Treatment of Acute and Closed Achilles Tendon Ruptures by Minimally Invasive Tenocutaneous Suturing

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Original Research

Although acute ruptures of the Achilles tendon account for about 35% of all tendon tears (1), the optimal treatment is still controversial (2–5). The possible techniques can be classified as conservative management, open repair, and percutaneous repair (6).

Some investigators strongly recommend conservative management (5,7); however, cast immobilization can lead to elongation of the tendon with reduced strength of the calf muscles and has a high rate of repeat rupture (8).

Open repair of acute and closed ruptures of the Achilles tendon is widely accepted (9,10). However, surgical complications can influence patients’ functional restoration and quality of life (11,12). These complications are of particular importance to athletes, who have high requirements for functional restoration (13).

Percutaneous suture of Achilles tendon rupture is a simple and safe surgical strategy in treating acute and closed Achilles tendon rupture with a substantially lower complication rate (14,15). However, our method that has functional results similar to those of open repair, and suture the tendinous sheath completely to preserve the blood supply. Minimally invasive tenocutaneous suturing, “comb” the ruptured Achilles tendon to promote healing, and suture the tendinous sheath completely to preserve the blood supply.

We report our results in treating 20 patients with acute and closed Achilles tendon ruptures, with this minimally invasive tenocutaneous suturing. The surgery was followed by regular visits for several years to observe the clinical effects and possible complications of this technique.

Patients and Methods

We studied all patients with acute and closed Achilles tendon ruptures who had undergone minimally invasive tenocutaneous suturing at our institution from June 1996 to February 2007. None of the patients underwent bilateral Achilles tendon repair. Achilles tendon ruptures were diagnosed from the magnetic resonance imaging and physical examination findings (Fig. 1) by the surgeon. All patients were also followed up through clinic visits and telephone calls with our surgeon.

Surgical Procedure

Surgery was performed within 3 days of presentation. All patients received continuous epidural anesthesia in the prone position with a tourniquet applied above the knee to exsanguinate the foot. During surgery, the surgeon located the rupture gap, placed a 3-cm-long transverse incision along the rupture site (Fig. 2A), and then opened the aponeurosis lengthwise. The tendinous sheath was usually complete, and the ruptured end of the Achilles tendon was shaped like a horse tail (Fig. 2B).
The hematoma at the ruptured end was removed, and the “horse tails” at the 2 ruptured ends were “combed” (Fig. 2). The skin was pierced with a cutting needle from inside to outside at about 4 to 5 cm on the side near the ruptured section and about 2 to 3 cm at the far side of the ruptured section to avoid the surface projection of the nervus suralis and to prevent damaging it.

Double-stranded no. 10 thread was passed through the skin and Achilles tendon. The ankle was put in plantar flexion so that the ends of the tendon overlapped by 2 cm, and the tension suture was knotted outside the skin (Fig. 2). Before knotting, ankle flexion was confirmed to be the same as that of the contralateral ankle joint so that the tendon could be restored to its original length. The incision was then closed and covered with a rubber urethral catheter to reduce compression on the skin (Fig. 2C). In the case of exstrophy of the horsetail thread-like fiber and distension, the incision could be loosely closed with absorbable sutures to put the ends of the tendon into an introversion and ensure proper continuity in the appearance of the tendon and reduce scarring. Concurrently, the aponeurosis and tissues surrounding the tendon were repaired with 4-0 absorbable suture to maintain the circulation (Fig. 2D).

Postoperative Care

After surgery, the knee and ankle were each flexed 30° and immobilized in a plaster cast. A window was left in the cast at the Achilles tendon to allow dressing changes. The day after surgery, the patients began plantar flexion and dorsal angulation exercises for the metatarsophalangeal and interphalangeal joints and contracting and relaxing exercises for the quadriceps femoris to reduce swelling and prevent the formation of venous emboli.

