Enhanced Tenodesis for Retrocalcaneal Surgery

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Retrocalcaneal surgery is complex and difficult. Over the years, many different approaches to retrocalcaneal surgery have been described. Partial or total release of the tendo Achillis is often necessary, with reattachment being of paramount importance to allow for optimal function following surgery. Although numerous anchoring devices have been introduced for tendo Achillis reattachment, the authors have found the DePuy TiMAX Spider Plate (DePuy ACE, Warsaw, Indiana) to be superior. This article describes the Spider Plate and associated surgical technique, which have greatly enhanced the outcome of retrocalcaneal surgery. (J Am Podiatr Med Assoc 92(4): 200-209, 2002)

Posterior heel pain is a relatively common disabling problem often associated with calcification within the tendo Achillis and at its insertion (Fig. 1). Clinically, patients may exhibit erythema and edema at the insertion of the tendo Achillis. The posterior heel is exquisitely tender, and pain may be accompanied by a localized bursitis. Unfortunately, conservative treatment options for retrocalcaneal pathology are limited and often unsuccessful. When conservative treatment modalities have failed and activities of daily living become difficult, patients frequently seek out surgery.

Surgical treatment of the retrocalcaneal pathology often involves partial or complete detachment of the tendo Achillis from its insertion to ensure complete resection of any hypertrophic bone. Reattachment of the tendo Achillis to the calcaneus is of utmost importance, as an intact tendo Achillis absorbs up to 900 kg of force during strenuous exercise.[1]

The authors' search for a superior method of osteotenodesis with minimal inherent difficulty or tendency for failure has led them to use the DePuy TiMAX Spider Plate (DePuy ACE, Warsaw, Indiana). Because of its ease of placement, strength of fixation, and reproducible results, the Spider Plate has become the authors' preferred fixation method for Achilles tenodesis in retrocalcaneal surgery.

Historical Review

Reattachment of the tendo Achillis following retrocalcaneal surgery is not new. Many different techniques to secure soft tissue to bone have been described in the literature.[2-7] Prior to the introduction of soft-tissue anchors, surgeons employed drill or trephine holes, buttons, screws, and washers.[7]

Goble et al[4] claim to have introduced the first modern suture anchor in 1985. However, nearly a decade

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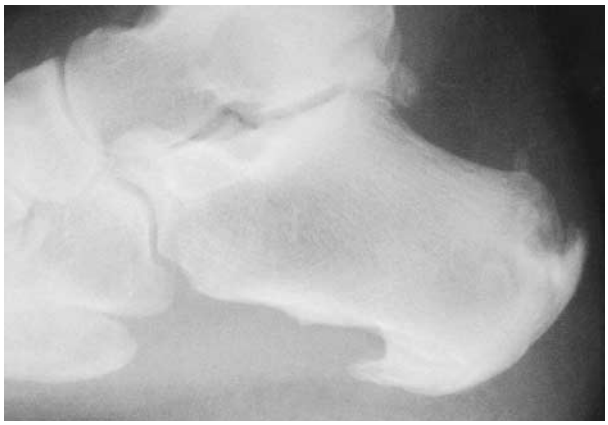


Figure 1. Lateral weightbearing radiograph demonstrating a large symptomatic retrocalcaneal exostosis with intratendinous calcification. Note the large incidental asymptomatic plantar heel spur.

earlier, Furnas and Bloom[2] introduced a Teflon toggle strip and suture that many consider the first example of an anchoring device. Eventually this evolved into the modern-day Statak (Acufex Microsurgical, Inc, Mansfield, Massachusetts), Mitek (Mitek Surgical Products, Norwood, Massachusetts), Suretac (Acufex Microsurgical, Inc), ROC (Innovasive Devices, Inc, Marlboro, Massachusetts), and Ogden (Orthofix, Richardson, Texas) anchor systems. Since that time, the use of anchors has allowed more confident calcaneal bone resection with decreased healing time and earlier return to work.[8] While no universal tenodesis technique or device exists, there is continued refinement of additional soft-tissue anchors.

Use of soft-tissue anchors has become common in the reattachment of the tendo Achillis after retrocalcaneal surgery. Multiple centers have addressed tenodesis of a surgically detached tendo Achillis. Downey[9] and Downey and Kalish[10] successfully used drill holes and nonabsorbable suture and also experimented with Mitek G2 bone anchors. Saxena[8] recommended the Panalok (Zimmer, Warsaw, Indiana) device with PDS (Ethicon, Somerville, New Jersey) suture, especially when the tendo Achillis needs extensive debridement from its insertion. In 1991, Pederson et al[3] demonstrated success with the original Mitek device, using it for primary repair of ankle ligaments, lateral ankle stabilization procedures, and reattachment of the tendo Achillis. They found the procedure to be technically easy with minimal soft-tissue irritation. Kuwada[7] advocated the ROC anchor for general soft-tissue anastomosis to bone, demonstrating its success in a subset of two patients with insertional calcaneal exostosis. Knudson et al[5] recommended the Ogden Anchor, citing its versatility and the surgeon's ability to salvage and reuse the device if the suture fails. The concomitant use of multiple devices has been advocated under select circumstances, including difficult or complication-prone repairs.[6, 9, 11]

