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Conservative management of mid-portion Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning

--Manuscript Draft--

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Abstract:	ABSTRACT Clinicians manage mid-portion Achilles tendinopathy (AT) using complex clinical reasoning underpinned by a rapidly developing evidence base. The objectives of the study were to develop an inclusive, accessible review of the literature in combination with an account of expert therapists' related clinical reasoning to guide clinical practice and future research. Searches of the electronic databases, PubMed, ISI Web of Science, PEDro, CINAHL, Embase, and Google Scholar were conducted for all papers published from inception to November 2011.Reference lists and citing articles were searched for further relevant articles. Inclusion required studies to evaluate the effectiveness of any conservative intervention for mid-portion AT. Exclusion criteria included in vitro, animal and cadaver studies and tendinopathies in other locations (e.g. patella, supraspinatus). From a total of 3497 identified in the initial search, 47 studies fulfilled the inclusion criteria. Studies were scored according to the PEDro scale, with a score of >8/10 considered of excellent quality, 5-7/10 good, and <4/10 poor. The strength of evidence supporting each treatment modality was then rated as 'strong,' 'moderate,' 'limited,' 'conflicting, or 'no evidence' according to the number and quality of articles supporting that modality. Additionally, semi-structured interviews were conducted with physiotherapists to explore clinical reasoning related to the use of various interventions with and without an evidence base, and their perceptions of available evidence. Evidence was strong for eccentric loading exercises and extracorporeal shockwave therapy; moderate for, splinting/bracing, active rest, low-level laser therapy and concentric exercises (i.e. inferior to eccentric exercise). In-shoe

	foot orthoses and therapeutic ultrasound had limited evidence. There was conflicting evidence for topical glycerin tri-nitrate. Taping techniques and soft tissue mobilization were not yet examined but featured in case studies and in the interview data. Framework analysis of interview transcripts yielded multiple themes relating to physiotherapists' clinical reasoning and perceptions of the evidence, including the difficulty in causing pain while treating the condition and the need to vary research protocols for specific client groups - such as those with metabolic syndrome as a likely etiological factor. Physiotherapists were commonly applying the modality with the strongest evidence base, eccentric loading exercises. Barriers to research being translated into practice identified included the lack of consistency of outcome measures, excessive stringency of some authoritative reviews and difficulty in accessing primary research reports. The broad inclusion criteria meant some lower quality studies were included in this review. However, this was deliberate to ensure that all available research evidence for the management of mid-portion AT, and all studies were evaluated using the PEDro scale to compensate for the lack of stringent inclusion criteria. Graded evidence combined with qualitative analysis of clinical reasoning produced a novel and clinically applicable guide to conservative management of mid-portion AT. This guide will be useful to novice clinicians learning how to manage this treatment-resistant condition and to expert clinicians reviewing their evidence based practice and developing their clinical reasoning. Important areas requiring future research were identified including the effectiveness of orthoses, the effectiveness of manual therapy, etiological factors, optimal application of loading related to stage of presentation and how to optimize protocols for different types of patients such as the older patient with metabolic syndrome as opposed to the athletically active.
Response to Reviewers:	General Comments to Authors To ensure the technical accuracy of your manuscript, please take particular care over the following important aspects: * Consistency (particularly with numerical data) between the various parts of the manuscript (text, figures, tables, abstract) * appropriate units are included with numerical data * data in tables are correct (totals add up, percentages are correctly calculated etc) * where significance of results is discussed appropriate statistical values are given, and all statistical values calculated or quoted are correct * references are included where necessary (to support key statements in text, for all studies quoted in text, figures and tables etc) We have checked this on numerous occasions and now believe the manuscript is accurate. Reviewer #1 General Comments I think in general this review is a good addition to the literature on this subject. 1.There needs to be a bit of clarification throughout the paper regarding whether the authors are referring to insertional or mid-portion Achilles tendinopathy as these are quite different entities. Response: The paper is focussed on mid-portion Achilles tendinopathy. This has been clarified in the title and where appropriate in the text. 2.I think the addition of the commentary from the PT's is good as it does help put the evidence into some context. It would be better if the actual data were a little more accessible rather than all in an appendix at the end - leads to a lot of flipping back and forth in the paper. Response: As also suggested by the editor, we are happy for the multiple Tables within the Appendix to be collapsed into one, maintaining the sub-headings, and it be included as a Table in the results section.

3.Finally, I would consider changing the way the data are presented in the appendix with the high LOE data presented earlier on rather than in reverse chronological order.

Response: As suggested, this has been changed so that the higher quality studies come first.

Overall, I think this paper is useful to educate therapists on appropriate treatment for Achilles tendinopathy as well as for the identification of areas where additional research are needed.

Specific Comments

4.Title - I think the title should specify that this study addresses mid-portion Achilles tendinopathy.

Response: This has been adjusted as suggested.

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5.Page 7 - last sentence - poor grammar, consider "It is envisioned?" or "It is anticipated?"

Response: As suggested, this has been changed to read “It is anticipated.”

Methods

6.Page 8 - line 3 - I would just say the search was performed through November 2011.

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7.I think the results section should be expanded a bit - at least include a brief summary of which modalities have the best evidence.

Response: The following paragraph was added to the ‘Findings’ section:

‘The review identified strong evidence (Table ii) for the efficacy of eccentric loading exercises and extra-corporeal shockwave therapy. Moderate evidence supported low-level laser therapy and continued tendon loading as opposed to active rest. Moderate evidence found concentric exercises to be effective but not as effective as eccentric exercises. Foot orthoses and therapeutic ultrasound had limited evidence. Only single case studies and a within-subject design study were identified for taping and soft-tissue mobilizations which were classed as “No Evidence (Randomized Control Trial’s or Case Control Trial’s)” (Table ii). There is conflicting evidence for topical glyceryl trinitrate.’

Discussion

8.It is difficult to follow this study the way data are currently presented. One must continuously flip between the discussion section and appendix 1 to see the evidence to which the authors are referring.

Response: This information will now be presented in the results as table vi (see Response to comment 2).

Appendix

9.All of the results of this paper are essentially listed in this appendix. It may make more sense to include this as a table - are appendices printed in the journal or just available online as a supplement? If they are not routinely printed, this information should be moved to a table.

Response: Agreed (see Responses to comment 2 and 8).

10.Further, the papers listed under each modality are listed in reverse chronological order. I think it would be more useful to list the highest level of evidence studies first under each modality, followed by lower quality studies. See my comments above on the choice of rating method for study quality.

Response: Agreed (see response to comment 3), table vi has been amended.

11.Finally, no differentiation is made between low energy and high energy ESWT. In my experience these are quite different modalities (high energy requires anesthesia, low energy could be used in clinic) that should be reported separately.

Response: most studies used ‘low energy’ ESWT based on the criterion of not being administered with local anaesthetic. This has been clarified in the text as well as the Table.

‘ Only one study [29] reported using ‘high-energy’ ESWT but this definition was primarily based on application following local aneasthetic rather than energy transmitted, which was higher in some other studies (see Table vi). The group treated with high-energy ESWT had significantly lowered pain VAS at 12 months compared to a control group. In one study using low-energy ESWT…’

Reviewer #2

I have with great interest read this article and I commend the authors for the novel approach of using mixed methods to combine the systematic review with a qualitative research approach to understand the clinical reasoning. I think this study therefore is of great interest to both researchers and clinicians.
Response: Thank you, we found the data and findings extremely interesting to analyse and present.

1.One of the limitations however could be that the generalization of the data could be questionable outside of the country where the study was performed. I think this could be further discussed in the discussion section. Nevertheless the data is valid and of interest.

Response: This is an excellent point made by the reviewer and it has now been acknowledged in the ‘limitations’ section with the final paragraph modified as follows:

‘All physiotherapists were recruited from in and around London, United Kingdom. Therefore, it is possible that qualitative data may not reflect that of physiotherapists working in other geographical settings. However, to strengthen the external validity, a sample of physiotherapists from private sector, public sector, and academic roles with a range of years of experience were recruited. Finally, qualitative research has been criticized for being subject to researcher bias [68]. This possibility was addressed by using a systematic framework method of analysis. Additionally, completing qualitative research has the potential to yield abundant data elucidating findings that can only be derived through this form of investigation. The combined approach yielded more

clinically applicable results than a stringent literature review or qualitative research alone.'

I only have two main comments that I think need to be addressed by the authors.

2.The first is concerning the systematic review. You have described the methods well and it was nice with the included table of search terms and the flow chart of the articles found. I compared your results to what Magnussen et al published in 2009 (your reference #10). They have included injection therapies which you have excluded which I think you argued well for. However they also found one study evaluating iontophoresis which is not an injection. How come this study was not included in your article. It seems to me that this one fits your criteria.

Response: The study you mention was on a cohort of individuals with acute Achilles tendon pain (i.e. < 3 months). The purpose of the current review was to identify evidence for chronic tendinopathy (i.e. > 3 months). The following sentence has been added to the 'literature review' section of the 'Methods':

'Studies were required to recruit participants with chronic pain or symptoms (i.e. at least 3 months), to ensure a true tendinopathy was studied.'

3.The other main problem I am having is that you have included the same studies twice. Meaning if an RCT was published and then the authors performed a long-term follow-up of that study it should not be included as a new RCT. For example the study by de Vos have two more studies on the same data (a 1 year follow-up and a 5 year follow-up). If you use these as new studies in how you are reporting it will skew the data in favor of the results from the main RCT. If I understand correctly when performing a systematic review these type of follow-up studies are excluded and not used when reporting the number of studies which supports a certain outcome. I think this needs to be addressed and discussed prior to publication.

Response: We checked that follow up studies did not effect the level of evidence awarded to each modality and have adjusted the manuscript so that the five follow up studies are flagged.

4.The authors also discuss limitations of qualitative studies. In my opinion methods for qualitative studies are valid and reliable and I think should not be considered as less strict compared to quantitative studies. However this requires that researchers who publish qualitative studies in the more traditionally qualitative journals really explains the methods well with appropriate references. I think the method section for the qualitative part can be improved.

Response:
A number of sentences have been added to help aid clarity to the methods section, while trying to not make the text unwieldy – a concern when using mixed methods. Specific changes were:

'A topic guide was constructed using results from the literature review and discussion within the research team to ensure that key aspects were covered and explored in depth (see Appendix 1).'

'Data for each main theme were presented as a chart with sub-themes. One chart was developed for each theme. Each chart provided an analytical tool through emerging concepts could be identified.

VR undertook the interview coding, with CB, PM and DM triangulating the analysis. Respondent validation was further conducted by presenting a group of the physiotherapists that were interviewed with the final framework charts.[18]'

Also, please see below where specific points relating to the methodology have been addressed.

Methods

5.Under the methods section Step 2. You have a reference after the first sentence, why? This reference I assume is to support why you chose these physiotherapist. I would like a clarifying statement before the reference so that readers who are not experienced with this type of method understands that this is an appropriate sampling method.

Response: The reference mentioned here was supposed to be contained in the following sentence and has been moved accordingly. Additionally, the purpose of recruiting experienced physiotherapists and using a sampling frame has been further clarified in this section:

“Physiotherapists with extensive experience of managing Achilles tendinopathy were recruited to take part in the study to optimise the wealth of information able to be obtained. To optimise external validity of qualitative findings, a sampling frame was developed to purposively recruit [16] therapists with a wide range of experience and backgrounds, including physiotherapists working in the public, private, research and clinical settings with a range of years of experience (Table iii).

6.I would like for you to include the topic guide.

Response: This will now be included as an Appendix.

7.What were the guiding questions?

Response: A brief synopsis of the guiding questions has now been added to the Methods section:

“Guiding questions covered the physiotherapist’ background, frequency of treating AT, important aspects of treatment, perceptions of evidence for various interventions, and factors which affect treatment decisions.”

8.Please include references following the description of semi-structured interviews so the reader can get information regarding what this is.

Response: Reference to Lewis and Ritchie (2003) has been added here to provide the reader with a source of additional information.

9.Also what was the setting for the interviews? This is considered important to qualitative methods.

Response: The following sentence has been added to clarify this:

“The interviewer was not familiar with the participants and the interviews took place in a setting convenient for each participant, usually their place of work.”

10.Did the interviewer know the informants or no?

Response: No, see additional sentence above.

11.How was the data analyzed? Maybe this can be better described. Was it only one researcher who analyzed or two? I think these types of clarification is important to the manuscript and will help the reader understand the reliability and validity of the qualitative research method
and data.

Response: Qualitative data was primarily interpreted by the primary author who is a

non-clinician. The opening sentence of this section has been modified accordingly:

“Framework analysis was completed by the primary author (VR) who is a non-clinician to evaluate the interview transcripts.[17]”

Additionally, data accuracy of data interpretation was checked by three expert physiotherapists. The following sentence was added to the end of this section to reflect this:

“Finally, accuracy of interpretation from the framework analysis was confirmed and potentially new information was sought by three expert physiotherapists (CB, PM and DM) involved in the study.”

Specific comments

12.On page 13 the paragraph before ESWT you state a realistic success rate is 60-65%? Is this your opinion or do you have data to support this. Please clarify for the reader.

Response: The point we were trying to make here is that there is variability in outcomes among studies reporting success of eccentric training in managing Achilles tendinopathy. The figures quoted may seem arbitrary so we have replaced them with the following bolded inserts to the text:

Similar success rates were produced when treating both sedentary [47] and athletic [45] patients with eccentric exercises. However, clinical outcomes vary widely [2, 47, 51] and superior clinical outcomes have been reported for mid-portion tendinopathy compared to insertional. [51]

13.On page 14 under LLT it would be nice if you include a reference to the table when you state that the review indicated moderate evidence.

Response: Reference to this Table has been added.

14.In the discussion on concentric exercise I think it is important to point out that in the studies you refer to patients who performed concentric exercise improved as well. Meaning this treatment is also effective. The study by Mafi et al also had differences in the amount of load between the groups not only a difference in concentric and eccentric loading. Also in the study by Silbernagel et al 2007 an exercise program that uses both concentric and eccentric exercise with a specific program on when to include the different exercises is included in the study. It might be of interest to refer to this in reference to the discussion under concentric exercise on page 16.

Response: Thank you for bringing this to our attention. We agree with the potential discussion points raised and have added this text to the text on page 16:

There is moderate evidence to suggest that concentric calf muscle training is not as effective as an eccentric training regime. Two studies [39, 60] randomised participants to either eccentric or concentric calf muscle training for 12 weeks. The results from both studies showed significantly greater reductions in pain for the eccentric training group compared to the concentric training group, although factors other than contraction type were different between groups, such as load-intensity in the study by Mafi et al [39]. However, in both studies patients did register some improvement with concentric exercises and in practice, combined concentric-eccentric exercises were frequently prescribed initially where eccentric exercises were intolerable due to pain or the patient was too weak to start with eccentric. This practice by clinicians in mixing contraction types is similar to the exercise program in Silbernagel et al 2007 [23] where patients progressed from combined eccentric/concentric to eccentric contraction (discussed in ‘continued tendon loading’ section). Physiotherapists interviewed felt that guidance on when to introduce combined concentric-eccentric exercises was lacking, and viewed the evidence as conflicting despite anecdotal success, indicating the need for further research in this area.

Thank you for allowing me to review this study.

Editor's comments

1.Abstract - could you please restructure this without subheadings.

Response: This has been restructured without sub-headings.

2.Text headings - to be consistent with heading style for review articles in the journal, can you please change 'Methods' to 'Methodology' and 'Results' to 'Findings'.

Response: This has been changed in the manuscript to conform with the journal style.

3.Table iii - please define 'NHS' in a footnote to the table.

Response: This has been completed.

4.Appendix 1 - the tables in this appendix can be included in the article if they are combined together into one long table vi (with table subheadings, i.e. Eccentric exercise training, Extracorporeal shockwave therapy etc). Please confirm that this is OK (if so, we can reformat the table if you prefer). If you require the tables in this appendix to be run as separate tables, the appendix will need to be placed on the journal website as supplementary digital content (with a cross-reference in the article), because there is insufficient text to support the inclusion of so many separate tables. Please advise.

Response: We are more than happy for this to become one big Table within the manuscript and think it is a good idea if space permits.

5.Please include a cross-reference to figure 1 at an appropriate point in the text.

Response: Reference to this Figure is now made in the first sentence of the ‘Methodology’ section.

6.You say 45 studies were reviewed but figure 1 mentions 47 studies. Can you please clarify this discrepancy in the article (apologies if I have missed this point).

Response: 47 studies were reviewed (including 42 original and 5 follow ups). This is now accurate and consistent in the ‘Abstract’ and ‘Findings’, as well as the Figure. We apologise for the original inaccuracy and associated confusion.

7.Tables iv and v have identical headings - can you please reword the headings in a way that differentiates the content of the two tables.

Response: These have been changes and now read:

“Table iv. Perceptions of the evidence for AT and clinical reasoning principles”

And

“Table v. Perceptions of the evidence for AT in relation to individual treatment modalities”

8.Table v - please define all abbreviations used in the table in footnotes to the table.

	Response: Definitions have now been added. 9.Reference list - could you please abbreviate all journal titles according to the National Library of Medicine list of abbreviations for journals. Response: This has now been completed with the exception of reference 40 where we cannot find an abbreviation.

Conservative management of **mid-portion** Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning

Author response date: 9th April 2012

Dear Roger

We would like to thank you and the two reviewers for critical appraisal and helpful suggestions related to this manuscript. We believe that addressing the expert feedback and suggestions provided has enhanced the quality of this manuscript. We hope we have addressed all issues raised to a satisfactory level and are happy to deal with any further feedback/suggestions as part of the 'Sports Medicine' editorial review process. All changes within the manuscript are in bold for ease of identification, as well being included in the clean manuscript.

We have added the table, and I have left the column headings in place at various junctures for ease of reviewing but these should likely be reworked for publication.

Further, we have added a new appendix containing the topic guide as requested by one reviewer.

Kind regards

Dylan

General Comments to Authors

To ensure the technical accuracy of your manuscript, please take particular care over the following important aspects:

* Consistency (particularly with numerical data) between
the various parts of the manuscript (text, figures, tables, abstract)
* appropriate units are included with numerical data
* data in tables are correct (totals add up, percentages are correctly calculated etc)
* where significance of results is discussed appropriate statistical values are given, and all statistical values calculated or quoted are correct
* references are included where necessary (to support key statements in text, for all studies quoted in text, figures and tables etc)

We have checked this on numerous occasions and now believe the manuscript is accurate.

Reviewer #1

General Comments

I think in general this review is a good addition to the literature on this subject.

1. There needs to be a bit of clarification throughout the paper regarding whether the authors are referring to insertional or mid-portion Achilles tendinopathy as these are quite different entities.

   Response: The paper is focussed on mid-portion Achilles tendinopathy. This has been clarified in the title and where appropriate in the text.

2. I think the addition of the commentary from the PT's is good as it does help put the evidence into some context. It would be better if the actual data were a little more accessible rather than all in an appendix at the end - leads to a lot of flipping back and forth in the paper.

   Response: As also suggested by the editor, we are happy for the multiple Tables within the Appendix to be collapsed into one, maintaining the sub-headings, and it be included as a Table in the results section.

3. Finally, I would consider changing the way the data are presented in the appendix with the high LOE data presented earlier on rather than in reverse chronological order.

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Overall, I think this paper is useful to educate therapists on appropriate treatment for Achilles tendinopathy as well as for the identification of areas where additional research are needed.

Specific Comments

4. Title - I think the title should specify that this study addresses mid-portion Achilles tendinopathy.

   Response: This has been adjusted as suggested.

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5. Page 7 - last sentence - poor grammar, consider "It is envisioned?" or "It is anticipated?"

Response: As suggested, this has been changed to read “It is **anticipated.”**

Methods

6. Page 8 - line 3 - I would just say the search was performed through November 2011.

Response: This has been changed as suggested.

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7. I think the results section should be expanded a bit - at least include a brief summary of which modalities have the best evidence.

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journal or just available online as a supplement? If they are not routinely printed, this information should be moved to a table.

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' **Only one study [29] reported using 'high-energy' ESWT but this definition was primarily based on application following local aneasthetic rather than energy transmitted, which was higher in some other studies (see Table vi). The group treated with high-energy ESWT had significantly lowered pain VAS at 12 months compared to a control group.** In one study **using low-energy ESWT**…'

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12. On page 13 the paragraph before ESWT you state a realistic success rate is 60-65%? Is this your opinion or do you have data to support this. Please clarify for the reader.

Response: The point we were trying to make here is that there is variability in outcomes among studies reporting success of eccentric training in managing Achilles tendinopathy. The figures quoted may seem arbitrary so we have replaced them with the following bolded inserts to the text:

Similar success rates were produced when treating both sedentary [47] and athletic [45] patients with eccentric exercises. However, **clinical outcomes vary widely [2, 47, 51] and** superior clinical outcomes have been reported for mid-portion tendinopathy compared to insertional. [51]

13. On page 14 under LLT it would be nice if you include a reference to the table when you state that the review indicated moderate evidence.

Response: Reference to this Table has been added.

14. In the discussion on concentric exercise I think it is important to point out that in the studies you refer to patients who performed concentric exercise improved as well. Meaning this treatment is also effective. The study by Mafi et al also had differences in the amount of load between the groups not only a difference in concentric and eccentric loading. Also in the study by Silbernagel et al 2007 an exercise program that uses both concentric and eccentric exercise with a specific program on when to include the different exercises is included in the study. It might be of interest to refer to this in reference to the discussion under concentric exercise on page 16.

