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

- **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.

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

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

- **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.

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.

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.

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

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 hypoechoic 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.

Conclusions

Midportion and insertional Achilles tendinopathy

- **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.

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

- **Grade**	The most commonly used radiological diagnostic criteria on ultrasound for midportion Achilles tendinopathy in randomised studies are: 1) local thickening of the Achilles tendon 2) heterogeneous tendon structure with hypoechoic areas 3) presence of intratendinous or peritendinous Doppler flow

Insertional Achilles tendinopathy

- **Grade**	The only radiological diagnostic criterion used in ultrasound for insertional Achilles tendinopathy in one randomised study is: 1) intratendinous calcifications

Midportion and insertional Achilles tendinopathy

- **Grade**	The only radiological diagnostic criterion used in ultrasound for midportion and insertional Achilles tendinopathy in one randomised study is: 1) the presence of intratendinous or peritendinous Doppler flow.

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 study[6], 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 study[7] 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

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.

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

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.

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.

MRI
Description 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.

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) intratendineous 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-ray
Description 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 scan
Description 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

Very low Grade	*Symptoms associated with (sports) loading (VISA-A)* 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. *Source: de Jonge et al.[22]*

- Grade	Due to the lack of studies, there are no conclusions on prognostic factors on ultrasound for return to sports or patient satisfaction.

- **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.

Figures and Tables supplementary file Module 3

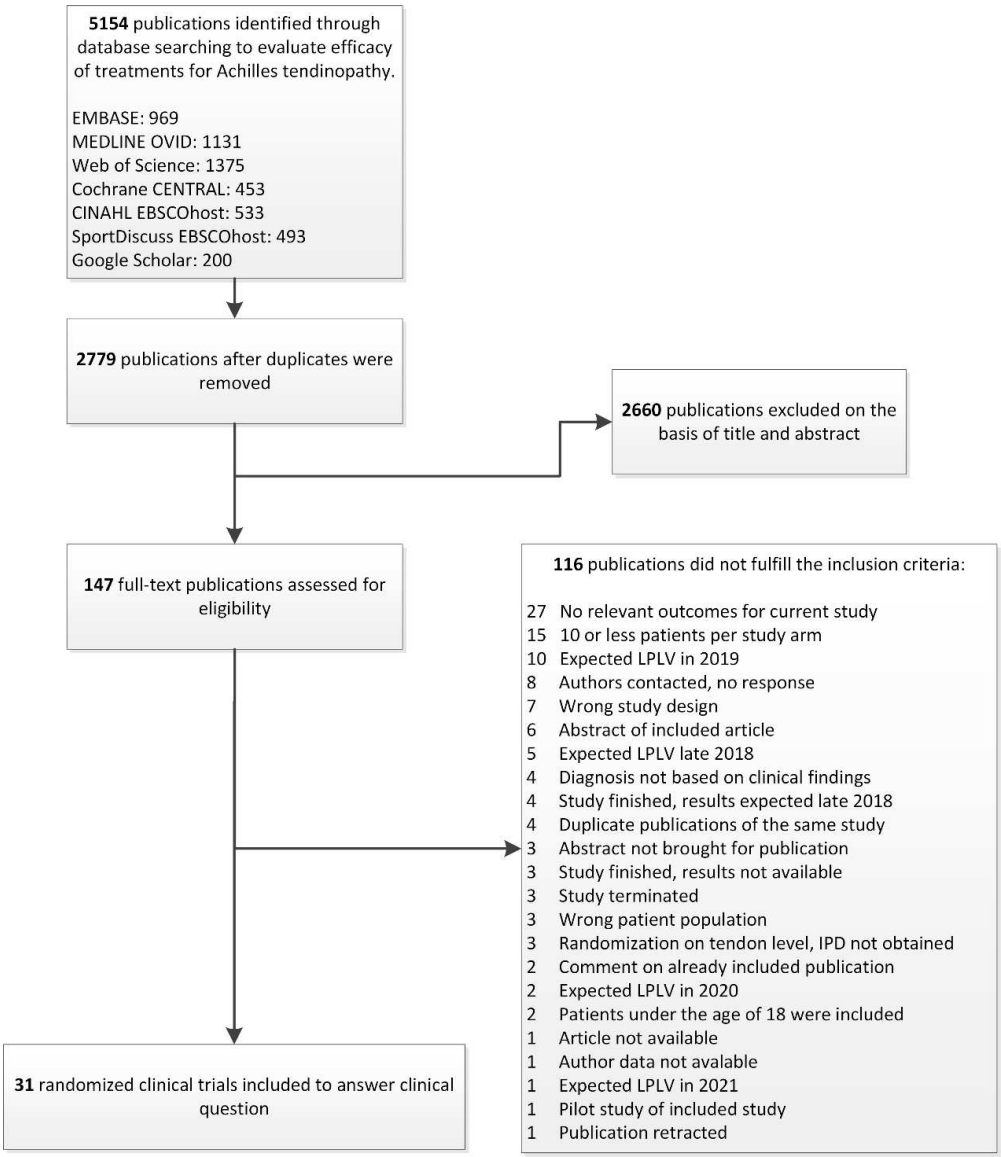

Figure 3.1 – PRISMA flowchart of the sub-module 3.3: What are the diagnostic criteria for Achilles tendinopathy?

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) 1946 – may 2019	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) 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	**584**
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)))	

	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) 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 'hypoechogenicity'/exp OR hypoechogenicit*: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)) AND (english)/lim NOT 'conference abstract':it = 439	

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
Tsehaie, 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

	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.

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

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)

Study reference	Study characteristics	Patient characteristics	Prognostic factor(s)	Follow-up	Estimates of prognostic effect	Comments
De Jonge, 2014	Type of study: prospective cohort study, data from 3 RCT's Setting and country: Medical centre, The Netherlands Funding and conflicts of interest: not reported	Inclusion criteria: Clinical diagnosis "chronic midportion Achilles tendinopathy": Painful thickening 2–7 cm proximal to the distal insertion Age 18–70 years 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 N= 127 (141 tendons) Mean age ± SD: 47.1±8.7 91% of the patients were active in sports, 41 patients (32%) at competitive level and	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+. 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)	Duration or endpoint of follow-up: 1 year 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) 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)	(Adjusted) Factor-outcome associations (include SEs or 95%CI and p-value if available): Incremental predictive value[1]: 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 ($P = 0.865$). This analysis also corrected for therapy? Not clear	To calculate the prognostic value of all parameters in the short and longer terms, a repeated measurement general linear model was used.

		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 (first author, year of publication)	**Study participation[1]** Study sample represents the population of interest on key characteristics? (high/moderate/low risk of selection bias)	**Study Attrition[2]** 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)	**Prognostic factor measurement[3]** Was the PF of interest defined and adequately measured? (high/moderate/low risk of measurement bias related to PF)	**Outcome measurement[3]** Was the outcome of interest defined and adequately measured? (high/moderate/low risk of measurement bias related to outcome)	**Study confounding[4]** Important potential confounders are appropriately accounted for? (high/moderate/low risk of bias due to confounding)	**Statistical Analysis and Reporting[5]** 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.

Study	N	Classification AT	Imaging findings	Outcome measures	Statistical test	Results
Ultrasound						
De Vos, 2007	58	Midportion AT	Neovascularisation Absent: grade 0 Present: grade 1-4	12 weeks: o VISA-A o Pain (VAS) o 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	o Degree of recovery (14 months) o 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: o 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).

Study	N	Type	Imaging findings	Change symptoms	Statistic tests	Results
Mri						
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.

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