Acta Orthop. Belg., 2013, **79**, 123-134

REVIEW ARTICLE

Septic arthritis of the paediatric hip – A review of current diagnostic approaches and therapeutic concepts

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A misdiagnosed septic arthritis (SA) of the paediatric hip is a nightmare for many physicians. The authors tried to trace the most recent information about this problem. A Medline search, using PubMed interface, was focused on the period from 01.01.2002 to 31.08. 2012. A total of 53 papers were included in the study. They led to the following statement, among others, about the differential diagnosis between SA and transient synovitis : "CRP > 20 mg/L, non-weight-bearing, temperature > 38.5 °C and peripheral white blood cell count > 12 × 10⁹ cells /L offers a predictive probability for septic arthritis of 87%". As soon as the clinical data point to septic arthritis, a diagnostic needle aspiration becomes mandatory : for cell count, Gram stain and culture. Immediately afterwards, antibiotics should be started, knowing that they need to be adapted to the antibiogram as soon as it is available. If the clinical picture and the CRP improve within 24 hours, antibiotics are continued, classically for 3 to 3.5 weeks. If not, some kind of surgical intervention becomes necessary : arthrotomy, or daily repeated ultrasound-guided aspiration and irrigation, or arthroscopic irrigation and drainage. A diagnostic and therapeutic algorithm is presented. Finnish current literature proposes to reduce the aggressiveness of the treatment of SA, at least in previously healthy children with a short medical history (less than 5 days) : antibiotic therapy of less than two weeks and avoidance of a surgical intervention, apart from a diagnostic needle aspiration, might be justifiable in these cases.

Keywords : septic arthritis ; coxitis ; pediatric hip joint ; treatment.

INTRODUCTION

Septic arthritis of the hip joint is a bacterial infection of the synovium and subsequently of all the structures within the joint, which causes an intense inflammatory reaction, possibly leading to destruction of the articular cartilage and later of the complete joint. Most cases occur by haematogenous dissemination of bacteria (*2,40,49*), and only a few cases by direct inoculation of pathogens (*29*). It usually affects infants and toddlers (*2,40*). Generally known risk factors are young age, male gender, respiratory distress syndrome, umbilical artery catheterisation (*21*), host phagocytic defects, haemoglobinopathies, interventions on joints, and instrumentation of the urinary or intestinal tract (*42*). However, most cases of septic arthritis occur in previously healthy children (*42*). In the literature there are only scarce data about its incidence. In South Africa the incidence of septic arthritis of the paediatric hip is estimated to be approximately 1:20.000 (*34*). Boys are more often affected than girls (*2,11,34*). Septic

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No benefits or funds were received in support of this study.
The authors report no conflict of interests.

arthritis of the paediatric hip has an ongoing importance because of its sequelae : early osteoarthritis (*9,6,26*), damage of the growth plate (*9,40*) with discrepancy of leg length (*8,9,22*), hip dislocation (*22,40*) due to distension and destruction of the joint capsule (*9*), severe limitation of motion (*22*), generalized sepsis (*6,26,46*), or osteonecrosis (*6,8,9,26, 34,42,46*) and complete loss of the femoral head and neck (*8,9*) as the worst case scenario. Early diagnosis and treatment significantly improve the clinical outcome (*17,34,53*). Diagnostic and therapeutic algorithms (Fig. 1) can facilitate decision-making.

METHODS

The authors used the electronic database MEDLINE (Medical Literature Analysis and Retrieval System Online) through PubMed interface, via the keywords/terms 'septic arthritis hip children', combined with 'epidemiology' or 'etiology' or 'clinical features' or 'presentation' or 'therapy'. A total of 53 papers, published between 01.01.2002 and 31.08. 2012, were included, also if written in other languages than English. One exception was made for a paper by Kocher *et al,* published in 1999 (*25*). This paper proposed clinical predictors to differentiate septic hip arthritis from transient synovitis. It was used as a first step towards an algorithm for the clinical prediction of septic hip arthritis (Fig. 1). Papers suggesting surgical techniques for the management of sequelae caused by septic hip arthritis in children were excluded.

