

Consensus statement

Supplementary file Module 3**Scoping question**

What is the role of imaging in Achilles tendinopathy?

Literature search and selection sub-module 3.1

The search question for sub-module 3.1 was:

Which imaging techniques can be used for assessing Achilles tendinopathy in clinical practice?

No systematic literature review was performed to answer the search question as this question could not be formulated using the PICO approach.

Literature Summary

There is no summary of the literature for this search question. Therefore, no conclusions with their GRADE level of evidence have been formulated.

Conclusion

Midportion and insertional Achilles tendinopathy

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| Grade | No literature review was carried out for the search question of this sub-module 3.1. Therefore, no summary of the evidence was made on the imaging modalities that can be used in Achilles tendinopathy in clinical practice. |
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Considerations

In musculoskeletal radiology, the most frequently applied conventional imaging techniques are X-ray, ultrasound, MRI and CT. The imaging techniques most commonly used in clinical practice for Achilles tendinopathy are X-ray, ultrasound and MRI. Both the midportion and the insertion of the Achilles tendon are superficially located structures and can be well assessed with these techniques. The imaging modality is selected based on accuracy, patient friendliness and acceptability, availability, and costs.

An important and common clinical characteristic of chronic Achilles tendinopathy is thickening of the Achilles tendon. If this cannot be adequately assessed during clinical examination, ultrasound can be considered. Ultrasound is a reliable modality to measure tendon thickness.¹ Ultrasound is very patient-friendly and widely available in clinical practice. In addition, this modality has very low costs compared to the other imaging techniques.²

MRI has the best diagnostic test properties, but has limited availability and is relatively expensive.³ Therefore, a MRI-scan can be considered if ultrasound is not available, when there is an unexplained discrepancy between the ultrasound result and the symptoms, when an (additional) alternative diagnosis is expected that cannot be detected by ultrasound or during pre-operative workup.

An X-ray or CT-scan can be performed to visualise other pathology such as intratendinous calcifications and a Haglund's morphology. In addition to MRI, these modalities can also be considered during the pre-operative workup.

In addition to these conventional imaging modalities, there are numerous new imaging techniques to visualise the Achilles tendon. These include ultrasound tissue characterisation (UTC), shear-wave elastography (SWE), contrast-enhanced ultrasound (CEUS) and ultrashort echotime (UTE) MRI. These techniques are, however, not widely available in clinical practice and are not discussed further in this guideline.

In the previous version of the previous Dutch multidisciplinary chronic Achilles tendinopathy guideline (2007), imaging was described in a separate module. The working group of the previous guideline concluded that in most cases the diagnosis can be made clinically and imaging has

1 de Vos R-J, et al. Br J Sports Med 2021;0:1–10. doi:10.1136/bjsports-2020-103867

Consensus statement

limited added value. Ultrasound may still be useful if: (1) there is uncertainty regarding the diagnosis (for example: is it an Achilles tendon problem, bursal abnormality or a combination of both?), (2) the severity of the abnormality should be visualised (e.g. when surgery is considered or for follow-up during rehabilitation).

According to the expert group of this previous Dutch multidisciplinary guideline (2007), MRI is only of additional value when surgery is considered. There is no distinction in this guideline between midportion Achilles tendinopathy and insertional Achilles tendinopathy. The guideline of the American Association for Physiotherapy (2018)⁴ states that ultrasound and MRI can be of added value when the diagnosis of midportion Achilles tendinopathy cannot be made clinically.

Advantages and disadvantages of the intervention and the quality of the evidence

Ultrasound is the first choice modality when imaging of the Achilles tendon is being considered. It is sufficiently accurate, patient-friendly, available and inexpensive. Disadvantages are that it is less reproducible and that the interpretation is operator-dependent.

MRI has the highest accuracy and is a good alternative, but has limited availability and is relatively expensive.

An X-ray is suitable for assessment of intratendinous calcifications and Haglund's morphology. X-ray is sufficiently accurate, available and inexpensive. A CT-scan has the disadvantage of limited availability, radiation, and it is relatively expensive.

Literature search and selection sub-module 3.2

The search question for sub-module 3.2 was:

Which qualifications are required to perform imaging?

No systematic literature review was carried out to answer this search question as this question could not be formulated using the PICO approach.

Literature Summary

There is no summary of the literature for this search question. Therefore, no conclusions with their GRADE level of evidence has been formulated.

Conclusion

Midportion and insertional Achilles tendinopathy

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| - Grade | No literature review was performed for the search question of sub-module 3.2. Therefore, no summary of the evidence was made on the necessary qualifications when performing imaging in clinical practice in Achilles tendinopathy. |
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Considerations

The working group considers that each imaging modality should ideally be performed by a person with sufficient qualification and experience. This was decided for several reasons.

The availability of imaging in clinical practice has increased. Most hospitals have a complete range of imaging modalities. The final responsibility for imaging of Achilles tendinopathy lies within many healthcare institutions with the radiologist or musculoskeletal (MSK) radiologist.

However, a range of other professions represented in this working group are expected to implement and assess imaging and communicate the results to patients. The availability of ultrasound in particular has increased, mainly as the equipment has become more affordable. As a result, ultrasound is no longer only used by radiologists, but also by other healthcare providers that are represented in the working group.

Consensus statement

In radiology in Holland, no absolute numbers are recorded that an (MSK) radiologist must meet in order to adequately be able to perform or assess an imaging modality. The competence is focused on training; a radiologist or resident is competent for a particular examination when this is decided in consultation as determined by the supervisors.

The specialisation as an MSK radiologist in the Netherlands can be completed after a full-time fellowship MSK Radiology for 1 year and which can be completed in specific centres. The title MSK radiologist is granted by the Dutch Association of Radiology on behalf of the Musculoskeletal Radiology Section. With this data, an impression can be made regarding the time and training required to reach an acceptable level to perform and interpret different imaging modalities.

Currently, there is no national consensus in Holland on the criteria that healthcare providers from the various professions must comply with in order to adequately carry out an ultrasound examination of the posterior ankle. The British Medical Ultrasound Society (BMUS)⁵ developed a code for the professional performance of ultrasound (Table 3.1). Although not all criteria are directly applicable to imaging in Achilles tendinopathy and the application of imaging in the Dutch clinical setting, we consider it useful to highlight certain criteria and translate them to clinical practice. The working group advises that the following considerations be taken into account, despite the low-threshold availability of imaging:

- The healthcare provider who refers for imaging (or performs the imaging themselves) is able to critically consider the added value of the imaging modality. Performing the imaging modality should be clinically important to the patient.
- The healthcare provider who performs and assesses the imaging modality identifies his or her own limitations and has sufficient education and experience. For the maintenance and renewal of knowledge, regular further training and peer review is recommended.
- The healthcare provider who communicates the results of the imaging has sufficient knowledge of the clinical presentation and the relationship between findings on imaging and the outcome of Achilles tendinopathy. In clinical practice, a solution could be to work in a multidisciplinary matter to optimise treatment.

Literature search and selection sub-module 3.3

The search question for sub-module 3.3 was:

Which imaging findings are characteristic for Achilles tendinopathy?

To answer this search question, a systematic literature search was performed. We searched for published scientific studies, existing guidelines, descriptive reviews and expert opinions describing imaging findings in Achilles tendinopathy. A PICO was designed for this search question:

- P:** individuals with or without clinically established Achilles tendinopathy;
I: clinical diagnosis Achilles tendinopathy;
C: no Achilles tendon symptoms
O: imaging findings (ultrasound, MRI, X-ray or CT) in or surrounding the Achilles tendon

Relevant outcome measures

The working group considered specific imaging findings as the primary outcome measures. The working group defined these primary outcome measures by imaging technique:

Ultrasound: degree of tendon thickening (including maximum thickness of the tendon and length of the thickened part of the tendon), change in echogenicity of the tendon (including presence of hypoechoic areas and loss of the normal architecture of the tendon), degree of hypoechoic or anechoic areas around the tendon (indicative of fluid), degree of peritendinous or intratendinous Doppler flow. Other associated findings may include: increased amount of fluid in the retrocalcaneal bursa, increased amount of fluid in the superficial subcutaneous bursa.

Consensus statement

MRI: degree of tendon thickening (including maximum thickness of the tendon, length of the thickened part of the tendon and tendon volume), change of signal intensity of the tendon (including presence hyperintense and/or hypointense areas on specific sequences and loss of the normal architecture of the tendon), specific signal intensities around the tendon indicative of peritendinous fluid. Other associated findings may include: increased amount of fluid in the retrocalcaneal bursa, increased amount of fluid in the superficial subcutaneous bursa, presence of a Haglund's morphology and infiltration of the Kagers' fat pad.

X-ray: degree of tendon thickening and presence and degree of calcifications in the Achilles tendon. Other associated findings may include: presence of Haglund's morphology and increased density of Kagers' fat pad tissue indicative of infiltration.

