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RESEARCH ARTICLE

Paediatric Septic Arthritis of the Hip: Epidemiology, Diagnosis, and Treatment

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ABSTRACT

Background: Septic arthritis of the hip is an orthopaedic emergency which requires prompt diagnosis and treatment. If treated late or inadequately, it can have devastating consequences for the development of the hip joint. Infection is most commonly caused by *Staphylococcus aureus* which spreads via the blood stream or from an adjacent area of osteomyelitis. Diagnosing and managing this condition continue to be challenging and poor outcomes may occur. Neonates may present with sepsis and failure to thrive. There may be no fever. The hip is held in flexed, abducted and externally rotated position. The limb is held still and any passive movement causes pain. Older children typically present with a limp or refusal to walk. Children typically have elevated erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels. Needle aspiration is the most specific diagnostic test. Prompt surgical drainage and postoperative antibiotic therapy until signs of infection resolve are necessary to prevent late sequelae.

Objectives: The present review aims to discuss the published evidence related to the diagnosis of septic arthritis of the hip based on history, physical examination, laboratory tests, imaging studies and arthrocentesis, and management including antibiotic treatment and surgical joint debridement.

Conclusion: With prompt diagnosis and appropriate treatment, outcomes are generally good, with only few long-term sequelae. Delay in diagnosis and treatment may result in growth disturbances and joint destruction.

Introduction

Septic arthritis of the hip is a bacterial infection of the joint synovium and later, of all structures within the joint. The hip is a common location for septic arthritis in children[1], and this usually affects infants and toddlers[2]. Dissemination of microorganisms into the joint occurs most commonly through haematogenous spread[2], and less commonly by direct inoculation[3]. Septic arthritis of the paediatric hip may lead to destruction of the articular cartilage and later, the joint. The damage caused by infection is more prevalent in the hip than other joints[1,4]. Septic arthritis is less common than osteomyelitis, is less studied and remains a management challenge[5].

The prevalence of infections caused by particular organisms vary depending on patient age, vaccination history, geography and antibiotic resistance. Vaccines targeting *Haemophilus influenzae* and *Streptococcus pneumoniae* have led to a dramatic decrease of septic arthritis caused by these microorganisms[6]. Known risk factors include young age, male gender, respiratory distress syndrome, umbilical artery catheterisation[7], host phagocytic defects, haemoglobinopathies, intervention on joints, instrumentation of urinary or intestinal tracts[8] and concomitant infection[9]. Most cases of septic arthritis occur in previously healthy children[8].

The consequences of septic arthritis of the hip can be severe and include reduced hip range of motion[10], early osteoarthritis, damage to the growth plate, leg length discrepancy, hip dislocation, avascular necrosis, complete destruction of the femoral head and neck[11] and sepsis[12]. The purpose of this review is to summarize the literature on the epidemiology, pathophysiology, diagnostic tools and management options of septic arthritis of the hip in children.

Epidemiology

The literature provides limited data regarding the incidence of septic arthritis of the hip in the paediatric age group and it differs around the world. In the United States it is estimated to be approximately 1.07 cases per 100,000 children[13]. In South Africa, it is estimated to be approximately 5 cases per 100,000 children[14], while in Malawi it is estimated to be 20 cases per 100,000 children[15].

A variety of pathogens may cause hip joint infections in children. The epidemiology varies between different geographical regions. Causative organisms of septic arthritis of the hip vary with patient's age. In neonates, Group-B *Streptococcus* is the most common causative organism[16]. In children between one and five years, *Staphylococcus aureus, Streptococcus pneumoniae* and *Kingella kingae* are the most common organisms involved[17]. In children older than five years, *Staphylococcus aureus* is the most dominant infective organism[17]. An increasing concern relates to the rising incidence of infections caused by community-associated methicillin-resistant *Staphylococcus aureus* strains (CA-MRSA), which affect children without risk factors[16, 18].

