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Modified percutaneous repair of acute achilles tendon rupture: A sliding knot technique using absorbable suture

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Abstract

The purpose of this study was to describe our technique and to assess its clinical efficacy. The modified percutaneous approach, we hypothesized, would provide additional resistance to tendon lengthening during the healing process. Between 2017 and 2019, 28 patients with an acute Achilles tendon rupture received treatment with a sliding-locking knot and absorbable suture in a modified percutaneous technique. After eligibility criteria, a total of 23 consecutive patients enrolled in this study. Participants in the study ranged in age from 18 to 50 years. Polydioxanone suture (PDS) was utilized in all patients. From the middle medial stab incision to the proximal lateral incision, an oblique injection with a PDS-loaded semi-curved needle was made. Samsung Medical Center (SMC) sliding knot was used to form a self-locking loop by pulling the post strand. At the final follow-up, patients were evaluated postoperatively using the American Orthopedic Foot and Ankle Society (AOFAS) Hindfoot Questionnaire score. The mean age of the patients was 37.5±6.1 years (range, 28-47 years). The mean AOFAS score, ATRA degree, calf circumference, and single-leg heel raise count at the last follow-up were 93.4±4.1 (range, 88-100), 55.4±6.2 degrees (range, 45–74 degrees), 38.4±7.1 cm (range, 28–49 cm) and 39.5±8.3 (range, 27–96). The mean operation duration was 14.4±3.2 minutes (range, 10–23 min). Temporarily, the sural nerve damage was found in 2 patients (8.7%). The neurological symptoms resolved within three months of the surgery. A modified percutaneous method utilizing an absorbable suture and a sliding-locking knot may be an acceptable treatment option for AATR due to its low complication rate and rapid return to work.

Keywords: Achilles tendon rupture, surgery, modified percutaneous repair techniques, sliding knot

Introduction

The surgical intervention for acute Achilles tendon rupture (AATR) has several goals: restoring structural integrity without tendon lengthening, providing quicker functional performance with accelerated rehabilitation, and avoiding complications like re-rupture [1]. Percutaneous repair techniques also provide better cosmetics and reduce the risk of surgical site complications [2]. Nevertheless, percutaneous repair techniques have a higher risk of sural nerve injury and re-rupture compared with an open technique. Furthermore, several studies have proposed that it may lead to tendon elongation during the healing process [3,4]. It may be related to failure to provide the original tendon length, suture cutting through the tendon, or knot slipping [5].

Several studies have reported that Achilles tendon elongation has a deleterious effect on functional outcomes due to changes in ankle range of motion and plantarflexion strength [3,6,7].

In light of these concerns, we thought the technique needed to be modified. The percutaneous repair with a sliding knot according to contralateral side length may provide the original tendon length and thus maintain the tendon length during the healing process, which means better functional outcomes. In this retrospective study, a modified percutaneous technique method using a sliding knot with absorbable sutures was applied for AATR.

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The purpose of this study was to describe our technique and to assess its clinical efficacy. The modified percutaneous technique, we hypothesized, would provide additional resistance to tendon elongation during the healing process.

Materials and Methods

Twenty-eight patients with an AATR were treated with a sliding knot using absorbable sutures in a modified percutaneous procedure between 2017 and 2019. This study was approved by an institutional ethics committee of Ondokuz Mayis University (2021/424). Inclusion criteria were (1) patients aged between 18 and 50; (2) repair of the rupture using a modified percutaneous technique. Five patients were excluded from the study because of accompanying medical contraindications (autoimmune disorders) (n=1), less than 24 months of follow-up (n=2), and time from injury to surgery of more than 3 weeks (n=2). A total of 23 patients were enrolled in this study.

All 23 cases with an AATR were diagnosed by a positive Thompson test and a palpable gap in the Achilles tendon. Postoperatively, patients were evaluated using the American Orthopedic Foot and Ankle Society (AOFAS) Hindfoot Questionnaire score at final follow-up. Return to work, ability to do single-leg heel rise, calf circumference, calculated limb symmetry indexes, Achilles tendon resting angle (ATRA), duration of surgery time, and related complications were used as functional outcome measures.

Operative Technique

All interventions were performed in the prone position under local anesthesia without a tourniquet. The gap was palpated and three pairs of small incisions were made on each end of the ruptured tendon. Lateral incisions were placed more medially to avoid sural nerve damage. Blunt dissection of the subcutaneous tissue was made [Figure 1a]. In all patients, No. 1 absorbable Polydioxanone suture (PDS) was used. A PDS-loaded semi-curved needle was introduced obliquely from the middle medial stab incision to the proximal lateral incision, approximately 45° to the long axis of the tendon. The needle was then transversely passed from lateral to medial and inserted distally through the ipsilateral proximal incisions. These steps were repeated at the level of the distal pair of incisions [Figure 1b]. And, the suture ends were pulled to tighten at the level of the middle medial incision. By pulling the post strand, a non-locking loop was created using a sliding knot [Figure 1c]. The tightness of the knot was adjusted by evaluating the Achilles resting angle of the contralateral healthy side. The palpable gap disappeared and finally, the incisions were closed with absorbable sutures.

