

RESEARCH ARTICLE

Open Access



Minimally invasive excision and reconstruction of Achilles tendon xanthoma using free autologous semitendinosus tendon transfer: a surgical technique

Francesco Oliva¹, Emanuela Marsilio¹, Federica Mastrodonato¹, Filippo Migliorini^{2,3*}  and Nicola Maffulli^{1,4,5}

Abstract

Background Tendon xanthomatosis is often associated with familial hypercholesterolemia, but it can also occur in other medical conditions. The Achilles tendon is the most common site of tendon xanthomas. Reconstruction of large defects after the xanthoma excision, can be challenging.

Methods We propose a novel technique for Achilles tendon reconstruction with the use of an ipsilateral autologous semitendinosus tendon graft. The technique consists of six steps.

Results This procedure has a low rate of complications and provides results that are at least comparable with those reported with other surgical approaches.

Keywords Xanthoma, Achilles tendon, Surgery, Tendon graft, Hypercholesterolemia

Introduction

The term xanthoma derives from the Greek word “xanthos” (yellow) [1]. Tendon xanthomas are benign masses characterized by lipid deposition within the tendon structure, frequently associated with genetic factors; they may be single or bilateral [2]. Tendon xanthomas are often associated with coronary artery disease and a high risk

of cardiovascular events [3, 4]. In addition to the Achilles tendons, the other tendons where xanthomas usually appear are the tendons of the hand (extensor tendons) and the elbow [5]. Xanthomas have also been reported in the plantar fascia, fascia and periosteum overlying the lower tibia, the peroneal tendons, the triceps tendon and the patellar tendon [6]. Mechanical stress and neo-vascularization are considered as predisposing factor for xanthomas growth [7]. In addition to tendinous xanthomas, several types of xanthomas can be found such as tuberous and eruptive xanthoma, eyelid xanthelasma and xanthoma planum [6]. Xanthomas are frequently associated with hyperlipidemia, and high levels of triglycerides and total cholesterol: within families affected by familial hypercholesterolemia and type II hyperlipoproteinemia Achilles tendon xanthomas are frequent, probably because of the low-density lipoprotein storage in the tendon [7]. Furthermore, the presence of endothelial cells and macrophages is the main factors contributing to the pathogenesis of tendon xanthomas [8]. Achilles tendon

*Correspondence:

Filippo Migliorini
migliorini.md@gmail.com

¹ Department of Medicine, Surgery and Dentistry, University of Salerno, 84081 Baronissi, Salerno, Italy

² Department of Orthopaedic, Trauma, and Reconstructive Surgery, RWTH University Hospital, Pauwelsstraße 30, 52074 Aachen, Germany

³ Department of Orthopaedic and Trauma Surgery, Eifelklinik St. Brigida, 52152 Simmerath, Germany

⁴ School of Pharmacy and Bioengineering, Keele University Faculty of Medicine, ST4 7QB Stoke on Trent, England

⁵ Barts and the London School of Medicine and Dentistry, Centre for Sports and Exercise Medicine, Mile End Hospital, Queen Mary University of London, E1 4DG London, England



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

xanthomas may be detected by clinical examination and imaging studies. Clinical evaluation, including inspection and palpation of the Achilles tendon, plays a fundamental role to reach the diagnosis [5]; demonstrating painless soft tissue nodules or aching papules that can be detected within the tendon, most commonly in its distal portion [8, 9]. Achilles tendon xanthomas are usually accompanied by an increase in tendon size, caused not only by the intratendinous storage of lipids but also by the edema and inflammation of the area [5]. Xanthomas of the Achilles tendon can cause pain, swelling, loss of function and problems with footwear, and psychological problems related to the deformity of the affected limb [10]. Ultrasonography is considered the first-line imaging examination. Xanthomas are visualized as hypoechoic nodules or a diffuse heterogeneous abnormality of the tendon, with markedly increased anteroposterior diameter [11, 12]. Surgical treatment of Achilles xanthomas tendon is usually limited to patients who have severe enlargement of the tendon, causing pain or mobility problems [13]. Several drugs, such as Pravastatin and Lovastatin, can decrease the size of the xanthomas; but they recur when the medication is stopped [5, 14, 15]; have, but they recur when the medication is stopped [16, 17]. We propose a novel technique in which the Achilles tendon xanthoma is removed in its entirety, and the tendon defect reconstructed using an ipsilateral free semitendinosus tendon graft. This procedure has a low rate of complications and provides results that are at least comparable with those reported with other surgical approaches.

