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Are conventional treatments effective for patients with chronic plantar fasciopathy? – A review of the literature

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Background

Plantar fasciopathy (PF) is a common pathology with an incidence of 10% in adults [1,2]. With a 7.9% incidence in runners, PF is the third most common overuse running injury with an estimated financial burden of $376 million per year in the United States of America [3,4]. Despite a wealth of research PF is still considered a difficult condition to treat.

Currently, it is not clear which intervention, physiotherapy, podiatry, pharmacological treatment, or surgery best stimulate a healing response. While there is no consensus among orthopaedic clinicians regarding the best treatment for PF, many authors recommend exhausting conventional treatment options typical of Physiotherapy and Podiatry (exercise, orthotics, manual therapy, tape, acupuncture, night splints) before proceeding to extracorporeal shockwave therapy (ESWT), injection therapy or surgery [5]. The advantages of a conventional approach include lower associated costs and less risk of complications such as infection, rupture, fat pad atrophy, osteomyelitis or nerve damage when compared to injection or surgery [6,7].

Symptoms of PF are plantar heel pain on first steps after waking, pain on sustained loading and pain on palpation of the medial calcaneal tubercle [8]. Historically, this condition has been referred to as plantar fasciitis which would suggest an inflammatory pathology. This may be inappropriate as the underlying pathophysiology of this condition is not fully understood. Structural changes consistent with degeneration [9], associated plantar intrinsic muscle atrophy [10,11], softening of the plantar fascia [12], hypertonic muscle patterns [13] and a failed healing response have been reported rather than inflammation. The term plantar fasciopathy is therefore more reflective of this condition.

A number of narrative and systematic reviews have been conducted regarding conventional treatments for PF. A search of MEDLINE, AMED, EMBASE, Cochrane and PEDro databases between 2007 and September 2017 identified six systematic reviews of conservative treatments for plantar fasciopathy. These included tape [14, 15], stretching [16], acupuncture [17] and orthotics [18]. One review considered a limited range of modalities [19]. To the authors' knowledge no review has exclusively looked at high quality evidence (randomised controlled trials) of conservative treatments alone. As PF is considered difficult to treat, interventions that are considered in the normal scope of Physiotherapy and Podiatry are usually recommended as the first line of management, the aim of this systematic review was to evaluate the efficacy of these treatments.

Materials and method

Data source

The electronic databases of MEDLINE, EMBASE, Cochrane and PEDro were searched. The keywords used for the search are presented in table 1. The inclusion and exclusion criteria for the review are listed in table 2. The period for the review was from the beginning of the databases until March 2018.

Study identification

Two reviewers (AL and AMH) independently reviewed all titles and abstracts that were identified against the eligibility criteria. Full-text manuscripts were requested when eligibility could not be assessed from the abstract and title.

Data extraction

The reviewer (AL) performed data extraction for each eligible paper. Data extraction included population characteristics (sample size, mean age, gender, and duration of symptoms), clinical diagnostic criteria,

Table 1. Keywords used in the search, "$" indicating a truncated search term

1	plantar fasciitis OR plantar fasciosis OR plantar fasciopathy OR heel pain
2	Tap$ OR electro$ OR la$er OR LLLT OR cryo$ OR heat OR stretch$ OR physiotherap$ OR exercise$ OR physical therap$ OR podiatr$ OR ultrasound OR orthotic$ OR insole$ OR night splint$ OR acupuncture
3	Exploded terms: plantar fasciitis, physical therapy modalities, exercise therapy, orthotic devices, acupuncture
	1 AND (2 OR 3)

Table 2. Eligibility criteria

Inclusion	Exclusion
Randomised Controlled Trials	Aged under 18 years old
English Language	Use of injection therapies
Treatments considered by author consensus to be within the normal scope of practice for Physiotherapists or Podiatrists	Use of ESWT
Chronic PF (duration of symptoms over 3 months) (if this was not explicitly stated studies were included)	Use of invasive techniques
Human subjects	Pilot studies

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Table 3. Data extraction included population characteristics (sample size, mean age, gender, and duration of symptoms), clinical diagnostic criteria, investigations, treatment interventions, outcomes, results, follow-up period, country of study and athletic population (involvement in sport)

