Case Report

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Open Neural Tube Defects: A Case Presentation of 30-year-old Secundigravida with Spina Bifida of the Fetus

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Abstract

Spina bifida is a neural tube defect that occurs in about 1 in 1,500 pregnancies. Open spinal defects are associated with paralysis, incontinence and hydrocephalus requiring postnatal shunting of the cerebrospinal fluid. Neural tube defects are preventable through preconceptional folic acid supplementation. Occasionally, the diagnosis is made during routine anomaly scan at 18-20 weeks of gestation, as the earliest signs of the anomaly can be seen at the end of first trimester. The information provided by ultrasound plays a crucial role in patient counseling and pregnancy management. The authors report a case of prenatal diagnosis of spina bifida aperta with focus on detailed ultrasound presentation and difficulties in consulting in relation to the prognosis for the newborns.

Keywords: Spina bifida, neural tube defect, alfa-feto protein, ventriculomegaly

Introduction

Spina bifida is the most frequent non lethal birth defect of the central nervous system with an incidence of 0.5 to 2 per 10 000 established pregnancies, including live births, pregnancy losses, and abortions [1]. This anomaly originates during embryogenesis and results from failure of the neural tube to close between the 18th and 28th embryonic day [2]. Spina bifida is commonly subdivided into two main types – spina bifida aperta (open spinal defect), and spina bifida occulta (covered with skin).

An occurrence frequency of the disease is 1 case per 1,000 births [3,4] and each year nearly 300,000 infants with Neural Tube Defects (NTDs) are born, further resulting in death or lifelong disabilities [1,5]. Therefore,

socioeconomic cost associated with NTD patients is very high due to the increased morbidity and premature mortality [4,6,7]. Around 17% of cases are presented with spina bifida occulta with better prognosis for the developing fetus, due to lack of central nervous system involvement [8,9].

The risk of NTDs is greatly reduced by folic acid supplementation starting from at least one month before conception and continuing throughout the first trimester of pregnancy [10,11], which reduces the possibility for NTD by 60–70% [12,13]. Only 5% of cases occur in families with a positive family history, while 95% occurs spontaneously. The risk for recurrence in subsequent pregnancies is 3–8% increased [14]. In about 10% an open defect is associated with chromosomal abnormalities

(mainly trisomy 18), single mutant genes, maternal diabetes mellitus, hyperthermia in early pregnancy [10], antiepileptic drugs intake (valproic acid, carbamazepine) [15], arsenic, pesticides, mycotoxins, influenza virus, [16] iodine, iron, and vitamin B12 deficiency [17,18].

Although fetal surgery by prenatal repair of the defect is a common treatment approach [19], the malformation may lead to severe progressive complications after birth, like hydrocephalus, cognitive impairments, and sensory-motor deficits [3,20]. Timely prenatal diagnosis is crucial for the fetus and the family, as the prognosis and associated problems for the infant depend on the type of the defect.

Case Presentation

It is a case of a 30-year-old secundigravida in 19 weeks,

aimed at specialized obstetrics and gynecology hospital - Varna with suspicion for a neural tube defect. With a history of previous normal pregnancy finished with a live-birth 6 years ago, without concomitant diseases and congenital anomalies in the family. After a thorough ultrasound examination, meningocele below the level of 12th thoracic vertebrae and kyphoscoliosis in association with Arnold-Chiari complex were found (Figure 1-4). The given finding is expected to have an extremely unfavorable prognosis with lower limb paralysis and incontinence, as well as a high risk of developing hydrocephalus with the need for shunting. After detailed explanations and discussion by a medical commission, a decision was made to terminate the pregnancy on medical grounds and the diagnosis was confirmed (Figure 5).

Figure 1: Transabdominal 2D ultrasound. Meningocele in the lumbosacral region.

Figure 3: Transabdominal 2D ultrasound. Posterior cranial fossa defect - "Banana sign".

Figure 2: Transabdominal 2D ultrasound. Kyphoscoliosis in lumbosacral region of the spine.

Figure 4: Transabdominal 2D ultrasound. Concavity of the frontal bones - "Lemon sign".

Figure 5: Macroscopic examination of the abortive material, confirming the diagnosis - Spina bifida occulta of the lumbar region.

