Total knee arthroplasty in patients with rheumatoid arthritis, severe osteoporosis, and genu valgum

Tao Zhang
the Fourth Affiliated Hospital of Harbin Medical University

Yong Zhou
the Fourth Affiliated Hospital of Harbin Medical University

Rui Zhang
the Fourth Affiliated Hospital of Harbin Medical University

Mi Li
the Fourth Affiliated Hospital of Harbin Medical University

Dapeng Zhang
the Fourth Affiliated Hospital of Harbin Medical University

Naiwu Hu (675934448@qq.com)
the Fourth Affiliated Hospital of Harbin Medical University

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Abstract

Background: Rheumatoid arthritis (RA) is a systemic inflammatory disease characterized by symmetric, relapsing, and chronic destructive synovitis. This retrospective study aimed to assess the clinical benefits of TKA in patients with RA, severe osteoporosis, and moderate genu valgum.

Methods: This was a retrospective study of patients with RA, osteoporosis, and genu valgus treated using TKA at the Fourth Affiliated Hospital of Harbin Medical University between 05/2016 and 05/2019. Posterior stable prostheses were used in all patients. The Knee Society Scoring System (KSS) was used to assess surgical outcomes.

Results: There were eight males (10 knees) and 24 females (34 knees). Healing by the first intention was achieved in all patients. All patients were followed for a mean of 2.9 (range, 1-4) years. At the last follow-up, the KSS clinical score improved from 32.1±9.8 to 82.0±5.8 (P<0.001). The KSS functional score of the patients improved from 38.3±9.3 to 88.1±10.7 (P<0.001). The flexion-extension range of motion (ROM) of the knee joint improved from 81.8°±27.9° to 105.8°±17.0° (P<0.001). The femorotibial angle (FTA) changed from 23.1°±2.8° to 6.8°±1.9° (P<0.001). Common peroneal nerve paralysis and periarticular infection each occurred in one patient.

Conclusion: TKA by the medial parapatellar approach with proper osteotomy and soft tissue balancing can restore knee function in patients with RA, severe osteoporosis, and genu valgum.

Background

Rheumatoid arthritis (RA) is a systemic inflammatory disease characterized by symmetric, relapsing, and chronic destructive synovitis [1-3]. There may also be multisystem involvement [1-3]. The condition is more common in women, with onset between 30 and 60 years of age [1-3]. The global prevalence of RA is about 0.24% [4]. The most common complication is musculoskeletal disability due to destructive arthritis. Extraarticular complications include rheumatoid nodules, dermal vasculitis, keratoconjunctivitis sicca with associated Sjogren syndrome, interstitial lung disease, pericarditis, mononeuritis multiplex, amyloidosis, and increased cardiovascular mortality, and occur primarily in seropositive patients [1-3].

Besides, patients with RA generally suffer from severe osteoporosis [5, 6], which in turn may lead to severe pain and functional limitation in the knee joint [7]. Thus they might require total knee arthroplasty (TKA) [8, 9]. Such patients generally display joint deformity, especially genu valgum [10], which could increase the risk of developing postoperative complications such as common peroneal nerve injury and patellar maltracking [8, 9]. Proper intraoperative osteotomy and adequate soft tissue balancing and gentle and correct procedures, are vital factors influencing postoperative prosthesis stability and restoration of joint functions in patients with RA who undergo TKA [8, 9]. Nevertheless, no studies have comprehensively reported the effectiveness of TKA in RA patients with severe osteoporosis and genu valgum.

This retrospective study aimed to assess the clinical benefits of TKA in patients with severe osteoporosis and moderate genu valgum at a single center. The results could provide insights into the management of such patients.

Methods

Study design and patients

This study was a retrospective study of patients with RA, osteoporosis, and genu valgus treated using TKA at the Orthopedics Department of the Fourth Affiliated Hospital of Harbin Medical University between May 2016 and May 2019. This work was carried out following the Declaration of Helsinki (2000). The study was approved by the ethics committee of the Fourth Affiliated Hospital of Harbin Medical University. The requirement for informed consent was waived by the committee.

