Hindfoot pain

Terminology, treatment and outcome

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Kim Theresia Maria Opdam

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1 General introduction

We are built to move, however in daily life we have become less active with a more sedentary lifestyle. Over one-third of the world's population is overweight or obese and this has become a major health problem. Worldwide the prevalence rates of overweight and obesity have almost doubled since 1980. [1] Therefore, keeping fit is very important for physical health and for mental health. [2] In today's society there is a wide variety in the way of participating in sports. This can be in the gym, a running group or even online lessons at home. In this "keep-fit culture" the endurance sports such as running and triathlons have become very popular. However, the combination of a sedentary lifestyle during the week and excessive training in the weekends is a recipe for overuse injuries.

When participating in sports, we often expose our lower extremities to stress. Reported incidence rates of foot and ankle overuse injuries per 1000 athletes per year range from 17 to 380. [3] The highest incidence is reported in running and dancing and the highest prevalence is reported in triathlon. [3] Out of all sports injuries 30-50% are tendon injuries. [4] One of the main general running-related musculoskeletal injuries is Achilles tendinopathy, but it is also one of the most common in ultra-marathon related musculoskeletal injuries. [5] In the recreational athletes, the under loaded Achilles tendon is not exposed to adequate levels of physiological stress during the week and can become unable to cope with the increased demands in the weekends. This may result in an imbalance between tendon healing and tendon degeneration, however in competitive athletes this imbalance is often due to the constant repetition of the same movement. [6, 7] Regarding chronic Achilles tendon problems, the most common clinical diagnosis is mid-portion tendinopathy followed by insertional problems such as retrocalcaneal bursitis and insertional spurs or calcifications. [8]

For Achilles tendon-related problems, this thesis focuses on terminology of Achilles tendon related disorders, outcome of endoscopic treatment on mid-portion Achilles tendinopathy and retrocalcaneal bursitis, and on a patient-reported outcome measure specific for Achilles tendon ruptures. Of the wide variety in causes of hindfoot pain two other issues are addressed in this thesis: the accuracy of an injection technique and treatment outcome on flexor hallucis longus (stenosing) tenosynovitis and the effect of corticosteroid injections on pain reduction in posterior ankle impingement syndrome.

MID-PORTION ACHILLES TENDINOPATHY

Mid-portion Achilles tendinopathy is frequently seen with an incidence rate of 1.85 per 1.000 registered patients in Dutch general practices per year and with an incidence rate of 2.35 per 1.000 in the adult population (21–60 years) per year. [9] The aetiology remains unclear and many intrinsic and extrinsic factors have been implicated such as: tendon vascularity, gastrocnemius-soleus dysfunction, age, sex, body weight and height, pes cavus, and lateral ankle instability, changes in training pattern, poor sports technique, previous injuries, footwear and environmental factors such as training on hard, slippery or slanting surfaces. [10]

Mid-portion Achilles tendinopathy is a clinical diagnosis characterized by pain and swelling located at 2-7 cm from the insertion onto the calcaneus, and stiffness especially when getting up after a period of rest often combined with impaired performance. [8] Swelling can be diffuse or localized. On clinical examination palpation of the nodular thickening gives recognizable pain. The pain is mostly on the anteromedial side of the Achilles tendon. There are different theories about the cause of pain. It is theorized that the cause is the peritendineum or tendon proper or both. Intratendinous degeneration and nodular thickening of the Achilles tendon without appropriate healing can be the cause of pain or the neovascularizations and accompanying ingrowth of nerve fibres in combination with the adhesions from the plantaris tendon to the Achilles tendon. [11-13]

Achilles tendinopathy and paratendinopathy often co-exist. The Achilles tendon lacks a synovial sheath but has a paratenon between the tendon and the crural fascia. [14] Between the paratenon and the Achilles tendon lies the epitenon. In isolated paratendinopathy, there is local thickening of the paratenon. This can be acute or chronic. In acute isolated paratendinopathy, the tendon glides within the inflamed covering and this results in peritendinous crepitation. [14] At clinical examination, areas of local heat, erythema and palpable nodules or defects in the tendon can be present. In chronic Achilles paratendinopathy, the pain that increases with activities is still present while crepitation and swelling diminish. Also, the area of swelling does not shift when the ankle is moved. [8]

In mid-portion Achilles tendinopathy, ultrasound can reveal typical findings as enlarged tendons, hypoechoic and hyperechoic lesions within the tendon. Power Doppler imaging can show neovascularizations. [15] MRI provides visualization of the pathologic conditions of the tendon tissue and peritendinous structures. [13]

The main conservative treatment options offered to patients with mid-portion Achilles tendinopathy are wait-and-see, exercise therapy, injections, shockwave therapy, orthosis and medication. [16, 17] After six months of conservative treatment without improvement, surgical treatment is indicated. Due to the limited understanding of the exact pathophysiology there is a variation in operative techniques. Most studies show good results for a single evaluated procedure: tenotomies have been performed to improve the healing process of the Achilles tendon. Also, Achilles tendoscopy can be performed with release of the paratenon combined with a resection of the plantaris tendon which reliefs symptoms by denervation. [12, 18, 19] It is known that minimally invasive and endoscopic procedures have lower complication rates with similar patient satisfaction compared to open procedures. [19] However, it is important to know the outcome of endoscopic procedures to compare this to other operative techniques on mid- to long-term.

RETROCALCANEAL BURSITIS

Retrocalcaneal bursitis is an inflammation of the bursa between the superoposterior aspect of the calcaneus and ventral side of the Achilles tendon. It is caused by repetitive compression resulting

in painful swelling, medial and lateral to the Achilles tendon at the level of the posterosuperior calcaneal prominence. [8] There is onset of pain near the insertion of the Achilles tendon when restarting to walk after a period of rest.

By history taking and physical examination the correct diagnosis can be made. A conventional lateral radiograph should be made and a posterosuperior calcaneal prominence can be identified. The retrocalcaneal bursa is situated in the posteroinferior corner of the pre-Achilles fat pad, which is an adipose tissue mass occupying the Kager's triangle. [20] The Kager's triangle is a sharply marginated radiolucent triangle seen posterior on lateral radiographs of the ankle. In case of a retrocalcaneal bursitis the posterior angle of the Kager's triangle is obliterated because the fluid-filled bursa is less radiolucent, making it difficult to delineate the retrocalcaneal recess. [20, 21] In case of uncertainty regarding the diagnosis, an ultrasound or MRI can be performed. Ultrasound shows a hypoechogenic bursal fluid collection and MRI shows a bursal fluid collection and bursal extension. [22]

Conservative treatment includes orthotics, avoidance of tight shoes, activity modification, use of padding, physical therapy, non-steroidal anti-inflammatory drugs and corticosteroid injections. [23] If conservative treatment fails, surgical treatment can offer a solution. There is a wide variation of surgical techniques that have proven to be effective. [24] These procedures can be open or minimally invasive. [25-27] Open procedures consist of osteotomies or excision of excessive bone with a variation of approaches. The minimally invasive procedure, termed endoscopic calcaneoplasty, was first described by van Dijk et al. in 2001. [28] In experienced hands, the endoscopic technique is superior to open techniques regarding patient satisfaction and complication rates. [24] However, mid- to long-term results of endoscopic calcaneoplasty are not yet reported.

ACHILLES TENDON RUPTURE

The Achilles tendon consists of the fibres of the soleus muscle and gastrocnemius muscle and is the strongest, longest and thickest tendon in the human body. [29] However, the Achilles tendon is also the most frequently ruptured tendon in the human body with an increasing incidence and is most occurring during sports activities in men ages 30 to 40 years. [30, 31] The aetiology is still unknown. The injury can be the culmination of the degenerative process or it is due to a sudden overload on the Achilles tendon itself. [32] When rupturing the patient can notice a loud "pop" or "snap" and experiences pain and swelling. [31]

On physical examination a gap can be palpated. The Simmonds-Thompson test is the clinical reference standard. This test is positive when the physical response to calf squeezing is aberrant were the foot fails to plantar flex caused by the lack of continuity of the Achilles tendon, indicative of a rupture. [33]

When in doubt, an ultrasound can be made. [31] On ultrasound a focal lucency is seen in the tendon with a small amount of fluid surrounding the tendon. In patients with a rupture a gap

is visible in dorsiflexion. In plantarflexion juxtaposition of the stumps can be assessed. A lateral radiograph can be helpful in case of an avulsion rupture. MRI should be considered if ultrasound is unavailable or equivocal. [31]

There is still no agreement on the best available treatment for Achilles tendon ruptures. The treatment can be surgical or nonsurgical. [34] Outcome studies evaluating the various treatment options were aimed at assessing objective measures, such as surgeons' assessment of range of motion. In addition to evaluate treatment results, the outcome from patients' perspective on health outcomes should be assessed by a patient-reported outcome measure.

FLEXOR HALLUCIS LONGUS (STENOSING) TENOSYNOVITIS

Flexor hallucis longus (FHL) tenosynovitis is relatively unknown in the general population. It is more common among athletes that perform repetitive forefoot push-offs and extreme plantar flexion, such as runners and ballet dancers. FHL tenosynovitis often coexists with other pathology such as posterior ankle impingement syndrome (PAIS) and therefore the prevalence may even be higher due to the lack of recognizing FHL tenosynovitis next to PAIS. [35]

Retromalleolar pain at the posteromedial side is experienced. When the hallux is flexed and the ankle extended in 10-20 degrees of plantar flexion, the FHL glides up and down through a sliding channel located behind the medial malleolus and is enclosed by a flexor retinaculum at the level of the talar process. In hyperdorsiflexion of the hallux and ankle, the muscle belly can be pulled into this sliding channel and this can lead to tenosynovitis. In case of (stenosing) tenosynovitis crepitus, pain or nodules can be felt on palpation.

Conservative treatment consists of rest, icing, modification or restriction of activities, NSAIDs, physical therapy, steroid injections and orthosis. [36, 37] Studies have reported on image-guided injections, but the accuracy of blind injection has not yet been studied. Furthermore, it is unclear what kind of conservative treatment protocols exist and to what extent conservative treatment is effective. If conservative treatment fails there are open, minimally invasive and endoscopic approaches for release of the FHL. [38-40] A systematic review of the conservative and operative treatment options would give a clear overview of available techniques and outcomes thereof.

POSTERIOR ANKLE IMPINGEMENT SYNDROME

Posterior ankle impingement syndrome (PAIS) is a pain syndrome whereby pain at the posterior aspect of the ankle is experienced during forced plantarflexion. It is important to differentiate PAIS from Achilles tendon pathology. PAIS can be caused by overuse or trauma often in combination with an anatomical anomaly such as an os trigonum or a hypertrophic posterior talar process. [41]

PAIS is common in ballet dancers and runners due to the repetitive hyperplantarflexion that results in extreme compression of the posterior structures of the ankle. [42]

On physical examination there is pain on palpation of the posterior aspect of the talus. A positive passive forced plantar flexion test in combination with pain on posterolateral palpation is suggestive for PAIS. The diagnosis is confirmed if the pain disappears after injection of the capsule between the posterior talar process and the posterior edge of the tibia with Xylocaine.

As diagnostic a standard lateral radiograph can be made. However, the posterior impingement (PIM) view, a lateral 25-degree external-rotation oblique view of the ankle, is superior for the detection of an os trigonum. [43] Additional assessment can be done with CT, MRI or technetium bone scanning.

In the literature, mainly outcomes of surgical treatment are described while a period of conservative treatment is recommended first. Operative treatment involves removal of the hypertrophic tissue and/or excision of the os trigonum or removal of a hypertrophic posterior talar process. These procedures can be done by open surgery or hindfoot endoscopy. [44] Conservative treatment consists of modification of activities (e.g. correction of dance technique), physical therapy (e.g. stretching, muscles strengthening), icing, NSAIDs and injection of steroids. [45] However, reports on the effect of corticosteroid injection therapy on pain are lacking.

PATIENT-REPORTED OUTCOME MEASURES

Nowadays there is a trend from volume-based to value-based health care. [46, 47] Patient-reported outcome measures (PROMs) measure patients' perspectives on health outcomes and are more and more used in health care. They are an addition to evaluate results in health care in the evaluation of the treatment of patients in clinical practice. In foot and ankle disorders there is a wide variety of PROMs used. The most commonly used PROMs are the Foot Function Index (FFI), the Foot and Ankle Outcome Score (FAOS) and the Foot and Ankle Activity Measure (FAAM). [48, 49] Besides the generic PROMs it is important to have disease specific PROMs that are sensitive to detect changes in health or functional status that are related to a given disease, for example the Victorian Institute of Sport assessment for the Achilles tendon (VISA-A) for Achilles tendinopathy. [50]

For Achilles tendon ruptures a disease specific PROM can help to refine surgical indications and improve shared decision-making especially since there is still no consensus about the best treatment option, namely operative or conservative treatment.

In 2007, a new patient-reported outcome measure specific for Achilles tendon ruptures was developed: the Achilles tendon Total Rupture Score (ATRS). It is a self-administered questionnaire evaluating symptoms and physical activity after treatment for an Achilles tendon rupture and is validated in several languages. [51] Subjective scoring systems can be used in all countries after translation and validation for specific language and population. To date, no Dutch PROM is validated for Achilles tendon ruptures specifically. Since there is a lack of a validated Dutch instru-

ment for measuring outcome related to symptoms and physical activity after treatment of Achilles tendon ruptures specifically, there is a need for a validated translation of the ATRS in Dutch.

AIM AND OUTLINE OF THIS THESIS

The aim of this thesis is to provide insight into terminology use, treatment and outcome of different causes of hindfoot pain.

Clear and uniform terminology is necessary for proper assessment, treatment and also for clarity in research. However, terminology of Achilles tendon and related disorders is inconsistent and confusing. Over the years, many have to address this issue resulting in numerous eponyms and classifications by location or pathology. The aims of **Chapter 2** are to evaluate the current terminology in daily practice and in literature and assess the influence of the latest proposal on the current terminology used for Achilles tendon related disorders.

The aetiology of mid-portion Achilles tendinopathy remains unclear and due to this limiting understanding there is a variation in operative techniques. The aim of **Chapter 3** is to evaluate the mid- to long-term results of endoscopic treatment, by a release of the paratenon combined with a partial resection of the plantaris tendon, in patients affected by mid-portion Achilles tendinopathy regarding patient satisfaction, functional outcome and pain scores.

Minimally invasive treatment is preferable compared to open treatment, and has proved to cause less postoperative complications, to facilitate shorter rehabilitation and quicker return to sport. In **chapter 4** the degree of patient satisfaction at a minimum of five years follow-up after endoscopic calcaneoplasty is determined. It was hypothesized that there is a high patient satisfaction and good functional outcome after endoscopic calcaneoplasty of retrocalcaneal bursitis on the long-term.

Chapter 5 reviews the currently available literature for treatment of FHL (stenosing) tenosynovitis with the aim to provide an overview of the different treatment options as well as an analysis, evaluation and comparison of their outcomes. Historically FHL (stenosing) tenosynovitis has been treated using corticosteroid injections into the FHL tendon sheath. In the literature injections of the tendon sheath are always performed with imaging guidance. In **chapter 6** it is hypothesized that a blind injection technique into the FHL tendon sheath based on only clinical examination can be performed with high accuracy.

In daily practice corticosteroid injection are commonly used for PAIS. Ballet dancers are among the population that is most affected by PAIS. It is important for them to know what the outcome is after injection regarding to the effect on pain, duration of the effect and time to return to dance. The aim of **chapter 7** is to evaluate the effect of corticosteroid injections on pain reduction in ballet dancers with PAIS.

PROMs have become more important in the transition from volume-based to value-based health care and they have become a cornerstone for the evaluation of treatment in clinical setting and in research. The ATRS is a PROM for outcome and assessment of an Achilles tendon rupture and is

validated in many languages, including English, Turkish, Persian, Norwegian and Greek.[51-56] The aim of **chapter 8** is to translate the ATRS to Dutch and evaluate its reliability and validity in the Dutch population.

In **chapter 9**, the findings presented in this thesis will be discussed and future perspectives on the research topics will be considered.

Summaries of this thesis in English and Dutch are presented in **chapter 10**.

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2 Increasing consensus on terminology of Achilles tendon-related disorders.

K.T.M. Opdam
R. Zwiers
J.I. Wiegerinck
C.N. van Dijk
Ankleplatform Study Collaborative – Science of Variation Group

Knee Surgery, Sports Traumatology, Arthroscopy 2021

ABSTRACT

Purpose: Aims of this study are to evaluate the current terminology and assess the influence of the latest proposals on the terminology used for Achilles tendon-related disorders in both daily practice and literature.

Methods**:** (1) All orthopaedic surgeons experienced in the field of foot and ankle surgery of the Ankleplatform Study Group were invited to participate in this survey by email. They were requested to fill out a survey on terminology in six typical cases with Achilles tendon-related disorders. (2) A systematic literature search of Achilles tendon-related disorders was performed in eight foot and ankle journals in Medline, Embase (Classic) from 2000 to 2016. All extracted terms were counted and compared to the terminology proposals, based on anatomic location, symptoms, clinical findings and histopathology.

Results: (1) In total, 141 of the 283 (50%) orthopaedic surgeons responded to the survey. In five out of six cases with Achilles tendon-related disorders, the majority gave an answer according to latest proposals. (2) An overview of terminology used for Achilles tendon-related disorders from 2000 to 2016 show an increase in use of terminology according to the latest proposals based on anatomic location, symptoms, clinical findings and histopathology.

Conclusion: The revised terminology for Achilles tendon-related disorders based on anatomic location, symptoms, clinical findings and histopathology is used by the majority of orthopedic surgeons and is increasingly used in literature. However, the indistinct Haglund eponyms are still frequently used in Achilles tendon-related terminology.

INTRODUCTION

Several Achilles tendon-related disorders can be distinguished and for each pathology different definitions and terms or eponyms arose over time. As a result, the terminology for Achilles tendon-related disorders is inconsistent and confusing [8, 17].

Initially terms were used such as "cellulite peritendineuse", "tendinitis Achillae traumatica", "paratendinitis", "tenosynovitis" and "peritendinitis" [10, 18]. The term 'achillodynia' was introduced as a descriptive term for Achilles tendon-related pain [1]. Subsequently terms were based on histological findings and a subdivision was made into insertional and non-insertional Achilles tendon problems [7, 14, 16]. Maffulli et al. [12] observed that terminology used for tendon conditions was misused and confusing. In their opinion definitions as tendinitis, tendinosis and paratendonitis can only be diagnosed after biopsy; however, they were often used in clinical practice without histopathologic examination. Due to a lack of consistence in nomenclature, Maffulli et al. advocated to use the term tendinopathy to describe clinical overuse conditions around the tendon characterized by pain, swelling and impaired performance [12]. Depending on the affected tissue, the terms tendinopathy, paratendinopathy or pantendinopathy were proposed.

In 2011, an addition was proposed to further purify the terminology used in Achilles tendon-related disorders to effectuate uniform and clear terminology [24]. This terminology is based on anatomic location, symptoms, clinical findings and histopathology and consists of the following five terms: mid-portion Achilles tendinopathy, insertional Achilles tendinopathy, Achilles paratendinopathy, retrocalcaneal bursitis and superficial calcaneal bursitis [24].

Uniform terminology provides the ability to communicate with an universal language in daily practice amongst clinicians and researchers. The aims of this study are to evaluate the current terminology and assess the influence of the latest proposals on the current terminology used for Achilles tendon-related disorders in both daily practice and literature.

MATERIAL AND METHODS

This study consists of two parts, a survey amongst orthopaedic surgeons on terminology in six typical cases with Achilles tendon-related disorder and a systematic search of literature.

Survey

Members of the Ankleplatform Study Group - Science of Variation Collaborative were invited. All orthopaedic surgeons, experienced in the field of foot and ankle surgery, were invited by mail to log on to the website –www.ankleplatform.com– and were requested to fill out their demographics characteristics and a questionnaire.

Six typical cases with Achilles tendon-related disorders were presented (see Appendix I) [24]. Participants were asked to give their preferred diagnosis for each case presented. A reminder was sent after 2 weeks. Incomplete questionnaires were excluded from the study.

Literature search

All terms described in publication about terminology of Achilles tendon-related disorders in 2011 were used [24]. Literature was reviewed for the terminology used in papers on Achilles tendon-related disorders and thereafter a systematic literature search was performed (See Appendix II for search strategy).

Eight journals in the field of foot and ankle surgery were selected: the American Journal of Sports Medicine, British Journal of Sports Medicine, Knee Surgery Sports Traumatology Arthroscopy, Foot & Ankle International, Journal of Orthopaedic Research, Acta Orthopaedica, Journal of Foot and Ankle Research and Journal of Foot and Ankle Surgery. All articles on Achilles tendon-related disorders, except Achilles tendon ruptures, published from 2000 until 2016 were included. Title and abstract were screened and the used terminology was extracted. All extracted terms were counted and divided into "according to the latest proposals" and "not according to the latest proposals", based on anatomic location, symptoms, clinical findings and histopathology, which was published January 2011 (See Table 1) [24]. When multiple terms were used in one publication, for example mid-portion Achilles tendinopathy and insertional Achilles tendinitis, this was scored as "not according to the latest proposals".

Table 1. The latest proposed terminology by van Dijk et al. [18]

Mid-portion Achilles tendinopathy	A clinical syndrome characterized by a combination of pain, swelling and impaired performance. It includes but is not limited to, the histopathological diagnosis of tendinosis.
Insertional Achilles tendinopathy	This is located at the insertion of the Achilles tendon onto the calcaneus, bone spurs and calcifications in the tendon proper at the insertion site may exist.
Achilles paratendinopathy	An acute or chronic inflammation and/or degeneration of the thin membrane around the Achilles tendon. There are clear distinctions between acute paratendinopathy and chronic paratendinopathy, both in symptoms as in histopathology.
Retrocalcaneal bursitis	Is an inflammation of the bursa in the recess between the anterior inferior side of the Achilles tendon and the posterosuperior aspect of the calcaneus (retrocalcaneal recess).
Superficial calcaneal bursitis	Inflammation of the bursa located between a calcaneal prominence or the Achilles tendon and the skin.

Statistical analysis

All collected data was imported into Statistical Package for Social Sciences (SPSS) version 25.0 (SPSS Inc. Chicago, IL). Analyses of outcome data was descriptive. Continuous outcome measures were presented as mean with standard deviation for data with a normal distribution and as median with interquartile range in case of non-normal distributed data. Distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Descriptive data was presented as frequencies with percentages in case of categorical data.

RESULTS

Survey

In total, 283 orthopaedic surgeons were invited by mail of which 141 participated in the study (response rate 50%). Respondents originated from 50 different countries, the most common country of origin was United Kingdom (7%), followed by Portugal (3%), the Netherlands (3%), and Italy (3%). Thirteen participants did not complete the questionnaire and were, therefore, excluded. Table 2 shows the demographic characteristics.

Table 3 presents the preferred diagnosis in each of the six cases. Only in case 5, the majority gave a diagnosis not according to the latest terminology proposals, namely Haglund's disease instead of retrocalcaneal bursitis.

Table 2. Demographics.

	N=141 (100%)
Male	133 (94.3)
Female	8 (5.7%)
Age	Median 40.0 (IQR 37.5-46)
Years in practice	Median 10 (IQR 6-16)
Number of patients with Achilles pathology each year	Median 50 (IQR 30-100)

Literature review

After the search, 257 articles remained for review. Thirteen articles were excluded based on other pathology than Achilles tendon pathology and 244 articles remained. Table 4 presents an overview of the numbers of times the terms were used in literature from 2000 to 2016. The most used terms are (chronic) Achilles tendinopathy, mid-portion Achilles tendinopathy and (chronic) Achilles tendinosis. Also, eponyms are still frequently used. Figure 1 provides an overview of the distribution of terminology used for Achilles tendon-related disorders according to the latest proposal and terminology not according to the latest proposals in percentages from 2000 to 2016. In 2000, 20% used terminology according to the latest proposals based on anatomic location, symptoms, clinical findings and histopathology and in 2016, 93%.

Figure 2 shows the distribution of terms used for mid-portion Achilles tendinopathy and Achilles paratendinopathy in percentages from 2000 to 2016. In 2000, 33% uses terminology according to the latest proposals and in 2016, 100%. The distribution of terms used for insertional Achilles tendinopathy and retrocalcaneal bursitis is shown in Fig. 3, in 2000, 0% uses terminology according to the latest proposals and in 2016, 80%.

Table 3. Overview of case answers.

Case	1	2	3	4	5	6
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
	128 (100)	128 (100)	128 (100)	128 (100)	128(100)	127(100)
Achilles pantendinopathy	-	-	7 (5.5)	-	-	7 (5.5)
Achilles tendinitis	4(3.1)	-	13 (10.2)	-	-	2 (1.6)
Achilles tendinopathy	18 (14.1)	-	1 (0.8)	1 (0.8)	-	10 (7.9)
Achilles tendinosis	19 (14.8)	-	2 (1.6)	-	-	6 (4.7)
Achilles tendon bursitis	-	9 (7.0)	-	-	-	1 (0.8)
Achillodynia	1 (0.8%)	-	-	-	-	-
Achillotendinitis ossificans	-	-	-	6 (4.7)	-	-
Acute Achilles paratendinopathy	-	-	62 (48.4)	-	-	3 (2.4)
Bursitis Achillea	-	7 (5.5)	1 (0.8)	-	-	-
Cellulite peritendineuse of the Achilles tendon	-	-	6 (4.7)	-	-	1 (0.8)
Chronic Achilles paratendinopathy	4 (3.1)	-	4 (3.1)	-	-	46 (36.2)
Haglund's deformity	-	6 (4.7)	-	2 (1.6)	24 (18.8)	-
Haglund's disease	-	4 (3.1)	-	5 (3.9)	31 (24.2)	-
Haglund's exostosis: pump-bump, calcaneus altus, high prow heels, knobbly heels, cucumber heel	-	13 (10.2)	-	10 (7.8)	11 (8.6)	-
Haglund's syndrome	-	1 (0.8)	-	1 (0.8)	23 (18.0)	-
Insertional Achilles tendinopathy	-	16 (12.5)	-	86 (67.2)	1 (0.8)	-
Mid-portion Achilles tendinopathy	39 (30.5)	-	-	1 (0.8)	-	14 (11.0)
Paratendinitis	1 (0.8)	-	11 (8.6)	-	-	4 (3.1)
Peritendinitis	-	-	10 (7.8)	-	-	2 (1.6)
Retrocalcaneal bursitis	-	17 (13.3)	1 (0.8)	1 (0.8)	29 (22.7)	-
Superficial Calcaneal bursitis	-	42 (32.8)	-	-	-	-
Tendinitis Achillea traumatica	-	-	-	-	-	-
Tenosynovitis	-	-	6 (4.7)	-	-	1 (0.8)
Midportion Achilles tendinopathy and paratendinopathy combined	34 (26.6)	1 (0.8)	1 (0.8)	1 (0.8)	-	28 (22.0)
Insertional Achilles tendinopathy and retrocalcaneal bursitis combined	-	10 (7.8)	-	10 (7.8)	6 (4.7)	-
Other	8 (6.3)	1 (0.8)	3 (2.3)	5 (3.9)	3 (2.3)	2 (1.6)

Table 4. Overview of the used terms in literature from 2000 to 2016.

