Knee Surgery, Sports Traumatology, Arthroscopy
https://doi.org/10.1007/s00167-018-4890-x

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Meniscus repairs can be saved in the event of postoperative septic arthritis

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Received: 23 October 2017 / Accepted: 28 February 2018

Abstract

Purpose No systematic studies on optimal treatment of postoperative septic arthritis following arthroscopic meniscus repair are available. The purpose of this study was to retrospectively evaluate the fate of repaired menisci in cases of postoperative septic arthritis, with treatment for infection focused on arthroscopic irrigation and debridement (I&D) and intention to maintain the meniscus.

Methods Data of two sports orthopedics centers of the last 10 years were pooled (approximately 25,000 arthroscopic procedures of the knee). All cases of septic arthritis following arthroscopic meniscus repair were identified. These cases were retrospectively evaluated with regard to clinical course and management, especially the number of necessary I&Ds, if eradication was achieved, and if the repaired meniscus was retained or a partial resection was necessary ('early failure'). Patients with initially maintained meniscus repairs were contacted if further meniscus surgery was performed in further follow-up ('late failure').

Results 20 patients with 23 repaired menisci were included. In 65% (13 cases), a concomitant anterior cruciate ligament reconstruction was performed. A mean of 2.0 ± 1.0 (1–4) arthroscopic I&Ds were performed in the treatment of septic arthritis. In two cases, additional open surgery was performed (after outside-in sutures). Eradication was achieved in all cases. Four repaired menisci (17.4%) showed loosened fixation or substantial degradation and were consequently partially resected within treatment for septic arthritis (early failures). The follow-up rate for the 19 initially maintained menisci was 94.7% after 3.0 ± 2.2 years (median 2.8, 0.4–7.8). Three of these underwent further partial resection (13.0%). Cumulative 3-year survival rate (Kaplan–Meier method) of all repairs was 70.7% (95% CI 50.3–91.1%), and for the subgroup of initially maintained menisci 85.6% (95% CI 67.0–100.0%), respectively.

Conclusion Septic arthritis following meniscus repair can be successfully treated with (sequential) arthroscopic I&Ds. There is a considerable rate of early failures, however, in a mid-term follow-up the failure rate of initially retained menisci is low and comparable to what we know from the literature for cases without infection. Therefore, it is generally recommended to try to save the repaired menisci in these cases.

Level of evidence IV, therapeutic case series.

Keywords Infection · Meniscus · Repair · Arthroscopy · Complication · Revision · Resection · Bacteria · Suture · Septic arthritis

Introduction

The number of arthroscopic procedures for various knee pathologies is constantly increasing, and especially meniscus surgery is quite common [1]. The important role of the meniscus in preventing degenerative changes is well known by this time, and the risk for osteoarthritis significantly increases with the extent of lost meniscus substance [9, 10, 13, 21, 22, 27, 28]. Meniscus lesions are quite common in combination with anterior cruciate ligament (ACL) injuries

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Published online: 06 March 2018

[33]. Beyond its well-known chondroprotective function, in anterior cruciate ligament reconstruction (ACLR), the loss of meniscus substance (both medially and laterally) is also an important independent risk factor for failure of the ACLR [25]. With increasing knowledge on these important functions of the meniscus, repair rather than resection became more popular [1]. Generally, good-to-excellent results for meniscus repair have been reported for various types of meniscus lesions and repair techniques [8, 11, 12, 16, 19, 24, 29, 34, 38, 39].

Postoperative septic arthritis is a quite rare complication of arthroscopic surgery, but it can cause substantial damage to the joint [40]. Nowadays, standard treatment consists of repeated arthroscopic irrigations and debridements (I&Ds) combined with antibiotic therapy [14, 26, 32, 37]. In cases following ligament surgery, the treatment is focused on graft retention [32]. Although a high success rate in the treatment of this complication has been reported, some studies show slightly inferior results in cases of postoperative infection, e.g., after ACLR [20, 35, 37]. To our knowledge, no systematic investigations focusing on septic arthritis following meniscus repair have been performed so far, and no reasonable and profound recommendations exist.

