

Post-arthroscopic septic arthritis of the knee. Analysis of the outcome after treatment in a case series and systematic literature review

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Abstract. – OBJECTIVE: The aim of this study was to review the characteristics of patients with septic arthritis after ACL reconstruction comparing our results with those deriving from the literature review.

PATIENTS AND METHODS: Patients with suspected post arthroscopic septic arthritis of the knee occurring within 6 months after surgery were evaluated to be included in the investigation. Septic arthritis was defined by i) clinical evidence; ii) laboratory investigations; iii) synovial fluid leukocyte count of more than $2,5 \times 10^4/\mu\text{L}$ or positive cultures obtained by synovial fluid aspirate.

RESULTS: Thirty-nine patients (median age 25 years, range 17-42) with septic arthritis following ACL reconstruction were enrolled. Staphylococci were the main bacteria identified. Resolution within 4 weeks of local signs was observed more frequently in those receiving arthroscopic debridement and synovectomy coupled with antibiotic therapy (18/21 vs. 9/18, $p < 0.05$). Fever was present in 33 (85%) cases. Fever disappearance and CRP normalization within 4 weeks were reported more frequently in patients receiving intravenous antibiotics (17/20 vs. 9/19, $p < 0.05$). Similar findings were retrieved by literature analysis.

CONCLUSIONS: An intravenous antibiotic therapy with surgical debridement is the first-line treatment for septic arthritis. Staphylococci are the main causative agents, justifying an empiric therapeutic approach with an anti-MRSA agent and cephalosporin.

Key Words

Septic arthritis, Infection, Knee, Anterior cruciate ligament, Nosocomial infection.

Abbreviations

ACL, anterior cruciate ligament; EB, *Enterobacter*; EC, *Escherichia coli*; EF, *Enterococcus faecalis*; CI, confidence interval; CN, Culture negative; CO, *Corynebacterium*; CoNS, coagulase-negative staphylococci; CRP, C-reactive protein; ESR, erythrocyte

sedimentation rate; MIC, minimal inhibitory concentration; MRSA, methicillin-resistant *Staphylococcus aureus*; N/A, not available; PA, *Propionibacterium acnes*; PM, Polymicrobial; PS, *Pseudomonas*; SE; ST, *Streptococcus*; SA, *Staphylococcus aureus*; SM, *Serratia Marcescens*; TB, *Mycobacterium tuberculosis*; WKS, weeks.

Introduction

Septic arthritis is an uncommon but potentially devastating complication of peri- and intra-articular surgical procedures (including arthroscopy) estimated to occur in less than 1% of patients undergoing arthroscopically guided anterior cruciate ligament (ACL) reconstruction surgery¹⁻¹⁵. Currently, septic arthritis after ACL reconstruction is classified as acute when it occurs within 2 weeks from surgery, subacute when it is diagnosed between 2 weeks and 2 months after surgery, and late when it is diagnosed more than 2 months postoperatively^{13,16-18}.

Regardless of the use of autograft or allograft, the replaced ACL has to be considered a foreign body without any blood supply where bacteria can grow. The graft can become infected because of a number of events such as the contamination from the surgical incision or arthroscopic portals or the spread from the tibial bony tunnel. Hematoma collection in the pretibial subcutaneous tissue is considered the main cause of infection¹⁶. *Staphylococcus aureus* and Coagulase Negative staphylococci (CoNS) are involved in the majority of cases, whereas Gram-negative bacteria are rarely found.

Several algorithms tried to standardize the diagnostic procedures and the treatment of septic arthritis occurring after ACL reconstruction^{1,3,6,7,9,10,13,15}, but no consensus has been reached so far, probably due to the small number of patients included in the studies available. The main

unresolved questions remain: (i) the diagnostic role of serum inflammatory markers and synovial fluid aspirate, (ii) the route of administration (intravenous *vs.* oral) of antibiotics for the long-term treatment, (iii) the need for surgical revision, (iv) the role of local irrigation, and (v) the fate of the implanted ACL graft.

