Injury, Int. J. Care Injured xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Full length article

A novel minimally invasive surgery combined with early exercise therapy promoting tendon regeneration in the treatment of spontaneous Achilles tendon rupture

Amuding Aisaiding[a,1], Jianping Wang[a,1], Rouziwanguli Maimaiti[a], Ayidaer Jialihasia[a], Rakimbaiev Aibek[a], Bayixiati Qianman[a], Nuerai Shawutali[a], Aynaz Badelhan[a], Wulan Bahetiya[a], Aliya Kubai[a], Mailamuguli Kelamu[a], Yeermike Nuerdoula[a], Elihaer Makemutibieke[a], Yerzat Bakyt[a], Jianati Wuerliebieke[a], Jiasharete Jielile[a,b,*]

[a] Department of Orthopedics Centre, The First Teaching Hospital of Xinjiang Medical University, Kazakh Medical Association of Xinjiang Uygur Autonomous Region, The Sports Medicine Research Centre of Orthopedics Research Institute, Xinjiang Uygur Autonomous Region, Urumqi, 830054, China
[b] Department of biophysics and biomedicine, Biology and Biotechnology faculty, Al-Farabi Kazakh National University, Almaty, Kazakhstan

ARTICLE INFO

Article history:
Accepted 29 October 2017

Keywords:
Kazakh medicine
Spontaneous
Achilles tendon rupture
Minimally invasive surgical approach
Yurt-bone suture
Tendon regeneration

ABSTRACT

Objective: Acute closed spontaneous Achilles tendon rupture often occurs in elderly individuals and is usually accompanied with many complications. Conventional surgical approaches to remove the tendon lesions and enthesophytes are highly traumatic and cause complications. In this study, a previously established minimally invasive surgical approach was modified and combined with a Kazakh exercise therapy to reduce trauma, improve wound healing, and promote tendon regeneration in the management of acute closed spontaneous Achilles tendon rupture.

Methods: Fifty-two patients with acute closed spontaneous Achilles tendon rupture were randomly classified into 2 groups. Group A included 23 patients that were treated with the novel approach. Group B included 29 patients that were treated with a continuous medial oblique surgical approach. Follow-up examinations were performed at post-operative weeks 12 and 24, and year 2. Outcomes were assessed by Achilles tendon rupture score (ATRS), a heel-rise endurance test, and ultrasonographic and multislice spiral computerized tomography.

Results: Mean ATRS in Group A was 68.6 and 86.0 at post-operative week 12 and 24, respectively, significantly higher than that in Group B (55.9 and 72.0, respectively). Recovery of patients in Group A was significantly better compared to Group B ($p < 0.01$), allowing them to participate in early rehabilitating kinesiotherapy. Patients in Group A rarely experienced complications after surgery, such as infection and Achilles tendon exposure, while in Group B, the wound healing was slower, the inside flaps were prone to necrosis and infection, and Achilles tendon exposure occurred in 10% of patients.

Conclusions: The novel minimally invasive surgery is more advantageous in the treatment of acute closed spontaneous Achilles tendon rupture over previous approaches by promoting wound healing and tendon regeneration.

Introduction

The Achilles tendon is the thickest and strongest tendon in the human body. It is about 15.0 cm long, located at the back of the ankle, and attaches the plantaris, gastrocnemius, and soleus muscles to the calcaneus. The Achilles tendon plays a central role in plantar flexion of the ankle and knee flexion, and controls motion in activities such as walking, running, and jumping [1–4].

Acute closed spontaneous Achilles tendon rupture is uncommon when normal levels of stress are put on the tendon, but is frequently associated with chronic pathological changes, including tendinopathy and calcification [5–11]. It mostly occurs in patients with predisposing factors, such as previous exposure to fluoroquinolone antibiotics or corticosteroids [10,12]. It is more often

* Corresponding author at: Department of Orthopedics Centre, The First Teaching Hospital of Xinjiang Medical University, Kazakh Medical Association of Xinjiang Uygur Autonomous Region, The Sports Medicine Research Centre of Orthopedics Research Institute, Xinjiang Uygur Autonomous Region, Urumqi, 830054, China.
E-mail address: 3081257306@qq.com (J. Jielile).
[1] These authors contributed equally as first author to this study.

https://doi.org/10.1016/j.injury.2017.10.046
0020-1383/

seen among men with chronic Achilles tendonitis and those performing high level athletic activities.

Achilles tendon ruptures can be classified as acute, sub-acute, or chronic based on the duration of injury. Acute Achilles tendon ruptures refer to injuries occurring within 2 weeks [13]. Depending on the severity of injury, Achilles tendon ruptures can also be categorized as partial or complete [13]. In addition, ruptures can be open, when the ruptured tendons are exposed to the air, or closed, when the ruptured tendons are underneath skin or other tissues. In this study, only the cases with acute, closed, spontaneous, and complete Achilles tendon ruptures were focused.

