# SOFT TISSUE ANCHORS

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Soft tissue attachment is a common and important surgical procedure. Traditional methods are varied, including trephine bone plugs, suture drill holes, staples, and polyacetyl washers with screws. Each of these methods has its own advantage and has been successfully utilized for many years.

Soft tissue anchors were introduced in 1988 and function primarily to facilitate re-attachment of soft tissues such as ligaments, tendons, and joint capsules to bone. Although initially designed for repair of the rotator cuff in shoulder surgery (Bankart procedure), these devices have found increasing applications in many areas. Their popularity in podiatric surgery has escalated during the last several years. (Fig. 1) The ease and speed of application of these devices are convenient characteristics that do not sacrifice the integrity of secure fixation. There are three devices currently available in various sizes: Statak (Zimmer), Mitek (Mitek Surgical Products, Inc.), and TAG (Acufex Microsurgical, Inc.).

**Fig. 1**. Radiograph of two soft tissue anchors (Mitek) utilized for primary repair of medial deltoid ligament, in conjunction with ORIF of the fibular fracture.

## ZIMMER - STATAK DEVICE

Zimmer first produced the Statak device in 1988. The Statak soft tissue attachment device is manufactured of Tivanium Ti-6Al-4V (titanium alloy containing 6% aluminum and 4% vanadium). This alloy is chosen for its improved biologic compatibility and strength. The Statak device is supplied with two #2 Dacron nonabsorbable sutures attached to the anchor. (Fig 2) The device can be inserted into any standard Jacob's chuck or trauma drill and has the ability to drill, tap, and countersink in one simple step. Once inserted, Keith or eye needles are attached to the suture ends for soft tissue attachment.

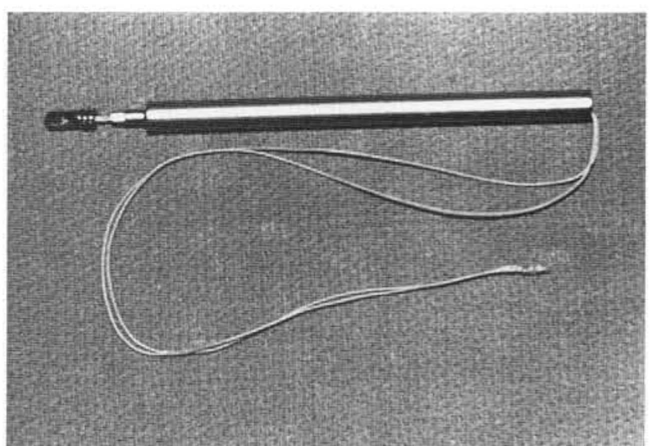

**Fig. 2.** Statak soft tissue anchor complete with metallic drill housing and dacron sutures attached.

The one disadvantage of this device is its size, which ranges from 3.82 mm to 11.42 mm. Due to the large diameter of the drill hole required and the device itself, the applications have primarily been limited to the rearfoot.

The Statak anchor with the countersinking depth is 18 mm in length. Therefore using this device in a bone with an equal or smaller diameter is contraindicated. Like the other devices, moderate to severe osteopenia or osteoporosis may be a relative contraindication. A case is presented involving excision of a fractured retrocalcaneal exostosis and utilization of the Statak device for re-attachment of the Achilles tendon. (Fig. 3A-3J)

## MITEK SYSTEMS

A second soft tissue anchor device is the G-I system, produced by Mitek in 1989. Pederson et al., first described the Mitek anchor system in tenodesis and ligamentous repair of the foot and ankle in the *Journal of Foot Surgery* in 1990. Since then, Mitek has introduced a second system, the G-II anchor system. Both of these systems are manufactured utilizing Tivanium alloy. (Fig. 4)

Mitek anchors are designed to "lock" within the subcortical cancellous bone. They are inserted through the cortical bone into a pre-drilled hole, and function in a manner similar to a mollybolt. Once inserted into place, the single and double anchors open back to their original

