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ORIGINAL PAPER

Periprosthetic joint infection—effect on quality of life

Peter Helwig · Julia Morlock · Michael Oberst · Oliver Hauschild · Johannes Hübner · Johannes Borde · Norbert P. Südkamp · Lukas Konstantinidis

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Abstract
Purpose Relatively little is known about the extent to which periprosthetic joint infections (PJI) affect the patient's long-term quality of life (QoL). Our study aim was to assess the effect of a periprosthetic infection on our patients' QoL.
Methods We collected data retrospectively of patients who had undergone surgery in our institution between 2006 and 2011. To capture their overall QoL, we telephoned the patients who could be reached and asked them the questions on the SF-12 questionnaire.
Results In 84 patients (53 male, 31 female, 43 TKA and 41 THA), 88 % of the hip infections and 62 % of the knee infections had been successfully treated. The hip infections' cure rate was significantly higher than that of the knee joint infections.

The average SF-12 score was 36.2 points on the physical scale and 52 on the mental scale. The difference in QoL between patients with and without successful infection therapy was not significant, nor did the site of the infection (knee or hip) influence QoL significantly.

Comparison of our patients' QoL data to that from the general population revealed a significant difference in the physical scale but not the mental scale.
Conclusion From these results QoL is substantially reduced after a prosthetic infection. We did however observe that post-Girdelstone procedure patients or those with an arthrodesis attained an acceptable QoL, and that those methods remain therapeutic alternatives as far as patient-perceived QoL is concerned.

Keywords Periprosthetic joint infection · SF-12 · Quality of life

P. Helwig · O. Hauschild · N. P. Südkamp · L. Konstantinidis
Department of Orthopaedics and Traumatology, University Hospital Freiburg, Freiburg im Breisgau, Germany

J. Morlock
Department of Cardiac and Vascular Surgery, University Hospital Freiburg, Freiburg im Breisgau, Germany

M. Oberst
Department of Orthopaedics and Traumatology, Ostalb-Hospital Aalen, Aalen, Germany

J. Hübner · J. Borde
Division of Infectious Diseases, Department of Medicine, University Hospital Freiburg, Freiburg im Breisgau, Germany

P. Helwig (✉)
Department of Orthopaedics and Traumatology,
Albert-Ludwigs-University Freiburg, University Hospital Freiburg,
Hugstetterstr. 55, 79106 Freiburg, Germany
e-mail: peter.helwig@uniklinik-freiburg.de

Introduction

Periprosthetic joint infection (PJI) is the second most frequent complication in endoprosthetics after aseptic loosening [1, 2]. As the prostheses nowadays remain in the body much longer than they used to, the risk of contracting a periprosthetic infection naturally increases [3]. We can therefore assume that the absolute numbers of such infections will continue to rise. In addition there is a high estimated number of unreported cases due to difficulty in proving infection [4, 5].

Most periprosthetic infections are caused by two different factors: the first, by the perioperative dissemination of an infection via contamination, and secondly, by the blood-borne distribution of bacteria from another infected site in the body. The latter can take even decades to appear after the initial implantation, while perioperative infections tend to become symptomatic during the first weeks after surgery [3].

The therapeutic gold standard for delayed periprosthetic infections is two-stage revision in conjunction with the implantation of a temporary antibiotic-loaded bone-cement

spacer; the recommended prosthesis-free interval between operations varies in the literature. Recent studies have demonstrated that a one-stage revision can resolve infections in certain patients at a similar rate of success while obtaining better clinical outcomes [6, 7]. However, little is known about how a prosthetic infection affects a patient's long-term quality of life (QoL). Thus the aim of our study was to examine the influence a prosthetic infection has on QoL.

Patients and methods

We documented retrospectively all the patients surgically treated at our institution between 2006 and 2011 for an infected knee or hip prosthesis. Our parameters were age, gender, comorbidities, and how long the prosthesis had been in place, gleaned from the patient records; to assess their general health we referred to the ASA classification from the anaesthesia protocols. To differentiate between early and late infections, we relied on Tsukayama's [8] and Zimmerli's [7] definition.

Since CRP and ESR showed only low specificity in the work of Johnson et al. [9], we didn't look for the effect of these variables.