The inclusion criteria were 1) preoperative femorotibial angle of 18°-27°, 2) first-ever TKA, 3) TKA through the medial parapatellar approach, 4) severe osteoporosis, defined as mean bone mineral density (BMD) T-value measured by dual-energy X-ray absorptiometry (DEXA) of -3.7±0.6 [11], and 5) follow-up of at least 1 year. The exclusion criteria were 1) femorotibial angle >27°, 2) underwent revision surgery, 3) TKA through the lateral parapatellar approach, 4) DEX) showed that the T-value of the BMD was >-3, and 5) poor compliance to follow-up.

Data collection

Demographic (age and sex), anthropometric (height, weight, and body mass index (BMI)), and clinical (symptoms and range of motion (ROM)) were collected from the charts. Genu valgus was classified according to Ellison's valgus deformity classification criteria [12]. The Knee Society Scoring System (KSS) was used to assess surgical outcomes [13]. The anteroposterior and lateral X-ray images of the knee joint, as well as the loaded full-length X-ray image of bilateral lower extremities, were taken routinely. DEXA (Lunar DPX-NT; GE, Boston, Massachusetts, USA) was used to determine the BMD of the lumbar vertebral body, bilateral femoral necks, Ward's trigonum, and greater trochanter of all the patients on the anteroposterior images. All patients had to meet the diagnostic criteria of osteoporosis of the Suggested Diagnostic Criteria of Osteoporosis in Chinese People (2nd edition) issued in 2000 [11].

Surgical methods

All operations were performed by the same team of surgeons, led by a chief surgeon with 28 years' experience in orthopedics. The first assistant was an associate chief surgeon with 15 years' experience in orthopedics. Post-stable prostheses (Link; Germany) were used for all patients, fixed with bone cement. After anesthesia (general anesthesia in 17 patients and continuous epidural anesthesia combined with subarachnoid space block anesthesia in 27 patients), the patients were placed in the supine position. Pneumatic tourniquets were applied, with a pressure of 45-60 kPa. The tourniquets were deflated for 15 min after 90 min of continuous use before being inflated again. A longitudinal incision at the medial knee

was made for all patients, and tibial and femoral osteotomies were conducted through the medial parapatellar approach. The highest point at the medial plateau was used as the reference point for the measurement to ensure that the highest osteotomy thickness was ≤14 mm. A distal femoral osteotomy was conducted with the knee physical valgus angle (KPV) of 5°-7°. For patients with lateral femoral condyle dysplasia or bone defects, the distal femur's highest osteotomy amount was <16 mm. During joint capsule release, secondary osteotomy was conducted through the tibial plateau or distal femur to increase the flexion-extension gap. The residual tibial plateau or defects of femoral condyle after osteotomy were repaired. Peripheral bone defects with a depth of <5 mm were filled with bone cement. For bone mass with cystic degeneration of the tibial plateau induced by severe osteoporosis, which was found in one patient in this study, a long-stem post-stable prosthesis (LINK, Weiliande Orthopaedic Technology Co., Ltd., Beijing, China) was used for reparation. Since simultaneous bilateral TKA involved more prolonged anesthesia, this was only carried out for patients deemed fit to undergo such a procedure. Otherwise, staged surgery was performed. The Ranawat technique [14] was used for soft tissue release. According to the tension of the lateral soft tissues, stepwise release from posterior-medial to anterior-lateral was conducted. After osteotomy and release of lateral soft tissues were completed, the prosthesis was tested to assess the medial and lateral knee joint stability. No patellar replacement was conducted, but the patellofemoral articular surface was reconditioned. Denervation in the surrounding tissues and resection of osteophytes were also conducted. For patients with patellar maltracking or accompanied with lateral patellar subluxation, placing the prostheses of femur and tibia slightly at the lateral side, the lateral patellar soft tissues' release and tight suturing at the medial patella were conducted to improve their condition [15].