There have been descriptions of repair after complete detachment of the tendo Achillis using drill holes with large-gauge, nonabsorbable intraosseous sutures or a through-and-through suture anchoring a button to the plantar heel.[12, 13] Reattachment of the tendo Achillis by means of anchoring devices after complete rupture has also been advocated.[6, 12, 14, 15]

Strength studies have been performed for the majority of anchoring devices.[4, 16-18] Although anchoring devices are important for structural support in the early postoperative period, the strength of fixation eventually becomes secondary as soft tissue readheres to bone. Using *in vivo* animal models, Bagley et al[18] demonstrated that soft-tissue attachment by suture is superior in strength to attachment by screw and washer at the third postoperative month. Additionally, weakening of the tendo Achillis may theoretically occur with screw fixation.[18] Contradictory to these findings was a recent study by Janis et al,[1] who, in comparison studies of 34 cadaveric specimens, found the screw and spiked metal washer superior to multiple Mitek anchors and Bionx Tacks (Bionx Implants, Inc, Blue Bell, Pennsylvania) in terms of stability following Achilles tenodesis. Furthermore, all failures associated with the screw and washer were secondary to tendon failure rather than fixation failure. Studies by Goble et al[4] and Robertson et al[16] have also noted enhanced tenodesis with the screw and spiked washer apparatus compared with other devices, including staples and suture.

Potential complications have been described in association with all forms of soft-tissue anchoring devices, including deployment errors or misfires,[7, 8] hardware loosening,[4] suture reactions or severe adhesions,[7] tendon weakening,[19] tendon rupture,[10, 20] nerve entrapments,[7, 20] neuropathy,[20] and postoperative tendinitis.[9]

The Spider Plate

The TiMAX Spider Plate is one of three plates that compose the DePuy Ace TiMAX Pe.R.I. (periarticular reduction implants) small-fragment lower-extremity system. These plates are made of titanium and have proven very successful for a variety of orthopedic and trauma procedures. The tensile strength is higher than 316 surgical grade stainless steel. Owing to its low modulus of elasticity compared with other commonly used biomaterials, stress shielding should be

minimized. In addition, fatigue strength is increased while the frictional characteristics, notch sensitivity, and likelihood of galling are decreased. The material promotes osteointegration, is notably biocompatible, and has increased corrosive resistance as well as superior magnetic resonance and computed tomographic imaging compared with stainless steel.

The Spider Plate is circular in overall shape, with a smooth posterior surface and a series of spiked blunt projections on the anterior surface. The purpose of these projections is to engage comminuted bone fragments, distribute load in osteoporotic bone, and anchor tendons and ligaments to bone, making it very useful in reconstructive surgery. The devices are available in different sizes: 16 mm (small device), 20 mm (large device), and 25 mm (large offset device). The device is anchored to the underlying bone with a fully threaded 3.5-mm cortical screw or 4.0-mm cancellous screw. Partially threaded 4.0-mm (lag design) cannulated screws are also available (Fig. 2). Each screw is self-drilling and self-tapping to facilitate insertion. The screws boast a unique thread design with superior pullout strength and greater head torque strength. Centered and offset hole designs make application and insertion easier and facilitate tendon reattachment. A Kirschner wire hole is also present in the large offset Spider Plate to help complete the application and placement process. Rigid internal compression of the tendon to the posterior surface of the calcaneus is readily and predictably achieved. Intraoperative x-rays or fluoroscopy is effective for visualizing proper placement of the device and screw.

