Long-Term Function following Periprosthetic Fractures

Dlouhodobé funkční výsledky po periprotetických zlomeninách

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ABSTRACT

PURPOSE OF THE STUDY

Clinical results of long-term follow-up after traumatic periprosthetic femur fractures and different therapies (ORIF vs. revision arthroplasty)

MATERIAL AND METHODS

The Visual Analog Scale (VAS), Harris-Hip-Score (HHS), Oxford-Hip-Score (OHS), Oxford-Knee-Score (OKS), Knee-Society-Score (KSS), SF-36 Questionnaire and Funktionsfragebogen Hannover (FFH) were used to evaluate outcome and functionality. Radiological examinations were performed and the Vancouver (THA) and Lewis and Rorabeck (TKA) classifications used.

RESULTS

70 patients suffered a periprosthetic hip fracture (29× revision prosthesis, 41x ORIF), 23 patients underwent an ORIF due to periprosthetic fracture of a TKA (total mean age 75.2 years).

47 patients (follow-up rate 51%) were examined 40 months after surgery (mean age 72 years) (THA: 16× revision, 23× ORIF, TKA: 8× ORIF).

The VAS revealed significant less pain in the group that had undergone revision hip arthroplasty than in the ORIF group: 3.9±1 vs. 5.1±1.7 ($p<0.05$), respectively. 5/16 patients with revision arthroplasty had excellent or good results in the HSS compared to 3/23 patients after ORIF. The OHS yielded excellent or good results in 12/16 patients after revision arthroplasty vs. 10/23 after ORIF. The VAS after ORIF in patients who suffered periprosthetic knee fractures was 4.9±2.1. 3/8 patients achieved excellent or good results according to the OKS.

CONCLUSION

Every functional score (HSS, OHS, FFH, SF-36) of those patients who had undergone revision arthroplasty was slightly higher and their VAS significantly lower than the scores of the patients after ORIF.

Key words: periprosthetic fractures, trauma, open reduction and internal fixation, revision arthroplasty.

INTRODUCTION

The incidence of periprosthetic femoral fractures is reported to be between 0.1% and 3.5% after primary hip implantation and 6% after revision surgery (2, 7, 21), and the incidence of periprosthetic supracondylar femoral fractures after total knee arthroplasty ranges from 0.3% to 2.5% (18).

Moreover, the incidence and complexity of the femoral fracture around a previously implanted prosthetic component has been increasing over the last ten years because of several factors: the population living with a total hip arthroplasty (THA) in place is growing. As total hip arthroplasty surgery has proved so successful, the indication for THA has broadened considerably, with ever more younger and elderly patients now undergoing the procedure than in the 1980s. Average life expectancy is rising, and there are thus more elderly patients now than before the 1980s who have had a hip implant for many years, increasing the risk that their implant will loosen due to poor bone quality and/or periprosthetic bone loss (29). Moreover, the use of THA in younger and more active patients means that the pool of such patients developing local osteolysis and at risk for high-energy trauma is also growing (29).

Treatment of periprosthetic femoral fractures is a challenging clinical problem and to manage it effectively, expertise in both trauma and revision surgery is required.

Treatment can therefore be complex, expensive, and associated with a high risk of local and systemic complications. This patient population also typically presents with many comorbidities. The surgical options for treating periprosthetic fractures include open reduction and internal fixation of bone or revision arthroplasty. Although many authors prefer open reduction and internal fixation (ORIF) for periprosthetic fractures without prosthetic loosening (Vancouver classification B1) (6, 15, 16, 20, 34, 36), stem replacement is the preferred option for fractures that show signs of loosening (Vancouver classification B2 or higher) (12, 27, 35).

There is, however, limited data on the functional outcome following these injuries. Very little is known about the clinical outcome after different treatment methods. The purpose of this study was therefore to analyze the clinical long-term follow-up results of patients suffering a traumatic periprosthetic femur fracture and treated with one of the two different surgical options (ORIF vs. revision arthroplasty).

