Achilles tendinopathy: new insights in cause of pain, diagnosis and management

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Publication date
2012

General discussion

TERMINOLOGY

The best possible management of different pathologies begins with universal language in science and daily clinical practice. Uniform terminology is believed to provide us with higher consistency and understandability of a problem and therefore ensures that information can be shared and compared seamlessly amongst clinicians. In **chapter 1** a new terminology for Achilles tendon related disorders was proposed, including the combination of anatomic location, symptoms, clinical findings and pathological changes for each entity. Examining the evolution of terminology over the last century, the ways to describe a clinical problem became endless and eponyms received pole position. The reasoning behind a change in terminology is unclear; it may for example be caused by different interpretation of pathology. However, constructing terminology in which Haglund's deformity, - syndrome and -disease are all dissimilar entities is not desirable. The use of improper terms however is acquired over centuries and may be complex to cure. Restrain is advocated regarding the adoption of new terms or modify a pre-existent terminology solely on personal preference or interpretation.

OUTCOME MEASURES AND ASSESSMENT TOOLS

In 2001 Tallon et al published a review on the outcome after surgery in patients with chronic Achilles tendinopathy[74]. They pointed at the deficiencies in outcome assessment and criteria, and subsequently recommended the use of outcome measures that were condition-specific, reliable, sensitive, and correlated with clinical severity. Outcome assessment tools provide the opportunity for universal outcome reporting. Data collected at widespread points can then be fairly compared, and common goals of therapy can be determined. In **chapter 2** a summary is given of the available outcome measures and assessment tools. Assessment tools described are strength measurements with dynamometry, endurance- and jump testing. Strength measurements have shown to be reliable and valid for measuring improvement in strength, but are curiously not useful in a clinical setting as they do not correlate sufficiently with (subjective) functional performance[13]. The normal number of heel rise repetitions in muscular endurance testing ranges from 25-70[48]. Therefore only a difference over time can be measured and again there is no correlation with initial functional performance. This also accounts for jump tests used to evaluate loading of the Achilles tendon. Assessment tools do not correlate with initial functional performance, but are useful in measuring the effectiveness of a treatment modality. The subjective VISA-A score is recommended for scientific purposes as it has good reliability and validity, and has now been used in at least 19 different studies[16,18,20].

In **chapter 3**, after the German, Swedish and Italian, the VISA-A questionnaire was translated to the Dutch language (VISA-A-NL) and tested for reliability, internal consistency, construct- and content validity. Application to non- athletes was also evaluated. The VISA-A-NL

showed high reliability (0.97 (95% CI 0.95-0.98)). Reliability of the translation was excellent, with a statistically not significant difference between assessments. Crohnbach's alpha for internal consistency was good at 0.80. It even increased to 0.88 without the activity domain of the questionnaire, accounting for 40% of points. As approximately 30% of patients do not participate in sporting activities[10] we concluded that patients with a non-athletic history should receive a modified VISA-A score from which questions 7 and 8 are deleted, especially as the effect of treatment in non-athletes otherwise can be underestimated.

Correlation of the VISA-A-NL with other subjective questionnaires (VAS, FAOS, SF-36) and the AOFAS only was good compared with the functional subscale of the SF-36. Correlation with other questionnaires was moderate or poorer. Noticeable is the moderate correlation with VAS, with is a validated subjective outcome measure frequently used for scientific means[63]. Although the FAOS has shown to be responsive to changes over time[65], it has not been validated for Achilles tendinopathy. To constructively discuss this matter these questionnaires first need to be validated for Achilles tendinopathy. We decided not to, as filling out larger amounts of paperwork would be a burden for patients, with a lower response rate as a consequence.

