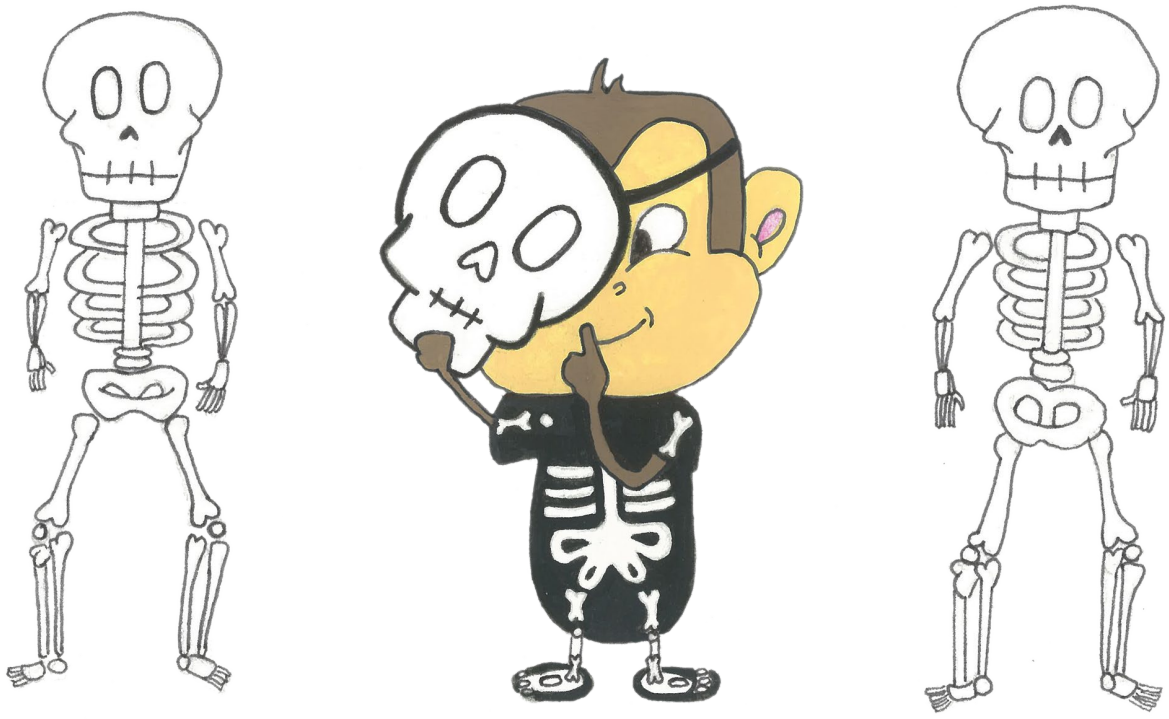
Chapter 12:

MUSCULOSKELETAL DISORDERS

Student Authors: Carol Naidoo, Lehlohonolo Ntlatlapo,
Sean Mashau and Dyavan Singh
Specialist Advisor: Dr Chantel Richardson



This chapter covers the following topics:

- Juvenile idiopathic arthritis (JIA)
- In-toeing/pigeon-toeing
- Genu valgum (knock knees)
- Genu varum (bow legs)
- Septic arthritis
- Osteomyelitis
- Systemic lupus erythematosus (SLE)
- Congenital myopathies
- Duchenne muscular dystrophy (DMD)
- Perthes disease
- Slipped upper femoral epiphysis (SUFE)
- Juvenile dermatomyositis (JDM)

JUVENILE IDIOPATHIC ARTHRITIS (JIA)

It is a chronic (>6 weeks duration) inflammatory condition which develops in children <16 years old. It develops in the absence of infection and has no known cause.