The causative microorganism was identified by consulting patient records with additional differentiation in case of multiresistant strains (vancomycin-resistant enterococci [VRE], methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase [ESBL]).

The surgical method applied in each patient's operation was documented; we differentiated according to whether the joint had been retained, one- and two-stage revisions, amputation and arthrodesis for knee prostheses, and the Girdlestone procedure for hip arthroplasties.

We considered treatment success as the outcome parameter. A therapy that failed to cure the infection was regarded as unsuccessful; these were patients who had experienced secondary arthrodesis, a Girdlestone procedure, or amputation whose infections had not been resolved permanently, or who died of a sepsis associated with the original joint infection. Therapeutic success was one which resulted in a clinically functioning and infection-free artificial joint at least one year after surgery.

After securing approval from our institutional ethics committee (No. 21/12), the patients were contacted by telephone and asked the questions on the Short Form Health Survey 12 (SF-12) as to their overall QoL. The SF-12 is a standardized questionnaire devised to capture health-related QoL. This measuring instrument can be applied across diseases; the SF-12 is an economical abridged version of the SF-36 and, like the latter, covers eight different dimensions [10]. Physical and mental scales are drawn from these eight dimensions, each having a value from 1 to 100. We used the version of the SF-12 questionnaire that captures in its 12 items the patients' condition in the four weeks prior to the questioning, reflecting the patient's self-perceived QoL. The SF-12 questionnaire was revised according to Bullinger's handbook [11], whereby physical and mental scales for each patient are determined using SPSS from the 12 items and eight subscales, which then yield values standardized according to an American random sample whose means equalled 50+ and the standard deviation 10. This system guarantees a uniform assessment and allows data from other studies to be compared [11].

We applied the t-test to statistically analyse each means of the scale. We examined the influence of independent variables (i.e., affected joint, early vs. late infection, type of therapy, etc.) on our target variables in univariate analysis. That entailed using the independent variables in Fisher's exact test in the presence of ordinal and nominal measuring niveau. The Mann-Whitney test was applied for metric parameters. The level of significance was set at 5 %.

Results

We enrolled 84 patients in this study (53 male [63.1 %] and 31 female [36.9 %]). Average age was 69 (SD ±10.7 years). Age revealed no significant influence on therapy success (p=0.654).

Of the infected implants, 43 (51.2 %) were knee prostheses and 41 (48.8 %) hip prostheses. Table 1 illustrates the frequency of therapeutic success in relation to the infection site. The success rate in our cohort's hip group was 88 % and in the knee group 62 % (Table 1). Two patients died of a sepsis associated with the prosthetic infection. We noted a statistically significant difference in therapeutic success between the hip and knee prostheses (p=0.016).

Our entire cohort's average ASA score was 2.7 (SD±0.6), including three patients (3.6 %) with as ASA 1, 24 (28.6 %) with ASA 2, 54 (64.3 %) with ASA 3, and 3 (3.6 %) with ASA 4. As a characterization of comorbidities, the ASA classification revealed no influence on therapeutic success (p=0.406).

The implantation time of the infected prostheses was 63.6 months (SD±72.7, range zero–383 months) at the time of infection diagnosis. Its 0.836 p value indicates that implantation time had no significant effect on therapeutic success.

Seven patients (8.5 %) presented an early infection: five hip and two knee prostheses. Seventy-five patients (91.5 %) had late infections, with 40 affecting the knee and 35 the hip. We

Table 1 Result in hip and knee joints

Location	Success	Failure	Total
Hip	36 (88 %)	5 (12 %)	41
Knee	27 (62 %)	16 (38 %)	43
Total	63 (75 %)	21 (25 %)	84

were unable to identify the implantation date of one hip and one knee prosthesis, and could thus not differentiate early or late infection in those two individuals.

The causative organisms isolated most frequently in this patient cohort was coagulase-negative *Staphylococcus* in 25 patients (31.6 %) and *Staphylococcus aureus* in 23 patients (29.1 %). In descending order we identified *Enterococcus spp.* (7.6 %), *Propionibakterium acnes* (5.1 %), *Streptococcus spp.* (3.8 %), *Pseudomonas aeruginosa* (2.4 %), *Corynebakterium striatum* (1.2 %), *Abiotrophia* (1.2 %), *Granulicatella corrodens* (1.2 %) and *Escherichia coli* (1.2 %). In 12 patients (15.2 %) we detected multiple causative organisms and in five no bacteria could be isolated. The causative organism showed no significant effect on therapeutic success (p=0.675).