Author year	Modality	Country of study	Mean age, SD, range	No. subjects, No. fascias	Gender male / female	Population sporting / sedentary	Minimum symptom duration / mean (months)	Diagnosis Radiological or clinical	Outcome Measures	Treatments	Main between groups result	Follow-up (months)	PEDro score /10 (* If calculated by authors)
Alotaibi 2015	Exercise	USA	49.3, NR, NR	44 / NR	22 / 22	NR	NR / 12	clinically	VAS PPT ADL FAAM U/S thickness	4 weeks monophasic pulsed current (MPC) vs MPC and plantar fascia stretch	Nil difference	1	5
DiGiovanni 2003	Exercise	USA	46, 7.5, 23-60	82 / 82	24 / 58	NR	10 / NR	Clinically	Modified FFI	Calf stretch vs plantar fascia stretch	Plantar stretch better than calf stretch	2	4
DiGiovanni 2006	Exercise	USA	NR	66 / 66	NR	NR	10 / NR	clinically	Modified FFI	Calf stretch vs plantar fascia stretch	Nil difference	24	3
Engkananuwat 2017	exercise	Thailand	49.8, 6.5, NR	50 / 50	18 / 32	NR	1 / 7.25	clinically	VAS-FA ROM PPT VAS	Achilles stretch Vs Plantar fascia stretch	Improved PPT in plantar stretch at 1 month only	1 3	8 *
Kamonseki 2016	Exercise	Brazil	45.8, NR, NR	83 / 83	18 / 65	NR	1 / 18.3	clinically	VAS FAOS SEBT	Stretching Vs Stretching & foot strength Vs Stretch & foot & hip strength	Nil difference	2	6 *
Radford 2007	Exercise	Australia	50, 11, NR	92 / 92	36 / 56	NR	1 / 13 (median)	clinically	FHSQ VAS 1st step	Sham U/S & stretch vs Sham U/S	Nil difference	2 weeks	8 *
Rathleff 2014	Exercise	Denmark	46, 8, NR	48 / 48	16 / 32	NR	03-Jul	Clinically & ultrasound	FFI U/S thickness	Insoles and stretches vs insoles and strength training	Strength training better at 3 months only	1 3 6 12	6 *
Abigail 2017	Manual therapy	India	NR, NR, NR	30 / 30	NR	NR	NR / NR	clinically	NPRS FFI	U/S Vs U/S & frictions	Manual better	10 days	7 *
Ajimsha 2014	Manual therapy	Qatar	41.5, NR, NR	65 / 65	17 / 48	sedentary	NR / 4	clinically	FFI PPT	Myofascial release vs sham U/S	Myofascial better	3	6
Cleland 2009	Manual therapy	USA and New Zealand	48.4, 8.7, NR	54 / 54	Oct-44	NR	NR / 8.7	clinically	LEFS FAAM NRS	U/S, ice and iontophoresis vs soft tissue and rear foot mobs with mobs to hip, knee, ankle, foot as required	Manual better than electrotherapy	1 6	7*
Dimou 2004	Manual therapy	United Kingdom	NR, NR, 23-59	20/20	13-Jul	NR	NR / 23.2	clinically	PSW PSL FSP PPT HPL	foot and ankle joint mobilisations with stretches Vs insoles	Mobs better at 1 month No difference at 2 months	1 2	6*
Ghafoor 2016	Manual therapy	Pakistan	47.4, 9.1, NR	60 / 60	Dec-48	NR	NR	clinically	FAAM LEFS NRS	standard vs standard & soft tissue and joint mobs to the foot and calf	Manual better	3 weeks 1.5	6

