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Minimally invasive surgical treatment of patients with early "classic" percutaneous rupture of the Achilles tendon

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Introduction An Achilles tendon injury is a most common trauma (up to 47 %) among all subcutaneous ruptures of the tendon. **Objective** Improve outcomes of early percutaneous Achilles tendon ruptures using minimally invasive surgical procedure**. Material and methods** The review included outcomes of 47 patients treated for early "classic" percutaneous rupture of the Achilles tendon at trauma and orthopaedic department № 1 Samara State Medical University from 2009 to 2016. Algorithm of diagnosis included clinical assessment, dynamic ultrasound examination, comprehensive stride assessment (podometry), electromyography of triceps surae muscle, and thermography of tibiae. Visualisation of the rupture site, less trauma to the surrounding soft tissues (skin, paratenon), reliable adaptation of Achilles fragments were considered when devising a suturing technique. **Results** No infection was observed at the site of surgical intervention at the early postoperative stage. Functional recovery of the patients indicated to symmetrical force in the triceps surae muscle, restored thermal balance at thermography, and absence of limping at podometric assessment at 6-month follow-up. **Conclusion** Minimally invasive surgical procedure offered to treat patients with early “classic” percutaneous ruptures of Achilles tendon allowed for early reliable restoration of the ankle function.
Keywords: Achilles tendon, examination, treatment, tendon repair

INTRODUCTION

An Achilles tendon injury is a most common trauma (up to 47 %) among all subcutaneous ruptures of the tendon [1, 2].

Various surgical techniques have been reported in the literature; however, controversy remains regarding the optimal treatment method of Achilles tendon ruptures [3, 4]. Less articles published in the literature address conservative options for Achilles tendon repair with a lower risk of complications (skin necrosis, wound infection) post surgery due to percutaneous location of Achilles tendon and a relatively poor vascularisation in the lower third of tibia [5]. Most surgeons would opt for surgical treatment ensuring tendon approximation and facilitating healing, and thus, a lower re-rupture rate [6, 7].

There are publications describing percutaneous tendon repair technique but it involves major disadvantages such as having no direct visualization of the tendon ends and the associated complications of re-rupture, wound breakdown and poor recovery of triceps surae muscle [8–11].

Purpose of the study: improve outcomes of early percutaneous Achilles tendon ruptures using minimally invasive surgical procedure**.**

Goals:

– develop a new technique for surgical treatment of early "classic" percutaneous rupture of the Achilles tendon;

– provide adequate restorative treatment of the patients post surgery aimed at early mobilization of the ankle joint;

– evaluate short- and long-term follow-ups of the surgical treatment.

MATERIAL AND METHODS

The review included outcomes of 47 patients treated for early "classic" percutaneous rupture of the Achilles tendon at trauma and orthopaedic department № 1 Samara State Medical University from 2009 to 2016. This cohort of patients had injury aged under 10 days old with the rupture site being 4 to 8 cm off the heel.

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Algorithm of diagnosis included clinical assessment, dynamic ultrasound examination, comprehensive stride assessment (podometry), electromyography of triceps surae muscle, and thermography of tibiae. The usage of dynamic functional techniques (podometry, thermography, dynamic ultrasound, electroneuromyography) ensured improved diagnosis, choice of treatment method and long-term outcome assessment through evidence-based medicine. Visualisation of the rupture site, less trauma to the surrounding soft tissues (skin, paratenon), reliable adaptation of Achilles fragments were considered when devising a suturing technique. Minimally invasive percutaneous suturing of the Achilles tendon was developed by the staff of our education department and patented (patent RF № 2554227 dtd 27.05.2015) [12]. A signed, informed consent to participate in the research study was obtained from all patients.

Vicryl suture thread No.1 was used for stitching with tensile strength of 40 days and complete absorption of 70 days. A skin incision of not more than 3 cm was produced above the rupture site on the posterior aspect of tibia (Fig. 1a). Using guiding curettes (**Fig. 1b**) percutaneous sutures were made in the coronal plane consecutively to the proximal end at different levels.