Material and methods

The technique consists of six steps.

Step 1: Patient positioning.

Step 2: Incision, Semitendinosus tendon visualization and harvest.

Step 3: Achilles tendon insertion incision and xanthoma exposure.

Step 4: Xanthoma excision.

Step 5: Calcaneal osteotomy and tunnel drilling.

Step 5: Tunnel passage.

Step 6: Shuttling of the tendon graft in the calcaneal tunnel.

Step 7: Graft fixation with an interference screw and deep tissues and skin closure.

Surgical procedure

With the patient prone under epidural, spinal or general anesthesia, a tourniquet is applied to the root of the thigh and inflated to 300 mmHg after exsanguination (Fig. 1). Skin preparation is performed in the usual fashion, and the sterile field is prepped.



Fig. 1 Pre-operative clinical photograph of the ankle showing the xanthoma of the Achilles tendon

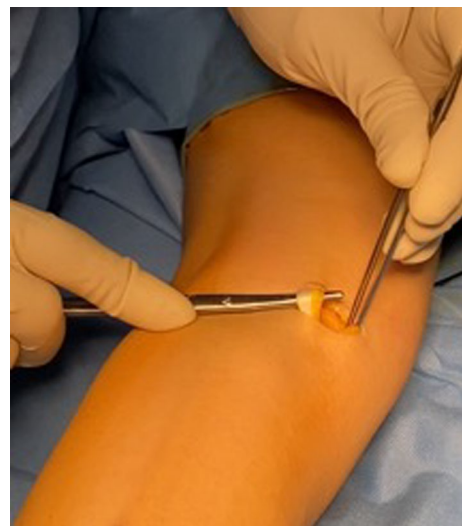


Fig. 2 Transverse incision of about 2 cm on the medial aspect of the popliteal fossa. The semitendinosus tendon is visualized

Accurate palpation allows to identify the semitendinosus tendon in the postero-medial corner of the popliteal fossa. The tendon is harvested through a 2.5–3 cm transverse incision (Figs. 2 and 3).

The Achilles tendon insertion is reached through a para-Achilles postero-lateral incision, the size of which may vary according to the size of the xanthoma (Fig. 4).

The proximal portion of the Achilles tendon is exposed through a para-Achilles postero-medial incision, and



Fig. 3 Harvest and preparation of semitendinosus tendon graft



Fig. 6 Excision of the Achilles tendon xanthoma



Fig. 4 The postero-lateral incision at the Achilles tendon insertion

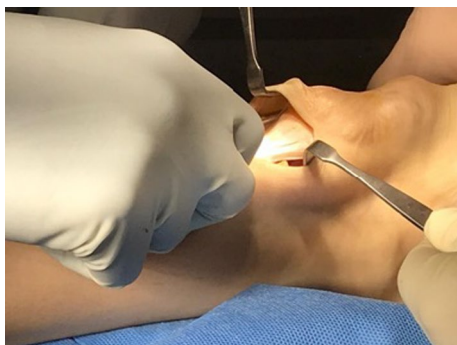


Fig. 5 Removal of xanthoma adhesions



Fig. 7 Section of the removed xanthoma

the xanthoma appears as a large yellowish white nodular mass involving the Achilles tendon.

After detaching and removing the adhesences (Fig. 5), the xanthoma can be excised (Figs. 6 and 7).

After its removal, a large defect is present, which can be difficult to reconstruct from primary repair. Each end of the semitendinosus tendon is then prepared using 2 Vicryl (Polyglactin 910 Braided Resorbable Suture; Johnson & Johnson, Brussels, Belgium) with three or four passes in a whip stitch configuration (Fig. 8).

The proximal end of the Achilles tendon is mobilized and freed from the peritendinous adhesences. An osteotomy of the posterior-superior corner of the calcaneus



Fig. 8 The extremities of the semitendinosus tendon are with 2 Vicryl (Polyglactin 910 Braided Resorbable Suture; Johnson & Johnson, Brussels, Belgium) in a whipstitch configuration, and passed transversely through the proximal stump of the Achilles tendon. The entry and exit points are secured with two Vicryl

with a small sagittal saw is made, removing a “-slice-” of bone approximately 5 mm thick, without removing the distal tendon stump, exposing the insertion of the Achilles tendon on the calcaneus.