Am 2010	Manual therapy	India	35.5, NR, NR	60 / 60	35 / 25	NR	3 / NR	clinically	FFI VAS	Standard vs positional release	No difference	10 days	4
Kuhar 2007	Manual Therapy	India	43, NR, 28-62	30 / 30	15 / 15	NR	4.5 / NR	clinically	VAS FFI	Standard (U/S, cryotherapy, strength) Vs Standard * myofascial release	Myofascial release better	10 days	7 *
Renan-Ordine 2011	Manual therapy	Brazil	44, 10, NR	60 / 60	15 / 45	NR	NR / 4.6	clinically	Modified SF-36 PPT	Stretching vs stretching & trigger point therapy (TPT)	TPT better	1	7*
Shashua 2015	Manual therapy	Israel	51.3, 12.6, 23-73	56 / 56	14 / 32	NR	NR / 5.91	clinically	NRS LEFS PPT ROM	Standard vs standard with sub-talar, talocrural, mid-foot mobs	No difference	2 ½	8
Wynne 2006	Manual therapy	USA	NR, NR, 20-66	20 / 20	Apr-16	NR	NR	Clinically	P&DQ Stretch reflex H reflex	Osteopathic counterstrain vs placebo	Counterstrain better immediately, no difference at 6 days	Immediate 6 days	2
Basford 1998	electrotherapy	USA	NR, NR, 26-64	28 / 31	Jul-24	NR	1 / median 6.5	clinically	Distance VAS Windlass	LLLT vs placebo	No difference	1	7
Brook 2012	electrotherapy	USA	52, NR, NR	70 / 70	18 / 52	NR	NR / 12.4	Clinically and x-ray	VAS	Pulsed radiofrequency electromagnetic field therapy vs placebo	PRFE better than placebo	1 week	9*
Cinar 2017	electrotherapy	Turkey	45.5, 9.9,	49 / 49	Sep-40	NR	1 / NR	clinically	AOFAS 12-minute walk VAS	Insoles and stretch Vs Insole, stretch, LLLT	LLLT better at 3 months only	3 weeks 3 months	7 *
Crawford 1996	electrotherapy	United Kingdom	NR, NR, NR	19 / 26	15-Nov	NR	NR / NR	Clinically X-ray	VAS	U/S Vs Sham U/S	No difference	1	8 *
Gudeman 1997	electrotherapy	USA	42.1, 13.6, NR	36 / 40	Jul-32	NR	NR	Clinically and x-ray	MFS	Iontophoresis and standard vs placebo and standard	Iontophoresis better than placebo at 2 weeks, no difference at 6 weeks	½ 1.5	6
Kiritsi 2010	electrotherapy	Greece	40, NR, NR	25, 25	15-Oct	NR	1.5 / NR	Clinically and U/S	VAS U/S thickness	LLLT vs placebo	LLLT better	1.5	7
Marcias 2015	electrotherapy	USA	56.7, NR, 31 -75	69 / 69	17 / 42	NR	3 / 12.2	Clinically U/S	FSP FFI U/S thickness	LLLT vs placebo	VAS better for LLLT at 2 months only	1 week 2 weeks 3 weeks 1 1.5 2	9*
Osbourne 2006	electrotherapy	Australia	51.1, 10.6, NR	31 / 42	28 / 34	NR	NR / 11.8	Clinically X-ray U/S	VAS stiffness	Iontophoresis with: Acetic acid Dexamethasone placebo	Acetic acid better	½	9*
Straton 2009	electrotherapy	USA	41, NR, NR	26 / 26	NR	NR	¼ / 3.5	clinically	ADL FAAM VAS	Standard vs standard with low frequency electrical stimulation	No difference	1 3	5

Hyland 2006	tape	USA	39.5, NR, NR	41 / 41	21 / 20	NR	NR	clinically	PSFS,	Stretching vs tape vs sham tape vs control	Tape better for VAS	1 week	4
									VAS 1st step				
Khatavkar 2015	tape	India	31.5, NR, NR	30 / 30	Sep-21	NR	NR / NR	Clinically	VAS	Intrinsic foot exercises & cryotherapy	Tape better all measures	1 week	7 *
								U/S	U/S thickness	Vs			
									PFPS	kinesiotape			
Radford 2006	tape	Australia	50, 14, NR	92 / 92	37 / 55	NR	1 / 9 (median)	clinically	FHSQ,	Sham U/S and tape	Tape better for 1st step VAS only	1 week	9*
									VAS 1st step	Vs			
										Sham U/s			
Tsai 2010	tape	Taiwan	NR, NR, NR	52 / 57	19 / 33	NR	Less than 10 / 4	Clinically	FFI	U/S & TENS vs U/S TENS & kinesiotape	Tape better	1 week	5
								U/S	McGill				
									U/S thickness				
Vishal 2010	tape	India	38.4, NR, NR	60 / 60	35 / 25	NR	NR	clinically	VAS	Stretch, U/S & calcaneal tape	Plantar fascia tape better than calcaneal	1 week	4
									FFI	Vs			
										Stretch, U/S and plantar fascia tape			
El Salam 2010	Tape and orthotics	Saudi Arabia	53, NR, NR	30 / 30	23-Jul	NR	1 / NR	clinically	VAS average,	Standard and tape	Orthotic better than tape	3 weeks	7
									MFPDS	Vs			
										Standard and pre-fab orthotic			
Baldassin 2009	Orthotics	Brazil	47.4, NR, NR	105 / 105	25 / 80	sedentary	NR / 17.9	clinically	Modified FFI	Pre-fabricated vs custom insole	No difference	2	8
									Pressure pain				
Fong 2012	Orthotics	China	50.6, 5.3, NR	15 / 15	03-Dec	NR	NR / 11	clinically	VAS first step	Barefoot vs normal shoes with flat insoles (NSF) vs normal shoes with custom insoles (NSC)	All better than barefoot,	immediate	6*
									Plantar pressure in-shoe	Vs rocker shoe flat insoles (RSF) vs rocker shoe custom insole (RSC)			
											Rocker better than normal		
											Custom insoles better than flat		
Landorf 2006	Orthotics	Australia	48.3, NR, NR	135 / NR	46 / 89	NR	NR / 12 (median)	clinically	FHSQ	Orthotics:	3 months	3	9
										Sham	Custom & pre-fab better than sham	12	
										Vs	No difference custom vs pre-fab.		
										Pre-fab	12 months		
										Vs	No difference		
										Custom			
Oliviera 2015	Orthotics	Brazil	50.5, NR, NR	74 / NR	Aug-66	NR	NR / 4	clinically	VAS	Custom Insole	Improved 6 min walk for custom.	3	8
									6 min walk test	Vs	No other difference	6	
									FFI	Flat control insole			
									FHSQ				
									SF-36				
									Likert				

