ORIGINAL PAPER
PŮVODNÍ PRÁCE

Mid-Term Survival of Total Knee Arthroplasty in Patients with Posttraumatic Osteoarthritis

Střednědobé přežití totální náhrady kolena u pacientů s potraumatickou artrózou

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ABSTRACT

PURPOSE OF THE STUDY

There is limited evidence on survival and complication rates in patients after total knee arthroplasty for posttraumatic osteoarthritis. The failure mechanisms leading to revision remain an issue of constant debate. The purpose of this study was to analyze the mid-term survival of primary total knee arthroplasties as well as to evaluate complications and failure mechanisms in patients with posttraumatic knee osteoarthritis.

MATERIAL AND METHODS

This retrospective study included 79 patients with an average age of 59 years at the time of primary total knee arthroplasty. A functional and radiographic assessment was obtained during outpatient clinical follow-up at 3 and 12 months postoperatively and yearly intervals after that. Survival rates were calculated using Kaplan-Meier analyses. The mean postoperative follow-up was 69 months.

RESULTS

At 69 month the revision-free survival rate was 88.6%. In nine cases (11.4%) a revision procedure was performed. The leading cause of revision was a periprosthetic infection (n = 6, 66.6%). An age of fewer than 55 years at the time of total knee arthroplasty had a significant influence on implant survival (p = 0.018) with superior survival in favor of the older patient population. At most recent follow-up, a mean Knee Society Score of 82 points and an average Function Score of 77 points were observed.

CONCLUSIONS

Periprosthetic joint infection is the primary failure mechanism leading to a revision in patients with total knee arthroplasty for posttraumatic osteoarthritis. Apart from the increased infection rate, total knee arthroplasties in patients with posttraumatic osteoarthritis revealed results that were comparable to patients with primary osteoarthritis.

Key words: posttraumatic knee osteoarthritis, total knee replacement, survival, complications, revision, outcome.

INTRODUCTION

In 12% of all cases of knee osteoarthritis, a previous trauma is considered to be the cause of joint degeneration (5). Posttraumatic osteoarthritis occurs after fractures of the proximal tibia or distal femur as well as following ligament and meniscal lesions. Up to 44% of tibial plateau fractures result in the development of posttraumatic knee osteoarthritis (20, 23). After anterior cruciate ligament (ACL) tears, Friel and Chu observed the occurrence of symptomatic osteoarthritis in approximately 50% of all patients in 10–15 years after injury (7). Reconstructions of the ACL after a rupture did not contribute to a reduction in the rate of posttraumatic osteoarthritis of the affected patients in the long term (15). Therefore, the percentage of posttraumatic osteoarthritis of the knee in orthopedic patients will not change in the future. Total knee arthroplasty (TKA) remains the gold standard in the treatment of osteoarthritis (2). One crucial patient-specific difference between posttraumatic osteoarthritis of the knee and primarily degenerative joint pathologies is the young age of the affected patients (5, 9). The increased functional demands in this young patient population results in higher biomechanical loads after a TKA and this is therefore associated with an increased risk of implant failure due to aseptic loosening and polyethylene wear (3, 8, 9, 24). Studies on TKA in patients with posttraumatic osteoarthritis have reported on worse functional results and increased complication rates compared to primary osteoarthritis patients (14, 24, 25).

A small number of studies in the current literature have conducted survival analyses of posttraumatic knee implants, usually with small patient cohorts (2, 9, 13, 14, 17). The purpose of this study, therefore, was to quantify mid-term TKA survival for patients with post-

traumatic osteoarthritis. Secondary outcome measures were the evaluation of clinical results and complications as well as a radiological analysis of the postoperative alignment after joint replacement.

MATERIAL AND METHODS

After approval was received from the local ethics committee (reference number EA4/095/14), a retrospective data acquisition process was performed. Informed consent was obtained from all individual participants included in the study. Using the hospital's in-house information system and the relevant ICD code, all patients who had undergone TKA due to posttraumatic osteoarthritis in our hospital between January 2009 and February 2014 were selected. Out of 124 initially analyzed patients, 79 individuals met the inclusion criteria (Fig. 1). This resulted in a dropout rate of 36.3%.

