

New technical procedure involving Achilles tendon rupture treatment through transcutaneous suture

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Abstract

The Achilles tendon is the widest tendon of the human body. Achilles tendon belongs to the extrasynovial tendons group and this allows it a faster recovery, thanks to local hematoma from the peritenon, necessary for the scarification. We concluded that in Achilles tendon rupture treatment it is essential to maintain the tendon covering skin integrity, the peritendinous integrity, to maintain the local hematoma formed during and after tendon rupture, reattaching the ruptured tendon heads and maintain them in this position by suturing them and by relaxing the sural triceps muscle. The percutaneous suture requires five pairs of mirror micro-incisions (5 mm) on one side and the other of the tendon. It is necessary for one of the pairs to be placed to the rupture level. With a surgical needle, we arm the proximal and distal heads of the tendon by different threads. By traction and muscular relaxation, we bring in contact the two ruptured heads and then we knot together the arming threads. The inferior member was cast immobilized in relaxing position for the sural triceps muscle for a 45 days period. Using this technique, we have operated 15 cases in our Clinic. In all the cases, we obtained a healing by first intention of the tegument micro-incisions. After the cast immobilization suppression, during 30 days the patients were in a recovery program. At the end of this program, they have recovered completely the dorsal and plantar flexion and the walking. In four months after the surgery, the esthetic of the area is completely restored, this technique being the only surgical technique that realizes this recovery.

Keywords: percutaneous suture, Achilles tendon, recovery, new technique.

Introduction

As is known in the literature, the surgical treatment of the traumatic ruptures of the Achilles tendon is difficult because of the poor vascularization of the tegument, which is applied directly on the affected tendon. Moreover, the tensions created by the surgical reconstruction of Achilles tendon lead to necrosis of the wound tegument, which is hard to fix even through plastic or reparatory surgery. These difficulties have been major challenges for orthopedic surgeons who attempted to find new ways to treat ruptures of Achilles tendon. At the Orthopedic Clinic of the University of Medicine and Pharmacy of Craiova, Romania, we have envisioned and tested our own transcutaneous suture technique. The objective of this study is to validate the proposed technique by clinical reevaluations and magnetic resonance imaging (MRI) after full recovery of the patients. There are many different studies regarding the Achilles tendon suture but there is no universal agreement about the strategy for acute total Achilles tendon rupture. Many surgeons prefer open surgical suture contributing to a low incidence of re-rupture, ranging from 1.4% to 2.8% [1–3]. High incidence of re-ruptures (12% to 17%), lengthened tendon and loss of strength are the main arguments for the opponents to criticize this method [1–6]. It is an alternative to opened operative treatment. There are biomechanical studies that show greater biomechanical strength of the transcutaneous suture, with the strength comparable to open

procedures [7–9]. Percutaneous repair was first described by Ma & Griffith, in 1977 [10].

Patients and Methods

Our study includes 15 patients, aged between 19 to 58 years, suffering of acute total Achilles tendon rupture (football: six; basketball: two; tennis: one; handball: one; volleyball: one; home activity: four) over the past five years. Almost all patients suffered an indirect trauma with excessive strain on the tendon (fall, stumbling) in 12 cases and three cases of direct blunt trauma. There were two cases with a small open injury to the tendon. All patients provided signed agreement before this new procedure and a standard consent form, according to ethical procedures. We also obtained the approval of Ethics Commission of the Emergency County Hospital of Craiova.

The operation was performed with the patient in prone position, with the injured foot lying free to the edge of the table in order to manipulate the foot between neutral position and maximal flexion. Skin was cleaned and disinfected during pre-operative preparations. Regularly, only a generic antibiotic or antithrombotic prophylaxis was given. Absorbable thread – Vicryl No. 2, on long, semi-curved, triangularly cut needles was used. The procedure can be performed better with two needles for each thread. The rupture and the gap between the ruptured tendon margins must be localized. The procedure was performed under rachianesthesia using Marcaine spinal

0.5% (5 mg/mL) – 4 mL. The anesthesiologist made the injection using 8–10 mm spinal needles. After that, proximally and distally (about 4 cm) around the palpated gap, the skin was cut with the edge of the surgical scalpel at the marked points. There are six or 10 puncture holes where the thread was led according to the retraction of the tendon heads. At every site of the first needle entrance or exit, the incision should be widened in longitudinal direction by pushing the scalpel blade. The procedure was started at proximal and distal points. First, the thread was transversely passed through the tendon, proceeding with the diagonal suture. After that, we pulled each side of the thread in a zigzag manner. The thread was then longitudinally, subcutaneously and extratendineously led to the exterior, meeting at the site of rupture. The proximal and the distal threads were pulled out. After tightening, when feeling both ends of the Achilles tendon were completely approximated and the defect was no longer palpable, we made the knots – one medially and the other laterally (Figure 1).