The aim of this study was to discuss these unresolved questions reviewing a series of patients with septic arthritis after ACL reconstruction and comparing our results with those deriving from the systematic literature review.

Patients and Methods

Patients with suspected post arthroscopic septic arthritis of the knee occurring within 6 months after surgery and referred to our Centre for an Infectious Diseases (ID) consultation over a 5-year period were evaluated to be included in the study. The internal review board approved the research. Patients gave an informed consent before being included in the study according to accredited expert opinions, septic arthritis was defined by i) clinical evidence including fever, local pain, swelling, erythema or tenderness; ii) laboratory investigations including leucocytosis, increased erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP); iii) synovial fluid leukocyte count of more than $2,5 \times 10^4/\mu\text{L}$ or positive cultures obtained by synovial fluid aspirate¹⁷. Postoperative infections were classified as acute (<2 weeks postoperative), subacute (between 2 weeks and 2 months), or late (>2 months).

Following the previously established internal protocol for cases of suspected infection of the orthopaedic surgical site, a trained ID specialist and an Orthopaedic Surgeon evaluated each case jointly. At the time of their first visit, clinical data were collected, and general laboratory investigations such as peripheral white blood cell (WBC) count, serum CRP, and ESR were obtained. Synovial aspiration of the knee for leukocyte count and microbiological investigation was performed in all patients. Standard radiographic investigation completed the baseline evaluation. Patients with a follow-up period of at least 48 months were included.

Microbiologic studies

Cultures for aerobic and anaerobic bacteria were performed before antibiotic treatment on the samples of synovial fluid aspirate. Synovial fluid volumes of 0.5-3 ml were inoculated in Bactec

Peds Plus/F bottles and incubated in a Bactec 9240 instrument for 14 days¹⁹. Susceptibility to antimicrobials was evaluated by E-test. Minimal inhibitory concentration (MIC) for EUCAST breakpoints was used as interpretative criteria.

Treatment

Once the diagnosis of septic arthritis was obtained, patients received empirical intravenous antibiotic therapy considering Gram-positive multi-drug resistant bacteria coverage, (i.e., third-generation cephalosporins and glycopeptides), at the dose generally recommended for joint and bone infections. Intravenous therapy was administered for at least 2 weeks after the diagnosis. After this period, on the basis of the clinical judgement based on local and general symptoms resolution, CRP and WBC normalisation, patients received a course of at least 6 weeks of oral or intravenous antibiotic treatment based on the microbiological findings retrieved. Additional surgical treatments including arthroscopic debridement and partial synovectomy with intra-articular washing without ACL removal were considered as part of the patients' work-up.

Follow-up

Serum CRP, ESR, and full blood count were evaluated every 7 days during the 2-week period of intravenous antibiotic treatment. Thereafter, routine laboratory data (full blood count, serum ESR and CRP, liver enzymes, blood urea, and creatinine) were assessed every 4 weeks either during the antibiotic treatment or over a 24-week period after drug discontinuation. The cure was defined by i) disappearance of clinical and radiologic evidence of septic arthritis, and ii) serum CRP normalization 24 weeks after the discontinuation of antibiotic treatment

Questionnaires

Validated questionnaires were administered to assess the functionality of the knee and the level of activity. The Lysholm Knee Scoring Scale²⁰ was used to evaluate the functionality of knee preoperatively and at the last follow-up control. This instrument is graded from 0 to 100, where 100 is the best score. Pre-injury and final levels of activity were assessed using the Tegner Activity Scale²¹, which is graded from 0 to 10, with 10 representing the best score.

