Neuromuscular disorders: a guide for the orthopaedic surgeon

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Abstract

Patients with neuromuscular conditions are frequently seen in final professional clinical examinations as they have good clinical signs, which often point towards the underlying diagnosis. This paper outlines some of the most common neuromuscular disorders that you are likely to come across in orthopaedic practise.

Keywords arthrogryposis; Charcot-Marie-Tooth; Friedreich's ataxia; hereditary sensory motor neuropathy; muscular dystrophy; neuromuscular conditions; poliomyelitis; spinal muscular atrophy

Introduction

Neuromuscular disorders encompass a variety of conditions in which the primary abnormality can be found in the peripheral nervous system. Muscle weakness and sensory symptoms (if present) often follow a characteristic pattern for each disorder and lead to muscle imbalance with predictable deformity. The role of the orthopaedic surgeon is to maintain the patients function, ambulation and independence where possible.

This paper discusses some of the more common neuromuscular conditions, their aetiology, clinical signs and a brief overview of the management. Detailed surgical management of the deformities seen in each condition is not within the scope of this paper.

Neuromuscular conditions can be hereditary or acquired (Table 1) but are best classified based on the location of the defect (Figure 1).

Hereditary sensory-motor neuropathies

Hereditary sensory-motor neuropathies (HSMN) are a group of inherited disorders, which affect both the sensory and motor function of peripheral nerves. The most common form of HSMN is Charcot-Marie-Tooth.

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Hereditary and acquired neuromuscular conditions

Hereditary	Acquired
Hereditary sensory motor neuropathies	Poliomyelitis
Muscular dystrophies	Myasthenia gravis
Arthrogryposis	Tetanus
Spinal muscular atrophy	Trauma
Friedreich's ataxia	
Congenital myasthenic syndromes	

Table 1

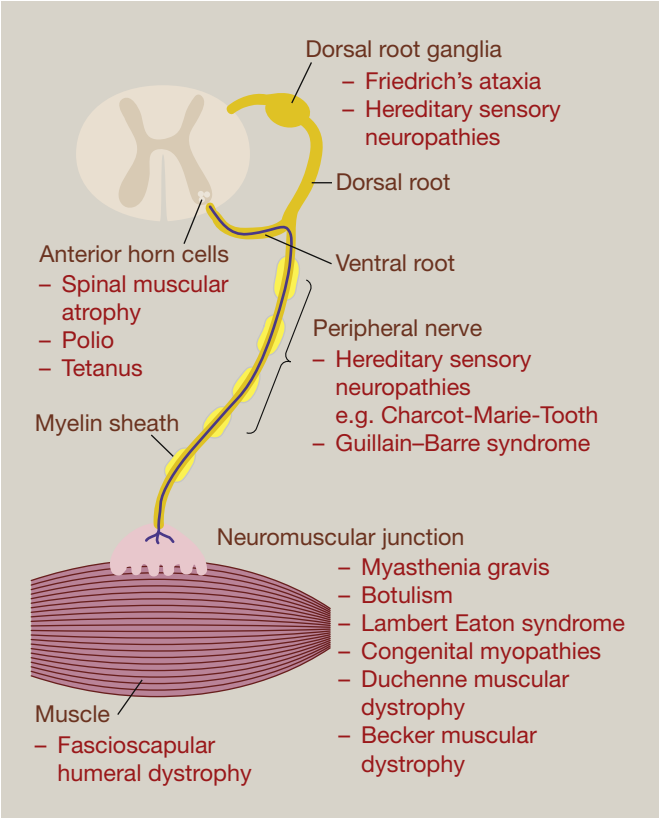

Figure 1 Classification of neuromuscular conditions by location of their effects on the peripheral nervous system.

Charcot-Marie-Tooth (CMT)

CMT is the most common inherited neuropathy. It is not one clinical syndrome but covers a range of disorders. Its prevalence is approximately 1 in 2500–300 people worldwide. Whilst the majority of cases of CMT have a genetic correlation, spontaneous mutations can occur.

CMT is caused either by an abnormality of the myelin sheath (a demyelinating neuropathy) or of the peripheral nerves (an axonal neuropathy).[1,2] As our understanding of the disease and genetic testing for the condition improves, more sub-types of CMT are being discovered.

Classification: CMT is classified based on the site of the pathology (demyelinating or axonal neuropathy), the mode of inheritance and the specific gene mutation. Within each type of

CMT are several subtypes (e.g. CMT1A, CMT1B) stratified according to the specific gene mutation.

CMT Type 1 – is the commonest form, comprising around 50% of cases.[1,2] The commonest subtype, CMT1A (70% of CMT type 1), is caused by mutation of the peripheral myelin protein 22 (PMP-22) gene on chromosome 17. This leads to a demyelinating neuropathy. It has an autosomal dominant inheritance pattern and presents in the first or second decade of life. Patients will typically present with a history of recurrent ankle sprains or falls caused by weakness in the foot. Examination shows weakness of tibialis anterior and most commonly a classical cavovarus foot deformity, although in 15–20% of cases a pes planus foot deformity can occur (Figures 2–5).

CMT Type 2 – is the second most common form of CMT and accounts for around 30% of cases.[1,2] It also has an autosomal dominant inheritance pattern and is caused by a mutation in the Mitfusion 2 gene resulting in an axonal neuropathy. Clinical features are very like CMT Type 1 but less severe. Nerve conduction studies are used to distinguish between the two conditions. A de- or dysmyelinating neuropathy will cause decreased nerve conduction velocity. An axonal neuropathy will cause a decrease in amplitude.

CMT Type 3 (Dejerine-Sottas disease) – is an infantile onset form of CMT.[1,2] It has an autosomal dominant inheritance and is a more severe form of the condition.

CMT Type 4 – is autosomal recessive and can result in either a demyelinating or an axonal neuropathy.[1,2] It is a severe form of CMT and is characterized on microscopy by folding of the myelin sheath.