The distal part of the Achilles tendon was sutured in coronal plane using guiding curettes. Suture ends together with tendon fragments were brought out to the wound at the rupture level. Then the same sutures are used to apply additional locking knots to the proximal and distal tendon to prevent cutting out of crossed stitches. The sutures were tightened and tied together approximating the tendon fragments. Finally, U-shaped suture was applied for better adaptation (**Fig. 2**).

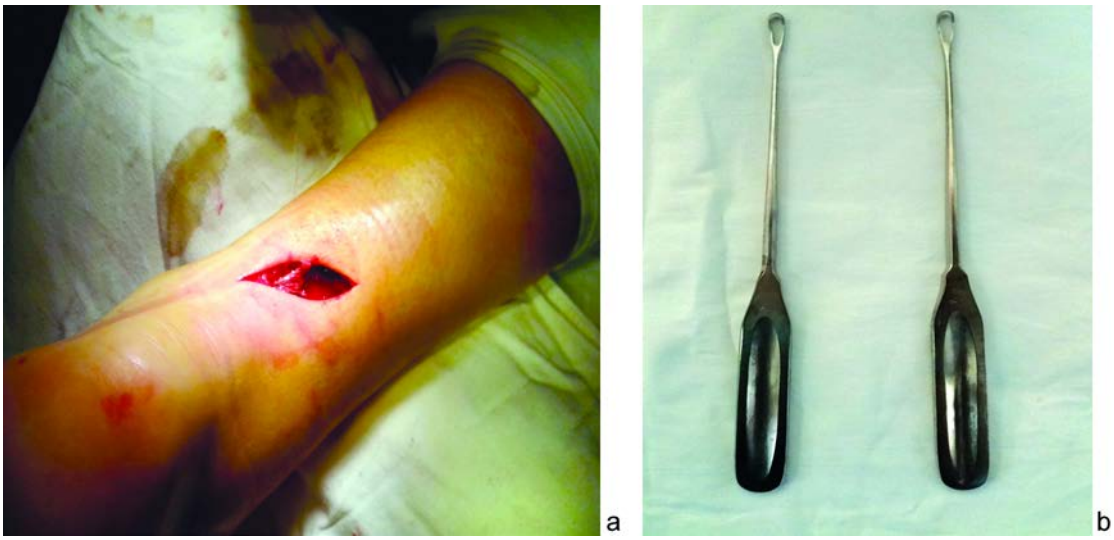

Fig. 1 Surgical approach to a rupture (a) and guiding curettes (b)

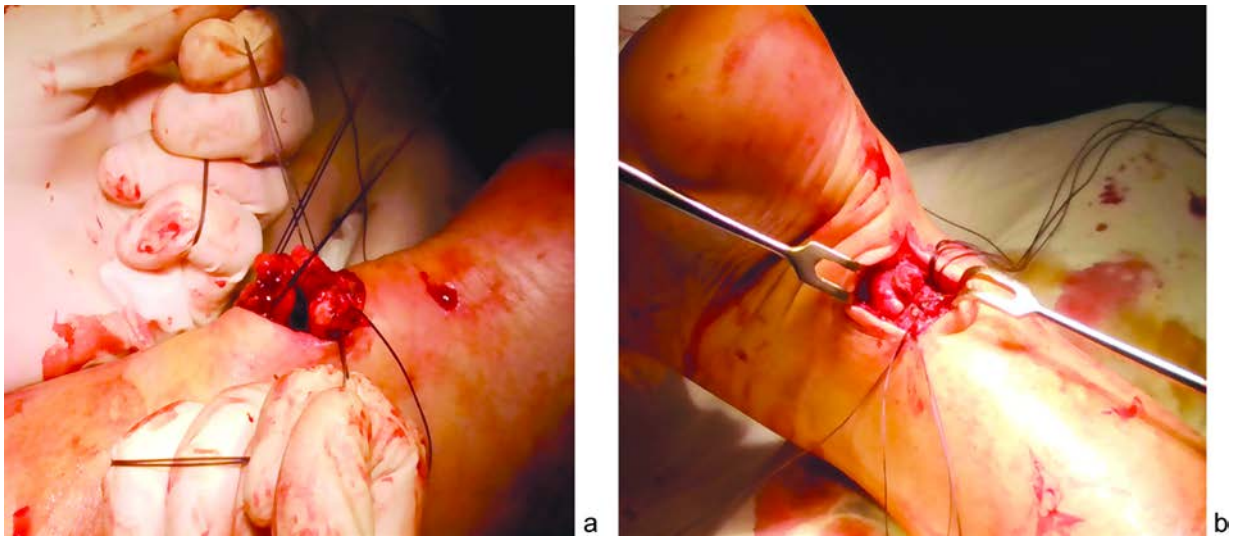

Fig. 2 Application of percutaneous sutures to the tendon fragments (a), adaptation of the tendons' ends (b)

