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Case Report

3D templating and patient-specific instrumentation in primary total knee arthroplasty with retained internal fixation hardware: Two case reports

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A R T I C L E I N F O

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A B S T R A C T

Two elderly female patients with Kellgren–Lawrence grade 4 knee osteoarthritis (KOA) having varus knee deformity and retained hardware for internal fixation in either femur or tibia underwent total knee arthroplasty (TKA) using 3D templating and patient-specific instrumentation (PSI). TKA was performed to treat KOA by minimally removing or without removing the retained hardware for the internal fixation of distal femoral or tibial diaphyseal fractures. Throughout a 2-year follow-up period, no superficial or deep infection was observed. In additions, no radiological symptoms of suspected component loosening were observed. Furthermore, both patients can currently walk without using crutches. 3D templating and PSI in primary TKA for patients with retained hardware for internal fixation of femoral or tibial fractures are considered suitable treatment options for reducing surgical invasion.

Introduction

Total knee arthroplasty (TKA) is a widely used surgical procedure to relieve pain and improve daily activities in patients with end-stage knee osteoarthritis (KOA). An intramedullary alignment system is commonly used for fixing the distal femoral cut, whereas an extramedullary alignment system is used for fixing the proximal tibial cut. Although the femoral intramedullary guide is accurate and reproducible, its use in patients with retained hardware is prevented without hardware removal [1]. Intramedullary nail (IMN) fixation is a common treatment strategy employed for tibial diaphyseal fractures. However, because of the position of the nail, this treatment may complicate the placement of the tibial components [2]. Furthermore, hardware removal would impose a physical and financial burden on the patient [3]. Currently, there is no agreement on whether a staged or concurrent approach for hardware removal at the time of TKA is preferable [4]. TKA without hardware removal would reduce surgical invasion in patients with KOA following femoral or tibial fractures. Hence, we herein present two cases of TKA using 3D templating and patient-specific instrumentation (PSI) to treat KOA by minimally removing or without removing the retained hardware for the internal fixation of distal femoral or tibial diaphyseal fractures. These patients experienced severe initial pain and progressive protective limping.

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Case histories

Case 1

A 75-year-old woman was admitted to the knee sports traumatology departmental clinic of our hospital due to complaints of chronic pain and knee instability while walking. Radiography revealed Kellgren–Lawrence (KL) grade 4 KOA and a varus knee deformity of 10.3°. The range of motion was −20° during extension and 110° during flexion. Ten years before admission, she had undergone internal fixation with LCP distal femur plates (DepuySynthes, Solothurn, Switzerland) as a treatment for an AO 33-A1 distal femoral fracture. Preoperative planning of the prophecy evolution medial pivot patient-specific instrumented knee replacement systems (MicroPort Orthopedics, Inc., Arlington, TN) [5] revealed that at least three distal locking screws needed to be removed during femoral bone resection using a four-in-one cutting guide (Fig. 1). Therefore, PSI-assisted mechanically aligned (MA)-cruciate retaining (CR) TKA was planned following partial screw removal from the LCP.

Surgical procedure using PSI-assisted MA-CR TKA

The parapatellar approach was used to conduct PSI-assisted TKA with a CR, cemented, fixed bearing medial pivoted implant (Evolution, MicroPort Orthopedics, Inc., Arlington, TN). Patella resurfacing was not performed. Subsequently, three distal locking screws were removed before femoral bone resection using a four-in-one cutting guide as suggested in the preoperative planning. Another two distal locking screws were removed because they had become visible and might intrude on the femoral component. The distal femoral and proximal tibial cut lines were then defined according to PSI pin locations to get a rectangular extension gap. The transepicondylar axis (TEA) of the femur was 2.0° external from the posterior condyles. First, an adequate flexion gap was obtained by setting the osteotomy line of the posterior condyles parallel to the TEA according to the size suggestion of the femoral component from PSI. Then, the 12-mm CR-fixed bearing was inserted and the postoperative ROM under anesthesia after incision closure was measured to be 0° during extension and 125° during flexion (Fig. 2).

During a 2-year follow-up period, no superficial or deep infection was observed, and her visual analog scale (VAS; best: 0, worst: 100) score at the time of walking on even ground had improved from 71 to 0, and her Oxford knee score (OKS; best: 0, worst: 48) had improved from 24 to 2 at the time of the latest follow-up. No radiological signs of suspected component loosening were observed. Besides, the patient can now walk without using crutches.