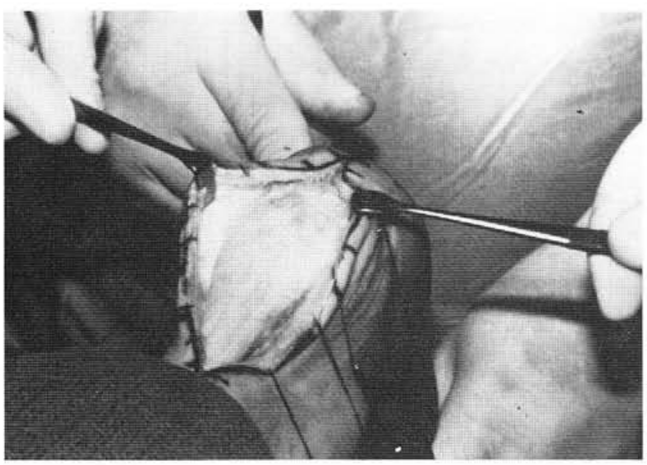

**Fig. 3A.** Excision of a retrocalcaneal exostosis with reattachment of the Achilles tendon utilizing Statak soft tissue anchors. Posterior exposure shown for direct access to the retrocalcaneal spur.

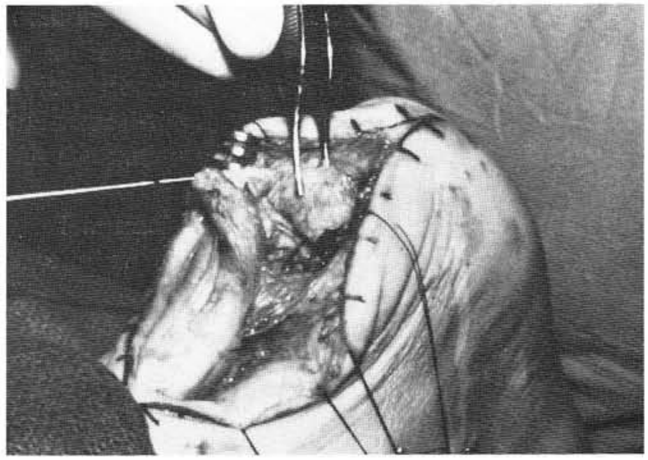

**Fig. 3B.** Reflection of the Achilles tendon with removal of the exostosis.

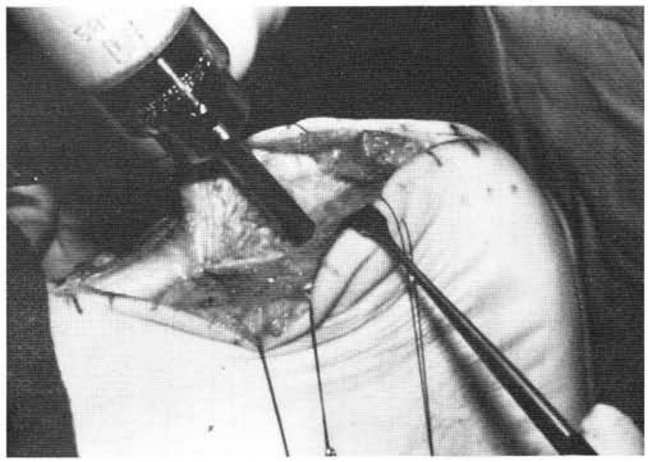

**Fig. 3C.** A Jacobs chuck utilized to countersink, tap and drill a Statak anchor for reattachment of the Achilles tendon.