Response: Thank you for bringing this to our attention. We agree with the potential discussion points raised and have added this text to the text on page 16:

There is moderate evidence to suggest that concentric calf muscle training is not as effective as an eccentric training regime. Two studies [39, 60] randomised participants to either eccentric or concentric calf muscle training for 12 weeks. The results from both studies showed significantly greater reductions in pain for the eccentric training group compared to the concentric training group, **although factors other than contraction type were different between groups, such as load-intensity in the study by Mafi *et al* [39]. However, in both studies patients did register some improvement with concentric exercises and** in practice, combined concentric-eccentric exercises were frequently prescribed initially where eccentric exercises were intolerable due to pain or the patient was too weak to start with eccentric. This practice by clinicians in mixing contraction types is similar to the exercise program in **Silbernagel *et al* 2007 [23] where patients progressed from combined eccentric/concentric to eccentric contraction (discussed in 'continued tendon loading' section).** Physiotherapists interviewed felt that guidance on when to introduce combined concentric-eccentric exercises was lacking, and viewed the evidence as conflicting despite anecdotal success, indicating the need for further research in this area.

Thank you for allowing me to review this study.

Editor's comments

1. Abstract - could you please restructure this without subheadings.

   Response: This has been restructured without sub-headings.

2. Text headings - to be consistent with heading style for review articles in the journal, can you please change 'Methods' to 'Methodology' and 'Results' to 'Findings'.

   Response: This has been changed in the manuscript to conform with the journal style.

3. Table iii - please define 'NHS' in a footnote to the table.

   Response: This has been completed.

4. Appendix 1 - the tables in this appendix can be included in the article if they are combined together into one long table vi (with table subheadings, i.e. Eccentric exercise training, Extracorporeal shockwave therapy etc). Please confirm that this is OK (if so, we can reformat the table if you prefer). If you require the tables in this appendix to be run as separate tables, the appendix will need to be placed on the journal website as supplementary digital content (with a cross-reference in the article), because there is insufficient text to support the inclusion of so many separate tables. Please advise.

   Response: We are more than happy for this to become one big Table within the manuscript and think it is a good idea if space permits.

5. Please include a cross-reference to figure 1 at an appropriate point in the text.

   Response: Reference to this Figure is now made in the first sentence of the ‘Methodology’ section.

6. You say 45 studies were reviewed but figure 1 mentions 47 studies. Can you please clarify this discrepancy in the article (apologies if I have missed this point).

   Response: 47 studies were reviewed (including 42 original and 5 follow ups). This is now accurate and consistent in the ‘Abstract’ and ‘Findings’, as well as the Figure. We apologise for the original inaccuracy and associated confusion.

7. Tables iv and v have identical headings - can you please reword the headings in a way that differentiates the content of the two tables.

   Response: These have been changes and now read:

   "Table iv. Perceptions of the evidence for AT and clinical reasoning principles"

   And

   "Table v. Perceptions of the evidence for AT **in relation to individual treatment modalities"**

8. Table v - please define all abbreviations used in the table in footnotes to the table.

   Response: Definitions have now been added.

9. Reference list - could you please abbreviate all journal titles according to the National Library of Medicine list of abbreviations for journals.

   Response: This has now been completed with the exception of reference 40 where we cannot find an abbreviation.

Conservative management of mid-portion Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning

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Word count 4003

Running title: Managing Achilles tendinopathy conservatively

Table of contents

Figure caption:

Figure 1. Conservative management pathway for Achilles tendinopathy with components identified from the literature review and qualitative data.
ESWT = extracorporeal shockwave therapy; TGTN = topical glyceryl trinitrate; LLLT = low level laser therapy.

ABSTRACT

Clinicians manage mid-portion Achilles tendinopathy (AT) using complex clinical reasoning underpinned by a rapidly developing evidence base. The objectives of the study were to develop an inclusive, accessible review of the literature in combination with an account of expert therapists' related clinical reasoning to guide clinical practice and future research. Searches of the electronic databases, PubMed, ISI Web of Science, PEDro, CINAHL, Embase, and Google Scholar were conducted for all papers published from inception to November 2011.Reference lists and citing articles were searched for further relevant articles. Inclusion required studies to evaluate the effectiveness of any conservative intervention for mid-portion AT. Exclusion criteria included *in vitro*, animal and cadaver studies and tendinopathies in other locations (e.g. patella, supraspinatus). From a total of 3497 identified in the initial search, 47 studies fulfilled the inclusion criteria. Studies were scored according to the PEDro scale, with a score of $\geq$8/10 considered of excellent quality, 5-7/10 good, and $\leq$4/10 poor. The strength of evidence supporting each treatment modality was then rated as 'strong,' 'moderate,' 'limited,' 'conflicting, or 'no evidence' according to the number and quality of articles supporting that modality. Additionally, semi-structured interviews were conducted with physiotherapists to explore clinical reasoning related to the use of various interventions with and without an evidence base, and their perceptions of available evidence. Evidence was strong for eccentric loading exercises and extracorporeal shockwave therapy; moderate for, splinting/bracing, active rest, low-level laser therapy and concentric exercises (i.e. inferior to eccentric exercise). In-shoe foot orthoses and therapeutic ultrasound had limited evidence. There was conflicting evidence for topical glycerin tri-nitrate. Taping techniques and soft tissue mobilization were not yet examined but featured in case studies and in the interview data. Framework analysis of interview transcripts yielded multiple themes relating to physiotherapists' clinical reasoning and perceptions of the evidence, including the difficulty in causing pain while treating the condition and the need to vary

research protocols for specific client groups – such as those with metabolic syndrome as a likely etiological factor. Physiotherapists were commonly applying the modality with the strongest evidence base, eccentric loading exercises. Barriers to research being translated into practice identified included the lack of consistency of outcome measures, excessive stringency of some authoritative reviews and difficulty in accessing primary research reports. The broad inclusion criteria meant some lower quality studies were included in this review. However, this was deliberate to ensure that all available research evidence for the management of mid-portion AT, and all studies were evaluated using the PEDro scale to compensate for the lack of stringent inclusion criteria. Graded evidence combined with qualitative analysis of clinical reasoning produced a novel and clinically applicable guide to conservative management of mid-portion AT. This guide will be useful to novice clinicians learning how to manage this treatment-resistant condition and to expert clinicians reviewing their evidence based practice and developing their clinical reasoning. Important areas requiring future research were identified including the effectiveness of orthoses, the effectiveness of manual therapy, etiological factors, optimal application of loading related to stage of presentation and how to optimize protocols for different types of patients such as the older patient with metabolic syndrome as opposed to the athletically active.

Key Words: Achilles tendinopathy; qualitative research; systematic review; physiotherapy

INTRODUCTION

Mid-portion Achilles tendinopathy (AT) is a chronic condition characterized by localized Achilles tendon pain and swelling, often leading to loss of occupational capacity and reduced athletic performance.[1] It affects both recreational and professional sports participants, with up to 9% of elite athletes in sports involving running or jumping suffering from AT.[2] AT is commonly associated with elite athletic activity, but affects a varied population with 33% of AT patients being sedentary individuals, particularly men aged between 35-45 years. [1, 2] The cause of AT is multi-factorial, and proposed etiological factors include overuse, adverse lower limb biomechanics (e.g. excessive foot pronation [3]), and inappropriate footwear. Patients with diabetes, inflammatory and autoimmune conditions are affected by AT, [4] and an emerging development is the connection of metabolic factors, such as dyslipidemia, to the risk of developing AT. [5]

Conservative treatment is commonly the first line of management for Achilles tendinopathy, usually applied for 3 to 6 months before alternative options such as sclerosing injections, [6] high volume image guided injections [7] or minimally invasive surgery are considered. The outcome of surgical treatment after failed conservative management is at times unpredictable, and involves extensive post-surgical rehabilitation. [8] A retrospective study of athletes surgically treated for AT found that it took an average of 11.1 months to return to competitive sport. [9] Considering the invasiveness and pitfalls of surgical interventions, it is important to identify conservative modalities that yield the best clinical outcomes.

There have been previous systematic reviews evaluating conservative treatment of Achilles tendinopathy.[2, 3, 10] A previous systematic review of non-operative treatment for mid-portion Achilles tendinopathy included five conservative modalities and three injection therapies, concluding that eccentric exercises have the strongest supporting evidence and shockwave therapy would benefit from

further research. [10] Recent work has expanded the available evidence base. Further, the highly stringent approach taken, i.e. including only high quality RCTs with criteria mainly developed for drug trials, means that some conservative interventions with supporting evidence from medium quality studies were not included. It is possible that practitioners using these systematic reviews as their only guide for clinical reasoning may therefore omit the use of potentially effective interventions in a clinical setting. Further, this limited evidence does not incorporate clinical reasoning, important to consider when the evidence base is incomplete and the condition manifests in diverse patient sub-groups.

Clinical reasoning requires a therapist to draw on knowledge of evidence, underlying theoretical constructs and past experience to deliver optimal clinical care.[11] Informal evidence derived from clinical practice also has a role in developing clinical reasoning and guiding future research.[12] Therefore, describing therapist clinical reasoning alongside a graded review of the literature has the potential to enhance evidence translation by illustrating the review findings with experts' clinical decision making paradigms and perceptions of the published evidence. We anticipated that this combined approach would make the evidence 'come alive', and therefore enhance both accessibility and applicability.

The overall aim of this study was to develop evidence-based, descriptive and clinically applicable guidance to conservative management of mid-portion Achilles tendinopathy. Our objectives were to (i) grade evidence for conservative treatments for Achilles tendinopathy via a thorough literature search and critique; (ii) qualitatively analyze physiotherapists' clinical reasoning related to the use of a wide range of interventions; (iii) establish clinicians' perceptions of the available evidence; and (iv) identify areas for future research emerging both from the evidence base and semi-structured interviews. It is anticipated that this guide will not only present a review of the state of the current evidence base but also extend the clinical utility of the findings via the illustration provided by clinical reasoning descriptions.

METHODOLOGY

Step 1: Literature Review

Searches of the electronic databases, PubMed, ISI Web of Science, PEDro, CINAHL, Embase, and Google Scholar were conducted for all papers published from inception through to November 2011(see Figure 1). The search strategy was designed to be highly sensitive, and included a wide range of terms for possible conservative treatment modalities for AT and study types (see Table i for details). Duplicates were removed, and relevant titles selected from the search results. Full papers were retrieved if the subjects were human adults (aged $\geq$ 18 years) with mid-portion Achilles tendinopathy. Studies with insertional tendinopathies were only included if a sub-group of mid-portion AT participants could be separated from the main group. Studies were required to recruit participants with chronic pain or symptoms (i.e. at least 3 months), to ensure a true tendinopathy was studied. Conservative modalities were considered as any intervention not involving surgery, injection therapy or orally administered pharmacotherapies. Studies were required to make a comparison between two groups or compare the before and after effects of an intervention. Exclusion criteria included *in vitro*, animal and cadaver studies and tendinopathies in other locations (e.g. patella, supraspinatus). Reference lists and citing articles were searched for further relevant articles.

Studies were scored according to the PEDro scale [13], with a score of $\geq$8/10 considered of excellent quality, 5-7/10 good, and $\leq$4/10 poor. This is a reliable measure for the quality of evidence.[14] This involved a supplementary search of the PEDro database for pre-scored articles. If a study had not yet been graded on the database, two reviewers (VR, SJH) scored the article on two separate occasions. A third assessor (DM) was available to resolve any contentious issues, of which there were two.

All interventions described in a multi-intervention trial were discussed individually. The strength of evidence supporting each treatment modality was then assessed

and assigned a level of 1 to 5 determined by the number and quality of articles supporting that modality according to pre-determined criteria proposed by van Tulder *et al* (Table ii).[15]

Step 2: Semi-structured Interviews

Physiotherapists with extensive experience of managing Achilles tendinopathy were recruited to take part in the study to optimise the wealth of information able to be obtained. To optimise external validity of qualitative findings, a sampling frame was developed to purposively recruit [16] therapists with a wide range of experience and backgrounds, including physiotherapists working in the public, private, research and clinical settings with a range of years of experience (Table iii). The sample inclusion criterion was that physiotherapists needed to have been practicing for 5 years or more in a setting and specialty in which they saw a significant number of patients with Achilles tendinopathy, and was designed to optimize the external validity to practicing physiotherapists while ensuring a high level of expertise to contribute to the interviews. In total, 19 physiotherapists were recruited and interviewed. Ethics approval for conducting the qualitative part of the study was granted by the Queen Mary Research and Ethics Committee. Written informed consent was obtained prior to each interview.

A topic guide was constructed using results from the literature review and discussion within the research team to ensure that key aspects were covered and explored in depth (see Appendix 1). Guiding questions covered the physiotherapists' background, frequency of treating AT, important aspects of treatment, perceptions of evidence for various interventions, and factors which affect treatment decisions. Key areas included perceptions of evidence for conservative modalities and reasoning for choosing certain treatments and not others. Face-to-face, semi-structured interviews [16] lasting an average of 30 minutes were recorded and transcribed. The interviewer was not familiar with the participants and the interviews took place in a setting convenient for each

participant, usually their place of work. The interview transcripts were analyzed concurrently with data collection until data saturation (i.e. no new themes were emerging).

Analysis

Framework analysis was completed by the primary author (VR) who is a non-clinician to evaluate the interview transcripts.[17] The researcher familiarized themselves with the interview data and identified themes and sub-themes forming a thematic framework. The framework was indexed, and this was applied to the transcripts as a labeled code for sections of text. Data for each main theme were presented as a chart with sub-themes. One chart was developed for each theme. Each chart provided an analytical tool through which allowed for emerging concepts to be identified.

VR undertook the interview coding, with CB, PM and DM triangulating the analysis. Respondent validation was further conducted by presenting a group of the physiotherapists that were interviewed with the final framework charts.[18] Four physiotherapists completed feedback forms with agreements, disagreements and further comments for each theme that was presented. Any new data were included in the analysis. Finally, accuracy of interpretation from the framework analysis was confirmed and potentially new information was sought by three expert physiotherapists (CB, PM and DM) involved in the study.

FINDINGS

Literature Review

Forty-two studies and five follow-up studies were reviewed and scored according to the PEDro scale [13], yielding 5 studies of excellent quality [19-23], 17 of good quality [24-40], and 25 of poor quality [41-65]. Eleven treatment modalities were identified, and the levels of evidence underpinning them are summarized in Table vi. Follow-up studies were not used in awarding a level of evidence to a modality.

The review identified strong evidence (Table ii) for the efficacy of eccentric loading exercises and extra-corporeal shockwave therapy. Moderate evidence supported low-level laser therapy and continued tendon loading as opposed to active rest. Moderate evidence found concentric exercises to be effective but not as effective as eccentric exercises. Foot orthoses and therapeutic ultrasound had limited evidence. Only single case studies and a within-subject design study were identified for taping and soft-tissue mobilizations which were classed as “No Evidence (Randomized Control Trial’s or Case Control Trial’s)” (Table ii). There is conflicting evidence for topical glyceryl trinitrate.

Qualitative Analysis

Nineteen interview transcripts were analyzed. The topic guide was used to inform the themes with 14 themes and 48 subthemes identified. The themes were charted into 7 groups under two sections: firstly, perceptions of the evidence for AT and clinical reasoning principles (Table iv); secondly, clinical reasoning in relation to specific treatment modalities (Table v).

The findings are both tabulated in tables iv and v and discussed in the results section alongside the evidence review findings.

DISCUSSION

The findings from the literature review and semi-structured interviews have been combined to guide clinical reasoning by physiotherapists regarding treatment modalities for **mid-portion** AT. The qualitative data provided a rich complement to the evidence review, and importantly can be used to guide future research regarding conservative interventions for AT.

Outcome Measures

The primary outcome measure of concern in the literature review was assessment of pain, and pain reduction was the main focus in the majority of studies. Secondary outcomes of function and strength were also assessed. The most valid and reliable outcome measure used was the Victorian Institute of Sport Assessment-Achilles questionnaire (VISA-A).[65] Thirteen (29%) of the studies in the literature review used the VISA-A score as an outcome measure. From the qualitative analysis, pain reduction was believed to be a primary concern to the patient. However, the physiotherapists interviewed highlighted the importance of educating patients that eccentric loading exercises will increase their pain during completion, and the difficulties therefore created in the therapeutic relationship.

Eccentric Exercises

Eccentric loading exercises have the strongest supporting evidence of all the conservative treatment modalities in the literature review. [24-28, 41-53] All physiotherapists were aware of this strong evidence base and nearly always used eccentric loading exercises for mid-portion AT patients, based on the belief that they would stimulate healing and strengthen the tendon. Similar success rates were produced when treating both sedentary [48] and athletic [46] patients with eccentric exercises. However, clinical outcomes vary widely [2, 48, 52] and superior clinical outcomes have been reported for mid-portion tendinopathy

compared to insertional. [52]

Most studies used an eccentric training protocol similar to the one described by Alfredson et al. [53] Although physiotherapists commonly used eccentric training, they reported using complex clinical reasoning to adapt research protocols for individual patients. For example, the need to vary eccentric loading protocols in patients where pain prevented adherence to published protocols by substituting with mixed concentric / eccentric or isometric loading initially. To assist this process, future research could focus on variables within the eccentric training program that could affect its efficacy: speed of exercises, duration, rate of progression and loading, chronicity and severity of condition.

Extracorporeal Shockwave Therapy (ESWT)

Extracorporeal shockwave therapy is one of only two conservative modalities with a strong supporting evidence base [19-21, 29, 32, 54-56]. Only one study [29] reported using 'high-energy' ESWT but this definition was primarily based on application following local aneasthetic rather than energy transmitted, which was higher in some other studies (see Table vi). The group treated with high-energy ESWT had significantly lowered pain VAS at 12 months compared to a control group. In one study using low-energy ESWT, VISA-A and pain numerical rating scores improved at 4 months when ESWT was combined with eccentric exercise training compared to eccentric exercises alone [20]. However, at 12 month follow up of Likert scores there was no difference in outcome between the groups. The authors suggested that due to the cost of implementing ESWT, it may be considered an inappropriate addition to the treatment of AT, with eccentric exercises being as effective in the long run. However, it may be desirable for athletic patients requiring a quicker recovery and return to sport. These feelings were reflected by physiotherapists who would consider using ESWT due to the emerging evidence but identified cost and restricted access to the devices as being currently a barrier to its application in practice.

Orthoses

The literature review identified two poor quality studies examining orthotics for treating AT [60, 62]. Over a period of 4 weeks, a group of AT patients given custom fit semi-rigid insoles was compared to a group receiving multi-modal physiotherapy group and a control group with no intervention. A significant reduction in pain was reported for patients in the physiotherapy and insole groups [60]. A case study found reduced symptoms and improved function, 31 days after the application of foot orthoses [62]. Despite the lack of evidence for orthoses, all of the interviewed physiotherapists expressed that they would consider orthotic prescription to treat AT.

Physiotherapists identified biomechanical assessment as an important part of the treatment process for AT and would use orthotics to correct foot alignment and 'off-load' the Achilles tendon. Physiotherapists' training and access to inexpensive, prefabricated orthoses were suggested to increase use in practice. Additional research evaluating long-term outcomes of using foot orthoses for AT, indications for their prescription, long-term outcomes and the effect of retraining movement patterns is needed.

Low-Level Laser Therapy (LLLT)

The literature review indicated moderate evidence (Table ii) for the use of laser therapy in the treatment of AT [22, 30]. A good quality RCT [30] concluded that LLLT in combination with eccentric loading exercises decreased recovery time in recreational athletes with AT. Additionally, when LLLT was used on its own, it reduced pain by a greater extent than a placebo laser unit at 4, 8 and 12 weeks. Despite these positive short-term findings for LLLT, none of the interviewed physiotherapists considered using LLLT to treat AT as it was viewed as more applicable to inflammatory diseases. Cost and access to laser devices were also identified as barriers to LLLT use in clinical practice. Further high quality RCTs following the CONSORT guidelines [67] evaluating the effectiveness of LLLT in

athletic and sedentary patients and for varying stages of tendinopathy are now required to confirm previous positive findings. It was suggested that modalities such as laser therapy might be most appropriate when a tendon is in a reactive rather than degenerative state – another area ripe for future research.

Topical Glyceryl Trinitrate (TGTN)

In one good quality study with a 3 year follow-up, a 1.25 mg/24 hr TGTN patch with eccentric loading exercises was found to improve pain to a greater extent than a placebo patch and eccentric loading exercises over 24 weeks [34, 35]. However, in another RCT no significant difference in outcomes was identified when a 2.5 mg/24 hr TGTN patch was combined with eccentric loading exercises over 6 months, compared to eccentric loading exercises alone [33]. The evidence remains conflicting as to TGTN's effectiveness for AT, with different dose patches used in studies. Further high quality RCTs are required to address this.

Adherence to this treatment in studies was limited by side effects of skin rashes and headaches. These side effects and no prescribing rights were reported by the interviewed physiotherapists as barriers to the use of TGTN in clinical practice. To address this barrier in the future, physiotherapists should ensure they maintain close communication with the patient's general practitioner or sports physician who has both prescription rights and greater pharmacological knowledge.