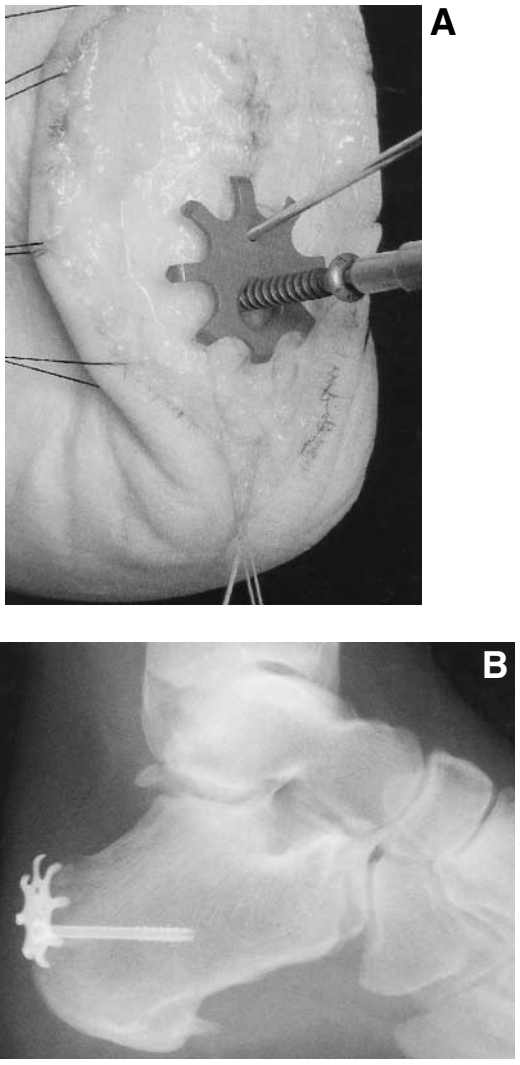


Figure 2. A, The 25-mm large offset Spider Plate prior to being anchored with a 4.0-mm cancellous screw. Note the temporary Kirschner wire helping to maintain the position of the device. B, Lateral weightbearing radiograph at 2-year follow-up demonstrating use of the 25-mm large offset Spider Plate with a partially threaded 4.0-mm cannulated cancellous screw.

Surgical Technique

Although any incisional approach can be used at the discretion of the surgeon, a longitudinal or curvilinear incision provides good exposure to the entire insertion of the tendo Achillis and posterior calcaneus (Fig. 3). The incision is deepened to the level of the tendon, and the medial and lateral wound margins are retracted; silk sutures are helpful for maintaining retraction with minimal trauma to the skin edges (Fig. 4). To minimize postoperative wound complications, gentle handling of the medial and lateral margins is extremely important.

The insertion of the tendo Achillis is carefully examined to identify the extent of osseous pathology. Pathologic soft tissues such as bursae or cysts are also identified and excised. The tendon is incised or split in a longitudinal manner from the superior aspect of the calcaneus to just inferior to its insertion, identified by the posterior osseous ridge (exostosis). The surgeon makes a transverse incision overlying the exostosis, creating an inverted T-incision through the tendinous expansion of the insertion. The tendon is meticulously dissected off of the calcaneus from distal to proximal working outward (medially and laterally) from the vertical split (Fig. 5). The dissection is tedious and must be done with great care to fully appreciate the extent of the osseous and tendon pathology. A cavalier, nonanatomical, haphazard, or traumatic dissection technique will result in increasing frustration as the procedure progresses.



Figure 3. Posterior view demonstrating incision planning. A central linear-oriented incision directly over the insertion of the tendo Achillis is drawn. The incision is carried down to the plantar aspect of the heel to ensure full visualization of the insertion and exostosis.

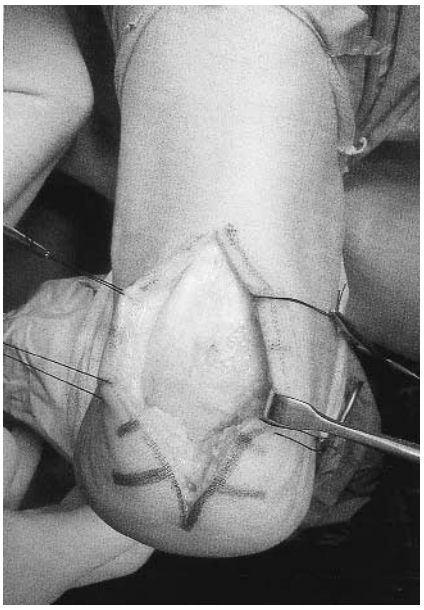


Figure 4. Dissection through the subcutaneous tissue to the level of the tendon. Undermining is done along the tendon. The medial and lateral incisional margins are retracted with silk retention sutures. Some degeneration of the tendon is seen lateral to the midline.

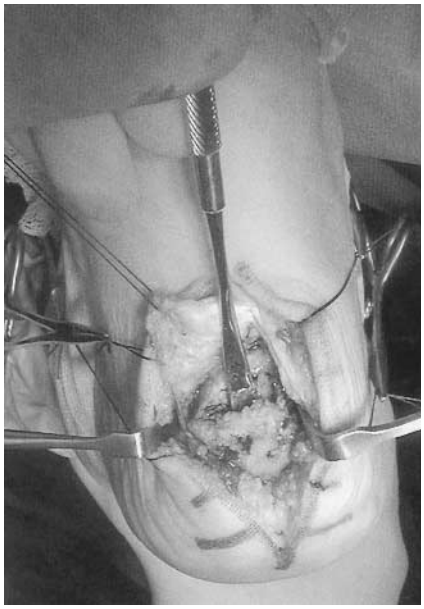


Figure 5. Reflection of the tendon with retraction using nonabsorbable suture. The extent of the retrocalcaneal spur is seen. A Freer elevator is used to explore the extent of the recess anterior to the osseous ridge.