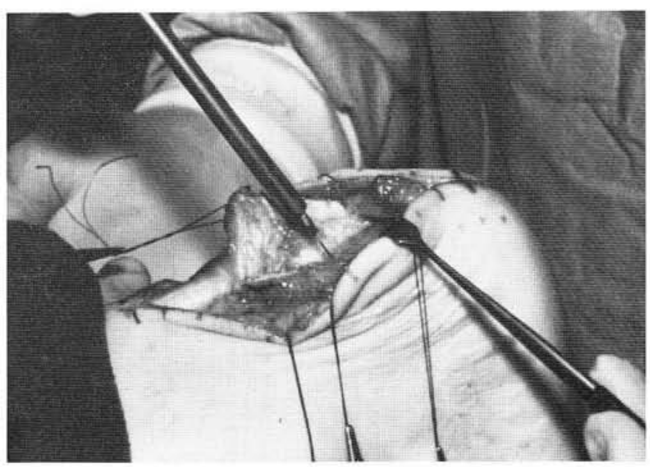

**Fig. 3D.** The metal sleeve simply pulls off of the suture, leaving the anchor embedded with the cancellous bone.

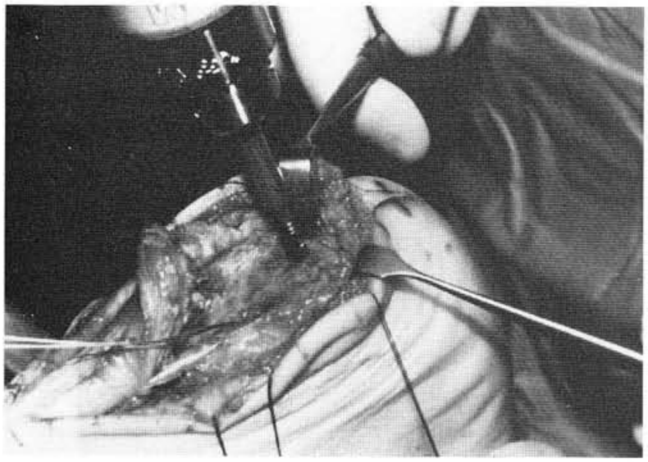

**Fig. 3E.** Once proper position is determined, application of the anchor takes one step.

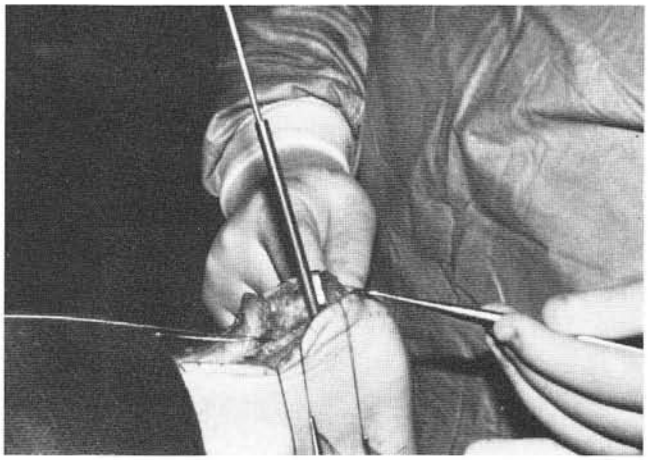

**Fig. 3F.** A second anchor in place for the Achilles reattachment.

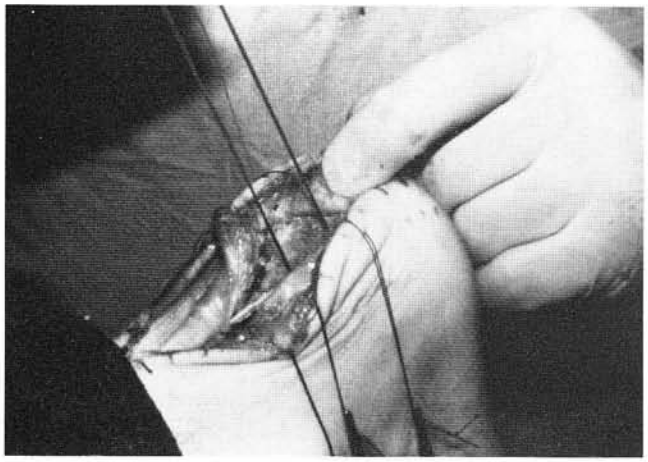

**Fig. 3G.** Both anchors are seated and ready for reattachment of the achilles tendon.

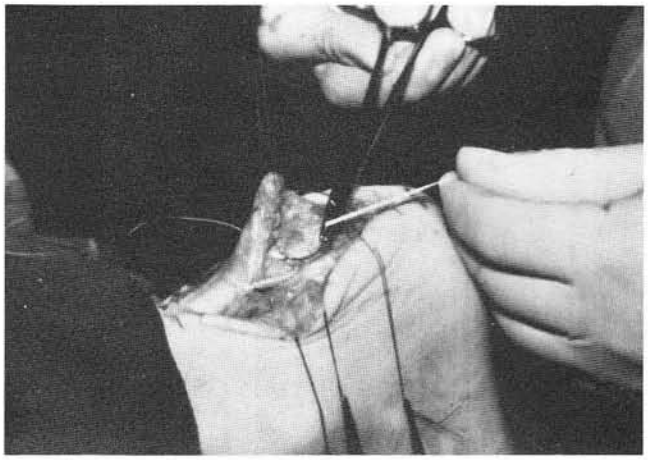

**Fig. 3H.** Keith eye needles are attached for suturing down the tendon.

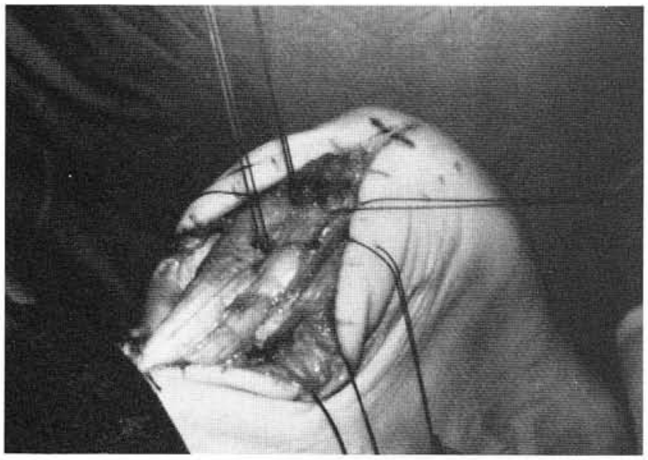

**Fig. 3I.** Achilles tendon is securely reattached to its original insertion.

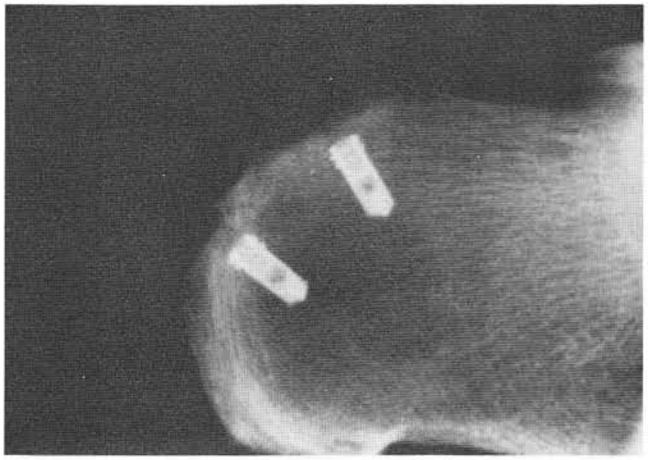

