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Treatment of midportion Achilles tendinopathy: an evidence-based overview

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Abstract In Achilles tendinopathy, differentiation should be made between paratendinopathy, insertional- and midportion Achilles tendinopathy. Midportion Achilles tendinopathy is clinically characterized by a combination of pain and swelling at the affected site, with impaired performance as an important consequence. The treatment of midportion Achilles tendinopathy contains both non-surgical and surgical options. Eccentric exercise has shown to be an effective treatment modality. Promising results are demonstrated for extracorporeal shockwave therapy. In terms of the surgical treatment of midportion Achilles tendinopathy, no definite recommendations can be made.
Level of evidence IV.

Keywords Achilles tendinopathy · Treatment · Conservative · Surgical

Introduction

In Achilles tendinopathy, differentiation should be made between paratendinopathy, insertional- and midportion Achilles tendinopathy [98]. Midportion Achilles tendinopathy is located 2–7 cm proximal of the Achilles insertion onto the calcaneus. Clinically, it is characterized by a combination of pain and swelling at the affected site, with impaired performance as an important consequence.

The treatment of midportion Achilles tendinopathy contains both non-surgical and surgical options. The initial treatment consists of non-surgical management, but in approximately 25 % of the patients, a surgical intervention is still required [38, 44, 47]. Regarding non-surgical treatment, several rehabilitations protocols have been developed, with excellent results. Nevertheless, the treatment of midportion Achilles tendinopathy remains challenging. Over the years, many alternative treatment options have been developed. Although there is a lot of literature available, the strength of the evidence is often low. This review will provide an evidence-based overview of the current options in midportion Achilles tendinopathy. This overview may be useful for physicians to make evidence-based decisions in the treatment of Achilles tendinopathy.

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Non-surgical non-invasive treatment

The initial treatment for midportion achilles tendinopathy is conservative. Activity adaptation or cessation, in the early phase sometimes with the use of NSAIDS, is often combined with specific training regimes and orthoses to distribute the peak forces on the Achilles tendon. Although commonly administered, the possible healing effect of NSAIDs is modest at best and is not supported by the literature [7] The positive (short term) effect may only lie in its analgesic effect. Regarding activity adaptation or cessation, a study showed allowing continued activity in terms of running and jumping but limiting the amount by the use of a pain-monitoring model is not detrimental for recovery [85]. Eccentric exercises are the mainstay of a prolonged rehabilitation programme [5, 20, 23, 49, 79–81, 104] (Table 1).

Eccentric and concentric training

A range of randomized trials and meta-analyses thereof have evaluated different eccentric training regimes showing

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beneficial effects. In general, a twelve-week programme is advocated, in which an eccentric exercises programme is developed under supervision of a physical therapist [5, 49, 50, 62, 65, 75, 87]. In addition, six-week programmes have also shown to be beneficial; however, this is a much less studied exercise programme [81]. The current literature on eccentric loading for midportion tendinopathy is graded as strong [82], with consistent statistically significant findings favouring eccentric loading over a night splint, deep friction massage, ultrasound, concentric loading or a wait and see policy [33, 80, 81]. Long-term results are good with some mild residual pain complaints [96]. Recently, the focus has again been shifted to a more pragmatic training regime: a combination of eccentric and concentric exercises [31, 105]. Previous work concluded that concentric was less effective; however, some studies showed good results [76]. This pragmatic regime is generally preferred as the exercises are performed more easily and can be advised in case of bilateral Achilles tendinopathy [58]. Studies evaluating this combination show promising results [31]; however, as some study concluded inferior results, this should be further analysed in the near future [82, 103].

Extracorporeal shock wave therapy

A randomized trial added shock wave therapy (ESWT) to an eccentric loading regime, showing superior results compared to a solitary eccentric loading regime [79]. Other studies have shown beneficial effects of ESWT predominantly in women, and improved outcome after previous non-surgical therapy had failed [28, 53].

The pathway of effect of both eccentric exercise and ESWT remains somewhat of a mystery [78]. Eccentric loading is known to induce a normalization of tendon structure with reduction of neovascularization, albeit it is unknown how this is achieved. For ESWT, the effect may lie in its disturbance of sensory nerve fibres and changes in dorsal root ganglia inducing a decrease of pain sensation. Healing responses may be further induced by changes in transforming growth factor-beta1 (TGF-B1), insulin-like growth factor-1 (IGF-1) and cavitation; however, this has only been studied in animal research.

