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Late recognition of an early catastrophic failure of a carbon fiber reinforced distal femoral plate: A case report☆

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ABSTRACT

The use of carbon fiber reinforced implants to address distal femur fractures has gained in popularity due to their favorable mechanical characteristics and potential for improved healing. The failure of metal locked plates for this application has been widely reported. Here is presented a novel case of early failure of a carbon fiber reinforced polyetheretherketone (PEEK) plate applied for a distal femur fracture. This is the first known report of failure of a carbon fiber reinforced distal femur plate in a patient with a traumatic fracture. Due to the radiolucent characteristics of the plate, the failure was not immediately recognized. While there may be advantages to these plates, early catastrophic failure can still occur.

Introduction

Lateral locked plating has become a standard method of fixation of distal femur fractures. Typically, stainless steel or titanium plates are used. Carbon fiber reinforced polyetheretherketone (PEEK) plates have potential advantages when compared to metal alloy plates. They have a Young's modulus closer to cortical bone and improved fatigue strength. Their radiolucent properties can improve radiographic fracture visualization visualization of the fracture and healing process [1].

Published series have shown encouraging results using carbon fiber PEEK plates to treat distal femur fractures. There are trends to earlier union and decreased rates of implant failure [2–4]. However, catastrophic failure of the plate can occur. Here we present a novel case of an early fracture of a carbon fiber reinforced PEEK plate.

Case report

The patient is a 64-year-old woman who suffered a standing level fall at home. Imaging was significant for a comminuted distal femur fracture (OTA fracture classification 33A3.3) and significant preexisting osteoarthritis (Fig. 1). Due to the fracture pattern and the patient's recent apixaban use, external fixation was performed by the on-call orthopedic surgeon.

Six days later, she underwent a second surgery to remove the external fixation and perform open reduction and internal fixation with application of a carbon fiber reinforced PEEK lateral distal femur plate (CarboFix Orthopedics, Inc. Ocean Isle Beach, North Carolina). This was affixed with locking screws in the distal fragment and non-locking screws in the diaphysis (Fig. 2).

☆ This work has not been previously presented at any meeting in whole or in part

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Post-operatively, the patient was permitted to weight bear as tolerated. On post-operative day 1 (from open reduction and internal fixation), she reported an audible snap when standing with physical therapy. She did not have any increased pain. She continued to work with therapy and was able to stand for 2–3 min at a stretch. She was transferred to an inpatient rehabilitation facility on post-operative day 3.

On post-operative day 7, a femur X-ray was taken at the inpatient rehabilitation facility due to increasing pain and instability at the fracture site (Fig. 3). This was read as normal findings by the radiologist. On post-operative day 11 the surgeon was consulted who reviewed the X-ray, determined that the plate had fractured, and recommended revision surgery.

On post-operative day 14, she underwent revision surgery. At time of surgery, the plate was noted to have failed with multiple small fragments in the zone of the plate fracture. The plate and fragments were removed (Fig. 4). Reduction was obtained and then fixation was achieved with both a retrograde intramedullary femoral nail (DePuy Synthes, Warsaw, Indiana) and titanium distal femur locking plate (Zimmer, Inc. Warsaw, Indiana).

After revision surgery, she was allowed flat-foot touchdown weight bearing. She was transferred to an inpatient rehabilitation facility on post-operative day 4. She progressed and was discharged home after a 15-day rehabilitation stay. She was allowed to progress to weight bearing as tolerated at 7 weeks post-operatively. At six months after surgery, she was able to bear full weight on the operative leg with minimal pain, but still used a walker for ambulation. She returned to work 7 months after the second surgery. At one year after surgery, the patient reported minimal to no pain in the operative leg. Progressive radiographic healing was seen on the x-ray. She continued to use a walker for ambulation.

Discussion

Distal femur fractures remain challenging fractures to treat. Significant effort has gone into optimizing the fixation construct including modifying the plate length, plate screw interface, and plate material [5,6]. Nonunion rates are high, with reported rates of 3–40% [4].

Carbon fiber PEEK implants have potential advantages over traditional metal implants with few reports of failure in the literature. While there may be advantages to carbon fiber PEEK implants, early catastrophic failure can still occur. These plates are radiolucent with a thin embedded strip of radiopaque material. As these plates remain less common than traditional metal plates, not all physicians may be familiar with this feature, especially if they do not employ these plates in their own practice. This can make recognizing construct failure more challenging. In our case, there was a delay in diagnosis as the radiologist did not recognize the discontinuity in the radiopaque line.

