CLINICAL REVIEW

Evaluating the child who presents with an acute limp

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A child may limp after trivial trauma, as a sign of local or systemic disease, or for no apparent reason. When there is a clear history of injury evaluation is usually straightforward. The diagnostic challenge is to distinguish between disease processes that are benign and self limiting (such as transient synovitis), acute or life threatening (such as septic arthritis or acute leukaemia), or chronic and disabling (such as Perthes' disease). In most cases the causes are benign and self limiting, and around two thirds of patients can be managed without referral to specialist care.[1] [2]

Here, we highlight diagnostic pitfalls and provide a framework for early assessment and management of the child who presents with a limp based on evidence from case series, laboratory studies, observational studies, and expert reviews.

What constitutes a limp in a child?

A limp is an abnormal gait pattern usually caused by pain, weakness, or deformity. The term is most commonly used to described a shortened "stance phase" in the gait cycle, in which a person "hurries" off one leg to offload a source of pain; it is better described as an antalgic gait. Parents often use the term "limping" to describe any abnormality of gait. A fundamental difficulty of assessing a limp is that children do not have a mature, reproducible, rhythmic gait cycle until after 7 years of age,[w1] so discussion between doctor and parents must elicit specific changes in the child's gait.

How common is limping in children?

Few studies have outlined the incidence of limping in the children. A hospital based study in Edinburgh identified 243 cases of non-traumatic limps over six months and suggested an annual incidence of 3.6 cases per 1000 children aged 0-14 years.[1] A nationwide community based study from the Netherlands identified an annual incidence of 1.5 cases per 1000 children of non-traumatic hip pathology.[3] The true incidence probably varies by country and region.

How do I assess the limping child?

History

Most importantly, consider the child's age. Children become vulnerable to a variety of diseases that manifest as a limp at different stages in their childhood (box 1).

Listen to the child and observe their interaction with the parents. Remember that in cases of abuse the history the parents give may not accurately reflect the mechanism of injury. A child may associate a symptom with a previous injury that may not be related. For example, children presenting with Perthes' disease often describe a traumatic origin to their symptoms.[w2]

Elicit the nature of the limp and take the duration of symptoms and presence of pain into account. Like adults children may present with referred pain. Children present with knee pain in a variety of hip disorders.[3]

The birth and developmental history help to identify risk factors for diseases such as hip dysplasia and cerebral palsy and to gauge global motor development. In a systems review consider that systemic illness, such as transient synovitis or leukaemia, may present with a limp.

Examination

In practice the history may unhelpful and clinical signs scant, so a directed examination that actively seeks pathology is useful. The musculoskeletal examination in children can be difficult for doctors of all grades and

SOURCES AND SELECTION CRITERIA

We searched Google Scholar and Medline (1965-2010) using the terms "limp", "hip", "Perthes", "developmental dysplasia", "transient synovitis", "irritable hip", and "slipped epiphysis". We also searched bibliographies of retrieved articles for articles not indexed elsewhere and identified references from searches of our files. Only papers published in English were reviewed. No related Cochrane reviews were available. We selected articles if they were the best evidence available or best summary of the evidence. Some articles were included to place the review in historical context.

SUMMARY POINTS

Atraumatic limps are a source of concern to both the family doctor and emergency practitioner

Age is the key factor in forming a list of differential diagnoses

The hip is the most common source of pathology, and pain is often referred to the knee

A delay in the diagnosis of a slipped upper femoral epiphysis may worsen the outcome

Transient synovitis and septic arthritis may be difficult to differentiate so any clinical concern warrants urgent investigation

Box 1 | Primary differential diagnosis of an "atraumatic limp" by age*

0-3 years

Septic arthritis or osteomyelitis

Developmental hip dysplasia

Fracture or soft tissue injury (toddler's fractures or non-accidental injury)

3-10 years

Transient synovitis or irritable hip

Septic arthritis or osteomyelitis

Perthes' disease

Fracture or soft tissue injury (stress fracture)

10-15 years

Slipped upper femoral epiphysis

Septic arthritis or osteomyelitis

Perthes' disease

Fracture or soft tissue injury (stress fracture)