The full extent of the exostosis is directly visualized and resected with a bone rongeur; in more severe cases, an osteotome and a mallet are used. The remaining bone is contoured and smoothed with a power reciprocating or hand-held rasp (Fig. 6). All osseous projections must be removed. In some cases, the posterosuperior aspect of the calcaneus will also be prominent and require remodeling and recontouring. Cautious resection of the posterosuperior section of the calcaneus is essential to ensure that the tendon is not reattached to the superior surface of the calcaneus, but to the posterior surface. To facilitate reattachment of the tendo Achillis, the upper posterior one-third of the calcaneus, which is covered by a smooth cartilaginous surface, can be drilled or roughened.

The tendo Achillis is carefully inspected, and any diseased tendon and calcifications are excised (Fig. 7). Multiple calcifications within the tendon substance itself are not uncommon and are usually readily identified on preoperative radiographs or other specialized studies. The first 2 cm of the tendon may demonstrate significant thickening and degeneration, as evidenced by its yellowish color, boggy consistency, and loss of the normal longitudinal configuration of tendon fibers. A #11 blade may be helpful for thinning the tendon when excising the degenerative or



Figure 6. The posterior aspect of the calcaneus following resection of the exostosis and recontouring of the bone.

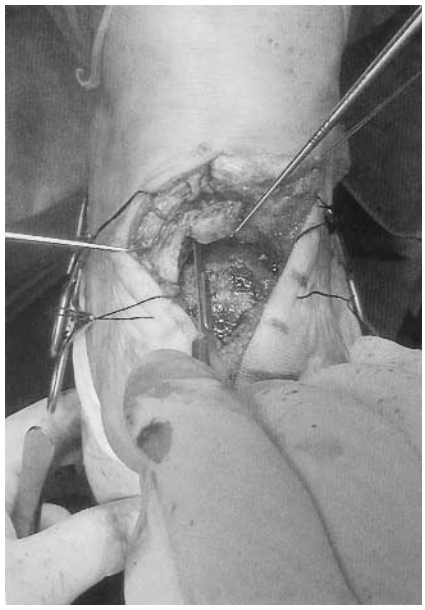


Figure 7. Process of excision of a large, intratendinous calcification from the tendo Achillis proximal to its insertion. A skin hook is being used to place tension on the bone fragment to facilitate retrieval with minimal disturbance of the tendon fibers.

anterior diseased tendon tissue. This excised tissue is wedge-shaped; it is thinner at its medial and lateral margins and thicker centrally. The most medial and lateral expansions of the tendo Achillis insertion are usually not disturbed. Periodic dorsiflexion of the foot during the dissection confirms preservation of the attachment of the medial and lateral insertional expansions.

Intraoperative x-rays are recommended to confirm removal of the posterior exostosis, remodeling of the posterior calcaneus, and excision of all peritendinous calcifications (Fig. 8). The tendon is now ready for reattachment to the posterior surface of the calcaneus. A heavy-gauge, nonabsorbable polyester suture is temporarily attached to the end of the tendon and used to place distal traction on the tendon over the posterior surface of the calcaneus. Simultaneous plantarflexion of the foot and ankle will facilitate the reattachment process (Fig. 9). The surgeon determines the appropriate size of Spider Plate and places it directly over the tendon. A temporary Kirschner wire can be inserted to help maintain the device in proper position. The Kirschner wire usually passes between the medial and lateral components of the vertical split (Fig. 10). A guidewire is then inserted into the body of the calcaneus through the hole for the 4.0-mm fully threaded cancellous screw. Other screws, such as the 3.5-mm cortical or 4.0-mm noncannulated partially threaded cancellous screw, could also be used depending on surgeon preference. The screw orientation is most commonly parallel to the plantar aspect of the foot, with the typical screw length being between 30 and 40 mm. The screw is inserted and tightened, providing a very secure attachment of the tendo Achillis to the calcaneus (Fig. 11). Significant compression is created over a large surface area. Although it is not necessary, insertion of the Kirschner wire and screw can be done under fluoroscopic visualization; to ensure proper placement of the device, final radiographic confirmation is recommended. An excessively long screw improperly oriented could conceivably enter the subtalar joint complex, creating a serious postoperative complication.

