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Original article

# Arthroscopic treatment of septic arthritis of the knee in children



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## ARTICLE INFO

### Article history:

Received 2 July 2015

Accepted 30 August 2015

### Keywords:

Septic arthritis  
 Knee  
 Arthroscopy  
 Children

## ABSTRACT

**Introduction:** Childhood septic arthritis of the knee is a serious disease that can impair growth and cause serious functional sequelae. There are few data on arthroscopic treatment in children, and series were always less than 20 cases.

**Hypothesis:** The objective of this study was to assess clinical and radiographic results of arthroscopic drainage combined with antibiotic therapy for the treatment of childhood septic arthritis of the knee. The hypothesis was that arthroscopic treatment is also effective in children.

**Materials and methods:** A retrospective study, conducted between January 2003 and December 2012, included patients under 15 years of age with septic arthritis of the knee treated by arthroscopic drainage with a minimum of 2 years' follow-up.

**Results:** Fifty-six patients, with a mean age at surgery of 3.4 years (range, 3 months to 12 years), were included. *Staphylococcus aureus* was the most common causative organism. Two patients (3.6%) had recurrence, successfully treated by repeat arthroscopic drainage. Mean Lysholm score was 96.9 (range, 70–100) and mean KOOS-Child pain, symptoms, daily life, sports and quality of life scores were respectively 97 (81–100), 95 (75–100), 98 (89–100), 93 (71–100) and 95 (70–100) at a mean 65 months' follow-up. Ranges of motion were normal. Radiology found no joint damage.

**Discussion and conclusion:** Arthroscopic drainage combined with antibiotic treatment is a simple and effective treatment for childhood septic arthritis of the knee and is for our reference attitude. It can also be indicated in case of recurrence.

**Level of evidence:** IV, retrospective study.

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## 1. Introduction

Childhood septic arthritis is a potentially serious pathology which can lead to severe functional sequelae or death [1–5]. All joints are exposed, but the knee and hip are the most frequently involved [6–10].

Arthrotomy results at a mean 5 years' follow-up were reported to be excellent in 68% of cases and good in 20% [11]. The essential predictive factor is time to treatment [3–5,7,10,12–14]; any delay in diagnosis or ineffective treatment may result in osteomyelitis, chondrolysis, physeal growth disorder, lower-limb length discrepancy or severe sepsis [1–5,7,11,12].

The choice of joint drainage technique is controversial between needle aspiration, arthrotomy or arthroscopy. In adults, arthroscopic drainage with synovectomy is the consensual treatment of choice in septic arthritis of the knee, with lower rates of infectious recurrence than needle aspiration and better functional results than

open surgery [15–19]. In children, there have been fewer studies and the interest of arthroscopy remains to be clearly demonstrated [20–24].

The present study assessed medium-term clinical and radiological results of arthroscopic treatment of childhood septic arthritis of the knee. The study hypothesis was that arthroscopy is effective in children.

## 2. Materials and methods

### 2.1. Study population

The study design was observational, retrospective and single-center. Case files for childhood septic arthritis of the knee were retrieved from our center's database. All procedures were performed by senior surgeons, between January 2003 and December 2012.

All patients aged less than 15 years at surgery and with a minimum 2 years' follow-up, presenting purulent effusion at the knee (white blood cells [WBC] > 50,000/μL and/or > 90% neutrophils) or

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with retrospectively confirmed positive joint fluid culture were included.

Patients with associated osteomyelitis or subperiosteal abscess were excluded.

## 2.2. Surgical technique

All patients underwent emergency surgery. Preliminary needle aspiration was performed under general anesthesia. When suspected septic arthritis was confirmed by macroscopic analysis of the joint fluid, an anterolateral approach was performed for the 5-mm arthroscope plus an anteromedial approach for aspiration. The knee joint was washed with 2–3 L of physiological saline until the fluid became clear. Synovectomy was not performed. A drain was fitted in one of the approaches at end of surgery. Postoperative care was standardized, with long-leg cast immobilization and probabilistic parental antibiotic therapy. Antibiotics were then adapted in the light of the bacteriology findings, with oral relay as soon as the inflammatory syndrome showed clinical and biological improvement. Treatment success was defined as symptom resolution and a reduction in inflammation markers; failure was defined by a need for revision surgery. No rehabilitation was performed.

