

REVIEW ARTICLE

Common paediatric conditions of the lower limb

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Abstract: Growing children are susceptible to a number of disorders to their lower extremities of varying degrees of severity. The diagnosis and management of these conditions can be challenging. With musculoskeletal symptoms being one of the leading reasons for visits to general practitioners, a working knowledge of the basics of these disorders can help in the appropriate diagnosis, treatment, counselling, and specialist referral. This review covers common disorders affecting the hip, the knee and the foot. The aim is to assist general practitioners in recognising developmental norms and differentiating physiological from pathological conditions and to identify when a specialist referral is necessary.

Key words: cavus; equinovarus; heel pain; hip dysplasia; intoeing; Osgood-Schlatter; Perthes.

The Hip

Development dysplasia of the hip

Developmental dysplasia of the hip (DDH) is a broad term used to describe the condition in which there is an abnormal relationship between the femoral head and the acetabulum. This includes frank dislocations, subluxations, instability of the femoral head and various findings on ultrasound and X-ray that reflect inadequate formation of the acetabulum. Signs may be present at birth or develop as the baby grows. Hip dysplasia occurs in 1 in 100 babies and usually resolves spontaneously by 6 weeks of age. Frank hip dislocation occurs in 1 in 1000 babies.

Universal screening of all newborns with hip ultrasound (US) is not generally recommended; however, screening of all newborn infants by physical examination should be performed, followed by the appropriate use of imaging before 6 months of age in those infants with positive clinical findings or with significant risk factors. All families should be advised about safe swaddling and wrapping techniques and should be encouraged to do gentle adductor stretching at bath time or nappy changes.

Hips should be examined at the 6-week neonatal check and at each vaccination visit during infancy. The infant should be assessed with the nappy off and in a relaxed state to best allow for the detection of subtle findings. The most important sign of a dislocated hip is asymmetric abduction when the hip is flexed to 90° – limited hip abduction of less than 60° may be the most sensitive sign for detecting dislocated hips. Further clinical examination techniques vary with age. At less than 3 months of age, Ortolani (reduction) and Barlow (hip stress) manoeuvres are recommended (Fig. 1). Benign 'hip clicks' resulting from soft tissue snapping over bony prominences must be distinguished from 'hip clunks' detected in a positive Ortolani manoeuvre as the dislocated femoral head is reduced and from subluxation of the femoral head felt during Barlow's test.

At older than 3 months of age, these tests become more difficult; thus, other signs to look for are limited hip abduction, leg length discrepancy and asymmetrical thigh and gluteal skin folds. A 'short thigh' or leg length discrepancy (positive Galeazzi test) can be detected with the hip and knees flexed to 90°, assessing the vertical level of the knees. Asymmetric thigh and gluteal folds can occur in up to 25% of normal infants; thus, this alone is not a critical clinical finding. The walking-age child may have an abnormal gait, such as a limp with toe walking on the affected side or flexion on the unaffected side. Increased lumbar lordosis, prominent buttocks or a waddling gait may indicate bilateral hip disease.

A 6-week hip ultrasound scan should be arranged in infants with clinical findings or those who have risk factors for DDH. Risk factors include breech presentation, family history of DDH (especially if parent or sibling), large baby (>4 kg), overdue (>42 weeks), reduced uterine volume or prolonged swaddling with legs in extension.

Risk factors for DDH necessitating screening US examination:

- Breech presentation
- Family history of DDH
- Torticollis
- Calcaneovalgus or metatarsus adductus foot

Those with mild dysplasia (40–50% femoral head coverage with only mildly dysplastic acetabula) should continue to be monitored, with serial clinical examination and appropriate imaging at 3 months, 6 months and 1 year of age. Ultrasound should be conducted in all infants younger than 6 months of age as the femoral head is largely cartilaginous; at older than 6 months of age, plain anteroposterior (AP) pelvis radiographs may be used.

All babies with obvious clinical findings on examination and/or moderate to severe dysplasia (ultrasound demonstrating less than 40% of bony coverage and a moderate to severe dysplastic acetabular shape) should be referred for urgent paediatric orthopaedic assessment.