Pathogenesis

The pathogenesis of JIA is unclear, however there are multiple factors that interact and contribute to its development:

- Genetic factors – certain genetic sequences predispose families to JIA
- Immune mechanisms – many human leukocyte antigen (HLA) classes contribute to JIA e.g. HLA-DR8, HLA-DR11
- Environmental factors – it has been theorised that certain infections (e.g. rubella, EBV, *C. trachomatis*, influenza A) contribute to the development of seasonal JIA

Clinical Features

Generally, the child with JIA may present with:

- Joint symptoms and signs:
    - Pain
    - Early morning stiffness
    - Gelling (stiffness especially after periods of immobility e.g. after sleeping or long drives)
    - Swelling and inflammation of the joint with thickening of the synovium
    - Swelling of the soft tissues surrounding the joint
- A change in walking style (development of a limp)
- Mood and behavioural changes
- Decreased enjoyment of usual activities and avoidance of certain physical activities

Investigations

One should order:

- Blood tests:
    - FBC
    - ESR and CRP

    - Rheumatoid factor (RF), ANA and anti-cyclic citrullinated peptide antibodies (anti-CCP)
    - Hb
    - HIV
    - Liver enzymes (to check liver function before therapy is initiated)
- Mantoux test
- Imaging:
    - Chest X-ray
    - X-ray of the affected joint(s)
    - Ultrasound
    - MRI

Classification of JIA

There are at least six different subtypes of JIA:

- Oligoarticular JIA (involves of ≤4 joints; has a good prognosis)
- Polyarticular JIA (involves >4 joints)
- Systemic JIA (arthritis is associated with fever and rash)
- Psoriatic arthritis
- Enthesitis-related arthritis (ERA)
- Unclassified arthritis (does not fit into any of the abovementioned subtypes)

Table 12.1: Classification and Features of JIA

JIA Subtype	Age of Onset	Sex ratio (F:M)	Articular pattern	Extra-articular features	Laboratory Findings
Oligoarticular JIA	1-4years	4:1	Involves ≤4 joints (usually knee, ankle or wrist). >4 joints may be involved after 6 months (extended oligoarticular arthritis).	Chronic anterior uveitis (in 20% of cases) and leg length discrepancy.	70% of patients are ANA-positive. Acute phase reactants (APRs) and platelets may be raised.
RF-positive polyarthritis	1-3 years	3:1	Involves the small joints of the hand (including the distal	Iridocyclitis.	APRs and platelets are elevated

			interphalangeal (DIP) joints.		RF-negative but ANA-positive in 40% of cases.
RF-negative polyarthritis	Late adolescence	6:1	Widespread joint involvement. Symmetrical small joint involvement but with sparing the metacarpophalangeal (MCP) joints.	Iridocyclitis is not a feature.	Elevated APRs, anaemia, RF-positive (on two occasions) and anti-CCP-positive.
Systemic JIA	1-10 years	1:1	Initially no arthritis (just arthralgia or myalgia), but then oligo- or polyarthritis.	Fever with evanescent rash, lymphadenopathy, serositis and hepatosplenomegaly.	Raised APRs, neutrophilia, thrombocytosis and anaemia. RF-negative.
ERA	6-16 years old	1:7	Arthritis or enthesitis of the sacroiliac joint, inferior pole of patella, Achilles tendon or plantar fascia insertion into the calcaneus.	Sacroiliitis or lumbosacral pain, first-degree relative with ERA or ankylosing spondylitis and anterior iridocyclitis.	HLA-827-positive, elevated ESR and anaemia.
Psoriatic arthritis	1- 16 years old	2:1	Similar to oligoarthritis	1. Dactylitis 2. Nail abnormalities 3. Family history of psoriasis 4. Iridocyclitis	RF-negative. Half of patients are ANA-positive.

Management

Non-Pharmacological Management

The patient, his/her parents and teachers must be counselled and educated on the condition.

Referrals to a physiotherapist and occupational therapist should be made.

Pharmacological Management

The patient should be prescribed:

- Non-steroidal anti-inflammatories e.g. ibuprofen, diclofenac
- Intra-articular steroid injections
- Oral steroids (start at 1 mg/kg and increase until effective then attempt to taper to the lowest possible dose)

If symptoms and signs are not controlled on the above treatment, one should prescribe disease-modifying anti-rheumatic drugs (DMARDs) e.g. methotrexate 0.4 mg/kg orally or subcutaneously. If control is still not gained, refer for specialist opinion (will likely start biological agents e.g. anti-tumour necrosis factor/TNF).

