

Nearly half of patients with chronic tendinopathy may have a neuropathic pain component, with significant differences seen between different tendon sites: a prospective cohort of more than 300 patients

Patrick C Wheeler ^{1,2}

To cite: Wheeler PC. Nearly half of patients with chronic tendinopathy may have a neuropathic pain component, with significant differences seen between different tendon sites: a prospective cohort of more than 300 patients. *BMJ Open Sport & Exercise Medicine* 2022;**8**:e001297. doi:10.1136/bmjsem-2021-001297

Accepted 7 July 2022

ABSTRACT

Objectives Identifying the prevalence of neuropathic pain components in patients with chronic tendinopathy conditions using the Self-Administered Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) questionnaire.

Methods Patients with chronic tendinopathy and ‘tendon-like’ conditions treated within a single hospital outpatient clinic specialising in tendinopathy were identified. Pain scores, plus global function patient-reported outcome measures (5-Level version of EuroQoL-5 Dimension and Musculoskeletal Health Questionnaire (MSK-HQ)), were completed and compared with the S-LANSS questionnaire

Results 341 suitable patients with chronic tendinopathy and potentially similar conditions were identified. Numbers: lateral elbow tendinopathy (39), greater trochanteric pain syndrome (GTPS; 112), patellar tendinopathy (11), non-insertional Achilles tendinopathy (40), insertional Achilles tendinopathy (39), plantar fasciopathy (100). 68% were female, with a mean age of 54.0±11.3 years and a mean symptom duration of 38.1±33.7 months.

There was a mean S-LANSS score of 11.4±6.4. Overall, 47% of patients scored 12 or greater points on S-LANSS, indicating the possible presence of neuropathic pain. The highest proportion was in patients with plantar fasciopathy (61%), the lowest in those with GTPS (33%). Weak correlations were found between the S-LANSS score and MSK-HQ score, the numerical rating scale (0–10) values for ‘average pain’ and for ‘worst pain’, but not with the MSK-HQ %health value.

Conclusion S-LANSS identified nearly half of patients with chronic tendinopathy as possibly having a neuropathic pain component. This is of unclear clinical significance but worth further study to see if/how this may relate to treatment outcomes. These results are from a single hospital clinic dealing with patients with chronic tendinopathy, without a control group or those with shorter symptom duration. However, this reinforces the probability of neuropathic pain components in at least some patients with chronic tendinopathy.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Tendinopathy conditions, and similar conditions such as plantar fasciitis, are common sources of chronic musculoskeletal pain, and it is recognised that some patients with tendinopathy may have a hyperalgesia or allodynia component to their pain. Some patients with some types of chronic pain will have a neuropathic pain component, but this has not yet been well studied in patients with chronic tendinopathy.

WHAT THIS STUDY ADDS

⇒ Nearly half of patients presented here with tendinopathy conditions or plantar fasciitis scored highly enough on Self-Administered Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) to indicate the possible presence of neuropathic pain. Differences were found between conditions. The highest prevalence was in those with plantar fasciopathy (61%) and the lowest in those with greater trochanteric pain syndrome (33%). The S-LANSS may be measuring novel areas of symptoms as only weak correlations were found between the S-LANSS score and the Musculoskeletal Health Questionnaire score, or the self-reported values for ‘average pain’ and ‘worst pain’.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study demonstrates that a high proportion of patients with tendinopathy and other conditions will score highly enough on the S-LANSS questionnaire to suggest the presence of neuropathic pain. Clinicians should be aware of the possibility of different pain types coexisting in patients. How this relates to overall treatment choices and outcomes as yet remains unknown.

INTRODUCTION

Tendinopathy conditions are relatively common musculoskeletal problems which can affect a wide range of tendons of the



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

¹Department of Sport and Exercise Medicine, University Hospitals of Leicester NHS Trust, Leicester, UK

²SSEHS, Loughborough University, Loughborough, UK

Correspondence to
Dr Patrick C Wheeler;
P.Wheeler@lboro.ac.uk

upper and lower limbs. Although symptoms are often self-limiting, with improvements typically seen over 6–12 months, 10%–35% of patients can be left with ongoing symptoms with impaired quality of life.^{1–3} This study investigates patients with five common tendinopathy conditions plus plantar fasciitis, which may share some properties with certain insertional tendinopathies, seeking to identify if patients may have neuropathic pain as a component of their chronic symptoms. The conditions investigated here all have certain similarities in their symptoms, pathophysiology and treatment options. These are all common conditions, most typically affecting people aged 40–60, affecting women slightly more than men, with several risk factors, including activity, or lack thereof, obesity, impaired lower limb flexibility and multiple genetic factors.^{2 4–8} There are some differences between tendon conditions. For example, patellar tendinopathy is less common in sedentary populations than other tendinopathies and is associated with individuals particularly involved in sports with sprinting or jumping/landing components.⁹ Patellar tendinopathy more commonly affects younger populations than some other tendon conditions, with one study having a mean onset of patellar tendinopathy symptoms at 23.8 years (range 16–47).¹⁰