MIDPORTION ACHILLES TENDINOPATHY: CAUSE OF PAIN AND TREATMENT MODALITIES

Numerous treatment modalities for midportion Achilles tendinopathy have been reported over the last decades. However, only few (e.g. eccentric training) render a good outcome. Unsatisfactory treatment results can be caused by the reality that the mechanisms by which these diverse treatments attack pathology are unclear. Moreover, the mechanism by which the problem originates is even unidentified. In other words: should we not first identify the problem before coming up with a solution?

When work on this thesis started, one of the newest treatment modalities for midportion Achilles tendinopathy was Ethoxysclerol as introduced by Alfredson et al.[5-8,36,79]. Etoxysclerol damages the intima of bloodvessels after which they obliterate. The theory on which the injection of this substance was built, neovascularisation and accompanying neo-innervation in and around the tendon as the cause of complaints, also broke new ground and formed the basis of current new insights. The godfathers of Etoxysclerol treatment instructed our team and from 2004-2007 a total of 113 consecutive patients with 140 symptomatic Achilles tendons underwent colour Doppler ultrasonography investigation (US) in our clinic. Sixty-two patients had 70 symptomatic tendons showing neovascularisation (50%). In 50% of tendons with Achilles tendinopathy no neovessels were found. Others found neovascularisation in 50-88% of symptomatic tendons[23,62,64,78].

If only present in 50% of tendons, can neovessels yet be the cause of complaints? Or do they obliterate in the progress of pathology or healing?

Furthermore, of these patients only 44% of tendons were painless or minimally painful at six weeks after treatment. At 2.7-5.1 year follow-up 53% of *all* treated tendons had undergone various forms of additional treatment (conservative or surgical). Three patients still had complaints. Can we conclude from this study, combined with Paavola et al.[59] that whatever treatment is commenced, that on the long term the natural history is benign?

The main focus of treatment of Achilles tendinopathy is on relieving pain. It is questionable if degeneration of the tendon itself is the main cause of pain, since intratendinous changes are found in up to 34% of people *without* complaints[27,33,40,42]. Persistent structural abnormalities and thickening of the tendon 13 years after intra-tendinous surgery for Achilles tendinopathy was seen, whereas all patients were satisfied with the results and went back to Achilles tendon loading activities without restrictions[9]. Degeneration had not completely resolved, and although ruptured tendons show degenerative changes on histology[41], there is no evidence that pathological tendons are more prone to rupture. On the contrary, most often intratendinous changes are addressed in surgical treatment. But are these changes responsible for the pain?

Chapter 8 comprises a philosophy of the cause of pain in midportion Achilles tendinopathy. It is postulated that the process of tendinopathy does start with localized tendon micro-injury and degeneration, caused by ageing and repetitive strain. The pain is often prominent at 2-7 cm proximal to the calcaneus, where the tendon makes a twist; it is described that at this site blood flow even declines[10,58]. When the demands of the tendon exceed fiber strength, micro-injuries can develop[1]. An inadequate repair process causes a repetitive cycle of inadequate collagen and matrix production, tenocyte disruption, a further decrease of collagen and matrix and consequently increased vulnerability to further micro-injuries. Due to the lack of vascularisation, instead of a chemical-, a neurogenic inflammatory process is activated to repair these microruptures.

This neurogenic inflammatory response comprised of a new ingrowth of nerve fibers[15,28] accompanying the peritendinous vascular ingrowth from the paratenon into the tendon proper[46,67]. With this nerve ingrowth, levels of glutamate, calcitonin gene-related peptide (CGRP) and substance P rise[2,11]. Sensory neonerves cause an increase in pain signalling by producing these nociceptive substances past the critical threshold[4,11]. Transition to *symptomatic* tendinopathy now occurs. Also, myofibroblasts proliferate and synthesize abundant amounts of collagen to repair the tendon proper, but also cause the formation of *scar tissue* around the tendon and consequently the paratenon adheres onto the Achilles tendon at the location of the neurovascular ingrowth. Scarring in turn may lead to impaired circulation and further contribute to the pathogenesis of Achilles tendinopathy. In the earlier described 20-50% of patients without neovascularisation, vasoconstriction and scarring with mechanical constriction may already have lead to obliteration of neovessels. Nerves however will survive.