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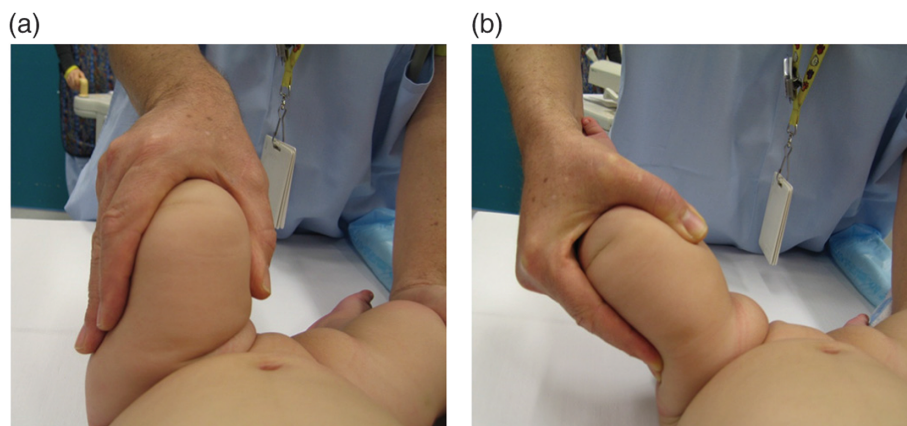


Fig. 1 (a) Barlow test – The baby's left hip is adducted and flexed to 90°, and the examiner applies pressure directed posteriorly. The test is positive when the hip dislocates posteriorly. (b) Ortolani test – The baby's left hip is flexed and gently abducted while the examiners fingers elevate the greater trochanter. The test is positive when the femoral head is reduced into the acetabulum.

Indications for specialist referral:

- Asymmetric abduction (or limited if bilateral) when the hip is flexed to 90°
- Moderate to severe dysplasia: (i) positive clinical examination; and (ii) <40% bony coverage on US
- Mild dysplasia not improving
- Acetabular index >30°

Babies who do not show improvement on serial examination should also be referred to an orthopaedic surgeon for an assessment. These include infants with hips that have an abnormal ultrasound at 3 months with less than 50% head coverage and abnormal acetabular features or have an X-ray with acetabular indices (Fig. 2) of greater than or equal to 30°.

The primary goal of treatment is to stabilise the unstable hip – to achieve a stable concentric reduction of the hip to allow for normal joint development. Most unstable hips stabilise by the age of 4–6 weeks. Those that remain unstable or dislocated are treated with a dynamic flexion-abduction brace known as a 'Pavlik' harness (Fig. 3). Firmer abduction braces are available for the management of more mature infants. These braces should be worn at all times in the earlier period, and compliance should strongly be emphasised when advising families.

Surgical intervention is required in those who fail bracing or in those who are diagnosed late and are not suitable for bracing, thus demonstrating the importance of early diagnosis. The earlier a dislocated hip is detected, the simpler and more effective the treatment. Premature hip joint degeneration requiring joint replacement and back pain are common long-term consequences

of missed or late-diagnosed DDH – careful clinical examination, investigations and a high level of suspicion are critical.

Perthes disease

Legg-Calve-Perthes disease refers to an idiopathic hip disorder that leads to avascular necrosis of the capital femoral epiphysis. During the disease process, there is an imbalance of femoral head resorption and reformation, with a predominance of resorption resulting in femoral head deformity and mechanical weakening. The disease process can last anywhere from 2 to 5 years. It typically affects boys aged 3–11 years, with bilateral disease presenting in 10–15% of patients. The later the onset of the disease, the less favourable the outcome: the majority of patients who experience onset before the age of 6 go on to do well, whereas patients older than 8 years at the onset of the disease have a poorer prognosis.

In general, most cases present with a mild pain, limp and/or limited hip motion. The pain is usually insidious in onset; is felt in the hip or can be experienced in the knee, thigh or groin region; and is typically worse after activity. The child is otherwise well and, at some stage, may have been diagnosed with transient synovitis; however, despite time, the limp persists.

On physical examination, a limp may be observed. Some patients may have a positive Trendelenburg sign. The hip range of motion varies with the stage of the disease. Hip motion is generally good in the early stages but may be reduced and irritable