Therefore, the purpose of this study was to retrospectively evaluate the fate of repaired menisci in cases of postoperative septic arthritis, with treatment for infection focused on arthroscopic I&Ds and with the intention to maintain the repaired meniscus. It is the first systematic investigation in this uncommon disease in a larger cohort. The hypotheses of this study were that arthroscopic I&D is effective in the treatment of postoperative septic arthritis, and that repaired menisci can be saved.

Materials and methods

Data of two sport orthopedics centers with currently together about 3000 arthroscopic knee procedures annually were pooled (altogether approximately 25,000 procedures). All cases of septic arthritis of the knee joint treated at each of the two institutions within the last 10 years were retrospectively identified. Infection was considered confirmed if bacterial growth was noted on cultures from joint aspiration or a biopsy specimen or if the clinical presentation together with intraoperative findings was obvious. Cases without preceding meniscus repair in the same knee were excluded. Further, cases that were initially treated elsewhere with different meniscus repair techniques were excluded. One case with postoperative septic arthritis following the implantation of a medial collagen meniscus was also excluded. A total of 20 patients with 23 meniscus repairs were identified and subsequently included in the study.

The medical records of these cases were analyzed with special regard to the type of meniscus lesion and concomitant procedures performed within the index surgery. Further, the postoperative course was analyzed with regard to the time from index surgery to arthroscopic reoperation, level of C-reactive-proteine (CRP) on admission, number of necessary arthroscopic I&Ds, if additionally open surgery had to be performed, if infection could be eradicated, infection-causing bacteria, the duration of inpatient treatment and antibiotic therapy, and especially if the initially repaired meniscus could be maintained or had to be (partially) resected within the treatment of septic arthritis ('early failure').

Patients with initially maintained meniscus were contacted via telephone, email or postal questionnaire and were asked if meniscus surgery was performed again in further course for the initially repaired meniscus. These cases were defined as 'late failures', whereas cases without further meniscus surgery were defined as success.

Surgical technique of index procedure

All meniscus repairs were standardized performed arthroscopically through anterior standard portals. Surgery was performed without tourniquet in isolated meniscus repairs and with inflated tourniquet (250–350 mmHg) in cases of ACLR, respectively. Generally, no meniscus repairs were performed in unstable knees. Before meniscus suture or reconstruction, an intensive preparation of the tear especially to enhance healing capabilities was performed with a meniscal rasp or a shaver. The type of meniscus repair depended on the type of lesion and its configuration. No inside-out techniques were performed. Generally, all-inside devices were used for sutures in the posterior parts of both menisci. Lesions that extended anteriorly to the pars intermedia (mostly bucket-handle tears) were usually performed with hybrid fixation techniques (all-inside devices posteriorly and outside-in-sutures in the pars intermedia). All-inside sutures were performed with the FasT-Fix device (Smith & Nephew, Memphis, TN), and outside-in sutures were performed with PDS (polydioxanone) sutures (Ethicon, Somerville, NJ) in the early years of the study and then with FibreWire 2.0 (Arthrex, Naples, FL). Generally, vertical sutures were preferred.

Concomitant ACLRs were performed with hamstring or quadriceps tendons in arthroscopic technique and with independent drilling for femoral tunnel placement. In these cases meniscus repairs were performed almost at the end of the operation, with the ACL graft already in place and after its femoral fixation.

Postoperative rehabilitation protocol was individually depending on the type of lesion and repair, but usually consisted of partial weight bearing (10–20 kg) for 4 weeks, a

brace for 6 weeks with occasional limitation in range-of-motion (e.g., radial tears, bucket-handle tears), but usually without limitation and immediate full range of motion, respectively.

Treatment algorithm in septic arthritis

All cases were treated with a standardized treatment algorithm, which was the same for all knee joint infections: An arthroscopic approach with two standardized anterior portals was used. Only in cases of concomitant macroscopic wound infections (e.g., from outside-in repairs) an open revision of these sites was additionally performed. Five biopsies of the synovial membrane (and subcutaneous tissue when necessary) were taken for microbiological assessment and were cultured for 14 days. An arthroscopic debridement of devitalized or necrotic tissue and a removal of fibrin layers and coagulated blood clots were carried out. An extensive irrigation with 10–15 l of saline fluid was performed. Synovectomy was not routinely performed as it enhances the risk of arthrofibrosis. Removal of grafts (e.g., in ACLR) would only have been considered in loosened fixation or substantial graft insufficiency. Repaired menisci were tried to be maintained: Sutures were left in place, and partial meniscus resection was only performed in cases of loosened fixation.