Concentric Exercises

There is moderate evidence to suggest that concentric calf muscle training is not as effective as an eccentric training regime. Two studies [39, 61] randomised participants to either eccentric or concentric calf muscle training for 12 weeks. The results from both studies showed significantly greater reductions in pain for the eccentric training group compared to the concentric training group, although

factors other than contraction type were different between groups, such as load-intensity in the study by Mafi *et al* [39]. However, in both studies patients did register some improvement with concentric exercises and in practice, combined concentric-eccentric exercises were frequently prescribed initially where eccentric exercises were intolerable due to pain or the patient was too weak to start with eccentric. This practice by clinicians in mixing contraction types is similar to the exercise program in Silbernagel *et al* 2007 [23] where patients progressed from combined eccentric/concentric to eccentric contraction (discussed in 'continued tendon loading' section). Physiotherapists interviewed felt that guidance on when to introduce combined concentric-eccentric exercises was lacking, and viewed the evidence as conflicting despite anecdotal success, indicating the need for further research in this area.

Splinting/Bracing

Moderate evidence suggests that night splints [36-38] and AirHeel braces [57, 58] do not improve clinical outcome in addition to eccentric exercises. The majority of physiotherapists interviewed would not consider splinting or bracing, particularly in the early stages due to perceived detrimental effect of immobilization on the Achilles tendon [68]. However, splinting and bracing was considered for failed healing and late stage tendinopathies. This sub-group of patients may benefit from research on the effectiveness of splinting/bracing.

Continued Tendon Loading or Physical Activity

One excellent quality RCT showed no detrimental effect of continued tendon loading activity (i.e. sporting activity), as long as pain was monitored and a threshold of 5/10 on a VAS was not exceeded. [23] There were no significant differences in symptomatic outcome between continued tendon loading and active rest groups at 5 year follow up. [59]

The interviewed physiotherapists agreed with the research, and rarely instructed patients to cease exercise. However, physiotherapists frequently recommended a reduction in the level and frequency of tendon loading activities (i.e. relative rest), citing anecdotal evidence that this improves treatment outcomes. However, perceptions of the evidence base to support active rest were conflicting; one physiotherapist thought that a study had showed that active rest was necessary, and another thought that it had been shown to make the problem worse.

Physiotherapists continue to use clinical judgment in managing patients' loading patterns, attempting to balance therapeutic tendon loading and avoidance of harmful over-load. The need for clearer evidence concerning tendon loading activities and safe progression to sporting return was highlighted in the qualitative analysis.

Therapeutic Ultrasound

The literature review only yielded one good quality pilot RCT evaluating therapeutic ultrasound for the treatment of TA, with inconclusive results for pain and function. [31] Additionally, many of the physiotherapists interviewed reported no anecdotal benefits from using therapeutic ultrasound for AT clinically and were reluctant for patients to become dependent on the modality. However, considering some physiotherapists use therapeutic ultrasound to treat AT, further high quality RCT research following the CONSORT guidelines [67] is needed to confirm its apparent ineffectiveness.

Taping

Anti-pronation taping was used in a case report to assess the suitability of a "32 year old male soccer player with a two year history of AT" [62] for orthotic prescription. The anti-pronation taping immediately increased jogging distance and decreased pain. Subsequent orthotic prescription maintained a reduction in

pain during jogging, which was assessed for 31 days post-prescription. The literature review identified a poor quality study that reported kinesiotape to have no effect on hop distance, pain or motor-neuronal excitability in patients with AT [63].

Physiotherapists were not aware of any evidence for the use of taping but used it as an assessment tool and to improve function in the short-term. Future research could assess efficacy of different taping techniques for pain in AT patients and the effect on function in the short term.

Specific Soft-tissue Mobilization

A single case study evaluated the effectiveness of “accessory and combined specific soft tissue mobilizations (SSTMs)” [64] on pain function and muscle length in a 39 year old female club hockey player with a 5 year history of AT. The study consisted of Phase A- baseline measurements taken once a week for 6 weeks with no intervention given; Phase B- treatment based on the Hunter protocol [69] for 6 weeks; Phase A- post-treatment assessment, baseline measurements taken once a week for 6 weeks with no intervention given. A significant increase in VISA-A score was reported between the pre-treatment phase A and the treatment Phase B. The maximum VISA-A score of 100% was achieved by the end of Phase B and maintained until follow-up at 3 months. There was a significant decrease in VAS for pain between the pre-treatment Phase A and Phase B which was also maintained at 3 months follow-up.

The limitation of the single case study is a lack of control and generalizability to a wider group of AT patients. The findings of this study warrant future RCTs to confirm the efficacy of soft-tissue mobilization for treating AT and indications for their use. The physiotherapists that were interviewed were aware that evidence was anecdotal for soft tissue mobilization to treat AT but would often employ such techniques despite a lack of evidence.

Calf Stretches

Calf stretches featured as an adjunct to some of the modalities being studied in the literature review, but were not identified as a separate modality. The qualitative analysis produced conflicting views on using calf stretches for AT. Some physiotherapists felt that it was an important part of the treatment process whereas reasoning for not incorporating stretches was to avoid compression of the tendon and loss of strengthening. Range of movement was not considered such an important element of the treatment process for AT unless specific joint or muscle restrictions were identified. Research on the effects of stretching on the tendon in AT patients and when to incorporate calf stretches into rehabilitation is needed, with a suggestion being that some patients have problems associated with stiffer myo-tendinous complexes and others with more lax structures. The relationship of stretching efficacy with respect to pre-existing mechanical properties of the triceps surae myo-tendinious complex was postulated as an important clinical decision that was not fully evidence based.

SUMMARY

In general, there was good awareness amongst physiotherapists of which treatment modalities had supporting evidence for AT, indicating an adequate evidence based practice approach to clinical reasoning. Interviewed physiotherapists used eccentric loading exercises as the core of rehabilitation programs for mid-portion AT but varied their application significantly in response to patient-specific factors. Further research evaluating the speed of exercises, duration, rate of progression and optimal loading progression, is needed.

General gaps within the research for mid-portion AT were identified through both the literature review and interview process, including: (i) predicting intervention outcomes for patient sub-groups; (ii) effective stage specific interventions; and (iii) effectiveness of various combinations of interventions. Physiotherapists

suggested that barriers to evidence based practice when treating AT include gaps in the evidence along with difficulty accessing and comparing study results.

LIMITATIONS

The strength of the evidence presented within the literature review may be questioned by some due to the broad inclusion criteria. However, this was a deliberate approach to ensure that the findings of the present review erred on the side of inclusivity in assessing the available research evidence for the management of AT. Additionally, when using literature identified by the review to determine level of evidence for each intervention, the PEDro quality assessment scale was used to compensate for the lack of stringent inclusion criteria [13]. However, it may be possible that some conclusions, notably derived from those studies with a low level of evidence, must be viewed cautiously. Yet, findings of the literature review can be regarded as being further strengthened by combining them with qualitative assessment of physiotherapists' clinical reasoning related to the available literature.

All physiotherapists were recruited from in and around London, United Kingdom. Therefore, it is possible that qualitative data may not reflect that of physiotherapists working in other geographical settings. However, to strengthen the external validity, a sample of physiotherapists from private sector, public sector, and academic roles with a range of years of experience were recruited. Finally, qualitative research has been criticized for being subject to researcher bias [70]. This possibility was addressed by using a systematic framework method of analysis. Additionally, completing qualitative research has the potential to yield abundant data elucidating findings that can only be derived through this form of investigation. The combined approach yielded more clinically applicable results than a stringent literature review or qualitative research alone.

CONCLUSION

The graded evidence combined with qualitative analysis of clinical reasoning produced novel guidance to the conservative management of mid-portion AT, relevant to both practitioners and researchers looking to progress practice. Empirical research indicates strong evidence for eccentric loading exercises and extra-corporeal shockwave therapy and moderate evidence for low-level laser therapy. Additionally, the physiotherapists interviewed reported anecdotal evidence for concentric exercises, soft-tissue mobilizations and foot orthoses. These interventions currently lack rigorous scientific validation, and therefore require additional research. Physiotherapists identified barriers to evidence based practice during the interviews, which included lack of access to journals and time for interpreting and comparing studies. Possible solutions to these barriers could include widely available and free clinical guidelines developed from the current levels of evidence for conservative treatment modalities for mid-portion AT.

Areas requiring further research to inform practice were highlighted. General gaps within the evidence include: i) predicting intervention outcomes for patient sub-groups; ii) effective stage-specific interventions; iii) effectiveness of combinations of interventions. Physiotherapists supported the need for further research to consider when to vary loading prescriptions, optimally apply stretching, and determine the efficacy of both foot orthoses and specific soft-tissue mobilization for mid-portion AT patients.

Acknowledgements
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Conflicts of interest
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Table i. Electronic database search terms

Terms for conservative treatment modalities	(Physiotherapy or adjustment or physical-therapy or exercise or mobilisation or immobilisation or mobilization or manual-therapy or treatment or conservative or mckenzie or maitland or cyriax or emt or pens or kaltenborn or mulligan or nerve-block or primary-care or proprioception or non-operative or management or multiple-treatment or functional-outcome or range-of-motion or supervised neglect or acupuncture or massage or electrotherapy or soft-tissue or economic or bracing or taping or evaluation or cost-analysis or myofascial or intervention or pain-management or cognitive-behavioural-therapy or multidisciplinary or biomechanic or occupational-therapy or work-hardening or off-loading or eccentric or rehabilitation or strength-training or advice or semi-rigid or ankle-brace or ankle-stabilizer or ankle-stabiliser or orthotics or shoe-inserts or compression-wrap or compression or strengthening or balance) AND
Terms for achilles tendinopathy	(Achilles tendon or Achilles-tendinopathy or Achilles-tendinitis or Achilles-tedinosis or Achilles-

	paratenonitis or mid-portion or noninsertional or insertional or heel-tendon or Achilles-paratendinopathy or Achilles tendin or Achilles-tendonopathy or Achilles-tendonitis or Achilles-tendonosis or heel-tendin or Achilles paratendonopathy) AND
Types of trial	(Observation or case-control or randomised-control-trial or controlled or systematic or comparison or comparator or intervention or randomized or randomised or placebo-controlled or placebo or double-blind or prospective or clinical-study or efficacy or multiple-subjects or Cochrane or multivariate analysis).

Table ii. Criteria for the level of evidence existing for each treatment modality.[9] RCT-randomized control trial, CCT-case control trial.

Level of Evidence	Criteria
Strong	Consistent findings among multiple high quality RCTs
Moderate	Consistent findings among multiple low quality RCTs and/or CCTs and/or one high quality RCT
Limited	One low quality RCT and/or CCT
Conflicting	Inconsistent findings among multiple trials (RCTs and/or CCTs)
No evidence	No RCTs or CCTs

Table iii. Sampling frame

		Academic	Clinical	
			NHS[1]	Private
Male	5-8 years	1	1	3
	>8 Years	1	1	3
Female	5-8 Years		2	2
	>8 years		2	3
Totals		2	6	11

[1] National Health Service

Table iv. Perceptions of the evidence for AT and clinical reasoning principles

Topic	Findings	Illustrative Quotes (interviewee number)
Perceptions of evidence for AT		
General Perceptions	Evidence Some core components have good existing research. Not a solid evidence base with a clear message. Clinical decision making viewed as being as important as evidence. Feelings -Good access in teaching hospitals, courses available, web databases accessible. Need for Athens password. -Self-motivated reading is time consuming and access to full texts is restrictive. Locums struggle with access to research. -Protocols may not be practical in reality. -Practitioners need to have the confidence and education to try new techniques/change past practice.	*"I think we're getting a bit more knowledge about the pathology behind it an the treatment options but, at the same time, we've discovered that still there much to know" (5).* *"I use MEDLINE, CINAHL and journal searches. Access is okay if you've got an password. If you don't, then it's a real hassle"* (16) *"Keeping up with research, that's facilitated by working in a large secondary care hospital, there's university links" (9).* *"An example of that is eccentric exercises, you do three sets of 15 twice a day. patients won't really be able to do that" (4).*
Gaps in Evidence	Which modalities have the best efficacy for treating athletic and non-athletic patients and different stages of tendinopathy. Causative factors, weight, and prevention. Biomechanical interventions, stretching, core stability. Translation into practice is hindered by conflicting research, study populations not reflecting individuals, access to funding for new treatments, knowledge of how to combine modalities.	*"New research now saying that non-athletes don't respond to eccentric loadi good as athletes. Why is that? So, shall we treat them differently?"(3).* *"Biomechanics and orthotics. It's an area that could be evidenced further" (1* *"How about if we combine all these different things, is that better than wait a is it better than them by themselves" (12).*
Assessment and Treatment of AT		
Implications of different patient presentations	Athletic/sedentary patients: athletic patients require a greater focus on functional re-training and may desire a shorter time frame for rehabilitation. Some patients may not tolerate aggressive rehabilitation, with focus on pain reduction and walking ability. Stage of disease, mid-portion/insertional, reactive/degenerative classification is important for prognosis	*"Someone who's highly active, they're probably going to be pain-free during g everyday activities. So, starting simple eccentric exercises, and then getting to point where they can hop, and doing some gait re-training, running stuff" (2)* *"They're not an athlete, they're older, so take into account what they would n do, what functional level are you trying to go back to? Still consider the whol chain but not going to the same degree as you would, for an athlete" (8).* *"If it's from the muscular tendon junction then I tend to treat them with eccer*

	and choice of modality.	*loaded exercises. If it's from the attachment then I haven't really found that t* *tends to irritate them so I go down offloading it, strengthening it, as opposed* *eccentric route" (10)* *"Degenerative versus a early stage reactive cause that has a lot of influence i* *the decisions here, what you do in eccentric training, pain interventions, how* *loading, how much off loading you´re doing" (12).*
Important elements in treatment	Eccentric exercises are used as the core component, tailored to individuals. Biomechanical assessment. Muscle strength aiming towards specific sports function or walking. Pain is an important issue to patients, during exercises therapists will work within an acceptable pain range. Education is vital to promote compliance and the role of exercises.	*"We've got a fairly standard treatment that we put them through and vary th* *treatment according to certain things but the core will be the same, eccentric* *exercises" (1).* *"I usually go for the biomechanics and muscle re-education as the two bigges* *and I'd put joint range of movement in second place" (13)* *"Eccentric loading it and pushing them to pain, as long as it's not getting wor* *"I'll talk about micro-trauma, actually go through that process with the patie* *draw the pictures. It's critical; it helps with the motivation and compliance" (

Table v. Perceptions of the evidence for AT **in relation to individual treatment modalities.**

Treatment Modality	Findings	Illustrative Quotes (interviewee number)
	STRONG EVIDENCE	
Eccentric Exercise Training	Applied to the majority of patients to strengthen the tendon and stimulate healing. Modify protocols depending on the patient's capabilities. A strong supportive evidence base for mid-portion AT with particular awareness of Alfredson's protocol. May not be suitable for insertional, acute or reactive tendinopathies.	*"What we know is that the eccentric exercises strengthen the collagen fibres, which, again decreases the thickening of the tendon" (5).* *"Definitely, for me, eccentric exercise is one of the biggest research-based treatments that I can use" (3).* *"Evidence behind eccentric, is that Alfredson's programme, 3 times a day, 3 sets of 15, to a pain level of about 3 to 4, that painful heel drop programme, has reasonably good evidence" (7).*
Extracorporeal Shockwave Therapy	Not widely used at present although is being considered with the emergence of evidence. Being used for very resistant cases. Conflicting patient outcomes had been experienced. Barriers to its use are expensive devices, costs passed on to the patient and not knowing how to use it.	*"We've had some good effects with a number of patients with chronic Tendinopathy and no effect at all for some others. It seems to think they need to be very carefully chosen patients" (1).* *"There's been a lot of recent research conducted in that, and from what I can gather, the early signs are positive, probably needs some more research behind it" (2).*
	MODERATE EVIDENCE	
Orthoses	Orthotics would often be considered for foot alignment issues, temporary off-loading of the tendon and if taping had decreased the patient's pain. No good, supporting research specific to AT. Lack of access, expensive, referral to podiatry time consuming.	*"Orthotics, yes because biomechanics has a big role to play in causing Achilles' tendinopathies. If someone is over-pronating significantly, and physically that can't be controlled, then you need some artificial help in terms of inner-soles to address that" (4).* *"I didn't think there was any evidence on orthotics at all "(1).*
Low Level Laser Therapy	Not being used in practice for AT, perceived as more applicable to acute inflammation. No knowledge of supportive evidence for AT. Lack of access, expensive device.	*"Not enough evidence to support its use" (6).* *"I don't have access to it. I think laser therapy is mainly for very, very acute, inflamed conditions. And we know Achilles' tendinopathy, most of the time, is not an inflammatory condition" (3).*

Concentric Exercises	Used when eccentric exercise were not achieved, if pain cannot be tolerated. Used in combination with eccentric exercises to increase muscle power. General perception that there was no supporting evidence and existing studies had conflicting results regarding whether to use in conjunction with eccentric exercises.	*"If the pain's too great but you want to do the eccentric exercises, start concentric, and slowly progress towards less and less support" (2).* *"It works very well but there is just no evidence for it"* (12). *"A study said that concentric wasn't as effective as eccentric, but then others have said that it's okay" (8).*
Splinting/Bracing	Sometimes used as a last resort. Aircast boots used after failed healing of stage 3 tendinopathies. No awareness of supporting evidence. Expensive, immobilising goes against the principles of tendon rehabilitation.	*"These people have gone everywhere else, are in a stage 3 – or stage 2 where there's been failure of healing, and you get them to the point where they have six consecutive weeks pain-free in this boot" (9).* *"I've never read any research about bracing for tendinopathy" (8).*
Active Rest	Necessary to reduce the patient's regular activity when giving rehabilitation exercises. Complete rest would be advised for acute, swollen and stage 3 tendinopathies. Not an evidence based principle. Worry of immobilisation leading to further degradation of the tendon.	*"Active resting, definitely, with more athletic people, so they're doing some sort of exercise, but not aggravating it "(8).* *"In regards to whether it's actually been studied, as a principle, applied to people not doing active rest. No, it's more just a general principle of rehab, really, not something that's based in evidence, as far as I'm aware" (9).*
	CONFLICTING / INCONCLUSIVE EVIDENCE / NO RCT'S	
Topical Glyceryl Trinitrate	Not being used in practice for AT. Evidence supports the use for elbow tendinopathy but no research supporting the use in AT. Physiotherapists are not able to prescribe. Too many side effects.	*"I've had more side effects with GTN in patients so I don't tend to jump to that anymore. I did use it with a couple of the skiers but, they had too many headaches and blood pressure control problems" (6).* *"Clinically, there are reports that it's been helpful, but I don't think it's been studied in an RCT or any sort of strong study like that" (9).*
Therapeutic Ultrasound	Ultrasound was only considered for acute inflammation. Past experience had not produced any benefits to patients. Therapists were not aware of any supporting evidence. The number of sessions required was perceived as unrealistic in an NHS setting. Makes the patient dependant on one modality with no self-management.	*"I don't use much ultrasound at all. Maybe to help with reducing pain. Unless there were some clear signs that it was not a tendinopathy but rather like a tendonitis or irritation of the outer sheath of the tendon" (4).* *"There's theoretical evidence. In terms of evidence for Achilles, I'm not aware that there is evidence that supports the use" (2).*
Taping	To correct foot posture, offload the Achilles tendon in sporting environments, facilitate muscle activation and to	*"We did a taping course and there are certain types of taping that we could use to alter biomechanics; alter the tracking of the tendon"* (19)

	analyse foot biomechanics. No supporting evidence for use with AT.	*"I don't know any evidence for it" (5).*
Joint/Soft-tissue Mobilisations	Evidence viewed as anecdotal for AT. Generally considered for treating AT if decreased ankle joint range of movement observed.	*"I'd say that probably most of the stuff is anecdotal regarding specifically joint mobilisation because I know there's some stuff on muscle mobilisation but I'm not sure if I know of much evidence on that" (18).* *"Whether you would be able to just use specific soft tissue mobilisations, that would be an interesting thing. I think is easy and would be very useful" (17),* *"mobilisations, potentially if it's a joint problem, perhaps manipulation" (16).* *"I do use mobilisations into the ankle joint, probably more around the subtalor joint" (14).*
Calf Stretches	Conflicting views on using stretches. Sometimes incorporated alongside eccentric exercises for tightness in lower limb structures. No good evidence for use with AT. General evidence on remodelling effects. Stretching was not advised to avoid compressing the tendon, loss of strengthening and exacerbating pain.	*"It's a conflicting area with regard to stretching, for example, how long to stretch for, what you're actually doing stretching, how long it lasts for, that's always a little bit of a grey area"* (16). *"That area of the tendon is a weak area and therefore you run the risk of making it more weak" (1).*

GTN = Glyceryl Trinitrate, RCT = Randomised Controlled Trial, NHS = National Health Service, AT = Achilles Tendinopathy

Table vi. Summaries of the studies reviewed, grouped by modality.

