The Journal of Foot & Ankle Surgery 58 (2019) 562–566

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Anterior Rectus Sheath Autograft in WRAP-Augmentation of Achilles Tendon Rupture

Frank P. Schäfer, MD[1], Victor Sander, MD[2], Carina E.M. Pothmann, MD[2], Florin Allemann, MD[3], Hans-Peter Simmen, MD[4], Hans-Christoph Pape, MD[5]

[1] *Attending Physician, Department of Trauma Surgery, University Hospital Zurich, Switzerland*
[2] *Medical Resident, Department of Trauma Surgery, University Hospital Zurich, Zurich, Switzerland*
[3] *Senior Attending Physician, Department of Trauma Surgery, University Hospital Zurich, Zurich, Switzerland*
[4] *Former Chief of Surgery and Clinical Director, Department of Trauma Surgery, University Hospital Zurich, Zurich, Switzerland*
[5] *Current Chief of Surgery and Clinical Director, Department of Trauma Surgery, University Hospital Zurich, Zurich, Switzerland*

ARTICLE INFO

Level of Clinical Evidence: 4

Keywords`:
Achilles tendon
anterior rectus sheath
augmentation
autologous tissue rupture

ABSTRACT

Achilles tendon ruptures can be counted as the most common traumatic ankle injuries. As such, there is a comparatively large set of treatment options including surgical and nonsurgical approaches. The purpose of this case report is to demonstrate a new technique for a specific subgroup of Achilles tendon ruptures that present with a large tendinous gap. We used a 2-step procedure designed to grant additional stability through an autograft from the anterior rectus sheath of the patient. Two patients were treated after suffering traumatic Achilles tendon ruptures on the left side with a gap of >3.5 cm and a high demand in daily activities. The reconstruction was performed using an upper quadrant recuts sheath as a WRAP-augmentation. After securing the transplant tissue, the abdominal wall was reconstructed using a Vicryl™-Prolene™ mesh (VYPRO®, Johnson & Johnson Medical GmbH, Ethicon Deutschland, Norderstedt, Germany). After, a standard approach to the Achilles tendon was performed with a Kirchmayr-Kessler suture. The end result was then stabilized with a rectus sheath WRAP over a length of 14 to 15 cm. On the cases reported here, multiple clinical follow-ups were performed over a 5-year period. We can report highly satisfying results, with a return to sports activity after 6 months and no complications. As such we believe the rectus sheath autograft an effective solution for Achilles tendon ruptures with large gaps in healthy patients that demonstrate a high demand in daily activities.

Treatment options for Achilles tendon ruptures are diverse and context dependent. In this case report, we outline a new surgical technique that applies specifically to the repair of zone II Achilles tendon ruptures where end-to-end suture technique is felt to be inadequate. Here we present 2 cases from our department in which autologous rectus sheath transplants have been used to treat this specific injury. Two active male patients, 64 years of age at the date of trauma, who presented with zone II Achilles tendon ruptures on the left side, are described in this technical report. Both were nonsmokers and had no history of diabetes. Patient A's medical history included treatment with oral anticoagulants for atrial fibrillations as well as polyneuropathy and restless legs syndrome diagnosed in 2012. Patient B presented with occlusive peripheral artery disease, gout, and calcium pyrophosphate deposition crystal arthropathy. In addition, this patient had had a partial Achilles tendon rupture on the opposite side in the previous year and had been surgically treated. Both reported to have experienced a trauma of the upper ankle joint during sports, tennis and skiing respectively, on average 4.5 weeks before their first presentation in our hospital. Clinically, chief complaints were pain, loss of strength, and function of the injured extremity with a positive Thompson test in each case. Radiological confirmation was obtained by ultrasound for patient A and magnetic resonance imaging for patient B. The diastasis between tendon ends was measured to be 5.5 and 3.5 cm, respectively.

