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A systematic review of the optimal drainage technique for septic hip arthritis in children

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Abstract

Introduction: The hip is one of the most commonly affected joints in paediatric septic arthritis. Drainage can be performed using arthrocentesis (articular needle aspiration), arthroscopy or arthrotomy. The objective of this systematic review was to identify the most effective drainage technique for septic hip arthritis in the paediatric population.

Materials and methods: The electronic MEDLINE, EMBASE and Cochrane databases were systematically searched for original articles that reported outcomes of arthrocentesis, arthroscopy or arthrotomy for septic arthritis of the paediatric hip. Outcome parameters were additional drainage procedures, clinical outcomes and radiological sequelae. The quality of each of the included studies was assessed with the Methodological Index for Non-randomized Studies (MINORS) score.

Results: Out of 2428 articles, 19 studies with a total of 406 hip joints were included in the systematic review. Additional arthroscopy or arthrotomy was performed in 15% of the hips treated with arthrocentesis, in 14% after arthroscopy and in 3% after arthrotomy. Inferior clinical outcomes and more radiological sequelae were seen in patients treated with an arthrotomy. A meta-analysis could not be performed due to the diversity and low quality of the studies (MINORS median 4 [range 2–15]).

Conclusions: This systematic review gives a comprehensive overview of the available literature on treatment for septic hip arthritis in children. Arthrocentesis and arthroscopic procedures may have a higher risk of additional drainage procedures in comparison with arthrotomy. However, arthrotomy might be associated with inferior outcomes in the longer term. The included studies are diverse and the scientific quality is generally low.

Keywords

Arthrocentesis, arthroscopy, arthrotomy, hip, paediatric, septic arthritis

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Introduction

In Europe the incidence of septic arthritis is 2–7 per 100,000 children and the most commonly affected joints are the hip and knee.[1,2] The classical presentation of septic hip arthritis in children is a combination of a painful hip joint with limited range of motion, fever, malaise and inability to bear weight on the affected limb.[3–5] Misdiagnosis or inappropriate treatment of acute septic arthritis of the hip in children can result in devastating damage of the joint and possible lifelong disability.[6] An increase in intracapsular pressure in the hip joint may lead to compressive ischaemia and avascular necrosis of the femoral head

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when not promptly addressed.[3] Ultrasound and laboratory tests may distinguish infection from other extra-articular diseases with similar symptoms that may lead to referred hip pain.[6–8]

Staphylococcus aureus, both methicillin sensitive and methicillin resistant, is the most commonly cultured organism. It is followed by *Kingella kingae, Streptococcus pyogenes* and *Streptococcus pneumoniae*.[9] Antibiotic coverage should be administered in suspected cases as soon as synovial fluid samples have been collected and the joint has been drained.[4,5]

Joint drainage techniques include arthrocentesis (articular needle aspiration), arthroscopy and arthrotomy. Each technique has advantages and disadvantages relating to invasiveness, duration, and completeness of irrigation. The literature is inconclusive with respect to the optimal drainage technique in children with septic arthritis of the hip. According to the European Society for Paediatric Infectious Diseases (ESPID) Bone and Joint Infection Guidelines from 2017 the technique of choice depends on the preference and experience of the treating clinicians and surgeons.[1] To provide the paediatric orthopaedic surgeon with a better handle on optimal treatment of this challenging disease, this study aims to systematically review the literature concerning the optimal drainage technique for septic hip arthritis in children.

Materials and methods

Study design

This systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[10] In accordance with the PRISMA guidelines, this systematic review was registered with the International Prospective Register of Systematic Reviews (PROSPERO) at https://www.crd.york.ac.uk/PROSPERO/ under registration number CRD42018117795.

Literature search and study selection

3 online medical databases (PubMed, Embase, and the Cochrane database for clinical trials) were searched on 24 August 2019 using the following keywords: septic arthritis, child, aspiration, arthroscopy, arthrotomy and their respective synonyms, adjusted for the specific databases. Full search details are available in Appendix 1. Studies were not blinded for author, affiliation, or source. After exclusion of duplicate literature, all titles and abstracts were reviewed by 2 independent reviewers (CD and AS) for suitability of inclusion. A full-text review by the same reviewers was then performed to evaluate if the paper was eligible for inclusion. Any disagreement was resolved by discussion by the reviewers. If an article was not accessible, then the authors of that article were contacted. Additionally, the reference list of the included articles and review articles were manually checked for potentially relevant publications.

