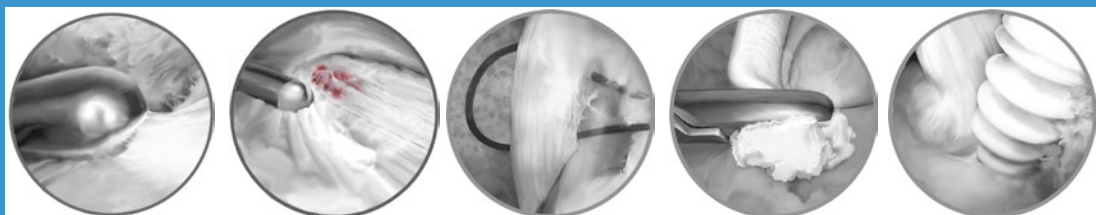


Hajo Thermann · Christoph Becher
Michael R. Carmont · Jón Karlsson
Nicola Maffulli · James Calder
C. Niek van Dijk *Editors*



The Achilles Tendon

An Atlas of Surgical Procedures



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Preface

The publication of a detailed operating atlas for Achilles tendon surgery is logically consistent with the three previously published books, which reflected the pathologies, treatment concepts and results based on the latest standard.

The special feature of this atlas is being the contribution of globally renowned Achilles tendon surgeons, who present their specific approach to various pathologies and their personal techniques.

So it is as if we were looking over the shoulder of the “masters”.

The format of the book is selected in such a way that the most important steps in a surgical procedure and its technical execution are standardised and easily reproducible in each chapter. The authors are mainly concerned with setting, the indications as well as demonstration of technical tricks within the scope of the operation, which – in our opinion – were not emphasised in the literature.

Our major concern is the reflection of the “Pearls and Pitfalls” which raises the attention of the surgeon to these particular highlights in order to improve the results and to avoid encountering the mistakes that we all have behind us.

The compilation of the international authors can only go beyond the editors in such an atmosphere in order to achieve an absolutely international “top-ranking spectrum” for this book.

We also wanted to underline the uniqueness of this book through the artistic presentation. The pictures by Mr. Jörg Kühn in our view are extraordinary and represent the details in high quality. The cooperation between the authors and the artist has been carried out purposefully in order to illustrate the carried-out operations thoroughly. The editors would like to thank all the authors involved for the participation and the expertise and the transfer of knowledge.

Special thanks go to Dr. Christoph Becher, PhD, who has been the “working horse” for organisation, communication and review. Special thanks also go to Mike Carmont, who has improved the linguistic style for the non-native speakers once again with excellent Oxford English.

All in all, the editors are happy that an operative standard work has been created, which will hopefully serve all Achilles tendon surgeons as a “vade mecum” to improve their surgical skills.

In contrast to previous other books, this book has already included the minimally invasive and the endoscopic Achilles tendon surgery, so that it can already be a “door opener” for every surgeon who will turn to these techniques, which will play an outstanding role in the future.

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Part I

**Acute Achilles Tendon Ruptures:
Suture Techniques**

Jon Karlsson, Nicklas Olsson, Michael R. Carmont,
and Katarina Nilsson-Helander

1.1 Indication and Diagnosis

Acute Achilles tendon rupture usually occurs in the midportion 2–6 cm proximal from the insertion site of calcaneus. In general there are usually no warning symptoms and the injury frequently occurs with a very distinct ankle trauma. The rupture is generally total and partial Achilles tendon rupture is very rare in the cases of specific pop sensed and localized to the midportion of the tendon. The diagnosis is clinical with positive Thompson's test (calf squeeze test), reduced plantar flexion strength, and a palpable gap in the tendon. Surgical and nonsurgical treatment is still debated, together with the timing of the key components of rehabilitation, e.g., weight-bearing, movement, and functional bracing [1]. Open surgery (end-to-end repair) may be considered the

gold standard surgical procedure. There has been shown no advantage in a fascial turndown over end-to-end appositional repair for acute ruptures [2]. Primary repair without an augmentation can be performed approximately within 3 weeks. Contraindications include peripheral vascular diseases, skin affections, and systemic diseases with high risk of infection.

1.2 Operative Setup

Open end-to-end repair can be carried out in local, regional, or general anesthesia. The procedure is performed with a patient placed in prone position, with the feet over a pillow or outside the operating table. A setup of excessive plantar flexion increases the risk of overtightening the repair and shortening of the tendon. The risk of lengthening is a more common issue and should be avoided. Tendon lengthening will lead to reduced plantar flexion strength [3]. Therefore it is wise to dress the uninjured side to be able to compare the neutral position. A wedge can be used below the contralateral pelvis to straighten the position of the hind foot. Antibiotic prophylaxis is recommended (local recommendations decides the type of antibiotics) to reduce the risk of the major complication of deep infection. Prophylaxis against deep-vein thrombosis is recommended due to the high risk of deep venous thrombosis [4]. A tourniquet is generally not needed.