Surgical Technique

The approach began with the patient in supine position for the procurement of an autologous rectus sheath transplant. The tissue can be obtained from the upper right or the upper left abdominal quadrant and should measure 10 × 15 cm (Fig. 1A–C). For ventral rectus sheath reconstruction, 2 Vicryl – Prolene – meshes (VYPRO®,

Financial Disclosure: None reported.
Conflict of Interest: None reported.
Address correspondence to: Frank P. Schäfer, MD, University Hospital Zurich, Rämistrasse 100, 8049 Zürich, Zürich, Switzerland
E-mail address: frankpeter.schaefer@usz.ch (F.P. Schäfer).

1067-2516/$ - see front matter https://doi.org/10.1053/j.jfas.2018.09.021

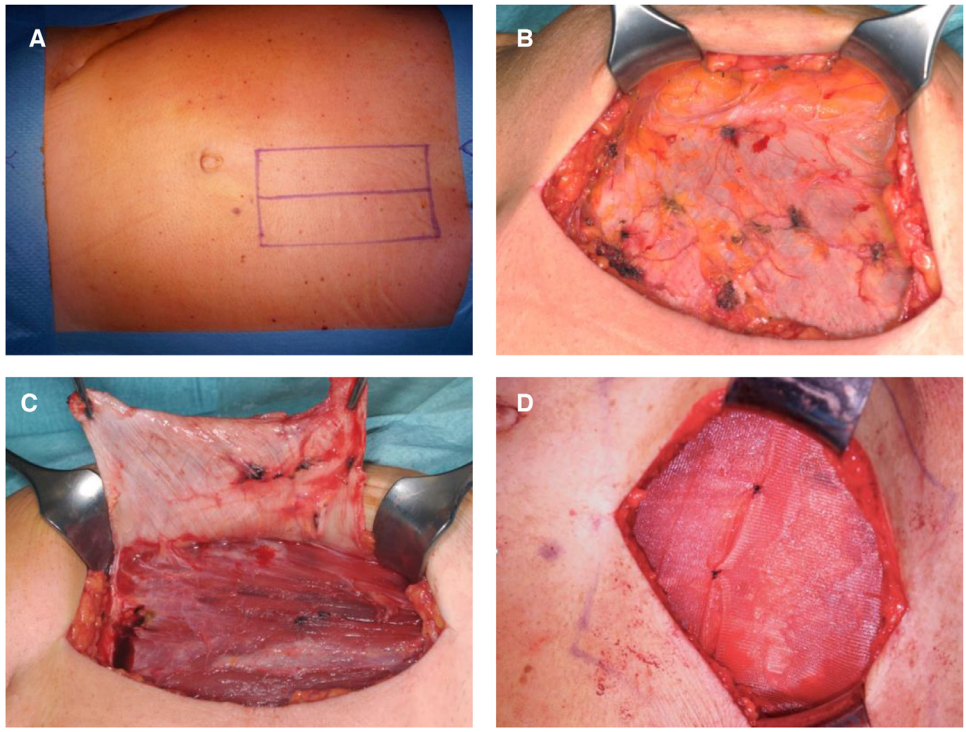

Fig. 1. Surgical approach for the rectus sheath autograft. Preoperative measurement of the rectus sheath transplant from the left upper quadrant: (*A*) Intraoperative preparation site, (*B*) anterior rectus sheath autograft displayed after partial resection, and (*C*) anterior rectus sheath reconstruction at donor site using (*D*) VYPRO® mesh.

Fa. ETHICON - Germany) were adapted tension free with single interrupted sutures. The edges of the mesh and the rectus sheath should overlap sufficiently for ideal stability (Fig. 1D).

In the second part of the surgery, the patient was then turned over into a prone position for the approach to the Achilles tendon. Incision was started in the area of the Achilles tendon from a distal medial pole to a proximal median endpoint. Dissection was continued through layers and paratendinous structures to the ruptured tendon ends (Fig. 2A). Adaption of the tendinous ends was performed with a central suture according to the Kirchmayr-Kessler technique but only using loose tension (Fig. 2B).