Involvement of the plantaris tendon in the process of tendinopathy is considered, as it runs with the Achilles tendon on its medial side within a shared paratenon. When constriction of the paratenon develops, the plantaris tendon gets involved. As described, it is tri-articular and the medial side of the midportion of the Achilles tendon is bi-articular, hypothetically causing altered mechanics and pain as a consequence. Recently Lintz et al. performed a biomechanical study indicating that the Achilles tendon elongates a greater distance than the plantaris tendon under similar tensile stresses. As a consequence the two surfaces could trap peritendinous tissues between them, which could be subject to shear stresses and cause pain[47].

In **chapter 5** Achilles tendoscopy as invented by van Dijk et al. in 1997 is described[75]. The paratenon is endoscopically released from the Achilles- and plantaris tendon is cut with good clinical results. Alfredson et al. recently described a series of 73 Achilles tendons in which during treatment with ultrasound and Doppler-guided scraping an invaginated, or close by located, enlarged plantaris tendon was found in 58 of cases[3]. In these patients, the plantaris tendon was surgically removed with good clinical results and the authors confirm that the plantaris tendon might be of interest in the aetiology and treatment of midportion Achilles tendinopathy.

However, large comparative studies are lacking as the population in the academical setting is small, and patients demanding surgery even less. Ideal would be a randomized clinical trial comparing open surgery with endoscopic release of the paratenon and a group undergoing the endoscopic approach as well as transsecting the plantaris tendon. Currently a prospective study on Achilles tendoscopy is being carried out. However, involvement of the plantaris tendon in the pathological process had not yet been studied anatomically nor clinically in an isolated procedure.

In **chapter 6** it is hypothesized that constriction of the paratenon onto the Achilles tendon consequently causes adhesion of the plantaris tendon to the surrounding tissues. After formation of adhesions, the different mechanical properties of both the Achilles- and plantaris musculotendinous complex may be the cause of complaints. However, absence of the plantaris tendon in 7-20% of human cadavers has been described[21,22,30,32,54,68]. An observational study of 107 lower extremities on the anatomy at the level of the Achilles tendon was conducted. In all a plantaris tendon was identified, which was occasionally difficult due to a mixture of 9 different insertion sites, especially the variant with insertion into the medial side of the Achilles tendon proper. However, when dissecting from proximal to distal it was identified in all specimens. This could be an explanation for the tentative absence in the earlier mentioned 7-20% of legs. Another explanation could be absence due to isolated rupture[25,35]. With our relatively large group of specimens, we not only contradict earlier findings of its absence, but also raise implications for daily practise. The plantaris tendon is often used for grafting because it can be sacrificed without discernible deficit, and is of adequate length and thickness for many applications[14,49,53,69]. We advise to retrieve the

tendon proximally (e.g. with a tendon stripper). The use of ultrasound- or MR- imaging prior to surgery to pre-assess its course may be helpful.

In 11 specimens (10%) firm connections were found at the level of the Achilles tendon midportion. It was not possible to perform histology of these findings, or of the involved Achilles tendons, a flaw of this study.

Chapter 7 illustrates a pilot study of a new surgical technique in which the plantaris tendon is excised with a hamstring stripper through a small incision on the medial side of the proximal calf. Three patients with complaints of midportion tendinopathy were treated in this pilot. Although the tendon stripper appeared too short in one patient, the plantaris tendon ruptured above the adhesions in the other, and in one the procedure went as planned, all were satisfied with the result and reported no complaints at 1 year follow-up. This outcome may well be attributable to coincidence as only 3 patients were treated. Although the procedure went with varying success, different pull of adhered tendons was eliminated in all by excising the tendon. Another explanation for pain relief could be indirect stripping of the paratenon with introduction of the tendon stripper.