We detected multiresistant pathogens in ten patients (11.9 %) affecting five knee and five hip prostheses. The multiresistant pathogens identified were four cases of methicillin-resistant *Staphylococcus aureus* (MRSA), three of multiresistant coagulase-negative *Staphylococcus*, two of vancomycin-resistant *enterococcus* (VRE) and one extended-spectrum beta-lactamase builder. Of the proven *Staphylococcus aureus* isolates, 17 % were MRSA. Again, we detected no correlation between multiresistance and therapeutic success (p=0.682).

In ten patients we were able to retain their prostheses (11.9 %). Four patients (4.8 %) underwent one-stage revision and 44 (52.4 %) two-stage revision. Nine patients (10.7 %) underwent either a primary arthrodesis (knee) or a primary Girdlestone procedure (hip). Twelve patients (14.3 %) had to undergo a secondary arthrodesis or Girdlestone procedure, and five (6.0 %) underwent amputation.

Of the 84 patients in our study cohort, 14 had died and one was in a persistent vegetative state at the time of the telephone interviews. Another was unwilling to provide information. Ten patients could not be contacted either personally or through their general practitioner and are thus considered "lost to follow-up". A total of 58 questionnaires were ultimately filled out, yielding a return rate of 69 %.

Our study patients' physical scale was markedly lower than their mental scale (Table 2).

Comparing the groups with hip (N=29) and knee (N=29) QoL in terms of the infection site yielded no significant difference between physical scale 36,66 (hip) and 35,84 (knee) (p=0.787) and mental scale 52,33 (hip), 51,73 (knee) (p=0.869). Nor did comparing their QoL in terms of successful vs. unsuccessful therapy (Table 3) yield a significant difference (physical scale p=0.556, mental scale p=0.234).

Table 2 Results of the SF-12

Scale	N	Mean (SD)	Range
SF-12 Physical scale	58	36.25 (11.35)	15–56
SF-12 Mental scale	58	52.03 (13.58)	18–71

Table 3 SF-12 according to therapy success

Scale	Result	N	Mean (SD)
SF-12 Physical scale	Success	49	35.95 (11.87)
	Failure	9	37.91 (8.35)
SF-12 Mental scale	Success	49	53.20 (12.72)
	Failure	9	45.67 (16.96)

To compare our patient cohort's QoL with that of the general population, we used the German sample from 1994 (N=2805). This yielded an average of 49.03 points on the physical part (SD±9.35) and 52.24 points on the mental part (SD±8.10) [11]. Here, comparison with our patient cohort yielded a significant difference in the physical scale (p<0.001), whereas the scores on the mental part did not differ significantly (p=0.907).

Discussion

Our cohort's periprosthetic joint infections were treated successfully in 75 % of the patients. This success rate corresponds closely to those cited in the current literature, where similar studies report rates of 67 % and 94 % [12–16]. However, being so diverse, these studies are difficult to compare. For example, Hart and Jones only examined patients who had undergone two-stage revision and whose infections were caused by a single pathogen [12]. Kusuma et al. also enrolled only those patients who had had two-stage revision, and their main criterion was infection eradication at the time of prosthesis re-implantation; they report on no further follow-up [13]. In another study by Mortazavi et al., only patients post-two-stage revision were included and the necessity of a further surgical intervention was defined as therapy failure [14]. Study comparability is further hampered by the fact that therapy success is not uniformly defined, and that inclusion and exclusion criteria vary. Many studies examine therapy success in a pre-selected patient population. We excluded no patients in this investigation. Moreover, we examined all modes of treating periprosthetic infections, which makes our results more comparable with the results of Wimmer et al. [16] in terms of treatment, since they achieved success in 70.4 – 71.7 %, without differentiating between hip and knee joints.