The distal edge of the proximal tendon is sutured to the distal periosteal flap to further secure the tendo Achillis. The portion of the vertical split of the tendon not under the Spider Plate is repaired with 0 or 2-0 synthetic absorbable suture of choice; an inverted over-and-over stitch is recommended to bury the knot within or deep to the tendo Achillis. The wound is irrigated, the tourniquet released, and hemostasis confirmed prior to closure of the subcutaneous tissue and skin. The subcutaneous tissue is reapproximated with synthetic 4-0 absorbable suture, and the skin is closed by means of a subcuticular stitch with 5-0 synthetic absorbable suture of

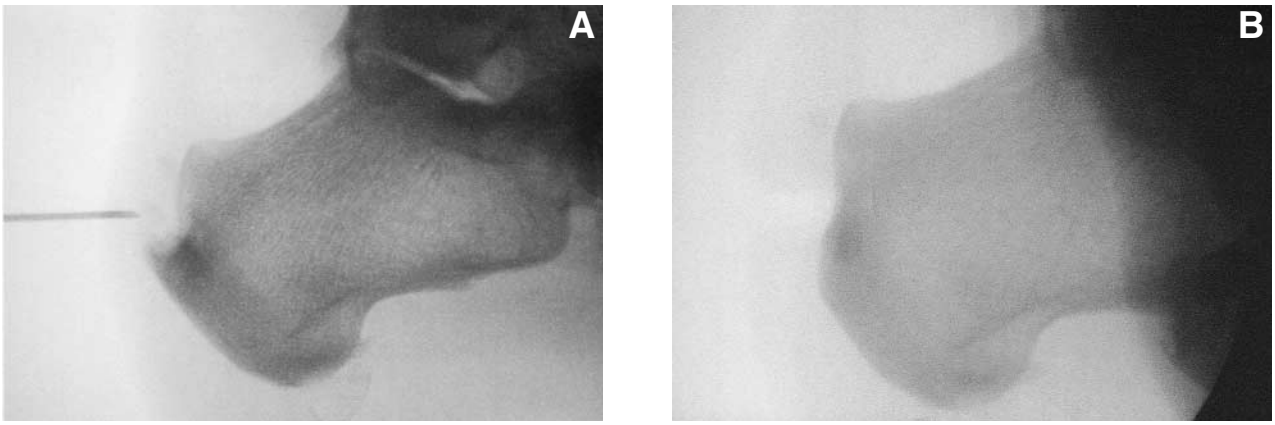


Figure 8. A, Intraoperative radiograph of a retrocalcaneal exostosis. Note the needle pointing to an intratendinous calcification at the posterior aspect of the calcaneus just superior to the exostosis. B, Intraoperative radiograph after remodeling of the posterior aspect of the calcaneus and excision of one of the intratendinous calcifications. The second lesion can also be identified within the substance of the tendo Achillis and was excised.

choice. A running or simple interrupted stitch with synthetic nonabsorbable material of choice may also be used (Fig. 12). Wound-closure strips are usually applied to maintain apposition and minimize tension on the skin edges; they are typically left in place throughout the cast immobilization.

Patients are routinely managed postoperatively with a Jones compression bandage to maintain position of the foot and ankle at 90° and minimize postoperative edema. A dressing change is usually performed 5 to 7 days following surgery. A cast is then applied with the foot and ankle at 90°. A thin layer of nonadhering foam may be applied over the posterior aspect of the heel to protect the area, minimize edema, promote tendon adhesion, and minimize postoperative fibrosis and scar-tissue formation.

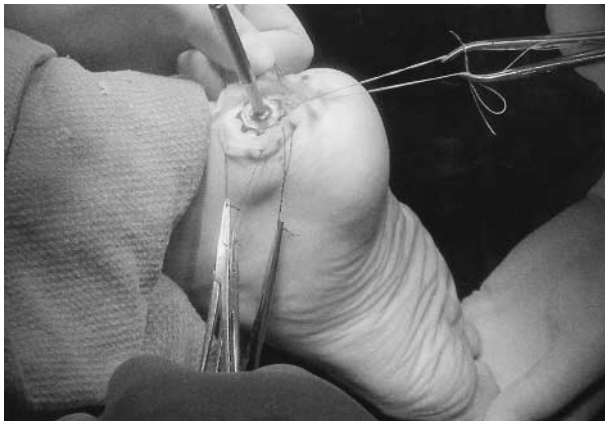


Figure 9. Distal traction of the tendo Achillis with heavy-gauge, nonabsorbable suture over the posterior aspect of the calcaneus. Note the simultaneous plantarflexion of the foot to facilitate the reattachment process.