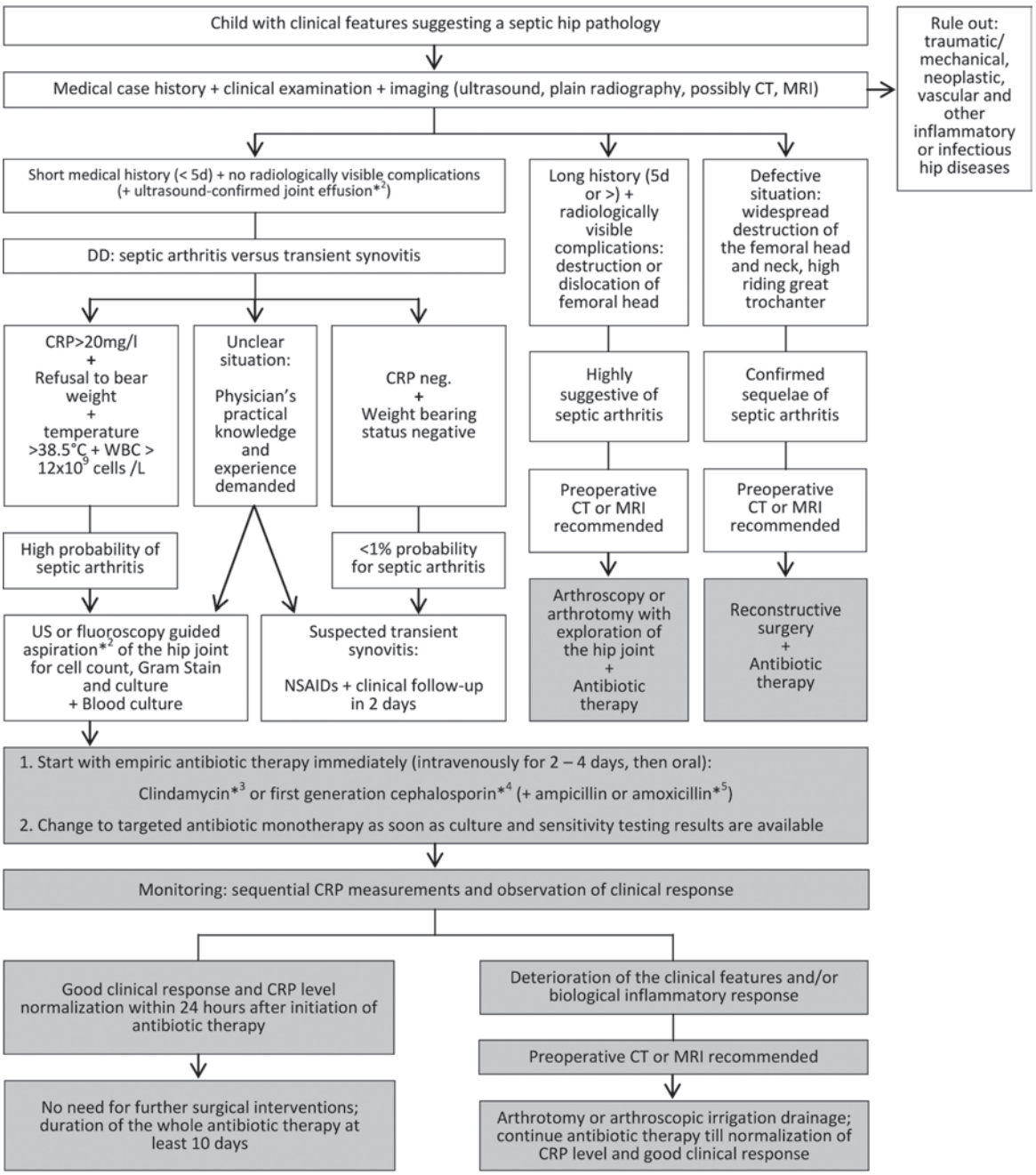
CLINICAL FEATURES

Children with septic arthritis of the hip may present a variety of clinical symptoms. Systemic symptoms such as fever, malaise and poor appetite are often seen (*42*). In neonates typical symptoms and signs of hip infection can be unclear or absent, which makes the diagnosis particularly difficult (*21,32*). Moreover, neonates and young infants can present a pseudoparalysis of the affected limb (*34*), or manifest a paradoxical irritability (consoling by a parent irritates rather than comforts the neonate) (*34,42*). Toddlers may complain of a spontaneous onset of progressive hip, groin or thigh pain, demonstrate a limp or abnormal gait, or refuse to bear weight (*2,9,11,24,26,30,34,40,42,44*). Often the affected limb is held in a relieving posture (slightly flexed, externally rotated and abducted (*29,40,42*) to reduce intracapsular pressure. Swelling, warmth, erythema (*2*) and pain on palpation or passive movement can be further clinical manifestations (*11,29,40*). Limited passive range of motion may be a very early clinical sign (*29*).

"*Septic arthritis of the hip joint in children is an emergency"* (*39*). Early diagnosis and appropriate treatment are associated with a good outcome (*2,8,17*), but the kind of therapy still is controversial. There is a tendency towards less aggressiveness without losing efficiency (*19,36,38*).