MATERIAL AND METHODS

We carried out a retrospective analysis of all surgically-treated periprosthetic femoral fractures between January 2000 and December 2009 using the documentation software of two participating hospitals. One is a university hospital (trauma center 1); the other trauma center (trauma center 2) also provides maximum medical care and is a university teaching hospital under the umbrella of trauma center 1.

Patients presenting an intraoperative periprosthetic fracture during the primary prosthesis implantation were excluded. Moreover, all pathological fractures and polytrauma patients were excluded.

One staff member on the orthopedic medical team attempted to contact all patients by phone or letter, invited them for a clinical investigation, and then carried out the clinical long-term follow-up examination. Patients who could not be contacted or refused the examination were excluded from further analysis. During the clinical examination, the Visual Analog Scale (VAS), Harris-Hip-Score (HHS), Oxford-Hip-Score (OHS), Oxford-Knee-Score (OKS), Knee-Society-Score (KSS), SF-36 Questionnaire and Funktionsfragebogen Hannover (FFH) were administered to evaluate the outcome and functionality of patients in their daily routine. The VAS could not be captured from all the participating patients because some were in such discomfort from other comorbidities or other extremities that isolated reflection on the pain in the region of our surgical interest after periprosthetic fracture was either inadequate or impossible.

Radiological investigations for fracture classification were performed by two independent, experienced orthopedic surgeons using available CT scans and X-rays. All hip fractures were classified using the Vancouver classification, which is based on the fracture's location, the amount of available proximal bone stock, and the stability of the stem (9).

We applied the most widely-accepted classification system for periprosthetic knee fractures according to Lewis and Rorabeck that considers both fracture displacement and prosthesis stability (38). The type of periprosthetic fracture (THA and TKA) was investigated separately and the different treatment methods (revision arthroplasty vs. ORIF) analyzed.

For ORIF, plates were used from Synthes® and Aesculap/Braun®; Aesculap/Braun® implants were used for THA revision. The aim of our study was the clinical long-term follow-up without taking X-rays and therefore the ethics-committee has given their approval.

Statistical analysis was performed by SPSS (Version 19) using the t-test.

RESULTS

A total of 93 patients (60 female, 33 male) were evaluated who had suffered a traumatic periprosthetic femur fracture and whose mean age was 75 ± 9.5 years (range: 48–95 years) at the time of fracture (n = 80 trauma center 1, n = 13 trauma center 2). 70 THA patients were treated for a periprosthetic hip fracture: 29 underwent revision prosthesis of the hip and the other 41, ORIF.

The Vancouver classification and treatment methods were: 1× A1: ORIF, 33× B1 (6× revision arthroplasty, 27× ORIF), 15× B2 (14x revision arthroplasty, 1× ORIF), 12× B3 (8× revision arthroplasty, 4× ORIF), 9× C (1× revision arthroplasty, 8× ORIF). All 23 patients (23× Lewis and Rorabeck 2) suffering a periprosthetic femoral fracture with existing total knee arthroplasty (TKA) underwent ORIF.

Fractures were mainly caused by a fall in 67 patients (low-energy trauma). Moreover, 6 patients had a traffic accident, 2 suffering the fracture during the rehabilitation 1 patient had an epileptic seizure, 1 fracture was associated with an infection, and in 16 patients the reason could not be definitively ascertained retrospectively.

We observed the following surgical complications after ORIF.

In the 4 patients with pseudarthrosis/breaking of the plate: 2 underwent ORIF and 2 revision prosthesis; 1× revision after malpositioning; 1× screw exchange because of postoperative pain; 6× revision due to postoperative seroma, hematoma, infection.

Other complications were 3× pneumonia, 3× urinary tract infection, 2× anemia: 2× electrolyte imbalance, 2× symptomatic transitory psychotic syndrome, 2x acute renal failure, and 1× fatal pulmonary embolism.