Pfeffer 1999	Orthotics	USA	NR, NR, 23-81	200 / 200	65 / 135	NR	NR	clinically	FFI	Stretch vs Stretch silicone heel pad vs Stretch felt insert vs Stretch heel cup vs Stretch custom	Pre-fab better than custom or stretching alone	2	5
Ryan 2009	Orthotics	Canada	40.3, NR, NR	20 / 21	NR	NR	Jun-21	Clinically and x-ray	VAS	Ultra-flexible shoe Vs Conventional running shoe	No difference	3 6	4
Winemiller 2003	Orthotics	USA	41.3, NR, NR	101 / 101	21 / 80	NR	1 / 100	Clinically	Likert VAS	Magnetised insoles vs placebo insoles	No difference	2	10
Wrobel 2015	Orthotics	USA	49.6, 12.7, 23-75	69 / 69	26 / 43	NR	Less than 12 / 5.2	X-ray and U/S	FFI FSP SF-36 Physical activity	Orthotics: Sham Vs Pre-fab Vs Custom	Custom orthotic increased activity. No other difference	3	9*
Batt 1996	Night Splint	USA	45.7, NR, 20-74	32 / 33	Nov-21	NR	NR / 12.7	Clinically and X-ray	VAS Number self reported as healed	Standard vs standard with night splint	standard 6/17 healed at mean 8.8 weeks night splint 16/16 healed at mean 12.5 weeks	3	4
Lee 2012	Night Splint	Hong Kong	44, NR, 31-54	28 / 28	Feb-26	NR	NR / 7.3	clinically	FFI VAS	Orthosis Vs orthosis and night splint	No difference	½ 2	6*
Martin 2001	Night Splint	USA	47, NR, 21-70	193 / 193	68 / 125	NR	NR / 5	clinically	VAS	Custom orthotic vs pre-fab orthotic Vs night splint	no difference	3	3
Powell 1998	Night Splint	USA	48, NR, 22-72	37 / 49	Aug-29	NR	6 / NR	Clinically and X-Ray	MCSS AHRS	Night splint for 4 weeks (crossover)	Better with night splint	6	2
Probe 1999	Night Splint	USA	46, 11, NR	116 / 146	35 / 81	NR	NR / 5	Clinically & X-Ray	Pain 4-point scale SF-36	stretches, piroxicam vs stretches, piroxicam and night splint	No difference	1 2 3	4
Roos 2006	Night Splint	Sweden	46, NR, 22-63	34 / 34	Jul-27	40% "active in sports"	>1 / 4.2	clinically	FAOS	Custom Orthosis vs night splint vs both	no difference	3	6
Wheeler 2017	Night splints	United Kingdom	52.1, NR, NR	40 / 40	Nov-29	NR	4 / 25.2	Clinically & either U/S or MRI	FFI MOXFQ EQ-5D-5L HADS PSQI	Exercises Vs Exercises and night splint	Nil difference	1.5 3	7 *
Cotchett 2014	acupuncture	Australia	56, 122, NR	84 / 84	44 / 40	NR	Jan-14	clinically	VAS FHSQ	Dry needling vs sham dry needling	Dry needling better	1 ½	9

Kumnerddee 2012	acupuncture	Thailand	53, NR, NR	24 / 24	NR	NR	6 / NR	clinically	VAS FFI	Conventional vs conventional and electro acupuncture	Electro acupuncture better	1 ½	6
Zhang 2011	acupuncture	Hong Kong	48, NR, NR	53 / 53	14 / 39	NR	Mar-34	clinically	Pressure pain VAS	Acupuncture vs control acupuncture	Acupuncture better at 1 & 6 month	1 3 6	8

Outcome Measures: AHRS – Ankle Hind foot Rating Scale, DF ROM – dorsiflexion range of movement, FAAM – Foot and Ankle Ability Measure, FAOS – Foot And Ankle Outcome Score, FFI – Foot Function Index, FHSQ – Foot Health Status Questionnaire, FSP – First Step Pain, HPL – Heel pain Leisure, LEFS – Lower Extremity Functional Scale, McGill – McGill Medlnack pain questionnaire, MCSS – Mayo Clinical Scoring System, MFDPS – Manchester foot pain & disability Schedule, MFS – Maryland Foot Score, NRS – Numerical Rating Scale, P&DQ – Pain and Dysfunction Questionnaire, PFPS – Plantar fasciopathy pain / Disability Scale score, PPT – Pressure Pain Threshold, PSFS – Patient Specific Functional Scale, PSL – Pain Scale Least, PSW – Pain Scale Worst, SF-36 – Medical Outcomes Study Short Form-36, VAS – Visual Analogue Scale

F/u – follow-up, LLLT – low light laser therapy, Mobs – mobilisations, MRI – Magnetic resonance imaging, NR – not reported, NSAIDs – Non-Steroidal Anti-Inflammatory Drugs, Rx – Treatment, U/S – ultrasound

investigations, treatment interventions, outcomes, results, follow-up period, country of study and athletic population (involvement in sport) (Table 3).