Other non-surgical treatment options

Deep friction massage has been proposed to aid in the recovery of tendinopathy, but no evidence exists that evaluate the effectiveness of joint mobilization and/or soft tissue massage for midportion Achilles tendinopathy [11]. Stretching of the calf muscles is often recommended for patients with symptoms of the Achilles tendon. The purpose of stretching is to increase muscle–tendon length, reduce stiffness and increase the joint range of motion. Only one study has evaluated the effectiveness of stretching compared with eccentric exercise in patients with Achilles tendinopathy. Both treatment groups improved; however, no ankle range of motion measuring was performed [61]. Research is needed to evaluate whether and which patients benefit from stretching. Tape has been used for long time in patients with Achilles tendinopathy; however, no single study has reported on the effect. One study reported no beneficial effect of the use of kinesio tape (elastic therapeutic

Table 1 Overview of non-surgical non-invasive treatment options

	Level of evidence	
Strong evidence supporting use in treatment of midportion Achilles tendinopathy		
Eccentric exercise	Multiple level I studies	
Moderate evidence		
ESWT	Multiple level I studies	
Limited evidence		
Iontophoresis	One level I studies	Beneficial in one study
Stretching	One level I studies	Beneficial in one study
GTN	>One level I studies	Conflicting results
Low-level laser	>One level I studies	
No evidence		
Therapeutic US	One level I studies	Only RTC no benefit
Night splints	>One level I studies	No benefit in multiple studies
NSAIDs	One level I studies	Only RTC no benefit
Taping	Level IV studies	
Cryotherapy	Level IV studies	
Deep fraction massage	Level IV studies	
Orthosis	Level IV studies	
Heel lifts	Level IV studies	

ESWT extracorporeal shockwave therapy, *GTN* topical glycerine trinitrate, *Therapeutic US* therapeutic ultrasound

skin tape) [24]. Decreasing the amount of strain on the tendon by using heel lifts is commonly used; however, evidence is limited. Also, for the beneficial effects of orthotics is limited evidence [82]. One study showed physiotherapy and semirigid insoles to reduce pain after four weeks [57]. The use of night splints, whether or not in addition to eccentric exercise, for treatment of midportion Achilles tendinopathy, has not demonstrated to be of additional benefit [20, 21, 81]. Two systematic reviews support the effect of low-level laser therapy in patients with Achilles tendinopathy [89, 95]. Especially in combination with eccentric exercise, LLLT was showed to be beneficial [88]. It is suggested that therapeutic ultrasound may enhance tendon healing, although other studies did not show positive results of therapeutic ultrasound over placebo for tendinopathy [77, 97]. In the only clinical study on Achilles tendinopathy, a pilot study, both eccentric exercise and therapeutic ultrasound showed acceptable short-term results with no adverse events [14]. Conflicting evidence exists on the use of glyceryl trinitrate patches. A randomized trial and follow-up showed better results in patients treated with glyceryl trinitrate [69, 70]. However, in another trial, no superior results of topical glyceryl trinitrate were found [36]. Little evidence exists on the use of iontophoresis. However, in a randomized controlled trail, iontophoresis with dexamethasone has been shown to be of benefit for patients with Achilles tendinopathy [60].

Injections

Corticosteroid injections

The use of corticosteroid injections is controversial. Although corticosteroid injections are a commonly used treatment for chronic tendinopathies, the rationale for the use of anti-inflammatory injections in Achilles tendinopathy is debated [84]. The injection of corticosteroids around weight-loaded tendons is associated with an increased risk of tendon ruptures [6, 13, 51], although the evidence is not strong. Other studies did not report an increased risk [15, 26, 74]. A recent systematic review concluded that there is no significant evidence to draw any conclusions on the positive effect of local corticosteroid treatment in patients with midportion Achilles tendinopathy [50]. Together with the commonly assumed risk of tendon rupture, the use of corticosteroid injections is not recommended.

