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Our Approach to Treatment of Neglected Achilles Tendon Ruptures. Is There a Simple Solution?

D.V. Chugaev, N.S. Konovalchuk, E.P. Sorokin, P.G. Kogan, A.I. Gudz, S.A. Lasunsky, D.V. Stafeev

Vreden Russian Research Institute of Traumatology and Orthopedics
8, ul. Akad. Baykova, 195427, St. Petersburg, Russian Federation

Abstract

Introduction. Subcutaneous rupture of Achilles tendon is a frequent lesion, the greater part of patients with such pathology is constituted by men of active working age. Even though such lesion is often accompanied by severe malfunction of ankle joint, patients may appear for treatment very late. In such cases the diagnosis is defined as "chronic" or "neglected rupture" and requires treatment options that are different from acute trauma management. Despite a vast variety of surgical treatment options available for neglected Achilles tendon lesions there is still no consensus on the simplest, most efficient and the safest technique.

Purpose of the study — to evaluate the efficiency of peroneus brevis grafting of type III (G. Kuwada classification) Achilles tendon defects and to assess if this method can provide outcomes that are comparable to functional outcomes after end-to-end suture of acute Achilles tendon rupture.

Material and Methods. Patients were divided into two groups: 13 patients after grafting of Achilles tendon defect by peroneus brevis tendon (group I) and 18 patients after end-to-end suture after acute rupture (group II). Group I included patients with neglected Achilles tendon ruptures who for various reasons did not undergo primary tendon suture and required grafting of a significant defect.

Results. Mean surgery duration in group I was 91.9±6.6 (Me — 100) min, in group II — 43.2±2.2 (Me — 45) min (p = 0.0001). Function of affected ankle joint in both groups was evaluated with Achilles Tendon Total Rupture Score at an average postop period of 1 year. Mean score in group I — 86,6±2,28 (Me — 87) points, in group II — 93.4±1.01 (Me — 94) points (p = 0.04). Thus, despite a rather high outcome score in group I, statistically the result was worse than in patients who underwent primary suture of Achilles tendon. There were no differences in the rate of postoperative complications between the two groups (p>0.05). The most frequent complication registered in both groups was ROM limitations in ankle joint. The authors observed no cases of frontal ankle joint instability in patients after harvesting peroneus brevis tendon.

Conclusion. Reconstruction of type III (G. Kuwada classification) defects with peroneus brevis autograft in patients with neglected Achilles tendon lesions is an efficient and safe procedure which provides good and excellent outcomes that are comparable with functional outcomes after end-to-end suture of acute Achilles tendon rupture in absolute values but are reliably worse in terms of statistical evaluation.

Keywords: Achilles tendon, peroneus brevis tendon, tendon defect grafting, subcutaneous tendon rupture, reconstruction, tendon suture.

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Dmitry V. Chugaev. 8, ul. Akad. Baykova, 195427, St. Petersburg, Russian Federation; e-mail: dr.chugaev@gmail.com

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Introduction

The "Achilles tendon" term was for the first time used by a Dutch surgeon Philip Verheyen in 1693 [1]. Prior to be named after a Greek hero this tendon was described as "tendo magnus of Hippicrates". Subcutaneous rupture of this tendon is a frequent lesion occurring due to a single overload. The greater part of patients with such pathology is constituted by men of active working age who sustained a trauma in result of irregular sports activity [2]. Despite the fact that such lesion is often accompanied by severe malfunction of ankle joint, it is not infrequent that patients appear very late for treatment. In such cases the diagnosis is defined as "chronic" or "neglected rupture". Current literature reports various timelines indicating transfer of acute rupture into neglected one, from four weeks up to three months and more from the moment of trauma [3–5].