For patients who fail to improve with rehabilitation alone, many treatment options are available to treat different tendinopathies, with many of the same treatments being offered to tendon pathologies of different anatomical locations.^{11–13} These different treatments may conceptually address nociceptive pain and/or functional impairments, although any molecular or structural effects of these interventions may remain unclear.¹⁴ Depending on the tendon location, these treatments may include tension night splints (TNS),^{15–17} guided injections—including high-volume image-guided injections (HVIGI)^{18–20} or autologous blood injections (ABI),^{21–24} extracorporeal shock wave therapy (ESWT)^{25–29} or surgery in recalcitrant cases.^{30–32}

The pathophysiology of tendinopathies has been extensively studied, with hypotheses moving from a primarily inflammatory-driven pathology to a degenerative mechanical ‘failed-healing’ model.^{33–35} However, inflammatory processes are present, particularly in the early stages,^{36 37} with some evidence demonstrating the persistence of chronic inflammation throughout established tendinopathies,³⁸ although the heterogeneity of studies means that firm conclusions are hard to draw.³⁹ These inflammatory processes may underlie the possible sources of different pains experienced in those with tendinopathy. While tendon pathology has been explored greatly, the issues of tendon pain remain far less clear, with one review previously stating that ‘*tendon pain remains an enigma*’³⁵ and describes the conundrum between local tendon pain with its ‘on/off’ characteristic seen in relation to loading that is seen in patients with tendinopathy, but also the example of what is described as ‘pathophysiological pain’ associated with changes within

the nervous system including hyperalgesia (where a stimulus evokes greater than usual pain) or allodynia (where a stimulus evokes pain in a situation where it normally would not).³⁵ The presence of this ‘pathophysiological pain’ is supported by a systematic review identifying the presence of hyperalgesia due to nervous tissue sensitisation in patients with tendinopathy across several different anatomical locations studied.⁴⁰

The concept of neuropathic pain is defined as ‘*pain arising as a direct consequence of a lesion or disease affecting the somatosensory system*’,^{41 42} and is associated with higher ratings of pain intensity, that is, hyperalgesia. The great heterogeneity between different classifications in studies makes drawing firm conclusions unreliable.⁴³ However, neuropathic pain may be present in 7%–10% of the general population,⁴⁴ and 50% of patients with chronic low back pain.^{45 46} The presence of specific neuropathic pain in patients with tendinopathy has been previously proposed,⁴⁷ as has the issue of increased, potentially centrally mediated, sensitisation in at least some types of tendinopathy.⁴⁰ However, the mechanisms, drivers and implications for this are not well understood. The presence of neovascularisation has been well established in various tendinopathies.¹⁴ Although several studies in recent years have identified that while this ingrowth of blood vessels may be common, its precise function remains unclear; and while hypotheses suggest these may be related to tendon hypoxia,⁴⁸ their presence poorly correlates with symptoms^{49–51} and neovessels are not necessarily changed by treatments.^{52 53} In addition to these neovessels, tendinopathy samples have been shown to have higher levels of several neurochemicals directly associated with pain including glutamate, substance P and lactate.^{54–56} The significance of these neurotransmitters remains unclear, but in addition to promoting angiogenesis, these may be triggering a ‘neuropathic-type’ pain by stimulation of the local nerve endings, as it is thought that the development of neovascularity may also be associated with the ingrowth of abnormal sensory nerve endings into tendinopathic tendons.^{57–60} This concept of neoneuralisation has not been explored in as much detail as the presence of neovascularisation, but this could potentially be a direct source of (neural) pain in patients with tendinopathies. Lastly, certain tendon structures are anatomically associated with neural structures (eg, plantar fascia and Baxter’s nerve, or common extensor elbow tendon and radial nerve branches). At least theoretically, these structures could be aggravated, even if not mechanically compressed in established tendinopathy, giving rise to pain out of the tendon structure itself.

The development of validated questionnaires has improved the diagnosis of neuropathic pain,⁶¹ and by identifying and addressing neuropathic pain components, improved outcomes may be possible.^{62 63} Preliminary work has sought to identify the presence of either neuropathic or centralised pain has been studied previously in populations with chronic tendinopathies

using painDETECT⁶⁴ and Central Sensitisation Inventory⁶⁵ questionnaires, respectively. These have shown that more than a quarter of patients score highly enough on these two questionnaires for these factors to be considered important. While neither of these two questionnaires are truly diagnostic of neuropathic or centralised pain, there is an ongoing consideration that many patients with chronic musculoskeletal pain of various causes will have pain that is not purely nociceptive in origin. The Self-administered version of the Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) aims to identify pain which is predominantly of neuropathic origin, based on responses to seven written questions.⁶⁶ The S-LANSS is easy for patients to self-administer, giving a simple total score, and a value of 12 or greater indicates the presence of neuropathic pain with a sensitivity of 70%–78%.^{66 67} This study seeks to identify the possible presence of neuropathic pain via the S-LANSS questionnaire in a population with chronic tendinopathy.