The average age of the patients at the time of primary TKA was 58.8 years ± 11.3 years (36–82 years). 32 of the patients (41%) were under 55 years of age. Regarding etiology, posttraumatic osteoarthritis was attributable to fractures of the tibia, fibula, femur or patella in 49 cases (62%). In 26 patients (33%), osteoarthritis had been preceded by ligament and meniscal lesions. In four patients (5%), combined ligament lesions and fractures were identified as the cause of posttraumatic osteoarthritis. In 71 cases (90%), a surgical procedure had been performed following the initial injury. The average period between the initial injury and primary TKA was 19.6 ± 15.5 years (1–53 years). All patients received a full cemented total knee arthroplasty using a medial parapatellar approach. A total of seven different prosthesis models were used (table 1). The mean body mass index (BMI) was 29.3 ± 5.3 kg/m^2 (20.2–47.85 kg/m^2). The average follow-up period was 68.6 ± 36.8 months (range 13–144 months). Three attending orthopedic surgeons performed all interventions.

Table 1. Different prosthesis models: e.motion®, Aesculap AG, B. Braun Melsungen AG, Hessen, Deutschland; Innex®, Zimmer, Warsaw, Indiana, USA; NexGen® LPS-Flex Mobile, Zimmer, Warsaw, Indiana, USA; TC-PLUS™, Smith & Nephew, London, United Kingdom; RT-PLUS™ Solution, Smith & Nephew, London, United Kingdom; P.F.C.® Sigma®, DePuySynthes, Warsaw, Indiana, USA; P.F.C.® Sigma® TC3, DePuySynthes, Warsaw, Indiana, USA; Attune®, DePuySynthes, Warsaw, Indiana, USA. CR, cruciate retaining; PS, posterior stabilized; VVC, varus-valgus constraint

Producer	Prosthesis	Constraint	Count
Aesculap	e.motion®	CR	3
	e.motion®	PS	4
Zimmer	Innex®	CR	1
	NexGen®	PS	2
Smith & Nephew	TC-PlusTM	CR	2
	RT-PlusTM Solution	Rotating hinge	9
DePuySynthes	P.F.C.® Sigma®	CR	17
	P.F.C.® Sigma®	PS	23
	Sigma® TC3™	VVC	14
	ATTUNE®	CR	3
	ATTUNE®	PS	1