An empiric antibiotic therapy was started after multiple biospies have been taken and was re-evaluated after receiving microbiological results and antibiogram. Postoperative care was based on daily physical examination and blood tests (CRP) every other day. In cases of persistent infection, especially with recurrent effusion, increasing pain, increasing temperature or rise of CRP level another and if necessary sequential arthroscopic I&D were performed. With CRP in normal range, antibiotic therapy was terminated.

The study was approved by the competent research ethics boards (Landesärztekammer Baden-Württemberg, F-2014-039).

Statistical analysis

Data were obtained and analyzed retrospectively. Statistical analysis was performed using IBM SPSS Statistics for Windows (version 24, IBM Corp., Armonk, NY). Survival curve is shown as Kaplan–Meier plot. Unless otherwise stated, descriptive results are demonstrated as mean ± standard deviation (median, and range).

Results

20 cases of postoperative septic arthritis following meniscus repair at our institutions were included (23 menisci, in three knees both medial and lateral menisci were repaired). Demographic data are presented in Table 1, detailed information on individual cases is presented in Table 2.

The mean interval from index procedure to the first I&D was 18 ± 17 days (median 9, 6–57), with 55% of the patients presenting in the second week (day 7–14) after surgery. In two cases, a period of more than 7 weeks was present between index surgery and reoperation: in one case, a very uncommon bacteria was identified (Enterobacter cloacae), which might explain this late onset; in the other case, the patient was referred to our institution with already having symptoms of infection for more than a week. Mean CRP level was 174 ± 99 mg/l (32–417) on admission. A mean of 2.0 ± 1.0 (1–4) arthroscopic I&Ds were performed. In two cases, additional open surgery was performed to address extra-articular abscess formations (both after outside-in bucket-handle tear repairs), in one case once, and in one case twice, respectively. In all cases, eradication was achieved. In 16 of 20 cases (80.0%), infection-causing bacteria were identified. In two cases (10.0%), two bacteria were identified. *Staphylococcus aureus* (6, 33.3%) and *Staphylococcus epidermidis* (6, 33.3%) were the most common, followed by *Staphylococcus caprae* (4, 22.2%), *Staphylococcus*

Table 1 Demographic data of the 20 included patients (23 repaired menisci)

Age (years)	26.9 ± 10.0 (12.7–47.4)
Sex	
Male	16 (80.0%)
Female	4 (20.0%)
Side	
Left	10 (50.0%)
Right	10 (50.0%)
Type of meniscus lesion	
Medial	
Bucket-handle	4 (17.4%)
Longitudinal	7 (30.4%)
Complex	3 (8.7%)
Lateral	
Bucket-handle	2 (8.7%)
Longitudinal	2 (8.7%)
Complex	5 (21.7%)
Type of repair	
Medial	
All-inside	11 (47.8%)
Hybrid	3 (13.0%)
Lateral	
All-inside	6 (26.1%)
Hybrid	3 (13.0%)
Concomitant ACL reconstruction	13 (65.0%)

Data presented as number (percentage) or mean ± standard deviation (range)

ACL anterior cruciate ligament reconstruction

Table 2 Clinical data of the individual 20 patients (23 repaired menisci)