Other diagnoses

Haematological disease, such as sickle cell anaemia

Infective disease, such as pyomyositis or discitis

Metabolic disease, such as rickets

Neoplastic disease, such as acute lymphoblastic leukaemia

Neuromuscular disease, such as cerebral palsy or muscular dystrophy

Primary anatomical abnormality, such as limb length inequality

Rheumatological disease, such as juvenile idiopathic arthritis

*Based on studies of the common diagnoses encountered in atraumatic limps[1] and atraumatic hip disease in children.[3] [4] Non-accidental injury is included because of the importance of making a prompt diagnosis. We examined age distribution in the more common diagnoses to allow classification of the diagnosis by age (transient synovitis[3] [5] Perthes' disease,[6] [7] slipped capital femoral epiphysis,[8] late presenting developmental dysplasia of the hip,[9] osteomyelitis,[10] [11] toddler's fracture,[12] and orthopaedic injuries in non-accidental injury[13] [14])

Box 2 | Modified paediatric "gait, arms, legs, and spine" examination for the limping child

Screening questions

"Do you have any pain or stiffness in your joints, muscles, or back?"

Gait/general

Record the child's temperature*

Observe the child walking. Ask the child to walk on his or her tiptoes and heels

Arms

Not directly applicable

Legs

Feel for effusion of the knee

Ask the child to: "Bend and then straighten your knee" and feel for crepitus

Apply passive flexion (90°) with internal rotation of hip

Spine

Observe the spine from behind

Ask the child: "Can you bend and touch your toes?"

Observe the curve of the spine from the side and behind

*Item added to the standard examination

Box 3 | An orthopaedic "look, feel, move" approach to the child with a limp

Look

Is the child unwell, feverish, or tachycardic?

Can the child stand?

Is the spine straight?

Is there any evidence of spinal dysraphism (tufts of hair or sacral pit)?

Is the pelvis level?

Are the legs of equal length?

Are the joints swollen or bent?

Do the muscles look hypotrophic or hypertrophic?

Feel

Can the patient localise the pain?

Is focal tenderness present? (Systematically palpate the spine, pelvis, lower limbs, and perhaps the abdomen and testicles)

Is there increased heat over joints?

Move

Can the child walk?

Is there any evidence of a gait abnormality, such as antalgic or trendelenburg gait (downward tilt of the pelvis when standing on one leg on the side of abnormality)?

Does each joint move fully and without pain?

Pay special attention to the hips. Do the hips move normally? Do they internally rotate symmetrically and without pain (pain or restricted internal rotation is a sensitive sign of pathology of the hip joint)?

specialties.[15] The "paediatric gait, arms, legs, and spine" (pGALS) examination is a quick to perform, acceptable, and validated musculoskeletal screening examination in school aged children.[16] Box 2 shows a slightly modified version of the examination that is useful when examining a limping child. Box 3 details an orthopaedic "look, feel, move" approach to assessment using questions that we believe are helpful in making a diagnosis.

Meticulous examination of the hips is crucial because this joint is a common source of unexplained limp.[1] Restricted internal rotation is the most sensitive marker of hip pathology in children, followed by a lack of abduction, according to expert opinion. Loss of abduction in a child can be difficult to assess even in experienced hands because children often tilt their pelvis to give a false impression of hip abduction.

Both intra-abdominal pathology[w3] and testicular torsion[w4] may present simply as a limp, so examination of the abdomen and, in boys, the testicles is important.

What are the potential causes of a limp?

Trauma is the most common cause of limping in children. Children have growth plates that are more vulnerable to injury than ligaments, and a "sprain" in a child should raise suspicion of a physeal injury. Children are more flexible than adults, so seemingly trivial force can cause joint subluxation or dislocation in normal children.[w5] The threshold for radiographic assessment in the child is therefore low, especially when the diagnosis is uncertain.

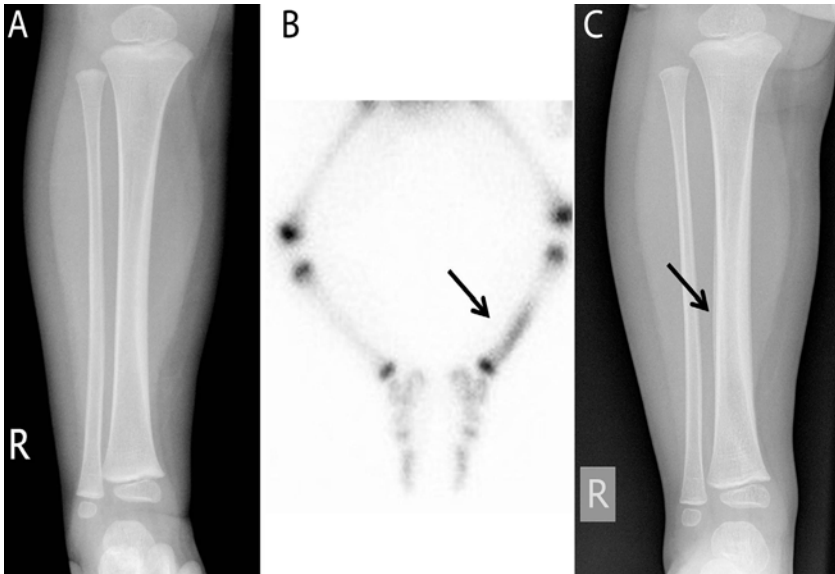In a prospective series of 243 children presenting to one emergency department with an acute atraumatic

