The purpose of this study was to evaluate the surgical effort of total knee arthroplasty (TKA) for posttraumatic osteoarthritis (PTOA) compared with primary osteoarthritis (OA). A total of 1841 TKAs were analyzed, including 170 patients with PTOA, that resulted from soft tissue trauma in 83 patients and fractures in 87 patients. Results showed that patients were significantly younger at the time of surgery in the posttraumatic group (62 vs 71 years; \( P < .001 \)). Furthermore, fracture was associated with 3.7 years earlier need of TKA compared with soft tissue trauma. Operation time was significantly longer for both of the posttraumatic groups compared with OA (\( P < .001 \)). Patients undergoing TKA after knee injuries are younger and surgical treatment is more challenging compared with TKA for OA. Extended operation time and implant systems with higher constraint and modular options are required. [Orthopedics. 2016; 39(3):S36-S40.]

**TKA for Posttraumatic Osteoarthritis Is More Complex and Needs More Surgical Resources**

**Julian Dexel, MD; Franziska Beyer; Cornelia Lützner; Christian Kleber, MD; Jörg Lützner, MD**

Knee injuries often result in posttraumatic osteoarthritis (PTOA).¹⁻⁹ Potential triggers of PTOA are fractures with or without malalignment, ligament tears, meniscal tears, and cartilage defects.¹⁻⁵ The accuracy of primary reconstruction (anatomic reposition with <2 mm step in joint line) and practice stable osteosynthesis are crucial to prevent PTOA. Furthermore, missed accompanying ligamental and/or meniscal injuries predispose patients for PTOA.

In literature, the prevalence of PTOA varies from 10% to 44%.¹⁻³,⁵ After trauma, it takes in average 7 years (range, 2 to 11 years) until radiographic signs of osteoarthritis (OA) appear.⁴⁻¹⁰ If conservative treatment fails, total knee arthroplasty (TKA) is an option to improve function and reduce pain.³,¹¹ However, TKA following trauma is rare and accounts for less than 2% of all indications for TKA.¹¹,¹²

Despite this rare indication, performing TKA in patients with PTOA can be a challenging procedure due to scars, contracture, instability, malalignment, malunion, bone defects, retained internal fixation devices, and latent or low-grade infection.⁷,¹³,¹⁴ Only a few studies have been published demonstrating the surgical challenges and outcomes of TKA in PTOA. Furthermore, high complication rates (36% to 63%) and less favorable functional outcome compared with TKA in primary osteoarthritis underscores the clinical challenge.²⁻⁵,¹⁵

The purpose of this study was to evaluate necessary surgical resources for TKA in PTOA compared to standard TKA in osteoarthritis.

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Correspondence should be addressed to: Jörg Lützner, MD, Department of Orthopaedic and Trauma Surgery, University Hospital Carl Gustav Carus, TU Dresden, Fetscherstr 74, D-01307 Dresden, Germany. (joerg.luetzner@uniklinikum-dresden.de).

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Materials and Methods

After approval of the Institutional Review Board, patients’ records were reviewed. Between January 2005 and December 2013, a total of 1841 TKAs were performed at the current authors’ arthroplasty center, including 170 patients with PTOA (9.2%). All routine data were prospectively assessed in the current authors’ arthroplasty center.

Surgical Procedure

Before TKA, all patients had a standardized preoperative radiographic evaluation, including anteroposterior and lateral radiographs, merchant view, and a full-length standing hip-to-ankle radiograph. A standard medial parapatellar approach was always performed. In the standard group, both femoral and tibial components were cemented, and the patella was not resurfaced. Depending on the ligament balance after bone cuts, a condylar TKA with a cruciate retaining or posterior cruciate ligament–substituting insert was used. In the posttraumatic group, if necessary, intercondylar stabilizing or rotating-hinge TKA were used, and patellar resurfacing was performed. Operation time was defined as time from incision to suture.