There are two other published accounts of failure of a carbon fiber reinforced PEEK plate. In the first case the entire plate pulled off the bone rather than breaking [3]. The more recent case involved a patient with a pathologic fracture [7]. In this case, the plate fractured after four months, which is far later than in the case reported here. There are two case reports of fracture of carbon fiber reinforced intramedullary nails [8,9].

Much like the few other case reports of carbon fiber PEEK implant fracture, this implant failure resulted in multiple small carbon fiber PEEK fragments. Fortunately, carbon fiber PEEK fragments have been shown to be relatively inert in animal studies [10]. However, the long-terms effects of carbon fiber PEEK splintering remain unknown.

While carbon fiber PEEK plates do offer potential advantages to metal plates, early catastrophic failure can occur. Surgeons should

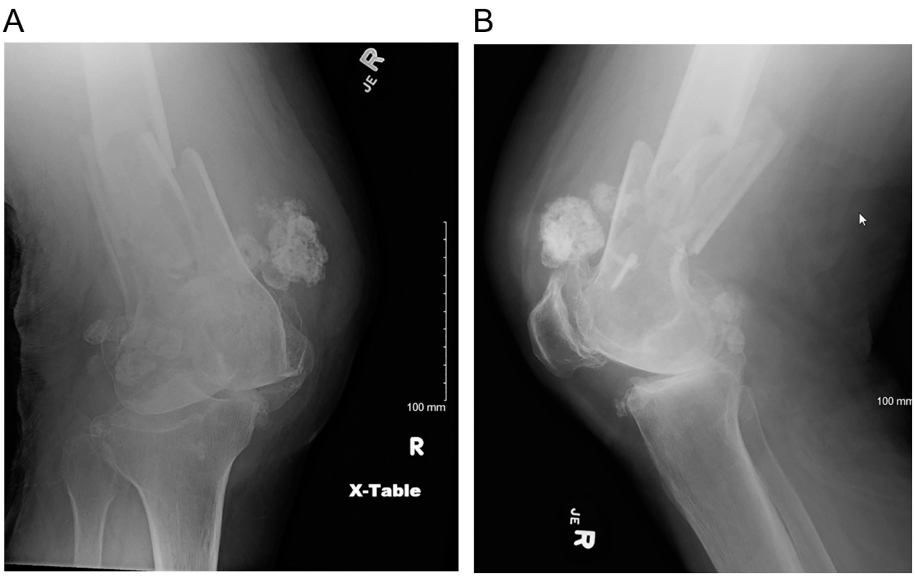

Fig. 1. AP and lateral knee x-rays showing the distal femur fracture with significant pre-existing arthritis and osteochondral loose bodies.