METHODS

Procedure logs were examined from a single UK hospital outpatient clinic, which has a regional reputation for managing patients with chronic tendinopathy. Patients who were being treated for several specific conditions were identified. These conditions were: lateral elbow tendinopathy, greater trochanteric pain syndrome (GTPS), patellar tendinopathy, Achilles tendinopathy (both insertional and non-insertional subtypes) and plantar fasciopathy. The treatments that these patients were to undertake included TNS devices, ESWT, HVIGI or ABI. The diagnosis of the condition was made by a single Hospital Consultant who specialises in musculoskeletal conditions and whose patient case mix is heavily slanted towards patients with pain from chronic tendinopathy, based on detailed clinical assessment, the exclusion of other differential diagnoses (including inflammatory joint disease, or local nerve entrapments mimicking/presenting with tendon pain) and the use of investigation modalities. All patients had symptoms that had failed to settle with simple conservative therapies, including a structured, progressive home rehabilitation programme typically involving progressive loading, non-provocative stretching and proprioception/balance training over a minimum of 3 months.

Before the treatments, and as a part of their routine care, patients completed baseline questionnaires about their pain and level of functioning, including a 0–10 numerical rating scale (NRS) value for their levels of ‘average pain’ and their ‘worst pain’. In addition, the Self-Administered Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS)^{66 67} was completed to seek to identify patients who may have neuropathic pain component to their symptoms. Additional validated questionnaires were completed to assess the level of function overall, which were the 5-Level version of Euro-Qol-5 Dimension questionnaire^{68 69} as a marker of global health and functioning and the Musculoskeletal Health

Questionnaire (MSK-HQ)^{70 71} as a measure of overall musculoskeletal functioning. Patient consent was gained at the time questionnaires were completed.

Statistical analysis

Anonymised data from the procedural logs were inputted into an Excel spreadsheet (MS Excel for Mac—current V.16.49) by the author. All data were anonymised before analysis and held/used in accordance with hospital procedures. From this, group values (including means, SDs and ranges) were calculated for the patient group as a whole and also for different conditions as subgroups. Most data collected (age, NRS and different patient-reported outcome measures (PROMs)) were scale data. This information was analysed through SPSS (V.27), and the Shapiro-Wilk test was performed to assess normality. Most data were not normally distributed; therefore, non-parametric testing was used, typically independent samples Mann-Whitney U test, Kruskal-Wallis test or Pearson χ^2 test as appropriate, with Spearman’s correlation used to assess relationships between variables. Statistical significance was set at $p < 0.05$. Missing value analysis was not undertaken.

Patient and public involvement

Patients were not directly involved in the design of this project. The concept of the project has come from numerous conversations with patients seen in the clinic with pain from chronic tendinopathy that appears to be more than ‘just mechanical pain’. Patients’ views were informally taken during consultations about the questionnaires that they were asked to complete and how they found these to complete. Patients were given feedback on their own results and how these compared with normative data for questionnaires.

RESULTS

Results were available for a total of 341 consecutive patients who attended this hospital clinic for several specified conditions and who had completed the S-LANSS questionnaire. All data collected were from November 2017 to February 2022. All patients had their diagnosis confirmed on imaging, typically ultrasound or MRI, which was used to confirm the clinical diagnosis and, where necessary, exclude differential diagnoses. Results were available for the following patients and tendon conditions: lateral elbow tendinopathy (n=39), GTPS (n=112), patellar tendinopathy (n=11), Achilles tendinopathy (total n=79, comprised non-insertional tendinopathy (n=40)/insertional tendinopathy (n=39)—listed separately hereafter) and plantar fasciopathy (n=100).

Patient demographics

The mean age of the patients was 54.0 ± 11.3 years (range: 22.2–84.6 years), and 68% of patients were female. The symptom duration was 38.1 ± 33.7 months (range: 6 months to 20 years). In keeping with inclusion criteria as stipulated in the Methods section, all patients had

Table 1 Patient demographics

	Age (years)	Gender (%male/%female)	Duration of symptoms (months)
All studied conditions (n=341)	54.0±11.3	32/68	38.1±33.7
Lateral elbow tendinopathy (n=39)	47.9±8.4	46/54	30.0±22.2
Greater trochanteric pain syndrome (n=112)	59.7±10.4	14/86	49.4±40.4
Patellar tendinopathy (n=11)	37.1±15.7	9/ 9	18.5±3.2
Non-insertional Achilles tendinopathy (n=40)	50.0±8.8	40/60	33.0±41.7
Insertional Achilles tendinopathy (n=39)	55.3±12.7	51/49	32.1±22.8
Plantar fasciopathy (n=100)	52.9±8.9	30/70	36.2±28.4
P value	<0.001*	<0.001*	<0.001*

Data are mean±SD.
*indicates p<0.05.

previously undertaken a rehabilitation programme of exercises over a minimum of 3 months, with progression as individually tolerated. The patient demographics for each condition are displayed in [table 1](#), with data displayed as mean±SD.

As displayed in [table 1](#), these demographic variables differed significantly between the different conditions studied (all p<0.001), which was predominately explained by the differences seen in the group seen with patellar tendinopathy (younger, a greater proportion of males, shorter duration of symptoms), compared with the remainder of the conditions studied. There were no statistical differences between the ages of male and female patients. Female patients had a slightly longer average duration of symptoms than male patients (40.4±35.9 vs 33.6±28.4, p=0.014) which may be explained by the low number of female patients in the patellar tendinopathy group compared with the larger groups with GTPS or plantar fasciitis.

