The Principles of Interference Screw Fixation: Application to Foot and Ankle Surgery

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Based on the success of the anterior cruciate ligament model, interference screw fixation is now being applied to a wide variety of orthopedic conditions that require the fixation of tendon or ligament to bone. The primary focus of this article is to present the principles of interference screw fixation. By understanding the principles of interference screw fixation, the foot and ankle surgeon will be able to apply this fixation technique to a wide variety of surgical applications for tendon transfers or ligament repairs. The surgical technique, history, principles of fixation, studies of fixation strength, tissue healing, and foot and ankle indications are reviewed. A modified Girdlestone digital flexor tendon transfer procedure description is included to illustrate how interference screw techniques may be applied to foot surgery. (The Journal of Foot & Ankle Surgery 44(6):455–461, 2005)

Key words: interference screw, tendon transfers, flexor tendon transfers, foot

Interference fixation is accomplished when a soft tissue graft (tendon or ligament) or a soft tissue graft with an attached bone plug is placed into a cancellous bone tunnel. The graft is then secured with a screw, by side-to-side compression, against the wall of the cancellous bone tunnel. In time, screws were designed specifically for interference fixation and were marketed as "interference screws."

In 1983, Lambert presented a new surgical technique for fixating anterior cruciate ligament (ACL) reconstruction grafts (1). In Lambert's technique, the patellar bone-tendon-bone graft was placed across the knee to replicate the ACL and inserted within both tibial and femoral bone tunnels (Fig 1). The graft was fixated distally and proximally with 6.5 × 30-mm cancellous surgical screws. The screw fixation compressed the patellar bone-plug portion of the graft against the wall of the bone tunnel. This technique allowed for modulation of the appropriate tension of the ACL graft. The interference fixation maintained tension, while the patellar bone plug healed to the wall of the cancellous bone tunnel.

In 1987, Kurosaka developed a custom 9.0-mm large diameter headless cancellous screw for ACL reconstruction and interference fixation (2). Kurosaka tested the strength of his 9.0-mm interference screw fixation against other means of fixation including staples, suture button techniques, and the 6.5-mm cancellous screw technique. The 9.0-mm interference screw provided the greatest strength of fixation. When testing patellar bone-tendon-bone grafts, Kurosaka's custom 9.0-mm interference screw had tensile strength of 475.8 ± 110.9 N, whereas the interference screw used by Lambert demonstrated a tensile strength of 208.0 ± 27.5 N. Because of the significant increase in strength of fixation documented in Kurosaka's study, most of the interference screws currently used in ACL reconstruction are large-diameter, headless, cannulated screws.

Later, authors reported that the patellar bone-tendon-bone technique for ACL repair was associated with an increase in postoperative dysfunction of the knee extensor mechanism (3–6). In 1996, Scranton et al described a technique in which a hamstring tendon graft without bone plugs was fixated directly to the walls of the tibial and femoral bone tunnels with a metal interference screw (7). The success of fixating soft-tissue grafts without bone plugs directly to the wall of a cancellous bone tunnel has given rise to a variety of similar orthopedic techniques.

In the upper extremity, authors have recommended the use of interference screws to reattach the biceps tendon to the humeral head, reattaching the ulnar collateral ligament to the medial epicondyle of the humerus, and to repair the ulnar collateral ligament in gamekeeper's thumb (8–11). In the foot and ankle, interference screws have been used for tissue fixation in lateral ankle stabilization, flexor digitorum longus (FDL) transfers for the treatment of posterior tibial tendon insufficiency, and split tibialis anterior tendon transfers (12–14).

