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Case Report

Application of lariat lock catch knot suture in the achilles tendon rupture

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Abstract: The aim of this study was to summarize the clinical experience of repairing the Achilles tendon rupture by lariat lock catch knot suture. Between January 2011 and February, 2014, 32 cases of the Achilles tendon rupture were treated by lariat lock catch knot suture. There were 26 males and 6 females, with the average age of 39 years (range 17-53 years), including 13 left knees and 19 right knees. 29 wounds healed by first intention, and 3 cases who were performed local flap transfer due to necrosis of skin were healed by second intention. Thirty-two cases were followed up 10-25 months (13 months on average). No re-rupture of Achilles tendon or deep infection occurred during follow-up period. According to Arner-Lindholm assessment standard, the results were excellent in 19 cases and good in 13 cases, the excellent and good rate was 100%. Lariat lock catch knot suture is a safe and effective method for repairing Achilles tendon.

Keywords: Achilles tendon, lariat lock catch knot, tendon suture, achilles tendon lengthening

Introduction

Achilles tendon rupture is one of common Achilles tendon diseases [1], and has high incidence rate in males with the age from 30 to 50 years [2]. There are about 2 to 10 ruptures per 100,000 people in developed countries [3], but there is a relative low incidence rate of ruptures in developing countries [4]. The mean age for an Achilles tendon rupture was about 35 years, and the ratio of male and female was from 4:1 to 20:1. Two types group of people at high risk of Achilles tendon rupture should be paid attention, including people who discontinuously take part in high intensity sports but the routine life was relative quiet and who had low intensity sports for a long time [5]. Warm season is the high risk period for Achilles tendon rupture, and the highest incidence rate of Achilles tendon rupture occurred when the climate is changing from not fit for sports to fit for sports, especially at the end of winter and the beginning of spring or at the end of summer and the beginning of autumn [6].

Except for Achilles tendon caused by direct violence, the reason of Achilles tendon caused by indirect violence was that triceps muscle of calf was suddenly powerful at ankle point. When the ankle dorsiflexion was 20-30 to have plantar flexion, there was a big radius from tuberis calcaneal to the axes of ankle, and Achilles tendon kept extremely tension state. Once people suddenly jumped, the tense Achilles tendon need undertake over much more times power than itself power, therefore, the Achilles tendon rupture happened [7].

Furthermore, there are other high risk factors to cause Achilles tendon rupture, including steroids use, quinolones drugs use, gout, thyrotoxicosis, renal inadequacy, arteriosclerosis, history of ruptures, infections, systemic inflammatory diseases, hypertension and obesity [8]. There are many methods to treat Achilles tendon rupture [9], most of which is surgical repairment. Under the good surgical condition, the re-rupture rate is only 2-3% after surgical repairment, but non-surgical repairment is up to 10% to 30% [10]. Moreover, the muscle power is stronger after surgical therapy. Repairment methods included percutaneous suture, Krackow suture, Lindholm suture, and Lynn suture and peroneus brevis tendon or plantaris tendon reinforce-

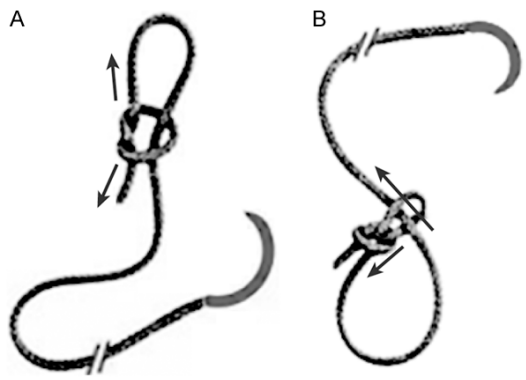

Figure 1. Operating mimetic diagram of locking loop suture. A: Making lariat; B: Suture crossing lariat to form lock catch.

ment operation [11]. Although there are many repairment techniques, each technique has advantages and disadvantages, for example, common suture has poor tolerance on plantaris tendon and weakly preventing slip and tearing that affect tendon healing [12]. Or in order to prevent gap formation at the broken ends of fractured tendon, people can't conduct functional exercise at the early stage so as to affect the recovery of injured parts [13].

We designed and invented the locking-loop knotter (ZL201210115284.X) and repaired 32 patients of the Achilles tendon rupture in our hospital during January 2011 to February, 2014 by lariat lock catch knot suture using non-absorbable orthopedic suture materials and got satisfied effects.