The fascia transplant was then wrapped around the sutured tendinous stumps where it overlapped itself approximately 1.5-fold in its circumference (Figs. 2C–E).

To prevent displacement or unfolding of the transplant, it was secured in place with a single interrupted suture at the proximal and distal end. As the end result, the Achilles tendon was covered by the transplant over a distance of 14 to 15 cm with a final diameter of 2 to 2.5 cm (Fig. 2F). To guarantee adequate soft-tissue coverage, cutis and subcutis should be mobilized laterally and medially. For immediate postoperative care, a ventral plaster splint is applied in the operating room to keep the foot in a 30° plantarflexion. On the third postoperative day, the ventral plaster splint was removed and a closed cast with 30° plantarflexion was applied. After suture removal on postoperative day 14, the cast was renewed 1 additional time.

For the first 6 postoperative weeks, the patients wore a closed cast with 30° plantarflexion and were instructed of partial weightbearing of a maximum of 15 kg with the use of crutches. After, full weightbearing was permitted while wearing an orthopedic high boot with integrated stabilizers and adjustable heel wedge. That wedge was started at 3 cm and was lowered 1 cm every 2 weeks until neutral position was attained. Clinical follow-up appointments were scheduled after 2, 6, and 12 weeks, 6 and 12 months, and 5 years. Both patients showed a high degree of satisfaction and optimal healing over time, which was later confirmed with magnetic resonance imaging scans. Six and 12 months after surgery, gait was fluent on even ground and satisfactory range of motion was achieved in the affected left upper ankle joint in both cases. Both patients returned to their initial sport activities after 6 months at the latest.

Furthermore, we can report highly satisfactory results from the most recent 5-year follow-up visits, in which both individuals, now 69 and 70 years of age, are healthy and physically very active without any residual complications or deficits. Patient A said that he plays tennis about 6 hours per week and swims approximately 5 km per week in the summertime. Patient B, who now lives in an area of the central swiss Alps, is described as very active in his daily routine and highly actively participating in sports, such as skiing between 100 and 120 days per season, 10-hours hiking trips, and cycling on a regular basis.

Both patients were also standing and walking straight without limping. Walking on tiptoes and heels, 1-leg stand on left and right tiptoes was possible, as were quick changes between tiptoes and heels. Muscular strength of the lower extremities was thereby equivalent on both sides. Thompson test in both individuals was negative. When measuring the left upper ankle joint function after 12 months and 5 years, patient A continuously presented a dorsiflexion of 20° and a plantarflexion of 40° (20°-0°-40°, neutral-zero-method). Patient B after 12 months showed 10° in dorsiflexion and 45° in plantarflexion (10°-0°-45°; neutral-zero-method) and a slight decrease in dorsiflexion to 5° and an increase in plantarflexion to 50° (5°-0°-50°, neutral-zero-method) at the 5-year follow-up visit.

At the 1- and 5-year follow-up, wound healing at the heel showed no complications (Fig. 3 A-D). Furthermore, no abdominal wall hernias and no occurrence of tendon rerupture were observed over the 5-year postoperative period.