Postoperative management

Prophylactic use of antibiotics was performed routinely after the operation. A drainage tube was indwelled in the articular cavity. Compression bandaging was conducted. Cryotherapy with an ice bucket for 48 h was conducted. CPM functional training was started 24 h after operation, with the ROM increased gradually to reach a flexion range of 90°-120° 1 week later. The compression bandaging and the drainage tube were removed 24 h later. Subcutaneous injection of low-molecular-weight heparin calcium injection (Fraxiparine; 0.4 mL/d) was conducted for 14 days. Oral intake of rivaroxaban (Xarelto) was conducted for 2 weeks after discharge to prevent deep venous thrombosis (DVT). A plantar ankle pump was used to prevent lower extremity deep venous thrombosis (LEDVT). The patients were allowed to stand on the floor 48-72 h after the operation and perform functional training by walking with the help of walking aid. The suture was removed, and the patients were discharged at 2 weeks after the operation. The patients were followed at 6 weeks, 3 months, 6 months, and 1 year at the outpatient department. The KSS clinical and functional scores, flexion-extension ROM of the knee joint, and a full-length X-ray image of bilateral lower extremities were assessed. The patients were also guided with functional training during follow-up. Standard anti-osteoporosis therapy was conducted after the operation, including calcium carbonate or calcium citrate 300 mg each time, twice a day with meals or after meals; vitamin D 400 IU, one capsule per day; and long-acting diphosphate preparation continuous use, once a year.

Statistical analysis

SPSS 13.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Data are presented as means ± standard deviation and ranges. The paired t-test was used for comparisons pre/post-surgery. Two-sided P-values <0.05 were considered statistically significant.

Results

Characteristics of the patients (Table 1)

Table 1. Characteristics of the patients

Characteristics	Values
Patients, n	32
Knees, n.	44
Sex, n (%)	
Male	8 (25.0)
Female	24 (75.0)
Age, years, mean (range)	68.5 (54-82)
Weight, kg, mean (range)	68.2 (56-108)
Height, cm, mean (range)	161 (155-177)
Body mass index, kg/m^2, mean± standard deviation	26.2±4.1
Genu valgus deformity, range	18°-27°
Course of disease, years, mean (range)	8.2 (3-21)
Flexion-extension range of motion, mean± standard deviation	81.8°±27.9°
Flexion contracture, mean± standard deviation	11.4°±10.4°
Knee Society Scoring System, mean± standard deviation	32.1±9.8
Functional score, mean± standard deviation	38.3±9.3
Inversion angle, mean± standard deviation	23.1°±2.8°

There were eight males (10 knees) and 24 females (34 knees). The mean age was 68.5 (range, 54-82) years, mean body weight was 68.2 (range, 56-108) kg, mean height was 161 (range, 155-177) cm, and mean BMI was 26.2±4.1 kg/m^2. Genu valgus in all patients was moderate (18°-27°). The mean disease course was 8.2 (range, 3-21) years. The major clinical manifestations were knee joint deformity, pain, and limitation of motion. The pain was mainly at the lateral joint space and patellofemoral joint. The flexion-extension ROM of the knee joint was 81.8°±27.9°, and 17-knee had a flexion contracture of 11.4°±10.4°.

The preoperative KSS was 32.1±9.8, and the functional score was 38.3±9.3. The inversion angle measured by X-ray was 23.1°±2.8°. Besides, the lateral articular space of the femorotibial joint was narrower in all patients.

Surgical characteristics

Among the 12 patients with bilateral knees involved, five received simultaneous TKA, while the other seven received staged TKA, with the mean interval between the two surgeries of 8 months. Healing of the incisions by the first intention was achieved in all patients.

Follow-up

All patients were followed for a mean of 2.9 (range, 1-4) years. At the last follow-up, the KSS clinical score improved from 32.1±9.8 to 82.0±5.8 (P<0.001). The KSS functional score of the patients improved from 38.3±9.3 to 88.1±10.7 (P<0.001). The flexion-extension ROM of the knee joint improved from 81.8°±27.9° to 105.8°±17.0° (P<0.001). The femorotibial angle (FTA) changed from 23.1°±2.8° to 6.8°±1.9° (P<0.001) (Table 2).

Table 2. Knee outcomes before the operation and at the last follow-up

	Preoperative	Last follow-up	P
KSS clinical score	32.1±9.8	82.0±5.8	<0.001
KSS functional score	38.3±9.3	88.1±10.7	<0.001
ROM of the knee joint (°)	81.8±27.9	105.8±17.0	<0.001
FTA (°)	23.1±2.8	6.8±1.9	<0.001

KSS: Knee Society Scoring System; ROM: range of motion; FTA: femorotibial angle.

