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# Quality of Life and Functional Outcome of Periprosthetic Fractures around the Knee Following Knee Arthroplasty

## Kvalita života a funkční výsledky léčby periprotetických zlomenin v oblasti kolena po náhradě kloubu

**S. MÄRDIAN, K.-D. SCHASER, F. SCHEEL, J. GRUNER, P. SCHWABE**

Charité – University Medicine Berlin, Centre for Musculoskeletal Surgery, Berlin, Germany

## ABSTRACT

PURPOSE OF THE STUDY

The present study aimed to analyse both, the functional outcome and quality of life after surgical treatment of periprosthetic fractures following TKA.

MATERIAL AND METHODS

A retrospective review of all periprosthetic fractures following knee arthroplasty which have been surgically treated at our institution between January 2005 and January 2012 was conducted. Beside epidemiologic data, type of surgery and postoperative complications were recorded. The functional outcome was assessed using range of motion, Knee Society Score and VAS to evaluate pain. Quality of life was evaluated using SF-36 and WOMAC. Furthermore patients mobility and comorbidities were analysed.

RESULTS

25 (mean age 76 ± 8 years; m:w 5:20) patients were included. The overall complication rate was 24%. Mean KSS knee score was 73 ± 19 and a function score was 41 ± 36. Range of motion revealed 95° ± 24° (active) and 98° ± 16° (passive). The total SF-36 scored a mean of 41 ± 6 and 29 ± 19 in average considering the WOMAC index (pain: 19 ± 20; stiffness: 23 ± 27; daily: 47 ± 29). 20% were able to mobilise without help as opposed to 80% that were in need for assistance. Our analysis revealed no influence of the final outcome as a function of fracture type or type of treatment. Multiple regression analysis could not reveal significant influence of the comorbidities.

CONCLUSION

Periprosthetic fractures following knee arthroplasty are accompanied by a significant decrease of the knee function and quality of life as well as high complication rates. Since patient's quality of life apparently depends on the functional outcome, future efforts should aim to improve these parameters.

**Key words:** periprosthetic fracture, total knee arthroplasty, quality of life, functional outcome, locking plate.

## INTRODUCTION

Although explicit numbers of periprosthetic fractures following total knee arthroplasty (TKA) are barely known, estimates range from 0.6% to 2.5% after primary and 1.6% to 3.8% after revision TKA (1, 15). Due to the demographic changes in the industrial countries with an aging but active population, the continuously increasing life expectancy and the prolonged survivorship of the prostheses, the incidence and rate of periprosthetic fractures following TKA is expected to markedly increase (14). Their management is technically demanding and may require profound expertise in both osteosynthetic techniques and revision arthroplasty (14, 15). Especially in elderly patients, sufficient stabilisation of those fractures may be particularly complicated by the presence of poor bone stock, previous revision surgeries and a high prevalence of medical comorbidities (14). Among others, osteoporosis, rheumatoid arthritis, previous revision arthroplasty as well as septic or aseptic loosening are the most abundant risk factors (1, 14). Supracondylar femur fractures are by far the most common with a reported incidence of 0.3–2.5% (1, 27) followed by periprosthetic tibia and patella fractures. Hence, various classifications for the different fractures have been proposed (2, 5, 19, 24). The most crucial aspect in the classification and surgical work-up is the determination whether the prosthesis is fixed or loose in order to pursue the appropriate treatment algorithm (14, 27). Nevertheless, high complication rates accompanied by poor outcome have been reported following surgical treatment (3). Whereas in the majority of clinical trials outcome data are merely focused on functional measures and comparison of different implant types, only very few studies have only partially considered postoperative quality of life (QoL) (1, 4, 6). Furthermore, none of these studies have tried to identify causative factors, i.e. active/passive knee function, type of underlying fracture and surgical treatment and radiographic result, expected to determine resultant postoperative QoL. In addition, the few available studies are very heterogeneously designed, compare new treatment options (e.g. allografts in combination with revision TKA) or are presented as case series with few patients only (10, 17).