Complications

They may include:

- Chronic anterior uveitis:
    - Children with JIA should have regular ophthalmology appointments, especially if they have oligoarticular JIA and are antinuclear antibody (ANA)-positive.
- Flexion contractures of the joints:
    - They develop because the joints are chronically held in the most comfortable position to minimise pain.
- Growth failure:
    - It occurs because of anorexia, chronic disease and systemic corticosteroid use.
- Leg length discrepancy (due to overgrowth of a localised area)
- Osteoporosis:
    - It is caused by systemic corticosteroid use, poor diet and decreased weight-bearing.

IN-TOEING/PIGEON-TOEING

Pathophysiology and Aetiology

The abnormal positioning of the leg may be due to:

- Femoral anteversion:

    - Normal children are born with ~40º femoral anteversion but this gradually corrects as the child grows.
- Internal/medial tibial torsion:
    - It is a variation of normal anatomy and is partially caused by the child's position in-utero.
- Metatarsus adductus (inward curving of the foot):
    - Its exact cause is unknown, however it is believed to be due to in-utero positioning.

Thus, the cause of the in-toeing may be at the hips, legs or feet, respectively.

Clinical Features

The child will have his/her:

- Feet turned inwards when walking
- Patella face inwards when standing with the feet facing forward

'W' sitting position is more comfortable for the child.

Management

It is rarely treated. However, one may offer:

- Conservative management:
    - Reassure and observe.
    - Encourage the parents to gently stretch the foot of the child with metatarsus adductus to neutral a few times a day.
    - Suggest that the parents buy the child straight-last/reverse-last shoes
- Surgical management:
    - Refer the child to an orthopaedic surgeon for femoral anteversion (derotational femoral osteotomy; not to be done before 8 years of age).

GENU VALGUM (KNOCK KNEES)

Aetiology

Genu valgum may be part of normal growth and development or it could be a sign of an underlying bone disease e.g. osteomalacia, rickets (due to a lack of calcium, phosphorus or vitamin D). Occasionally, it may be the result of injury to the tibial growth plate. It is important to differentiate the above mentioned causes from

obesity-related genu valgum. However, obesity can worsen genu valgum in patients with any of the abovementioned causes.

Clinical Features

When standing, the child's knees will touch (symmetrically lean inward) but the ankles will not touch (in a child with an average weight). This is best seen with the child's toes pointed forward.

Management

Management may be:

- Conservative:
    - Reassure the parents and observe the child who is 2-5 years old.
    - Suggest splints or braces if the genu valgum (see related image here) does not spontaneously correct by the age of 7 years or if there is an underlying systemic or metabolic cause.
- Surgical:
    - Refer the child to an orthopaedic surgeon who will perform a guided-growth procedure (done if significant deformity persists to the age of 10-11 years) (see related images here).

GENU VARUM (BOW LEGS)

Pathophysiology

It is mostly physiological in children under 2 years. However, it may be the result of an underlying condition e.g. Blount's disease (caused by an abnormality of the tibial growth plate), rickets.

Clinical Features

Either or both legs may be affected. The child will have a distinct space between the lower legs and knees when standing with his/her feet together. This bowing is exaggerated by walking (see related image here). Adolescents with Blount's disease will have pain associated with the bowing.

Investigations

One may perform:

- Blood tests:
    - Calcium, phosphorus, parathyroid hormone and, when indicated, vitamin D studies
    - Urinary pH and renal function tests (to assess for rickets)
- X-ray

Management

It may be:

- Conservative:
    - Reassure and observe
    - Give braces for Blount's disease (if caught early)
- Medical:
    - Vitamin D supplementation for the patient rickets
- Surgical:
    - Refer to an orthopaedic surgeon if:
        - Rickets persist despite treatment.
        - The child has physiological genu varum which is severe and is not correcting with time.
        - The child has Blount's disease which is worsening despite the use of braces or if the diagnosis is only made in adolescence.

SEPTIC ARTHRITIS

It is a serious infection as it can lead to bone destruction. Infection of the joint can be caused by bacteria, fungi, viruses or mycobacteria.