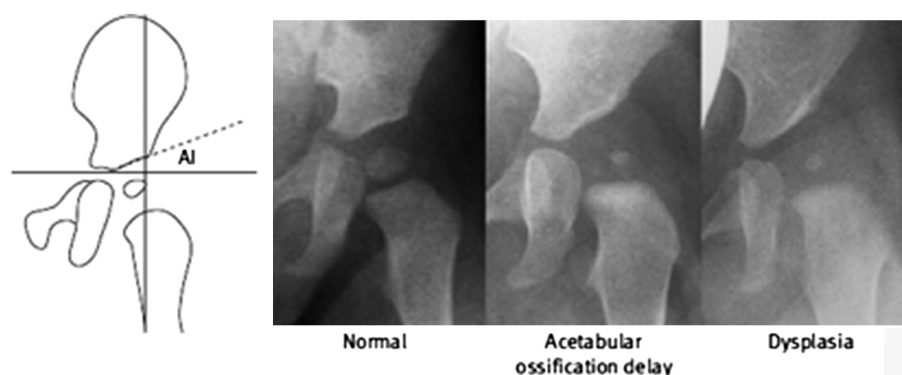


Fig. 2 Acetabular index.



Fig. 3 Pavlik harness.

due to synovitis. Abduction and internal rotation are the earliest movements to decrease; as the disease progresses, flexion and adduction contractures may develop. Depending on the duration of the disease, muscular atrophy in the buttock, thigh and calf may be observed, as well as a limb length discrepancy of 1–2.5 cm.

Imaging of the hip should include an AP pelvis X-ray and frog lateral. Changes on X-ray may be subtle and may vary depending on the stage of the disease. Early changes can include widening of the joint space or subchondral lucency. As the disease progresses, fragmentation, sclerosis and frank collapse of the femoral epiphysis is observed. If initial radiographs are normal and symptoms persist for more than 6 weeks, consider repeating the radiographs. MRI is also helpful in detecting early changes but is best ordered by a specialist.

The goal in the management of Perthes is containment – in other words to keep the femoral head within the acetabulum. Management options range from activity restriction to physiotherapy, bracing or surgery. The choice varies with the stage and onset of the disease. All patients with confirmed or suspected Perthes should be referred for orthopaedic assessment.

Key Points

- Classic physical exam findings for Perthes include reduction of hip internal rotation and abduction.
- High-impact physical activities such as running and jumping should be restricted.
- All confirmed or suspected Perthes disease should be referred for orthopaedic assessment.

Slipped capital femoral epiphysis

Slipped capital femoral epiphysis (SCFE), also referred to as slipped upper femoral epiphysis (SUFE), is the most common hip disorder affecting adolescents, usually occurring between the ages of 8 and 15. The condition is characterised by the displacement of the upper femoral epiphysis from the metaphysis through the physis. In most cases, the cause of SCFE is unclear, but male gender; periods of rapid growth; endocrine abnormalities; and mechanical factors such as obesity, femoral retroversion and physeal obliquity are all risk factors. These conditions result in the weakening of the upper femoral physis, and shearing stress from excessive body weight may cause the femoral capital epiphysis to displace from its normal position relative to the femoral neck. Of children diagnosed with SCFE, 63% have a weight in the 90th percentile or higher. There is evidence to suggest that with the increasing rates of obesity, there is an increased prevalence of patients with an SCFE. It has also been noted that as the mean weight of patients with SCFE is increasing, the age at diagnosis is decreasing. However, it is important to be aware that there are a number of patients presenting with SCFE who are slim and active.

The incidence of SCFE varies between 0.2 per 100 000 and 10 per 100 000. Bilateral involvement of the hips has been reported to occur in 18–50% of patients, and approximately 50% of patients with bilateral SCFE have it at initial presentation. In most patients, the second slip occurs within 18 months after the initial presentation, with younger patients and those with endocrinopathies being at a much higher risk for bilateral involvement.

Traditionally, SCFE has been classified as pre-slip, acute slip, chronic slip and acute on chronic slip. This is based on history, duration of symptoms, physical examination and radiographs. More recently, a more clinically relevant classification has been developed based on physeal stability and relates to the prognosis of subsequent avascular necrosis (AVN). In a stable SCFE, the patient is able to ambulate, with or without pain; in an unstable SCFE, no ambulation is possible, with or without crutches. AVN is rare in a stable slip, and those with an unstable slip have an incidence of AVN of up to 50%. The prognosis of SCFE is related to how quickly the condition is diagnosed and treated. Prompt diagnosis and management are important as a delayed diagnosis can lead to altered hip mechanics and can increase the risk of avascular necrosis and early-onset degenerative hip arthritis.

Suspicion is the key to diagnosis. SCFE should be considered in any child aged 8–15 years with hip, groin, thigh or knee pain, no matter how mild or intermittent. SCFE can occur either with or without trauma. Those with more severe symptoms usually present after a fall or a sports injury, and most will present directly to the emergency department.