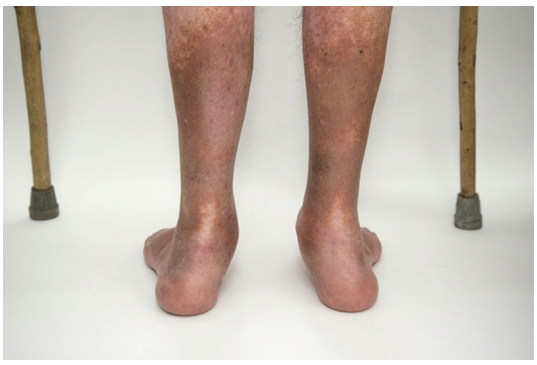

Figure 4 Charcot-Marie-Tooth. Bilateral hindfoot valgus deformity.

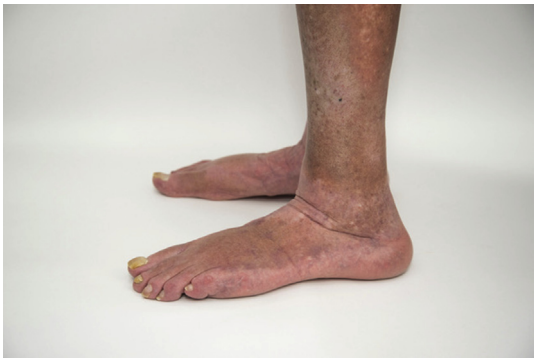

Figure 5 Charcot-Marie-Tooth. Pes planus deformity.

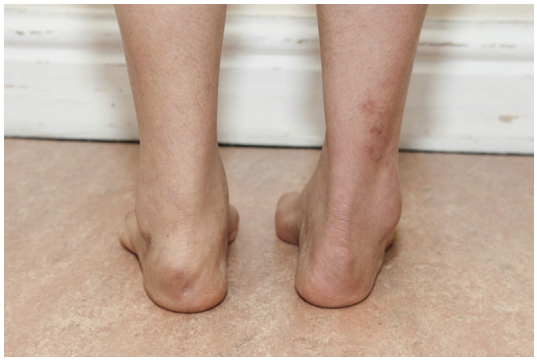

Figure 2 Charcot-Marie-Tooth. Classical varus hindfoot postion on the right side. Patient had undergone surgical correction on the left side.

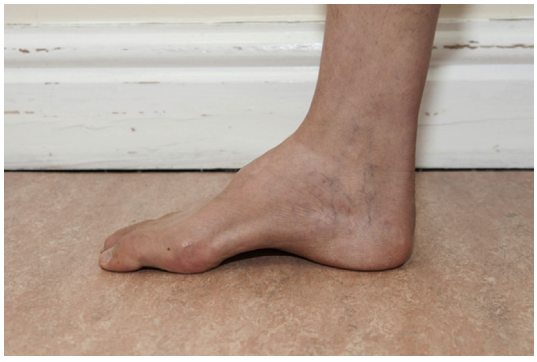

Figure 3 Charcot-Marie-Tooth. Lateral view of foot showing high arch and plantar flexed first ray.

CMT X – is an X-linked condition caused by a mutation in the connexion 32 (C x 32) gene.[1,2] This results in a demyelinating and axonal neuropathy. Both males and females are affected but males have more severe symptoms due to the absence of a normal X chromosome. Males tend to have an axonal neuropathy and females a demyelinating neuropathy.

Disease progression: the classical cavovarus foot deformity, with clawing/hammering of the toes, is caused by a predictable pattern of muscle imbalance. This pattern of deformity occurs in around 80% of cases, with the remaining patients having a valgus or planovalgus deformity.

Tibialis anterior is affected first, leading to weakness of ankle dorsiflexion and eventually a foot drop. This may present with a history of recurrent falls or sprains. To achieve ankle dorsiflexion during the initial contact phase of gait, the toe extensors and peroneus tertius may be recruited. Weakness of peroneus brevis leads to a loss of active eversion. Tibialis posterior and peroneus longus are unaffected and have unopposed actions, causing varus and plantarflexion of the first ray. Unopposed action of the toe flexors due to weakness of the intrinsics (EHB and EDB) causes hammering or clawing of the toes. This deformity is initially supple and can be managed with orthotics. With time, or neglect, the deformity becomes fixed. Other clinical features of CMT are shown in Box 1.

Respiratory function can also be compromised in CMT due to involvement of the phrenic nerve. Ventilatory support may be

Common clinical features of Charcot-Marie-Tooth

- ☐ Upper limb
  - — Wasting intrinsics
  - — Clawed hands
  - — Weakness of pinch and grip strength
- ☐ Spine
  - — Scoliosis (10—20% of patients)
  - — Left thoracic and kyphotic curve
- ☐ Lower Limbs
  - — Hip dysplasia (<10% of patients)
  - — Champagne bottle legs (due to muscle wasting)
  - — Cavovarus foot
  - — Toe hammering or clawing
  - — Valgus or planovalgus feet
- ☐ Decreased respiratory function
- ☐ Neuropathic pain

Box 1

required after any surgical procedure overnight (bilevel or continuous positive airway pressure) to maintain oxygenation. Spirometry should be performed regularly to monitor respiratory function.

Neuropathic pain is also commonly seen in patients with CMT. Amitrypline, pregabalin, gabapentin, and duloxetine may be helpful in managing these symptoms.

Diagnosis: once a diagnosis of CMT is suggested by clinical features with or without a positive family history, the diagnosis can be confirmed with genetic tests (the three most common mutations tested for are PMP22, MPO and Cx32) and if these are negative, nerve conduction studies and more detailed genetic testing can be performed. A formal diagnosis is not possible in all patients.

Management: management of CMT is aimed at maintaining the patients mobility and independence for as long as possible. As the disease is progressive, the needs of patients will vary with age. Even within the same family group, the rate of progression is variable and some may require intervention earlier.