Inclusion and exclusion criteria

The inclusion criteria for full text review were: inclusion of at least 5 hip joints; age under 18 years old; an established diagnosis of acute septic arthritis and a surgical intervention (arthrocentesis, arthroscopy or arthrotomy). The diagnosis of acute septic hip arthritis was established when one or more of the following findings were present: pus aspirated from the joint; a positive culture of the joint fluid; a positive gram stain of the joint fluid; or a white blood cell count in the joint fluid $>50{,}000/mm^3$. All included articles presented original data on paediatric patients who had septic arthritis. Studies were limited to articles published in the English, French, German or Dutch. Reviews, letters to the editor, case reports, expert opinions and surgical technique articles were excluded. If different joints or patients with (concomitant) osteomyelitis were included without separate analysis, then studies were also excluded from further analysis.

Data extraction

The following parameters were recorded where available: numbers of joints, age, type of treatment (arthrocentesis, arthroscopy or arthrotomy), time between onset of symptoms and treatment, and the duration of follow-up. Relevant outcome parameters included additional drainage arthrocentesis or surgical procedures, clinical outcomes and radiological sequelae.

Methodological quality

The Methodological Index for Non-Randomized Studies (MINORS) was used to assess the risk of bias.[11] MINORS is a validated and established index for evaluating the methodological quality of non-randomised studies. The index contains 12 criteria for comparative studies, of which 8 criteria have been designed for non-comparative studies. These items were scored according to the set criteria: 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). The maximum score for comparative studies is 24, and the maximum for non-comparative studies is 16.2 reviewers (CD and AS) independently calculated each study according to the MINORS index and the mean of these calculations was described.

Analysis

Descriptive data are presented in this review. Due to the heterogeneity of the data it was not possible to perform a meta-analysis and therefore no statistical tests were applied.