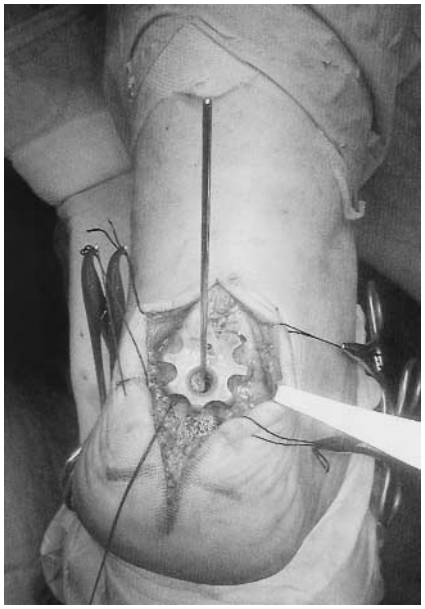


Figure 10. Insertion of the guide pin for a 4.0-mm cancellous screw between medial and lateral portions of the vertical split in the tendo Achillis prior to securing a Spider Plate. The second hole can be used to help stabilize the plate while inserting the screw.



Figure 11. Final appearance after reattachment of the tendo Achillis with a large 25-mm offset Spider Plate and screw. Note the spikes on the anterior surface of the Spider Plate, which enhance the compression of the tendon and bone. A small hole was drilled to accept the most inferior projection of the plate, further promoting stability.

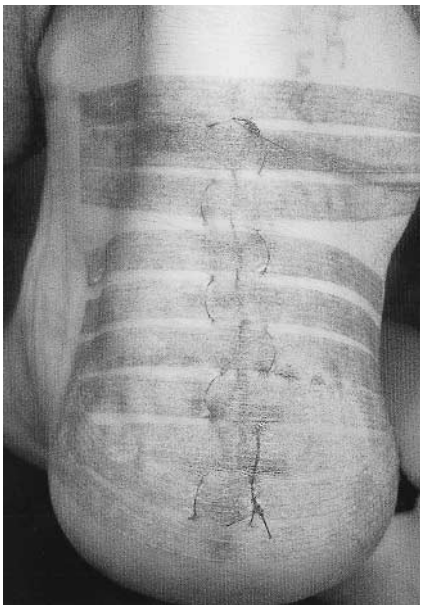


Figure 12. Skin closure by means of subcuticular (intradermal) stitch with synthetic 5-0 absorbable suture combined with a running horizontal mattress suture technique with 3-0 nonabsorbable synthetic monofilament suture after application of wound-closure strips. To minimize complications, the strips are maintained for 5 to 6 weeks. Wound-closure strips are applied for additional support.

Patients remain nonweightbearing for 3 weeks. Weightbearing without ambulation is permitted in week 4. Weightbearing with ambulation is permitted for 1 to 2 additional weeks, and the cast is removed 5 to 6 weeks postoperatively. Full ambulation and weightbearing are encouraged as tolerated. Physical therapy is employed to assist with triceps surae strengthening and resolution of residual edema and inflammation. Strenuous activities are usually discouraged for a minimum of 3 months.

Compression stockings or sleeves help to resolve edema and provide a comfortable heel cushion posteriorly and plantarly. Two devices are commonly employed: the Bauerfeind Achillotrain (Bauerfeind USA, Inc, Kennesaw, Georgia) and the Silipos Achilles Heel pad (Silipos, Inc, Niagara Falls, New York). These devices have usually been dispensed to the patients as part of the conservative treatment regimen prior to surgery.

Discussion

As with any surgical procedure, there are potential complications. Wound complications, including infection, dehiscence, slough, and hypertrophic or keloid scars, are not unique to this procedure, but are associated with surgery in general. Should a major wound complication occur in this area, it can be very difficult to resolve, especially if the underlying tendo Achillis is exposed. The authors have not experienced any increase in the nature or frequency of these complications with their technique. The authors strongly recommend gentle handling of the tissues in this area, especially the skin and subcutaneous tissues, to minimize postoperative wound complications.

Prominence or loosening of internal fixation devices is also a potential concern. Traditional screws and polyacetyl washers have not gained popularity for this reason. Surprisingly, the Spider Plate rarely requires removal, and screw loosening has not been encountered by the senior author (G.V.Y.); excellent purchase of the screw has been a consistent experience, although inadequate screw purchase could occur in severely osteopenic bone, necessitating the use of a larger screw. Only one patient has undergone removal of the device owing to occasional discomfort with certain shoes. The device is not readily palpable when inserted properly. Patients do not express concern over temperature sensitivity as one

might anticipate; all patients are, however, informed of the potential need to remove the device at some time in the future. When removal is necessary, it is easy to perform with either a longitudinal or a transverse incision.

Recurrent exostosis formation and peritendinous calcification have been seen as incidental findings in several of the authors' cases, but have been asymptomatic at greater than 1-year follow-up (Fig. 13). None of the authors' patients have required revisional surgery for the removal of recurrent calcifications or exostosis. Such recurrence is not unique to this technique, but appears inherent to retrocalcaneal surgery in general. This phenomenon represents an aspect of this clinical entity that is not well understood and is a subject of ongoing study, controversy, and debate.