Self-reported pain and general function scores

There was a mean±SD overall self-reported ‘average pain’ score of 6.5±1.7/10 and a ‘worst pain’ score of 8.1±1.5/10. There was a mean %health score from the EuroQol-5 Dimension (EQ-5D) questionnaire of 67%±20% and a mean MSK-HQ score of 32.8±9.1. No significant differences were found between the different conditions studied for any of these variables. These data are all displayed in [table 2](#) as mean±SD, with overall values for the cohort as a whole and values for the different conditions reported in separate rows.

There were differences found between genders for the self-reported 0–10 value for ‘average pain’ (male patients mean 6.1±1.7/female patients 6.6±1.7, p=0.006) and ‘worst pain’ (male patients 7.8±1.7/female patients

8.2±1.4, p=0.029), but not for the other variables studied ([table 2](#)). However, any differences may have been influenced by the different proportions of male/female patients with different conditions, as when subgroups were analysed, the difference was found to be non-significant and appears to be at least partially confounded by different proportions of male/female patients with the different conditions studied.

Possible neuropathic pain

The S-LANSS was used to assess for the presence of neuropathic pain, with a score of 12 or more suggesting that pain may be non-nociceptive in origin.⁶⁶ Overall, there was a mean score of 11.4±6.4 (range 0–24), with 47% of all patients questioned scoring 12 or higher. The values for the different conditions were found to be statistically significantly different (p<0.001), and the overall and the individual condition subscores are displayed in [table 2](#).

The proportion of patients scoring 12 or more varied greatly among the different tendon conditions studied, ranging from 33% for those with GTPS to 61% for those with plantar fasciopathy. This proportion was found to be statistically significantly different between the different conditions (p=0.004). These data are displayed in [table 2](#).

There were no statistically significant correlations between any of the patient demographics and the S-LANSS score: age (p=0.566), gender (p=0.133) and duration of symptoms (p=0.933). There were no statistically significant correlations seen between the S-LANSS score and the %health scale of the EQ-5D (p=0.063), but a weak correlation was identified between the S-LANSS score and the score from the MSK-HQ questionnaire ($r_s = -0.364$, p<0.01). Weak correlations were also found between both the self-rated measure of ‘average pain’ ($r_s = 0.229$, p<0.01) and ‘worst pain’ ($r_s = 0.242$, p<0.01),

Table 2 Self-reported PROMs

	Self-reported 'average pain' (0–10)	Self-reported 'worst pain' (0–10)	EQ-5D-5L (%health score)	MSK-HQ score	S-LANSS	% S-LANSS score of 12+
All studied conditions (n=341)	6.5±1.7	8.1±1.5	67±20	32.8±9.1	11.4±6.4	47
Lateral elbow tendinopathy (n=39)	6.2±1.3	8.0±1.2	65±20	33.3±8.5	11.7±5.7	49
Greater trochanteric pain syndrome (n=112)	6.5±1.8	8.2±1.5	66±21	30.8±8.5	9.1±5.6	33
Patellar tendinopathy (n=11)	5.7±1.8	7.3±2.5	73±14	35.8±9.1	9.9±3.4	36
Non-insertional Achilles tendinopathy (n=40)	6.2±2.0	7.9±1.6	68±17	34.8±8.7	11.9±5.7	48
Insertional Achilles tendinopathy (n=39)	6.7±2.0	8.2±1.6	71±20	34.7±7.6	11.9±6.7	49
Plantar fasciopathy (n=100)	6.6±1.8	8.2±1.6	67±20	33.0±10.3	13.6±7.2	61
P value	0.320	0.618	0.544	0.114	<0.001*	0.004*

Data are mean±SD.

*indicates $p < 0.05$.

EQ-5D-5L, 5-Level version of EuroQol-5 Dimension; MSK-HQ, Musculoskeletal Health Questionnaire; PROM, patient-reported outcome measure; S-LANSS, Self-Administered Leeds Assessment of Neuropathic Symptoms and Signs.

although these latter two may be confounded by a strong correlation found between the self-reported measures of 'average pain' and 'worst pain' ($r_s = 0.749$, $p < 0.01$).

DISCUSSION

This project has investigated the possible prevalence of neuropathic components of pain in patients presenting with different recalcitrant tendinopathy and similar conditions to this single outpatient department for further treatment. While the presence of neuropathic pain in patients with tendinopathy was proposed more than 10 years ago,⁴⁷ this is the first publication which has sought to identify the prevalence of neuropathic pain in patients with chronic tendinopathy with this validated questionnaire. While neuropathic pain should not be diagnosed from a questionnaire alone, this project has demonstrated that nearly one-half of patients overall score highly enough on the S-LANSS questionnaire to suggest a neuropathic component to their symptoms may be present. Previous work assessing for the presence of neuropathic pain in patients with tendinopathy using a different questionnaire (painDETECT) identified that neuropathic pain may be likely in 28% of patients with chronic tendinopathy, and in another 29%, the score was equivocal.⁶⁴ Additional work has suggested that about a quarter of patients with chronic tendinopathy may have some element of central sensitisation.⁶⁵ Should such patients exist, avenues for reducing the hyperalgesia and/or allodynia components to their pain should be explored to optimise care pathways.⁷²

There were statistically significant differences found in the study between different conditions. Although the levels of self-reported pain were the same between the

different conditions, nearly twice as many patients with plantar fasciopathy scored 12 or more with the S-LANSS (61%), suggesting the possible presence of neuropathic pain compared with those with GTPS (33%). The reasons for this difference, and the clinical significance of this, remain unknown from this study. There were no differences seen in those with insertional Achilles tendinopathy compared with those with non-insertional Achilles tendinopathy, nor any difference between tendons of the upper and lower limbs (table 2).