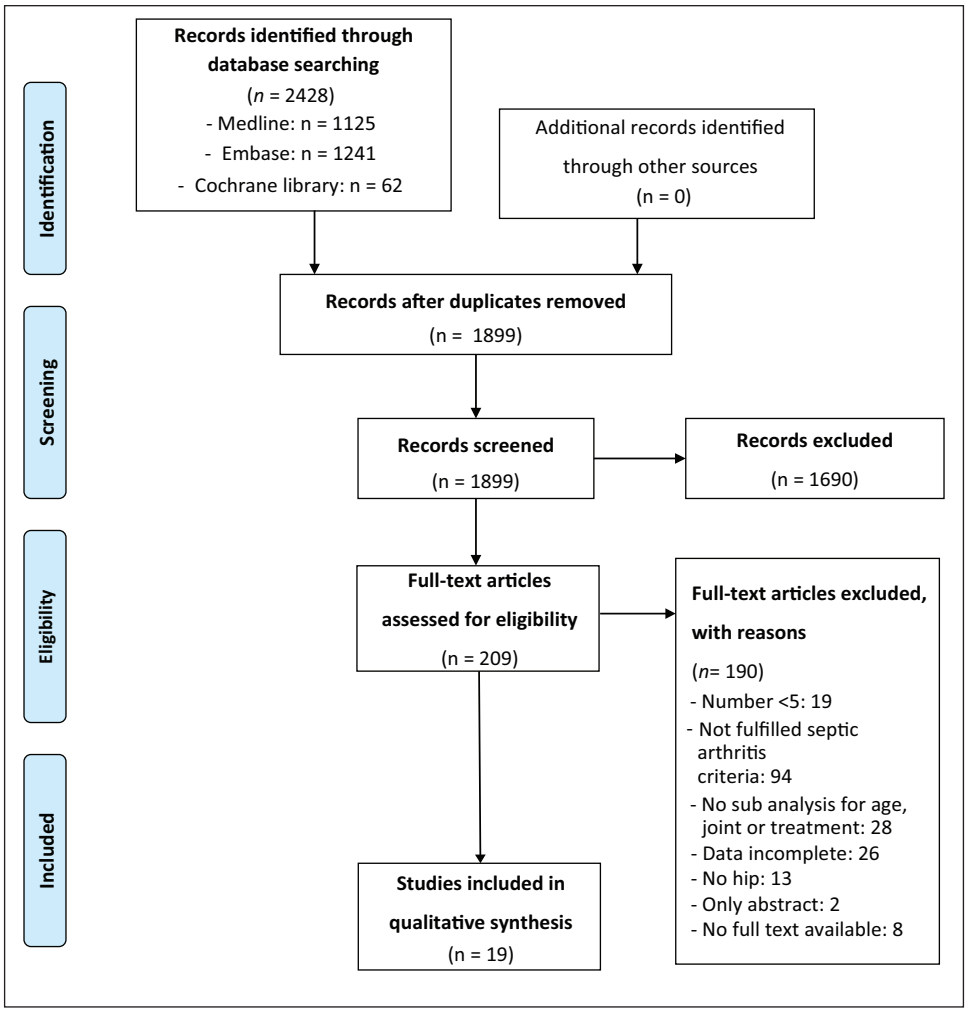

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) flow diagram of the study-selection process.

Results

Selection process

The search strategy identified 1899 unique articles. A total of 209 studies were selected for full text screening, of which 177 articles were excluded from further analysis. Another 13 studies were excluded because they did not include (enough) patients with septic arthritis of the hip. Hence 19 articles were included in this review. No additional relevant articles were found in the reference lists of the included articles and review articles. Figure 1 shows the PRISMA flow diagram of the study-selection process.

Methodological quality and risk of bias

The individual MINORS scores after consensus for all included articles are displayed in Tables 1–3. The median MINORS score of the included articles was 4 (range 2–15). The major methodological limitation of the selected studies was a biased assessment of endpoints.

Study characteristics

A total of 16 retrospective studies,[12,14–18,20,22–30] 2 prospective studies[13,21] and 1 prospective controlled study were included.[19] In 2008, El-Sayed[19] published the only prospective controlled randomised study, comparing the outcomes of children (aged 3–12 years) with an early presentation of no more than 5 days since onset of symptoms, 10 by an arthroscopy and 10 by an arthrotomy.

The number of patients with septic hip arthritis varied widely across the studies, ranging from 6 to 45 patients. A total of 406 hip joints with septic arthritis were included; 155 (38%) hip joints were treated with arthrocentesis,[12–17] 54 (13%) hip joints with arthroscopy[18–22] and 197 (49%) hip joints with an arthrotomy.[12,19,23–30] The described time between onset of symptoms and treatment had a maximum

of 5 days for arthrocentesis, 7 days for arthroscopy and 27 days for arthrotomy (see Tables 1–3).

Arthrocentesis

In 28 of 155 (18%) hip joints arthrocentesis with irrigation was the treatment.[14] The procedures were followed by a drain in 61 of 155 (39%) hip joints after arthrocentesis.[13,16]

Additional drainage procedures. The hip joints treated with arthrocentesis ($n=155$) needed an additional arthrotomy in 15% ($n=23$). An additional arthrocentesis in hip joints without drain (($n=49$) with numbers of additional arthrocentesis described) was needed in 71% of cases ($n=35$).[12,14,17]

Clinical outcomes. Clinical outcomes were described in 5 of the 6 studies including 148 hip joints with a mean follow-up of 4 years.[13–17] Only 1 hip joint had limitation of hip movements while another experienced hip pain without limited joint range movement or radiologic modification.[13,16] The other 146 hip joints had full range of movement and no leg-length discrepancies were seen.

Radiological sequelae. 5 of the 6 studies described radiological sequelae with a mean follow-up of 4 years.[13–17] A total of 148 hip joints were included. In 6 of the 148 hip joints (4%) radiological changes were described.[13,16] All 6 hip joints were treated with arthrocentesis followed by a drain and 4 of these hip joints needed an additional arthrotomy.[13,16] 4 hip joints had coxa magna, 2 hip joints a smaller ossification nucleus and in 2 joint destruction was found.