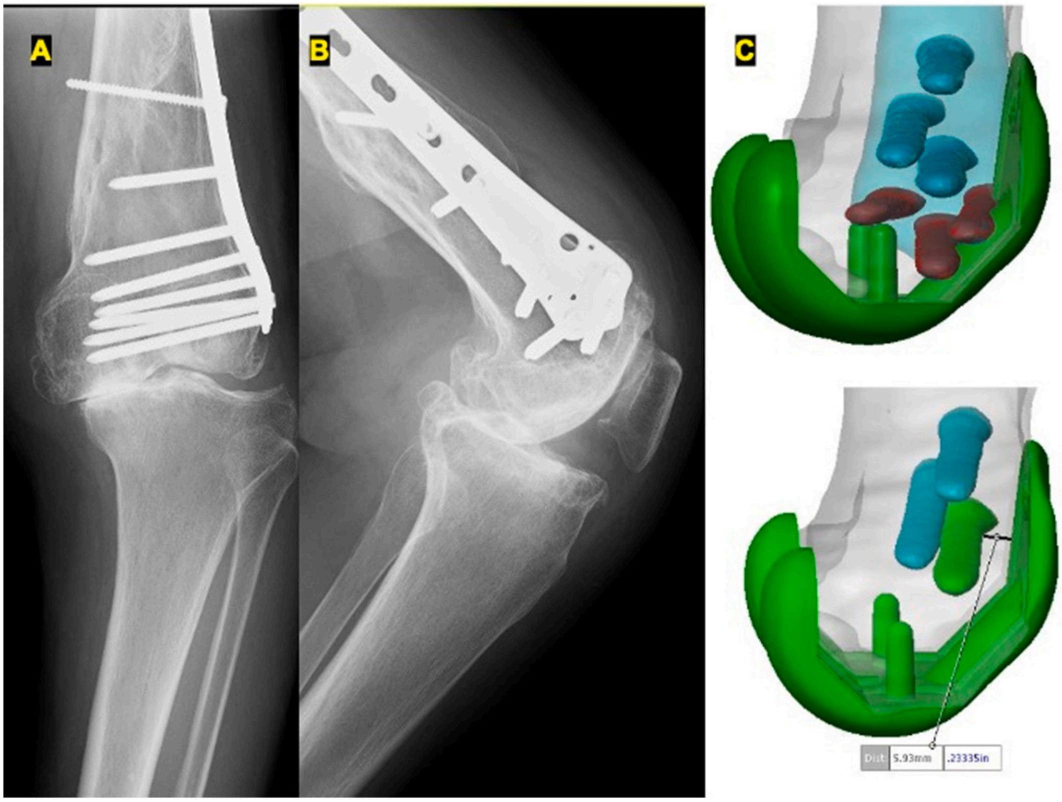

Fig. 1. Preoperative images of the left knee. (A) Anteroposterior and (B) lateral view plain radiographs. (C) Three dimensional templating showing that at least three distal locking screws required removal at the time of femoral bone resection.