CT: degree of tendon thickening, presence and degree of calcifications in the Achilles tendon. Other associated findings may include: presence of a Haglund morphology, increased density of the Kagers' fat pad tissue indicative of infiltration.

Clinically important difference

A clinically important difference is not defined for findings on imaging.

Search and Select (Method)

On May 27th 2019, the Medline databases (via OVID) and Embase (via Embase.com) were searched with relevant search terms for case-control studies describing imaging findings in Achilles tendinopathy. The search strategy is presented in Table 3.2. The literature search yielded 218 studies. These studies were selected on the following selection criteria:

Inclusion criteria:

- The study evaluated imaging findings of the Achilles tendon (ultrasound, MRI, X-ray or CT).
- The study is either a cohort where potential confounders (age, gender, BMI and level of physical activity) are corrected, with the minimum corresponding numbers of participants ($n > 50$) or the article has a case-control design that matches age, gender, BMI and level of physical activity and included at least 25 participants per group.

Exclusion criteria:

- Imaging techniques that are not available in mainstream practice (e.g. Ultrasound Tissue Characterisation or Shearwave Elastography).

After consulting the title and abstracts, 17 studies were preselected. After consulting the full text, all 17 studies were excluded (Table 3.3).

Furthermore, existing national and international guidelines were consulted to answer the initial scoping question: previous Dutch multidisciplinary chronic Achilles tendinopathy guideline (2007) and (inter)national guideline databases of the Dutch General Practitioners Society (NHG), National Institute for Health and Care Excellence (NICE), National Guidelines Clearinghouse (NGC) and Guidelines International Network (G-I-N).

Results

No studies were identified that met the initial inclusion criteria. The working group decided to use diagnostic criteria extracted from randomised studies of the treatment module to answer the initial scoping question.

In the treatment module, a search was conducted for randomised studies in which the effectiveness of a treatment option for Achilles tendinopathy was assessed. Studies were included when: 1) a clinical diagnosis of Achilles tendinopathy was present (local pain and reduced loadbearing capacity) and 2) age of the study population ≥ 18 years. Studies included at least 10

Consensus statement

patients per treatment arm. For more information about this process see Module 4. This aims to consider the opinion of international experts into answering the initial scoping question in sub-module 3 (characteristic findings on imaging).

The systematic search for the effectiveness of treatment options yielded a total of 2779 references after removal of duplications. All references found were judged on title and abstract. After this preselection, the full text of 147 articles was reviewed. A total of 116 of these articles were excluded. The flowchart (Figure 3.1) shows the reasons for exclusions. In the end, 31 studies met the criteria and were included in the literature analysis.

Characteristic imaging findings were also discussed in the previous Dutch multidisciplinary chronic Achilles tendinopathy guideline (2007).

Literature Summary

Results

Midportion Achilles tendinopathy

No studies were found that examined the characteristic imaging findings in midportion Achilles tendinopathy.

Insertional Achilles tendinopathy

No studies were found that examined the characteristic imaging findings in insertional Achilles tendinopathy.

Results extraction diagnostic criteria

Radiological diagnostic criteria of 31 randomised trials included in Module 4 were extracted to answer the search question. The majority of these studies were focused on midportion Achilles tendinopathy (26 studies). The other studies focused on insertional Achilles tendinopathy (3 studies) and Achilles tendinopathy where the location was not specified (2 studies). The radiological criteria used for both types of Achilles tendinopathy are shown in Table 3.4 and Table 3.5.

Midportion Achilles tendinopathy

12 of the 26 studies used imaging to diagnose Achilles tendinopathy and 10 of these 12 studies (83%) reported radiological diagnostic criteria. The majority of these studies used ultrasound for imaging (1 study used MRI to diagnose tendinopathy; no criteria listed). The 3 most commonly used imaging criteria in the scientific literature to diagnose midportion Achilles tendinopathy were local thickening of the Achilles tendon (10/10 studies), heterogenous tendon structure with hypochoic areas (8/10 studies) and the presence of Doppler flow (5/10 studies). The criteria are shown in summary in Table 3.4 and in detail in Table 3.7.

Insertional Achilles tendinopathy

Two of the 3 studies used imaging to diagnose tendinopathy and 1 of these studies (50%) reported radiological diagnostic criteria. The only radiological criterion used to diagnose insertional Achilles tendinopathy was the presence of calcifications in the Achilles tendon on ultrasound. The criteria used are shown in summary in Table 3.5 and in detail in Table 3.7.

Midportion and insertional Achilles tendinopathy (location not specified)

One of the 2 studies used imaging to diagnose tendinopathy reporting radiological diagnostic criteria. The only radiological criterion used to diagnose Achilles tendinopathy was the presence of Doppler flow on ultrasound (not specified how this was assessed). The criteria used are shown in summary in Table 3.6 and in detail in Table 3.7.

Level of evidence

There is no summary of the literature for this search question as there was no literature available meeting the predefined criteria. Therefore, no conclusions with their GRADE level of evidence has been formulated.

Consensus statement

Conclusions

Midportion and insertional Achilles tendinopathy

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| - Grade | Due to the lack of eligible studies, no conclusion could be made on the characteristic imaging findings on ultrasound, MRI, CT and X-ray in Achilles tendinopathy. |
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After extraction of radiological diagnostic criteria of the randomised studies included in the Treatment module (Module 4), the following conclusions were formulated.

Midportion Achilles tendinopathy

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| - Grade | The most commonly used radiological diagnostic criteria on ultrasound for midportion Achilles tendinopathy in randomised studies are: <ol style="list-style-type: none"> 1) local thickening of the Achilles tendon 2) heterogeneous tendon structure with hypoechoic areas 3) presence of intratendinous or peritendinous Doppler flow |
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Insertional Achilles tendinopathy

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| - Grade | The only radiological diagnostic criterion used in ultrasound for insertional Achilles tendinopathy in one randomised study is: <ol style="list-style-type: none"> 1) intratendinous calcifications |
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Midportion and insertional Achilles tendinopathy

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| - Grade | The only radiological diagnostic criterion used in ultrasound for midportion and insertional Achilles tendinopathy in one randomised study is: <ol style="list-style-type: none"> 1) the presence of intratendinous or peritendinous Doppler flow. |
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Considerations

No eligible literature was found to answer the predefined question which imaging findings are characteristic for Achilles tendinopathy. Therefore, the recommendations are based on data from RCTs and other considerations.

Two studies have been published comparing ultrasound findings between patients with Achilles tendinopathy and patients without symptoms.^{6,7} These studies were not (adequately) matched and therefore the quality of the evidence was found to be insufficient to include in the literature analysis. In Leung's study⁶, significant thickening (both the measured surface area and an increased anterior to posterior diameter) at the insertion and midportion was seen in Achilles tendinopathy compared to an asymptomatic population. Areas of altered echogenicity (focal or diffuse hypoechoic areas) were seen in 67% of patients and 11% in the asymptomatic population. Increased Doppler flow was seen in 47% of patients, this was not seen in the asymptomatic population. In addition, focal calcifications (7% vs. 2%) and morphological calcaneal changes (87% vs. 63%) were more common in patients with Achilles tendinopathy. Romero's study⁷ showed significantly increased thickening in Achilles tendinopathy when compared to individuals without symptoms. In summary, the most studied findings in these articles are: tendon thickening (anterior to posterior diameter, surface area, length of thickening and tendon volume), change in tendon structure (altered echogenicity on ultrasound and altered signal intensity on MRI) and neovascularisation (activity on Doppler flow).

Due to the lack of published diagnostic studies, the working group chose to extract diagnostic criteria from existing randomised intervention studies for Achilles tendinopathy. With this approach, we were able to assess which radiological diagnostic criteria are most frequently used by experts in this field. Most studies describe radiological diagnostic criteria for midportion Achilles tendinopathy (n=10) and insertional Achilles tendinopathy (n=1). The following diagnostic criteria were used very frequently (> 50% of the studies) for midportion Achilles tendinopathy: thickening of the Achilles tendon, changes in the structure of the Achilles tendon

Consensus statement

and an increased ultrasonographic Doppler flow in and around the Achilles tendon. In insertional Achilles tendinopathy, calcifications in the Achilles tendon on ultrasound examination were identified as a radiological criterion. One study that did not specify the location (midportion or insertion) used increased ultrasonographic Doppler flow within and around the Achilles tendon as criterion. The working group considers it plausible that radiological findings are similar for midportion and insertional Achilles tendinopathy. This was confirmed in a recent systematic review, in which these 3 parameters are frequently described in tendinopathies at different locations.⁸ It should be mentioned that the degree of tendon thickening in these 2 separate entities could be different. For insertional Achilles tendinopathy, additional associated radiological criteria are described in the literature: presence of intratendinous calcifications or a 'spur' and a Haglund's morphology (prominence of the superior aspect of the calcaneus). There are conflicting results of the association between these findings and symptomatology in existing studies.⁹⁻¹³ These studies could not be included in the GRADE assessment because they did not meet the inclusion criteria for various reasons. The working group considers these parameters of added value when analysing imaging in insertional Achilles tendinopathy. This can affect clinical decision-making. Further research into the diagnostic value of the radiological criteria is necessary and therefore identified as a knowledge gap.