Discussion

Neural tube defects are multifactorial, as many genetic and environmental factors such as folic acid supplementation, obesity, diabetes or viral infection are involved [10,15,17,18]. The incidence of the disease is on average 1-3 per 10,000 live births [9]. This malformation occurs at all levels of the spine, but most commonly affects the sacroiliac region [9,21]. Depending on the content of the nerve elements that prolapse through the unhealed vertebral arches there are 3 forms of the disease [22]:

1. Meningocele - is a herniation of the hard and soft meninges of the spinal cord, without involvement of nerve elements;
2. Myelomeningocele - in addition to the spinal cord, nerve elements (roots and spinal cord) also prolapse. It is the most common form of the disease.
3. Lipomeningocele - in addition to nerve elements and sheaths of the spinal cord, in herniated sac a tumor of adipose tissue with large size and wide base is found.

Ultrasound examination is the gold standard for prenatal diagnosis of congenital malformations. It has been reported that detection rate of open spina bifida in first trimester can reach up to 80-90% with combined screening (ultrasound and biochemical) [23]. Myelomeningocele can be detected on fetal ultrasonography before 12th postmenstrual week by irregularities of the spine or a bulging of the posterior contour of the fetal back [15]. According to different

authors there is a soft marker in first trimester with suspicion for NTD. This marker is the fourth ventricle, considered as Intracranial Translucency (IT) between 11 and 13 + 6 weeks of gestation. Lack of IT has been identified as a marker for spina bifida [16,24,25].

The level of alpha-feto protein (AFP) in amniotic fluid can be helpful to distinguish between open and closed spina bifida. Maternal serum alpha fetoprotein test is routinely performed between 15 and 20-22 gestational weeks and utilizes a threshold of 2.5 multiples of the median value, with a sensitivity of 85% for detection of neural tube defects [14,26]. Elevated AFP concentrations are almost found in open defects, while in closed ones it is always within normal ranges. The level of acetylcholinesterase in amniotic fluid has been found to be more specific than AFP and may also be useful in distinguishing between open and closed defects.

Although the spinal defect can be detected early during pregnancy, the diagnosis of open spina bifida is routinely performed in the middle of the second trimester. Prenatal diagnosis of meningomyelocele by ultrasound was significantly improved in the mid-1980s by describing several characteristic intracranial findings that were easier to establish than direct visualization of the spinal defect, as the prenatal detection rate is 86-96% [27].

A thorough examination of the neural tube from the cervical to the sacral region must be performed both

transversely and longitudinally. In cross-section, the normal spine is a closed circle covered with intact skin. In cases with spina bifida aperta, the damaged vertebral arch gives it a U-shape, allowing protrusion of the spinal cord (meningocele or myelomeningocele) [8,17]. The prevalence of the defect and associated kyphoscoliosis are examined sagittally. As open defects occur early during pregnancy, there is a prolonged period during which secondary neurological damage develops. There is a leakage of cerebrospinal fluid into the amniotic cavity which leads to displacement of the cerebellar vermis, fourth ventricle and medulla oblongata through foramen magnum (Arnold-Chiari or Chiari II malformation), which lead to pathognomonic intracranial changes, detected by ultrasound [28]. Sonographically, these changes of cranial anatomy led to small head measurements, abnormal shape of the cerebellum with ventriculomegaly at variable degree. In 70-90% of cases abnormalities of corpus callosum such as hypoplasia or aplasia of the rostrum are presented. In closed spina bifida, the neural tube defect is covered with skin, there is no loss of cerebrospinal fluid, and cranial anatomy is normal [1,13,29].

The most important role of antenatal sonographic diagnosis of the type of spina bifida is the different prognosis for the fetus in postnatal development, as open defects lead to paralysis, incontinence and hydrocephaly requiring shunting [19,27].

Intracranial anatomy in spina bifida aperta

The most specific and sensitive finding for the diagnosis of spina bifida are changes in the posterior cranial fossa. In axial section sonographic finding is called “banana sign” representing the herniated cerebellum in foramen magnum. The defect is due to a reduction in the size of cisterna magna and the small size of the cerebellum, which is defined as a transcerebellar diameter less than the 10th percentile for the gestational age [9,25,30].

Visualization of a normally located cerebellum and cistern magna has a very high negative prognostic value to rule out an open defect.

Ventriculomegaly is observed in 70-90% of fetuses with spina bifida aperta and is diagnosed as size of the lateral cerebral ventricles above 10 mm in diameter in axial section at the level of the thalamus. The ventricles may be asymmetrically dilated, or one may be dilated and the other with normal size.