Reference	Study Design	Sample	Outcome Measures	Intervention and Dose	Results/Conclusions	PEDro Score
Eccentric Exercise Training						
Van der Plas et al. (2011)	5-yr follow-up of RCT (de Vos et al. 2007)	- 58 patients (70 tendons; 58 tendons included for analysis) - midportion.	- VISA-A - Pain status - Alternative treatments - Ultrasonographic neovascularisation score	Five yrs post Alfredson's heel drop exercise programme.	58 tendons, VISA-A sig. increased (49.2 to 83.6). 39.7% of patients completely pain-free and 48.3% had received 1+ alternative treatment(s). Tendon thickness sig. decreased.	7/10 as per original study
Yelland, M. *et al* (2011)	Randomised Clinical Trial ELE Vs Prolotherapy injection Vs Combined	-43 patients -Mid-portion -Activity related pain ≥6 weeks -M & F -40-58 years	-VISA-A -7 point Likert scales for treatment satisfaction. -Patient Global Impression of Change. -0-10 scales for worst pain in the last week, usual morning stiffness and limitation of activities.	**ELE group**: 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee. **Prolotherapy group**: prolotherapy injections of hypertonic glucose with lignocaine **Combined group**: 12 weeks of ELE+ prolotherapy injection	Prolotherapy and ELE combined with prolotherapy give more rapid improvements in symptoms than ELE alone but long term VISA-A scores are similar.	6/10
Knobloch, K 2007	RCT ELE Vs Control	-20 patients -Insertional & midportion -Symptoms ≥3 months -M & F -≥18 years	-11 point VAS for pain -Capillary blood flow -Tissue oxygen saturation -Post-capillary venous filling pressure	**ELE group**: 12 week programme of 3 sets of 15 reps 1 x day, straight knee only. **Control Group**: Crushed ice for 10 mins and relative rest to relieve pain	In the ELE group, pain was sig. reduced by 48%. Paratendon blood flow sig. decreased at three sites. No sig. changes in oxygen saturation. Post-capillary venous filling pressure sig. reduced.	5/10

Langberg, H. *et al* (2007)	CCT ELE Tendinopathy Vs Healthy Controls	-6 male elite soccer players with unilateral tendinosis (26±1year) -6 healthy male elite soccer player controls. (22±1 year) -Mid-portion -Symptoms 19 ±7 mnths	-Collagen synthesis -Collagen degradation, -VAS pain.	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	Collagen synthesis increased sig. in injured tendons post ELE. It was unchanged in healthy tendons. Collagen degradation was not affected in either group after ELE. Sig decrease in pain in injured group after ELE.	5/10
Silbernagel, KG. *et al.* (2001)	RCT ELE Vs Control	-40 patients (most involved in sport, types and training varied) -mid-portion -symptoms >3 months -M+F -19-77 years	-Pain VAS -Ankle ROM	**ELE group**: Week 1; exercises to increase local blood circulation of the lower leg, ankle range of motion, balance and gait exercises, and a toe-raise programme which progressed to a) 2s of 20 reps of *two-legged concentric/eccentric toe-raises*, b) 3s of 15 reps of *one-legged toe-raise on a step* immediately followed by c) 10 reps of *eccentric toe-raises on one leg on a step,* d) 3s of 20–100 reps of *quick rebounding toe-raises* e) *Stretching of the calf muscles* for 20 s afterwards. Pain allowed to reach 5 on VAS. **Control group:** exercise programme 3x/day, 2s of 30reps *stretching of the*	ELE group had sig. improvements in plantar flexion, pain on palpation, pain on walking, swelling and asymptomatic periods. Sig. more ELE group satisfied at 1 year.	5/10

				calf muscle, 2s of 30 reps of *two-legged concentric/eccentric toe-raises.* Informed to progress to 3sof 5 reps, if possible, of *Regular concentric/ eccentric toe-raises on one leg* as soon as symptoms allowed		
Ohberg, L. *et al.* (2004)	PCS ELE	-26 tendons, 25 patients. -Mid-portion -Symptoms 6-120 months -M&F -Mean age 50 years	-Tendon thickness and structure on ultrasound. -Symptoms and satisfaction questionnaire.	12 week eccentric training regimen.	Long-term ultrasonographic follow-up of chronic mid-portion AT patients showed a decreased tendon thickness and normalised structure in 19/26 tendons treated with ELE. Remaining structural abnormalities were associated with residual pain. 22/25 were satisfied with treatment and had a desired level of tendon loading activity.	4/10
Shalabi, A. *et al.* (2004)	PCS ELE	-25 patients (10 sports related tendinopathy) -Mid-portion	-Tendon volume and mean intratendinous signal on MRI.	12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee.	ELE produced decreased tendon thickness and intratendinous signal	4/10

		-M&F -28-70 yrs	-Pain and performance questionnaire		which correlated with improved clinical outcome. Clinical outcome was excellent in 10, good in 3, fair in 5 and poor in 8 patients.	
Fahlstrom, M[23] 2003	PCS ELE Mid-portion Vs insertional	-78 mid-portion AT patients -30 insertional AT patients -variable levels of activity, more high-level athletes in the insertional group -symptoms >3 months -M+F	-VAS pain	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	ELE had sig. good clinical results in mid portion AT but not for insertional AT.	4/10
Alfredson, H. *et al.* (1998)	CCT ELE Vs Control	-15 recreational athletes treated with ELE. (44.3 $\pm$7 yrs). -15 recreational athletes treated with surgery - control group (39.6$\pm$7.9 yrs). -Mid-portion. -Symptoms 3-100 months. -M&F.	-Calf muscle strength -Pain during activity VAS.	**ELE group**: 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee **Control group:** Not on any training regime for 3 months prior to surgery. Post-operative training programme.	After 12 weeks all 15 ELE participants were back to full activity levels with a sig. decrease in pain during activity. Calf muscle strength on the injured side increased sig. in the ELE group so it did not differ from the healthy side. The post-surgical group had sig. lower calf muscle strength than the healthy side. There was a sig. decrease in pain score post-surgery.	4/10

					The ELE 12 week model had a very good short-term effect on athletes in their early forties.	
Maffulli, N[22] (2008)	PCS ELE	-45 athletic patients (≥club level: soccer, track and field, racket sports) -Mid-portion -symptoms 7-31 months -M&F -18-46 yrs	-VISA-A	Progressed to 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	VISA-A improved significantly. 60 % benefited from ELE alone. ELE is a viable option for management of athletic patients.	3/10
Herrington, L[19] (2007)	RCT ELE Vs control	-25 patients (achilles-loading sports) -Mid-portion -symptoms >3 months -M&F -20-55 years	-VISA-A	**Control group**: 1xweek for 6 weeks; 15 mins of deep friction massage, 1MHz US at 1 W/cm^2 continuous for 5 mins over the most painful area of tendon, stretching programme (Neison-Vertommen *et al* 1992, Stanish *et al* 1986). **ELE group**: as per control group + 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	The ELE group had a significantly better improvement over 12 weeks compared to the control group. Addition of ELE to ultrasound and deep transverse friction is beneficial.	3/10
Sayana, MK[21] (2007)	PCS ELE	-34 sedentary patients (<3 x 20mins/week) -Mid-portion -symptoms >6 months	-VISA-A	Progressed to 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	A sig. difference in pre and post VISA-A scores. 15 patients did not improve with ELE. ELE may not benefit	3/10

		-M+F -20-76 years			sedentary patients to the extent reported in athletes.	
Knobloch, K. *et al* 2007	PCS ELE	-59 patients -49 mid-portion, 10 insertional	-Capillary blood flow -Tissue oxygen saturation -Post-capillary venous filling pressure.	12 week programme of ELE: 3 sets of 15 reps 1 x day, straight knee only.	Pain was sig. reduced in the mid-portion and insertional tendinopathy groups.	3/10
Norregaard, C. *et al.* 2007	RCT ELE Vs Control	-45 patients -insertional and mid-portion -Symptoms ≥3months -M&F -18-70 years	-Manually assessed tenderness score 0-3 -Ultrasonography findings -Self-reported symptoms questionnaire. -Patient's global assessment. Follow-up was performed at 3, 6, 9, 12 weeks and 1 year	**ELE group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **Control group**: 5 reps 2xday for 12 weeks of standing straight leg and bent knee stretches held for 30s.	Sig. improvements in symptoms assessed by questionnaires from 3 months. No sig. differences between the groups. Tenderness and ultrasonographic findings were sig. improved at 12 months. No sig. difference between groups.	3/10
Alfredson, H. *et al.* (2003)	PCS ELE	-6 patients -Mid-portion -Symptoms, mean of 22 months -4 females, 2 males -mean age 48 years	-VAS pain on tendon loading	12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee	VAS decreased from 69 (mean) before treatment to 17 (mean) after treatment. All six patients were back at pre-injury Achilles tendon-loading activity level.	3/10
Croisier,JL. *et al.*	PCS ELE	-34 patients (9 AT: 6 males, 3 females)	-Pain VAS	Isokinetic dynamometer training protocol for		3/10

(2001)		-Symptoms 6 ±3 months -mean age 26 ±6 years		Triceps Surae, 1-3 sets of 30 reps, progressing from 30°/s to 120°/s and 30%MAX intensity to 80%Max. 3 x week for 20-30 sessions.		
Knobloch, K. *et al.* (2009)	PCS ELE Females Vs Males	-75 patients -Mid-portion -Pain ≥12 weeks -M&F -≥18 years	-VISA-A -Pain VAS -FAOS	12 week programme of ELE. 3 sets of 15 reps 2 x day, straight knee only.	Symptomatic females do not benefit as much as males from 12 weeks of ELE. Pain reduction and improvement in FAOS and VISA-A scores was sig. lower among females in contrast to males.	2/10
Verrall, et al. (2011)	CCT ESE	- 190 patients (108 males; 82 females; mean age 39 years; 156 followed-up) - 142 Mid-portion & 14 insertional. - Symptoms >12 weeks -M&F.	- VAS - 0 – 10 score on scale of treatment effectiveness - Time from treatment to return to full activity	**ESE program:** 6 weeks of eccentric stretching, with stretch maintained for at least 15 s.	Pain sig. reduced from 7.2 to 2.9. Patient satisfaction 7 and above (excellent) in 80% of patients (mid-substance 86%). Overall mean time to return to pre-morbid activity 10 weeks.	1/10
Gardin, A. *et al* (2010)	4.2 year follow-up to Shalabi, A. 2004 PCS	-20 patients treated with 3 months of daily ELE. (9 participated in sport) -Mid-portion -Symptoms 6-120 months	-Intratendinous MRI signal. -Tendon volume -Modified Curwin & Stanish pain and performance questionnaire.	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	Intratendinous signal in treated tendons decreased significantly from baseline. 4 patients that did not complete ELE, did not improve regarding pain, performance, intra-tendinous signal or	1/10

		-M&F -33-75 yrs			tendon volume. No sig. change in mean tendon volume. 19/20 patients had sig. decreased pain at 4.2 yrs, 17/20 had sig. improved performance	

Extracorporeal Shockwave Therapy

Reference	Study Design	Sample	Outcome Measures	Intervention and Dose	Results/Conclusions	PEDro Score
Rasmussen S[17] (2008)	RCT **Low-energy** ESWT Vs sham	-48 patients -symptoms >3 months -M+F -19-80 yrs	-AOFAS -Pain VAS	**ESWT group:** 4 sessions over 4 weeks of stretching and eccentric training followed by 4 sessions 1xweek using Piezoson 100. 2000 shocks (0.12-0.51 mJ/mm^{2,} 50Hz) to the area of tenderness, no local anaesthetic. **Sham group:** as per ESWT group but with 2000 shocks delivered at 0mJ/mm^2, 50Hz	Sig. results at 8 and 12 weeks for intervention group AOFAS score. No sig. difference in pain VAS. ESWT supplements Treatment of AT.	9/10
Rompe, JD[35] (2007)	RCT ELE Vs **Low-energy** ESWT Vs Wait & See	-75 patients (athletic and non-athletic). -Mid-portion -Symptoms >6months -M+F -18-70yrs	-VISA-A -Pain NRS	**ELE group:** Progressed to 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ESWT group:** 3 sessions 1 week apart of 2000 pulses at a pressure of 3 bar, 8 pulses/s. Circumferential to the point of maximum tenderness, no local	ELE and ESWT sig. improved pain, function and general outcome at 4 months. Wait and See was ineffective	8/10

				anaesthesia, using EMS Swiss Dolorclast. **Wait & See group:** 1 consultation to discuss training modification, stretching exercises and ergonomic advice. Prescribed paracetamol 2000-4000mg/day or naproxen 1000mg/day if necessary.		
Rompe, JD[36] (2009)	RCT ELE Vs ELE+**Low-energy** ESWT	-68 Patients (21 out of 28 participated in sport at least once a week). -Mid-portion -symptoms >6 months -M+F -18-70 yrs.	-VISA-A -Pain NRS	**ELE group:** Progressed to 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE+ESWT group:** as per ELE group. After 4 weeks received 3 sessions 1 week apart of 2000 pulses at a pressure of 3 bar, 8 pulses/s. Circumferential to the point of maximum tenderness, no local anaesthesia, using EMS Swiss Dolorclast.	For all outcome measures, groups differed significantly to favour combined ELE+ESWT at 4 months. No sig. diff. at 1 year. Combined treatment is more effective for short-term outcomes.	8/10
Costa, ML. 2005	RCT **Low-energy** ESWT Vs Sham	-49 patients -Insertional & midportion -Symptoms $\geq$4 months -M & F -$\geq$18 years	-VAS Pain scores: walking, rest, during sport. -Ankle ROM -Walking on tip-toe -Able to jump	**ESWT group:** Storz Modulith® SLK applied over the area of maximum tenderness. Maximum of 0.2 mJ/mm^2 according to pain threshold. No local anaesthetic. 1500 shocks 1xmonth for 3 months	No sig. differences between the groups for any outcomes. At 1 year follow-up 13/41 patients were pain free.	6/10

			-EQol -FILLA	**Sham group:** as per ESWT group but with bubble wrap covered in an opaque cloth was inserted between the machine and tendon.		
Furia, JP[37] (2008)	CCT **High-energy** ESWT Vs control	-68 patients (various sports, levels of participation not defined, some sedentary) -Mid-portion -Symptoms >6months -M+F -18-76 yrs	-Pain VAS	**ESWT group:** Single application using the Dornier Epos lithotripter to the area of maximum tenderness extending up to 4cm.50 shocks given at each power level1-4 for a total of 200 shocks. Final 2800 shocks given at level 5 (0.21 mJ/mm^2). Frequency increased from 60 shocks/min level 1 to 240 shocks/min level 5. Ankle block with or without IV sedation. **Control Group:** traditional non-operative therapy.	Sig. results for ESWT, lowering pain VAS at 12 months. ESWT is effective for chronic mid-portion AT	5/10
Vulpiani, MC. (2009)	PCS **Low-energy** ESWT	-105 patients, 127 tendons (84 insertional, 43 mid-portion) -10 professional, 63 amateur and 32 recreational sports participants. -Symptoms $\geq$6 months -M&F	-0-4 Scale of subjective symptoms: Before therapy, 2 months, 6-12 months and 13-24 months post ESWT.	Average of 4 sessions (minimum three, maximum five), with a 2/7-day interval. 1, 500-2, 500 impulses were administered with an energy varying between 0.08 and 0.40 mJ/mm2.	Satisfactory results in 47.2% of cases (60 out of 127 tendons) at two-months follow-up, increasing to 73.2% at medium-term follow-up (93 out of 127 tendons), and 76% at 13-24 months (92 out of 121 tendons). ESWT has a positive effect in the treatment of AT with a long-lasting	4/10

		-18-74 yrs			improvement of painful symptoms.	
Lakshmanan P. *et al.* (2004)	PCS **Low-energy** ESWT	-16 tendons (15 patients, 11 participated in sport, 4 sedentary). -Mid-portion -M&F -35-77 yrs	-VISA-A -AHS	Swiss Dolorclast device to the area of tenderness, with no local anaesthetic. 1xweek for 3 weeks. 2000 shocks, 2.5 bar pressure, frequency of 6-10Hz.	A sig. improvement at mean follow up of 20.7 months in AHS and VISA-A scores. Patients with low AHS before treatment benefited the most. 6 patients had pain during therapy.	4/10
Saxena, A. *et al.* (2011)	PCS **Low-energy** ESWT	-74 tendons (32 paratendinosis, 23 mid-portion, 19 insertional). -48.6 yrs $\pm$ 12.94. -M&F	-Roles and Maudsley score	3 shockwave treatments 7-3 days apart with a Storz D-Actor 200 device. 2500 shocks, at 2.4 Bar ranging from 11 to 13 Hz, without anesthesia, applied directly to the affected area.	All groups had a sig. improvement 12-24 months post- ESWT. -Mid-portion, 78% improved -paratendinosis, 75% improved -Insertional, 84% improved. ESWT is a safe, viable and effective treatment for AT.	2/10
Low-Level Laser Therapy						
Reference	**Study Design**	**Population**	**Outcome Measures**	**Results**	**Results/Conclusions**	**PEDro Score**
Tumilty, S[33]	Pilot RCT ELE+LLLT Vs ELE	-20 patients	-VISA-A	**ELE+LLLT group:** Thor DD Laser Therapy Unit	Sig. within group improvements at 4 & 12	10/10

(2008)	+ placebo LLLT	-M+F -18-65 yrs	-VAS pain	applied to 3 points each side of the tendon (insertion, 2cm and 4cm proximal) for 30s. Total dose of 3J per point/18J per session. 3xweek for 4 weeks. **ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent and straight knee. **Placebo group:** as per treatment group but with placebo laser treatment.	wks. Between group differences were minimal. Low statistical power so conclusions on effectiveness can't be made.	
Stergioulas A[34] (2008)	RCT ELE+placebo LLLT Vs ELE+LLLT	-52 recreational athletes (attending 1-5x/week, volleyball, soccer, basketball, tennis, running) -Mid-portion -M+F	-VAS pain -Ankle ROM	**ELE+LLLT:** Progressed to 12 sets of 12 reps 4xweek for 8 weeks, straight and bent knee. Static gastrocnemius and soleus stretching. Laser probe with Ga-Al-As diode. **Placebo group**: Progressed to 12 sets of 12 reps 4xweek for 8 weeks, straight knee and bent knee. Static gastrocnemius and soleus stretching. Placebo laser unit.	Pain and ROM were sig. lower in LLLT group than placebo at all stages. LLLT accelerates clinical recovery when added to an ELE regimen. The results at 4 weeks were similar to the placebo LLLT results at 12 wks.	7/10

Therapeutic Ultrasound

Reference	Study Design	Sample	Outcome Measures	Intervention and Dose	Results/Conclusions	PEDro Score
Chester, R[32]	RCT ELE Vs US	-16 patients (non-athletic)	-VAS Pain	**ELE group:** 12 week programme of 3 sets of 15	No sig. difference between the groups.	5/10

(2008)		-symptoms >3 months. -M+F -31-76 yrs.		reps 1 x day, bent knee and straight knee. **US group:** Pulsed 2:8 US using 3 MHz at 0.5w/cm^2 applied for 2min/cm^2 over the palpable swelling of the Achilles tendon, 2 x week for 6 weeks.	Small sample size. Larger study needed.	
Topical Glyceryl Trinitrate						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Kane, TPC[31] (2008)	RCT ELE Vs TGTN	-40 patients -Mid-portion -22-68 yrs.	-VAS Pain + disability	**GTN group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Daily transdermal patch of GTN applied to the tenderest area. 2.5mg/24hrs. **Control group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee.	No sig. difference in pain or disability scores at 6 months. Data was not collected between baseline and 6 months. TGTN did not offer any clinical benefit over standard physiotherapy	6/10
Paoloni, JA[39] (2007)	3 year follow up to RCT TGTN Vs Placebo	-68 tendons -mid-portion -symptoms >3months -M+F -36-77 years	-VISA-A	**GTN group**: transdermal patch delivering 1.25mg/24hrs. Rotated around the site of maximum tenderness for 6 months. **Placebo group:** placebo demonstration patch. Rotated around the site of	TGTN group had sig. less tenderness and improved VISA-A scores. Pain, function and return to sport were non-sig. TGTN treatment benefits continued at 3 years, suggesting that TGTN has more than an	6/10

				maximum tenderness for 6 months.	analgesic effect.	
Paoloni, JA[38] (2004)	RCT TGTN Vs Placebo	-84 tendons -Mid-portion -symptoms >3 months -M+F -24-77 years	-5 point verbal descriptor questionnaire for pain	**GTN group**: transdermal patch delivering 1.25mg/24hrs. Rotated around the site of maximum tenderness for 6 months. **Placebo group:** placebo demonstration patch. Rotated around the site of maximum tenderness for 6 months.	TGTN significantly reduced pain with activity and at night, also improving function in AT	6/10
Splinting/Bracing						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
de Vos, RJ[26] (2007)	RCT ELE Vs ELE+NS	-70 tendons (active participation in sport) -Mid-portion -Symptoms >2 months -18-70 yrs	-VISA-A	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Ankle positions of 0° and 5° dorsiflexion marked on a NS. First 4 weeks at 0°. After this, 5° or more.	Both groups improved sig. but no difference between groups. NS not beneficial in addition to ELE.	7/10

de Jonge, S[27] (2008)	1 year follow up of de Vos *et al* RCT ELE Vs ELE+NS	-63 tendons (active participation in sport) -Mid-portion -symptoms >2 months. -18-70 years	-VISA-A	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Ankle positions of 0° and 5° dorsiflexion marked on a NS. First 4 weeks at 0°. After this, 5° or more.	Sig. improvement in VISA-A scores in both groups from baseline-1 year. No sig. differences between groups. ELE with or without a NS improved functional outcome at 1 yr follow up.	6/10
Roos, EM[28] (2004)	RCT ELE Vs NS Vs ELE+NS	-44 patients (non-athletic) -Symptoms >4 weeks -M+F -20-60 yrs	-FAOS -5 point Likert scale difficulty during sport	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **NS:** An anterior night splint holding the foot in 90° dorsiflexion **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee + An anterior night splint holding the foot in 90° dorsiflexion.	At 6 weeks ELE group had a sig. reduction in pain that lasted 1 year. The night splint groups had sig. but less pain reduction than ELE. More patients in ELE group returned to sport. Didn't recruit the 60 patients needed for statistical power.	6/10
Knobloch, K. *et al.* (2006)	RCT ELE Vs ELE + AHB	-112 patients ("healthy sports" and training) -Insertional and mid-portion - Symptoms >12 weeks	- Pain VAS - FAOS - Tendon O_2 saturation - Post-capillary venous	ELE group: 3s 15 reps 1x day for 12 weeks for each tendon. **AHB group:** ELE 3s 15 reps, 1x day for 12 weeks. Regular sports activity performed throughout the	Tendon oxygen saturation was increased, and capillary venous clearance facilitated using an AHB in addition to a daily 12-week ELE programme.	5/10