We noted these complications after prosthesis revision:

1x ORIF because of a broken locking screw, 1 Girdelstone situation was done because of pseudarthrosis, 1 revision of a seroma. Non-orthopedic complications were 2× pneumonia, 7× urinary tract infection, 1× anemia, 1× electrolyte imbalance, 1× symptomatic transitory psychotic syndrome, 1× sepsis, 1× cardiac decompensation.

47 patients (follow-up rate 50.5%) participated in clinical and radiological investigations on average 39.5

± 28.9 months after surgery at a mean age of 71.9 ± 9.2 years.

47 patients (trauma center 1: 14 male, 20 female, trauma center 2: 6 male, 7 female) participated in this clinical long-term follow-up study yielding a follow-up rate of 51%. 16 patients underwent a revision hip arthroplasty. An ORIF was performed in 23 patients following a periprosthetic hip fracture,and 8 also presented periprosthetic TKA fractures. The mean age of all study patients was 71.9 ± 9.2 years (range 48–90 years) at the time of fracture and the clinical investigation took place on average 39.5 ± 28.8 months postoperatively. The initial arthroplasty had been done on average 6.6 ± 7 years prior to the periprosthetic fracture.

Hip prosthesis

The 16 patients receiving a revision hip arthroplasty were compared to the 23 patients after ORIF with similar epidemiological data.

Revision arthroplasty/ORIF:
– age: 74.2 ± 8.8/69.8 ± 10.2 years p = 0.190
– follow-up time
36.9 ± 30.6/46.5 ± 30.3 months p = 0.341
– OR time 162 ± 81/118 ± 21 minutes p* = 0.046
– inpatient stay 21 ± 11/30 ± 21 days p = 0.495
– time since initial arthroplasty
8.4 ± 7.6/6.3 ± 7.3 years p = 0.478

The periprosthetic hip fractures were analyzed by using the Vancouver classification with the following fracture types:
– 18× type B1: 4x revision, 14× ORIF
– 11× type B2: 10x revision, 1× ORIF
– 5× type B3: 2x revision, 3× ORIF
– 5× type C: 5× ORIF

In the clinical follow-up, the patients receiving a revision hip arthroplasty reported significant less pain with 3.9 ± 1 points according to the VAS for pain intensity than the post-ORIF patients with 5.1 ± 1.7 points ($p<0.05$).

At the clinical investigation we observed excellent or good surgical results in in 21% of the periprosthetic hip fractures (n = 8/39) according to the HHS with a mean score of 64 ± 17.9 points. Furthermore, 31% in the revision-arthroplasty subgroup (n = 5/16) and 13% of patients treated with ORIF (n = 3/23) (p = 0.341) achieved excellent or good results (Fig. 1).

Linear regression analysis revealed a strong correlation between age and the HHS in all our participating THA patients (p = 0.001). (Fig. 2).

A total of 56% (n = 22/39) of the hip patients achieved excellent or good results according to the OHS with a mean of 30.6 ± 10 points. Furthermore, 75% of the post-revision arthroplasty (n = 12/16) group showed excellent or good results, as did 44% (n = 10/23) in the post-ORIF group (p = 0.253). (Fig. 3).

In the FHH, the post-revision arthroplasty group scored on average 48.1 ± 24.6 points compared to the 38.9 ± 25.1 points scored by the after-ORIF group (p = 0.263). We observed similar scores after revision arthroplasty

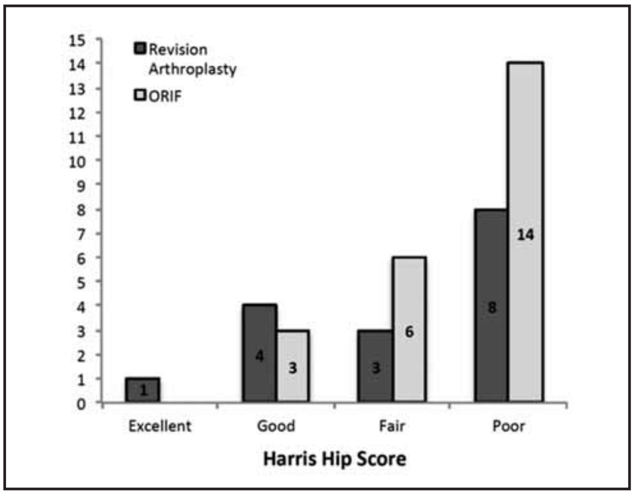

Fig. 1. Harris Hip Score results after revision arthroplasty and ORIF after periprosthetic fractures in patients with THA