Clinical examinations can reveal an antalgic gait or a limp due to shortening and external rotation of the affected leg. Examination of the hip will show reduced range of motion, particularly of internal rotation; flexion of the affected hip is associated with obligatory external rotation. Further investigation with radiographs is used to confirm the diagnosis and grade severity. An AP pelvis and frog lateral of both hips should be arranged; if unable to bear weight, the child should be sent to the emergency department, and an AP pelvis and cross-table lateral should be arranged. The diagnosis is confirmed when radiographs

demonstrate the posterior and inferior displacement of the epiphysis relative to the metaphysis (Fig. 4). Radiographic findings in mild slips may be very subtle, and the slip may only be detected on the lateral X-ray. If X-rays are normal but there are persistent symptoms and localised physical signs, a discussion with an orthopaedic surgeon is recommended.

The management of SCFE of any severity is always surgical and includes screw fixation of the epiphysis to stabilise it and prevent any further slip. Upon diagnosis, the child should be allowed to put any weight on the affected limb, and an urgent referral to an orthopaedic surgeon or hospital emergency department is critical. Any delay may allow a stable slip to become unstable, risk avascular necrosis and a worse outcome.

Key Points

- Consider SCFE in any child over the age of 8 years with hip, thigh or knee pain.
- SCFE of any severity requires urgent admission to hospital for surgical fixation.
- The child should be non-weight bearing on crutches until admitted.

The Knee

Genu varum and genu valgum (bow legs and knock knees)

A significant proportion of referrals from primary care to paediatric orthopaedic physicians involve 'bow legs' and 'knock knees'. The most important aspect to understand is what is normal and what is not. Most lower extremity variants are physiological and resolve spontaneously, so early recognition of the benign nature of the deformity is almost as important as the diagnosis of pathological conditions. This allows reassurance for parents, avoidance of any unnecessary treatment and minimisation of excessive attention on the deformity.

At birth, genu varum and mild internal tibial torsion is common and thought to be related to intra-uterine positioning; these positions become more noticeable as the child starts to weight-bear. This 'physiological' genu varum corrects itself, and at the age of 2 years and onwards, a genu valgum alignment appears. This deformity is most obvious around the ages of 3 and 4 and goes on to correct itself to the normal adult valgus of 7–8° between the ages of 6 and 7. Genu valgum can be accentuated by torsional abnormalities, such as femoral neck anteversion and

a compensatory external tibial torsion; however, education and reassurance is the mainstay of treatment for physiological variations.

Clinical examination is critical in distinguishing physiological variants from pathological deformities. Some factors that might raise the possibility of pathological causes are pain, asymmetrical deformity, deformity not in keeping with normal development, a suspected syndrome or associated musculoskeletal abnormalities. The physical examination should include a gait assessment and observation of the overall lower extremity alignment. It should also focus on excluding any rotational abnormalities and ligamentous laxity. The intercondylar distance should be measured with the medial malleoli in contact and be less than 6 cm when assessing for genu varum. The intermalleolar distance should be measured with the knees in contact, and it should be less than 8 cm in those with genu valgum. Further investigation is warranted when there is any persistent varus after the age of 2 and any valgus greater than 10° after the age of 7. Investigations should include a full-standing AP X-ray of the lower extremities with the patella pointing forward, and laboratory investigations are recommended if warranted by the clinical assessment.

Pathological causes of genu varum include Blount's disease, metabolic disorders (rickets), growth plate injury, osteogenesis imperfecta and skeletal dysplasias. Metabolic causes of genu varum include nutritional and vitamin D-resistant (hypophosphataemic) rickets. If rickets is a concern based on clinical assessment, a metabolic work-up/biochemical screening is suggested with referral to an endocrinologist for medical management, in addition to regular orthopaedic follow-up. Appropriate medical therapy often corrects the genu varum or genu valgum.

Blount's disease can occur in toddlers as well as adolescents. It results from an abnormality in the proximal medial tibial physis, leading to proximal tibial vara. The growth disturbance is likely related to a mechanical overload, with excessive pressure leading to growth inhibition at the proximal medial tibial physis. Risk factors for infantile Blount's include obesity and early independent walking. The severity of Blount's is classified based on the severity of changes seen in the proximal tibia on radiographic examination. Management options include guided growth, physeal bar resection or corrective osteotomies with internal or external fixation.