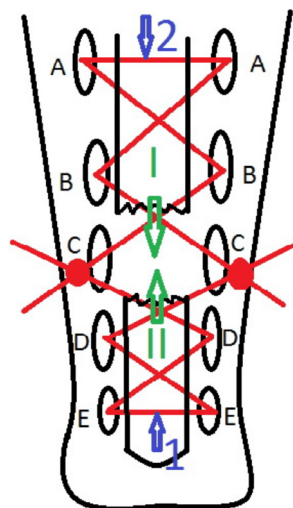


Figure 1 – Surgical technique for passing the threads. I, II: Parts of the ruptured tendon; 1, 2: First and second thread; A, B, C, D, E: Medial and lateral skin incisions necessary to introduce the threads into the tendon; E: Entry point for the first thread; A: Entry point for the second thread; C: Exit points for the threads where the knots are being made.

The knots were then sunk under the skin. After surgery, no thread could be seen on the skin, except the small stab wounds on the skin that later disappeared. Postoperative examination was made by ultrasonography and MRI. Immobilization was applied for three weeks in 20° of plantar flexion of foot. Patients used crutches to walk. Weight bearing of approximately 5 kg was allowed. Next three weeks progressive weight bearing up to 20 kg was allowed. Neutral position was applied after three weeks. It enabled plantar flexion and prevented dorsal flexion. Patients walked with crutches and were allowed to bear weight as tolerated. After six weeks, the immobilization was removed and the patients were allowed to walk without crutches. The patients should correct pattern of walking – no limping. Swimming and walking in the pool with weight bearing is tolerated. Stretching exercises are allowed after eight weeks with careful increasing of the load.

Results

The immediate results have been satisfactory. Using this technique, we have operated 15 cases in our Clinic. In all the cases, we obtained a healing by first intention of the tegument micro-incisions (Figures 2 and 3).

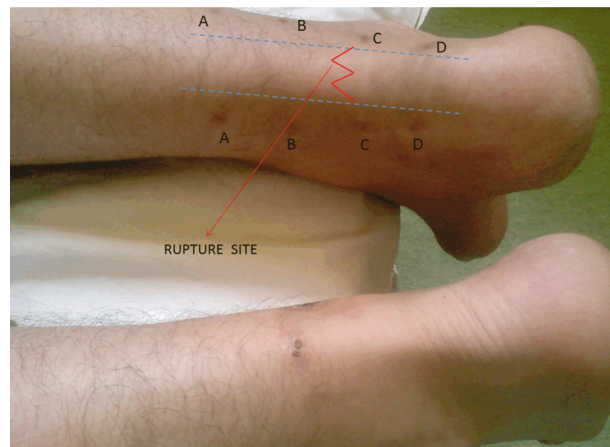


Figure 2 – Surgical incisions – medial view. A, B, C, D: Medial and lateral skin incisions necessary to introduce the threads into the tendon; D: Entry point for the first thread; A: Entry point for the second thread; C: Exit points for the threads where the knots are being made; Discontinuous lines: Medial and lateral limit of the Achilles tendon.

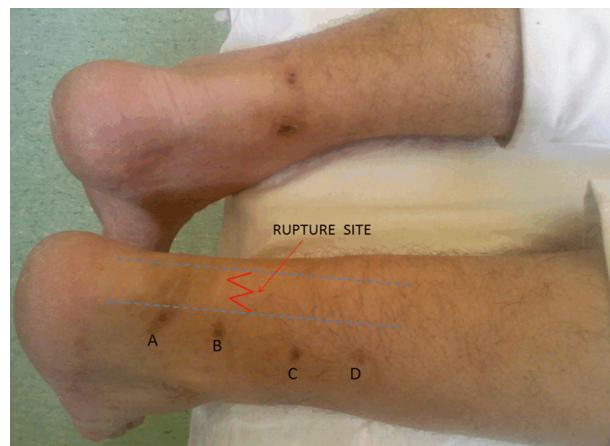


Figure 3 – Surgical incisions – lateral view. A, B, C, D: Medial and lateral skin incisions necessary to introduce the threads into the tendon; D: Entry point for the first thread; A: Entry point for the second thread; C: Exit points for the threads where the knots are being made; Discontinuous lines: Medial and lateral limit of the Achilles tendon.