Arthroscopy

The procedures were followed by a drain in 19 of 54 (35%) hip joints after arthroscopy.[18,19]

Additional drainage procedures. 5 hip joints (14%) treated with an arthroscopy without a drain ($n=35$) needed an additional arthroscopy.[20–22] No additional drainage procedure was needed in hip joints treated with an arthroscopy followed by a suction drain ($n=19$).[18,19]

Clinical outcomes. Good to excellent clinical results with full range of motion were found in 44 of the 45 hip joints with a mean follow-up of 3 years.[19–22] 1 hip joint had limitations in its range of motion and a clinical fair result according to the Harris Hip Score.[21]

Radiological sequelae. In all hip joints ($n=54$) radiological sequelae were investigated with a mean follow-up of 3 years.[18–22] In 9% ($n=5$) of the hips treated with arthroscopy radiological changes were seen in hip joints treated with arthroscopy. 2 hip joints had focal metaphyseal radiodensity,[18] 1 hip joint had slight enlargement of the femoral epiphysis,[18] 1 hip joint had metaphyseal lytic image,[22] and 1 hip joint had avascular necrosis.[21]

Arthrotomy

The procedures were followed by a drain in 16 of 197 (8%) hip joints after arthrotomy.[24]

Additional drainage procedures. In 6 of the 197 hip joints (3%) additional arthrotomies were needed. In 2 of these 6 hip joints 2 additional surgeries were performed,[23,28] and in 1 hip joint 3 additional arthrotomies were performed.[26]

Clinical outcomes. In 7 of the 10 studies clinical outcomes were described with a mean follow-up of 2 years.[19,23–25,27,29,30] 12 of the 149 hip joints (8%) had poor clinical outcomes, permanent disability or severe hip pain. The other hip joints had no significant loss of range of motion and no impediment. 2 of the studies described clinical outcomes according to the criteria of Griffin and Green.[29,30] The criteria divide the results into 4 groups, namely excellent, good, fair and poor. Akakpo et al.[30] described an excellent result according to the above-mentioned criteria in 9 of the 12 hip joints and good results in the other 3 hip joints without description of a follow-up time. Umer et al.[29] also described their clinical outcomes using Griffin and Green criteria in 39 patients (40 hip joints) with a follow-up between 1 and 2 years. Good and excellent results were seen in 30 of the 39 patients and 4 patients had fair results. In 5 patients a poor result was seen; 4 of these 5 patients had a delay >10 days. El-Sayed[19] used the Bennett's clinical assessment criteria, while the other 4 studies used descriptive clinical outcomes without a scoring system or criteria.[23–25,27]

Radiological sequelae. Radiological sequelae were described in 7 of the 10 studies with a mean follow-up of 3 years.[19,23–27,29] In 49 of the 162 hip joints (30%) radiographic changes were described at follow-up. The following radiological sequelae were mentioned: ischaemic necrosis and resorption of the capital epiphysis ($n=6$), avascular necrosis ($n=1$) and partial avascular necrosis of the femoral capital epiphysis ($n=1$).[23,25,29] Other radiological findings included heterotopic ossifications ($n=7$), coxa magna ($n=16$), dysplasia of the acetabulum ($n=8$), partial growth plate injury ($n=2$), narrowing of the joint space ($n=4$) and smaller size of the ossific nucleus ($n=3$).[25–27,29] One hip joint showed a healed osteomyelitic ilium at follow-up.[23]

Discussion

This systematic review is a comprehensive review of the literature on drainage techniques for septic hip arthritis in children. An arthrotomy has the lowest chance (3%) of an

Table 1. Studies including septic arthritis of the paediatric hip joint treated by arthrocentesis.