Pathological causes of genu valgum include idiopathic, post-traumatic, metabolic (rickets, renal osteodystrophy), skeletal dysplasias and asymmetric femoral growth. Idiopathic genu valgum occurs when physiological valgus persists or worsens without an underlying diagnosis. It is thought to be due to excessive forces

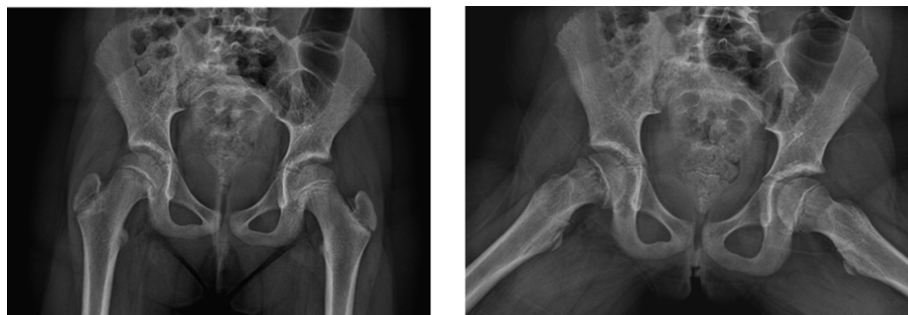


Fig. 4 Anteroposterior and frog lateral radiograph of a right slipped capital femoral epiphysis.

through the lateral knee joint. Some related factors that may be seen are obesity, ligamentous laxity, pes planus and hypoplasia of the lateral femoral condyle.

Post-traumatic genu valgum may develop as the result of a proximal tibial metaphyseal (Cozen's) fracture. It is postulated that this overgrowth of the tibia may occur due to a hyperaemic response to the fracture. Any child with a proximal tibial metaphyseal fracture should be monitored for developing genu valgum and leg length discrepancy.

Renal osteodystrophy is a metabolic cause of both varus and valgus deformities of the lower extremities but more commonly leads to genu valgum. It generally presents in older children. Orthopaedic intervention is only recommended once the renal disease has been stabilised either by medical treatment or transplantation.

'Bow' legs and 'knock' knees are common presenting problems in the paediatric population. It is important that the assessing physician is familiar with the normal lower extremity development and be familiar with factors that may suggest the possibility of a pathological deformity. For children with genu varum, a referral to an orthopaedic surgeon for assessment should be made in any severe deformity (greater than two SD above the norm), an asymmetric deformity, if genu varum persists beyond 2 years of age and if there are any other associated syndromic or musculoskeletal findings. Similarly, a referral for genu valgum should be made in any severe deformity, an asymmetric deformity, increased valgus beyond 8 years of age and if there are any other associated syndromic or musculoskeletal findings.

Orthopaedic referral for genu varum:

- Severe deformity
- Asymmetric deformity
- Persistence beyond 2 years of age
- Associated syndrome

Orthopaedic referral for genu valgum:

- Severe deformity
- Asymmetric deformity
- Intermalleolar distance >8 cm
- Associated syndrome

Osgood-Schlatter syndrome (tibial apophysitis)

Approximately 30 million children participate in organised sport, and approximately a third of those sustain an injury requiring medical attention. There are a multitude of risk factors at play, including varying degrees of athletic ability, inherent developmental factors, lack of fully developed complex motor skills and heightened training. Limb length, mass and moments of inertia naturally change with age; however, where limb length increases by a factor of 1.4 from age 6 to 14, limb mass increases by a factor of 3, leading to musculoskeletal imbalance and increased strain on the tendons, musculo-tendinous junctions and apophyses.

Osgood-Schlatter syndrome is one of the most common causes of knee pain in late childhood and early adolescence. The knee acts as a hinge joint, with the quadriceps muscles attached to the tibial tuberosity via the thick patellar tendon. During a growth spurt, the quadriceps becomes tighter, causing a traction apophysitis (or increased strain) on the tibial tubercle. Repetitive tensile

stresses acting on the insertion of the patellar tendon into the tibial tubercle cause inflammation and increased strain to the tibia.

Boys tend to be more affected than girls, and one or both knees can be affected. It is often seen in children who are highly active, particularly in activities such as running, jumping, kneeling and stair climbing, and typically ceases with rest. Patients usually describe pain, swelling or prominence and localised tenderness in the area over the area of the tibial tubercle. The diagnosis of Osgood-Schlatter syndrome is mainly based on the history and clinical findings. Additional tests, such as an X-ray or ultrasound, may be indicated to exclude other causes of pain around the knee.