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1.3 Surgical Technique

A 5–8 cm posteromedial skin incision is preferred to minimize any risk of injury to the branches of the sural nerve. The paratenon should be carefully identified before further incision to optimize the wound closure (Fig. 1.1). The paratenon is opened centrally and the frayed ends are easily visualized. In general, healthy tendon is located in proximal and distal direction from the rupture site (Fig. 1.2). This is where to place the sutures for greatest stability. The skin and subcutaneous tissue should be handled with care due to the limited blood supply, in order to reduce the risk of tissue breakdown. The gap and tendon ends are cleaned and carefully debrided to optimize the repair. The ends should be apposed without major tension. There are different sutures and techniques in the literature, but this suture technique is the author's preference [5].

A combination of both core and circumferential sutures are used for a stable repair. The core suture consists of two semi-absorbable sutures (No. -2) using a modified Kessler technique [6]. The double Kessler locking loop should be carefully placed away from the rupture site in healthy tendon (Fig. 1.3). The sutures must be able to glide and also care to not damage the core sutures with the needle. The foot is placed in 20–30° plantarflexion when tying the sutures. The uninjured side, tendon quality, and tension are all used to estimate the tendon length. One can also take into account a lengthening of approximately 1 cm until the tendon is healed [7]. Next a running circumferential suture is used with absorbable sutures (No. -0) using an epitendinal crisscross technique described by Silfverskiöld et al. to reinforce the core sutures (Fig. 1.4) [8]. The paratenon should be carefully repaired, thereafter using absorbable subcutaneous sutures and meticulous wound closure with nylon sutures.

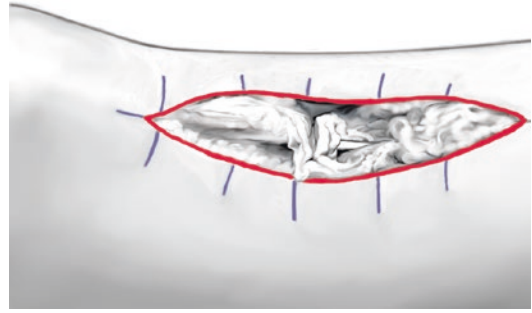


Fig. 1.1 Posteromedial skin incision and identification of paratenon

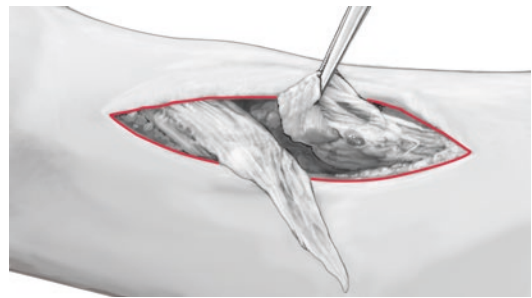


Fig. 1.2 The blood clot is removed and the frayed ends are identified and debrided. Healthy tendon is seen in the distal end

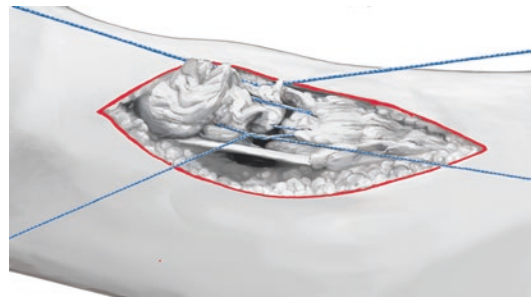


Fig. 1.3 The first core suture is applied in healthy tendon. Both core sutures are in place and tied from each side to the estimated tendon length. A gentle pressure could be applied in ankle dorsal flexion to feel the stability of the sutures and for correct tension in the sutures before tying. The plantaris tendon is visualized in the figure

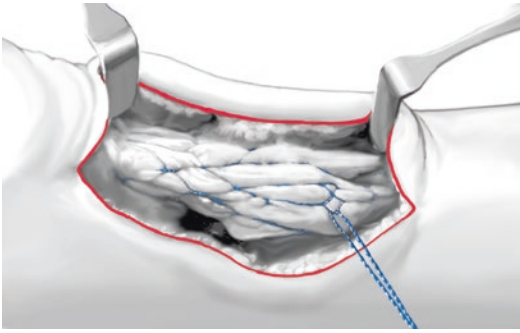


Fig. 1.4 The tendon is sutured in a circumferential criss-cross technique to reinforce the repair

1.4 Postoperative Care

In the first phase of wound healing, a cast is applied for 2 weeks. No weight-bearing is allowed in this stage when the ankle is positioned in plantarflexion. Next, the sutures are removed (day 14), and a pneumatic walker brace with heel pads is adopted. Generally three pads are used and these are gradually removed in 6 weeks. Full weight-bearing is encouraged from the first day with brace. A physical therapist continuously should follow a standardized rehabilitation protocol.