Critical appraisal

The methodological quality of each article was assessed using the Physiotherapy Evidence Database (PEDro) score. This scoring system was selected as it was developed to assess the internal validity of randomised controlled trials (RCTs) investigating Physiotherapy modalities [20]. The PEDro score is an 11-point scale rating the internal validity of a study's method. It was developed using a Delphi approach with one measure of external validity not contributing to the total score [20]. Reliability and validity of this approach have been established [21,22] where a PEDro score of 0 represents a study with poor internal validity and a score of 10 a high internal validity. When a study had yet to be reviewed by PEDro this was performed by the authors, indicated by * on table 3. Using the PEDro score, studies were considered excellent quality (≥8/10), good quality (5-7/10) or poor quality (≤4/10) [21,23]. The quality and number of studies were combined for each modality to establish the strength of supporting evidence against criteria proposed by van Tulder, *et al.* [24] (Table 4).

Table 4. Criteria for strength of evidence (RCTs – randomised controlled trials, CCTs – case-control trials)

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

Results

Search strategy

A total of 1941 articles were identified by the initial search, following removal of duplicates 1102 remained for review of which 1034 studies were excluded from their title and abstracts against the inclusion and exclusion criteria leaving 68 articles requiring review of the full-texts. Five articles were unobtainable, in these cases the lead authors were contacted via e-mail. One author replied and was included; the remaining four did not reply and therefore were not included in the review. Seven studies were excluded based on the eligibility criteria (two were not RCTs, three reported mean symptom duration of less than 3 months, one used non-steroidal anti-inflammatory medication, one used cortisone injections). In seven studies only the abstracts had been published leaving 50 eligible articles (Figure 1). A meta-analysis could not be performed due to the extensive heterogeneity in methodology, follow-up and outcome measures used. As a result, an in-depth narrative review was conducted.

Population characteristics

The gender distribution of 45 studies (not reported by 5 studies) was 67% females and 33% males with a mean age (reported in 41 studies) of 46.9 years, a range of 20 – 81 and mean symptom duration of 16.0 months (reported in 26). This is similar to a recent meta-analysis of ESWT for PF with a 65% : 35% female to male ratio, mean age of 50.7 years and mean duration of 16.2 months based on 9 studies and 935 patients [25].

The 50 studies were conducted in 19 countries (USA n=17, Australia n=5, India n=5, Brazil n=4, United Kingdom n=3, Hong Kong n=2, Thailand n=2 and n=1 for China, Canada, Denmark, Greece, Israel, Pakistan, Qatar, Saudi Arabia, Sweden, Taiwan and Turkey with a multi-national study in New Zealand and USA). Racial differences in foot morphology have been demonstrated [26] potentially affecting the ability to generalise these results to a specific population group.

Clinical diagnosis and investigations

To the authors' knowledge, no clinical tests have been investigated for accuracy in diagnosing PF so the reliability and validity of the tests used within the studies are not known. Only 8 studies employed imaging to support the diagnosis, 7 used ultrasound [27-33] and one study used either ultrasound or MRI [34].

Critical appraisal

Findings of the critical appraisal are presented in table 3. Whilst only the highest level of evidence, namely RCTs, were chosen for this review widespread methodological limitations were seen. Only studies considered high quality (PEDro ≥8/10) or medium-quality (PEDro 5-7/10) were included in the final analysis however all studies were included in table 3 for completeness. Sample sizes of studies were frequently small with a range of 15 to 200 patients and a mean sample size of 59 patients. The internal validity as assessed by the PEDro score showed substantial variability ranging from 2/10 to 10/10 with a mean of 6/10. Only 15 of the 50 studies achieved a high PEDro score (≥8/10) and a further 24 achieved a medium PEDro score (5-7/10).

Treatments

The review identified 50 RCTs that tested the efficacy of conservative treatments for PF. Seven categories of treatments were identified; exercise (n=7), manual treatment, (n=10), electrotherapy (n=9), tape (n=6), orthotics (n=8), night splints (n=7), and acupuncture (n=3).