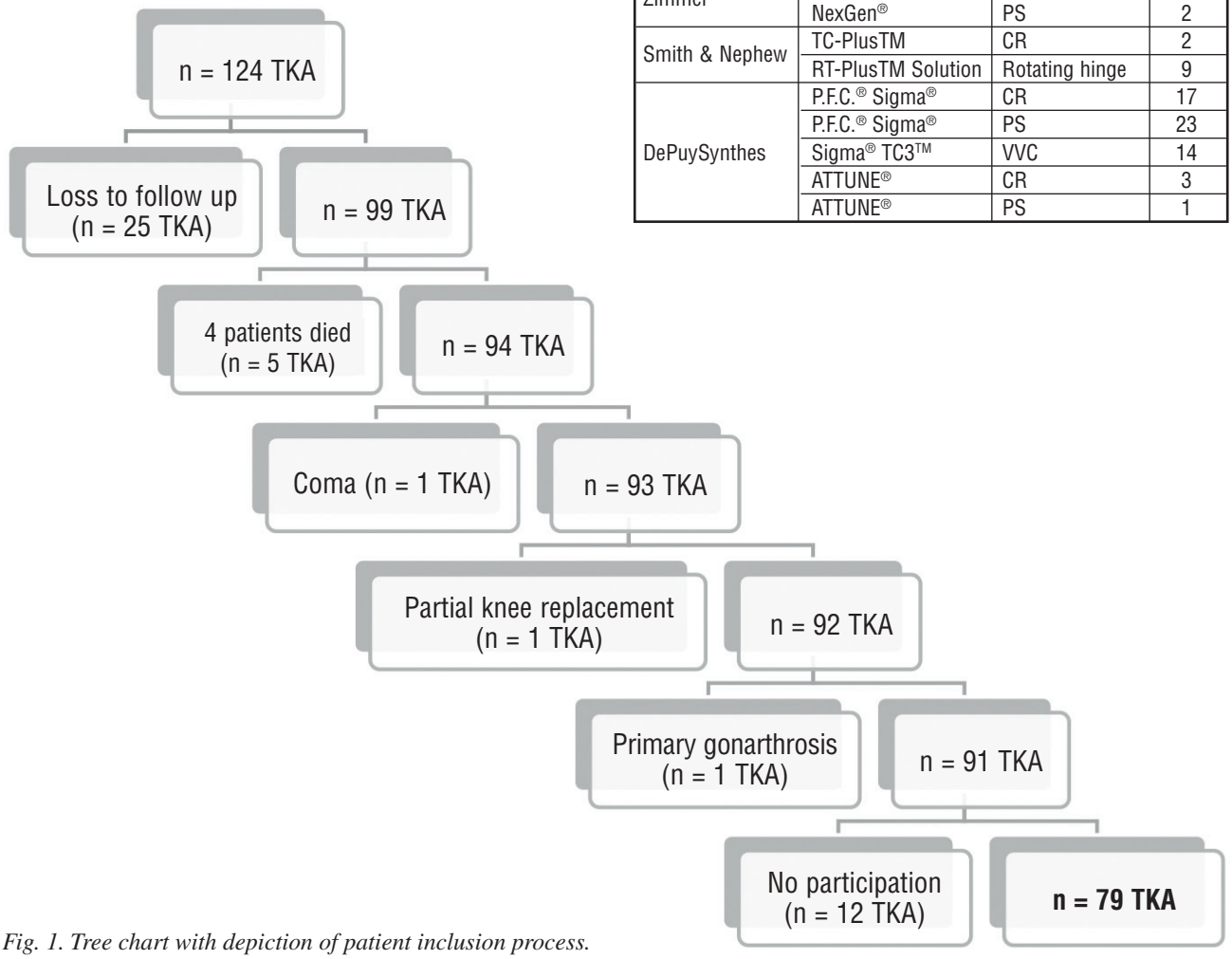

Fig. 1. Tree chart with depiction of patient inclusion process.

Radiographs were reviewed during outpatient clinical follow-up. The patients were followed up at 3 and 12 months postoperatively and at yearly intervals after that. The functional results were recorded using the Knee Society Score (KSS) and the Knee Function Score (10, 18). At final follow-up, all patients completed a questionnaire on the evaluation of knee function and to document other interventions after total knee replacement for an any event analysis. The following interventions or manipulations were defined as "any event": Revision (partial or complete change of the components, inlay exchange), arthroscopy, scar resection and manipulation under anesthesia. Statistical analysis was performed using the SPSS software package (Version 21, IBM, Armonk, NY, US) with a defined significance level of $p < 0.05$. The survival rates were calculated using Kaplan-Meier analyses. Group-specific differences in the survival functions were calculated using the log-rank test (12).