BACTERIOLOGY

A wide spectrum of pathogenic germs may cause septic arthritis of the hip joint in children. The epidemiology varies from country to country. Most recent studies report that nowadays the commonest germ is *Staphylococcus aureus* (*2,3,6-8,10,11,14,19,24, 32,34,36,38,41-44,49,51*). A raising problem seems to be the increased incidence of methicillin-resistant S. aureus (MRSA), which causes infections in patients without established risk factors for MRSA (*3,7,10,14,31,32,41,51*). These are so-called community-associated MRSA strains and differ from hospital MRSA strains causing health-care-associated infection : the community-associated MRSA strains carry less resistance determinants (*3,49*). The authors focus only on the community-acquired MRSA strains. Since the emergence of MRSA, worldwide changes in the severity of staphylococcal infections have been documented (*3*). A few studies demonstrate that septic arthritis caused by MRSA is often more serious (e.g. longer duration of fever after initiation of therapy and longer hospitalization) than arthritis caused by methicillin-sensitive S. aureus strains (MSSA) (*3, 7,31,41*). Other causative agents are group A *Streptococci,* group B *Streptococci*, *Streptococcus pneumoniae*, Coagulase-negative *Staphylococc*i, *Enterococcus spp., Corynebacteriaceae*, *Micrococcus*, *Abiotrophia*, *Haemophilus influenzae*, *Neisseria meningitidis*, *Neisseria gonorrhoeae, Enterobacteriaceae, Brucella, Borrelia and Kingella kingae*. *Haemophilus influenza*e used to be a very common pathogen causing septic arthritis (*36*), but this dimin-



*1 Validity : septic arthritis of the pediatric hip in previously healthy infants in industrialized countries ; neonates excluded
*2 Injection of 3-5 ml sterile saline and reaspiration when no fluid is obtained on aspiration (9).
*3 Choice when suspected clindamycin sensitive MRSA pathogens. Dosage Clindamycin : 40 mg/kg per day every 6 h.
*4 Choice when suspected MSSA strains. Dosage first generation cephalosporin : 150 mg/kg per day every 6 h.
*5 In children who have not been immunized against Haemophilus influenzae, additional administration of ampicillin or amoxicillin (Dosage both ampicillin and amoxicillin : 200 mg/kg per day every 6 h).
CT : computerized tomography ; MRI : magnetic resonance imaging ; DD : differential diagnosis ; CRP : C-reactive Protein ; NSAIDs : non-steroidal anti-inflammatory drugs ; MRSA : methicillin-resistant Staphylococcus aureus ; MSSA : methicillin-sensitive Staphylococcus aureus.

Fig. 1. — Diagnostic workup and therapy of septic arthritis of the paediatric hip joint*1

Table I. — Causative microorganisms of septic arthritis

Gram-positive bacteria
Staphylococcus aureus (e.g. methicillin-sensitive S. aurus, methicillin-resistant S. aureus) (*2,3,6-8,10,11,24,32,34,36,38,41-44,49,51*)
Coagulase-negative Staphylococci (e.g. Staphylococcus epidermidis) (*6,10,43*)
Streptococcus pneumoniae (*2,3,6,8,10,11,24,32,36,38,42,44,45,51*)
Group A Streptococci (e.g. Streptococcus pyogenes) (*2,8,10,11,24,36,38,42-44,51*)
Group B Streptococci (e.g. Streptococcus agalactiae) (*2,3,10,42,43*)
Enterococcus spp. (*43*)
Corynebacteriaceae (e.g. C. diphtheria) (*6,43*)
Micrococcus (*6*)
Abiotrophia (*6*)
Gram-negative bacteria
Enterobacteriaceae (e.g. Escherichia coli (*8*), Klebsiella spp. (*8,34*), Enterobacter (*10*), Salmonella spp. (*1,2,18,33*), Serratia spp. (*2,34*) (*10,42*)
Haemophilus influenzae (*2,10,36,38,42,51*)
Neisseria meningitidis (*24,43,51*)
Neisseria gonorrhoe (*10*)
Kingella kingae (*41,42*)
Brucella (e.g. B. melitensis) (*2,10,52*)
Maroxella (e.g. M. lacunata (*10*))
Borrelia (*13*)

ished since the introduction of the conjugated vaccine for the Gram-negative Haemophilus influenzae as of 1990 (*2,10,11,14,36,51*). Thus, Gram-positive organisms became predominant (*2*). Although some children with Salmonella arthritis, both non-typhoid and typhoid, had underlying immunosuppressive states or other predisposing factors, other infants had no pre-existing conditions (*1,18,33*) (Table I).