Statistical analysis

Quantitative data were compared using the Mann-Whitney U-test. Wilcoxon signed rank test was used to determine whether follow-up data

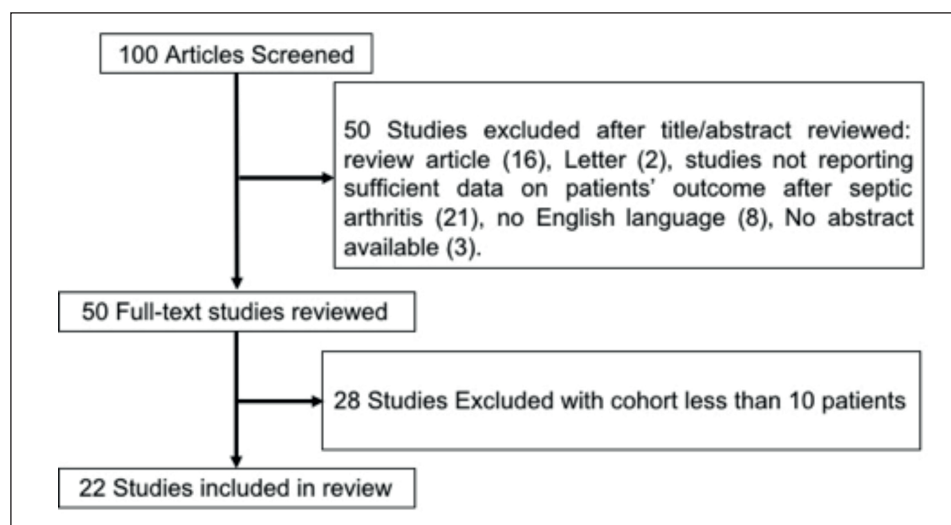


Figure 1. Flow diagram representing systematic review process used in the study. A total of 22 studies were included for final analysis.

were significantly changed with respect to baseline clinical scores.

Fisher’s exact test and the chi-squared test were used to compare qualitative variables. Time-to-treatment failure was assessed for the entire cohort according to the Kaplan-Meier method and curves were compared by the log-rank test. The two-tailed *p-values* below 0.05 were considered statistically significant. The statistical analysis was performed using SPSS 20.0 software.

Literature review

To identify relevant papers dealing with knee infection after ACL reconstruction surgery, we carried out a research of English language literature using the MEDLINE database with the search string "septic arthritis" AND "ACL reconstruction" from January 1968 to April 2018. And by checking of the Cochrane Library and named research of the references from available review reports about septic arthritis and ACL reconstruction. This systematic review adopted the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA).

A total of 100 published papers were extracted. Two authors (GB and TA) independently reviewed each paper. Once a paper was identified as likely to be included, the full-text version was obtained. Conflict about the inclusion of a paper was resolved by further evaluation which was undertaken by the senior author (PP). A total of 50 papers were excluded from the analysis for the following reasons: 16 were review articles, 21 did not report sufficient data on patients’ outcome after septic arthritis, 8 were not English literature, two were letters to the editor and in 3

papers the abstract was not available. Further 28 reports including less than 10 patients were finally excluded. Therefore, 22 papers were finally considered for the systematic review (Figure 1).

Results

Thirty-nine patients (median age 25 years, range 17-42, males 77%) with septic arthritis of the knee following ACL reconstruction [8 (20%) bone patellar tendon bone autografts and 31 (80%) hamstring tendon autografts] were enrolled in the study. All cases had received pre-operative antibiotic prophylaxis with cephalosporin.

Acute and subacute septic arthritis were diagnosed in 22 (56%) and 17 (44%) patients, respectively. No late infection was observed (Table I).

Table I. Characteristics of 39 patients with septic arthritis of the knee after ACL reconstruction.