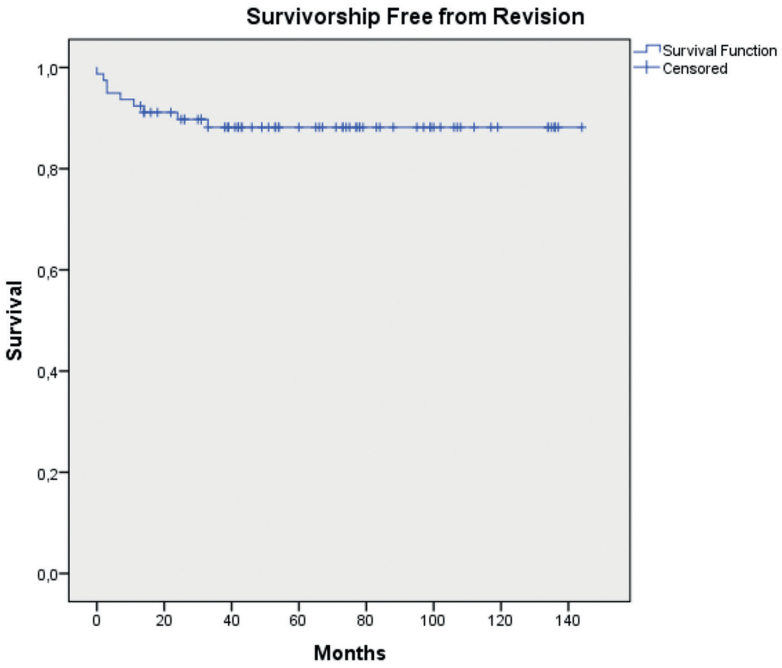

Fig. 2. Kaplan-Meier survivorship curve depicting 12-year survivorship free from revision.

RESULTS

Survival

Overall, the estimated cumulative survival rate was 88.2% after 144 months (95%CI; 0.81-0.95; Fig. 2). 70 patients (88.6%) experienced revision-free survival throughout the observation period. Nine prostheses had to be revised after an average period of 68.6 months (11.4%). The reason in six cases (7.6%) was a periprosthetic infection, including two low-grade infections and two late infections (revision after 24 months), which were all treated with a two-stage septic revision. After multiple prior septic interventions due to a femoral fracture, one patient contracted persistent osteomyelitis three months after primary TKA, which subsequently required amputation of the distal femur. Liner exchange with synovectomy was performed in one female patient due to persistent wound secretion with the suspicion for early infection. Overall, an estimated infection-free survival rate of 92% was observed after 144 months (95%CI; 0.86–0.98; Fig. 3). Also, three revisions were performed: two for instability and due to a limited range of motion in one patient with arthrofibrosis. This patient underwent open arthrolysis with liner exchange. Detailed failure analysis of patients requiring a revision procedure is depicted in table 2. Calculation of the revision-free survival curves in correlation to the patient's age showed improved cumulative survival rates for patients who were over 55 years of age at the time of primary TKA. Among those over 55 years of age (n = 47), two revisions occurred during the observation period, resulting in a survival rate of 95.7%. The younger patient cohort under 55 years of age (n = 32) required seven revisions, resulting in a survival rate of 78.1%. The difference between the age groups in respect of TKA revision was significant (p = 0.018; Fig. 4).

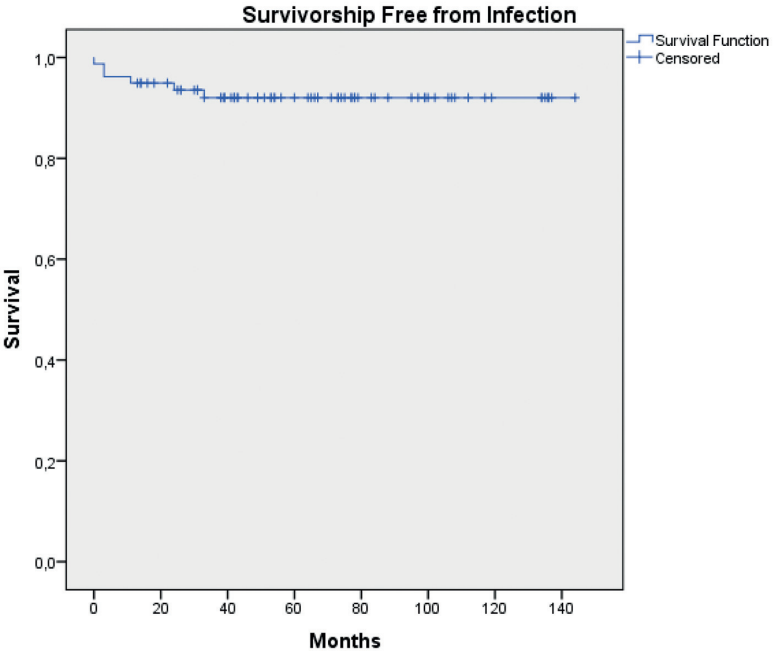

Fig. 3. Kaplan-Meier survivorship curve depicting 12-year survivorship free from infection.