Therefore present study aimed to retrospectively analyse patient characteristics, type of surgical treatment, postoperative complications and the functional outcome in order to predict prognostic influence of these causative factors on the recorded postoperative quality of after surgical treatment of periprosthetic fractures following TKA.

## MATERIAL AND METHODS

A retrospective review of all periprosthetic fractures following total knee arthroplasty which have been surgically treated at our institution between January 2005 and January 2012 was conducted. For this type of study informed consent was not necessary. We recorded epidemiologic data (age, gender, BMI, interval between arthroplasty and fracture), details of surgery (type of treatment: osteosynthesis, revision arthroplasty, combined) and postoperative complications (infection, hardware failure, non-union, periprosthetic re-fracture). The functional assessment included the range of motion (ROM) and the Knee Society Score (KSS) with its two subscores (functional score and knee score) (8) and a visual analogue scale (VAS) to evaluate pain (in rest and under loaded conditions). Patient s postoperative quality of life was evaluated using the short form 36 questionnaire (SF-36), (25) and the Western Ontario and McMaster Universities Arthritis Index (WOMAC) (23). The patients mobility was quantified by the use of walking aids of different categories (able to walk without help, one walking stick, crutches, walking frame, wheelchair/inability to walk) as described before (16). Comorbidities were weighed by the use of the classification according to the American Society of Anaesthesiologists (ASA), (20).

### Statistical analysis

All data were recorded and analysed using IBM® SPSS® Statistics Release 22.0 (IBM Corporation, Armonk, New York, United States). The assumption of normality and homogeneity of variance was tested using the Kolmogorov-Smirnov test. The statistical analysis was performed using the t-test for testing numeric matched/unmatched samples. For interval scaled factor analysis an ANOVA was performed. In case of multiple comparisons the post-hoc Bonferroni correction for repeated measurements was applied. When sample sizes in the groups where dif-ferent the Man-Whitney-U-Test was calculated. To correlate numeric values the Pearson's correlation coefficient was used. The Chi-square-test was performed for cross table evaluation. Subgroups containing only one patient were excluded from analysis. To verify predictive factors to the outcome a multiple regression analysis was performed including variables that showed significant correlation to the outcome parameter in a preanalysis. Differences were considered significant for $p < 0.05$.

## RESULTS

A total of 39 patients were identified who underwent surgical treatment for a periprosthetic fracture following total knee arthroplasty. 25 (64.1%) patients had complete follow-up data and were included in the analysis. Of the remaining 14 patients, 9 died during the study period (23.1%) and 5 were lost to follow-up (12.8%). Among those included into the analysis 20 (80%) were female and 5 (20%) male ($p = 0.004$) with a mean age of 76 ± 8 years. The mean follow-up time was 34 ± 19 months. The mean duration between arthroplasty and occurrence of fracture was 7.3 years. The mean hospitalisation time was 12 ± 3 days. The main cause of injury were simple falls on even ground in 22 (88%). In 3 (12%) patients the fracture occurred spontaneously.

### Surgical details and complications

The analysis of the fracture distribution regarding the femur revealed 52% (n = 13) type Su I, 28% (n = 7) type Su II and one type Su III fracture. We recorded four periprosthetic tibia fractures (8% Felix II (n = 2), 4% Felix II (n = 1) and 4% Felix III (n = 1)). No patella fractures were seen in our study group. 84% (n = 21) patients were fixed using a locking plate osteosynthesis (Fig. 1) as opposed to 16% (n = 4) patients that were managed with a combination of revision arthroplasty and locking plate osteosynthesis (Fig. 2). Thus, we did not include any patient, fulfilling the inclusion criteria with isolated revision arthroplasty in our cohort. The overall complication rate was 24%. In 8% (n = 2) of the patients we documented non-unions that lead to revision surgery and 4% (n = 1) suffered from a postoperative infection. Another 4% (n = 1) suffered from a hardware failure. Due to another fall on even ground, 8% of the patients (n = 2) were re-admitted with a periprosthetic re-fracture. The analysis of the complications revealed no significant differences when matched to fracture type ($p = 0.370$) or type of surgical intervention ($p = 0.694$). Analysis demonstrated a mean number of reoperations of 0.64 ± 1.3 (0–4). The mean time until fracture union was considered to be completed ranges from 2 to 15 months (mean time to healing: 4.9 ± 2.8 months). Although patients suffering from a complication had a longer time to union than those without (8.5 ± 4.5 versus4 ± 1.3) statistical testing showed no significance ($p = 0.143$).