Number of times	Term
70	(Chronic) Achilles tendinopathy
45	Mid-portion Achilles tendinopathy
29	(Chronic) Achilles tendinosis
23	Insertional Achilles tendinopathy
11	(Chronic) Non-insertional Achilles tendinopathy
11	Insertional Achilles tendinosis
9	Achilles tendinitis
8	Mid-portion Achilles tendinosis
7	Haglund's deformity
6	Retrocalcaneal bursitis
5	Haglund's syndrome
4	Mid-substance Achilles tendinopathy
2	Haglund's disease
2	Insertional tendinitis
2	Achillodynia
1	Achilles paratendinitis, Achilles paratendinopathy, Achilles tendon pathology, chronic tendinopathic tendons, insertional Achilles pathologic entities, insertional calcific Achilles tendinosis, mid-tendinous Achilles tendinopathy, tenosynovitis of the tendo Achilles and tuberculous tenosynovitis of the Achilles tendon, Haglund's triad.

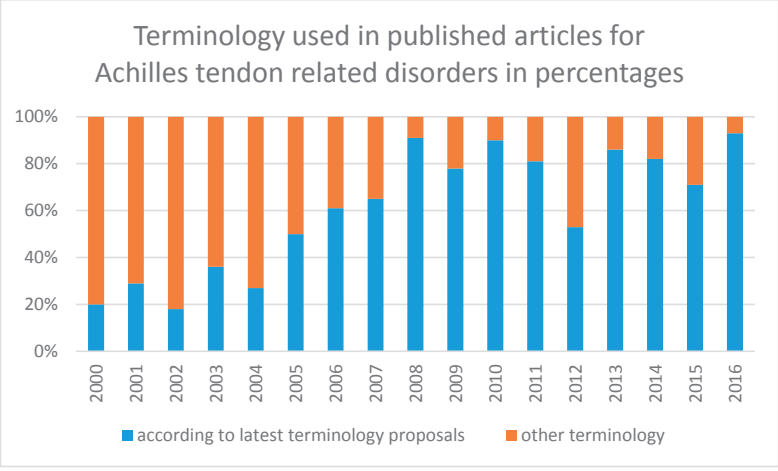

Figure 1. Overview of terminology used for Achilles tendon-related disorders in percentages of published articles (Y-axis) over the years (X-axis).

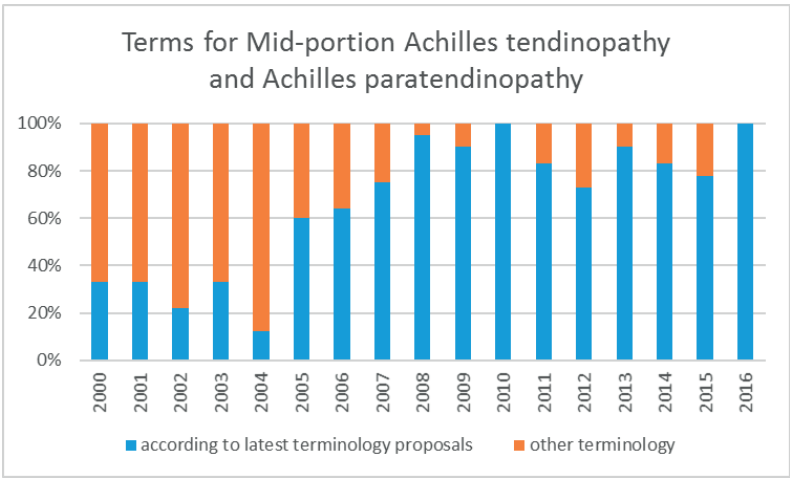

Figure 2. The distribution of terms used or mid-portion Achilles tendinopathy and Achilles paratendinopathy in percentages of published articles (Y-axis) over the years (X-axis).

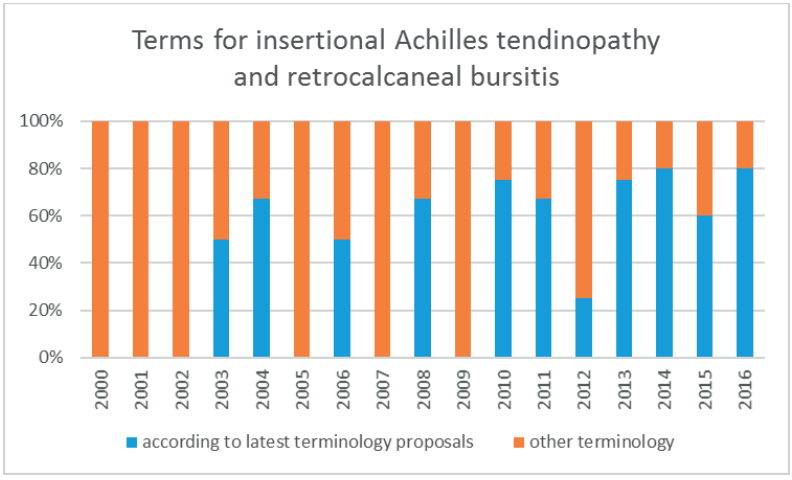

Figure 3. The distribution of terms used for insertional Achilles tendinopathy and retrocalcaneal bursitis in percentages of published articles (Y-axis) over the years (X-axis).

DISCUSSION

The main findings of this study were that terminology for Achilles tendon-related disorders according to the latest proposals based on anatomic location, symptoms, clinical findings and histopathology is being used by the majority of orthopedic surgeons in daily practice and is increasingly being used in literature. However, the indistinct Haglund eponyms are still frequently used in Achilles tendon-related terminology.

The wide variety in terminology for Achilles tendon-related disorders is confusing. The term that represents the entity must be neutral yet descriptive, uniform and clear. Therefore, descriptive terms are preferable to eponymous terms [21]. Terminology which includes the combination of anatomic location, symptoms and clinical findings and pathological changes for each entity has, therefore, been advocated.

Symptoms around the Achilles tendon often have a similar presentation and it is, therefore, important to define the pathology or the combination of pathologies. For example, lack of distinction between entities, such as insertional tendinopathy and chronic retrocalcaneal bursitis is crucial to determine further treatment and it impedes the process for researchers to perform an all-encompassing systematic review [3, 27].

In five out of six cases in the survey, the majority of orthopaedic surgeons gave a diagnosis according to the terminology based on anatomic location, symptoms, clinical findings and histopathology. The exception is the fifth case, where the majority choose Haglund's disease instead of retrocalcaneal bursitis. A possible reason for this is the ingrained use of the eponym Haglund. There are approximately 20,000 medical eponymous terms in use today and literature shows that using eponymous terms is an inaccurate and unreliable method of communication [4, 5, 21]. Somford et al. questioned 244 orthopedic surgeons worldwide on common eponymous terms and reported a low agreement on use of eponymous terms (kappa 0.11; proportion of agreement, 68%). Nevertheless, eponymous terms are often used in clinical setting and are passed onto the residents and students [11, 15, 22, 26]. Also, eponymous terms used in published articles are often inconsistent and do not match their original definition [20, 23].

Terminology in which Haglund eponyms such as Haglund's deformity, Haglund's syndrome and Haglund's disease are all dissimilar entities should be avoided because there is a large variation in the presumed meaning of these eponymous terms [21]. Haglund's syndrome was first defined as a common cause of posterior heel pain, characterized clinically by a painful soft tissue swelling at the level of the Achilles tendon insertion [13]. Haglund's deformity was first described as a tender swelling in the region of the Achilles tendon with visible prominence of the postero-lateral aspect of the calcaneus [25]. Haglund's disease, however, refers to osteochondrosis of the accessory navicular bone [6, 19].

In systematic reviews, many eponymous diagnosis have to be converted to anatomical diagnostic groupings and at all studies are excluded based on aberrant or uninterpretable definitions of an eponym or pathology, which can lead to different research results which are often leading for the best scientific-based treatment in clinical practice [2, 9, 27].

The survey was send to members of the Ankleplatform Study Group, which caused selection bias. Even though orthopaedic surgeons from over the whole world responded, these were specifically experienced in the field of foot and ankle pathology what could have led to an overestimation of the terms used compared by orthopaedic surgeons in general. Also, the presumed definitions of the terms used for Achilles tendon-related disorders were not assessed which could have provided

insight in the misuse of terms. In the literature study, we included a selection of eight foot and ankle journals, which caused selection bias.

Uniform terminology provides the ability to communicate with an universal language in daily practice amongst clinicians and researchers and will lead to the best available scientific-based treatment in clinical practice.

CONCLUSION

The revised terminology for Achilles tendon-related disorders is used by the majority of orthopedic surgeons and is increasingly used in literature. However, the indistinct Haglund eponyms are still frequently used in Achilles tendon-related terminology.

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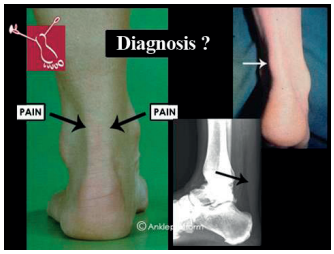
APPENDIX I.

Case 1

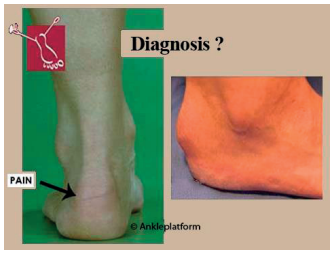


The photo on the left shows the location of the pain in a normal ankle. The photos on the right show the pathology.

- 40-year-old male.
- Pain over his right Achilles tendon, which impairs his activity.
- Painful localized fusiform swelling of the Achilles tendon located 6 cm proximal to the insertion onto the calcaneus.
- X-ray shows deviation of soft tissue contours.
- Ultrasound showed a larger tendon than normal (in cross-sectional area and antero-posterior diameter). There were hypoechoic areas within the Achilles tendon and increased tendon vascularity (mainly in the ventral peritendinous area).

What is your diagnosis? **Mid-portion Achilles tendinopathy**

Case 2

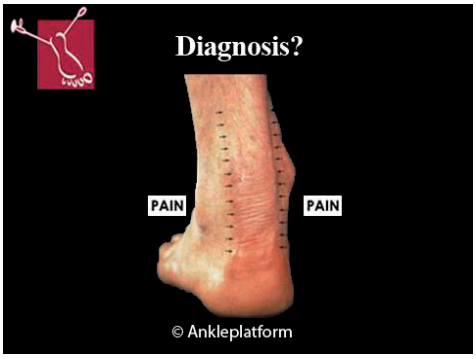


The photo on the left shows the location of the pain in a normal ankle. The photos on the right show the pathology.

- 30-year-old female.
- Posterolateral heel pain on the right side (worsens with shoes with rigid posterior portion).
- Visible, painful and solid swelling with discoloration of the skin located at the posterolateral calcaneus.
- X-ray shows no abnormality.
- Ultrasound showed fluid between the skin and the Achilles tendon.

What is your diagnosis? **Superficial calcaneal bursitis**

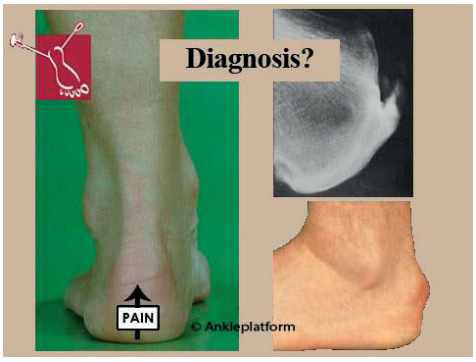
Case 3



- 32-year-old male.
- Since 4 days edema and hyperemia around the midportion Achilles tendon on the left side.
- Redness and swelling of the skin over the full length of the Achilles tendon. .
- On palpation there are crepitations.
- X-ray shows no abnormalities.
- Ultrasound showed a normal Achilles tendon with a circumferential hypoechogenic halo.

What is your diagnosis? **Acute Achilles paratendinopathy**

Case 4

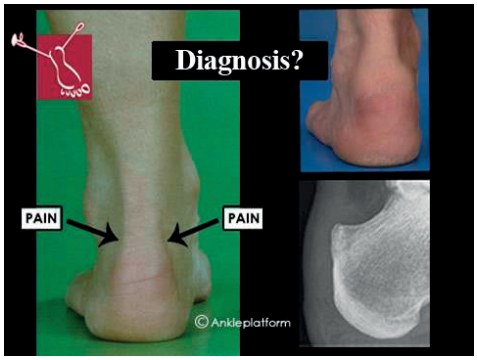


The photo on the left shows the location of the pain in a normal ankle. The photos on the right show the pathology.

- 60-year-old male.
- Stiffness and pain on the posterior aspect of the calcaneus on the left foot.
- Painful Achilles tendon insertion at the mid-portion of the posterior aspect of the calcaneus with visible swelling
- X-ray shows calcaneal bone spur at the insertion of the Achilles tendon.

What is your diagnosis? **Insertional Achilles tendinopathy**

Case 5

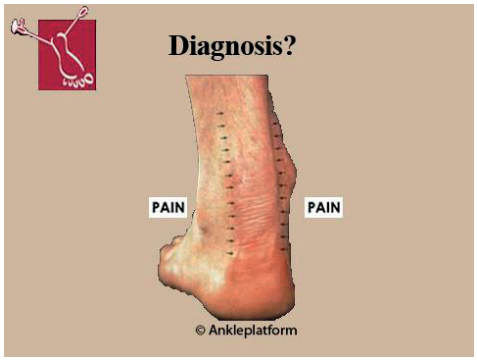


The photo on the left shows the location of the pain in a normal ankle. The photos on the right show the pathology.

- 35-year-old female patient.
- Painful swelling superior to the calcaneus of the left foot.
- Painful soft tissue swelling, medial and lateral to the Achilles tendon at the level of the postero-superior calcaneus.
- X-ray shows bony prominence of the posterosuperior calcaneus.
- Ultrasound showed fluid in the retrocalcaneal area (hyperechoic).

What is your diagnosis? **Retrocalcaneal bursitis**

Case 6



- 39-year-old male.
- Since one year exercise-induced pain around the midportion Achilles tendon of the left foot.
- Minimal swelling and some crepitations around the midportion Achilles tendon.
- X-ray shows no abnormalities.
- Ultrasound shows thickened hypoechoic paratenon and the echo-Doppler shows increased tendon vascularity (mainly in ventral peritendinous area).

What is your diagnosis? **Chronic Achilles paratendinopathy**

APPENDIX II

Search strategy

A systematic literature search was performed in Medline, Embase (Classic). A search with the following keywords was performed: *"Achilles tendinitis OR Achilles tendinopathy OR Achilles tendinosis OR Achilles tendon bursitis OR Achillodynia OR Achillotendinitis ossificans OR Acute Achilles paratendinopathy OR Bursitis Achillea OR Cellulite peritendineuse Achilles tendon OR Chronic Achilles paratendinopathy OR Haglund's deformity OR Haglund's disease OR Haglund's exostosis OR pump-bump OR calcaneus altus OR high prow heels OR knobbly heels OR cucumber heel OR Haglund's syndrome OR Insertional Achilles tendinopathy OR Mid-portion Achilles tendinopathy OR Paratendinitis Achilles OR Peritendinitis Achilles OR Retrocalcaneal bursitis OR Superficial Calcaneal bursitis OR Tendinitis Achillea traumatica OR Tenosynovitis Achilles OR non-insertional Achilles tendinopathy OR noninsertional Achilles OR Midportion Achilles tendinopathy"*.

3 Endoscopic treatment of mid-portion Achilles tendinopathy: a retrospective case series of patient satisfaction and functional outcome at a 2- to 8-year follow-up.

K.T.M. Opdam
T.P.A. Baltes
R. Zwiers
J.I. Wiegerinck
C.N. van Dijk

Arthroscopy, 2018

ABSTRACT

Purpose: To evaluate the results of endoscopic treatment in patients affected by mid-portion Achilles tendinopathy, by release of the paratenon combined with a resection of the plantaris tendon, regarding patient satisfaction, functional outcome and pain scores.
Methods: This retrospective study evaluated patients endoscopically treated for mid-portion Achilles tendinopathy between 2000 and 2013. Patient satisfaction, functional outcome, pain scores and health-related quality of life were measured by use of a numeric rating scale, the Foot and Ankle Outcome Score, the Victorian Institute of Sport assessment for the Achilles tendon, the numeric rating scale for pain during running and during sport, and the EuroQol-5D (EQ-5D-3L) standardized questionnaire. Additional questions were asked on effectiveness of the treatment and sport participation.
Results: The response rate was 76.3% (45 of 59). Thirty-five (78%) patients were treated unilateral and 10 (22%) patients were treated bilaterally. For the unilateral treated patients, the median time to follow-up was 67 months (interquartile range (IQR) 48-99 months) and for the bilateral treated patients, it was 89.5 months (IQR 37.5-161.75 months). The median satisfaction score for treatment results was nine out of 10 (IQR 7-10) and 9.5 (IQR 7-10), respectively. The median Foot and Ankle Outcome Score subscales were scored 75 to 99 and 75 to 97, the median Victorian Institute of Sport assessment for the Achilles tendon scored 81 (IQR 47-90) and 97 (IQR 87-100), and the median numeric rating scale for pain during both running and sports were 1 (IQR 0-6.5) for the unilaterally treated patients and 0 (IQR 0-4.5) and 0 (IQR 0-1) for the bilaterally treated patients, respectively. The median EQ-5D were 0.81 (IQR 0.71-1) and 1 (IQR 0.64-1), respectively. One reoperation for recurrence of symptoms was necessary.
Conclusion: This study shows a high patient satisfaction and good functional outcomes in patients affected by mid-portion Achilles tendinopathy who were endoscopically treated by means of release of the paratenon in combination with transection of the plantaris tendon.

INTRODUCTION

Mid-portion Achilles tendinopathy is an overuse injury of the Achilles tendon, often seen in athletes such as runners and jumpers.[1] Initially, treatment of mid-portion Achilles tendinopathy is nonsurgical. However, if such treatment results in unsatisfactory outcome, surgical treatment must be considered. In approximately 25% of the patients surgical treatment is indicated to alleviate symptoms.[2]

Initially, open surgical techniques were used. Over the last 20 years, minimally invasive and endoscopic procedures have been developed, driven by the low complication rates and short recovery of these procedures.[3] In 2002, Maquirriain et al. published the first case series of endoscopically treated patients with chronic Achilles tendinopathy.[4] This endoscopic technique consisted of a release of the peritenon and longitudinal tenotomies.

Since then various endoscopic techniques for mid-portion Achilles tendinopathy have been described. These techniques differ from each other by whether or not the paratenon is resected, tenotomies are carried out, the flexor hallucis longus is transferred and if the plantaris tendon is released.[4-10] The variation in surgical techniques is the result of limited understanding of the exact pathophysiology of mid-portion Achilles tendinopathy.

Hitherto, only small retrospective case series have been published on endoscopic treatment of mid-portion Achilles tendinopathy, and little is known about patient satisfaction after endoscopic treatment.[4-10] Better knowledge of the outcome of endoscopic treatment options will lead to better information for the future patient.

The purpose of this study was to evaluate the results of endoscopic treatment in patients affected by mid-portion Achilles tendinopathy, by release of the paratenon combined with a resection of the plantaris tendon regarding patient satisfaction, functional outcome and pain scores. We hypothesized that patients have good satisfaction scores and good functional outcome scores after a median time of 4.9 years (interquartile range (IQR) 3.7-7.9 years) after the endoscopic treatment for midportion tendinopathy.

METHODS

Patients

In this retrospective case series, we identified all patients from the orthopedics department of the Academic Medical Center who underwent an endoscopic treatment for mid-portion Achilles tendinopathy between January 1st, 2000 and December 31st, 2013. The eligibility criteria were: above 18 years of age, diagnosed by physical examination and/or additional imaging for mid-portion Achilles tendinopathy without other serious lower limb injury. Patients that were not able to complete a questionnaire in the Dutch language were excluded.

The study was approved by the local ethics committee of the Academic Medical Center (reference number W15_184#).

Operative technique

For the endoscopic treatment, each patient was placed in a prone position with both feet positioned at the end of the table. Epidural, spinal, or general anaesthesia was used, and a tourniquet was placed around the affected upper leg. At first the distal portal was created and was located on the lateral border of the Achilles tendon 2 to 3 cm distal to the pathologic painful thickened nodule. The proximal portal was located 2 to 4 cm above the nodule on the medial border of the Achilles tendon. First the plantaris tendon was identified just medial to the Achilles tendon and then resected. A resection of the paratenon was performed on the anterior side of the tendon at the level of the painful nodule. All areas of neovascularizations were removed, by means of a shaver, from the Achilles tendon at the level of the painful nodule. This could also involve the medial or lateral border of the Achilles tendon.

The portals were sutured, and a compressive bandage was applied for 4 days. Full weight bearing was allowed. Patients were encouraged to actively perform range-of-motion exercises.

Data collection

Demographics were obtained from the patients' medical records. Patients were invited to participate in this study by mail. A questionnaire was send to the patients that accepted the study invitation. To enhance the response rate, a reminder was send 2 weeks after sending the questionnaire. When patients were treated bilateral, they were requested to score the questionnaires according to the side that was affected the worst. The data of the unilateral cases and bilateral cases are separated. In clinical practice, there are patients who are treated bilateral for mid-portion Achilles tendinopathy; therefore, we do not want to withhold these results.

Outcome measures

The questionnaire measured the numeric rating scale (NRS) for patient satisfaction of the treatment; NRS for pain during running and during sports; the Foot and Ankle Outcome Score (FAOS)[11, 12]; the Victorian Institute of Sport assessment for the Achilles tendon (VISA-A) and EuroQol 5D (EQ-5D-3L) standardized questionnaire.[13-15]

In this study, an 11-point NRS for satisfaction was used, where patients were asked to score their satisfaction level of the treatment, ranging from 0 to 10 with 0 indicating very unsatisfied and 10 indicating very satisfied.

For the NRS pain during running and during sports, patients were requested to quantify the intensity of their pain on a scale from 0 to 10, with 0 indicating no pain and 10 indicating the worst pain imaginable.[16]

The FAOS is a general foot and ankle patient-reported outcome measure (PROM) that consists of five subscales: pain, other symptoms, activity in daily living, recreational and sport activities and

foot- and ankle-related quality of life. A total of 42 questions were scored, and the score ranges from 0 to 100, where 0 represent the worst score and 100 the best score. The FAOS is the most appropriate PROM for general foot and ankle complaints in the Netherlands, with adequate clinimetric properties.[17]

The VISA-A is a PROM consisting of 8 questions for evaluation of pain, symptoms, and their effect on physical activity, specifically in patients affected by Achilles tendinopathy.[13] The VISA-A is a validated Dutch questionnaire and a disease-specific questionnaire, specific for patients with chronic Achilles tendinopathy.

The EQ-5D is a descriptive system of health-related quality of life states and consists of 5 dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression).[14, 15] The minimum score is 0 and the maximum score is 1.

Also, we added the following questions to the questionnaire. We asked if the treatment was effective, and the 4 multiple-choice answers were as follows: no/yes, but there are minor residual complaints/yes, there was a temporary effect/yes, complaints never reoccurred. Participants were asked if they participated in sports and at what level (professional/competitive/recreational) before the complaints and at follow-up.

Statistical analysis

Presentation of data was descriptive. No inferential statistics were performed. Continues variables were presented as mean with standard deviation for data with a normal distribution and as median with IQR in case of non-normal distribution. Distribution was assessed using the Kolmogorov-Smirnov test. Categorical variables were presented as frequencies with percentages. Ordinal outcome variables were presented as median and IQR. The data analysis of the bilateral cases is a separate subset. Statistical analyses were performed with Statistical Package for Social Sciences (SPSS) version 23.0 (SPSS Inc. Chicago, IL).

RESULTS

Questionnaires were sent to a total of 59 patients, who were treated endoscopically for mid-portion Achilles tendinopathy of the Achilles tendon. The response rate was 76.3% (45 of 59). Thirty-five (78%) patients were treated unilateral. Ten (22%) patients were treated bilaterally, of which six were treated bilateral in the same surgical procedure and four patients were first treated for one side and later received treatment for the contra-lateral side. Figure 1 shows the inclusion flowchart, and table 1 presents the characteristics of the participants in the study and non-responders.

For the unilateral treated patients, the median time to follow-up was 67 months (IQR 48-99 months) and for the bilateral treated patients, 89.5 (IQR 37.5-161.75 months). The median satisfaction score for treatment results was 9 out of 10 (IQR 6-10) for unilateral treated patients. Table 2 shows the NRS pain scores for running and sports and the functional outcome scores. For unilater-

ally treated patients, the median FAOS subscales were scored 75 to 99, the median VISA-A score was 81 (IQR 47-90), the median NRS pain during both running and sports was 1 (IQR 0-6.5), and the median EQ-5D of 0.81 (IQR 0.71-1).