Fig 1 | (A) Anteroposterior radiograph of the tibia at the initial presentation on the side of the limp. No abnormality is apparent. (B) Bone scan shows obvious increased uptake in the distribution of the right tibia. (C) After four weeks a florid periosteal reaction can be seen, which supports the diagnosis of toddler's fracture
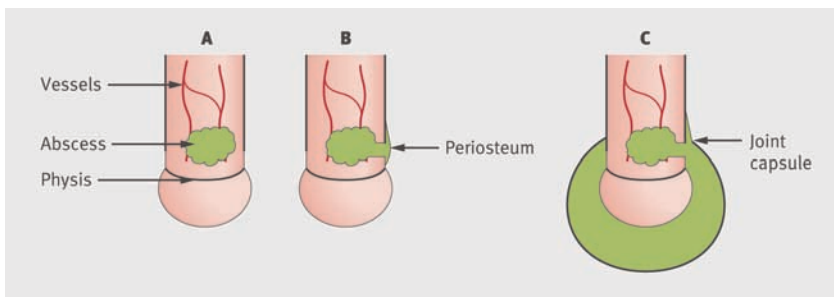

Fig 2 | Development of septic arthritis. Infection often begins as a metaphyseal focus of osteomyelitis (A). The thin cortex of the metaphysis is easily breached and the infection spreads to the subperiosteal space forming a periosteal abscess (B). If the metaphysis is intra-articular, inoculation of the joint space may occur, resulting in septic arthritis (C)

limp, the pathology arose from the hip in more than 60% of cases in which a diagnosis was made.[1] In this series the most common diagnosis was transient synovitis or irritable hip (40%). Chronic muscle sprains or unreported trauma accounted for a further 16% of diagnoses. No diagnosis was made in 30% of cases. Other diagnoses were Perthes' disease (2%), osteomyelitis (1.5%), toddler's fracture (1%), and slipped capital femoral epiphysis (1%). Less common diseases made up the remainder (see box 1).

What key diagnoses should be considered?
Toddler's fracture
This is a subtle undisplaced spiral fracture of the tibia usually seen in preschool children.[w6] It is caused by a sudden twist, often after an unwitnessed fall. The unclear history may prompt the clinician to consider abuse. Examination may be difficult in the child with few clinical signs. Localised tenderness over the tibial shaft may be present or gentle strain on the tibia may provoke symptoms. Diagnosis may be delayed if initial radiographs show little evidence of fracture. In one series of 37 cases, five fractures were not present on initial radiographs, although this result may

be biased by poor case ascertainment.[12] If the history and clinical examination suggest a fracture and other differential diagnoses are excluded, the child can be immobilised and managed expectantly. The diagnosis may be confirmed by follow-up radiographs that show evidence of callus at the fracture site (fig 1). In the absence of a clear diagnosis a bone scan may identify the pathology.

Transient synovitis
Atraumatic limp is usually caused by transient synovitis.[1 3 4] It is most common in boys aged 4-8.[1 5] It is self limiting and weak evidence supports the theory that it follows a viral illness.[17 w7] Definitive diagnosis is based on a confirmed hip effusion and the exclusion of other potential causes. A link between transient synovitis and the development of Perthes' disease has been suggested, but again the evidence is weak.[w8]

Septic arthritis
Septic arthritis is an infection of the synovium and joint space. Pathogens vary by geography and time. A recent series of 102 Australian cases found that *Staphylococcus aureus* was the most common organism, with no cases of *Haemophilus influenzae* since the introduction of vaccination against this organism.[11] Group B *Streptococcus* is also a consideration in neonates.[w9]

Seeding of the infection is usually through haematogenous bacterial spread. Joints with an intra-articular metaphysis (hip, shoulder, ankle, and elbow) are particularly vulnerable. In children under 18 months the physis does not prevent blood entering the epiphysis, making joints more vulnerable to infection.