Conservative management: flexible deformities can be managed with orthotics, usually an ankle-foot orthosis (AFO) to correct the cavovarus foot position and allow clearance through swing. Accommodative orthotics can be used for fixed deformities. Physiotherapy is used to try to maintain muscle strength. Occupational therapists can assess needs for adaptions to the patient's environment to try and help fatigue.

Surgical management: the aims of surgical management are to rebalance and create a stable plantigrade foot. In flexible cavovarus deformities this may involve osteotomies of the calcaneum and first ray with tendon transfers; commonly a split tibialis posterior to tibialis anterior and tenodesis of peroneus brevis to longus. Fixed deformity will require joint fusion procedures, such as a triple fusion, to achieve the same aims. Following surgery, orthotics may still be required to support the new foot position.

Muscular dystophies

Muscular dystrophies are a group of inherited conditions characterized by the progressive loss of muscle, which is replaced by

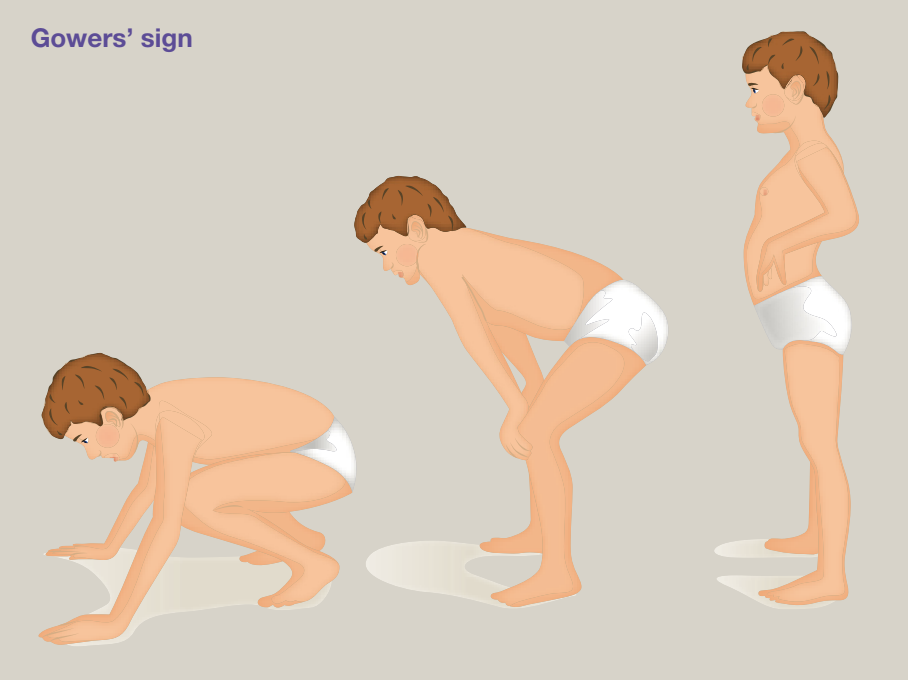

Figure 6 Gowers' sign: starting from a seated position on the floor, the child uses their hands to 'climb up' their legs to achieve a standing position. This is due to weakness in the pelvis, hips and thighs.

connective and fatty tissues. Each form of muscular dystrophy is caused by a mutation of a specific protein involved in muscle function.

Duchenne muscular dystophy (DMD)

Duchenne muscular dystrophy in an X-linked recessive disorder affecting the dystrophin gene. The incidence is about 1 in 3500 male births.

Males with the condition are largely normal at birth and achieve their initial gross motor milestones. From 2–6 years old, motor weakness becomes evident, with boys walking with a wide-based, waddling gait. Leg weakness is progressive and children struggle to stand after floor play and will use Gowers' sign (Figure 6), bilateral tip-toe walking and develop pseudo calf hypertrophy. Muscle weakness affects the lower limbs more than the upper, and proximal muscles more than distal (Box 2).[2,3]

Respiratory and cardiac muscle are also affected leading to respiratory failure in the later teens and cardiomyopathy, which usually manifests in the early teens. Approximately 30% of children will have learning difficulties and autistic features as well as speech and language delay.

Diagnosis: creatine kinase (CK) levels are markedly elevated from birth, but peak around the age of 3 years with levels into the 10,000s. After this age, CK levels decrease due to increasing muscle wasting.[3] A few areas of the UK are screening for Duchenne muscular dystrophy at birth by measuring CK levels from Guthrie heel prick cards. A positive finding is an indication for a formal CK level measurement.[4]

Prognosis: around the age of 8 years, children struggle to walk upstairs and by age 12 are wheelchair dependent. This leads to worsening weakness, contractures and the development of a kyphoscoliosis. The scoliosis is aggressively managed, with surgical correction being performed when the Cobb angle reaches around 20°. Early surgical intervention is indicated not only to prevent worsening cardiorespiratory function but also to intervene whilst the patient is still well enough.

Life expectancy is reduced. Historically, boys lived until their late teens or early 20s but with improved standards of care and the use of steroids the average age of death is now 26 years with some patients living into their 40s.

Common clinical features of Duchenne and Becker muscular dystrophy

- ☐ Proximal > distal muscle weakness
- ☐ Lower limbs > upper limbs
- ☐ Bilateral tip-toe walking
- ☐ Calf hypertrophy
- ☐ Gowers' sign
- ☐ Deep tendon reflexes present
- ☐ Kyphoscoliosis
- ☐ Respiratory and cardiac compromise
- ☐ Learning difficulties
- ☐ Speech and language delay

Box 2

Management: high-dose corticosteroids have been shown to be beneficial in the treatment of DMD, maintaining mobility and prolonging life expectancy. There are side effects to chronic glucocorticoid use; restricted growth, Cushingoid appearance, osteoporosis (which can impact on orthopaedic management) glucose intolerance, fat embolism syndrome and a delay in the onset of puberty.