The osteotomy is started just above the insertion of the Achilles tendon on the calcaneus and performed with an angle of approximately 45° to the long axis of the tendon (Fig. 9).

The calcaneus is prepared removing the posterosuperior corner and drilling a tunnel of an appropriate diameter just anterior to the insertion of the Achilles tendon on the calcaneus (Fig. 9).

The looped semitendinosus graft is passed transversely through the substance of the proximal stump of the Achilles tendon and sutured at both its entry and exit points with two Vicryl sutures to achieve adequate stability and prevent distal migration of the graft.

The graft is passed through the subcutaneous tissue, shuttled through the calcaneus tunnel, and then secured to the calcaneus with an interference screw of appropriate diameter keeping the ankle in maximum plantar flexion. (Figs. 10 and 11) The final position and stability are verified, and the incisions are sutured in a started fashion. The patient is immobilized in a synthetic below the knee cast, leaving the metatarsal heads free.



Fig. 9 Calcaneus preparation, osteotomy, and tunnel drilling



Fig. 10 The two ends of the semitendinosus tendon are shuttles distally and in the calcaneus tunnel, and the tendon graft in secured to the calcaneus



Fig. 11 Fixation of the graft with an interference screw

Post-operative protocol

After surgery, the leg is immobilized in a below the knee plaster cast with the foot in equinus leaving the metatarsal heads free. The patient can weight bear on the metatarsal heads with the use of elbow crutches immediately. After 3 weeks, the plaster cast is removed and an Aircast boot with five heel wedges is applied (XP Walker, DJO Ltd, Guilford, England, UK). Physiotherapy starts immediately afterward, focusing on proprioception, plantar flexion of the ankle, inversion, and eversion of the foot, avoiding dorsiflexion of the ankle and local massage [18, 19]. During this rehabilitation phase, patients are directed to weight bear as comfortable. Although full weight bearing is recommended, patients usually require a single crutch for two or three weeks [20, 21]. A heel wedge is removed at the end of the fourth week, and the boot is finally removed at the end of the eighth-tenth post-operative week [22]. The “GAIT” study group (German, American, Italian Tendon) established a post-operative protocol for the rehabilitation of Achilles tendon rupture after surgical reconstruction agreeing on a first period of non-weight bearing (2.3 weeks), and the first 4 weeks of plantarflexion, followed by concentric bilateral heel raises exercises from the 6th week. Before 12 weeks exercises beyond neutral to restore the ROM, stretching, and eccentric exercises are not recommended, while the use of treadmill and heel pads to be placed in shoes seems to be useful for a full rehabilitation [23].

Discussion

Tendon xanthomas are yellowish masses from macrophage deposits full of lipids [24]. Clinical examination and past medical family history can guide the diagnosis of xanthomatosis [25]. Although the usual treatment of Achilles tendon xanthoma is directed primarily toward lowering the level of serum cholesterol and managing the complications of coronary atherosclerosis, some patients require surgical management. Surgical removal is suggested in large tendon xanthomas that can limit joint motion and cause physical or psychological discomfort [6]. Several techniques of reconstruction of the Achilles tendon after xanthoma removal have been described. Samal et al. described bilateral reconstruction of the Achilles tendon with the use of the peroneus brevis tendon graft, giving a satisfactory outcome [2]. Senthil et al. described reconstruction of the Achilles tendon after removal of the xanthoma with a tensor fascia lata graft, with results comparable to the reconstruction performed by tendon-calcaneal allograft in terms of patients reported outcomes [9]. Moroney et al. described reconstruction of the Achilles tendon after removal of the xanthoma using a flexor hallucis longus tendon transfer and a Bosworth turndown flap. This combination avoids donor site morbidity, minimizes the risk of infection, and uses locally material available for reconstruction. Furthermore, the distal location of the muscle belly of the flexor hallucis longus provides improved vascularization to the reconstructed site [26]. It requires wide exposure of the tendon and gastrocnemius to allow fashioning of the turndown flap. Saraf et al. used a flap with distal base modeled from the remainder proximal tendon and aponeurosis of the gastrocnemius. After 2 years of follow-up, patients were able to stand on tip-toe and the ankle was stable with acceptable cosmetic appearance [27]. Other reconstruction techniques have been described, including VY advancement flaps, proximal gastrocnemius/soleus turndown flaps, cadaveric allografts and synthetic grafts [28–37]. No technique is considered as gold standard for the surgical management of large defects of the Achilles tendon. Our study offers a novel and reproducible less invasive technique of Achilles tendon reconstruction with a semitendinosus tendon graft after removal of large xanthomas.