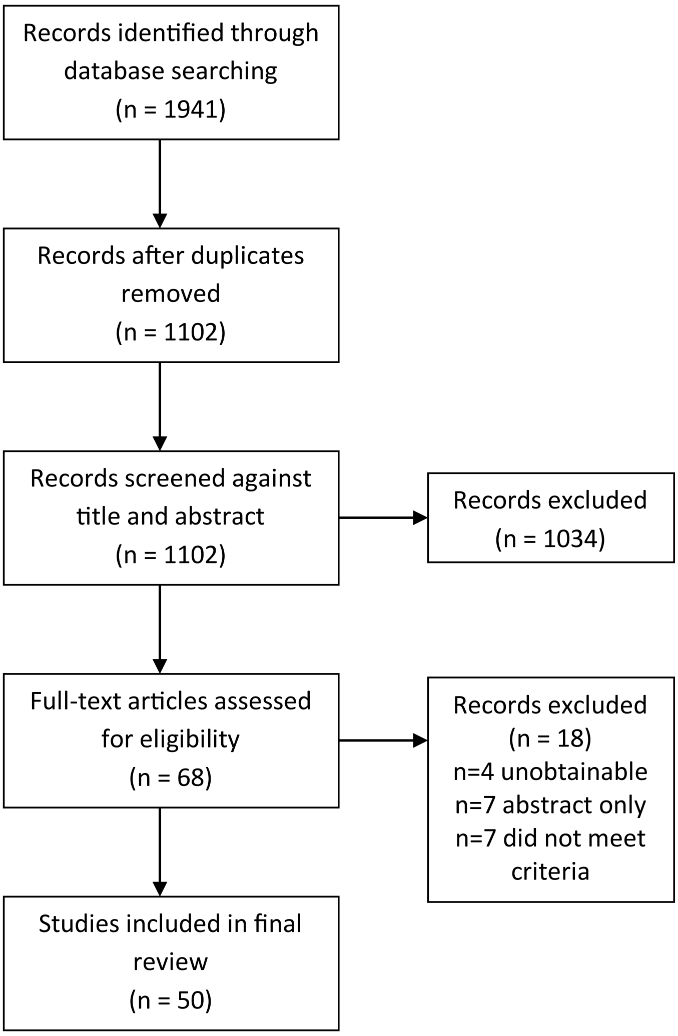

Figure 1. Flow chart showing the search results

Exercise (n=7)

Seven studies investigated exercise therapy; five were medium or high quality. Five reviewed the efficacy of stretching [35-39] and two reviewed strengthening [30,40]. Two studies found short term benefits of exercise, DiGiovanni, *et al.* [35] found a plantar fascia specific stretch to be more effective than a calf stretch after eight weeks treatment and Rathleff, *et al.* [30] found strengthening (weighted heel raises with maximum metatarsal phalangeal joint dorsiflexion) superior to stretching at 12 weeks. Kamonseki, *et al.* [40] found no benefit of adding either foot or foot and hip strengthening to stretching. Whilst a within-group benefit was demonstrated with exercise, no one exercise was found to be superior to another beyond 3 months.

When evidence was combined based on the criteria proposed by van Tulder, *et al.* (table 4) stretching was not useful in either the short term defined as ≤1 month (strong evidence) or the mid-term defined as <6 months (moderate evidence). Strengthening was not useful in the short or long term defined as ≥6 months (moderate and limited evidence respectively) with conflicting evidence in the mid-term.

Manual therapy (n=10)

Ten studies investigated the efficacy of manual therapy techniques including joint mobilisations, soft tissue mobilisation or a combination of both [41-50]. Different manual therapy techniques were investigated in each study and inconsistencies in results were demonstrated. Joint mobilisations were investigated in two studies [41, 48] with neither finding benefit at 2 months. Soft tissue therapy was investigated in six studies finding no benefit of positional release or counterstrain techniques [42,45] however benefit was shown with local frictions at 10 days [50], myofascial release at 10 days and 3 months [43,47] and trigger point therapy at 1 month [46]. A combination of soft tissue and joint techniques were supported by both investigating studies. Joint mobilisations to the foot with soft tissue mobilisations to the foot and calf were beneficial at 3 and 6 weeks [49]. Soft tissue and rear-foot joint mobilisations combined, as required, with mobilisations to the hip, knee and ankle joints were beneficial at 4 weeks and 6 months [44].

When evidence was combined joint mobilisations have limited support in the short term with moderate evidence of no effect in the mid-term. Soft tissue mobilisations were useful in the short term (moderate evidence) and mid-term (limited evidence). A combination of joint and soft tissue techniques were beneficial during the short, mid and long-term (moderate evidence).