After the cast immobilization suppression, during 45 days the patients were in a recovery program. At the end of this program, they have recovered completely the dorsal and plantar flexion and the walking. To mention that on four months after the surgery the esthetic of the area is completely restored, this technique being the only surgical technique that realizes this recovery. The patients treated through this technique have after-surgery periods between three months and one year. They are having a normal life. There was only one patient that presented an anesthesia on the lateral side of the foot, on the sural nerve territory. Three months later, the symptoms disappeared.

We now have under observations patients operated five years ago. We have examined them clinically and through MRI, the results of our examinations have shown a good recovery of the Achilles tendon (Figure 4). The treated patients are able to perform the entire range of motions accessible to a healthy patient, including even the practice of sports with a high solicitation of the Achilles tendon.

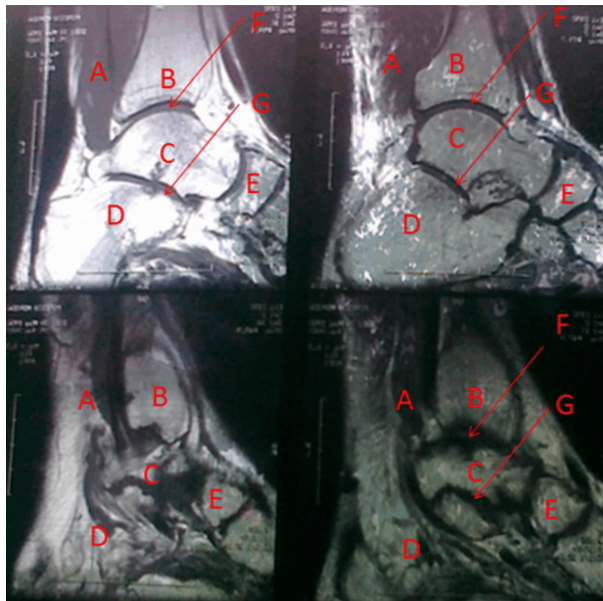


Figure 4 – MRI image of Achilles tendon. A: Achilles tendon; B: Tibia; C: Talus; D: Calcaneus; E: Navicular; F: Tibio-talar joint; G: Talo-calcaneal joint.

Discussion

Percutaneous repair was first described by Ma & Griffith, in 1977 [10]. Complete rupture of Achilles tendon leads to retraction of the triceps surae and then to diastasis of the torn ends. The gap between is filled with fibrous tissue that will never be as strong as the original tendon, contributing to a high incidence of re-rupture [6, 11]. Review studies including a large number of patients show the re-rupture rate with conservative treatment of 12% [2, 6] to 13.4% [1].

Percutaneous method is a blind one, the exact position of the torn ends and approximation cannot be visualized [3]. This technique developed a reputation for iatrogenic sural nerve injuries, with Klein *et al.* reporting a 13% rate of sural nerve involvement [12]. The main concern with percutaneous techniques is the possibility of damaging the sural nerve, which has reportedly occurred in 0 to 10% of cases [13]. In a case control study using a percutaneous technique, the sural nerve was injured in 18% of repairs in which the nerve was not exposed intraoperatively [14]. Rouvillain *et al.* reports, in 2010, a series of 60 repair using percutaneous suture, without sural nerve lesion, two re-ruptures at two and five months respectively and mean return to work of 85 days and return to sports in five months [15]. Webb & Bannister [6] developed a percutaneous technique, placing the sutures in the midline rather than the side close to the nerve to avoid the risk of iatrogenic injury. Their series of 27 patients returned to work at four weeks and sports activities at four months. No sural nerve injuries or late re-ruptures were cited. Large radius of curvature of the needle means that the stab incisions tend to avoid the path of the sural nerve [16]. Some authors recommend direct visualization of the nerve to reduce the risk of such lesions [14].