Treatment includes activity modification or relative rest, avoiding activities that cause symptoms for a couple of weeks, with a gradual return to sport as symptoms allow. Frequent use of ice packs will help with localised pain and swelling, and anti-inflammatories are suggested as needed. Stretching and strengthening exercises focusing on the quadriceps, hamstrings and the iliotibial band are recommended and can be provided by a physiotherapist. In some instances, a period of immobilisation with a removable splint is required, in which the splint should be removed for daily exercises to maintain range of motion. Osgood-Schlatter syndrome usually resolves spontaneously within 12 months; however, symptoms may remain until the apophysis closes. Up to 10% of patients may go on to have pain in adulthood as a result of the formation of a separate ossicle; however, surgical excision is rarely necessary.

Key Points

- Osgood-Schlatter syndrome is a common cause of anterior knee pain in late childhood and early adolescence.
- Osgood-Schlatter syndrome is a clinical diagnosis.
- Osgood-Schlatter syndrome is self-limiting – symptoms are activity-related and resolve with rest.
- X-ray and ultrasound are not necessary except to exclude other causes of knee pain.
- Key to management when symptoms are troublesome is activity modification, followed by a gradual return to sport as symptoms allow is the first line treatment.
- Since this is largely a benign, self-limiting condition, many children are happy to continue with sports once they understand the cause of their symptoms.

Patellar instability

The patella sits in the groove of the femur and slides evenly up and down with flexion and extension of the knee. The quadriceps muscles come together to form a tendon attachment to the patella, helping the patella to track within the groove. There are times when the patella moves too far laterally or rarely medially, causing it to slip out of place, either partially or completely, resulting in pain and/or dysfunction. In the first-time dislocator, up to 20% of patients will have an additional episode of subluxation or dislocation, of whom up to 50% will go on to re-dislocate further.

The acute patellar dislocation is typically a non-contact twisting injury but may also result from a direct blow to the knee. The

patella often relocates spontaneously. There are cases in which the patella dislocates with very little force, suggestive of underlying abnormalities in the knee's extensor mechanism. A shallow or uneven groove, miserable mal-alignment (femoral anteversion with external tibial torsion), ligamentous laxity, a weak or dysplastic vastus medialis oblique muscle, tight lateral structures, a high-riding patella and family history are all risk factors for patellar instability.

Symptoms vary depending on the degree of translation of the patella. Some general symptoms include anterior knee pain, feelings of knee instability, swelling and apprehension with running and changing direction. Those with recurrent subluxation may complain of mechanical symptoms. Examination reveals tenderness along the medial retinaculum or the quadriceps insertion on the patella. There is often an effusion and a positive apprehension sign. The apprehension test is performed with the knee flexed to 30°, and the patella is pushed laterally. Overall knee stability, lower extremity alignment and a rotational profile should be assessed, and generalised ligamentous laxity should be looked for.

Investigations, including an AP and lateral radiographs of the knee, should be performed in the acute setting. Upon reassessment, a patella skyline or Merchant view should be performed to rule out any acute trauma and assess for any skeletal abnormality. MRI should be arranged acutely in patients with a significant haemarthrosis, persistent pain and/or effusion, limited range of motion 1–2 weeks post-dislocation and for those with suspicious findings on X-ray. An MRI should also be considered in males with tight extensor mechanisms as well as in injuries with a high-energy mechanism.

Treatment of a patellar dislocation first requires reduction. One reduced, the knee should be treated with an elasticated bandage and ice therapy to reduce swelling, early mobilisation and weight bearing as tolerated, and a referral should be made for urgent physiotherapy. An orthopaedic referral should be made for all first-time dislocators within 2 weeks of the injury. A repeat evaluation of the patient should be performed to rule out any intra-articular pathology. Once the knee has settled, physical therapy should commence focussing on quadriceps strengthening, particularly the vastus medialis muscle. Indications for urgent surgical intervention are an osteochondral fracture that is large and/or symptomatic and a patella that is irreducible by closed means. Surgical methods to address patellar instability vary with the underlying pathology; however, the most urgent matter to address surgically in the acute setting is the fixation or removal of the osteochondral fracture fragment.