1.5 Pearls Tips and Pitfalls

- Stable surgical technique allows early range of motion training and early weight-bearing.
- The tendon length is probably crucial for the result, but the estimated length is difficult during the surgical repair.

References

1. Khan RJ, Carey Smith RL. Surgical interventions for treating acute Achilles tendon ruptures. *Cochrane Database Syst Rev* (Online). (2010);(9):CD003674. doi:[10.1002/14651858.CD003674.pub4](https://doi.org/10.1002/14651858.CD003674.pub4).
2. Heikkinen J, Lantto I, Flinkkila T, Ohtonen P, Pajala A, Siira P, Leppilahti J. Augmented compared with nonaugmented surgical repair after total achilles rupture: results of a prospective randomized trial with thirteen or more years of follow-up. *J Bone Joint Surg Am*. 2016;98(2):85–92. doi:[10.2106/JBJS.O.00496](https://doi.org/10.2106/JBJS.O.00496).
3. Silbernagel KG, Steele R, Manal K. Deficits in heel-rise height and Achilles tendon elongation occur in patients recovering from an Achilles tendon rupture. *Am J Sports Med*. 2012;40:1564–71. doi:[10.1177/0363546512447926](https://doi.org/10.1177/0363546512447926).
4. Nilsson-Helander K, Thurin A, Karlsson J, Eriksson BI. High incidence of deep venous thrombosis after Achilles tendon rupture: a prospective study. *Knee Surg Sports Traumatol Arthrosc*. 2009;17(10):1234–8. doi:[10.1007/s00167-009-0727-y](https://doi.org/10.1007/s00167-009-0727-y).
5. 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(12):2867–76. doi:[10.1177/0363546513503282](https://doi.org/10.1177/0363546513503282).
6. Kessler I. The “grasping” technique for tendon repair. *Hand*. 1973;5(3):253–5.
7. Kangas J, Pajala A, Ohtonen P, Leppilahti J. Achilles tendon elongation after rupture repair: a randomized comparison of 2 postoperative regimens. *Am J Sports Med*. 2007;35(1):59–64.
8. Silfverskiöld KL, Andersson CH. Two new methods of tendon repair: an in vitro evaluation of tensile strength and gap formation. *J Hand Surg Am*. 1993;18(1):58–65. doi:[10.1016/0363-5023\(93\)90246-Y](https://doi.org/10.1016/0363-5023(93)90246-Y).

Percutaneous Suturing with a Double-Knot Technique

2

Hajo Thermann and Christoph Becher

2.1 Indication and Diagnosis

Management of Achilles tendon (AT) rupture depends on various factors and can be divided into nonoperative and operative treatment. Many different techniques have been described for operative treatment, with a lack of consensus regarding the best option [1]. For acute rupture, percutaneous repair of the AT is associated with a relatively low complication rate (particularly regarding wound disorders and infection) and high level of patient satisfaction [1, 2]. It was shown that percutaneous repair of the AT resulted in reduced costs and comparable outcome and complications rates to open repair [3]. A further advantage of the presented technique is the remaining integrity of the paratenon, which is essentially important for the healing process.

The best indications for percutaneous AT repair are patients with an acute rupture 2–6 cm proximal to the calcaneal insertion with sonographical adaptation of the tendon stumps at plantar flexion. Since percutaneous repair

techniques demonstrated an increased susceptibility to early repair elongation compared with the open technique [4], athletes or patients that warrant accelerated rehabilitation are questionable good candidates for percutaneous repair since the repair should be sufficiently protected postoperatively to allow for biological healing and avoid early repair elongation and potential gapping between the healing tendon ends. The at this point presented technique might overcome these drawbacks due to the possibly increased stiffness of the tape used for augmentation [5] and the double-knot technique.

Distal ruptures <2 cm proximal to the calcaneal insertion need other treatment considerations to maintain end-to-end tendon apposition and suture stability. To avoid suture pull-through, the small distal stump, the internal fixator used for the percutaneous suture, should be passed through a trans-osseous calcaneal tunnel, or a different technique with direct anchoring of the tendon into the calcaneal insertion should be used.

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