FIRST STEP : Noninvasive differential diagnosis between septic arthritis and transient synovitis

The differential diagnosis of irritable hip in childhood includes many entities : infection, inflammation, trauma, vascular or neoplastic pathology. But of all acute non-traumatic hip pathologies transient synovitis is the diagnosis with the highest incidence (*26,40,50,53*). Most of the differential diagnoses can be excluded with a thorough medical case history, a careful clinical examination, and with the aid of imaging. A long medical history (longer than 5 days) or a defective hip situation with radiologically visible complications, such as destruction or dislocation of the femoral head, or a widespread destruction of the femoral head and neck and high riding greater trochanter (*40*), respectively, are highly suggestive of sequelae of septic hip arthritis. Diagnosis is more difficult in cases with a short medical history (less than 5 days), because transient synovitis and septic arthritis are often left as the most probable etiologies (*25,30,44*). The difficulty in differentiating septic arthritis of the hip from transient synovitis exists especially in the early course of the two diseases being similar, such as spontaneous onset of progressive hip, groin or thigh pain, limp, complete or partial inability to bear weight, fever and irritability (*20,23-25,28,30,44,46,53*). Since the two diseases require a totally different therapy it is very important to distinguish between the two. Whereas transient synovitis is a self-limiting disease, easily managed with analgesics and observation, with no known long-term sequelae (*6,20,23,25,28,30,43,44,46, 50,53*), septic arthritis demands a much more aggressive therapy.

In 1999 Kocher *et al* (*25*) set up a retrospective study *in a tertiary children's hospital*. They found four independent multivariate clinical predictors for the differentiation between septic arthritis and transient synovitis : fever $\geq 38.5°C$, non-weight-bearing, ESR ≥ 40 mm/h, WBC $> 12 \times 10^9$cells/L. If all four predictors were positive, they achieved a

Table II. — Differential diagnosis of the irritable hip in children

Infectious:	Septic arthritis Fungal infection (*29*) Tuberculosis (*29*) Lyme disease (*9*) Osteomyelitis (*9,29,35,42,47*) Pyomyositis (*4,5,9,27,42*) Appendicitis (*42*)
Inflammatory:	Transient synovitis (*6,9,20,23-26,28,30,42,46,50,53*) Juvenile rheumatoid arthritis (*9,29,42*) Ankylosing spondylitis (*9*) Reiter syndrome (*9*) Rheumatic fever (*29,42*)
Traumatic/mechanical:	Fractures (*9,29,42,44*) Cartilage problems (*29*) Muscle injuries (*9*) Contusions (*9*) Slipped capital femoral epiphysis (*9,26,29,42,44*)
Vascular:	Legg-Calvé-Perthes disease (*9,26,29,42,44*) Osteonecrosis (*9*) Haemoglobinopathies (haemophilia, sickle-cell disease) (*9,29,42*) Purpura Schonlein Henoch (*29*)
Neoplastic:	Benign tumours with impending fractures (*9,29,42,44*) Benign aggressive tumours (*9,29,42,44*) Malignant tumours (*9,29,42,44*) Leukaemia (*9,42*) Lymphoma (*9*)

predicted probability of 99.6% for septic arthritis. In 2004 (*24*) they validated their findings via a prospective study : this time they reached a predictive probability of 93% when all four predictors were positive. However, in the same year Luhmann *et al* (*30*), using the same predictors *in a primary referral general hospital*, found a predictive value of only 59%. Caird *et al* (*6*) (2006) added a fifth predictor, namely CRP > 20 mg/L, and found via a prospective study a predicted probability of 98%. However, this study was again conducted *in a tertiary referral centre*. Sultan *et al* (*44*) (2010) tested these five clinical predictors retrospectively, in a *primary referral general hospital ;* they achieved a predicted probability of only 59.9%. They explained this poor result via the statistical thesis that even highly specific tests, when applied to low-prevalence events, have less predictive value. And of course the prevalence of septic arthritis is lower *in a primary referral centre*. Indeed, the percentages of patients with septic arthritis (among all irritable hips) were lower in Luhmann's (*30*) and Sultan's (*44*) studies than in the two studies of Kocher (*24,25*) and in the study of Caird (*6*) : 28.5% and 5.2%, versus 48.8%, 33.1% and 70.8%. Sultan *et al* (*44*) concluded that clinical predictors should be applied with caution.

