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Total knee arthroplasty, following application of Taylor Spatial Frames to treat knee osteoarthritis with severe tibia extraarticular deformity due to fracture malunion: A case report

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ABSTRACT

Obtaining alignment during end-stage knee osteoarthritis with extraarticular deformities has always been challenging. Therefore, we report a case of total knee arthroplasty, following the application of Taylor Spatial Frame to treat knee osteoarthritis with severe tibia extraarticular deformity due to a proximal tibia fracture injury for more than 50 years ago. First, proximal tibial opening wedge osteotomy was conducted below the patellar tendon insertion from the anterior to the posterior direction to correct the deformity in multiple planes gradually. Then, osteotomy was done to restore both the varus and recurvatum deformities. Finally, Taylor Spatial Frame was used as a virtual hinge, with gradual adjustments to correct the deformity. Afterward, patient-specific instrumentation-assisted total knee arthroplasty was conducted after correcting the extraarticular deformity. During the two-year follow-up, no superficial and deep infection occurred, and his Oxford Knee Score had improved from 32 to 19 out of 48 at the time of the latest follow-up. Moreover, the patient walked using a one-hand clutch without protective limping. Hence, patient-specific instrumentation-assisted total knee arthroplasty, following proximal tibial osteotomy with Taylor Spatial Frame, should be considered a treatment option for patients with knee osteoarthritis having severe proximal tibia extraarticular deformity.

Introduction

During end-stage osteoarthritis of the knee, total knee arthroplasty (TKA) alleviates pain and improves activities of daily living. However, even though it is proposed to increase the risk of knee osteoarthritis (KOA), only a few studies have been reported on the management of extraarticular deformity with TKA use [2,3]. Extraarticular deformities have always been a challenge to obtain alignment. Moreover, Thienpont et al. reported using patient-specific instrumentation (PSI) systems to conduct mechanically aligned (MA)-TKA in patients without access to the intramedullary canal. This method was adopted because of extraarticular deformities, which improved function and restored limb alignment through intra-articular correction of deformities under 20° [4]. Hence, we report a case of TKA, following the application of Taylor Spatial Frame (TSF), to treat knee osteoarthritis with severe tibia extra-articular deformities due to a proximal tibia fracture injury for more than 50 years ago. The patient exhibited severe starting pain and

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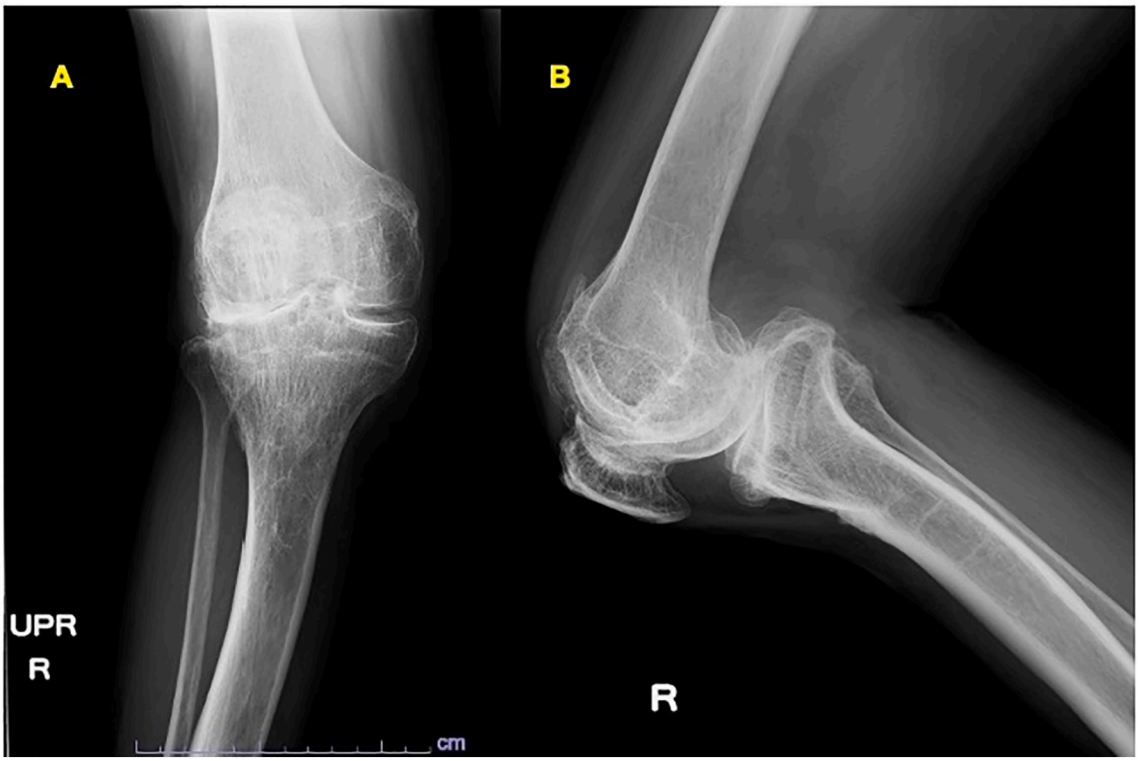