Pathophysiology and Aetiology

It is most common in children <2 years old and usually spreads to the joint:

- Haematogenously
- Through a wound or infected skin (VZV infection)
- From adjacent osteomyelitis

S aureus is the most common cause of septic arthritis. Organisms implicated in neonatal septic arthritis are group B streptococci, *N. gonorrhoea* and Gram-negative bacilli.

Clinical Features

The child may present with a history of trauma or underlying osteomyelitis. On examination, one may find:

- Signs of inflammation of the involved joint (swelling, tenderness and limited mobility of the joint) (see related image here)
- Maintenance of the joint in a specific position, decreased mobilisation of that joint and refusal to weight bear
- Neonates and young infants:
    - Subtle signs and symptoms
    - Involvement of >1 joint
- Older children and adolescents:
    - Pain on active and passive movement (key feature)
    - Constitutional symptoms e.g. fever, irritability, poor appetite, tachycardia, malaise

*Note***:** If more than one joint is involved, then the diagnosis of septic arthritis needs to be reviewed.

Investigations

They should include:

- Bloods tests:
    - FBC with differential count
    - CRP and ESR
    - Blood culture
- Joint aspiration and analysis of synovial fluid:
    - FBC and differential count
    - Microscopy, culture and sensitivity
- Imaging:

- X-ray of the joint (to exclude any fractures and identify capsular swelling)
- Ultrasound or MRI (to detect joint effusions)

Management

Diagnosis and management should be carried out quickly and efficiently to prevent long- term damage to bones and joints. The child should be managed in conjunction with an orthopaedic surgeon. Management includes:

- Arthrocentesis:
  - It is the cornerstone of management.
  - The joint should be drained and a lavage done via arthrotomy, arthroscopy or needle aspiration.
- Antibiotic therapy:
  - Empiric antibiotic therapy should be given as soon as possible, if the child has any of the classical signs of infection and positive blood results.
  - The antibiotic should cover for *S. aureus* in all age groups and any other relevant organisms depending on the child's age.
  - If the child is <3 months old, the antibiotic should cover for *S. aureus*, group B streptococci and Gram-negative bacilli.
  - If the child is ≥3 months, the antibiotic should cover for *S. aureus* and Gram-positive organisms.

OSTEOMYELITIS

It is inflammation of the bone and is usually caused by bacterial infection (see related image here).

Pathophysiology

In children, the infection is spread haematogenously but can be spread from other sources as well. This is because there is a rich vascular supply to the bones as they are still growing. Circulation within the metaphyseal capillary loops is sluggish, which is why infection tends to start there. Commonly affected bones include the femur, tibia, and humerus.

Aetiology

Common causative organisms include *S. aureus*, *S. pneumoniae and S. pyogenes.* Other causes include *Pseudomonas aeruginosa*, fungi (in the immunocompromised patient), *Salmonella* sp (in sickle cell anaemia and other haemoglobinopathies).

Clinical Features

The child may have:

- Cardinal signs of inflammation (fever, bone pain, swelling and erythema)
- Guarding
- Inability to weight-bear
- Asymmetrical movement of the limbs (pseudoparalysis; an early sign in neonates and young infants)

Investigations

One must exclude cellulitis, subcutaneous abscess, fractures and bone tumours. Thus, the following investigations are done:

- Bloods:
    - FBC
    - CRP and ESR
    - Blood culture or bone/joint aspirate culture
- Imaging (MRI or X-ray)

Management

The patient should be started on antibiotics (after taking samples for the lab). Cloxacillin is usually given or vancomycin may be given if the child has a penicillin allergy.

SYSTEMIC LUPUS ERYTHEMATOSUS (SLE)

SLE is an autoimmune, inflammatory condition that leads to the damage of essential organs. Its natural history is unpredictable as patients may present with chronic symptoms or acute life-threatening disease. Its cause remains poorly understood.

Clinical Features and Complications

The child may present with:

- Haemolytic anaemia, thrombocytopaenia, leukopaenia, or lymphopaenia
- Nephrotic or nephritic syndrome
- Psychosis, seizures, cognitive disorders or peripheral neuropathies
- Pulmonary haemorrhage, fibrosis or infarct
- GIT manifestations
- Serositis
- Arthritis
- Endocrinopathies
- Cardiac abnormalities
- Rash (malar, annular, discoid, psoriasiform, etc.)