The most recent study was performed *in a tertiary level unit* by Singhal *et al* (*43*) in 2011, reviewing a great number of cases (29 septic arthritis and 282 transient synovitis). Firstly they found that CRP is a strong and the most significant independent predictor of septic arthritis. Secondly, including CRP either in a four-variable predictive model with weight-bearing status, temperature and peripheral white blood cell count, or in a two-variable predictive model with weight-bearing status, demonstrated that the inclusion of CRP within a model eliminates the significance of other variables. Whereas the positivity of the four mentioned variables offered a predictive probability for septic arthritis of 87%, the positivity of only two determinants still achieved a predictive probability of septic

Table III. — Overview of clinical prediction algorithms used in previous studies listed chronologically

Year of publication	Authors	% septic arthritis cases in the study population	Clinical predictors of septic arthritis	Predicted probability of septic arthritis in presence of all predictors
1999	Kocher *et al* (*25*)	48.8%	- History of fever (> 38.5°C) - Non-weight-bearing - ESR ≥ 40 mm/h - Serum WBC > 12 × 10^9/L	99.6%
2004	Kocher *et al* (*24*)	33.1%	- History of fever (> 38.5°C) - Non-weight-bearing - ESR ≥ 40 mm/h - Serum WBC > 12 × 10^9/L	93%
2004	Luhmann *et al* (*30*)	28.5%	- History of fever (> 38.5°C) - Non-weight-bearing - ESR ≥ 40 mm/h - Serum WBC > 12 × 10^9/L	59%
2006	Caird *et al* (*6*)	70.8%	- History of fever (> 38.5°C) - Non-weight-bearing - ESR > 40 mm/h - Serum WBC > 12 × 10^9/L - CRP > 20 mg/L	98%
2010	Sultan *et al* (*44*)	5.2%	- History of fever (≥ 38.5°C) - Non-weight-bearing - ESR ≥ 40 mm/h - Serum WBC > 12 × 10^9/L - CRP ≥ 20 mg/L	59.9%
2011	Singhal *et al* (*43*)	9.3%	- CRP > 20 mg/L - Non-weight-bearing - CRP > 20 mg/L - Non-weight-bearing - History of fever (≥ 38.5°C) - Serum WBC > 12 × 10^9/L	74% 87%

ESR = erythrocyte sedimentation rate ; WBC = white blood cells ; CRP = C-reactive Protein ; °C = degrees Celsius ; mm, millimeters ; h, hour; L, liter.

arthritis of 74%. Singhal *et al* (*43*) noted that adding more variables to the diagnostic model did not alter the sensitivity or specificity. The two-variable predictive model yielded a negative predictive probability of < 1% for septic arthritis if both weight-bearing status and CRP were negative. Only 13 out of 282 cases (4.6%) of transient synovitis underwent an arthrotomy while wrongly suspecting septic arthritis. In other words, 95.4% of the transient synovitis cases needed no formal confirmation of an aseptic joint. This represents good evidence of a working clinical prediction algorithm (Table II and III).

Other authors focused on imaging modalities (*23,28,50,53*). Plain radiographs are not sensitive enough to exclude the diagnosis of septic arthritis (*42*). There is general agreement that ultrasound is very helpful to detect hip joint effusion (*2,9,15,23, 34,40,42,53*). Nevertheless Gordon *et al* (*15*) showed that it leads to a false negative rate of 5%. Hence they concluded that a negative ultrasound result must be interpreted with caution when the symptoms were present for less than 24 hours. Consequently sonography is not useful to safely distinguish between septic arthritis and transient synovitis (*53*). MRI : Yang *et al* (*50*) reported signal intensity

alterations of the bone marrow and signal intensity alterations and contrast enhancement of the soft tissues, statistically significant for septic arthritis. Contralateral (asymptomatic) joint effusion and absence of signal intensity abnormalities of the bone marrow were typical for transient synovitis. Kwack *et al* (*28*) observed a significant decreased perfusion at the femoral epiphysis on fat-suppressed gadolinium-enhanced coronal T1-weighted MRI in eight of nine patients with septic arthritis. Kim *et al* (*23*) recommended a Dynamic Contrast-Enhanced MRI (DCE-MRI) for the differentiation between septic arthritis and transient synovitis : in an optimal time window (2.7-4.3 minutes) there exists a maximal difference in signal intensity or rather in the enhancement pattern between the femoral heads in septic arthritis and transient synovitis on DCE-MRI. Unfortunately, MRI is not a routine diagnostic tool and less accessible than other imaging modalities.

SECOND STEP : Diagnostic needle aspiration

Aspiration becomes mandatory as soon as the 4 clinical variables, mentioned above, point to septic arthritis, or if the situation is unclear (Fig. 1). Cell count, Gram stain, and culture of the synovial fluid are classical. When no fluid is obtained, 3 to 5 ml of sterile saline are injected and re-aspirated.