Study	Study design	Number of joints	Mean age (range)	Mean total delay* (range)	Mean follow-up (range)	Treatment	Additional drainage procedure	Radiological outcome	Clinical outcome	MINORS
Samilson et al.[12]	Retrospective	7	<13 y	nm	10 y	Arthrocentesis	Arthrotomy ($n=3$)	nm	nm	3/16
Biyani and Sharma[13]	Prospective	42	0–13 y	⩽5 d	1–3 y	Arthrocentesis + Drain (duration: 90% 2–3 d)	Arthrotomy ($n=4$)	Coxa magna at 3 years follow–up ($n=3$) Joint destruction ($n=1$) (all patients with additional arthrotomy)	Limitation of hip movements ($n=1$)	4/16
Givon et al.[14]	Retrospective	28	4 y (0–15 y)	<1 d	5 y (2–9 y)	Arthrocentesis + Irrigation	Arthrocentesis (3rd [$n=16$], 4th [$n=9$], 5th [$n=3$]) Arthrotomy ($n=4$)	None	FROM No leg–length discrepancy	4/16
Pääkkönen et al.[15]	Retrospective	45	7 y (IQR 4–11 y)	3 d (1–5 d)	> 1 y	(repeated) Arthrocentesis (1–6×)	Arthrotomy ($n=12$)	None	FROM No leg–length discrepancy No complaints after 1 year	4/16
Griffet et al.[16]	Retrospective	19	5 y (1–10 y)	3 d (1–5 d)	2 y (1–3 y)	Arthrocentesis + Drain (duration: 5 d [3–6 d])	None	Mild coxa magna ($n=1$) Ipsilateral slightly smaller ossification nucleus ($n=1$)	FROM Hip pain without joint range movement limitation or radiologic modification ($n=1$)	5/16
Kotlarsky et al.[17]	Retrospective	14	3 y (0–14 y)	3 d (IQR 2–3 d)	4 y (IQR, 6 mos–8 y)	Arthrocentesis	Arthrocentesis (2nd [$n=4$], 3rd [$n=1$], 4th [$n=2$])	None	FROM No leg–length discrepancy No complaints Normal activities within 24 d (IQR, 14–39 days).	5/16

d, days; mo, month; y, years; nm, not mentioned; FROM, full range of motion; MINORS, Methodological Index for Non-Randomized Studies
*Time between onset of symptoms and treatment.

Table 2. Studies including septic arthritis of the paediatric hip joint treated by arthroscopy.

Study	Study design	Number of joints	Meanage (range)	Mean total delay* (range)	Mean follow-up (range)	Treatment	Additional drainage procedure	Radiological outcome	Clinical outcome	MINORS
Chung et al.[18]	Retrospective	9	4 y (2–7 y)	4 d (1–7 d)	nm	Arthroscopy + Drain (duration: 24 h)	None	Focal metaphyseal radiodensity ($n = 2$) Slight enlargement of the femoral epiphysis ($n = 1$)	nm	4/16
El-Sayed[19]	Prospective controlled	10	8 y (4–12 y)	3 d (1–5 d)	2 y (1–3 y)	Arthroscopy + Drain (duration: 2 d [range 1–4 d])	None	None	Infrequent joint aches ($n = 1$) Bennett's clinical assessment criteria: excellent ($n = 9$), good ($n = 1$)	15/24
Nusem and McAllister[20]	Retrospective	6	10 y (6–13 y)	3 d (2–5 d)	4 y (1–7 y)	Arthroscopy	None	None	Excellent results based on Bennett's criteria. All FROM	5/16
Fernandez et al.[21]	Prospective	18	7 y (3–14 y)	4 d (1–7 d)	2 y (6 mo–4 y)	Arthroscopy	A'scopy ($n = 3$)	Avascular necrosis ($n = 1$)	Limitation of hip movements ($n = 1$) HHS: fair result ($n = 1$), excellent clinical results ($n = 17$)	2/16
Sanpera et al.[22]	Retrospective	11	6 y (2–12 y)	4 d (2–7 d)	3–8 y	Arthroscopy	A'scopy ($n = 2$)	Metaphyseal lytic image ($n = 1$)	HHS: excellent clinical results ($n = 11$)	2/16

d, days; mo, months; y, years; nm, not mentioned; FROM, full range of motion; HHS, Harris Hip Score; MINORS, Methodological Index for Non-Randomized Studies.
*Time between onset of symptoms and treatment.

