]. In this syndrome, unlike split cord malformations, duplication is not limited to the distal spine and clinical manifestations are present in all three germ layers, including the hindgut structures. In this study, there was an isolated spine duplication with lipomyelomeningocele, and caudal duplication syndrome was not diagnosed since fetal autopsy did not detect any malformations in other abdominal organs. In caudal duplication syndrome, gastrointestinal anomalies usually include duplicated colons, genitourinary anomalies include duplication of external genitalia, urethra and bladder, and duplication of cervix or vagina in female patients[14]. Therefore, patients with caudal duplication syndrome may have worse outcomes compared to split cord malformations due to the presence of concomitant anomalies.

Split notochord syndrome is caused by the persistent communication of the embryonic endoderm and ectoderm layers and is accompanied by vertebral anomalies[15]. Almog et al.[16] were the first to publish prenatal ultrasonographic findings of two fetuses with split notochord syndrome. In a literature review of fetuses with split notochord syndrome diagnosed prenatally, most of the fetuses had a thoracic cystic mass[15]. In this study, there was no thoracic or abdominal cystic mass or anomaly in the visceral organs, and these ultrasonographic findings differentiated it from split notochord syndrome.

In this study, the diagnosis was made by 2D ultrasonography. With 3D ultrasonography, more demonstrative images could be obtained and thus, the vertebrae could be evaluated more clearly. Multi-planner evaluation of the vertebrae in 3D ultrasonography may be useful in determining the level and characteristic features of the malformation. Therefore, we recommend the use of multi-planner 3D ultrasonography for evaluating spinal malformations. Additionally, fetal MRI in

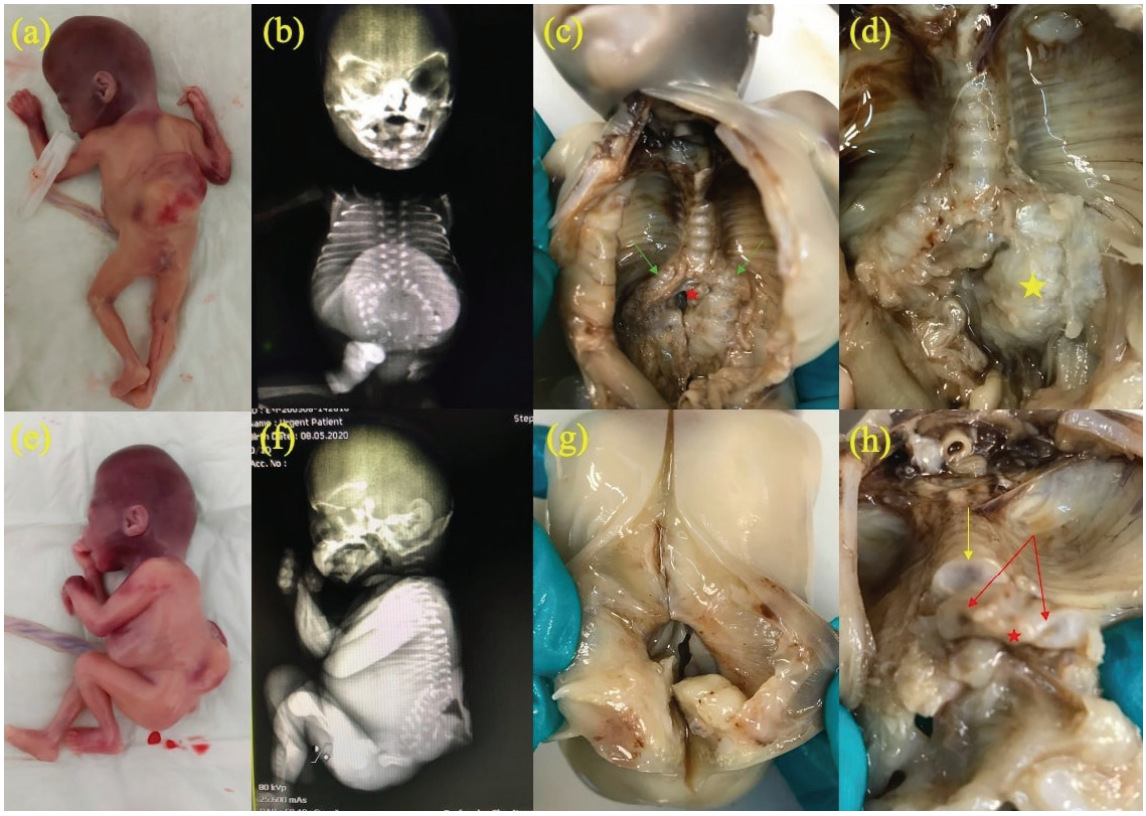

Figure 3. Fetal autopsy images and radiographic images of fetus with spine duplication and lipomyelomeningocele

Images of a cystic mass protruding from the thoracolumbar region on the fetal back (a,e). Antero-posterior and lateral radiographic images of spine duplication with lipomyelomeningocele (b,f). Fetal autopsy images of spine duplication with lipomyelomeningocele (c,d,g and h). Green arrows (c) and red arrows (h) marks right and left vertebrae. Red star marks the lipomyelomeningocele sac originating from the vertebral bifurcation (c,h). Yellow star marks the lipomatous tissue between the right and left vertebrae (d). Posterior dissection of the lipomyelomeningocele sac (g)

the late second trimester or third trimester may contribute to the diagnosis of vertebral anomalies. Moreover, performing fetal MRI may contribute to the detection of genitourinary and gastrointestinal system anomalies that cannot be detected by ultrasonography. We recommend performing fetal MRI in the late second trimester or the third trimester in complex vertebral anomalies.

Split cord malformations are not associated with chromosomal abnormalities[17]. In this study, the karyotype and microarray results were reported as normal. However, an associated gene could be detected if advanced genetic diagnostic tests, such as whole-exome sequencing were performed. The *AXIN1* gene located in the 16p13.3 chromosome region has been associated with caudal duplication syndrome[18]. Therefore, we recommend performing advanced genetic testing in fetuses with complex vertebral anomalies if no genetic abnormality is detected in karyotype and microarray analysis. Thus, genetic counseling can be provided to the parents for a subsequent pregnancy.

In conclusion, our case report is the first case to reveal that the spine duplication can be diagnosed by prenatal ultrasonography. Spine duplication is a rare malformation and has clinical consequences ranging from asymptomatic to severe neurological dysfunction. Therefore, we suggest a multidisciplinary approach that includes neonatology specialists, pediatric neurosurgeons, geneticists and radiology specialists in the prenatal and postnatal management of these cases. Although it is not associated with a known chromosomal anomaly, microarray and, if necessary, whole-exome sequencing can be recommended in cases diagnosed in the prenatal period.

Ethics

Informed Consent: Informed consent of the parents was obtained.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: M.A., O.D., E.K., Concept: M.A., O.D., Design: M.A., G.E.D., Data Collection or Processing: E.K., Analysis or Interpretation: E.K., G.E.D., Literature Search: M.A., G.E.D., Writing: M.A., O.D.

Conflict of Interest: No conflict of interest was declared by the authors.

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