**Fig. 3J.** Postoperative radiograph of Statak anchors in the calcaneus. The anchors are radio-opaque, making postoperative assessment possible.

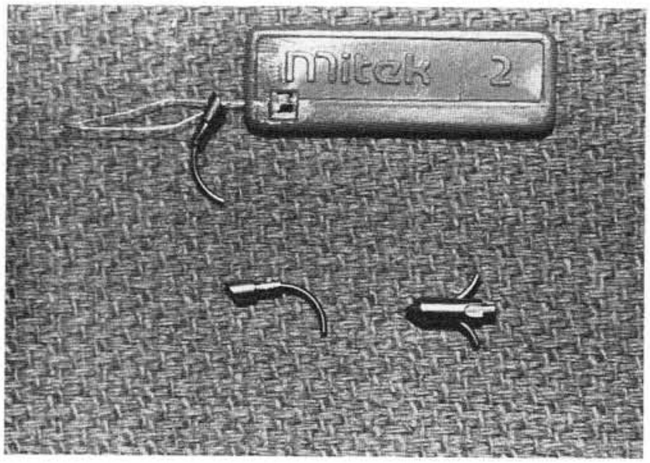


**Fig. 4.** Example of the Mitek G-I (single arc) and G-II (double arc) Mitek soft tissue anchors.

shape and can be set by pulling back on the suture. One selling point of this system is the size of the anchors. This system is the smallest of all devices presently available and seems to have greater practical podiatric applications. The G-I and GII anchors are 2.7 mm and 2.4 mm in diameter and are very practical for forefoot and rearfoot procedures. Mitek is available in four sizes to accommodate #2, #0, #2-0, and #4-0 sutures. The complete Mitek instrument set includes 2 drills, 2 inserters, and a drill guide in an autoclavable tray. The only components not included are the suture and the needles.