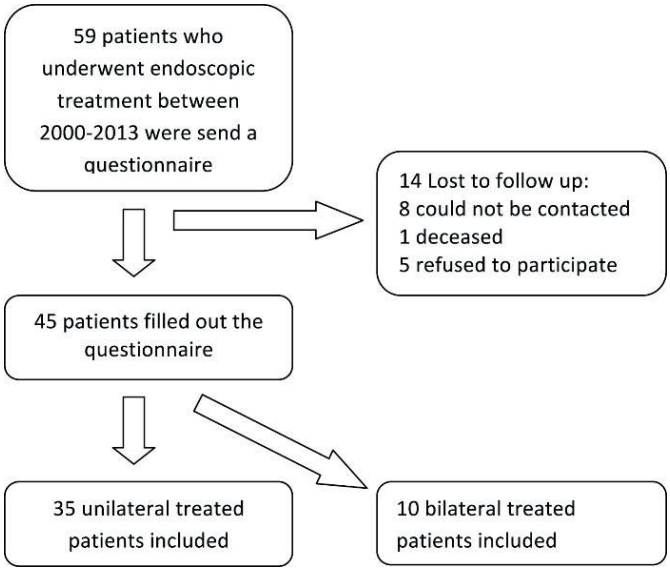


Figure 1. Inclusion flowchart.

Table 1. Characteristics of the present study

	Nonresponders, N=14 (100%)	Unilateral, N=35 (100%)	Bilateral, N=10 (100%)
Sex			
Male	9 (64%)	14 (40%)	4 (40%)
Female	5 (36%)	21 (60%)	6 (60%)
Age during operation*	41 (IQR 34.75-53.5)	50 (IQR 41-55)	46.5 (IQR 38.75-49.50)
BMI*	28.85 (IQR 25.20-30.38)	27.44 (IQR 24.98-29.79)	28.51 (IQR 23.28-32.50)
Side			
Left	6 (43%)	16 (45.7%)	
Right	6 (43%)	19 (54.3%)	
Bilateral	2 (14%)		10 (100%)
Duration of symptoms*	Months: 28 (IQR 13-56)	Months: 36 (IQR 19-49)	Months: 54 (IQR 15-254)
	Years: 2 (IQR 1-5)	Years: 3 (IQR 1-4)	Years: 5 (IQR 1-21)
Time to follow-up*	†Months: 59 (IQR 44-95.25)	Months: 67 (IQR 48-99)	Months: 89.5 (IQR 37.5-161.75)
	Years: 5 (IQR 4-8)	Years: 5 (IQR 4-8)	Years: 8 (IQR 3-14)

BMI, body mass index; IQR, interquartile range.
*Data in median (IQR).
†Estimated time to follow-up.

Table 2. Numeric rating scale pain scores for running and sports and the functional outcome scores

	Unilateral	Bilateral
	Median (IQR)	Median (IQR)
NRS pain running	1 (0-6.50)	0 (0-4.50)
NRS pain sport	1 (0-6.50)	0 (0-1.00)
FAOS symptoms	85.71 (67.86-92.86)	89.29 (67.56-100.00)
FAOS pain	94.44 (61.11-100.00)	95.83 (72.22-100.00)
FAOS ADL	98.53 (73.33-100.00)	97.06 (75.74-100.00)
FAOS sport	83.33 (55.00-100.00)	95.00 (41.25-100.00)
FAOS QOL	75 (43.75-93.75)	75.00 (42.19-100.00)
EQ-5D	0.811 (0.71-1.00)	1.00 (0.635-1.00)
VISA-A	81 (47-90)	97.00 (86.50-99.75)

ADL, activity in daily living; EQ-5D, EuroQol 5D; FAOS, foot and ankle outcome score; IQR, interquartile range; NRS, numeric rating scale; QOL, quality of life; VISA-A, Victorian Institute of Sport assessment for the Achilles tendon.

All unilateral treated patients were asked if treatment was effective. In 14 (40%) patients, Achilles tendon complaints never reoccurred, and in 16 (46%) patients there were minor residual complaints. One (3%) patient experienced a temporary effect and 4 (11%) patients stated that the operation was ineffective. In retrospect, 83% (29) of the patients would undergo endoscopic treatment again under the exact same circumstances, 3% (1) of the patients doubted if they would undergo surgical treatment again and 14% (5) of the patients would prefer not to undergo this procedure again. A reoperation for recurrence of symptoms was necessary in 3% (1) of the patients.

Before the treatment, 25 patients participated in sports, of whom 1 on professional, 8 on competitive, and 16 on recreational level. Of the 8 patients who ceased their sporting activities, only 2 (8%) patients were forced to cease sporting activities due to ankle complaints. However, 1 patient who had a good effect of the treatment, was able to start sporting activities after the treatment.

In total, 10 bilateral treated patients had a median satisfaction score for treatment results of 9.5 (IQR 7-10). Table 2 shows the NRS pain scores for running and sports and the functional outcome scores. The median FAOS subscales were 75 to 97, the median VISA-A score was 97 (IQR 87-100), the median NRS pain during running was 0 (IQR 0-4.5) and during sports 0 (IQR 0-1), and a median EQ-5D was 1 (IQR 0.64-1). In 6 patients, the complaints of the Achilles tendon never reoccurred after treatment, in 1 patient there were minor residual complaints, 2 patients had experienced a temporarily effect and 1 patient stated that the operation was ineffective. All of the bilateral treated patients would undergo the treatment again under the same circumstances.

DISCUSSION

The most important finding of this study is that there is an excellent median satisfaction score among patients who received endoscopic release of the paratenon and plantaris tendon in patients with mid-portion Achilles tendinopathy.

The overall median satisfaction score of 9 out of 10 is an excellent score. However, the FAOS domains are somewhat less than excellent. This could be due to the fact that 40% of the patients are completely free of symptoms and that 46% is largely free of symptoms. Thereby, patients are pleased with the relief of symptoms provided by this relative simple treatment, certainly after a median duration of symptoms of 3 years. Also, this result is supported by the fact that 83% of the patients would undergo the endoscopic treatment again under the exact same circumstances and that only 1 patient needed a reoperation for the same complaints.

Notable, the bilateral treated patients had an even higher satisfaction score and functional outcome scores, except for FAOS domain activity in daily living, than the unilateral treated patients. This could be because bilateral affected patients are more affected and are more disabled. However, we believe that the scores and outcomes of unilateral and bilateral affected patients cannot be compared with each other. This is due to the fact that it is hard to distinguish complaints of the right side when the left side is also affected and vice versa. However, in practice there are patients with bilateral complaints; therefore, we imparted these results.

Accordingly, the results reported in this study match those observed in earlier studies showing similar good to excellent results for patient satisfaction and functional outcome scores.[4-10] Only 1 long-term follow-up study with a mean follow-up of 7.7 years has been published. In this study, Maquirriain reported a patient global assessment response to therapy score which is excellent in 85.1% of the cases, and in all cases the score was good to excellent.[10] Maquirriain reported a mean postoperative VISA-A of 97.5 (standard deviation 12.1), which were in line with our VISA-A score of 86 (IQR 53-94). The other endoscopic studies that reported a satisfaction score had a mean follow-up of only 6 to 30 months.[6, 7, 9] Out of these 3 studies, only Pearce et al. used the same technique and reported that 8 of 11 (73%) patients were satisfied and 3 of 11 (27%) somewhat satisfied.[9]

Despite the various techniques, the results of endoscopic treatment are quite similar. Limited understanding of the exact pathophysiology has largely contributed to a variation in operative techniques. It was hypothesized that the intratendineous degenerations were the cause of pain, and authors claimed that performing multiple tenotomies would relieve symptoms by increasing the blood supply and thus the presence of viable cells which can improve the healing process of the Achilles tendon.[4, 6, 10] Tenotomies are often performed during endoscopic treatment of mid-portion tendinopathy of the Achilles tendon, but the thought that degeneration of the tendon is the main cause of the pain is questionable.[18]

Instead, Steenstra and van Dijk postulated that the focus had to be on the neovascularizations and accompanying ingrowth of nerve fibers rather than on the intratendineous degeneration and nodular thickening of the Achilles tendon. They hypothesized that chronic pain of the Achilles

tendon is the result of ingrowth of sensory nerve fibres in the paratenon. Release of the paratenon therefore causes relief of pain due to the denervation.[4, 9, 10] In 2006, they published a case series of endoscopically treated patients, in which no tenotomies were performed, with good results.[5] In line with this hypothesis, literature suggests that the intratendineous structure changes and thus restoration of the Achilles tendon are not required for improvement of symptoms and that intratendineous changes can exist without symptoms.[19, 20] Hence, we believe the tenotomies should not be performed.

In a normal situation, the plantaris tendon can move freely in relation to the Achilles tendon. In case of mid-portion Achilles tendinopathy, the inflammatory response of the paratenon causes adhesions between those 2 structures, wherefore a release can help to relieve symptoms.[18] Spang et al. show that in patients with mid-portion Achilles tendinopathy, the plantaris tendon is morphologically affected in a comparable way as the Achilles tendon, and also that there is sensory innervation of the connective tissue in the plantaris tendon tissue proper, which can explain that plantaris resection helps to alleviate symptoms.[21,22] Therefore, resection of the plantaris tendon should be standard in the treatment for mid-portion Achilles tendinopathy.

Limitations

Because of the design of this study, we were unable to compare the results at follow-up with pre-operative data, which can cause inherent bias. To that end, we are uncertain to what extent the functional outcome scores improved due to surgical treatment. Also, the small number of patients is a limitation.

There is a paucity of literature on patients treated endoscopically for mid-portion Achilles tendinopathy, this case series shows good results with a response rate of 76.3%. This study contributes to a better knowledge on outcome of endoscopic treatment, and will aid orthopedic surgeons in counseling future patients affected by mid-portion Achilles tendinopathy. The future step in evaluation of the different endoscopic techniques is to use uniform validated outcome measures. Furthermore, ideally prospective randomized studies are needed to compare various endoscopic treatment options.

CONCLUSION

This study demonstrates a high patient satisfaction and good functional outcomes

after a median time of 4.9 years (IQR 3.7-7.9 years) in patients affected by mid-portion Achilles tendinopathy who were endoscopically treated by means of release of the paratenon in combination with transection of the plantaris tendon.

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4 High patient satisfaction and good long-term functional outcome after endoscopic calcaneoplasty in patients with retrocalcaneal bursitis.

K.T.M. Opdam
R. Zwiers
J. Vroemen
I.N. Sierevelt
J.I. Wiegerinck
C.N. van Dijk

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ABSTRACT

Purpose: The primary objective of this study was to determine the degree of patient satisfaction at a minimum of 5 years of follow-up after endoscopic calcaneoplasty. The secondary objectives were to assess functional outcome measures, pain scores, analysis of of bone removal, reformation of exostosis at follow-up and correlation of the size of the exostosis and recurrent or persisting complaints.

Methods: This study evaluated patients who underwent endoscopic calcaneoplasty, between January 1st 2000 and December 31st 2010, for the diagnosis of retrocalcaneal bursitis. The evaluation consisted of PROMs (patient-reported outcome measures), a questionnaire and a visit to the outpatient clinic for physical examination and a standard lateral weight-bearing radiograph of the ankle. Patient satisfaction, functional outcomes and pain scores were measured by use of a numeric rating scale (NRS). Size of the posterosuperior calcaneal exostosis was measured on a standard lateral weight-bearing radiograph using parallel pitch lines (PPL) and the Fowler-Philip angle (PFA).

Results: The response rate was 28 out of 55 (51%) and the median time to follow-up was 101 (IQR 88.5-131.8) months. The median satisfaction score for treatment results was 8.5 out of 10 (IQR6-10). FAOS symptoms 84.5 (IQR 58.0- 96.4), FAOS pain 90.3 (IQR 45.1-100.0), FAOS ADL 94.9 (IQR 58.1-100.0), FAOS sport 90.0 (IQR 36.3-100.0) and FAOS QOL 71.9 (IQR 37.5-93.8) and median AOFAS was 100 (IQR 89-100). The median PLL difference between before operation and two weeks after the operation was -4mm (IQR-6 and -1) and the median PLL difference between two weeks after the operation and at follow-up was 1mm (0-2). The median PFA was 65 (63-69) at baseline, 66.5 (60.8-70.3) two weeks after the operation and 64 (60.8-65.3) at follow-up.

Conclusion: Despite the limited response rate, this study shows high patient satisfaction and good long-term functional outcome in patients affected by retrocalcaneal bursitis who underwent endoscopic calcaneoplasty.

INTRODUCTION

Retrocalcaneal bursitis is characterized by inflammation of the bursa between the superoposterior aspect of the calcaneus and ventral side of the Achilles tendon resulting in painful swelling, medial and lateral to the Achilles tendon at the level of the posterosuperior calcaneal prominence [1, 12]. Inflammation of this bursa was first described by Painter in 1898 and the first surgical treatment was performed and described by Haglund in 1928 [6]. The contributing biomechanical risk factors are a posterosuperior calcaneal prominence, hindfoot equinus, compensated hindfoot varus, compensated forefoot valgus, rigidly plantarflexed first ray, cavus foot and trauma to the apophysis in childhood [21].

Conservative treatment includes orthotics, avoidance of tight shoes, activity modification, use of padding, physical therapy, non-steroidal anti-inflammatory drugs and corticosteroid injections [21, 24]. If conservative treatment fails, surgical treatment can offer a solution, favoring endoscopic surgery over open surgery [8, 18, 28]. Endoscopic procedures have surpassed open techniques in many ways: lower morbidity, less postoperative pain, excellent perioperative visualization of the retrocalcaneal bursal space and Achilles tendon including its insertion, early allowance of functional rehabilitation, shorter recovery time and quick sports resumption in comparison with open techniques [3, 8, 28]. Short-term outcome on endoscopic calcaneoplasty shows good results on patient satisfaction, pain scale and functional outcome scores. However, little is known about the long-term results of endoscopic for patients with symptomatic retrocalcaneal bursitis. In this study, we assessed the results of endoscopic calcaneoplasty at a minimum of 5-year follow-up. Radiographic measurements were performed to analyze the extent of bone removal and to estimate the reformation of exostosis at follow-up. Also, the size of the exostosis and recurrent or persisting complaints were correlated.

It was hypothesized that there is a high patient satisfaction and good functional outcome after endoscopic calcaneoplasty of retrocalcaneal bursitis on the long term.

MATERIALS AND METHODS

This study was approved by the local medical ethics committee of the Academic Medical Center (reference number 2015_318#) and performed in accordance with the principles of the Declaration of Helsinki and the medical Research Involving Human Subjects Act (WMO).

Inclusion criteria and operative technique

In this case series, all patients who underwent endoscopic calcaneoplasty in the orthopedics department of the Academic Medical Center between January 1st 2000 and December 31st 2010 for the diagnosis of chronic retrocalcaneal bursitis were identified. Chronic retrocalcaneal bursitis was defined as a clinical inflammation of the retrocalcaneal bursa as shown by MRI or ultrasound,

which did not resolve with at least 6 months of conservative treatment (RICE (Rest,Ice, Compression, Elevation) therapy, pain inducing activity cessation in combination with a change in footwear and NSAID's (non-steroid anti-inflammatory drugs). The inclusion criteria were diagnosis by physical examination and additional imaging for retrocalcaneal bursitis, age over 18 years, capable of filling out a questionnaire and signed informed consent. Exclusion criteria were pregnant or possibly pregnant patients, inability to understand the patient information and the questionnaires (e.g. mental retardation, language barrier). If treated bilaterally, the subject was excluded. Endoscopic calcaneoplasty was performed by using two portal endoscopic calcaneoplasty technique as described by van Dijk et al. [25, 26].

Study procedures and data collection

All eligible subjects were extracted from the electronic patient file system. All subjects were invited to participate in our study by mail. In order to enhance response rate, a reminder was send 2 weeks after sending the first mail. Participation consisted of PROMs, a questionnaire and a visit to our outpatient department. At consultation, physical examination and one standard lateral weight-bearing radiograph of the ankle was performed.

Outcome measures

The main study parameter was the degree of patient satisfaction measured using a numeric rating scale (NRS) for satisfaction. This is an 11-point scale, where patients are requested to quantify their degree of satisfaction on a scale from 0 (very unsatisfied) to 10 (very satisfied).

The secondary study parameters were the outcomes of the Foot and Ankle Outcome Score (FAOS), Ogilvie-Harris score, NRS for pain, EQ-5D-3L, American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale and additional questions were asked. Radiographic measurements were done to analyze the extent of bone removal and to assess the reformation of exostosis at follow-up. Also, correlations were made between the size of the exostosis and recurrent or persisting complaints.

The questionnaire

The FAOS is the most appropriate foot- and ankle PROM for general foot and ankle problems and consists of 42-items [22, 23, 27]. It consists of five subscales: Pain, Other Symptoms, Function in Daily Living (ADL), Function in Sport and Recreation, and foot and ankle-related Quality of Life (QOL). Standardized answer options are given and each question is scored from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) is calculated for each subscale.

The Ogilvie-Harris score consists of 5 subscales: pain, swelling, stiffness, limping and activity. Each item is rated as excellent, good, fair, or poor. The lowest grade among the items determines the final score. The Ogilvie-Harris score is not been validated, however, we added the score because of its previous use in other studies and the importance of subjective outcome scores in clinical evaluation.

A NRS is a common and practical method for assessing pain severity on a scale from zero (indicating no pain) to 10 (indicating worst pain imaginable) [7].

The EQ-5D-3L is a standardized instrument, designed to measure health outcome applicable to a wide range of health conditions and treatments [16]. The questionnaire consists of five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression). The responses record three levels of severity (no problems/some or moderate problems/extreme problems).

The following questions were added to the questionnaire. If treatment was effective, the following options were given: 'complaints never reoccurred', 'minor residual complaints', 'only a temporary effect' and 'was ineffective'. Also, patients were asked about the current function and were given the following options: normal, almost normal, abnormal, and very abnormal and asked if they would undergo the operation again in the same situation. To further decrease the chance of missing data, complications were inquired for during the consultation and this was compared to the data extracted from the electronic patient file system.

Outpatient clinic with physical examination

Range of motion was investigated as well as, swelling, heel/toe walking, pain on palpation at the insertion of the Achilles tendon at the outpatient clinic. Also, the AOFAS was scored, which is a combined patient-reported and physician reported/objective and subjective clinical rating system. The score ranges from 1 to 100 points and is divided into pain, function and alignment. A score of 100 indicates the best outcome [15].

Radiological measurements

Size of the posterosuperior calcaneal exostosis was measured on a standard lateral weight-bearing radiograph by using parallel pitch lines (PPL) (See Fig. 1) [20]. Size will be defined as the largest distance between PPL and the calcaneal prominence, measured in mm perpendicular to the PPL.

Also, the Fowler-Philip angle (FPA), which reflects the relation of the inferior calcaneus to the posterior calcaneus, will be measured (see Fig. 1) [5]. This angle is measured on the lateral view of a weight-bearing ankle image, formed between a line tangent to the posterosuperior border of the calcaneus and the calcaneal tuberosity, and a line tangent to the inferior border of the calcaneus (longitudinal axis of the calcaneus). Its normal range is between 44° and 69°. If the FPA is more than 75 degrees, it is diagnostic of enlargement of the posterior aspect of the calcaneus, as seen in retrocalcaneal bursitis [5].

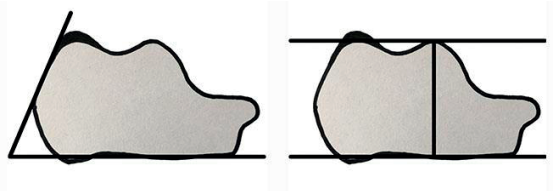

Figure 1. PFA angle (left) and the PPL (right).

Statistical analysis

Analyses of outcome data was mainly descriptive. Continuous outcome measures (e.g. FAOS, NRS, EQ-5D) were presented as mean with standard deviation for data with a normal distribution and as median with interquartile range in case of non-normal distribution or ordinal variables (Ogilvie-Harris score). Distribution of continuous variables was assessed using the Kolmogorov-Smirnov test. Outcome data was presented as boxplot. Descriptive data was presented as frequencies with percentages in case of categorical data. Correlations between radiological measurements and outcome data were assessed using Spearman's rho. Statistical analyses were performed with Statistical Package for Social Sciences (SPSS) version 25.0 (SPSS Inc. Chicago, IL).

RESULTS

In total, 59 patients, who underwent endoscopic calcaneoplasty in the Academic Medical Center between January 1st 2000 and December 31st 2010 for the diagnosis of retrocalcaneal bursitis were extracted from the electronic patient system. Four patients were treated bilateral and were, therefore, excluded.

The response rate was 28 out of 55 (51%). In total, 28 patients were identified as suitable to participate in this study. Of the 28 patients, 17 (67%) patients visited the outpatient clinic and 18 (71%)patients had taken a conventional lateral radiograph of the ankle at outpatient clinic follow-up (See fig. 2 for the inclusion flow-chart). Table 1 presents the characteristics of the participants in the study and non-responders. The median time to follow-up was 101 months (IQR 89-132) and the mean time to follow-up was 113 months (range 69-224, SD 36). Figure 3 presents the median NRS satisfaction of 8.5 (IQR 6-10), NRS pain in rest of 0.5 (IQR 0-6) and NRS pain during running of 1 (IQR 0-7). Figure 4 shows the FAOS subscales scores: Symptoms 84.5 (IQR 58.0- 96.4), Pain 90.3 (IQR 45.1-100.0), ADL 94.9 (IQR 58.1-100.0), Sport 90.0 (IQR 36.3-100.0) and QOL 71.9 (IQR 37.5-93.8). The median EQ-5D-3L was 0.79 (IQR 0.39-1.00). Table 2 shows the outcome of the Ogilvie-Harris score.

In 11 (39%) of the patients complaints never reoccurred and in 6 (21%) patients there were minor residual complaints. Eight (29%) patients experienced a temporary effect and three (11%) stated that the operation was ineffective. In 23 (82.1%) of the patients their current function is (almost) normal.

In retrospect, 17 (61%) of the patients would undergo endoscopic treatment again under the exact same circumstances, 8 (29%) of the patients doubted if they would undergo surgical treatment again and 3 (11%) of the patients would prefer not to undergo this procedure again. Of the three patients that would not undergo the procedure again, one patient was, however, satisfied with the procedure.

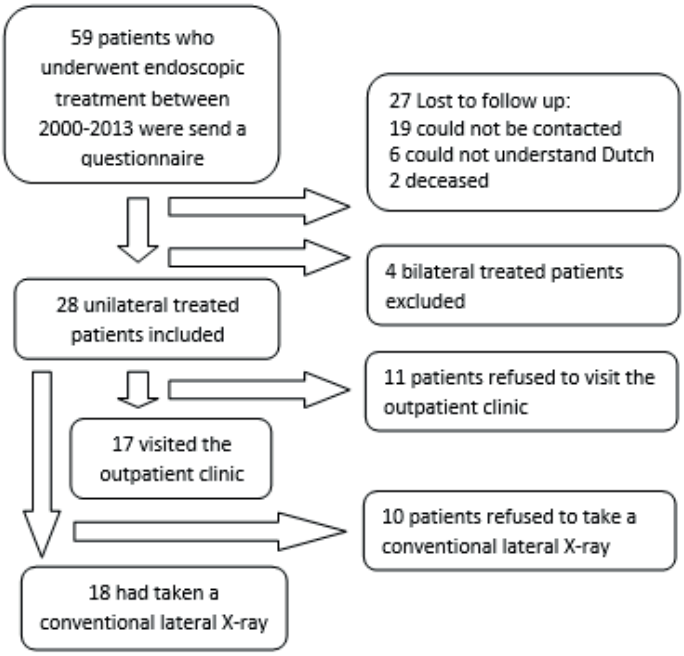

Figure 2. Inclusion flowchart.

Table 1. Characteristics of the participants and non-responders.

	Responders	Non-responders
	N=28 (100%)	N=27 (100%)
Sex		
Male	13 (46.4%)	19 (70.4%)
Female	15 (53.6%)	8 (29.6%)
Age during operation	Median 47 (IQR 34-52)	Median 37 (IQR 28-48)
Body Mass Index	27.7 (IQR 25.3-30.0)	25 (22.4-28.4)
Side		
Left	11 (39.3%)	14 (51.9%)
Right	17 (60.7%)	12 (44.4%)
Duration of symptoms	Months 33 (IQR 14-53)	Months 20 (IQR 12-29.25)
	Years 2 (IQR 1-4)	Years 1 (IQR 1-2.25
Time to follow-up	Months 101 (IQR 88.5-131.8)	Months 122 (IQR 98-163)
	Years 8 (IQR 7-10.75)	Years 10 (IQR 8-13)

IQR, interquartile range

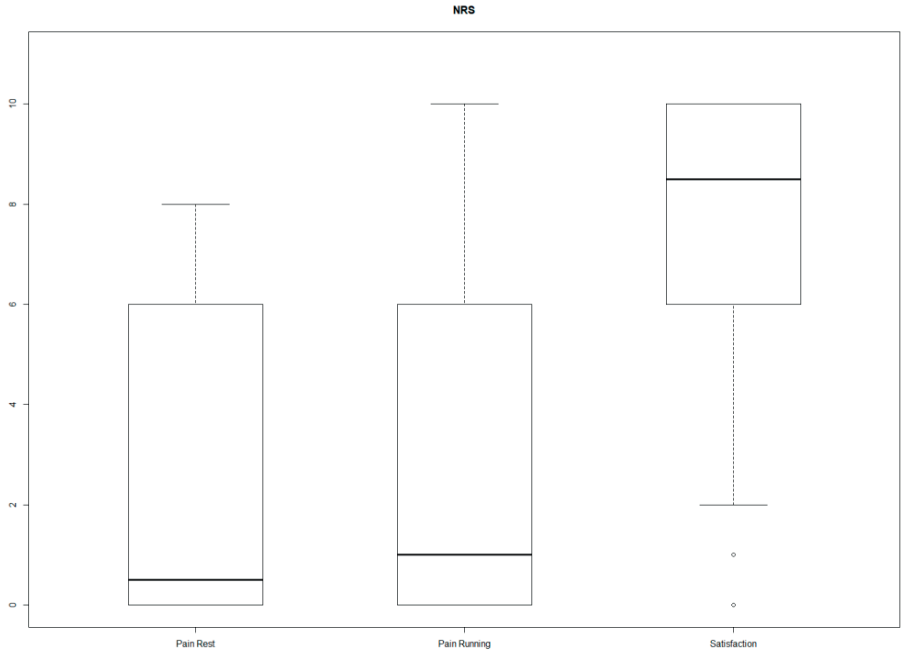

Figure 3 The median NRS satisfaction, NRS pain in rest and NRS pain during running.