Becker muscular dystophy (BMD)

Becker muscular dystrophy is a milder form of a dystrophinopathy with an X-linked recessive inheritance pattern. It is less common than DMD, with an incidence of 1 in 20,000. Clinical features are the similar to DMD (Box 2) but present later and progress at a slower rate, with affected males being ambulant for longer and most becoming non-ambulant in their 20s.[2]

Diagnosis: CK levels are elevated (in the 1000s) but not to the same degree as in DMD. MRI shows fatty infiltration of skeletal muscles.

Genetics of DMD and BMD: both conditions have an X-linked recessive inheritance pattern. This means that there is a female carrier in cases of DMD, although de novo cases without a female carrier have been reported. Males with DMD usually have reduced fertility, but with improved life expectancy offspring from an affected male are possible. In BMD, males are more likely to have offspring, as they have improved fertility and a longer life expectancy.

Female offspring can become carriers in one of two ways (Figure 7). Fathers with BMD will pass the recessive gene on to all female offspring but male offspring will be unaffected. Mothers who are carriers have a 50% chance of passing it on to their offspring making 50% of their daughters carriers whilst 50% of their sons are affected with DMD or BMD.

Fascio scapular humeral dystrophy (FSHD)

FSHD is the third most common form of muscular dystrophy.[2] It is characterized by progressive weakness of the face, shoulders and arms and has an incidence of 1 in 20,000 births. Males and females are equally affected, but males tend to have more severe manifestations.

The age on onset of symptoms varies from infancy to early adulthood. The infantile form of FSHD is more severe, with individuals being wheelchair bound by the age of 8–9 years and a life-expectancy of around 30 years due to respiratory involvement.

Genetics: about 80% of FSHD is caused by an autosomal dominant mutation. The remaining cases are due to a sporadic mutation. The specific genetic mutation, although known to occur on chromosome 4, is not yet fully understood.

Clinical features: most patients (approximately 80%) will initially present with shoulder girdle[5] problems. About 10% of patients will present with facial weakness and the remaining 10% with a foot drop due to weakness of ankle dorsiflexion.

Weakness involves serratus anterior, the rhomboids, teres major and minor and trapezius. Biceps, triceps and the pectorals are also often affected. Deltoid, supraspinatus, infraspinatus and

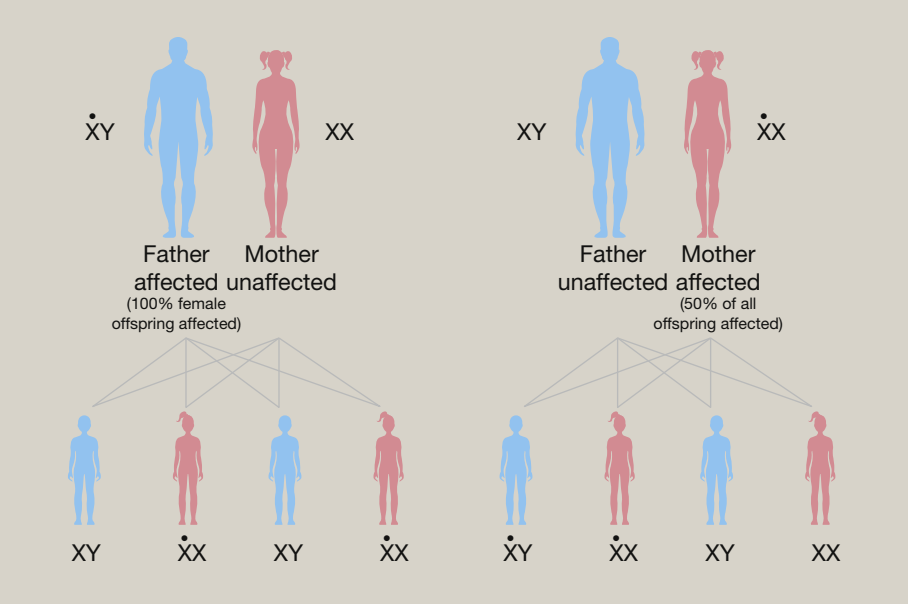

Figure 7 Genetic inheritance patterns of X-linked recessive conditions.

subscapularis are largely spared, but due to the weakness of other muscles, they are at a mechanical disadvantage and fatigue early. Other clinical features of FSHD are shown in Box 3.

Prognosis: weakness is progressive although life span is often normal. Up to 20% of patients will become wheelchair bound in adulthood.

Management: physiotherapy and occupational therapy may be useful to help maintain strength and create adaptations to improve function. Stabilization of the scapula to the posterior chest wall allows improved movement of the shoulder as the Deltoid becomes more functional. This is most reliably achieved by performing a scapulothoracic fusion[5] (Figures 8 and 9).

Common clinical features of fascio scapular humeral dystrophy

- ☐ Shoulder girdle
  - — Scapular winging
  - — Decreased abduction
  - — High sitting scapula
- ☐ Facial weakness
  - — Unable to purse lips or blow out cheeks leading to difficulties in whistling or blowing out candles
  - — Closing eyes against resistance
  - — Absence of facial wrinkles
- ☐ Abdominal muscle weakness
- ☐ Pelvic and lower limb
  - — Foot drop
  - — Hamstring weakness

Box 3

Spinal muscular atropy

Spinal muscular atrophy (SMA) is a group of conditions that affect the anterior horn cells of the spinal cord leading to progressive motor weakness.[2] It has an autosomal recessive pattern of inheritance and affects the survival motor neuron 1 gene (SMN) on chromosome 5. SMN1 produces 90% of the functional survival motor neurone protein whilst SMN2 only produces 10% of the functional protein. In SMA, individuals lack SMN1 hence it is the copy number of SMN2, to a large extent, that correlates