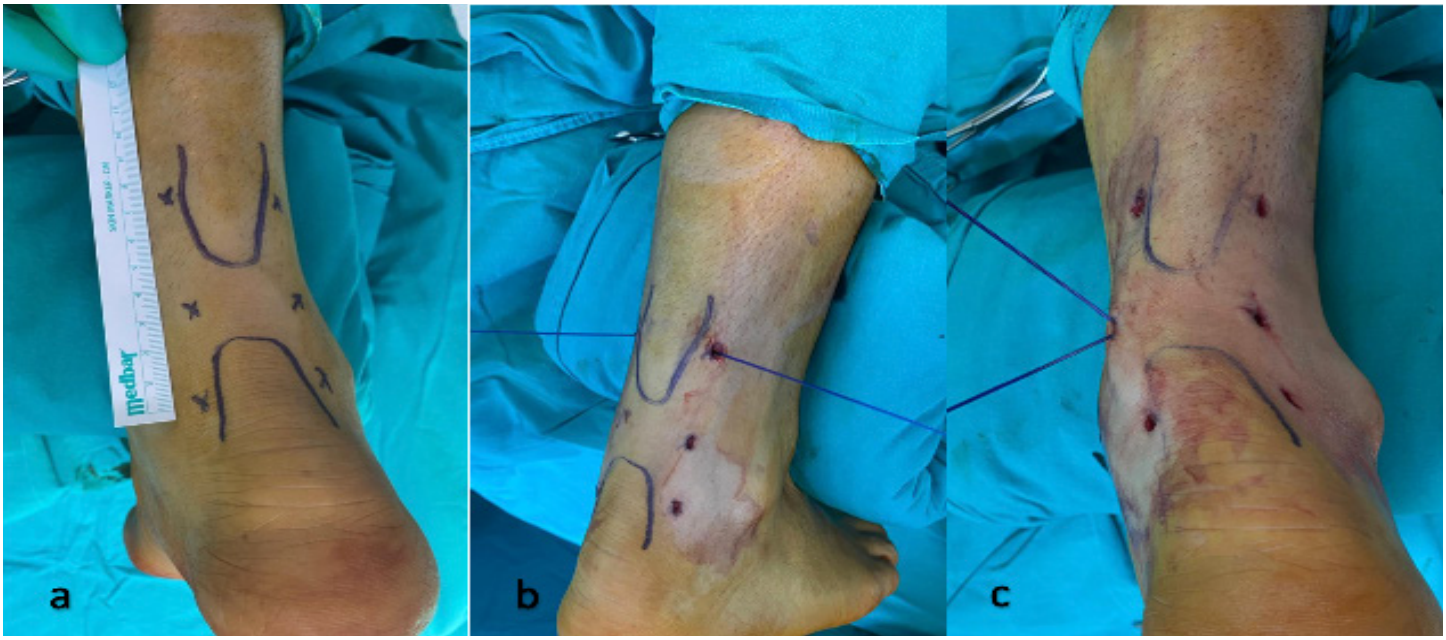

Figure 1a-c. Modified percutaneous repair with a sliding knot using absorbable suture

Postoperative Rehabilitation

Following surgery, the ankle was immobilized in a below-knee cast at a 20-degree angle of the equinus for two weeks. Following soft tissue healing, the cast was replaced with a second cast that was set at a 10-degree plantar flexion position for two weeks. During this period, muscle-strengthening exercises were recommended with partial weight-bearing. After 4 weeks, the brace was removed and the patients were referred to full weight bearing with isometric exercises. From 12 weeks postoperatively, patients were encouraged to gradually return to their previous exercise level.

Statistical Analysis

All statistical analyses were performed using Statistical Package for Social Sciences (SPSS) Version 21.0 statistical analysis software. The distribution of quantitative data was assessed using histograms. The descriptive data were shown as the mean, standard deviation (SD), percentage. The power of the sample group was set as a minimum of 80% (alpha error 5%).

Results

Twenty-three patients (17 male, 6 female) with AATR were enrolled in this study. The mean age of the patients was 37.5 ±6.1 years (range, 28-47 years). Detailed demographics are shown in Table 1.

Table 1. Patients' demographics

	Mean ± SD (Range)
Age	37.5±6.1 (28-47)
Sex (M / F)	17 / 6
BMI (kg/m2)	26.6±3.4 (21-32)
Side (R / L)	9 / 14
Level of rupture (cm)	5.6±1.2 (4.5-6.5)
Time form injury to surgery (days)	3.1 ±1.7 (1-8)
Follow-up (months)	33.2 ±7.2 (24-46)

BMI: body mass index; **M**: male; **F**: female; **R**: right; **L**: left; **SD**: standart deviation

The mean AOFAS score, ATRA degree, calf circumference, and single-leg heel raise count at the last follow-up were 93.4±4.1 (range, 88-100), 55.4±6.2 degrees (range, 45–74 degrees), 38.4±7.1 cm (range, 28–49 cm) and 39.5±8.3 (range, 27–96). The mean return to work and return to sport times were 41.3±6.7 days (range, 32–58) and 4.5±1.2 months (range, 3–6 months), respectively. The mean operation duration was 14.4±3.2 minutes (range; 10–23 min). The detailed measurement results were shown in Table 2.