As it is know the typical rupture location is a middle portion of tendon, in average 5 cm above it's attachment to calcaneus. Chen T. et al suggested one of explanations to this fact pointing out scarce perfusion of this location by peroneal artery which supplies also peroneal tendons while proximal and distal portions of Achilles tendon are filled from posterior tibial artery [6, 7]. However, the authors note that this can not be a single predisposing causes and rupture probability is significantly increased in the presence of factors deteriorating local regenerative tissues capabilities such as smoking, diabetes mellitus, reduction in bloodstream rate in lower limbs at cardiovascular events as well as in systemic diseases of connective tissue [6].

Acute Achilles tendon lesions can progress into neglected ones because of failure of conservative treatment (most often due to incorrect choice of treatment tactics) with overall failure frequency of 6%, which usually happens because of diagnostic mistakes during primary patient examination. This occurs in 20% of cases due to various reasons, for example, due to misinterpreting the results of ultrasound or magnetic resonance investigation [8, 9]. Complete rupture can be seen as "partial" because the scarring in the area of rupture may eliminate the palpable retraction, make results of Thompson test false-negative and allow patient to stand on toes (though in such cases patients are unable to repeat heel rise several times) [4]. Scar tissue is incapable of standing full functional load due to tendency of stretching which leads to continued retraction of proximal tendon end, and as it's known contracture of muscular fibers up to 60% of the initial length results in complete loss of function [10, 11].

Many authors agree that the major issue of neglected ruptures is the increasing gap between tendon ends which with high probability will require defect grafting. End-to-end tendon suture as in cases of acute ruptures according to various authors is possible if the gap is 2–3 to 5 cm, and attempt to make an end-to-end suture in patients with bigger defects may result in equinus ankle deformity and significant difficulties for postoperative rehabilitation [10–13].

At the moment there is a big variety of grafting options for Achilles tendon defects all of them can be divided into several main groups: with the use of local tissues (V-Y grafting, pivoted flap of gastrocnemius complex), with tendon transposition (peroneus brevis tendon, flexor digitorum longus, flexor hallucis longus), with use of free tendon graft (allotendon, autotendon) and synthetic materials [9]. Almost every mentioned method has numerous modifications, there are also reported combinations of two or more techniques.

Despite a vast variety of surgical methods available for treatment of neglected Achilles tendon lesions, currently there is no consensus on which one is the most simple, efficient and safe technique to restore the tendon function with the minimal complications risk. The most perspective method in our opinion was suggested in 1974 by A. Perez-Teuffer, he used peroneus brevis tendon as a graft. Originally the tendon was dissected distally from its attachment site, then inserted through a tunnel in calcaneus and used to bridge the defect of Achilles tendon; there is also a well-known and widespread modification of this procedure by V.J. Turco and A.J. Spinella [14, 15]. We also modified this technique and applied it for treatment of 13 patients.

Study hypothesis: Use of peroneus brevis tendon graft for reconstruction of Achilles tendon type III defects (Kuwada classification) is an effi-

cient procedure that provides good and excellent outcomes that are comparable to functional outcomes after end-to-end suture of acute Achilles tendon rupture.

Material and Methods

Patients were divided into two groups: 13 patients after grafting of Achilles tendon defect by peroneus brevis tendon (group I) and 18 patients after end-to-end suture after acute rupture (group II). Group I included patients with neglected Achilles tendon ruptures who for various reasons did not undergo primary tendon suture and required grafting of a significant defect (mainly because the lesion was not diagnosed at all or a "partial rupture" was diagnosed). Undoubtedly there are limitations in randomization of presented groups due to the fact that it would be perfect to compare outcomes of end-to-end suture and at least two types of grafting methods of Achilles tendon defects and to evaluate the obtained results. However due to relatively rare occurrence of such pathology the selection of such patients is very limited. That is why we used the method that according to our literature analysis is considered to be the most reproducible and efficient.

All patients in group II were operated within first seven days after trauma; in group I time elapsed from moment of trauma untill surgery was 90.0±12.5 days. Group I included 6 men and 7 women, group II — 6 men and 12 women. Mean age in group I was 38.6±11.6 years (Me — 39), in group II — 36.8±10.5 years (Me — 35).