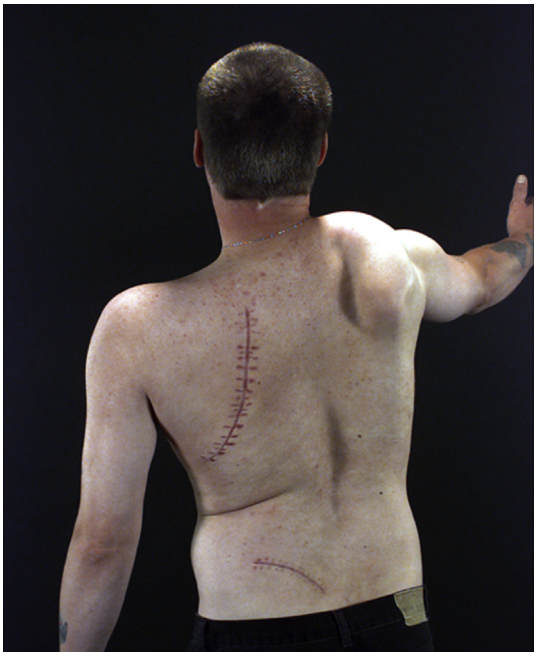

Figure 8 Fascio scapular humeral dystrophy. Generalized muscle atrophy around right shoulder girdle. On attempted abduction, there is scapular winging and poor range of movement.

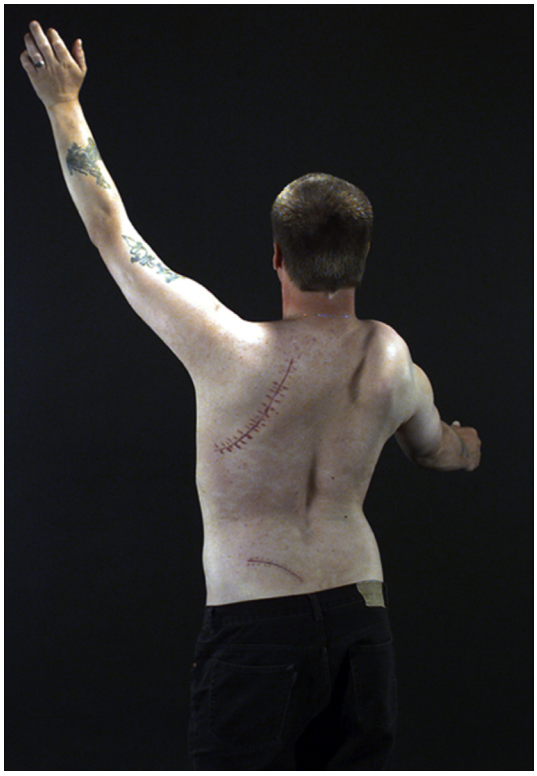

Figure 9 Same patient as in Figure 8 has undergone a scapulothoracic fusion on the left. Improved range of movement on abduction.

with the clinical phenotype and level of weakness and disability.[6,7] SMA type 1 is the commonest cause of death in infants from an inherited disorder and has an incidence of 1 in 10,000. Males and females are equally affected.

Classification

SMA Type 1 – infantile (Werding-Hoffman disease): is the commonest form of SMA.[2,6,7] Infants present by the age of 6 months with hypotonia, a weak cry and on examination will have tongue fasciculations and absent deep tendon reflexes. There may be a history of reduced foetal movements. Voluntary movements, when the baby has weakened, are often limited to the fingers and toes. Prognosis was previously poor with a life expectancy limited to between 6 months and 2 years. However with new drug treatments, both ASO (antisense oligonucleotides) and gene therapy, these babies are achieving milestones, such as sitting.

SMA Type 2 – intermediate form: presents between 6 and 18 months of age.[2,6,7] Infants will typically learn to sit but due to muscle weakness will need assistance to stand and are unlikely ever to walk. The lower limbs are affected more than the upper limbs. Clinical features are shown in Box 4. Prognosis is better than in SMA type 1 but life expectancy is variable. Most patients will live for 10 years or more following diagnosis but some may survive into the fifth decade of life.

SMA Type 3 – juvenile (Kugelberg-Welander disease): present between the age of 2 and 15 years.[2,6,7] Patients have normal or slightly delayed motor milestones until the disease progresses. Proximal muscles are affected, leading to a positive Gowers' sign and progressive loss of independent ambulation. Patients are typically wheelchair dependent in adulthood. Life expectancy is normal but respiratory support may be required.

Common clinical features for spinal muscular atrophy

- ☐ Onset of symptoms in infancy or early childhood
- ☐ Absent deep tendon reflexes
- ☐ Hypotonia
- ☐ Symmetrical muscle weakness
  - – Trunk
  - – Proximal > distal
  - – Lower limb > upper limb
- ☐ Normal sensation
- ☐ Normal mental function
- ☐ Fine resting tremor
- ☐ Gowers' sign
- ☐ Tongue and deltoid fasciculations
- ☐ Scoliosis
- ☐ Joint contractures
- ☐ Hip dysplasia/dislocations
- ☐ Premature death due to respiratory muscle weakness

Box 4

SMA Type 4: presents in adulthood at a mean age of 35 years.[6] Patients develop proximal muscle weakness although usually remain ambulant due to the slowly progressive nature of the condition.

SMA Type 0/1A: is a rare and severe form of SMA which presents in the neonatal period and is often associated with joint contractures which may require orthopaedic intervention.

Diagnosis

Diagnosis can be made based on clinical features, family history and genetic testing for the SMN-1 mutation. Nerve conduction studies and muscle biopsies are not routinely performed but may aid diagnosis in the later onset form of the condition.

Management

Treatment of SMA is aimed at preventing medical complications, primarily maintaining respiratory function. Historically, children with SMA type 1 would not have been considered for any form of surgical intervention due to the poor prognosis. Recent trials on the use of ASO has shown improved attainment and maintenance of motor milestones and an improved life expectancy in SMA type I, 2 and 3.[8] Children who would not previously have been considered for correction of deformities are now surgical candidates.

Hip dislocation, scoliosis and joint contractures are caused by immobility and muscle imbalance. Hip dysplasia may require surgical treatment in the form of osteotomies of the pelvis or femur. The scoliosis curve that develops is the typical long 'C' shaped neuromuscular curve. They tend to occur early and

progress rapidly. The more severe the SMA, the more severe the scoliosis.