See related image here.

Diagnosis

The Systemic Lupus International Collaborating Clinics (SLICC) Classification Criteria are used to diagnose SLE. For the diagnosis to be made, the patient must have:

- ≥4 criteria (of which there is at least 1 clinical criterion and 1 laboratory criterion) OR
- Biopsy-proven lupus nephritis with a positive ANA or anti-doubled stranded DNA antibody (anti-dsDNA) result

Table 12.2: SLICC Classification Criteria

Clinical Criteria	Laboratory Criteria
• Acute cutaneous lupus • Chronic cutaneous lupus • Oral or nasal ulcers • Nonscarring alopecia • Arthritis • Serositis • Renal dysfunction • Neurological symptoms • Haemolytic anaemia • Leukopenia • Thrombocytopenia (<1 000 000/mm^3)	• Positive ANA • Positive anti-dsDNA • Positive anti-Smith antibodies (anti-Sm) • Positive antiphospholipid antibodies • Low complement (C3, C4 or CH50) • Positive direct Coombs test (unreliable in the presence of haemolytic anaemia)

Investigations

See table 12.2 above for guidance on which investigations to order.

Management

The patient should be referred to a tertiary care facility. Management depends on the organ involved and the severity of its involvement. Non-pharmacological management includes dietary restrictions driven by the patient's medical therapy and pharmacological management ranges from NSAIDs and steroid therapy to cyclophosphamide.

CONGENITAL MYOPATHIES

Congenital myopathies are a heterogenous group of primary muscle disorders. Although they are present from birth, their expression may be delayed.

Pathophysiology

In these children, the muscle fibres do not function properly, leading to muscle weakness and/or hypotonia. The weakness is either stable or slowly progresses.

Clinical Features

The child may present with:

- Decreased facial animation (myopathic facies)
- External ophthalmoplegia (in some cases)
- Bulbar dysfunction e.g. poor cough, soft voice
- Hypotonia with head lag
- Proximal muscle weakness
- Decreased tendon reflexes
- Delayed motor milestones
- Normal intelligence

In some cases, distal muscles are affected, however myopathy usually affects proximal muscle more than distal muscles. Respiratory muscle is almost always affected. This usually occurs later in the disease.

Investigations

One should perform:

- Muscle biopsy
- Genetic testing
- Creatine kinase (CK) levels (usually distinguish myopathy from dystrophy)

Management

Although there is no known cure for congenital myopathies, symptomatic management is offered and patients should have regular consultations with specialists (such as orthopaedics and pulmonologists) to assess the progression of the disease. Rehabilitation with physiotherapists, speech and language pathologists and occupational therapists can help manage symptoms. Low-impact exercises can help maintain muscle bulk and strength e.g. swimming, walking.

DUCHENNE MUSCULAR DYSTROPHY (DMD)

It is an X- linked recessive disorder that results in progressive degeneration of muscle (see related image here).

Pathophysiology

Dystrophin connects the cytoskeleton of a muscle fibre to the extracellular matrix through the cell membrane. In DMD, there is a deletion in the dystrophin gene. It results in myofiber necrosis with an elevated creatine kinase (CK).

Clinical Features

The history may allude to the fact that there is a familial pattern of DMD. The child may present with:

- Proximal muscle atrophy with pseudohypertrophy of the calves
- Contractures
- Scoliosis (common complication)
- Decreased tone
- Proximal muscle weakness
- Decreased or absent reflexes

- Gait abnormalities (waddling)
- Positive Gowers's sign (the child must turn prone to rise after lying supine)
- Bulbar dysfunction (later in disease)
- Respiratory muscle weakness
- Cardiomyopathy with displaced apex (may also have a loud P2)
- Language delay (may or may not be present)
- Inability to perform certain physical activities e.g. climbing stairs, running (usually much slower and clumsier than other children in their age group)

These children have decreased life expectancies because of respiratory failure or associated cardiomyopathy. Due to the progressive nature of the disease, the average age of diagnosis is 5 years old and most children are no longer ambulant by 10-14 years old.