Functional and radiological results

After an average of 68.6 months, a mean KSS of 82.14 points and a Function Score of 76.8 points were recorded. A total of 73 patients were included in the

Table 2. Required TKA revisions and indications. ACL, anterior cruciate ligament; PE, Polyethylene; ROM, range of motion

Sex	Year of accident	Diagnosis	Previous operation	Time accident to TKA (years)	Indication for TKA revision	TKA survival (months)	Procedure
m	2000	tibial plateau fracture	yes	4	low-grade infection	11	two-stage TKA exchange
m	1999	knee distortion	yes	6	low-grade infection	33	two-stage TKA exchange
f	1978	meniscus-/ ACL-rupture	yes	31	instability	14	one-stage TKA exchange
m	1959	fracture of the distal femur	yes	51	instability	7	one-stage TKA exchange
m	2001	patellar fracture, quadriceps tendon rupture	yes	9	osteomyelitis	3	amputation of the distal femur
f	1996	open knee dislocation	yes	14	limited rom	2	PE liner exchange with synovectomy
m	1996	fracture of the distal femur	yes	15	infection	24	two-stage TKA exchange
m	2009	fracture of the distal femur	yes	2	infection	3	two-stage TKA exchange
f	1961	tibial plateau fracture	no	53	early infection	0	PE liner exchange with synovectomy

radiological analysis. An average postoperative tibial slope of 3° was measured. Additionally, a mean valgus femorotibial angle of 6° could be determined. No signs of implant loosening were observed on the radiographs of any non-revised prostheses at most recent follow-up.

Complications

13 (16.5%) patients required further surgical intervention. Apart from the nine revisions mentioned above, these included two knee arthroscopies, one scar resection and one manipulation under anesthesia. Overall, the revision for any event showed an estimated cumulative survival rate of 82.7% after 144 months (95%CI; 0.74–0.91; Fig. 5).

DISCUSSION

In this retrospective study, survival and complication analyses of 79 total knee arthroplasties in patients with posttraumatic osteoarthritis were performed. Overall, the cumulative survival rate was 88.6% after 12 years. The leading cause of revision was a periprosthetic infection. There was a significant difference in the survival function with an age cut-off of 55 years in favor of the older patient population. For 13 (16.5%) patients, further surgical intervention and thus postoperative complication could be observed. The revision rate of 11.4% was higher compared to TKA in patients with primary knee osteoarthritis (1,22).

In the current literature, only a small number of studies analyze the survival functions of total knee replacements in patients with posttraumatic osteoarthritis (2, 9, 14, 17, 25). In a study by Abdel et al. on the long-term survival of TKA in 62 patients with tibial plateau fractures, the authors reported a revision-free survival rate of 82% after 15 years (2). The rate of 88% after 12 years in this study showed a similar cumulative survival rate. The average age of the patients investigated by Abdel et al., at 63 years, was roughly comparable with that of the patients in our study. In a patient cohort with posttraumatic osteoarthritis due to a periarticular fracture, Houdek et al. observed an inferior revision-free TKA survival rate of 75% after 15 years (7). El-Galaly et al. recently published the data from the Danish prosthesis registry with over 1400 posttraumatic TKA's. For their 50–70-year-old patient population, the authors reported a cumulative revision-free survival rate of 86% after ten years (6). This substantial registry analysis shows comparable revision-free survival rates to ours. As in our study, most of the revision procedures occurred during the first postoperative year.

Overall, our study showed a cumulative survival free from any surgical intervention of 83% at 12 years. A comparable survival rate of 79% after ten years was calculated for the patient population investigated by Lunebourg et al. (16).