Table 3. Studies including septic arthritis of the paediatric hip joint treated by arthrotomy.

Study	Study design	Number of joints	Mean age (range)	Mean total delay* (range)	Mean follow–up (range)	Treatment	Additional drainage procedure	Radiological outcome	Clinical outcome	MINORS
Samilson et al.[12]	Retrospective	12	<13 y	nm	10 y	Arthrotomy	None	nm	nm	3/16
Wiley and Fraser[23]	Retrospective	16	0–16 y	nm	nm	Arthrotomy	Arthrotomy ($n=1$)	Healed osteomyelitic ilium ($n=1$) Avascular necrosis ($n=1$)	Permanent disability ($n=2$)	3/16
Katz et al.[24]	Retrospective	6	3 y (0–9 y)	4 d (3–6 d)	2 y (1–4 y)	Arthrotomy + Drain (duration: nm)	None	None	FROM and painless	2/16
Bennett and Namnyak[25]	Retrospective	45	4 y (0–11 y)	6 d (2–27 d)	4 y (2–5 y)	Arthrotomy	None	Coxa magna ($n=9$) Narrowing of the joint space ($n=4$) Ischaemic necrosis and resorption of the capital epiphysis ($n=6$) Dysplasia of the acetabulum ($n=8$)	Reduced hip motion ($n=12$) (6 of these had more than 40% loss) Limb length discrepancy ($n=6$) Hip pain severe enough to interfere with play ($n=5$)	4/16
Lyon and Evanich[26]	Retrospective	25	0–16 y	nm	4 mo–7 y	Arthrotomy	Arthrotomy ($n=1$)	2× Heterotopic ossification 1× Heterotopic ossification with ankyloses 1× Mild coxa magna and subluxation	nm	5/16
Kim et al.[27]	Retrospective	20	4 y (0–15 y).	3.6d (1–10d)	2 y (1–5 y)	Arthrotomy	Arthrotomy ($n=1$)	6× mild coxa magna 3× ossific nucleus slightly smaller than the opposite side	FROM Complaint of occasional pain after physical activity ($n=2$)	5/16
Gandini[28]	Retrospective	11	6 y (0–12 y)	nm	nm	Arthrotomy	Arthrotomy ($n=2$)	nm	nm	2/16
Umer et al.[29]	Retrospective	40	4 y (0–13 y)	6d(1–20 d)	1–2 y	Arthrotomy	Arthrotomy ($n=1$)	4× myositis ossificans 2× partial growth plate injury 1× partial avascular necrosis of the femoral capital epiphysis	Criteria of Griffin and Green: good or excellent ($n=30$), fair ($n=4$), poor ($n=5$) (4/5 delay >10 d) Early joint stiffness ($n=10$)	3/16
El-Sayed[19]	Prospective controlled	10	7 y (3–11 y)	3 d (1–5)	2 y (1–3 y)	Arthrotomy + Drain (duration: 3 d [range 2–5 d])	None	None	Infrequent joint aches ($n=2$) Abduction loss of 10° ($n=1$) External rotation in flexion reduces by 10° ($n=1$) Bennett's clinical assessment criteria: excellent ($n=7$), good ($n=3$)	15/24
Akakpo-Numado et al.[30]	Retrospective	12	nm	nm	nm	Arthrotomy	None	nm	Criteria of Griffin and Green: excellent ($n=9$), good ($n=3$) (pain when exercising and slight limitation of articulation) Disappearance of the hip pain after 2 weeks on average	3/16

d, days; mo, months; y, years; nm, not mentioned; FROM, full range of motion; MINORS, Methodological Index for Non-Randomized Studies.
*Time between onset of symptoms and treatment.

additional drainage surgery (arthroscopy or arthrotomy) compared to arthrocentesis (15%) and arthroscopy (14%). Additional arthrocentesis was performed in 71% of the hip joints treated with arthrocentesis without a drain compared to 0% treated with arthrocentesis followed by a drain. An additional arthrotomy was needed in 20% of the hip joints treated with arthrocentesis without a drain compared to 7% treated with arthrocentesis followed by a drain. Inferior clinical outcomes and more radiological sequelae were seen in patients treated with an arthrotomy in comparison with an arthroscopy and an arthrocentesis. However, the included studies are diverse and the scientific quality is generally low. Hence, it is inappropriate to draw firm conclusions from the collected results.