Patients were followed up by an independent examiner. At last follow-up, clinical work-up assessed range of motion, joint effusion, clinical limb-length discrepancy and return to sport. Functional assessment comprised Lysholm and KOOS-Child scores. Radiology comprised AP and lateral views centered on the knee, analyzing joint status in terms of degeneration and growth disorder.

## 3. Results

Sixty-six patient files (35 females, 31 males) were retrieved from the center's database. Six patients were lost to follow-up, although without known complications at more than 24 months. Four refused participation. Fifty-six patients were thus included for analysis (Table 1). Mean follow-up was 65 months (range, 26–141 months). Mean age at surgery was 3.4 years (range, 3 months to 11 years). Mean interval between symptom onset and admission was 3.2 days (range, 0–16 days). At admission to the emergency department, 14 patients (25%) were afebrile; all were in pain; 55 (98.2%) had joint effusion. CRP was elevated in 49 patients (87.5%), white blood cell count was elevated in 42 (75%) and sedimentation rate in 27 (48.2%).

**Table 1**  
Epidemiological data.

Number of patients	56
Age (years)	3.4 (range, 0.3–11)
Male	25
Female	31
M/F sex-ratio	0.8
Right side	26
Left side	30
Fever	42 (75%)
Effusion	55 (97.5%)
Pain	56 (100%)
Time from onset (days)	3.2 (range, 0–16)
WBC ( $10^9$ cells/L)	14.8 (range, 7.5–26.6)
CRP (mg/L)	57.3 (range, 3–273)
ESR (mm/h)	41.9 (range, 11–130)
Plain X-ray	56 (100%)
Ultrasound	17 (30.3%)
Hematogenic	52 (92.9%)
Deep wound	4 (7.1%)
Parenteral antibiotic therapy (days)	7.8 (range, 5–12)
Oral antibiotic therapy (days)	33.2 (range, 13–40)
Total antibiotic therapy (days)	40.9 (range, 21–45)
Hospital stay (days)	9.8 (range, 6–23)

**Table 2**  
Isolates.

Bacterium	Cases
<i>Staphylococcus aureus</i>	11 (40.7%)
<i>Kingella kingae</i>	7 (25.9%)
<i>Streptococcus pyogenes</i>	5 (18.5%)
<i>Enterobacter</i>	1 (3.7%)
<i>Streptococcus pneumonia</i>	2 (7.4%)
<i>Neisseria meningitidis</i>	1 (3.7%)

Systematic AP and lateral knee X-ray performed in the emergency department found no abnormalities. Seventeen patients (30.3%) had an ultrasound knee scan due to difficult clinical examination; joint effusion was systematically disclosed.

Etiology was considered to be hematogenic in 52 patients and secondary to direct joint inoculation in 4. Mean antibiotic therapy duration was 40.9 days (range, 21–45 days). Bacteriology identified a bacterium in only 27 cases (48.2%); 11 cases with *Staphylococcus aureus*, 7 with *Kingella kingae*, 5 with *Streptococcus pyogenes*, 2 with *Streptococcus pneumonia*, 1 with *Enterobacter* and 1 with *Neisseria meningitidis* (Table 2).

The aspiration drain was removed at a mean 5.3 days (range, 1–9 days). Mean hospital stay was 9.8 days (range, 6–23 days). Mean immobilization time was 26.1 days (range, 12–55 days).

There were 2 cases of in-hospital recurrence (3.6%), managed by a single repeat arthroscopic drainage; arthrotomy was not performed. In 1 case, aspiration drainage was not performed; in the other, with *S. aureus*, treatment took 15 days.

At last follow-up, none of the patients reported pain in the operated knee. Mean range of motion was 0.3° (range, 0°–10°) in extension and 148.8° (range, 120°–160°) in flexion and was symmetrical. Three cases showed <5 mm limb-length discrepancy on clinical examination. All patients resumed sport at their previous level.

In the series as a whole, at last follow-up, mean Lysholm score was 96.9 (range, 70–100), with 82% excellent, 14% good and 4% moderate results. Mean KOOS-Child scores at end of follow-up were 95 for symptoms (range, 75–100), 97 for pain (range, 81–100), 98 for daily life (range, 89–100), 93 for sport (range, 71–100) and 95 for quality of life (range, 70–100). In the 2 cases with recurrence, the Lysholm scores were 97 and 100 and the KOOS-Child scores respectively 100, 97, 100, 98 and 100 and 100, 100, 100, 100 and 100.