Validation of imaging techniques is a discussion point in this field. Few studies have compared imaging with pathological findings of tendinopathy, because a non-invasive gold standard does not exist. A biopsy could validate abnormalities on imaging. Ultrasound and MRI findings show good correlation with histopathology.³ However, this is an invasive examination and it is complex to match the abnormalities on imaging with the histological image. Histopathology also cannot fully explain the patient's symptoms with the current knowledge we have. In addition, there is variation in the description or classification of Achilles tendinopathy in the various articles. Another point of discussion is what should serve as the gold standard for diagnosis. When Achilles tendinopathy is considered to be a clinical diagnosis, then the role of imaging remains debatable. When tendinopathy is considered a condition that is accompanied by both local complaints and abnormalities on imaging (the pathological substrate), then imaging has a potential diagnostic role.¹⁴ However, abnormal radiological findings as described above may be present up to 59% of asymptomatic individuals.⁸ It is known that ultrasound abnormalities are more commonly found in specific populations. More knowledge is needed to interpret the value of the radiological diagnostic criteria.

Literature search and selection sub-module 3.4

The search question for sub-module 3.4 was:

Which imaging findings have prognostic value in Achilles tendinopathy?

To answer this search question, a systematic literature search was performed, looking for studies investigating prognostic value of imaging findings in Achilles tendinopathy. A PICO was designed for this search question:

- P:** patients with Achilles tendinopathy;
- I:** presence of prognostic factors on imaging of the Achilles tendon (ultrasound, MRI, X-ray or CT);
- C:** absence or to a lesser extent presence of the above prognostic factors;
- O:** degree of pain during activities, return to sports and patient satisfaction.

Potential imaging findings include:

Ultrasound: degree of tendon thickening (including maximum thickness of the tendon and length of the thickened part of the tendon), change in echogenicity of the tendon (including presence of hypoechoic areas and loss of the normal architecture of the tendon), degree of hypoechoic or anechoic areas around the tendon (indicative of fluid), degree of peritendinous or intratendinous Doppler flow. Other associated findings may include: increased amount of fluid in the retrocalcaneal bursa, increased amount of fluid in the superficial subcutaneous bursa.

Consensus statement

MRI: degree of tendon thickening (including maximum thickness of the tendon, length of the thickened part of the tendon and tendon volume), change of signal intensity of the tendon (including presence hyperintense and/or hypointense areas on specific sequences and loss of the normal architecture of the tendon), specific signal intensities around the tendon indicative of peritendinous fluid. Other associated findings may include: increased amount of fluid in the retrocalcaneal bursa, increased amount of fluid in the superficial subcutaneous bursa, presence of a Haglund's morphology and infiltration of the Kagers' fat pad.

X-ray: degree of tendon thickening and presence and degree of calcifications in the Achilles tendon. Other associated findings may include: presence of Haglund's morphology and increased density of Kagers' fat pad tissue indicative of infiltration.

CT: degree of tendon thickening, presence and degree of calcifications in the Achilles tendon. Other associated findings may include: presence of a Haglund morphology, increased density of the Kagers' fat pad tissue indicative of infiltration.

Important outcome measures

The working group considered the degree of symptoms associated with (sports) loading to be the primary outcome measure and return to sports and patient satisfaction for as secondary outcome measures.

The working group defined outcome measures as follows:

The primary outcome measure; symptoms associated with (sports) loading should be measured with the Victorian Institute of Sports Assessment-Achilles (VISA-A) score during the last follow-up measurement of the study. The validated VISA-A questionnaire consists of 8 questions that cover 3 domains: pain in activities of daily living, pain during functional tests and sports participation.¹⁵ A score of 100 points is optimal and represents an Achilles tendon with a normal function and without symptoms; a score of 0 points represents severe Achilles tendon dysfunction with severe symptoms.

The working group considered patient satisfaction and return to sports as secondary outcome measures. Patient satisfaction and return to sports should be patient-reported; the type of scale was not an exclusion criterion.

Clinically relevant differences for the VISA-A score have been reported in previous studies, with a large variation from 6.5 to 25 points.¹⁶⁻²⁰ In a recent large prospective study, the minimum clinically important difference of the VISA-A score was 14 points after 3 months of non-surgical treatment.²¹ This study used the most accepted anchor-based approach. Based on the above-mentioned results, the working group decided to define the minimum clinically important difference of the VISA-A score at 15 points.

The outcome measures patient satisfaction and return to sports have not been validated and no clinically important differences are known for these outcome measures. These secondary outcome measures are also presented, but without the use of predefined clinically important cut-off points.

Search and Select (Method)

On 27th May 2019, a search was performed in the Medline databases (OVID) and Embase (Embase.com) for studies describing imaging findings in Achilles tendinopathy. The search strategy is displayed in Table 3.2. The literature search yielded 218 hits. Studies were selected based on the following selection criteria:

Inclusion criteria:

- The study evaluated the degree of symptoms in patients with Achilles tendinopathy
- At least 20 participants were included
- The study had a randomised design or a prospective longitudinal design (cohort or case-series design) in which there was adjustment for confounding factors

Consensus statement

Exclusion criteria:

- The use of imaging techniques that are not available in regular practice (e.g. Ultrasound Tissue Characterisation or Shearwave Elastography)
- Studies in which only univariate analyses were performed

10 studies were preselected, based on title and abstract. After consulting the full text, 1 further study was selected. Four studies were excluded (Table 3.8) and 5 studies were not included in the GRADE assessment because they used univariate analysis (no conclusions, evidence tables or risk or bias tables were made, because the level of evidence was too low to judge using GRADE), but these studies are briefly described due to the limited number of studies with a multivariate design.

Results

One study was included in the literature analysis. The main study characteristics and results are included in Table 3.9. Assessment of the individual study design (risk of bias) is included in the risk of bias tables (Table 3.10).

Literature Summary

When evaluating prognostic factors, the ideal study design is an RCT in which the effectiveness of an internally and externally validated prognostic model is examined. If there is no study with this design, a study in which a prognostic model is validated externally is preferable. If there is also no study with this design, a study in which a prognostic model is validated internally is preferable. If there is also no study with this design, studies are used in which prognostic factors are studied through a multivariate analysis.

Regarding this search question, only studies that studied prognostic factors through a multivariate analysis were found, without internal or external validation. One study examined findings on ultrasound (neovascularisation) as a prognostic factor.²²

Due to the limited number of studies examining prognostic factors, the longitudinal studies with a univariate design are briefly described in the results and in Table 3.11 (ultrasound) and Table 3.12 (MRI). In these studies, GRADE assessment was not performed. The reliability of the prognostic value of these parameters is uncertain as the studies only used univariate analyses.

Ultrasound

Description of studies

De Jonge et al.²² described prospectively collected observational data from 3 clinical trials. In this study, the association between the presence of Doppler flow (grade 1 to 4) or absence of Doppler flow (grade 0), was examined with ultrasound. The degree of symptoms on (sports) loading (VISA-A) after 6 and after 12 months was assessed in patients with midportion Achilles tendinopathy (N=127 patients, 141 tendons) with a mean (SD) age of 47 ± 9 years. The ultrasound was performed by an examiner who was not aware of the patient's clinical status. The prognostic value of Doppler flow on baseline was statistically analysed with a repeated measurement general linear model. It is unclear for which confounders the authors corrected in their analysis.

Results

Degree of symptoms on (sports) loading (VISA-A score)

The presence of Doppler flow was not a prognostic factor compared to absence of Doppler flow, measured using the VISA-A score at short term (12 to 16 weeks) ($p=0.337$) or in the long term (24 to 52 weeks) ($p=0.865$).²² The full statistical model was not presented.

Return to sports

De Jonge et al.²² did not report this outcome measure.

Consensus statement

Patient satisfaction

De Jonge et al.²² did not report this outcome measure.

Level of evidence*Symptoms on (sports) loading (VISA-A score)*

The level of evidence for symptoms on (sports) loading was reduced by 3 levels, from 'High' to 'Very Low' risk of bias (-1, confounding not or not adequately corrected, statistical models not presented) and because of indirectness (-2: only 1 study was found that studied prognostic factors using a multivariate analysis, without internal or external validation).

There is no GRADE assessment for the secondary outcome measures return to sports and patient satisfaction due to the lack of studies.

Univariate studies

De Vos et al.²³ performed a prospective observational study examining the correlation between neovascularisation on power Doppler ultrasound and symptoms on (sports) loading measured with the VISA-A in adults with chronic midportion Achilles tendinopathy (N=58). A mean VAS score was also determined for pain during ADL and pain on (sports) loading. The ultrasound examination was performed and assessed by a radiologist who was not aware of the patient's clinical status. The Mann-Whitney U test showed no difference in change of VISA-A score ($p=0.865$) and change in VAS-score ($p=0.73$) after 12 weeks between the group with Doppler flow (grade 1 to 4) and without Doppler flow (grade 0) at baseline. The X^2 showed no difference in patient satisfaction ($p=0.91$) after 12 weeks between patients with and without neovascularisation at baseline.