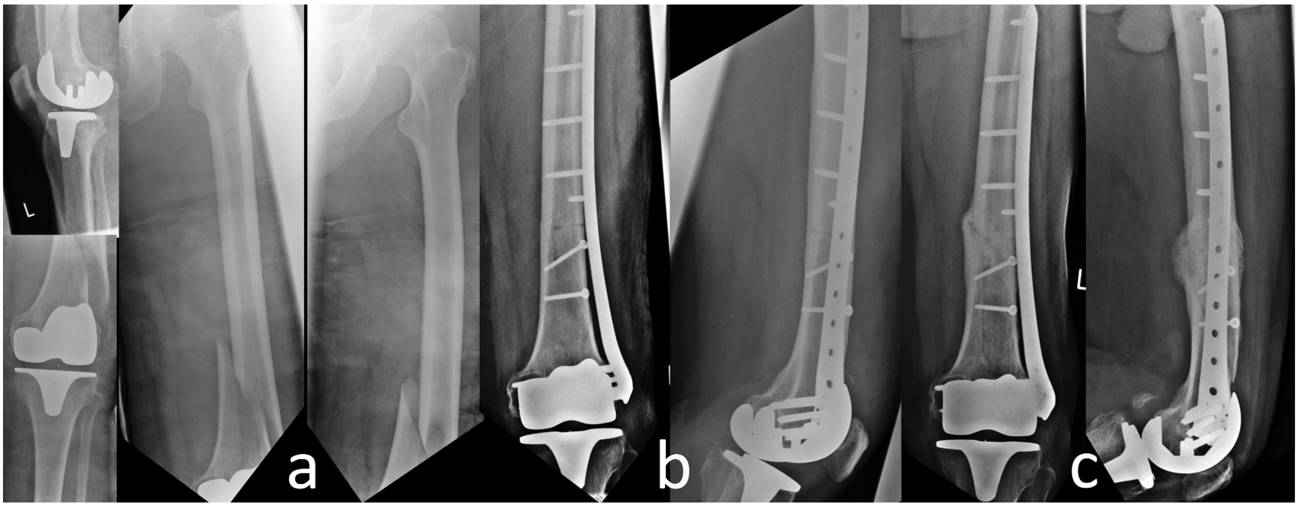


*Fig. 1. Type Su I periprosthetic fracture following TKA (a) of a 71-year-old male patient after a simple fall on even ground. Immediate surgical treatment (b) included closed fracture reduction followed by percutaneous leg screw insertion (4.5mm) and locking plate osteosynthesis (LCP DF, DePuy Synthes, Umkirch, Germany) which resulted in anatomic fracture reduction and stable fixation. After uneventful healing the patient presented at the 6 month follow-up with radiological fracture union.*

## Functional assessment

Functional assessment resulted in a mean KSS knee score of 73 ± 19 and a function score of 41 ± 36. The data for range of motion revealed 95° ± 24° (active) and 98° ± 16° (passive) with no significant difference ($p = 0.328$), (Table 1). No patient had a clinically measurable extension deficit. The visual analogue scale for pain yielded 2 ± 2.4 in rest which differed significantly ($p < 0.001$) from the score under loaded conditions (4.3 ± 3.3), (Table 1). The influence of different fracture types to the functional results could only be calculated between Su type I and Su type II fractures (n = 20, Table 2) due to subgroup sample sizes. These analyses showed no significant differences. Regarding the type of treatment patients with a combined (revision arthroplasty and osteosynthesis) surgical procedure revealed significant better KSS function scores (85 ± 7 versus 31 ± 23, $p = 0.012$) as opposed to the osteosynthetic group (Fig. 3).