Patients received symptomatic treatment, medications and physiotherapy at early postoperative period. Immobilisation was provided either with plaster cast applied from toes to mid tibia with the plantarflexed foot of 115° to 120° or functional orthosis with angular stability for a period of 6 weeks. At the beginning of week 4, patients were encouraged to gradually and actively exercise the ankle joint. Early mobilization was aimed at improving trophics and microcirculation in the posterior tibia, adhesion of the Achilles tendon and the surrounding tissues, thus, preventing contracture of the ankle joint.

Evaluation of treatment results included range of motion in the ankle joint, strength of triceps surae muscle, presence/absence of limping, biomechanical parameters taking into consideration early and delayed postoperative complications at 3- and 6-month follow-ups, functional condition of the involved limb post a course of comprehensive restorative therapy.

MS Statistica 6.0 software package was used for variance analysis. Study results met the criterion for statistically significance with a 95 % confidence interval and $p < 0.05$. Parametric (Student's, Welsh's) t-tests and non-parametric (Wilcoxon, Mann-Whitney) tests were applied for statistical hypotheses. The *p*-values corresponding to the calculated criteria were evaluated by asymptotic formulae and through randomization (permutation).

Patients with early mobilization of the ankle joint (gradually exercised following three weeks) showed an average postoperative six-week ROM of 75 % as compared to the contralateral side With early mobilisation of the ankle joint (gradual motion starting from week 4) an average range of motion in the ankle was 75 % as compared to the contralateral side at 6 postoperative weeks. All patients who had a course of restorative treatment showed completely regained range of motion at 3-month follow-up.

Criteria used to grade and record the strength of the ankle plantar flexors with Lovett's five-point scale included complete range of motion against gravity with full resistance (100 % of normal, grade 5), complete range of motion against gravity with some resistance (75 %, grade 4), complete range of motion with gravity (50 %, grade 3), complete range of motion with gravity eliminated (25 %, grade 2), evidence of slight contractility: muscle contraction detectable but insufficient to move the joint even when the forces of both gravity and manual resistance have been eliminated (10 %, grade 1) and no evidence of contractility: complete absence of visible and palpable muscle contraction (0 %, grade 0). Muscle strength of intact and involved limb was recorded on admission, after removal of plaster cast, complete course of restorative treatment and at six-month follow-up. Manual testing of triceps surae muscle showed an average grade of 4.65 at 6-month follow-up and after a course of restorative treatment.

Podometric assessment was conducted at 6-month follow-up. Limping assessment was based on asymmetric gait parameters (up to 5 % was considered as normal; from 5 to 10 % as latent limping; more than 10 % as evident limping). Gait asymmetry was evaluated as not more than 5 % in 40 patients; 5 to 10 % in 7 cases ($t = 4.1$, $F = 3.5$, $U = 14.0$, $p < 0.001$). No evident limping was detected in the patients.

Electrical activity of gastrocnemius in index group showed an average oscillation amplitude of 129.4 ± 3.2 mV (normal 148 ± 4.3 mV) in the middle portion of the muscle and 173.1 ± 3.7 mV (normal 199.3 ± 6.3 mV) ($p < 0.05$) in the lateral portion, correspondingly, at 3 months of injury.

An average oscillation amplitude of gastrocnemius measured 145.4 ± 3.2 mV (normal 148 ± 4.3 mV) in the medial portion of index patients and 195.1 ± 3.7 mV (normal 199.3 ± 6.3 mV) ($p < 0.05$) in the lateral portion of the muscle at 6-month follow-up.