High-volume injections

The rationale of high-volume injections lay in its local mechanical effects, causing neo-vessels to stretch, break or occlude. The disruption of these vessels would also damage the accompanying nerve supply, either by trauma or ischaemia, and therefore decrease symptoms [12]. Preliminary studies have shown that a high-volume injection with normal saline, local anaesthetic and corticosteroid can significantly reduce pain and improve short- and long-term function in patients with Achilles tendinopathy [12, 33, 34, 38–40, 46–49]. A recent study used aprotinin instead of hydrocortisone acetate resulting in significant improvement of the VISA-A score at one year follow-up, as well as a relatively high rate of return to sport. [45].

Sclerosing agents (Polidocanol)

Sclerosing therapy for chronic Achilles tendinopathy is based on the hypothesis that the process of neovascularization in the affected tendon is the source of the patient's pain. Some studies have implicated neovascularization as a possible (indirect) cause of symptoms in Achilles tendinopathy. These findings led to the hypothesis that the destruction of the vessels and accompanying nerves might lead to pain relief [3, 65].

A sclerosing agent is injected under ultrasound- and colour Doppler-guidance into the neovascularization in the anterior area outside the tendon. Retrospective case series with relatively short follow-up demonstrated promising clinical results [2, 42, 63, 64, 86]. However, the largest and most recent retrospective series included 53 tendon injections in patients with midportion Achilles tendinopathy. Only 44 % of the tendons were painless or minimally painful at 6 weeks following treatment, and 53 % of the treated tendons had undergone additional non-operative or surgical treatment [99]. Prospective comparative studies involved small numbers of patients: Polidocanol injections were superior to Lidocaine injections [3], and similar results were found when compared with patients undergoing mini-open surgery [4].

Protease inhibitors (Aprotinin)

Aprotinin is a broad-spectrum protease (including matrix metalloproteinase (MMP)) inhibitor. Initially, it was indicated for open heart and liver surgery to reduce blood loss. It is suggested that by inhibiting the enzymes that break down or degrade tendons, the healing response may be promoted. However, the clinical results of aprotinin injections have been conflicting. Aprotinin appears to have effect for patellar tendinopathy [10], whereas a prospective randomized controlled trial by Brown et al. [9] failed to show any significant benefit over placebo in patients with Achilles tendinopathy. The same group of authors subsequently reported successful treatment of non-insertional Achilles tendinopathy in a non-randomized study [66]. After studies associated aprotinin with an increased risk of complications

or death it was permanently withdrawn in May 2008, except for very restricted research use [52].

Hyperosmolar dextrose

Prolotherapy is based on the concept of creating irritation or injury to stimulate healing of a ligament. Hyperosmolar dextrose is said to initiate a local inflammatory response, causing fibroblast proliferation and subsequent collagen production, although the evidence for this is scant [27]. Dextrose acts by causing an osmotic shock to cells leading to the release of pro-inflammatory substances. Several studies have shown increased ligament mass and thickness after repeated prolotherapy injections [16, 50, 54, 56, 62, 64]. In an uncontrolled pilot study, Maxwell et al. [56] retrospectively analysed 33 patients with midportion and/or insertional Achilles tendinopathy and found that hyperosmotic injections yield good results in pain reduction in both rest and during activity.

A recent randomized clinical trial showed that combination of eccentric exercise with prolotherapy provides rapid improvements compared to eccentric exercise alone, but the long-term VISA-A scores were similar [104].

Low-dose heparin

Low-dose heparin has been used in the management of Achilles tendinopathies with the aim of limiting the formation of adhesions. However, there is no evidence for beneficial effect [38, 39, 64], and it has even been suggested that heparin, in itself, can *cause* degenerative tendinopathy in rats [91].

Deproteinized haemodialysate

Pförringer et al. [73] performed a double-blind, placebo-controlled trial to assess the effect of deproteinized haemodialysate, a filtered extract from calf blood. There was a significant reduction of tendon diameter and a reduction of pain as regards activity. No adverse effects were observed, though the follow-up was short.

Autologous blood

Autologous blood injections are increasingly popular treatment option for tendinopathy. A recent systematic review of these studies concluded that there were no advantages in using autologous blood products in patients with tendinopathies [18]. The proposed mechanism of action is that the cytokines and growth factors within the injected blood help to stimulate tissue healing and production of type 1 collagen [35].

