Are Terminally Threaded Guide Pins From Cannulated Screw Systems Dangerous?

WALKER FLANNERY, BS; JOSHUA BALTS, BS; JAMES J. MCCARTHY, MD; JEFFREY SWICK, BS; KENNETH J. NOONAN, MD; JEREMY OLSON, BS

abstract

Threaded and smooth pins are often used in orthopedic surgery. Although uncommon, injury to the soft tissues can and do occur, including nerve or vessel injury from aberrant pin placement. The purpose of this study was to compare the risk of nerve injury from threaded pins versus smooth guide pins due to: (1) past-point-drilling of the pin, or (2) entanglement of the pin with soft tissue. Past-point drilling was tested by a blindfolded participant drilling a 1.6-mm guide pin (terminally threaded or smooth) through a porcine femur until they felt they had drilled through the second cortex. The distance over-drilled was measured in millimeters. Twenty trials were randomly completed, 10 with each pin type. Entanglement of soft tissue was tested by placing the terminal portion of the guide pin on the nerve. Two drilling positions were tested: (1) drilling at 90° and (2) parallel to the nerve. The drill was run for 1 second and assessed for entanglement and magnitude of entanglement (measured in millimeters of nerve wrapped by the pin). Sixty trials were completed, 15 with each pin type, and in each of the 2 positions. The average past-point drilling depths were 4.6 and 16.9 mm for the smooth and threaded pins, respectively (P < .05). The mean nerve overwrapping was 0.45 and 4.7 mm, for the smooth and threaded pins, respectively (P < .05), drilled at 90° and 0.15 and 0.92 mm, respectively (P < .05) in the parallel position. In 13 of 60 trials with the smooth pin and 50 of 60 trials with the threaded pin, wrapping was observed (P < .05). This study demonstrates that it is difficult to determine by feel when the threaded pin has drilled through the second cortex of the bone, in contrast to the smooth pin. Furthermore, soft tissue entanglement is more likely and to a greater magnitude with threaded pins than with smooth.

Messrs Flannery, Balts, Swick, and Olson are from the School of Medicine, University of Wisconsin, Madison, Wisconsin; Dr McCarthy is from the Division of Orthopedic Surgery, Cincinnati Children’s Hospital Medical Center, Cincinnati, Ohio; and Dr Noonan is from the Department of Orthopedics and Rehabilitation, American Family Children’s Hospital, Madison, Wisconsin.

Messrs Flannery, Balts, Swick, and Olson, and Drs McCarthy and Noonan have no relevant financial relationships to disclose.

Correspondence should be addressed to: James J. McCarthy, MD, Division of Orthopedic Surgery, Cincinnati Children’s Hospital Medical Center, 3333 Burnet Ave, ML 2017, Cincinnati, OH 45229 (james.mccarthy@cchmc.org).

doi: 10.3928/01477447-20110627-16
Kirschner wires are widely used in orthopedic surgery for various procedures, including primary fixation of fractures or temporary fixation. Numerous serious complications have been reported with the use of K-wires (eg, wire breaking, loosening, migration, overgrowth, and infections), so threaded K-wires were introduced to alleviate movement-type complications. Terminally threaded guide pins are often used with the belief that they will not back out or inadvertently advance while over-drilling and placing a screw. However, potential problems exist with the threaded K-wire that must be considered by the attending surgeon. The “feel” when advancing the threaded wire is different than smooth wire and unintended penetration through bone may be less avoidable. Additionally, the threaded portion of the wire may more easily engage soft tissue structures. Both of these could lead to a higher risk of unintended nerve or vessel injury.

Previous studies have assessed duration of K-wire use, number of K-wires used, and K-wires versus plate and screw systems, but this is the first study to our knowledge, that addresses the differences between smooth and threaded K-wires. For the purposes of this study, we quantified the possibility of injury to neurovascular structures by terminally threaded and smooth K-wires in 2 ways: (1) we measured the degree of “past-point drilling” and compared smooth versus threaded K-wires, and (2) we measured the likelihood and degree of soft tissue wrapping on a smooth versus threaded K-wire.

We hypothesized that threaded K-wires would decrease the ability to feel when the second cortex has been pierced, and therefore increase the amount of overshoot through the second cortex. Furthermore, we postulated that terminally threaded K-wires would wrap the nerves to a greater degree than smooth K-wires.

**Materials and Methods**

**Past-Point Drilling**

Porcine femurs were taken from pigs ranging in age from 9 months to 2 years; they were fresh cadaver bones. A handheld cordless drill (Stryker 2012; Stryker, Mahwah, New Jersey) was used with both the terminally threaded and smooth 1.6-mm K-wires. The drilling was performed by 3 people: an orthopedic surgeon, a fifth-year orthopedic surgery resident, and a second-year medical student.

To assess past-point drilling, the femur was secured in a vice and the participants were blindfolded. The K-wire was positioned in the drill and over the diaphysis of the bone adjacent to the vice by a third party who supervised the procedure. The study participants were asked not to drill beyond the outer portion of the second cortex (ie, not to plunge), so they drilled until they felt like they had just penetrated through the second cortex. The distance penetrated through the second cortex was measured with a ruler and recorded in millimeters.

The participants were asked whether they felt initial contact with the far side (second) cortex, and the supervisor recorded whether the participants had plunged through the second cortex. A total of 20 trials were conducted: 10 using threaded K-wires and 10 using smooth K-wires. Each participant was given smooth or threaded K-wires in a random pattern. New K-wires were used for each participant.