A clinical instance. A 33-year-old patient A. was admitted to trauma and orthopaedic department № 1 at a hospital of Samara State Medical University on September 25, 2015 with early percutaneous 'classical' tear of the left Achilles tendon he sustained playing football on the same day. Additional examination was performed on the next day and Achilles tendon repaired with minimally invasive procedure described above. Postoperative period was uneventful. Range of motion and strength of triceps surae muscle symmetrically recovered at 6-month follow-up (**Fig. 3**).

The restored thermal balance indicated to the trophics normalised in the posterior aspect of the left tibia (**Fig. 4**).

Electromyography showed no differences in electrical activity of all portions of triceps surae muscle and the contralateral side.

Podometric assessment demonstrated symmetric stride, absence of limping and balanced gait.

The patient subjectively evaluated recovery of the Achilles tendon by 90 %.

Fig. 3 Result of treatment at 6 months of surgical intervention (the patient was able to lift his body weight on the operated lower limb)

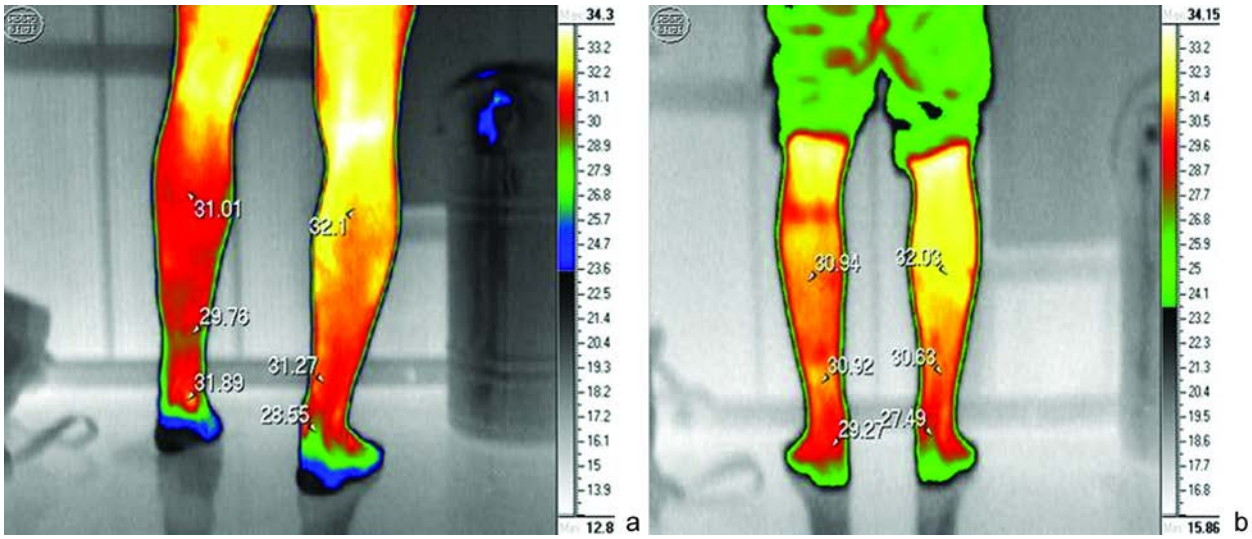

Fig. 4 Thermal balance as measured by thermography preoperatively (a) and at 6-month follow-up (b)

DISCUSSION

An open repair of Achilles tendon allows for reliable adaptation of the tendon ends in most of the cases and lower risk of rerupture due to connective tissue formation. Complications are reported to occur in 19.6 % with open surgical repair [3, 4, 13–15] including postoperative wound healing, infection, gross postoperative scar interfering with tendon gliding, contracture of the ankle joint, decrease in strength of triceps surae muscle with a longer in-patient period to follow, and in treatment efficacy [2, 7, 9, 11].

Patients with “classical” percutaneous rupture of the Achilles tendon developed neither a rerupture nor infection during 6 months following minimally invasive operative treatment. Symmetrical evaluation of triceps surae muscles with functional techniques (podometry, electromyography, ultrasonography in dynamics) showed no statistically significant differences. Ankle function recovered by 80 % to 100 % in the involved limb as reported by patients at 6-month follow-up.

CONCLUSION

Minimally invasive surgical procedure has shown to be practical in minimizing injury to the gliding mechanism, reducing the incidence of infection to allow for quality recovery of the Achilles tendon.

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