Archambault et al.²⁴ conducted a retrospective observational study, in which they investigated the relationship between (altered) Achilles tendon echogenicity and the time to recover from pain on palpation of the Achilles tendon midportion (2 to 5 cm above the calcaneus insertion) in 33 patients with a mean age of 36 years (range 18-59). Ultrasound was performed and assessed by an examiner who was not aware of the patient's clinical status. Findings were divided into 3 groups: I (normal tendon), II (thickened tendon with normal homogeneous echogenicity) and III (altered echogenicity with or without thickening). There was no statistically significant difference in the number of patients who fully recovered or with persistent symptoms (after at least 14 months) between ultrasound groups I, II and III: $X^2=2.20$, $p=0.30$. Time to recovery was found to be statistically different (Kaplan Meier curves) between the different echo type grades: $X^2=7.70$, $p=0.02$. Patients with normal tendon thickness and structure (grade I) had a shorter recovery time than patients with grade II or III changes

Khan et al.¹⁸ examined the association between the presence and degree of ultrasound abnormalities (classified according to the study of Archambault et al.²⁴) and VISA-A score in 45 adults (mean age: 42 years, range 20 to 66 years) with chronic insertional or midportion Achilles tendinopathy. The researcher who performed the ultrasound was blinded to the patient's clinical status. The severity of baseline ultrasound abnormalities was not associated with VISA-A score after 1 year ($X^2=5.45$; $p=0.25$).

Level of evidence

There is no GRADE rating because of the univariate analyses performed in these studies, which makes the reliability of the result very uncertain.

MRIDescription of studies

There are no studies with a multivariate design that examine prognostic factors using MRI.

Level of evidence

There is no GRADE rating because only univariate associations were investigated and the reliability of the results is therefore very uncertain.

Consensus statement

Univariate studies

Tsehaie et al.²⁵ conducted a prospective observational study in which the relationship between MRI characteristics and the prognosis in 25 adults with midportion Achilles tendinopathy who performed a 16-week eccentric calf muscle training program was examined. The researcher who assessed the MRI characteristics was blinded to the clinical status. The following MRI characteristics were evaluated: volume of tendon in the midportion region (Volume), maximum cross-sectional surface area (CSA), maximum anterior-posterior diameter (AP diameter), and degree of signal intensity, quantified as the weighted average of T2 relaxation time. The researchers showed that MRI volume ($R^2=0.003$, $p=0.78$), MRI CSA ($R^2=0.016$, $p=0.53$), MRI AP diameter ($R^2=0.01$, $p=0.62$) and MRI signal intensity ($R^2=0.023$, $p=0.45$) had no significant association with the change in the VISA-A score.

Khan et al.¹⁸ examined the association between the presence and degree of characteristics on MRI and VISA-A score in 45 adults (mean age: 42 years, range 20 to 66 years) with insertional or midportion Achilles tendinopathy. The researcher who performed and assessed the MRI was blinded to the clinical status. The presence and characteristics on MRI were classified in a similar way as in the study of Archambault et al.²⁴: I) normal tendon thickness without increased intratendinous signal intensity; II) thickened tendon with normal intratendinous signal intensity and III) intratendinous change in signal intensity regardless of thickening of the tendon. The severity of the MRI characteristics at baseline was significantly associated with the VISA-A score after 1 year ($X^2=13.1$, $p=0.02$), with a lower MRI grade associated with a better outcome at 12 months.

Level of evidence

There is no GRADE rating because only univariate associations were investigated and the reliability of the results is therefore very uncertain.

X-rayDescription studies and results

There are no studies that examine prognostic factors using X-ray.

Level of evidence

There is no GRADE-assessment for prognostic factors of an X-ray due to the lack of studies.

CT scanDescription studies and results

There are no studies that examine prognostic factors using a CT scan.

Level of evidence

There is no GRADE assessment for prognostic factors using a CT scan due to the lack of studies.

Conclusions

Midportion Achilles tendinopathy

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| Very low Grade | <p><i>Symptoms associated with (sports) loading (VISA-A)</i></p> <p>The presence of ultrasound Doppler flow in midportion Achilles tendinopathy was not associated with the change in symptoms associated with (sports) loading after non-surgical treatment in the short (12 to 16 weeks) term or the long (24 to 52 weeks) term.</p> <p><i>Source: de Jonge et al.²²</i></p> |
| - Grade | <p>Due to the lack of studies, there are no conclusions on prognostic factors on ultrasound for return to sports or patient satisfaction.</p> |

Consensus statement

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| - Grade | Due to the lack of studies, there are no conclusions on prognostic factors on MRI, X-ray and CT scan for the prognosis in Achilles tendinopathy. |
|--------------------|--|

Insertional Achilles tendinopathy

| | |
|--------------------|---|
| - Grade | Due to a lack of studies, no conclusions can be made about prognostic factors on imaging for return to sports and patient satisfaction. |
|--------------------|---|

Considerations

To answer the search question of sub-module 3.4, 1 observational ultrasound study with multivariate analysis was eligible.²² The study found no significant difference in VISA-A score at short-term (12 to 16 weeks) or the long-term (24 weeks to 1 year) between the groups with or without ultrasonographic Doppler flow at baseline.

The univariate studies showed contradictory results. De Vos et al.²³ reported no difference in VISA-A score at follow up between patients with and without neovascularisation on baseline. This is in keeping with the study of de Jonge et al.²². There is conflicting evidence for altered tendon echogenicity as a prognostic factor. Archambault et al.²⁴ found an increased recovery time in patients who had grade 2 or 3 (increased tendon thickening and altered echogenicity regardless of thickening respectively) compared to those with a normal tendon. Khan et al.¹⁸ found no relationship between the imaging findings at baseline and clinical outcome, measured with the VISA-A score. This is in keeping with a more recent study by de Jonge et al.²⁶, in which the tendon structure was quantified using Ultrasound Tissue Characterisation. In this study, the degree of ultrasonographic structural abnormalities in 54 patients with midportion Achilles tendinopathy did not have a prognostic value for the course of the VISA-A score within 1 year follow up.

Regarding prognostic factors on MRI, Tsehaie et al.²⁵ found that increased intratendinous signal intensity at baseline did not increase the chance of improvement of symptoms associated with (sports) loading after 24 weeks following eccentric calf muscle training. Other MRI findings also had no prognostic value. Khan et al.¹⁸ found a better prognosis after 12 months when MRI findings were normal (grade I) at baseline compared to grade II or III. The severity of MRI changes at baseline was associated with the VISA-A score after 1 year, with a lower MRI grade having a better outcome at 1 year. The reasons for the different outcomes between these 2 prospective studies remain unclear. The limited methodological quality, small sample size and univariate analyses may all play a role.

There is currently insufficient evidence to state that the presence of baseline imaging findings in Achilles tendinopathy has a prognostic value for the short- or long-term course of symptoms.

This means that no clear guidance can be given on how and when to use imaging during follow-up. Given these findings, it does not seem appropriate to use imaging with the aim of determining the prognosis. If imaging has been carried out, then the working group recommends that it should be explained to the patient that there is no evidence that the severity of imaging abnormalities has a prognostic value for the course of symptoms over time.