Conclusion

Large xanthomas of the Achilles Tendon are uncommon. One of the most common problems is incomplete removal of the lesion that predisposes for recurrence. Reconstruction of the defect after complete excision remains challenging. Several reconstruction options are available after removal of an Achilles tendon xanthoma,

and the use of an ipsilateral semitendinosus tendon autograft is a safe reproducible surgical option.

Acknowledgements

None

Author contributions

EM and FM were involved in writing-original draft preparation; FO contributed to supervision, revision, final approval; NM and FM were involved in revision, supervision; NM contributed to ideation and execution of the technique. All authors read and approved the final manuscript.

Funding

Open Access funding enabled and organized by Projekt DEAL. The authors received no financial support for the research, authorship, and/or publication of this article.

Availability of data and materials

The datasets generated during and/or analyzed during the current study are available throughout the manuscript.

Declarations

Ethical approval and consent to participate

This study complies with ethical standards.

Consent for publication

Written informed consent for publication of their clinical images was obtained from the patient.

Registration and protocol

The present review was not registered.

Competing interests

The authors declare that they have no conflicts of interest. Professor Maffulli is the Editor in Chief of the *Journal of Orthopaedic Surgery and Research*.

Received: 28 February 2023 Accepted: 26 March 2023

Published online: 04 April 2023

References

- Parente F, Vesnaver M, Massie R, Baass A. An unusual cause of Achilles tendon xanthoma. *J Clin Lipidol*. 2016;10(4):1040–4. <https://doi.org/10.1016/j.jacl.2016.05.001>.
- Samal P, Mohapatra NC, Mishra J, Mylarappa A, Das P. A rare case of giant cell tumour of bilateral Achilles tendon sheath - reconstruction with dual tendon transfer: a case report. *Malays Orthop J*. 2020;14(1):84–7. <https://doi.org/10.5704/MOJ.2003.014>.
- Abate M, Schiavone C, Salini V, Andia I. Occurrence of tendon pathologies in metabolic disorders. *Rheumatology*. 2013;52(4):599–608. <https://doi.org/10.1093/rheumatology/kes395>.
- Merino-Ibarra E, Castillo S, Mozas P, Cenarro A, Martorell E, Diaz JL, Suarez-Tembra M, Alonso R, Civeira F, Mata P, Pocovi M. Spanish group of familial H. Screening of APOB gene mutations in subjects with clinical diagnosis of familial hypercholesterolemia. *Hum Biol*. 2005;77(5):663–73.
- Tsouli SG, Kiortsis DN, Argyropoulou MI, Mikhailidis DP, Elisaf MS. Pathogenesis, detection and treatment of Achilles tendon xanthomas. *Eur J Clin Invest*. 2005;35(4):236–44. <https://doi.org/10.1111/j.1365-2362.2005.01484.x>.
- Rekha A, Rai DK. Tendon xanthomas. *Foot*. 2010;20(2–3):85–6. <https://doi.org/10.1016/j.foot.2010.04.004>.
- Squier K, Scott A, Hunt MA, Brunham LR, Wilson DR, Screen H, Waugh CM. The effects of cholesterol accumulation on Achilles tendon biomechanics: a cross-sectional study. *PLoS One*. 2021;16(9):e0257269. <https://doi.org/10.1371/journal.pone.0257269>.
- Fu Y, Huang QL. Xanthoma combined with gout infiltration of the Achilles tendon: a case report. *Clin Med Insights Arthritis Musculoskelet Disord*. 2019;12:1179544119865261. <https://doi.org/10.1177/1179544119865261>.
- Senthil L, Jambu N, Chittaranjan S. Treatment of large recurrent bilateral xanthomatosis of Achilles tendon - a case report. *J Orthop Case Rep*. 2015;5(1):11–4. <https://doi.org/10.13107/jocr.2250-0685.244>.
- Sastri V, Ravindranath VS, Metikala S, Kumar M. Bilateral xanthomas of tendons in a patient of cerebrotendinous xanthomatosis - a rare case report and review of literature. *J Orthop Case Rep*. 2014;4(4):40–3. <https://doi.org/10.13107/jocr.2250-0685.223>.