Our study recorded a mean KSS of 82 points and a Function Score of 77 points. Current studies confirm these data (3, 16, 24). Thus, Lunebourg et al. reported an average KSS of 77 points and a mean Function Score of 81 points for 33 patients with posttraumatic TKA (16). However, most of the studies with larger patient cohorts do not provide any details of the individual function scores for these patients (6, 24).

Studies to date mainly report an increased complication rate for TKA's in patients with posttraumatic osteoarthritis. Compared to TKA for primary osteoarthritis, our patient population showed a higher complication rate of 17% (11, 19). Houdek et al. also reported significantly

higher complication and infection rates in their TKA cohort of 531 patients with posttraumatic osteoarthritis in comparison to patients with primary osteoarthritis (9). In their 15-year-follow-up study, Abdel et al. observed a high complication rate of 34%. The most common cause of revision was polyethylene wear with subsequent prosthesis loosening (2). For this study, the main reason for revision was a periprosthetic infection (n = 6, infection rate of 8%). The infection rate was comparable to the data reported by Abdel et al. (infection rate 7%) and other studies in the current literature (9, 24). In the study by Lonner et al. for primary TKA for posttraumatic osteoarthritis in 31 patients, the authors reported a comparatively high infection rate of 10% (14). The average age of the patients, at 60 years, was comparable with that in our patient population, although the mean follow-up period in the study by Lonner et al. was shorter, at 46 months (14).

Patients who were over 55 years of age at the time of primary TKA showed a revision-free survival of 96% during our observation period. Thus, only two revisions occurred in those over 55 in the observation period, whereas there were seven revisions in the younger patient cohort group and a resulting revision-free survival rate of 78.1%. The difference between the age groups in respect of a revision procedure was significant (p = 0.018). The Danish prosthesis registry likewise shows a much higher revision rate for younger TKA patients with posttraumatic osteoarthritis. In fact, patient age of under 50 was identified as a predictor for revision surgery (6). Except for the registry study of El-Galaly, we are not aware of any other studies that considered patient age as a potential factor of influence for revision.

Despite its findings, this study has certain limitations. First, due to its retrospective design and a limited number of patients, a bias may be introduced. Although the current literature only includes a few studies with a comparably sized patient cohort, individual outliers exert a significant influence mainly on the calculations of the survival and revision rates. In this respect, further data and registry analyses are needed for an accurate individual risk assessment. Second, various types of injury leading to posttraumatic knee osteoarthritis were included in the evaluation of this study. These had initially been treated both by surgical and non-surgical means. Given the differing injury patterns, interindividual differences existed within the patient population. This reduced the homogeneity regarding the posttraumatic anatomy and stability of the knee joint. Compared to TKA in patients with primary osteoarthritis, there were fewer revisions due to instability (21). These may be attributable to the fact, that a higher number of varus-valgus-constraint knees and rotating hinges was included in this study. Patients with prior trauma leading to preexisting knee instabilities require a higher level of constraint. These could explain the good functional mid-term results in our patient population. On the other hand, the higher level of constraint also entails higher shear forces, might result