Fig. 1. Preoperative plain radiographs of the right knee. (A) Anteroposterior and (B) lateral views.

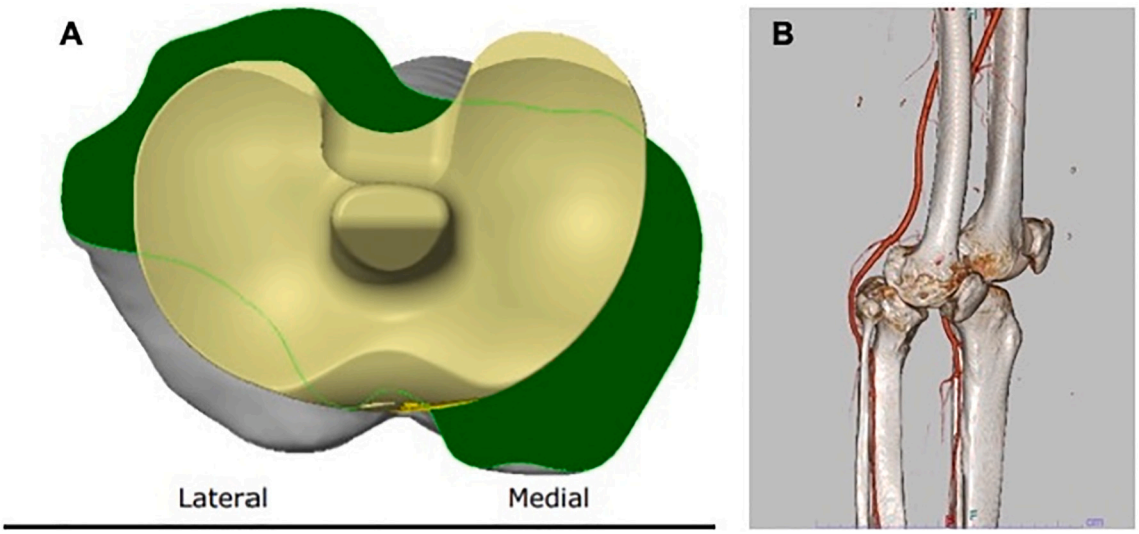

Fig. 2. (A) Preoperative planning of tibial baseplate placement after a proximal tibial bone cut, indicating overhang of the tibial baseplate. (B) CT angiography showed that the distance between the posterior cortex of the left proximal tibia to the anterior wall of the popliteal artery was much closer than that of the right proximal tibia.

progressive protective limping.

Case presentation

A 70-year-old male admitted to our hospital's Knee Sports Traumatology departmental clinic complained of chronic pain and knee instability when descending stairs. Radiographs demonstrated 35.2° of recurvatum deformity extra-articularly and 12.7° of tibial