Despite the management of Achilles tendon ruptures has been well described previously [14], there is no commonly acceptable approach to treat these injuries. Several management options are available for the treatment of acute closed spontaneous Achilles tendon rupture, and open surgery is currently believed to provide better outcomes than conservative non-surgical approaches [5–11]. Postoperative functional rehabilitation involving an early Kazakh exercise therapy [1], Kiymil arkili emdew (active motion of the ankle joint and weight bearing in Kazakh), has been reported to enhance tendon healing compared to postoperative cast immobilization [1–4]. Early postoperative Kiymil arkili emdew, which includes movements of the ankle joint without postoperative fixation or orthosis, uses dynamic mechanical forces and tension to accelerate tendon healing [1,2,4,15–19].

Continuous medial oblique surgical approaches are often used to excise pathological Achilles tendon tissues, including calcified tissue and enthesophytes [9]. These surgical techniques offer a wide and clear operation field; however, they are not always appropriate for the treatment of acute closed spontaneous Achilles tendon rupture, particularly in elderly patients, as they cause severe trauma and multiple complications. In this study, we modified a previously reported minimally invasive surgical technique [15] for the treatment of acute closed spontaneous complete Achilles tendon ruptures.

Materials and methods

Patient recruitment

This randomized prospective trial was approved by the research ethics committee of our University (Approval No. 199902064-5) and our Clinical Trial Registry (Approval No. ChiCRT-TRC-00000165). Written informed consent was obtained from all patients prior to recruitment.

Sixty-five patients with acute closed spontaneous Achilles tendon rupture were admitted to our University between August 2009 and December 2015. However, patients suffering from blood disorders, liver or kidney malfunction, diabetes mellitus, and psychopathic disorders were excluded. In addition, patients with anatomical deficiency of the plantaris tendon, which was used as a suture material during surgery to augment the space structure of the Achilles tendon gap, were also excluded. As a result, 52 patients were recruited in this study (Table 1). Three patients had bilateral acute closed spontaneous Achilles tendon rupture; of these, two experienced simultaneous bilateral ruptures, and one had two separate ruptures of the Achilles tendon, one year apart.

Surgical procedures

All surgeries were performed by a same surgeon (the corresponding author), with the support of a same team. The patients were anaesthetized via epidural analgesia and stabilized with a tourniquet in the prone position. Patients were randomly classified into 2 groups, except for the 3 patients with bilateral ruptures, who were allocated to specific groups. Group A included 23 patients (two with bilateral ruptures) who underwent a novel minimally invasive surgical approach. Achilles tendons were exposed by two separate longitudinal incisions, which resembled a scythe or letter "J" (Fig. 1A). When necessary, two 3–4 cm incisions were connected around the Kager's triangle and extended to the tendon rupture site. Group B contained 29 patients (one with bilateral ruptures) who were treated with a previously published continuous medial oblique surgical approach [20]. A 15 cm longitudinal, slightly curved central skin incision was created from the middle third of the gastrocnemius muscle, and it was medially curved towards the distal end in order to reduce the risk of injury to the sural nerve [20].

Acute closed spontaneous Achilles tendon rupture mostly occurs close to the Achilles tendon insertion on the posterior calcaneus, and calcified tissues are always found at the distal tendon. During the operation, approximately 5 cm of the proximal segment of the Achilles tendon was collected for pathological examination before the proximal end of the ruptured tendon were carefully excised (Fig. 1B). The remaining tendon, calcaneal tuberosity cartilage, and osteophytes were then removed with

Table 1
Demographic and clinical characteristics of the patients.

Characteristic	Group	Value
Gender (male/female)	A	23 (19/4)
	B	29 (23/6)
Mean age (year)	A	56.8 (47–71)
	B	57.2 (48–75)
Body weight (kg)	A	75.7 (56–92)
	B	78.1 (70–97)
Previous fluoroquinolone antibiotic use	A	5
	B	3
Previous corticosteroid use	A	7
	B	9
Rupture side	A	16 left, 7 right
	B	20 left, 9 right
Mean duration of disorder (day)	A	5 (2–7)
	B	5 (2–6)
Maximum load on tiptoe stepping on the operated side on a balance (Kg)	A	15 (13.8–16.7)
	B	15 (12.3–16.3)
Mean ruptured site from tendon insertion into the calcaneus, cm	A	0.0 (0.0–0.0)
	B	0.0 (0.0–0.0)
Mean defect length of Achilles tendon, cm	A	3.9 (3.7–4.5)
	B	4.0 (2.9–4.4)

Group A: Novel modified minimally invasive surgical approach; n = 23; Group B: Continuous medial oblique surgical approach, n = 29.

Please cite this article in press as: A. Aisaiding, et al., A novel minimally invasive surgery combined with early exercise therapy promoting tendon regeneration in the treatment of spontaneous Achilles tendon rupture, Injury (2017), https://doi.org/10.1016/j.injury.2017.10.046