

Overview of spina bifida and the nervous system

Chapter 1: The spinal cord and brain in myelodysplasias

This chapter defines various neurological abnormalities and terms specific to the management of spina bifida and related disorders.

Key issues for clinicians

- While spina bifida is a congenital condition, complications may occur in young people or adults.
- Neural tube defects can affect the entire length of the central nervous system. This includes the brain as well as the spinal cord.
- Hydrocephalus affects most people with spina bifida.
- All those with spina bifida and their relatives require genetic counselling prior to conception.
- High dose folate supplementation is given to all high risk cases.

Spina bifida is a complex birth defect that has been recognised for thousands of years. Until the middle of the last century, most babies born with spina bifida did not survive more than a year, but due to medical advances — especially in neurosurgery and urology — most infants will survive into adulthood.

Definitions

Spina bifida is the collective term used to describe a group of multiple, complex congenital abnormalities and anomalies of the neural tube known as myelodysplasias.^{1,2} As spina bifida affects the entire length of the neural tube, additional central nervous system abnormalities are very common, especially hydrocephalus and Arnold–Chiari malformations.

While spina bifida is a congenital condition, complications may occur in later life. The underlying pathology provides an understanding for the ongoing clinical management of those affected.



The commonest types of myelodysplasias are:

- spina bifida occulta
- meningocele
- myelomeningocele
- lipomatous malformations of the spinal cord and central nervous system
- other related conditions: sacral agenesis, Vater syndrome.

Spina bifida occurs when the spinal column does not form correctly at some point along its length. In reality, spina bifida refers to a complex of conditions. Of the 260 000 children born in Australia each year, 400 are affected by this condition.³

Spina bifida occulta refers to incomplete development of the vertebrae, but the spinal cord is intact with no obvious skin defects. Spina bifida occulta occurs in 5% of live births. The overlying skin may be normal, but may also be

associated with a dimple, hair patch or red discolouration — the so called herald or signature mark (*Figure 1*).⁴ Signature marks may be associated with significant spinal abnormalities. Abnormalities in function can emerge at any time later in life.

A meningocele is a cystic lesion filled with cerebrospinal fluid (CSF) where the meninges protrude into an external sac, usually located in the lumbosacral region, due to failed closure of the vertebral arches. The amount of skin covering the lesion varies. However, there is no nerve involvement. The lesion can be associated with hydrocephalus and central nervous system abnormalities.

A myelomeningocele is one of the most important and severe types of spina bifida that occurs in about one in 1000 live births (*Figure 2*). It occurs when part of the spinal column is undeveloped, with incomplete formation of the overlying vertebrae and no overlying skin. Most frequently located in the lumbosacral region, myelomeningoceles are generally cystic and contain CSF that drains when the thin sac is disrupted. Both the meninges and spinal cord protrude into the sac, and the spinal cord is often abnormal. The level and severity of the lesion affects malformations and patterns of functional loss. Myelomeningoceles are often associated with Arnold–Chiari type II malformations. Approximately 80% of children with this lesion develop hydrocephalus.

Other lesions

Diastematomyelia describes how the spinal cord is split into two hemicords with each having a set of dorsal and ventral nerve roots, each contained in a dural sheath. This belongs to the group of lesions called split cord malformations. Vertebral body abnormalities are often present, leading to scoliosis.

Syringohydromyelia occurs when a syrinx (a cystic cavity) forms within the spinal cord and may be found in the medulla or located anywhere from the cervical to the lumbar areas. Syringohydromyelia is associated with neural tube defects. The cystic cavity may or may not communicate with CSF flow pathways. The syrinx may progressively enlarge until pressure on the nervous tissue leads to serious, variable complications.

Lipomatous malformations, commonly called lipomeningocele, occur when excessive lipomatous tissue is within or attached to the spinal cord or filum terminale. This group of malformations are by far the most common form of closed spinal neural tube defects and vary from an enlarged filum terminale containing adipose tissue to a huge fatty mass occupying much of the dorsal lumbosacral region

which contains the spinal cord and CSF. This group of lesions includes the lipomeningocele, lipomyelocele, leptomyelolipoma, lumbosacral lipoma and lipoma of the filum terminale. They represent a continuum of embryologic maldevelopments with similar clinical findings and prognosis to the open neural tube defects.

Spina bifida and the brain

As neural tube abnormalities affect the entire length of the spine and central nervous system, most individuals with myelodysplasia will have associated brain abnormalities. This often results in hydrocephalus.