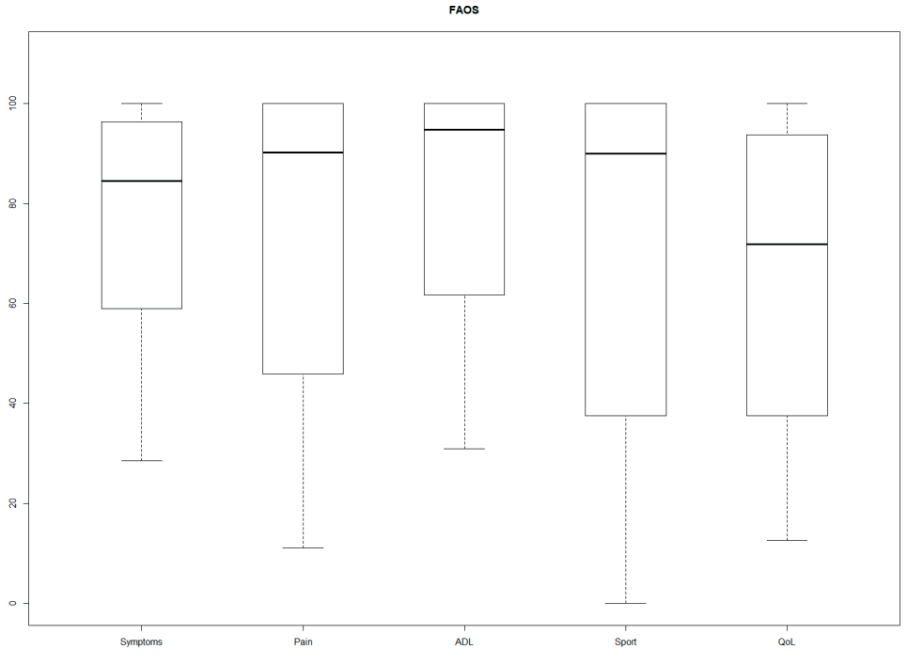

Figure 4. FAOS subscales scores.

Table 2. Outcome of the Ogilvie-Harris score

	Pain	Swelling	Stiffness	Limping	Activity
	N=28 (100%)	N=28 (100%)	N=27 (100%)	N=28 (100%)	N=28(100%)
Excellent	15(54%)	17(61%)	15(56%)	20(71%)	14(50%)
Good	3(11%)	6(21%)	3(11%)	1(4%)	6(21%)
Fair	6(21%)	2(7%)	9(33%)	4(14%)	5(18%)
Poor	4(14%)	3(11%)	-	3(11%)	3(11%)

Physical examination results

Seventeen patients visited the outpatient clinic for a physical examination. During physical examination dorsiflexion and plantarflexion of the affected side, were similar to the unaffected side. The median AOFAS score was 100 (IQR 89-100). Two patients (11.8%) had some swelling, six patients (11.8%) had tenderness on palpation of the insertion of the Achilles tendon onto the calcaneus, and one patient (5.9%) could not walk on heels, because this was too painful.

Radiologic measurements

Table 3 presents the median PLL and PFA preoperative, 2 weeks postoperative and at follow-up. The median PPL difference between before the operation and 2 weeks after the operation was -4mm (IQR -6 and -1) and the median PPL difference between 2 weeks after the operation and at follow-up was +1 mm (0-2). None of the radiological measurements was found to be significantly associated with clinical outcome or satisfaction.

Table 3. the median PLL and PFA preoperative, two weeks postoperative and at follow-up.

	Preoperative	Two weeks postoperative	At follow-up
PPL (mm)*	0 (0-3)	-2 (-3.5,-0.75)	-1 (-2.5-0.5)
PFA (degrees)*	65 (63-69)	66.5 (60.75-70.25)	64 (60.75-65.25)

*Median (IQR).

Re-operation

In two (7.1%) patients re-operation for recurrence of symptoms was performed. The time between the first operation and re-operation was 15 months and 81 months. The first case showed a hypertrophic scar that impinged on the posterolateral edge of the calcaneus and the second case had medial and lateral complaints and an increase of the PPL with 1 mm. After re-operation both patients had an uneventful recovery and no persisting complaints at late follow up.

Complications

There was temporary hypoesthesia of the skin in three (10.7%) patients. No other complications occurred.

DISCUSSION

The most important finding of this study is that there is a high patient satisfaction and good functional outcome after endoscopic calcaneoplasty for the diagnosis of retrocalcaneal bursitis on the long term.

The overall median satisfaction score of 8.5 out of 10 is an excellent score, even as the median AOFAS score of 100. This is supported by the fact that in 82% of the patients their current function is (almost) normal and that the NRS pain scores are very low. However, the FAOS subscales are scored less than excellent which can be due to the fact that 39% of the patients are completely free of symptoms and that 21% was largely free of symptoms. Unfortunately, the response rate of 51% is low, however, the obtained results are of the first patients of this new surgical technique at the time. Therefore, this case series contributes to knowledge, since there is a paucity on literature about the long-term outcome after endoscopic calcaneoplasty.

Nowadays, endoscopic treatment is considered to be superior to open intervention for retrocalcaneal bursitis [28]. A review by Wiegerinck et al. evaluated 397 open surgical procedures and reported a good to excellent patient satisfaction of 77% [2, 17, 19, 28]. In total 150 endoscopic procedures were evaluated and reported a good-to-excellent patient satisfaction of 90%. Possible reasons are quick resumption of activities, better cosmetic outcome and less complications [17, 28].

To our knowledge, the longest follow-up study for endoscopic calcaneoplasty results is published by Kaynak et al. after an average time of 58 months [13]. Their study included 30 feet of 28 patients and state that all patients were satisfied with the results; however, this was based on the question if patients were satisfied at the final follow-up visit. The degree of satisfaction was not measured and a face-to-face interview can result in bias. The average AOFAS score improved from 52.6 (range 24-75) preoperative to 98.6 (range 90-100) postoperative. Our study shows similar results with a median AOFAS score of 100 (IQR 89-100). Jerosch et al. published three studies on their cohort in 2003, 2007 and 2012 [9-11]. In 2012 the average follow-up is 46.3 (range 8–120) months in 164 patients. The clinical examination was performed using the Ogilvie-Harris score of which several parameters were documented: 71 patients presented good and 84 patients excellent results, while five patients showed fair results and four patients only poor results. However, we cannot compare our Ogilvie-Harris score since there are five subscores in the Ogilvie-Harris score, thereby it is a self-reported score by the patient and not a clinical examination score by the doctor. Ortmann reported on 30 heels in 28 patients with a mean follow-up of 35 months (range 3-62). The preoperative AOFAS was filled out retrospective with a mean 62 points (36-77) and postoperative score was 97 (78-100), similar to previous results [17].

In 17 (60%) of the patients, complaints never reoccurred or had minor residual complaints and 23 (82%) had a current function that was (almost) normal, this corresponds to the fact that 17 (61%) would undergo undergo endoscopic treatment again under the exact same circumstances. However, it cannot be explained that eight (29%) of the patients doubted if they would undergo

surgical treatment again and that of these patients, five had no reoccurring complaints or had minor residual complaints.

In the previous endoscopic studies, Kaynak et al. reports no complications, Jerosch et al had 1 superficial inflammation of the skin (0.6%) in the cohort of 164 patients and Ortmann et al reported an Achilles tendon rupture 3 weeks after operation (3.3%) and 1 reoperation (3.3%) because of residual pain and swelling directly postoperative [11, 13, 17]. In line with literature only minor complications occurred in our case series namely temporary hypoesthesia of the skin in three patients (10.7%). There were two re-operations (7.1%), one was due to hypertrophic scarring and the other patient was without symptoms for seven years after the first operation. After recurrence of the complaints, a subsequent endoscopic calcaneoplasty was performed with an uneventful recovery.

Concerning radiography it was stated that the Fowler and Philip angle can be measured, and that an angle of 75 degrees or more would cause symptoms [5]. However, other authors found a poor relationship between the FPA and symptoms [4, 14]. Our study shows a PFA of 65 degrees at baseline, which also disagrees with that statement. The exostosis is located on top of the calcaneus and when operated on, this will not influence the FPA. Thus, angle measurements on a lateral radiograph are considered to be obsolete. The height of the calcaneal prominence is more significant than angle measurements. Pavlov realised this and developed the parallel-pitch lines measurement [20]. During operation we resected 4 mm (IQR 6-1) and at the median follow-up time there was growth of 1 mm, however, this is within the measurement error and is therefore negligible.

Due to the design of this study it was not possible to compare the results at follow-up with pre-operative data, which can cause inherent bias. To that end, it is uncertain to what extend the functional outcome scores improved due to surgical treatment. Also, there is a low response rate of 51% and this small number of patients is a limitation. Every effort is made to increase our response rate, however, this study regards patients that were treated 9-19 years ago. In the meantime, patients had moved and the addresses were unknown. Also, our department is specialized in foot and ankle pathology, hereby six of the patients visited from abroad for treatment and could not be contacted which resulted in a lower response rate.

Outcome of short-term endoscopic calcaneoplasty shows promising results on patients satisfactory, pain scale and the different scales used to assess patient outcome. To our knowledge this is the first study to report on long-term outcome of patients treated by endoscopic calcaneoplasty for retrocalcaneal bursitis. This study contributes to a better knowledge on long-term outcome of endoscopic calcaneoplasty and will aid orthopedic surgeons in counselling future patients affected by retrocalcaneal bursitis.

CONCLUSION

Despite the limited response rate, this study shows high patient satisfaction and good long-term functional outcome in patients affected by retrocalcaneal bursitis who underwent endoscopic calcaneoplasty.

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5 Good results for treatment of flexor hallucis longus (stenosing) tenosynovitis: a systematic review.

K.T.M. Opdam
J.I. Wiegerinck
C.N. van Dijk

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ABSTRACT

Importance: Nowadays, it is unclear what kind of non-operative and operative treatment protocols exist for flexor hallucis longus (FHL) (stenosing) tenosynovitis and to what extent conservative treatment is effective.
Objective: The purpose of this study was to evaluate the literature on treatment of FHL (stenosing) tenosynovitis and to provide an overview of the different treatment options as well as an analysis, evaluation and comparison of their outcomes.
Evidence review: A structured systematic review of literature was performed to identify non-operative and operative therapeutic studies reporting on five or more patients with FHL (stenosing) tenosynovitis. Medline, Embase (Classic), Cumulative Index to Nursing and Allied Health Literature, Sportdiscus and Pedro databases were searched. Two reviewers independently performed data extraction. Extracted data consisted of population characteristics, treatment, outcome of treatment. The primary outcome was success rate. The secondary outcomes were patient satisfaction, complication rate, return to sport and the time to achieve return to sport or full activity after treatment. The Coleman score was used to assess the methodologic quality of the studies.
Findings: Six articles were included. The number of patients in these studies totaled 138 with 151 affected ankles. Overall good results were found for treatment of FHL (stenosing) tenosynovitis. Specific exercises to stretch the FHL are successful in 64%. An injection with 1% lidocaine to inflate the FHL tendon sheath is successful in 33%. If conservative treatment fails, operative treatment can offer a solution. There are open and endoscopic techniques for release of the FHL tendon and all the techniques have a successful outcome. All athletes return to sport after an average of five weeks and 90% of the athletes have a full return to sport after a mean time of four months.
Conclusion: There are many conservative treatment options mentioned for FHL tenosynovitis; nevertheless only outcomes of stretching and lidocaine injections are reported. If conservative treatment does not give sufficient relief of symptoms, operative treatment, by releasing the FHL by an arthroscopic or open technique, offers a safe and effective solution. Thereby, arthroscopic techniques are promising; however, there is a paucity of literature on this issue.
Relevance: It is important to know what kind of conservative and operative treatments are effective for FHL (stenosing) tenosynovitis.

INTRODUCTION

Flexor Hallucis Longus (FHL) tenosynovitis is a relative unknown condition in the general population. It is more common among athletes who perform repetitive forefoot push-offs such as runners [1] and extreme plantar flexion such as dancers [2]. For this reason FHL tenosynovitis is often referred to as dancers' tendinitis [3-6].

The FHL inserts on the posterior fibula and runs to the base of the distal hallux phalanx. At three levels the FHL passes below a retinaculum. At the level of each of these retinacular structures constriction can occur leading to a painful tenosynovitis. The location where the FHL passes below the retinaculum between posteromedial talar process and posterolateral talar proves is where most frequently pathology occurs. However, it has also been reported at the knot of Henry and the intersesamoid ligament [7]. Reports of pathology at the intersesamoïd ligament or at the level of the knot of Henry are anecdotal.

The vast majority of patients with FHL tenosynovitis experience retromalleolar pain due to constriction of the FHL at the level of the fibro-osseous tunnel located between the posteromedial talar process and the posterolateral talar process[8, 9]. The roof of this tunnel is formed by a light retinaculum. In case of a low riding muscle belly, the FHL tendon with its distal muscle fibers are repetitively forced into this narrow tunnel leading to a chronic tenosynovitis[8, 5, 10]. In cases where his overload leads to local thickening of the FHL it can lead to locking of the tendon under the retinaculum.

Pain is the most common presenting symptom. Limitation of the range of motion of the metatarsophalangeal joint can also occur. Pseudo-hallux rigidus can also occur, due to the nodular tenosynovitis. In case of stenosing tenosynovitis of the FHL, patients can have a clicking or stretching sensation, also referred to as trigger toe [11, 12, 9, 13]. On physical examination, a mild diffuse swelling can be identified behind the medial malleolus, sometimes accompanied with local heat [9, 10]. With the patient in sitting position and the ankle in 15 degrees plantar flexion, the patient is asked to flex the big toe repetitively. Thus, the FHL can be palpated behind the medial malleolus in its gliding channel [5]. There is recognizable tenderness on palpation and as the tendon glides up and down, sometimes a nodule can be felt [5].

The initial treatment is non-operative and the conservative treatment modalities consist of rest, icing, modification or restriction of activities, non-steroidal anti-inflammatory drug (NSAID), physical therapy, steroids and orthosis [14, 5, 15]. When non-operative treatment fails, surgical intervention is indicated. There are various surgical techniques depending on location of the pathology and surgical approach. They range from an open, to a minimal invasive, to an endoscopic approach.

Nowadays it is unclear what kind of conservative treatment protocols exist and to what extent conservative treatment is effective. Thereby we want to know the outcome of the different operative treatments. Therefore, the aim of this study was to systematically evaluate the literature on treatment of FHL (stenosing) tenosynovitis and to provide an overview of the treatment options as well as an analysis, evaluation and comparison of their outcomes. The primary outcome was success

rate. The secondary outcomes were treatment, outcome of treatment, patient satisfaction, complication rate, reoperations, return to sport rate and the time to achieve return to sport or full activity after treatment.

METHODS

Search strategy

We performed a systematic literature search of the Medline, Embase (Classic), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Sportdiscus and Pedro databases on July 24th , 2017. We performed the search with the following keywords:

((MH "Flexor Hallucis Longus" OR TI (flexor hallucis longus or FHL) OR AB (flexor hallucis longus or FHL)) AND ((MH "Tendinopathy") OR (MH "Tenosynovitis+") OR (TI tendinopath* or tendonit* or tendinit* or tendinos* or tenosynov* or dysfunction*) OR AB (tendinopath* or tendonit* or tendinit* or tendinos* or tenosynov* or dysfunction*))) OR ((TI dancer* OR AB dancer*) AND (TI (tendonit* or tendinit* or tendinopath* or tenosynov*) OR AB (tendonit* or tendinit* or tendinopath* or tenosynov*))).

Screening of the reference lists of relevant articles was performed to identify any additional articles potentially not identified through the literature search in the databases.

Inclusion and exclusion criteria

Studies that met the following inclusion criteria were reviewed: studies reporting on outcome of treatment of FHL (stenosing) tenosynovitis or patients' satisfaction or complication rate of treatment of FHL (stenosing) tenosynovitis and reporting data of more than five subjects and studies in English, Dutch and German. Exclusion criteria included: reporting on less than six patients, cadaveric studies, reviews, overviews, letters to the editor, expert opinion articles, and language other than English, Dutch and German. In studies that reported on isolated FHL (stenosing) tenosynovitis and on isolated FHL (stenosing) tenosynovitis with additional pathology we only extracted the data of the isolated pathology and if this was not possible the study was excluded. The inclusion and exclusion of the articles was performed independently by two reviewers (KO, JW). Disagreement was resolved after discussion among the reviewers and in consultation with the senior author (CN).

Data extraction and analysis

Data extraction was performed independently by two reviewers (KO, JW). Extracted data consisted of population characteristics, in addition to both primary and secondary outcome measures.

Quality assessment

Quality assessment of the included studies was performed independently by two reviewers (KO, JW). The Coleman methodological Score (CSM) was used to assess methodological quality [16]. The score consists of two parts, with highest possible score of 100. The authors of the score stated that an increase in CMS would show a decrease in effectiveness of the evaluated treatment. It was also described that an increase in CMS had a positive linear correlation with an increase in year of publication. The spearman correlation coefficient (ρ) is calculated for the second hypothesis. Two reviewers (KO, JW) independently performed a validated quality assessment of the included studies. Disagreement was resolved after discussion among the reviewers and in consultation with the senior authors.

Data presentation and statistical analysis

Due to the heterogeneity of the data, results were not pooled. Outcome data were presented per study.

RESULTS

Search results

After the search of the different databases was combined and duplicates were removed, 342 articles remained for review. Thereafter 341 articles were excluded based on other pathology (300), combined pathology (1), no treatment mentioned (13) or due to article formatting (27) . No studies were added after review of the reference list. On the base of the full-text evaluation, 34 articles were excluded. The remaining six articles were included in this systematic review [17-19, 1, 20, 21] (Figure 1).

Population characteristics

The number of patients in these studies totaled 138 (31 male and 81 female) with 151 affected ankles and with a weighted mean age of 32 years (table 1). Of the reported data, 8 ankles were affected on the right side and 14 ankles on the left side. The weighted mean for duration of symptoms was 65.9 months and the weighted mean for time to follow-up was 31.5 months. There were 121 cases of tenosynovitis of the FHL and 30 cases of stenosing tenosynovitis. In total there were 46 athletes, 63 non-athletes and the 11 remaining patients did not state if they participated in sports.

Primary outcome

Succes rate

Gould et al. reported on nine patients with stenosing tenosynovitis of the FHL tendon in the sesamoid area [18]. After failed previous treatment, 1% lidocaine inflation was injected into the proximal sheath and this was successful in three out of the nine patients (33%). Successful meant relief of symptoms with no further treatment necessary. The other six patients undergo tenolysis via plantar approach. The tenolysis was successful in all cases (100%), which meant complete relief of symptoms.

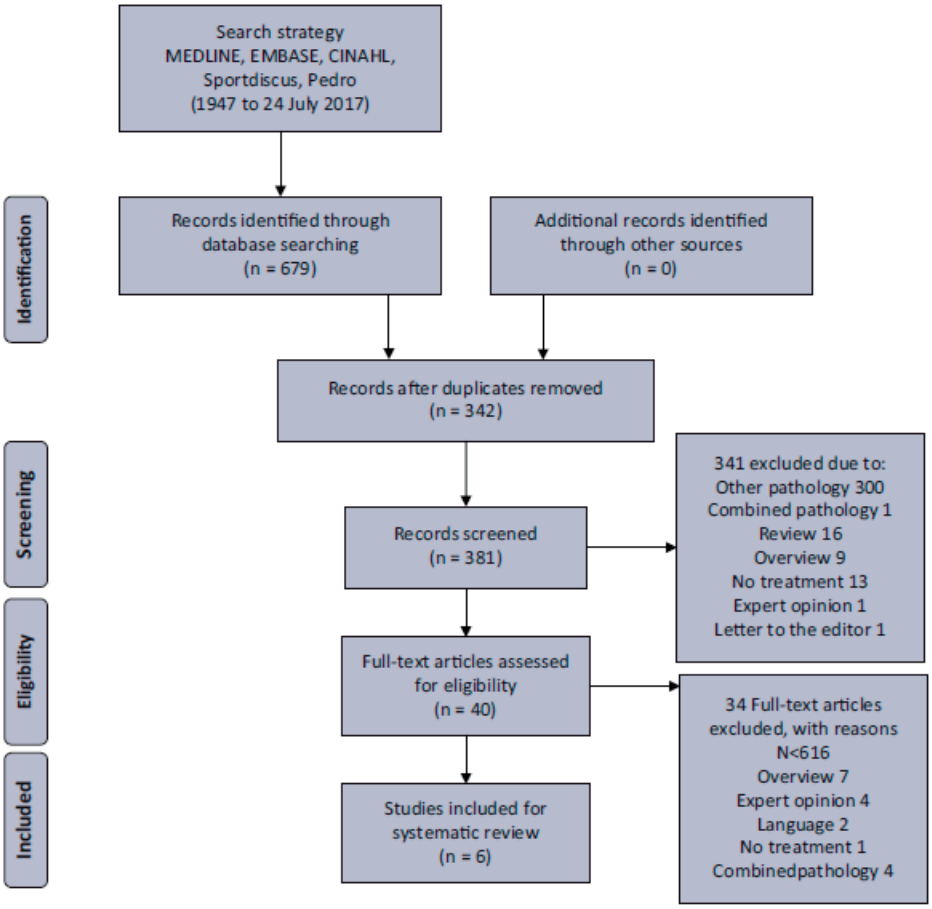

Figure 1. Flowchart of search strategy [27].

Michelson and Dunn reported on a cohort of 81 patients with FHL tenosynovitis [20]. The initial treatment was stretching of the FHL according to a specific protocol. If there was no improvement after the non-operative protocol, a MRI was obtained and operative treatment was considered. The operation consisted of an open release and synovectomy of the FHL posterior to the ankle. In total, 58 patients had solely non-operative treatment and 23 patients had operative treatment. A successful outcome meant that there was a near-complete or complete relief of pain and that the patient was able to return to normal activities without the need for analgesics. Of the 58 patients 37 had a successful outcome (64%), 18 were no better and three felt it got even worse. All of the operatively treated patients had a successful outcome (table 2).

Table 1. Characteristics of the included studies.

Study	Type of population	N patients (N tendons)	Gender (% female)	Affected side (% right)	Age (years)	Diagnosis	Duration of symptoms	Time to FU	Diagnosis made by	Previous conservative treatment
Fiévez et al.[17]	Ballet dancers	15 (28)	-	-	Average 13.5 (12-16)	FHL tenosynovitis crepitans (20) and tenosynovitis stenosans (8)	-	-	Physical examination	Yes, but undefined.
Gould et al.[18]	General population	9 (9)	89%	44%	Average 33 (range 14-68)	Stenosing tenosynovitis	Average 5.9 months	Average 2.5 years	Physical examination	None(4), rest(2), rest/archsupport/ local steroid(1), immobilisation fracture(1), oral steroids/orthosis(1)
Hamilton et al.[19]	Dancers: ballet(8), jazz(1)	9 (9)	56%	-	Average 20.2 (range 16-24)	FHL tendinitis	Average 16.9 months (range3-36)	Average 58.1 months (range3-36)	Physical examination	Modification of activities, NSAID, physical therapy modalities: contrast baths, ultrasound, massage, stretching, ice, and muscle strengthening; and analysis and correction of the patient's dance technique.
Kolettis et al.[1]	Ballet dancers	13 (13)	100%	31%	Mean 20 (range 13-26)	Stenosing tenosynovitis of FHL tendon	Mean 6 months (range 2-12 months)	Mean 6 years and 6 months (range 2-10 years)	Physical examination and X-ray	Restriction of activity, changes in dance technique, FT, administration NSAID, ice baths, corticosteroid injection, use of whirlpool and ultrasound.
Michelson et al.[20]	General population	81 (81)	68%	-	Average 38.3 (SD14.6, range 13-80)	FHL tenosynovitis	Mean 7.3 years (SD 20.3)	Mean 21.3 months (range 6 months to 5 years)	Physical examination	45 out of 81: stretching(10), cast/boot(17), night splint(9), NSAIDS(30), corticosteroid injection(9), surgery(1).
Ogut et al.[21]	General population	11 (11)	-	-	-	FHL tenosynovitis	-	-	Physical examination, X-ray and MRI	-

Table 2. Primary and secondary outcomes.