Hitherto, only two randomized controlled trials are conducted in which peritendinous autologous blood injections added to a standard eccentric training programme were compared with eccentric training alone. Both studies showed no additional benefit for autologous blood injections [8, 72].

Platelet-rich plasma

Platelet-rich plasma (PRP) is a bioactive component of autologous whole blood, which produced by the centrifugation of whole blood, yielding a concentration of platelets greater than baseline levels. The use of PRP has become widespread in different areas of orthopaedics and sports medicine. Theory behind the use of PRP is to enhance the process of tissue repair through the delivery of bioactive agents to provide chemotactic, proliferative and anabolic cellular responses and ultimately tissue function [25, 32].

Case series showing promising outcomes in patients with midportion Achilles tendinopathy has been published [29, 59, 67]. However, the only level one study regarding the use of PRP for chronic Achilles tendinopathy by de Vos et al. [17, 19] did not show any difference between exercises (standard care) combined with either a PRP injection (PRP group) or saline injection (placebo group) Also, at one year follow-up, the PRP group showed no clinical and ultrasonographic superiority compared with the control group. Caution is warranted when comparing different PRP studies. In literature, different types of PRP or PRP-derived products have been used, with a variety of platelet concentrations, inclusion of leucocytes, the use of anticoagulant and the use of activating agents (Table 2).

Surgical treatment

There is no high-level evidence on the surgical treatment. Literature on this topic consists of, mostly retrospective, case series often with small sample sizes. Surgical treatment for midportion Achilles tendinopathy is indicated after failure of appropriated non-surgical treatment, generally after a period of nonsurgical treatment of at least 6 months. Other factors associated with surgery are increased patient age, prolonged duration of symptoms and the presence of degenerative changes in the Achilles tendon [68]. Paavola et al. [68] reported that 29 % of the patients required surgical intervention. Contraindications to surgery include arterial insufficiency, active skin infection, poor soft tissue envelope and medical comorbidities that may increase the risk of surgical complications.

Over the years, different surgical procedures are described. Historically, surgical procedures consisted of debridement of degenerative nodules and fibrotic adhesions, with or without tenotomies to initiate neoangiogenesis in the tendon and so stimulate the healing response. Based on the theory, ingrowth of neovessels and accompanying nerves at

Table 2 Overview of injectable treatment options for midportion Achilles tendinopathy

Injection type	Substance	Level of evidence	+/−	Conclusion
Corticosteroid injections	Triamcinolone methylprednisolone	Two RCTs, several case series	− Conflicting outcomes − Possible risk on ruptures	Use should not be recommended
High-volume injections	Normal saline hydrocortisone aprotinin	No RCTs, several case series	+ Promising results − Limited evidence	No definitive conclusion possible
Sclerosing agents	Polidocanol	Three RCTs, several case series	+ Promising results in small RCTs − Small sample-size RCTs − Conflicting outcomes	No definitive conclusion possible
Protease inhibitors	Aprotinin	One RCT, some case series	− RCT has shown no benefit over placebo − Withdrawn after the suggestion of severe complications	No role in clinical practice
Prolotherapy	Hyperosmolar dextrose	One RCT, some case series	+ Promising short-term results − Limited evidence	No definitive conclusion possible
Anticoagulants	Low-dose heparin	One RCT	− Small sample size − No difference in comparison with placebo	No definitive conclusion possible
Haemodialysate	Deproteinized haemodialysate from calf blood (Actovegin®)	One RCTs	+ Promising short-term results − Limited evidence	No definitive conclusion possible
Autologous blood	Autologous whole blood	Two RCT	− No significant clinical effect	No definitive conclusion possible
	Platelet-rich plasma	One RCT, several case series	− No significant clinical effect	No definitive conclusion possible

Table 3 Overview of surgical techniques for midportion Achilles tendinopathy

Surgical technique		Rationale	Level of evidence
Open debridement			Level VI studies
	With stripping of paratendon		
	Without stripping		
Percutaneous tenotomies		Initiate neongiogenesis to stimulate healing response	Level VI studies
Minimally invasive tendon stripping		Denervation of the diseased tendon	Level VI studies
Mini-open "scraping"		Denervation of the diseased tendon	Level VI studies, one Level II (poor quality RCT)
Endoscopic debridement		Denervation of the diseased tendon	Level VI studies
Plantaris tendon release		Denervation of the diseased tendon	Level VI studies
Gastrocnemius recession		Unloading of diseased tendon	Level VI studies

the anterior aspect of the tendon are the presumable cause of pain, denervation of the diseased tendon. The technique used for operative management of tendinopathy depends on the stage of the disease and preference of the surgeon. Local degeneration and thickening are usually treated by excision and curettage. An insufficient Achilles tendon due to extensive degeneration can be reconstructed. Isolated paratendinopathy can be treated by excision or stripping of the affected paratendon (Table 3).