Joint destruction and growth arrest may occur (fig 2) if the infection is not treated urgently by surgical washout and intravenous antibiotics.

Perthes' disease
Perthes' disease is an idiopathic avascular necrosis of a developing femoral head. It typically presents in boys aged 4-8 years.[6] Affected children are usually shorter than their peers[18] and have a hyperactive tendency.[w10] It is diagnosed by plain anteroposterior radiography of the pelvis. Classic radiographic features include sclerosis, fragmentation, and eventual flattening of the proximal femoral epiphysis (fig 3).[w11] Radiographic changes may be absent in early disease, and Perthes' disease may initially be mistaken for transient synovitis. Symptoms typically settle within about two weeks in transient synovitis whereas in Perthes' disease they persist. If symptoms persist a technetium bone scan or magnetic resonance imaging can help to identify the pathology, which is seen as an area of reduced perfusion

A difficult case of limping
An 18 month child attended with limping. Initial examination, blood tests, and radiographs were unremarkable. Ultrasound of the hips was normal. Given the unclear presentation a technetium labelled bone scan was performed. This test showed increased uptake in the right mid-tibial region (fig 1) and the defect was treated as a toddler's fracture. A further radiograph four weeks later showed the periosteal reaction associated with the healing fracture
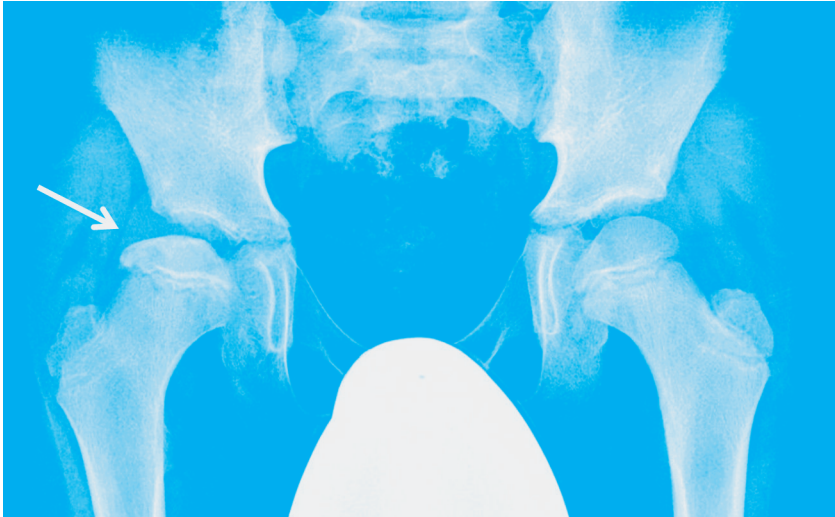
Fig 3 | Radiograph showing sclerotic change within right femoral epiphysis in early Perthes' disease

on bone scan or a signal change on magnetic resonance imaging. Both tests are thought to have similar sensitivity and specificity (98% sensitivity, 95% specificity for bone scan[w12]), although no such data are available for magnetic resonance imaging. Treatment requires "containment" of the hip within the acetabulum by surgical or non-surgical means. Prognosis depends on age, sex, and extent of epiphyseal involvement.[19]

Developmental dysplasia of the hip

Developmental dysplasia of the hip is the term that has replaced congenital dislocation of the hip. Most cases are identified through routine infant clinical screening and selective ultrasound screening of high risk groups. It mostly affects girls and when presentation is delayed

Box 4 | Red flags (requiring urgent investigation)

