CHAPTER **52**

PRINCIPLES AND TECHNIQUES OF TENDON AND LIGAMENT REPAIR

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INTRODUCTION

Surgical repair of soft tissue structures, including tendon, ligament, or capsule can be quite challenging. Various techniques may be utilized in a range of procedures, from emergent to elective, including laceration, retubularization, lengthening, and transposition or transfer. Advancements in repair techniques have been made, as well as modifications of standard repair techniques. It is the primary aim of this update to provide specific techniques for many commonly encountered podiatric procedures. Advancements in core suture techniques will be discussed for tendon laceration repair. Additionally, tendon retubularization, tendon shortening or reefing, and capsule or tendon plication techniques will be discussed. Current recommendations of tendon repair guidelines, as well as the above mentioned specific repair techniques will be reviewed.

CORE SUTURE TECHNIQUES

For tendon laceration or lengthening procedures, core suture repair techniques may be employed. Many variations of tendon repair exist, including some described by Kessler, Savage, Lee, Becker, Tajima, Tsuge, and Krakow (Figure 1). Numerous other repair techniques have been described and modifications exist for some of these procedures.

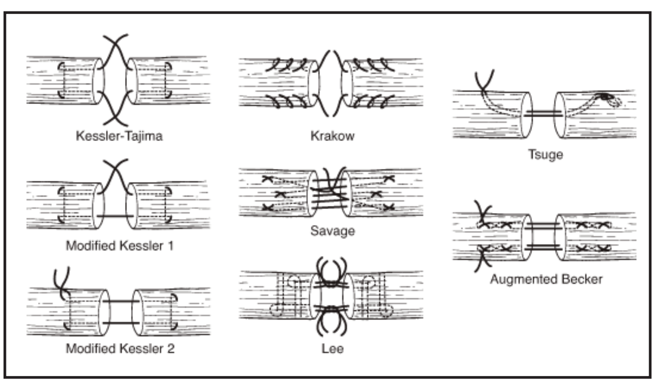

Figure 1. Various tendon repair techniques.

It has been shown that the strength of tendon repair is proportional to the number of sutures crossing the repair site and that initial repair techniques require twice the initial strength as what is required for active flexion.[1] Classic repair techniques, including Kessler and Tajima techniques, had only 2 suture arms spanning the repair site and represent weaker repair constructs. However, there are disadvantages of the multi-strand repair, which include added bulk and uneven repair due to the complexity of multiple tendon passes. It is generally recommended that 4 to 6 sutures cross the repair site, in addition to a running epitenon stitch.[2]

Converse to the above recommendations, it has been shown that the simplest and least traumatic repair constructs, while initially weaker, allow for more rapid healing of tendon.[3] Therefore, the surgeon must be prepared to modify repair techniques for specific patient circumstances. Additionally, increased tendon passes, as seen with the Bunnell repair, have been shown to lead to decreased tendon microcirculation. This suture repair type has been shown to lead to higher incidence of gap formation and tendomalacia. The most common modes of failure include gliding resistance and gap formation. Tendons with 3 mm or greater gapping have been shown to have an increased rupture risk when compared to those repaired with less than 1 mm gap.[3,4]

Suture type for tendon repair traditionally consisted of non-absorbable braided synthetic polyester material, such as ethibond suture. More recent tendon repair descriptions have employed non-absorbable monofilament material as the suture of choice. For example, prolene suture has been shown to generate less friction and cause less tendon deformation than braided suture.[5] In certain surgical settings, added strength from braided suture and increased frictional force may be positive attributes for tendon repair.

Suture placement must also been considered for individual patient needs. Volar or plantar suture placement has been shown to minimize interruption of blood flow. However, dorsal suture placement creates pull out strength, which is 50% stronger than volar suture placement.[6,7]

TENDON RETUBULARIZATION

As briefly discussed above, tendon retubularization is commonly performed in podiatric surgery for a variety of etiologies. A repair technique commonly employed by The Podiatry Institute will be reviewed. Individual surgical approaches will vary based on the tendon affected, location of tear or disease, and other factors. However, once the appropriate tendon has been identified, a step-wise approach for repair may be implemented. The tendon must first be visualized above and below the suspected location of pathology. It is also necessary to inspect the tendon along all anatomic surfaces. Tendon disease may occur on deep or superficial surfaces, along bony prominences, or as intra-substance tears. Tendon debridement follows visualization, with removal of all non-viable or hypertrophic portions of tendon. If the tendon appears heavily diseased, it may be necessary to perform an anastamosis to a nearby tendon or graft the repair site, rather than attempt salvage.