Non-absorbable sutures are required for maximum strength and integrity. The G-II anchors were developed for better purchase in osteoporotic bone and anchors more securely in these areas. This modification has allowed the soft tissue anchors to be used in areas previously not recommended. In early 1992, Mitek will be coming out with their "Superanchor", a four pronged anchor with each arc 90 degrees apart. The drill hole for this new device will still only be 2.7 mm.

Mitek has also developed a disposable system for their anchors which is completely self-sufficient. This is currently available in both the G-I (Quick-anchor) and G-II (Snap) designs, and can be purchased with varying sizes of suture. The anchors are positioned for easy loading and sutures are attached to eye needles for ease of soft tissue attachment. (Fig. 5) This option is more expensive yet is an extremely versatile and convenient alternative.

## ACUFEX - TISSUE ANCHOR GUIDE

The third anchor device on the market is the TAG (Tissue Anchor Guide) system introduced by Acufex in 1990. The TAG system comes in two styles: Wedge and Rod. Both anchors are manufactured from a nickel-free, non-metallic polymer minimizing any allergic reactions seen with implant materials. (Fig. 6)

The Wedge anchor is 5 mm in diameter and is seated under the cortical bone by a self-centering and expansion type fit. As tension is applied to the anchored device, expansion will occur beneath the subcortical bone and prevent suture/device pull-out. The Rod style is 4.25 mm in diameter and is seated by an interference (direct insertion) fit. Once driven into the subcor-

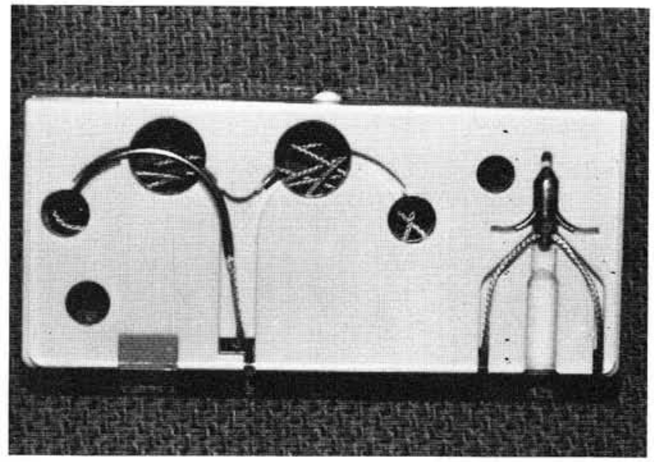

**Fig. 5.** Example of the Mitek G-II Snap anchor system. Note the suture and eye needles attached to the anchor.

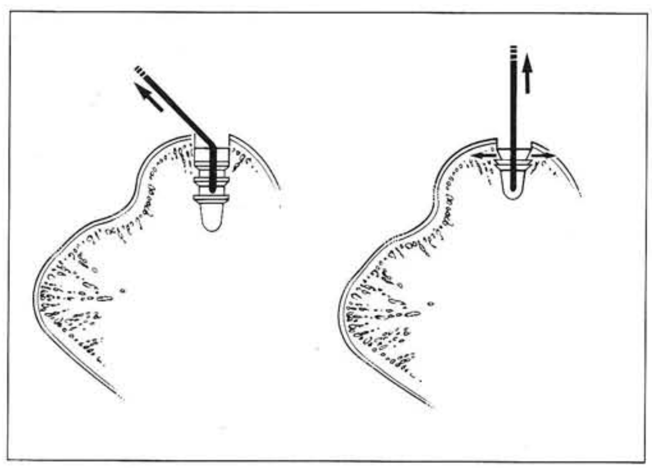

**Fig. 6**. Illustration of the Tissue Anchor Guide (TAG) System. The Rod anchor is secured by an oblique force, while the Wedge anchor is secured by a direct centering pull. Both of the anchors are locked beneath the cortical bone.

tical bone, this device is seated by an oblique pulling force on the suture. Due to the large drill holes required for insertion of these devices, their usefulness in podiatry is minimal. The only conceivable application may be for calcaneal attachment. The TAG system is included here for completeness in this discussion.