Complications

X-ray re-examination showed no complications, such as the collapse of the tibial plateau, prosthesis loosening, and patellar necrosis (Figure 1). Common peroneal nerve paralysis appeared after the operation in one patient, for whom nerve nutrition and acupuncture were conducted, and the sensorimotor functions completely recovered 5 months later, but lateral dorsal numbness was still found. Another patient had a periarticular infection 1 year after the operation. The infection was controlled by a 6-week anti-infectious therapy, and no revision arthroplasty was conducted. Residual genu valgum of 5°-9° was found in three patients, but knee joint functions were good.

Discussion

Patients with RA often have severe osteoporosis [5, 6], which may seriously affect knee functions [7]. TKA might be required [8, 9], but studies have yet to report the effectiveness of TKA in patients with RA, severe

osteoporosis, and genu valgum. Therefore, the present study aimed to assess the clinical benefits of TKA in patients with severe osteoporosis and moderate genu valgum at a single center. The results suggest that TKA by the medial parapatellar approach with proper osteotomy and soft tissue balancing could restore knee functions in patients with RA, severe osteoporosis, and genu valgum.

Various criteria are available for the classification of genu valgum, such as the Ellison criteria [12], Krackow criteria [16], Ranawat criteria [14], and SOO criteria [17]. Previous studies have reported that patients suitable for TKA are generally Ellison type I genu valgum. In this study, the Ellison classification of genu valgum in all the patients was type II, and lateral soft tissue release, medial soft tissue tightening, and application of post-stable prosthesis were conducted. All the patients were with high knee joint stability after the operation.

The operations in all patients were performed through the medial parapatellar approach. The medial parapatellar articular capsule approach could facilitate the operation procedures and exposure of the operating field. The complications of operations through the medial parapatellar approach are postoperative joint instability and prosthesis loosening [18-20]. The operations through the lateral parapatellar approach are generally accompanied by incision complications [21-24]. All patients in this study underwent operations through the medial parapatellar articular capsule approach, and a stepwise release was conducted and achieved adequate soft-tissue balance.

The mean postoperative FTA was 171.2°±6.2°, and some patients were still with residual genu valgum. In a previous study about TKA outcomes for patients with genu valgum by Nakano et al. [25], the medial parapatellar approach was used to treat 24 knee joints, of which the preoperative and postoperative FTA was 172.4°±2.7°. Residual genu valgum was found in some patients, supporting the present study. Femoral valgus resection could be one of the factors leading to residual valgus alignment, and conducting a 3°-5° femoral valgus resection could be performed to prevent insufficient correction [26-28]. Therefore, it is applicable to adjust the femoral osteotomy angle to improve the positioning and alignment of the graft.

The highest point is generally used as the reference point for the measurement for the osteotomy. Bone defects are very common at the lateral tibial plateau in patients with severe genu valgum, and they can be repaired by autogenous bone grafting or bone cement filling [29]. In the present study, one patient was with severe lateral tibial defects. We speculated that if the highest lateral point were used as the reference, the medial side's osteotomy amount would be too important. Therefore, the highest medial point was selected as the reference for osteotomy, and the severe lateral defects were filled with bone cement. After the osteotomy at the distal femur and tibial plateau was completed, the knee joint's flexion-extension gap was assessed. The lower extremity alignment was calculated to assess the correction of the genu valgum, based on which the thickness of the polyethylene liner was decided. A second osteotomy could be conducted if necessary. The patella was not replaced routinely, while the surrounding osteophyte was resected, the articular surface was reconditioned to be smooth, and the nerves surrounding the patella were blocked.