Data Management and Statistical Analysis

Data were taken from patients’ records and entered into a database. Radiographs and surgical reports were reviewed. Data description was based on means and standard deviation for continuous variables and absolute and relative frequencies for categorical variables. Comparisons between groups were accomplished using t-tests and analysis of variance for continuous variables and chi-square tests for categorical variables. Significance level was set at $P<.05$. All analyses have been performed with SPSS version 23 statistical software (IBM Corp, Armonk, New York).

Results

Posttraumatic osteoarthritis of the knee resulted from soft-tissue trauma in 83 patients and from fractures in 87 patients. Soft tissue trauma included traumatic meniscal tear, cruciate and collateral ligament lesions, rupture of the quadriceps or patellar tendon, dislocation of the patella, or a combination of these. The fracture group consisted of 79.3% (n=69) intra-articular (AO type B or C) proximal tibia, distal femur, or patella fractures.16 In 20.7% (n=18) extra-articular femur or tibia fractures resulted in malalignment of more than 5°.

Osteosynthesis was performed in 68 patients (78.2%), and conservative treatment was performed in 19 patients (21.8%). The initial treatment of the soft tissue trauma included surgical treatment in 70 patients (84.3%) and non-surgical treatment in 13 patients (15.7%).

The average time from injury until TKA was 27.8 years for the soft tissue trauma and 24.1 years for the fracture group (Table 1). The control group consisted of 1671 patients with osteoarthritis.

Demographic data for both groups are presented in Table 2. In the PTOA group, patients were significantly younger (70.5 vs 62.2 years; $P<.001$) at time of surgery, with a higher proportion of men (54.1% vs 34.1%; $P<.001$) compared with the osteoarthritis group. Patients with osteoarthritis were significantly more obese (body mass index 31.3 kg/m² vs 29.7 kg/m²; $P<.001$) compared with the PTOA group. Within the PTOA group, patients after fracture required TKA an average of 3.7 years earlier than patients after soft tissue trauma (24.1 years vs 27.8 years).

The operation time was significantly longer for both of the PTOA groups compared with the osteoarthritis group (Table 1). In the PTOA group, condylar TKA was used in 161 patients (94.7%) with cruciate-retaining (n=119) or cruciate-substituting (n=42) inserts. An intercondylar stabilizing system was required in 4 patients and a rotating-hinge TKA was necessary in 5 patients. A stem was used in 26 patients and additional wedges...
were needed in 9 patients (Table 3, Figure 1). In 2 patients, additional osteotomy of extra-articular deformities were necessary (Figure 2). In 45 patients, a navigation system was used.

In the PTOA group, 18 patients (10.6%) experienced complications during hospital stay. One lesion of the popliteal artery occurred after a distal multi-fragmentary fracture of the femur, which required a vascular surgical intervention. Intra-articular hematoma with surgical revision occurred in 2 patients. A wound dehiscence developed in 1 patient and required a surgical revision. A temporary lesion of the femoral nerve took place once after a femoral nerve block. Furthermore, deep vein thrombosis occurred in 7 patients, and muscle vein thrombosis occurred in 3 patients. Three patients required manipulation under anesthesia.

**DISCUSSION**

This study demonstrated that TKA for PTOA is more complex and associated with a higher surgical effort than routine TKA. In particular, PTOA following joint fractures is a demanding situation for TKA. Patients with previous knee injury undergo TKA at a significantly younger age and are more often male compared with osteoarthritis patients.

Extra- or intra-articular deformity, bone defects, instability, reduced range of motion, and pre-existing scars are the main challenges in TKA for PTOA. Achieving appropriate alignment is critical to ensure longevity of the TKA. A full-length standing hip-to-ankle radiograph is valuable to determine the extent and location of the preoperative deformity. During the planning process, information about potential collateral ligament imbalance might occur and the need for a higher constrained implant can be judged. Most cases of mechanical axis malalignment can be treated with soft tissue release and adjustment of intra-articular resections, but more severe deformities might require extra-articular osteotomy to minimize the risk of ligamentous osteotomy or component malalignment.