The high proportion of patients with plantar fasciitis scoring highly enough to be regarded as having neuropathic pain remains a potential outlier from the other conditions in this study. The adjacent location of neural structures to the plantar fascia origin (ie, Baxter's nerve⁷³) could at least hypothetically provide a potential source for pain if this is aggravated, even if this is not compressed, that is, no denervation was seen on MRI for the abductor digiti minimi muscles supplied by this nerve. It is recognised that there may be cases of plantar fasciopathy which overlap with Baxter's nerve compression⁷⁴ which in this study were identified as having plantar fasciopathy and treated as such. Alternatively, it may be that the deep fascia structure that comprises the plantar fascia is in some way more susceptible to the development of neuropathic pain than the insertion of tendons into bone seen in GTPS or insertional Achilles tendinopathy, or another mechanism may be underlying this difference seen. The cause for the difference between conditions and any implications from this difference is unknown from this study.

This questionnaire has not (yet) been specifically validated in patients with chronic tendinopathy and



similar conditions. The wording of this questionnaire could in some way lead to false positives in this population. However, the questions relate to general symptoms of paraesthesia, colour change, allodynia (evoked pain from a stimulus not thought to be painful) and hyperalgesia (pain greater than the level of stimuli should cause).⁶⁶ There are no obvious questions that would seem to be candidates for creating false positives in this patient population, but validating the questionnaire in this population could be the focus of further research.

This study only investigated patients with six different clinical conditions, and the number of patients with patellar tendinopathy in this study was relatively small (n=11), and this is a recognised limitation of this data set. It is also important to highlight that the clinical population studied here was not necessarily typical of the general population suffering from tendinopathy, and instead was a population with chronic symptoms, with the majority having symptoms for at least 3 years' duration, and who had all undergone previous treatments including a rehabilitation programme already. It is unclear from these data whether the patients may have been resistant to other treatments due to the presence of a neuropathic pain component (as assessed by the S-LANSS score) or whether this may have developed due to the chronicity of the symptoms, or if the two may be unrelated. It is noted that there was no significant correlation between the S-LANSS score and the duration of symptoms in this cohort, but this was in the presence of a long duration of symptoms, and it is not known if similar findings will be identified in a cohort with much shorter duration of symptoms, which would need to be the focus of further study.

Lastly, the clinical significance of those scoring highly on the S-LANSS questionnaire remains unclear. In this study, only weak correlations were found between the S-LANSS questionnaire and either the self-reported measures of 'average' or 'worst' pain or the validated MSK-HQ PROM. This suggests that potentially the S-LANSS is measuring something different from these other questions and potentially flagging a specific cohort of patients within the heterogeneous wider groups with the same condition. This questionnaire may be flagging a specific group of patients with neuropathic pain who could benefit from more targeted interventions. This study does not identify whether there was a specific prognostic value from the S-LANSS score and whether this could be used to identify responders/non-responders to treatments, but if this could be shown to have such a value, then this could potentially lead to individualised pathways of care.

In summary, the S-LANSS is a patient-rated questionnaire that may have value in the management pathways of patients with recalcitrant lower limb tendinopathies. This study suggests that nearly one-half of all patients with chronic tendinopathy score highly enough to indicate the presence of neuropathic pain, based on an identified threshold score from previously published

work, and that this varied significantly between different tendinopathy conditions. Several weak correlations were identified between the S-LANSS score and some of the other variables assessed in this study. However, the clinical implications of the S-LANSS scores in this clinical population remain unknown at this time and need further research, particularly to assess any potential role in predicting response to treatment.

Acknowledgements The author offers their thanks to the members of their departmental staff (both clinical and administrative) who have continued to support the author in a number of ways in their ongoing research and clinical work, of which this project is a part.

Contributors This manuscript has a single author. No other people are credited with coauthorship.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests The author is an associate editor for BMJ Open SEM. This manuscript has been prepared outside of this role.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Research involving human subjects complied with all relevant national regulations and institutional policies and is in accordance with the tenets of the Helsinki Declaration (as amended in 2013). This specific project used anonymised data already collected as a part of routine healthcare with appropriate consent in place. Patients were advised that these questions were intended to seek to better understand their pain and the impact that their symptoms had on their quality of life, and they were free to choose not to complete the questionnaires if they wished. This specific project, which compares anonymised data across different conditions, is a part of a wider ongoing body of work examining different aspects of chronic tendinopathy, which is fully registered with the hospital trust authorities. No additional data were required. This was not an interventional study, and clinical care was not altered based on this project. This was reviewed and registered by the employing hospital trust as a quality improvement project (registration number: 11976) and is reported under the normal mechanisms in place. This specific project does not fulfil the research criteria as stipulated by the UK Health Research Authority (HRA). Therefore, formal independent NHS REC approvals were not required for this project.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are included with this submission in tables. All data are available from the author on reasonable request.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Patrick C Wheeler <http://orcid.org/0000-0003-2509-9767>