No reliable differences were observed in patients of both groups in terms of accompanying somatic diseases. In group I three patients were smokers (23.8%) as well as in group II (17.65%). In both groups Achilles tendon lesion was most often registered on the left side: 69.23% in group I and 64.71% in group II.

In group I the mean defect length did not exceed 2-3 cm, in group II mean defect length was 5.15±1.46 (Me — 5) cm which corresponds to type II defect by G. Kuwada classification [12].

Following parameters were compared in the groups: intraoperative blood loss, duration of surgery, rate of postoperative complications, restoration of ankle joint function.

Statistical Analysis

After obtaining primary data the authors filled it in spreadsheets in Microsoft Excel. Past ver.3.17 (2017) software was used for statistical evaluation of obtained data and non-parametrical statistical methods were used for processing of study data. Data samples were compared with use of Mann – Whitney – Wilcoxon test or Kolmogorov – Smirnov test.

Diagnostic methods

Patients of group I underwent ultrasound examination of Achilles tendon with defect length assessment In case of doubt during diagnosis or in cases when rupture occurred more than 3 months ago the patients underwent magnetic resonance tomography (MRT). MRT did not only allow to identify the length of defect but also signs of degenerative alterations in gastrocnemius muscle. No patients in group II required ultrasound and MRT examinations because the diagnosis was obvious. The authors evaluated all patients in respect of walking ability without additional support, limping, ankle range of motion and Thompson test [16, 17].

Surgical Procedure

Operative treatment was performed with patient prone, both limbs were treated by antiseptic solution in order to create tension of affected Achilles tendon during end-to-end suture similar to contralateral leg (Fig. 1).

A midline posterior approach to Achilles tendon was used in all patients. In group II no technical complications were observed during end-to-end suture with Krakow method [18]. In group I Achilles tendon defect did not allow to perform end-to-end suture in neutral Ankle joint position. Surgical method based on end-to-end suture without defect grafting in extreme equinus foot position was considered faulty by authors and was not utilized during the study.

Through a 2 cm skin incision above the base of V metatarsal bone the authors performed layer-by-layer linear approach to the attachment site of peroneus brevis tendon, dissected it and sutured the autograft for further transposition (Fig. 2).

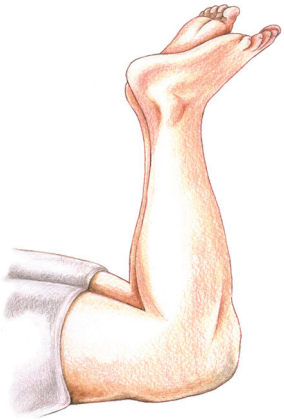

Fig. 1. Patient positioning during treatment of lower limbs by antiseptic solution

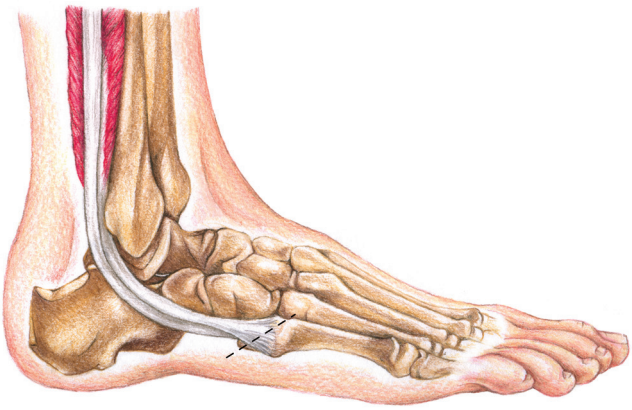

Fig. 2. Approach to *peroneus brevis tendon*

Peroneus brevis tendon was mobilized and its end was brought out into the surgical wound (Fig. 3 a).