		-≥18 years -M&F	filling pressures	study period of 12 weeks with the AirHeel wrap throughout the day.	VAS sig. reduced in both groups but no sig. difference between the groups.	
Knobloch, K[29] *et al* (2008)	RCT ELE Vs ELE+AHB	-116 patients (some participated in sports, no level information) -Mid-portion, -Symptoms >12 weeks, -M&F,	-FAOS -Pain VAS	**ELE + AHB:** 12 week programme of 3 sets of 15 reps 2 x day. AirHeel Brace worn from getting up until the evening. **ELE only;** 12 week programme of 3 sets of 15 reps 2 x day.	Sig. improvement in both groups. No sig. diff between groups. Micro-circulatory advantages with the AHB do not translate to superior clinical performance, compared with ELE alone.	4/10
Peterson, W[30] *et al* (2007)	RCT ELE Vs AHB Vs ELE+AHB	-100 patients (recreational athletes) -Mid-portion -M+F	-VAS pain -AOFAS	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **AHB:** instructed to wear during the daytime. **Combined:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee + wearing of AHB during the day.	No sig. difference between all 3 treatment groups although improvement in all groups. AHB as effective as ELE. No synergistic effect.	4/10
Active Rest						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Silbernagel KG[42] (2007)	RCT Tendon loading Vs Active Rest	-38 patients (non-athletic) -Mid-portion	-VISA-A-S (Swedish version)	Both groups received a daily Achilles loading strengthening programme for 12 weeks-6 months. **Exercise training group**:	No sig. differences between groups although significant improvement.	8/10

		-Symptoms >2 months -M+F -20-60 yrs		allowed to continue Achilles loading activity for the first 6 weeks of rehabilitation as long as pain did not exceed 5/10 on a VAS. **Active rest group:** Not allowed to perform activity involving tendon loading in the first 6 weeks of rehabilitation.	No negative effects from continued tendon loading	
Silbernagel KG. *et al.* (2011)	5 year follow-up to 2007 RCT Tendon loading Vs Active Rest	-34 patients (non-athletic) -Mid-portion -Symptoms >2months -M&F -51±8.2 years	-Questionnaire -VISA-A -Tampa scale for Kinesiophobia	Both groups received a daily Achilles loading strengthening programme for 12 weeks-6 months. **Exercise training group**: allowed to continue Achilles loading activity for the first 6 weeks of rehabilitation as long as pain did not exceed 5/10 on a VAS. **Active rest group**: Not allowed to perform activity involving tendon loading in the first 6 weeks of rehabilitation.	No sig. differences between initial treatment groups' questionnaires at 5 yrs. 80% fully recovered, 20% had remaining symptoms. Sig. negative correlation between kinesiophobia and heel-rise work recovery.	3/10
Orthotics						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Mayer, F[40] (2007)	RCT Multi-modal Physiotherapy Vs	-31 Male runners >32 km/wk	-Pain VAS	**Physiotherapy group:** 10 30min sessions (2 or 3/week over 4 weeks)	Sig. reduction in pain after 4 weeks with physiotherapy or	4/10

	Insoles Vs control	-Mid-portion -symptoms >6 months -18-50 years		including deep friction massage at the mid-substance, local pulsed ultrasound (1.5W/cm^2) ice sensory motor training (3 sets of 15 reps of balance exercises on a stability pad) and eccentric exercises. **Insole group:** individually fitted semi-rigid insoles with bowl-shaped heels, moulded longitudinal arch support and detorsion wedge provided on the basis of a dynamic plantar pressure distribution measurement. Worn for all physical activities. **Control group:** no intervention.	insoles.	
Concentric Exercises						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Mafi, N[24] (2001)	RCT ELE Vs Concentric	-44 patients (jogging walking) -Mid-portion -Symptoms >3 months -M+F	-VAS pain	**ELE group**: 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **Concentric group: weeks 1-2** 2 or 3 sets of 20 reps 2 x day, straight knee and bent knee.	ELE group had sig. better pain reduction.	5/10

		-mean age 48 yrs		**Weeks 3-5** 3 sets of 15 reps, 2 x day with straight knee.3 x 1min slow speed step ups. **Weeks 6-12** 3 sets of 15 reps, 2 x day with straight knee.3 x 1min slow speed step ups. 3-4mins slow rope skipping, 3 sets of 20reps side jumps.		
Niesen-Vertommen SL[25] (1992)	RCT ELE Vs Concentric	-17 non-competitive athletic patients, various sports. -Symptoms >4 weeks -M+F -22-49 years	-Pain NRS Peak torque plantar-flexor	**ELE group:** 5 sets of 10 reps 1x day, 6 days/wk for 12 weeks. (Warm up, static stretch 20-30s, ELEs , static stretch 20-30s, ice 10-15min). **Concentric group:** 5 sets of 10 reps 1x day, 6 days/wk for 12 weeks. (Warm up, static stretch 20-30s, concentric exercises, static stretch 20-30s, ice 10-15min).	ELE showed larger increases in peak torque but not significant. ELE had a sig. reduction in pain ratings over 4 weeks.	3/10
Taping						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Firth, BL[41] (2010)	Within-subject design Kinesiotape Healthy Vs AT	-24 healthy participants (21-44 yrs) -24 AT patients (31-68 yrs) -M&F	-Pain VAS -1-leg hop distance	Kinesiotape tendon correction technique (5cm width) applied at an approx. tension of 50% and 75% over the Achilles tendon to the MTJ where the tension was 15%-25%	Kinesiotape had no effect on hop distance, pain or motorneuronal excitability in healthy or AT subjects and it is not a supported treatment	4/10
Smith, M. *et al.*	SCS Anti-pronation	-Soccer Player	-Distance and time until onset of pain during jogging	**Anti-pronation taping**: 3 reverse sixes, 38 mm	Anti-pronation taping resulted in 10 x increase	4/10

(2004)	taping assessment for orthotic prescription	-Male - 2 year history -32 year old	over a 23m runway, max 1150m. -VAS for perceived global treatment effect and pain.	Leukosport(a) zinc oxide adhesive tape, originating at the medial malleolus, coursing antero-laterally over the foot, under the mid-foot and finally up the medial side of the foot and distal leg. Repeated application over 3 consecutive days. **Orthoses:** 31 day follow up after the application of a bilateral ¾ length heat-mouldable orthotics. A 2° rear-foot varus pad and a 4° forefoot varus wedge were added to the right orthotic.	in pain-free jogging distance. Used as a favourable indication for orthotic prescription. Orthotic intervention reduced symptoms and improved function. Limited external validity due to SCS design.	

Soft-tissue Mobilisation						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Christenson, RE. (2007)	SCS Specific Soft Tissue Mobilisations	-Female club hockey player -5 year history of bilateral Achilles pain -39 years old	-VISA-A -VAS pain -Dorsiflexion ROM gastrocnemius length. -Lunge test- soleus length.	**Weeks 1-2**: 30s, 15 reps accessory SSTM with patient prone and Achilles in neutral. **Week 3**: 30s, 15 reps combined SSTM with Achilles on stretch. **Week 4**: 30s, 15 reps combined SSTM with isometric plantarflexion in plantargrade.	VISA-A score reached a maximum of a 100% by the end of the treatment phase which was maintained until 3-month follow-up. Sig. improvement in VAS from pre-treatment to the end of study. Sig. increase in soleus and gastrocnemius lengths	3/10

				Week 5-6: 3x 20 combined SSTM with through range plantarflexion against theraband.	Limited external validity due to SCS.	

ELE: Eccentric Loading Exercises; **ESE:** Eccentric Stretching Exercise; **ESWT**: Extracorporeal Shockwave Therapy; **TGTN**: Topical Glyceryl Trinitrate; **US**: Ultrasound; **NS**: Night Splint; **AHB**: AirHeel™ Brace; **ROM**: Range of Movement; **RCT**: Randomised Control Trial; **CCT**: Case Control Trial; **PCS**: Prospective Case Study; **SCS**: Single Case Study; **AT** :Achilles Tendinopathy; **M**: male; **F**: female; **VISA-A**: Victorian Institute of Sport Assessment-Achilles; **AHS**: Ankle Hindfoot Score; **VAS**: Visual Analogue Scale; **FILLA:** functional index of lower limb; **ROM**: Range of Movement; **NRS**: Numerical Rating Scale; **AOFAS**: American Orthopaedic Foot and Ankle Society; **FAOS**: Foot Ankle Outcome Score; **Sig:** significant.

Conservative management of **mid-portion** Achilles tendinopathy: a mixed methods study, integrating systematic review and clinical reasoning

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Figure caption:

Figure 1. Conservative management pathway for Achilles tendinopathy with components identified from the literature review and qualitative data.
ESWT = extracorporeal shockwave therapy; TGTN = topical glyceryl trinitrate; LLLT = low level laser therapy.

ABSTRACT

Clinicians manage mid-portion Achilles tendinopathy (AT) using complex clinical reasoning underpinned by a rapidly developing evidence base. **The objectives of the study were t**o develop an inclusive, accessible review of the literature in combination with an account of expert therapists' related clinical reasoning to guide clinical practice and future research. Searches of the electronic databases, PubMed, ISI Web of Science, PEDro, CINAHL, Embase, and Google Scholar were conducted for all papers published from inception to November 2011.Reference lists and citing articles were searched for further relevant articles. Inclusion required studies to evaluate the effectiveness of any conservative intervention for mid-portion AT. Exclusion criteria included *in vitro*, animal and cadaver studies and tendinopathies in other locations (e.g. patella, supraspinatus). From a total of 3497 identified in the initial search, **47** studies fulfilled the inclusion criteria. Studies were scored according to the PEDro scale, with a score of $\geq$8/10 considered of excellent quality, 5-7/10 good, and $\leq$4/10 poor. The strength of evidence supporting each treatment modality was then rated as 'strong,' 'moderate,' 'limited,' 'conflicting, or 'no evidence' according to the number and quality of articles supporting that modality. Additionally, semi-structured interviews were conducted with physiotherapists to explore clinical reasoning related to the use of various interventions with and without an evidence base, and their perceptions of available evidence. Evidence was strong for eccentric loading exercises and extracorporeal shockwave therapy; moderate for, splinting/bracing, active rest, low-level laser therapy and concentric exercises (i.e. inferior to eccentric exercise). **In-shoe foot orthoses and therapeutic ultrasound had limited evidence.** There was conflicting evidence for topical glycerin tri-nitrate. Taping techniques and soft tissue mobilization were not yet examined but featured in case studies and in the interview data. Framework analysis of interview transcripts yielded multiple themes relating to physiotherapists' clinical reasoning and perceptions of the evidence, including the difficulty in causing pain while treating the condition and the need to vary

research protocols for specific client groups – such as those with metabolic syndrome as a likely etiological factor. Physiotherapists were commonly applying the modality with the strongest evidence base, eccentric loading exercises. Barriers to research being translated into practice identified included the lack of consistency of outcome measures, excessive stringency of some authoritative reviews and difficulty in accessing primary research reports. The broad inclusion criteria meant some lower quality studies were included in this review. However, this was deliberate to ensure that all available research evidence for the management of **mid-portion** AT, and all studies were evaluated using the PEDro scale to compensate for the lack of stringent inclusion criteria. Graded evidence combined with qualitative analysis of clinical reasoning produced a novel and clinically applicable guide to conservative management of **mid-portion AT**. This guide will be useful to novice clinicians learning how to manage this treatment-resistant condition and to expert clinicians reviewing their evidence based practice and developing their clinical reasoning. Important areas requiring future research were identified including the effectiveness of orthoses, the effectiveness of manual therapy, etiological factors, optimal application of loading related to stage of presentation and how to optimize protocols for different types of patients such as the older patient with metabolic syndrome as opposed to the athletically active.

Key Words: Achilles tendinopathy; qualitative research; systematic review; physiotherapy

INTRODUCTION

Mid-portion Achilles tendinopathy (AT) is a chronic condition characterized by localized Achilles tendon pain and swelling, often leading to loss of occupational capacity and reduced athletic performance.[1] It affects both recreational and professional sports participants, with up to 9% of elite athletes in sports involving running or jumping suffering from AT.[2] AT is commonly associated with elite athletic activity, but affects a varied population with 33% of AT patients being sedentary individuals, particularly men aged between 35-45 years. [1, 2] The cause of AT is multi-factorial, and proposed etiological factors include overuse, adverse lower limb biomechanics (e.g. excessive foot pronation [3]), and inappropriate footwear. Patients with diabetes, inflammatory and autoimmune conditions are affected by AT, [4] and an emerging development is the connection of metabolic factors, such as dyslipidemia, to the risk of developing AT. [5]

Conservative treatment is commonly the first line of management for Achilles tendinopathy, usually applied for 3 to 6 months before alternative options such as sclerosing injections, [6] high volume image guided injections [7] or minimally invasive surgery are considered. The outcome of surgical treatment after failed conservative management is at times unpredictable, and involves extensive post-surgical rehabilitation. [8] A retrospective study of athletes surgically treated for AT found that it took an average of 11.1 months to return to competitive sport. [9] Considering the invasiveness and pitfalls of surgical interventions, it is important to identify conservative modalities that yield the best clinical outcomes.

There have been previous systematic reviews evaluating conservative treatment of Achilles tendinopathy.[2, 3, 10] A previous systematic review of non-operative treatment for mid-portion Achilles tendinopathy included five conservative modalities and three injection therapies, concluding that eccentric exercises have the strongest supporting evidence and shockwave therapy would benefit from

further research. [10] Recent work has expanded the available evidence base. Further, the highly stringent approach taken, i.e. including only high quality RCTs with criteria mainly developed for drug trials, means that some conservative interventions with supporting evidence from medium quality studies were not included. It is possible that practitioners using these systematic reviews as their only guide for clinical reasoning may therefore omit the use of potentially effective interventions in a clinical setting. Further, this limited evidence does not incorporate clinical reasoning, important to consider when the evidence base is incomplete and the condition manifests in diverse patient sub-groups.

Clinical reasoning requires a therapist to draw on knowledge of evidence, underlying theoretical constructs and past experience to deliver optimal clinical care.[11] Informal evidence derived from clinical practice also has a role in developing clinical reasoning and guiding future research.[12] Therefore, describing therapist clinical reasoning alongside a graded review of the literature has the potential to enhance evidence translation by illustrating the review findings with experts' clinical decision making paradigms and perceptions of the published evidence. We anticipated that this combined approach would make the evidence 'come alive', and therefore enhance both accessibility and applicability.

The overall aim of this study was to develop evidence-based, descriptive and clinically applicable guidance to conservative management of **mid-portion** Achilles tendinopathy. Our objectives were to (i) grade evidence for conservative treatments for Achilles tendinopathy via a thorough literature search and critique; (ii) qualitatively analyze physiotherapists' clinical reasoning related to the use of a wide range of interventions; (iii) establish clinicians' perceptions of the available evidence; and (iv) identify areas for future research emerging both from the evidence base and semi-structured interviews. It is **anticipated** that this guide will not only present a review of the state of the current evidence base but also extend the clinical utility of the findings via the illustration provided by clinical reasoning descriptions.

METHODOLOGY

Step 1: Literature Review

Searches of the electronic databases, PubMed, ISI Web of Science, PEDro, CINAHL, Embase, and Google Scholar were conducted for all papers published from inception **through to** November 2011**(see Figure 1)**. The search strategy was designed to be highly sensitive, and included a wide range of terms for possible conservative treatment modalities for AT and study types (see Table i for details). Duplicates were removed, and relevant titles selected from the search results. Full papers were retrieved if the subjects were human adults (aged $\geq$ 18 years) with mid-portion Achilles tendinopathy. Studies with insertional tendinopathies were only included if a sub-group of mid-portion AT participants could be separated from the main group. **Studies were required to recruit participants with chronic pain or symptoms (i.e. at least 3 months), to ensure a true tendinopathy was studied.** Conservative modalities were considered as any intervention not involving surgery, injection therapy or orally administered pharmacotherapies. Studies were required to make a comparison between two groups or compare the before and after effects of an intervention. Exclusion criteria included *in vitro*, animal and cadaver studies and tendinopathies in other locations (e.g. patella, supraspinatus). Reference lists and citing articles were searched for further relevant articles.

Studies were scored according to the PEDro scale [13], with a score of $\geq$8/10 considered of excellent quality, 5-7/10 good, and $\leq$4/10 poor. This is a reliable measure for the quality of evidence.[14] This involved a supplementary search of the PEDro database for pre-scored articles. If a study had not yet been graded on the database, two reviewers (VR, SJH) scored the article on two separate occasions. A third assessor (DM) was available to resolve any contentious issues, of which there were two.

All interventions described in a multi-intervention trial were discussed individually. The strength of evidence supporting each treatment modality was then assessed

and assigned a level of 1 to 5 determined by the number and quality of articles supporting that modality according to pre-determined criteria proposed by van Tulder *et al* (Table ii).[15]

Step 2: Semi-structured Interviews

Physiotherapists with extensive experience of managing Achilles tendinopathy were recruited to take part in the study **to optimise the wealth of information able to be obtained. To optimise external validity of qualitative findings,** a sampling frame was developed to purposively recruit **[16]** therapists with a wide range of experience and backgrounds, including physiotherapists working in the public, private, research and clinical settings with a range of years of experience (Table iii). The sample inclusion criterion was that physiotherapists needed to have been practicing for 5 years or more in a setting and specialty in which they saw a significant number of patients with Achilles tendinopathy, and was designed to optimize the external validity to practicing physiotherapists while ensuring a high level of expertise **to contribute to the interviews**. In total, 19 physiotherapists were recruited and interviewed. Ethics approval for conducting the qualitative part of the study was granted by the Queen Mary Research and Ethics Committee. Written informed consent was obtained prior to each interview.

A topic guide was constructed using results from the literature review **and discussion within the research team** to ensure that key aspects were covered and explored in depth **(see Appendix 1)**. **Guiding questions covered the physiotherapists' background, frequency of treating AT, important aspects of treatment, perceptions of evidence for various interventions, and factors which affect treatment decisions.** Key areas included perceptions of evidence for conservative modalities and reasoning for choosing certain treatments and not others. Face-to-face, semi-structured interviews **[16]** lasting an average of 30 minutes were recorded and transcribed. **The interviewer was not familiar with**

the participants and the interviews took place in a setting convenient for each participant, usually their place of work. The interview transcripts were analyzed concurrently with data collection until data saturation (i.e. no new themes **were emerging)**.

Analysis

Framework analysis was **completed by the primary author (VR) who is a non-clinician** to evaluate the interview transcripts.[17] The researcher familiarized themselves with the interview data and identified themes and sub-themes forming a thematic framework. The framework was indexed, and this was applied to the transcripts as a labeled code for sections of text. Data for each main theme were presented as a chart with sub-themes. **One chart was developed for each theme. Each chart provided an analytical tool through which allowed for emerging concepts to be identified.**

VR undertook the interview coding, with CB, PM and DM triangulating the analysis. Respondent validation was **further** conducted by presenting a group of the physiotherapists that were interviewed with the final framework charts.[18] Four physiotherapists completed feedback forms with agreements, disagreements and further comments for each theme that was presented. Any new data were included in the analysis. **Finally, accuracy of interpretation from the framework analysis was confirmed and potentially new information was sought by three expert physiotherapists (CB, PM and DM) involved in the study.**

FINDINGS

Literature Review

Forty-two studies and five follow-up studies were reviewed and scored according to the PEDro scale [13], yielding 5 studies of excellent quality [19-23], 17 of good quality [**24-40**], and 25 of poor quality [**41-65**]. Eleven treatment modalities were identified, and the levels of evidence underpinning them are summarized in **Table vi**. **Follow-up studies were not used in awarding a level of evidence to a modality.**

The review identified strong evidence (Table ii) for the efficacy of eccentric loading exercises and extra-corporeal shockwave therapy. Moderate evidence supported low-level laser therapy and continued tendon loading as opposed to active rest. Moderate evidence found concentric exercises to be effective but not as effective as eccentric exercises. Foot orthoses and therapeutic ultrasound had limited evidence. Only single case studies and a within-subject design study were identified for taping and soft-tissue mobilizations which were classed as "No Evidence (Randomized Control Trial's or Case Control Trial's)" (Table ii). There is conflicting evidence for topical glyceryl trinitrate.

Qualitative Analysis

Nineteen interview transcripts were analyzed. The topic guide was used to inform the themes with 14 themes and 48 subthemes identified. The themes were charted into 7 groups under two sections: firstly, perceptions of the evidence for AT and clinical reasoning principles (Table iv); secondly, clinical reasoning in relation to specific treatment modalities (Table v).

The findings are both tabulated in tables iv and v and discussed in the results section alongside the evidence review findings.

DISCUSSION

The findings from the literature review and semi-structured interviews have been combined to guide clinical reasoning by physiotherapists regarding treatment modalities for **mid-portion** AT. The qualitative data provided a rich complement to the evidence review, and importantly can be used to guide future research regarding conservative interventions for AT.