The area of tendon retubularization should then have the superficial epitenon fibers superficially debrided in order to promote adhesion of the deep surfaces and increase frictional force. A running non-absorbable suture, such as #3-0 Ethibond, should be continuously run along the interior surface with alternating superficial suture passes, about 2 to 3 mm on either side of the tendon midline. Next, a second pass may be made slightly more laterally along the tendon in a similar manner as described above. If the repair site does not have a large width, then a single (rather than double) continuous suture line may adequately allow for repair, but this must be determined on an individual basis. The purpose of these suture passes is to provide retubularization to a flattened tendon with a non-exposed or buried suture. The suture knots are placed in a horizontal fashion at the interior aspects of the repair site. An absorbable suture, such as a #5-0 Vicryl, is then run in a baseball stitch fashion along then tendon edges to allow full reapproximation. This final absorbable suture allows further contouring and maintenance of the tendon repair site, which will not affect tendon glide function over the long term (Figures 2, 3).

Additional retubularization techniques have been described, including techniques for Jones or Chrisman-Snook procedures. This technique involves an interior running simple stitch, which is converted into an outer baseball stitch in the opposite direction. This application may also provide beneficial in certain cases, but does not allow for a combination of sutures as described above (Figure 4).[8]

Figure 2A. Podiatry Institute tendon retubularization sequence. Intital knot.

Figure 2B. Running stitch.

Figure 2C. Final knot.

Figure 2D. Baseball stitch.

Figure 2E. Final appearance.

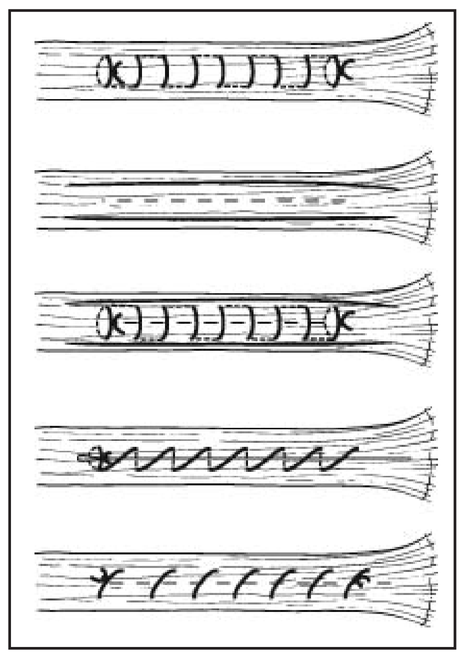

Figure 3. Podiatry Institute technique for tendon retubularization.

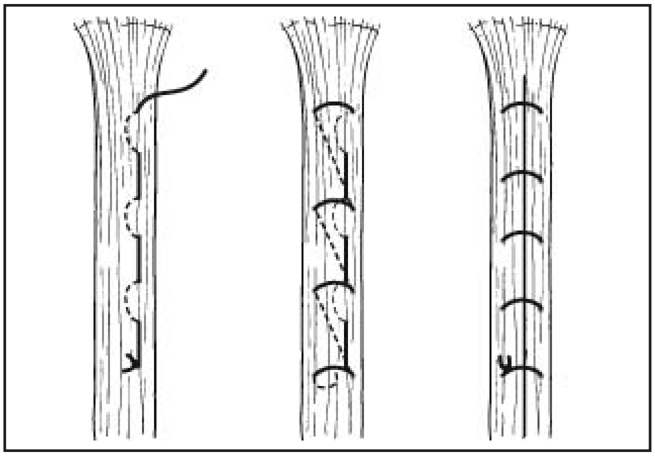

Figure 4. Pace's technique for tendon retubularization.