A K-wire was inserted from the center of peripheral stump of Achilles tendon into the center of calcaneus prominence and was used to form a tunnel by a hollow drill for tendon autograft (Fig. 3 b).

Traction suture was placed over the autograft and brought through the prepared bone tunnel with a k-wire (Fig. 3 c).

Axial traction was applied on suture inserted through bone tunnel to pull the autograft into the tunnel (Fig. 3 d).

Then fixation of autograft was performed by a plastic or bioresorbable screw through a nitinol guide by inside-outside technique through peripheral fragment of Achilles tendon, traction sutures were cut and grafting was performed to bridge the Achilles tendon defect (Fig. 3 e).

The authors performed hemostasis, rinsed the surgical wound by antiseptic solutions, closed the wound layer-by-layer and applied an aseptic dressing.

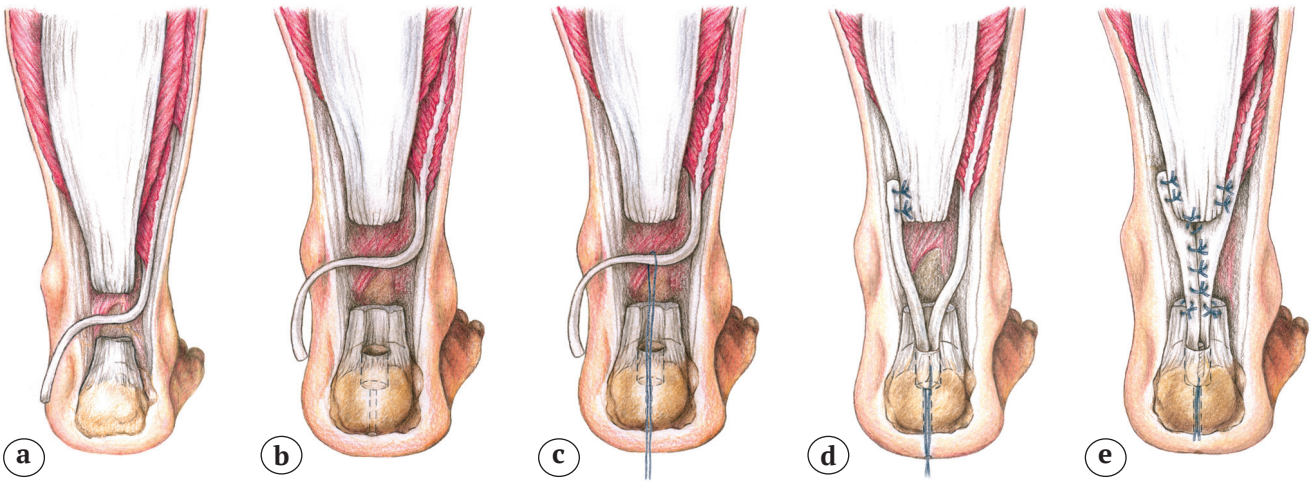

Fig. 3. Stages of surgical procedure:
a — bringing out the *peroneus brevis* tendon autograft into the posterior wound;
b — formation of bone tunnel in the calcaneus;
c — passing of sutures through the tunnel in calcaneus;
d — placement of constrained tendon autograft into the prepared tunnel;
e — grafting of Achilles tendon defect by a tendon autograft

Postoperative treatment of patients was similar in both groups: all patients were immobilized by an anterior plaster cast splint or by a premodeled brace made of low-temperature plastic from tiptoe to upper third of tibia in the neutral ankle position.

Immobilization was recommended to all patients for 6 weeks postoperatively as well as non-weightbearing walking with crutches during the whole period with latter switch to walking with a cane for another two weeks.

Results

Surgery duration in group I was 91.9±6.6 (Me — 100) min, in group II — 43.2±2.2 (Me — 45) min, a statistically significant difference was reported (p = 0.0001) (Fig. 4).