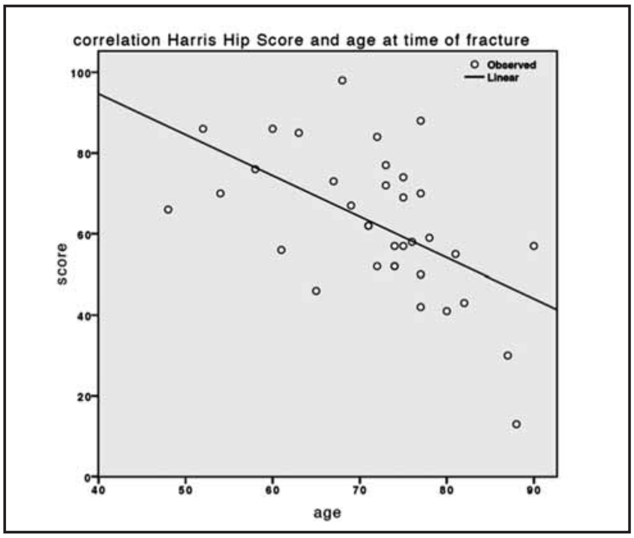

Fig. 2. correlation between the Harris Hip Score and age at time of fracture

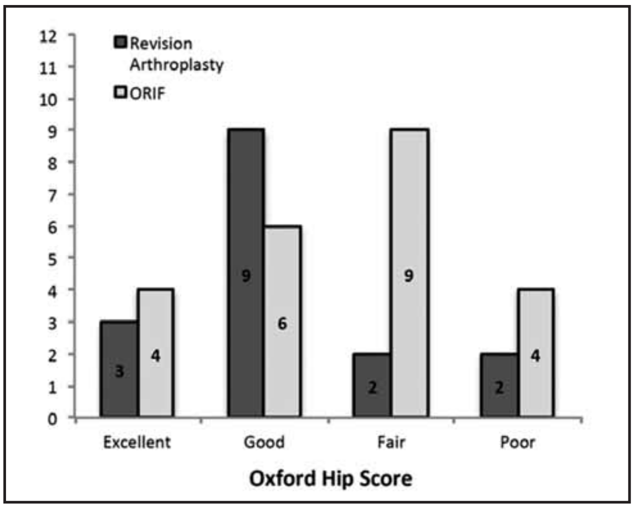

Fig. 3. Oxford Hip Score results after revision arthroplasty and ORIF after periprosthetic fractures in THA patients

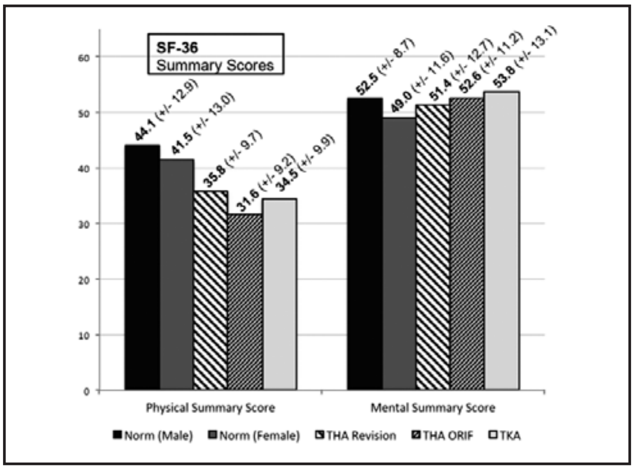

Fig. 4. SF-36 scores with the physical and mental summary scores in the revision arthroplasty and ORIF groups after periprosthetic fractures in THA patients and after ORIF, and in patients with periprosthetic knee fractures and TKA. Results of a normal age-related male and female population are also shown.

with 35.8 ± 9.7; after ORIF 31.6 ± 9.2 points (p = 0.181) according to the SF-36 questionnaire; these data were compared to the German normative population sample (13, 14). (Fig. 4).