Part 1							
Case number	Sex	Age (years)	Side	Concomittant procedures	Involved meniscus	Type of lesion	Type of repair[a]
1	Male	39.1	Left	ACLR	Medial	Bucket-handle	Hybrid
2	Female	15.9	Left	ACLR	Medial	Longitudinal	All-inside
3	Male	20.6	Right	ACLR	Lateral	Bucket-handle	Hybrid
4	Male	28.0	Right	–	Medial	Longitudinal	All-inside
5	Male	35.7	Right	ACLR	Medial	Longitudinal	All-inside
6	Female	16.1	Right	Revision-ACLR	Medial	Longitudinal	All-inside
7	Male	42.4	Right	Revision-ACLR	Medial	Radial	All-inside
					Lateral	Longitudinal	All-inside
8	Male	14.6	Left	–	Lateral (discoid)	Complex	Hybrid
9	Male	17.4	Left	ACLR	Lateral	Complex	All-inside
10	Male	21.0	Left	–	Medial	Longitudinal	All-inside
11	Female	22.5	Right	ACLR	Lateral	Complex	All-inside
12	Male	25.8	Right	ACLR	Medial	Longitudinal	All-inside
					Lateral	Complex	All-inside
13	Female	19.3	Left	ACLR	Lateral	Longitudinal	All-inside
14	Male	33.1	Left	–	Medial	Longitudinal	All-inside
15	Male	31.1	Right	ACLR	Medial	Bucket-handle	All-inside
16	Male	37.9	Right	ACLR	Medial	Complex	All-inside
					Lateral	Complex	All-inside
17	Male	26.8	Left	–	Medial	Bucket-handle	Hybrid
18	Male	12.7	Left	ACLR	Medial	Bucket-handle	Hybrid
19	Male	30.8	Right	–	Medial	Complex	All-inside
20	Male	47.4	Left	–	Lateral	Bucket-handle	Hybrid

Part 2						
Case number	Time to first I&D (days)	CRP on readmission (mg/l)	Number of I&D	Open revision	Failure	Identified bacteria
1	43	111	2	–	–	*Staph. caprae*
2	15	220	2	–	Late (4.5 years)	*Staph. caprae*
3	6	417	2	–	–	*Staph. aureus*
4	9	148	1	–	–	*Staph. epidermidis*
						Staph. lugdunensis
5	13	57	1	–	–	–
6	47	32	2	–	Late (1.5 years)	–
7	8	221	2	–	–	*Staph. aureus*
					–	
8	7	149	1	Yes (1x)	–	*Staph. aureus*
9	12	140	3	–	–	*Staph. epidermidis*
10	7	97	3	–	Early	*Staph. epidermidis*
11	29	156	1	–	–	–
12	6	67	1	–	–	*Staph. epidermidis*
					–	
13	52	80	2	–	–	*Enterobacter cloacae*
14	14	174	1	–	Late (0.8 years)	–
15	7	242	3	–	–	*Staph. aureus*
16	9	206	4	–	Early	*Staph. epidermidis*
					–	
17	13	120	1	–	Early	*Staph. caprae*

Table 2 (continued)

Part 2 Case number	Time to first I&D (days)	CRP on readmission (mg/l)	Number of I&D	Open revision	Failure	Identified bacteria
18	6	286	1	–	–	*Staph. epidermidis* *Staph. caprae*
19	9	318	4	Yes (2x)	Early	*Staph. aureus*
20	57	243	2	–	–	*Staph. aureus*

Early failure refers to partial resection with treatment for septic arthritis

ACLR *anterior cruciate ligament reconstruction*, CRP *C-reactive protein*, I&D *arthroscopic irrigation and debridement*

*Hybrid repair means a combination of all-inside and outside-in technique

lugdunensis (1, 5.6%) and *Enterobacter cloacae* (1, 5.6%). Mean duration of inpatient treatment was 14.2 ± 5.4 days (7–25) and mean duration of antibiotic therapy was 4.8 ± 2.7 weeks (1.4–11.3). No reinfection was seen within further follow-up.

Four repaired menisci (17.4%) showed loosened fixation or substantial degradation of meniscus tissue within arthroscopic reoperations and were consequently partially resected (early failures). The follow-up rate for the 19 initially maintained menisci was 94.7% after 3.0 ± 2.2 years (median 2.8, 0.4–7.8). From these 19 repaired menisci, three had further meniscus surgery and were considered as late failures (13.0%). Cumulative 3-year survival rate (Kaplan–Meier method) of all repairs was 70.7% [95% confidence interval (CI) 50.3–91.1%], and for the subgroup of initially maintained menisci 85.6% (95% CI 67–100%), respectively (Fig. 1). In concomitant ACLR, all but one graft (92%) were also retained.