Consensus statement

Figures and Tables supplementary file Module 3

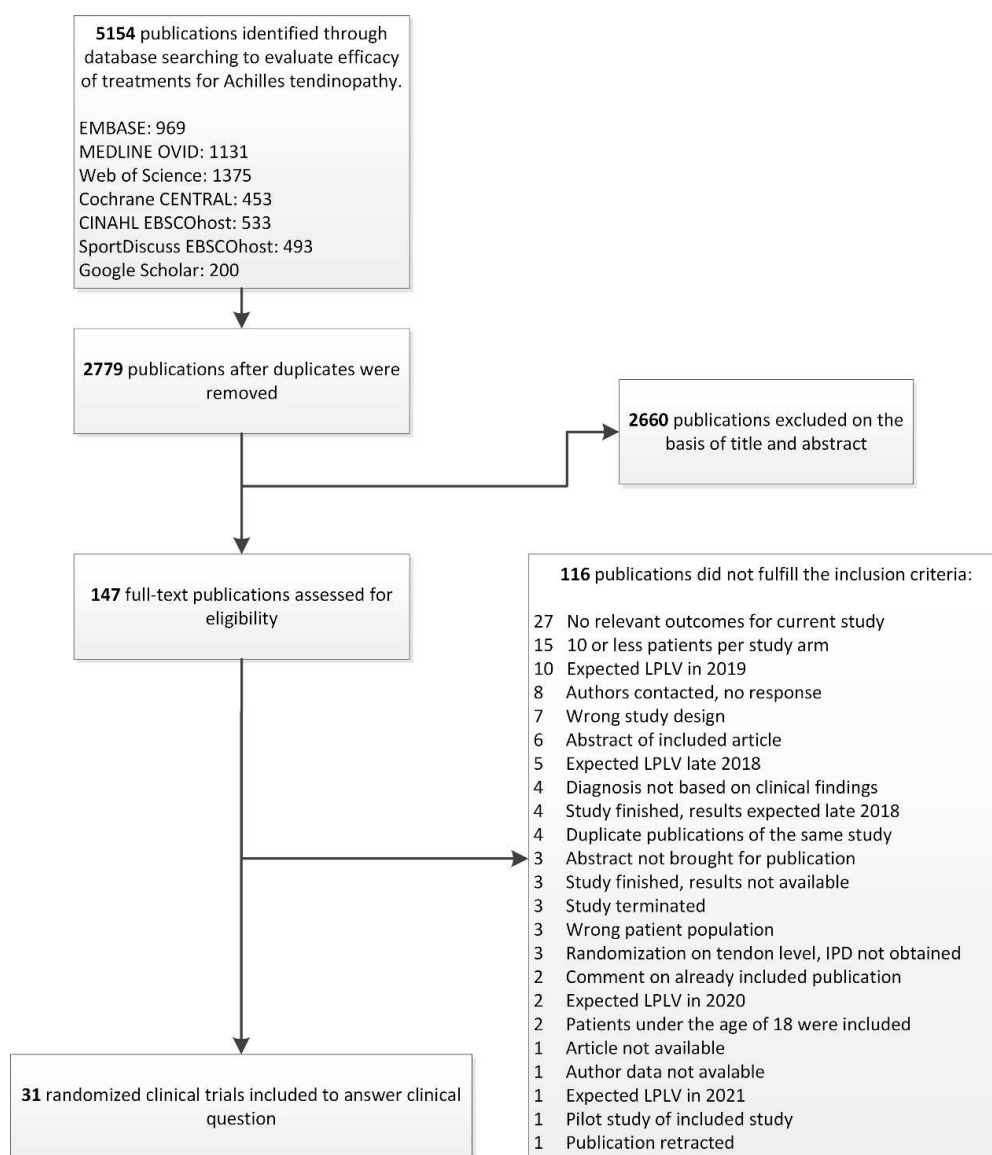


Figure 3.1 – PRISMA flowchart of the sub-module 3.3: What are the diagnostic criteria for Achilles tendinopathy?

Consensus statement

| A code of practice for sonographers | |
|-------------------------------------|---|
| 1. | Sonographers have a duty of care to their patients, patients and carers and to the minimisation of ultrasound exposure consistent with diagnostic needs. |
| 2. | Sonographers are ethically and legally obliged to hold in confidence any information acquired as a result of their professional and clinical duties, except where there is a legal obligation for disclosure. |
| 3. | Sonographers must be committed to the provision of a quality ultrasound service having due regard for the legislation and established codes of practice related to health care provision in order to minimize risk to patients, patients' carers and other professionals. |
| 4. | Sonographers are legally and professionally accountable for their own practice and must not be influenced by any form of discrimination. |
| 5. | Sonographers must identify limitations in their practice and request training and support to meet their perceived needs. |
| 6. | Sonographers will take all reasonable opportunity to maintain and improve their knowledge and professional competency and that of their peers and students. |
| 7. | Sonographers must pay due regard to the way in which they are remunerated for their work. |
| 8. | Sonographers have a duty of care to work collaboratively and in co-operation with the multi-disciplinary health care team in the interests of their patients. |
| 9. | Sonographers must act at all times in such a manner as to justify public trust and confidence, to uphold and enhance the reputation of sonography and serve the public interest. |
| 10. | Sonographers must ensure that unethical conduct and any circumstances where patients and others are at risk are reported to the appropriate authority. |
| 11. | Sonographers who are held accountable in another area of health care must relate this Code to others that govern their practice. |
| 12. | Student sonographers pursuing a qualification in medical ultrasound must adhere to their University's Codes of Conduct that relate to all elements of their ultrasound education and training. |

Table 3.1 – A code from the British Medical Ultrasound Society (BMUS) for the professional performance of ultrasound

| Database | Search terms | Total |
|-------------------|--|-------|
| Medline (OVID) | 1 ((Tendinopathy/ or Pathology/) and "Achilles tendon"/) or "Achilles tendon"/pa or ((Achilles or calcaneal) and (tendinitis* or tendinopath* or tendinosis* or tendonitis* or tendon-patholog*)).ab,ti. (2933) | 584 |
| 1946 – may 2019 | 2 exp Diagnostic Imaging/ or exp Ultrasonography/ or exp Tomography, X-Ray Computed/ or Magnetic Resonance Imaging/ or (imaging or echogra* or ultraso* or sonogram* or (tissue adj3 characteristic*) or utc or mri).ab,ti. (2965363) | |
| | 3 exp Vascular Calcification/ or (prognos* or predict* or value or future or calcification* or thickening or 'tendon volume' or 'signal intensity' or neovascularization or neovascularisation or hypoechogenicit* or haglund or 'Doppler flow' or kager*).ab,ti. (3200551) | |
| | 4 exp "Sensitivity and Specificity"/ or (Sensitiv* or Specific*).ti,ab. or (predict* or ROC-curve or receiver-operator*).ti,ab. or (likelihood or LR*).ti,ab. or exp Diagnostic Errors/ or (inter-observer or intra-observer or interobserver or intraobserver or validity or kappa or reliability).ti,ab. or reproducibility.ti,ab. or (test adj2 (re-test or retest)).ti,ab. or "Reproducibility of Results"/ or accuracy.ti,ab. or Diagnosis, Differential/ or Validation Studies.pt. (6121451) | |
| | 5 1 and 2 and (3 or 4) (481) | |
| | 6 limit 5 to english language (422) | |
| | = 422 | |
| Embase (Elsevier) | ('Achilles tendinitis'/exp OR (('tendinitis'/de OR 'pathology'/de) AND 'Achilles tendon'/de) OR ((Achilles:ab,ti OR calcaneal:ab,ti) AND (tendinitis*:ab,ti OR tendinopath*:ab,ti OR tendinosis*:ab,ti OR tendonitis*:ab,ti OR 'tendon patholog*':ab,ti))) | |

Consensus statement

| | | |
|--|--|--|
| | <p>AND ('diagnostic imaging'/exp OR 'echography'/exp OR 'computer assisted tomography'/exp OR 'nuclear magnetic resonance imaging'/exp OR imaging:ab,ti OR echogra*:ab,ti OR ultraso*:ab,ti OR sonogram*:ab,ti OR ((tissue NEAR/3 characteristic*):ab,ti) OR utc:ab,ti OR mri:ab,ti)</p> <p>AND (('prognostic value'/exp OR prognos*:ab,ti OR predict*:ab,ti OR value:ab,ti OR future:ab,ti OR 'soft tissue calcification'/exp OR calcification*:ab,ti OR 'thickening':ab,ti OR 'tendon volume':ab,ti OR 'signal intensity':ab,ti OR neovascularization:ab,ti OR neovascularisation:ab,ti OR 'hypoechoogenicity'/exp OR hypoechoogenicit*:ab,ti OR haglund:ab,ti OR 'Doppler flow':ab,ti OR kager*:ab,ti) OR ('sensitivity and specificity'/de OR sensitiv*:ab,ti OR specific*:ab,ti OR predict*:ab,ti OR 'roc curve':ab,ti OR 'receiver operator':ab,ti OR 'receiver operators':ab,ti OR likelihood:ab,ti OR 'diagnostic error'/exp OR 'diagnostic accuracy'/exp OR 'diagnostic test accuracy study'/exp OR 'inter observer':ab,ti OR 'intra observer':ab,ti OR interobserver:ab,ti OR intraobserver:ab,ti OR validity:ab,ti OR kappa:ab,ti OR reliability:ab,ti OR reproducibility:ab,ti OR ((test NEAR/2 're-test'):ab,ti) OR ((test NEAR/2 'retest'):ab,ti) OR 'reproducibility'/exp OR accuracy:ab,ti OR 'differential diagnosis'/exp OR 'validation study'/de OR 'measurement precision'/exp OR 'diagnostic value'/exp OR 'reliability'/exp))</p> <p>AND (english)/lim NOT 'conference abstract':it</p> <p>= 439</p> | |
|--|--|--|

Table 3.2 – Search strategy for imaging findings and prognosis (sub-module 3.3 and 3.4).

| Author and year | Reasons for exclusion |
|-------------------|---------------------------|
| Archambault, 1998 | Study design not suitable |
| Bakkegaard, 2015 | Study design not suitable |
| Boesen, 2012 | Study design not suitable |
| De Vos, 2007 | Study design not suitable |
| Gardin, 2006 | Study design not suitable |
| Haim, 2000 | Study design not suitable |
| Leung, 2008 | Study design not suitable |
| Khan, 2004 | Study design not suitable |
| Matthews, 2018 | Study design not suitable |
| Nicholson, 2007 | Other PICO |
| Nicholson, 2012 | Study design not suitable |
| Paavola, 2000 | Study design not suitable |
| Richards, 2005 | Study design not suitable |
| Richards, 2010 | Study design not suitable |
| Romero, 1998 | Study design not suitable |
| Tschaie, 2017 | Study design not suitable |
| Van Schie, 2010 | Study design not suitable |

Table 3.3 – Reasons for exclusion after screening the full text articles.

| Radiologic criteria used | Number of |
|--------------------------|-----------|
|--------------------------|-----------|

Consensus statement

| | studies |
|--|---------|
| • Ultrasonography: Local thickening of the tendon ¹ | 10/10 |
| • Ultrasonography: heterogenous tendon structure with hypoechoic areas | 8/10 |
| • Ultrasonography: Presence of Doppler flow | 5/10 |
| • Ultrasonography: Irregular fibre orientation | 4/10 |

Table 3.4 – Radiologic criteria for midportion Achilles tendinopathy used in randomised trials (n=10) in the Treatment module (Module 4) of this guideline.