Intra- and extra-articular deformities make the use of intramedullary alignment guides more difficult and in some cases impossible. Obtaining adequate information on the femoral alignment can be challenging in these cases. The use of a navigation system has been demonstrated as an advantage for reliable implant placement in distal femoral or proximal tibial deformities. However, the surgical effort increases with the use of navigation because of
set up, longer operation times, and costs increase.²⁴

Posttraumatic osteoarthritis can be associated with bone loss resulting in contained or uncontained defects. The frequent need of stems and metal wedge augments for the treatment of PTOA has been reported in previous studies. Weiss et al used augments or autologous bone grafts in 21% of the patients with tibial defects.²⁵ Lunebourg et al used stems and augments in 39% of patients in the PTOA TKA group, while this was not necessary in the osteoarthritis group.³

Stems can reduce stress in the proximal tibia if the bone stock is deficient and prevent premature failure.²⁶,²⁷ Brooks et al revealed that a 70 mm cemented tibial stem took over 23% to 38% of the axial load.²⁸ Patient stems and/or wedges were needed in 25% (n=22) of patients in the fracture group.

Injuries of the cruciate ligaments and meniscal tears predispose a knee to premature osteoarthritis. Prior surgeries may result in reduced range of motion, but a standard condylar TKA can be used in most patients. However, after lesions of the collateral ligaments, an implant with a higher constraint might be necessary. In the current authors’ patients, the surgical procedure after ligament injuries or meniscal tears was not significantly different from that of patients with osteoarthritis. A higher constrained TKA was necessary in only 5 cases of collateral ligament instability.

In this study, surgical time was significantly longer in the fracture group, and a navigation system and/or modular implants were more often needed due to intra- or extra-articular deformities and bone loss. Detailed preoperative planning should be performed to assess the need for higher constraint implants and/or modular implants with bone defect augmentation. Prior surgeries and compromised soft tissues can also be problematic. If possible, the previously applied skin incision should be used.

When multiple longitudinal skin incisions are present, the most lateral incision is usually preferred because the fascial perforators arise from the medial aspect of the knee.²⁹ Prior transverse incisions may be crossed with a perpendicular longitudinal incision.

The complication rate of 10.6% during the hospital stay was similar to the reported rate of 14% by Lizaur-Utrilla et al (including superficial infection, skin necrosis, knee stiffness, and partial rupture of the patellar tendon)³⁰ but lower than other reported rates of up to 63%.²⁵,¹⁵

In this study, the length of stay was not different between posttraumatic and standard TKA. This might be due to the older age of the primary osteoarthritis group (71 vs 62 years) despite the longer and more complex surgery in the PTOA group. However, the average length of stay of more than 8 days is common in the German health care system, but it is long compared with other countries. In 2013, the median LOS in Germany for TKA was still 10.8 days (SD, 1.6; range, 7-14 days).³¹

The presented data are, to the current authors’ knowledge, the largest reported series of TKA for PTOA. However, there are some limitations. Although routine data were assessed prospectively, the evaluation has been performed later. Therefore, data might be limited as the current authors were not able to collect all detailed information. Furthermore, type of injury and methods of initial treatment were heterogeneous. From a clinical perspective, distinct allocation of these injuries into specific subgroups is preferable but would
SURGERY

result in small group sizes with limited evidence in statistical analysis.

CONCLUSION

Total knee arthroplasty for PTOA is more complex than TKA for primary osteoarthritis. Patients with PTOA are significantly younger and require a significantly longer operation time in comparison to patients with osteoarthritis. Whereas only few TKA surgeries after soft tissue trauma require higher constraint and modular options, TKA surgeries after fractures are more challenging. To handle bone defects, various constrained implants and modular options should be available. Detailed preoperative planning can help to prevent unexpected problems during surgery.

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