The Arnold–Chiari malformation (type II) is the commonest brain abnormality in spina bifida (*Figure 3*). Affecting almost all people with spina bifida, this is an anatomical defect of the lower brain and cerebellar structures. This causes herniation of the cerebellar tonsils through the foramen magnum and also causes the medulla to kink and move downwards into the



Figure 1. Herald mark. Hairy patch over repaired lumbosacral spina defect.

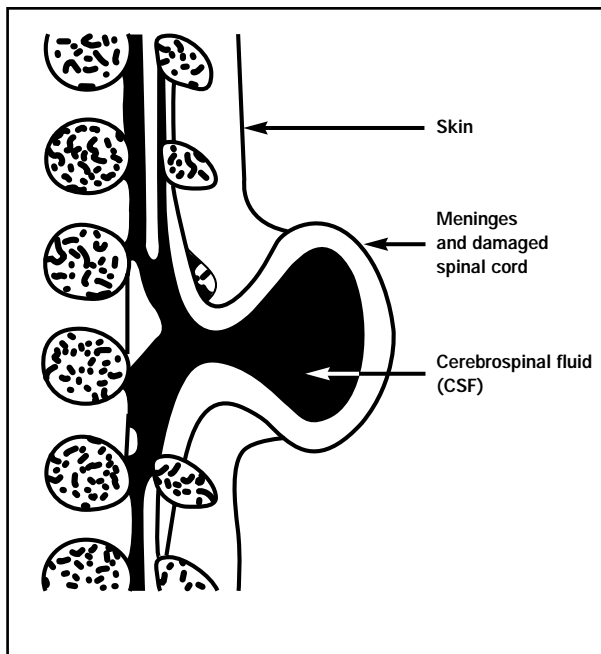


Figure 2. Myelomeningocele. Myelomeningoceles are the commonest cause of serious spina bifida related disability. The extent of the disability largely depends on the level of the lesion.

