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Late tibial post fracture following mobile-bearing posterior-stabilized total knee arthroplasty: A case report highlighting the role of malalignment and polyethylene wear

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Abstract

Tibial post fracture in mobile-bearing posterior-stabilized total knee arthroplasty (MB-PS TKA) is a rare but clinically significant complication associated with knee instability. A 72-year-old female presented with progressive knee pain and instability eight years after primary MB-PS TKA. Radiographic and clinical evaluation demonstrated varus malalignment and excessive posterior tibial slope. Revision TKA was performed, and intraoperative findings confirmed a fractured polyethylene tibial post with localized wear. Excessive posterior tibial slope may lead to anterior tibial translation and increased cam-post impingement, while varus malalignment results in asymmetric load distribution and accelerated polyethylene wear. Although mobile-bearing designs are intended to reduce stress concentration, these advantages may be negated under conditions of malalignment. Patient-related factors such as elevated body mass index and sustained physical activity may further contribute to implant failure. Proper component alignment and patient-specific risk assessment are essential to prevent tibial post fracture in MB-PS TKA. Clinicians should consider polyethylene-related complications in patients presenting with late instability, even in the absence of a clearly defined traumatic event.

Keywords: total knee arthroplasty, posterior-stabilized, mobile bearing, polyethylene tibial post, implant failure, knee instability

1. Introduction

Total knee arthroplasty (TKA) is a widely accepted and effective surgical procedure for treating advanced osteoarthritis (1). The posterior-stabilized (PS) TKA design was developed to enhance femorotibial range of motion and to prevent posterior subluxation of the implant. In the absence of the posterior cruciate ligament, stability is maintained through a central polyethylene tibial post that articulates with a femoral cam mechanism (2).

Two types of polyethylene inserts are commonly used in PS-TKA: fixed-bearing (FB) and mobile-bearing (MB) designs. The MB design has been reported to reduce contact stress on the articular surfaces and to delay polyethylene wear due to its mobility (3,4). Furthermore, MB inserts may better tolerate minor rotational mismatches between the femoral and tibial components (1,3,4).

Despite favorable outcomes, complications associated with PS-TKA can negatively impact long-term implant survival. Retrieval analyses of components during revision surgeries have demonstrated polyethylene tibial post wear as a significant issue (5). Aseptic loosening secondary to PE wear is a well-known cause of TKA failure (6). Tibial post fractures occur more frequently in FB designs due to constrained motion. In contrast, MB designs are associated with a lower risk of post fracture, as the insert's rotational freedom reduces stress concentration on the post (7–10).

In this study, we present a case of tibial post fracture of a polyethylene insert in a patient who underwent MB-PS TKA and subsequently developed knee instability—an uncommon but functionally significant complication.

2. Case History

A 72-year-old woman underwent primary TKA for right knee gonarthrosis approximately eight years ago. She received a MB-PS TKA with a polyethylene (PE) insert (Fig. 1). The patient lived in a rural area and remained physically active through agricultural work as a hobby. About one year after surgery, she developed mild knee pain and a subjective sense of instability, but declined further surgical intervention. As a result, she was managed conservatively with a soft knee brace and physical rehabilitation.

In the eighth postoperative year, the patient returned to our clinic with complaints of increased pain, a clicking sensation, worsening instability, and difficulty walking, requiring the use of a walker. Her medical history included controlled hypertension managed with antihypertensive medication. She

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was 153 cm tall, weighed 79 kg, and had a body mass index (BMI) of 33.7 kg/m².

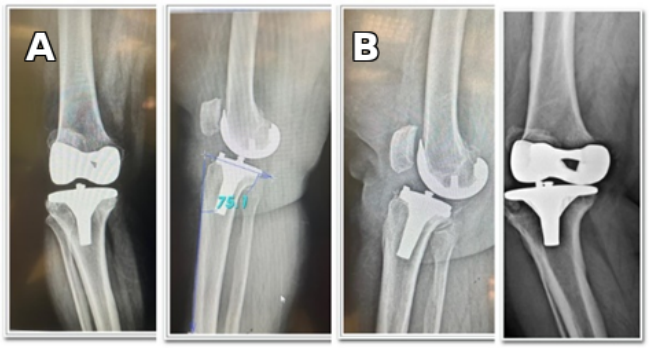

Fig. 1. Early and late postoperative radiographs of the patient. (A) Six-month postoperative radiograph demonstrating initial implant positioning. (B) Eight-year postoperative radiograph showing varus malalignment and increased posterior tibial slope (arrows), suggesting abnormal load distribution contributing to tibial post failure.