Key Points

- Indication for MRI.
- Acute significant haemarthrosis.
- Persistent pain and effusion (1–2 weeks post-injury).
- Limited ROM 1–2 weeks post-dislocation.
- VMO strengthening is important in preventing further dislocation.
- Indications for urgent surgical intervention.
- An irreducible patella by closed means.
- Large and/or symptomatic osteochondral fracture.

Osteochondritis dissecans

Osteochondritis dissecans (OCD) is a condition that develops in joints, affecting the subchondral bone and overlying articular cartilage with variable clinical patterns. With an OCD lesion, a small segment of bone weakens and begins to separate from the surrounding region due to a lack of blood supply, putting it at risk of loosening or dislodging from the joint surface. The highest rates of OCD appear between the ages of 10 and 15, with a male to female ratio of approximately 2:1. Bilateral lesions occur in 15–30% of cases, indicating the importance of assessing both knees.

The aetiology of OCD is poorly understood. In the knee, the classic location for an OCD lesion is the lateral aspect of the medial femoral condyle. The prognosis correlates with the age, location and appearance. A younger age correlates with a better outcome – open distal femoral physis is the best predictor of successful non-operative management. Lesions in the lateral aspect of the medial femoral condyle fare better, whereas lesions in the lateral femoral condyle and patella have a poorer prognosis.

Symptoms are usually vague and poorly localised. In the early stages, pain is often generalised to the anterior aspect of the knee and is primarily activity-related. An effusion and swelling about the knee may be seen in times of increased activity and tends to be intermittent. In patients with more advanced OCD, persistent swelling or effusion may be accompanied by mechanical-type symptoms, such as catching, locking or giving way. In the very late stages of the disease, patients may describe the sensation of a loose body.

On physical examination, localised tenderness is palpated over the area of the lesion, effusions are commonly found, and the knee tends to be stiff.

Radiological investigation of suspected OCD of the knee:

- Weight-bearing AP and lateral radiograph of both knees
- Patellar 'skyline' view – to identify lesions of the patella or trochlea
- 'Notch view' in 30–50° flexion – to identify posterior femoral condylar lesions
- MRI – to assess size, status of subchondral bone and overlying articular cartilage, stability of the lesion and presence of loose bodies

All patients with confirmed or suspected OCD should be referred to an orthopaedic surgeon for assessment. Lesions that appear stable are treated non-surgically as 50–75% of lesions will go on to heal spontaneously, particularly in children with an open physis. Non-operative management of OCD in the knee includes immobilisation and restricted weight bearing for 4–6 weeks. If the patient is then pain free, a rehabilitation programme may be initiated. Patients in whom non-surgical treatment fails, those who are approaching skeletal maturity or those who have unstable or loose intra-articular lesions may require operative intervention. This may range from 'drilling' the OCD lesion to promote healing to fixation of loose/unstable fragments with screws. Those lesions that are not fixable may require an intervention that replaces the damaged or missing cartilage.

The Foot

Foot anomalies identifiable at birth or shortly after

Positional or postural talipes

This is a common anomaly noted at birth and thought to be due to intra-uterine moulding. The foot is held in inversion and plantar flexion (Fig. 5) but can be passively corrected to a dorsiflexed and everted or abducted position. This differentiates it from structural talipes (see below). Most cases are mild and respond to parental stretching exercises, and there are no long-term consequences. A short period of casting is occasionally recommended for severe cases.

Metatarsus adductus (varus)

This is also thought to be due to intra-uterine moulding. The deformity seen is an inward curve of the forefoot at the junction between the midfoot and the forefoot. The hindfoot is normal. When looking at the sole of the normal foot, the lateral border is straight – in metatarsus adductus, it is curved (Fig. 6). There is a spectrum of flexibility, that is, whether or not the deformity can be passively corrected. There is no evidence that any intervention alters the natural history, with the possible exception of casting in infancy. The natural history is one of spontaneous improvement in 85% of patients by 6 years.

Calcaneovalgus foot

This is also due to intra-uterine moulding. At birth, the dorsum of the foot rests against or close to the lower anterior shin (Fig. 7). Initially, it may not be possible to fully plantar-flex the foot, but this will quickly improve with parental stretching. Because of the slight association of this condition with developmental hip dysplasia, a precautionary hip ultrasound examination should be arranged at 6 weeks of age.

Structural talipes/congenital talipes equinovarus (CTEV)/Clubfoot

This is not due to intra-uterine moulding but develops early in pregnancy. It may be identified on the 20-week prenatal ultrasound scan. It is twice as common in boys, bilateral in 50% and can be an isolated phenomenon or can be associated with other congenital anomalies and/or syndromes. The foot is held in cavus, equinus,



Fig. 5 Positional or postural talipes.



