Progressive Migration of Broken Kirschner Wire into the Proximal Tibia Following Tension-Band Wiring Technique of a Patellar Fracture
Case Report

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Abstract
Wire breakage and migration is a known complication of using a wire tension band construct to treat displaced patella fractures. We report a case of a broken K-wire that migrated from the patella completely into the proximal tibia without complication 9 years after the index surgery. This report highlights the fact that wire migration can occur long after fracture healing and be relatively asymptomatic. But because the complications of wire migration can be deadly, it requires diligence on the part of the physician to educate the patient that new knee pain after operative fixation requires formal evaluation by the treating surgeon.

Hardware failure and subsequent migration is a feared complication of smooth wire fixation. A common application of cerclage wiring and K-wires for a tension band construct is treatment of displaced patella and olecranon fractures. Hardware irritation following these procedures is common, while failure is less so. Rarely, this symptomatic retained hardware can migrate causing potentially serious complications. We describe a case of a broken K-wire that has migrated from the patella into the proximal tibia and remained in position without complication. The purpose of this case report is to bring attention to the treating surgeon that migration of smooth wires may occur long after fracture healing and can be relatively asymptomatic. Site of migration is potentially problematic and may therefore require removal.

Case Report
A 48-year-old male underwent primary operative fixation of a displaced, transverse patellar fracture of the right knee in May 1999 using a modified anterior tension band technique. Intraoperatively, two 1.6 mm K-wires and an 18 gauge cerclage wire were used for the tension band construct. He was treated postoperatively in a hinged knee brace locked in extension and allowed to weight-bear as tolerated. Early active and passive range-of-motion in the hinged knee brace was started at 2 weeks postoperatively after the surgical incision had completely healed. The patient was completely weaned from the knee brace at 3 months postoperatively with no complaint of knee pain and had no residual extensor lag.

Routine plain radiographs obtained approximately 1 year postoperatively (August 2000) demonstrated K-wire and cerclage wire breakage without displacement of the hardware (Fig. 1). The patient did not complain of any knee pain and did not recall any incident of trauma to the knee since the surgery. He was advised that serial radiographs of the knee should be obtained to monitor for wire migration; however, the patient was lost to follow-up for the next 7 years.

The patient returned to the office in February 2007 for evaluation of mild, intermittent anterior right knee pain, and plain radiographs demonstrated distal migration of the lateral K-wire (Fig. 2). Also noted was a newly identified fatigue break through the proximal aspect of the medial K-wire. Given the local migration of the hardware, the patient was advised that all retained hardware should be removed secondary to risk of migration into the intra-articular space potentially leading to chondral damage as well as potentially migrating out of the knee joint. The patient refused operative intervention at this time. He was then advised that serial radiographs should be obtained to monitor for further migration, but the patient did not return for follow-up until 2.5 years later (August 2009). The patient stated that his
knee pain had resolved. Plain radiographs at this visit demonstrated migration of the lateral K-wire completely into the proximal tibia without migration of the medial K-wire or the cerclage wire (Fig. 3). The patient has continued to refuse removal of hardware despite having full knowledge of the risks of retained broken K-wires and cerclage wires. The investigators have obtained the patient’s informed consent for print and electronic publication of the case report.

**Discussion**

Migration of broken K-wires after use in fracture fixation has been reported in the literature for a variety of surgical procedures including operative fixation of sternal fractures,

**Figure 1** AP and lateral plain radiographs taken approximately 1 year postoperatively demonstrating a healed patella fracture with a break in the proximal aspect of the lateral K-wire and a break in the proximal loop of the cerclage wire. There is no displacement of the hardware.

**Figure 2** AP and lateral plain radiographs approximately 7 years postoperatively demonstrating migration of the lateral K-wire distally. There is also a new break in the proximal third of the medial K-wire that does not demonstrate any displacement. The patient was complaining of mild, intermittent anterior knee pain. He refused removal of the hardware.
acromioclavicular joint dislocations, proximal humerus fractures, distal radius fractures, finger fractures, and patellar fractures.\textsuperscript{1-10} Complications arising from migration of these K-wires have been as benign as migration into adjacent soft tissue to as severe as migration into the heart causing cardiac arrhythmias, pericardial tamponade, and death.\textsuperscript{4,11}

In a search of Medline, English language journals, three separate case reports were identified that described four patients, each of whom had undergone cerclage wiring of the patella (two patients had modified anterior tension band (MATB) constructs, and two patients had circumferential cerclage wiring) and subsequently experienced failed hardware that migrated out of the soft-tissue envelope surrounding the patella.\textsuperscript{8-10}

Biddau and colleagues\textsuperscript{8} described the migration of the superior portion of a circumferential cerclage wire to the heart likely through the venous system for which the patient had to undergo sternotomy and a right atriotomy while on cardiopulmonary bypass. They recommended consideration for removal of broken hardware in young, active patients as they may incur higher risk of migration of fragments due to increased motion about the knee joint. Furthermore, they recommended Doppler ultrasound examination of any broken hardware that exhibited local migration around the knee joint to evaluate the proximity of the wire fragments to larger vessels. If proximity to a large vessel was noted, they thought it might influence the surgeon’s decision to remove the hardware.