Now where should the treatment of Achilles tendinopathy commence? Should the plantaris tendon be (surgically) addressed, or should the sympathetic nerves coming from the paratenon be denervated? What is effective in pain relief in the majority of patients?
Of course direct referral to surgical measures is undesirable. Conservative management should always be considered first. Injection with Etoxysclerol, saline and PRP could theoretically yield similar results as surgical denervation. With Etoxysclerol, nerves are probably also attacked. On the contrary, injection may not suffice because of low volume and effectiveness of the substance on nerves, and adhesions may be too solid to be adequately released. High-volume injection has been successfully performed, thereby obliterating neovascularisation and accompanying neonerves[18]. Brisement, first described in 1997[39], was initially meant to interrupt the degenerative cycle of the tendon proper by initiating a healing cascade, but in essence seems equivalent to current high-volume injections.

Moreover, small volume injections also seem to generate a response. Injection of PRP was compared with saline, producing an equivalent outcome[24]. Corticosteroid injections for lateral epicondylitis and aprotinin for Achilles tendinopathy were comparable with placebo, showing no statistically significant difference in outcome[70]. Could this mean that no matter what we introduce, an inflammatory response will be generated?

Surgical treatment should be reserved for patients that do not respond to primary conservative measures. When sufficiently researched in well-designed clinical trials early surgical management can be considered for professional athletes or patients depending on their fitness in daily life for a quicker return to normal activities.

RETROCALCANEAL BURSITIS: DIAGNOSIS AND TREATMENT

A symptomatic inflammation of the retrocalcaneal bursa is caused by repetitive impingement of the bursa between the anterior aspect of the Achilles tendon and a bony posterosuperior calcaneal prominence[26,71,72]. Most publications focus on this prominence, which however has not shown to be very reliable[17,29,61]. In retrocalcaneal bursitis, the normally sharply outlined radiolucent retrocalcaneal recess of Kager's triangle is obliterated. **In chapter 9** we determined the usefulness and reliability of the radiographic appearance of this recess in diagnosing a retrocalcaneal bursitis on digital radiographs. The sensitivity was 83% for observer 1 and 79% for observer 2. Specificity was 100% and 98% for observer 1 and 2. The interobserver reliability test calculated a kappa-value of 0.86. For observer 1 intraobserver reliability was 0.96 and 0.92 for observer 2. This means further diagnostic evaluation is not necessary, resulting in a higher cost-effectiveness and quicker treatment. MRI can still be performed in case of doubt. However, does Kager triangle normalize when complaints diminish? If yes, is the retrocalcaneal recess useful for diagnosis when complaints unhoped-for recur? Kager's triangle is distorted due to the inflammatory response after surgical treatment; in endoscopic surgery the flow of saline also causes distortion. Scar tissue develops which also causes a change in radiolucency, one that over time might diminish. Research on the usefulness of Kager's triangle after surgery is currently executed.

An optimal treatment algorithm for retrocalcaneal bursitis, as for midportion tendinopathy, has not been found yet. Conservative management includes inlays, adaptation of shoe wear, rest, NSAIDs and a single cortisone injection in the retrocalcaneal bursa[56,57,73]. Cortisone injections are not advised since these can weaken the tendon with the potential danger of rupture. The best level of evidence for this potential danger nevertheless is derived from case reports[19,34,43,50,77].

The aim of surgery for retrocalcaneal bursitis is to prevent impingement of the bursa between the Achilles tendon and the calcaneus. This can be accomplished by removing the inflamed retrocalcaneal bursa, followed by either resection of the posterosuperior tuberosity or by a closing wedge osteotomy to prevent recurrence. Posterosuperior calcaneal resection can be performed through a posterolateral or posteromedial incision or through a combination of both[12,44,60].

Due to inappropriate visualization of the Achilles tendon during open procedures, weakening or even rupture has been reported[45,52]. Full recovery time after open resection can take up to 2 years.