**Nerve Wrapping**

Nerve wrapping was assessed using nerves taken from pigs ranging in age from 9 months to 2 years that were fresh frozen within 1 hour of death. Following overnight thaw, the nerves were dissected out and placed into 0.9% sodium chloride irrigation. A handheld cordless drill (Stryker) was used with both the threaded and smooth K-wires. Two drilling positions were examined: drilling at a 90° angle to the table (Figure 1) and drilling parallel to the table (Figure 2). For parallel drilling with both the threaded and smooth wires, the distal first centimeter of the tip of the pin was placed on the nerve. For the threaded K-wire, the threaded portion was placed on the nerve. The two participants in the nerve portion of the study were both second-year medical students.

The nerves were removed from irrigation and placed onto a paper towel to remove any excess liquid on them, but were maintained in a moist state. Next, they were placed directly on the bench top and gently stretched out to their maximum length. They were measured using a ruler and the lengths were recorded. The participant then placed the drill, with the appropriate K-wire (threaded or smooth) randomly chosen, in the correct position (90° or parallel). The participant ran the drill for a 1-second burst. After the drill was run, the status of the nerve was assessed: either wrapped or not. Figures 3 and 4 show a wrapped nerve in the 90° and parallel drill positions, respectively. If it had wrapped around the wire, the nerve was re-measured to find its post-drilling length. The wrapped length was calculated as the pre-drilling nerve length minus the...
post-drilling nerve length (assuming the difference in nerve length was due to the portion of the nerve wrapped around the wire). This wrapped length was recorded.

For each participant’s testing parameter (ie, threaded K-wire in the 90° drill position), the drill was run 5 times; threaded and smooth pins were used in random order. At the end of each run, the nerve was placed back into the 0.9% sodium chloride irrigation. The next nerve was selected, and the same testing conditions were performed on that nerve. This process was repeated until all of the nerves had been used for those specific settings. Then, the other participant would perform the exact same order of tests until they had used all of the nerves in those specifications. A total of 60 tests were performed to assess wrapping: 15 tests were performed with both the threaded and smooth K-wires, and 15 tests with each type of wire in both the 90° and parallel positions.

**Statistical Methods**

The data were analyzed to ensure equal variances and a normal distribution. The distance drilled beyond the second cortex (past-point drilling), and the wrapping distance for threaded and smooth K-wires were compared using a standard t test (2 tailed). A $P$ value < .05 was considered significant.

**RESULTS**

The average past-point drilling was 4.2±1.6 mm for the smooth pins and 16.9±6.9 mm for the terminally threaded pins ($P<.05$). In 5 of 10 threaded pin cases, the participant drilled until the hub of the drill limited further advancement, indicating that the second cortex was never identified; however, this did not occur in any of the trials in which the smooth pin was used. There was only one instance in which the second (inner) cortex was identified when the participant drilled using the threaded guide pin. Plunging of the pin (ie, rapid advancement after penetrating the second cortex) occurred in 1 of 10 trials with the smooth pin, and not threaded pins. Although, even in this case the pin tip advanced only 8 mm, which was less than even the “best” terminally threaded screw. Despite the level of training, there was no statistical difference between participants. The mean past-point drilling is for each participant is shown in the Table. This study design was not meant to evaluate differences in experience and degree of past-point drilling.

Overwrapping occurred more commonly and to a greater extent with the threaded tip K-wire. At the 90° position, mean overwrapping was 0.5±1.2 mm for the smooth pins and 4.7±3.3 mm for the terminally threaded pins ($P<.05$). In the parallel position, mean overwrapping was 0.2±0.27 for the smooth pins and 0.9±0.15 mm for the terminally threaded pins ($P<.05$). In 13 of 60 trials with the smooth pin and 50 of 60 trials with the threaded pin, wrapping was documented ($P<.05$).

**DISCUSSION**

The terminally threaded pin advanced further beyond the outer limit of the second cortex, with little “feel” of either initial contact with or penetration through the second cortex of the bone. The threaded K-wire advanced in a smooth, constant fashion and although they never plunged unexpectedly, they advanced well beyond the cortex in all cases and were more likely to wrap the nerve more often and to a greater extent than the smooth wire. The smooth pin provided the normal “feel” of the second cortex and rarely advanced more than a few millimeters beyond the outer limit of the second cortex. However, in 1 case 1 participant suddenly plunged forward as the wire exited the second cortex. In clinical practice, plunging can be avoided by proper technique, but with a threaded K-wire, there is no proprioceptive feedback and even in experienced hands, can advance the guide pin well beyond the second cortex.

Regardless of pin type, practitioners must be cautious when using both types of K-wires. We recommend the use of fluoroscopy to determine location in bone, especially for threaded K-wires. The surgeon must be aware of the neurovascular structures that lie beyond the second cortex and should consider using a smooth guide pin, especially if structures are at risk as they lay adjacent to the second cortex. The lack of “feel” with a threaded pin can be deceiving, but smooth wires could potentially plunge through the second cortex. This may be especially important if there are structures at risk beyond the second cortex, such as the radial nerve in pinning a medial epicondyle fracture or the articular surface when using guide pins in the hip.

Weaknesses of this study include the inability to blind participants during the nerve wrapping portion of the study. Blinding was attempted, but it was too difficult to accurately place and keep the K-wire in the appropriate location.
tionally, this is an in vitro study, so nerve characteristics may not mimic the in vivo environment.

CONCLUSION
This study demonstrates that it is difficult to determine by feel when the threaded pin has drilled through the second cortex of bone in contrast to the smooth pin (or standard drill bits), even for experienced surgeons. Therefore, sensitive structures (eg, nerves, vessels, or articular cartilage) are at much higher risk when using a threaded pin versus a smooth pin. Additionally, soft tissue entanglement is more likely with threaded pins than smooth pins although it could occur with either.

REFERENCES