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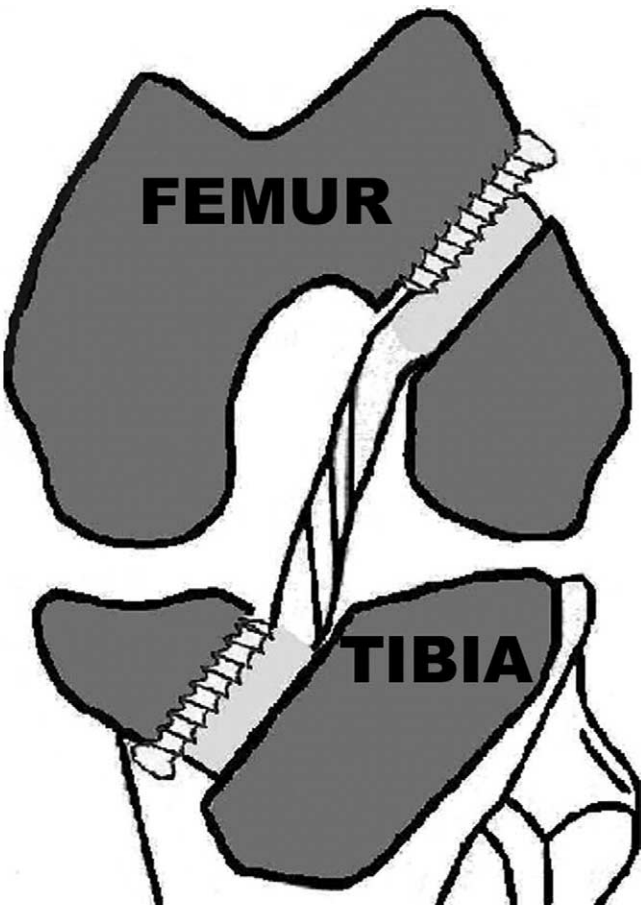

FIGURE 1 The initial description of interference fit fixation by Lambert (1). A patellar bone-tendon bone graft is secured in the femur and tibia with two 6.5- × 30-mm cancellous screws. Reprinted with permission.[1]

Variable of Interference Screw Fixation

There are 6 variables to interference screw fixation: the screw composition, shape of the interference screw, the diameter of the tissue graft, the diameter of the bone tunnel, and the diameter and length of the implant.

Interference Screw Material: Metal Versus Bioabsorbable

Initially, ACL repairs were performed exclusively with metal interference screws (1). But metal interference screws have several drawbacks. Metal screws were noted to migrate outside the bone tunnel, resulting in reduced fixation strength. In addition, the screw threads can lacerate the graft, and the ferromagnetic characteristics can interfere with magnetic resonance imaging (MRI) (15). Numerous studies have been performed comparing fixation strength of metal and bioabsorbable interference screws in ACL reconstruction, whether patellar bone-tendon-bone or hamstring grafts (15–24). They have demonstrated nearly equivalent strength between the metal and bioabsorbable interference screws.

Interference Screw Thread Shape

The initial Kurosaka type of metal interference screw was designed for compressing the bone plugs of a patellar bone-tendon-bone graft into tibial and femoral bone tunnels (2). Because this type of screw was designed for bone-to-bone fixation, the metal threads were somewhat sharp. When this type of screw was used for hamstring tendon-to-bone compressive fixation, the screw threads would lacerate and weaken the tendon graft (3). Metal and bioabsorbable interference screws with blunt/rounded threads reduce the risk of tendon injury, and are therefore recommended (3).

The Effect of Graft Diameter, Bone Tunnel Diameter, and Screw Diameter

Typically, the tendon or bone plug diameter, the bone tunnel diameter, and the interference screw diameter are of identical width. The bone drill-hole diameter obviously must match or exceed the size of the tendon diameter. The tendon diameter may be measured with sizing sleeves before selecting the size of the drill bit. Studies have demonstrated that greater fixation strength is obtained when the drill hole diameter more closely matches the tendon or bone plug diameter (25). When transferring smaller diameter tendons, such as in foot and ankle surgery, and with a small-diameter, bioabsorbable interference screw (<5 mm diameter), the drill hole may need to be slightly oversized. If the drill hole is too small, the smaller-diameter, bioabsorbable interference screws may not withstand the insertional torque as well as a larger-diameter interference screw, and the screw may fragment on insertion. This is particularly true for cannulated interference screws. If a substantial portion of the implant has been inserted and the head becomes fragmented due to insertional torque, one can assume that fixation is adequate. The surgeon may then resect the visible portion of the bioabsorbable interference screw.

In a cadaveric study, Louden et al compared the fixation strength of tendons placed into drill holes of 2 different sizes (26). In one part of the study, the flexor hallucis longus (FHL) tendon was placed into a calcaneal drill hole either 5.5 or 6.5 mm in diameter. The tendon was secured with a 7- × 20-mm bioabsorbable interference screw. The peak pull-out strength was approximately 170 N with both drill holes. In the second part of the study, the FDL tendon was placed into the medial navicular with a 5- × 20-mm bioabsorbable cortical screw and either a 3.9-mm or 4.5-mm