All scores were evaluated separately according to their type of fracture via the Vancouver classification (Table 1). We noted one statistical significance in comparing type B1 and B3 fractures in the HHS (p = 0.014): the B1 fractures had higher scores. Furthermore, B2 fractures scored higher than B3 fractures regarding pain in the VAS (p = 0.009) and HHS outcome (p = 0.016). (Table 1).

Table 1: SF-36, FFH, VAS-pain, HHS and OHS scores in correlation with the Vancouver fracture classification

Vancouver Classification		**SF-36** (physical summery score)	**FFH** (in %)	**VAS**	**HHS**	**OHS**
B1 (N=18)	mean	34.7	44.7	4.6	66.1	30.2
	SD	10.5	25.7	1.9	16.5	10.5
B2 (N=11)	mean	31.9	42.2	4.0	68.7	29.9
	SD	7.6	20.9	1.0	16.9	6.9
B3 (N=5)	mean	31.7	25.4	6.5	43.2	37.2
	SD	11.2	24.4	0.7	18.2	12.9
C (N=5)	mean	33.5	54.0	5.2	70.2	27.0
	SD	10.4	30.1	1.5	12.8	11.0
total (N=39)	mean	33.3	42.7	4.7	64.4	30.6
	SD	9.5	25.0	1.6	17.9	10.0

Table 2: SF-36, FFH, VAS-pain, OHS/OKS scores in correlation with patients presenting periprosthetic fracture after THA and TKA

Prosthesis		**SF-36** (physical summery score)	**FFH** (in %)	**VAS-pain**	**OHS/OKS**
THA (N=39)	mean	33.3	42.7	4.7	30.6
	SD	9.5	25.0	1.6	10.0
TKA (N=8)	mean	34.5	52.4	4.9	32.3
	SD	9.9	28.4	2.1	11.4
	p-value	0.741	0.334	0,750	0,678

The stable type B1 fractures were analyzed separately.

Results after 14x ORIF:
- mean HHS of 65.4 ± 13.7 points with 14% (2/14) of the patients achieving an excellent or a good result,
- mean OHS of 30.8 ± 9.1 points with 50% (7/14) of the patients achieving an excellent or a good result,
- mean SF-36 of 31.3 ± 8.2 points.

Results after 4x revision arthroplasty:
- mean HHS of 68.8 ± 26.8 points with excellent or good results in 2/4 patients,
- mean OHS of 28 ± 16.2 points with excellent or good results in 2/4 patients,
- mean SF-36 of 49.5 ± 4.9 points.

Periprosthetic knee fractures

All 8 patients with a periprosthetic supracondylar femoral fracture above a TKA had a type II fracture according to the Lewis and Rorabeck classification (38).

The VAS score of patients after ORIF suffering periprosthetic knee fractures was 4.9 ± 2.1 points.

A total of 3 of 8 patients achieved an excellent (n = 1) or good (n = 2) score according to the OKS (fair n = 4, poor n = 1). Patients achieved on average a knee society score of a mean 58 ± 19 points (0× excellent, 3× good,1× fair, 0× poor) and a function score of a mean 54 points ± 29 (1× excellent, 3× good, 1× fair, 3× poor). The overall FHH score in the periprosthetic knee fractures was 52.4 ± 28.4 points. Moreover, the SF-36 score of the periprosthetic knee fractures was 35.4 ± 9.9 points and thus lower than in the German normative population sample. (Fig. 4)

We observed no statistical difference when comparing the THA group to the TKA cohort in the SF-36, FFH, VAS and OHS/OKS scores (Table 2).