Electrotherapy (n= 9)

Nine articles investigated five different forms of electrotherapy including Low Light Laser Therapy (LLLT), Pulsed Radiofrequency Electromagnetic Field Therapy (PRFE), Low Frequency Electrical Stimulation (LFES), ultrasound and iontophoresis. LLLT was investigated in four studies with conflicting results [51, 28, 32, 52]. A PRFE device worn for 7 days was significantly better than a placebo at day 7 [53]. LFES was superior at 4 weeks however at 3 months there was no benefit over a placebo [54]. Ultrasound was of no benefit at 1 month [55]. Comparing iontophoresis with three different chemicals (acetic acid, dexamethasone or placebo) found acetic acid significantly more effective for pain relief and stiffness at 2 weeks [27]. Iontophoresis was significantly better than placebo iontophoresis at 2 weeks but not at 6 weeks [56].

When evidence was combined LLLT was not effective in the short term (strong evidence) however was effective in the mid-term (strong evidence). PRFE was effective in the short term only (moderate evidence), there was conflicting evidence for iontophoresis in the short-term and not effective in mid-term (limited evidence).

Tape (n=5)

Five studies investigated the efficacy of tape [57-59,29,31]. All studies found a significant improvement at a one week follow up, however the tape was applied differently in each study. Non-stretch tape applied to either the longitudinal arch or calcaneus was better than sham [57,58]. Non-stretch tape was more effective when applied to the longitudinal arch than the calcaneus [59]. Kinesio-tape on the calf and plantar surface was more effective than electrotherapy [29] and when applied to the plantar surface was more effective than intrinsic foot exercises [31].

Tape vs orthotics (n=1)

Non-stretch tape was compared to a pre-fabricated (pre-fab) orthotics for 3 weeks with the orthotic more effective [60]. The location of taping was not described.

When evidence was combined tape was effective in the short term (strong evidence) regardless of how applied. There was also limited evidence that an orthotic was more effective than tape in the short-term.

Orthotics (n=8)

Comparing shoe type, one study found both rocker shoes and normal shoes better than barefoot with a rocker better than normal shoes with immediate re-testing only [61], a second study found no difference between a normal running shoe and an ultra-flexible shoe [62].

Studies comparing pre-fabricated (pre-fab) and custom insoles found conflicting results. No difference in any outcomes were found at 2, 3 and 12 months [63,64]. In contrast a pre-fab was better than a custom insole at 2 months [65]; Oliveira, *et al.* and Wrobel, *et al.* found a custom insole increased activity only at 3 and 6 months respectively with no effect on pain [66,33]. On immediate re-testing only a custom insole was better than a flat insole [61].

Studies investigating a "true" insole (either a custom or pre-fab) against a sham insole, found a true insole better at 3 months with no difference at 12 months [63] and a magnetised insole was no better than a placebo insole [67].

When evidence was combined shoe type was effective in the short-term only (limited evidence). Comparing a custom and pre-fab insole there was conflicting evidence in the short term, no difference in the mid-term (strong evidence) or long term (moderate evidence). A "true" orthotic was more effective in the mid-term (moderate evidence) with no difference in the long term (moderate evidence).

Night splints (n=7)

Night splints were investigated in seven studies with conflicting results. No difference was found at 12 weeks between custom orthoses, night splints and a combination of both [68]. Similarly, no difference was detected between custom orthoses, prefabricated orthoses and night splints at 12 weeks [69]. No benefit was found by adding a night splint to calf stretches and NSAIDs at 4, 8 and 12 weeks [70]. No benefit was found by adding a night splint either to an exercise programme [34] or to an orthotic [71]. In contrast, 1 month of night splint use led to a significant improvement that was maintained at 6 months [72]. Also, night splinting gave a significant improvement when added to ibuprofen, calf stretches and a heel cushion at 12 weeks [73]. The quality of studies in this group was the lowest with a mean PEDro of 4/10 and only 3 studies of medium or high quality.

When evidence was combined night splints were ineffective in both the short term (limited evidence) and mid-term (moderate evidence)

Acupuncture (n=3)

Three studies investigated acupuncture [74], electro-acupuncture [75] or dry needling [76]. All demonstrated positive results although all had a relatively short follow-up period. 6 weeks of dry needling to myofascial trigger points was significantly more effective than sham dry needling at 6 and 12 weeks [76]. A specific acupuncture point (PC 7) was more effective than a control point (LI 4) at both 1- and 6-month follow-up [74]. A 5-week multimodal approach (analgesics, shoe modification, stretches to calf and plantar fascia) was compared to the same approach and twice weekly electro-acupuncture. After 6 weeks the electro-acupuncture group were significantly better [75]. The acupuncture group had the highest methodological quality with a mean PEDro of 7.7/10.

When evidence was combined acupuncture was effective in the short term (moderate evidence), mid-term (strong evidence) and long term (moderate evidence).

Discussion

The aim of this review was to determine the efficacy of conservative modalities considered by author consensus to be within the normal scope of practice for Physiotherapists and Podiatrists treating plantar fasciopathy, termed conventional treatment. This review included only RCTs with their internal validity assessed against the PEDro tool. A range of treatments are currently used reflecting either the difficulty in treating this condition, the poor efficacy of current treatments, or a lack of understanding of this pathology.