“Lemon sign” presented in most cases, describes the shape of the skull in transverse plane of scanning, characterized by concavity of the frontal bones near the coronary sutures. The finding was described in the affected fetuses as early as 13 weeks and in 50-90% of cases before 24 weeks of gestation, but only in 13% after this period [30,31]. It is important to note that the lemon sign is not pathognomonic for meningomyelocele, as up to 1% of normal fetuses show a slight concavity of the frontal bones. In addition, it is possible to “create” a lemon sign if the skull is not depicted in the correct axial plane [18,21,32].

In our case, meningomyelocele with kyphoscoliosis of lumbar region were presented with abnormal intracranial anatomy, suspicious for spina bifida. In open spina bifida, neurological involvement is a consequence of two different mechanisms: on one hand, abnormal differentiation, and development of the spinal cord, which leads to varying degrees of motor paralysis of lower extremities and incontinence and on the other hand, hydrocephalus due to malformation of Chiari II, with no intellectual disorders in some cases [33,34]. In closed spina bifida, there is usually less spinal cord involvement and Chiari II malformation does not develop, with a generally good prognosis, although mild neurological symptoms are often present [35].

There are additional anomalies associated with myelomeningoceles. While only 10% of neonates have clinically apparent hydrocephalus at birth within the first week of life this incidence sharply increases and hydrocephalus manifests in up to 85% of cases. At least 80% of neonates born with myelomeningocele required placement of a ventriculoperitoneal shunt to prevent neurological and intellectual impairment secondary to hydrocephalus [36]. Another paper noted a similar value of 85% of infants born with myelomeningoceles requiring placement of ventriculoperitoneal shunts, 45% of which required shunt revision within their first year secondary to complications such as occlusion and primary or secondary infection [37].

When the diagnosis of spina bifida aperta is made, the practitioner and the family have three main options: proceeding pregnancy with postnatal surgical repair, terminate the pregnancy or prenatal open/fetoscopic surgery [37]. Since 1994, prenatal surgical correction of myelomeningocele around 24 weeks of pregnancy has been used in the United States. In comparison with postnatal surgery, it is believed that prenatal

correction will preserve motor activity to a greater extent, although with this procedure it is impossible to restore the neurological functions. Although these good results, a complication risk as high as 30% was reported which included premature birth, placental abruption, premature fetal death and uterine rupture with intra-abdominal bleeding and the subsequent risk to maternal life [37]. Percutaneous fetoscopic repair is likely to have less severe maternal complications, although the rate of dehiscence and leakage from the myelomeningocele repair site can be higher, and long term outcome has yet to be reported [26,37]. Today many prospective mothers in the United States of America choose termination of pregnancy rather than suffer the potential risks involved [15], as the same situation is seen in Bulgaria, in addition that fetal surgical repair in our country is still a future perspective.

Mothers who choose to continue the pregnancy must prepare for a child with significant care needs and high medical expenses. Despite aggressive intervention, nearly 14% of all spina bifida neonates do not survive past 5 years of age, with the mortality rising to 35% in those with symptoms of brainstem dysfunction secondary to the Arnold-Chiari malformation [27]. While 70% of patients have an I.Q. above 80, only half are able to live independently as adults, even with adapted accommodations [37].

In our case the pregnancy was terminated on medical grounds. No genetic abnormalities were found after genetic examination of the abortive material. No obesity, diabetes or teratogenic drug intake was established.

Neural tube defects occur by day 35 of embryonic development. For this reason, in some cases, folic acid intake is not a sufficient measure when pregnancy is diagnosed. The addition of folic acid to the diet (400mcg daily) for 3 months preconception and during first trimester reduces the risk of spina bifida by about 75% [11,38].

As a final consideration choosing to terminate a pregnancy by mothers of fetus's diagnosed with myelomeningocele remains a very real option in many parts of the world. This issue has inherent ethical considerations and regional religious considerations are paramount. In Western Europe for example termination of pregnancy for mothers of a fetus antenatally diagnosed with the condition has, for the last two decades, been offered at any gestational age. In the United States of

America the option currently largely exists as long as it is done before the 3rd trimester. In South Africa the option to terminate a pregnancy for a fetus diagnosed with a myelomeningocele is currently legal irrespective of the gestational age [28].

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Conflict of interest

None

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