Materials and methods

General data

32 patients included 26 males and 6 females with the average age of 39 years (range 17-53 years), including 13 left knees and 19 right knees. They were injured when they have sports but change their actions suddenly, including starting running, jumping and stopping suddenly. Obvious broken injury area was touched in 30 cases and other 6 cases should be diagnosed by ultrasound and MRI examination. Operation time was from 47 h to 14 d after injury, and repaired by Lariat lock catch knot suture. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of the Second Hospital of Tangshan. Written informed consent was obtained from all participants.

Operation

Anesthesia, body position and incision: Patients were kept prone and lateral prone position under the condition of continuous epidural and combined spinal and epidural anesthesia and operated under the tourniquet. Vertical arch Incision was conducted at a 10.0 cm distance from medial margin of Achilles tendon to reach epitendineum and expose the broken end of Achilles tendon; meanwhile, blood clot was cleared.

Lariat lock was prepared with osteopathic 2th suture (**Figure 1A**), the method of suturing crossing lariat to form lock catch was showed in **Figure 1B**. Lock catch prepared lariat lock was sutured at one side of Achilles tendon about 3 cm distance from broken end (**Figure 2A**), then tendon suture crossed Lariat lock to form lock catch that locked one part of tendon (**Figure 2B**), then performed suture and reserve about 10 cm suture at the end of tendon. Furthermore, more than 3 positions in the different orientations and levels of the same side were conducted lariat lock and lock catch suture. Other side of broken end was also performed the same lariat lock catch suture, and end lines were reserved (**Figure 2C**).

Knot responding sutures were tighten at 30 degree of knee flexion and ankle plantar flexion respectively, and knots were embedded in the broken end of Achilles tendon (**Figure 2D**), and each suture should keep the same tension.

Surrounding suture: Tendinous fiber tissues were put clearly at the end position, transverse figure-of-eight suture was done with absorbable sutures in many places (**Figure 2E**), and zero tendon line was used to suture epitendineum discontinuously, and closed the incisions layer by layer and put catheter drainage.

Treatment after operation

Long leg plaster slab was fixed at 30 degree of knee flexion and ankle plantar flexion after operation. Meanwhile, patients were guided positive functional exercise and massage with ultrashort wave, infrared ray, laser and wax-

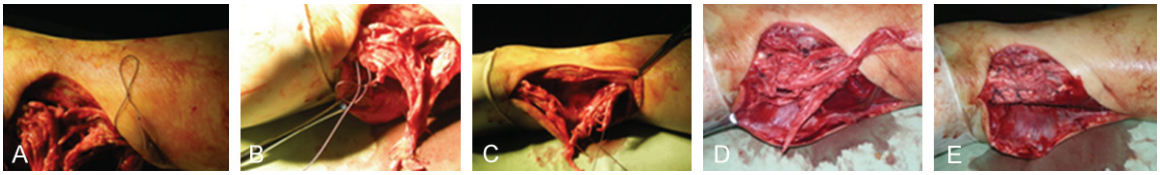

Figure 2. The continuous process of operation. A: Making lariat and suturing tendon; B: Suture crossing lariat to form lock catch to tighten some parts of tendon; C: Locking loop suture was performed at the symmetrical position; D: Knotting the end suture; E: Surrounding figure-of-eight suture.

Figure 3. The functional recovery after operation. A: The plaster slab of short leg was changed and knee joint was exercised. B: Plaster slab was removed and the patient could exercise ankle bend and stretch while walking with stick. C: Stick removed and the patient could walk without any stick help.

therapy. Short leg plaster slab was changed after 3 weeks and knee joint was exercised (**Figure 3A**). Plaster slab was removed after five weeks, and patients could exercise ankle bend and stretch. After six weeks, patients should wear high-heel shoes and walk with stick (**Figure 3B**). Stick could be removed after three months (**Figure 3C**) and patients should avoid intense sports after six months.

Results

29 wounds healed by first intention, and 3 cases who were performed local flap transfer due to necrosis of skin were healed by second intention. Thirty-two cases were followed up 10-25 months (13 months on average). No re-rupture of Achilles tendon or deep infection occurred during follow-up period. According to Arner-Lindholm assessment standard [14], the results were excellent in 19 cases and good in 13 cases, the excellent and good rate was 100%.