Study	Success rate conservative treatment	Outcome	Pre-operative scores	Succes rate operative treatment	Post-operative scores	Satisfaction level	Return to sport	Time to return to sport	Complication/re-operation
Fiévez et al.[17]	-	-	-	-	-	-	100% (15/15)	2 months (13/15) and 4 months (2/15)	Reoperation (retinaculum was not totally released distally)
Gould et al.[18]	33% (3/9)	-	-	100% (6/6)	-	-	100% (3/3)	Average 5 weeks	Tendon rupture following trauma one year after treatment wherefore operation.
Hamilton et al.[19]		-	-	-	A questionnaire was used to determine the patient's level of satisfaction with the outcome of the operation	Excellent(7), good(0), fair(0), poor(2)	100% (9/9) and full return to sport 78% (7/9)	Full return to sport time: average 6 months	Slight peroneal weakness(1)
Kolettis et al.[1]	-	-	-	-	-	-	100% (13/13) and full return to sport 85% (11/13)	Mean 5 months (range 2-9 months)	0(0%)
Michelson et al.[20]	64% (37/58)	Cured or improved	-	100% (23/23)	-	-	-	-	-
Ogut et al.[21]	-	AOFAS, MFS	Mean AOFAS: 48.7 Mean MFS:49.6	-	Mean AOFAS: 83.2 Mean MFS: 83.1	-	-	-	-

AOFAS, American Orthopaedic Foot and Ankle Society hindfoot score; FU, follow-up; MFS, Maryland foot scores.

Secondary outcome measures

Treatment

Non-surgical non-invasive treatment

Five out of the six studies report that the patients received conservative treatment ranging from 2 to 6 months [17-19, 1, 20]. The described conservative treatment that patients received earlier which consisted of many different treatment modalities. The mentioned options were: rest, modification/restriction of activities, physiotherapy (ultra-shall, iontophoresis), NSAID, physical therapy modalities: contrast baths, ultrasound, massage, stretching, ice, and muscle strengthening and analysis and correction of the patient's dance technique, ice and contrast baths, use of whirlpool and ultrasound, steroids and orthosis.

Michelson and Dunn are the only authors to describe their conservative treatment protocol [20]. This treatment protocol consist of specific exercises to stretch the FHL. To dorsiflex the first metatarsophalangeal joint, a book was placed under the hallux while the patient was facing the wall and leaning against the wall. The heel stays on the floor and by bending the knee the ankle is also dorsiflexed. This stretch was held for 10 seconds and repeated for 10 times, 3 to 4 times a day. The height of the book was increased to place more tension on the FHL. If there was no effect after 6 weeks, immobilization was instituted consisting of a night splint in addition to the stretching program. If this was ineffective after another 6 weeks, the walking boot was used full-time (23.5 hours per day) for increased immobilization for another 6 weeks.

Other non-surgical options

Injections

Gould *et al* injected 1% lidocaine in nine patients with stenosing tenosynovitis of the FHL after failed previous treatment [18]. A 22-gauge needle was inserted into the proximal sheath alongside the tendon. The 1% lidocaine inflated the sheath and adhesions diffracted until the resistant to the injection ceased. When the solution was felt in the great toe, passive flexion of the toe was done 20-30 times to free the tendon.

Surgical treatment

Out of the six included studies, five studies had an open approach and one study an endoscopic approach [17-19, 1, 20, 21].

Open

A curvilinear incision 1 cm posteromedial at the level of the medial malleolus can be made [17]. The proximal and fibro-osseous tunnel and further distal can be released. Also, a full plantar approach with tenolysis can be performed [18]. Two studies used a 4 cm curvilinear incision posterior to the medial malleolus and released the tunnel proximal to distal [19, 20]. The tunnel can be identified by motion of the great toe or by gently retract the neurovascular bundle anterior.

Table 3. Given conservative treatment, operation techniques and postoperative treatment for FHL (stenosing) tenosynovitis.

Study	Given conservative treatment	Operation technique	Postoperative treatment
Fiévez et al.[17]	-	Open technique: curvilinear incision 1cm posteromedial at the level of the medial malleolus was made. Release of the proximal and fibro-osseous tunnel at the level of the posterior processus tali and retinaculum flexorum and further distal.	0-2 weeks: passive and active exercises, no maximal plantar and dorsal flexion. 2-6 weeks: full weight bearing, stretching and flexibility exercises. After 10 weeks: all ballet exercises may be performed.
Gould et al.[18]	Injection with 1% lidocaine of the tendon sheath and 20-30x passively flexed and extended great toe.	Open technique: plantar full visualization approach with tenolysis.	Not disclosed.
Hamilton et al.[19]	-	Open technique: A four-centimeter curvilinear incision is made posterior to the malleolus at the level of the superior border of the calcaneus. The underlying tunnel is identified by motion of the great toe. The tunnel is then released, proximal to distal, to the level of the sustentaculum tali, and debridement or repair is performed as needed.	A compression dressing is applied and weight-bearing is allowed as tolerated with crutches. The dressing is removed at one week. An active range of motion is initiated as tolerance to pain permits. At two weeks, the patient begins physical therapy consisting of progressive active and passive range-of-motion and strengthening exercises.
Kolettis et al.[1]	-	A five-centimeter curvilinear incision is made inferior to the medial malleolus and directly medial to the subtalar joint. The medial retinaculum is incised over the neurovascular Bundle. Gentle anterior retraction of the bundle reveals the FHL in its sheath. The part of the retinaculum that forms the tunnel for the flexor hallucis longus tendon is divided longitudinally to the level of the sustentaculum tali to allow inspection of the site of impingement at the proximal margin of the tunnel. The excess tenosynovial tissue is excised, and any nodules in the tendon are debrided. Additional release of the retinaculum is carried distally under the sustentaculum tali until free gliding of the tendon is observed.	The patient usually is discharged on the day after the operation and remains non-weight-bearing until the initial follow-up visit, four to seven days after the operation. The splint then is removed, and formal physical therapy (including progressive weight-bearing and range-of-motion exercises) is begun. More exercises are added as healing permits.

Table 3. Given conservative treatment, operation techniques and postoperative treatment for FHL (stenosing) tenosynovitis. (continued)

Study	Given conservative treatment	Operation technique	Postoperative treatment
Michelson et al.[20]	Specific exercises to stretch the FHL. This stretch was held for ten seconds and repeated for ten times, three to four times a day. If there was no effect after six weeks immobilization was instituted consisting of a night splint in addition to the stretching program. If this was ineffective after another six weeks, the walking boot was used full-time (23.5 hours per day) for increased immobilization for another six weeks.	Open technique by Hamilton (see above). Release and synovectomy of the FHL posterior to the ankle.	Immediate full weight-bearing in a removable walking boot. Immobilization discontinued after 2 weeks and increased activities.
Ogut et al.[21]	-	Endoscopic technique: two-portal hindfoot technique by van Dijk. Tenolysis.	Immediately perform exercises and weight-bear as tolerated.

FHL, flexor hallucis longus.

Endoscopic

The endoscopic approach is the two-portal hindfoot technique by van Dijk [22]. Van Dijk *et al* described this technique in combination with a professional ballet dancer who suffered from chronic FHL tendinitis in combination with posterior ankle impingement syndrome. With the patient in prone position a posterolateral portal is made just lateral to the Achilles tendon and at the level of the lateral malleolus. The posteromedial portal is made at the same level and just medial to the Achilles tendon. With this technique, the posterior ankle compartment can be visualized and release of the FHL by detachment of the flexor retinaculum from the posterior talar process and removal of adhesions can be done [21, 22]. (table 3).

Outcome measurements

There is only one study that measured outcome scores of the treatment by obtaining the American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot and Maryland foot scores (MFS) preoperatively and postoperatively [21]. Ogut *et al* described their indications for two-portal hindfoot endoscopy over a period of 6 years. In total, 59 patients were treated by means of a two-portal approach, of which 11 patients for isolated FHL tenosynovitis by means of FHL tenolysis. The preoperative mean AOFAS improved from 48.7 to 83.2 points postoperative. And the MFS from 49.6 to 83.1. However, in all patients, they found FHL tenosynovitis and FHL tenolysis was performed (table 2).

Patient satisfaction

Only one study reports on patient satisfaction. Hamilton *et al* used a questionnaire for determination of the patient's satisfaction level (excellent/good/fair/poor) with the outcome of the treatment which consisted of release of the fibro-osseous tunnel via an open medial approach [19]. In his cohort, nine dancers had isolated tenosynovitis of the FHL. Seven (78%) scored excellent and two (22%) scored poor for satisfaction level.

Complications

Two studies reported no complications [1, 20]. Of the other four studies only half reported their complications [17-19, 21]. Gould reported a rupture following trauma of the FHL, 1 year after the operation. Hamilton reported a slight peroneal weakness in one patient, but it was not reported if this complication was persistent.

Reoperations

Fiévez *et al* reported that one out of the 15 patients needed a reoperation. During the reoperation they came to the conclusion that the retinaculum was not sufficiently released distally [17].

Return to sport and time to return to sport

Gould *et al* report a return to sport of three athletes after an average of 5 weeks [18].

Three other studies report on the full return to sport time (former level of sport) [17, 19, 1]. Fievez *et al* report on 15 ballet dancers who all return to sport, and 13 fully returned to sport after 2 months and 2 after 4 months. Hamilton *et al* reported that al the seven professional dancers fully returned to sport after an average of 6 months. The two amateur dancers did not return to preinjury sports level. Kolettis *et al* report on 13 ballet dancers who all return to sport and 11 out of 13 fully return to sport after a mean time of 5 months (range 2-9 months).

The overall return to sport percentage is 100 and 90% (36/40) of patients return to their previous level in sport. The average time to return to sport is 5 weeks and the weighted mean for time to full return to sport is 4 months (3.92 months).

Methodologic quality

The Coleman methodological scale ranged from 22 to 43 points out of a maximum of 100 points, with a median score of 30.5 points (table 4) [16]. According to our predefined criteria, on the basis of the Coleman methodological scale, all studies were of poor methodologic quality.

In addition, the authors of the CMS stated there is a positive linear correlation between the CMS and the year of publication. We found a rho of 0.55 and a p-value of 0.26 (figure 2).

Table 4. Coleman scores.

Author	Coleman score
Fiévez et al. [17] 1985	22
Gould et al. [18] 1981	31
Hamilton et al.[19] 1996	30
Kolettis et al. [1] 1996	20
Michelson et al. [20] 2005	37
Ogut et al. [21] 2011	43

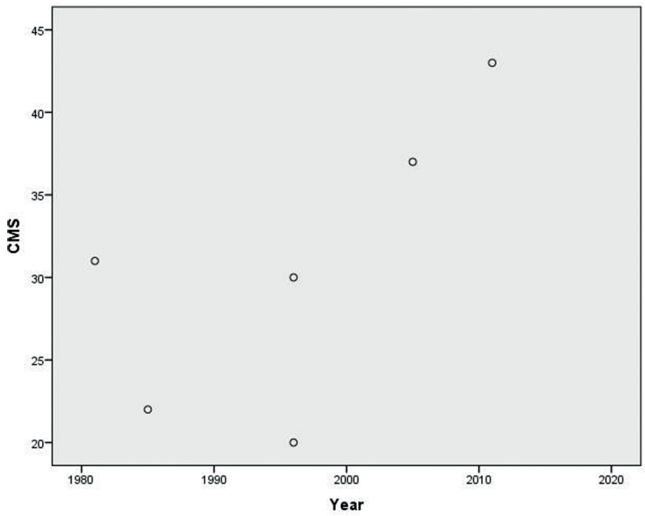

Figure 2. Correlation between the CMS and the year of publication. CMS, Coleman methodological Score.

DISCUSSION

In this review, good results are found for conservative and operative treatment of FHL (stenosing) tenosynovitis. Conservative treatment consisting of a specific stretching protocol of the FHL is successful in 64% and treatment by a lidocaine injection is sufficient in 33% of the cases. The success rate, after operative treatment by a sufficient release of the FHL, is 100%.

To provide an overview of current literature about treatment of FHL (stenosing) tenosynovitis, six studies were evaluated in this systematic review based on success rate, treatment, outcome of treatment, patient satisfaction, complication rate, reoperations, return to sport rate and the time to achieve return to sport or full activity after treatment. Overall, good results were found for treatment of FHL (stenosing) tenosynovitis.

Primarily, patients are treated non-surgical [17, 19, 1, 23, 24]. One study had a specific conservative treatment protocol which included stretching of the FHL and this had a successful outcome in 64%

(37/58) of the patients [20]. However, in literature, we found no other clear conservative treatment protocols.

A 1% lidocaine injection into the proximal sheath along the FHL tendon to inflate tendon sheath is sufficient in one out of three patients (33%) [18]. However, it is speculated that it has more effect on the acute cases than the chronic cases.

The success rate after operative treatment is 100% (n=29) and 78% (n=7) of the patients scored excellent for satisfaction. The differences between studies that use an open technique are excision of tenosynovial tissue, release of total tunnel of the FHL or a partial release. One study states that a complete release was not necessary to achieve unrestricted movement of the FHL tendon and they alert for the possibility of postoperative subluxation [1]. However, to our knowledge, there was no subluxation reported as complication of operative treatment by release. In this same study, the noduli on or within the FHL tendon were debrided, while Hamilton *et al* did not usually excised the noduli since the tunnel had been released and the movement of the tendon was no longer hampered [19].

Ogut *et al* showed that the two-portal hindfoot approach by van Dijk is an effective technique for treatment of numerous posterior ankle pathologies [21, 22]. They reported on 59 patients of which 11 patients were diagnosed with isolated FHL tenosynovitis. FHL tenolysis was performed and postoperative scores were good. Therewithal, they also promulgated to find FHL tenosynovitis in all of the patients. The FHL is often affected when there is other posterior pathology such as an os trigonum or a hypertrofic talar process, presumably due to the close relation. This is supported by Hamilton where 88% (35 out of 41) of the patients with posterior ankle pain had FHL tenosynovitis [19]. Also, Scholten *et al* report symptoms in 63% of their patients involving the FHL tendon in combination with posterior ankle impingement syndrome [25]. Thus, FHL tenosynovitis often coexist with other pathology and therefore the prevalence may even be higher due to lack of recognizing FHL tenosynovitis next to other pathology.

Limitations

The level of evidence of this study is limited by the heterogeneity of study designs and low methodologic quality of the included studies. Although there is some literature available, most of the included studies had small populations and none of the included studies was comparative. Nevertheless, this study is of clinical importance because it provides an overview of the current literature and underscores the need for high-quality studies with clearly defined inclusion criteria and validated outcome measurements [26].

CONCLUSION

There are many conservative treatment options mentioned for FHL tenosynovitis; nevertheless, only outcome of stretching or lidocaine injections is reported. If conservative treatment does not give sufficient relief of symptoms, operative treatment, by releasing the FHL by an arthroscopic or open technique, offers a safe and effective solution. Thereby, arthroscopic techniques are promising; however, there is a paucity of literature on this issue.

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6 The accuracy of an injection technique for flexor hallucis longus tendon sheath: a cadaveric study.

K.T.M. Opdam
X. Madirolas
R. Zwiers
M.P. Terra
F. Reina
C.N. van Dijk

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ABSTRACT

Background: Corticosteroid injections are used in the conservative treatment of Flexor hallucis longus (FHL) tendinopathy. Studies for imaging guided injection are done, however, the accuracy of blind injection has not yet been studied.
Purpose: The aim of this study was to determine the accuracy of a blind injection technique into the FHL tendon sheath.
Hypothesis: We hypothesize that a blind injections technique into the FHL tendon sheath based on only clinical examination has a high accuracy.
Study design: Descriptive cadaveric study.
Methods: Ten ankles of human cadavers were blindly injected with radiologic contrast mixed with methylene blue into the FHL tendon sheath. After injection, a CT scan of each ankle was performed to evaluate the location of contrast material. CT scans were reviewed by a musculoskeletal expert radiologist blinded to the procedure. Anatomic dissection was undertaken to assess the location of the injection.
Results: In nine ankles the radiological contrast was injected in the FHL tendon sheath. In one cadaver there was a technical problem and was therefore excluded.
Conclusion: This study shows that the FHL tendon sheath can be blindly injected based on only clinical examination with high accuracy.

INTRODUCTION

The Flexor Hallucis Longus (FHL) tendon runs deep through the flexor retinaculum in the posteromedial aspect of the ankle. Friction of the FHL in the tunnel below the flexor retinaculum can lead to painful tenosynovitis. Additional factors can contribute to tenosynovitis such as hypertrophy of the FHL muscle belly, a low-riding muscle belly and anatomic anomalies such as a large os trigonum or enlarged posterior talar process [1-3]. FHL tendinitis is common in athletes with repetitive forefoot push offs or with extreme plantarflexion, such as ballet dancers, and therefore is often referred to as dancer's tendinitis [4, 5].

There is a wide variation of conservative treatment options: rest, nonsteroidal anti-inflammatory drug (NSAID), massage, icing, muscle strengthening and analysis and correction of dance technique, steroids, orthosis and stretching the FHL [4, 6, 7]. However, there is little literature on the effectiveness of conservative treatment of FHL tenosynovitis. In case of failure of nonsurgical treatment, surgical treatment can be indicated, consisting of release of the FHL tendon sheath [1, 5, 7-12].

A commonly used treatment modality, is injecting the FHL tendon sheath with corticosteroids. Bergman et al. reported on the use of tenography for evaluation of the FHL sheath in stenosing tenosynovitis of the FHL and found that 76% of the patients had at least a mild symptom relief immediately after injection [13].

Two studies report on ultrasound-guided injections in the FHL tendon sheath, both had a success rate of 100% in 25 cases [14, 15]. Tenography showed adequate placement in 87% of the 39 cases [13]. Another study that accesses the FHL sheath in its course below the sustentaculum talus by using tenography had a 100% success rate in five cases [16]. Even though imaging guidance probably enhances injection accuracy, there is no evidence about the effectiveness of a blinded injection into the FHL tendon sheath.

The aim of this study was to determine the accuracy of a blinded injection technique into the FHL tendon sheath. We hypothesize that injections into the FHL tendon sheath based on only clinical examination have a high accuracy.

METHODS

Ten ankle specimens from human adult cadavers were obtained from the voluntary body donation program of the University of Girona (Department of Medical Sciences, Faculty of Medicine) pursuant to legal procedures and ethical framework governing body donation programs in Spain. All specimens were fresh frozen (-25ºC). None showed scars at the medial side of the ankle. The body donation program anonymity did not allow information regarding age and gender of the specimens. Prior to the injection, specimens were thawed to room temperature. A contrast medium mixed with methylene-blue was injected into the FHL tendon sheath. Injection of radiographic

contrast medium mixed with methylene-blue through a 25-gauge 1.5 in-needle was performed by the senior author (C.D.). The contrast medium was mixed with methylene blue in a 10cc syringe.

Injection technique

In order to identify the tendon, the big toe was repetitively flexed and extended. This was repeated multiple times until the palpating finger behind the medial malleolus had accurately identified the FHL tendon in its gliding channel. (Fig. 1A.). The 25-gauge 1.5 in-needle was inserted in an angle of 45 degrees (Fig. 1B.). The location of the needle was checked, by moving the big toe again and if located correctly, the needle was moving up and down synchronously to the movement of the big toe (Fig. 1C.). The needle was pulled slightly backwards, in order for the needle was not to be positioned into the FHL but just adjacent to it in the tendon sheath. One cc of the contrast with methylene-blue was then injected in the tendon sheath.

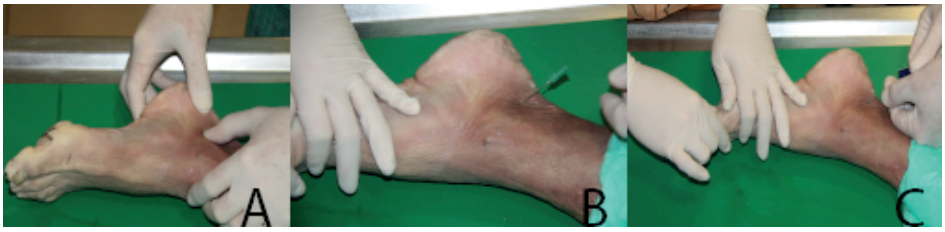

Fig. 1. Palpation of FHL (A). Insertion of the needle (B). Check of the location of the needle (C).

CT imaging and evaluation

Immediately after injection, a CT scan of each specimen was acquired using a CT (type BRIVO CT325 Series 2.34) to evaluate the location of contrast material. High accuracy was defined as more than 80% correct placement of the injection into the FHL tendon sheath according to the assessment of the radiologist. CT scans were anonymized and reviewed by a musculoskeletal expert radiologist blinded to the procedure. The radiologist was asked to determine the location of the contrast medium.

Anatomic dissection

Dissection was undertaken (by F.R., R.Z. and K.O.) to assess the location and diffuse pattern of the injection. The dissections took place four days after injection: meanwhile the specimens had been conserved at four degrees Celsius. The presence of methylene-blue fluid within the desired physiologic space was taken as confirmation of correct placement of the injection. Incorrect placement of the injection was determined by dark blue fluid that did not occupy the anatomic target space on dissection, or if the adjacent neurovascular structures were darkly stained with methylene blue, or if the enveloping tendon sheath was not stained dark blue on dissection.

Ethical approval by the institutional review board approval was not required for this cadaveric study.

RESULTS

Five left sided and five right-sided specimens were studied. In all injected cadavers the FHL tendon sheath, was successfully injected with contrast medium by the injection technique based on only clinical examination as described. In one specimen there was a technical problem. After injecting 0.2 ml, the syringe was empty and needed a refill, however the syringe was stuck on the needle and when trying to disconnect, the needle accidently was removed from the specimen. It was decided not to apply a new infiltration with another 0.8 cc since we anticipated that contrast medium mixed with methylene-blue would leak through the first needle hole. Unfortunately the 0.2 ml could not be detected on CT and therefore we excluded this specimen from further analysis.

CT results

In all nine injected specimens the target structure, the FHL tendon sheath, was filled with contrast medium (see Fig. 2). In eight out of nine there was also minimal contrast medium located near the neurovascular bundle. In two specimens there was also minimal contrast medium located at Kager fat. And one specimen showed contrast in the Flexor digitorum longus (FDL) tendon sheath.

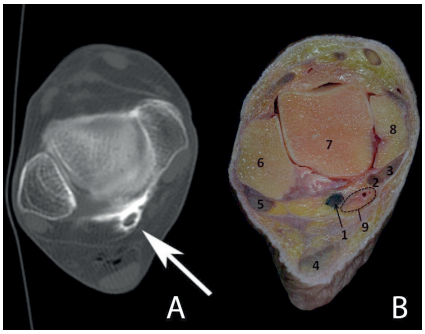

Fig. 2 (A) Axial slice of CT scan with contrast around the FHL tendon. (B) Cross section of a specimen previously injected with black natural colored latex in the FHL sheet. 1. Flexor hallucis longus tendon and synovial sheet; 2. Posterior tibial muscle tendon; 3. Posterior tibial muscle tendon; 4. Achilles tendon; 5. Peroneal tendons; 6. Lateral malleolus; 7. Talus; 8. Medial malleolus; 9. Posterior tibial neurovascular bundle.

Dissection

Anatomic dissection was carried out on two ankles to confirm the location four days after injection (Figs. 3 and 4). The skin and subcutaneous tissue was opened following the trajectory of flexor tendons in the retromalleolar region. Fig. 3A shows the exposition of the flexor retinaculum. It can be observed that the methylene blue did not extravasate the flexor retinaculum. The flexor retinaculum was opened in order to detect methylene blue in the FHL tendon sheath. Fig. 4 shows the opening of the posteriortibial tendon and flexor digitorum longus tendon sheath in order to visualize the absence of contrast. The neurovascular bundle was retracted and the contrast with methylene-blue could be observed within the tendon sheath of the FHL tendon.

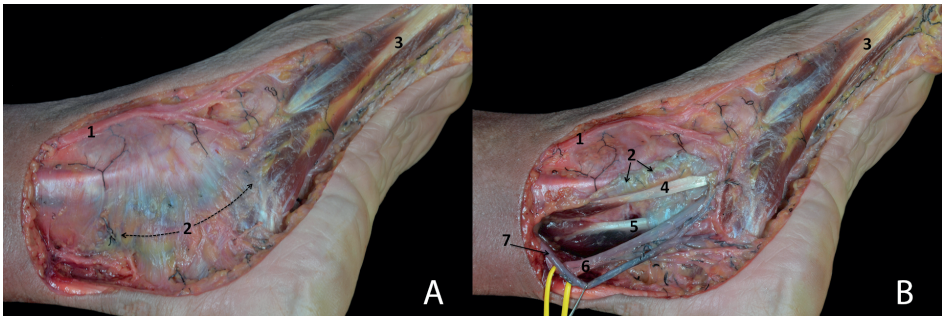

Fig. 3. (A) Dissection of specimen injected in the FHL tendon sheath. (B) The same specimen with the flexor retinaculum opened. 1. Saphena magna vein; 2. Flexor retinaculum; 3. Abductor hallucis muscle tendon. 4. Flexor digitorum longus muscle tendon; 5. Flexor hallucis longus muscle tendon; 6. Tibial nerve; 7. Posterior tibial artery.

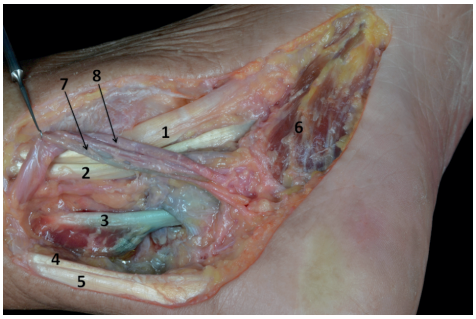

Fig. 4. Location of the methylene blue in the FHL tendon sheet in another dissected specimen. 1. Posterior tibial muscle tendon; 2. Flexor digitorum longus muscle tendon; 3. Flexor hallucis longus muscle tendon; 4. Plantaris longus tendon muscle; 5. Achilles tendon; 6. Abductor hallucis muscle tendon; 7. Tibial nerve; 8. Posterior tibial artery.

DISCUSSION

In all injected cadavers the FHL tendon sheath, was successfully injected with contrast medium by the injection technique based on only clinical examination as described.