- Scott A, Zahradnik TM, Squier K, Beck C, Brunham LR. Diagnostic accuracy of ultrasound and MRI for Achilles tendon xanthoma in people with familial hypercholesterolemia: a systematic review. *J Clin Lipidol*. 2019;13(1):40–8. <https://doi.org/10.1016/j.jacl.2018.10.013>.
- Szaro P, Nilsson-Helander K, Carmont M. MRI of the Achilles tendon - A comprehensive pictorial review. Part one. *Eur J Radiol Open*. 2021;8:100342. <https://doi.org/10.1016/j.ejro.2021.100342>.
- Rodriguez CP, Goyal M, Wasdahl DA. Best cases from the AFIP: atypical imaging features of bilateral Achilles tendon xanthomatosis. *Radiographics*. 2008;28(7):2064–8. <https://doi.org/10.1148/rq.287085001>.
- Valeo M, Dalla Vedova P, Di Giorgio L, Scarno AG, Giuliani A. The conservative treatment of xanthoma of the Achilles tendon in patients affected with type IIA hypercholesterolemia. *Chir Organi Mov*. 1996;81(3):303–10.
- Alam L, Lasam G, Fishberg R. Achilles tendon xanthoma thickness and carotid intima-media thickness in a patient with heterozygous familial hypercholesterolemia on PCSK9 inhibition: a case report and literature review. *Cureus*. 2020;12(9):e10497. <https://doi.org/10.7759/cureus.10497>.
- Inazu A, Koizumi J, Kajinami K, Kiyohar T, Chichibu K, Mabuchi H. Opposite effects on serum cholesteryl ester transfer protein levels between long-term treatments with pravastatin and probucol in patients with primary hypercholesterolemia and xanthoma. *Atherosclerosis*. 1999;145(2):405–13. [https://doi.org/10.1016/s0021-9150\(99\)00088-x](https://doi.org/10.1016/s0021-9150(99)00088-x).
- Illingworth DR, Cope R, Bacon SP. Regression of tendon xanthomas in patients with familial hypercholesterolemia treated with lovastatin. *South Med J*. 1990;83(9):1053–7. <https://doi.org/10.1097/00007611-1990090000019>.
- Maffulli N, Tallon C, Wong J, Peng Lim K, Bleakney R. No adverse effect of early weight bearing following open repair of acute tears of the Achilles tendon. *J Sports Med Phys Fitness*. 2003;43(3):367–79.
- Maffulli N, Oliva F, Maffulli GD, Buono AD, Gougoulas N. Surgical management of chronic Achilles tendon ruptures using less invasive techniques. *Foot Ankle Surg*. 2018;24(2):164–70. <https://doi.org/10.1016/j.fas.2017.02.002>.
- Maffulli N, D'Addona A, Gougoulas N, Oliva F, Maffulli GD. Ipsilateral free semitendinosus graft with interference screw fixation for surgical management of insertional acute Achilles tendon tears. *Injury*. 2020;51(Suppl 3):S73–9. <https://doi.org/10.1016/j.injury.2019.11.013>.
- Oliva F, Marsilio E, Asparago G, Gaii Via A, Biz C, Padulo J, Spoliti M, Foti C, Oliva G, Mannarini S, Rossi AA, Ruggieri P, Maffulli N. Achilles tendon rupture and dysmetabolic diseases: a multicentric epidemiologic study. *J Clin Med*. 2022. <https://doi.org/10.3390/jcm11133698>.
- Maffulli N, Gougoulas N, Maffulli GD, Oliva F, Migliorini F. Slowed-down rehabilitation following percutaneous repair of Achilles tendon rupture. *Foot Ankle Int*. 2022;43(2):244–52. <https://doi.org/10.1177/10711007211038594>.
- Saxena A, Gaii Via A, Gravare Silbernagel K, Walther M, Anderson R, Gerdsmeyer L, Maffulli N. Current consensus for rehabilitation protocols of the surgically repaired acute mid-substance Achilles rupture: a systematic review and recommendations from the "GAIT" study group. *J Foot Ankle Surg*. 2022;61(4):855–61. <https://doi.org/10.1053/j.jfas.2021.12.008>.
- Smithard A, Lamyman MJ, McCarthy CL, Gibbons CL, Cooke PJ, Athanasou N. Cerebrotendinous xanthomatosis presenting with bilateral Achilles tendon xanthomata. *Skeletal Radiol*. 2007;36(2):171–5. <https://doi.org/10.1007/s00256-006-0139-8>.
- Zak A, Zeman M, Slaby A, Vecka M. Xanthomas: clinical and pathophysiological relations. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub*. 2014;158(2):181–8. <https://doi.org/10.5507/bp.2014.016>.
- Moroney PJ, Besse JL. Resection of bilateral massive Achilles tendon xanthomata with reconstruction using a flexor hallucis longus tendon transfer and Bosworth turnaround flap: a case report and literature review.