Choi and associates\textsuperscript{10} described two cases of migration of broken cerclage wire and K-wire. In both cases, the patients complained of pain in the posterior aspect of the knee. In one case, they felt that standard operative technique was not followed adequately because a 2-knot tensioning technique was used, and this may have resulting in weakening the overall strength of the construct. This theory is not supported in the literature as we were unable to identify any biomechanical studies that suggested that 2 knots weaken the cerclage construct. In their other case, they felt that too thin a K-wire was used which weakened the construct although they state they were unable to identify the exact size of the wire. Traditionally, if K-wires are used to maintain the reduction, 1.6 mm K-wire are used.\textsuperscript{1} In both cases, they noted that the K-wires traveled through the subretinacular tissue into the popliteal fossa in close proximity to the neurovascular bundle.

Chen and coworkers\textsuperscript{9} described a case of intra-articular migration of a broken cerclage wire 3 years after the index surgery of circumferential cerclage wiring of a comminuted patellar fracture in which the patient presented with a swollen, painful knee. An arthrotomy was performed to remove the intra-articular fragment. The investigators felt that the cerclage wire was placed too posteriorly around the patella; thus, when it broke, there was little to no posterior soft-tissue buttress, and the broken wire easily penetrated through the joint capsule. They recommended paying extra attention to place the circumferential wire anterior in the substance of quadriceps and patellar tendon so that adequate soft tissue remained between the wire and the capsule.

\textbf{Figure 3} AP and lateral plain radiographs approximately 8 years postoperatively demonstrating migration of the distal two-thirds of the broken lateral K-wire completely into the proximal tibia. The patient was no longer complaining of knee pain.
In our case, a MATB technique was used with K-wires used to hold the reduction. The K-wires were bent proximally around the cerclage wire but were not bent distally. The patient initially complained of intermittent anterior knee pain, and radiographs of the knee demonstrated that the broken K-wire had migrated completely into the proximal tibia. We believe the broken K-wire migrated during knee motion and was driven into the proximal tibia. The wire remained extra-articular and did not appear to damage the tibial chondral surface. Migration into the proximal tibia may have been prevented had we utilized the technique described by Wu and colleagues whereby both the proximal and distal tips of the K-wire are bent around the cerclage wire to prevent migration of the K-wire.12

Ultimately, it is important for the treating surgeon to be aware of broken smooth wires about the knee after operative fixation of patellar fractures given the complications that can arise from both local migration and distant migration of the wire fragments. Local migration of broken wire fragments into the intra-articular space may cause irreversible chondral damage, and migration into the surrounding soft-tissue and bone can be a source of knee pain. If wire fragments migrate into the vicinity of the posterior neurovascular bundle, they have the potential to lacerate the popliteal vessels and migrate distally via either the venous or arterial system and act as emboli causing damage to distal vessels or cardiac complications such as cardiac arrhythmia, pericardial tamponade, and death.4,11 Knowledge of these potential complications will allow surgeons to appropriately counsel their patients for clinical and radiographic follow-up if new knee pain arises after successful operative treatment of patellar fractures and for serial radiographic follow-up if broken hardware is noted even in the absence of knee pain.

Conclusion
When performing repair of patella fractures utilizing a K-wire tension band technique, the patient should be counseled that hardware breakage is a possibility and that a second operation may be necessary to remove the broken implants. Other options include using alternative fixation constructs such as screws or braided suture. These constructs have been shown to be as biomechanically sound as their cerclage wire counterparts and less likely to require removal.3,14 We encourage surgeons to counsel their patients that onset of knee pain after successful treatment of patella fractures using smooth wires could potentially signal wire breakage or migration and should warrant clinical and radiographic evaluation. Once implant failure has been recognized, serial radiographic evaluation of known broken wire fragments should be undertaken to evaluate for wire migration even in patients without knee pain. The combination of patient age, activity level, and proximity of wire fragments to the intra-articular space and the posterior neurovascular bundle should aid the surgeon in determining if wire fragments should be removed.

Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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