Intraoperative blood loss was measured by visual estimation of fluid volume collected into a vacuum aspirator flask. In group I with it was 92.3±34.4 (Me — 100) ml, in group II — 41.4±6.8 (Me — 50). Absolute volumes differ but during assessment of confidence interval by Kolmogorov – Smirnov test showed value of p = 0,008.

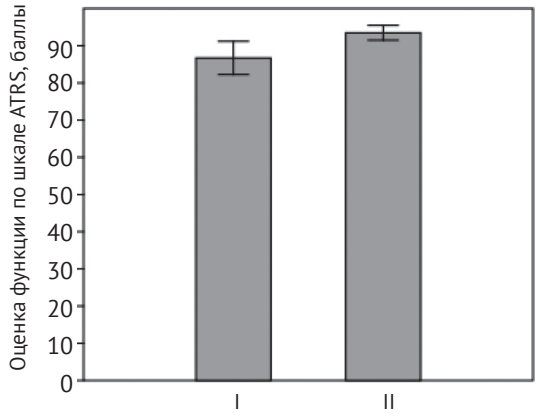

Fig. 4. Evaluation of ankle joint function by ATRS one year postoperatively, scores (p = 0.04)

Function of affected ankle joint in all patients was evaluated by 100-point Ahilles Tendon Total Rupture Score one year postoperatively [19]. The following data was reported: group I — 86.6±2.28 (Me — 87) points, group II — 93.4±1.01 (Me — 94) points (p = 0.04). Thus, despite a rather high outcome score in group I, statistically the result was worse than in patients who underwent primary suture of Achilles tendon.

There were no differences in the rate of postoperative complications between the two groups (p>0,05). The most frequent complication registered in both groups was ROM limitations in the ankle joint. After a more detailed analysis the authors concluded that those patients underwent insufficient rehabilitation.

Discussion

As it was mentioned earlier all grafting methods of Achilles tendon defects can be divided into several main groups: using local tissues, tendon transfer, free auto- and allografts and synthetic materials [9]. The main problem of choosing from a vast variety of treatment options is the fact that currently there are no studies that would statistically define the most rational and safe method [20]. Almost in all publications on the topic the number of cases doesn't exceed 20–40 patients and outcomes evaluation is performed non-homogeneously which additionally complicates the analysis of various techniques used in modern orthopaedics.

One of the simplest but at the same time quite traumatic method is so-called V-Y grafting; E. Abraham and A. Pankovich published results of this method in 4 patients in 1975 and reported 3 excellent and one satisfactory result (2 cm less distance from floor while doing heel rise) [21]. Currently the majority of surgeons utilize this method to treat defects of 4–5 cm, while in a bigger diastasis the tensile strength of gastrocnemius graft is not sufficient and requires additional reinforcement.

An isolated pivot of tendon-fascial flap can be used, for example, similar to the of V.A. Chernavsky which was widespread earlier in Russia, but this method as well as the above mentioned technique is efficient when defect length is no more than 3–5 cm [24, 13]. Some drawbacks should be also noted: a more exten-

sive approach for flap formation, flap application can result in tissue excess at grafting site which would be hard to cover during wound closure; the size of flap is anatomically limited [20].

Transposition of flexor digitorum longus tendon or flexor hallucis longus tendon is suggested to be used for replacement of extensive defects. This method allows to obtain a long autologous tendon graft (up to 10–12 cm) and apply traction force of transpositioned muscles for reinforcement of triceps function. At the same time use of described methods requires significant experience of surgeon and can be technically challenging [25, 26].

As an alternative to tendon transposition in severe diastasis of Achilles tendon ends some authors recommend to use free autograft (semitendinous or gracilis tendons) [28]. N. Maffulli and W. Leadbetter reported good and excellent outcomes of gracilis tendon application in 17 out of 21 patients [29].