On examination, the patient reported instability and pain during ambulation, but no rest pain or tenderness. The right knee range of motion was limited to -10° extension and 90° flexion. There were no signs of infection such as erythema, warmth, or swelling. Ligamentous examination suggested intact medial and lateral collateral ligaments. However, anterior and posterior drawer tests were positive, indicating sagittal plane instability. Approximately 15° of varus deformity was noted. Laboratory findings were within normal limits: white blood cell count 6.05 x10⁹/L, erythrocyte sedimentation rate (ESR) 5 mm/hr, and C-reactive protein (CRP) 3.11 mg/L.

Radiologic evaluation revealed narrowing of the medial joint space, increased radiolucency at the tibial component-bone interface, signs of osteolysis around both the tibial and femoral components, and approximately 18° varus deformity. Lateral radiographs demonstrated anterior tibial subluxation. Retrospective analysis of early postoperative imaging revealed a tibial slope of 14.8°.

Based on these findings, a revision of both femoral and tibial components was planned under the preoperative diagnosis of aseptic loosening. Revision surgery was performed under combined spinal-epidural anesthesia. The knee was approached via the previous medial parapatellar incision. No abscess or hematoma was identified, although mild metallic discoloration was noted in the synovial tissue. Upon flexion of the knee, the PE insert was removed, revealing no significant wear except for a fractured tibial post. The fragment was located in the femoral intercondylar notch, encapsulated by reactive soft tissue, and was extracted.

Intraoperatively, medial migration and mobility of the tibial component into the bone were observed. No macroscopic signs of femoral component loosening were noted. Both components were removed in a stepwise manner. Macroscopic examination of the removed implants showed no visible damage to the metallic components (Fig. 2). Upon irrigation and inspection, the fractured tibial post of the PE insert exhibited severe corrosive wear on its anterolateral aspect. The posterior surface showed less abrasion in the region that articulates with the femoral cam mechanism (Fig. 3).

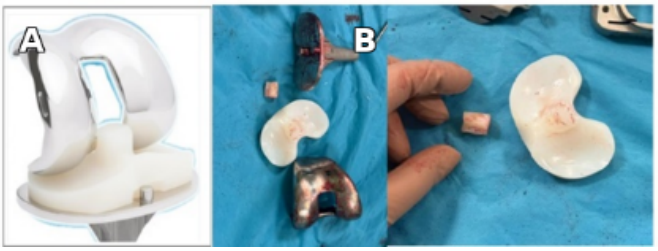

Fig. 2. Retrieved implant following revision surgery. (A) Postoperative radiograph after revision total knee arthroplasty. (B) Photograph of the removed polyethylene insert, demonstrating structural damage of the tibial post.

Fig. 3. Macroscopic view of the polyethylene (PE) insert. Visible wear and deformation on the anterolateral aspect of the tibial post are observed, consistent with repetitive cam-post impingement and localized stress concentration

During revision, new femoral and tibial components were implanted using cement fixation with extended stems. A properly sized PE insert was placed, and satisfactory joint alignment and stability were confirmed. The patient was mobilized on the first postoperative day with a walker. At the three-week follow-up, sutures were removed, and the patient demonstrated a right knee range of motion of 0° extension to 100° flexion, with no pain or instability.

3. Discussion

In this study, we report a case of PE insert tibial-post fracture in a patient who underwent MB-PS TKA. Retrospective analysis of early postoperative radiographs revealed a component malposition during the primary procedure. Excessive posterior tibial slope and significant varus alignment likely contributed to abnormal load distribution, leading to accelerated wear on the anterolateral aspect of the tibial post and eventual fracture. In addition, patient-related factors such as obesity may have further contributed to polyethylene wear. These findings highlight the critical importance of achieving optimal alignment during primary TKA.

Excessive posterior tibial slope increases anterior tibial translation during knee extension, resulting in abnormal contact between the femoral cam and the tibial post. This repetitive cam-post impingement leads to localized stress

accumulation and progressive polyethylene wear. In addition, varus malalignment shifts load distribution toward the medial compartment, producing asymmetric and eccentric loading on the tibial post. These combined biomechanical factors likely contributed to the accelerated wear observed on the anterolateral aspect of the tibial post and ultimately led to its fracture in the present case. This finding is consistent with previous biomechanical studies demonstrating that malalignment significantly increases stress concentration at the cam-post interface (8, 13).

3.1. Implant-related factors

Implant-related factors play a crucial role in tibial post failure. Compared to FB designs, MB inserts allow rotational freedom, which may reduce contact stress and delay polyethylene wear (1,3,4). However, despite these theoretical advantages, MB-PS designs remain susceptible to failure under conditions of abnormal loading, particularly when alignment is compromised (7–10). The reduced constraint in MB designs does not fully eliminate stress concentration on the tibial post, especially in the presence of repetitive impingement. In posterior-stabilized designs, the tibial post is subjected to both compressive and tensile stresses during articulation with the femoral cam, which may lead to material fatigue and eventual fracture over time (11,12).