Table 2. The clinical and functional outcomes of patients

	Mean ± SD (Range)
AOFAS score	93.4±4.1 (88-100)
ATRA (degree)	55.4±6.2 (45–74)
ATRA LS index (%)	102.5±6.8 (95–130)
Calf circumference (cm)	38.4±7.1 (28–49)
Calf circumference LS index (%)	95.4±5.6 (88–103)
Single leg heel raise (count)	39.5±8.3 (27–96)
Single leg heel raise LS index (%)	84.6±10.1 (52–115)
Return to work (day)	41.3±6.7 (32–58)
Return to sports (month)	4.5±1.2 (3–6)
Operation duration (min)	14.4±3.2 (10–23)

AOFAS: American Orthopaedic Foot Ankle Society Rating Score; **ATRA:** achilles tendon resting angle; **LS Index:** Limb symmety index= affected limb side/ healty limb side * 100 %; **SD:** standart deviation

Temporary sural nerve damage was found in 2 patients (8.7%). The neurological symptoms resolved spontaneously after three months of surgery. There were no complications such as deep or superficial infection, re-rupture, or stiffness of range of motion.

Discussion

The present study found that patients treated with a sliding knot using absorbable sutures after AATR had "excellent and good" clinical outcomes with a minimum of 24 months follow-up. At the final follow-up, the mean AOFAS score was 93.4±4.1 (range, 88-100). It provides a good adaptation of torn stumps with the restoration of original tendon length. The mean ATRA limb symmetry index was found to be 102.5±6.8 (range, 95–130).

The percutaneous technique was developed in 1977 by Ma and Grifth to minimize the wound complications related to open procedures [8]. Since then, percutaneous repair techniques have continued to evolve and there has been a gradual shift away from surgical intervention to reduce wound complications including infection, skin necrosis, adhesions [9,10]. Nowadays, orthopaedic surgeons routinely use percutaneous or minimally invasive procedures or nonoperative functional rehabilitation protocols [11]. However, the definitive treatment of AATR remains elusive. Several studies have shown that functional bracing carries an increased rate of re-rupture and tendon lengthening [12]. Similarly, percutaneous repair has been criticized as causing a sural nerve injury and healing in a lengthened tendon position [2].

Achilles tendon elongation is one of the major concerns of AATR [9]. Tendon elongation correlates with functional deficits in decreased plantar flexion strength and single-leg heel raise strength [6,7,12]. Clanton et al. found that the percutaneous repair techniques demonstrated significant early elongation when compared with open repair techniques [13]. They reported that the elongation was primarily a result of cut-out at the suture-tendon interface and knot slipping or stretching. In this study, we suggested the percutaneous method with a sliding knot to reduce the knot-related complications that cause the tendon elongation.

On the other hand, adjustment of the tendon length during surgery may be a challenge. Insufficient repair may lead to tendon elongation, while excessive tendon tightness may limit range of motion [14,15]. The superiority of the presented modified method consists of the sliding knot mechanism, which allows repair of the tendon in comparable tension with the contralateral side. It maintains the restoration of the original tendon length and provides good tendon healing without elongation. Intraoperatively, tightness of tendon repair was quantified using the contralateral ATRA. The mean ATRA limb symmetry index was found to be 102.5±6.8 (range 95–130) at the final follow-up.

Suture material deformation is another concern that may induce tendon elongation. Jordan et al. showed that plastic deformation occurs at a lower tension force in the monofilament sutures Prolene and PDS than Ethibond and Vicryl [16]. However, Kocaoglu et al. prospectively compared patients with AATR to absorbable vs nonabsorbable suture fixation [17]. They reported fewer complications in the absorbable group with similar clinical outcomes. Our study advocates the use of an absorbable suture with good to excellent clinical outcomes without re-rupture. Furthermore, temporary sural nerve damage may be related to the absorbability of the suture material. Sural nerve symptoms resolved spontaneously within three months of surgery.

The study has some limitations. The major limitation is the small number of patients, which might have under-covered some of the results. Further studies with larger cohorts are necessary to achieve more reliable results. Also, our study was retrospective. Finally, although the present study showed comparable results with previous studies, there was no control group. Future studies may perform additional comparisons between techniques. The role

of the sliding knot technique and suture material on outcomes also warrants further studies.

Conclusion

A modified percutaneous technique with a sliding knot using absorbable sutures may be a reasonable treatment option for AATR with a low complication rate and an early return to work.

Conflict of interests
The authors declare that there is no conflict of interest.

Financial Disclosure
No financial support was received for the study

Ethical approval
This study was approved by an institutional ethics committee of Ondokuz Mayis University (2021/424).

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