N° patients	39
Male	77%
Median age yrs. (range)	25 (17-42)
Acute	22 (56%)
Subacute	17 (44%)
Fever	33 (85%)
Pain and swelling	38 (97%)
PCR	37 (95%)
Median synovial fluid leukocyte cells/mL	80710 (52735-11300)
Positive microbiological findings	28 (72%)
Debridement	21 (54%)
Mean duration of antibiotic therapy	8 (6-10)

All patients had originally sustained a traumatic ACL lesion and none reported factors related to an increase of the risk of infection such as alcoholism, steroid or immunosuppressive drug use, diabetes or chronic inflammatory disease of the joint.

At the time of the first visit, all patients presented local signs of infection (local pain, swelling, tenderness, redness, and increased temperature). Fever was present in 33 (85%) cases. Dehiscence of the surgical wound was observed in only one patient. Median synovial fluid leukocyte count was 80×10^3 cells/ μ L (range 52-113). Positive cultures were obtained in 28 patients (72%). *S. aureus* was identified in 15 (38%) cases (7 methicillin-resistant strains), coagulase-negative staphylococci in 8 (20%), *Enterococcus faecalis* in 3 (8%), and *Pseudomonas aeruginosa* in 2 (5%). No microbiologic evidence was found in 11 out of 39 patients (28%). CRP was elevated in 37 patients (95%).

An arthroscopic debridement and partial synovectomy without ACL removal was planned in 21/39 (54%) patients. No significant difference in term of functional outcome was detected in patients receiving debridement in respect to those who did not receive surgery (46%), but the resolution within 4 weeks of local signs (pain and swelling) was observed more frequently in those receiving the surgical approach (18/21 vs. 9/18, $X^2 = 4.9, p = 0.03$). The median duration of antibiotic therapy was 8 weeks (range 8-10). After the 2-week period of intravenous antibiotic therapy, 19 (49%) shifted to oral therapy and 20 (51%) continue intravenous antibiotic treatment. Fever

disappearance and CRP normalization within 4 weeks were reported more frequently in patients receiving intravenous antibiotics (17/20 vs. 9/19, $X^2 = 6.2, p = 0.02$). At the last follow-up visit, (median follow-up 36 months (range 18-57), the functional outcome was satisfactory in all but two patients, who continued to have subjective problems and complained of pain, swelling, and limping. Both patients presented clinical and radiographic signs of degenerative arthritis, but did not show signs of active infection. There was a significant increase in Lysholm score in comparison with preoperative findings from 60.49 ± 6.84 to 79.51 ± 12.48 ($p < 0.001$) (Figure 2). However, the activity level at the final follow-up was reduced in this series. Indeed, the patients showed an average decrease close to 2 levels on the Tegner scale with respect to the pre-injury levels (6.40 ± 0.98 to 4.83 ± 0.98) ($p < 0.001$) (Figure 3). No significant difference in terms of final Lysholm and Tegner scores were detected in patients treated conservatively compared to patients who had undergone surgical debridement and in those treated with intravenous or oral antimicrobial therapy.

Literature Review

There were a total of 445 patients with septic arthritis after ACL reconstruction included in 22 studies analyzed. The incidence of septic arthritis after ACL reconstruction was reported in 21 papers with average estimated to be 0.97% (range 0.24% to 2.25%). The median duration of follow-up, calculated from the data deriving from 14 studies, was 43 (range 5 to 142) months^{1,5-11,13,14,22,25-27}. The average interval between ACL reconstruction

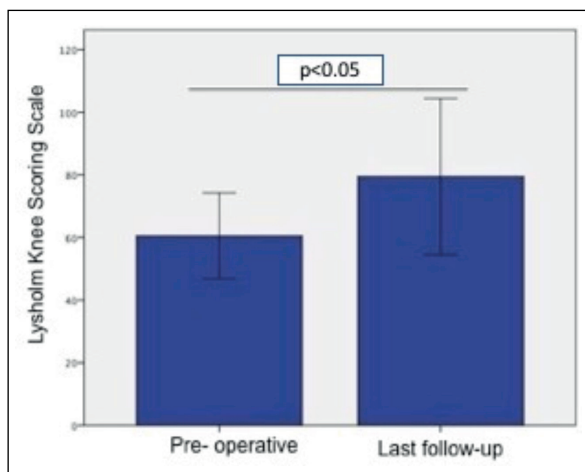


Figure 2. Lysholm score: improvement from pre-operative levels to final follow-up.