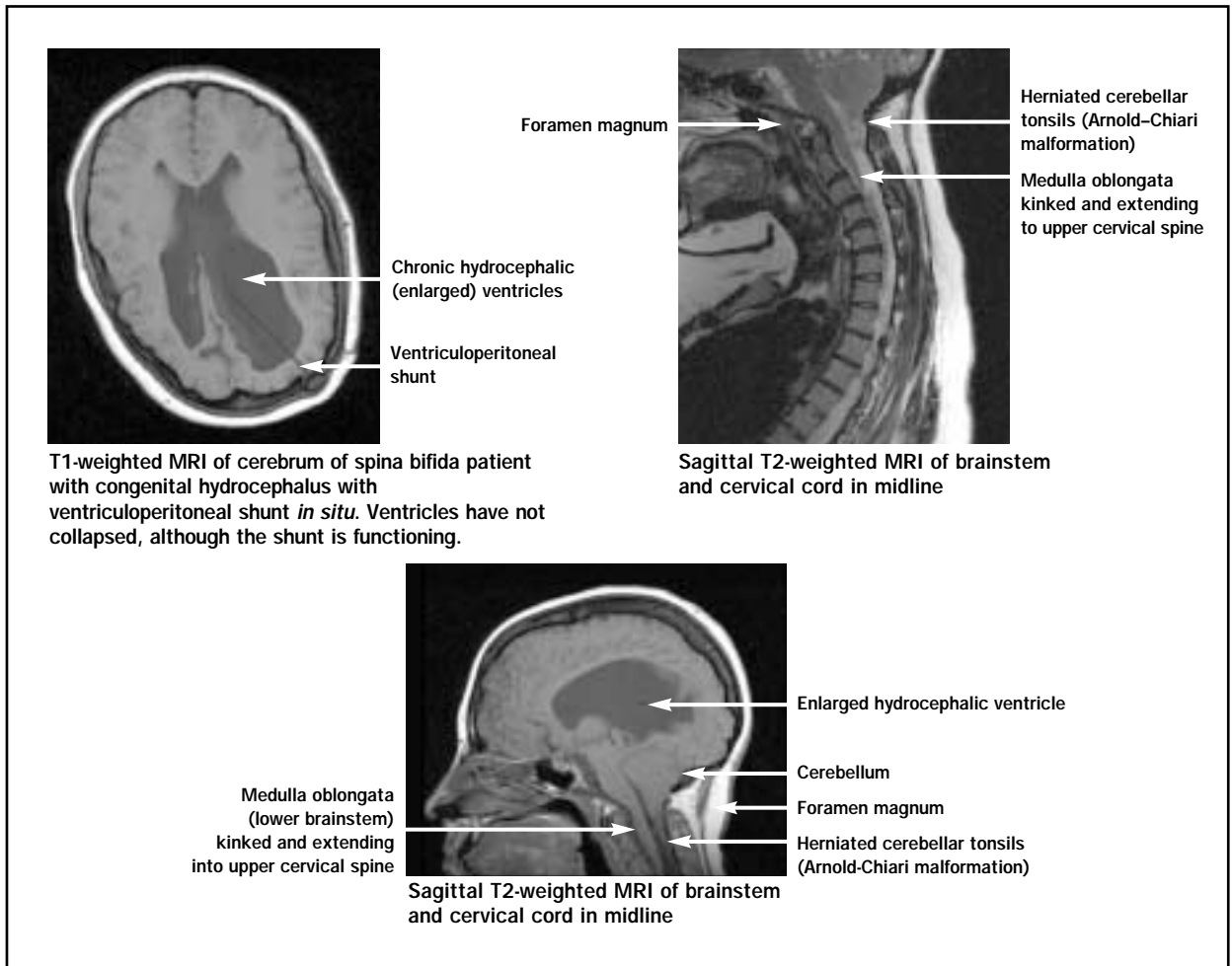


Figure 3. Hydrocephalus and Arnold-Chiari malformation. (Courtesy of Department of Diagnostic Imaging, Monash Medical Centre, Victoria.)

cervical spinal canal, also displacing cranial nerves. Around a quarter of patients with Arnold-Chiari malformations develop brainstem dysfunction, with symptoms often appearing in the first months of life.

Other central nervous system malformations can occur, including encephaloceles, syrinxes above the level of the lesion, callosal agenesis and other brain stem abnormalities.

Symptomatic decompensation secondary to anatomical abnormalities can also occur in adults.

Hydrocephalus

Hydrocephalus is found in most infants during prenatal ultrasonography. Most individuals with spina bifida and hydrocephalus require a ventriculoperitoneal shunt to relieve intracranial pressure.

If symptomatic hydrocephalus is present at birth, back surgery and shunt insertion may be performed at the same time.

Clinicians need to be aware of the signs and symptoms of hydrocephalus and the related signs and symptoms of ventriculoperitoneal shunt dysfunction (see *Chapter 2* for further information).



Skin abnormalities may herald serious signs

Skin abnormalities can be associated with neural tube defects. As the skin and nervous system share a common ectodermal origin, this may explain the simultaneous presence of malformation of the skin and nervous system (*Figure 1*).

Skin lesions can be indicators of occult spina bifida, and are important as they may connect to the spine and be a source of infection.

The presence of a 'herald mark' is an important sign in young people with lower lumbar pain or sphincter dysfunction.

Commonly associated lesions include: dimples, tufts and patches of hair, pigmented areas, achordons (pseudotails), lipomas, haemangiomas, dermoid cysts or sinuses.³

Development of myelodysplasias — mechanisms and risk factors

Myelodysplasias are also called neural tube defects, which refer to their origin as developmental abnormalities of the central nervous system. These developmental abnormalities can occur at any site along the length of the brain and spinal cord (*Figure 4*).

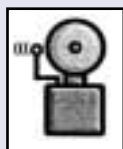
The critical development of the nervous system occurs in the first month after conception. If this process is disrupted, spina bifida may occur. When the brain does not develop, this results in anencephaly.

Spina bifida occurs early in pregnancy

As spina bifida occurs during the first month of pregnancy, most cases will develop before most women know they are pregnant.

Role of low folate

Low folate at the time of conception is one factor with an increased risk of myelodysplasias. Prevalence has decreased in areas where folate has been added to food supplies, such as bread.



Genetic factors

There is a strong familial tendency for myelodysplasias, although the exact mechanisms are unknown. A family with one child with spina bifida has a 4% chance of a second child being born with spina bifida and a 10% risk after two children with the condition. Siblings of a person with spina bifida and adults with spina bifida have a 2% chance of having a child affected with spina bifida. All relatives of people with spina bifida require genetic counselling. Genetic counselling is recommended:

- for mothers older than 35 years
- for all mothers with previously affected children
- when either prospective parent has myelodysplasia. This includes all potential fathers with spina bifida.
- when any family history of myelodysplasia is present.