REFERENCES

- 1 Paavola M, Kannus P, Paakkala T, *et al*. Long-Term prognosis of patients with Achilles tendinopathy. An observational 8-year follow-up study. *Am J Sports Med* 2000;28:634–42.
- 2 Lievense A, Bierma-Zeinstra S, Schouten B, *et al*. Prognosis of trochanteric pain in primary care. *Br J Gen Pract* 2005;55:199–204.
- 3 DiGiovanni BF, Nawoczenski DA, Lintal ME, *et al*. Tissue-Specific plantar fascia-stretching exercise enhances outcomes in patients with chronic heel pain. A prospective, randomized study. *J Bone Joint Surg Am* 2003;85:1270–7.
- 4 Williams BS, Cohen SP. Greater trochanteric pain syndrome: a review of anatomy, diagnosis and treatment. *Anesth Analg* 2009;108:1662–70.

- 5 Buchbinder R. Plantar fasciitis. *N Engl J Med Overseas Ed* 2004;350:2159–66.
- 6 Alfredson H. Chronic midportion Achilles tendinopathy: an update on research and treatment. *Clin Sports Med* 2003;22:727–41.
- 7 de Jonge S, van den Berg C, de Vos RJ, et al. Incidence of midportion Achilles tendinopathy in the general population. *Br J Sports Med* 2011;45:1026–8.
- 8 Orchard J. Plantar fasciitis. *BMJ* 2012;345:e6603.
- 9 Peers KHE, Lysens RJJ. Patellar tendinopathy in athletes. *Sports Medicine* 2005;35:71–87.
- 10 Cook JL, Khan KM, Harcourt PR, et al. A cross sectional study of 100 athletes with jumper's knee managed conservatively and surgically. The Victorian Institute of sport tendon Study Group. *Br J Sports Med* 1997;31:332–6.
- 11 van der Vliet AC, Winters M, Weir A, et al. Which treatment is most effective for patients with Achilles tendinopathy? A living systematic review with network meta-analysis of 29 randomised controlled trials. *Br J Sports Med* 2021;55:249–56.
- 12 Challoumas D, Pedret C, Biddle M, et al. Management of Patellar tendinopathy: a systematic review and network meta-analysis of randomised studies. *BMJ Open Sport Exerc Med* 2021;7:e001110.
- 13 Ladurner A, Fitzpatrick J, O'Donnell JM. Treatment of gluteal tendinopathy: a systematic review and Stage-Adjusted treatment recommendation. *Orthop J Sports Med* 2021;9:232596712110168.
- 14 Darrieutort-Laffite C, Soslowsky LJ, Le Goff B. Molecular and structural effects of percutaneous interventions in chronic Achilles tendinopathy. *Int J Mol Sci* 2020;21:7000.
- 15 Lee WCC, Wong WY, Kung E, et al. Effectiveness of adjustable dorsiflexion night splint in combination with accommodative foot orthosis on plantar fasciitis. *J Rehabil Res Dev* 2012;49:1557–64.
- 16 Wheeler PC. The effectiveness and tolerability of tension night splints for the treatment of patients with chronic plantar fasciitis – a case-series study. *Int Musculoskelet Med* 2014;36:130–6.
- 17 Wheeler PC. The addition of a tension night splint to a structured home rehabilitation programme in patients with chronic plantar fasciitis does not lead to significant additional benefits in either pain, function or flexibility: a single-blinded randomised controlled trial. *BMJ Open Sport Exerc Med* 2017;3:e000234.
- 18 Wheeler PC. The use of high-volume image-guided injections (HVIGI) for Achilles tendinopathy – a case series and pilot study. *Int Musculoskelet Med* 2014;36:96–103.
- 19 Wheeler PC, Mahadevan D, Bhatt R, et al. A comparison of two different high-volume image-guided injection procedures for patients with chronic Noninsertional Achilles tendinopathy: a pragmatic retrospective cohort study. *J Foot Ankle Surg* 2016;55:976–9.
- 20 Wheeler PC, Tattersall C. Novel interventions for recalcitrant Achilles tendinopathy: benefits seen following high-volume image-guided injection or extracorporeal shockwave Therapy-A prospective cohort study. *Clin J Sport Med* 2020;30:14–19.
- 21 Wheeler P. Autologous blood injections for chronic plantar fasciitis – a pilot case-series study shows promising results. *Int Musculoskelet Med* 2013;35:3–7.
- 22 Gross CE, Hsu AR, Chahal J, et al. Injectable treatments for noninsertional Achilles tendinosis: a systematic review. *Foot Ankle Int* 2013;34:619–28.
- 23 Wheeler PC. The role of autologous blood injections in the treatment for patients with chronic plantar fasciitis – a case series and longer-term follow-up. *Int Musculoskelet Med* 2015;37:47–53.
- 24 Wheeler PC, Dudson C. Similar benefits seen after radial extracorporeal shockwave therapy or autologous blood injection in patients with chronic plantar Fasciitis-A retrospective cohort study. *Clin J Sport Med* 2022;32:e107–15.
- 25 Mani-Babu S, Morrissey D, Waugh C, et al. The effectiveness of extracorporeal shock wave therapy in lower limb tendinopathy: a systematic review. *Am J Sports Med* 2015;43:752–61.
- 26 Wheeler PC, Tattersall C. The role of extra-corporeal shockwave therapy (ESWT) plus rehabilitation for patients with chronic greater trochanteric pain syndrome (GTPS): a case series assessing effects on pain, sleep quality, activity, and functioning. *Int Musculoskelet Med* 2016;38:27–35.