DISCUSSION

Periprosthetic femoral fractures following total hip arthroplasty are becoming more prevalent (29), and often require complex, costly surgery and rehabilitation. Numerous studies have focused on the epidemiology of a series of patients with fractures and fracture types, rather than providing long-term clinical follow-up analysis of these patients. The aim of this study was a long-term clinical follow-up examination of patients suffering periprosthetic femur fractures. According to various functional scoring systems, outcomes after revision arthroplasty tend to be slightly better than the outcomes of patients who have undergone ORIF, moreover, the revision-arthroplasty patients report less pain in the VAS than the ORIF patients. Generally speaking, the poor clinical outcome of patients suffering periprosthetic femur fractures can be attributed to the complexity of these injuries, and by the high complication rate noted previously (1, 28).

There is general consensus on how to treat periprosthetic femoral fractures (27). Vancouver type-C fractures, which are distal to a well-fixed stem, can be managed by ORIF. Locked plating has recently been reported to be highly successful in the treatment of Vancouver type-C fractures and supracondylar fractures proximal to a total knee arthroplasty (25, 34, 37). Vancouver type-B1 fractures, which occur around a stable femoral prosthesis, can also be managed via ORIF (24). Vancouver type-B2 fractures, which occur around a loose femoral prosthesis, are best treated with revision arthroplasty, yet no technique described in the literature has achieved consistent success in correcting Vancouver B2 fractures.

However, distinguishing between type-B1 and -B2 fractures can be challenging. Lindahl et al. reported a high rate of failure following ORIF for periprosthetic femoral fractures (28–30), concluding that surgeons may have misclassified unstable implants as being stable. Vancouver type-B3 fractures, which by the surgeon's estimation lack adequate femoral proximal bone stock, are generally treated with proximal femoral replacement with or without a femoral allograft (32, 33).

In our analysis of different treatment methods in this long-term clinical investigation, we observed that compared to the ORIF group, the group treated by revision arthroplasty scored slightly higher in all the functional scales we applied (HSS, OHS, FFH, SF-36), and they reported significantly less pain in the VAS. One reason for this observation may be the intraoperative large soft tissue damage that occurs during ORIF associated with the necessary implantation of a relatively long plate (especially when fixation cannot be done with minimally-invasive technique). However, little is known about the clinical follow-up of patients suffering periprosthetic femur fractures after these different treatment methods. Some studies report that after a successful revision arthroplasty, patients can often engage earlier in weight-bearing activities (22, 33, 37) than those treated with ORIF. Bhattacharyya et al. suggested that this early enhanced activity may partially explain the lower mortality in patients undergoing revision arthroplasty (3). Moreover, they reject the perception that revision arthroplasty is riskier than ORIF (25, 29). In their study, Laurer et al. found that treatment by plate osteosynthesis was associated with a high risk of implant failure, whereas functional outcome and systemic complications are comparable to treatment by revision arthroplasty (26).

In our small cohorts, the results after type B1 fractures were similar in both groups and we observed no advantage. However, recent publications have reported poor results after the treatment of type B1 fractures using angular stable plating, since only 8 of 14 healed (5). In contrast, several current publications propose treating periprosthetic femur fractures after hip replacement by angular stable plating. Chavakravarthy et al. reported that 10 out of 11 patients with type B1 and C fractures showed complete consolidation (median 4.8 months) and only one implant failed before fracture union (6). Other authors confirm good functional results with low complication rates following plating (15, 17, 20). To date it remains unclear whether these controversial results correlate with the introduction of angular stable plates or with the use of adjuncts such as bone morphogenic protein, cortical allografts, cancellous bone graft or other factors.

However, in spite of the reliability and validity that Brady et al. demonstrated with the Vancouver classification (4), it has been postulated that many fractures preoperatively classified as type B1 are in fact type B2 fractures where revision arthroplasty would be indicated (28). Since the treatment choice is sometimes made based on the initial radiographs, implant stability cannot be definitively assessed prior to surgery. A misinterpretation of implant stability as stable will most likely lead to implant failure in case of ORIF. The rationale for performing an ORIF in 3 patients with a B3 fracture and in 1 patient with a B2 fracture was their health status with an ASA IV (31) situation, whereby the ORIF was the less invasive procedure.