In treatment of musculoskeletal diseases the use of corticosteroid injections is widely accepted, even though evidence-based guidelines are lacking, and corticosteroids are routinely injected into soft tissues, tendon sheaths, bursae, and joints. The members of The American Orthopaedic Foot & Ankle Society(AOFAS) were queried about corticosteroid use of foot and ankle disorders in their practices and an average of 21 injections per month per clinician was reported for several indications such as tendinopathy, bursitis, fasciitis or arthritis. Unfortunately, no data about FHL injections was reported [17]. Corticosteroids appear useful in treating overuse syndromes, however, over the years accuracy of blind injections is called into question [15, 18]. There is controversial data on safety of corticosteroid injections. AOFAS members reported complications on skin depigmentation (5.1%),

atrophy (4%), flare reaction (3.5%), plantar fascia rupture (1.5%), and heel-pad atrophy (1.4%) [17]. Similar results were reported on 111 patients with tenography of tendons of the ankle after injection [19]. In conclusion, the complication rate is low and mostly related to the injection site and systemic complications are rarely seen.

Na et al. found that 76% had pain relief after injection [1, 13]. In our experience, patients do benefit from an injection, in particular athletes. If the injection does not have the desired result, releasing the FHL by open or arthroscopic technique shows excellent outcome [9].

The injection can be placed fluoroscopically guided. Na et al. tried to retrospectively correlate tenographic findings with surgery findings, but in 5 (13%) of the 39 tenograms a widespread contrast medium was present or an inadequate opacification of the sheath [13]. This resulted in an adequate placement in 87% of the cases. Gelbert et al. showed a 100% success rate with their tenography technique in five cases. Also, in their department, tenograms showed synovial irregularities that are consistent with synovitis, which were not seen on ultrasound [16]. The disadvantage for this technique is the fact that application of contrast medium is needed and ionizing radiation is used.

Another method is infiltration under ultrasound guidance. Ultrasound guided injections into the FHL tendon sheath provide a real-time image with visualization of the needle and adjacent structures. Visualization can ensure that the injection is placed on the targeted location, but only in experienced hands since there is a learning curve to handle the instrument and interpreting the images. Two studies report on ultrasound guided injections in the FHL tendon sheath. Mehdizade et al. reports on 20 cases that are ultrasound guided and all cases showed distension of the FHL tendon sheaths, which was the end point of a successful injection [14]. Reach et al. performed ultrasound-guided injections into five FHL sheaths. With dissection, the FHL peritendineous injections were 100% accurate [15]. The advantage is the apparent high accuracy. The downside is that the treatment a second visit for the patient and is can only be performed in a center with an experienced radiologist.

In the literature, no other imaging modalities for guidance for FHL tendon sheath injections are reported. Irrespective of the technique used, it is important to realize that there are anatomic variations like interconnections between tendon sheaths and joint cavities. An infiltration of corticosteroid into FHL tendon sheath might result in leakage of corticosteroids into adjacent tendons or joints. Interconnections between FHL and ankle joint has been reported in up to 50% of the patients and connections between FHL and subtalar joint has also been described. In our study, the indirect filling of the FDL was seen in one case.

Eight ankles showed minimal leakage of contrast towards the neurovascular bundle. To our opinion this is clinical irrelevant and would probably also have occurred when injecting with ultrasound or fluoroscopy. However, when injecting and disposing over imaging guidance such as ultrasound, this is probably safer because of visualization of the adjacent structures and confirmation of the location of the injection.

The advantage of a blinded technique without the need of tenography or ultrasound would be that the injection can be given by the orthopedic surgeon in the outpatient department without the need of a scheduling a new appointment.

Limitations

This study had a single 'surgeon' study setup. Although in this study a well-trained experienced surgeon performed the injections, based on the basic procedure the learning curve is expected to be short if one follows the injection technique strategy step by step. In this study we can only draw conclusion about placement of the injection in nine cadavers. We performed dissections of cadavers four days after injection with contrast medium mixed with methylene-blue, which has different dissemination properties than and differs from living tissue.

CONCLUSION

In conclusion, this study shows that the FHL tendon sheath can be blindly injected based on only clinical examination with high accuracy. This is useful information since imaging guidance is not needed. This can save time and is cost effective and is easier in logistics.

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7 Corticosteroid injections in posterior ankle impingement syndrome: a survey of professional and elite student ballet dancers.

K.T.M. Opdam
J. van Loon
R. Zwiers
P.P.F.M. Kuijer
C.N. van Dijk

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ABSTRACT

Posterior ankle impingement syndrome (PAIS) involves pain at the posterior aspect of the ankle, due in dancers largely to repetitive hyperplantarflexion. In daily practice, corticosteroid injection is often used to relieve the pain of PAIS, but little has been recorded with regard to its effectiveness. The primary objective of this study was to determine the effect on pain of corticosteroid injections in professional and elite student ballet dancers with PAIS. The secondary objectives were to evaluate the prevalence of PAIS, the duration of the effect of injection, patient satisfaction with the effect of injection, time to return to class and performance, and ability to dance after injection. All members of the Dutch National Ballet and the National Ballet Academy Amsterdam received a self-administered questionnaire focused on the use and effect of corticosteroid injections in the treatment of PAIS. The response rate was 61% (77 of 126). Of the included dancers, 38% (29 of 77) had suffered from PAIS, and 38% (11 of 29) had received at least one injection. The Numeric Rating Scale (NRS) was used to assess the severity of pain before and 2 and 6 weeks after injections. The median NRS pain before injection was 9.0 (IQR 8.0-9.5), 3.0 (IQR 0.5-6.5) 2 weeks after injection, and 3.0 (IQR 0.5-6.0) 6 weeks after injection. Overall median NRS satisfaction with the effect of injection was 7.0 (IQR 0-10), and satisfaction with the duration of the effect was 5.0 (IQR 2.0-10). It is concluded that there is a high prevalence of PAIS in ballet dancers and corticosteroid injections are regularly used for pain reduction with good results.

INTRODUCTION

Posterior ankle impingement syndrome (PAIS) is a condition in which pain is experienced at the dorsal ankle due to repetitive hyperplantarflexion or trauma, often in combination with anatomical anomalies.[1-3] PAIS is most common in sports and athletic activities involving this type of movement, such as soccer, cricket, high jumping, long jumping, and ballet dancing.[4-6] Of these activities dance accounts for 62% of the prevalence of PAIS, with 58% occurring in ballet.[3] This is due in large part to repetitive hyperplantarflexion during relevé and on pointe positions, resulting in excessive compression of the posterior structures of the ankle. This compressive force can reach 12 times the body weight of the dancer when she is on pointe.[7]

In the literature of dance medicine, the outcome of surgical treatment for PAIS has been described.[8-12] All authors recommend surgery only after a period of conservative treatment has failed. Regarding the efficacy of conservative treatment, however, little has been published since Ribbans et al. in 2015.[1,3,13] The standard conservative treatment options for PAIS are: rest, cessation of activity, technique modification, physical therapy, orthostatic and footwear modification, non-steroidal anti-inflammatory drugs (NSAIDs), and corticosteroid injections.[3] In daily practice, injections are often used. Moser et al.[7] reported that soft tissue lesions can be successfully treated with injection therapy; however, only two studies provide detailed outcomes of corticosteroid injection therapy in athletes with PAIS.[14,15] Both of these studies found that the injections allowed the majority of athletes to return rapidly to athletic activity without surgical intervention. Reports on injection therapy in ballet dancers are lacking.

Our hypothesis is that corticosteroid injections are regularly used and have a positive effect on pain reduction in ballet dancers with PAIS. Therefore, the aim of this study was to evaluate the effect of corticosteroid injections on pain reduction in ballet dancers with PAIS.

METHODS

The study was approved by the ethics committee of the Academic Medical Center in Amsterdam (W16_129#), and reporting was done in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: https://www.strobe-statement.org/index.php?id=strobe-home.

Patient selection and data collection

All 126 members of the Dutch National Ballet and the National Ballet Academy Amsterdam were personally invited after class to participate in the survey. The response rate was 61% (77 out of 126). Of these respondents 57% (n = 44) were members of the Dutch National Ballet and 43% (n = 33) were members of the National Ballet Academy Amsterdam. Table 1 presents the patient characteristics.

Table 1. Patient characteristics

	Overall	PAIS	Dutch National Ballet	National Ballet Academy Amsterdam
	(N = 77, 100%)	(N = 29, 38%)	(N = 44, 100%)	(N = 33, 100%)
Age (Years)	22.7 ± 6.3	25.5 ± 7.2	26.3 ± 6.3	18.0 ± 1.1
Sex: N (%)				
Male	33 (43%)	10 (34%)	19 (43%)	14 (42%)
Female	44 (57%)	19 (66%)	25 (57%)	19 (58%)
Level: n (%)				
1st Solist	7 (9%)	6 (21%)	7 (16%)	0 (0%)
2nd Solist	4 (5%)	1 (3%)	4 (9%)	0 (0%)
Grand Sujet	3 (4%)	2 (7%)	3 (7%)	0 (0%)
Coryphee	5 (6%)	2 (7%)	5 (11%)	0 (0%)
Corps de Ballet	15 (19%)	7 (24%)	15 (34%)	0 (0%)
Eleve	3 (4%)	0 (0%)	3 (7%)	0 (0%)
Junior	7 (9%)	5 (17%)	7 (16%)	0 (0%)
Student	33 (43%)	6 (21%)	0 (0%)	33 (100%)

After providing written informed consent, all participants were handed a self-administrated questionnaire that could be filled out in approximately 10 to 15 minutes. Two weeks later a reminder was sent to enhance response rate. Data were collected in IBM SPSS Statistics software version 25.0 (IBM, Amonk, New York, USA), R version 3.1.3 (The R Foundation, Vienna, Austria).

Primary outcome

The primary outcome was the effect of corticosteroid injections on pain in ballet dancers with PAIS as assessed following the final injection. The Numeric Rating Scale (NRS) was used to quantify the severity of the pain.[16] The NRS is an 11-point scale on which patients quantify the intensity of their pain from zero (no pain) to 10 (worst pain imaginable). The NRS scores were recorded before the first injection and 2 and 6 weeks after the last injection. Clinical reduction of pain was defined as a minimal reduction of two points.[17] Also, the degree of pain reduction was recorded by the patient as completely effective, completely but temporarily effective, partially effective, or not effective.

Secondary outcomes

The duration of effect of the received injections was recorded in terms of satisfaction with effect and duration of effect, time to return to class, and the period of time after injection that performance on stage was possible. Also, to measure the influence of performance during therapy, the questionnaire asked if only training or only performing on stage, or both training and performing on stage was stopped after receiving the last injection. In addition, the use of pain medication was questioned to isolate the effect of the corticosteroid injections on the reported pain.

Satisfaction with the effect of the injections was evaluated by use of the NRS satisfaction scale, from zero (not satisfied at all) to 10 (totally satisfied). Additionally, the participants were asked if they would choose injection therapy again, and how they would rate their ability to dance after the injections, from zero = 'not able to dance' to 10 = 'your lifetime best'.

Follow-up time was measured in weeks by the difference between the date the questionnaire was handed out and date of the last injection.

Statistical analysis

All data were analyzed using descriptive statistics. Continuous variables were presented as mean with standard deviation for data with a normal distribution and as median with interquartile range (IQR) in case of non-normal distribution. Distribution was assessed using the Shapiro-Wilkes test. Categorical variables were presented as frequencies with percentages. Ordinal outcome variables were presented as median and IQR. Differences in pain scores were tested using the Wilcoxon signed ranks test. A p-value of < 0.05 was considered to be statistically significant. Data were collected in IBM SPSS Statistics software version 25.0 (IBM, Armonk, New York, USA), and statistical analyses were performed using SPSS and Rstudio version 0.98.1103 (RStudio, Boston, MA, USA), and R Statistical software version 3.1.3 (The R Project for Statistical Computing, Vienna, Austria).

RESULTS

Of the participating ballet dancers (N = 77), 29 (38%) had been diagnosed with PAIS at some time in their career (Fig. 1). Twenty-three of those were professional dancers and six were elite student dancers. In total, 11 of 29 (38%) received corticosteroid injections (Fig. 2). Ten injections were performed by an orthopedic surgeon and one by a sports physician. The main complaints were pain and range of motion (ROM) restriction (N = 16, 57%), pain only (N = 7, 25%), and ROM restriction only (N = 5, 18%). Twenty-one of 29 (72%) visited an orthopedic surgeon for the PAIS complaints.

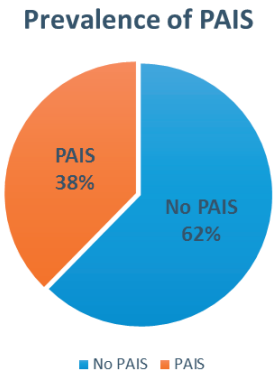

Figure 1 Prevalence of PAIS.

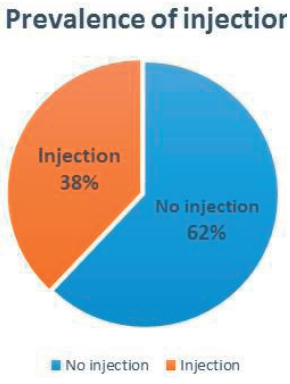

Figure 2 Corticosteroid injections for PAIS.

Primary outcome

Median NRS pain before the final injection was 9 (IQR 8-10), 2 weeks after injection 3.0 (IQR 0-7), and 3.0 (IQR 0-6) 6 weeks after injection (Fig. 3). When compared to the baseline score (before the final injection) both the 2-week and 6-week scores were significant ($p < 0.01$, $p=0.009$, and $p=0.006$, respectively). Corticosteroid injections totally resolved pain in nine of 11 ballet dancers with PAIS, of which three were permanent and six were temporary. Two of 11 had no effect.

Of the injected dancers, nine used pain medication for their complaints. The pain medications used were: non-steroidal anti-inflammatory drugs (N = 5), paracetamol (N = 1), and both (N = 1). Two patients did not specify their pain medication.

Table 2 presents the overall primary outcome, including sub-division by National Ballet and Academy of the National Ballet participants.

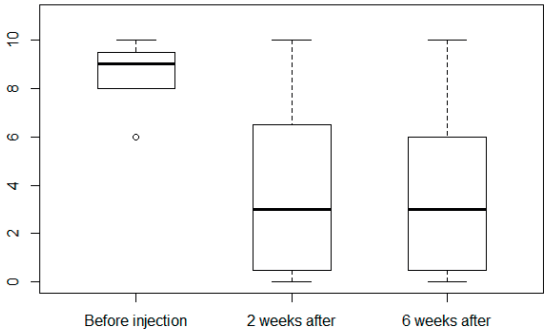

Figure 3 NRS pain before and after corticosteroid injection.

Table 2. Primary Outcome: Effect of Corticosteroid Injection on Pain

	Overall	Dutch National Ballet	National Ballet Academy Amsterdam
	(N = 77, 100%)	(N = 44, 100%)	(N = 33, 100%)
Received injection(s) (N)	11	8	3
Overall %	14%	8%	9%
Pecent of patients with PAIS	38%	35%	50%
Effect of injections on pain			
Complete effect	3 (27%)	3 (38%)	0 (0%)
Partial effect	0 (0%)	0 (0%)	0 (0%)
Temporary effect	6 (55%)	3 (38%)	3 (100%)
No effect	2 (18%)	2 (25%)	0 (0%)
NRS Pain: median (IQR)			
Before injection	9 (8-10)	9 (8-10)	9 (8.5-9)
2 weeks after injection	3 (0-7)	3 (0-8)	3 (2-5)
6 weeks after injection	3 (0-6)	1.5(0-7)	6 (4.5-6)
Use of pain medication: N (%)			
Yes	9 (82%)	7 (88%)	2 (67%)
No	2 (18%)	1 (13%)	1 (33%)

Secondary outcomes

At follow-up, three of 11 patients were free of pain after injection(s) at 2.3 years, 2.9 years, and 5.5 years. The six injections that had a temporary effect on pain had a median duration of 12 weeks (IQR 6-18).

After receiving one injection, one of 11 patients never experienced symptoms again. Three patients were injected a second time and two of them never experienced symptoms again.

Overall median NRS satisfaction with the effect was 7.0 (IQR 0-10), and satisfaction with duration of effect was 5.0 (IQR 2.0-10) (Fig. 4). Overall, six patients would choose to undergo the injection again if necessary and five would not.

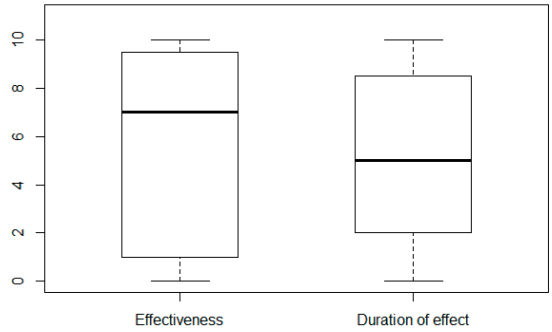

Figure 4 NRS satisfaction with effect and duration of effect.

The median time to return to dance class was 6 days (IQR 2.8-11.0), and time to return to performing was 21 days (5.5-47.5).

The median NRS ability to dance before injection was 3.0 (IQR 1.0-5.0), 2 weeks after 4.0 (IQR 2.0-7.0), and 6 weeks after 5.0 (IQR 4-7). Table 3 presents the secondary outcomes, including subdivision between the National Ballet professionals and students of the Academy of the National Ballet.

Table 3. Secondary Outcomes

	Overall	Dutch National Ballet	National Ballet Academy Amsterdam
	(N = 11, 100%)	(N = 8, 100%)	(n = 3, 100%)
Satisfaction with effect of injection	7 (0-10)	4.5 (0-10)	9 (8-9)
Satisfaction with duration of effect	5 (2-10)	4 (1-10)	5 (4.5-6)
Ability to dance before injection	3 (1-5)	2.5 (0-4.5)	5 (5-6.5)
Ability to dance 2 weeks after injection	4 (2-7)	3 (1-6)	5 (5-6)
Ability to dance 6 weeks	5 (4-7)	5 (3-8)	5 (5-5.5)
Undergo injection again: N (%)			
Yes	6 (55%)	5 (63%)	1 (33%)
No	5 (45%)	3 (38%)	2 (66%)

DISCUSSION

The main findings of our study are that there is a high prevalence of PAIS in ballet dancers, and that corticosteroid injections are regularly used with good results for pain reduction. Similar pain reduction is also seen in the study of Nazarian et al.[2] and Ayhan et al. [18] Nazarian et al. used corticosteroid injection in combination with ultrasound guided percutaneous needle fenestration in 49 patients with anterior or anterolateral soft tissue impingement to achieve a significant mean pain reduction of 4.0 ± 2 on the NRS after an average of 27 months (range: 2 to 63 months). Regrettably, it is not stated how many, if any, of the patients in that study were dancers.

In our study, three of 11 ballet dancers were still free of pain at 2.3 years, 2.9 years, and 5.5 years after injections. This is similar to the studies of Kudas et al.[19] and Robinson et al.[15] Of 12 injected football players suffering from PAIS, four returned to practice without needing surgery and two of 10 soccer players with PAIS were symptom free after sonographically guided injection at a median of 31 months.[15,19] Similarly, the study by Messiou et al. [14] demonstrated that eight of nine athletes symptom free at a median follow-up of 18 months.

The overall median NRS satisfaction with the effect of treatment of 11 patients in our study (7.0) was comparable to that in Nazarian et al., whose 49 patients reported a mean NRS satisfaction of 7.9 ± 2.4.[2]

Our patients median time for return to dance class equals the return to play after 3 weeks of the athletes by Kudas et al.[19] and Messiou et al.[14] Speedy return to play after injection therapy is important to athletes (including dancers), but it must be taken into account that the duration of the effect of corticosteroid injections can be influenced negatively by too early return. Unfortunately, the literature presently contains no validated estimation of what constitutes a "too early return". Therefore, we performed this study to gain some insight into the duration of the effect on pain of corticosteroid injections in dancers, and more specifically to explore whether there are differences in this respect between dancers who stop training and performance, or only training, or only performance.

The overall median NRS ability to dance before injection was 3.0 (IQR 1.0-5.0), 2 weeks after 4.0 (IQR 2.0-7.0), and 6 weeks after 5.0 (IQR 4-7). The dancers who did not use pain medication had a better median NRS ability to dance after injection compared to those who used pain medication. Those scores were 2.5 (IQR 2.0-3.0) before injection, 7.5 (IQR 7.0-8.0) at 2 weeks, and 7.0 (IQR 5.0-9.0) at six weeks, compared to 4.0 (IQR 0.0-5.0), 4.0 (IQR 1.0-5.0), and 5.0 (IQR 3.0-6.5), respectively.

In addition to dealing with pain, loss of ROM was our dancers other main pre-injection complaint. The fact that surgery can result in additional ROM restriction due to scar tissue is one reason our dancers would prefer to avoid it if possible. Thus, injections become especially relevant for this population. However, a study by Zwiers et al.[20] showed that ballet dancers who were treated endoscopically for PAIS had similar results regarding satisfaction and functional outcome as the general population at 5 to 15 years follow-up. Their patients included 13 ballet dancers, 12 suffering from

bony PAIS and one from soft tissue PAIS. They showed high satisfaction on the Foot and Ankle Outcome Score after surgery and 12 of the 13 ballet dancers said they would undergo the surgery again if necessary. Also, they experienced no recurrence after surgery. Even though posterior ankle arthroscopy is a safe treatment option when conservative treatment fails, corticosteroid injections should be considered as a treatment option before surgery is undertaken.

Study strengths and limitations

The strength of our study is that we obtained data from elite level ballet dancers on clinically relevant outcomes such as duration and recurrence of pain, and return to class and performance. The number of PAIS patients included in this study was limited, and given the specific population of the study there is the potential for selection bias such that the results cannot be interpreted for dancers in general. Also, the survey was sensitive for recall bias for the different time points, since this was a retrospective study.

Conclusion

In ballet dancers there is a high prevalence of PAIS, and corticosteroid injections are regularly used with good results for pain reduction. Therefore, corticosteroid injection is a viable treatment option for dancers before surgery becomes inescapable.

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8 Reliability and validation of the Dutch Achilles tendon Total Rupture Score.

K.T.M. Opdam
R. Zwiers
J. I. Wiegerinck
A.E.B. Kleipool
R. Haverlag
J.C. Goslings
C.N. van Dijk

Knee Surgery, Sports Traumatology, Arthroscopy 2018

ABSTRACT

Purpose: Patient-reported outcome measures (PROMs) have become a cornerstone for the evaluation of the effectiveness of treatment. The Achilles tendon Total Rupture Score (ATRS) is a PROM for outcome and assessment of an Achilles tendon rupture. The aim of this study was to translate the ATRS to Dutch and evaluate its reliability and validity in the Dutch population.
Methods: A forward-backward translation procedure was performed according to the guidelines of cross-cultural adaptation process. The Dutch ATRS was evaluated for reliability and validity in patients treated for a total Achilles tendon rupture from January 1th, 2012 until December 31th, 2014 in one teaching hospital and one academic hospital. Reliability was assessed by the intraclass correlation coefficients (ICC), Chronbach's alfa and minimal detectable change (MDC). We assessed construct validity by calculation of Spearman's rho correlation coefficient with domains of the Foot and Ankle Outcome Score (FAOS), Victorian Institute of Sports Assessment-Achilles questionnaire (VISA-A) and Numeric Rating Scale (NRS) for pain in rest and during running.
Results: The Dutch ATRS had a good test-retest reliability (ICC = 0.852) and a high internal consistency (Cronhbach's alpha = 0.96). MDC was 30.2 at individual level and 3.5 at group level. Construct validity was supported by 75% of the hypothesized correlations. The Dutch ATRS had a strong correlation with NRS for pain during running (r = -0.746) and all five the subscales of the Dutch FAOS (r = 0.724 to 0.867). There was a moderate correlation with the VISA-A-NL (r = 0.691) and NRS for pain in rest (r = -0.580).
Conclusion: The Dutch ATRS shows an adequate reliability and validity and can be used in the Dutch population for measuring the outcome of treatment of a total Achilles tendon rupture and for research purposes.

INTRODUCTION

The Achilles tendon is the most frequently ruptured tendon in the human body with an increasing incidence from 4.7/100,000 in 1981 to 32.6/100,000 in 2002 [10]. Optimal treatment of Achilles tendon ruptures remains controversial. Despite extensive research there is still no consensus about the best treatment option for Achilles tendon ruptures, namely operative or conservative treatment [6]. Patient-Reported Outcome Measures (PROMs) are an addition in the evaluation of the treatment of patients in the clinical practice and contribute to research purposes [9].

To date, no Dutch PROM is validated for Achilles tendon ruptures specifically. For the Dutch population, several ankle-specific PROMs are available, such as the Foot and Ankle Outcome Score (FAOS) and Foot and Ankle Ability Measure (FAAM) [16,17,21]. There is one Dutch PROM for patients with Achilles tendinopathy specifically, the VISA-A-NL [20]. However, the VISA-A-NL is only developed for evaluation of symptoms and their effect on physical activity. The advantage of a disease-specific PROM is that it is more sensitive to change compared to a generic health-related quality of life instrument and can therefore measure the outcome after treatment more specific [14,22].

In 2007, a patient-reported outcome measure specific for Achilles tendon ruptures was developed: the Achilles tendon Total Rupture Score (ATRS) [13]. The ATRS is validated in several languages, including English, Danish, Turkish and Persian [1,2,4,8,9].

As there is a lack of validated Dutch instruments for measuring outcome related to symptoms and physical activity after treatment of Achilles tendon ruptures specifically, there is a need for a validated translation of the ATRS for Dutch speaking individuals.

Therefore, the aim of this study was to translate the ATRS to a Dutch language version of the Achilles tendon Total Rupture Score and to evaluate its measurement properties.

MATERIALS AND METHODS

Translation procedure

The validated English ATRS was translated into the Dutch language according to the guidelines of cross-cultural adaptation [5]. Forward translations were performed by two native English speakers who fluently spoke Dutch and the backward translation by two Dutch native speakers who fluently spoke English. A diverse group of 10 volunteers checked for clarity of the wording and meaning of the questions. If there were discrepancies, this was dissolved with discussion.