- Foot Ankle Surg. 2012;18(3):e25–28. <https://doi.org/10.1016/j.fas.2012.03.004>.
27. Saraf SK, Sharma SV. Reconstruction for xanthoma of the Achilles tendon. *Int Orthop*. 1992;16(1):37–8. <https://doi.org/10.1007/BF00182982>.
 28. Abraham E, Pankovich AM. Neglected rupture of the Achilles tendon. Treatment by V-Y tendinous flap. *J Bone Joint Surg Am*. 1975;57(2):253–5.
 29. Bosworth DM. Repair of defects in the tendo achillis. *J Bone Joint Surg Am*. 1956;38(1):111–4.
 30. Scagnelli R, Bianco G, Imarisio D. Cadaver bone-tendon graft for xanthomatosis of the tendo Achillis. *J Bone Joint Surg Br*. 2009;91(7):968–71. <https://doi.org/10.1302/0301-620X.91B7.22315>.
 31. Panman WF, Hamming JJ. Xanthoma of the Achilles tendon. *Neth J Surg*. 1986;38(5):155–7.
 32. Maffulli N. CORR Insights((R)): is dual semitendinosus allograft stronger than turnaround for Achilles tendon reconstruction? An in vitro analysis. *Clin Orthop Relat Res*. 2017;475(10):2597–8. <https://doi.org/10.1007/s11999-017-5447-x>.
 33. Maffulli N, Oliva F, Del Buono A, Florio A, Maffulli G. Surgical management of Achilles tendon re-ruptures: a prospective cohort study. *Int Orthop*. 2015;39(4):707–14. <https://doi.org/10.1007/s00264-015-2686-x>.
 34. Maffulli N, Del Buono A, Loppini M, Denaro V. Ipsilateral free semitendinosus tendon graft with interference screw fixation for minimally invasive reconstruction of chronic tears of the Achilles tendon. *Oper Orthop Traumatol*. 2014;26(5):513–9. <https://doi.org/10.1007/s00064-012-0228-x>.
 35. Maffulli N, Loppini M, Longo UG, Maffulli GD, Denaro V. Minimally invasive reconstruction of chronic Achilles tendon ruptures using the ipsilateral free semitendinosus tendon graft and interference screw fixation. *Am J Sports Med*. 2013;41(5):1100–7. <https://doi.org/10.1177/0363546513479017>.
 36. Maffulli N, Del Buono A, Spiezia F, Maffulli GD, Longo UG, Denaro V. Less-invasive semitendinosus tendon graft augmentation for the reconstruction of chronic tears of the Achilles tendon. *Am J Sports Med*. 2013;41(4):865–71. <https://doi.org/10.1177/0363546512473819>.
 37. Maffulli N, Longo UG, Gougoulas N, Denaro V. Ipsilateral free semitendinosus tendon graft transfer for reconstruction of chronic tears of the Achilles tendon. *BMC Musculoskelet Disord*. 2008;9:100. <https://doi.org/10.1186/1471-2474-9-100>.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