Many authors have attempted to explain retrocalcaneal pain, both with and without an association with soft-tissue calcification.[9, 10, 21] Retrocalcaneal exostosis and peritendinous calcifications most likely result from a combination of systemic, metabolic, biomechanical, and mechanical factors. Morris et al[22] described an anatomical classification to identify the location of radiopaque lesions of the tendo Achillis. Type I is a true retrocalcaneal exostosis at the Achilles insertion or superior aspect of the calcaneus. Type II is calcification within the body of the tendo Achillis but not attached to the calcaneus, and type III calcifications are more proximal in the tendo Achillis near the myotendinous junction.

Many incisional and tendon approaches to retrocalcaneal surgery have been reported.[10, 13, 23, 24] Single and double linear peritendinous incisions, curvilinear incisions, longitudinal incisions, and transverse incisions have all been described. The likely reason for favoring curvilinear incisions that do not lie directly over the tendo Achillis is concern for the potential for poor scars as well as enhanced exposure. The authors generally prefer a single midline longitudinal incision directly over the tendo Achillis and have found that it provides excellent exposure to the entire posterior calcaneus and heals without complication. Additionally, this approach avoids vital structures, including the sural nerve and lesser saphenous vein. Recently interest has centered on the transverse incisional approach described by several authors, including Boberg[23] and Malay.[24] The transverse incisional approach may be useful in patients in whom the exostosis itself is the cause of symptoms. It should be performed with great caution. The rationale for this approach is the belief that the insertion of the tendo Achillis is minimally disturbed yet the exostosis can be readily visualized and resected. A prolonged recovery process with this approach, as with others, can be expected and has historically been the experience of the senior author as well as the other authors. Persistent low-grade symptoms for a prolonged period of time are not uncommon.[25]

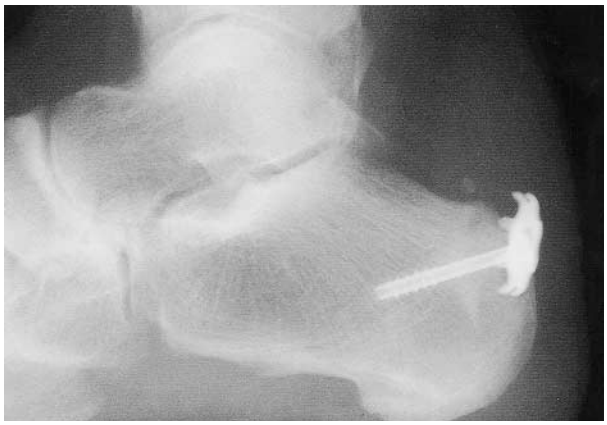


Figure 13. Lateral weightbearing radiograph at 2-year follow-up demonstrating recurrent peritendinous calcifications that were incidental and completely asymptomatic. The washer was not prominent or noticeable to the patient; all conventional shoes could be worn.

The authors believe patients' prolonged symptoms were due to a less-than-optimal reattachment or to readherence of the tendo Achillis to the posterior aspect of the calcaneus; in essence, it was compromise of the insertion and not the calcifications or exostosis that was responsible for a significant portion of the symptoms. It is not uncommon to treat patients with minimal or no evidence of retrocalcaneal exostosis formation but with significant disabling symptoms after a transverse incisional approach. Other patients may exhibit large retrocalcaneal exostoses with essentially no symptoms. Where there are significant symptoms and disability regardless of the size of the exostosis, a conventional bone scan will demonstrate intense focal uptake at the insertion. This usually correlates with impressive clinical symptoms, including profound inflammation, local increase in temperature, erythema, and bursa formation. It is the authors' contention that such patients suffer from enthesitis at the tendo Achillis insertion rather than a painful retrocalcaneal spur.

Surgical approaches to the retrocalcaneal exostosis have been described by many authors.[9, 10, 13, 21, 24] A central tendo Achillis splitting incision, allowing the lateral and medial insertional expansions of the tendo Achillis to remain intact, has become popular.[9, 10, 13] The authors' preferred method is to detach a majority of the tendo Achillis, using an inverted T-approach,

preserving the most medial and lateral insertions of the tendo Achillis. This allows for resection of any intratendinous calcification as well as effective remodeling of the entire posterior calcaneus, including medial and lateral extensions of any exostosis. Any diseased tendon or inflamed bursa tissue should be debrided or excised.