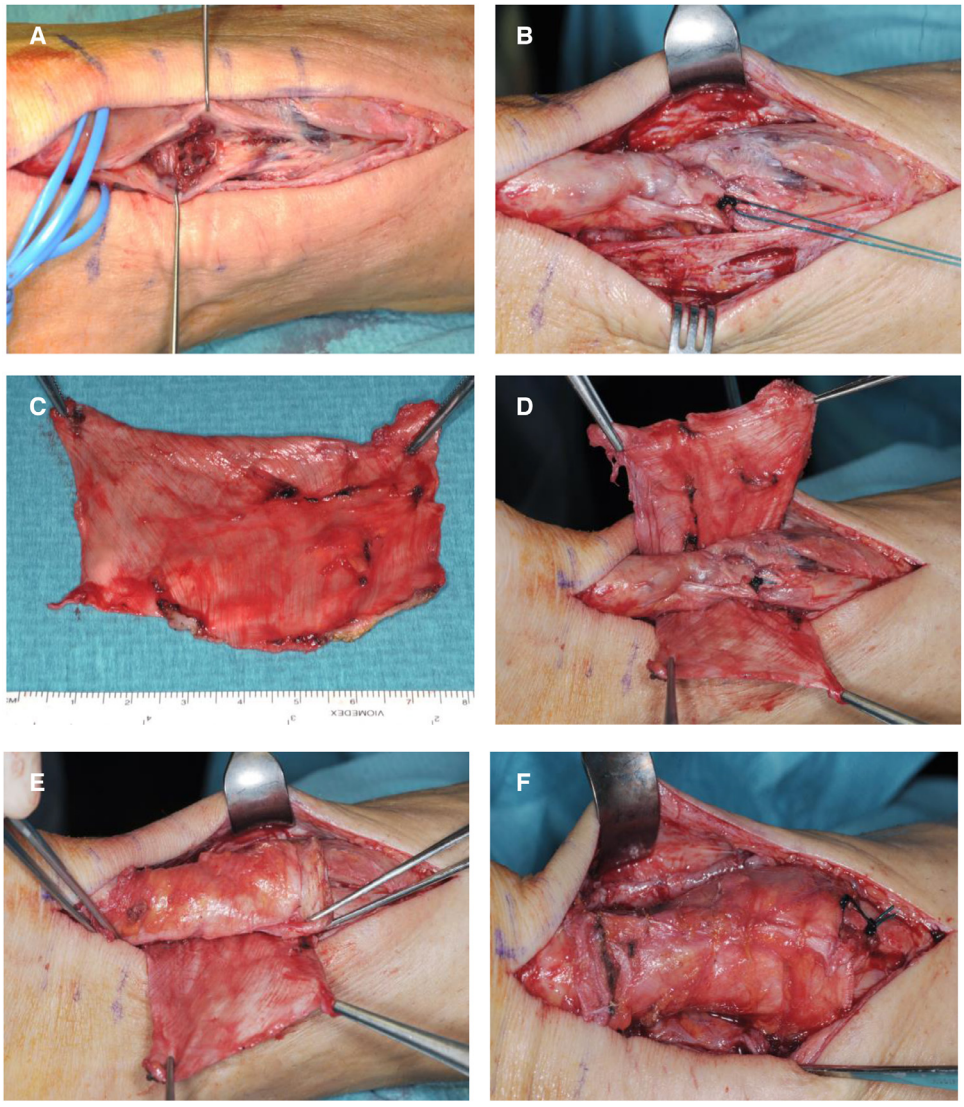

Fig. 2. Achilles tendon repair using the rectus sheath autograft. Ruptured Achilles tendon after surgical dissection before (*A*) suturing the Achilles tendon after Kirchmayer-Kessler suture. (*B*) Display of the autograft on surgical drape before transplantation. (*C*) Anterior rectus sheath autograft positioned underneath the Achilles tendon. (*D*) Rectus sheath partially wrapped around the Achilles tendon. (*E*) Final reconstruction of WRAP-augmented tendon (*F*).