Endoscopic calcaneoplasty offers a minimally invasive alternative to open surgery. Surgeons familiar with the endoscopic approach favor this procedure, because of its better visualization. Our results of endoscopic calcaneoplasty are comparable with other reports on endoscopic treatment[31,37,38,66,76]. Two portals are used, just lateral and medial to the Achilles tendon, at the level of the posterosuperior tuberosity of the calcaneus. During the

procedure, the inflamed retrocalcaneal bursal tissue and posterosuperior prominence of the calcaneus are resected using a Bonecutter shaver. However, due to the local anatomy, bulky subcutaneous tissue and swelling of the bursal tissue, palpation of the posterosuperior tuberosity is difficult and portals can easily be placed too proximal. This will result in a suboptimal procedure. Fluoroscopy is sometimes used to make portals, but can be time-consuming as the surgeon has to rely on availability and personnel. We therefore aimed to standardize portal placement using a self-developed 'Device for Optimal Portal Placement' (DOPP), using the *distance* from the distal tip of the fibula to the posterosuperior calcaneus (DFC) on a radiograph in volunteers as described in **chapter 11**. This tip has not been validated but is already used as a landmark for portal placement in standard 2-portal hindfoot endoscopy with good visualization. It was decided to use healthy volunteers, as the goals of this study were to 1) validate the DOPP for portal placement, 2) see if the distance DFC would help us determine the ultimate position of portals and 3) to recover a direct relationship between foot morphology and portal location. If standardization was performed in retrocalcaneal cases, many patients would have been needed as there is a large between- patient variance in calcaneal contour in retrocalcaneal bursitis.

However, from this study a numeric distance- scale to be used in all different foot morphologies could not be constructed. Although TMT1, -CI-angles and physical examination were found to be the best available objective measures to determine foot morphology[51,55], disappointing correlations were found. Apparently, the various foot morphologies show a marked overlap between the distances from posterosuperior calcaneus to fibula. We can conclude however that in flat feet portal location is significantly more proximal to the tip of the fibula, when compared to cavus feet. Still a limited amount of volunteers was included; with a larger population we might also find a significant difference between the DFC in flat and normal- and normal- and cavus feet and construction of a numeric scale may be possible.

The DOPP demonstrated to be highly reliable; with the limitation that inter-observer reliability was not tested. Future research is still needed to determine its validity. The project could be extended with a larger amount of volunteers. The next step could be testing the correlation of the DFC as measured pre-operatively with measurements of the distance of the fibula tip to the incision as placed by an experienced orthopaedist. When correlation is high, the DOPP might eventually be implemented in the daily clinic on individual patients with a retrocalcaneal bursitis scheduled for EC; or a gliding scale for portal placement may be constructed. Until then, when uncertain about portal placement, fluoroscopy should still be considered.

FUTURE RESEARCH

Research on Achilles tendon-related problems is ongoing. The first step to optimal management is to speak the same scientific language. This not only accounts for the Achilles tendon,

and therefore it is advocated to construct a standard terminology for all medical problems. Implementation however will be complex. Further research on chronic midportion Achilles tendinopathy should focus on the cause of pain instead of formulating more substances for injection in or around the tendon as currently seems to be the tendency. Recognizing the cause of complaints will help to further define therapeutic strategies. Undoubtedly, caution should be taken when considering surgical treatment, although endoscopic and minimally invasive procedures generate considerably less complications and shorter rehabilitation when compared to open surgery. Treatment in my opinion therefore needs to be individualized. Currently patients spend months to even years in the medical circuit. This also accounts for patients with retrocalcaneal bursitis. Surgery is less often considered in non-athletes with low demands in daily life and minor complaints, but endlessly applying conservative measures in athletes and patients with high daily physical demands requiring a quick return to normal activities may be unwanted. In minimally invasive and endoscopic surgery for midportion tendinopathy the degenerative lesion is often left untouched, of which it would be interesting to research the long-term consequences.

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