Distal spinal muscular atrophy (hereditary motor neuropathy)

Distal spinal muscular atrophy (dSMA) is also known as hereditary motor neuropathy and is characterized by distal muscle weakness in the absence of sensory symptoms. It is caused by a mutation affecting the anterior horn cells. Around a third of cases are due to an autosomal dominant mutation. The remaining cases may be autosomal recessive, X-linked or sporadic mutations. The age of onset is variable, ranging from infancy to young adulthood (6 months–19 years).

There are multiple types of distal muscular atrophy. Types I–III are clinically like CMT but lack the sensory component.[2] Clinical features are shown in Box 5 and Figures 10 and 11.

Diagnosis

dSMA is often a clinical diagnosis. The following can be used to help confirm clinical suspicion:

- ☐ elevated CK levels (in some forms of dSMA).
- ☐ nerve conduction studies showing decreased motor nerve amplitudes, normal sensory amplitudes, evidence of fasciculations and fibrillations
- ☐ MRI muscle-specific patterns of muscle atrophy can be seen particularly in some forms of dSMA.
- ☐ detection of specific genetic mutation is often screened for in genetic panels and research exome sequencing but not always conclusive.

Arthrogryposis

Arthrogryposis or arthrogryposis multiplex congenita (AMC) is not a single condition, but is a term that represents a spectrum of disorders characterized by joint stiffness.[9,10] It is a non-progressive disorder with an incidence of 1 in 3–4000. AMC is defined as contractures in two or more joints in multiple body areas. The most common form of AMC is amyoplasia.

Aetiology

The exact aetiology of arthrogryposis is unknown and is variable, depending upon the underlying condition. Any condition that affects foetal movement can lead to AMC. Some forms of AMC are genetic (e.g. distal arthrogryposis).[9,10]

Common clinical feature of distal muscular atrophy

- ☐ Lower limb > upper limb
- ☐ Muscle atrophy
- ☐ Distal muscle weakness
  - – Foot drop
  - – Cavovarus foot
  - – Toe clawing/hammering
- ☐ Normal sensation
- ☐ Hyperlordosis lumbar spine
- ☐ Diaphragmatic dysfunction

Box 5

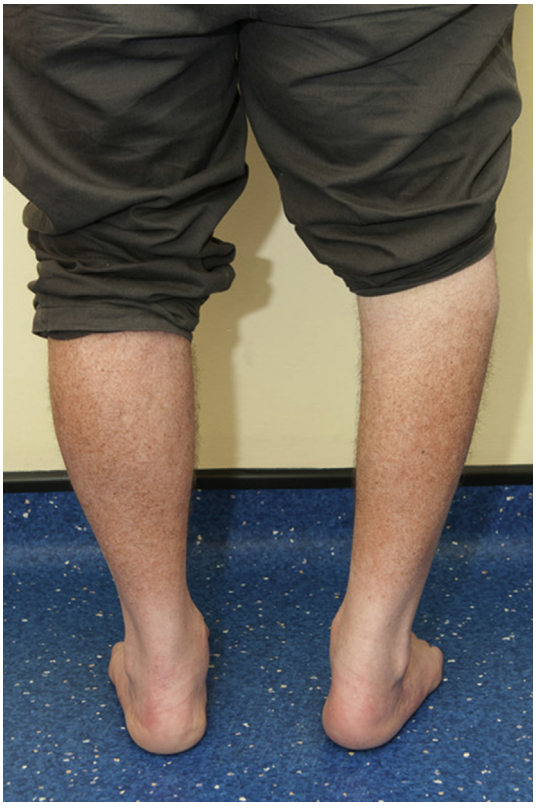

Figure 10 Distal muscular atrophy. View of lower limbs from behind. Note decreased calf bulk.

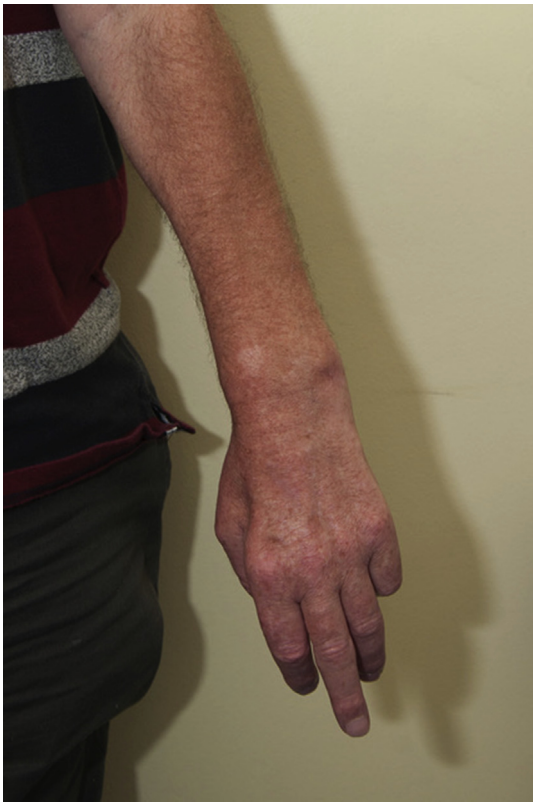

Figure 11 Distal muscular atrophy. Decreased muscle bulk in left forearm with intrinsic guttering in the hand and flexion deformity of the index, ring and little fingers.

Neurological abnormality: the most common neurological cause for arthrogryposis is an abnormality in the development of anterior horn cells. A lack of anterior horn cells leads to decreased movement and therefore joint contractures. Other neurological causes include neural tube defects, spinal muscular atrophy and myelodysplasia of the spinal cord and specific changes within the brain, such as corpus callosal abnormalities.

Muscle disorders: congenital myopathies and mitochondrial disorders lead to decreased movement and joint contractures.

Connective tissues disorders: abnormal connective tissues (abnormal collagen) can lead to joint restriction. Diastrophic dysplasia (a form of disproportionate dwarfism caused by a mutation in the sulphate transporter protein gene), Beals syndrome (similar features to Marfan syndrome but has joint contractures present at birth) and Ehlers–Danlos syndrome have all been implicated.