Reliability and validity evaluation

Patients

Patients treated for a total Achilles tendon rupture from 1 January 2012 to 31 December 2014 in the Academic Medical Center or Onze Lieve Vrouwe Gasthuis were recruited. The eligibility criteria

were: age above 18 years, isolated unilateral Achilles tendon rupture without other serious lower limb injury, and the ability to read, write and understand Dutch. Patients were invited by mail. To optimize the response rate, patients were given the choice to fill in the questionnaire sent to them by mail or by email. Two weeks after completing the first questionnaire, patients again received a questionnaire by mail or by email and were asked to complete the ATRS questionnaire a second time. Only complete ATRS questionnaires were included in the analysis.

Outcome measures

All questionnaires contained the in Dutch translated version of the ATRS, a validated Dutch FAOS, VISA-A and Numeric Rating Scale for Pain in rest and during activity (NRS). For the second questionnaire, one anchor question was added, to determine whether the status of the Achilles tendon complaints had changed. We used the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) checklist for validation of PROMs developed by the COSMIN Initiative [11,12,19].

The Achilles tendon Total Rupture Score (ATRS) is a patient-reported instrument and disease-specific tool designed to evaluate symptoms and physical activity in patients with Achilles tendon rupture. The ATRS is a self-administered instrument and contains ten items, each an 11-points Likert scale (0-10). A maximal score of 100 indicates no symptoms and full function, whereas a minimum score of 0 indicates severe symptoms and major limitations[13]. However, like the English version, the numbers were changed just to not make the patients confused, since they are used to 10 being the worst. Meaning that a minimum score of zero indicates no symptoms and full function, whereas a maximum score of 100 indicates severe symptoms and major limitations.

The Foot and Ankle Outcome Score (FAOS) is a 42-items self-administered questionnaire originally designed to evaluate patients with ankle ligament injuries [15]. The FAOS has thus far been used in patients with lateral ankle instability, plantar fasciitis and Achilles tendon rupture, but was not specifically developed for Achilles tendon pathologies. The FAOS consists of five subscales: pain, other symptoms, activity in daily living (ADL), recreational and sport activities and foot and ankle-related Quality of Life (QOL). In 2014, the FAOS was validated for the Dutch language [16]. Each question in the FAOS is answered on a five-point Likert scale ranging from 0-4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) was calculated for each subscale. If there were one or two answers missing in the questionnaire, it was allowed to substitute the missing value by the mean value of the subscale [15].

The Victorian Institute of Sports Assessment-Achilles questionnaire (VISA-A-NL) is a PROM consisting of eight questions, validated for evaluation of pain, symptoms, and their effect on physical activity specifically in patients with Achilles tendinopathy [20]. The score ranges from 0 to 100, where 0 represent the worst score and 100 the best score.

The Numeric Rating Scale for pain (NRS) is a common and practical method for assessing pain severity in rest and during activity such as running. In this study, a 11-point numeric rating scale was used, where patients are requested to quantify the intensity of their pain on a scale from 0 to 10

with zero indicating no pain and 10 indicating the worst pain imaginable [7]. We assessed the NRS in rest and during running.

Reliability

In this study the reliability was assessed by the internal consistency, the reproducibility (test-retest) and the measurement error. [12].

Internal consistency was defined as the degree of the interrelatedness among the items of the ATRS [12]. To measure interrelatedness among items we used the Cronbach's alpha with 0.7-0.95 assigned as good interrelatedness. [18].

The test-retest reliability was defined as the ability of The Dutch ATRS to measure the same outcome twice in patients with an unchanged state of condition of the complaints [12]. Patients who reported a change in their state were excluded from the test-retest analysis. We assessed the test-retest reliability by calculation of the intra-class correlation coefficients (ICC-agreement, type 3 two-way mixed model) [3]. An ICC of 0 indicated there is no agreement between the two questionnaires, and an ICC of 1 means there was a perfect agreement. An ICC > 0.7 was considered as good agreement [23].

Measurement error was defined as the systematic and random error of a patient's score that is not attributed to true changes in the construct of the ATRS [12]. Measurement error was calculated as the Standard Error of Measurement (SEM) which was calculated as standard deviation (SD)*√(1-reliability coefficient) [23]. From this SEM, the minimal detectable change (MDC) at individual level was calculated as 1.96 * √2 * SEM and the MDC at group level was calculated by dividing the MDC at individual level by √n [23].

Construct validity

Construct validity was defined as the degree to which the scores of the Dutch ATRS were consistent with the hypotheses stated below. [12]. Due to the lack of a 'golden standard', the construct validity of the Dutch ATRS was assessed in terms of consistency to the subscales of the FAOS, VISA-A-NL and NRS in rest and during running [12]. The ATRS was compared with the FAOS subscales, VISA-A-NL and NRS in rest and during running by analysing means of Spearman's correlation coefficients. Correlation coefficients between 0.4 and 0.7 (or between -0.4 and -0.7) were defined as a moderate correlation, coefficients lower than 0,4 or higher than -0,4 unconnected or measuring dissimilar constructs and coefficients above 0.7 or lower than -0.7 as strong correlation [18].

A priori hypotheses on correlation between the Dutch ATRS and the Dutch subscales of FAOS, VISA-A-NL and NRS were formulated to evaluate the construct validity. It was hypothesized that the Dutch ATRS would correlate strongly with the VISA-A-NL, The Dutch FAOS symptoms, FAOS function, FAOS pain, FAOS ADL and NRS during running, because the ATRS is a disease specific tool designed to evaluate symptoms and physical activity and should measure similar construct. Therefore, it was hypothesized that the Dutch ATRS would correlate moderate with the FAOS QOL and NRS in rest since the QOL domain is not disease specific and the NRS in rest is not comparable

to a status of activity. The construct validity was defined sufficient if at least 75% of the results were in correspondence with these hypotheses [18].

Interpretability

Interpretability was defined as the degree to which qualitative meaning can be assigned to the Dutch ATRS quantitative scores or changes in scores [12]. Interpretability was assessed by the distribution and occurrence of ceiling and floor effects. Floor or ceiling effects were considered to be present if more than 15% of respondents achieved the lowest or highest possible score.

Statistical analysis

Variables with a normal distribution were presented as the mean and standard deviation. Variables with a non-normal distribution were presented as the median and interquartile range, and the Kolmogorov-Smirnov test was used for data distribution assessment. Clinimetric properties were calculated as described above. All statistical analyses were performed with Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc. Chicago, IL).

RESULTS

During both of the forward and the backward translation there were no discrepancies in translation to discuss and no adjustments were necessary. Ten volunteers checked the Dutch version of the questionnaire and found the questionnaire to be clear. Appendix I of ESM presents the Dutch ATRS questionnaire.

Questionnaires were sent to 297 patients who were treated for a total Achilles tendon rupture. A total of 105 (35% response rate) patients filled out the questionnaires for the first time. Of these 105 questionnaires, 103 (98%) were complete. Table 1 shows the characteristics of participants within the study and non-responders. The median time between injury and participation in this study was 20 months (IQR 13 – 29). Hereafter, 95 (92%) patients completed the ATRS a second time for the test-retest reliability (see Fig. 1). Test-retest reliability was calculated over 75 patients, since 18 patients reported a change in state of complaints, and in one questionnaire the anchor question was missing and one patient did not fill out the retest ATRS completely. The median time between the questionnaires was 17 days (IQR 15–26).

Missing data

At baseline, four values (0.4%) of the 1050 (10 questions x 105 patients) ATRS questions were missing.

Table 1. Characteristics of present study.

	Non-responders (N=181)	ATRS (N=103)	Retest ATRS (N=75)
	N(%)	N (%)	N (%)
Sex			
Male	139 (76.8)	76 (73.8)	56 (74.7)
Female	42 (23.2)	27 (26.2)	19 (25.3)
Age[a]			
Years	44.3 (SD 13.2)	50.2 (SD 13.6)	51.29 (SD 13.9)
Ankle			
Left	79 (43.6)	50 (48.5)	35 (46.7)
Right	102 (56.4)	53 (51.5)	40 (53.3)
Treatment			
Conservative	103 (56.9)	53 (51.5)	41 (54.7)
Operative	78 (43.1)	50 (48.5)	34 (45.3)
Time since rupture to questionnaire[b]			
In months	16.0 (IQR 8.0-25.0)	20.0 (IQR13.0 – 29.0)	21.0 (IQR14.0-29.0)
Athlete			
Yes		77 (74.8)	56 (74.7)
No		26 (25.2)	19 (25.3)
Questionnaire			
By mail		96 (93.2)	33 (44)
By email		7 (6.8)	42 (56)
Time between questionnaires[b]			
In days			17 (IQR 15-26)

[a]Data in mean (SD)
[b]Data in median (interquartile range)

Reliability

The Cronbach's alpha of the Dutch ATRS was 0.96. The ICC of the test-retest reliability was 0.852. The SEM was 10.91 and the MDC was 30.2 at individual level and 3.5 at group level.

Construct validity

Of the prior hypothesized correlations, 75% was confirmed which indicates a sufficient construct validity. Table 2 presents the correlation coefficients assessed with Spearman's rho between the Dutch ATRS and the Dutch subscales of the FAOS, VISA-A and NRS for pain.

Interpretability

No floor effect was identified, none of the patients achieved the minimum score. Eight of the 103 patients (7.8%) achieved the maximum score.

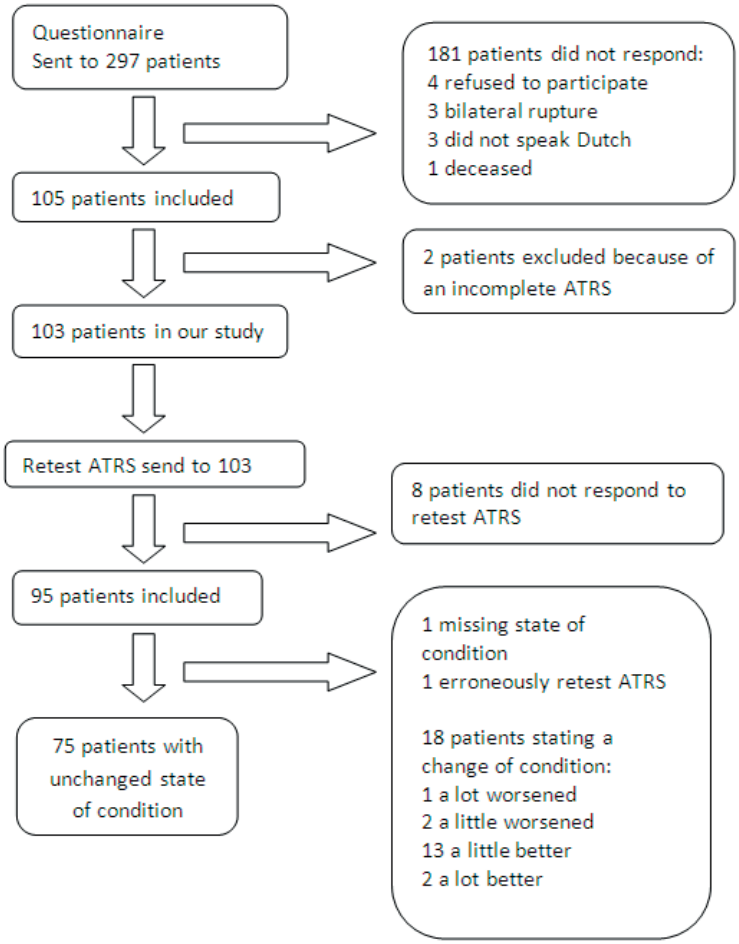

Fig. 1 Inclusion flowchart.

Table 2. Construct validity measured by correlation coefficients.

	ATRS	Hypothesis	Result
FAOS symptoms	0.77	Strong correlation	Strong correlation
FAOS pain	0.72	Strong correlation	Strong correlation
FAOS ADL	0.87	Strong correlation	Strong correlation
FAOS function	0.84	Strong correlation	Strong correlation
FAOS QOL	0.86	Moderate correlation	Strong correlation
VISA-A-NL	0.69	Strong correlation	Moderate correlation
NRS rest	-0.58	Moderate correlation	Moderate correlation
NRS running	-0.75	Strong correlation	Strong correlation

DISCUSSION

The most important finding of this study was that the Dutch ATRS shows an adequate reliability and validity, and can be used in the Dutch population.

The internal consistency of the Dutch ATRS is high (0.96) and the test-retest reliability is good (ICC value of 0.852).

The high internal consistency is in agreement with the previous reported internal consistencies of the ATRS, ranging from 0.89 to 0.96 [4,8,9,13]. Comparison of the test-retest reliability to previously reported data (ranging from 0.908 to 0.986), the ICC in this study was lower. This can be explained by the differences in time interval, ranging from 15 minutes to 21 days of the test-retest assessment in the previous studies [2,4,8,13]. We aimed at a time interval of 14 days for the test-retest assessment since the ATRS is a questionnaire consisting of only 10 items and we wanted to prevent that patients remembered the answers of the first questionnaire. Possibly, the reliability estimates are understated because it is likely that we influenced the ICC due to the fact that 47 patients filled out the first assessment on paper and the second assessment online by which we compromised the reliability assessment. For reliability assessment, it is necessary to fill out the questionnaire twice under the same circumstances, by using the different options of filling out the questionnaire, we could have influenced the test-retest reliability in a negative way.

The SEM in this study was higher in comparison with previous ATRS studies (3.2-6.673). As a result, the MDC on individual level (30.24) is large. This would mean that the questionnaire is not suitable for comparing individual patients since there is a difference needed of minimal 31 points to detect real change. However, the MDC at group level is 3.49 points which makes the ATRS suited for group evaluation. Of the other ATRS validation studies, only Carmont et al. reported an MDC for comparison between groups of 6.75 points [2].

In previous validation studies of the ATRS, the correlation with many different PROMs (FAOS subscales [8,13], VISA-A [4,13], DRI [9], SF-12 [8], SF-36 [4] and EQ-5D [9]) has been determined. We correlated the ATRS with the FAOS, VISA-A and NRS, because those are validated in Dutch and are the most disease specific PROMS available. Construct validity is supported by six out of eight of the hypothesized correlations (75%). The correlation coefficients between the Dutch FAOS subscales and the Dutch ATRS were all strong, even though we expected that the QOL subscale would correlate moderate. Nilsson et al. [13] reported strong correlation with three out of five FAOS subscales (symptoms, sport and QOL) and moderate correlations for the pain and ADL. Kaya et al. [8] also had a strong correlation with three out of five subscales of the FAOS (pain, ADL and sport) and the subscales of symptoms and QOL correlated moderate. It was hypothesized that the Dutch ATRS would have a strong correlation with the VISA-A as well as the Danish and Swedish cohort, but it showed to have a moderate correlation.

None of the patients achieved the minimum score and therefore no floor effect was present which is comparable to the percentages of other studies, which vary from 0 to 1% [4,9]. Only 7,8%

achieved the maximum score which is below the threshold of 15%, in other studies this percentage ranges from to 14% [4,8,9].

The number of missing items was low (0,4%), this can indicate that the questions are clear and are of value to the patient, since questions in questionnaires are often marked as not applicable by the patient or the online assessment could have been of influence.

A problem with validation of PROMS in general is a lack of a gold standard, therefore validity should be interpreted with caution. Although efforts were made to include as many participants as possible, only 105 out of 297 responded to our questionnaire. However, non-responders characteristics were not much different compared to the responders, and nevertheless, we were able to test the reliability. Furthermore, the time since rupture differed from 1 to 43 months after treatment which is a wide spread in time after injury and probably affects the results by making the group more heterogonous, because in daily practice evaluation only takes place after short time after rupture. However, the Dutch ATRS can be used in the Dutch population for group evaluation of treatment of a total Achilles tendon rupture and for research purposes. A next step for future studies is to assess responsiveness and to determine the minimum clinically important differences.

CONCLUSION

In conclusion, the Dutch ATRS shows an adequate reliability and validity, and can be used in the Dutch population for group evaluation of treatment of a total Achilles tendon rupture and for research purposes.

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APPENDIX I DUTCH ATRS

Achillespees Ruptuur Score (ATRS)

Alle vragen hebben betrekking op uw beperkingen/moeilijkheden met betrekking tot uw aangedane achillespees.
Plaats een kruisje in het hokje dat het beste bij uw niveau van beperking past.

De schaal loopt van 0 (geen problemen) tot 10 (onmogelijk).

1. Wordt u beperkt door een verminderde kracht in de kuit/achillespees/voet?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

2. Wordt u beperkt door vermoeidheid/een vermoeid gevoel in de kuit/achillespees/voet?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

3. Wordt u beperkt door stijfheid/een stijf gevoel in de kuit/achillespees/voet?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

4. Wordt u beperkt door pijn in de kuit/achillespees/voet?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

5. Wordt u beperkt tijdens activiteiten in het dagelijks leven?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

6. Wordt u beperkt/ ondervindt u moeilijkheden bij het lopen op oneffen ondergrond.

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

7. Wordt u beperkt wanneer u snel een trap of heuvel op loopt?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

8. Wordt u beperkt tijdens activiteiten waarbij u moet rennen?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

9. Wordt u beperkt tijdens activiteiten waarbij u moet springen?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

10. Wordt u beperkt bij het verrichten van zwaar lichamelijk werk?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Geen Probleem Onmogelijk

Totaalscore:_____

9 General discussion

TERMINOLOGY

Several Achilles tendon related disorders can be distinguished and for each pathology different definitions and terms or eponyms arose over time. As a result, the terminology for Achilles tendon related disorders is inconsistent and confusing. Maffulli et al. advocate using the term tendinopathy to describe clinical overuse conditions around the tendon, which is a combination of pain, swelling and impaired performance. Depending on the affected tissue, the terms tendinopathy, paratendinopathy or pantendinopathy were proposed. [1] In 2011, terminology for Achilles tendon related disorders was proposed based on anatomic location, symptoms, clinical findings and histopathology to effectuate uniform and clear terminology. [2] The following five terms were proposed: mid-portion Achilles tendinopathy, insertional Achilles tendinopathy, Achilles paratendinopathy, retrocalcaneal bursitis and superficial calcaneal bursitis. Also, it was proposed to depart from eponyms because using eponymous terms is an inaccurate and unreliable method of communication. [3-5] Uniform terminology provides the ability to communicate with a universal language in daily practice amongst clinicians and researchers. **Chapter 2** evaluates the current terminology used and assesses the influence of the latest proposals on the terminology used for Achilles tendon related disorders in both daily practice and literature. It consisted of two parts: a survey among orthopedic surgeons and a literature search. The study showed that terminology for Achilles tendon related disorders according to the latest proposals based on anatomic location, symptoms, clinical findings and histopathology is being used by the majority of orthopedic surgeons in daily practice and is increasingly being used in literature. However, eponyms are still frequently used in Achilles tendon related terminology. A possible reason for this is the ingrained use of the eponym Haglund. Eponymous terms are often used in clinical settings and are passed onto the residents and students. [3, 6] Is this because medical professionals are proud of their predecessors? Maybe this eponymous nomenclature has become lasting? [6] Or is it negligence because of the wide variation of terms? Chapter 2 creates awareness of used terminology. However, it is insufficient to pursue just uniformity in the use of terminology. There should be a guideline for diagnoses of Achilles tendon related disorders where the correct terminology is used. This guideline should be based on scientific literature and formed by specialists in the field, preferably worldwide. Also, authors of original research articles should at least be familiar with the clinical definitions and clearly define the condition to create clear terminology. In addition, errors or uncertainties of nomenclature need to be corrected in the peer review process before publication.

MID-PORTION ACHILLES TENDINOPATHY

Mid-portion Achilles tendinopathy is frequently seen in the Dutch primary care setting with an incidence rate of 2.35 per 1.000 per year in the adult population. [7] Mid-portion Achilles tendinopathy is a clinical diagnosis characterized by pain and swelling located at 2-7 cm from the

insertion onto the calcaneus, often combined with impaired performance. [2] The actual cause of pain is still unknown. If patients are unresponsive to conservative treatment, surgical treatment is indicated. [8] In 2016 a comprehensive systematic review on outcomes of surgical treatment for mid-portion Achilles tendinopathy was performed. [9] Twenty-three studies were grouped into five types of procedures: open surgery, minimally invasive tendon stripping/tenotomies, endoscopic procedures, open surgery for gastrocnemius lengthening, open surgery for resection of the distal Achilles tendon, followed by interposition of the flexor hallucis longus (FHL) tendon. Limited understanding of the exact pathophysiology has largely contributed to the large variation in techniques for the first three groups: release of the Achilles tendon, debridement of degenerative tissue, longitudinal tenotomies, a combination of debridement of degenerative tissue and longitudinal tenotomies, excision of degenerations followed by side-to-side sutures, release of the Achilles tendon and excision of the plantaris tendon, longitudinal tenotomies with additional release of adhesions by infiltration, debridement of the paratenon with additional release of the plantaris tendon or additional longitudinal tenotomies. It was concluded that minimally invasive and endoscopic procedures yield lower complication rates with similar patient satisfaction in comparison with open procedures. Nevertheless, no conclusion was drawn about the preferred surgical technique.

It is hypothesized that intratendinous degeneration and nodular thickening of the Achilles tendon without appropriate healing are the cause of pain. Performing multiple tenotomies would relieve symptoms by increasing the blood supply and thus the presence of viable cells that can improve the healing process of the Achilles tendon. [10, 11] The thought that degeneration of the tendon is the main cause of the pain is questionable. [12] Literature suggests that the intratendinous structure changes and thus restoration of the Achilles tendon is not required for improvement of symptoms and that intratendinous changes can exist without symptoms. [13, 14]

Another theory is that the causes of pain are the neovascularizations and accompanying ingrowth of nerve fibers in combination with the adhesions from the plantaris tendon to the Achilles tendon. [12] Normally, the plantaris tendon can move freely in relation to the Achilles tendon, however in case of mid-portion Achilles tendinopathy, the inflammatory response of the paratenon causes adhesions between those two structures wherefore release can help to alleviate symptoms. [4, 15-17] It is important to recognize mid- to long-term results of the various techniques that have shown good short-term outcome. Long-term results are important when the degenerative lesion is left untouched. **Chapter 3** shows a high mid- to long-term patient satisfaction and good functional outcomes in terms of patient reported outcome measures (Foot and Ankle Outcome Score (FAOS) and Victorian Institute of Sport assessment for the Achilles tendon (VISA-A) in patients affected by mid-portion Achilles tendinopathy who were endoscopically treated by means of release of the paratenon in combination with transection of the plantaris tendon. [18] This supports the theory that the intratendinous degenerative lesions can be left untouched. It is therefore advocated to not perform tenotomies, as it is reported that the calf circumference and ankle plantarflexion strength are not fully restored after multiple tenotomies. [10] Also, in patients with mid-portion Achilles tendinopathy, the plantaris tendon is morphologically affected in a comparable way as the Achilles

tendon. There is sensory innervation of the connective tissue in the plantaris tendon tissue proper that can explain that plantaris resection helps to alleviate symptoms. [15, 16] Therefore, resection of the plantaris tendon should be the standard in treatment for mid-portion Achilles tendinopathy.

RETROCALCANEAL BURSITIS

Retrocalcaneal bursitis is an inflammation of the bursa between the superoposterior aspect of the calcaneus and ventral side of the Achilles tendon caused by repetitive compression resulting in painful swelling, medial and lateral to the Achilles tendon at the level of the posterosuperior calcaneal prominence. [2] If patients are unresponsive to conservative treatment, surgical treatment can offer a solution. Open procedures consist of osteotomies or excision of excessive bone of the calcaneal prominence with a variation of approaches. Nowadays endoscopic treatment is considered to be superior to open interventions for retrocalcaneal bursitis. [19] The inflamed retrocalcaneal bursa and the bony prominence of the calcaneus on the impingement site are removed under visualization. Patients are more satisfied, the rehabilitation period is shorter, resumption of daily activities is quicker, the cosmetic results are better and there is a lower complication rate compared to an open procedure. In a systematic review on the outcomes of surgical treatment of chronic retrocalcaneal bursitis, the one major complication in 150 endoscopic procedures was an Achilles tendon rupture three weeks after the operation. [20] There is better visualization during endoscopic calcaneoplasty. A smaller resection volume is seen in endoscopic versus open bone resection which reduces the risk of weakening the insertion. [21] A biomechanical study compared postsurgical pullout strength following endoscopic calcaneoplasty and midline tendon-splitting approach in cadaveric specimens. The postsurgical pullout strength following endoscopic calcaneoplasty was significantly higher than that for midline tendon-splitting calcaneoplasty, approximately three times, whereby it appears that the endoscopic technique preserves the native Achilles tendon strength. [22] Short-term outcome of endoscopic calcaneoplasty already showed good results. [23, 24] In **chapter 4** mid- to long-term results of endoscopic calcaneoplasty were reported, showing a high patient satisfaction and good long-term functional outcome in terms of the FAOS and the American Orthopaedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale in patients affected by retrocalcaneal bursitis who underwent endoscopic calcaneoplasty. With these good results on the long-term, endoscopic calcaneoplasty should be preferred over open surgery.

