



# Fracture of the polyethylene tibial post in the posterior-stabilized total knee prosthesis: arthrographic and CT arthrographic diagnosis

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## Abstract

Fracture of the polyethylene tibial post in the posterior-stabilized total knee prosthesis is often delayed in diagnosis due to its nonspecific symptoms and the radiolucent characteristic of polyethylene on conventional radiography. Therefore, the diagnosis is always established by arthroscopy. Notwithstanding recent advances in imaging modalities, we are presently aware of only two related case reports on MRI and even no reports about arthrographic or CT-arthrographic diagnosis of fractured tibial post. We hereby report a case of a 58-year-old female patient who developed recurrent knee pain during the third year after total knee arthroplasty. The displaced polyethylene tibial post was clearly outlined by administered contrast material in the posterior knee. Under the diagnosis of fracture of the tibial post, the patient underwent isolated replacement of the broken polyethylene insert. Her knee pain significantly improved after the operation.

**Keywords** Total knee arthroplasty · Posterior-stabilized design · Tibial post fracture · CT arthrography

## Introduction

Total knee arthroplasty (TKA) is a procedure undertaken for treating end-stage osteoarthritis of the knee. The total knee prosthesis is generally composed of a metallic bicondylar femoral component, a metallic tibial tray component, a polyethylene tibial insert, and a polyethylene patellar button. There are several TKA designs, offering different constraining levels of stability, including the PCL-retaining, PCL-substituting, varus-valgus constrained, and rotating-hinge types [1]. The posterior-stabilized (PS) knee prosthesis is of an unconstrained design tailored for patients in which preservation of the native posterior cruciate ligament is not possible. This design is featured by implementing the post-cam mechanism to substitute for the function of the posterior cruciate ligament

(Fig. 1). The interaction between the femoral cam and polyethylene tibial post allows for femoral roll-back during knee flexion and prevents posterior subluxation of the tibia. Fracture of the polyethylene tibial post is a well-documented complication of the post-cam design. At our institution, the radiologists and orthopedists are more experienced in conventional arthrography and CT-arthrography to diagnose polyethylene tear and prosthesis loosening. To the best of our knowledge, no reports are found in the available literature on imaging diagnosis of fracture of polyethylene tibial post by means of conventional arthrography or CT-arthrography. We hereby report the first case using conventional arthrography and CT-arthrography to establish the diagnosis of fractured polyethylene tibial post, a problem both radiologists and clinicians may encounter in their practice.

## Case report

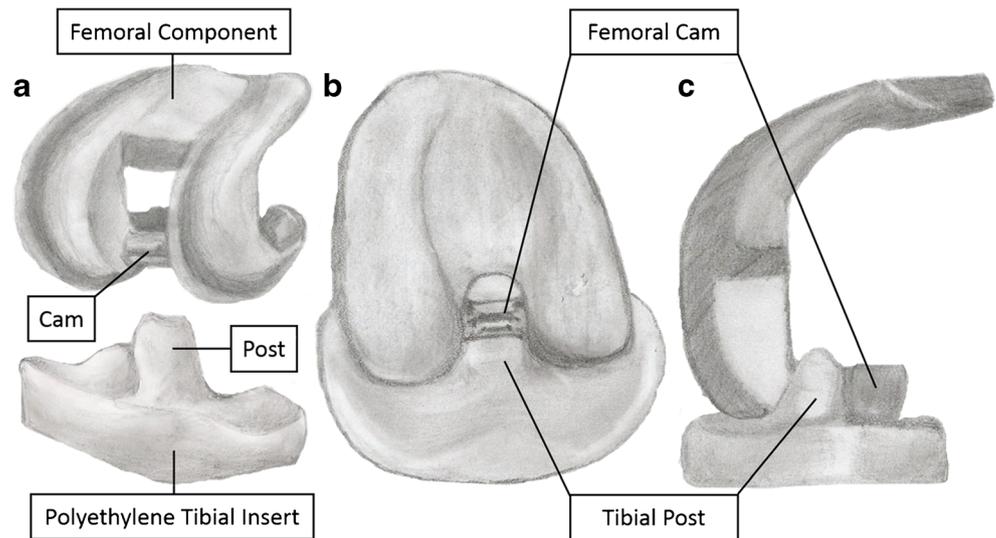
The subject is a 58-year-old female patient with a history of poliomyelitis, resulting in atrophy of the right lower extremity. She had undergone left total knee replacement 3 years previously due to osteoarthritis and pain of the joint. The posterior-stabilized knee prosthesis (Zimmer) was implanted via an anteromedial approach. The knee was examined intraoperatively to be stable with acceptable flexion and extension