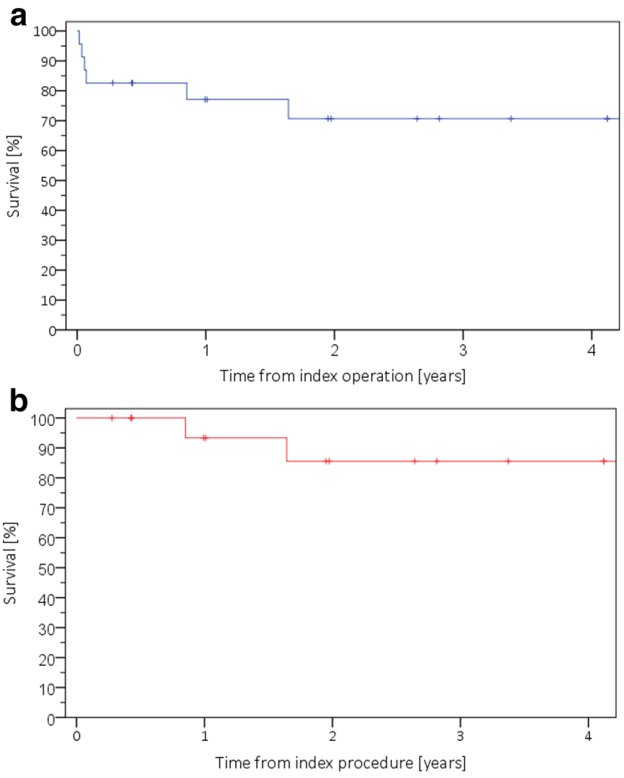

Fig. 1 Survival of all repaired menisci ($n = 23$, **a**) and all initially maintained menisci ($n = 19$, **b**)

Discussion

The major findings of this study are that successful treatment for septic arthritis following meniscus repair is possible with (sequential) arthroscopic I&Ds. There is a considerable rate of early failures that resulted in partial meniscectomy, however, in the majority of cases the meniscus could be maintained, with a low-failure rate in the further course of a mid-term follow-up. Therefore, the hypotheses of this study were confirmed.

Generally, the complication rate after arthroscopic meniscus repair using modern devices is low [11, 31]. Yeranosian et al. reported on an incidence rate for postoperative septic arthritis of 0.17–0.30% after arthroscopic meniscus repair, based on more than 20,000 patient records obtained from a large insurance company database in the United States [40]. The ideal treatment of postoperative septic arthritis has been controversially discussed throughout the last years, however, nowadays an arthroscopic approach has become widely accepted, as it has proven to be superior to open approaches with arthrotomy [14, 26]. Treatment is focused on prevention of conducted reconstructions. In ACLR, the main objective is retention of the graft, which has been shown to be successful in the majority of cases [32, 37].

There is a number of studies investigating in results of meniscus repair in the literature, with various techniques and different type of lesions included [1, 4, 5, 8, 11, 12, 15–19, 24, 29, 34, 36, 38, 39]. A systematic review including 13

studies with a minimum follow-up of 5 years reported on a pooled failure rate of 23.1% [24]. The authors reported a greater failure rate for medial meniscus repair (24.2%) compared to lateral meniscus repair (20.2%). Generally, it is assumed that meniscus repair in combination with ACLR might have a higher success rate [7]. However, conflicting results have been published [24]. Westermann et al. reported on 298 meniscus repairs combined with ACLR, and found a failure rate of 14% after 6 years [39]. Other factors that have been published to be associated with higher failure are smoking, high BMI, delayed repair, revision repair and the presence of peripheral or bucket-handle tears [5, 17, 18, 36]. No systematic data are available with regard to how postoperative infections influence the failure rate.

Against the background of these results published in the current literature, the overall failure rate of this series is higher. However, with regard to the subgroup of initially maintained meniscus repairs, it is within the range given in the literature. Further, the heterogeneity of the study cohort has to be taken into account. Therefore, it might be assumed, that as long as no partial resection is necessary during the treatment for infection, acceptable success rates equivalent to those in the absence of infectious complications are present.