Outcome Measures

The primary outcome measure of concern in the literature review was assessment of pain, and pain reduction was the main focus in the majority of studies. Secondary outcomes of function and strength were also assessed. The most valid and reliable outcome measure used was the Victorian Institute of Sport Assessment-Achilles questionnaire (VISA-A).[65] Thirteen (29%) of the studies in the literature review used the VISA-A score as an outcome measure. From the qualitative analysis, pain reduction was believed to be a primary concern to the patient. However, the physiotherapists interviewed highlighted the importance of educating patients that eccentric loading exercises will increase their pain during completion, and the difficulties therefore created in the therapeutic relationship.

Eccentric Exercises

Eccentric loading exercises have the strongest supporting evidence of all the conservative treatment modalities in the literature review. [24-28, 41-53] All physiotherapists were aware of this strong evidence base and nearly always used eccentric loading exercises for **mid-portion** AT patients, based on the belief that they would stimulate healing and strengthen the tendon. Similar success rates were produced when treating both sedentary [48] and athletic [46] patients with eccentric exercises. However, **clinical outcomes vary widely [2, 48, 52] and** superior clinical outcomes have been reported for mid-portion

tendinopathy compared to insertional. [52]

Most studies used an eccentric training protocol similar to the one described by Alfredson et al. [53] Although physiotherapists commonly used eccentric training, they reported using complex clinical reasoning to adapt research protocols for individual patients. For example, the need to vary eccentric loading protocols in patients where pain prevented adherence to published protocols by substituting with mixed concentric / eccentric or isometric loading initially. To assist this process, future research could focus on variables within the eccentric training program that could affect its efficacy: speed of exercises, duration, rate of progression and loading, chronicity and severity of condition.

Extracorporeal Shockwave Therapy (ESWT)

Extracorporeal shockwave therapy is one of only two conservative modalities with a strong supporting evidence base [19-21, 29, 32, 54-56]. **Only one study [29] reported using 'high-energy' ESWT but this definition was primarily based on application following local aneasthetic rather than energy transmitted, which was higher in some other studies (see Table vi). The group treated with high-energy ESWT had significantly lowered pain VAS at 12 months compared to a control group.** In one study **using low-energy ESWT**, VISA-A and pain numerical rating scores improved at 4 months when ESWT was combined with eccentric exercise training compared to eccentric exercises alone [20]. However, at 12 month follow up of Likert scores there was no difference in outcome between the groups. The authors suggested that due to the cost of implementing ESWT, it may be considered an inappropriate addition to the treatment of AT, with eccentric exercises being as effective in the long run. However, it may be desirable for athletic patients requiring a quicker recovery and return to sport. These feelings were reflected by physiotherapists who would consider using ESWT due to the emerging evidence but identified cost and restricted access to the devices as being currently a barrier to its application in practice.

Orthoses

The literature review identified two poor quality studies examining orthotics for treating AT [60, 62]. Over a period of 4 weeks, a group of AT patients given custom fit semi-rigid insoles was compared to a group receiving multi-modal physiotherapy group and a control group with no intervention. A significant reduction in pain was reported for patients in the physiotherapy and insole groups [60]. A case study found reduced symptoms and improved function, 31 days after the application of foot orthoses [62]. Despite the lack of evidence for orthoses, all of the interviewed physiotherapists expressed that they would consider orthotic prescription to treat AT.

Physiotherapists identified biomechanical assessment as an important part of the treatment process for AT and would use orthotics to correct foot alignment and 'off-load' the Achilles tendon. Physiotherapists' training and access to inexpensive, prefabricated orthoses were suggested to increase use in practice. Additional research evaluating long-term outcomes of using foot orthoses for AT, indications for their prescription, long-term outcomes and the effect of retraining movement patterns is needed.

Low-Level Laser Therapy (LLLT)

The literature review indicated moderate evidence **(Table ii)** for the use of laser therapy in the treatment of AT [22, 30]. A good quality RCT [30] concluded that LLLT in combination with eccentric loading exercises decreased recovery time in recreational athletes with AT. Additionally, when LLLT was used on its own, it reduced pain by a greater extent than a placebo laser unit at 4, 8 and 12 weeks. Despite these positive short-term findings for LLLT, none of the interviewed physiotherapists considered using LLLT to treat AT as it was viewed as more applicable to inflammatory diseases. Cost and access to laser devices were also identified as barriers to LLLT use in clinical practice. Further high quality RCTs

following the CONSORT guidelines [67] evaluating the effectiveness of LLLT in athletic and sedentary patients and for varying stages of tendinopathy are now required to confirm previous positive findings. It was suggested that modalities such as laser therapy might be most appropriate when a tendon is in a reactive rather than degenerative state – another area ripe for future research.

Topical Glyceryl Trinitrate (TGTN)

In one good quality study with a 3 year follow-up, a 1.25 mg/24 hr TGTN patch with eccentric loading exercises was found to improve pain to a greater extent than a placebo patch and eccentric loading exercises over 24 weeks [34, 35]. However, in another RCT no significant difference in outcomes was identified when a 2.5 mg/24 hr TGTN patch was combined with eccentric loading exercises over 6 months, compared to eccentric loading exercises alone [33]. The evidence remains conflicting as to TGTN's effectiveness for AT, with different dose patches used in studies. Further high quality RCTs are required to address this.

Adherence to this treatment in studies was limited by side effects of skin rashes and headaches. These side effects and no prescribing rights were reported by the interviewed physiotherapists as barriers to the use of TGTN in clinical practice. To address this barrier in the future, physiotherapists should ensure they maintain close communication with the patient's general practitioner or sports physician who has both prescription rights and greater pharmacological knowledge.

Concentric Exercises

There is moderate evidence to suggest that concentric calf muscle training is not as effective as an eccentric training regime. Two studies [39, 61] randomised participants to either eccentric or concentric calf muscle training for 12 weeks. The results from both studies showed significantly greater reductions in pain for

the eccentric training group compared to the concentric training group, **although factors other than contraction type were different between groups, such as load-intensity in the study by Mafi *et al* [39]. However, in both studies patients did register some improvement with concentric exercises and** in practice, combined concentric-eccentric exercises were frequently prescribed initially where eccentric exercises were intolerable due to pain or the patient was too weak to start with eccentric. This practice by clinicians in mixing contraction types is similar to the exercise program in **Silbernagel *et al* 2007 [23] where patients progressed from combined eccentric/concentric to eccentric contraction (discussed in 'continued tendon loading' section).** Physiotherapists interviewed felt that guidance on when to introduce combined concentric-eccentric exercises was lacking, and viewed the evidence as conflicting despite anecdotal success, indicating the need for further research in this area.

Splinting/Bracing

Moderate evidence suggests that night splints [36-38] and AirHeel braces [57, 58] do not improve clinical outcome in addition to eccentric exercises. The majority of physiotherapists interviewed would not consider splinting or bracing, particularly in the early stages due to perceived detrimental effect of immobilization on the Achilles tendon [68]. However, splinting and bracing was considered for failed healing and late stage tendinopathies. This sub-group of patients may benefit from research on the effectiveness of splinting/bracing.

Continued Tendon Loading or Physical Activity

One excellent quality RCT showed no detrimental effect of continued tendon loading activity (i.e. sporting activity), as long as pain was monitored and a threshold of 5/10 on a VAS was not exceeded. [23] There were no significant

differences in symptomatic outcome between continued tendon loading and active rest groups at 5 year follow up. [59]

The interviewed physiotherapists agreed with the research, and rarely instructed patients to cease exercise. However, physiotherapists frequently recommended a reduction in the level and frequency of tendon loading activities (i.e. relative rest), citing anecdotal evidence that this improves treatment outcomes. However, perceptions of the evidence base to support active rest were conflicting; one physiotherapist thought that a study had showed that active rest was necessary, and another thought that it had been shown to make the problem worse.

Physiotherapists continue to use clinical judgment in managing patients' loading patterns, attempting to balance therapeutic tendon loading and avoidance of harmful over-load. The need for clearer evidence concerning tendon loading activities and safe progression to sporting return was highlighted in the qualitative analysis.

Therapeutic Ultrasound

The literature review only yielded one good quality pilot RCT evaluating therapeutic ultrasound for the treatment of TA, with inconclusive results for pain and function. [31] Additionally, many of the physiotherapists interviewed reported no anecdotal benefits from using therapeutic ultrasound for AT clinically and were reluctant for patients to become dependent on the modality. However, considering some physiotherapists use therapeutic ultrasound to treat AT, further high quality RCT research following the CONSORT guidelines [67] is needed to confirm its apparent ineffectiveness.

Taping

Anti-pronation taping was used in a case report to assess the suitability of a "32 year old male soccer player with a two year history of AT" [62] for orthotic

prescription. The anti-pronation taping immediately increased jogging distance and decreased pain. Subsequent orthotic prescription maintained a reduction in pain during jogging, which was assessed for 31 days post-prescription. The literature review identified a poor quality study that reported kinesiotape to have no effect on hop distance, pain or motor-neuronal excitability in patients with AT [63].

Physiotherapists were not aware of any evidence for the use of taping but used it as an assessment tool and to improve function in the short-term. Future research could assess efficacy of different taping techniques for pain in AT patients and the effect on function in the short term.

Specific Soft-tissue Mobilization

A single case study evaluated the effectiveness of "accessory and combined specific soft tissue mobilizations (SSTMs)" [64] on pain function and muscle length in a 39 year old female club hockey player with a 5 year history of AT. The study consisted of Phase A- baseline measurements taken once a week for 6 weeks with no intervention given; Phase B- treatment based on the Hunter protocol [69] for 6 weeks; Phase A- post-treatment assessment, baseline measurements taken once a week for 6 weeks with no intervention given. A significant increase in VISA-A score was reported between the pre-treatment phase A and the treatment Phase B. The maximum VISA-A score of 100% was achieved by the end of Phase B and maintained until follow-up at 3 months. There was a significant decrease in VAS for pain between the pre-treatment Phase A and Phase B which was also maintained at 3 months follow-up.

The limitation of the single case study is a lack of control and generalizability to a wider group of AT patients. The findings of this study warrant future RCTs to confirm the efficacy of soft-tissue mobilization for treating AT and indications for their use. The physiotherapists that were interviewed were aware that evidence was anecdotal for soft tissue mobilization to treat AT but would often employ

such techniques despite a lack of evidence.

Calf Stretches

Calf stretches featured as an adjunct to some of the modalities being studied in the literature review, but were not identified as a separate modality. The qualitative analysis produced conflicting views on using calf stretches for AT. Some physiotherapists felt that it was an important part of the treatment process whereas reasoning for not incorporating stretches was to avoid compression of the tendon and loss of strengthening. Range of movement was not considered such an important element of the treatment process for AT unless specific joint or muscle restrictions were identified. Research on the effects of stretching on the tendon in AT patients and when to incorporate calf stretches into rehabilitation is needed, with a suggestion being that some patients have problems associated with stiffer myo-tendinous complexes and others with more lax structures. The relationship of stretching efficacy with respect to pre-existing mechanical properties of the triceps surae myo-tendinious complex was postulated as an important clinical decision that was not fully evidence based.

SUMMARY

In general, there was good awareness amongst physiotherapists of which treatment modalities had supporting evidence for AT, indicating an adequate evidence based practice approach to clinical reasoning. Interviewed physiotherapists used eccentric loading exercises as the core of rehabilitation programs for **mid-portion** AT but varied their application significantly in response to patient-specific factors. Further research evaluating the speed of exercises, duration, rate of progression and optimal loading progression, is needed.

General gaps within the research for **mid-portion** AT were identified through both the literature review and interview process, including: (i) predicting

intervention outcomes for patient sub-groups; (ii) effective stage specific interventions; and (iii) effectiveness of various combinations of interventions. Physiotherapists suggested that barriers to evidence based practice when treating AT include gaps in the evidence along with difficulty accessing and comparing study results.

LIMITATIONS

The strength of the evidence presented within the literature review may be questioned by some due to the broad inclusion criteria. However, this was a deliberate approach to ensure that the findings of the present review erred on the side of inclusivity in assessing the available research evidence for the management of AT. Additionally, when using literature identified by the review to determine level of evidence for each intervention, the PEDro quality assessment scale was used to compensate for the lack of stringent inclusion criteria [13]. However, it may be possible that some conclusions, notably derived from those studies with a low level of evidence, must be viewed cautiously. Yet, findings of the literature review can be regarded as being further strengthened by combining them with qualitative assessment of physiotherapists' clinical reasoning related to the available literature.

All physiotherapists were recruited from in and around London, United Kingdom. Therefore, it is possible that qualitative data may not reflect that of physiotherapists working in other geographical settings. However, to strengthen the external validity, a sample of physiotherapists from private sector, public sector, and academic roles with a range of years of experience were recruited. **Finally, q**ualitative research has been criticized for being subject to researcher bias [70]. **This possibility was** addressed by using a systematic framework method of analysis. **Additionally, completing** qualitative research has the potential to yield abundant data elucidating findings that can only be derived through this form of investigation. The combined approach yielded more

clinically applicable results than a stringent literature review or qualitative research alone.

CONCLUSION

The graded evidence combined with qualitative analysis of clinical reasoning produced novel guidance to the conservative management of **mid-portion** AT, relevant to both practitioners and researchers looking to progress practice. Empirical research indicates strong evidence for eccentric loading exercises and extra-corporeal shockwave therapy and moderate evidence for low-level laser therapy. Additionally, the physiotherapists interviewed reported anecdotal evidence for concentric exercises, soft-tissue mobilizations and foot orthoses. These interventions currently lack rigorous scientific validation, and therefore require additional research. Physiotherapists identified barriers to evidence based practice during the interviews, which included lack of access to journals and time for interpreting and comparing studies. Possible solutions to these barriers could include widely available and free clinical guidelines developed from the current levels of evidence for conservative treatment modalities for mid-portion AT.

Areas requiring further research to inform practice were highlighted. General gaps within the evidence include: i) predicting intervention outcomes for patient sub-groups; ii) effective stage-specific interventions; iii) effectiveness of combinations of interventions. Physiotherapists supported the need for further research to consider when to vary loading prescriptions, optimally apply stretching, and determine the efficacy of both foot orthoses and specific soft-tissue mobilization for **mid-portion** AT patients.

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Table i. Electronic database search terms

Terms for conservative treatment modalities	(Physiotherapy or adjustment or physical-therapy or exercise or mobilisation or immobilisation or mobilization or manual-therapy or treatment or conservative or mckenzie or maitland or cyriax or emt or pens or kaltenborn or mulligan or nerve-block or primary-care or proprioception or non-operative or management or multiple-treatment or functional-outcome or range-of-motion or supervised neglect or acupuncture or massage or electrotherapy or soft-tissue or economic or bracing or taping or evaluation or cost-analysis or myofascial or intervention or pain-management or cognitive-behavioural-therapy or multidisciplinary or biomechanic or occupational-therapy or work-hardening or off-loading or eccentric or rehabilitation or strength-training or advice or semi-rigid or ankle-brace or ankle-stabilizer or ankle-stabiliser or orthotics or shoe-inserts or compression-wrap or compression or strengthening or balance) AND
Terms for achilles	(Achilles tendon or Achilles-tendinopathy or Achilles-

tendinopathy	tendinitis or Achilles-tedinosis or Achilles-paratenonitis or mid-portion or noninsertional or insertional or heel-tendon or Achilles-paratendinopathy or Achilles tendin or Achilles-tendonopathy or Achilles-tendonitis or Achilles-tendonosis or heel-tendin or Achilles paratendonopathy) AND
Types of trial	(Observation or case-control or randomised-control-trial or controlled or systematic or comparison or comparator or intervention or randomized or randomised or placebo-controlled or placebo or double-blind or prospective or clinical-study or efficacy or multiple-subjects or Cochrane or multivariate analysis).

Table ii. Criteria for the level of evidence existing for each treatment modality.[9] RCT-randomized control trial, CCT-case control trial.

Level of Evidence	Criteria
Strong	Consistent findings among multiple high quality RCTs
Moderate	Consistent findings among multiple low quality RCTs and/or CCTs and/or one high quality RCT
Limited	One low quality RCT and/or CCT
Conflicting	Inconsistent findings among multiple trials (RCTs and/or CCTs)
No evidence	No RCTs or CCTs

Table iii. Sampling frame

		Academic	Clinical	
			NHS[1]	Private
Male	5-8 years	1	1	3
	>8 Years	1	1	3
Female	5-8 Years		2	2
	>8 years		2	3
Totals		2	6	11

[1] National Health Service

Table iv. Perceptions of the evidence for AT and clinical reasoning principles

Topic	Findings	Illustrative Quotes (interviewee number)
Perceptions of evidence for AT		
General Perceptions	Evidence Some core components have good existing research. Not a solid evidence base with a clear message. Clinical decision making viewed as being as important as evidence. Feelings -Good access in teaching hospitals, courses available, web databases accessible. Need for Athens password. -Self-motivated reading is time consuming and access to full texts is restrictive. Locums struggle with access to research. -Protocols may not be practical in reality. -Practitioners need to have the confidence and education to try new techniques/change past practice.	*"I think we're getting a bit more knowledge about the pathology behind it an the treatment options but, at the same time, we've discovered that still there much to know" (5).* *"I use MEDLINE, CINAHL and journal searches. Access is okay if you've got an password. If you don't, then it's a real hassle"* (16) *"Keeping up with research, that's facilitated by working in a large secondary care hospital, there's university links" (9).* *"An example of that is eccentric exercises, you do three sets of 15 twice a day. patients won't really be able to do that" (4).*
Gaps in Evidence	Which modalities have the best efficacy for treating athletic and non-athletic patients and different stages of tendinopathy. Causative factors, weight, and prevention. Biomechanical interventions, stretching, core stability. Translation into practice is hindered by conflicting research, study populations not reflecting individuals, access to funding for new treatments, knowledge of how to combine modalities.	*"New research now saying that non-athletes don't respond to eccentric loadi good as athletes. Why is that? So, shall we treat them differently?"(3).* *"Biomechanics and orthotics. It's an area that could be evidenced further" (1* *"How about if we combine all these different things, is that better than wait a is it better than them by themselves" (12).*
Assessment and Treatment of AT		
Implications of different patient presentations	Athletic/sedentary patients: athletic patients require a greater focus on functional re-training and may desire a shorter time frame for rehabilitation. Some patients may not tolerate aggressive rehabilitation, with focus on pain reduction and walking ability. Stage of disease, mid-portion/insertional, reactive/degenerative classification is important for prognosis	*"Someone who's highly active, they're probably going to be pain-free during g everyday activities. So, starting simple eccentric exercises, and then getting to point where they can hop, and doing some gait re-training, running stuff" (2)* *"They're not an athlete, they're older, so take into account what they would n do, what functional level are you trying to go back to? Still consider the whol chain but not going to the same degree as you would, for an athlete" (8).* *"If it's from the muscular tendon junction then I tend to treat them with eccer*

	and choice of modality.	*loaded exercises. If it's from the attachment then I haven't really found that t tends to irritate them so I go down offloading it, strengthening it, as opposed eccentric route" (10)* *"Degenerative versus a early stage reactive cause that has a lot of influence i the decisions here, what you do in eccentric training, pain interventions, how loading, how much off loading you´re doing" (12).*
Important elements in treatment	Eccentric exercises are used as the core component, tailored to individuals. Biomechanical assessment. Muscle strength aiming towards specific sports function or walking. Pain is an important issue to patients, during exercises therapists will work within an acceptable pain range. Education is vital to promote compliance and the role of exercises.	*"We've got a fairly standard treatment that we put them through and vary th treatment according to certain things but the core will be the same, eccentric exercises" (1).* *"I usually go for the biomechanics and muscle re-education as the two bigges and I'd put joint range of movement in second place" (13)* *"Eccentric loading it and pushing them to pain, as long as it's not getting wor* *"I'll talk about micro-trauma, actually go through that process with the patie draw the pictures. It's critical; it helps with the motivation and compliance" (

Table v. Perceptions of the evidence for AT **in relation to individual treatment modalities.**

Treatment Modality	Findings	Illustrative Quotes (interviewee number)
	STRONG EVIDENCE	
Eccentric Exercise Training	Applied to the majority of patients to strengthen the tendon and stimulate healing. Modify protocols depending on the patient's capabilities. A strong supportive evidence base for mid-portion AT with particular awareness of Alfredson's protocol. May not be suitable for insertional, acute or reactive tendinopathies.	*"What we know is that the eccentric exercises strengthen the collagen fibres, which, again decreases the thickening of the tendon" (5).* *"Definitely, for me, eccentric exercise is one of the biggest research-based treatments that I can use" (3).* *"Evidence behind eccentric, is that Alfredson's programme, 3 times a day, 3 sets of 15, to a pain level of about 3 to 4, that painful heel drop programme, has reasonably good evidence" (7).*
Extracorporeal Shockwave Therapy	Not widely used at present although is being considered with the emergence of evidence. Being used for very resistant cases. Conflicting patient outcomes had been experienced. Barriers to its use are expensive devices, costs passed on to the patient and not knowing how to use it.	*"We've had some good effects with a number of patients with chronic Tendinopathy and no effect at all for some others. It seems to think they need to be very carefully chosen patients" (1).* *"There's been a lot of recent research conducted in that, and from what I can gather, the early signs are positive, probably needs some more research behind it" (2).*
	MODERATE EVIDENCE	
Orthoses	Orthotics would often be considered for foot alignment issues, temporary off-loading of the tendon and if taping had decreased the patient's pain. No good, supporting research specific to AT. Lack of access, expensive, referral to podiatry time consuming.	*"Orthotics, yes because biomechanics has a big role to play in causing Achilles' tendinopathies. If someone is over-pronating significantly, and physically that can't be controlled, then you need some artificial help in terms of inner-soles to address that" (4).* *"I didn't think there was any evidence on orthotics at all "(1).*
Low Level Laser Therapy	Not being used in practice for AT, perceived as more applicable to acute inflammation. No knowledge of supportive evidence for AT. Lack of access, expensive device.	*"Not enough evidence to support its use" (6).* *"I don't have access to it. I think laser therapy is mainly for very, very acute, inflamed conditions. And we know Achilles' tendinopathy, most of the time, is not an inflammatory condition" (3).*