In cases of genu valgum deformity, the lateral tissues are generally with different degrees of tension. Thus soft tissue release is among the most critical procedures of TKA for genu valgum, leading to postoperative joint stability and the survival of the prosthesis. Nevertheless, soft tissue release has also been acknowledged as the most challenging part of this operation [30]. In the present study, the Ranawat technique [14] was adopted to release the lateral contracture structures step by step. The flexion-extension gap balancing and varum-valgum stability were assessed after each step of release to prevent over-releasing. The popliteus tendon was preserved as possible, and the integrity of the lateral stable structures was maintained to prevent postoperative lateral instability. For the loosened medial structures, tight suturing was adopted to improve stability. By using these procedures, adequate soft tissue balance was obtained, and no joint instability was found after the operation. Bremer et al. [31] also adopted these techniques and avoided semi-restrictive and restrictive prosthesis. Mullaji et al. [32] adopted similar techniques for the release of posterior cruciate ligament and iliotibial band, followed by computer-navigated posterosuperior femoral osteotomy, which helped obtain more accurate positions.

For patients found with medial knee joint loosening, enhancing lateral releasing and thickness of padding appropriately and using restrictive padding and tightening the medial ligaments, could help achieve medial and lateral balance, which was followed by the application of post-stable prosthesis. The post-stable prosthesis could facilitate the intraoperative soft tissue release, provide higher internal stability to match the articular surface, and allow the femoral and tibial prostheses' maximum lateral shifting to improve the patellar tracking. Therefore, a post-stable prosthesis is recommended for genu valgum patients using a non-condyle restrictive prosthesis.

Severe osteoporosis is not an absolute contraindication of TKA, but perioperative treatment and preparation are essential. The frequency of osteoporosis is high in patients with RA [5, 6], and TKA in such patients can be highly difficult [8, 9]. First, improper position, inappropriate traction, and rough operating during TKA could induce bone fracture [8, 9, 33]. Therefore, all surgical procedures in osteoporotic patients must be meticulous and gentle. The tools, including power saw and drill, should be used instead of a bone knife and bone chisel. The procedures of planting prosthesis and flexion-extension of the knee joint, should also be careful to avoid intraoperative bone fracture [33]. For patients with underlying bone defects, impaction bone grafting is generally required to improve the prosthesis's fixation and reduce the amount of bone cement used. Still, the bone mass of osteoporotic patients is generally poor, and a suitable bone graft is lacking. Therefore, allogeneic bone is frequently used in such patients.

An essential aspect of TKA is postoperative functional training. In addition to routine postoperative function training, there are still some specificities in RA patients. For instance, such patients are generally of advanced ages and long disease courses, and their physical condition is often poor. In addition, such patients have reduced activities. Thus, they are generally with different degrees of osteoporosis and muscle atrophy, leading to imbalanced strength of the muscles surrounding the knee joint [34, 35]. Therefore, training of the quadriceps femoris muscle should be stressed and the training of the flexion-extension function of the knee joint.

The present study has limitations. Only 32 patients (44 knees) were included in this study. In addition, this was a single-center study, and it was a retrospective study with a follow-up of 1 year.

Conclusions

In conclusion, TKA via the medial parapatellar approach with proper osteotomy and soft tissue balancing could restore the knee function in patients with RA, severe osteoporosis, and genu valgum.

Abbreviations

BMD: bone mineral density; BMI: body mass index; DEXA: dual-energy X-ray absorptiometry; DVT: deep venous thrombosis; FTA: femorotibial angle; KSS: Knee Society Scoring System; KPV: knee physical valgus angle; LEDVT: lower extremity deep venous thrombosis; ROM: range of motion; RA: Rheumatoid arthritis; TKA: total knee arthroplasty.

Declarations

Ethics approval and consent to participate

This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. The study was approved by the ethics committee of the Fourth Affiliated Hospital of Harbin Medical University. The need for informed consent was waived by the committee.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

TZ carried out the studies, participated in collecting data, and drafted the manuscript. TZ and NH performed the statistical analysis and participated in its design. YZ, RZ, ML, and DZ participated in the acquisition, analysis, or interpretation of data and drafted the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

X-ray image of a 63-year-old woman with RA and genu valgum (Ellison classification: moderate) in bilateral knee joints. (a) Image of full-length bilateral lower extremities before the operation. (b) Anteroposterior and lateral X-ray images of the right knee before the operation. (c) Anteroposterior and lateral X-ray images of the right knee immediately after the operation.