Kakiuchi proposed a semi-open method, with an incision is made at the site of rupture and the approximation is checked under visual control [17]. Maes *et al.* changed

their technique to mini-open technique [18]. Opening the site of a rupture the injury becomes an open one with all the risks and loss of hematoma with stimulating factors [19]. However, as the torn ends are pulled apart, the gap between them can be palpated and the position of the ends thereby located. Prospective study has shown significantly fewer complications in the group of proposed percutaneous repairs in comparison with the group of open repairs. Functional assessment using various scores showed no statistically significant differences between both groups [19]. Dacron threads applied to malleable needles and a harpoon were used in Martinelli's series reporting return to pre-injury sports activity after 120 to 150 days (3–5 months) [20]. McClelland & Maffulli [21] described another modification of Ma & Griffiths' technique [10] and this was subsequently modified [16]. The needle is passed through stab paratendinous incisions in a Bunnel fashion emerging through a central stab at the rupture site. Elite athletes were retrospectively assessed at an average of 72 months from the procedure. All patients reported that they were able to weight bare fully at the end of the 8th post-operative week and that the average time to return to sport was 4.8 months [22].

The Achillon jig has been developed from an initial minimally invasive technique [17, 23]. Clearly, there is a risk of nerve puncture but as the sutures are removed through the same puncture pass the risk of permanent nerve symptoms are very unlikely but possible. In a small series of 15 patients repaired using the jig, Chan *et al.* reported a recovery of 95% isometric peak force recovery compared to the non-injured side, resumption of sports activity and no complications [24].

Sometimes, there are painful subcutaneous nodules described in certain reports [25, 26], that are probably due to using a non-absorbable suture. The technique does not require expensive surgical material and above all, does not leave any foreign body externally in contact with the skin [27], which could be a source of local inflammation, or even of cutaneous necrosis [18].

Some physiotherapy protocols recommend early passive mobilization of the talocrural joint after surgery [28]. This is meant to improve the blood supply of the tendon [25] and thus produce more rapid recovery of mobility while limiting the risk of tendon shortening [29]. We, therefore, consider that the strict immobilization protocol of six weeks that we recommend does not have any major influence on the long-term functional result and allows patients to limit the painful constraints of immediate mobilization.

Conclusions

Percutaneous suture of the Achilles tendon is a simple, efficient, quick, and inexpensive surgical technique. It combines the advantages of open surgery with a low risk of rerupture and those of functional treatment with a low risk of infection. There is a risk of damage to the sural nerve. That can be prevented by a rigorous technique for passing the threads through the tendon. The very long-term results of this method are good, permitting to reintegrate at work or to practice different sports. Physiotherapy is needed to achieve better functional results.

Conflict of interests

The authors declare that they have no conflict of interests.