To our knowledge, no systematic investigations on septic arthritis following arthroscopic meniscus repair are available in the literature, and there is a lack of reasonable and profound recommendations. Blevins et al. reported on a cluster of three cases of septic arthritis following arthroscopic meniscus repair within a 4-day-period at their institution [6]: All three were bucket-handle tears in young males. In all cases, the meniscus repair was intact and left in place within the reoperations for the treatment of septic arthritis. In a short-term follow-up, no further surgery was necessary for re-tears of these menisci. The authors recommended trying to maintain the meniscus, as long as the repair is stable. This is in line with the findings of this study, when partial resection was only considered if the fixation was loosened or the tissue substantially degraded. In contrast to these results, Myerthall and Ogilvie-Harris reported on three quite similar cases of infections following bucket-handle tear repairs in young adults [23]. Similarly, all repairs were intact at the time of reoperation, and were left in situ. However, after 6, 10 and 13 months, all suffered from displaced bucket-handle tears again, and all were considered as failures. The authors concluded that even in cases of initial successful treatment, the event of postoperative septic arthritis might be a mechanism for subsequent failure, and worsens the overall prognosis. The present study disproves this conclusion, showing that initially maintained menisci had comparable success rates to the literature.

There is a number of studies reporting on individual cases of postoperative infections: Haklar et al. reported on three cases of septic arthritis in a series of 112 medial meniscus lesions repaired with an inside-out technique, and they performed a partial resection in all cases [12]. The authors reported that the infections were located at the suture knots just outside the joint capsule. Albrecht-Olsen et al. reported on two cases of deep infection following meniscus repair [2]. In both cases, partial meniscectomies were performed. Kise et al. investigated in the outcome of all-inside meniscal repair devices [15]. There was one infection in their series of 46 cases, which was successfully maintained without the need of subsequent reoperation. Bae et al. reported on a case of septic arthritis following meniscus allograft transplantation, which was successfully treated and the graft was retained [3]. Although limited to a low number of cases, the authors of these studies seem to either generally prefer resection or retention. With regard to the results of this study, it can be concluded that an individual approach seems to be advantageous: The majority of cases without loosened fixation can successfully be treated for septic arthritis and the meniscus repair can be retained.

Meniscal healing is a complex process and histologically substantially characterized by fibroblasts, blood vessels and fibrous material [30]. It might be assumed that these processes might be impaired in the presence of substantial inflammation and infection, and the resulting scar formation might theoretically be inferior compared to undisturbed healing. Therefore, the event of postoperative infection might indeed lead to a mechanism of 'biological failure'.

However, in the present study, patients with initially maintained meniscus had a low rate of 'late failures' which is comparable to the literature for cases without infection. Therefore, it seems that even repaired menisci in knees that suffer from postoperative septic arthritis have a good prognosis, when treated consistently with arthroscopic I&D. Therefore, it is generally recommend to try to maintain the conducted meniscus reconstruction whenever possible—analogous to what is known for retention of the graft in ACLR.

There are some limitations of this study that have to be considered: first, the study population is very heterogeneously, with different kinds of meniscus lesions, suture techniques and performed concomitant procedures. Isolated meniscus lesions as well as meniscus lesions in combination with ACLR were included. Therefore, there are different success rates that could have been expected even in the absence of septic complications for the individual cases of this study, and no control group is available. No clinical scores are available within follow-up. Further, no clinical examination or MRI has been performed. Therefore, cases of meniscus repair failure might have been missed if not resulting in reoperation. Last, the total number of cases is low; however, the topic restricts high numbers.

The findings of this study might encourage surgeons in their daily clinical practice to try to save the repaired meniscus in the cases of postoperative septic arthritis, if they are faced with this rare but serious complication.

Conclusion

Septic arthritis following meniscus repair can be successfully treated with (sequential) arthroscopic I&Ds. There is a considerable rate of early failures, however, in a mid-term follow-up, the failure rate of initially retained menisci is low and comparable to what we know from the literature. Therefore, it is generally recommended to save the repaired meniscus in these cases.

Funding The authors received no financial support for the research, authorship, and/or publication of this article.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the Ethical committee of the institution.

Informed consent Patients were informed, and they consented to conduct the study.

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