Children with underlying predisposing factors are prone to different types of bacterial infection. For example, children with sickle cell anaemia are predisposed to infection with *Salmonella* species[19]. Immunocompromised children and those with comorbidities are at risk for joint infections with *Pseudomonas spp.*, anaerobes or fungi[20-22].

Unvaccinated children are at risk for joint infections by *Haemophilus influenzae*[23]. Infections with *Neisseria gonorrhoeae* should be suspected in sexually active adolescents or in children with history of sexual abuse[24]. Children infected with human immunodeficiency virus (HIV) have higher rates of *Streptococcus pneumoniae* infections[25]. In areas where Lyme disease is endemic, this condition should be considered as part of the differential diagnosis[26]. Even with the application of all advanced diagnostic and microbiology techniques, the causative organism is not identified in up to 66% of cases with septic arthritis[27].

Pathophysiology

Haematogenous spread of bacteria from remote infection during an episode of bacteraemia is the most common way for intra-articular infection. Synovial fluid is an ultra-filtrate of blood plasma. During events of bacteraemia, pathogens can transfer across the synovium. The synovial fluid contains monocytes and some polymorphonuclear leukocytes that provide a defence line against bacteria. Once the pathogenic load is great enough to overcome the joint's local immune response, a true septic joint occurs. Trans-osseous spread from an area of osteomyelitis can happen and this is mainly in joints in which the physis is intracapsular, such as the hip joint. Direct inoculation of a joint can also occur to cause infection.

Once infection becomes established, bacteria multiply rapidly inducing release of inflammatory cytokines from the synovial lining cells, which in turn cause the release of matrix metalloproteinases (MMPs). MMPs soften the articular cartilage due to an initial breakdown of glycosaminoglycans and later by breakdown of collagen fibres. This immune response causes a joint effusion which raises intra

articular pressure, damaging the softened cartilage, and together with the tamponade-like effect to local blood vessels, also reduces oxygen and nutrient delivery. In addition, bacterial toxins released have a direct effect on chondrocytes[28].

Diagnosis

CLINICAL FINDINGS

The clinical presentation varies, depending on the age of the child. The most important factor is to consider the diagnosis early.

Neonates and infants

Neonates may be septic and present with failure to thrive. There may be no fever. The hip is held in flexed, abducted and externally rotated position. The limb is held still and any passive movement causes pain.

Children

The older child may be unwell with anorexia and irritability. Typically, the child presents with a limp or refuses to walk. Pain is often referred to the knee. On examination, the older child may present with fever. Limited motion of the hip is marked. It is not uncommon for the child or family to report an episode of minor trauma, which can distract from the true diagnosis. Examination should include the spine and sacroiliac joints as well as the remainder of the limb. It is also important to carry out an examination of the child as a whole, to see if a predisposing systemic disease is evident.

EVALUATION

The evaluation for suspected hip sepsis should include full blood count with differential counts, erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) and blood cultures. Anteroposterior pelvic radiograph and a lateral view of the affected hip should also be obtained. Ultrasound can be helpful if there is doubt about the diagnosis.

LABORATORY RESULTS

The accepted diagnostic threshold for white blood-cell (WBC) count is >12,000 cells/mm^3, although the sensitivity of this is only 40%-58%[29]. Morrey et al[30] found that only one third of their patients with septic hips had an elevated leukocyte count. There may be a 'left shift' with increased number of polymorphonuclear cells on blood film. The ESR is a reliable haematological marker. Up to 95% of children present with an ESR of 20 mm/h or greater[31]. C-reactive protein (CRP) is an acute phase protein and is elevated in 95% of cases of septic arthritis. Its levels rise and fall rapidly in response to infection and subsequent treatment[32-33]. There is overlap in the values of WBC count, ESR and CRP in septic arthritis and those with other pathologies. Thus, they are sensitive tests, but lack specificity.

Although blood cultures are routinely performed to assist with the diagnosis, only between 10%-40% of patients with septic arthritis are reported to have positive blood cultures[26, 33-34].