In the 56 patients with radiologic assessment of the operated knee, there were no physeal or epiphyseal growth abnormalities or cases of joint impingement.

## 4. Discussion

Arthroscopic treatment of childhood septic arthritis of the knee was effective in 96.4% of cases in the present series.

Demographically, the present series was comparable to those reported in the literature. Forty-five patients (80.4%) were under 5 years of age and 6 (10.6%) under 1 year; mean age was 3.2 years, comparable to 3 years 4 months in the series reported by Glorion et al. [11]. The early signs of septic arthritis are insidious, which accounts for the mean 3.2 days' mean time to admission, which was identical to that reported by Griffet et al. [13]. Elevated CRP and WBC count are important prognostic factors [3,4,10,12]; 87.5% of the present series showed CRP elevation and hyperleukocytosis. Pus aspirated from the joint is the main diagnostic criterion [3,4,10,12,13,25]; definitive diagnosis is retrospective, founded on positive culture or purulence (WBC > 50,000/ $\mu$ L and/or > 90% neutrophils) found in the joint fluid.

The present rate of 48.5% positive culture was comparable to literature reports [6,8,10–13,26,27]. *S. aureus* was the most

**Table 3**  
Comparison of published studies.

Authors	Number of cases	Number of arthroscopies	Recurrences	Follow-up
Skyhar and Mubarak [21] (1987)	20	15 (75%)	0 (0%)	31 months
Stanitski et al. [23] (1989)	16	16 (100%)	0 (0%)	36.7 months
Angel and Hall [24] (1989)	9	9 (100%)	0 (0%)	5.9 months
Ohl et al. [20] (1991)	16	16 (100%)	1 (6.3%)	10 months
Glorion et al. [11] (1993)	51	4 (7.8%)	1 (25%)	5 years
Sanchez and Hennrikus [22] (1997)	5	5 (100%)	0 (0%)	26 months
Present study	56	56 (100%)	2 (3.6%)	65 months

frequent isolate, followed by *K. kingae* and *S. pyogenes*, as in several other studies [4,9,10,12,25,28,29]. *K. kingae* is presently emerging strongly in pediatric joint infection; a recent Swiss study found an 82% rate in joint infection in under 4-year-olds [30]. Initial parenteral antibiotic therapy with oral relay according to clinical progression is consensual, but optimal duration and type of admission are not; treatment durations of less than 6 weeks do not seem to lack efficacy [31–34].

Onset of septic arthritis of the knee constitutes a surgical emergency. Diagnosis should be immediate and treatment must be effective, to minimize long-term sequelae [2–5,7,11–13]. Although the joint drainage technique used to be controversial [35], arthroscopic implementation is now an attitude of choice in both adults [15–19] and children [20–24] in many centers; unlike in adults, however, there is no validated prognostic staging classification for children and, in the present series, no compartment formation or cartilage or bone damage were found.

Needle aspiration is indeed a simple technique, as Herndon et al. described it [35] in a series of 49 patients with septic arthritis managed by aspiration and antibiotics; they reported 15 failures (31%) and the same rate of revision by arthrotomy within 15 days of admission. We consider a 31% failure rate to be unacceptable.

In a continuous series of 51 cases of childhood septic arthritis of the knee, Glorion et al. [11] performed 36 arthrotomies, 11 needle aspirations and 4 arthroscopies; at a mean 5 years' follow-up, they reported 35 (68%) excellent, 10 (20%) good and 6 (12%) poor results, but including 4 cases of recurrence and 2 arthrodeses for cartilage lesions. The present results confirm that the arthroscopic technique gives reliable results that were excellent in 82% of cases, good in 14% and moderate in 4%, with a 3.6% recurrence rate and no cartilage damage at last follow-up. There have been few reports of arthroscopy in the management of childhood septic arthritis of the knee, but all published results have overall been good (Table 3). Arthroscopy provides a useful alternative to needle aspiration and arthrotomy. It does not require a dedicated pediatric arthroscope and can thus be applied in any center performing arthroscopy. It enables complete drainage and precise joint assessment in a single step, unlike needle aspiration, which often needs repeating. Compared to arthrotomy, it leaves less scar tissue and allows faster joint recovery and shorter hospital stay [22].