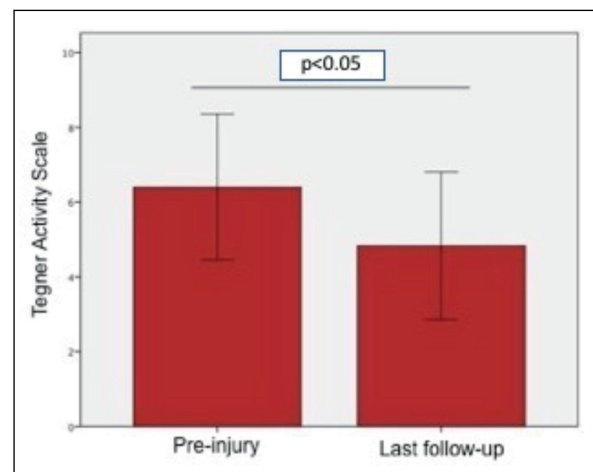


Figure 3. Comparison of Tegner activity score from pre-injury level to final follow-up.

and presentation of symptoms was reported in 15 studies, with a mean of 20.5 days (range 1 to 205 days) from surgery^{1,2,4,5,9,11-13,15,22,28,29}. Patients usually presented with a painful knee joint with a limited range of motion, persistent effusion, and local erythema. Fifty-six percent of the cases investigated presented with fever. Positive synovial fluid cultures were obtained in 356 (80%) cases. Coagulase-negative staphylococci were identified in 44% of the cases, and *S. aureus* was cultured in 27%. The pathogens reported in each study are presented in Table II.

The treatment modalities were clearly stated in all patients reported. Fifteen patients received non-surgical treatment (antibiotic therapy only) and only one investigation demonstrated a faster resolution of symptoms and a shorter period of antibiotic treatment for those receiving both antibiotics and debridement in respect to antibiotic therapy only^{7,14,15}. Irrigation with saline solution or arthroscopic debridement followed by antibiotic therapy was performed in 425 (96%) patients. Seventy-six patients had the ACL graft removed due to severe infection, autodigestion, or loss of function^{2,4,6,7,10,11,13,24-27,29-32}.

Duration of antibiotic treatment was reported in 9 papers with an average period of 5 (range 2 to 13) weeks^{1,2,6,8,9,11,15,27,30,31,32}. Functional outcomes after septic arthritis are summarized in Table II and include the Lysholm knee scoring scale and Tegner activity score. Lysholm scores were reported in 10 studies, with a frequency-weighted mean of 80 (range 25 to 98.3)^{1,5,6,9,11,13,14,22,25,26}. Additional 7 studies reported Tegner activity levels, with a mean of 5.3 (range, 3.8 to 6.7)^{1,5,9,11,13,22,26}.

Discussion

Septic arthritis of the knee occurs in a percentage ranging from 0.5 to 2.25 of patients who have undergone arthroscopically assisted ACL reconstruction. Graft failure, cartilage destruction, and arthrofibrosis are the main consequences. The present case series represents the largest series of patients with septic arthritis after ACL reconstruction. It focuses on two different therapeutic approaches (conservative vs. surgical treatment) and two different antibiotic regimens (oral vs. intravenous) after two weeks of intravenous antibiotic therapy.