Child <3 years old

Unable to bear weight

Fever

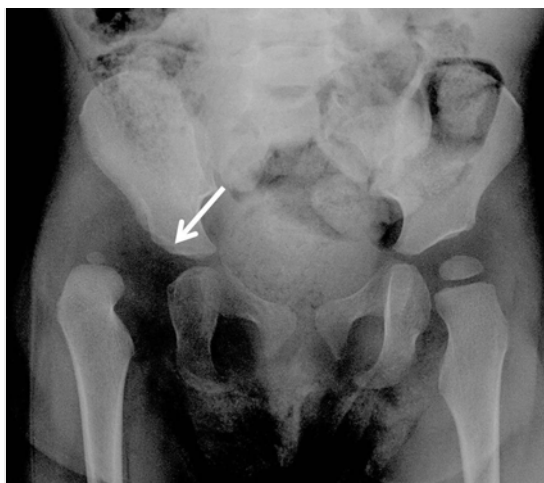Systemic illness

Child >9 years old with pain or restricted hip movements

Fig 4 | Radiograph of a 16 month old child showing a right dislocated hip

typically presents as a limp.[9] Diagnosis is based on a plain radiograph of the pelvis in children of walking age (fig 4). Bilateral developmental dysplasia of the hip may be more difficult to detect than unilateral disease, because the resultant loss of abduction, limb shortening, and altered gait are symmetrical and difficult to identify.

Slipped capital femoral epiphysis

Slipped capital femoral epiphysis, otherwise known as slipped upper femoral epiphysis, usually affects children over 10 years.[8]

The proximal femoral epiphysis displaces relative to the metaphysis. It is slightly more common in boys and patients are often overweight.[w13] It is associated with endocrinal abnormalities such as hypothyroidism and growth hormone deficiency.[20]

Knee pain is common, and a review of 106 cases of slipped capital femoral epiphysis found this to be the primary feature in 15% of cases.[21] Periadolescents who have pain or discomfort on internal rotation of the hip require radiological imaging.

The defect must be diagnosed promptly to avoid poor outcome. Two retrospective studies of 102 and 65 cases of mainly stable slipped capital femoral epiphysis found a significant tendency to greater deformity in the group with a delayed diagnosis.[21 22] A recent meta-analysis of five studies assessed the urgency of surgical fixation in unstable slipped capital femoral epiphysis (<24 hours v >24 hours). Although the results were not statistically significant, early fixation seemed to improve outcome.[23]

Plain anteroposterior radiographs of the pelvis may be unremarkable if the slip is subtle. A lateral projection is essential if this condition is suspected and should be requested as (fig 5)[w14] many radiology departments do not routinely obtain lateral projections of children's hips.

A pragmatic approach to managing limps not attributable to trauma

Advice on how to manage a childhood limp varies greatly. Orthopaedic and emergency medicine journals generally suggest immediate investigation, yet general practitioners often take a more considered approach, with one Dutch community based study showing that they often opt for close follow-up rather than immediate investigation.[24] A retrospective study of 350 child hospital emergency attendees in New Zealand who underwent radiography for a limp or hip symptoms found that 38% were afebrile and able to bear weight at presentation. All but one of these patients had transient synovitis.[4] The child with an alternative diagnosis had osteomyelitis, which can go undetected even with blood investigations.[25] On the basis of these reviews and our own experience we suggest a considered approach.

Children under 3 years

These children are vulnerable to septic arthritis and non-accidental injury. Transient synovitis is rare, so this diagnosis should be made with extreme caution and only after excluding more serious pathology. Clinical signs may be scant and the child may simply not move the limb—so called pseudoparalysis. Most practitioners lack experience in assessing children of this age and urgent referral is advised (box 4).
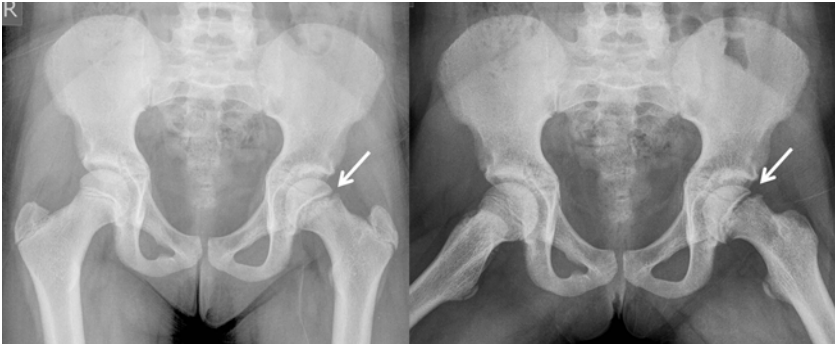
Fig 5 | Left sided slipped capital femoral epiphysis. The "frog" lateral radiograph shown on the right is important to detect the abnormality, which is difficult to see on plain anteroposterior radiography

Children 3-9 years

Transient synovitis is most likely in this age group. A brief period of observation is permissible if the child is well, afebrile, mobile, but limping and has had symptoms for under 48 hours. Manage with rest and advice and follow-up within the next 48 hours. Tell parents to attend the emergency department if symptoms worsen or if fever or systemic illness supervenes. If symptoms are resolving at follow-up the working diagnosis is transient synovitis and no investigations are needed. The child should be reviewed a week later to confirm complete resolution of symptoms. If the symptoms worsen or fail to resolve start investigations.