In a recent prospective pediatric study, El-Sayed, comparing results between arthroscopy and arthrotomy in septic arthritis of the hip, found significantly shorter hospital stay with arthroscopy [14]. A similar study should be conducted regarding the knee.

Complications are rare in arthroscopy, the main one being infectious recurrence. Ohl et al. [20] reported 1 such case out of 16 patients (6%) and Glorion et al. [11] 1 out of 4; all were managed by arthrotomy, whereas in the present study recurrence was managed arthroscopically.

The present retrospective observational design entails a low level of evidence, despite the large number of cases and low loss to follow-up over more than 2 years. The low level of identified isolates (48.2%) was comparable to other reports and could be improved by using PCR. The present retrospective analysis of joint

fluid, with WBC > 50,000/ $\mu$ L and/or > 90% neutrophils as an inclusion criterion countered this bias.

## 5. Conclusion

Arthroscopic drainage associated to antibiotic therapy is an effective treatment for childhood septic arthritis of the knee, providing good medium-term functional and radiological results. Iterative draining is possible in case of recurrence, as in adults.

## Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

## References

- [1] Ilharreborde B. Sequelae of pediatric osteoarticular infection. *Orthop Traumatol Surg Res* 2015;101(Suppl. 1):29–37.
- [2] Porat S, Goitien K, Saperia BS, Liebergall M, Abu-Dalu K, Katz S. Complications of suppurative arthritis and osteomyelitis in children. *Int Orthop* 1991;15(3):205–8.
- [3] Pääkkönen M, Peltola H. Management of a child with suspected acute septic arthritis. *Arch Dis Child* 2012;97(3):287–92.
- [4] Dodwell ER. Osteomyelitis and septic arthritis in children: current concepts. *Curr Opin Pediatr* 2013;25(1):58–63.
- [5] Howard JB, Highgenboten CL, Nelson JD. Residual effects of septic arthritis in infancy and childhood. *JAMA* 1976;236(8):932–5.
- [6] Goergens ED, McEvoy A, Watson M, Barrett IR. Acute osteomyelitis and septic arthritis in children. *J Paediatr Child Health* 2005;41(1–2):59–62.
- [7] Shaw BA, Kasser JR. Acute septic arthritis in infancy and childhood. *Clin Orthop* 1990;(257):212–25.
- [8] Wilson NI, Di Paola M. Acute septic arthritis in infancy and childhood. 10 years' experience. *J Bone Joint Surg Br* 1986;68(4):584–7.
- [9] Grimprel E, Cohen R. [Epidemiology and physiopathology of osteoarticular infections in children (newborns except)]. *Arch Pediatr* 2007;14(Suppl. 2):81–5.
- [10] Kang S-N, Sanghera T, Mangwani J, Paterson JMH, Ramachandran M. The management of septic arthritis in children: systematic review of the English language literature. *J Bone Joint Surg Br* 2009;91(9):1127–33.
- [11] Glorion C, Palomo J, Bronfen C, Touzet P, Padovani JP, Rigault P. Acute infectious arthritis of the knee in children. Prognosis and therapeutic discussion apropos of 51 cases with an average follow-up of 5 years. *Rev Chir Orthop* 1993;79(8):650–60.
- [12] Faust SN, Clark J, Pallett A, Clarke NMP. Managing bone and joint infection in children. *Arch Dis Child* 2012;97(6):545–53.
- [13] Griffet J, Oborocianu I, Rubio A, Leroux J, Lauron J, Hayek T. Percutaneous aspiration irrigation drainage technique in the management of septic arthritis in children. *J Trauma* 2011;70(2):377–83.
- [14] El-Sayed AMM. Treatment of early septic arthritis of the hip in children: comparison of results of open arthrotomy versus arthroscopic drainage. *J Child Orthop* 2008;2(3):229–37.
- [15] Ivey M, Clark R. Arthroscopic debridement of the knee for septic arthritis. *Clin Orthop* 1985;(199):201–6.
- [16] Smith MJ. Arthroscopic treatment of the septic knee. *Arthroscopy* 1986;2(1):30–4.
- [17] Lane JG, Falahee MH, Wojtys EM, Hankin FM, Kaufer H. Pyarthrosis of the knee. Treatment considerations. *Clin Orthop* 1990;(252):198–204.
- [18] Bussièrè F, Beaufile P. [Role of arthroscopy in the treatment of pyogenic arthritis of the knee in adults. Report of 16 cases]. *Rev Chir Orthop* 1999;85(8):803–10.
- [19] Jackson RW. The septic knee – arthroscopic treatment. *Arthroscopy* 1985;1(3):194–7.
- [20] Ohl MD, Kean JR, Steensen RN. Arthroscopic treatment of septic arthritic knees in children and adolescents. *Orthop Rev* 1991;20(10):894–6.
- [21] Skyhar MJ, Mubarak SJ. Arthroscopic treatment of septic knees in children. *J Pediatr Orthop* 1987;7(6):647–51.