Symptoms reported (local pain, erythema, swelling, limited range of motion of the knee joint, and fever) are frequently observed in those with an uncomplicated ACL reconstruction. For

this reason, the diagnosis may not be obvious and needs to be confirmed by laboratory investigations including culture of synovial fluid and synovial cells count^{3,17,24,33}. Cultures of synovial fluid confirmed the diagnosis in about 70% of cases and *S. aureus* was the most common pathogen, followed by CoNS. Instead, in the remaining cases, the diagnosis could be based on synovial cell count coupled with suggestive clinical findings and increase of CRP and leukocytes. Literature analysis demonstrates similar findings, demonstrating that staphylococci are the bacteria cultured with the highest frequency. Drugs active against Gram-positive MDR bacteria should be considered before cultures are available or in those with negative cultures.

A number of treatment protocols have been proposed in the selected studies and no study was designed to investigate which treatment (conservative or operative) is most effective^{14,15}. However, the majority of the studies evaluated in the literature review adopted arthroscopic debridement combined with antibiotic treatment, as a standard of care. A success rate ranging between 80 and 100% was reported. Faster resolution of symptoms due to combined approach was reported in respect to antibiotic treatment without surgery in the only study reporting comparative data^{1,6,9,10,15,25}. In our case series, no significant difference in terms of cure rate between a conservative approach (antibiotic therapy only, 18 cases) and an arthroscopic debridement without sacrifice of the ACL graft (21 cases) was observed. However, a faster resolution of symptoms for those patients who underwent antibiotic treatment coupled with surgery was registered. On the basis of our data and those deriving by literature analysis, an approach including intravenous therapy, arthroscopic debridement, and intra-articular lavage has to be considered the standard of care for patients with septic arthritis following ACL reconstruction^{1,5,8,12,14,15,34}.

Removal of the graft as part of the surgical treatment of septic arthritis is considered effective in 2 studies^{18,35}. Burks et al³⁴ reported excellent clinical and functional results in patients undergoing graft removal followed by early ACL reimplantation after an average interval of 3 weeks following antibiotic discontinuation. However, according to the literature data, the removal of ACL graft should be only carried out on patients with infections that are difficult to eradicate, whenever the graft is directly involved in the process, as well as when the graft is not functional^{4,13}.

Table II. Studies reporting post-arthroscopic septic arthritis. Literature review.

	N° Cases (incidence)	Onset symptoms (days)	Fever n (%)	% bacterial isolation	Conser- vative (antibiotic only)	Irrigation/ Arthroscopic debridment n (%)	(graft removed) n (%)	Duration antibiotic treatment weeks (range)	Average (Range) Follow-up, months	Average (Range) Lysholm score	Average (Range) Tegner activity score
Judd et al ⁶ (2006)	11 (0.68)	14.2 (6-45)	5 (45%)	73% CoNS 29% SA 9% PA 9% EA	0	10 (91%)	1 (9%)	4 (2-6)	22 (10-48)	71.6 (36-99)	N/A
Schollin- borg et al ⁹ (2003)	10 (1.7)	9.5	9 (90%)	60% CoNS 10% SA 10% PA 20% CN	0	10 (100%)	0 (0%)	6.9 (4-12)	35.8 (19-56)	74.9 (23-100)	5.3 (2-9)
Schulz et al ¹⁰ (2007)	24 (0.78)	N/A	N/A	25% CoNS 50% SA 8% ST 17% CN	0	7 (29%)	17 (71%)	N/A	66 (11-142)	65.6 (25-91)	3.8 (N/A)
Van Tongel et al ¹³ (2007)	15 (0.5)	10.9	N/A	53% CoNS 7% SA 7% ST 13% PM 20% CN	0	14 (93%)	1 (7%)	N/A	58 (9-99)	83 (57-100)	5.6 (3-10)
Viola et al ¹⁴ (2000)	14 (0.78)	N/A	N/A	14% CoNS 86% CN	8 (57%)	6 (43%)	0 (0%)	N/A	14.4 (5-43)	93.2 (80-100)	N/A
Wang et al ¹⁵ (2009)	21 (0.52)	13.3 (3-29)	21 (100%)	53% CoNS 10% SA 5%EF 5%CO 5% PM 24% CN	6 (29%)	15 (71%)	0 (0%)	3 (2-5)	N/A	N/A	N/A
Sonnery- Cotted et al ¹² (2011)	12 (0.61)	15.7 (2-37)	9 (75%)	92% CoNS 8% PA	0 (0%)	12 (100%)	0 (0%)	N/A	N/A	N/A	N/A

Continued

Table II (Continued). Studies reporting post-arthroscopic septic arthritis. Literature review.