Kang *et al* (*21*) stated that "*no single investigation, …, is sufficiently reliable to diagnose conclusively joint infection*". Nevertheless we depend on the hitherto existing diagnostic tools. In most studies, diagnostic joint aspiration of the affected joint (ultrasound or fluoroscopy guided) (*9*), was considered to be the investigation of choice (*2,8,9, 12,17,19,20,23-25,28-30,36,38,40,42,44,46,49-51*). After aspiration the following laboratory results were accepted as confirmative of septic hip arthritis : positive culture (*2,9,20,24,25,28,30,36,44,49,51*), or positive Gram stain (*23,51*), or positive culture and pus (*42,50*), or $>$ 50,000 white blood cells per mm^3 (*12*) with a predominance of polymorphonuclear cells (*9*). A positive blood culture was also considered to confirm septic arthritis (*2,9,20,28,36,51*). The probability of finding microorganisms in synovial fluid or blood varies from 29% to 82% (*21,22*). In cases where cultures were negative, other features such as laboratory parameters, clinical symptoms (*12,49*) and imaging signs consistent with septic arthritis (*49*) were necessary for the diagnosis.

The question remains : when does a presumption of septic arthritis warrant an invasive needle aspiration ? Several recent studies attempted to develop algorithms, including clinical, laboratory and imaging features, which could be useful in selecting patients for needle aspiration. The latest attempts are shown in figure 1.

THIRD STEP : Antibiotic therapy

There is no time to wait for the growth of the blood or joint fluid cultures. An immediate empirical antibiotic therapy is necessary. However, the organisms causing septic arthritis have changed, since vaccination against the Gram-negative *Haemophilus influenzae* has increased the incidence of the Gram-positive *Staphylococcus aureus* (*2*). Several authors (*7,10,32,49,51*) agree that nowadays the empirical antimicrobial treatment of septic arthritis should cover for MRSA, due to its increasing role in septic arthritis.

Clindamycin as empirical therapy in suspected MRSA cases is widespread (*3,7,10,14,31,36,41,42*), but an induced clindamycin resistance among MRSA strains is observed (*31*) : more than 10% of the MRSA isolates are resistant (*14,31*). Alternatives are vancomycin (*3,7,14,31,41,42,49*),trimethoprim-sulfamethoxazole (*7,31,41,42*), newer generation fluoroquinolones (*42*) and linezolid (*31,41,42*). Finally, empirical antibiotic therapy should be adapted to the regional epidemiology, the antibiotic susceptibility patterns of local isolates, as well as to individual factors linked to the severity of the illness (*3*), risk factors, age and immunization status (*2*). A targeted antibiotic therapy must follow as soon as the joint fluid or blood culture and the antibiogram are available.

FOURTH STEP : 24 hours of expectancy

If the clinical picture improves within 24 hours, while the CRP tends to improve, the antibiotic treatment is simply continued and later adapted to the antibiogram. If this is not the case, surgery becomes necessary.

The duration of antibiotic treatment ranged in the reviewed literature from 10 days (*36*) to 24 weeks (*19*). Vinod *et al* (*48*) (2002) retrospectively stressed the efficacy and safety of an antibiotic treatment of 3-3.5 weeks in cases of uncomplicated septic arthritis. The median duration of antibiotic treatment in more recent studies varies from 20 (*31*) to 31 (*2*) days. In 2009 Peltola *et al* (*36*) showed in a randomized, multicenter prospective trial in Finland that septic arthritis can often be treated with a large dose of well-absorbed antimicrobials for only approximately 10 days (initially administered intravenously).