3.2. Surgical factors

Surgical alignment is one of the most critical determinants of implant longevity. Instability resulting from inadequate ligament balancing and component malposition during primary TKA can predispose to tibial post failure (15). Sagittal malalignment, particularly excessive posterior tibial slope, may increase the risk of anterior tibial translation and impingement. Similarly, coronal plane malalignment, such as varus deformity, leads to uneven load distribution and increased stress on the medial compartment. Diamond OJ et al. reported a coronal plane valgus of 5–7° and an average tibial slope of 5.4° in the sagittal plane (8). In contrast, the present case demonstrated a tibial slope of 14.7° and varus alignment of 18°, which likely contributed significantly to the observed failure.

3.3. Patient-related factors

Patient-related factors may further contribute to implant failure. High body mass index (BMI) increases mechanical loading across the joint, while an active lifestyle may accelerate polyethylene wear through repetitive stress cycles (6,16). Previous studies have reported an increased risk of tibial post fracture in overweight and physically active individuals (6). In the present case, the patient had a BMI of 33.7 kg/m² and maintained an active lifestyle, which may have exacerbated the mechanical burden on the tibial post and contributed to progressive wear.

After fracture of the polyethylene insert, knee instability often becomes more prominent than pain (16). In the present case, the patient initially experienced mild pain, followed by progressive instability over time. Although no clear traumatic event was identified, the possibility of unrecognized minor or repetitive microtrauma cannot be excluded. This may explain the delayed recognition of polyethylene failure.

The time interval between primary TKA and tibial post fracture varies widely in the literature. Ueyama et al. reported an average duration of 40 months, while other studies have reported a mean duration of approximately 59.3 months (12–14,17–24). In contrast, the present case demonstrated a longer interval of 94 months, indicating that tibial post fracture may also occur in the late postoperative period and should not be considered solely an early complication.

As shown in Table 1, the number of reported cases of tibial post fracture in MB-PS TKA remains limited, and alignment parameters are frequently underreported in the literature. The pronounced varus alignment and excessive posterior tibial slope observed in our case highlight the potential synergistic effect of coronal and sagittal malalignment on tibial post failure.

Table 1. Summary of reported tibial post fracture cases in mobile-bearing posterior-stabilized total knee arthroplasty (MB-PS TKA)

Author (Year)	BMI (kg/m²)	Time to fracture	Alignment	Treatment
Ueyama et al. [6]	36.7	40 months	NR	Revision TKA
D'Angelo et al. [14]	39	NR	Malalignment	Revision TKA
Lee et al. [18]	27.8	NR	NR	Insert exchange
Present study	33.7	94 months	Varus deformity+increased posterior tibial slope	Revision TKA

Abbreviations: BMI, body mass index; NR, not reported; TKA, total knee arthroplasty.

Although polyethylene insert exchange is recommended in some cases, total revision surgery may be necessary depending on the extent of implant failure and associated instability (16,17). In our case, revision of both femoral and tibial components was performed to restore alignment and stability. Tibial post fractures have been reported across different implant designs (17,18), and further studies are warranted to better elucidate the underlying risk factors and optimize preventive strategies.

This case highlights the critical importance of achieving proper component alignment and soft tissue balance during TKA. Increased tibial slope and varus malalignment were observed in the initial procedure, which likely contributed to excessive polyethylene wear and eventual tibial post fracture in the MB-PS design. The observed severe wear on the anterolateral surface of the tibial post supports this hypothesis.

Despite the theoretical advantages of mobility in MB-PS polyethylene inserts, improper alignment can still result in high stress concentrations and material failure. Additionally, patient-related factors such as obesity and a physically active

lifestyle may exacerbate wear mechanisms.

This case emphasizes that surgical precision in alignment, along with consideration of patient-specific risk factors, is essential to ensure implant longevity and to prevent complications such as tibial post fractures. In cases where such complications arise, revision surgery should aim to correct alignment and restore soft tissue balance.

Early radiological evaluation should be considered in patients presenting with unexplained instability after TKA, as early detection of polyethylene wear may prevent catastrophic implant failure and the need for extensive revision surgery.

Conflict of interest

The authors declare that they have no conflict of interest.

Informed patient consent

The authors declare that written informed consent has been obtained from the patient concerned and consent to the publication of the information provided in this study.

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Authors' contributions

Concept: T.A., Y.E.Ş., S.G., Design: T.A., Y.E.Ş., Data Collection or Processing: T.A., Y.E.Ş., Analysis or Interpretation: T.A., Literature Search: T.A., Writing: T.A, Y.E.Ş.

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