	N° Cases (incidence)	Onset symptoms (days)	Fever n (%)	% bacterial isolation	Conser- vative (antibiotic only)	Irrigation/ Arthroscopic debridment n (%)	(graft removed) n (%)	Duration antibiotic treatment weeks (range)	Average (Range) Follow-up, months	Average (Range) Lysholm score	Average (Range) Tegner activity score
Monaco et al ⁸	12 (0.98)	21 (N/A)	12 (100%)	91% CoNS 9% EC	0 (0%)	12 (100%)	0 (0%)	4 (6-8)	36 (N/A)	98.3 (69-100)	7.2 (5-9)
Abdelaziz et al ¹ (2014)	24 (0.94)	12.4 (5-45)	24 (100%)	29% SA 29% CoNS 13% CN 8% PA 4% EF/EC/ PS/ST/PM	0 (0%)	24 (100%)	0 (0%)	4 (3-6)	59 (18-96)	85(72-93)	5.5 (4-7)
Sechriest et al ²⁹ (2013)	24 (1.9)	31 (8-14)	5 (21%)	75% CoNS 17% SA 4 % SM 4% CN	0 (0%)	24 (100%)	3(12,5%)	N/A	N/A	N/A	N/A
Maletis et al ⁷ (2013)	34 (0.32)	N/A	N/A	24% SA 32% CoNS 6% SM 3% ST/PA/EB/PM 26% CN	1 (3%)	33 (97%)	9 (26%)	N/A	12 (N/A)	N/A	N/A
Torres- claramut et al ²⁵ (2013)	15 (1.8)	N/A (7-35)	N/A	66% CoNS 20% SA 6% PA 7% CN	0 (0%)	15 (100%)	1 (6,7%)	N/A	39.3(N/A)	77.7 (N/A)	N/A
Barker et al ² (2010)	18 (0.58)	32 (5-205)	8 (44%)	33% SA/CN 22% CoNS	11% PA	0 (0%)	18 (100%)	5 (27,8%)	6 (N/A)	N/A	N/A N/A
Benner et al ⁴ (2011)	13 (0.24)	30 (11-117)	N/A	N/A	0 (0%)	18 (100%)	2 (15,4%)	N/A	N/A	N/A	N/A
Schuster et al ¹¹ (2015)	36 (0.51)	17.1 (4-37)	14 (39%)	62.5% CoNS 21.9% SA 9.4% PA 3.1% EF 3.1% EB 11.1% CN	0 (0%)	36 (100%)	1 (2.8%)	5.4 (2-13)	56 (8-134)	N/A	N/A

Continued

Table II (Continued). Studies reporting post-arthroscopic septic arthritis. Literature review.