Investigations

They should include

- CK levels (usually elevated)
- Genetic analysis (for depletions, duplications or point mutations)

Management

The child should be managed by a multidisciplinary team:

- Physiotherapists (can help prevent the development of contractures)
- Cardiologists (initiate the patient on enalapril and regularly monitor his/her ejection fraction)
- Surgeons (may perform Achilles tendon lengthening and scoliosis surgery)

Due to the respiratory muscle weakness, children with DMD may develop nocturnal hypoxia and may require overnight CPAP to improve breathing.
Glucocorticoids may be prescribed as they also help preserve mobility and prevent scoliosis. However, their exact mechanism of action is not known. Glucocorticoids have also been shown to benefit cardiac muscle function.

PERTHES DISEASE

It is more common in males (M:F = 5:1) and mainly affects children 5-10 years old.

Pathophysiology

There is avascular necrosis of the epiphysis of the femoral head due to loss of the blood supply. This is followed by revascularisation and re-ossification.

Clinical Features

They are usually insidious. The child will usually present with hip or knee pain and/or limp of acute onset. The disease is bilateral in 10-20% of cases.

Investigations

One should request a frog-leg lateral X-ray of both hips. The X-ray will show increased density, flattening, sclerosis and fragmentation of the femoral head.

Management

It includes rest, physiotherapy (to increase hip movement) and, in some cases, traction, casts or surgery.

SLIPPED UPPER FEMORAL EPIPHYSIS (SUFE)

It is defined as displacement of the femoral epiphysis from the femoral neck along the physeal plate.

Aetiology

The displacement is caused by a force exerted on the femoral head which exceeds the strength of the femoral physis. Factors which contribute to the weakening of a weak femoral physis include:

- Normal periosteal thinning and widening of the physis
- Trauma
- Obesity
- Inflammatory changes
- Genetic predisposition
- Irradiation (as in cancer patients)
- Endocrine abnormalities (hypothyroidism and hypogonadism)

Clinical Features

The child may present with limb or hip pain which may be referred to the knee. On examination, one will find restricted abduction and internal rotation of the hip.

Investigations

A frog-leg lateral X-ray of the hips will show the slipped upper femoral epiphysis.

Management

These patients are managed surgically with pin fixation.

JUVENILE DERMATOMYOSITIS (JDM)

It is an autoimmune myopathy which is primarily caused by a capillary vasculopathy. It is 2-5 times more common in females than males,

Pathophysiology and Causes

JDM is associated with systemic vasculopathy and is sometimes associated with occlusive arteriopathy and capillary necrosis, which eventually lead to capillary loss and tissue ischemia. As with adult dermatomyositis (see images of dermatomyositis here and here), it is likely an antibody-dependent, complement-mediated disease in which capillary injury results in muscle fibre atrophy.

Although the aetiology remains unclear, it has been proposed that JDM is caused by an autoimmune reaction in genetically susceptible individuals, possibly in response to infection or environmental triggers e.g. prenatal exposure to tobacco smoke and particulate inhalants. Thus, it may be the result of:

- Genetic susceptibility
- Immunological mechanisms
- Infection

Clinical Presentation

The child will present with:

- Muscle weakness (symmetrical muscle weakness that is more apparent proximally than distally)

- Heliotrope discoloration of the eyelids and malar or facial erythema
- Scaly, red rash on the knuckles with Gottron papules (erythematous, papulosquamous eruption over the dorsal surfaces of the knuckles)
- Constitutional symptoms (fever, weight loss, fatigue and headache):
    - They may be the initial finding prior to the onset of muscle weakness and rash.
- Nonerosive arthralgia and arthritis
- Lipodystrophy

Investigations

One should perform:

- Biopsy of affected skin:
    - The hallmark biopsy finding in JDM is perifascicular atrophy.
- Elevated serum muscle enzyme levels (CK, LDH, aldolase, ALT, AST):
    - This is indicative of muscle damage and is common in JDM.

Management

Mild-to-moderate disease may be managed with oral prednisone or steroid sparing drugs e.g. methotrexate. Severe or life-threatening disease may be managed with IV methylprednisolone or IV cyclophosphamide.