## Quality of life assessment

The total SF-36 scored a mean of 41 ± 6 (the detailed results of all subcategories are summarised in Table 2). Neither the fracture types Su I and Su II nor the

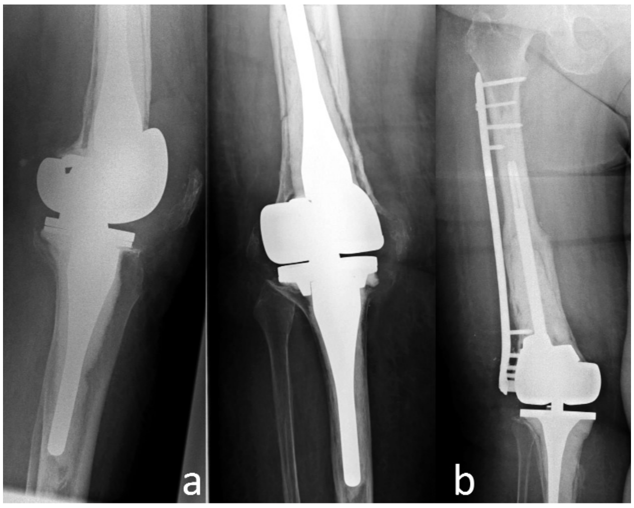


*Fig. 2. 74-year-old female with a history of knee pain presented with a Su type II fracture (a) in a situation of obvious loosening of the prosthesis. After complete workup in which we could eliminate an infection as cause of loosening a cemented revision endoprosthesis was implanted with an additional lateral locking plate due to the poor bone stock (b).*

*Table 1. The functional outcome data are shown as mean ± standard deviation. Significant differences are marked bold. First the influence of fracture type was investigated. The second analysis was performed to compare the treatment strategy. We could demonstrate a significant better KSS function score for patients that underwent a combined surgical therapy. All other parameters revealed no significant differences. (*1 p-value of the student s t-test; *2 p-value of the Man-Whitney-U-Test due to non-homogeneous group sample sizes)*

| PARAMETER | SU I | SU II | P-VALUE*1 | OSTEOSYNTHESIS | COMBINED | P-VALUE*2 |
|---|---|---|---|---|---|---|
| KSS KNEE | 71±19 | 69±21 | 0.807 | 69±19 | 79±22 | 0.573 |
| KSS FUNCTION | 34±29 | 40±28 | 0.673 | 31±23 | 85±7 | 0.012 |
| VAS REST | 2.3±2.4 | 2.1±2.9 | 0.894 | 2.4±2.6 | 1.7±2.1 | 0.765 |
| VAS LOADED | 4.2±3.4 | 4.4±2.9 | 0.899 | 4.2±3 | 5±5 | 0.842 |
| ROM ACTIVE | 96±13 | 103±14 | 0.302 | 98±13 | 105±21 | 0.655 |
| ROM PASSIVE | 96±13 | 103±14 | 0.302 | 98±13 | 105±21 | 0.655 |

*Table 2. The results of the quality of life assessment is shown as mean ± standard deviation. First the influence of fracture type was investigated. The second analysis was performed to compare the treatment strategy. We could not demonstrate any significant differences in these analyses. (*1 p-value of the student s t-test; *2 p-value of the Man-Whitney-U-Test due to non-homogeneous group sample sizes)*