Discussion

Closed Achilles tendon rupture mostly presented mangle type, especially sports injury, such like running, tumbling, jumping to shoot basketball and long jump [15]. Closed Achilles tendon mostly occurs at 3-4 cm on the top of calcaneal region and broken end tendon presents horsetail shape and had different length and thickness, which indicates that Achilles tendon has degeneration on the basis of anatomy. Pathological examination shows Achilles tendon manifests glass and fibrosis degeneration, some adipose tissues between tendon fibers, small round cell infiltration and vascular proliferation. The therapy aim of Achilles tendon is to recover the integrity and tenacity of tendon, even keep tendon's physical length and plantar flexion power of triceps surae muscle. The therapeutic methods include surgical and non-surgical method, and each method has its advantages and disadvantages. Non-surgical therapy has less skin infection but high risk of re-rupture of Achilles tendon [16], which is not applied by clinical doctors. Presently, most doctors mainly advocate using surgical method to repair Achilles tendon, which has better prognosis than traditional therapy in the future [17]. Repairment quality directly affects the recovery. Suture method not only fixes the broken end of bones but reduces synechia. Achilles tendon is the longitudinal tendinous fibers tissue, therefore, suture method makes tendinous suture have tensile strength as strong as possible. Traditional suture, such as discontinuous and mattress suture, has poor tensile

strength not to bear enough tension and fix broken ends well, which cause many knots outside of bones and high rate of synechia after surgery. Meanwhile, traditional suture easily results in tendon bundle splitting at the broken ends of Achilles tendon so as to affect intention effect. Thus, this suture method has been given up now.

Bunnell, Lindholm [18], Kessler [19], Krackow [20] and Jaakkola *et al*. [21] suture methods make full use of triple bunch techniques to repair acute Achilles tendon rupture. Because broken end of Achilles tendon shows uneven horsetail shape, some sutures are limited. LARS ligament and anchor have stronger mechanical property [22, 23], but need special materials and high cost, even possibly inflammatory response, thus it is not worthy promotion in clinical application. Gastrocnemius aponeurosis turndown is used to repair tendon rupture, which causes severe injury [24]. Moreover, there are other applications, including V-Y plasty and gastrocnemius-soleus fasica turndown graft [25, 26]. Meanwhile, minimally invasive surgery has taken great development for the past few years. A small scale study (thirteen patients with acute Achilles tendon ruptures) primary suggested that minimally invasive operative methods was successful and meaningful, showing good functional results [27]. But there is still lack of large scale clinical study further.

This suture method fits for the bigger tendon rupture and far end with available tendon stump, especially for Achilles tendon rupture.

Locking-loop suture has many advantages as follows: 1) Locking-loop belongs to pre-tense locking suture method through partly catching tendon fiber, which has skidproof and split resistant effects, and increases tensile strength of tendon after repairment and effectively resists the gap formation, additionally, this suture method is benefit of early function exercise of tendon; 2) Locking loop catches fewer tendon fibers and stereoscopic suture with different angles and levels has little influence on tendon blood supply to benefit for tendon recovery; 3) This suture fits for much bigger tendon that makes stoma have even power in different orientation. Furthermore, it had stronger tensile strength to prevent tendon from adherence; 4) Knots are embedded in the broken end of Achilles tendon after suture, and absorbable sutures are used to reinforce suture and make Achilles tendon much smoother and keep continuous, which reduce the incidence of tendon adherence after operation.

Steel wire is not used to avoid the secondary injury and bring about fear for patients when steel wire is pulled out. Meanwhile, it reduces skin oppression and wound infection opportunity, even therapy costs.

Operating simply without special materials is convenient for promotion in any hospitals.

Broken end of Achilles tendon is uneven, each knot position should be remembered and ensure each knot at different levels and angles when we performed locking loop suture, which avoids tendon wind at the same level to block tendon blood supply. This might affect the Achilles tendon recovery; the body should be fixed when the end lines are sutured, furthermore, tension of each suture should be controlled to make tension strength reach maximum on the stoma of tendon. Each loop should be arranged symmetrically, including front and back position, left and right position, in order to make the Achilles tendon keep even strength. Moreover, aponeurosis tissue ought to repair carefully to supply blood nutrition.

Locking-loop suture has a good effect in the repairment of acute Achilles tendon, but it lacks of some studies on biomechanical approach, which would be improved in our future study.

Disclosure of conflict of interest

None.

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