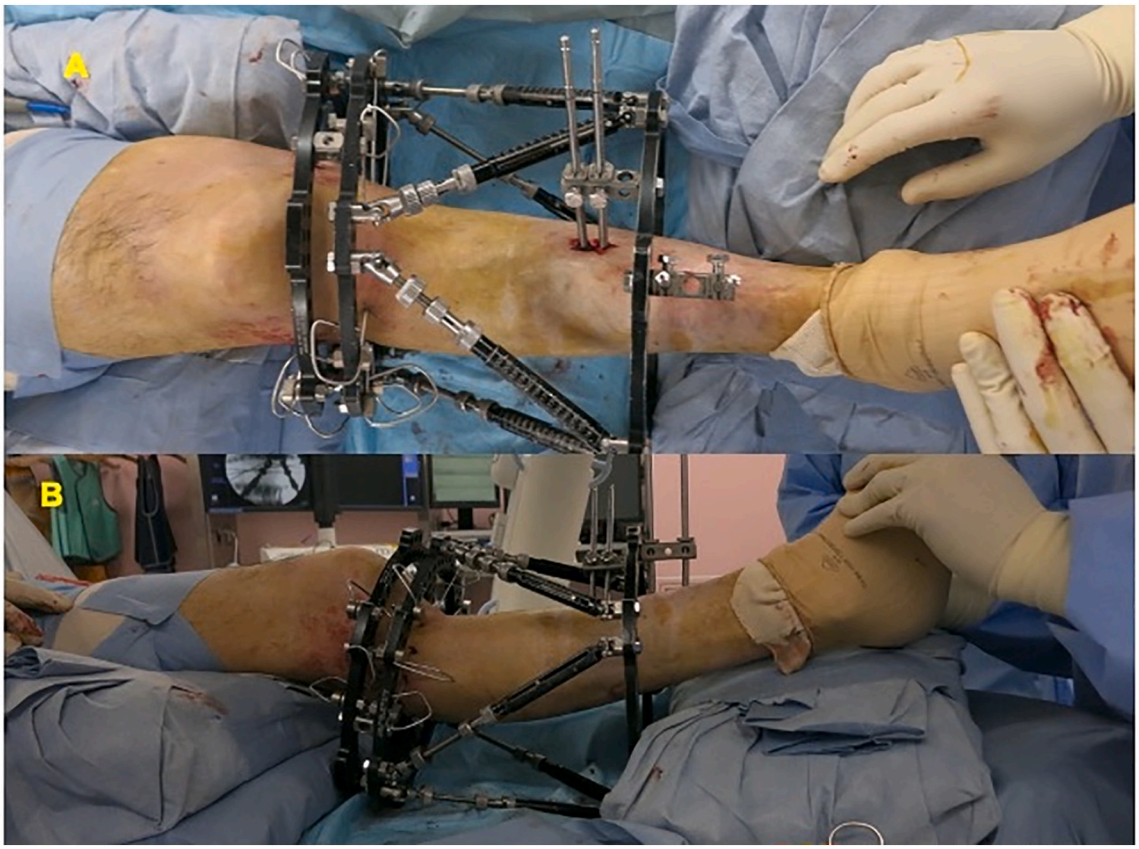

Fig. 3. Proximal tibial osteotomy with Taylor Spatial Frame application. (A) Anteroposterior and (B) lateral views.

valgus deformity (Fig. 1A, B). The range of motion was −20° of extension and 90° of flexion. Therefore, we first planned to conduct mechanically aligned TKA using computed tomography (CT)-based patient-specific cutting guides. However, CT angiography showed that the distance between the posterior cortex of the left proximal tibia to the anterior wall of the popliteal artery was much closer than that of the right proximal tibia. Additionally, the preoperative planning of Prophecy Evolution medial pivot patient-specific instrumented knee replacement systems (MicroPort Orthopedics, Inc., Arlington, TN) [5] showed tibial baseplate overhang when the posterior tibial slope was set at 3° and when tibial baseplate was simulated one size under that of the femoral component (Fig. 2A, B). This finding indicated size mismatches between femoral and tibial components. Therefore, PSI-assisted MA-TKA, followed by gradual extraarticular deformity correction using TSF, was planned.

The surgical procedure using proximal tibial opening wedge osteotomy and Taylor Spatial Frame application (first surgery)

Under general anesthesia, proximal tibial opening wedge osteotomy below the patellar tendon insertion from anterior to posterior direction was conducted to correct the deformity in multiple planes gradually (Fig. 3A, B). Then, osteotomy was performed to restore both the varus and recurvatum deformities, after which TSF was used as a virtual hinge, with gradual adjustments made to correct the deformity.

Postoperative management

Gradual correction of both the varus and recurvatum deformities was also conducted, after which callus formation at the osteotomy site was confirmed three months after the first surgery.

However, the pin site infection caused by Methicillin-resistant *Staphylococcus aureus* occurred five months after surgery, resulting in the removal of TSF earlier. Thus, we conducted cast immobilization until the union. At the time of frame removal, knee ROM had deteriorated to −20° of extension and 45° of flexion. Therefore, the patient underwent outpatient physiotherapy and preoperative ROM eight months after the first surgery.