IMAGING

In septic arthritis, up to 50% of radiographs may show abnormalities. Depending on the duration and severity of the infection, radiographic changes in the hip may include soft tissue swelling and loss of tissue planes, widening of the joint space and capsular distention, and subluxation of the hip or associated osteomyelitis of the proximal femoral metaphyseal region.

Ultrasound can be used if there is doubt about the diagnosis or to determine the presence of an effusion in the hip joint. Compared with the contralateral hip, the affected hip will show asymmetry of the capsule. An echo-free effusion indicates transient synovitis or fresh haemorrhagic effusions. Echogenicity indicates septic arthritis or clotted haemorrhagic collections. When these criteria were used, ultrasonography was found to have a sensitivity of 100% in detecting a joint effusion[35]. However, it is not highly specific and therefore clinical data must be combined with ultrasound findings to determine whether hip aspiration should be performed. Ultrasound has a false-negative rate of 5%-14% in the diagnosis of septic arthritis of the hip[36-37].

Scintigraphy is rarely needed to diagnose septic hip arthritis but it can be useful in the difficult case in which the diagnosis remains uncertain despite clinical, radiographic and ultrasonographic examination[38]. It also has utility in establishing the diagnosis of isolated proximal femoral osteomyelitis in a child with mild signs and symptoms.

Magnetic resonance imaging (MRI) is not indicated routinely in the work-up of patients with hip septic arthritis. It is recommended in patients presenting with inconsistent clinical findings and to evaluate concomitant or other periarticular infection processes[39-40].

NON-INVASIVE DIFFERENTIAL DIAGNOSIS

The differential diagnosis of the irritable hip in the paediatric age group includes infection, inflammation, trauma, vascular and neoplastic pathologies. Of all acute non-traumatic hip conditions, transient synovitis has the highest incidence[37,41]. In 1999 Kocher et al[42] in a

retrospective study found four clinical predictors for the differentiation between septic arthritis and transient synovitis which are fever ≥38.5°C, non-weight-bearing, ESR ≥40mm/h and WBC count >12,000 cell/l. The authors observed that if all four predictors were positive, the predicted probability of septic arthritis was 99.6%. Jung et al[43] using five independent predictors which included body temperature >37°C, ESR >20 mm/h, CRP >1 mg/dL, WBC >11,000/mL, and an increased hip joint space of >2 mm found a predictive probability of 99.1% when all five predictors were positive. In 2004, Kocher et al[44] validated their findings with a prospective study and reported 93% predictive probability if all four predictors were positive.

During the same year, Luhmann et al[45] in a retrospective review using the four independent predictors proposed by Kocher reported only 59% predictive probability if all predictors were positive. Caird et al[46] in a prospective study added CRP >20mg/L as a fifth predictor and found a predictive probability of 98% if all predictors were positive. Sultan et al[29] using Caird's predictors in a retrospective study reported a 59.9% predictive probability if all five predictors were positive. Singhal et al[33] found that CRP is the most significant independent predictor in a four-variable predictive model.

JOINT ASPIRATION

Ultrasound or fluoroscopic guided arthrocentesis is indicated when the clinical variables point to septic arthritis or in cases where the clinical situation is not clear. Samples obtained should include WBC count with differential, Gram stain and culture of the synovial fluid[47]. When fluid is not obtained during the initial aspiration attempt, three to five millilitres of sterile saline can be injected into the joint and re-aspirated. Despite being considered the gold standard in the diagnosis of septic arthritis, synovial fluid Gram-negative bacilli stain and culture are positive in only 40%-60% of cases[42, 48]. The supplemental use of polymerase chain reaction (PCR) techniques improves the detection of bacteria in the joint fluid especially for organisms like *Kingella kingae*[34].

Treatment

ANTIBIOTICS

Antibiotic therapy should be initiated as soon as samples for microbiologic examination are obtained. The causative organism can generally be predicted accurately on the basis of the age of the patient.

In the otherwise healthy neonate, Group-B Streptococcal infection is most common, usually presenting with only a single joint involvement. Initial antibiotic coverage should consist of nafcillin or oxacillin, with gentamicin added for the high-risk neonate.