Limited uterine space: if the foetus does not have sufficient room to move during uterine development, it is at risk of developing joint contractures. Structural abnormalities of the uterus such as fibroids or a bicornate uterus, breech presentation, multiple pregnancy, amniotic bands and oligohydrominos have all been linked.

Maternal illness: mothers with myasthenia gravis may develop antibodies to foetal acetylcholine (ACh). This continuous flow of ACh receptor antibodies during pregnancy may cause decreased foetal movement and hence poor muscle development and AMC. Diabetes, multiple sclerosis, maternal infections and maternal hyperthermia in the first trimester are also thought to have an association.

Genetic: a significant number of AMC cases will have a genetic abnormality underlying; either as a single gene change or part of a syndromic diagnosis and is always important to review whether a child/adult has a cleft palate, cardiac defects.

Whatever the cause of arthrogryposis, lack of joint movement leads to joint stiffness, which in turn leads to weakness of the surrounding muscles and tendons. Joints fail to develop normally leading to stiffness and deformity.

The clinical features (Box 6 and Figures 12 and 13) of arthrogryposis can be broadly classified into three groups:

1. predominantly limb involvement
2. limb involvement with another body area involved (e.g. gastrointestinal tract)
3. limb involvement with CNS dysfunction.

Children with predominantly limb involvement have a good life expectancy and can be kept ambulant with surgical intervention. They have normal intelligence.

Management

Patients should be managed by a multidisciplinary team whose aims are to optimize quality of life and promote independent living and ambulation if appropriate. Management commences from birth and is life-long. Treatment will include physiotherapy, orthotics, adaptations, and surgical interventions such as scoliosis correction, tendon transfers, osteotomies and fusions in later life.

Managing the deformity associated with arthrogryposis is difficult. Tissues and joints are often abnormal and any form of corrective surgery is prone to a high rate of deformity recurrence.

Common clinical features of arthrogryposis

General features

- ☐ Decreased foetal movements
- ☐ Absent flexor creases
- ☐ Normal sensation
- ☐ Dimples over joints

Upper limb

- ☐ Internally rotated, adducted shoulders
- ☐ Elbows extended
- ☐ Wrist flexion and ulnar deviation
- ☐ Thumb adducted
- ☐ Intrinsic plus position fingers

Spine

- ☐ Neuromuscular C-shaped scoliosis (33%)

Lower limb

- ☐ Teratologic hip subluxation or dislocation (70–80%)
- ☐ Hips flexed, abducted and externally rotated
- ☐ Knee extended
- ☐ Foot deformities
  - – Severe clubfoot
  - – Vertical talus
  - – Rigid cavus
  - – Rigid equinovalgus

Box 6

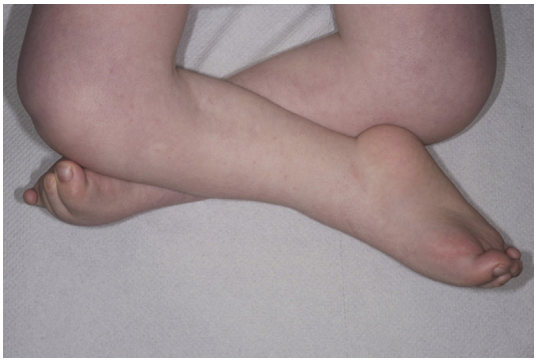

Figure 12 Arthrogryposis. Young child with fixed flexion deformities of both knees and a fixed equinocavovarus deformity of the feet.

Friedreich's ataxia

Friedreich's ataxia is an autosomal recessive condition, which causes multiple GAA repeats on chromosome 9. This leads to loss of the frataxin gene.[2] It is the most common hereditary

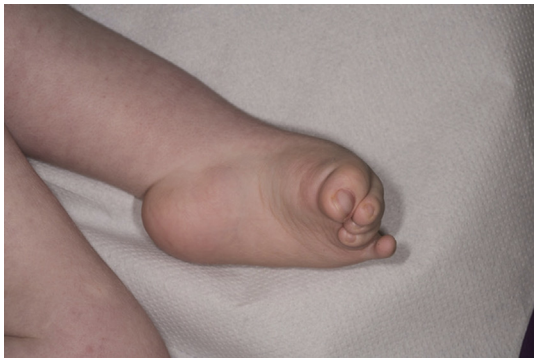

Figure 13 Arthrogryposis. Fixed equinocavovarus deformity of the feet.

spinocerebellar condition. It has an incidence of 1 in 50,000 births.

Age of onset of symptoms is between 7 and 25 years but typically around puberty. Patients present with an ataxic gait and generalized clumsiness. Clinical features are shown in Box 7. The severity of the scoliosis curve is dependant on age of onset of symptoms. Those whose Friedreich's ataxia onset was before the age of 10 years are more likely to have a severe and progressive scoliosis which requires correction.[2]

The diagnosis is confirmed by genetic testing. MRI shows atrophy of the cervical spinal cord. Sensory amplitudes on nerve conduction studies are reduced more so than motor.

Prognosis

The majority of patients are wheelchair bound within 15 years of diagnosis. Life expectancy is reduced due to cardiomyopathy with a mean age of death around 50 years of age.

Management

The treatment of Friedreich's ataxia is largely supportive. Correction of scoliosis and foot deformity may be indicated, depending on severity. Idebenone is a powerful antioxidant, which has been shown to slow the progression of cardiomyopathy, therefore prolonging life. It also has a stabilizing effect on neurological symptoms when given to children.