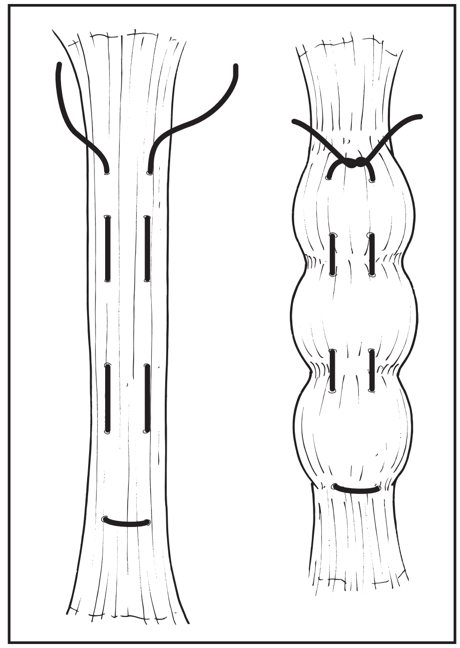

Figure 5. Hoffa's method of tendon shortening.

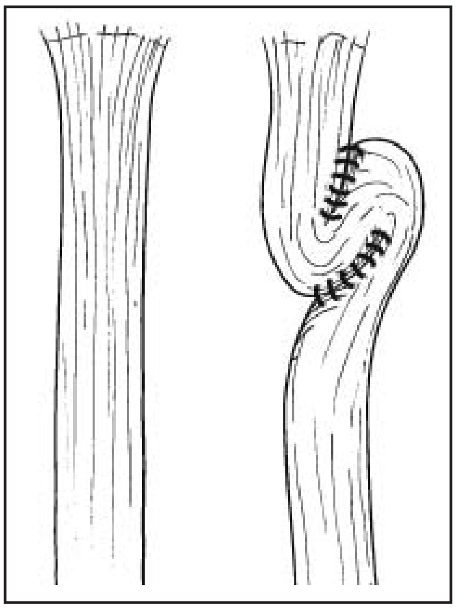

Figure 6. Double-over technique for tendon shortening.

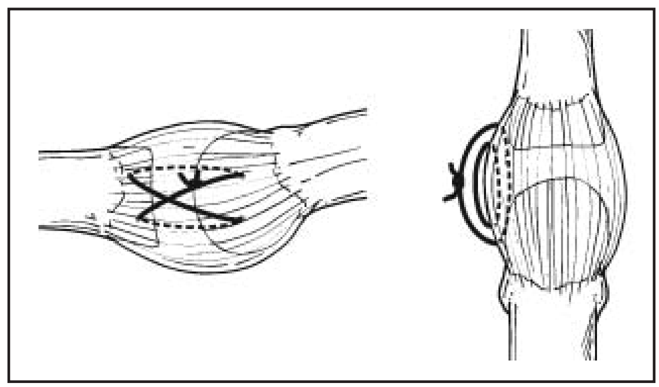

Figure 7. MTPJ capsular plication technique.

TENDON REEFING OR SHORTENING

Hoffa described a simplistic method for shortening a tendon. This method is performed by running suture along the longitudinal axis of the tendon in a simple linear manner. After completing the desired length, a single suture pass is made in the transverse plane to the opposite side of the tendon, and the same longitudinal simple running suture technique is utilized in reverse. Once reaching the suture origin, tension is placed as desired to shorten the tendon, and the suture is tied. Shortening can also be controlled by the length of suture passes (Figure 5).[9]

Additionally, a doubling over procedure may be employed to provide a similar result. It will cause added bulk in an isolated area, but less bulk along the tendon course as the Hoffa technique will produce. Therefore, each procedure may be of greater benefit in certain surgical circumstances. This technique is performed by overlapping the tendon in an S-like fashion, and approximating the interior edges (Figure 6).

MTPJ CAPSULE PLICATION

It is also possible to repair soft tissue deficits utilizing simple suture techniques. This technique may be utilized for correction of lateral deviation of digits at the metatarsal phalangeal joint level. An over and over suture technique is employed utilizing a # 2-0 Ethibond. It is important to note that the first stitch may only remove slack in a moderately to severely deformed joint and a second over and over stitch may be needed to gain the desired correction (Figure 7).

CONCLUSION

It is important to incorporate and apply the above mentioned techniques to the appropriate surgical setting. For laceration or rupture, core suture techniques should be employed, but will vary dependent on tendon, location of rupture, and physical activity of patient. The principles mentioned above may be adapted or modified for individual patient circumstances. Additionally, specific tendon repair techniques commonly encountered in foot and ankle surgery have been reviewed.

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