FIFTH STEP : Surgical management

Insufficient response to treatment (symptoms, CRP) within 24 hours after the start of antibiotic treatment, means surgical treatment (*38*) (Fig. 1). In the literature there is no consensus regarding the type of surgical intervention in septic arthritis of the hip joint. In many studies, the management of septic arthritis included, besides antibiotic therapy, an arthrotomy (*1,11,20,34,43, 44,49,53*). Thus, arthrotomy seemed to be an accepted surgical procedure for septic arthritis of the hip joint (*12*). During the last ten years there have been studies applying alternative surgical methods. Givon *et al* (*12*) showed that daily repeated ultrasound-guided aspiration and irrigation of the infected hip joint in combination with antibiotic treatment is safe and efficacious in children aged 6 months to 15 years. This method provided in addition the advantage that a general anaesthesia could be avoided, by means of topical anaesthesia or sedation. Moreover they observed a faster return to normal activity. In 2008 El-Sayed *et al* (*8*) compared in a prospective study the results of open arthrotomy with those of arthroscopic irrigation and drainage in early cases in children aged between 3 and 12 years. They concluded that arthroscopic irrigation/drainage, always in combination with an antimicrobial treatment, is effective, provided that the orthopaedic surgeon is skilled in paediatric arthroscopy. In a multicenter study about septic arthritis in general, in Finland by Peltola *et al* (*36*), the number of surgical interventions was kept to a minimum. Apart from diagnostic needle aspiration, no repeated aspiration or arthrotomy was recommended, not even in hips, providing that there was a good clinical response and an improvement of the CRP level within 24 hours after initiation of antibiotic therapy. Pääkkönen *et al* (*38*) focused on the septic hips in this multicenter trial and retrospectively compared their outcome with or without arthrotomy. Of the 62 septic hip arthritis patients in total, who were all treated with large doses of well-absorbed antimicrobials for at least 10 days (initially administered intravenously for 2-4 days), only 12 underwent an arthrotomy. Thus, in 81% of the septic hips, invasive surgery could be avoided. None of the 62 patients developed permanent sequelae. They demonstrated that most cases of septic hip arthritis did well with a diagnostic aspiration and an antibiotic treatment, provided that they had a short medical history (< 5 days) and no pre-existing condition. Before the publication of this Finland trial controversial opinions existed, believing that simple needle aspiration is not a sufficient therapy in any septic hip (*16,40*). In a retrospective study, published in 2011 by Journeau *et al* (*19*), 43 paediatric septic hips were treated with needle aspiration and irrigation under general anaesthesia combined with antibiotic therapy. In 85% of their cases this was efficient so that no further surgical intervention was necessary. The other cases had after the needle aspiration and irrigation a deterioration of the clinical features and/or of the biological inflammatory response necessitating a secondary arthrotomy. For those patients who underwent a secondary arthrotomy they could not find any statistically significant negative prognostic factor, although the biological inflammatory response of these patients was initially clearly elevated while the delay between the beginning of the symptoms and the hospitalization was longer in the arthrotomy group than in the aspiration/irrigation group. In another recently published study by Griffet *et al* (*17*), focusing on the surgical management of septic arthritis in children (the hip in 35%), the authors recommend a percutaneous aspiration irrigation drainage with a gravity non-suction drainage placed into the affected joint for an average of 4.5 days. Associated with immobilization and intravenous antibiotics for 8 to 10 days, rapid clinical and biological improvement

Table IV. — Overview of alternative surgical procedures versus routine arthrotomy

Year of publication	Author	% of septic hip arthritis patients in study population	Surgical treatment*	Preconditions/ inclusion criteria	Advantage (compared with arthrotomy)
2004	Givon *et al* (*12*)	100%	Daily repeated ultrasound-guided aspiration and irrigation	- Children aged 6 months to 15 years - Short medical history (< 24 h after initiation of symptoms)	- No general anaesthesia - Lower morbidity - Faster return to normal activity
2008	El-Sayed *et al* (*8*)	100%	Arthroscopic drainage and irrigation	- Short medical history - uncomplicated case - orthopaedic surgeon skilled in paediatric surgery/ arthroscopy	- Less invasive - Less hospital stay - Quicker recovery and return to activities
2010	Pääkkönen *et al* (*38*)	100%	No surgical therapy if normalization of CRP and good clinical response within 24 hs after initiation of antibiotic treatment	- Children aged 3 months to 15 years - Short medical history (≤ one week) - Causative agent methicillin-sensitive - treatment with large doses of clindamycin or first-generation cephalosporin	- Less invasive treatment
2011	Journeau *et al* (*19*)	100%	Needle aspiration and irrigation in general anesthesia	- Children aged 3 days to 14 years - Presumed short medical history	- Less aggressive treatment
2011	Griffet *et al* (*17*)	63%	Percutaneous aspiration irrigation drainage for an average of 4.5 days	- Children aged 3 weeks to 15 years - Presumed short medical history - Thin synovial fluid	- avoidance of surgical morbidity of arthrotomy - simple procedure - postoperative control of synovial effusion - only one general anaesthesia necessary

*Always in combination with antibiotic therapy. Diagnostic needle aspiration is not regarded as surgical treatment. These alternative surgical methods proved their efficacy and safety in the listed studies under the circumstances detailed.

and absence of long-term sequelae resulted. These authors stressed the following advantages of their technique : the simplicity of the procedure, the post-operative control of synovial effusion, the necessity of only one general anaesthesia and the minimal iatrogenic morbidity. However in cases of neonatal septic hip arthritis or too thick purulent fluid, they advised to favour an open arthrotomy. The majority of the studies proposing a less invasive surgical option implied that the patients presented within a short time after the onset of the symptoms (*8,12,17,19*).