Patients were encouraged to move other parts of their body to prevent atrophy of the quadriceps femoris, strengthen the body’s immunity, and enhance blood circulation at the wound, which helped reduced inflammation and swelling at the surgery site. Patients were also asked to perform isometric exercises of the gastrocnemius and musculus soleus.

After surgery, the patients were allowed to rise from their beds using crutches, but they were cautioned not to place weight on the injured leg and to keep the foot in plantarflexion. The cast was changed after 2 weeks, the degree of plantarflexion was reduced to 15°. After the cast was removed at 4 weeks, the patients were instructed to flex the ankle while lying down. After 8 weeks, the patients were allowed to stand with crutches and were encouraged to place some weight on the leg, gradually increasing the degree of flexion and extension, and to walk with a thick gauze cushion in the shoe. Full weightbearing was allowed 8 to 10 weeks after surgery.

The athletes and opera performers were encouraged to conduct adaptive rehabilitation exercises after the plaster cast was removed, such as swimming and cycling, and could gradually resume their training after 3 to 4 months. Steroid and aldosterone drugs were not used during treatment.

Follow-up Examinations and Endpoints

The patients were followed up until 2007. At 3 months after surgery, magnetic resonance imaging scans were obtained of the ankle, and healing of the Achilles tendon was visually evaluated by 3 of us, and the American Orthopedic Foot and Ankle Society Ankle Hindfoot score was determined for all patients (16). In addition, the radiologic and visual appearance of the repaired tendon was compared with the normal radiologic and visual appearance.

Results

We identified 20 patients (14 males), ranging in age from 21 to 66 years (mean 39.5), who were eligible for the present study. By profession, 8 (40%) were martial arts actors from the Beijing Opera, 4 (20%) were opera teachers, 5 (25%) were athletes, 2 (10%) were elderly sports fans, and 1 (5%) was an elderly patient with a slight injury experienced while walking. Most injuries were work-related (the professions share a characteristic bouncing motion); however, in 1 patient (5%), a direct strike from a heavy object had ruptured the tendon.

All patients had recent closed injuries without symptoms of autoimmunization, genetic collagen disorder, contagious diseases, or incomplete neural function. One patient died and one was lost to follow-up after 2 months. The reason the patient was lost to follow-up was not known. The follow-up period for the remaining 18 patients ranged from 1 to 7 years (mean 2).

Postoperative Functional Assessment

Of the 20 patients, 18 (90%) underwent magnetic resonance imaging 3 months postoperatively. In general, the imaging studies
revealed continuity of the Achilles tendon, which had been properly repaired and shaped and was close to, or approached, the imaging findings for a normal Achilles tendon (Fig. 3). The raising heel test showed that 18 patients (90%) could raise their heels forcefully and that the shape of the Achilles tendon was good (Fig. 3). The mean American Orthopedic Foot and Ankle Society Ankle Hindfoot score was 95 (range 90 to 98), and the maximum length of postoperative scaring was 3 cm. No large irregular scars, such as those sustained during immobilization, were present over the Achilles tendon.

Postoperative Complications

One patient ruptured the same Achilles tendon again 1 year after surgery in a sports accident. The tendon was repaired with Kessler suturing and purely reverse reinforced suturing of the gastrocnemius. At 10 months after repair, the repaired tendon was still intact.

In another patient, the nervus suralis was damaged during surgery (possibly by inadvertently piercing the tension suture at the near end), causing postoperative numbness and swelling. The tension suture was quickly removed at the patient’s bedside, external immobilization with the cast was prolonged by 2 months, and the exercise intensity was increased more gradually than for the other patients. The symptoms disappeared after 4 months, and the patient recovered well and experienced no additional ruptures.

Other complications, such as infection, skin necrosis, adhesion between tendon and skin, formation of a cystic lesion at the tendon, and stiffening of the ankle joint, were not found in any patient during surgery or during the follow-up visits.