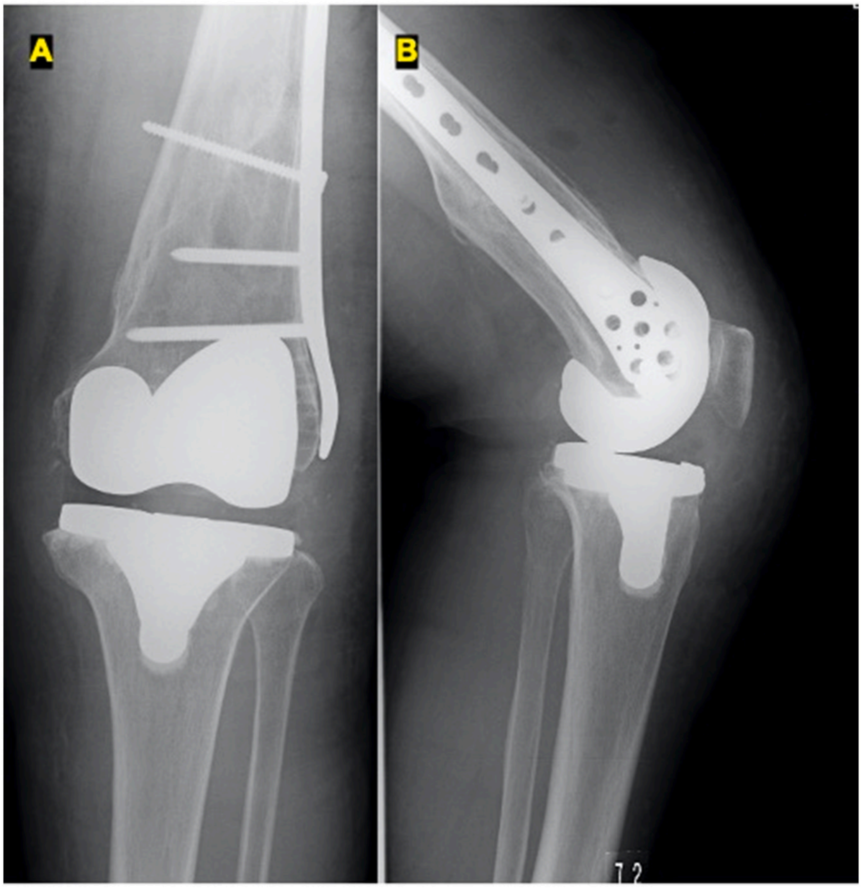

Fig. 2. Postoperative images of the left knee. (A) Anteroposterior and (B) lateral view plain radiographs.

Case 2

An 85-year-old woman was admitted to the knee sports traumatology departmental clinic of our hospital due to complaints of chronic pain and knee instability while walking. Radiography revealed KL grade 4 KOA and a varus knee deformity of over 20°. The range of motion was −15° during extension and 115° during flexion. Two years before admission, she had undergone internal fixation using IMN as a treatment for a tibial diaphyseal fracture. CT data for each scan were transferred to 3D template software (Zed knee, Lexi, Japan). The 3D template software showed that when the tibial posterior inclination was set at 0°, IMN removal was unnecessary (Fig. 3). As a result, PSI-assisted MA-cruciate substituting (CS) TKA with IMN removal as a backup was planned.

Surgical procedure using PSI-assisted MA-CS TKA

The midvastus approach was used to perform PSI-assisted TKA with a CS, cemented, fixed bearing implant (BKS Trimax, Ortho Development, Inc., Draper, UT). Patella resurfacing was not performed. To obtain a rectangular extension gap, the distal femoral and proximal tibial cut lines were defined according to PSI pin locations. However, the width of the proximal lateral tibia bony resection was 9.0 mm, which was 1.5 mm less than the PSI planning. As a result, 2-mm additional proximal tibial bone resection was performed, resulting in sufficient extension and flexion gaps. Despite the additional 2-mm-wide tibial bone resection, IMN was not observed via the cavity for the tibial baseplate. Thus, there was sufficient space for IMN removal without causing damage to the tibial baseplate if required at a later stage due to postoperative infection or leg pain. The thinnest 10-mm CS-fixed bearing was inserted, and postoperative ROM under anesthesia after incision closure was measured to be 0° during extension and 130° during flexion (Fig. 4). During a 2-year follow-up period, no superficial or deep infection was observed, and her VAS score while walking on even ground improved from 100 to 25, and her OKS improved from 43 to 17 at the time of the most recent follow-up. No radiological signs of suspected component loosening were observed. Besides, the patient is now walking without using crutches.

Discussion

Retained hardware removal during primary TKA for patients with end-stage KOA is a significant burden that requires an additional