Drug induced myelodysplasias

The antiepileptic drug valproic acid (Epilim, Valpro) causes spina bifida. Alcohol and some antipsychotic drugs have also been implicated as causes.

Valproic acid can cause spina bifida.

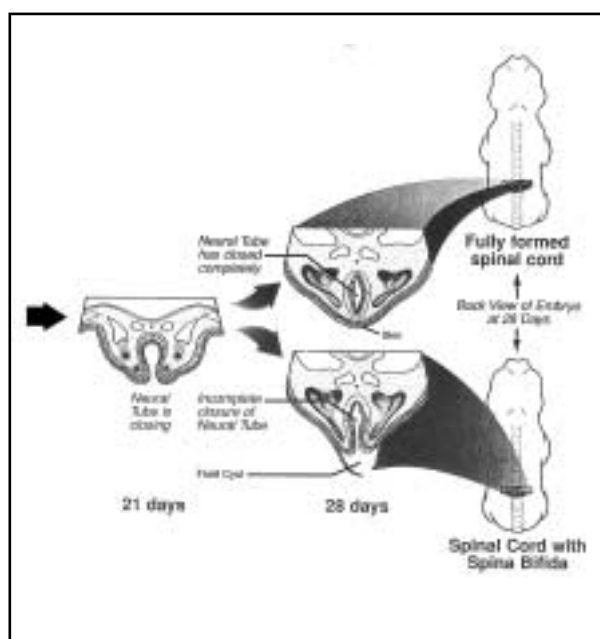


Figure 4. Development of spina bifida compared to normal development of the spinal vertebrae and central nervous system.

Prenatal detection and management of spina bifida

Currently about one in 1000 pregnancies are affected with myelodysplasia although the number of new myelodysplasias is decreasing due to the increased use of routine folate and early detection of myelodysplasia through ultrasound scanning and serum alphafoeto-protein testing during pregnancy. Current management practice consists of:

- preconception genetic counselling usually by a geneticist, neurologist and obstetrician on the risks and benefits to enable patients to make informed decisions
- preconception folate
- antenatal diagnosis.

Preconception genetic counselling⁴⁻⁷

Those at increased risk of having children with spina bifida are offered genetic counselling (see *Chapter 9 Organisations and further resources* and also *Table 1*). Some young people and adults may not be aware of these increased risks and clinicians should always assess whether their patients are familiar with the risks of pregnancy and refer accordingly.

Preconception folate

High dose preconception folate supplementation is the cornerstone of reducing the risk of spina bifida in families at risk.

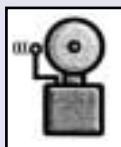
Table 1. Preconception genetic counselling issues for those at increased risk of children with spina bifida

- Discussion of risks of newly affected child
 - approximately 2% risk where one parent affected
 - approximately 4% risk where previous child is affected
- Attitudes of couples toward having a baby with neural tube defects including exploring their personal experience and understanding of these conditions.
- Discussion of possibility, risks and impact of anencephaly and spina bifida
- Role of preconception folic acid supplementation in reducing risk
- Availability and use of screening tests during pregnancy

While routine folate administration has been demonstrated to reduce the risk of neural tube defects on a population basis (such as 0.4–0.5 mg folate once daily), higher dosages of folate are routinely used in high risk patients (such as 5 mg once daily).

High folate supplementation is given in ALL high risk cases — not just to high risk mothers, but also to fathers in a group at high risk of developing spina bifida.

High dose folate supplementation is given to ALL high risk cases.



Antenatal diagnosis

Ultrasonography can detect around 95% of cases of spina bifida by the age of 18–20 weeks. High risk pregnancies need to be screened by ultrasonographers experienced in the detection of neural tube defects. The first child with spina bifida in a family is often missed on ultrasound, as the pregnancy may be considered at low risk due to a lack of previous family history of spina bifida.

Expert ultrasound can provide an approximate guide regarding the severity and level of the neural tube defect to assist in determining the prognosis for the fetus.

Alphafetoprotein serum levels can be raised at the 16th week of pregnancy. Spina bifida is not the only cause

of a raised serum alphafetoprotein, but this is an indication for further testing. This especially applies to at risk pregnancies, such as in older women and individuals with, and relatives of those with, spina bifida. A typical screening schedule would include:

- 12 week expert ultrasound examination
- 18 week expert ultrasound examination
- option of maternal serum screening (for trisomy 21 and neural tube defects).

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