Treatment success was attained in 88 % of patients in our hip-prosthesis group, but in only 62 % in the knee-prosthesis group. There are relatively few investigations that focus on two infection sites to compare the probability of successful resolution of a prosthetic infection in the knee vs. the hip. Kilgus et al. examined 70 infected prostheses and detected no significant difference between hip and knee joints. However,

at 63 %, their success rate was higher in the hip prosthesis group than in the knee prosthesis group (54 %) [17]. Thus our findings here correlate with those in the literature. The exact reason behind the difference in hip and knee prosthesis outcomes cannot be answered definitively. There may be a relationship between the earlier limitation of soft tissue coverage and extensor mechanism failure in knee joints compared to hip joints. Since there is no data in the literature on this topic and it wasn't the aim of our study this cannot be proven.

The pathogen we identified most frequently was coagulase-negative *Staphylococcus* in 25 patients (31.6 %) and *Staphylococcus aureus* in 23 patients (29.1 %). This result is in line with the epidemiological data reporting that periprosthetic infections are mainly caused by transient and resident pathogens on the skin [18].

Ten of our patients presented multiresistant pathogens. However, we observed no statistically significant difference in infection outcomes whether the pathogen was sensitive or multiresistant. Our small patient numbers may be behind this failure to detect significance. Only one study group has also demonstrated that MRSA infections do not result in a worse treatment outcome than infections caused by sensitive pathogens [19]. Most studies have reported that MRSA infections result in worse treatment success rates than those caused by sensitive pathogens [14, 17, 20]. This is the reason why Zimmerli et al. [3, 7] suggest different therapy strategies with respect to the underlying causative organism, especially when not sensitive to rifampicin. This was the case in about 5 % of our patients who underwent a one-stage revision with only monobacterial infections by gram-positive pathogens that were not multiresistant as in many other study groups [6, 21].

To our surprise our patient population's SF-12 displayed no significant difference in the physical vs. the mental results in terms of either gender or infection site. Nor was there a significant difference in QoL in comparison of patients whose infections had been successfully resolved with those whose infections had not been. While the successfully-treated patients' mental scale were higher (at 53 points) than the unsuccessfully-treated patients' (46 points), this difference did not attain statistical significance. The limited number of patients and retrospective study design without other patient-reported outcome measurements like the Oxford hip score [22] or even a validated objective score could be a reason for that. It could be possible that our population yielded very low joint functioning with known influence on general health status [23].

Our patient cohort's physical scale (36) was significantly lower than that of the general population (49), yet both groups' mental scale were an identical 52. In the German sample, stroke patients also have 36 on the physical scale [24]. This difference between patients' physical and mental states is an effect other working groups have also demonstrated. Two studies reported lower physical than mental scales, although one [25] compared one-stage with two-stage revisions. There is interesting evidence [26] that a revision because of aseptic loosening or stiffness yields lower values on the SF-36. This contradicts findings made by Wang et al. [27], who compared QoL via the SF-12 in patients who had undergone septic and aseptic revision surgery on knee prostheses; they demonstrated that the patients with a periprosthetic infection had lower scores in both the physical and mental categories than infection-free patients. Still another working group [28] investigated the QoL (using the SF-36) of patients with uncomplicated prostheses in patients whose knee or hip prosthesis had become infected, also demonstrating significantly lower physical and emotional scores in the latter group. Also applying the SF-12, Meek et al. compared septic with aseptic knee-prosthesis revisions. They, however, demonstrated that patients with PJI scored higher in both the physical and mental categories than their control group, although the difference was not statistically significant [18].

Limitations of our study are, for one, the brief follow-up period and, secondly, its retrospective design, which prevents us from drawing any conclusions regarding QoL during the actual prosthetic infection. Furthermore, the QoL of the two patients who succumbed to sepsis and those who could not be contacted could not be considered. Nevertheless, ours is, to the best of our knowledge, the first investigation so far to have compared QoL in the context of successful vs. unsuccessful treatment for a prosthetic joint infection.

In conclusion, QoL is substantially reduced after a prosthetic joint infection. What surprised us was discovering that the restriction in physical QoL was independent of the result of the therapy of the periprosthetic infection. This may be due to the study's design and its small patient cohort. We could, however, demonstrate that patients achieve an acceptable QoL after the Girdlestone procedure or knee arthrodesis, and that these two methods continue to be suitable therapeutic alternatives in view of patients' subjective QoL.

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