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**Fig. 1** Illustrations of the separated and assembled posterior-stabilized knee prostheses. Oblique view of the separated prosthesis (a) shows the metallic femoral component and polyethylene tibial insert. Coronal (b) and sagittal (c) views of the assembled prosthesis well demonstrate the relationship between femoral cam and tibial post. (Illustration by Chen Hsu)

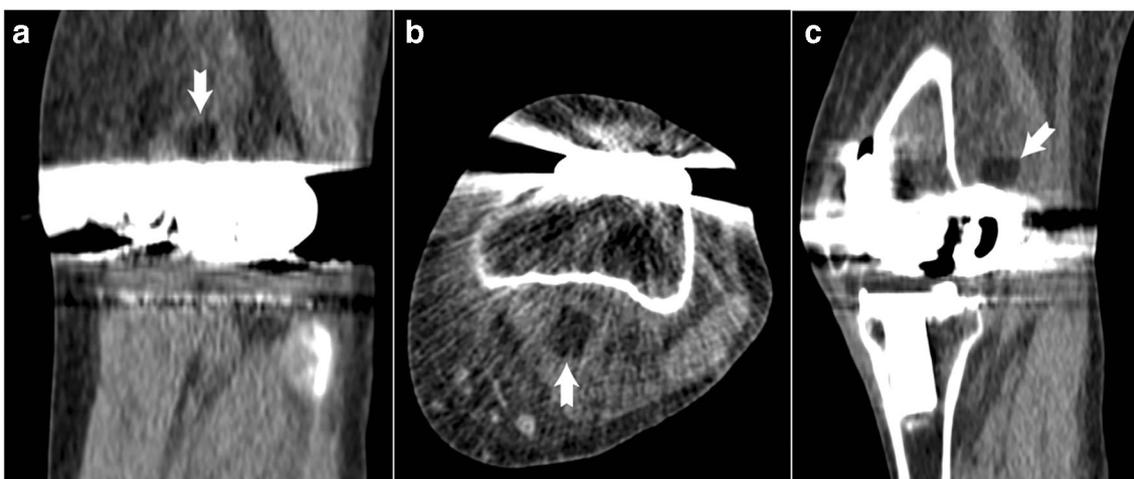


gaps. The patient made a good post-operative recovery and was followed up at the orthopedic outpatient department. Three years later, she began to experience recurrence of knee pain accompanied by a locking sensation. Routine radiographs of the left knee revealed no evidence of loosening, malalignment, periprosthetic fracture, or any other abnormal radiolucency around the joint. Under the tentative impression of polyethylene wear, the orthopedists requested non-contrast CT and CT-arthrography. On initial non-contrast enhanced CT, a radiolucent block could be observed in the posterior knee (Fig. 2). The radiolucent block was later noted to be completely outlined by administered contrast material with a sugar cube-like appearance on both digital subtraction arthrography (Fig. 3) and CT-arthrography (Fig. 4). These imaging findings are highly indicative of a displaced fractured tibial post, a well-documented complication of knee replacement with the PS prosthesis. Arthroscopy confirmed the

fracture at the base of the polyethylene tibial post with displacement of the fragment (Fig. 5). Because the other components of the prosthesis appeared intact and show no evidence of malalignment, she underwent isolated replacement of tibial polyethylene insert. The patient's knee pain subsided markedly after the operation.