FLEXOR HALLUCIS LONGUS (STENOSING) TENOSYNOVITIS

Flexor hallucis longus (FHL) (stenosing) tenosynovitis is relatively unknown in the general population but more common among athletes who perform repetitive forefoot push-offs. [25] The majority of patients with FHL tenosynovitis experience retromalleolar pain due to constriction of the

FHL at the level of the fibro-osseous tunnel. The purpose of **Chapter 5** was to evaluate the literature on treatment of FHL (stenosing) tenosynovitis and to provide an overview of the different treatment options as well as an analysis, evaluation and comparison of their outcomes. There are many conservative treatment options reported for FHL (stenosing) tenosynovitis, but only of stretching and lidocaine injections the outcomes are reported. A lidocaine injection into the proximal sheath along the FHL tendon to inflate the tendon sheath is sufficient in one out of three patients. Stretching of the FHL had a successful outcome in 64% of the patients. [26, 27]

Five open techniques were described and one endoscopic technique for release of the FHL tendon. [28, 29] Two studies reported a success rate of operative treatment and both were 100%. All athletes returned to sport after 5 weeks. Ninety percent of the athletes have a full return to sport after a mean time of 4 months. However, of the included studies, the study designs were heterogeneous and the methodologic quality was low whereby the level of evidence of this study is limited. There is a lack of evidence in the literature. Most of the included studies had a small number of included patients. Also, none of the included studies was comparative. Nevertheless, this study gives a review of the available literature and shows that there is a need for high-quality prospective studies which use inclusion criteria that are clearly and outcome measurements that are validated.

As stated in the previous paragraph, injection therapy for FHL (stenosing) tenosynovitis had good results in 33% of the cases. [27] Ultrasound guided injections in the flexor hallucis longus tendon sheath resulted in 100% success rate in two studies with 25 cases. If tenography was used an adequate injection placement of 87% was reported. [30-32] These studies reported on image-guided injections, however, performance of blind injection based on clinical examination and thus without image-guided techniques have not been evaluated. The argument for imaging guidance is increased accuracy and thus maximization of clinical benefits of this injection. Literature showed that for subacromial impingement syndrome in the shoulder, ultrasound-guided injections provide no additional clinical benefit over unguided injections. [33, 34] Ultrasound guided injections provide a real-time image with visualization of the needle and adjacent structures, but only in experienced hands of a radiologist since there is a learning curve to handle the instrument and interpreting the images. Image guiding comes with additional costs. **Chapter 6** showed that the FHL tendon sheath could be injected without ultrasound guidance and placement only based on clinical examination with a 100% success rate. This blinded technique is useful since it is time and cost effective and imaging devices are not required. Routine use of image guiding is therefore not necessary.

POSTERIOR ANKLE IMPINGEMENT SYNDROME

Posterior ankle impingement syndrome (PAIS) is a pain syndrome that is experienced at the posterior aspect of the ankle on forced plantarflexion. PAIS is most common in sports and athletic activities involving repetitive hyperplantarflexion such as soccer and ballet dancing. Open and endoscopic surgical procedures for PAIS yield good outcome. Endoscopic treatment seems superior

to open procedures in terms of complication rates and time to return to full activity. [35] Even though we know that posterior ankle arthroscopy is safe and effective for treatment of PAIS, first conservative treatment should be considered.

In daily practice corticosteroid injections are often used for PAIS, however reports on the effect on pain are lacking. [36-38] Robinson and Bollen evaluated the efficacy of steroid and anesthetic injections in ten elite soccer players suffering from PAIS. [38] All returned to previous level of sport within three weeks after injection. An os trigonum was found in two subjects, of which one was symptom free after a second injection and the other after endoscopic resection of the os trigonum and synovitis after one failed injection. Messiou et al. showed that eight out of nine athletes were asymptomatic after injection at a follow-up of 18 months. [37] And Kudas et al. described 26 cases of PAIS in elite football players of which conservative treatment was effective in 2/3 of the cases. [39] When an athlete experiences PAIS, it is important that he is free of complaints as soon as possible and that he is not delayed in performing with time consuming conservative or surgical treatment. It is important to know what can be expected of a treatment, especially when the professional career is relatively short. [40] In **chapter 7** it was hypothesized that corticosteroid injections are regularly used and have a positive effect on pain reduction in ballet dancers with PAIS. It is concluded that there is a high prevalence of PAIS in ballet dancers of 38% and corticosteroid injections are regularly used for pain reduction with good results. This retrospective survey with a small number of patients is a start for future research. There is a lack of literature on the difference in outcome of conservative treatment of the different types of impingement, such as pain, time to return to sport or recurrence rate. A prospective study is required to inform the ballet dancers with hard facts about the outcome of corticosteroid injection therapy on pain and return to dance in different types of PAIS.

PATIENT-REPORTED OUTCOME MEASURES

A valid, reliable and responsive patient-reported outcome measure (PROM) can measure "the value" from a patient's perspective and provide better information for value-based healthcare. [41, 42] Worldwide there are up to 50 PROMs in the field of foot and ankle diseases. [43] In the Dutch language, the Foot and Ankle Outcome Score (FAOS) and the Foot and Ankle Ability Measurement (FAAM) are validated as foot- and ankle-PROMs. The Manchester Foot Pain and Disability Index (MFPDI) and the 5-point Foot Function Index (FFI-5pt) are validated as foot-PROMs. There are two disorder-specific PROMs, namely, the Victorian Institute of Sports Assessment-Achilles (VISA-A) for Achilles tendinopathies and the Foot Impact Scale for Rheumatoid Arthritis (FIS-RA). [44]

In 2007, a PROM specific for Achilles tendon ruptures was developed: the Achilles tendon Total Rupture Score (ATRS). [45] **In chapter 8** the ATRS was translated to Dutch and its reliability and validity in the Dutch population was evaluated. The ATRS has an adequate reliability and validity. It can be used in the Dutch population for measuring the outcome of treatment of an Achilles

tendon rupture and for research purposes. However, the minimal detectable change (MDC) at the individual level was low. Our study did not assess the responsiveness or the minimum clinically important differences. Recently, Dams et al. investigated the responsiveness of the Dutch ATRS and concluded that the Dutch ATRS is responsive to change in the clinical follow-up period (3 and 6 months) after Achilles tendon rupture. [46] The Dutch ATRS can be used for longitudinal research and has the ability to detect changes over time, as reflected by its responsiveness, which is useful for clinical use. [47] Also, in addition to the disorder-specific PROMs, there are the generic PROMs that relate to the patient's general health and quality of life, like for example the SF-36 and the EQ-5D. [48, 49] All these PROMs can help refine surgical indications or improve shared-decision making. The downside however are the expenses. Furthermore, filling out the forms is time consuming and a burden to the patient.

The National Institutes of Health (NIH) invested in Patient-Reported Outcomes Measurement Information System (PROMIS®) to overcome these limitations. PROMIS® was developed using item databases and computerized adapted testing (CAT). [50] An item database is a set of questions that measure the same construct. The items are placed in order of difficulty using the item response theory. The CAT selects the next question. This question is easier or more difficult, based on the patients' response to the previous question. The Dutch–Flemish PROMIS Group was established in 2009, to implement PROMIS® in the Netherlands and Flanders. PROMIS® results in more relevant questions, shorter questionnaires and a reliable score, however, it consists of generic PROMs only and major strides are still required to cover all constructs. [51, 52]

CONCLUSIONS

1. The revised terminology for Achilles tendon related disorders based on anatomic location, symptoms, clinical findings and histopathology is used by the majority of orthopedic surgeons and is increasingly used in literature. However, the indistinct Haglund eponyms are still frequently used in Achilles tendon related terminology.
2. There is a high patient satisfaction and good functional outcomes in patients affected by mid-portion Achilles tendinopathy who were endoscopically treated by means of release of the paratenon in combination with transection of the plantaris tendon on the mid- to long-term.
3. Patients affected by retrocalcaneal bursitis who underwent endoscopic calcaneoplasty show high patient satisfaction and good long-term functional outcome.
4. Based on current best available evidence, there are many conservative treatment options mentioned for FHL tenosynovitis. Nevertheless, only outcomes of stretching and lidocaine injections are reported. If conservative treatment does not give sufficient relief of symptoms, operative treatment, by releasing the FHL by an arthroscopic or open technique, offers a safe and effective solution. Thereby, arthroscopic techniques are promising. However there is a paucity of literature on this issue.

5. The FHL tendon sheath can be blindly injected based on only clinical examination with high accuracy. This is useful information since imaging guidance is not needed. This saves time, saves costs and is easier logistically.
6. In ballet dancers there is a high prevalence of posterior ankle impingement syndrome (PAIS). Corticosteroid injections are used regularly with good results for pain reduction.
7. The Dutch Achilles tendon Total Rupture Score (ATRS) shows an adequate reliability and validity, and can be used in the Dutch population for measuring the outcome of treatment of an Achilles tendon rupture and for research purposes.

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10 Summary (English and Dutch)

SUMMARY

The aim of this thesis is to provide insight into terminology use, treatment and outcome of different causes of hindfoot pain.

Hindfoot pain can be caused by a variety of pathologies and chapter 1 is an introduction about the addressed issues of this thesis.

It is necessary to have uniform terminology because it provides the ability to communicate with an universal language in daily practice amongst clinicians and researchers and will lead to the best available scientific-based treatment in clinical practice. Therefore, it is necessary to know the current status of the terminology used in daily practice and in literature. Chapter 2 evaluates the current terminology in daily practice and in literature and assess the influence of the latest proposal on the current terminology used for Achilles tendon related disorders. It consisted of two parts: a survey among orthopaedic surgeons and a literature search. It is concluded that the revised terminology for Achilles tendon related disorders based on anatomic location, symptoms, clinical findings and histopathology is used by the majority of orthopaedic surgeons and is increasingly used in literature. However, the indistinct Haglund eponyms are still frequently used in Achilles tendon-related terminology.

When participating in sports, we often expose our lower extremities to stress. Regarding chronic Achilles tendon problems, the most common clinical diagnosis is mid-portion tendinopathy followed by insertional problems such as retrocalcaneal bursitis. For mid-portion Achilles tendinopathy and retrocalcaneal bursitis a wide variety of surgical techniques have proven to be effective. The next two chapters evaluate endoscopic treatments which are considered to be superior to open interventions. Chapter 3 describes a retrospective case series that evaluates the results of endoscopic treatment in patients affected by mid-portion Achilles tendinopathy, by release of the paratenon combined with a resection of the plantaris tendon, regarding patient satisfaction, functional outcome and pain scores. The median satisfaction score was 9 (scale 0 to 10) and there were good functional outcomes on mid- to long-term. In 2001, endoscopic calcaneoplasty was first described and showed good short-term results. Chapter 4 provides insight on mid- to long-term results of endoscopic calcaneoplasty and showed high median patient satisfaction score of 8.5 out of 10. Also, there were good long-term functional outcome in patients affected by retrocalcaneal bursitis who underwent endoscopic calcaneoplasty.

Nowadays it is unclear what kind of non-operative and operative treatment protocols exist for Flexor Hallucis Longus (FHL) (stenosing) tenosynovitis and to what extent treatment is effective. Chapter 5 is a systematic review of the treatment of FHL (stenosing) tenosynovitis. There are many conservative treatment options mentioned for FHL tenosynovitis, nevertheless only outcomes of stretching and lidocaine injections is reported. If conservative treatment does not give sufficient relief of symptoms, operative treatment, by releasing the FHL by an arthroscopic or open technique,

offers a safe and effective solution. Thereby, arthroscopic techniques are promising, however there is a paucity of literature on this issue.

In conservative treatment of FHL tendinopathy corticosteroid injections are used. Studies for image-guided injection are done, however, the accuracy after blind injection has not yet been studied. Chapter 6 shows in a cadaveric study that the FHL tendon sheath can be blindly injected based on only clinical examination with high accuracy. This can save time, is cost effective and is easier in logistics.

In daily practice a corticosteroid injection is regularly used to relieve pain of posterior ankle impingement, but little has been reported with regard to its effect on pain and duration or satisfaction of the effect of injection in ballet dancers. It is important to know what can be expected of a treatment, especially when the professional career is relatively short. In chapter 7 the results of a survey among all 126 members of the Dutch National Ballet and the National Ballet Academy Amsterdam were reported. It concludes that there is a high prevalence of posterior ankle impingement in ballet dancers of 38% and corticosteroid injections are regularly used for pain reduction with good results.

For the evaluation of the effectiveness of treatment validated tests are important and Patient-reported outcome measures (PROMs) have therefore become a cornerstone. The Achilles tendon Total Rupture Score (ATRS) is a PROM for outcome and assessment of an Achilles tendon rupture that was not yet translated and validated into Dutch. In chapter 8 the ATRS is translated into Dutch and is validated according to the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) criteria. The Dutch ATRS shows an adequate reliability and validity, and can be used in the Dutch population for measuring the outcome of treatment of a total Achilles tendon rupture on group level and for research purposes.

Finally in chapter 10, the findings of this thesis are discussed in a broader context. Within this general discussion, the aims reached are discussed and implications for the future are given.

NEDERLANDSE SAMENVATTING (DUTCH SUMMARY)

Het doel van dit proefschrift is inzicht geven in terminologiegebruik, behandelingen en uitkomsten van verschillende oorzaken van pijn aan de achtervoet.

Pijn aan de achtervoet kan verschillende oorzaken hebben en hoofdstuk 1 bevat een introductie over de genoemde onderwerpen in dit proefschrift. Het is belangrijk dat er uniforme terminologie wordt gebruik want hierdoor is duidelijke communicatie mogelijk zowel in de dagelijkse praktijk tussen clinici maar ook in de literatuur tussen wetenschappers. Dit zal leiden tot de best beschikbare wetenschappelijk onderbouwde behandeling in de klinische praktijk. In hoofdstuk 2 wordt de huidige terminologie voor achillespees gerelateerde pathologie in de dagelijkse praktijk en in de literatuur geëvalueerd en wordt de invloed van de laatste voorstellen op de huidige terminologie voor achillespees gerelateerde pathologie bekeken. Er wordt een enquête verricht onder orthopeden wereldwijd om te kijken welke termen zij gebruiken en welke diagnosen zij geven aan klinische casussen. Daarnaast wordt een literatuur studie gedaan om te kijken welke termen er in de literatuur worden gebruikt. Er blijkt uit deze studie dat de gereviseerde terminologie voor achillespees pathologie welke is gebaseerd is op anatomische locatie, symptomen, klinische bevindingen en histopathologie, wordt gebruikt door de meerderheid van de orthopaedisch chirurgen en dat deze steeds meer wordt gebruikt in de literatuur. Echter worden de onduidelijke Haglund-eponiemen nog steeds vaak gebruikt in achillespees gerelateerde pathologie.

Wanneer we deelnemen aan sport belasten we vaak onze onderste extremiteiten. Met betrekking tot chronische achillespees problemen is de meest voorkomende klinische diagnose midgedeelte achilles tendinopathie gevolgd door problemen bij de aanhechting van de achilllespees zoals retrocalcaneaire bursitis. Voor midgedeelte achilles tendinopathie en retrocalcaneaire bursitis bestaat er een grote variatie aan operatieve behandelingen welke hebben bewezen effectief te zijn. De volgende 2 hoofdstukken evalueren endoscopische behandelingen welke als superieur worden beschouwd vergeleken met open interventies. Hoofdstuk 3 beschrijft een case-serie welke de uitkomsten van endoscopische behandeling voor midgedeelte achilles tendinopathie middels losmaken van het paratenon, het vlies om de achillespees, en het doornemen van de plantarispees evalueert middels patiënt tevredenheid, functionele uitkomsten en pijn sores. De mediane tevredenheidsscore was 9 (schaal 0 tot 10) en er goede functionele uitkomsten op midden- tot lange termijn. In 2001 werd de endoscopische calcaneoplastiek geïntroduceerd en deze liet goede korte termijn resultaten zien. Hoofdstuk 4 geeft inzicht in de midden- en lange termijn uitkomsten van de endoscopische calcaneoplastiek. Er is een hoge mediane patiënt tevredenheidsscore van 8.5 uit 10. Ook zijn er goede functionele uitkomsten op lange termijn bij patiënten met retrocalcaneaire bursitis welke endoscopische calcaneoplatiek ondergingen.

De buigpees van de grote teen, genaamd flexor hallucis longus pees, kan bij veelvuldig buigen soms leiden tot een peesontsteking. Dit komt niet vaak voor bij de algemene populatie maar is welbekend bij atleten zoals balletdansers en voetballers. Er zijn vele conservatieve en operatieve

behandelingen bekend maar een duidelijk overzicht van al deze behandelingen is er niet. Hoofdstuk 5 geeft een systematisch overzicht van de verschillende behandelingen en laat zien dat rekken van de pees en lidocaïne injecties goede uitkomsten bieden voor conservatieve behandeling. Als operatieve behandeling kan de peesschede om de buigpees van de grote teen opengemaakt worden, dit geeft met arthroscopische en open technieken goede resultaten. Arthroscopische technieken zijn veelbelovend, maar er is een gebrek aan literatuur over dit onderwerp.

Als conservatieve behandeling van flexor hallucis longus tendinopathie worden er vaak corticosteroïd injecties gebruik. Wanneer er gekozen wordt voor een injectie in de peesschede wordt dit vaak met beeldvorming gedaan, echter is de accuraatheid van de injectie die zonder beeldvorming wordt gezet nooit vastgesteld. In hoofdstuk 6 wordt er een studie verricht op kadavers, waarbij de peesschede alleen op basis van lichamelijk onderzoek wordt geïnjecteerd. Deze studie laat zien dat een zogenoemde blinde injectie met accuraatheid kan worden gezet. Dit bespaart tijd, is kostenbesparende en is logistiek eenvoudiger.

Een ander probleem welke pijnklachten geeft aan de achtervoet is posterieure enkel impingement. Hierbij is er pijn aan de achterzijde van de enkel bij buigen van het enkelgewricht naar plantair. Bij klachten wordt er regelmatig een corticosteroïd injectie gegeven maar er is weinig bekend over het effect hiervan op pijn en de duur of tevredenheid van het effect van injectie bij balletdansers. Het is belangrijk om te weten wat er van een behandeling verwacht kan worden, zeker als de professionele loopbaan relatief kort is. In hoofdstuk 7 worden de resultaten van een survey-onderzoek onder alle 126 leden van Het Nationale Ballet en de Nationale Balletacademie getoond. Er is bij deze populatie een hoge prevalentie posterieure enkel impingement van 38% en er worden dan ook regelmatig corticosteroïd injecties gegeven met goed resultaat op het reduceren van pijn.

Voor het evalueren van behandelingen worden tegenwoordig steeds vaker patiënt gerapporteerde uitkomstmaten (PROMs) gebruikt. De Achilles tendon Total Rupture Score (ATRS) is een PROM gebruikt voor uitkomsten en beoordeling van Achillespeesrupturen. Deze PROM was nog niet in het Nederlands vertaald en gevalideerd. In hoofdstuk 8 wordt de vertaling van deze PROM gevalideerd aan de hand van de COSMIN criteria. De Nederlandse ATRS laat een goede betrouwbaarheid en validiteit zien en kan als follow-up instrument op groepsniveau worden gebruikt en voor onderzoeksdoeleinden.

Ten slotte worden in hoofdstuk 10 de bevindingen van dit proefschrift in een bredere context geplaatst. Binnen deze algemene discussie worden de bereikte doelen besproken en worden implicaties hiervan voor de toekomst gegeven.

A

PhD portfolio

List of publications

Acknowledgements
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Curriculum vitae

PHD PORTFOLIO

Name PhD student:	Drs. K.T.M. Opdam
PhD period:	October 2014 – June 2021
Promotor:	Prof. dr. C.N van Dijk
Copromotores:	Dr. ir. L. Blankevoort en dr. J. I. Wiegerinck

Courses	**Year**	**Workload**
AMC world of science	2014	0.7
Searching for a systematic review	2014	0.1
EndNote	2014	0.1
Basic Course Legislation and Organization for Clinical Researchers (BROK)	2015	1
Systematic Reviews	2015	0.7
Practical Biostatistics (e-learning)	2015	1.1
Embase/Medline via Ovid	2015	0.1
Scientific Writing in English	2015	1.5
Clinical Data Management	2015	0.3
Randomized Controlled Trials	2015	0.6
herregistratie BROK	2019	-

Podium presentations	**Event**	**year**
Reliability and validation of the Dutch Version of the Achilles tendon Total Rupture Score.	Scientific day Push, AMC, Eumedica	2015
Corticosteroid injections in posterior ankle impingement syndrome: a survey of professional and elite student ballet dancers.	Keuzeonderwijs, Arts en topsport, AMC	2020
Ankle & Hindfoot tendinopathy: the role of arthroscopy?	ESSKA-AFAS Core Curriculum webinar “Ankle Arthroscopy Indication - Evidence Based Medicine”	2021

Poster presentations	**Congress**	**Year**
Long-term results of endoscopic release of the Achilles tendon in patients with midportion tendinopathy	ESSKA, Barcelona, Spain	2016
Reliability and validation of the Dutch Version of the Achilles tendon Total Rupture Score.	NVA congress, Amsterdam	2016
Treatment of Flexor Hallucis Longus (Stenosing) Tenosynovitis: a Systematic Review of Current Literature.	ESSKA, Glasgow, United Kingdom	2018
Good functional outcome and high patient satisfaction after endoscopic treatment in patients with midportion tendinopathy: a follow-up study.	ESSKA, Glasgow, United Kingdom	2018

High patient satisfaction and good functional outcome after endoscopic calcaneoplasty in patients with retrocalcaneal bursitis: a long term follow-up study.	NVA jaarcongres	2018
Corticosteroid injections in posterior ankle impingement syndrome; a survey amongst professional ballet dancers	ESSKA	2021

(Inter)national conference visitor	**Year**
Nederlandse Orthopaedische Vereniging	2014 – heden
16th ESSKA Congress Amsterdam	2014
NVA Jaarcongres, Amsterdam	2016
17th ESSKA Congress Barcelona	2016
18th ESSKA Congress Glasgow	2018

Teaching / supervision bachelor and master thesis /PhD	**Year**
De anatomische les, Hogeschool voor de Kunsten Utrecht	2016
Jacobien Oosterhoff Diagnostic accuracy of MRI and ultrasound for identifying pathology in clinically suspected midportion Achilles tendinopathy	2014/2015
Dennie van den Noort Treatment of flexor hallucis longus tendinitis: a systematic review	2015/2016
Marlieke Hagemeijer Posterior arthroscopic treatment of posterior located osteochondral defects of the talus: A long-term follow up study.	2016/2017
Nathaniel Sullivan The role of ultrasonography in the diagnosis of mid-portion Achilles tendinopathy	2017/2018
Justin van Loon Posterior Ankle Impingement Syndrome (PAIS) in ballet dancers / PhD	2018 - heden

Peer reviewed	Journal	Year
Posterior Ankle Labral Changes at MRI: A Preliminary Study	European Journal of Radiology	2016
Taping and Bracing in the prevention of ankle sprains - Current Concepts	Journal of ISAKOS	2016
Foot and Ankle Tendoscopy Current Concepts Review	EFORT Open Reviews	2016
Tendoscopic peritendon shaving of midportion Achilles tendinopathy: A randomised, placebo-controlled study	Scandinavian Journal of Medicine and Science in Sports	2021

LIST OF PUBLICATIONS

In this thesis

K.T.M. Opdam, R. Zwiers, J.I. Wiegerinck, C.N. van Dijk; Ankleplatform Study Collaborative – Science of Variation Group. Increasing consensus on terminology of Achilles tendon-related disorders. *Knee Surg Sports Traumatol Arthrosc. 2021 May 15. Online ahead of print.*

K.T.M. Opdam Opdam, J. van Loon, R. Zwiers, P.P.F.M. Kuijer, C.N. van Dijk. Corticosteroid Injections in Posterior Ankle Impingement Syndrome: A Survey of Professional and Elite Student Ballet Dancers. *J Dance Med Sci. 2021 Mar 15;25(1):24-29.*

K.T.M. Opdam, R. Zwiers, J. Vroemen, I.N. Sierevelt, J.I. Wiegerinck, C.N. van Dijk. High Patient Satisfaction and Good Functional Outcome after Endoscopic Calcaneoplasty in Patients with Retrocalcaneal Bursitis: A 5-19 years Follow-up Study. *Knee Surg Sports Traumatol Arthrosc. 2020 Jul 25.*

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K.T.M. Opdam, J.I. Wiegerinck, C.N. van Dijk. Good results for treatment of flexor hallucis longus (stenosing) tenosynovitis: a systematic review. *JISAKOS 2017;2:325–331.*

Not in this thesis

J. van Loon J, D. Hoornenborg, H.M. van der Vis, I.N. Sierevelt, **K.T.M. Opdam**, G.M.M.J. Kerkhoffs, D. Haverkamp. 'Ceramic-on-ceramic vs ceramic-on-polyethylene, a comparative study with 10-year follow-up.' *World J Orthop 2021; 12(1): 14-23.*

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CURRICULUM VITAE

Kim Opdam was born on the 18th of June 1988 in Warmenhuizen, the Netherlands. She grew up in Warmenhuizen with her parents and older brother. After graduating Murmellius Gymnasium in Alkmaar, she was admitted through the decentralized selection to study medicine at the University of Amsterdam in 2007. When the first part of her medical education (doctorandus) was completed, she broadened her scope and studied to become a radiation protection expert (level 3) at the Delft University of Technology. During her medical study, Kim contributed to medical research, first as research student at Joint Research at Onze Lieve Vrouwe Gasthuis (OLVG) with prof. dr. Poolman and later at the Amsterdam University Medical Centers (AUMC) as research student (prof. dr. Kerkhoffs). Furthermore, she worked at the orthopedic department of OLVG as student employee which only made her more fanatical about orthopedics. Her medical internship confirmed her passion for orthopedics. She successfully obtained her medical degree (cum laude) in 2014, and was given the opportunity to start as PhD candidate under supervision of prof. dr. van Dijk. After two years as a PhD candidate she took the chance to work at AVE orthopedische klinieken (dr. Haverkamp). In 2017 she was accepted as a resident in orthopedic surgery at the AUMC (prof. dr. Kerkhoffs), starting with general surgery at Tergooi hospital in Hilversum (dr. van Geloven). After general surgery, she commenced the orthopedic part of the residency in the Amphia hospital in Breda (prof. dr. Eygendaal) and continued this at the AUMC (dr. Schafroth). Kim recently moved from Amsterdam to Muiden, where she lives together with her husband and daughter (with another little one on the way) and in her spare time she enjoys race cycling and social life with friends and family.