We suggested already in a previous study to adapt the choice of the surgical treatment to the length of the medical history (*40*). In the acute stage of septic arthritis, which was defined as a short medical history with no radiologically visible complications, we suggested an antibiotic therapy for at least two weeks combined with an arthroscopic irrigation. In the chronic stage, defined as a long medical history (> 5 days) with radiologically visible complications, we considered several possibilities. Without subluxation or dislocation of the hip joint the sug-

gested treatment was based on antibiotics and arthrotomy with inspection. In case of subluxation or dislocation, open reduction was proposed. In defective situations, when a widespread destruction of the femoral head and neck was present , an individually tailored reconstructive operation was recommended (*40*). We recommend a diagnostic and therapeutical workup of septic arthritis of the paediatric hip, based on this review of the current literature (Fig. 1, Table IV).

DISCUSSION AND CONCLUSION

Differential diagnosis between septic arthritis and transient synovitis

Until now there is no simple, highly sensitive and specific test for the differentiation between septic arthritis of the hip and transient synovitis (*6,9*). Several algorithms have been evaluated to strengthen a suspicion that a child presenting with an irritable hip could have a septic hip arthritis, and to justify a diagnostic needle aspiration or other invasive interventions. The most recent study suggesting a clinical prediction algorithm, by Singhal *et al* (*43*), seems to be conclusive, although an external prospective validation is indicated. A CRP > 20 mg/L and refusal to bear weight are highly suggestive of septic arthritis and warrant an ultrasound or fluoroscopy- guided hip aspiration for cell count, Gram stain and culture. If no fluid is obtained on aspiration, it is suggested to inject 3-5 ml. sterile saline in the affected hip. The re-aspirated fluid is sent for microbiology (*9*). An additional blood culture allows microbiological confirmation of septic arthritis and, if indicated, the change to a targeted antibiotic therapy. A negative CRP and no refusal to bear weight, suggesting transient synovitis, justify an anti-inflammatory therapy and a clinical follow- up for two days. Physician's practical knowledge and experience are needed in an unclear situation.

Medical treatment

In the literature there are sparse powerful studies discussing management of septic hip arthritis in children. Furthermore, when there are reliable data, the possibly new treatment option is only applicable if all criteria correspond to the inclusion criteria of the study. In cases presenting exclusion criteria the physician has to refer to old standards or to his own experience. Moreover the management of septic hip arthritis depends on the availability of medical resources and on the doctor's skills. The treatment concepts of Peltola *et al* and Pääkkönen *et al* (*36-38*), validated in their multicenter prospective study in Finland, seems to be sufficiently reliable and therefore applicable to the same conditions as in their study, in the hope that the validity of their management of septic arthritis would be confirmed in other settings. It means that a short-term (10 days) antibiotic therapy with high doses of clindamycin (initially administered intravenously for 2-4 days) or first generation cephalosporin seems to be applicable in previously healthy children not younger than 3 months presenting with a septic hip arthritis caused by Gram-positive agents, MRSA excluded. According to the literature clindamycin proved its efficacy, also in septic hip arthritis caused by clindamycin-sensitive MRSA strains. Since septic arthritis caused by MRSA is often more serious than if caused by MSSA (*3,7,31,41*), the antimicrobial treatment may take longer than the short-term treatment proposed by Peltola *et al* (*36*). In children who have not been immunized against *Haemophilus influenzae*, ampicillin or amoxicillin should be administered additionally till the causative pathogen is identified.

Surgical treatment

While choosing an adequate surgical treatment, it seems to be important to distinguish between short (< 5 days) and long (> 5 days) medical histories. There is a consensus that a diagnostic joint aspiration is necessary in suspected septic arthritis, hoping to confirm the diagnosis and to enable a targeted antimicrobial therapy. Peltola *et al* and Pääkkönen *et al* (*36-38*) proved with their study that under certain circumstances, apart from the diagnostic hip aspiration, it is possible to omit further surgical procedures in septic hip arthritis in children. We based our therapeutic algorithm on their studies, among others (Fig. 1). But the children coming into con-

sideration for this management should be carefully selected. Attention should be paid to the local epidemiology, the resistance pattern of the common regional pathogens, the duration of symptoms (< or > 5 days), the age, the immunization protection, as well as the pre-existing condition of the individual case. Unfortunately there exists no comparable study showing in a representative trial an effective management for paediatric septic arthritis of the hip joint in developing countries with its different patient population.

Managing early (symptoms less than 5 days) and uncomplicated cases of septic hip arthritis in children less aggressively may be acceptable, according to the current literature, considering the comparable outcome. In our opinion, at all times a septic joint condition should be treated as an emergency and after finding pus by the diagnostic needle aspiration, arthrotomy or arthroscopic irrigation should be performed immediately. In other cases a more aggressive therapy may be mandatory according to the current literature: arthrotomy, daily repeated ultrasound-guided aspiration and irrigation, or arthroscopic drainage.

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