ESWT has become more common as an intervention for plantar fasciopathy and tendinopathies. Despite the increase in use, ESWT is still not widely available due to the high equipment cost and additional training required to deliver this modality. A literature search of ESWT for PF identified four recent meta-analyses of RCTs [77-80]. Due to these recent high-level reviews and its use as a second line modality (after initial conservative treatment has failed) ESWT was not included in this review by author consensus.

The studies included in this review highlight a lack of high-quality research in conventional modalities for this pathology. Only 15 of the 50 included studies were deemed of high quality (PEDro ≥8/10). A common limitation of the studies was a short follow-up period with only 3 studies following their patients for one year or longer and two studies only investigating an immediate effect of treatment. No data were provided in any study on symptom recurrence.

This review demonstrated inconsistencies in the ability of conventional treatments to reduce pain and function with no single treatment being found to be superior at all time points. No adverse outcomes were reported for stretching or strengthening programs. In contrast, long-term use of orthotics was found to reduce intrinsic plantar muscle strength [81] which has been linked to PF [10,11].

Only one study reported their patient group included a sporting population [68]. No study exclusively examined the athletic population, so this group is under-represented both in this review and the current literature. Differences in the rate, repetition and duration of plantar fascia loading are expected between, for example, high-mileage runners and sedentary groups. As such the findings of this review should be applied to this group with caution.

No study has investigated the accuracy (reliability and validity) of clinical diagnostic tests for PF. It was therefore surprising to find that only 8 of the 50 studies employed radiological imaging to support their clinical diagnosis (US n=7, US or MRI n=1). Findings by McMillan, *et al.* [82] demonstrated a fascial thickening greater than 4mm and hypoechoic areas detected on US were 100 and 200 times respectively more likely to confirm the presence of PF. A number of differential diagnoses for PF exist including Baxter's nerve compression, tarsal tunnel syndrome, calcaneal stress fracture and plantar fascia rupture [83,84] with 15% of plantar heel pain suggested to be neural in origin [85]. It is therefore possible that in the trials that did not use radiological investigations patients may have been included who did not have PF. The validity of these studies is therefore questionable, and this should be considered in any interpretation.

A meta-analysis of included studies was not possible as 22 different outcome measures were used. The most common outcome measures were versions of the Visual Analogue Scale / Numerical Rating Scale (n=7). The substantial variation in outcome measures as well as the lack of validated instruments for assessing the efficiency of treatments for PF makes this an area of priority for future research.

Efficacy of individual treatments is difficult to conclude as only 14 studies assessed interventions against a placebo and 16 against a control intervention. The remaining 20 studies compared two or more interventions. When interventions are compared without a control, between-group and within-group differences are difficult to interpret. For example, Rathleff, *et al.* [30] compared stretching to strengthening with no between group difference at 1-year follow-up however both groups showed a within group difference. Either this may represent the natural time course of PF or that both treatments were equally effective.

Moderate or strong evidence from medium and high quality RCTs (PEDro ≥5) were collated. Supported modalities in the short-term (up to 1 month) were manual therapy, PRFE, tape and acupuncture. In the mid-term (less than 6 months) manual therapy, LLLT, an orthotic and acupuncture were beneficial. In the long term (6 months or longer) only manual therapy and acupuncture were supported. Using strong evidence only, a very limited number of modalities were supported. In the short term only tape was supported, in mid-term LLLT and acupuncture were supported, no modalities were supported in the long term based on strong evidence alone.

Interestingly, a survey of 457 UK Physiotherapists' and Podiatrists' perception of the most effective treatment for PF does not correlate with the findings of this review [86]. Both professions advocated calf stretches, Podiatrists advocated custom orthotics, arch support orthotics and night splints, while Physiotherapists advocated electrotherapy (specifically ultrasound), manual therapy and acupuncture.

Limitations

This systematic review was limited by the inability to perform a meta-analysis as 22 different outcome measures were used. Only RCTs were included in the review to enhance the validity of conclusion however robust cohort studies may have added to the evidence base available to review.

Conclusion

This review has highlighted no major safety concerns of the conventional treatments for plantar fasciopathy. The research is generally of low to medium quality with poor sample sizes and short follow-up making definitive conclusions difficult to formulate. Based on strong evidence alone tape was supported in the short term (≤1 month), low light laser therapy (LLLT) and acupuncture were supported in the mid-term (<6 months) and there was no strong evidence for any modality in the long term (≥6 months). Further well-designed multi-centre RCTs that include accurate clinical diagnostic criteria as well as valid and reliable outcome measures are required to help guide therapists to the optimal conservative treatments for this condition.

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