¹ The majority of studies (80%) did not specify local thickening of the Achilles tendon. In two studies (30%) thickening was defined: one study defined this as increased anterior-posterior thickening of > 50% compared to the asymptomatic side, the other study defined this as thickening of >1 mm compared to the contralateral Achilles tendon.

| Radiologic criteria used | Number of studies |
|--|-------------------|
| • Ultrasonography: calcification in the tendon | 1/1 |

Table 3.5 – Radiological criteria for insertional Achilles tendinopathy used in the only randomised trial (n=1) in the Treatment module (Module 4) of this guideline. The other study included ultrasound to exclude other diagnoses, without further specification.

| Radiologic criteria used | Number of studies |
|--|-------------------|
| • Ultrasonography: Neovascularisation/presence of Doppler flow | 1/1 |

Table 3.6 – Radiological criteria for midportion and insertional Achilles tendinopathy (not specified) used in 1 randomised study in the Treatment module (Module 4) of this guideline.

Consensus statement

| Study | Imaging criteria |
|--|---|
| Midportion Achilles tendinopathy | |
| Balius, 2016 ²⁷ | • Ultrasonography: Local thickening of the tendon, irregular tendon structure with hypoechoic areas, and irregular fibre orientation |
| Bell, 2013 ²⁸ | • Diagnosis confirmed by ultrasonography (criteria not reported) |
| Beyer, 2015 ²⁹ | • Ultrasonography: Local anterior-posterior thickening of the midtendon level with a hypoechoic area and a colour Doppler signal within the hypoechoic area |
| Boesen, 2017 ³⁰ | • Ultrasonography: Tendon thickness and intratendinous vascularity |
| de Jonge, 2010 ³¹ | • None |
| de Jonge, 2011 ³² | • None |
| Heinemeier, 2017 ³³ | • Ultrasonography: Increased Achilles tendon thickness at the midportion, with hypoechoic areas and presence of colour Doppler signal. |
| Herrington, 2007 ³⁴ | • None |
| Hutchison, 2013 ³⁵ | • Ultrasonography: hypoechogenic area within the tendon with loss of the normal ribbon-like intratendinous and/or an increase in the thickness of the tendon anteroposteriorly by > 50% compared with the asymptomatic contralateral side |
| Krogh, 2016 ³⁶ | • Ultrasonography: Achilles tendon with spindle-shaped ultrasonographic thickening of the tendinous tissue of >1 mm in relation to the contralateral tendon • Ultrasonography: Definite signs of tendinopathy, with a colour Doppler flow of at least grade 2 of 4 (0-4) |
| Lynen, 2017 ³⁷ | • None |
| Morrison, 2017 ³⁸ | • MRI: MRI-proven diagnosis of AT, not further specified |
| Munteanu, 2015 ³⁹ | • Ultrasonography: Presence of local thickening and/or irregular fibre orientation and/or irregular tendon structure with hypoechoic areas and/or vascularisation within the mid-portion of the Achilles tendon |
| Mafi, 2001 ⁴⁰ | • Ultrasonography: Localised widening of the tendon and hypoechoic areas |
| Pearson, 2012 ⁴¹ | • None |
| Rompe, 2007 ⁴² | • Ultrasonography: Local thickening of the tendon and/or irregular tendon structure with hypoechoic areas and/or irregular fibre orientation |
| Rompe, 2009 ⁴³ | • Ultrasonography: Local thickening of the tendon and/or irregular tendon structure with hypoechoic areas and/or irregular fibre orientation |
| Roos, 2004 ⁴⁴ | • None |
| Silbernagel, 2001 ⁴⁵ | • None |
| Silbernagel, 2007 ⁴⁶ | • None |
| Stevens, 2014 ⁴⁷ | • None |
| Tumilty, 2012 ⁴⁸ | • None |
| Tumilty, 2016 ⁴⁹ | • None |
| Usuelli, 2017 ⁵⁰ | • None |
| Yelland, 2011 ⁵¹ | - None |
| Zhang, 2013 ⁵² | - None |
| Insertional Achilles tendinopathy | |
| Hunt, 2015 ⁵³ | • Not reported |
| Njawaya, 2017 ⁵⁴ | • Ultrasonography: calcification in the tendon |

Consensus statement

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|--|---|
| Rompe, 2008 ⁵⁵ | • Ultrasonography: To exclude other diagnoses (not further specified) |
| Achilles tendinopathy (not further specified) | |
| Auclair, 1989 ⁵⁶ | • Not reported |
| Ebbesen, 2018 ⁵⁷ | • Ultrasonography: Neovascularisation |

Table 3.7 – Radiological criteria for Achilles tendinopathy used in Treatment module (Module 4) of this guideline.

| Author and year | Reasons for exclusion |
|-----------------|---------------------------|
| Boesen, 2012 | Study design not suitable |
| Nicholson, 2007 | Other PICO |
| Paavola, 2000 | Study design not suitable |
| Richards, 2010 | Pilot study |

Table 3.8 – Reasons for exclusion of articles after full text screening (sub-module 3.4)

Consensus statement

| Study reference | Study characteristics | Patient characteristics | Prognostic factor(s) | Follow-up | Estimates of prognostic effect | Comments |
|-----------------|--|---|---|--|---|--|
| De Jonge, 2014 | <p>Type of study: prospective cohort study, data from 3 RCT's</p> <p>Setting and country: Medical centre, The Netherlands</p> <p>Funding and conflicts of interest: not reported</p> | <p>Inclusion criteria: Clinical diagnosis “chronic midportion Achilles tendinopathy”: Painful thickening 2–7 cm proximal to the distal insertion Age 18–70 years</p> <p>Exclusion criteria: Clinical suspicion of other musculoskeletal injuries (insertional disorders or ruptures) Systemic illness Already performed heavy load eccentric exercises or inability to perform the exercises</p> <p>N= 127 (141 tendons)</p> <p>Mean age \pm SD: 47.1\pm8.7 91% of the patients were active in sports, 41 patients (32%) at competitive level and</p> | <p>Described prognostic factor(s) and method of measurement: Neovascularisation (Doppler ultrasonography) Neovascularisation was determined by Doppler ultrasonography of the Achilles tendon in both transversal and longitudinal planes and scored according to Öhberg (Ohberg et al., 2001) ranged from 0 to 4+.</p> <p>0 (no vessels visible), 1+ (one vessel mostly in the anterior part), 2+ (one or two vessels throughout the tendon), 3+ (three vessels throughout the tendon), and 4+ (more than three large vessels throughout the tendon)</p> | <p>Duration or endpoint of follow-up: 1 year</p> <p>For how many participants were no complete outcome data available? N=3 patients, N=8 data on VISA -A Reasons: loss to follow up (N=2 patients), loss to 1 follow up moment (N=1)</p> <p>N=25 data on neovascularisation missing. Not clear how many patients: loss to follow up (N=2 patients), loss to 1 follow up moment (N=12 measurements))repair of the sonographic machine (N=5 measurements)</p> | <p>(Adjusted) Factor-outcome associations (include SEs or 95%CI and p-value if available):</p> <p>Incremental predictive value¹:</p> <p>Only p value reported: Presence of neovascularisation at baseline did not influence the short-term improvement significantly ($P = 0.337$) neither the long-term improvement ($P = 0.865$).</p> <p>This analysis also corrected for therapy? Not clear</p> | To calculate the prognostic value of all parameters in the short and longer terms, a repeated measurement general linear model was used. |

Consensus statement

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|--|--|--|--|--|--|--|
| | | 87 patients (68%) at recreational level. Sex: 43% M / 57% F Potential confounders or effect modifiers: therapy | | | | |
|--|--|--|--|--|--|--|

Table 3.9 – main study characteristics and results of the included study.