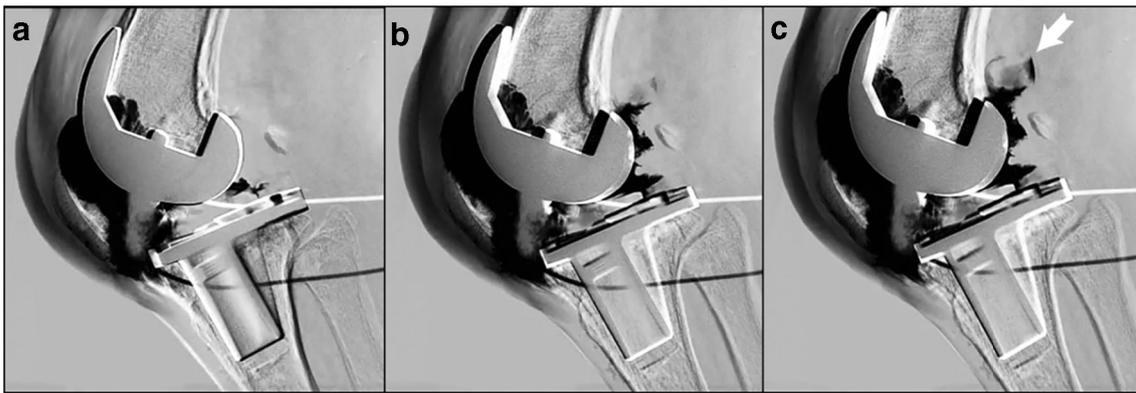
## Discussion

The posterior-stabilized (PS) total knee prosthesis is one of the most successful designs in the realm of total knee arthroplasty. However, the design of the PS total knee prosthesis is characterized by a specific complication: fracture of the polyethylene post [2–6], a condition necessitating surgical intervention. Clinical presentations are nonspecific and include sudden onset knee pain with or without locking, a clicking sensation, or



**Fig. 2** A 58-year-old woman with fracture of the polyethylene tibial post in a posterior-stabilized knee prosthesis confirmed by arthroscopy. Retrospectively, a radiolucent block (white arrow) was observed in the

posterior knee on the coronal (a), axial (b) and sagittal (c) non-contrast computed tomography images



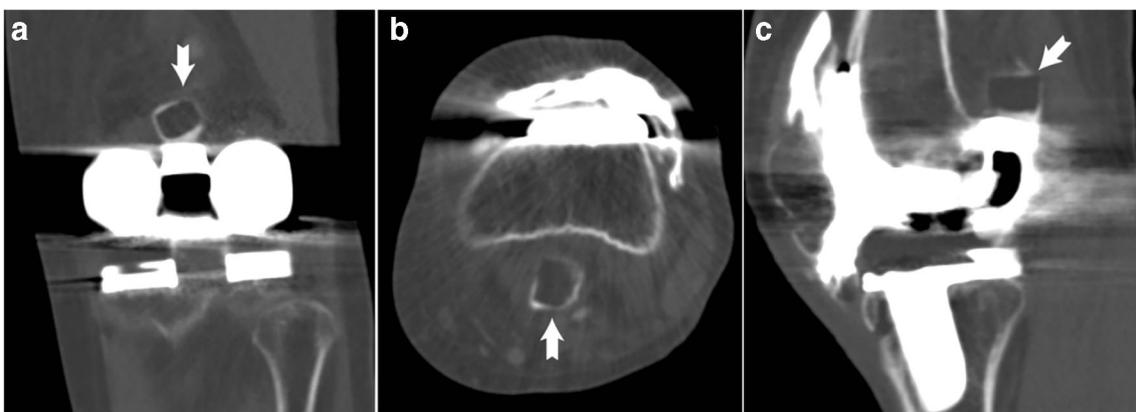
**Fig. 3** a–c Dynamic subtraction images of single-contrast knee arthrography revealed a radiolucent block outlined by contrast medium exhibiting the appearance of a “sugar cube”

an audible clunk, which mimics another PS-TKA complication – patellar clunk syndrome [5], which needs imaging to differentiate.