Open debridement

Open surgery consisted of a tenotomy with debridement of abnormal tissue degenerative nodules and fibrotic adhesions, with [41] or without stripping of the paratendon [40].

Usually, the tendon is even after thorough debridement strong enough. In case more than 50 % of the tendon is debrided, augmentation of the tendon using the FHL tendon is recommended [102].

The only systematic review on surgical treatment for midportion Achilles tendinopathy was published in 2001 [90]. The success rate varied widely; however, the mean success rate was 77 %. The outcome of this review should be interpreted with caution, since an inverse relation between study quality and outcome had been shown. Maffulli et al. [48], however, reported that only 36 % had good results after open debridement procedures.

Percutaneous tenotomies

Testa et al. [93] described a technique of percutaneous longitudinal tenotomy in which multiple, ultrasound-guided and percutaneous incisions are made through the diseased areas of the Achilles tendon. In their series, they described up to 75 % good to excellent results, even on the long term [46, 92].

Minimally invasive tendon stripping

Longo et al. [43] described a minimally invasive technique in which they used a large diameter suture to free the Achilles tendon from adhesions in the pre-Achilles fat pad. This technique is based on the precept that the process of neovascularization in the damaged tendon is the source of symptoms; however, no clinical results are published to date.

Mini-open "scraping"

Alfredson et al. [4] introduced a mini-open US and Doppler guided scraping technique based on the relationship between vessels and nerves on the ventral side of the Achilles tendon. In a region of degenerative changes and with a high blood flow, the tendon was completely released from the soft tissue. In addition, the plantaris tendon was frequently released. Good clinical outcomes were reported for this technique [83]. In a randomized controlled trial, the results for polidocinol injections and mini-open scraping technique were similar. In addition, in another randomized trial, no difference was found between mini-open scraping and a percutaneous approach using a needle [1].

Endoscopic debridement

To achieve faster recovery and less postoperative complications, endoscopic techniques have been developed. Steenstra and van Dijk were the first to describe an endoscopic technique to release the paratenon and debridement of the tendon. Good results have been described after endoscopic surgery although series are small and the follow-up is short [54, 55, 71, 94]. The main advantage of this technique is the quick recovery. Return to sport activities takes average 6–8 weeks compared to 5–6 months with tenotomy techniques.

Plantaris tendon

Van Sterkenburg and van Dijk [101] addressed the possible role of the plantaris tendon in midportion Achilles tendon. Small series demonstrated promising results after plantaris tendon release [71, 100].

Another new approach is gastrocnemius recession, first described by Gentchos et al. [30]. Lengthening of the gastrocnemius muscle was thought to decrease the load on the tendinopathy area and relief symptoms [22, 37].

Conclusion

The most important finding of the present study was the large amount of available literature on treatment of midportion Achilles tendiopathy. The level of evidence of these studies, however, is mainly low. Only for eccentric and concentric exercise, there is strong evidence and is therefore recommended as treatment of first choice in patients with midportion Achilles tendinopathy. For the use extracorporeal shockwave therapy, promising results are reported. Regarding other treatment modalities, more high-level studies are required to make definite recommendations.

Limitation of this study is that it only gives a qualitative overview of the available literature. To actually compare outcomes of the different treatment modalities, a more quantitative evaluation is required.

Concerning the non-surgical management, eccentric-concentric exercise has proven to be an effective treatment modality. Promising results are demonstrated for extracorporeal shockwave therapy in several studies. For all other non-surgical treatment options, evidence is too limited to make reliable recommendations. In terms of the surgical treatment of midportion Achilles tendinopathy, no definite recommendations can be made.

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