Discussion

Rupture of the Achilles tendon can lead to significant disability of the patient and be a devastating injury that can prevent return to play for up to 30.6% of professional athletes (1). In general, conservative therapy shows an increased rerupture rate between 11% and 35% (2,3) and healing of the Achilles tendon in pathologic elongation and soleus muscle atrophy (4–8). Nevertheless, there is no consensus or unambiguous data about the therapy of this injury. Not surprisingly, there is not yet an established guideline for a surgical approach to larger tendinous defects (4,9–12). Most often, operative treatment is the best option to avoid increased patient morbidity and mortality and has, in 93% of cases, a very high patient satisfaction (13). Indications for operative therapy of a ruptured Achilles tendon include difficulties in gait, weakness of the triceps surae complex, and functional elongation of the gastrocnemius complex (14). Möller et al. (15) found in a prospective randomized study that patients at 8 weeks and 2 years postoperatively presented with a significantly better quality of life with surgical repair than those treated nonoperatively. However, substantial defects of the tendon after debridement require operative techniques to sufficiently bridge the gap (14). Surgeons may approach these injuries using autografts, allografts, xenografts, and tendon prosthesis (12,16). Although biomaterials have become critical components in the development of effective new medical therapies for wound care in the past few decades (12,16,17), specimens of the anterior rectus sheath have already served in the reconstruction of different substance defects with great reliability for years. Achilles tendon allografts have been combined with a free rectus abdominis flap with anterior rectus sheath for augmentation of an Achilles tendon rupture (18). Flap plastic using the anterior rectus sheath is an established method for effective and inexpensive herniotomy as well as in the treatment of Peyronie's disease (19,20). The posterior rectus sheath has also been used as a donor site for a free flap reconstruction of defects of the hand and dorsal foot (21). Biological scaffolds of protein-based extracellular matrices that are usually derived from human or animal connective tissues are another alternative; however, they are currently associated with a variety of

Fig. 3. Five-year clinical follow-up of patient A. (*A*) Posterior view of both heels. (B) Side view of both feet. (*C*) Posterior view of both heels in toe stand. (*D*) Posterior view of both heels in heel stand.

drawbacks. Most noteworthy are the lesser mechanical properties, a nonspecific ability for induction, an undefined degradation rate, and variation in biocompatibility depending on the source of raw materials, which can cause inflammatory response and even implant rejection (12,22). Finally, even though there have not been any reported cases, the use of biological scaffolds manufactured from human or animal tissue also carries the risk of disease transmission, which remains a feasible concern (22). On the other hand, drawbacks of autologous tissue transplants are associated with the requirement for an adequate donor site. In the specific case of anterior rectus sheath transplantation, one has to consider medical aspects such as the theoretical risk of herniation. This is however addressed in our approach with the well-established sheath repair using a VYPRO® mesh implant. Furthermore, because the intraabdominal cavity is not affected, we would not expect complications such as prolonged intestinal passage or even ileus. The additional effort and time required because of a switch of patient position from supine to prone does require an overall longer surgery time in comparison to the simple tendon reconstruction but it has been our impression that with an experienced team this difference can be compensated in clinical practice. More important, the additional time is counterbalanced by a difference in costs compared to alternative transplants. As an example the expenses for a single GRAFTJACKET® (Wright Medical, Arlington, TN, USA) with a needed minimal size of 5×10 cm can be priced at about US$3900, whereas costs for the VYPRO® mesh used in these cases, described size 15×15 cm, is about US$170. We consider this 1 of the biggest advantages of a WRAP-augmentation; the easy availability of the autologous tissue and substantially lower costs in comparison to allogenic products. Finally, we deemed it advantageous to be able to avoid using exogenous tissues in an area where endogenous healing processes may already be limited and restricted and interference can be kept at a minimum.

In conclusion, we believe that operative treatment through augmentation with an Autograft-WRAP from anterior rectus sheath is a new, safe and reliable alternative to those already in current literature described operative methods to treat a ruptured Achilles tendon.