| PARAMETER | OVERALL | SU I | SU II | P-VALUE*1 | OSTEOSYNTHESIS | COMBINED | P-VALUE*2 |
|---|---|---|---|---|---|---|---|
| PHYSICAL FUNCTIONING | 23±24 | 18±19 | 20±16 | 0.821 | 17±16 | 27±28 | 0.616 |
| ROLE PHYSICAL | 26±42 | 23±44 | 14±28 | 0.640 | 18±26 | 33±58 | 0.765 |
| BODY PAIN | 56±31 | 54±31 | 57±29 | 0.800 | 58±31 | 38±16 | 0.258 |
| GENERAL HEALTH | 46±15 | 46±13 | 48±17 | 0.858 | 46±16 | 50±3 | 0.479 |
| VITALITY | 52±20 | 49±23 | 51±10 | 0.874 | 49±21 | 53±8 | 0.546 |
| SOCIAL FUNCTIONING | 69±31 | 59±37 | 77±20 | 0.242 | 64±30 | 71±51 | 0.546 |
| ROLE EMOTIONAL | 81±39 | 69±48 | 90±25 | 0.293 | 73±44 | 100±0 | 0.479 |
| MENTAL HEALTH | 63±19 | 61±23 | 59±16 | 0.443 | 64±20 | 60±28 | 0.546 |
| SUMMARY PHYSICAl | 28±8 | 28±8 | 26±4 | 0.496 | 27±5 | 27±13 | 0.416 |
| SUMMARY MENTAL | 53±11 | 50±14 | 57±6 | 0.207 | 52±12 | 55±11 | 1.000 |
| TOTAL SF-36 | 41±6 | 39±7 | 42±2 | 0.372 | 40±6 | 41±6 | 0.616 |
| | | | | | | | |
| WOMAC PAIN | 19±20 | 22±23 | 22±19 | 0.973 | 24±22 | 7±10 | 0.261 |
| WOMAC STIFFNESS | 23±27 | 23±28 | 23±26 | 0.971 | 22±25 | 33±46 | 0.749 |
| WOMAC DAILY | 47±29 | 50±25 | 57±31 | 0.619 | 56±27 | 28±1 | 0.235 |
| WOMAC INDEX | 29±19 | 32±20 | 35±13 | 0.619 | 35±17 | 22±19 | 0.441 |

different surgical treatment types yielded significant differences in subgroups analysis. Patients scored 29 ± 19 in average considering the WOMAC index (pain: 19 ± 20; stiffness: 23 ± 27; daily: 47 ± 29). In concordance to the SF-36 analyses the WOMAC revealed no significant differences in the subgroups (Table 2). Functional outcome measurements and quality of life scores did not correlate except SF-36 which was positively correlated to the KSS function score (r = 0.478, p = 0.038, Fig. 4).

## Mobility assessment

The analysis of walking assistance devices showed that 20% (n = 5) patients were able to walk without any further help. 16% (n = 4) used a walking stick for long distances. 20% (n = 5) of the patients were dependent on crutches for daily activity. 32% (n = 8) patients could only mobilize themselves with the assistance of a walking frame and another 12% (3) were bedridden or in need for a wheel chair. There was no significant influence of fracture type (p = 0.508) or type of treatment (p = 0.064).

## Comorbidities

The analysis of the ASA classification showed of the patients a score of 2, 3 and 1 in in 52% (n = 13), 44% (n = 11) and 4% (n = 1), respectively. Multiple regres-

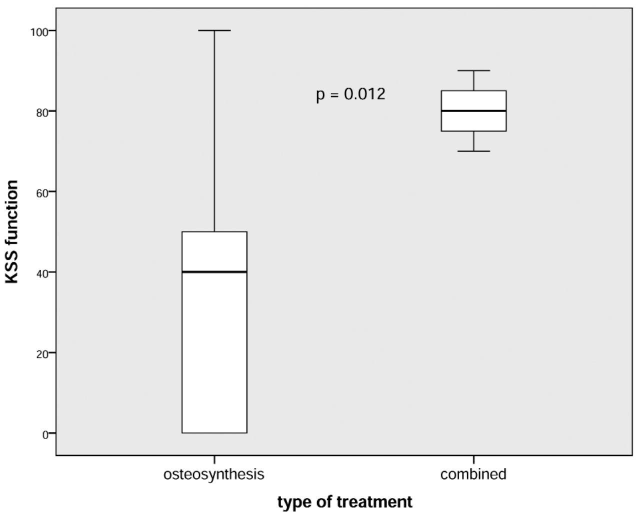


*Fig. 3. Analysis of the two treatment strategies revealed a significant better KSS function score in patients that underwent a combined surgical treatment (revision endoprosthesis and osteosynthesis).*