Discussion

We treated the ruptured Achilles tendons of 20 patients with minimally invasive percutaneous suturing. This procedure preserved
the original length, continuity, and appearance of the tendon with few postoperative complications.

The Achilles tendon is the strongest and largest tendon in the human body. About 15 cm long, it originates from the lower third of the calf and inserts at the midpoint of the tuberosity of calcaneus. It has a pad of bursa synovialis at the front and back. The tendon has no sheath, only loose reticular tissue that links the tendon with the surrounding aponeurosis. It is vascularized (17). During surgery, we repaired the aponeurosis to ensure a good blood supply to the tendon. We believe we can achieve better healing by “combing” the horse-tail-like ends of the tendon and overlapping them by 2 cm when making the repair. Other percutaneous suturing methods do not straighten the tendon fiber; thus, we believe these methods are not as strong.

Traditional Achilles suturing methods include the steel wire Bunnett method and the mattress suturing method, among many others. These “direct open repairs” of the ruptured tendon can require a large incision, which can seriously damage the tissue around the tendon, impair circulation to the tendon, and predispose the repair to postoperative infection and adhesions. Studies of the blood supply to the Achilles tendon (18,19) have revealed that these methods can impair the microcirculation inside the tendon and seriously impair healing.

In contrast, many surgeons find modified Kessler suturing and fine-thread intermittent suturing of tendon bundles to be simpler, more efficient, and more practical and, therefore, the preferred method for restoring the Achilles tendon (20). However, recent research has found that suturing with a minimal percutaneous incision soon after the rupture and systematic functional exercise can greatly reduce the possibility of complications (21–23).

We believe minimally invasive percutaneous suturing conforms to the anatomic and physiologic features of the Achilles tendon and meets the healing requirements inside the tendon. In particular, the technique has the following advantages.

First, the small incision reduces damage to the tissues surrounding the tendon. We only make a simple repair on the ruptured end to make it neat. This method does not require a regular direct incision that requires strong suturing of the ruptured ends to provide continuous and steady tension. The method provides good blood circulation at the ruptured ends, reduces the possibility of postoperative adhesions, and provides good conditions for tendon repair.

Second, we placed the tenocutaneous sutures at the healthy part of the tendon, far from the ruptured end. This method provides steady and continuous tension for the repair of the tendon. This “distant” tension allows matching of the ruptured ends, shares most of the tension at the ruptured end, and avoids the influence of tension on the blood supply to the ruptured ends.

Third, the method retains the horse-tail shape at the residual end of the ruptured tendon. Overlapping tissues are properly arranged and not directly sutured, maintaining the appearance of the tendon. The overlapping length provides a repair that will not differ greatly from the desired length of the tendon. Moreover, it will not lead to possible shortening of the Achilles tendon caused by “direct open” surgery, and the ankle joint has a better degree of mobility postoperatively.

Fourth, the ruptured ends of the Achilles tendon were repaired using absorbable fine suture to maintain neat matching between the ruptured ends. Thus, knots from regular suturing were not seen at the 2 ruptured ends of the tendon, and the possibility of infections and postoperative complications was reduced.

Finally, a gradual functional restoration plan was followed postoperatively. The patients were encouraged to start functional exercise as early as possible to reduce postoperative adhesions and restore function. The goal was to restore the level of function to that before rupture.

In conclusion, minimally invasive tenocutaneous suturing for repair of ruptured Achilles tendons can provide good results with few complications. The method combines features of tension suturing and percutaneous suturing and preserves blood circulation to the Achilles tendon through “distant” tension. Through a single neat and accurate incision, the method can restore the original length, continuity, appearance, and function of the tendon.

The limitations in our research included that the sample size was small, the outcomes assessors were also a part of the surgical team, we were unable to compare the intervention with those of other therapies, and were unable to compare the outcomes status to the preoperative status. However, our research was hypothesis generating, and the descriptive statistical findings can be used in the development of future prospective cohort studies and randomized controlled trials.

References