- 27 Wheeler PC, Tattersall C. Extracorporeal shockwave therapy plus rehabilitation for patients with chronic plantar fasciitis might reduce pain and improve function but still not lead to increased activity: a Case-Series study with multiple outcome measures. *J Foot Ankle Surg* 2018;57:339–45.
- 28 Wheeler PC, Therapy E-CS. Extracorporeal shock wave therapy plus rehabilitation for Insertional and Noninsertional Achilles tendinopathy shows good results across a range of domains of function. *J Foot Ankle Surg* 2019;58:617–22.
- 29 Wheeler PC, Dudson C, Calver R, et al. Three sessions of radial-Extra-Corporeal Shockwave Therapy (rESWT) gives no additional benefit over “minimal-dose” rESWT for patients with chronic greater trochanteric pain syndrome (GTPS), a double-blinded randomised controlled trial. *Clin J Sport Med* 2022;32:e7–18.
- 30 Wheeler P, Boyd K, Shipton M. Surgery for patients with recalcitrant plantar fasciitis: good results at short-, medium-, and long-term follow-up. *Orthop J Sports Med* 2014;2:2325967114527901.
- 31 Wiegerinck JL, Kerkhoffs GM, van Sterkenburg MN, et al. Treatment for insertional Achilles tendinopathy: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2013;21:1345–55.
- 32 Voos JE, Rudzki JR, Shindle MK, et al. Arthroscopic anatomy and surgical techniques for peritrochanteric space disorders in the hip. *Arthroscopy* 2007;23:1246.e1–5.
- 33 Abate M, Silbernagel KG, Siljeholm C, et al. Pathogenesis of tendinopathies: inflammation or degeneration? *Arthritis Res Ther* 2009;11:235.
- 34 Cook JL, Purdam CR. Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *Br J Sports Med* 2009;43:409–16.
- 35 Rio E, Moseley L, Purdam C, et al. The pain of tendinopathy: physiological or pathophysiological? *Sports Med* 2014;44:9–23.
- 36 D'Addona A, Maffulli N, Formisano S, et al. Inflammation in tendinopathy. *Surgeon* 2017;15:297–302.
- 37 Millar NL, Murrell GAC, McInnes IB. Inflammatory mechanisms in tendinopathy – towards translation. *Nat Rev Rheumatol* 2017;13:110.
- 38 Dakin SG, Newton J, Martinez FO, et al. Chronic inflammation is a feature of Achilles tendinopathy and rupture. *Br J Sports Med* 2018;52:359–67.
- 39 Jomaa G, Kwan C-K, Fu S-C, et al. A systematic review of inflammatory cells and markers in human tendinopathy. *BMC Musculoskelet Disord* 2020;21:78.
- 40 Plinsinga ML, Brink MS, Vicenzino B, et al. Evidence of nervous system sensitization in commonly presenting and persistent painful Tendinopathies: a systematic review. *J Orthop Sports Phys Ther* 2015;45:864–75.
- 41 Finnerup NB, Haroutounian S, Kamerman P, et al. Neuropathic pain: an updated grading system for research and clinical practice. *Pain* 2016;157:1599–606.
- 42 IASP. International Association for the Study of Pain - Terminology. Available: <https://www.iasp-pain.org/resources/terminology/> [Accessed 5 Apr 2022].
- 43 van Hecke O, Austin SK, Khan RA, et al. Neuropathic pain in the general population: a systematic review of epidemiological studies. *Pain* 2014;155:654–62.
- 44 Colloca L, Ludman T, Bouhassira D, et al. Neuropathic pain. *Nat Rev Dis Primers* 2017;3:17002.
- 45 Gudala K, Bansal D, Vatte R, et al. High prevalence of neuropathic pain component in patients with low back pain: evidence from meta-analysis. *Pain Physician* 2017;20:343–52.
- 46 Heraughty M, Ridehalgh C. Sensory descriptors which identify neuropathic pain mechanisms in low back pain: a systematic review. *Curr Med Res Opin* 2020;36:1695–706.
- 47 Webborn ADJ. Novel approaches to tendinopathy. *Disabil Rehabil* 2008;30:1572–7.
- 48 Järvinen TA. Neovascularisation in tendinopathy: from eradication to stabilisation? *Br J Sports Med* 2020;54:1–2.
- 49 De Marchi A, Pozza S, Cenna E, et al. In Achilles tendinopathy, the neovascularization, detected by contrast-enhanced ultrasound (CEUS), is abundant but not related to symptoms. *Knee Surg Sports Traumatol Arthrosc* 2018;26:2051–8.
- 50 Jaworski Łukasz, Zabrzyńska M, Klimaszewska-Wisniewska A, et al. Advances in microscopic studies of tendinopathy: literature review and current trends, with special reference to neovascularization process. *J Clin Med* 2022;11:1572.
- 51 De Jonge S, Warnaars JLF, De Vos RJ, et al. Relationship between neovascularization and clinical severity in Achilles tendinopathy in 556 paired measurements. *Scand J Med Sci Sports* 2014;24:773–8.
- 52 van Oosten CCM, van der Vliet AC, van Veldhoven PLJ, et al. Do high-volume injections affect the ultrasonographic neovascularization in chronic Achilles tendinopathy? A randomized placebo-controlled clinical trial. *Clinical Journal of Sport Medicine* 2021; Publish Ahead of Print.
- 53 Santamato A, Beatrice R, Micello MF, et al. Power Doppler ultrasound findings before and after focused extracorporeal shock wave therapy for Achilles tendinopathy: a pilot study on pain reduction and neovascularization effect. *Ultrasound Med Biol* 2019;45:1316–23.
- 54 Alfredson H, Thorsen K, Lorentzon R. In situ microdialysis in tendon tissue: high levels of glutamate, but not prostaglandin E2 in chronic Achilles tendon pain. *Knee Surg Sports Traumatol Arthrosc* 1999;7:378–81.