Recent technological advances have resulted in the development of numerous anchoring devices to perform tenodesis of the tendo Achillis to the calcaneus following partial or total detachment. Although anchoring devices have enhanced repair, surgical management of retrocalcaneal pathology has proven difficult and may lead to poor results. A predictable, secure reattachment of the tendo Achillis is therefore essential for successful functioning following any surgery involving release of the tendon, preventing spontaneous or traumatic avulsion or rupture (Fig. 14). Devices that consist of one or more strands of nonabsorbable braided suture (eg, polyester) are likely to cause a reaction and can contribute to a persistent low-grade inflammatory process postoperatively. The senior author has previously recommended that when knots are employed in this procedure, they be buried within or deep to the tendo Achillis.[11]

The prolonged recovery process of up to 1 year after retrocalcaneal surgery may be accompanied by persistent low-grade inflammation and compromised function of the tendo Achillis, often secondary to compromised insertion. The use of two or three anchoring devices is not uncommon in retrocalcaneal surgery, but the use of single or multiple anchoring devices does not seem to accelerate the recovery process. Traditional anchors do not provide an effective reattachment, as they are confined to a very small area. In contrast, the Spider Plate provides compression through the entire insertional area. This may compromise circulation to the underlying soft tissue,[1] but the authors have not found this to be a problem. Recently, the authors have found that the Spider Plate allows rapid, full recovery of function without the prolonged low-grade inflammatory process associated with other forms of Achilles tenodesis.

Conclusion

Retrocalcaneal exostosis, tenocalcinosis, and related disorders of the posterior aspect of the calcaneus can be challenging and difficult to treat. The DePuy TiMAX Spider Plate has proven to be a very effective device for reattachment of the tendo Achillis in retrocalcaneal surgery requiring tendo Achillis detachment. While the authors' experience is limited to eight cases, the results have been very promising for patients and physicians alike. The technique, although tedious, is not excessively demanding or diffi-

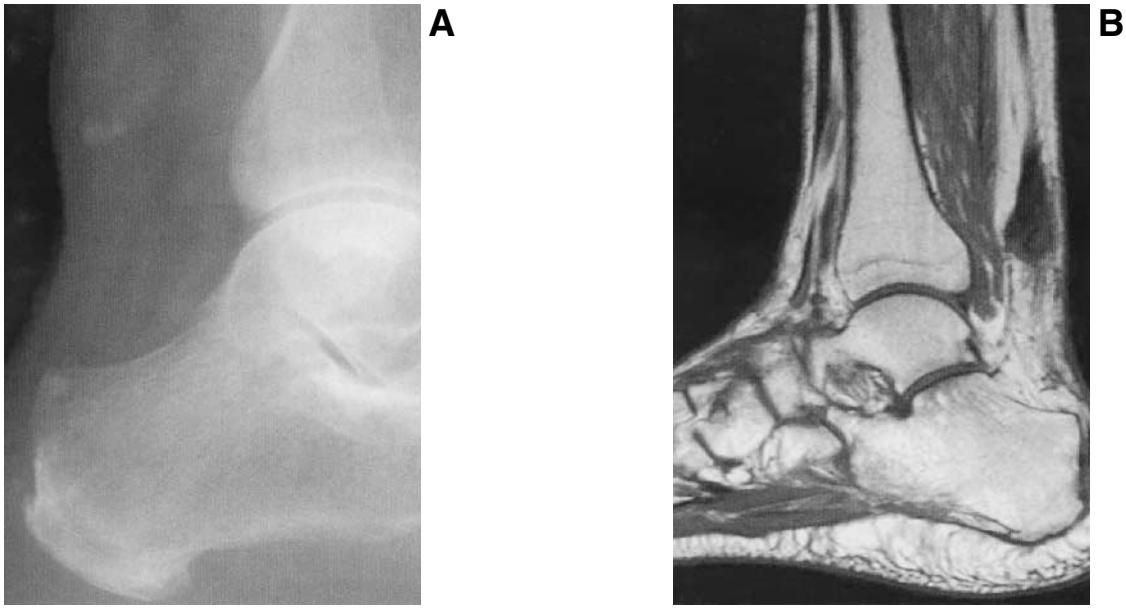


Figure 14. A, Postoperative lateral radiograph of a patient who underwent retrocalcaneal surgery. At 5 months postoperatively, the tendo Achillis ruptured from its insertion and retracted proximally. B, Magnetic resonance image demonstrating greater than 5 cm of proximal retraction of the tendo Achillis.

cult and is both clinically effective and cost-effective, with each plate costing approximately $65.00 and the 4.0-mm fully threaded cancellous and partially threaded cannulated cancellous screws running around $31.00 and $116.00 each, respectively. Where significant compromise of the tendo Achillis insertion is present, whether owing to a traumatic event or to a surgical procedure, a secure reattachment can be attained with this device. Following experimentation with various devices, including staples, suture, and anchors, the authors prefer the DePuy TiMAX Spider Plate for Achilles tenodesis during retrocalcaneal surgery. The plates are low profile, easy to insert, and very stable, and have a low likelihood of future surgical removal.

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