The epidemiological data from our collective study concur with the latest literature, e.g., the high mean age of 75.2 years, the majority of type B1 and B2 fractures (74%) and mean time interval from hip arthroplasty to fracture (6.6 years); they also correspond to the excellent descriptive efforts by Lindahl et al. on 1,049 fractures documented in their Swedish hip arthroplasty register from 1979 to 2000 (29). Therefore, we consider our collective to be representative for this entity. However, when creating our study design we faced the same problems as most study groups and thus encountered some unavoidable limitations: a high average age with numerous co-morbidities, non-comparable mobility before fracture, and frequent failures to follow up. We maintain that a periprosthetic femur fracture after knee replacement represents an entirely different entity demanding a different classification and treatment option, which is why we analyzed this injury separately in our study (39). We therefore carried out statistical tests between these two groups in general health scores only (SF-36, FFH) the VAS, and OHS/OKS. Further limitations of our study include a lost-to-follow-up rate for functional outcome of 49.5%; this can be regarded as the natural consequence of our study patients being so elderly and presenting multiple comorbidities. We admit that, in terms of our cohorts and although performed at two centers, our treatment algorithm has undergone modification over the years. Although most of the plating took place using angular stable implants (locking compression plate, LCP, or less invasive stabilization systems, LISS) some patients received additional cable wires and/or bone enhancing means. However, the focus of this study was on the clinical follow-up.

The Vancouver classification has been generally accepted as the best classification system available, although it does not necessarily identify the group of patients that should receive ORIF. It defines a group with poor bone quality. Nonetheless, the use of cement in primary hip arthroplasty is not addressed. Although our patient numbers are too low to justify further group stratification, we do believe that cemented femoral components should be taken into account when planning ORIF due to the reduced bone vitality. Further studies should address this question.

Whereas the incidence of periprosthetic femur fractures is rising, overall case numbers are still low. Considering that Lindahl collected 1,049 cases over 21 years from a nationwide register (representing about 50 cases per year), our 93 cases in 10 years (equal to 9.3 cases per year) at two level I trauma and orthopedic centers are adequate for this type of study. A multicenter approach is in any case preferable. Data from the Swedish register reveal that the surgical treatment of periprosthetic femur fractures is generally associated with only moderate outcomes and a high frequency of postoperative complications (18%) (30), adding credence to the moderate results that our study population achieved.

Follow-up results in the literature seem to resemble our results after fixation of periprosthetic femur fractures above total knee arthroplasty. In a midterm follow-up of 46 months after fixation of periprosthetic knee fractures with less invasive stabilization, the authors describe 19 patients with an average knee society score of 80.8 with 18 patients achieving excellent or good results (23). Preliminary reports were published with interesting results concerning periprosthetic femoral fractures treated with locking plates, minimally invasive surgery and immediate weight-bearing (10, 11).

CONCLUSION

The increasing use of primary joint replacements and the rising age of the population will most likely lead to a growing rate of periprosthetic fractures (8, 19).

The generally low scores in the scales we analyzed are at least in part associated with the high age, multiple comorbidities and hindered mobilization of most of our patients. However, they merely highlight the severity and significance of this particular type of fracture.

Orthopedic surgeons must be increasingly familiar with the treatment of periprosthetic fractures, and implants need to be readily available. All forms of osteosynthesis and techniques of revision arthroplasty must be chosen individually.

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Conflict of Interest statement:
Jörn Zwingmann, Michael Krieg, Friedrich Thielemann, Norbert Südkamp and Peter Helwig declare that they have no conflict of interest

Compliance with Ethical Requirements:
The aim of our study was the clinical long-term follow-up without taking X-rays and therefore the ethics-committee has given their approval (Nr. 298/09).

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