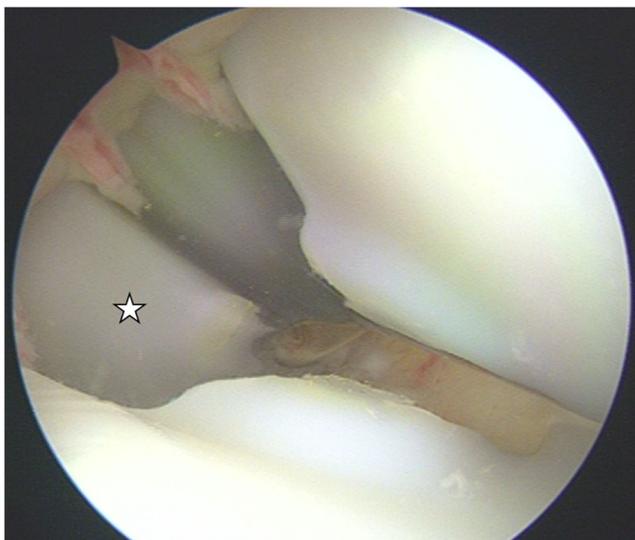
Diagnosis of a fractured polyethylene post is difficult due to the material’s lucent characteristic on conventional radiography. Posterior subluxation of the tibia is sometimes observed because of post-cam failure [5]. With advances in magnetic resonance imaging technology gradually overcoming problems posed by metallic artifacts, MRI is a useful tool in the evaluation of a poorly functioning or painful TKA [7]. However, the available literature yielded only two reports on MRI diagnosis of the fractured polyethylene tibial post [4, 8], a condition always presenting as a signal-void loose body [9]. In our experiences, CT images are also limited by beam-hardening artifacts caused by the metallic femoral and tibial components of the implant. However, with the aid of intra-articular injection of contrast material, the contour and interface of the polyethylene tibial insert can be clearly outlined. The wear, tear, and even fragmentation of the polyethylene tibial insert can thus be better visualized. Because fracture of the polyethylene tibial post usually occurs at the base of the tibial post [2–6], the shape of the fragment is usually cube-shaped. Hence, the fragment outlined by injected contrast

material resembles a sugar cube on arthrography and CT-arthrography. Therefore, arthrography and CT-arthrography are helpful tools when fracture of the polyethylene tibial post cannot be conclusively diagnosed on MRI studies. The specific image appearances provided by arthrography and CT-arthrography, combined with relevant clinical information, are important in the diagnosis of a fractured polyethylene tibial post.

The primary cause of a fractured polyethylene tibial post is known to be hyperextension of the knee joint [2–6]. In addition to interacting with the femoral cam to substitute for the posterior cruciate ligament, the tibial post also takes on some of the role of the anterior cruciate ligament [10], which is always removed during total knee arthroplasty. During hyperextension of the knee joint, anterior impingement of the tibial post with the femoral component resists anterior tibial translation, but also results in wear and tear at anterior side of the tibial post [2, 10]. Eventually during high flexion of the knee joint, the femoral cam propagating a lift-off force anteriorly to the tibial post, the fracture occurs as the structural integrity of the tibial post being overwhelmed [2]. To date, mobile-bearing PS knee prostheses and new post-cam designs have been developed [11,



**Fig. 4** The fractured and displaced polyethylene tibial post (*white arrow*) outlined by contrast medium is clearly demonstrated on the coronal (a), axial (b) and sagittal (c) computed tomography – arthrography images



**Fig. 5** The fractured and displaced polyethylene tibial post (white star) of our patient was identified by the arthroscopic examination

[12] to overcome design-related complications, but fracture of the tibial polyethylene insert cone due to non-traumatic longitudinal bending stress has still been reported [13]. In addition, mobile-bearing PS knee prostheses do not seem to yield better long-term survival rates [14].

Surgical intervention is always necessary in the management of a fractured polyethylene tibial post. Definitive treatment involves complete revision of all components of the prosthesis. Alternatively, isolated exchange of the tibial polyethylene insert can also be performed [15], the advantages being preservation of bone stock, shorter operating time, less blood loss, faster rehabilitation, and lower cost [16]. Even though isolated exchange of the tibial polyethylene insert is associated with unpredictable outcomes, particularly in patients who had undergone TKA for less than 3 years [17], it is still a viable option to be taken into consideration when there is no malalignment or malrotation of the other components of the TKA prosthesis [18].

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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