Concentric Exercises	Used when eccentric exercise were not achieved, if pain cannot be tolerated. Used in combination with eccentric exercises to increase muscle power. General perception that there was no supporting evidence and existing studies had conflicting results regarding whether to use in conjunction with eccentric exercises.	*"If the pain's too great but you want to do the eccentric exercises, start concentric, and slowly progress towards less and less support" (2).* *"It works very well but there is just no evidence for it"* (12). *"A study said that concentric wasn't as effective as eccentric, but then others have said that it's okay" (8).*
Splinting/Bracing	Sometimes used as a last resort. Aircast boots used after failed healing of stage 3 tendinopathies. No awareness of supporting evidence. Expensive, immobilising goes against the principles of tendon rehabilitation.	*"These people have gone everywhere else, are in a stage 3 – or stage 2 where there's been failure of healing, and you get them to the point where they have six consecutive weeks pain-free in this boot" (9).* *"I've never read any research about bracing for tendinopathy" (8).*
Active Rest	Necessary to reduce the patient's regular activity when giving rehabilitation exercises. Complete rest would be advised for acute, swollen and stage 3 tendinopathies. Not an evidence based principle. Worry of immobilisation leading to further degradation of the tendon.	*"Active resting, definitely, with more athletic people, so they're doing some sort of exercise, but not aggravating it "(8).* *"In regards to whether it's actually been studied, as a principle, applied to people not doing active rest. No, it's more just a general principle of rehab, really, not something that's based in evidence, as far as I'm aware" (9).*
	CONFLICTING / INCONCLUSIVE EVIDENCE / NO RCT'S	
Topical Glyceryl Trinitrate	Not being used in practice for AT. Evidence supports the use for elbow tendinopathy but no research supporting the use in AT. Physiotherapists are not able to prescribe. Too many side effects.	*"I've had more side effects with GTN in patients so I don't tend to jump to that anymore. I did use it with a couple of the skiers but, they had too many headaches and blood pressure control problems" (6).* *"Clinically, there are reports that it's been helpful, but I don't think it's been studied in an RCT or any sort of strong study like that" (9).*
Therapeutic Ultrasound	Ultrasound was only considered for acute inflammation. Past experience had not produced any benefits to patients. Therapists were not aware of any supporting evidence. The number of sessions required was perceived as unrealistic in an NHS setting. Makes the patient dependant on one modality with no self-management.	*"I don't use much ultrasound at all. Maybe to help with reducing pain. Unless there were some clear signs that it was not a tendinopathy but rather like a tendonitis or irritation of the outer sheath of the tendon" (4).* *"There's theoretical evidence. In terms of evidence for Achilles, I'm not aware that there is evidence that supports the use" (2).*
Taping	To correct foot posture, offload the Achilles tendon in sporting environments, facilitate muscle activation and to	*"We did a taping course and there are certain types of taping that we could use to alter biomechanics; alter the tracking of the tendon"* (19)

	analyse foot biomechanics. No supporting evidence for use with AT.	*"I don't know any evidence for it" (5).*
Joint/Soft-tissue Mobilisations	Evidence viewed as anecdotal for AT. Generally considered for treating AT if decreased ankle joint range of movement observed.	*"I'd say that probably most of the stuff is anecdotal regarding specifically joint mobilisation because I know there's some stuff on muscle mobilisation but I'm not sure if I know of much evidence on that" (18).* *"Whether you would be able to just use specific soft tissue mobilisations, that would be an interesting thing. I think is easy and would be very useful" (17),* *"mobilisations, potentially if it's a joint problem, perhaps manipulation" (16).* *"I do use mobilisations into the ankle joint, probably more around the subtalor joint" (14).*
Calf Stretches	Conflicting views on using stretches. Sometimes incorporated alongside eccentric exercises for tightness in lower limb structures. No good evidence for use with AT. General evidence on remodelling effects. Stretching was not advised to avoid compressing the tendon, loss of strengthening and exacerbating pain.	*"It's a conflicting area with regard to stretching, for example, how long to stretch for, what you're actually doing stretching, how long it lasts for, that's always a little bit of a grey area"* (16). *"That area of the tendon is a weak area and therefore you run the risk of making it more weak" (1).*

GTN = Glyceryl Trinitrate, RCT = Randomised Controlled Trial, NHS = National Health Service, AT = Achilles Tendinopathy

Table vi. Summaries of the studies reviewed, grouped by modality.

Reference	Study Design	Sample	Outcome Measures	Intervention and Dose	Results/Conclusions	PEDro Score
Eccentric Exercise Training						
Van der Plas et al. (2011)	5-yr follow-up of RCT (de Vos et al. 2007)	- 58 patients (70 tendons; 58 tendons included for analysis) - midportion.	- VISA-A - Pain status - Alternative treatments - Ultrasonographic neovascularisation score	Five yrs post Alfredson's heel drop exercise programme.	58 tendons, VISA-A sig. increased (49.2 to 83.6). 39.7% of patients completely pain-free and 48.3% had received 1+ alternative treatment(s). Tendon thickness sig. decreased.	7/10 as per original study
Yelland, M. *et al* (2011)	Randomised Clinical Trial ELE Vs Prolotherapy injection Vs Combined	-43 patients -Mid-portion -Activity related pain ≥6 weeks -M & F -40-58 years	-VISA-A -7 point Likert scales for treatment satisfaction. -Patient Global Impression of Change. -0-10 scales for worst pain in the last week, usual morning stiffness and limitation of activities.	**ELE group**: 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee. **Prolotherapy group**: prolotherapy injections of hypertonic glucose with lignocaine **Combined group**: 12 weeks of ELE+ prolotherapy injection	Prolotherapy and ELE combined with prolotherapy give more rapid improvements in symptoms than ELE alone but long term VISA-A scores are similar.	6/10
Knobloch, K 2007	RCT ELE Vs Control	-20 patients -Insertional & midportion -Symptoms ≥3 months -M & F -≥18 years	-11 point VAS for pain -Capillary blood flow -Tissue oxygen saturation -Post-capillary venous filling pressure	**ELE group**: 12 week programme of 3 sets of 15 reps 1 x day, straight knee only. **Control Group**: Crushed ice for 10 mins and relative rest to relieve pain	In the ELE group, pain was sig. reduced by 48%. Paratendon blood flow sig. decreased at three sites. No sig. changes in oxygen saturation. Post-capillary venous filling pressure sig. reduced.	5/10

Langberg, H. *et al* (2007)	CCT ELE Tendinopathy Vs Healthy Controls	-6 male elite soccer players with unilateral tendinosis (26±1year) -6 healthy male elite soccer player controls. (22±1 year) -Mid-portion -Symptoms 19 ±7 mnths	-Collagen synthesis -Collagen degradation, -VAS pain.	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	Collagen synthesis increased sig. in injured tendons post ELE. It was unchanged in healthy tendons. Collagen degradation was not affected in either group after ELE. Sig decrease in pain in injured group after ELE.	5/10
Silbernagel , KG. *et al.* (2001)	RCT ELE Vs Control	-40 patients (most involved in sport, types and training varied) -mid-portion -symptoms >3 months -M+F -19-77 years	-Pain VAS -Ankle ROM	**ELE group**: Week 1; exercises to increase local blood circulation of the lower leg, ankle range of motion, balance and gait exercises, and a toe-raise programme which progressed to a) 2s of 20 reps of *two-legged concentric/eccentric toe-raises*, b) 3s of 15 reps of *one-legged toe-raise on a step* immediately followed by c) 10 reps of *eccentric toe-raises on one leg on a step,* d) 3s of 20–100 reps of *quick rebounding toe-raises* e) *Stretching of the calf muscles* for 20 s afterwards. Pain allowed to reach 5 on VAS. **Control group:** exercise programme 3x/day, 2s of 30reps *stretching of the*	ELE group had sig. improvements in plantar flexion, pain on palpation, pain on walking, swelling and asymptomatic periods. Sig. more ELE group satisfied at 1 year.	5/10

				calf muscle, 2s of 30 reps of *two-legged concentric/eccentric toe-raises.* Informed to progress to 3sof 5 reps, if possible, of *Regular concentric/ eccentric toe-raises on one leg* as soon as symptoms allowed		
Ohberg, L. *et al.* (2004)	PCS ELE	-26 tendons, 25 patients. -Mid-portion -Symptoms 6-120 months -M&F -Mean age 50 years	-Tendon thickness and structure on ultrasound. -Symptoms and satisfaction questionnaire.	12 week eccentric training regimen.	Long-term ultrasonographic follow-up of chronic mid-portion AT patients showed a decreased tendon thickness and normalised structure in 19/26 tendons treated with ELE. Remaining structural abnormalities were associated with residual pain. 22/25 were satisfied with treatment and had a desired level of tendon loading activity.	4/10
Shalabi, A. *et al.* (2004)	PCS ELE	-25 patients (10 sports related tendinopathy) -Mid-portion	-Tendon volume and mean intratendinous signal on MRI.	12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee.	ELE produced decreased tendon thickness and intratendinous signal	4/10

		-M&F -28-70 yrs	-Pain and performance questionnaire		which correlated with improved clinical outcome. Clinical outcome was excellent in 10, good in 3, fair in 5 and poor in 8 patients.	
Fahlstrom, M[23] 2003	PCS ELE Mid-portion Vs insertional	-78 mid-portion AT patients -30 insertional AT patients -variable levels of activity, more high-level athletes in the insertional group -symptoms >3 months -M+F	-VAS pain	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	ELE had sig. good clinical results in mid portion AT but not for insertional AT.	4/10
Alfredson, H. *et al.* (1998)	CCT ELE Vs Control	-15 recreational athletes treated with ELE. (44.3 $\pm$7 yrs). -15 recreational athletes treated with surgery - control group (39.6$\pm$7.9 yrs). -Mid-portion. -Symptoms 3-100 months. -M&F.	-Calf muscle strength -Pain during activity VAS.	**ELE group**: 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee **Control group:** Not on any training regime for 3 months prior to surgery. Post-operative training programme.	After 12 weeks all 15 ELE participants were back to full activity levels with a sig. decrease in pain during activity. Calf muscle strength on the injured side increased sig. in the ELE group so it did not differ from the healthy side. The post-surgical group had sig. lower calf muscle strength than the healthy side. There was a sig. decrease in pain score post-surgery.	4/10

					The ELE 12 week model had a very good short-term effect on athletes in their early forties.	
Maffulli, N[22] (2008)	PCS ELE	-45 athletic patients (≥club level: soccer, track and field, racket sports) -Mid-portion -symptoms 7-31 months -M&F -18-46 yrs	-VISA-A	Progressed to 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	VISA-A improved significantly. 60 % benefited from ELE alone. ELE is a viable option for management of athletic patients.	3/10
Herrington, L[19] (2007)	RCT ELE Vs control	-25 patients (achilles-loading sports) -Mid-portion -symptoms >3 months -M&F -20-55 years	-VISA-A	**Control group**: 1xweek for 6 weeks; 15 mins of deep friction massage, 1MHz US at 1 W/cm^2 continuous for 5 mins over the most painful area of tendon, stretching programme (Neison-Vertommen *et al* 1992, Stanish *et al* 1986). **ELE group**: as per control group + 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	The ELE group had a significantly better improvement over 12 weeks compared to the control group. Addition of ELE to ultrasound and deep transverse friction is beneficial.	3/10
Sayana, MK[21] (2007)	PCS ELE	-34 sedentary patients (<3 x 20mins/week) -Mid-portion -symptoms >6 months	-VISA-A	Progressed to 12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee.	A sig. difference in pre and post VISA-A scores. 15 patients did not improve with ELE. ELE may not benefit	3/10

		-M+F -20-76 years			sedentary patients to the extent reported in athletes.	
Knobloch, K. *et al* 2007	PCS ELE	-59 patients -49 mid-portion, 10 insertional	-Capillary blood flow -Tissue oxygen saturation -Post-capillary venous filling pressure.	12 week programme of ELE: 3 sets of 15 reps 1 x day, straight knee only.	Pain was sig. reduced in the mid-portion and insertional tendinopathy groups.	3/10
Norregaard , C. *et al.* 2007	RCT ELE Vs Control	-45 patients -insertional and mid-portion -Symptoms ≥3months -M&F -18-70 years	-Manually assessed tenderness score 0-3 -Ultrasonography findings -Self-reported symptoms questionnaire. -Patient's global assessment. Follow-up was performed at 3, 6, 9, 12 weeks and 1 year	**ELE group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **Control group**: 5 reps 2xday for 12 weeks of standing straight leg and bent knee stretches held for 30s.	Sig. improvements in symptoms assessed by questionnaires from 3 months. No sig. differences between the groups. Tenderness and ultrasonographic findings were sig. improved at 12 months. No sig. difference between groups.	3/10
Alfredson, H. *et al.* (2003)	PCS ELE	-6 patients -Mid-portion -Symptoms, mean of 22 months -4 females, 2 males -mean age 48 years	-VAS pain on tendon loading	12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee	VAS decreased from 69 (mean) before treatment to 17 (mean) after treatment. All six patients were back at pre-injury Achilles tendon-loading activity level.	3/10
Croisier,JL. *et al.*	PCS ELE	-34 patients (9 AT: 6 males, 3 females)	-Pain VAS	Isokinetic dynamometer training protocol for		3/10

(2001)		-Symptoms 6 ±3 months -mean age 26 ±6 years		Triceps Surae, 1-3 sets of 30 reps, progressing from 30°/s to 120°/s and 30%MAX intensity to 80%Max. 3 x week for 20-30 sessions.		
Knobloch, K. *et al.* (2009)	PCS ELE Females Vs Males	-75 patients -Mid-portion -Pain ≥12 weeks -M&F -≥18 years	-VISA-A -Pain VAS -FAOS	12 week programme of ELE. 3 sets of 15 reps 2 x day, straight knee only.	Symptomatic females do not benefit as much as males from 12 weeks of ELE. Pain reduction and improvement in FAOS and VISA-A scores was sig. lower among females in contrast to males.	2/10
Verrall, et al. (2011)	CCT ESE	- 190 patients (108 males; 82 females; mean age 39 years; 156 followed-up) - 142 Mid-portion & 14 insertional. - Symptoms >12 weeks -M&F.	- VAS - 0 – 10 score on scale of treatment effectiveness - Time from treatment to return to full activity	**ESE program:** 6 weeks of eccentric stretching, with stretch maintained for at least 15 s.	Pain sig. reduced from 7.2 to 2.9. Patient satisfaction 7 and above (excellent) in 80% of patients (mid-substance 86%). Overall mean time to return to pre-morbid activity 10 weeks.	1/10
Gardin, A. *et al* (2010)	4.2 year follow-up to Shalabi, A. 2004 PCS	-20 patients treated with 3 months of daily ELE. (9 participated in sport) -Mid-portion -Symptoms 6-120 months	-Intratendinous MRI signal. -Tendon volume -Modified Curwin & Stanish pain and performance questionnaire.	12 week programme of ELE. 3 sets of 15 reps 2 x day, bent knee and straight knee	Intratendinous signal in treated tendons decreased significantly from baseline. 4 patients that did not complete ELE, did not improve regarding pain, performance, intra-tendinous signal or	1/10

		-M&F -33-75 yrs			tendon volume. No sig. change in mean tendon volume. 19/20 patients had sig. decreased pain at 4.2 yrs, 17/20 had sig. improved performance	
Extracorporeal Shockwave Therapy						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Rasmussen S[17] (2008)	RCT **Low-energy** ESWT Vs sham	-48 patients -symptoms >3 months -M+F -19-80 yrs	-AOFAS -Pain VAS	**ESWT group:** 4 sessions over 4 weeks of stretching and eccentric training followed by 4 sessions 1xweek using Piezoson 100. 2000 shocks (0.12-0.51 mJ/mm^{2,} 50Hz) to the area of tenderness, no local anaesthetic. **Sham group:** as per ESWT group but with 2000 shocks delivered at 0mJ/mm^2, 50Hz	Sig. results at 8 and 12 weeks for intervention group AOFAS score. No sig. difference in pain VAS. ESWT supplements Treatment of AT.	9/10
Rompe, JD[35] (2007)	RCT ELE Vs **Low-energy** ESWT Vs Wait & See	-75 patients (athletic and non-athletic). -Mid-portion -Symptoms >6months -M+F -18-70yrs	-VISA-A -Pain NRS	**ELE group:** Progressed to 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ESWT group:** 3 sessions 1 week apart of 2000 pulses at a pressure of 3 bar, 8 pulses/s. Circumferential to the point of maximum tenderness, no local	ELE and ESWT sig. improved pain, function and general outcome at 4 months. Wait and See was ineffective	8/10

				anaesthesia, using EMS Swiss Dolorclast. **Wait & See group:** 1 consultation to discuss training modification, stretching exercises and ergonomic advice. Prescribed paracetamol 2000-4000mg/day or naproxen 1000mg/day if necessary.		
Rompe, JD[36] (2009)	RCT ELE Vs ELE+**Low-energy** ESWT	-68 Patients (21 out of 28 participated in sport at least once a week). -Mid-portion -symptoms >6 months -M+F -18-70 yrs.	-VISA-A -Pain NRS	**ELE group:** Progressed to 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE+ESWT group:** as per ELE group. After 4 weeks received 3 sessions 1 week apart of 2000 pulses at a pressure of 3 bar, 8 pulses/s. Circumferential to the point of maximum tenderness, no local anaesthesia, using EMS Swiss Dolorclast.	For all outcome measures, groups differed significantly to favour combined ELE+ESWT at 4 months. No sig. diff. at 1 year. Combined treatment is more effective for short-term outcomes.	8/10
Costa, ML. 2005	RCT **Low-energy** ESWT Vs Sham	-49 patients -Insertional & midportion -Symptoms $\geq$4 months -M & F -$\geq$18 years	-VAS Pain scores: walking, rest, during sport. -Ankle ROM -Walking on tip-toe -Able to jump	**ESWT group:** Storz Modulith® SLK applied over the area of maximum tenderness. Maximum of 0.2 mJ/mm^2 according to pain threshold. No local anaesthetic. 1500 shocks 1xmonth for 3 months	No sig. differences between the groups for any outcomes. At 1 year follow-up 13/41 patients were pain free.	6/10

			-EQol -FILLA	**Sham group:** as per ESWT group but with bubble wrap covered in an opaque cloth was inserted between the machine and tendon.		
Furia, JP[37] (2008)	CCT **High-energy** ESWT Vs control	-68 patients (various sports, levels of participation not defined, some sedentary) -Mid-portion -Symptoms >6months -M+F -18-76 yrs	-Pain VAS	**ESWT group:** Single application using the Dornier Epos lithotripter to the area of maximum tenderness extending up to 4cm.50 shocks given at each power level1-4 for a total of 200 shocks. Final 2800 shocks given at level 5 (0.21 mJ/mm^2). Frequency increased from 60 shocks/min level 1 to 240 shocks/min level 5. Ankle block with or without IV sedation. **Control Group:** traditional non-operative therapy.	Sig. results for ESWT, lowering pain VAS at 12 months. ESWT is effective for chronic mid-portion AT	5/10
Vulpiani, MC. (2009)	PCS **Low-energy** ESWT	-105 patients, 127 tendons (84 insertional, 43 mid-portion) -10 professional, 63 amateur and 32 recreational sports participants. -Symptoms $\geq$6 months -M&F	-0-4 Scale of subjective symptoms: Before therapy, 2 months, 6-12 months and 13-24 months post ESWT.	Average of 4 sessions (minimum three, maximum five), with a 2/7-day interval. 1, 500-2, 500 impulses were administered with an energy varying between 0.08 and 0.40 mJ/mm2.	Satisfactory results in 47.2% of cases (60 out of 127 tendons) at two-months follow-up, increasing to 73.2% at medium-term follow-up (93 out of 127 tendons), and 76% at 13-24 months (92 out of 121 tendons). ESWT has a positive effect in the treatment of AT with a long-lasting	4/10