Children over 9 years

Slipped capital femoral epiphysis becomes a consideration in this group. Patients need urgent investigation (box 4), including anteroposterior and lateral radiographs of the hips. Additional investigations are based on the clinical presentation. An 8 year old child with risk factors for a slipped capital femoral epiphysis (obesity, history of endocrinopathy, radiotherapy) would also need urgent investigation.

Investigations

Investigations depend on the suspected diagnosis but should include a full blood count, erythrocyte sedimentation rate, and C reactive protein, along with radiographs of the site of pain and the pelvis if restricted hip movements or knee pain is present.

Ultrasound can identify a hip effusion and help localise the sight of pathology but cannot identify the underlying

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Box 5 | Kocher's criteria for differentiating septic arthritis from transient synovitis

Factors for predicting septic arthritis
Fever >38.5°C
Cannot bear weight
Erythrocyte sedimentation rate >40 mm in the first hour
Serum white blood cell count >12×10⁹/l

Probability of septic arthritis
No factors: <0.2%
1 factor: 3%
2 factors: 40%
3 factors: 93.1%
4 factors: 99.6%

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pathology. A prospective hospital based study found that routine ultrasound of the hips had a low sensitivity (57%) and specificity (59%) for establishing a diagnosis in children with atraumatic limps. Nevertheless, a negative result was useful in that it prompted further investigation.[26]

In the absence of a working diagnosis, or when symptoms persist, further investigations include technetium labelled bone scans and magnetic resonance imaging. These tests may uncover unexpected diagnoses such as intervertebral discitis, toddler's fractures, or Perthes' disease. Consider additional blood tests, such as creatine kinase (muscular dystrophy), immunogenic markers (rheumatological disease), and a sickle cell screen in high risk groups.

How can transient synovitis and septic arthritis be differentiated?

This is one of the most difficult problems for practitioners faced with a child with an "irritable hip." Ultimately the "gold standard" is to aspirate the joint and identify the presence, or absence, of organisms. However, this is invasive and would yield a large proportion of negative results. Clinical and biochemical markers may therefore be used to help in this process.

In 1999 a retrospective series of 168 children with a confirmed hip effusion identified four factors that were useful in differentiating septic arthritis from transient synovitis.[27] When all four variables were positive the probability of septic arthritis was 99.6%. This algorithm (Kocher's algorithm) has since been validated prospectively,[28] although external validation failed to support the strength of the positive predictive value, suggesting only a 59% probability of septic arthritis with all four variables present.[29] Although the accuracy of Kocher's algorithm is debated, it is currently the most useful tool available (box 5).

If a practitioner has any concerns regarding the clinical differentiation of these disorders, urgent referral to secondary care will allow blood samples to be collected facilitate this process.

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ANSWERS TO ENDGAMES, p 463. For long answers go to the Education channel on bmj.com

STATISTICAL QUESTION
Hazard ratios

Answers *a* and *d* are true, whereas *b* and *c* are false.

ON EXAMINATION QUIZ
Pancreatitis

Answer D is the correct answer.

PICTURE QUIZ
Management of paediatric burns

1 The total body surface area is less than 1% using the palmar method for small burns: the area of patient's palm and fingers corresponds to about 0.8% total body surface area in children and adults. For larger burn areas use Lund and Browder charts (children) or Wallace's rule of nines (adults).
2 Superficial dermal. Although the burn appears lighter than the patient's normal skin tone, the examination findings (moist, blanched on gentle pressure, and sensate) are clinical features of this depth of burn. Blistering denotes a dermal burn but does not help determine whether it is superficial or deep dermal.
3 No, the burn is less than 10% of the total body surface area, which is the threshold for defining a major burn that requires intravenous fluids in children.
4 Yes. The location of this burn is on a "critical site"—the feet.
5 Infection; scarring: scar hypertrophy is more common in certain areas of the body (including the feet), and problems of hypopigmentation or hyperpigmentation are more common in people with dark skin; and toxic shock syndrome, which is often missed. It is a rare but serious complication and the most common cause of unexpected death in children with small burns.