Drainage of the hip joint with septic arthritis is important because an increase in intracapsular pressure in the hip joint may lead to compressive ischaemia and avascular necrosis of the femoral head when not promptly addressed.[3] Each of the different drainage techniques has advantages and disadvantages. Arthrocentesis has the advantage of being a minimal invasive and short procedure. It is often guided by ultrasound and under anaesthesia, but with a possible higher risk of ineffectively draining the viscous pus. In this review there was a large chance of multiple arthrocentesis and 15% of the hip joints treated with arthrocentesis needed an additional arthrotomy. Advantages of arthroscopy include direct visualisation of the joint and a larger irrigation in comparison with arthrocentesis. However, it is technically more demanding, and the surgeon must be experienced in performing arthroscopies of the hip joint in children. An arthrotomy gives the surgeon a total overview of the joint and an extensive irrigation can be performed, but it can possibly lead to prolonged recovery and more scar tissue. El-Sayed,[19] the only prospective controlled study that could be included, compared arthroscopy to arthrotomy. They concluded that arthroscopy is an effective method in treating septic arthritis of the hip and that it is associated with shorter hospital stay and in early uncomplicated cases forms a valid alternative procedure for orthopaedic surgeons skilled in paediatric arthroscopy.

The time between onset of symptoms and treatment can affect the clinical and radiological outcomes of the different treatment methods. The maximum delay was larger in patients treated with arthrotomy (27 days) compared to arthroscopy (7 days) and arthrocentesis (5 days), which may explain the inferior clinical outcomes and the higher number of radiological sequelae in patients treated with an arthrotomy. Only 2 studies with hip joints treated with arthrotomy mentioned a maximum delay of 6 days.[19,24] In both these studies no hip joints needed an additional drainage procedure, no radiological sequelae were seen and all had good to excellent clinical outcomes.

To the best of our knowledge, this is the first detailed systematic review about surgical treatment of septic hip arthritis in children with an overview of results of included studies. In 2009, Kang et al.[31] published a systematic review of the English language literature about the management of septic arthritis in children but unfortunately without an overview of the results of the included studies. They concluded that the roles of arthrocentesis, arthroscopy or arthrotomy are not clear. In our systematic review less additional drainage procedures were reported in patients treated with arthrotomy for septic hip arthritis in comparison with arthrocentesis and arthroscopy. Rutz and Spoerri[32] published a review about the current diagnostic approaches and therapeutic concepts of septic arthritis of the paediatric hip in 2013. They advised to reduce the aggressiveness of the treatment of septic arthritis in previously healthy children with a time between onset of symptoms and treatment less than 5 days.

One of the strengths of this review is the systematic search method to identify relevant articles for this subject. Furthermore, an established diagnosis of acute septic arthritis was well-defined in our inclusion criteria. Finally, we have used the numbers and available results of all patients in the included articles to show a detailed overview of the available literature on the different invasive treatments of septic hip arthritis in children.

There are several limitations. Unfortunately, 16 of the 19 studies are retrospective and the majority of the studies included a small number of patients, although in 4 studies over 40 hip joints were treated.[13,15,25,29] Most of the included articles were incomplete in reporting important details, e.g., the delay to treatment was not always mentioned. Subanalyses based on age were impossible because all studies had a large age range.

In conclusion, this systematic review shows a clear overview of the literature on treatment for septic hip arthritis in children. Arthrocentesis and arthroscopic procedures may have a higher risk of additional drainage procedures compared to arthrotomy. The results of the present review may assist orthopaedic surgeons treating children with acute septic arthritis of the hip. A prospective study, multicentre with a larger number of patients, an established diagnosis of acute septic arthritis, restriction of delay and an adequate follow-up time are recommended.

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Supplemental material

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