- 55 Merkel MFR, Hellsten Y, Magnusson SP, *et al.* Tendon blood flow, angiogenesis, and tendinopathy pathogenesis. *Transl Sports Med* 2021;4:756–71.
- 56 Alfredson H, Bjur D, Thorsen K, *et al.* High intratendinous lactate levels in painful chronic Achilles tendinosis. An investigation using microdialysis technique. *J Orthop Res* 2002;20:934–8.
- 57 Dean BJF, Franklin SL, Carr AJ. The peripheral neuronal phenotype is important in the pathogenesis of painful human tendinopathy: a systematic review. *Clin Orthop Relat Res* 2013;471:3036–46.
- 58 Lian Øystein, Dahl J, Ackermann PW, *et al.* Pronociceptive and antinociceptive neuromediators in patellar tendinopathy. *Am J Sports Med* 2006;34:1801–8.
- 59 Alfredson H, Öhberg L, Forsgren S. Is vasculo-neural ingrowth the cause of pain in chronic Achilles tendinosis? *Knee Surg Sports Traumatol Arthrosc* 2003;11:334–8.
- 60 Ackermann PW, Salo PT, Hart DA. Neuronal pathways in tendon healing. *Front Biosci* 2009;14:5165–87.
- 61 Attal N, Bouhassira D, Baron R. Diagnosis and assessment of neuropathic pain through questionnaires. *Lancet Neurol* 2018;17:456–66.
- 62 Baron R, Binder A, Wasner G. Neuropathic pain: diagnosis, pathophysiological mechanisms, and treatment. *Lancet Neurol* 2010;9:807–19.
- 63 Finnerup NB, Sindrup SH, Jensen TS. The evidence for pharmacological treatment of neuropathic pain. *Pain* 2010;150:573–81.
- 64 Wheeler PC. Neuropathic pain may be common in chronic lower limb tendinopathy: a prospective cohort study. *Br J Pain* 2017;11:16–22.
- 65 Wheeler PC. Up to a quarter of patients with certain chronic recalcitrant tendinopathies may have central sensitisation: a prospective cohort of more than 300 patients. *Br J Pain* 2019;13:137–44.
- 66 Bennett MI, Smith BH, Torrance N, *et al.* The S-LANSS score for identifying pain of predominantly neuropathic origin: validation for use in clinical and postal research. *J Pain* 2005;6:149–58.
- 67 Weingarten TN, Watson JC, Hooten WM, *et al.* Validation of the S-LANSS in the community setting. *Pain* 2007;132:189–94.
- 68 Janssen MF, Pickard AS, Golicki D, *et al.* Measurement properties of the EQ-5D-5L compared to the EQ-5D-3L across eight patient groups: a multi-country study. *Qual Life Res* 2013;22:1717–27.
- 69 Herdman M, Gudex C, Lloyd A, *et al.* Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res* 2011;20:1727–36.
- 70 Hill JC, Kang S, Benedetto E, *et al.* Development and initial cohort validation of the arthritis research UK musculoskeletal health questionnaire (MSK-HQ) for use across musculoskeletal care pathways. *BMJ Open* 2016;6:e012331.
- 71 Hill J, Kang S, Benedetto E, *et al.* Development of the musculoskeletal health questionnaire (MSK-HQ) for use in different conditions and different healthcare pathways. *Value in Health* 2016;19:A544.
- 72 Nijs J, George SZ, Clauw DJ, *et al.* Central sensitisation in chronic pain conditions: latest discoveries and their potential for precision medicine. *Lancet Rheumatol* 2021;3:e383–92.
- 73 Moroni S, Zwierzina M, Starke V, *et al.* Clinical-anatomic mapping of the tarsal tunnel with regard to Baxter's neuropathy in recalcitrant heel pain syndrome: part I. *Surg Radiol Anat* 2019;41:29–41.
- 74 Jaring MRF, Khan AZ, Livingstone JA, *et al.* A case of bilateral Baxter's neuropathy secondary to plantar fasciitis. *J Foot Ankle Surg* 2019;58:771–4.