References

1. Trofa DP, Miller JC, Jang ES, Woode DR, Greisberg JK, Vosseller JT. Professional athletes' return to play and performance after operative repair of an Achilles tendon rupture. Am J Sports Med 2017;45:2864–2871.
2. Wills CA, Washburn S, Caiozzo V, Prietto CA. Achilles tendon rupture. A review of the literature comparing surgical versus nonsurgical treatment. Clin Orthop Relat Res 1986;156–163.
3. Jones MP, Khan RJ, Carey Smith RL. Surgical interventions for treating acute Achilles tendon rupture: key findings from a recent cochrane review. J Bone Joint Surg Am 2012;94:e88.
4. Ulmar B, Simon S, Eschler A, Mittlmeier T. (Rupture of the Achilles tendon). Unfallchirurg 2014;117:921–939.
5. Pagenstert G, Leumann A, Frigg A, Valderrabano V. (Achilles tendon ruptures and tibialis anterior tendon ruptures). Orthopade 2010;39:1135–1147.
6. Thermann H, Hufner T, Tscherne H. (Achilles tendon rupture). Orthopade 2000;29: 235–250.
7. Heikkinen J, Lantto I, Flinkkila T, Ohtonen P, Niinimaki J, Siira P, Laine V, Leppilahti J. Soleus atrophy is common after the nonsurgical treatment of acute Achilles tendon ruptures: a randomized clinical trial comparing surgical and nonsurgical functional treatments. Am J Sports Med 2017;45:1395–1404.
8. Lantto I, Heikkinen J, Flinkkila T, Ohtonen P, Siira P, Laine V, Leppilahti J. A prospective randomized trial comparing surgical and nonsurgical treatments of acute Achilles tendon ruptures. Am J Sports Med 2016;44:2406–2414.
9. Wong J, Barrass V, Maffulli N. Quantitative review of operative and nonoperative management of Achilles tendon ruptures. Am J Sports Med 2002;30:565–575.
10. Lepow GM, Green JB. Reconstruction of a neglected Achilles tendon rupture with an Achilles tendon allograft: a case report. J Foot Ankle Surg 2006;45:351–355.
11. Olsson N, Silbernagel KG, Eriksson BI, Sansone M, Brorsson A, Nilsson-Helander K, Karlsson J. Stable surgical repair with accelerated rehabilitation versus nonsurgical treatment for acute Achilles tendon ruptures: a randomized controlled study. Am J Sports Med 2013;41:2867–2876.
12. Longo UG, Lamberti A, Maffulli N, Denaro V. Tendon augmentation grafts: a systematic review. Br Med Bull 2010;94:165–188.
13. Kellam JF, Hunter GA, McElwain JP. Review of the operative treatment of Achilles tendon rupture. Clin Orthop Relat Res 1985;201:80–83.
14. Peterson KS, Hentges MJ, Catanzariti AR, Mendicino MR, Mendicino RW. Surgical considerations for the neglected or chronic Achilles tendon rupture: a combined technique for reconstruction. J Foot Ankle Surg 2014;53:664–671.

15. Moller M, Movin T, Granhed H, Lind K, Faxen E, Karlsson J. Acute rupture of tendon Achillis. A prospective randomised study of comparison between surgical and non-surgical treatment. J Bone Joint Surg Br 2001;83:843–848.
16. Aurora A, McCarron J, Iannotti JP, Derwin K. Commercially available extracellular matrix materials for rotator cuff repairs: state of the art and future trends. J Shoulder Elbow Surg 2007;16:S171–S178.
17. Coons DA, Alan Barber F. Tendon graft substitutes-rotator cuff patches. Sports Med Arthrosc 2006;14:185–190.
18. Yuen JC, Nicholas R. Reconstruction of a total Achilles tendon and soft-tissue defect using an Achilles allograft combined with a rectus muscle free flap. Plast Reconstr Surg 2001;107:1807–1811.
19. Jimenez Pacheco A, Lopez Luque A, Verdu Perez M. (Peyronie's disease. Complete plaque excision and autologous graft with anterior rectus fascia). Actas Urol Esp 2010;34:564–565.
20. Craatz S, Spanel-Borowski K, Begemann JF, Olianas R, Fisch M, Hohenfellner R. The dorsal lamina of the rectus sheath: a suitable grafting material for the penile tunica albuginea in Peyronie's disease? BJU Int 2006;97:134–137.
21. Salgado CJ, Orlando GS, Serletti JM. Clinical applications of the posterior rectus sheath-peritoneal free flap. Plast Reconstr Surg 2000;106:321–326.
22. Chen J, Xu J, Wang A, Zheng M. Scaffolds for tendon and ligament repair: review of the efficacy of commercial products. Expert Rev Med Devices 2009;6:61–73.