¹ Incremental predictive value is the predictive value beyond standard demographic factors and the established risk factors (for example smoking, blood pressure, lipid levels, diabetes, cancer stage, et cetera), for example change in c-statistic.

| Study reference | Study participation ¹ | Study Attrition ² | Prognostic factor measurement ³ | Outcome measurement ³ | Study confounding ⁴ | Statistical Analysis and Reporting ⁵ |
|-------------------------------------|--|---|---|---|---|---|
| (first author, year of publication) | Study sample represents the population of interest on key characteristics? (high/moderate/low risk of selection bias) | Loss to follow-up not associated with key characteristics (i.e., the study data adequately represent the sample)? (high/moderate/low risk of attrition bias) | Was the PF of interest defined and adequately measured? (high/moderate/low risk of measurement bias related to PF) | Was the outcome of interest defined and adequately measured? (high/moderate/low risk of measurement bias related to outcome) | Important potential confounders are appropriately accounted for? (high/moderate/low risk of bias due to confounding) | Statistical analysis appropriate for the design of the study? (high/moderate/low risk of bias due to statistical analysis) |
| De Jonge, 2014 | Low risk of selection bias | Low risk of attrition bias | Low risk related to prognostic factor | Moderate risk (note different follow up times) | High risk | High risk (not corrected, models not presented) |

Table 3.10 – Risk of Bias assessment of the included study.

Consensus statement

| Study | N | Classification AT | Imaging findings | Outcome measures | Statistical test | Results |
|-------------------|----|--|---|--|--|--|
| <i>Ultrasound</i> | | | | | | |
| De Vos, 2007 | 58 | Midportion AT | Neovascularisation Absent: grade 0 Present: grade 1-4 | 12 weeks: ○ VISA-A ○ Pain (VAS) ○ Patient satisfaction | Mann Whitney U test (VISA-A and VAS) and X ² (patient satisfaction) | No difference in VISA-A (p=0.865), VAS (p=0.728) and patient satisfaction (p=0.908) between neovascularisation and no neovascularisation at baseline |
| Archambault, 1998 | 33 | No information about inclusion of patients with insertional or midportion tendinopathy | Thickening, change in echogenicity Grade I, II or III | ○ Degree of recovery (14 months) ○ Time of recovery 6-54 months | X ² Kaplan Meier, ¹⁰ ² | Degree of recovery: 2=2.20, p=0.297 ² Grade II and III longer time of recovery compared to grade I: X ² =7.70, p=0.02 |
| Khan, 2003 | 45 | Insertional and midportion AT | Ultrasonography grade of severity* on T0 | 52 weeks: ○ VISA-A | X ² | 2 ² =5.45; p=0.25 |

Table 3.11 – Summary of univariate studies on ultrasound for the prognosis in Achilles tendinopathy.

AT: Achilles tendinopathy; VISA-A: Victorian Institute of Sports Assessment Achilles. *Ultrasound grading according to Archambault: I) Normal tendon thickness and architecture; II) thickened tendon, normal echogenicity and III) changed echogenicity of tendon regardless of thickening (Archambault, 1998).

Consensus statement

| Study | N | Type | Imaging findings | Change symptoms | Statistic tests | Results |
|---------------|----|-------------------------------|--|------------------|---|--|
| <i>Mri</i> | | | | | | |
| Tsehaie, 2017 | 25 | Midportion AT | MRI Volume, MRI CSA MRI AP diameter MRI signal intensity | 24 weeks: VISA-A | General linear mixed model with repeated measurements | MRI volume ($R^2=0.003$, $p=0.777$), MRI CSA ($R^2=0.016$, $p=0.532$), MRI AP diameter ($R^2=0.01$, $p=0.618$) and MRI signal intensity ($R^2=0.023$, $p=0.448$) |
| Khan, 2003 | 45 | Insertional and midportion AT | MRI grade of severity* on T0 | 52 weeks: VISA-A | X^2 | $X^2=13.1$, $p=0.02$ |

Table 3.12 – Summary univariate studies MRI thickness and architecture; II) thickened tendon, normal echogenicity and III) changed echogenicity of tendon regardless of thickening.

REFERENCES

1. Thoirs KA, Childs J. Are Ultrasound Measurements of Achilles Tendon Size Reliable? A Systematic Review of Rater Reliability. *Ultrasound Med Biol.* 2018;44(12):2476-91.
2. Bleakney RR, White LM. Imaging of the Achilles tendon. *Foot Ankle Clin.* 2005;10(2):239-54.
3. Åström M, Gentz CF, Nilsson P, et al. Imaging in chronic achilles tendinopathy: A comparison of ultrasonography, magnetic resonance imaging and surgical findings in 27 histologically verified cases. *Skeletal Radiol.* 1996;25(7):615-20.
4. Martin RL, Chimenti R, Cuddeford T, et al. Achilles Pain, Stiffness, and Muscle Power Deficits: Midportion Achilles Tendinopathy Revision 2018. *J Orthop Sports Phys Ther.* 2018;48(5):A1-A38.
5. Thomson N, Williams W. Guidelines for Professional Ultrasound Practice Standards for the provision of an ultrasound service. *BMUS Guidelines for Professional Ultrasound Practice. Revision 2.* December 2017.
6. Leung JL, Griffith JF. Sonography of chronic Achilles tendinopathy: a case-control study. *J Clin Ultrasound.* 2008;36(1):27-32.
7. Romero-Morales C, Martín-Llantino PJ, Calvo-Lobo C, et al. Comparison of the sonographic features of the Achilles Tendon complex in patients with and without achilles tendinopathy: A case-control study. *Phys Ther Sport.* 2019;35:122-26.
8. Matthews W, Ellis R, Furness J, et al. Classification of Tendon Matrix Change Using Ultrasound Imaging: A Systematic Review and Meta-analysis. *Ultrasound Med Biol.* 2018;44(10):2059-80.
9. Shibuya N, Thorud JC, Agarwal MR, et al. Is Calcaneal Inclination Higher in Patients with Insertional Achilles Tendinosis? A Case-controlled, Cross-sectional Study. *J Foot Ankle Surg.* 2012;51(6):757-61.
10. Singh R, Rohilla R, Siwach RC, et al. Diagnostic significance of radiologic measurements in posterior heel pain. *Foot (Edinb).* 2008;18(2):91-8.
11. Kang S, Thordarson DB, Charlton TP. Insertional Achilles tendinitis and Haglund's deformity. *Foot Ankle Int.* 2012;33(6):487-91.
12. Lu CC, Cheng YM, Fu YC, et al. Angle analysis of Haglund syndrome and its relationship with osseous variations and Achilles tendon calcification. *Foot Ankle Int.* 2007;28(2):181-5.
13. Sundararajan PP, Wilde TS. Radiographic, clinical, and magnetic resonance imaging analysis of insertional Achilles tendinopathy. *J Foot Ankle Surg.* 2014;53(2):147-51.
14. de Vos RJ, van der Vlist AC, Winters M, et al. Diagnosing Achilles tendinopathy is like delicious spaghetti carbonara: it is all about key ingredients, but not all chefs use the same recipe. *Br J Sports Med.* 2021;55(5):247-248.
15. Robinson JM, Cook JL, Purdam C, et al. The VISA-A questionnaire: a valid and reliable index of the clinical severity of Achilles tendinopathy. *Br J Sports Med.* 2001;35(5):335-41.
16. de Vos RJ, Weir A, van Schie HT, et al. Platelet-rich plasma injection for chronic Achilles tendinopathy: a randomized controlled trial. *JAMA.* 2010;303(2):144-9.