After the bony union of the osteotomy site (Fig. 4A, B), a second PSI planning was conducted, after which the size mismatch between the femoral and tibial components was resolved because the anterior tibial inclination was corrected to 3° of posterior

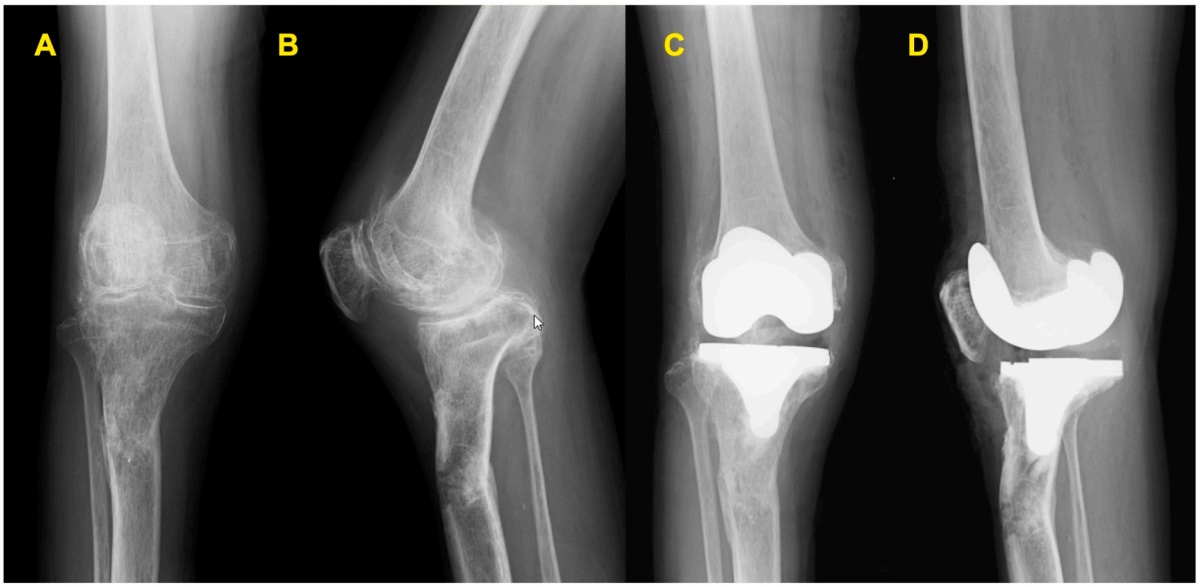

Fig. 4. Plain radiographs after completion of treatment with Taylor Spatial Frame; (A) anteroposterior and (B) lateral views, and postoperative plain radiographs of the right knee after TKA; (C) anteroposterior and (D) lateral views.

inclination.

The surgical procedure using PSI-assisted MA-TKA (second surgery)

PSI-assisted TKA was conducted using a posterior-stabilized (PS), cemented, fixed bearing medial pivoted implant (EVOLUTION, MicroPort Orthopedics, Inc., Arlington, TN) via the para-patellar approach. However, patella resurfacing was not done. Subsequently, quadriceps sniping was conducted to obtain better patellar retraction. Then, the distal femoral and proximal tibial cut lines were defined according to PSI pin locations to get a rectangular extension gap. No soft tissue release was required to obtain an adequate extension gap.

The femur's trans-epicondylar axis (TEA) was 3.5° external from the posterior condyles. First, an adequate flexion gap was obtained when the osteotomy line of posterior condyles was set parallel to TEA according to the size suggestion of the femoral component from PSI. Then, the thinnest (10 mm) PS-fixed bearing was inserted, after which postoperative ROM under anesthesia after incision closure was measured as 0° of extension and 125° of flexion (Fig. 4C, D).

During a two-year follow-up, no superficial and deep infection occurred, and his Oxford Knee Score [6] had improved from 32 to 19 out of 48 at the time of the latest follow-up. Additionally, no radiological symptom of suspected component loosening was observed. Besides, the patient walked with a one-hand clutch without protective limping.

Discussion

A percutaneous osteotomy combined with gradual correction using TSF provides a strategy to correct tibial deformity independent of magnitude, complexity, or location. The procedure uses small incisions and minimal soft tissue release that can be used in all zones of the tibia. Therefore, without complex frame modifications, TSF can be used to correct angulation and translation in the coronal, sagittal, and axial planes around a virtual hinge, known as the term six-axis correction [7]. Additionally, a gradual amendment of the anterior tibial inclination using TSF enabled us to conduct PSI-assisted MA-TKA. This correction was also done without size mismatches between the femoral and tibial components, altering femorotibial contact forces and potentially influencing polyethylene wear and subsequent implant loosening [8].

Therefore, due to the difficulty in accurate extra-medullary guided tibial osteotomy with proximal tibial deformity, PSI-assisted TKA following proximal tibial osteotomy with TSF should be considered a treatment option for patients with knee osteoarthritis having severe proximal tibia extraarticular deformities.

Declaration of competing interest

None.

Acknowledgments

None.

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