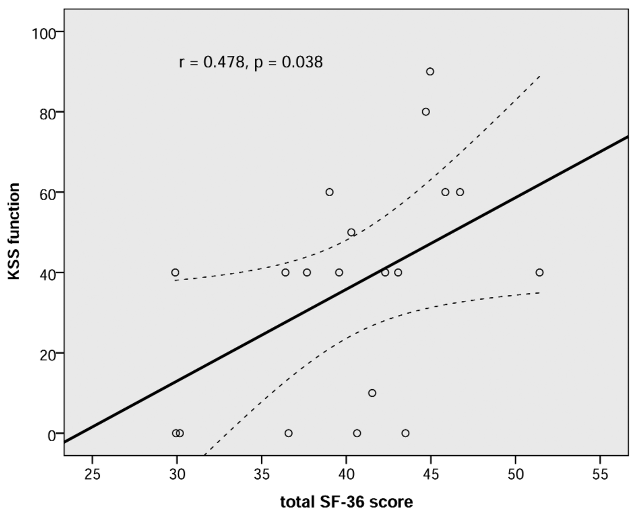


*Fig. 4. The SF-36 was found to significantly correlate with the KSS function score. Thus, it could be shown that quality of life can be enriched by improving the functional outcome. The Pearson's correlation coefficient and the corresponding p-value are given in the graph.*

sion analysis could not reveal significant influence of the comorbidities as reflected by the ASA score with regard to quality of life (SF-36: p = 0.242, WOMAC: p = 0.283) as well as the functional outcome (KSS knee: p = 0.395; KSS function: p = 0.105).

## DISCUSSION

A multitude of studies is dealing with the outcome after surgical treatment of periprosthetic fractures following TKA (1, 4, 6, 12). Nevertheless, these reports mainly focus on the type of surgical care, the fracture distribution and complications. Functional outcome, if assessed, is mentioned by the mean of the Knee Society Score as well as the range of motion. However, very few reports have yet been published simultaneously focusing on functional outcome (KSS, ROM) and quality of life (SF-36, WOMAC) of patients with periprosthetic fractures following TKA. Thus, exact comparison to our results is complicated by the heterogeneity of available studies and insufficient current evidence.

Our findings clearly demonstrate that QoL and joint function in patients following periprosthetic fractures after TKA is significantly decreased and only 20% of the patients can mobilise without further assistance. As demonstrated by the significant positive correlation, improvement of the functional outcome with minimal complications was found to be the only predictive and significant parameter directly positively affecting QoL. Interestingly, this functional improvement was not observed to be dependent on either the type of underlying fracture or the surgical treatment. Apart from the restrictive fact, that potentially predictive preoperative data on the collected parameters were not available, these findings most likely underscore the individual and heterogeneous fracture and patient characteristics and may partly be biased by the low number of patients in each subgroup. Nevertheless, among the factors which can be influenced by the treating orthopaedic surgeon, our findings support the notion that efficient improvement in postoperative knee function (irrespective of the surgical strategy) is the main causative factor, triggering increase in resultant postoperative QoL.