Use of allografts and synthetic materials attracts surgeons by technical simplicity in application, no need for additional incisions and manipulations as well as by an extensive choice of graft sizes. However there are still issues with a higher infection risk, allergic response and formation of an extended avascular area which can further slow down the regeneration at the grafting site of Achilles tendon [9, 30].

In the authors opinion the use of peroneus brevis tendon is the optimal method which allows to obtain a sufficiently long autologous constrained graft without risk to damage key anatomical structures on the medial surface of the ankle joint (as in case of flexor digitorum tendon) and to preserve blood supply at grafting site due to vessels penetrating from muscle belly (in contrast to free tendon grafts, allotendons and synthetic materials) [31]. In addition this technique doesn't seriously restrict active ankle movements while peroneal muscles are responsible for only 4% of dorsal foot flexion power and peroneus brevis muscle is responsible only for 28% of foot eversion power [32]. It should be noted that many authors report a theoretical possibility of a iatrogenic frontal instability at the ankle joint after transfer of peroneus brevis tendon, but at the same time during the content analysis the authors of the present study did not find any studies reporting the above complication and its direct cause-effect relations with mentioned reconstruction procedure [33–35].

The additional advantage of peroneus brevis tendon use for replacement of Achilles tendon defect is a high mechanical strength of graft which in particular exceeds mechanical characteristics of flexor hallucis tendon graft [36]. The present technique is easily reproducible, not requiring a long learning curve, which makes it one of preferred methods to bridge extensive Achilles tendon defects in neglected lesions.

Thus the discussed problem can be described as follows: at the moment there is a tendency to a greater application of conservative treatment of acute Achilles tendon lesions, for example, during last 25 years in Finland the rate of surgical procedures reduced twofold; functional outcomes of conservative treatment are comparable with end-to-end suture, but at the same time there are patients with neglected lesions and extensive defects of Achilles tendon which require nontrivial solutions, one of those being grafting by one of existing techniques [37, 38]. In real clinical practice there is no recognized approach to selection of optimal method and thus require transformation and adaptation to current requirements in terms of efficiency and safety.

Conclusion

Treatment of neglected Achilles tendon lesions with peroneus brevis autograft in type III defects (G. Kuwada classification) is an efficient and safe procedure which provides good and excellent outcomes that are comparable with functional outcomes after end-to-end suture of acute Achilles tendon rupture in absolute values but are reliably worse in terms of statistical evaluation. These realities indicate that neglected Achilles tendon lesions remain a complex orthopaedic challenge and we should continue search for efficient and safe procedures; this can be accomplished by use of other types of grafting, improvement of applied technique or by elaboration of new rehabilitation program. Further selection of patients with such pathology, their surgical treatment, collection of data and content analysis of current literature will allow to work out a

"road map" for treatment of such patients and to achieve a maximum restoration of lost function in the ankle joint.

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INFORMATION ABOUT AUTHORS:

Dmitrii V. Chugaev — Researcher, Knee Joint Pathology Department, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

Nikita S. Konovalchuk — Graduate Student, Vreden Russian Research Institute of Traumatology and Orthopedics St. Petersburg, Russian Federation

Evgenii P. Sorokin — Cand. Sci. (Med.), Researcher, Scientific Department of Diagnosis and Treatment of Musculoskeletal System Injuries, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

Pavel G. Kogan — Cand. Sci. (Med.), Researcher, Scientific Department of Diagnosis and Treatment of Musculoskeletal System Injuries, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

Anton I. Gudz — Researcher, Hip Joint Pathology Depertment, Orthopaedic Surgeon of the Trauma and Orthopaedic Department N 7, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

Sergei A. Lasunsky — Cand. Sci. (Med.), Head of the Trauma and Orthopedic Department N 7, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation

Dmitrii G. Stafeev — Cand. Sci. (Med.), Orthopaedic Surgeon, Trauma and Orthopaedic Department N 7, Vreden Russian Research Institute of Traumatology and Orthopedics, St. Petersburg, Russian Federation