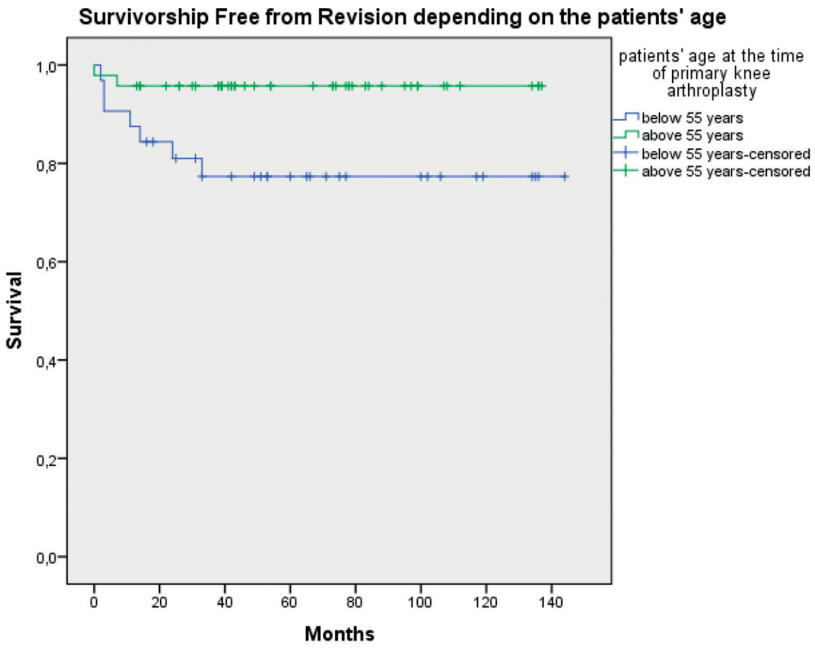

Fig. 4 Kaplan-Meier survivorship curve depicting 12-year survivorship for revision depending on the patient's age at the time of primary knee arthroplasty

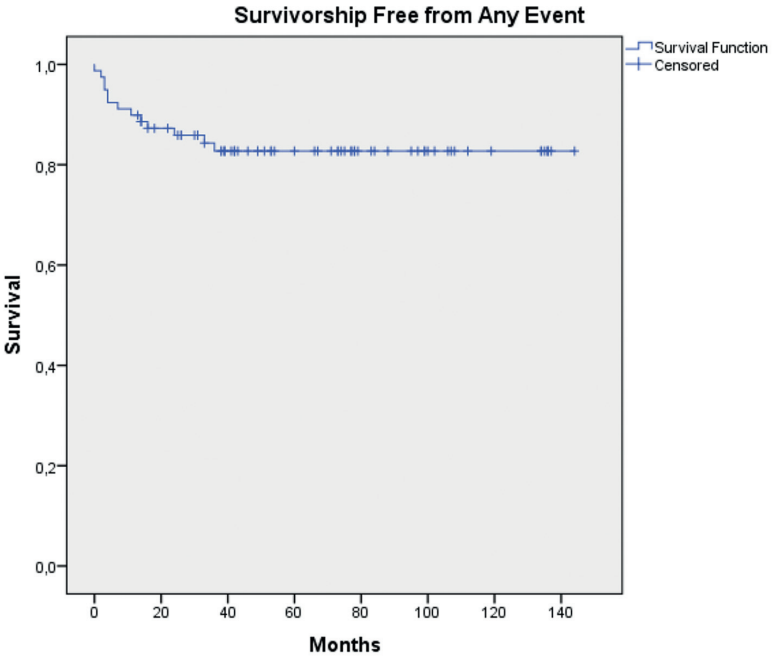

Fig. 5. Kaplan-Meier survivorship curve depicting 12-year survivorship free from any event.

in a higher rate of TKA failure due to aseptic loosening in the long-term follow-up.

Periprosthetic infection was the leading cause of TKA failure and as such the main reason for a reduced mid-term survival of TKA in posttraumatic osteoarthritis. If those complications can be avoided, equivalent results can be possible. Data from the current literature indicate an implant infection rate of to 30% after open reduction and internal fixation for fracture treatment (4). Respecting these results, a two-stage procedure with implant removal and prosthesis implantation at a later stage might reduce the infection rate in patients with posttraumatic osteoarthritis of the knee.

Ethics, consent, and permissions

Consent for publication: Informed consent for publication of the pseudonymized and anonymized data was obtained from all individual participants included in the study.

Availability of data and material: Not applicable, (excel, word and SPSS files of the respective patients can be provided at any time if the editors require further information)

Conflict of Interest and competing interests: The authors declare that they have no conflict of interest.

Funding: There is no funding source.

Authors' contributions: Not applicable

Authors' information (optional: Not applicaple

Acknowledgments: Not applicable

Ethical approval: The local ethics committee approved the study (reference number EA4/095/14).

Informed consent: Informed consent was obtained from all individual participants included in the study.

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