References

- [1] Cetti R, Christensen SE, Ejsted R, Jensen NM, Jorgensen U. Operative *versus* nonoperative treatment of Achilles tendon rupture. A prospective randomized study and review of the literature. *Am J Sports Med*, 1993, 21(6):791–799.
- [2] Lo IK, Kirkley A, Nonweiler B, Kumbhare DA. Operative *versus* nonoperative treatment of acute Achilles tendon ruptures: a quantitative review. *Clin J Sport Med*, 1997, 7(3):207–211.
- [3] Maffulli N. Rupture of the Achilles tendon. *J Bone Joint Surg Am*, 1999, 81(7):1019–1036.
- [4] Kocher MS, Bishop J, Marshall R, Briggs KK, Hawkins RJ. Operative *versus* nonoperative management of acute Achilles tendon rupture: expected-value decision analysis. *Am J Sports Med*, 2002, 30(6):783–790.
- [5] Washburn SD, Caiozzo VJ, Wills CA, Hunt BJ, Prietto CA. Alterations in the *in vivo* torque–velocity relationship after Achilles tendon rupture. Further evidence of speed-specific impairment. *Clin Orthop Relat Res*, 1992, 279:237–245.
- [6] Webb JM, Bannister GC. Percutaneous repair of the ruptured tendo Achillis. *J Bone Joint Surg Br*, 1999, 81(5):877–880.
- [7] Čretnik A, Žlajpah L, Smrkolj V, Kosanović M. The strength of percutaneous methods of repair of the Achilles tendon: a biomechanical study. *Med Sci Sports Exerc*, 2000, 32(1):16–20.
- [8] Watson TW, Jurist KA, Yang KH, Shen KL. The strength of Achilles tendon repair: an *in vitro* study of the biomechanical behavior in human cadaver tendons. *Foot Ankle Int*, 1995, 16(4):191–195.
- [9] Zandbergen RA, de Boer SF, Swierstra BA, Day J, Kleinrensink GJ, Beumer A. Surgical treatment of Achilles tendon rupture: examination of strength of 3 types of suture techniques in a cadaver model. *Acta Orthop*, 2005, 76(3):408–411.
- [10] Ma GWC, Griffith TG. Percutaneous repair of acute closed ruptured Achilles tendon: a new technique. *Clin Orthop Relat Res*, 1977, 128:247–255.
- [11] Wills CA, Washburn S, Caiozzo V, Prietto CA. Achilles tendon rupture. A review of the literature comparing surgical *versus* nonsurgical treatment. *Clin Orthop Relat Res*, 1986, 207:156–163.
- [12] Klein W, Lang DM, Saleh M. The use of the Ma–Griffith technique for percutaneous repair of fresh ruptured tendo Achillis. *Chir Organi Mov*, 1991, 76(3):223–228.
- [13] Gorschewsky O, Vogel U, Schweizer A, van Laar B. Percutaneous tenodesis of the Achilles tendon. A new surgical method for the treatment of acute Achilles tendon rupture through percutaneous tenodesis. *Injury*, 1999, 30(5):315–321.
- [14] Majewski M, Rohrbach M, Czaja S, Ochsner P. Avoiding sural nerve injuries during percutaneous Achilles tendon repair. *Am J Sports Med*, 2006, 34(5):793–798.
- [15] Rouvillain JL, Navarre T, Labrada-Blanco O, Garron E, Daoud W. Percutaneous suture of acute Achilles tendon rupture. A study of 60 cases. *Acta Orthop Belg*, 2010, 76(2):237–242.
- [16] Carmont MR, Maffulli N. Modified percutaneous repair of ruptured Achilles tendon. *Knee Surg Sports Traumatol Arthrosc*, 2008, 16(2):199–203.
- [17] Kakiuchi M. A combined open and percutaneous technique for repair of tendo Achillis. Comparison with open repair. *J Bone Joint Surg Br*, 1995, 77(1):60–63.
- [18] Maes R, Copin G, Averous C. Is percutaneous repair of the Achilles tendon a safe technique? A study of 124 cases. *Acta Orthop Belg*, 2006, 72(2):179–183.
- [19] Čretnik A, Kosanović M, Smrkolj V. Percutaneous *versus* open repair of the ruptured Achilles tendon: a comparative study. *Am J Sports Med*, 2005, 33(9):1369–1379.
- [20] Martinelli B. Percutaneous repair of the Achilles tendon in athletes. *Bull Hosp Jt Dis*, 2000, 59(3):149–152.
- [21] McClelland D, Maffulli N. Percutaneous repair of ruptured Achilles tendon. *J R Coll Surg Edinb*, 2002, 47(4):613–618.
- [22] Maffulli N, Longo UG, Maffulli GD, Khanna A, Denaro V. Achilles tendon ruptures in elite athletes. *Foot Ankle Int*, 2011, 32(1):9–15.
- [23] Rippstein PF, Jung M, Assal M. Surgical repair of acute Achilles tendon rupture using a “mini-open” technique. *Foot Ankle Clin*, 2002, 7(3):611–619.
- [24] Chan SK, Chung SCY, Ho YF. Minimally invasive repair of ruptured Achilles tendon. *Hong Kong Med J*, 2008, 14(4):255–258.
- [25] Gelberman RH, Menon J, Gonsalves M, Akeson WH. The effects of mobilization on the vascularization of healing flexor tendons in dogs. *Clin Orthop Relat Res*, 1980, 153:283–289.
- [26] Ingvar J, Tågil M, Eneroth M. Nonoperative treatment of Achilles tendon rupture: 196 consecutive patients with a 7% re-rupture rate. *Acta Orthop*, 2005, 76(4):597–601.
- [27] Delponte P, Potirer L, de Poulpique P, Buisson P. Treatment of subcutaneous ruptures of the Achilles tendon by percutaneous tenorrhaphy. *Rev Chir Orthop Réparatrice Appar Mot*, 1992, 78(6):404–407.
- [28] Bosworth DM. Repair of defects in the tendo Achillis. *J Bone Joint Surg Am*, 1956, 38-A(1):111–114.
- [29] Roberts CP, Palmer S, Vince A, Deliss LJ. Dynamised cast management of Achilles tendon ruptures. *Injury*, 2001, 32(5):423–426.

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