## POTENTIAL INDICATIONS AND USES

There are a variety of traumatic and non-traumatic conditions in which various soft tissues are either re-attached to bone, detached for surgical exposure purposes and subsequently reattached, or transferred to another area. The various soft tissue attachment/re-attachment devices are potentially helpful in each of these situations.

Traumatic conditions with rupture of major tendons and/or ligaments from their osseus attachments include:

1. Medial or lateral collateral ankle ligaments
2. Rupture of the tendo achilles from its insertion into the calcaneus
3. Rupture of other major tendons (Tibialis Posterior, Peroneus Brevis)

Resection of retro-calcaneal exostosis or extensive tenocalcinosis will frequently require detachment of the tendo achilles for adequate exposure. Re-attachment of the tendon can be facilitated by the use of these devices. Similarly, the devices may be used when an extensive Haglund's deformity requires detachment of the tendo achilles or following complete detachment of the Tibialis Posterior tendon when performing a Kidner type procedure.

Tendon transfer or advancement (i.e. Murphy procedure) is another area of potential use for these devices. Standard tendon transfers such as the STATT, Hibbs, and TPTT are frequent examples. Ankle stabilization procedures for chronic ankle instability may be an indication as well.

A primary advantage of these devices is the ability to provide secure attachment of various soft tissue structures to the underlying bone. In addition, they do not have the problem of physical prominence as is commonly seen with large bone staples, polyacetyl washers, and screws. They are all relatively easy and quick to insert. All require some type of power instrumentation to pre-drill the hole or insert the device themselves.

The major drawback to the use of soft tissue anchors is the cost and the difficulty of removal, if necessary. The cost of a single anchor to the hospital can be up to one hundred dollars. The cost to the patient can be considerably higher. The anchors are essentially designed for permanent placement. Removal of these devices is cumbersome and can cause added soft tissue or osseus damage which may lead to decreased integrity of these structures. Careful and accurate initial placement of the anchors is critical to the success of the procedure.

Care must be taken not to insert these devices too close to articular surfaces, epiphyseal growth plates, or bony apophyses. Particularly when utilizing the Mitek anchors, the metallic arc should always be oriented into the greatest volume of bone to minimize possible damage to adjacent structures.

DonJoy Biomechanics Research Laboratory recently published a comparative evaluation of soft tissue anchor systems in cadaveric specimens. Four anchors were tested in the study: Statak, G-II, Wedge, and Rod. The anchors were tested in three locations around the human shoulder. The mean failure load and the Pull-out percentage were determined for all four anchors including suture. Pull-out was performed in the worse case scenario, with the force being parallel to the axis of the insertion hole. (Table 1)

**TABLE 1**

**COMPARATIVE EVALUATION OF SOFT TISSUE ANCHOR SYSTEMS**

Mean Failure Load (Newtons)

| | |
|---|---|
| Suture | 129.04 |
| Wedge | 110.22 |
| G-II | 109.52 |
| Rod | 103.61 |
| Statak | 95.09 |

Pull-out Percentage (%)

| | |
|---|---|
| G-II | 32.3 |
| Statak | 36.6 |
| Wedge | 58.4 |
| Rod | 62.6 |

When drill holes for the Rod, Wedge, and Statak were within 4 mm of one another, propagation of a cortical crack between adjacent drill holes occurred as one anchor was pulled to failure. This was not found with the G-II anchors.

## SUMMARY

Soft Tissue anchors are an exciting recent development for soft tissue attachment. Although the products all claim technical ease and speed of application, it is important to practice and study the application of these devices prior to utilizing them intraoperatively.

## REFERENCES

Cawley P: *Technical Report: Comparative evaluation of Bone Suture Anchor Systems in Human Cadaveric Shoulders.* Donjoy Biomechanics Research Laboratory, Carlsbad, California, 1989.

Pederson B, Tesoro D, Wertheimer SJ, Coraci M: Mitek Anchor System: A New Technique for Tenodesis and Ligamentous Repair of the Foot and Ankle. *J Foot Surg,* 30:48-51, 1991.