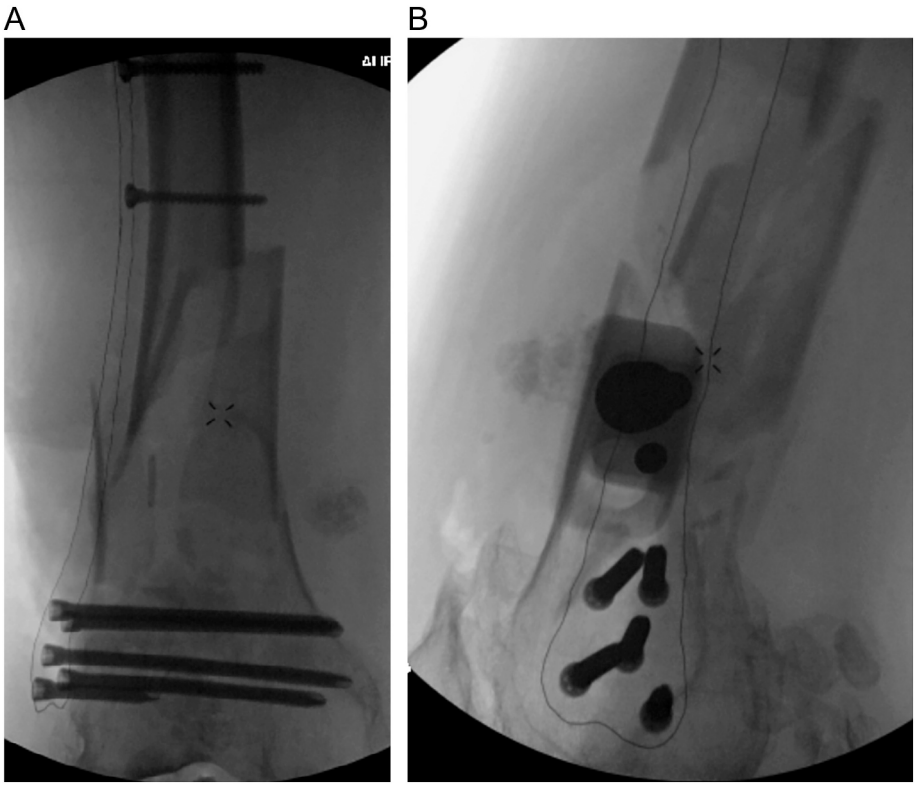

Fig. 2. Intraoperative AP and lateral fluoroscopic images after fracture open reduction and internal fixation with a carbon fiber PEEK plate.

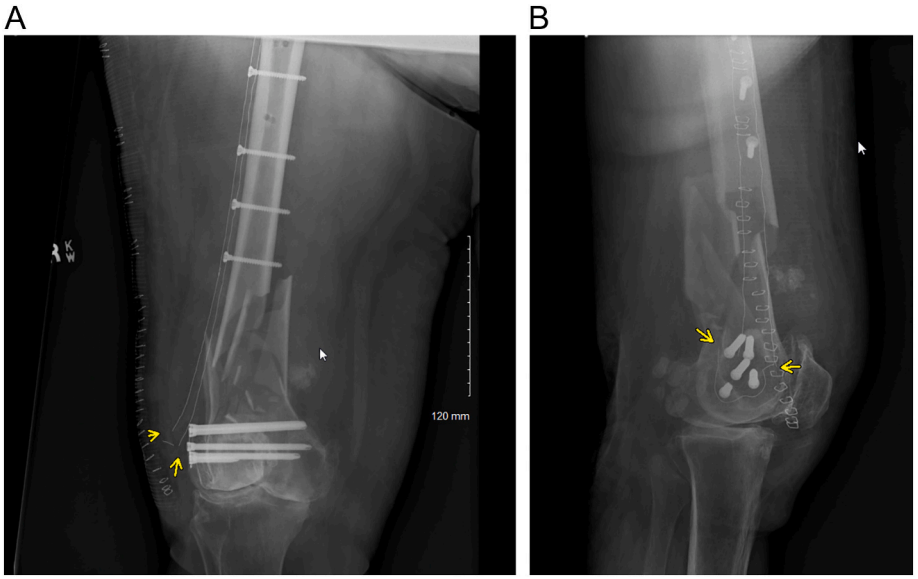

Fig. 3. AP and lateral knee x-ray taken on post-operative day 7 due to increasing pain. Note the discontinuity in the radiopaque wire embedded within the plate.

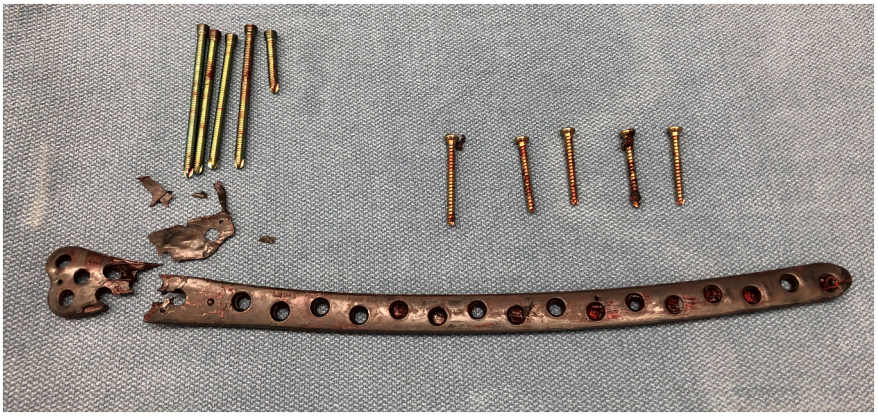

Fig. 4. Photograph showing the explanted carbon fiber PEEK plate and titanium screws. There is extensive fragmentation at the point of fracture.

be alert to this possibility and scrutinize x-rays due to the radiolucent nature of the plate. Additional studies are needed to further delineate the role of carbon fiber PEEK implants in the orthopedic armamentarium.

Informed consent

The patient in this case was informed that the data concerning her case would be submitted for publication and she agreed.

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Declaration of competing interest

None.

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