		-18-74 yrs			improvement of painful symptoms.	
Lakshmanan P. *et al.* (2004)	PCS **Low-energy** ESWT	-16 tendons (15 patients, 11 participated in sport, 4 sedentary). -Mid-portion -M&F -35-77 yrs	-VISA-A -AHS	Swiss Dolorclast device to the area of tenderness, with no local anaesthetic. 1xweek for 3 weeks. 2000 shocks, 2.5 bar pressure, frequency of 6-10Hz.	A sig. improvement at mean follow up of 20.7 months in AHS and VISA-A scores. Patients with low AHS before treatment benefited the most. 6 patients had pain during therapy.	4/10
Saxena, A. *et al.* (2011)	PCS **Low-energy** ESWT	-74 tendons (32 paratendinosis, 23 mid-portion, 19 insertional). -48.6 yrs $\pm$ 12.94. -M&F	-Roles and Maudsley score	3 shockwave treatments 7-3 days apart with a Storz D-Actor 200 device. 2500 shocks, at 2.4 Bar ranging from 11 to 13 Hz, without anesthesia, applied directly to the affected area.	All groups had a sig. improvement 12-24 months post- ESWT. -Mid-portion, 78% improved -paratendinosis, 75% improved -Insertional, 84% improved. ESWT is a safe, viable and effective treatment for AT.	2/10
Low-Level Laser Therapy						
Reference	**Study Design**	**Population**	**Outcome Measures**	**Results**	**Results/Conclusions**	**PEDro Score**
Tumilty, S[33]	Pilot RCT ELE+LLLT Vs ELE	-20 patients	-VISA-A	**ELE+LLLT group:** Thor DD Laser Therapy Unit	Sig. within group improvements at 4 & 12	10/10

(2008)	+ placebo LLLT	-M+F -18-65 yrs	-VAS pain	applied to 3 points each side of the tendon (insertion, 2cm and 4cm proximal) for 30s. Total dose of 3J per point/18J per session. 3xweek for 4 weeks. **ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent and straight knee. **Placebo group:** as per treatment group but with placebo laser treatment.	wks. Between group differences were minimal. Low statistical power so conclusions on effectiveness can't be made.	
Stergioulas A[34] (2008)	RCT ELE+placebo LLLT Vs ELE+LLLT	-52 recreational athletes (attending 1-5x/week, volleyball, soccer, basketball, tennis, running) -Mid-portion -M+F	-VAS pain -Ankle ROM	**ELE+LLLT:** Progressed to 12 sets of 12 reps 4xweek for 8 weeks, straight and bent knee. Static gastrocnemius and soleus stretching. Laser probe with Ga-Al-As diode. **Placebo group**: Progressed to 12 sets of 12 reps 4xweek for 8 weeks, straight knee and bent knee. Static gastrocnemius and soleus stretching. Placebo laser unit.	Pain and ROM were sig. lower in LLLT group than placebo at all stages. LLLT accelerates clinical recovery when added to an ELE regimen. The results at 4 weeks were similar to the placebo LLLT results at 12 wks.	7/10
Therapeutic Ultrasound						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Chester, R[32]	RCT ELE Vs US	-16 patients (non-athletic)	-VAS Pain	**ELE group:** 12 week programme of 3 sets of 15	No sig. difference between the groups.	5/10

(2008)		-symptoms >3 months. -M+F -31-76 yrs.		reps 1 x day, bent knee and straight knee. **US group:** Pulsed 2:8 US using 3 MHz at 0.5w/cm^2 applied for 2min/cm^2 over the palpable swelling of the Achilles tendon, 2 x week for 6 weeks.	Small sample size. Larger study needed.	
Topical Glyceryl Trinitrate						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Kane, TPC[31] (2008)	RCT ELE Vs TGTN	-40 patients -Mid-portion -22-68 yrs.	-VAS Pain + disability	**GTN group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Daily transdermal patch of GTN applied to the tenderest area. 2.5mg/24hrs. **Control group:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee.	No sig. difference in pain or disability scores at 6 months. Data was not collected between baseline and 6 months. TGTN did not offer any clinical benefit over standard physiotherapy	6/10
Paoloni, JA[39] (2007)	3 year follow up to RCT TGTN Vs Placebo	-68 tendons -mid-portion -symptoms >3months -M+F -36-77 years	-VISA-A	**GTN group**: transdermal patch delivering 1.25mg/24hrs. Rotated around the site of maximum tenderness for 6 months. **Placebo group:** placebo demonstration patch. Rotated around the site of	TGTN group had sig. less tenderness and improved VISA-A scores. Pain, function and return to sport were non-sig. TGTN treatment benefits continued at 3 years, suggesting that TGTN has more than an	6/10

				maximum tenderness for 6 months.	analgesic effect.	
Paoloni, JA[38] (2004)	RCT TGTN Vs Placebo	-84 tendons -Mid-portion -symptoms >3 months -M+F -24-77 years	-5 point verbal descriptor questionnaire for pain	**GTN group**: transdermal patch delivering 1.25mg/24hrs. Rotated around the site of maximum tenderness for 6 months. **Placebo group:** placebo demonstration patch. Rotated around the site of maximum tenderness for 6 months.	TGTN significantly reduced pain with activity and at night, also improving function in AT	6/10
Splinting/Bracing						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
de Vos, RJ[26] (2007)	RCT ELE Vs ELE+NS	-70 tendons (active participation in sport) -Mid-portion -Symptoms >2 months -18-70 yrs	-VISA-A	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Ankle positions of 0° and 5° dorsiflexion marked on a NS. First 4 weeks at 0°. After this, 5° or more.	Both groups improved sig. but no difference between groups. NS not beneficial in addition to ELE.	7/10

de Jonge, S[27] (2008)	1 year follow up of de Vos *et al* RCT ELE Vs ELE+NS	-63 tendons (active participation in sport) -Mid-portion -symptoms >2 months. -18-70 years	-VISA-A	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. Ankle positions of 0° and 5° dorsiflexion marked on a NS. First 4 weeks at 0°. After this, 5° or more.	Sig. improvement in VISA-A scores in both groups from baseline-1 year. No sig. differences between groups. ELE with or without a NS improved functional outcome at 1 yr follow up.	6/10
Roos, EM[28] (2004)	RCT ELE Vs NS Vs ELE+NS	-44 patients (non-athletic) -Symptoms >4 weeks -M+F -20-60 yrs	-FAOS -5 point Likert scale difficulty during sport	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **NS:** An anterior night splint holding the foot in 90° dorsiflexion **ELE + NS:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee + An anterior night splint holding the foot in 90° dorsiflexion.	At 6 weeks ELE group had a sig. reduction in pain that lasted 1 year. The night splint groups had sig. but less pain reduction than ELE. More patients in ELE group returned to sport. Didn't recruit the 60 patients needed for statistical power.	6/10
Knobloch, K. *et al.* (2006)	RCT ELE Vs ELE + AHB	-112 patients ("healthy sports" and training) -Insertional and mid-portion - Symptoms >12 weeks	- Pain VAS - FAOS - Tendon O_2 saturation - Post-capillary venous	ELE group: 3s 15 reps 1x day for 12 weeks for each tendon. **AHB group:** ELE 3s 15 reps, 1x day for 12 weeks. Regular sports activity performed throughout the	Tendon oxygen saturation was increased, and capillary venous clearance facilitated using an AHB in addition to a daily 12-week ELE programme.	5/10

		-≥18 years -M&F	filling pressures	study period of 12 weeks with the AirHeel wrap throughout the day.	VAS sig. reduced in both groups but no sig. difference between the groups.	
Knobloch, K[29] *et al* (2008)	RCT ELE Vs ELE+AHB	-116 patients (some participated in sports, no level information) -Mid-portion, -Symptoms >12 weeks, -M&F,	-FAOS -Pain VAS	**ELE + AHB:** 12 week programme of 3 sets of 15 reps 2 x day. AirHeel Brace worn from getting up until the evening. **ELE only;** 12 week programme of 3 sets of 15 reps 2 x day.	Sig. improvement in both groups. No sig. diff between groups. Micro-circulatory advantages with the AHB do not translate to superior clinical performance, compared with ELE alone.	4/10
Peterson, W[30] *et al* (2007)	RCT ELE Vs AHB Vs ELE+AHB	-100 patients (recreational athletes) -Mid-portion -M+F	-VAS pain -AOFAS	**ELE:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **AHB:** instructed to wear during the daytime. **Combined:** 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee + wearing of AHB during the day.	No sig. difference between all 3 treatment groups although improvement in all groups. AHB as effective as ELE. No synergistic effect.	4/10
Active Rest						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Silbernagel KG[42] (2007)	RCT Tendon loading Vs Active Rest	-38 patients (non-athletic) -Mid-portion	-VISA-A-S (Swedish version)	Both groups received a daily Achilles loading strengthening programme for 12 weeks-6 months. **Exercise training group**:	No sig. differences between groups although significant improvement.	8/10

		-Symptoms >2 months -M+F -20-60 yrs		allowed to continue Achilles loading activity for the first 6 weeks of rehabilitation as long as pain did not exceed 5/10 on a VAS. **Active rest group:** Not allowed to perform activity involving tendon loading in the first 6 weeks of rehabilitation.	No negative effects from continued tendon loading	
Silbernagel KG. *et al.* (2011)	5 year follow-up to 2007 RCT Tendon loading Vs Active Rest	-34 patients (non-athletic) -Mid-portion -Symptoms >2months -M&F -51±8.2 years	-Questionnaire -VISA-A -Tampa scale for Kinesiophobia	Both groups received a daily Achilles loading strengthening programme for 12 weeks-6 months. **Exercise training group**: allowed to continue Achilles loading activity for the first 6 weeks of rehabilitation as long as pain did not exceed 5/10 on a VAS. **Active rest group**: Not allowed to perform activity involving tendon loading in the first 6 weeks of rehabilitation.	No sig. differences between initial treatment groups' questionnaires at 5 yrs. 80% fully recovered, 20% had remaining symptoms. Sig. negative correlation between kinesiophobia and heel-rise work recovery.	3/10
Orthotics						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Mayer, F[40] (2007)	RCT Multi-modal Physiotherapy Vs	-31 Male runners >32 km/wk	-Pain VAS	**Physiotherapy group:** 10 30min sessions (2 or 3/week over 4 weeks)	Sig. reduction in pain after 4 weeks with physiotherapy or	4/10

	Insoles Vs control	-Mid-portion -symptoms >6 months -18-50 years		including deep friction massage at the mid-substance, local pulsed ultrasound (1.5W/cm^2) ice sensory motor training (3 sets of 15 reps of balance exercises on a stability pad) and eccentric exercises. **Insole group:** individually fitted semi-rigid insoles with bowl-shaped heels, moulded longitudinal arch support and detorsion wedge provided on the basis of a dynamic plantar pressure distribution measurement. Worn for all physical activities. **Control group:** no intervention.	insoles.	
Concentric Exercises						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Mafi, N[24] (2001)	RCT ELE Vs Concentric	-44 patients (jogging walking) -Mid-portion -Symptoms >3 months -M+F	-VAS pain	**ELE group**: 12 week programme of 3 sets of 15 reps 2 x day, bent knee and straight knee. **Concentric group: weeks 1-2** 2 or 3 sets of 20 reps 2 x day, straight knee and bent knee.	ELE group had sig. better pain reduction.	5/10

		-mean age 48 yrs		**Weeks 3-5** 3 sets of 15 reps, 2 x day with straight knee.3 x 1min slow speed step ups. **Weeks 6-12** 3 sets of 15 reps, 2 x day with straight knee.3 x 1min slow speed step ups. 3-4mins slow rope skipping, 3 sets of 20reps side jumps.		
Niesen-Vertommen SL[25] (1992)	RCT ELE Vs Concentric	-17 non-competitive athletic patients, various sports. -Symptoms >4 weeks -M+F -22-49 years	-Pain NRS Peak torque plantar-flexor	**ELE group:** 5 sets of 10 reps 1x day, 6 days/wk for 12 weeks. (Warm up, static stretch 20-30s, ELEs , static stretch 20-30s, ice 10-15min). **Concentric group:** 5 sets of 10 reps 1x day, 6 days/wk for 12 weeks. (Warm up, static stretch 20-30s, concentric exercises, static stretch 20-30s, ice 10-15min).	ELE showed larger increases in peak torque but not significant. ELE had a sig. reduction in pain ratings over 4 weeks.	3/10
Taping						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Firth, BL[41] (2010)	Within-subject design Kinesiotape Healthy Vs AT	-24 healthy participants (21-44 yrs) -24 AT patients (31-68 yrs) -M&F	-Pain VAS -1-leg hop distance	Kinesiotape tendon correction technique (5cm width) applied at an approx. tension of 50% and 75% over the Achilles tendon to the MTJ where the tension was 15%-25%	Kinesiotape had no effect on hop distance, pain or motorneuronal excitability in healthy or AT subjects and it is not a supported treatment	4/10
Smith, M. *et al.*	SCS Anti-pronation	-Soccer Player	-Distance and time until onset of pain during jogging	**Anti-pronation taping**: 3 reverse sixes, 38 mm	Anti-pronation taping resulted in 10 x increase	4/10

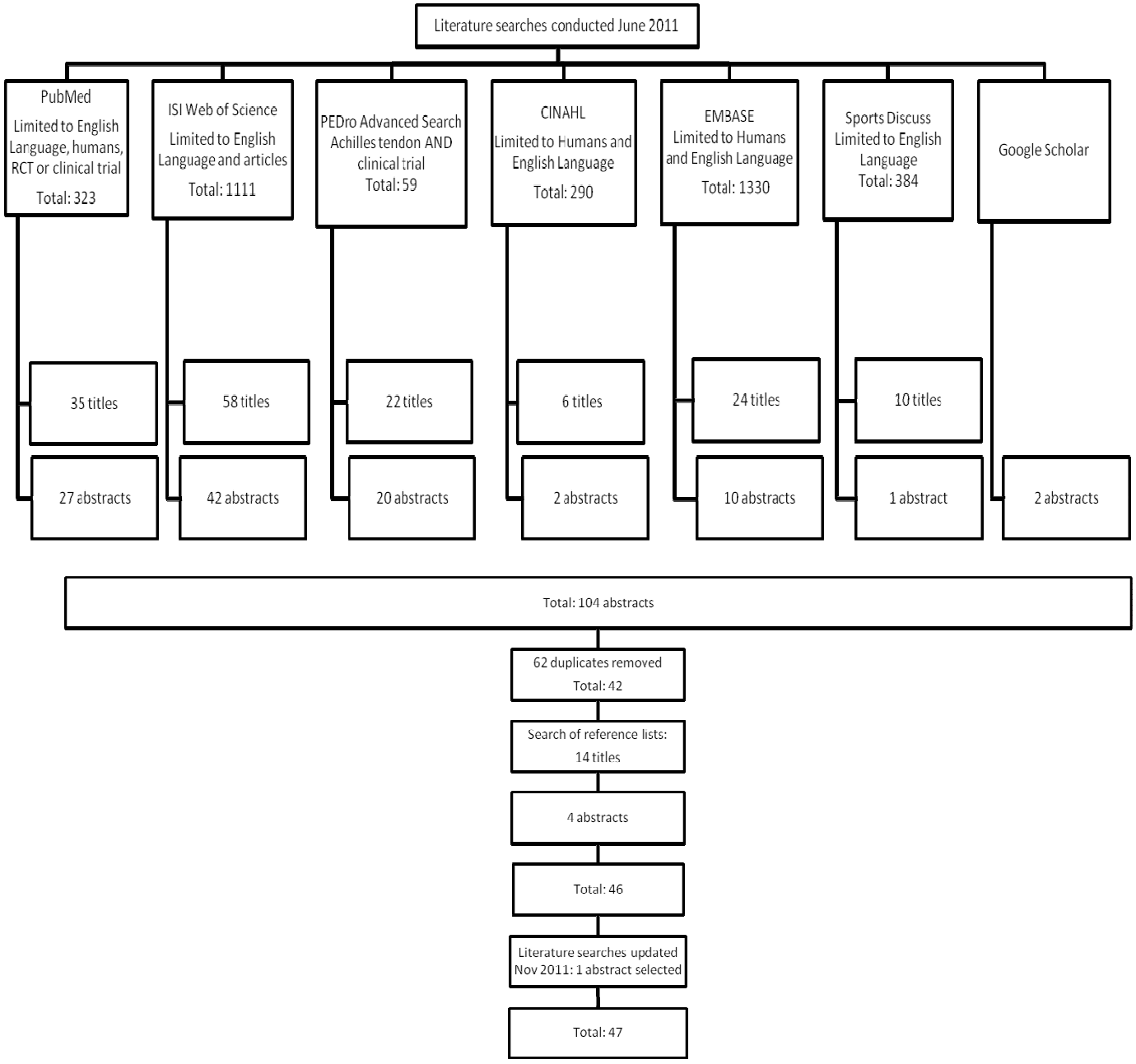
(2004)	taping assessment for orthotic prescription	-Male - 2 year history -32 year old	over a 23m runway, max 1150m. -VAS for perceived global treatment effect and pain.	Leukosport(a) zinc oxide adhesive tape, originating at the medial malleolus, coursing antero-laterally over the foot, under the mid-foot and finally up the medial side of the foot and distal leg. Repeated application over 3 consecutive days. **Orthoses:** 31 day follow up after the application of a bilateral ¾ length heat-mouldable orthotics. A 2° rear-foot varus pad and a 4° forefoot varus wedge were added to the right orthotic.	in pain-free jogging distance. Used as a favourable indication for orthotic prescription. Orthotic intervention reduced symptoms and improved function. Limited external validity due to SCS design.	

Soft-tissue Mobilisation						
Reference	**Study Design**	**Sample**	**Outcome Measures**	**Intervention and Dose**	**Results/Conclusions**	**PEDro Score**
Christenson, RE. (2007)	SCS Specific Soft Tissue Mobilisations	-Female club hockey player -5 year history of bilateral Achilles pain -39 years old	-VISA-A -VAS pain -Dorsiflexion ROM gastrocnemius length. -Lunge test- soleus length.	**Weeks 1-2**: 30s, 15 reps accessory SSTM with patient prone and Achilles in neutral. **Week 3**: 30s, 15 reps combined SSTM with Achilles on stretch. **Week 4**: 30s, 15 reps combined SSTM with isometric plantarflexion in plantargrade.	VISA-A score reached a maximum of a 100% by the end of the treatment phase which was maintained until 3-month follow-up. Sig. improvement in VAS from pre-treatment to the end of study. Sig. increase in soleus and gastrocnemius lengths	3/10

				Week 5-6: 3x 20 combined SSTM with through range plantarflexion against theraband.	Limited external validity due to SCS.	

ELE: Eccentric Loading Exercises; **ESE:** Eccentric Stretching Exercise; **ESWT**: Extracorporeal Shockwave Therapy; **TGTN**: Topical Glyceryl Trinitrate; **US**: Ultrasound; **NS**: Night Splint; **AHB**: AirHeel™ Brace; **ROM**: Range of Movement; **RCT**: Randomised Control Trial; **CCT**: Case Control Trial; **PCS**: Prospective Case Study; **SCS**: Single Case Study; **AT** :Achilles Tendinopathy; **M**: male; **F**: female; **VISA-A**: Victorian Institute of Sport Assessment-Achilles; **AHS**: Ankle Hindfoot Score; **VAS**: Visual Analogue Scale; **FILLA:** functional index of lower limb; **ROM**: Range of Movement; **NRS**: Numerical Rating Scale; **AOFAS**: American Orthopaedic Foot and Ankle Society; **FAOS**: Foot Ankle Outcome Score; **Sig:** significant.

Figure


Literature searches conducted June 2011
PubMed
Limited to English Language, humans, RCT or clinical trial
Total: 323
ISI Web of Science
Limited to English Language and articles
Total: 1111
PEDro Advanced Search
Achilles tendon AND clinical trial
Total: 59
CINAHL
Limited to Humans and English Language
Total: 290
EMBASE
Limited to Humans and English Language
Total: 1330
Sports Discuss
Limited to English Language
Total: 384
Google Scholar
35 titles
58 titles
22 titles
6 titles
24 titles
10 titles
27 abstracts
42 abstracts
20 abstracts
2 abstracts
10 abstracts
1 abstract
2 abstracts
Total: 104 abstracts
62 duplicates removed
Total: 42
Search of reference lists:
14 titles
4 abstracts
Total: 46
Literature searches updated
Nov 2011: 1 abstract selected
Total: 47

Appendix 1: Topic guide for interviews regarding treatment of Achilles tendinopathy.

Introduction and background factors

- Introduction of interviewer and the study.
- Confidentiality issues and interview procedure.
- How long interviewees have been practicing.
- Setting in which interviewees currently work, and associated caseload.
- Frequency of Achilles Tendinopathy seen in interviewee's clinical practice?

Treating Achilles Tendinopathy

- Interviewee beliefs regarding important aspects of treatment?
- Factors considered when treating Achilles Tendinopathy (introduce interview prompt: flowchart of modalities with varied levels of evidence).
- Perception of the strength of evidence for individual modalities. What else should be considered? Which would Interviewees choose and why (expand on clinical reasoning)?

Do other factors influence the treatment decision, how? Prompts to include:

- Patient factors - age, sport, mind-set/character
- Time taken to deliver treatment
- Pressure – from employer/patient for a certain treatment
- Cost factors
- Teaching of /experiential learning concerning certain treatments
- How do interviewees deal with prescribing a painful treatment?
- Do interviewees use different treatments or often the same?
- Have interviewees changed how they treat Achilles Tendinopathy from past practice, why?
- How do interviewees feel in regards to treating Achilles tendinopathy: confident, unsure - why?

Evidence Based Medicine (EBM)

- What do interviewees understand by the term EBM? Importance?
- How do interviewees incorporate EBM in clinical practise? Influence of teaching?
- Effect of EBM on Achilles Tendinopathy treatment?
- Barriers to practicing EBM?
- Any suggestions for improved evidence base and translation into clinical practise?

Closing Interview

- Summarise what has been discussed and why.
- Invite any questions and thank interviewees.

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Fees for participation in review activities such as data monitoring boards, etc	√		
Payment for writing or reviewing the manuscript	√		
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