In patients between the ages of 3 months and 3 years, *Haemophilus influenzae* type B has, in the past, been the most common organism, followed by *Staphylococcus spp.* and *Streptococcus spp.* However, with the introduction of the *Hemophilus influenzae* type B vaccine in the late 1980s, there has been a drastic decline in the incidence of infections due to this pathogen[49]. The preferred antibiotics are cefotaxime or ceftriaxone.

In children older than two years, septic hip arthritis is most commonly caused by *Staphylococcus aureus* or *Streptococcus spp.* The initial choice of antibiotic is either a semisynthetic penicillin or a first- or second-generation cephalosporin.

Oral administration of antibiotics is initiated after good clinical response is seen during intravenous antibiotics. Oral administration is more convenient and less expensive and has been shown to be successful in the treatment of septic arthritis when used after parenteral antibiotics. A total of two weeks of antibiotic treatment is usually adequate for less virulent bacteria. Two to three weeks of antibiotics may be required for *Staphylococcus aureus* infection. Infection with a Gram-negative bacilli or an unusual resistant organism may require longer duration of antibiotic treatment[50].

SURGICAL MANAGEMENT

Most authors agree that early operative intervention remains the mainstay of treatment in all cases of septic hip arthritis[51].

Aspiration

Daily repeat aspiration and irrigation is an available option. It is reported to be efficient and provide rapid return to normal activities. It is not associated with surgery and its complications, and prevents scarring and the need for general anaesthesia[52-54]. The technique remains controversial as it does not allow drainage of viscous pus or removal of connective septa in cases with long presentation, and most authors recommend that the technique is to be used in children with presentation shorter than five days from onset of symptoms[7, 55].

Arthroscopy

Hip arthroscopy is becoming more popular for the management of hip septic arthritis. It offers a minimally invasive approach, increased access to the hip joint, improved visualization while

eliminating risks such as avascular necrosis (AVN) of the femoral head, hip instability, extensive surgical approach, scarring, postoperative pain, and prolonged hospital stay[56-58]. Both supine[59] and lateral decubitus[60] positions can be used. Two[58] or three standard[56-57] portals are used. The joint is irrigated with 6-8 litres of normal saline 0.9%[57-58]. Some authors do not recommend the use of postoperative drains[57], while others do[56, 58].

Open Arthrotomy

Open arthrotomy and drainage is recommended by most authors for the management of septic arthritis of the hip[7,55]. Anterior and lateral approaches of the hip are usually used to reduce the risk of damage to the vascular supply of the femoral head.

Donders et al[61] in a systematic review of drainage procedures for septic arthritis of the hip concluded that aspiration and arthroscopy may have a higher risk of additional drainage in comparison with arthrotomy. However, arthrotomy might be associated with inferior outcomes in the longer term. Postoperatively some authors recommend a short period of bed rest and non-weight bearing[56], while others allow early non restricted weight bearing and active hip range of motion exercises[57].

Outcome

Good outcome is achieved in most cases with early diagnosis, joint debridement, and appropriate antibiotic therapy. Misdiagnosis or delay in treatment my result in poor functional or radiological outcomes, AVN of the femoral head, chondrolysis, leg-length discrepancy, subluxation or dislocation of the hip, growth arrest, femoral osteomyelitis and hip joint ankylosis[61-62]. Several authors suggested classification systems that may be useful to guide treatment and prognosis of late sequelae of septic arthritis of the hip[63-64]. The authors suggested that longer follow-up is needed to assess the real benefit of reconstruction for unstable hips.

Conclusion

The management of septic arthritis of the hip in the paediatric population has evolved over time. Surgery is still considered mainstay of treatment. Prompt diagnosis, thorough history taking and clinical examination with supporting radiological examinations plus collection of appropriate specimens and timely targeted treatment with antibiotics have resulted in generally good outcomes, with few long-term sequelae. Delay in diagnosis and treatment may result in poor functional outcomes as a result of the associated skeletal deformities.

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