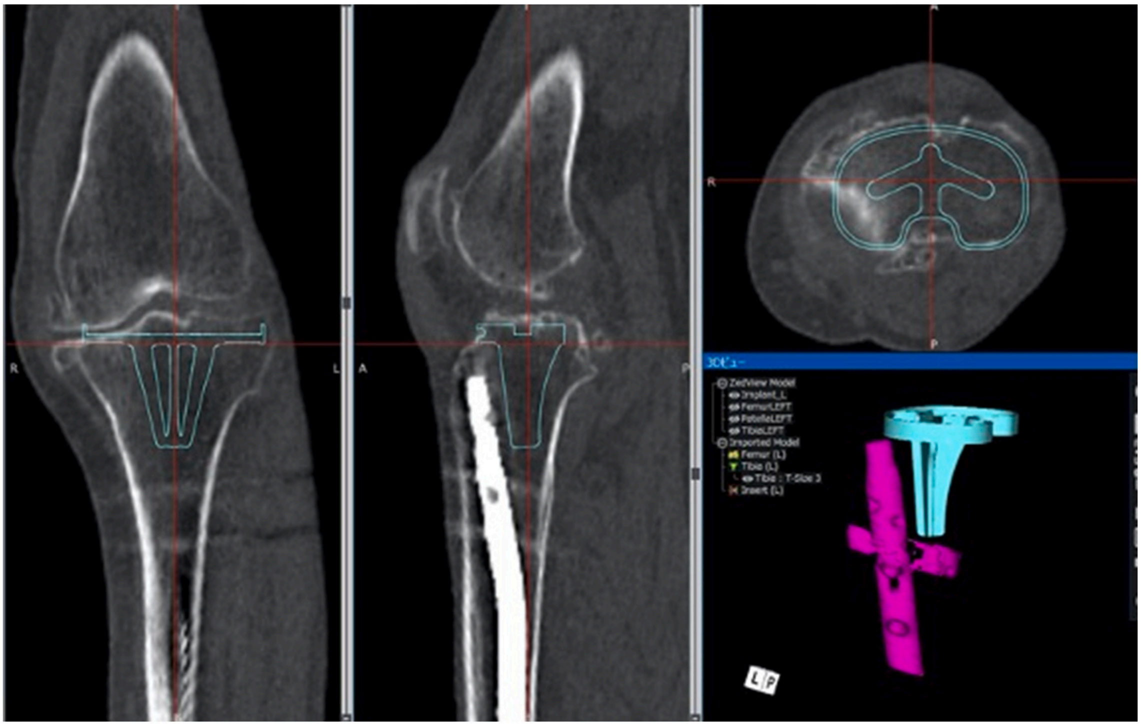

Fig. 3. Preoperative 3D templating showing that when tibial posterior inclination was set at 0°, removal of the intramedullary nail would not be required.

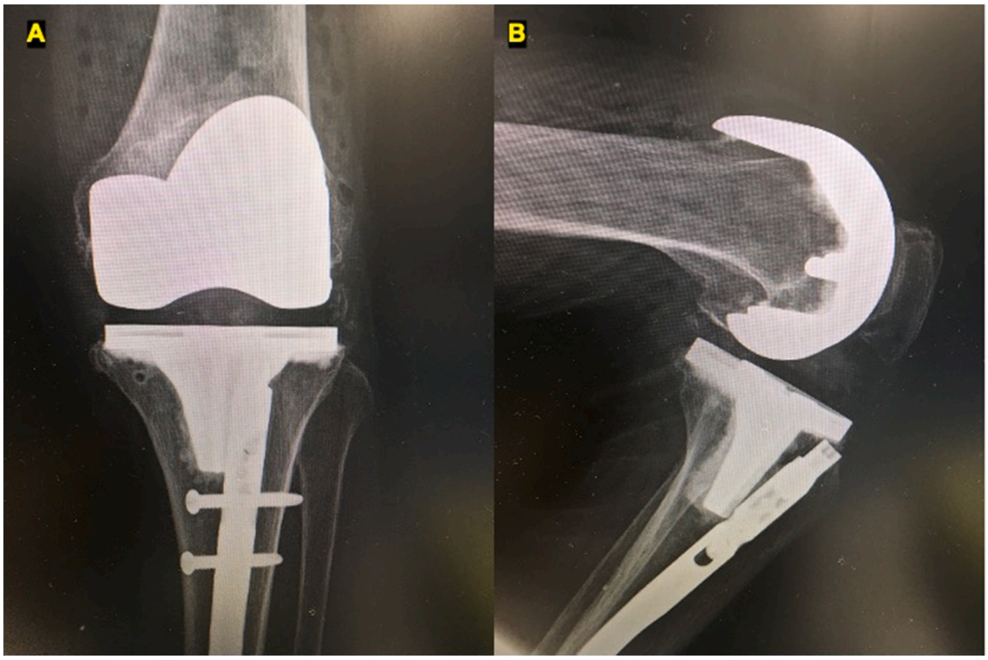

Fig. 4. Postoperative images of the left knee. (A) Anteroposterior and (B) lateral view plain radiographs.

skin incision during internal fixation and a longer operative time. At present, there is no precedent for staged or concurrent hardware removal, and a case-by-case approach should be considered [4]. Several studies have described the efficacy of using a navigation system for TKA in patients with retained hardware [6,7]. However, an appropriate definition of the anatomical landmark seemed difficult because the lateral femoral condyle was covered with LCP in case 1, which may have affected the surgical epicondylar axis, and the sensor pins for CT-free navigation may have interfered with the retained hardware in cases 1 and 2. These are the reasons we relied on PSI rather than the navigation system in our cases. Despite primary TKA, removal of the tibial IMN causes loss of trabecular bone in the distal direction.

However, nail removal was correctly included in the operative strategy and could have been performed if impingement had occurred during initial trials. In addition, there was a possibility that it became continuous with the cavity for the tibial baseplate as the cement–bone interface might become inadequate and loosen prematurely. Although primary TKA with porous tantalum cone and stem augmentation provided excellent outcomes [8], our surgical treatment strategy using PSI enabled us to perform MA-TKA in patients without access to the intramedullary canal [9]. Hence, compared with navigation, PSI technology could reduce operative time [10].

Conclusion

Using 3D templating and PSI in primary TKA for patients with retained hardware for internal fixation of femoral or tibial fractures is considered a suitable treatment option to reduce surgical invasion.

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