Mean KSS knee score and function score revealed 73 ± 19 and 41 ± 36, respectively, which is comparable to published data ranging from 69 to 86 for the knee score but differs in terms of the function score ranging from 76 to 81 (1, 6). An explanation might be that our cohort had an increased mean age when compared to published data (Gondalia et al.: 70 years (no standard deviation or range given), Agarwal *et al.*: 67 (range 45–85) years) (1, 6). With a mean ROM of 95° ± 24° the affected knee was considerably limited although our results are in concordance to Gondalia et al. (mean ROM following internal fixation of 96° ± 20° in the plating and 100.7° ± 18.4°in the nailing group). Agarwal et al. reported a mean ROM of 98.5° but did not specify the range or standard deviation. The VAS has yielded significantly lower scores when resting as compared to loading condition during ADL (activities of daily living), (2 ± 2.4 versus 4.3 ± 3.3, p < 0.001). Hoffmann et al. used a VAS to record pain. However, they only stated that 77.1% of their patients reported either no or mild pain during the last follow-up without giving detailed values (7). Our subgroup analysis revealed a significantly better KSS function score for patients undergoing a combined treatment (revision endoprosthesis plus osteosynthesis, p = 0.012). But, these results should be interpreted with caution due to small sample sizes. Quality of life assessment by the means of SF-36 and WOMAC index revealed 41 ± 6 and 29 ± 19, respectively. Lee et al. who reported on 25 fractures, documented a mean WOMAC of 30.2 (range 5-55) which is consistent to our data (11). However, in contrast to the present study these patients were treated by intramedullary nailing. Nevertheless, Norrish et al. published a small cohort (5 patients in the fracture group) and compared those to a control group (TKA without fracture). They could not find any significant differences regarding SF-12 and the Oxford Knee Score (17). Another group published data of 12 patients that were treated for a supracondylar periprosthetic fracture using revision TKA and allografts. In this cohort the mean SF-36 score was significantly lower regarding the physical function and bodily pain subcategory compared to the normal Canadian population (10). Unfortunately, the authors did not provide corresponding measurement values allowing comparison to our data. Due to paucity of further studies that utilise the SF-36 for analysing the QoL following periprosthetic knee fracture management comparative conclusions cannot be drawn. Several studies investigating the QoL following revision arthroplasty have been published (9, 18, 26) that demonstrate higher SF-36 scores compared to our data underscoring the severity of periprosthetic fractures.

We found a significant correlation (0.478, p = 0.038) of the functional (KSS function) and quality of life data (SF-36), indicating that quality of life may be increased if functional outcome is improved. Our analysis of the final outcome as a function of fracture type or type of treatment did not reveal any further statistical influence, which is consistent to published data (6, 12, 13). Singh et al. reported a mean time to union of 5 month and a high number of patients (76.5% ) that needed assistive devices for mobilisation, which is in concordance to our data (mean time to union 4.9 ± 2.8 months, 80% need for assistive devices), (22). Analysis of comorbidities as reflected by the ASA score results did not seem to have an impact on final outcome in our study, although high ASA scores have yet been identified as a risk factor for the occurrence of periprosthetic fractures (21). The overall complication rate in our cohort was 24% with non-union and periprosthetic re-fracture (8% each) representing the most frequent ones. The relatively high complication rate confirms results of previously published studies which report complication rates as high as 29% (3, 6).

Limitations of this study are obviously its retrospective character thus a direct comparison of preoperative to postoperative function and quality of life score is not possible. There were only periprosthetic knee fracture patients included who were treated by internal fixation but not with isolated revision arthroplasty, again restricting the interpretation of the results to osteosynthetic reconstruction. Additionally, the midterm follow up of less than three years and small sample size in the subgroups with only 21 and 4 fractures of the femur and tiba with none of the patella is slightly impairing the strength of the study. Future prospective studies with long term outcome measurements have to be conducted to validate the results derived from the present investigation.

## CONCLUSION

Regardless of the type of fracture or consecutive surgical treatment, periprosthetic fractures following knee arthroplasty result in a significantly decrease of knee function and quality of life as well with high complication rates. Apart from fracture healing with minimum complications, our data clearly show, effective improvement in functional outcome markedly increases resultant postoperative QoL. Consequently, current and future efforts in the treating periprosthetic fractures after TKA should be directed towards refinement of surgical techniques, leading to an increased functional outcome, the necessary precondition for improved QoL.

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**Corresponding author:**
Sven Märdian, M.D.
Charité – University Medicine Berlin
Centre for Musculoskeletal Surgery
Augustenburger Platz 1
13353 Berlin, Germany
E-mail: sven.maerdian@charite.de