Consensus statement

17. Iversen JV, Bartels EM, Langberg H. The victorian institute of sports assessment - achilles questionnaire (visa-a) - a reliable tool for measuring achilles tendinopathy. *Int J Sports Phys Ther.* 2012;7(1):76-84.
18. Khan KM, Forster BB, Robinson J, et al. Are ultrasound and magnetic resonance imaging of value in assessment of Achilles tendon disorders? A two year prospective study. *Br J Sports Med.* 2003;37(2):149-53.
19. McCormack J, Underwood F, Slaven E, et al. The Minimum Clinically Important Difference on the VISA-A and LEFS for Patients with Insertional Achilles Tendinopathy. *Int J Sports Phys Ther.* 2015;10(5):639-44.
20. Tumilty S, Munn J, Abbott JH, et al. Laser therapy in the treatment of achilles tendinopathy: A pilot study. *Photomed Laser Surg.* 2008;26(1):25-30.
21. Lagas IF, van der Vlist AC, van Oosterom RF, et al. Victorian Institute of Sport Assessment-Achilles (VISA-A) questionnaire: Minimal clinically important difference for active people with mid-portion Achilles tendinopathy - a prospective cohort study. Accepted for publication in *J Orthop Sports Phys Ther.* 2021.
22. de Jonge S, Warnars JL, De Vos RJ, et al. Relationship between neovascularization and clinical severity in Achilles tendinopathy in 556 paired measurements. *Scand J Med Sci Sports.* 2014;24(5):773-8.
23. de Vos RJ, Weir A, Cobben LP, et al. The value of power Doppler ultrasonography in Achilles tendinopathy: a prospective study. *Am J Sports Med.* 2007;35(10):1696-701.
24. Archambault JM, Wiley JP, Bray RC, et al. Can sonography predict the outcome in patients with achillodynia? *J Clin Ultrasound.* 1998;26(7):335-9.
25. Tsehaie J, Poot DHJ, Oei EHG, et al. Value of quantitative MRI parameters in predicting and evaluating clinical outcome in conservatively treated patients with chronic midportion Achilles tendinopathy: A prospective study. *J Sci Med Sport.* 2017;20(7):633-37.
26. de Jonge S, Tol JL, Weir A, et al. The Tendon Structure Returns to Asymptomatic Values in Nonoperatively Treated Achilles Tendinopathy but Is Not Associated With Symptoms: A Prospective Study. *Am J Sports Med.* 2015;43(12):2950-58.
27. Balius R, Álvarez G, Baró F, et al. A 3-Arm Randomized Trial for Achilles Tendinopathy: Eccentric Training, Eccentric Training Plus a Dietary Supplement Containing Mucopolysaccharides, or Passive Stretching Plus a Dietary Supplement Containing Mucopolysaccharides. *Curr Ther Res Clin Exp.* 2016;78:1-7.
28. Bell KJ, Fulcher ML, Rowlands DS, et al. Impact of autologous blood injections in treatment of mid-portion Achilles tendinopathy: Double blind randomised controlled trial. *BMJ.* 2013;346(7908).
29. Beyer R, Kongsgaard M, Hougs Kjær B, et al. Heavy Slow Resistance Versus Eccentric Training as Treatment for Achilles Tendinopathy: A Randomized Controlled Trial. *Am J Sports Med.* 2015;43(7):1704-11.
30. Boesen AP, Hansen R, Boesen MI, et al. Effect of High-Volume Injection, Platelet-Rich Plasma, and Sham Treatment in Chronic Midportion Achilles Tendinopathy: A Randomized Double-Blinded Prospective Study. *Am J Sports Med.* 2017;45(9):2034-43.
31. de Jonge S, de Vos RJ, Van Schie HT, et al. One-year follow-up of a randomised controlled trial on added splinting to eccentric exercises in chronic midportion Achilles tendinopathy. *Br J Sports Med.* 2010;44(9):673-7.
32. de Jonge S, de Vos RJ, Weir A, et al. One-year follow-up of platelet-rich plasma treatment in chronic Achilles tendinopathy: a double-blind randomized placebo-controlled trial. *Am J Sports Med.* 2011;39(8):1623-29.
33. Heinemeier KM, Øhlenschläger TF, Mikkelsen UR, et al. Effects of anti-inflammatory (NSAID) treatment on human tendinopathic tissue. *J Appl Physiol.* 2017;123(5):1397-405.
34. Herrington L, McCulloch R. The role of eccentric training in the management of Achilles tendinopathy: A pilot study. *Phys Ther Sport.* 2007;8(4):191-96.
35. Hutchison AM, Pallister I, Evans RM, et al. Intense pulsed light treatment of chronic midbody Achilles tendinopathy: A double blind randomised placebo-controlled trial. *Bone Jt J.* 2013;95 B(4):504-09.
36. Krogh TP, Ellingsen T, Christensen R, et al. Ultrasound-Guided Injection Therapy of Achilles Tendinopathy With Platelet-Rich Plasma or Saline: A Randomized, Blinded, Placebo-Controlled Trial. *Am J Sports Med.* 2016;44(8):1990-97.

Consensus statement

37. Lynen N, De Vroey T, Spiegel I, et al. Comparison of Peritendinous Hyaluronan Injections Versus Extracorporeal Shock Wave Therapy in the Treatment of Painful Achilles' Tendinopathy: A Randomized Clinical Efficacy and Safety Study. *Arch Phys Med Rehabil.* 2017;98(1):64-71.
38. Morrison RJM, Brock TM, Reed MR, et al. Radiofrequency Microdebridement Versus Surgical Decompression for Achilles Tendinosis: A Randomized Controlled Trial. *J Foot Ankle Surg.* 2017;56(4):708-12.
39. Munteanu SE, Scott LA, Bonanno DR, et al. Effectiveness of customised foot orthoses for Achilles tendinopathy: a randomised controlled trial. *Br J Sports Med.* 2015;49(15):989-94.
40. Mafi N, Lorentzon R, Alfredson H. Superior short-term results with eccentric calf muscle training compared to concentric training in a randomized prospective multicenter study on patients with chronic Achilles tendinosis. *Knee Surg Sports Traumatol Arthrosc.* 2001;9(1):42-47.
41. Pearson J, Rowlands D, Highet R. Autologous blood injection to treat achilles tendinopathy? A randomized controlled trial. *J Sport Rehabil.* 2012;21(3):218-24.
42. Rompe JD, Nafe B, Furia JP, et al. Eccentric loading, shock-wave treatment, or a wait- and-see policy for tendinopathy of the main body of tendo Achillis: A randomized controlled trial. *Am J Sports Med.* 2007;35(3):374-83.
43. Rompe JD, Furia J, Maffulli N. Eccentric loading versus eccentric loading plus shock-wave treatment for midportion achilles tendinopathy: A randomized controlled trial. *Am J Sports Med.* 2009;37(3):463-70.
44. Roos EM, Engström M, Lagerquist A, et al. Clinical improvement after 6 weeks of eccentric exercise in patients with mid-portion Achilles tendinopathy - A randomized trial with 1-year follow-up. *Scand J Med Sci Sports.* 2004;14(5):286-95.
45. Silbernagel KG, Thomeé R, Thomeé P, et al. Eccentric overload training for patients with chronic Achilles tendon pain--a randomised controlled study with reliability testing of the evaluation methods. *Scand J Med Sci Sports.* 2001;11(4):197-206.
46. Silbernagel KG, Thomee R, Eriksson BI, et al. Continued sports activity, using a pain-monitoring model, during rehabilitation in patients with Achilles tendinopathy: a randomized controlled study. *Am J Sports Med.* 2007;35(6):897-906.
47. Stevens M, Tan CW. Effectiveness of the alfredson protocol compared with a lower repetition-volume protocol for midportion achilles tendinopathy: A randomized controlled trial. *J Orthop Sports Phys Ther.* 2014;44(2):59-67.
48. Tumilty S, McDonough S, Hurley DA, et al. Clinical effectiveness of low-level laser therapy as an adjunct to eccentric exercise for the treatment of Achilles' tendinopathy: A randomized controlled trial. *Arch Phys Med Rehabil.* 2012;93(5):733-39.
49. Tumilty S, Mani R, Baxter GD. Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial. *Lasers Med Sci.* 2016;31(1):127-35.
50. Uselli FG, Grassi M, Maccario C, et al. Intratendinous adipose-derived stromal vascular fraction (SVF) injection provides a safe, efficacious treatment for Achilles tendinopathy: results of a randomized controlled clinical trial at a 6-month follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(7):2000-2010.
51. Yelland MJ, Sweeting KR, Lyftogt JA, et al. Prolotherapy injections and eccentric loading exercises for painful Achilles tendinosis: a randomised trial. *Br J Sports Med.* 2011;45(5):421-28.
52. Zhang BM, Zhong LW, Xu SW, et al. Acupuncture for chronic achilles tendnopathy: A randomized controlled study. *Chin J Integr Med.* 2013;19(12):900-04.
53. Hunt KJ, Cohen BE, Davis WH, et al. Surgical Treatment of Insertional Achilles Tendinopathy with or Without Flexor Hallucis Longus Tendon Transfer. *Foot Ankle Int.* 2015;36(9):998-1005.
54. Njawaya MM, Moses B, Martens D, et al. Ultrasound Guidance Does Not Improve the Results of Shock Wave for Plantar Fasciitis or Calcific Achilles Tendinopathy: A Randomized Control Trial. *Clin J Sport Med.* 2018;28(1):21-27.
55. Rompe JD, Furia J, Maffulli N. Eccentric loading compared with shock wave treatment for chronic insertional achilles tendinopathy: A randomized, controlled trial. *J Bone Jt Surg Am.* 2008;90(1):52-61.
56. Auclair J, Georges M, Grapton X, et al. A double-blind controlled multicenter study of percutaneous niflumic acid gel and placebo in the treatment of Achilles heel tendinitis. *Current Therapeutic Research, Clinical & Experimental.* 1989;46(4):782-88.

Consensus statement

57. Ebbesen BH, Mølgaard CM, Olesen JL, et al. No beneficial effect of Polidocanol treatment in Achilles tendinopathy: a randomised controlled trial. *Knee Surg Sports Traumatol Arthrosc*. 2018;26(7):2038-44.