	N° Cases (incidence)	Onset symptoms (days)	Fever n (%)	% bacterial isolation	Conser- vative (antibiotic only)	Irrigation/ Arthroscopic debridment n (%)	(graft removed) n (%)	Duration antibiotic treatment weeks (range)	Average (Range) Follow-up, months	Average (Range) Lysholm score	Average (Range) Tegner activity score
Bostrom Windhamre et al ⁵ (2014)	27 (0.98)	8 (1-22)	N/A	74% CoNS 18.5% SA 3.7% Klebsiella 3.7% PA	0 (0%)	27 (100%)	0 (0%)	N/A	60 (13-108)	81 (46-100)	5.1 (1-8)
Nag et al ²³ (2009)	26 (2.25)	64.4 (23-152)	2 (7.6)	42.3% SA 15.4% CoNS 7.7% ST 3.8% EB 34.6% TB	0 (0%)	26 (100%)	0 (0%)	N/A	43.6 (25 - 72)	N/A	N/A
Waterman et al ²⁷ (2018)	31 (0.32)	N/A	N/A	42% SA 6% CoNS 3% EB 48% CN	0 (0%)	31(100%)	22(7%)	6.3(3-12)	26.9	N/A	N/A
Perez-Prieto et al ³⁰ (2017)	15 (1.8)	N/A	N/A	66.6% CoNS 20% SA 6.7 % PA 6.7% CN	0 (0%)	15 (100%)	1(6.7)	6	N/A	N/A	N/A
Perez- Prieto et al ³¹ (2016)	15 (0.97%)	N/A	N/A	60 % CoNS 20 % SA 6.7 % PA 6.7% CN	N/A	N/A	1(6.7)	N/A	N/A	N/A	N/A
Gille et al ²⁶ (2015)	31(N/A)	N/A	N/A	51.6% SA 22.6% CoNS 6.4 ST 19.4% CN	0 (0%)	31 (100%)	12 (39%)	N/A	71 (13-140)	63.9 (25-91)	4.5 (N/A)
Ristic et al ²⁸ (2014)	17 (1.2)	7.5 (3-20)	14 (82%)	65% SA 23.5% CoNS 17.6% ST 5.9% CN	N/A	N/A	N/A	N/A	N/A	N/A	N/A N/A

Abbreviations: ACL, anterior cruciate ligament; CN, Culture negative; CO, *Corynebacterium*; CoNS: Coagulase-negative staphylococci; EB, *Enterobacter*; EF, *Enterococcus faecalis*; N/A, not available; PA, *Propionibacterium acnes*; PM, Polymicrobial; PS, *Pseudomonas*; ST, Streptococcus; SA, *Staphylococcus aureus*; WKS, weeks; SM, *Serratia Marcescens*; EC, *Escherichia coli*; TB, *Mycobacterium tuberculosis*.

The duration of antibiotic therapy is also a matter of debate, and conclusive data are not highlighted by literature analysis. Most authors recommend a 4-week or even longer course of intravenous antibiotics^{2,9,11}. Conversely, Wang et al¹⁵ proposed a more individualized approach and recommended intravenous antibiotic treatment for 2 to 3 weeks and changed to oral administration for 2 or 3 supplemental weeks when CRP levels were normalized. Data deriving by Literature analysis and those reported in our case-series suggest that a therapeutic schedule considering intravenous antibiotics (at least until symptoms resolution and significant reduction of CRP occurs) should be considered the best approach for the treatment of these patients. This observation is different than observed in patients with prosthetic joint infection who can be treated with oral antibiotics without any detrimental effect on outcome^{36,37}.

The Lysholm score recorded in our patients at the last follow-up visit was significantly improved in comparison with the pre-treatment status. Similar findings were reported by other authors investigating the outcome on the basis of this score evaluation^{1,4-6,8,9,13-15,25,26}. Conversely, the level of activity was markedly reduced in respect to the pre-injury status. Moreover, the Tegner score at the last follow-up visit was slightly lower in comparison with the findings of the previous studies^{1,5,8,9,13,15,26}. This lower activity level after septic arthritis could be explained by arthrofibrosis or cartilage damage due to the infection³⁸⁻⁴⁰.

Conclusions

An intravenous antibiotic therapy with surgical debridement could decrease the time needed to eradicate the infection, permitting the retention of the graft and reducing the time of disability. Staphylococci are the causative agents in the majority of the cases of septic arthritis, justifying an empiric therapeutic approach with an anti-Methicillin Resistant *Staphylococcus aureus* agent and cephalosporin as first-line therapy in the majority of cases.

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Conflict of Interests

All authors declare that they have no conflict of interest.

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