Fig. 6 Metatarsus adductus of the patient's left foot, evident by the medial deviation of the hindfoot and forefoot, as well as the curvature of the lateral border of the foot.



Fig. 7 Calcaneovalgus – Dorsum of the foot positioned against the anterior border of the shin.

varus and adduction (Fig. 8) and is not passively correctable to a normal position. The baby should be referred to a specialist unit, ideally for Ponseti casting to commence within the first 6 weeks of life.

Intoeing

The cause of intoeing can be determined from an accurate history and physical examination, including examination of the rotational profile.

The rotational profile can indicate one or more of metatarsus adductus, internal tibial torsion and/or femoral anteversion on examination.

Metatarsus adductus

With the patient lying prone, the overall foot alignment is noted. The heel bisector line should point towards the second toe with the lateral border of the foot being straight. Any deviation of the forefoot towards the midline indicates metatarsus adductus. As discussed previously, there is no evidence that any intervention alters the natural history with the possible exception of casting in infancy. The natural history is one of spontaneous improvement in 85% of patients by 6 years.

Internal tibial torsion

The thigh-foot angle is assessed. With the child lying prone and the knees flexed to 90°, the angle formed by a line bisecting the axis of the thigh and a line bisecting the axis of the foot is measured. If the foot is directed inwards, it represents internal tibial torsion. The normal range is from 10° of internal rotation to 15° of external rotation. This generally becomes apparent as a cause of intoeing after the onset of independent walking. Spontaneous improvement of the internal tibial torsion occurs by 6 years of age.

Femoral anteversion

With the patient lying prone and the knees bent to 90°, the amount of internal and external rotation of the hip is measured. For internal rotation, allow the legs to fall away from the midline as far as they will go. For external rotation, allow for the legs to cross at the midline as far as they will go. The normal range of internal rotation is 20–60°, and the normal range of external rotation is 30–60°. Increased internal rotation with decreased external rotation is suggestive of femoral anteversion. Spontaneous improvement is typically seen within 9 or 10 years of age.

Toe walking

This can often be managed by serial casting, particularly in younger children. It is essential to exclude an underlying neurological cause, such as Duchenne muscular dystrophy.

Red flags for toe walking:

- Difficult birth history
- Delayed walking
- Normal walking initially
- Unilateral toe walking

Flexible flat foot

The flexibility of the foot important and can easily be identified by toe stance or Jacks test. Rigid flat feet are not physiological.

Flexible flat foot seen in 45% of children under 4 years and in 15% of adults, that is, flat foot will improve in two thirds of children.

Orthotics DO NOT alter natural history, that is, will not convert a flat foot to a normal arched foot (Wenger DR *et al.* Corrective shoes and inserts as treatment for flexible flat foot in infants and children. *J. Bone Joint Surg. Am.*, 1989; 71(6):800–810.)

Reserve orthoses for flat foot is associated with painful symptoms (usually in adolescence, if at all).

Heel pain

Severs disease, or calcaneal apophysitis, is a benign, self-limiting condition commonly affecting boys aged 9–11 years. They typically experience activity-related heel pain, which comes on during activity or when rising from sitting after activity. The pain generally resolves by the next day and returns with further activity. Normally, there is minimal functional impairment. Management is with reassurance, activity modification if desired (often, the child is happy to continue with exacerbating activities once an explanation is provided), warm-up and warm-down calf stretches and heel raise. Cast immobilisation can be tried for the most severe cases.

Cavus foot

A cavus foot has a high medial arch (Fig. 9). In children, they are often asymptomatic but may be associated with ankle



Fig. 8 Congenital talipes equinovarus foot is held in cavus, varus, adductus and equinus.

Fig. 9 Patient with a cavus foot – Elevated medial arch, with a plantar flexed first ray. The hindfoot is typically found to be in varus, but this is variable.



instability, frequent tripping or falls; 70% of patients with pes cavus will be found to have an underlying neurological cause. In bilateral cases, this is most commonly Charcot-Marie-Tooth disease.

Unilateral cases may be associated with spinal cord pathology or localised neural trauma. Refer to a paediatric orthopaedic specialist for management of the foot and to a neurologist for investigation of the cause.



Mrs Meows by Mia Djukic (age 11) from Operation Art 2016