- [22] Sanchez AA, Hennrikus WL. Arthroscopically assisted treatment of acute septic knees in infants using the Micro-Joint Arthroscope. *Arthroscopy* 1997;13(3):350–4.
- [23] Stanitski CL, Harvell JC, Fu FH. Arthroscopy in acute septic knees. Management in pediatric patients. *Clin Orthop* 1989;(241):209–12.
- [24] Angel KR, Hall DJ. The role of arthroscopy in children and adolescents. *Arthroscopy* 1989;5(3):192–6.
- [25] Young TP, Maas L, Thorp AW, Brown L. Etiology of septic arthritis in children: an update for the new millennium. *Am J Emerg Med* 2011;29(8):899–902.
- [26] Abuamara S, Louis J-S, Guyard M-F, Barbier-Frebourg N, Lechevallier J. Osteo-articular infection in children: evaluation of a diagnostic and management protocol. *Rev Chir Orthop* 2004;90(8):703–13.
- [27] Joshy S, Choudry Q, Akbar N, Crawford L, Zenios M. Comparison of bacteriologically proven septic arthritis of the hip and knee in children, a preliminary study. *J Pediatr Orthop* 2010;30(2):208–11.
- [28] Ferroni A, Al Khoury H, Dana C, Quesne G, Berche P, Glorion C, et al. Prospective survey of acute osteoarticular infections in a French paediatric orthopedic surgery unit. *Clin Microbiol Infect* 2013;19(9):822–8.
- [29] Pääkkönen M, Kallio MJT, Kallio PE, Peltola H. Shortened hospital stay for childhood bone and joint infections: analysis of 265 prospectively collected culture-positive cases in 1983–2005. *Scand J Infect Dis* 2012;44(9):683–8.
- [30] Ceroni D, Cherkaoui A, Ferey S, Kaelin A, Schrenzel J. *Kingella kingae* osteo-articular infections in young children: clinical features and contribution of a new specific real-time PCR assay to the diagnosis. *J Pediatr Orthop* 2010;30(3):301–4.
- [31] Grimprel E, Lorrot M, Haas H, Pinquier D, Perez N, Ferroni A, et al. Osteo-articular infections: therapeutic proposals of the Paediatric Infectious Diseases Group of the French Society of Paediatrics (GPIP). *Arch Pediatr* 2008;15(Suppl. 2):S74–80.
- [32] Lorrot M, Doit C, Ilharreborde B, Vitoux C, Le Henaff L, Sebag G, et al. Antibiotic therapy of bone and joint infections in children: recent changes. *Arch Pediatr* 2011;18(9):1016–8.
- [33] Lavy CBD, Thyoka M. For how long should antibiotics be given in acute paediatric septic arthritis? A prospective audit of 96 cases. *Trop Doct* 2007;37(4):195–7.
- [34] Peltola H, Pääkkönen M, Kallio P, Kallio MJT. Prospective, randomized trial of 10 days versus 30 days of antimicrobial treatment, including a short-term course of parenteral therapy, for childhood septic arthritis. *Clin Infect Dis* 2009;48(9):1201–10.
- [35] Herndon WA, Knauer S, Sullivan JA, Gross RH. Management of septic arthritis in children. *J Pediatr Orthop* 1986;6(5):576–8.