Common clinical features of Friedreich's ataxia

General

- ☐ Ataxia
- ☐ Areflexia
- ☐ Decreased vibration and proprioception
- ☐ Positive plantar response
- ☐ Muscle weakness
- ☐ Nystagmus, dysarthria, hearing loss

Lower limb

- ☐ Rigid cavovarus foot
- ☐ Toe clawing

Spine

- ☐ Scoliosis (almost 100%)

Cardiac

- ☐ Cardiomyopathy: cause of death in 50s

Box 7

Poliomyelitis

Poliomyelitis is a highly infectious viral illness of childhood and was common until the last major outbreak affecting the UK in 1956. The polio virus has a strong affinity for the anterior horns cells of the spinal cord and brainstem motor nuclei leading to non-progressive loss of motor function but intact sensory function.[2] Following the introduction of the vaccination programme, polio has been eradicated in the western world with only 29 cases reported worldwide in 2018.[11] Although we no longer see acute cases in the UK, patients who were affected by polio in childhood are now in their 60–70s. The motor weakness is permanent, so patients often still require treatment.

The poliomyelitis infection occurred in two stages. The initial 'minor illness' was non-specific, with fever, fatigue, pharyngitis, headache, nausea, vomiting and abdominal pain. Most people recovered without any further effects but for those developing the 'major illness' (around 1 in 200), symptoms recurred at 3–10 days.[2,12] Major illness was characterized by CNS involvement with or without muscle paralysis. Paralysis peaked in severity at 48 hours after onset; the lower limbs were affected more than the upper limbs and proximal muscles affected more than distal muscles. Mortality was 5–10% and caused by respiratory paralysis.

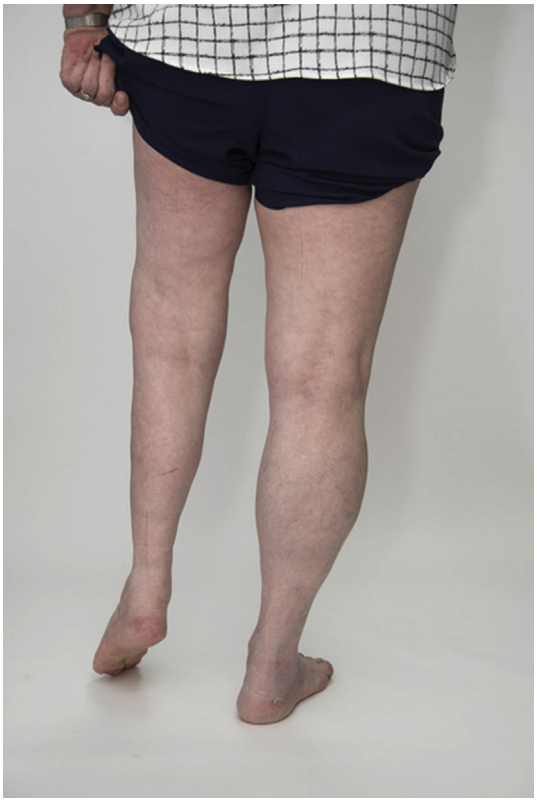

Figure 14 Polio. Image from behind showing limb length discrepancy and general wasting o the lower limb. Foot is flaccid.

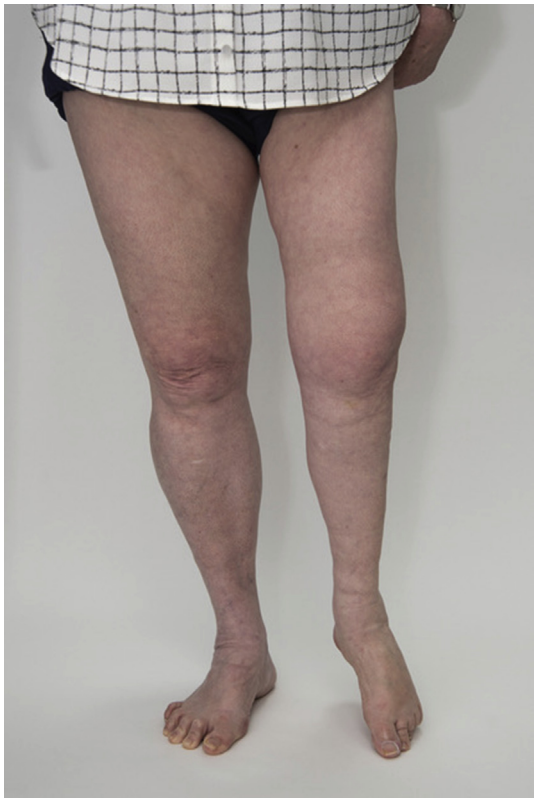

Figure 15 Polio. Same patient as in Figure 14 from the front. Wasting of thigh and leg muscles with flaccid foot.

Clinical features

The clinical features are dependent on the pattern of muscle weakness. Recuvartum and valgus deformity of the knee are common (Figures 14 and 15). The calf muscles are often weak, leading to an equinus contracture. Foot deformity is also common. This may be cavus, due to weakness of the peroneals, or planus due to weakness of tibialis posterior. Foot intrinsics are usually spared so although toe clawing is not a direct feature of polio, it can be caused by overactivity of the long flexors or extensors (Box 8).

Post-polio syndrome

Although now eradicated in the UK, survivors of childhood polio are now experiencing a steady decline in motor function, so called post-polio syndrome.[2,12] The exact mechanism is unknown but with normal ageing comes loss of motor units. Those with polio already have a reduced number of motor units. Normal ageing therefore has much more of a profound effect on polio survivors leading to enhanced weakness, which may be difficult to overcome. Weight gain and overuse have also been implicated.

Management

The management of patients with polio includes supportive care and maintenance of ambulation and function if required with orthotics. The type of orthotic is dependent upon the level of motor weakness.

Patients with post-polio syndrome should remain active but at sub-exhaustion levels to prevent fatigue and damage to the remaining functioning muscle. ◆

Common clinical features of poliomyelitis

- ☐ Motor weakness
  - – Lower limb affected > upper limbs
  - – Proximal muscles > distal muscles
- ☐ Valgus knees
- ☐ Knee hyperextention
- ☐ Areflexia
- ☐ Sensation intact
- ☐ Cranial nerve (VII, IX, X) involved in 10–15%

Box 8

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